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Cook et al.

[11] **3,796,094**

[45] **Mar. 12, 1974**

[54] **METHOD AND APPARATUS FOR CONTINUOUSLY DETECTING ABNORMAL CROSS-SECTIONAL AREAS IN RUNNING TOW**

[75] Inventors: **David E. Cook; John W. Clapp, Jr.,** both of Kingsport, Tenn.

[73] Assignee: **Eastman Kodak Company,** Rochester, N.Y.

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[52] **U.S. Cl.** **73/159,** 73/94

[51] **Int. Cl.** **G01n 33/36**

[58] **Field of Search**..... 73/159, 160, 94; 33/143 L, 33/147 N, 148 H; 19/65 T

[56] **References Cited**

UNITED STATES PATENTS

2,826,911	3/1958	Hartford et al.	73/159
3,386,145	6/1968	Harris	73/160
3,363,459	1/1968	Brown	73/160

FOREIGN PATENTS OR APPLICATIONS

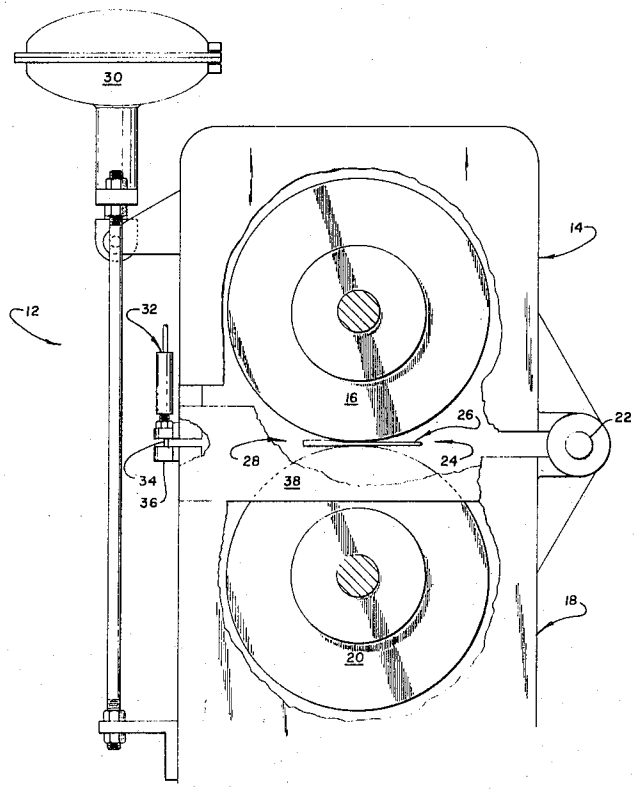
952,886	3/1964	Great Britain	73/159

Primary Examiner—S. Clement Swisher
Attorney, Agent, or Firm—Malcolm G. Dunn

[57] **ABSTRACT**

Method and apparatus by which a tow having hundreds of thousands of continuous length filaments may be continuously monitored for abnormal cross-sectional areas while the tow is being processed and wherein the tow is continuously and momentarily compressed and forced into a predetermined minimum cross-sectional area, as between two rolls and side plates at the ends of the rolls, substantially eliminating all voids; and then detecting as by an electronic displacement gage a predetermined threshold change in the minimum cross-sectional area, which change may be caused by abnormal cross-sectional areas occurring in the cabinet ends or creel ends constituting the tow and passing through and within the momentarily compressed tow minimum cross-sectional area, or by dropped or missing or added cabinet or creel ends.

