MONITORING DEVICE FOR TEXTILE MACHINES FOR DETERMINING INTERRUPTIONS AT MOVING FIBER STRANDS OR THE LIKE
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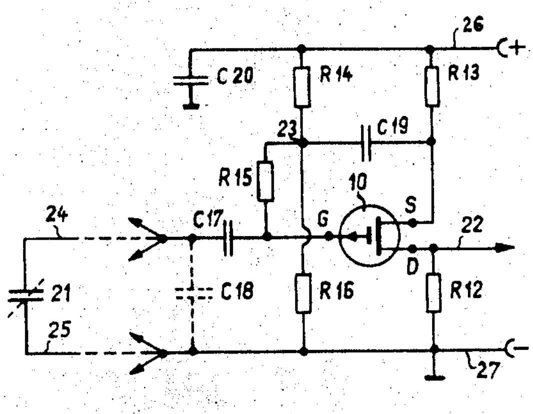

Fig. 1

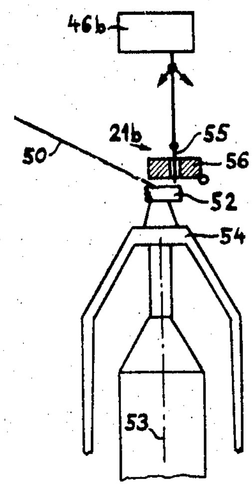

Fig. 3

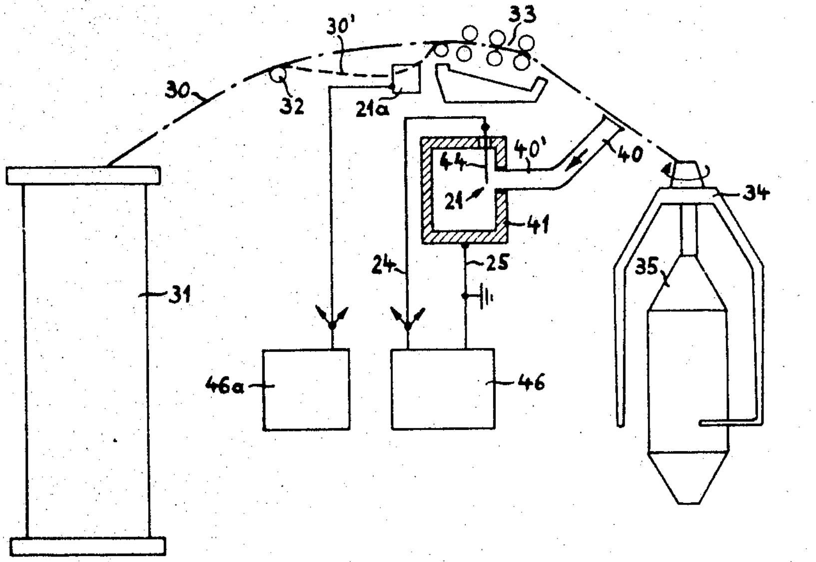

Fig. 2

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MONITORING DEVICE FOR TEXTILE MACHINES FOR DETERMINING INTERRUPTIONS AT MOVING FIBER STRANDS OR THE LIKE

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U.S. 57—81 9 Claims

ABSTRACT OF THE DISCLOSURE

A monitoring device in textile machines for determining interruptions of moving fiber strands. Capacitive measuring feelers are disposed at the textile machine and exhibit changes in capacitance dependent on the condition of the fiber strand. These changes in capacitance are fed to the control electrode of a field effect transistor through a series capacitor, the resulting output signal from the field effect transistor then being evaluated.

The present invention relates to an improved monitoring device for textile machines which serves to determine interruptions or the like (as such term will be more fully defined hereinafter) at moving fiber strands by means of one or more capacitive measuring feelers connected with an amplification and evaluation circuit.

It is known in the textile art to associate a pneumatic yarn suction device in spinning machines, for example, with each spindle or winding location. In the event of yarn rupture, the suction device is able to seize the yarn end and to convey such to a defined, different path or location. In cooperation with these suction devices, monitoring devices are also known which make use of the fact that, for example, in a roving or fly frame, upon rupture of the slubbing, the latter is torn by the air current and pulled in pieces into the suction channel. The passing flight of these torn or ruptured pieces through the suction channel can be determined by means of electric feelers arranged in the suction or collecting channel of the suction installation. The resulting signal from the feelers can be advantageously employed for triggering control operations at the machine or for counting purposes, and so forth.

