Nov. 14, 1961 H. LOCHER 3,009,101

DEVICE FOR DETERMINING SPONTANEOUS CROSS SECTIONAL VARIATIONS IN TEXTILE MATERIALS

Filed May 5, 1959 5 Sheets-Sheet 1

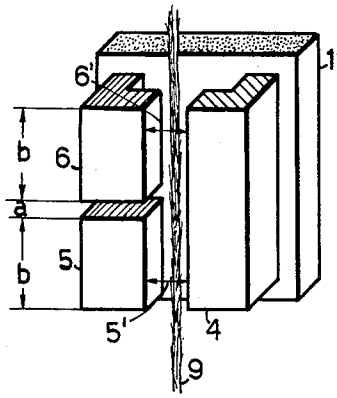


Fig. 1

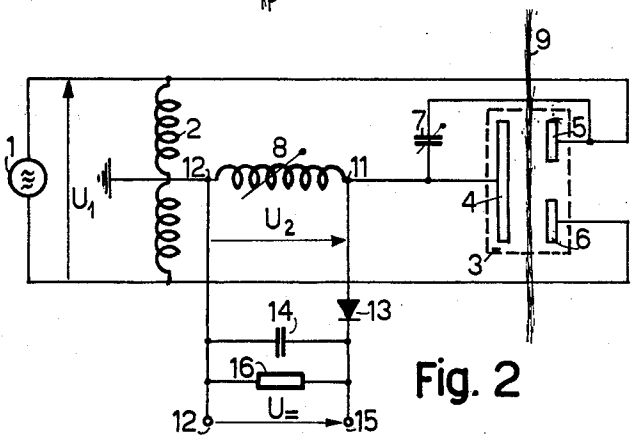


Fig. 2

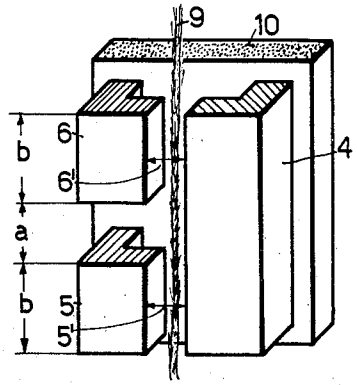


Fig. 3

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Fig. 4

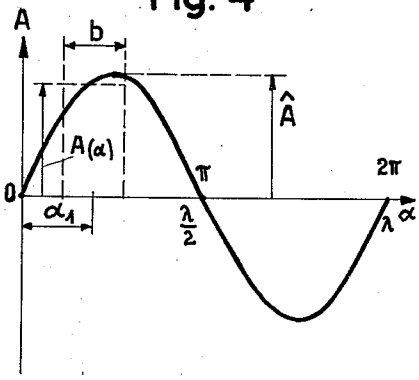
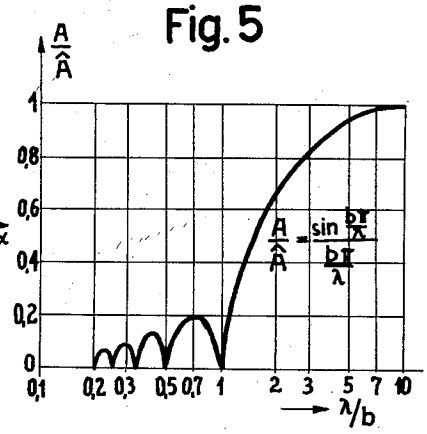


