

March 2, 1971

J. N. BULLA ET AL

3,566,683

NEEDLE PULL TESTER

Filed April 1, 1969

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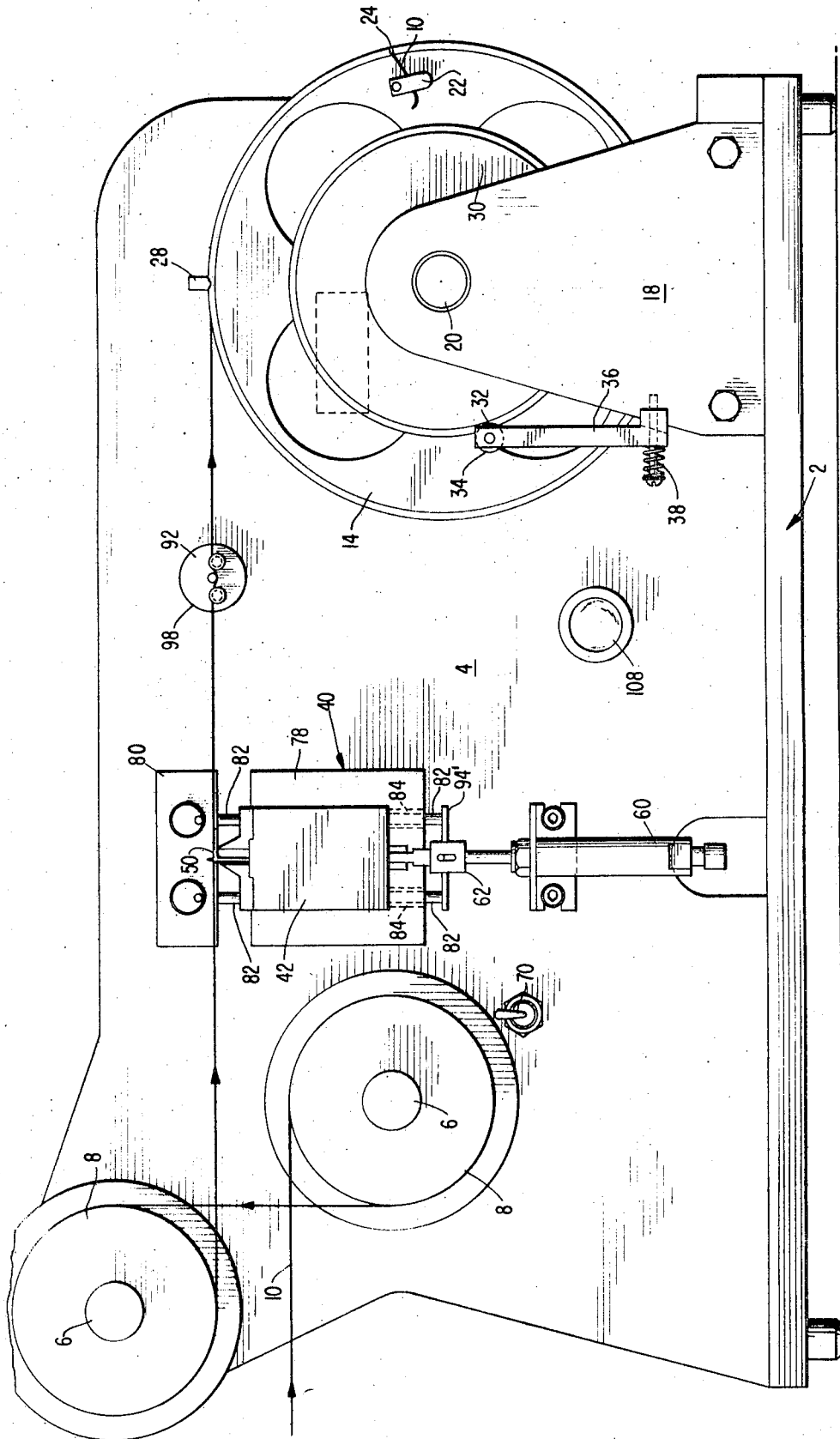