Numerous types of electric monitoring feelers have been proposed for this purpose. According to one example, an impact member is provided which extends transversely to the air current. This impact member is placed into mechanical oscillation upon impact of the ruptured pieces of the fiber strand. These oscillations are electromagnetically or electrostatically transformed into an appropriate electrical signal. Another proposed solution relates to the actual arrangement of the electrodes in the air channel. The electrodes are electrostatically charged with respect to the channel wall, so that contact by the passing fiber particles brings about a partial discharge or change in charge of the electrodes which produces a signal in an external current circuit. An improvement of this technique resides in the arrangement of an air condenser as a measuring feeler in the suction channel. The relevant fiber particles or portions then act as a dielectric and, therefore, change the capacitance. The capacitor, together with a coil, forms an electric oscillating circuit, the changed resonance characteristics of which is then determined.

With the above arrangements there exists the drawback that individual portions of the feeler or the electrodes constitute obstructions for the air flow. Fiber particles constantly deposit at these obstructions impairing the electrical operation of the feeler and suppressing the air flow more and more until it is finally completely clogged.

In order to overcome these disadvantages, capacitive measuring feelers are required having electrode arrangements which obstruct the suction air current as little as possible. However, this would automatically result in capacitor constructions having a very small capacitance due to the necessarily small "plate" area so that the changes in capacitance brought about by the passing of fiber particles, and thus the electric signals appearing at the feeler, are extremely weak. Another requirement is that the time-curve and the shape of the produced signals should be capable of being precisely determined, so that the monitoring device, on the basis of an analysis of the signals undertaken at an evaluation circuit, is capable of responding only to the really interesting situations. This is particularly important since, in a roving frame, for example, particles of different origin are conveyed through the measuring feeler and determine the form or shape of the signal in the following manner:

(a) By means of the surrounding air, a larger number of sporadic, suspended fiber particles (so-called fly, for instance originating from the flyer) are continuously sucked in at the suction nozzles and bring about a relatively weak, irregular, fluctuating disturbance signal ("noise");

(b) Individual, larger fluffy fiber bunches, such as short slubbing pieces or so-called "lumps" are seized at larger time intervals. Because they are freely movable with the air, they are accelerated as a unit but are possibly separated in the air channel into a number of components or portions, and consequently, produce at the measuring feeler one or more isolated impulses of greater intensity and steepness;

(c) Upon rupture of a slubbing, the free end thereof is engaged by the suction nozzle, whereas the slubbing is conveyed further through the drafting frame and is guided in such. A short fiber slubbing, for instance formed of cotton, is therefore quickly torn apart into a sequence of relatively short flocks which are practically accelerated to the velocity of the air current and produce an appropriate series of quick, sucessive pulses of higher intensity and flank steepness. A long fiber slubbing or a fiber strand which exhibits a certain twist is more readily torn off as a unit or entity and moves in the form of a longer section through the measuring feeler. Because of the wave motion or undulations of the slubbing piece brought about by air turbulence, a series of steep pulses which have a certain similarity with those of a short fiber ruptured slubbing appear as a general rule.

It should be clear that with the previously considered applications for a monitoring device, the device should not respond to the normal signal shapes or forms considered under items (a) and (b), whereas it certainly should respond to the situation listed under item (c).

Apart from the mentioned monitoring of the slubbing, there are still further monitoring functions in textile machines such as the determination of the rupture of the warp at weaving looms, or the monitoring of the web or the proper slubbing formation at the output of a carding machine.

In consideration of the many fields of application above it is to be understood that in the context of this description and the appended claims, the term "fiber strand" not only encompasses a strand with a more or less round cross-section, but also includes a sliver or a relatively wide and flat fiber layer or mat (web). Additionally, the expression "interruptions" or any equivalent thereof, should not be limited to the situation where a fiber strand is torn or broken during passage through the textile machine. This expression is to be understood in a far broader sense. In certain situations there must also be determined the actual end of a strand. This is true, for instance, at a roving or fly frame when the supply of the roving coming out of the can and into the machine is depleted, or when a spool from which a yarn is withdrawn is depleted. In other situations, monitoring of directly imminent interruptions or breakage of the fiber strands is desirable; it is for instance known that in a roving or fly frame a fiber lap forming at a flyer head and in the form of a small so-called "cap" or "nest" signifies an imminent rupture or interruption of the fiber strand. Thus the term "interruption" is meant to encompass situations similar to those above.

