

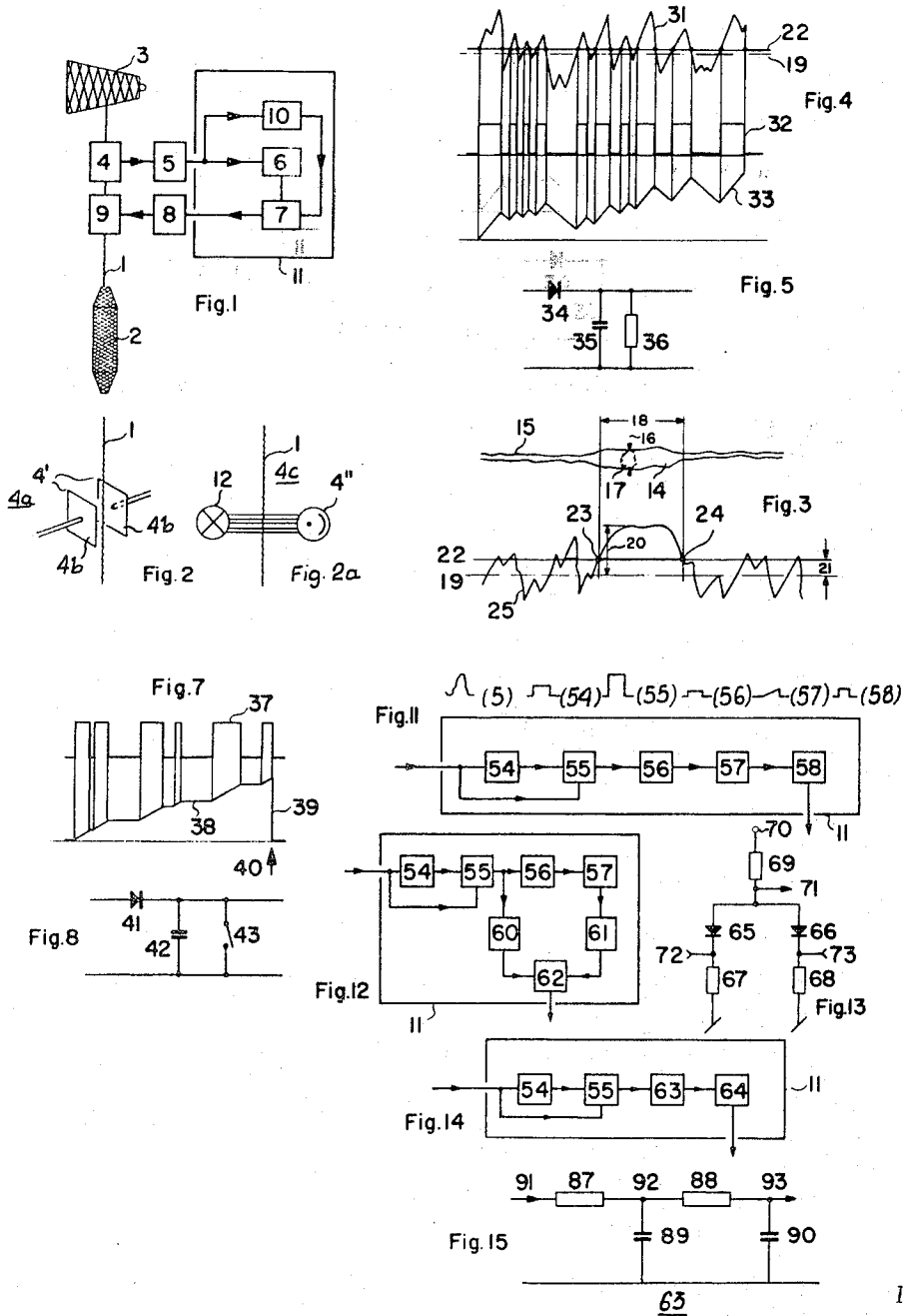
Feb. 14, 1967

E. LOEPFE
APPARATUS FOR SENSING YARN IRREGULARITIES AND
PRODUCING A CONTROL SIGNAL

3,303,698

Filed Dec. 16, 1963

2 Sheets-Sheet 1



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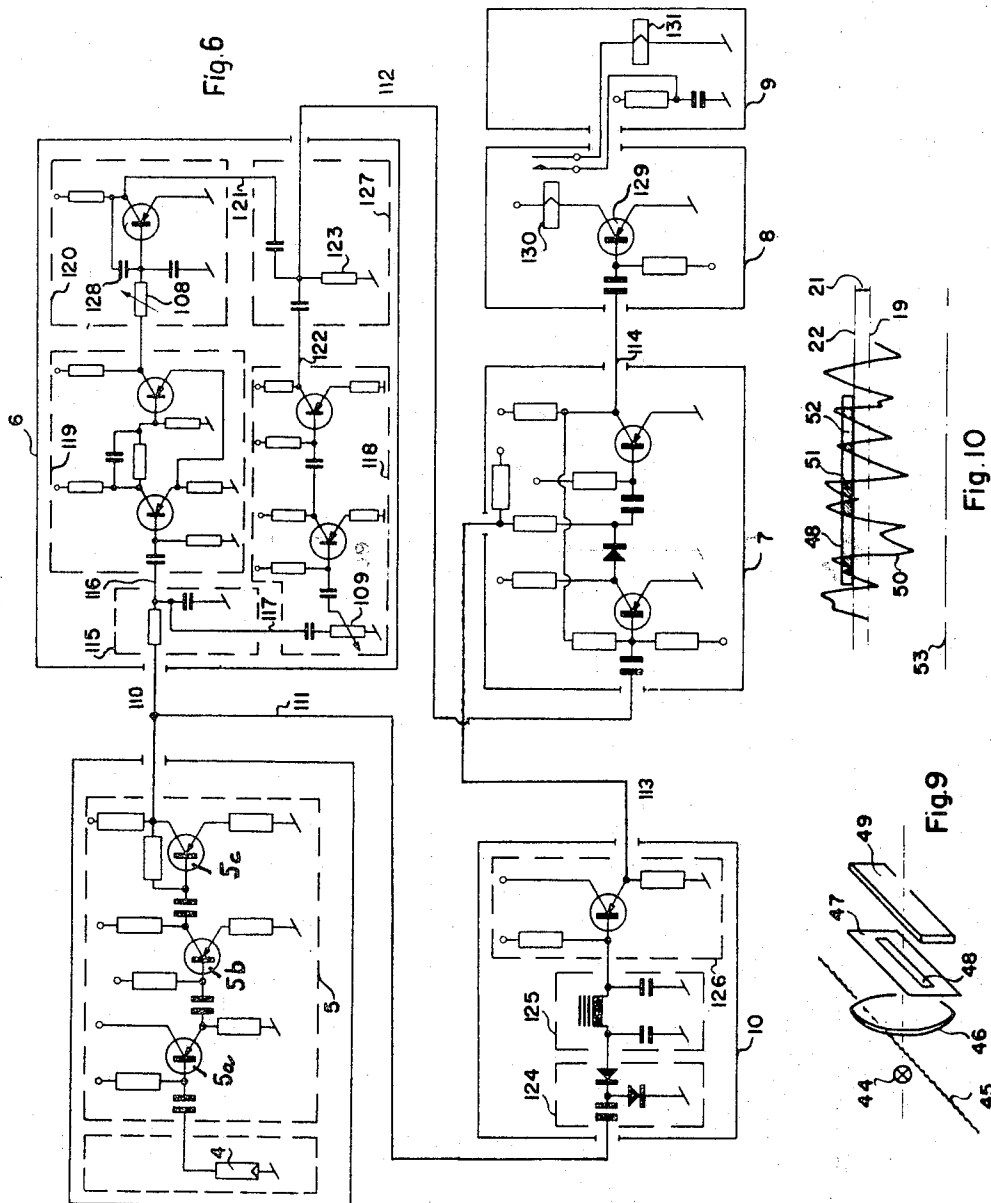
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APPARATUS FOR SENSING YARN IRREGULARITIES AND PRODUCING A CONTROL SIGNAL**Erich Loepfe, Forch, Zurich, Switzerland, assignor to Aktiengesellschaft Gebrüder Loepfe, Zurich, Switzerland, a joint-stock company of Switzerland**

Filed Dec. 16, 1963, Ser. No. 330,776

Claims priority, application Switzerland, Dec. 22, 1962, 15,076/62

27 Claims. (Cl. 73—160)

The present invention has reference to an improved process and apparatus for controlling the yarn in a winding machine by means of scanning the yarn thickness. The invention has significance, in particular, for a so-called "yarn cleaner." Under such there is to be understood an apparatus applied at a textile winding machine of any desired type which scans the throughpassing yarn for its uniformity and in the presence of an irregularity, such as constrictions, thickened portions, slubs, etc. delivers a control signal, such signal then can be employed for switching-out the corresponding winding station or location, for cutting the yarn, or for automatically cleaning the yarn at the corresponding location of irregularity.

The origin or formation of the irregularities of a yarn can be divided in accordance with two groups. The first group encompasses the natural, purely statistical fluctuations or variations which are conditional upon the number of fibers of a staple yarn and the thus resulting variations of the yarn cross-section. In addition thereto, there is distinguished a second group which is to be designated as the essential yarn flaws or defects, namely: (1) foreign bodies in the yarn, such as rinds, wood fragments or bast fibers; (2) defects resulting from machine imperfections, such as unround drafting cylinders; and (3) irregularities resulting from operating errors, such as unclean piecer and spun-in fly.

The present invention, therefore, contemplates as one of its primary objects to detect such essential defects out of the totality of irregularities coming into appearance, not, however, the statistical variations or fluctuations of the yarn cross-section.