FIG 1

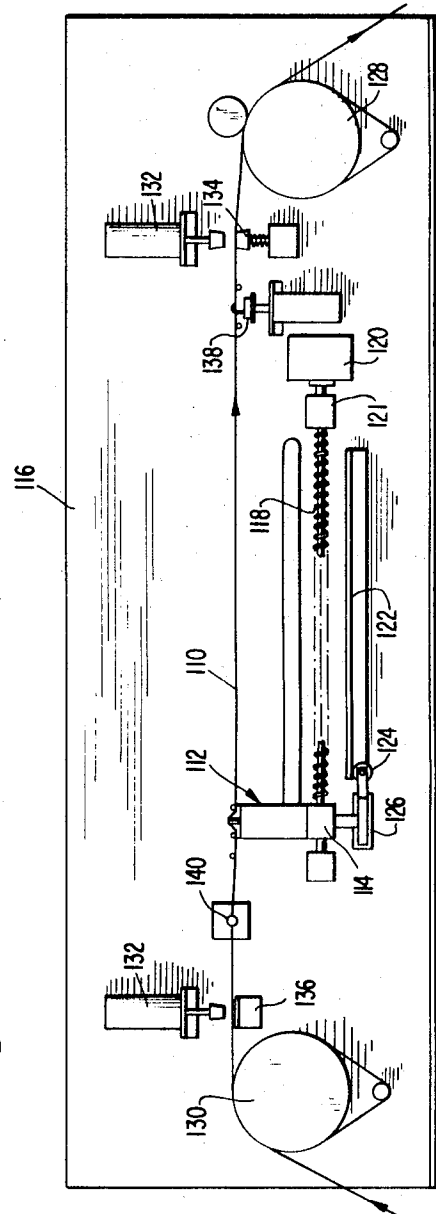
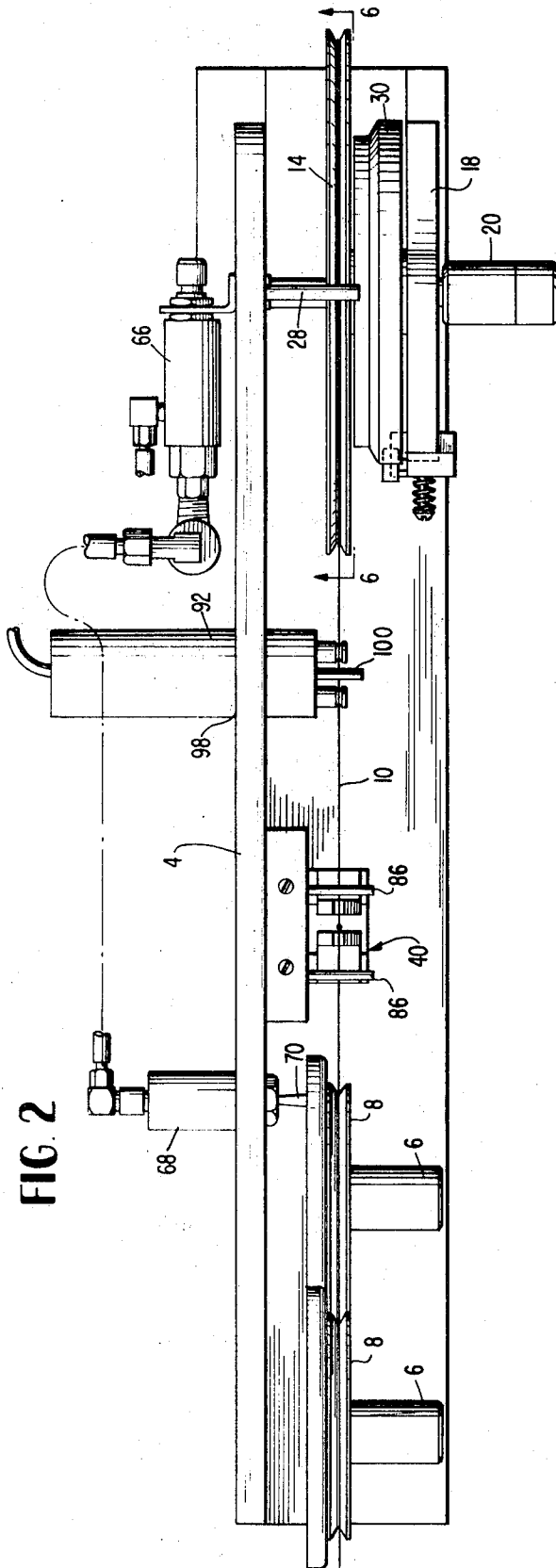
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FIG. 3