Fig. 5



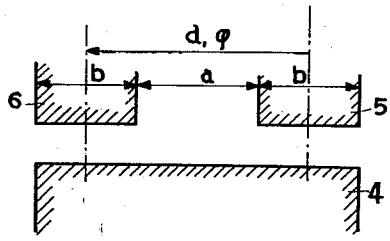


Fig. 6

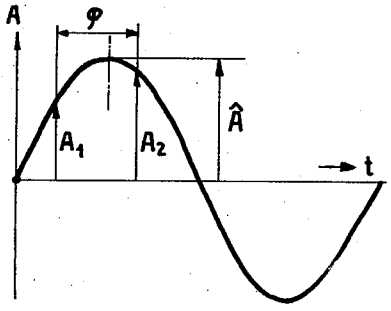
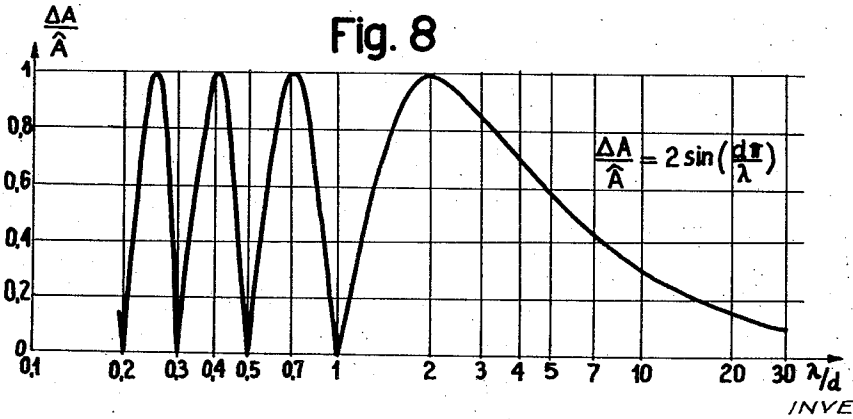


Fig. 7

Fig. 8



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DEVICE FOR DETERMINING SPONTANEOUS CROSS SECTIONAL VARIATIONS IN TEXTILE MATERIALS

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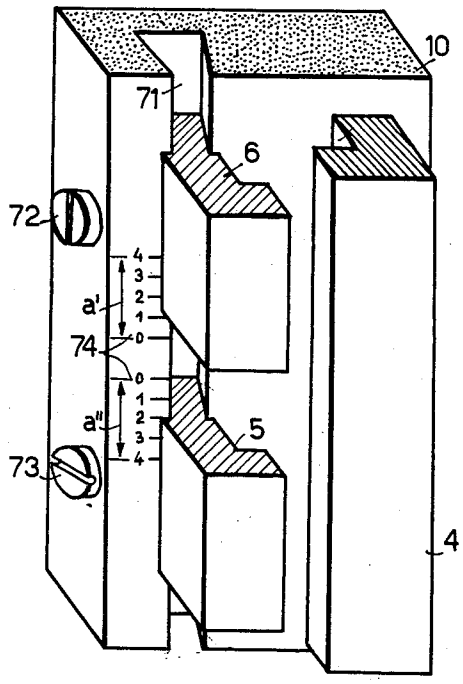


Fig. 9

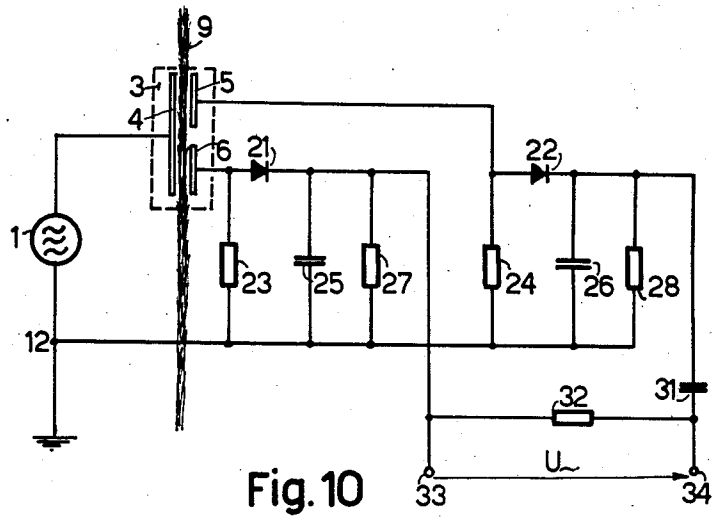


Fig. 10

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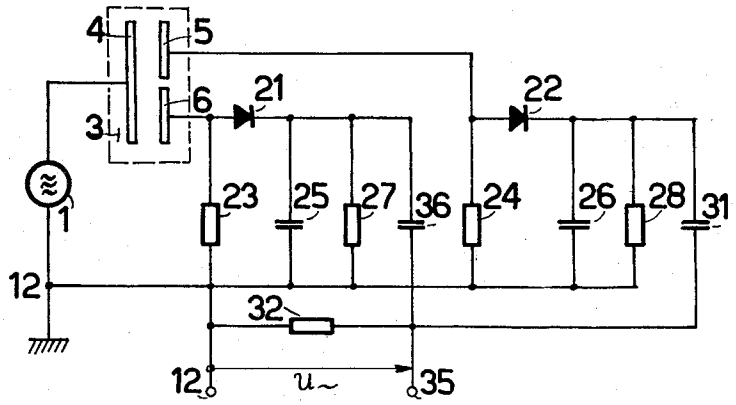