5 Claims, 5 Drawing Figures



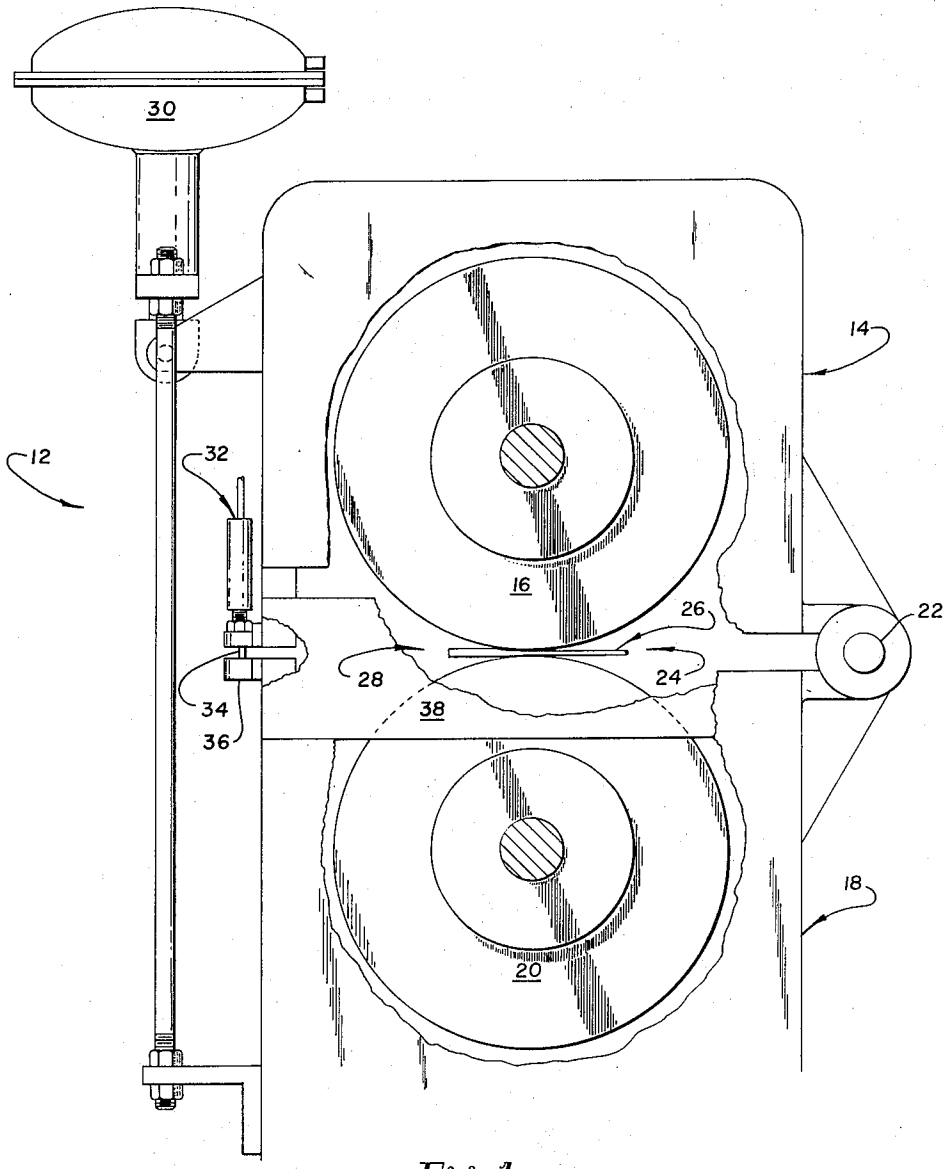


Fig. 1

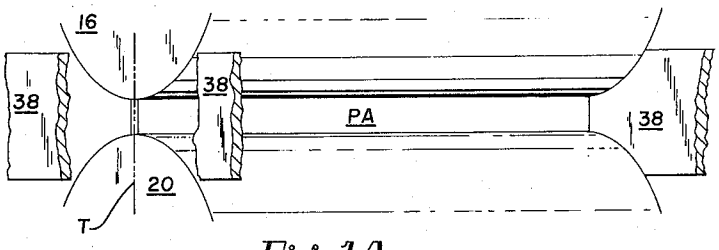


Fig. 1A

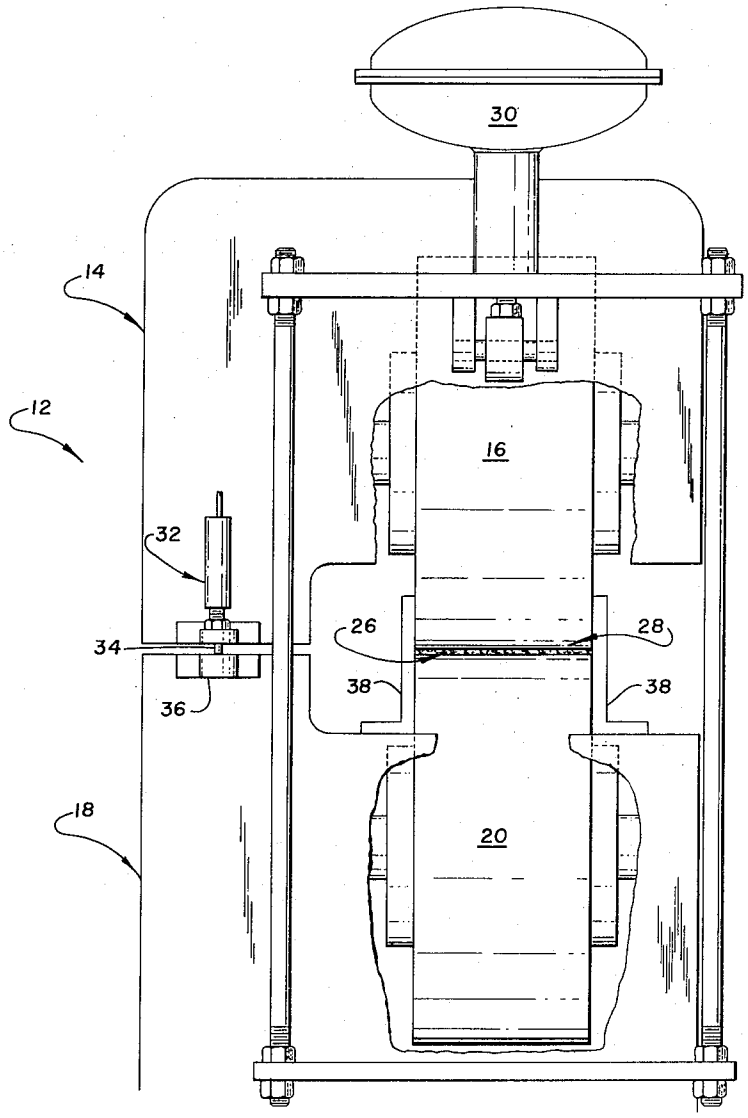


Fig. 2

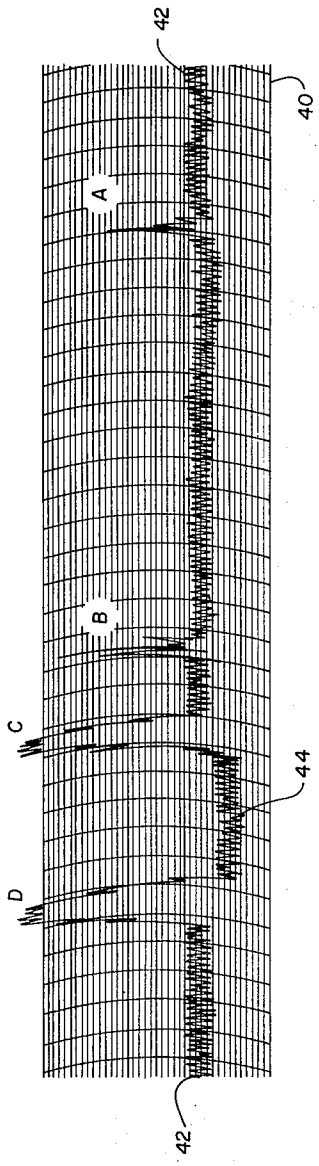


Fig. 3

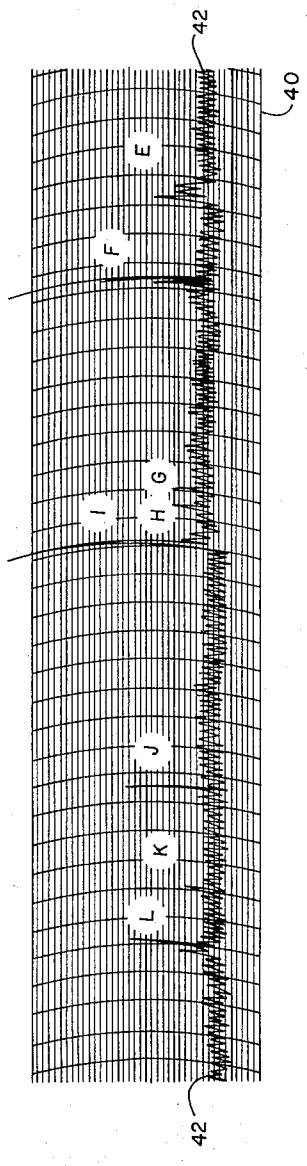


Fig. 4

METHOD AND APPARATUS FOR CONTINUOUSLY DETECTING ABNORMAL CROSS-SECTIONAL AREAS IN RUNNING TOW

BACKGROUND OF THE INVENTION

The present invention is directed to a method and apparatus for continuously monitoring a moving tow of continuous length multifilaments such as for textile products and detecting abnormal cross-sectional areas in the tow.

It is well-known in the prior art to detect slubs and other defects or abnormal cross-sections in yarn filaments, thread and cabinet ends. For instance, in U.S. Pat. No. 3,386,145 to Harris a multifilament yarn such as a cabinet end is pulled over guides in such manner as to spread out or band the yarn into a flat web-like configuration. This tends to force defects, such as a slub or undrawn broken filament, whose cross-sectional diameter is larger than that of the normal filaments, to protrude from the surface of the banded yarn and be detected by a movable guide member which in turn is connected to a switching means for producing an output signal leading to an alarm or recorder. The invention disclosed in the patent thus detects enlarged cross-sections of individual fibers.