Broadly speaking, this object is fulfilled according to the inventive process in that upon deviation of the yarn thickness from a pre-given range or limit there is determined the length of the faulty yarn portion exhibiting such deviation and this length is utilized for triggering a control operation or for the performance of a desired operation. While the foregoing gives in quite broad terms an underlying concept of the invention, the description to follow will explain specific embodiments of the inventive process for controlling the yarn at a textile machine, particularly a winding machine.

In actual practice it is difficult to always arrive at a good differentiation and determination of the essential or important defects for the large number of different types of yarn. It is often impossible to permit passage of short, relatively thick flaws which do not disturb to any great degree because they can be easily removed from the fabric, and, on the other hand, to determine long yarn sections or portions which exceed the average cross-section only by a small amount, but which are nonetheless strongly disturbing in the fabric or to its texture. Thus, even a small increase of the sensitivity of the control apparatus out of a range in which still too few thickened portions of the yarn are detected, can almost suddenly lead into a range having an unpermissively high detecting rate.

According to a preferred embodiment of the present invention it is possible to accommodate the process and the apparatus for carrying out such process, on the one hand, to the large number of different types of yarn in a manner that all essential flaws or defects are detected, and on the

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other hand, however, the natural or statistical irregularities are not taken into consideration. Due to the utilization of a second criterion in addition to the yarn thickness, namely, the lengthwise dimension of the faulty yarn section or portion, the elimination of a yarn defect location is made dependent upon two values or dimensions. By logically and/or functionally linking both dimensions it is possible to achieve considerable accommodation of the process to all conditions and all requirements which generally occur in actual practice and are placed upon the uniformity of the yarn.