Fig. 11

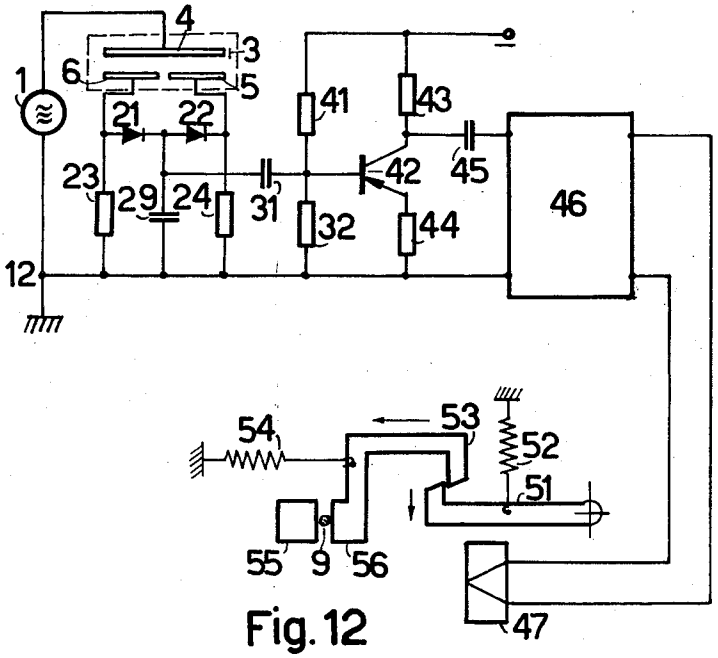


Fig. 12

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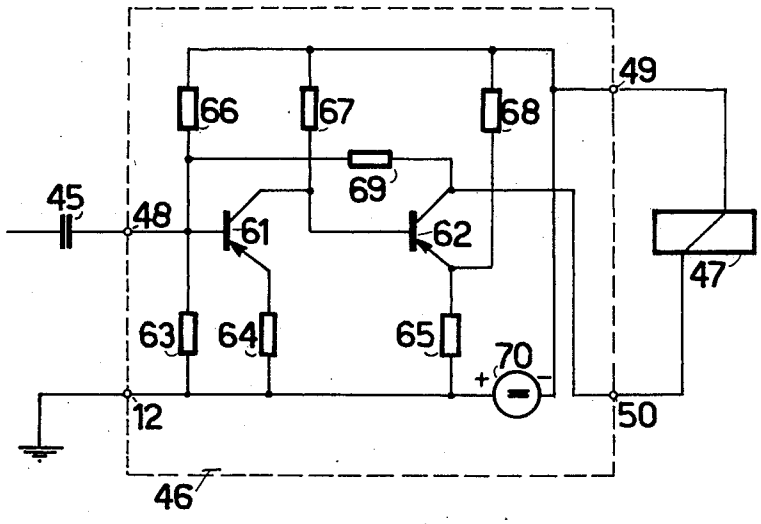


Fig. 13

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3,009,101

DEVICE FOR DETERMINING SPONTANEOUS CROSS SECTIONAL VARIATIONS IN TEXTILE MATERIALS

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Claims priority, application Switzerland May 9, 1958
7 Claims. (Cl. 324—61)

The present invention relates to a method and device for determining spontaneous cross sectional variations in textile materials.

When spinning yarn it is desired to produce material whose cross section does not materially change. Particularly two groups of irregularities are observed:

Firstly, so-called count variations which occur in waves having a length of approximately 10 cm. to several thousand meters. These count variations are due to inaccurate operation of the spinning machines and their amplitudes can be reduced by better adjustment of the machines.

Secondly, spontaneous thickening and thinning which in most cases extend along the yarn for only a few centimeters and which have several causes. Short yarn portions of increased thickness are very undesirable because when knitting, they cannot pass through the eyes of the needles and therefore cause frequent needle breaks. When weaving thick yarn portions cause a number of difficulties such as poor appearance of the woven fabric and additional loom stoppages which are necessary because the thick portions chafe in the harness and cause thread breakages.