In U.S. Pat. No. 3,477,021 to Dosch et al., the invention disclosed in the patent speaks of initiating control operations upon the occurrence of a certain predetermined defect volume, the "defect volume" actually referring to that of a single bundle of filaments constituting a yarn thread in which the defect, for instance, may exceed a certain thickness of the thread.

In U.S. Pat. No. 3,363,459 to Brown, the sensing means detects defects in a strand of yarn, with the strand being banded into a flat web or band.

In the normal processing of continuous length multifilament tow, however, such as polyester tow, there may be in excess of 600,000 continuous filaments making up the tow. Generally, the polyester fiber is melt spun from a spinneret having a plurality of holes, one for each filament, into a quenching cabinet and emerges as a "cabinet end". There is usually a series of such cabinets in one line with each cabinet end being combined with other cabinet ends as they run past the cabinet series and are subsequently puddled into cans, which when combined with other such cans constitute in their entirety what is called a "creel". Later, a number of such cans are aligned in rows and the combined cabinet ends are withdrawn from each can as "creel ends" and are joined with those from the other cans to be combined into a tow or tow band that under suitable conditions of tension may take on the form of a band, for example, that is about 8 inches wide and about 1/16 to ⅛ inch in thickness and has perhaps in excess of the aforementioned 600,000 filaments. The tow, as combined, is then processed through hot water baths, drafting sections, oriented, heat treated, crimped or crimped and heat treated and the like before being cut into staple fiber and baled for shipping.

Under the general processing conditions described above, it is impractical, if not impossible, to spread a tow of such size into any finer web so as to detect abnormal cross-sectional areas occurring in the various cabinet ends and creel ends making up the tow, as taught by the prior art. Such attempt to spread the tow could result in destruction of the integrity of the tow and possibly of the individual filaments.

Some of the problems associated with and which affect the quality of the tow are undrawn fiber such as "harsh"; married fibers; fused clusters, where some of the ends have become fused together; loopy defects, which result from either the cabinet ends or the creel ends forming into a loop when withdrawn from the creel and which continue to remain in loop form even in the formed tow or tow band; dropped cabinet and creel ends, which are not drafted when in the tow passing through the drafting sections; and any other condition resulting in abnormal cross-sectional areas for whatever reasons.

The prior art does not appear to disclose any method or apparatus, without destroying the integrity of the tow or of any of its individual filaments making up the tow, that is simple and practical to use for detecting such abnormal cross-sectional areas occurring in tows having filaments numbering in the hundreds of thousands. The above-mentioned tow having in excess of 600,000 filaments is only one example, because much larger as well as smaller tows are processed as a matter of course.