Other objects, features and advantages of the present invention will become apparent by reference to the following detailed description and drawings illustrating a number of illustrative embodiments of the invention. The examples of the inventive apparatus illustrated in the drawings depict a so-called "yarn cleaner" by means of which sections or portions of the yarn possessing essential or important errors are automatically cut-out or otherwise controlled.

In the drawings:

FIG. 1 illustrates a block diagram of such an apparatus;

FIGS. 2 and 2a illustrate, by way of example, two respective sensing devices suitable for testing or scanning the yarn in the apparatus of FIGURE 1;

FIGS. 3 and 4 illustrate curve diagrams serving to explain several principles according to which the important or essential defects of a yarn can be detected with the apparatus according to FIG. 1;

FIG. 5 illustrates a special circuit which can be employed during execution of the principles described in conjunction with FIG. 4;

FIG. 6 is a detailed circuit diagram of the components of the system shown in the block diagram of FIG. 1;

FIG. 7 illustrates a curve diagram serving to explain a further principle employed for the determination of the important flaws or defects of a yarn;

FIG. 8 shows details of a circuit employed in carrying-out the principles explained with reference to FIG. 7;

FIG. 9 schematically illustrates a special constructional embodiment of an optical sensing device;

FIG. 10 graphically depicts the mode of operation of the sensing device of FIG. 9;

FIG. 11 is a block diagram illustrating a further embodiment of evaluation circuit adapted to be employed in the arrangement of FIG. 1;

FIG. 12 illustrates in block diagram a third embodiment of evaluation circuit adapted to be used in the arrangement of FIGURE 1;

FIG. 13 is a circuit diagram showing details of a specific component of the arrangement of FIGURE 12;

FIG. 14 shows a fourth embodiment in block diagram of an evaluation circuit; and

FIG. 15 is a detailed circuit diagram of a component of an evaluation circuit depicted in FIGURE 14.

Referring now to the drawings and, more particularly, to FIGURE 1, it will be recognized that the yarn 1 is drawn-off of a cop or supply spool 2 and wound-up a cross-wound bobbin or wind-up spool 3 at a non-illustrated winding machine. A sensing element 4 is operably arranged at the yarn 1, for example a transducer in the form of a photocell, as will be more fully explained shortly. The sensing element 4 serves to determine the thickness of the yarn 1 and to produce electric signals which indicate the variations of the yarn thickness, in a manner well known to the art. The voltage source generally associated with this sensing element 4 has, for the sake of simplicity, not been illustrated. In order to amplify the electric signals generated by the sensing element 4 there is electrically coupled to the aforesaid sensing element an input or low-level amplifier 5. The output of the input amplifier 5 is connected to the input of an evaluation device 11

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constructed according to the invention, also sometimes referred to herein as evaluation circuit 11.

In the present instance, the evaluation device 11 consists in its essential components for example, of a signal transforming or converter circuit 6 and a discriminator circuit 7 electrically coupled with its first input to the signal transforming circuit 6. Furthermore, the evaluation device 11 is here shown to be provided with an automatically operating threshold regulating circuit 10 connected between the output of the input amplifier 5 and a second input of the discriminator 7. The automatic threshold regulating circuit 10 is not an absolutely essential component of the evaluation circuit 11, yet, however, in many instances, improves its mode of operation. At the output of the discriminator 7 there is connected an output amplifier 8 and, to such, in turn, an operating member 9. This operating or executing member 9, in the present instance, in which one is concerned with a so-called "yarn cleaner," for example effects cutting of the yarn and bringing to standstill the non-illustrated winding apparatus as soon as essential or important yarn defects occur, that is to say, when there appear yarn defects which exceed the permissible threshold or thresholds.

The mentioned thresholds are determined by the construction and dimensioning of the evaluation device or circuit 11. These thresholds can be preset or are manually adjustable. In the present case they are automatically, continuously regulated by means of the threshold regulating circuit 10 in dependence upon the output signal of the feeler member or transducer 4 and the input amplifier 5, respectively, as such will be more fully described herein-after.

The signal transforming circuit 6 has the function of deriving transformed signals from the continuously delivered signal waves or curves coming from the input amplifier 5 which contain for example information regarding thickness of the yarn and length of the faulty yarn sections or portions in a form suitable for processing by the series connected discriminator 7. The discriminator 7 only allows such signals delivered by the signal transforming circuit 6 to arrive at the output amplifier 8 which in this case exceed the predetermined thresholds as regards the length and thickness of the faulty yarn portions or sections, and thereby denote considerable or essential yarn defects. After amplification in the output amplifier 8 the output signals thereof act upon the operating member 9. The operating member 9 can be constructed as a separating mechanism or device which upon actuation cuts the yarn 1. According to a variant embodiment this operating member 9 can also be constructed to act as a stop-motion device for the mechanism of the winding apparatus, or can carry out both functions.

In FIGURES 2 and 2a there are shown, by way of example, two respective embodiments of the sensing element, which in accordance with FIGURE 1 serve to test or scan the yarn 1. More specifically, in FIGURE 2 there is illustrated a sensing element 4a constructed as a condenser or capacitor 4' between the plates 4b of which passes the yarn 1 to be tested. In doing so, the capacitance of the condenser 4' is continually varied due to irregularities of the yarn 1. Such variations of the capacitance with the aid of electrical means can, in known manner, be employed for modulating a voltage signal. This modulated voltage signal can be further processed in the electric circuits in FIGURE 1.

In FIGURE 2a there is depicted a sensing element 4c incorporating a photocell 4''. A bundle of light rays generated by a light source 12 and which is modulated by the irregularities of the travelling yarn 1 impinges upon the photocell 4''. As a result, the photocell 4'' generates a modulated photo-current in accordance with these irregularities which can be further processed by the electric circuits illustrated in FIGURE 1.