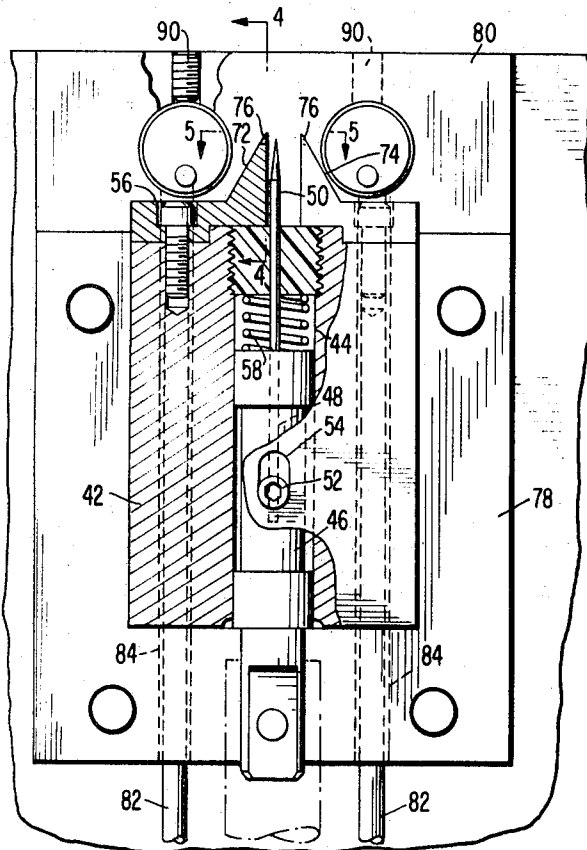


FIG. 4

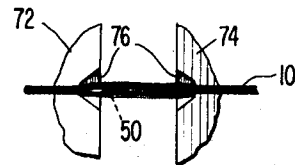
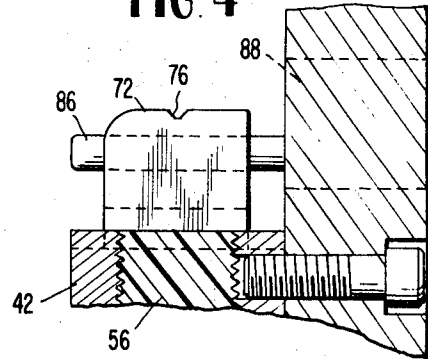