SUMMARY OF THE INVENTION

The present invention thus discloses a method, and an apparatus for practicing the method, by which a tow having thousands and hundreds of thousands of continuous length filaments may be continuously monitored for abnormal cross-sectional areas while it is being processed. The method and apparatus involve continuously and momentarily compressing the tow and forcing it into a predetermined minimum cross-sectional area, substantially eliminating all voids, and then detecting a predetermined threshold change in the minimum cross-sectional area, which change will result from abnormal cross-sections occurring in the cabinet ends or creel ends passing through and within the momentarily compressed tow minimum cross-sectional area.

The apparatus that may be used for practicing the method is in part usually already in existence on the normal tow processing line. This part of the apparatus comprises the stuffer box crimper wherein the tow is forced to converge for movement into and through the throat of the crimper and pass between an upper roll and a lower roll, with the pair of rolls being bounded at the sides of the throat by side plates. The rolls and the side plates thus serve to momentarily compress the tow and force the tow into a predetermined minimum cross-sectional area, substantially eliminating all voids. For instance, in a 6 inch crimper a tow having about 667,000 filaments with each filament being 1½ d/f is forced to converge and move into a throat 6 inches wide and is momentarily compressed into a predetermined minimum cross-sectional area of about 0.136 square inch. The minimum area would occupy that area bounded by the nip or common points of tangencies of the rolls with the tow and the roll side plates. Since the lower roll is normally fixed, and the upper roll is supported for movement toward and away from the lower roll, we have discovered that by working from a known predetermined minimum cross-sectional area for tow having a substantial absence of abnormal cross-sectional areas we can monitor the movement of the upper roll of the crimper roll pair and find abnormal

cross-sectional areas in the tow including dropped or missing cabinet or creel ends. We can, as by the attachment of an electronic displacement gage (such as a linear variable differential transformer system — L.V.D.T.) to the housing support for the upper roll and of a base platform, which is the bench mark for the gage, to the housing of the lower roll, continuously measure the separation of the upper roll from the lower roll. The signal from the electronic displacement gage may be conditioned to energize recorders, trigger alarms, trigger defect rejection systems or whatever else may be desired.

Since other instrumental defect detectors use bars and guides which are extraneous to a yarn processing system and which disadvantageously tend to abrade the yarn and produce excess tension in such process, the present invention overcomes such disadvantages by not altering in any way the normal processing of the tow.

The invention makes it possible to set up threshold limits for continuously monitoring and detecting abnormal cross-sectional areas of various sizes because such abnormal cross-sectional areas will cause a change in the predetermined minimum cross-sectional area to which the tow is momentarily compressed. It is possible to set up the electronic displacement gage so that it will be connected to equipment which will record different sizes of defects, such as recording all abnormal cross-sections, but perhaps only adapted to trigger a rejection of the tow portions in which the abnormal cross-sectional areas extend beyond or under a predetermined size. Such abnormal cross-sectional areas will cause, an increase or decrease in the total cross-sectional area under compression between the rolls and the side plates.

Although advantageously an existing crimper on a processing line may be used, in the absence of such pre-existing crimper an apparatus can be readily constructed to practice the method wherein the tow passes between two rolls bounded by side plates with one of the rolls being movable toward and away from the other roll; the rolls and the side plates would serve to momentarily confine and compress the tow in the manner disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side elevational view of an apparatus, such as a stuffer box crimper, with portions of the roll housing removed to illustrate the rolls, the pivotal support of one housing relative to the other housing, and the tow in exaggerated size compressed between the rolls;

FIG. 1A is an enlarged isometric view of a portion of FIG. 1 for purposes of illustrating the compression of tow in a planar area between the nips of the rolls and the roll side plates, the planar area of tow being greatly exaggerated;

FIG. 2 is a front elevational view of the apparatus shown in FIG. 1 with portions of the roll housings removed to show the tow momentarily compressed between the rolls; and