The mode of operation of the signal transforming circuit 6 with respect to the derivation of what will be re-

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ferred to herein as length signals is illustrated in FIGURES 3 and 4 and in light of the curve diagrams depicted thereat, such signals representing a measure for the length of the portion or section of the tested yarn 1 exhibiting a flaw or defect.

In the upper portion of FIGURE 3 there is schematically depicted, in enlarged view, a faulty textile yarn 15 possessing a particularly thick yarn section or portion 14. The cross-section of the yarn 15 located between the arrows 16 is reproduced in the plane of the drawing by means of a collapsed, cross-hatched surface 17. The cross-section of the yarn 15, as shown in the drawing, is generally irregular. For this reason, it is recommendable to modify, in known manner, the photoelectric sensing devices of FIGURES 2 and 2a such that there can also be detected a yarn cross-section which deviates from a round or circular-form, so that the scanning operation gives a local average value of the diameter of the yarn derived from the cross-section in question.

In the lower portion of FIGURE 3 there is indicated in exact chronological or per unit time correlation with respect to the tested length of yarn 15 the electric signal wave or curve 25 generated by the sensing element 4 and input amplifier 5 of FIGURE 1, respectively, wherein the time increases from the left to the right of the graph. The horizontal line 19 in this case serves as the time axis which corresponds to the average value per unit time of the amplitudes of the signal wave 25, that is, the area disposed above the time axis 19 and beneath the signal curve 25, enclosed by the axis and signal curve, is the same size as the corresponding area lying beneath the axis 19, whereby these areas are averaged over a very long yarn portion or section. The position of the time axis 19 is essentially determined by the statistical variations of the yarn diameter, since considerable yarn defects such as perhaps thickening 14 occur very seldom. The amplitude of the signal wave or curve 25 measured from the time axis 19 is thus a measure for the deviation of the diameter or the local averaged diameter, respectively, of the yarn 15 at the cross-section of the yarn tested during the relevant period of time from the average value per unit time of the diameter.

Above the time axis 19 of FIGURE 3 there is located a parallel line 22 which should be considered and has been designated as a boundary or limit line, and is spaced from time axis 19 at a distance designated by reference numeral 21. The positive deviation of the amplitude of the signal wave 25 is determined by this boundary line 22, all tip or curve portions of the signal wave 25 above such limit or boundary line are utilized for obtaining a length signal in the signal transforming circuit 6 of FIGURE 1. The mentioned length signal thus serves for denoting faulty yarn portions.

The distances or sections shown by thick or darkened lines on or along the boundary line 22 cut by the signal wave 25 and which lie beneath the upwardly directed tips of the signal wave 25 define the length L of the faulty yarn portions. The thus determined yarn portions are, however, for the most part, attributable to statistical defects and, thus, not to important or essential yarn defects. The aforementioned distances on the boundary line 22 as well as the associated yarn portions shall hereinafter generally be referred to as "length portions or sections." Such a particularly large length portion 18 is disposed between the points of intersection 23 and 24 of the boundary line 22 with the signal wave 25, the maximum amplitude a of the signal wave 25 within this length portion 18 is designated by reference number 20.

In the simplest instance it is possible to consider the length L of such an individual length portion as criterion for a considerable yarn defect, that is, for such a defect which should result in actuation of the operating member 9 of FIGURE 1. In this case then it is only necessary to establish a permissive lower threshold value for the mentioned length and to dimension the apparatus of FIGURE

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1 in such a manner that upon exceeding this threshold value the operating member 9 is activated. In the block diagram of FIGURE 1 the mentioned threshold value is determined or fixed by the discriminator 7. The discriminator 7 then only permits such length signals to pass to the output amplifier 8 which show a transgression of the pre-set threshold value by the relevant length section or portion. In this simplified situation, the evaluation circuit can incorporate, at least as regards essential components thereof, a signal transforming circuit 6 including a trigger circuit, such as the Schmitt-trigger 119 of FIGURE 6, for forming length signals which can then be directly delivered to a discriminator 7, or else first integrated by a suitable integrator prior to delivery to such discriminator, the latter then responding in the manner just explained.

However, it generally better corresponds to the requirements of actual practice to derive a length signal from a series of successive length portions. In this manner there is obtained a dimension or value which hereinafter should be referred to as "resultant length." A continuous derivation of such type of length signal is explained in conjunction with FIGURE 4.

In FIGURE 4 the signal wave or curve produced by the sensing element 4 and input amplifier 5 (FIGURE 1) is designated by reference numeral 31. In the same manner as in FIGURE 3 there is here shown a time axis 19 and a boundary or limit line 22. From the signal curve or wave 31 there is derived a rectangular or square-wave train 32 of constant height, as such will be further explained in conjunction with FIGURE 6, whereby the length of the individual rectangular or square-wave pulses indicates the magnitude of the associated length sections or portions which the signal wave or curve 31 produces on the boundary line 22. From this rectangular or square-wave train 32 there is derived a continuous zigzag wave or curve 33 which consists of alternating ascending and descending curve portions. The ascending portions per unit time of the zigzag curve 33 represent an integration per unit time of the associated square-wave pulse of the rectangular or square-wave 32. The subsequent descending curve portions possess an inclination which is determined in desired sense by the time-constant of the apparatus, as will be further explained shortly.

It is possible to achieve such a wave-form or curve 33 from a rectangular or square-wave 32, in the simplest case, with the help of an electric transducer or quadripole as shown in FIGURE 5, incorporating a storage condenser 35 with a parallel resistor 36 as shunt element and a diode 34 as series element coupled to one of the input conductors. If the series of pulses 32 is applied to the diode 34 then there occurs during the pulse duration, charging of the condenser 35 via the diode 34 and during the pulse gaps or spaces discharging via the resistor 36. The diode 34 blocks during the period of discharge of the network input.