FIG. 5a

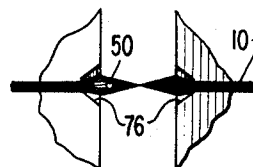


FIG. 5b

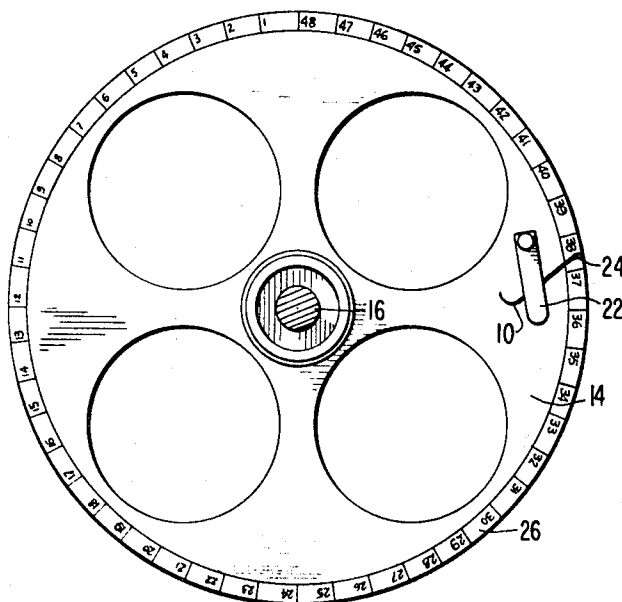


FIG. 6

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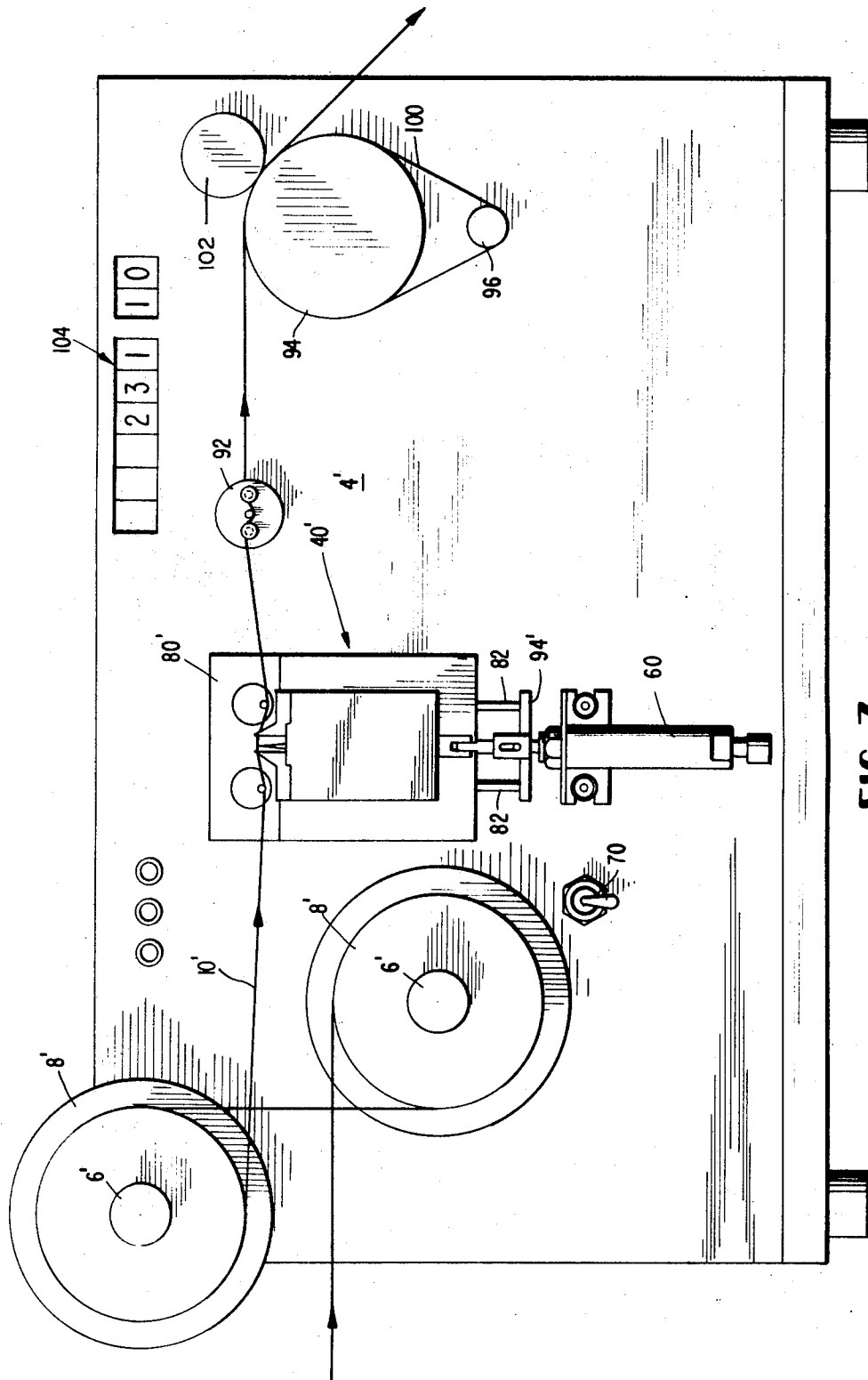
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NEEDLE PULL TESTER

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5 Claims

ABSTRACT OF THE DISCLOSURE

The degree of entanglement in a length of yarn is measured by arranging the yarn along a predetermined path with a needle positioned adjacent the yarn path. The yarn is spread laterally adjacent the needle at a predetermined tension and the yarn is then pierced by the needle. The yarn is moved relative to the needle along the yarn path and when an increase in tension in the yarn above a predetermined value is reached, the length of the relative movement of the yarn is a measure of the degree of entanglement of the yarn.

BACKGROUND OF THE INVENTION

This invention relates to textile and related yarns, and more particularly to method and apparatus for determining yarn characteristics.

Conventional yarns contain a plurality of filaments which are held together by a lengthwise twist of the entire bundle of filaments. Recently, multifilament yarns have been produced which do not have the conventional twist, but rather are rendered coherent by randomly interlacing the filaments in the yarn. This produces yarns which have a different structure from those yarns that are twisted in accordance with the conventional practice. These yarns are known as interlaced yarn to distinguish them from the conventional twist yarn. In interlaced yarns, the individual filaments and groups of filaments are randomly intermingled with adjacent filaments, and adjacent groups, along the length of the yarn to form a coherent yarn bundle. When an interlaced yarn is subjected to subsequent textile processes, the frictional constraints between adjacent filaments and groups of filaments tend to preserve the geometry of the bundle. The cohesiveness of interlaced yarns helps to retain individual filaments and groups of filaments within the bundle so that they have less opportunity to become snagged, broken or peeled off the main bundle when the yarns are subjected to textile processes. Since the performance of interlaced yarn depends on the degree of the intermingling and cohesiveness of the filaments, the need for a method for determining the characterization of these yarns is apparent.

One method that has been proposed is to encapsulate the interlaced yarn in plastic and then to cut through the plastic to obtain a transverse cross-section of the yarn. Successive photographs of a plurality of cross-sections spaced lengthwise of the yarn are taken. When a series of these photographs are projected on a screen, the migration of the individual filaments is observed and a characterization number defined as "events per inch" is assigned. This method is too expensive and time consuming for a routine use.

Another method that has been proposed is known as the "hook drop" method. The interlaced yarn sample is suspended vertically and a predetermined tension is applied thereon. A hook having a specified weight for the particular denier per filament of the yarn is then inserted into the yarn bundle and permitted to drop at a prescribed

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rate until the weight of the hook is supported by the entangled filaments in the yarn. The test is repeated one hundred times and the statistical mean drop length is obtained, from which the "coherency factor" is derived. This procedure is based on the statistical concept that the hook is inserted on the average at a point equidistant between two entanglements. The hook drop method is a relatively simple test which can be performed manually. It is, however, slow and tedious and demands a degree of skill and patience of the operator so that the hook is inserted close to the centerline of the bundle and the filaments are not rearranged during the hook insertion operation by excessive handling by the operator. The test is particularly difficult to perform with light denier yarns, such as 55/15.