Attempts have been made to eliminate all spontaneous cross sectional variations in the textile material by providing in the yarn processing machines, for instance, in the winding machines, supervisory systems which break the thread where undesired thickening occurs. Of the various systems which serve this purpose, some contain only purely mechanical devices and recently others combine mechanical and electronic devices.

Mechanical devices use plates which have slots of a specific width, through which slots the textile material to be checked is drawn. If the yarn thickness increases to a predetermined value the movement of the thread is stopped and the thread is broken. These devices have the disadvantage that when the slot is narrow enough to stop all defects, the yarn is damaged by chafing, whereas when the slot is wide enough to prevent chafing, thick portions which should be broken off will pass through the slot.

In conventional electronic measuring means difficulties are experienced which are chiefly caused by the electronic measuring devices themselves. The long wave count variations must be distinguished from short cross sectional variations of the textile material. Conventional devices electrically produce a signal varying as a function of the thickness of the yarn. The thickness of the yarn varies relatively to an average thickness and the deviations of the thickness can be used for producing different electric wave lengths. In the electric image an alternating voltage is superimposed on a D.C. component, whereby the frequency of the alternating voltage can be obtained by using the formula

$$f=\frac{v}{\lambda}$$

f being the frequency of the alternating current component of the electric image, v being the travel velocity of the yarn, and λ the length of the cross sectional variations.

The superimposed A.C. voltage is a very complex mixture of frequencies. For detecting only those portions of the textile material whose cross section is increased but which are short, electric frequency filters have been employed. These filters respond only to predetermined relatively high frequencies of the electric image of the cross section of the textile material, the frequencies depending not only on the cross sectional configuration of the examined material portion but also on the velocity at which it travels through the checking point. Since the speed of operation of the spinning machines, for example of winders, is not constant the characteristics of the frequency filters of the conventional electronic measuring apparatus must be coordinated with the respective velocities. This is a great disadvantage and impairs the operating reliability of such apparatus.

Other disadvantages of conventional apparatus are deviations of the average indications due to disturbances in the electric measuring system, for example those caused by varying temperatures.

The present invention overcomes the aforementioned difficulties by providing a method for indicating cross sectional variations of relatively short portions of textile materials, for example, yarns, rovings, and slivers wherein the material to be examined passes through a combination of electric measuring condensers including at least two neighboring measuring fields, the respective condenser elements being interposed in two different branches of an electric bridge circuit, so that short cross sectional variations can affect only one condensing field at a time and the bridge is unbalanced by short cross sectional irregularities whereas long cross sectional irregularities simultaneously affect both measuring fields in the same way and do not disturb the balance of the electric bridge.

The present invention also provides an apparatus for registering and eliminating undesired short cross sectional irregularities in textile materials wherein the textile material consecutively passes through at least two neighboring measuring fields formed by a combination of measuring condensers having at least three electrodes and arranged in different branches of an electric bridge circuit. Disturbance of the balance of the latter produces indications and control signals corresponding to short cross sectional variations of the textile material.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawing, in which:

FIG. 1 is a diagrammatic perspective illustration of a measuring condenser combination.

FIG. 2 is a circuit diagram.

FIG. 3 is a diagrammatic perspective illustration of a modified condenser arrangement.

FIG. 4 is a diagram illustrating a sinusoidal cross sectional variation.

FIG. 5 is a diagram illustrating functions at different electrode lengths.

FIG. 6 is a diagram showing dimensions of a measuring condenser combination.

FIG. 7 is a diagram illustrating a sinusoidal cross sectional variation.

FIG. 8 is a diagram illustrating functions at different electrode spacings.

FIG. 9 is a perspective diagrammatic illustration of an adjustable measuring condenser combination.

FIGS. 10 and 11 illustrate two modifications of electric circuits.

FIG. 12 is a more detailed diagrammatic illustration of

another modification of an electric circuit and of means actuated thereby.

FIG. 13 is an electric circuit diagram of a part of the arrangement shown in FIG. 12.

In FIG. 1 numerals 4, 5 and 6 designate condenser electrodes mounted on a common insulated base plate 10 whereby the condenser electrode 4 is opposite the condenser electrodes 5 and 6. The latter are spaced from each other by a distance *a*. The textile material 9 to be examined passes at constant speed through passages 5', 6' between the electrode 4 and the electrodes 5 and 6, respectively. Each of the three condenser electrodes 4, 5 and 6 is connected to a source U_1 of high frequency voltage as will be described below. Two electric fields are formed between opposed surfaces of the condenser electrodes whereby the textile material 9 forms part of the dielectric.