In FIGURE 6 there is illustrated a detailed circuit diagram of the apparatus depicted in block diagram in FIGURE 1. In both FIGURES 1 and 6 the reference numerals 4, 5, 6, 7, 8 and 9 designate the same circuit components. The mode of operation of the apparatus depicted in FIGURE 6 will now be described with reference to the previous figures.

The sensing element 4 in accordance with FIGURE 6 is constructed as a silicon photoelement for example, and corresponding to the schematic representation of FIGURE 2 is operably arranged at the yarn to be scanned or tested. The input or low-level amplifier 5 capacitively coupled with the photoelement 4 contains three capacitive coupled transistor stages 5a, 5b, 5c providing a voltage amplification of about a thousand times. The alternating-current voltage signal delivered by the photoelement 4, lying in the millivolt range, is amplified into an alternating voltage in the volt range by means of this amplifier 5. The alternating voltage signal delivered by the input

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amplifier 5 arrives, on the one hand, via the conductor 110 at the signal transforming circuit 6 and, on the other hand, via the conductor 111 at the threshold regulating circuit 10.

The signal transforming circuit 6 contains a smoothing element 115 which smooths the sharp tips of the signal wave or curve 25 of FIGURE 3 and wave or curve 31 of FIGURE 4, respectively. Two parallel channels connect with the smoothing element 115, namely a length channel 116, 119, 121 for determining and evaluating the length portions of the signal curves 25 or 31, respectively, and an amplitude channel 117, 118, 122 for evaluating the amplitudes of the signal wave, that is to say, the deviations of the yarn diameter from the average value per unit of time which is determined or fixed by the time axis 19 of FIGURES 3 and 4. Both of these channels, namely length channel and amplitude channel are connected with their outputs to a linking or combining circuit 127 in which, in this instance, there occurs an addition of the output signals coming from both of these channels. This linking circuit 127 forms the output circuit of the signal transforming network or circuit 6.

The length channel of the signal transforming circuit 6 in this case is shown to incorporate a bistable multivibrator or Schmitt-trigger 119 and a subsequent Miller-integrator 120. The Schmitt-trigger 119 remains blocked for input pulses the height of which lie beneath a predetermined limit. It effects a transformation of the signal wave or curve delivered from the smoothing element 115 according to the diagram of FIGURE 4, whereby a rectangular or square-wave 32 results. The subsequently connected Miller-integrator 120 transforms the square-wave 32 into a zigzag wave or curve 33, the amplitudes of which contain the desired information concerning the length portions, that is, the above defined resultant length. It is apparent that this resultant length in the case of FIGURE 4 is not formed by integrating the successive length portions. Indeed, a given amplitude of the zigzag curve 33 contains contributions from all previous or preceding length sections, however these contributions are relatively that much smaller the further the individual length portions lie back on the time axis 19. In order to guarantee for a purposeful mode of operation of the length channel in actual practice, the time-constant for the charging of the storage member 128 of the Miller-integrator 120 should be in the same order of magnitude as the time-constant for discharging of this storage member. For the purpose of adjusting these time-constants to one another the input resistor 108 of the integrator circuit 120 is constructed as an adjustable resistor.

The amplitude channel of the signal transforming circuit 6 contains a linear functioning amplifier 118 whose amplification can be changed by means of an adjustable resistor 109 arranged in its input circuit. In the linking circuit 127 there is formed the sum of the resultant length according to wave or curve 33 of FIGURE 4 and the amplitude of the smoothed and linear amplified signal curve 31 according to this same FIGURE 4.

The thus resulting combined or summation signal is delivered via the conductor 112 to the first input of the discriminator 7 advantageously constructed as a monostable multivibrator for example. This discriminator 7 only responds to such input signals from the conductor 112, the value or magnitude of which exceed a predetermined threshold value. This threshold value is determined by the direct-current bias voltage delivered by the threshold regulating circuit 10 via conductor 113 to the second input of the discriminator 7. If response occurs then the discriminator 7 delivers but one time a rectangular or square-wave pulse to its output lead 114. This pulse is amplified in the output amplifier 8 and effects triggering of the relay 130 which, in turn, causes actuation of the cutting or separating knife 131 in the operating circuit 9 such that the tested or scanned yarn is cut off.

The mode of operation of the automatic threshold

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limiting circuit 10 is as follows: The alternating voltage signal delivered by the conductor 111 of the input amplifier 5 is rectified in the rectifier circuit 124 and is smoothed by the subsequent filter member 125. The buffer or separator stage 126 following the filter member 125 delivers a direct-current voltage which is proportional to the pulsation factor or waviness of the signal curve, and which thereby provides a measure for the irregularity of the scanned yarn. This direct-current voltage is delivered via the conductor 113 to the second input of the discriminator 7 and effects a regulation or adjustment of the threshold response of such discriminator in such a manner that, with strong irregularity the threshold is relatively high and with small irregularity the threshold is relatively low. Due to this type of automatic control of the threshold response or sensitivity, the statistical irregularities of the cross-section of the different yarns are taken into consideration.

FIGURES 7 and 8 illustrate a principle wherein by means of intermittent interrogation a different type of length information can be obtained regarding the faulty yarn portions. In contradistinction thereto, the principle illustrated with reference to FIGURE 4 provides for a continuous transmission or output of length information which is given by the zigzag curve 33.