FIGS. 3 and 4 are illustrations of oscillographs showing some examples of recorded normal and abnormal cross-sectional areas.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In reference to FIGS. 1, 1A and 2 of the drawings, an apparatus 12, which may be a stuffer box crimping apparatus, is disclosed as having an upper housing 14 for support of an upper roll 16, and a lower housing 18 for support of a lower roll 20. The upper housing 14 and its supported upper roll 16 are pivotally supported by means of torsion bars 22 for movement toward and away from the lower housing 18 and its supported lower roll 20. Only one torsion bar happens to be shown in the drawing, but it should be understood that the upper housing is pivotally supported by torsion bars at either side of the exit throat 24 from the apparatus 12. The upper housing 14, and its roll, is controlled for movement toward and away from the lower roll 20, for predetermined compression of tow 26 moving into the entrance throat 28 and through the apparatus, by a conventionally operated bellows device 30.

As mentioned, the disclosed apparatus may be an existing stuffer box crimper on a tow processing line; but in the absence of such, the apparatus may be fabricated so as to have the basic components necessary for carrying out the equivalent functions of the aforementioned crimper.

The movement of the upper roll 16 toward and away from the fixed lower roll 20 is continuously monitored or measured by an instrument such as an electronic displacement gage indicated in general at 32, which may be a linear variable differential transformer system — L.V.D.T. The gage is mounted on the movable upper roll housing 14 and is preferably located at the upstream side of the housing having the entrance throat 28 for a reason which will be discussed later. The particular gage illustrated is a SEMICON DDCP-50 Displacement Transducer, supplied by Columbia Research Laboratory Incorporated in Woodlyn, Pennsylvania, by way of example.

The electronic displacement gage 32 has a feeler element or probe 34 which is spring-biased for engagement with the fixed bench mark device 36 which is mounted on the fixed lower housing 18 and is located directly below the feeler element. Any movement of the feeler element or probe in either an upward or downward direction as a result of the movement of the upper housing causes activation of a transformer within the housing of the gage resulting in a generation of voltage proportional to the amount of movement and representing a measured cross-sectional area.

The operation of an L.V.D.T. is well-known in the art. In general, it is constructed of three uniaxially cylindrical coils of wire, one centrally-located primary and two secondaries. A soft iron core which travels through the coils electromagnetically couples the secondary coils with the primary when an alternating current is fed to the primary. These two secondaries are wound in opposite directions to each other so that as the soft core moves to either side of a central null position, a positive or negative electrical signal results. This signal is proportional to the displacement of the soft iron core. The linearity of the response, the sensitivity obtainable, and the lack of wear of the parts make the L.V.D.T. ideal for use in this invention. Since such device is well-known, it is not deemed necessary to show the details of such device or the electronic circuitry to which it is connected; however, reference may be had

to U. S. Pat. No. 2,809,519 to Kaestner for a more complete description of a similarly operating L.V.D.T. The proportional voltage generated by an L.V.D.T. may serve to supply a signal through appropriate electronic circuitry for activating recording devices, fiber rejection systems, signal alarms or whatever else may be desired.

In operation, the tow **26** moves into the apparatus **12** through the entrance throat **28** and is caused to be converged from its normal tow width and to be momentarily compressed and forced into a predetermined minimum cross-sectional area by the upper roll **16** and lower roll **20** and between the roll side plates **38** mounted within the throat at each end face of the pair of rolls. The upper roll is forced toward the lower roll by the bellows device **30,** although springs or other suitable adjustment devices may also be employed, so as to compress the tow in the manner described and substantially eliminate all voids. The tow, therefore, is momentarily compressed at the nip of the rolls within the planar area PA (FIG. 1A) extending between the common points of tangency of and between the two rolls and bounded by the side plates. Phantom line T indicates the location along which lies the common points of tangency and planar area PA extending between the two rolls. Since the bellows device or whatever other device employed is adjusted to cause a certain desired compression of a normal cross section tow, any abnormal cross-sectional areas and including the absence of cabinet or creel ends moving through the area under compression will cause the upper roll and its supporting housing **14** to either move away from or toward the lower roll **20.** Such movement will be monitored and detected by the feeler element or probe **34** of the electronic displacement gage. By placing the gage at the farthest location on the upper housing away from the rolls and the point of pivotal movement of the upper roll housing a mechanical advantage is derived so that the movement of the upper roll will amplify the movement of the probe and make it more sensitive to the slightest upper roll movements.