A third method for the characterization of interlaced yarn is known as the "needle pull" method. The yarn is pierced by a stationary needle so that at least one-third of the filaments are on one side of the needle. The yarn is then pulled lengthwise by hand along a meter stick until an entanglement point is sensed against the needle. The distance over which the yarn is pulled is analogous to the travel of the hook in the "hook drop" test. The "needle pull" test procedure is considerably faster than the "hook drop" test, but it neither reduces operator fatigue, nor eliminates the manual handling of the yarn.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide method and apparatus for determining the cohesiveness of interlaced yarn which requires no manipulation of yarn by the operator which would rearrange filaments in preparation for test.

It is another object of this invention to provide method and apparatus for determining the cohesiveness of interlaced yarns which provide numerical results that are closely comparable to results obtainable with the "hook drop" test.

A further object of the invention is to provide method and apparatus for determining the cohesiveness of interlaced yarns which are reliable and operate rapidly.

These objects are accomplished in accordance with a preferred embodiment of the invention by passing the yarn over a tensioning device and winding the yarn on a take-up reel. Between the reel and the tensioning device, a yarn piercing device is positioned. The piercing device includes yarn guides for retaining the yarn along a prescribed path which intersects the central axis of the needle. The needle is movable longitudinally for successively piercing the yarn at spaced intervals. Between the yarn piercing device and the take-up reel, the yarn passes over a load cell which signals an increase in tension above a predetermined level. This increase in tension results from entanglement of the filaments in the yarn which retards progress of the needle lengthwise along the yarn. When tension in the yarn reaches a predetermined level the movement of the yarn is stopped. This distance travelled by the yarn from the point at which the yarn was pierced by the needle provides a measure of the degree of cohesiveness of the yarn.

In another embodiment, the needle piercing device is mounted on a carriage that is movable longitudinally of the yarn, and clamping means are provided for holding the yarn stationary during the test. A predetermined tension is then applied to the stationary yarn and the carriage moves the needle longitudinally of the yarn. When the tension in the yarn, as sensed by a load cell, has increased to a predetermined level, the carriage is stopped. The distance travelled by the carriage provides a measure of the degree of cohesiveness of the yarn.

DESCRIPTION OF THE DRAWINGS

These preferred embodiments are illustrated in the accompanying drawings in which:

FIG. 1 is a front elevational view of the semi-automatic tester apparatus of this invention;

FIG. 2 is a top plan view of the tester in FIG. 1;

FIG. 3 is an enlarged detail view of the needle piercing assembly in the tester of FIG. 1;

FIG. 4 is a cross-sectional view of the needle piercing assembly along the line 4—4 in FIG. 3;

FIG. 5a is a cross-sectional view of the tester along the line 5—5 in FIG. 3 showing the yarn arranged in an untwisted ribbon;

FIG. 5b is a cross-sectional view of the tester along the line 5—5 in FIG. 3 showing the yarn in a twisted ribbon;

FIG. 6 is a cross-sectional view of the tester along the line 6—6 in FIG. 2;

FIG. 7 is a front elevational view of the fully automatic tester of this invention; and

FIG. 8 is a schematic view of another embodiment of the fully automatic tester of this invention.

DESCRIPTION OF PREFERRED EMBODIMENT

The semi-automatic tester of this invention is shown in FIGS. 1 to 6. In this embodiment, the advancement of yarn during the measuring step, the successive reeling off of new lengths of yarn for presentation of the needle and the reaching of the distance tracked by the yarn during the measuring step are done manually by the operator. The functions that the semi-automatic tester performs automatically are pretensioning the yarn to a prescribed level, presenting the yarn to the needle accurately, spreading a small length of yarn in the immediate vicinity of the needle in a ribbon-like configuration so that the target presented to the needle is thereby enlarged, piercing the yarn centrally and accurately by the needle, detecting the increase in the tension in the yarn downstream of the needle to a prescribed level and withdrawing the needle at the completion of the measuring step. The tester includes a platform 2 which supports an upright mounting plate 4. Two conventional hysteresis brakes 5 and 6 mounted in series on the front of the plate 4 and includes pulleys 8 over which the yarn 10 passes in a non-slip contact.

A take-up reel 14 is mounted for rotation on an axle 16. One end of the axle 16 is journaled in a bearing block 18 and the opposite end is journaled in the plate 4. The outer end of the axle 16 is provided with a knob 20 to permit manual rotation of the reel 14. The reel 14 has a clip 22 for securing the end of the yarn, which passes through a slot 24 in the rim of the reel 14. The perimeter of the reel is marked with a scale 26 (FIG. 6) to indicate the length of yarn that is wound on the reel during the successive tests. A pointer 28 (FIG. 1) extends outwardly from the mounting plate 4 as an indicator for the scale 26.