The sequence or train of square-wave or rectangular pulses 37 depicted in FIGURE 7 is obtained in corresponding manner as was previously described with reference to the square-wave curve 32 of FIGURE 4. By means of continuous integration of the square-wave pulses 37 there is derived a stepped curve 39, the height of which in each case denotes the "overall length" of all integrated length portions. In contradistinction to FIGURE 4, in this case the level of the curve 38 for the pulse spaces or gaps now remains constant. For the purpose of gaining the desired length information the stepped wave or curve 38 in this instance is periodically interrogated by means of a predetermined interrogation frequency, whereby at the same time, as represented by the end flank 39, there occurs a return of the stepped curve 38 to the null level. The period or point of time of interrogation is designated in the figure by means of the arrow 40.

In FIGURE 8 there is illustrated an electric transducer or quadripole by means of which the stepped curve 38 depicted in FIGURE 7 can be obtained. This electric transducer consists of a storage condenser 42 with parallel connected controllable switch member 43 as shunt element and a charging diode 41 as series element. The switch member 43 serving for discharging the storage condenser 42 is conveniently indicated in FIGURE 8 with the usual switch symbol; normally, however, such switch member 43 is constructed as a controllable electronic switch, for example as a transistor, the emitter-collector path of which is controlled as the switching path via the base. The interrogation frequency of the controllable switch element can be adjusted through the agency of known means by hand, or can be controlled automatically in dependence upon the speed of travel of the yarn. The length information obtained in accordance with FIGURES 7 and 8, in each case gives the sum of the lengths of all length portions over a finite length of yarn obtained during an interrogation cycle.

FIGURES 9 and 10 demonstrate a manner for length evaluation in which there likewise occurs a summation of individual length sections or portions, and moreover, through the agency of purely optical means in place of the electric means of FIGURES 7 and 8.

In FIGURE 9 there is depicted a yarn testing device which consists of a point source of light 44, image lens 46, a diaphragm or shield 47 having an elongated rectangular slot 48 extending in the lengthwise direction of the yarn 45, and a photoelement 49. The yarn 45 travels between the light source 44 and the lens 46. The apparatus is adjusted such that the peripheral portions of the yarn 45 fall onto the gap 48, as such is schematically represented in FIGURE 10 now to be explained.

According to FIGURE 10 the width of the gap 48 is

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transverse to the lengthwise direction of the yarn 45 represented by the center-line 53, and is small in comparison with the maximum amplitude variation of the information signal 50 representing variations of the edge or peripheral line of the yarn and which corresponds to the signal wave or curve 25 of FIGURE 3. The time axis 19, the boundary line 22 and the mutual spacing 21 accordingly have a corresponding meaning as defined in conjunction with FIGURE 3. Moreover, the lower longitudinal edge of the elongated gap 48 corresponds to the boundary line 22, as clearly shown in FIGURE 10. The area beneath the wave or curve 50 corresponds to the yarn portions which do not permit passage of light, the area above the curve 50 the locations of free passage of light. The yarn portions which do not permit passage of light and lying within the gap 48 correspond to the cross-hatched illustrated sections 51, the transparent gaps 52 the portions of the yarn lying therebetween.

The light-current arriving at the photoelement 49 is a measure for the overall length of the yarn portions which exceed the permissive boundary line towards the top. The sensing device of FIGURE 9 thus delivers by virtue of the output voltage of the photoelement 49 a continuous information regarding the overall length of the yarn defects appearing within a predetermined or finite yarn length. The electric apparatus for evaluating this information is considerably simplified in comparison with the electric apparatus of FIGURE 1 by employing the sensing device illustrated in FIGURE 9. In this case then the evaluation circuit 11 provided in FIGURE 1 is reduced to the discriminator 7 which is activated each time then, and actuates the operating member 9 through the agency of the output amplifier 8, when the amplitude of the signal delivered by the input amplifier 5 exceeds a predetermined limit.

In FIGURE 11 there is depicted a further embodiment of an evaluation circuit 11 which can be used in lieu of the corresponding evaluation circuit of FIGURE 1. In accordance with FIGURE 11 the evaluation circuit 11 consists of the following series connected individual circuits: a trigger circuit 54, a modulator circuit 55, an amplitude discriminator circuit 56, an integrator circuit 57 and a length discriminator circuit 58. In order to explain the mode of operation of the evaluation circuit 11 of FIGURE 11, there is indicated above the individual boxes schematically representing the aforesaid individual circuits a schematic representation of the output signals produced by such respective circuits, whereby the numbers appearing in parentheses in each case beneath the indicated output signal designate the association thereof with the individual circuit also designated by the same reference numeral.

The output signal (5) of the input amplifier 5 (FIGURE 1); in accordance with FIGURE 11, is supplied to the trigger circuit 54 as well as also to the modulator circuit 55. This output signal (5) contains, as described in detail in conjunction with FIGURE 3, information regarding the length L of the faulty yarn portions and information regarding the amplitude of the variations in diameter. In the trigger circuit 54, which for example can advantageously be constructed as a Schmitt-trigger, there is derived a rectangular or square-wave pulse (54) the height of which is independent of a , the length of which however, is proportional to L . The square-wave pulse (54) is modulated in its amplitude with the maximum amplitude a of the relevant yarn portion in the modulator 55, to which is delivered as second input signal the output signal (5) of the input amplifier 5. The rectangular or square-wave pulse (55) appearing at the output of the modulator circuit 55 is in its length proportional to L and in its height proportional to a . This pulse (55) is delivered to the discriminator 56 which, for example, can be a Schmitt-trigger, and which produces an output pulse (56) of constant height when the height of the pulse (55) exceeds a predetermined threshold. The length of the pulse (56) is

proportional to L . In the integrator circuit 57 which, for example, is constructed as a Miller-integrator, the pulse (56) is integrated, whereby there results a ramp or triangular pulse (57), the end height of which is proportional to L . The discriminator circuit 58, for example a monostable multivibrator, produces a constant, that is to say, an output signal (58) independent of L , if only the end height of triangular or ramp pulse (57) exceeds a predetermined threshold value. The output signal (58), as described in conjunction with FIGURE 1, is delivered to the output amplifier 8 and thereby influences actuation of the operating member 9.