In FIGS. **3** and **4** portions of an oscillograph chart **40** are shown and on which monitoring recordings were made by an oscillograph connected through appropriate circuitry (not shown) to the electronic displacement gage. The baseline signal level **42** is the recorded representation of normal tow having no significant defects. Any defects detected show up on the chart as deviations or "peaks" from the baseline signal level.

For instance, during a trial tow processing run peak J (FIG. **4**) indicates a short, thick defect which upon analysis of the tow at the same relative position proved to be a large round contour. Peak E indicates a longer but smaller defect than J, and subsequent analysis of the tow at the same relative position revealed a wide flat strip of undrafted filaments. Other peaks A (FIG. **3**), F, I and L indicate a combination of the two types J and E. Upon tow analysis these peaks were defects that were found to be relatively long sections of undrafted tow with folded portions or with points at which the defect crossed through the tow.

Several small peaks observed during the trail tow run and peaks G and H represented defects resulting from the shearing of what appears to be about 10 or 15 filaments. The defect represented by peak K, which appeared to exhibit the same order of magnitude as peaks G and H, could not be located in the tow and it may have been hidden in the other filaments because of its small size.

In reference of FIG. **3,** peak C represents a creel end dropping out which thereafter results in a new but lower baseline signal level indicated at **44.** Peak D represents a creel end coming back into the tow with the result that the upper baseline signal level **42** is again achieved. In either event the respective dropped and returning creel ends represent undrafted filaments which will undesirably have a different dye take-up rate than normal drafted filaments, and it may thus be desirable to trigger a rejection system for the portion of the tow length containing such.

The electronic displacement gate may be adjusted, also, to generate a signal only upon the detection of an abnormal cross-sectional area.

The overall disclosed arrangement has also been found to be sufficiently sensitive so as to detect roll eccentricities and poor or defective roll bearings. If such defections are not desired, suitable threshold limits can readily be established.

While the invention has been described in detail with particular 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 in the appended claims.

We claim:

1. Method for monitoring a tow of continuous length multifilaments, and comprising:

continuously moving the tow along a path;

momentarily compressing the moving tow at a location along the path and forcing the tow at that location into a predetermined minimum cross-sectional area substantially eliminating all voids; and

continuously measuring the minimum cross-sectional area of the tow at that location and detecting abnormal cross-sectional areas occurring within the tow that cause an increase or decrease of area in the predetermined minimum cross-sectional area.

2. The method as defined in claim **1,** and generating a signal upon detecting an abnormal cross-sectional area.

3. The method as defined in claim **1,** and continuously generating a signal representative of the measured said predetermined minimum cross-sectional area and changing the signal generated upon detecting an abnormal cross-sectional area.

4. Apparatus for monitoring a moving tow of continuous length multi-filaments, and comprising:

means for momentarily compressing the tow moving through the apparatus and forcing it into a predetermined minimum cross-sectional area substantially eliminating all voids, the means including:

a pair of rotatable rolls between which the tow moves, with one of the rolls being movable toward and away from the other of the roll pair;

a pair of side plates each positioned against and extending between the two end faces at either end of the pair of rolls; and

means for moving said one roll toward or away from the other roll;

a housing for supporting each roll, the two housings defining therebetween an entrance throat and an exit throat for the tow moving into and out of the

apparatus, the housing for the movable roll adapted to move with the movable roll;

means for continuously measuring the minimum cross-sectional area of the tow and detecting abnormal cross-sectional areas occurring within the tow that cause an increase or decrease of area in the predetermined minimum cross-sectional area, the latter means including (a) a fixed member mounted on one of the housings and defining a bench mark, and (b) means mounted on the other housing that is movably engageable with said fixed member and is adapted to measure the movement of the movable housing and generate a signal representative of such housing movement.

5. Apparatus as defined in claim 4, and wherein the predetermined minimum cross-sectional area of the tow lies within a plane defined between the pair of rolls taken at their common points of tangency with the tow located between the rolls and between the side plates.

* * * * *