The reel 14 is returned to a zero position before each test. A wheel 30 which turns with the reel 14 facilitates aligning the zero position on the scale 26 with pointer 28. The wheel 30 has a transverse groove 32 in the rim at the angular position which corresponds to the zero position of the reel 14. A roller 34 is supported on an arm 36 which extends upwardly from the bearing block 18. A spring 38 urges the roller 34 against the wheel 30. When the wheel 30 has been rotated so that the groove 32 is not aligned with the roller 34, there is no resistance to rotation of the reel 14. When the roller 34 drops into the groove 32, it resists slightly further rotation of the reel and thereby provides a rapid means for aligning the scale 26 at the zero position prior to the next test.

The needle piercing assembly 40 is mounted on the plate 4 between the brake reels 8 and the take-up reel 14. Referring to FIG. 3, the assembly 40 includes a

housing 42 with a longitudinal bore 44. A plunger 46 is mounted in the bore 44 for reciprocating movement. Preferably, the plunger is formed of a low friction material, such as polytetrafluoroethylene. The plunger 46 has a central bore 48 and a needle 50 is inserted in the bore 48. The needle 50 is held in place by a set screw 52. A slot 54 in the housing 42 provides access to the screw 52 so that the needle 50 can be readily replaced. The upper end of the bore 44 is threaded to receive a bushing 56 through which the needle 50 passes. A spring 44 is inserted between the plunger 46 and the bushing 56 to urge the plunger downwardly for retracting the needle 50.

The lower end of the plunger 46 extends below the housing 42 and is connected with the piston of an air cylinder 60 by a slotted clevis 62 (FIG. 1). The air cylinder is supported by a bracket 64 on the mounting plate 4. Air from a source of supply is conducted through a filter and an air regulator 66 (FIG. 2) to a three-way toggle valve 68. The valve 68 has a control lever 70 on the front of the plate 4 for controlling operation of the cylinder 60.

Knife blades 72 and 74 are rigidly secured to the top of the housing 42 on opposite sides of the needle 50. Each knife blade 72 and 74 has a notch 76 for centering the yarn over the needle 50. The bottom of each notch has a flat, horizontal surface as shown in FIG. 4, which spreads the yarn filaments that are supported between the notches 76. As shown in FIGS. 3, 5a and 5b, the needle 50 is placed close to the upstream knife blade 72.

This arrangement provides a maximum target area for the yarn that is to be pierced by the needle and provides a precise relationship between the yarn bundle and the piercing needle. The spreading and centering action of notches 76 is illustrated in FIG. 5a. Between the notches the yarn normally assumes the ribbon-like configuration and the width of the ribbon is several times larger than the diameter of the yarn upstream and downstream of the cooperating pair of notches 76. Occasionally, a twisted segment of yarn finds itself positioned between the notches as illustrated in FIG. 5b. Again, the positioning of needle 50 close to the upstream knife blade 72 ensures adequate size of the target and the near central piercing of the yarn bundle by the needle.

The housing 42 (FIG. 3) is secured on a support 78, which in turn is mounted on the plate 4. A liftable block 80 located at the top of the support 78 is guided by means of two rods 82 which operate in vertical bores 84 in support 78. Rods 82 are attached to plate 94' (FIG. 1) which is fastened to slotted clevis 62. A pair of ceramic pins 86 (FIG. 3) project outwardly from the block 80. Each pin is mounted eccentrically in a cylindrical plug 88. By rotating the plugs 88, the positioning of the pins 86 relative to the knife blades 72 and 74 can be adjusted. Set screws 90 are provided in the block 80 to lock the plugs 88 at their respective adjusted positions.

The tester apparatus also includes a tension responsive system. The system includes a load cell 92 mounted on plate 4 and projecting through an opening 98 in the plate 4. The load cell may include a commercially available Rothschild 100 gram measuring head together with a Rothschild tensiometer model R-1092, manufactured by Rothschild Elektronische Moss- und Stevergerate of Zurich, Switzerland. The load cell and tensiometer comprise the tension responsive system.

In operation, the yarn is threaded over the tension pulleys 8 and under pins 86. The yarn then is supported by the knife blades 72 and 74 and is positioned in the notches 76. The adjustable pins 86 are rotated to deflect the yarn below the notches 76 both upstream and downstream from the blades. The yarn 10 then passes between the pins of the load cell 92. It is then wound on the take-up reel 14 after the free end of the yarn 10 is inserted under the clip 22. The reel 14 is rotated clockwise by means of the knob 20. When the pointer 28 is positioned at the zero indication of the scale 26, the roller

34 rests in the transverse groove 32 on the disc 30. The needle 50 is initially retracted by relieving the air pressure in the cylinder 60 by operation of the switch lever 70 to allow the spring 58 to displace the piston 46 downwardly.