Quite obviously, with an apparatus as described according to FIGURE 11 there is also possible the occurrence of an additional automatic regulation, as has been described within the framework of FIGURE 1 with reference to the threshold regulating circuit 10.

In the illustrated embodiment of FIGURE 11, and for the purpose of actuating the operating member 9, the threshold value of the amplitude discriminator circuit 56 as well as also the threshold value of the length discriminator 58 must be exceeded. Thus, the cross-section or diameter of the yarn as well as also the length of the relevant yarn portion must therefore exceed a respective predetermined threshold value. There accordingly appears a logical linking in the sense of a conjunction of length L and amplitude a (not only-but also i.e. coincidence).

In this example, as well as generally, the discriminators for amplitude and length can be constructed such that in addition to an upper threshold they also contain a lower threshold, in such a manner that they become operable when exceeding the upper threshold towards the top and when exceeding the lower threshold towards the bottom, and thereby effect actuation of the operating member 9.

A further embodiment which effects a logical linking of length L and amplitude a is depicted in the block diagram of FIGURE 12, wherein only the construction of the evaluation circuit 11 of FIGURE 1 will be considered, since the remaining components can be arranged in accordance with FIGURE 1. The blocks 54, 55, 56 and 57 depicted in the upper row of this figure possess the same construction and mode of operation as the corresponding blocks designated with like reference numerals in FIGURE 11. However, in accordance with FIGURE 12 the output signal of the modulator circuit 55 and the output signal of the integrator circuit 57 are delivered to an amplitude discriminator 60 and a length discriminator 61, respectively. The output signals of both of these discriminators appearing when exceeding the threshold values are delivered to a logical circuit 62 which processes the mentioned output signals, for example in the sense of a conjunction. The output of the logical circuit 62 is connected with the output amplifier 8 of FIGURE 1.

In FIGURE 13 there is illustrated a coincidence network which can be employed as the logical circuit 62 of FIGURE 12. This coincidence network only then delivers a signal at its output 71 when input signals simultaneously appear at both of its inputs 72 and 73. The coincidence network contains two parallel branches, each of which are provided with a diode 65 and 66 respectively, and a resistor 67 and 68 respectively, in series connection. Both of these branches are connected to one end of a resistor 69 at the side of the diodes 65, 66. The other respective ends of the branches are connected to ground. If a positive potential or voltage is applied to the free end of the resistor 70 then a voltage signal only appears at the output 71 if at both of the inputs 72 and 73 there simultaneously arrive input signals. It is also possible to employ a different circuit for the logical circuit 62 in the block diagram of FIGURE 12 which processes the input signals in the disjunctive sense (either-or).

In FIGURE 14 there is illustrated in block diagram a further embodiment of an evaluation circuit 11 in which there is carried out a functional linking of length L and amplitude a . The evaluation circuit 11 in this embodiment consists of four components connected in series, namely, a trigger circuit 54, a modulator circuit 55, a linking circuit 63 and a discriminator circuit 64. The trigger circuit 54 and the modulator circuit 55 are correspondingly constructed and have the same function as such has been described with reference to FIGURE 11. The output signal of the modulator 55 is thus a rectangular or square-wave pulse, the duration of which corresponds to the length L and the height of which corresponds to the maximum amplitude a of the length portion belonging to length L . Both of the variables a and L thus appear in the output signal of the modulator 55 as separated values. This output signal is delivered to the non-linear linking circuit 63 which delivers a signal at its output the terminal amplitude of which is proportional to the product $a \cdot L^2$ for example.

The non-linear linking circuit 63 is reproduced in FIGURE 15 in the form of a detailed circuit diagram. This linking circuit 63 consists of an electric transducer or quadrupole having two series connected resistors 87 and 88, and two condensers 89 and 90 as shunt elements. These circuit components are dimensioned such that the voltage signal at the input 91 is always large in comparison with the voltage signal at the junction point 92 of the resistors 87 and 88, and the voltage signal at junction 92 is again large in comparison with the voltage signal at output 93. In this instance, the non-linear linking circuit 63 carries out a double integration of the applied input signal with respect to time, that is to say, the output signal of the linking circuit 63 possesses an amplitude which within the relevant pulses is proportional the time squared. The end or terminal amplitude of the output signal thus possesses an amplitude which is proportional to the square of the duration of the pulses and thereby proportional L^2 and also proportional to the amplitude a of the input signal. This end amplitude thus provides a function which climbs monotonically with a and L and which, therefore, can be employed for controlling a discriminator as well as also the variable a and L themselves.

It is to be distinctly understood that the invention is in no way limited to what has been referred to herein as a so-called "yarn cleaner", and as such has been illustrated in the figures. Thus, for example, the operating member 9 of FIGURE 1 can also be constructed as a counter device or mechanism by means of which the number of essential or considerable defects of the yarn for a given period of time or in a given yarn of larger length can be indicated or registered. The operating member 9 can also serve to control the yarn in another manner, for example by continuously photographing, by means of a photographic camera, the yarn portions exhibiting an essential or important defect.

While there is shown and described present preferred embodiments of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. Apparatus for producing signals for yarn control comprising:

- (a) means for generating time dependent input electrical signals varying in accordance with thickness of said yarn;
- (b) first means receiving input signals from said generating means and producing first output signals from the input signals received thereby, which first output signals indicate the lengths of the yarn in which irregularities in the thickness are outside a given range;
- (c) second means receiving input signals from said generating means and producing second output electrical

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signals, which second output electrical signals indicate the thickness of irregularities in said lengths of yarn; and,

- (d) means responsive to said first and second output signals for triggering a desired operation to be performed with respect to the yarn.