FIG. 2 shows the arrangement of the measuring condenser combination 3 in an electric circuit. The high frequency voltage U_1 obtained from a high frequency generator 1 passes through an earthsymmetric coil 2. The condenser electrodes 5 and 6 are arranged in parallel relation to the coil 2 whereas the condenser electrode 4 is connected through a choke coil 8 to the grounded center 12 of the coil 2. A trimmer condenser 7 affords adjustment of the two branches of the electric bridge to counteract minor asymmetries of the system. This adjustment is effected by changing the capacity of the trimmer condenser 7 when no material passes through the measuring fields 5' and 6' until the high frequency voltage U_2 between the ends 11 and 12 of the coil 8 is zero. When the device is in operation the high frequency voltage U_2 is restified in a rectifier 13 and filtered through a filter condenser 14 so that an easily measurable D.C. voltage $U_=$ is available between terminals 15 and 12' across a parallel resistor 16. When the measuring fields 5' and 6' are empty or contain equal amounts of textile material to be examined, the high frequency bridge is balanced and no high frequency voltage occurs across the coil 8 between the points 11 and 12. When there is a relatively greater amount of textile material in one of the measuring fields 5' or 6', i.e., when the average cross section of the material in the two measuring fields is not the same, the electric bridge is unbalanced and there is a high frequency voltage between the points 11 and 12 which voltage is rectified and appears as D.C. voltage $U_=$ between the points 15 and 12'. The presence of this D.C. voltage indicates that there are different amounts of textile material in the fields 5' and 6'. The D.C. voltage $U_=$ may be amplified and used for operating registering and/or correcting mechanisms. The D.C. voltage $U_=$ may be used to produce a control signal which actuates a device for cutting the textile material in the conventional manner.

The value $U_=$ of the D. C. voltage between the terminals 15 and 12' indicates only the difference between the amounts of textile material 9 in the measuring fields 5' and 6' and does not depend on the speed at which the material moves through the condenser combination 3.

It is also important that if the cross sectional variations of the textile material extend over long portions of the material which variations are known as count variations, the amount of material forming a dielectric is the same in both measuring fields 5' and 6' and the balance of the bridge is not disturbed. By proper selection of the length *b* of the condenser electrodes 5 and 6 and of the space *a* therebetween, the length of portions of irregular cross section of the textile material which produces an indication can be determined.

FIG. 3 shows a measuring condenser combination 3 of the type shown in FIG. 1 in which the space *a* between the electrodes 5 and 6 is increased whereas the length *b* of the electrodes is not changed. The distance *a* depends on the type of cross sectional variations which are intended to be determined. If the distance *a* is small, as in FIG. 1, very short cross sectional irregularities will be indicated whereas, if the distance *a* is greater, as in FIG. 3, relatively long cross sectional irregularities of the textile material to be examined will be indicated.

The short count changes of the textile material which are indicated by the apparatus according to the invention depend on the electrode length *b*. It is therefore possible to separately register different kinds of short cross sectional variations of the textile material by suitable choice of the distance *a*, but also to influence the magnitude of the indications by a suitable choice of the electrode length *b*. It is obvious from the drawing that cross sectional variations of the textile material which are longer than the condenser electrode 4 cannot affect or can only very slightly affect the balance of the electric bridge forming part of the apparatus according to the invention so that there is no indication. Therefore, short cross sectional variations can be determined without the use of frequency filters and the like. This means a considerable simplification of the apparatus which is, as has been described before, also independent of the speed of travel of the textile material through the apparatus.

The configuration and size of short cross sectional variations is essentially due to the average staple length of the individual fibres of which the textile material 9 to be examined is composed. Short staple fibres, for example cotton, produce short cross sectional variations. The staple length, therefore, is an essential quality factor of cotton and one which has far reaching effects on the processing operations. The staple length of each crop is regularly determined and the results are published by the United States Department of Agriculture, so as to be readily available to the processors. The average staple length of cotton is between 22 mm. and 32 mm. Fibre accumulations which are considered short cross sectional variations frequently have a length of about 25 mm. Therefore, for examining cotton material the electrode length *b* is not less than 4 mm. and not more than 30 mm. in an apparatus according to the invention.