To start the test, the lever 70 is displaced upwardly to conduct air into the cylinder 60 which drives the plunger 46 upwardly, thereby first causing the needle 50 to pierce the bundle of yarns that is supported between the knife blades 72 and 74 and pins 86. Further continuing upward movement of plunger 46 causes pin 96 to strike the upper end of slot 100 in slotted clevis 62 thereby actuating upwardly plate 94 and pins 82 until block 80 reaches its top position and pins 86 are no longer in frictional contact with yarn 10. Rotation of the knob 20 in a clockwise direction causes the reel 14 to rotate clockwise, thereby drawing the yarn from the brake reels 8 toward the right as viewed in FIG. 1 relative to the stationary needle 50. When the needle 50 encounters an entanglement point, the tension in the yarn between the needle and the reel 14 increases, thereby actuating the tension sensing system. This completes the circuit causing the lamp 108 to be turned on as an indication that a predetermined increase in tension in the yarn has taken place. The length of displacement of the yarn 10 between the location where the needle 50 first pierces the yarn and the entanglement point is measured by means of the scale 26 on the reel 14 (FIG. 6). The lever 70 is then operated to relieve the pressure in the cylinder 60, causing the needle to be retracted along with block 80. The yarn is again advanced to a zero position as determined by the indicator 28 and the groove 32, and the test is repeated. Thus, the operator merely turns the knob 20 and operates the valve lever 70, so that the test can be conducted rapidly and provide repeatable results.

A fully automotive embodiment of the tester is illustrated schematically in FIG. 7. In this embodiment all functions except for the initial lace up are performed automatically with no attention required by the operator. The tester includes a mounting plate 4', two conventional hysteresis brakes 6' and pulleys 8' and needle piercing assembly 40' which correspond to the structure of the tester of FIG. 1. The block 80' of the needle assembly is shown in its lowered position in FIG. 7. The operation of the needle assembly of the tester in FIG. 7 is substantially the same as that previously described with respect to the tester of FIG. 1. In place of the lamp 108 and the manual take-up reel 14 of the FIG. 1 embodiment, the automatic tester has a drive roll 94 which is driven by a motor 96 through a belt 100. Another roll 102 cooperates with the roll 94 to draw the yarn 10' toward the right as viewed in FIG. 7. When the needle has been inserted in the yarn 10', the motor 96 causes the roll 94 to apply tension to the yarn to displace the yarn toward the right until a predetermined tension is sensed by the load cell 92. The length of travel of the yarn is measured by the extent of rotation of the roll 94 and is recorded on an indicator 104. Additional switching functions are performed in response to the load cell 92 being energized. The needle is retracted, the pulleys 8' and roll 94 are rotated to advance a predetermined length of yarn after each operation of the load cell 92. The functions are programmed by means of control circuits (not shown) which initiate and control motors and mechanisms (also not shown) for sequential advancing of the yarn, piercing the yarn by the needle, measuring the advancement of yarn during the measuring step, recording the measurement on paper tape or punched tape, totalling the measurements, retracting the needle, reeling off yarn between measurements in a predetermined series and shutting down of tester after completion of the test series. In the rare instances when the piercing needle misses the yarn bundle, the sensing device does not register the increase of tension and the yarn continues to be advanced for a

predetermined length that is significantly longer than the expected distance between entanglements when this length is detected by appropriate circuiting. Additional circuiting ensures that this length is not included in the test data and that a reject test is automatically executed.

In the fully automated tester, another feature (not illustrated) consists of additional apparatus and controlling, operating and recording circuitry that automatically and sequentially presents to the tester yarns drawn off a plurality of yarn packages placed on a special reel. This additional apparatus relieves the operator from the loading of fresh ends of yarn to the tester and limits his functions to replacing yarn packages on the reel and placing the free ends in the appropriate mechanism thus greatly increasing the utility of the tester.