2. Apparatus according to claim 1 wherein said first means includes means responsive to said input signals to produce first output signals which indicate the length of individual yarn portions in which the irregularities in thickness exceed a given value and the distances between said portions.

3. Apparatus according to claim 1 wherein said first means includes means responsive to said input signals to produce first output signals which indicate the overall length of the yarn portions in which the irregularities in thickness exceed a given value over a finite length of the yarn.

4. Apparatus according to claim 1 wherein said second means includes means responsive to said input signals to produce second output signals which indicate the maximum value of the yarn thickness within said lengths of the yarn.

5. Apparatus according to claim 1 wherein said means responsive to said first and second output signals includes means for combining and evaluating said first and second output signals and generating a trigger signal when a mathematical function of the length as well as of the thickness of said lengths of yarn portions exceeds a predetermined value.

6. Apparatus according to claim 5 wherein said means for combining and evaluating said first and second output signals includes function forming network means for establishing a mathematical relation between the length and the thickness of the said lengths of yarn, and discriminator means for generating a trigger signal when said relation exceeds a given threshold value.

7. Apparatus according to claim 6 wherein said function forming network means include means for adding said first and second output signals.

8. Apparatus according to claim 6 wherein said means for combining and evaluating said first and second output signals include modulator means for producing pulses having a length and height correlated to the length and the maximum thickness of said lengths of yarn.

9. Apparatus according to claim 1, wherein said means responsive to said first and second output signals includes circuit means for combining and evaluating said first and second output signals, said circuit means comprising discriminator means for said first output signals, and discriminator means for said second output signals, said discriminator means being connected to generate a trigger signal when the length or thickness or both of said length of yarn exceeds predetermined threshold value.

10. Apparatus for producing signals for yarn control means for testing yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising signal transforming circuit means for generating information signals regarding the length of faulty yarn portions, and discriminator means responsive to length signals exceeding a predetermined threshold value, and an operating member activated by said discriminator means when the latter responds.

11. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising a signal transforming circuit for producing signals indicating the resultant length of a series of successive faulty yarn portions and discriminator means responsive to resultant length signals exceeding a predetermined threshold value, and an operating member activated by said discriminator means when the latter responds.

12. Apparatus for controlling a yarn according to claim

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11 wherein said signal transforming circuit includes a length channel.

13. Apparatus for controlling a yarn according to claim 12 wherein said length channel includes a bistable multi-vibrator and an integrator.

14. Apparatus for controlling a yarn according to claim 12 wherein said length channel includes a Schmitt-trigger and a Miller-integrator.

15. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising a signal transforming circuit and processing means, and an operating member activated by said processing means when the latter responds, said signal transforming circuit including a length channel for generating information signals regarding the resultant length of a series of successive faulty yarn portions and an amplitude channel for evaluating the amplitudes of the signals generated by said testing means, and a linking circuit for combining the resultant length signals with the amplitude signals of the amplitude channel, said processing means being a discriminator responsive to the signals received from the linking circuit exceeding a predetermined threshold value.

16. Apparatus for controlling a yarn according to claim 15 wherein said amplitude channel includes a linear functioning amplifier.

17. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising a signal transforming circuit for producing signals containing information concerning faulty yarn portions and means for processing such information signals, and an operating member activated by said processing means when the latter responds, said signal transforming circuit incorporating means for generating information signals regarding the overall length of the faulty yarn portions of a finite length of yarn, said processing means being a discriminator responsive to overall length signals exceeding a predetermined threshold value.

18. Apparatus for controlling a yarn according to claim 17 wherein said overall length signal generating means comprises a storage condenser with a parallel connected controllable switch member as shunt element and a diode as series element.

19. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals and producing signals containing information concerning faulty yarn portions and means for processing such information signals, and an operating member activated by said processing means when the latter responds, said evaluation means comprising a trigger, modulator, amplitude discriminator, integrator and length discriminator.

20. Apparatus for controlling a yarn according to claim 19 wherein said trigger, modulator, amplitude discriminator, integrator and length discriminator are successively connected in series.

21. Apparatus for controlling a yarn according to claim 19 wherein said amplitude discriminator and integrator are connected in parallel to one another at the output of said modulator and said length discriminator is connected to the output of said integrator, and a logical circuit connected to the respective outputs of said amplitude discriminator and length discriminator.

22. Apparatus for controlling a yarn according to claim 21 wherein said logical circuit is designed as a coincidence network.

23. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals and for producing signals containing information concerning faulty yarn portions

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and means for processing such information signals, and an operating member activated by said processing means when the latter responds, said evaluation means comprising a trigger, modulator, linking circuit and discriminator.

24. Apparatus for controlling a yarn according to claim 23 wherein said linking circuit is a non-linear linking circuit.

25. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising a signal transforming circuit for producing signals containing information concerning faulty yarn portions and discriminator means for processing such information signals, and an operating member activated by said processing means when the latter responds.

26. Apparatus for controlling a yarn according to claim 25 wherein said evaluation means further includes a threshold regulating circuit for automatically regulating the threshold response of said discriminator circuit.

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27. Apparatus for controlling a yarn comprising means for testing a yarn and for generating signals concerning variations of the yarn thickness, evaluation means for receiving the generated signals, said evaluation means comprising means for producing signals containing information concerning faulty yarn portions and means for processing such information signals, an input amplifier coupled between said yarn testing means and said evaluation means, and an operating member activated by said processing means when the latter responds.

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