Long staple textile material as, for example wool, having a staple length of 80 mm. to 150 mm. produces relatively long cross sectional variations. These can be indicated by means of correspondingly longer electrodes wherein *b* is between 10 mm. and 60 mm. without substantial reduction of the magnitude of the indicated values. It is, therefore, desirable to provide apparatuses having different condenser combinations 3 or to provide the apparatus with interchangeable measuring condenser combinations.

The following, in combination with FIGS. 4 and 5, shows which cross sectional variations can be indicated by using a measuring combination 3 having an electrode length *b*:

The amplitude A corresponding to the cross sectional irregularity α at a portion α_1 of the textile material is:

$$A=\frac{1}{\hat{b}}\hat{A}\int_{\alpha_1-\hat{b}/2}^{\alpha_1+\hat{b}/2}\sin\alpha\,d\alpha \qquad (1)$$

wherein

b=electrode length in mm.
$\hat{b}$=electrode length in circular measure.

Therefore the new cross sectional variation appearing as damped oscillation is

$$\frac{A}{\hat{A}}=\frac{1}{\hat{b}}\int_{\alpha=0}^{\alpha=\pi}\int_{\alpha_1-b/2}^{\alpha_1+b/2}\sin\alpha\,d\alpha \qquad (2)$$

wherein $\hat{A}$=peak value of the amplitude of the cross sectional variation.

The resulting function is again a sine oscillation so that only the damping of the peak value need be calculated:

$$\frac{A}{\hat{A}}=\frac{1}{\hat{b}}\int_{\frac{\pi}{2}-\frac{b}{2}}^{\pi/2+b/2}\sin\alpha d\alpha=|-\cos\alpha|_{\frac{\pi}{2}-\frac{\hat{b}}{2}}^{\frac{\pi}{2}+\frac{\hat{b}}{2}} \quad (3)$$

$$\frac{A}{\hat{A}}=\frac{2}{\hat{b}}\cos\left(\frac{\pi}{2}-\frac{\hat{b}}{2}\right)=\frac{2}{\hat{b}}\sin\left(\frac{\hat{b}}{2}\right) \quad (4)$$

$\hat{b}$ inserted in circular measure:

$$\frac{\hat{b}}{2\pi}=\frac{b}{\lambda};\ \hat{b}=2\pi\frac{b}{\lambda}$$

$$\frac{A}{\hat{A}}=\frac{2}{2\pi b/\lambda}\cdot\sin\frac{2\pi b}{2\lambda}$$

$$\frac{A}{\hat{A}}=\frac{\sin\frac{b\pi}{\lambda}}{\frac{b\pi}{\lambda}} \quad (5)$$

This dependency is shown in FIGURE 5 as function of λ/b.

The following table serves as numerical example:

Length of electrode b (mm.)	Length of cross sectional irregularity λ (mm.)	Indication A/Â percent
10	10	0
10	20	63
10	30	82
10	50	95

This shows that an electrode of the length b which is equal to the length of a short cross sectional variation consisting of a thickening and immediate subsequent thinning of the material, or vice versa, does not produce any indication which is proportional to the cross section of the textile material. All cross sectional variations which are shorter than the length b of the electrodes produce an indication $A/\hat{A}$ which is at best 10% to 20% of the original amplitude (FIG. 5). Therefore, the length b of the electrodes must not be greater than approximately one half of the total longitudinal extent of a short cross sectional variation. If the value λ/b increases, i.e., if the length of short cross sectional variations increases and the electrode length b remains the same, the value $A/\hat{A}$ asymptotically approaches the value 1 and amounts to 95% of the full amplitude Â if λ/b is 5.

If the material to be examined is cotton having an average staple length of 20 mm. to 30 mm., the length b of the electrodes must be at least 4 mm. At an electrode length b which is greater than 40 mm. cross sectional variations which are 20 mm. long do not produce an indication at all.

When long staple wool is examined and the length of the cross sectional variations is 50 mm., the length b of the electrodes must be between 4 mm. and 60 mm. in order to produce an indication.

Another characteristic dimension of the measuring condenser combination **3** is the distance a between the electrodes **5** and **6** or the distance

$$d\left(=a+2\frac{b}{2}\right)$$

between the centers of the electrodes (FIG. 6). The relation between the values a or d and the configuration and extent of the spontaneous cross sectional variations to be measured can be calculated, if a sinusoidal cross sectional variation is assumed.