A modified form of the invention of the fully automatic tester is illustrated schematically in FIG. 8. In this embodiment, the yarn 110 is held stationary while the needle is displaced longitudinally of the yarn. The needle assembly 112, which corresponds to the needle assembly 40 in FIG. 1, is mounted on a carriage 114 for reciprocating movement along the base 116. The carriage 114 is connected with a lead screw 118 which is driven by a motor 120. A rail 122 projects upwardly from the base 116 and a roller 124 rolls along the rail 122 as the carriage 114 advances. The roller 124 drives an odometer 126 which records the length of travel of the needle assembly 112 between the point at which the yarn 110 is first pierced by the needle and the point at which the needle engages an entanglement. The odometer 126 may be calibrated in any convenient linear measurement. A take-up roll 128 advances the yarn 110 toward the right as viewed in FIG. 8 and tension is imparted to the yarn by a brake assembly 130. During the test, the yarn is held under tension by clamps 132 which are preferably operated by electrical solenoids. The plunger of one clamp 132 engages a fixed stop and the plunger of the other clamp 132 engages a spring loaded stop 134. A calibrated weight 138, which is held in a raised position by a solenoid, or other means is lowered until the hook at the upper end engages the yarn 110, so that the weight is supported by the yarn, thereby applying a predetermined tension in the yarn. Between the needle assembly 112 and the first clamp 132 the yarn 110 passes over a tension sensing device 140 corresponding to the load cell 92 shown in FIG. 7.

In operation, the yarn 110 is pulled from the bobbin over the pretensioning device or brake 130, and threaded over the needle assembly 112, as shown in FIG. 8. The spring loaded plunger 134 displaces the yarn above the level of the needle assembly 112 and the take-up roll 128. At the beginning of the test, the yarn is under tension provided by the brake assembly 130. The needle assembly 112 is at the extreme left of its path of travel. The needle is then inserted into the yarn by operation of the pneumatic cylinder. The clamps 132 are then displaced outwardly to grip the yarn between the stationary anvil 136 and the spring loaded anvil or plunger 134. This causes the yarn to descend adjacent the take-up drum 128 to introduce slack into the yarn between the needle assembly 112 and the clamp 132. The calibrated weight 138 is then lowered to apply a predetermined tension in the yarn.

The drive motor 120 is then operated to advance the carriage 114 toward the right, as viewed in FIG. 8. As the carriage moves, the needle is dragged through the yarn while the odometer 126 indicates the distance of travel. When the load cell 140 senses a predetermined tension, the carriage motor 120 stops and the needle retracts. Simultaneously, the clamps 132 are released and the weight is lifted to its raised position. The motor 120 then operates in reverse to return the carriage 112 to the extreme left hand position and the take-up roll 128 rotates to draw another length of yarn from the bobbin over the brake 130 and the cycle is repeated. If the needle should fail to pierce the yarn, for example if the yarn is not

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centered over the needle, the load cell 140 will not sense an increase in tension as the carriage 114 progresses toward the right and the carriage will travel the full distance until it strikes a limit switch 121, which will return the carriage to the left hand position and the length of travel of the carriage can be deducted from the odometer reading.

The tester of FIG. 8 approximates the conditions of the conventional "hook drop" method, but performs the test more rapidly and requires less skill from the operator. The yarn 110 is maintained under a prescribed tension and the hook or needle travels relative to the stationary yarn. The yarn 110, however, is arranged horizontally, while in the manual hook drop the yarn is suspended vertically.

While this invention has been illustrated and described in three preferred embodiments, it is recognized that variations and changes may be made therein without departing from the scope of the invention set forth in the claims.

What is claimed:

1. Apparatus for measuring the degree of entanglement in a length of yarn comprising:

stationary base means, a needle on said base means, means mounting said needle for longitudinal reciprocating movement along the path,

guide means on opposite sides of said needle path for supporting said yarn in a predetermined path intersecting said needle path,

means including a reel for effecting relative movement between said yarn and said needle by advancing said yarn along said path, means applying tension to said yarn, and means indicating an increase in yarn tension above a selected value, said indicating means including means in engagement with said yarn between said guide means and said reel and a switch means actuating said indicator upon an increase in tension above said selected value.

2. The measuring apparatus according to claim 1 wherein said guide means includes knife blades on opposite sides of said needle path, said blades having a substantially flat support surface extending laterally of said yarn path,

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and including a guide pin adjacent each knife blade for urging said yarn against said knife blades, whereby the yarn filaments are spread in the shape of a wide flat ribbon between said support surfaces.

3. The measuring apparatus according to claim 2 where said needle path is closer to one knife blade than the other knife blade, said guide pins being movable relative to said knife blades for threading yarn over said blades, whereby the yarn bundle is spread from the mid-point between said support surfaces where a minimum width of the yarn ribbon may occur.

4. A method of measuring the degree of entanglement in a length of yarn comprising:

arranging said yarn along a predetermined path, positioning a needle adjacent said yarn path,

applying a predetermined tension to said yarn, spreading said yarn laterally adjacent said needle, piercing said yarn by end-wise movement of said needle into said spread yarn, causing relative movement between said needle and said yarn along said yarn path, and subsequently indicating an increase in tension in said yarn above a predetermined value, whereby the length of said relative movement required to produce said tension increase indication is a measure of degree of entanglement of said yarn.

5. The apparatus of claim 2 wherein said knife blades have yarn centering notches disposed therein.

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