FIG. 7 shows the values of the amplitudes which are necessary for the calculation, φ designating the distance

between the centers of the electrodes in circular measure (phase shift)

$$A_1=\hat{A}\cdot\sin\omega t \quad (6)$$

$$A_2=\hat{A}\cdot\sin(\omega t+\varphi) \quad (7)$$

$$\Delta A=A\ (\sin\omega t-\sin(\omega t+\varphi) \quad (8)$$

$$\frac{\Delta A}{\hat{A}}=\sin\omega t-\sin(\omega t+\varphi)=2\cos\left(\frac{2\omega t+\varphi}{2}\right)\cdot\sin\left(\frac{-\varphi}{2}\right) \quad (9)$$

$$\frac{\Delta A}{\hat{A}}=2\cos\left(\omega t+\frac{\varphi}{2}\right)\cdot\sin\left(\frac{\varphi}{2}\right) \quad (10)$$

$$\frac{d}{\lambda}=\frac{\varphi}{2\pi}\qquad\varphi=\frac{2\pi d}{\lambda}$$

$$\frac{\Delta A}{\hat{A}}=2\cdot\underbrace{\cos\left(\omega t+\frac{d\pi}{\lambda}\right)}_{\text{function of time}}\cdot\underbrace{\sin\left(-\frac{d\pi}{\lambda}\right)}_{\text{function of damping}} \quad (11)$$

For evaluation of the amplitude as a function of the electrode spacing only the damping function

$$\frac{\Delta A}{\hat{A}}=2\cdot\sin\left(\frac{d\pi}{\lambda}\right) \quad (12)$$

is needed.

FIG. 8 illustrates this damping function on the basis of λ/d. This shows also that at certain values λ/d, for example, 1, 0.5, 0.33, etc., no indication is produced whereas at other values λ/d, for example 2, 0.7, 0.41, the full amplitude of the spontaneous cross sectional variations is indicated.

This mathematical derivation shows that by proper selection of the distance d between the centers of the condenser electrodes **5** and **6** spontaneous cross sectional variations of certain lengths can be either fully indicated or not indicated at all.

As has been explained before, the length of the most frequent short cross sectional variations of cotton is between 20 mm. and 30 mm. In order to assure indication of the short cross sectional variations it is of advantage to make the distance d between the centers of the electrodes **5** and **6** adjustable so that the full amplitude of short cross sectional variations will be indicated when different kinds of cotton material are examined. The smallest adjustable distance d should be 10 mm. and the greatest adjustable distance a should be 30 mm.

For examining wool textile material the distances d between the centers of the electrodes must be chosen according to the ratio λ/d and must be at least 10 mm. and the value a must not be greater than 80 mm.

The great steepness of the curves shown in FIG. 8 due to a very selective action of the filters necessitates an adjustment of the spacing a between the electrodes. The distance d between the centers of the electrodes and the length b of the electrodes must be changed, if materials **9** are examined whose fibres have other staple length than cotton and wool. For example, in the case of staple fibre having a staple length of 40 mm. the following dimensions should be used:

b_{min}=4 mm. $\quad d_{min}$=10 mm.
b_{max}=40 mm. $\quad d_{max}$=40 mm.

FIG. 9 illustrates a measuring condenser combination having displaceable electrodes **5** and **6**. The latter are slidable in a groove **71** of the base plate **10** and their position can be fixed by clamping screws **72** and **73** within ranges a' and a''. Scales **74** are preferably provided alongside the groove **71** to facilitate adjustment of the position of the electrodes **5** and **6**.

The apparatus according to the invention is independent of temperature variations and of other external influences, because the arrangement is symmetric in every respect.

FIG. 10 shows a modified circuit in which the coils 2 and 3 are omitted. One pole of the high frequency generator 1 is grounded and the other pole is connected to an electric bridge including the condenser electrodes 4, 5 and a resistor 23 as well as the condenser electrodes 4, 6 and a resistor 24. The condenser electrodes 5 and 6 form the coupling of two rectifier arrangements 21, 25 and 27 as well as 22, 26, and 28 which are alike. A separating or blocking condenser 31 precludes D.C. voltage differences between the rectifier arrangements so that only low frequency A.C. voltages U ~ corresponding to the short cross sectional variations of the textile material 9 can act on a resistor 32. The arrangement shown in FIG. 10 produces a voltage on the terminals 33 and 34 which is symmetrical to the ground potential 12 and which may be undesired for further evaluations.

FIG. 11 illustrates a circuit system producing an asymmetric low frequency A.C. voltage potential U ~. The rectifier 21 is connected through a separating condenser 36 to the terminal 35. The rectifier 22 is connected to the terminal 35 through a separating condenser 31. Low frequency A.C. current voltage differences U~ on the resistor 32 appear between the terminal 35 and the grounded terminal 12' in case of cross sectional variations of the textile material 9.

FIG. 12 illustrates a circuit arrangement coupled with an amplifying stage including a transistor 42 with voltage divider 41, 32, collector resistor 43 and emitter resistor 44, and with a trigger circuit 46 for transforming voltage changes at the collector of the transistor 42 to signals for actuating a relay 47.

In the example illustrated in FIG. 12 the relay 47 actuates an armature 51 which is held in its rest position by a spring 52, blocking a pawl 53. The latter is pulled to the left in FIG. 12 by a spring 54 which, however, is prevented by the element 51 as long as the relay 47 is not energized. The pawl 53 is provided with a blade 56 placed opposite a stationary blade 55, between which blades the textile material 9 is conducted.

If a relatively thick portion of the textile material 9 runs through the measuring condenser combination 3, a low frequency A.C. voltage U ~ is produced which energizes the trigger circuit 46 and also the relay 47. Thereby the armature 51 is pulled down against the action of the spring 52 and the pawl 53 is disengaged. This causes movement of the blade 56 towards the blade 55 and cutting of the material 9. The time elapsing between the occurrence of the A.C. signal at the resistor 32 and the closing of the blades 55, 56 can be coordinated to the time needed for the movement of the textile material from the condenser set 3 to the cutting point so that the irregularity in the material 9 which initiates the cutting operation in any case reaches the blades 55 and 56 when the latter are closed. In this way the textile material is cut immediately ahead of the irregular portion. After each cutting operation the mechanism is returned to the initial position by conventional means.

FIG. 13 shows an example of a trigger circuit 46 for energizing the relay 47. The signal arriving through the separating condenser 45 which signal is produced by a spontaneous cross sectional variation, reduces the potential impressed by a voltage divider with the resistors 63 and 66 on the base of a first transistor 61. Thereby the collector current of the transistor 61 is reduced so that the voltage drop on a resistor 67 becomes smaller. The collector potential of the transistor 61 and thereby the base potential of a second transistor 62 becomes more negative. Consequently, the current from the emitter to the collector of the transistor 62 increases so that the relay 47 connected to terminals 49 and 50 is energized and disengages the pawl 53. The current flow through the relay 47 is facilitated in the original direction by a feedback resistor 69 which, in addition to the input signal transmits the positive current signal produced by the voltage drop across the relay 47 to the base of the transistor 61. The described trigger circuit receives the necessary feed voltage from a voltage source 70.

I claim:

1. In apparatus for determining short cross sectional variations of textile material, particularly yarn, roving and sliver, comprising two spaced measuring condensers for the material to be examined and means for continuously comparing the effects produced by the passing material on the two condensers, at least one electrode for each condenser having a length along the path of the material which is substantially less than the wave length of the cross sectional variations due to the average stape length of the material.

2. In apparatus for determining short cross sectional variations of textile material, particularly yarn, roving and silver, comprising two spaced measuring condensers for the material to be examined and means for continuously comparing the effects produced by the passing material on the two condensers, at least one electrode for each condenser having a length along the path of the material which is not more than one half the wave length of the cross sectional variations due to the average staple length of the material.

3. In apparatus according to claim 1, electrodes for use with cotton textile each having a length between 4 mm. and 30 mm.

4. In apparatus according to claim 1, electrodes for use with wool textile each having a length between 4 mm. and 60 mm.

5. In apparatus according to claim 1, means for supporting the electrodes spaced apart a distance such that the difference in the effects produced by cross sectional variations due to the staple length of a particular material is a maximum.

6. In apparatus according to claim 1, means for adjustably supporting the electrodes for examining cotton material with their center lines spaced from 10 mm. to 30 mm.

7. In apparatus according to claim 1, means for adjustably supporting the electrodes for examining wool material with their center lines spaced from 10 mm. to 80 mm.

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