The signal obtained from the above operations must be carefully evaluated and analyzed. Accordingly, the present invention provides for an exact determination and careful amplification of the electric signals appearing at the measuring feeler.

Capacitive-type measuring feelers are already known in the textile art and also in other environments such as in so-called yarn cleaners which serve to eliminate undesired yarn irregularities or thickened portions or in apparatuses for measuring and recording the yarn cross-section. With such feelers the momentary value of the feeler capacitance is continuously determined by means of a high frequency measuring technique. The feeler is either coupled in a capacitance measuring bridge, or it is a component of a high frequency-oscillating circuit, the resonance frequency of which varies in accordance with changes in capacitance. With measuring processes of this type, the feeler current circuit must be supplied with a high frequency reference oscillation from an oscillator circuit. This requires a considerable expenditure so that the reference frequency remains sufficiently constant, and, in operation, difficulties occur with the precise dimensioning of the circuit components.

Other known feelers make use of a different technique in which an electric change in charge of separated electrodes take place through the fiber strand or the fiber flocks, and wherein there is made use of a certain conductivity or electrostatic charging of the fiber material. Since, in this case, a galvanic contact between the fiber material and the electrodes is required, arrangements of this type cannot be designated as true capacitive feelers.

The instant inventive monitoring device utilizes one or more capacitive feelers and is characterized by the features that a high-impedance signal input circuit is provided by utilizing a field effect transistor in the amplifier-input stage, and the measuring feeler or feelers which are connected in parallel with one another are also connected in series with a capacitor.

The invention will be better understood, and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawing wherein:

FIGURE 1 schematically illustrates the circuit diagram of an amplifier-input stage with the signal-input circuit of a preferred embodiment of the inventive monitoring device;

FIGURE 2 schematically depicts two different arrangements of monitoring devices at a roving or fly frame; and

FIGURE 3 schematically depicts a further arrangement of a monitoring device and a feeler at the region of the flyer head at a roving frame or spinning machine.

Describing now the drawing, in the input stage shown in FIGURE 1, a field effect transistor **10** with the electrodes G (gate), S (source) and D (drain) serves as the amplifier element. The path S–D of the transistor **10** exhibits a variable resistance which is dependent upon the internal field intensity determined by the potential at the control electrode G. The control electrode G, together with the controlled path S–D merely forms a capacitance, there being negligible leakage therebetween, for which reason the control takes place with no practical power dissipation.

The supply for the circuit is a non-illustrated direct-current source connected via the plus conductor or lead **26**, with the minus conductor **27** being connected to ground. Element **C20** is a filter condenser for removing any remaining alternating current-voltage components in the operating direct current-voltage. The path S–D of the transistor **10** is provided between the resistors **R12** and **R13**, the amplified output signal from the transistor being removed at the working resistor **R12** and delivered via the conductor **22** to the next stage of the amplifier and evaluation circuit. The resistors **R14** and **R16** form a voltage divider, the potential at the junction or point **23** being carried via a high ohm resistor **R15** to the control electrode G. As a result, this control electrode G receives a positive biasing potential and the operating point of the field effect transistor **10** is determined. A capacitor **C19**, connected between the electrode S and the point **23**, provides a "feed-back" path in that it delivers or conducts the signal appearing across the resistor **R13** to the control electrode G in opposite phase to the input signal. A capacitor **C17** with a capacitive measuring feeler **21** connected in series is disposed in the signal input circuit between the control electrode G and the ground conductor. In the event that a number of capacitive measuring feelers **21** are desired, they are connected in parallel to one another by means of the measuring conductors **24, 25** as indicated. The signal input circuit is polarized by the potential difference between the positive biased electrode G and ground.

With the capacitive measuring feeler **21**, one is concerned with a capacitor of variable capacitance. As previously mentioned, the changes in capacitance are preferably brough about by fiber strand particles or flocks moving in the electric field producing changes in the capacitor dielectric.

During operation, the signal appearing at the feeler **21**, or the feelers as the case may be, is coupled via the series capacitor **C17** with the control electrode G, and the amplified output signal is removed via the resistor **R12**. Since the resistors between the control electrode G and the controlled path S–D of the field effect transistor are of high ohmic value, no appreciable current flow is possible from the input circuit to the remainder of the device. Thus, when a signal is impressed at the input circuit, a "change of charge" of the input capacitance takes place rather than a true current flow. This capacitance is provided by the galvanic separation at the capacitor **C17**, as well as the separation of the measuring conductors **24, 25** themselves.

It is advantageous to further provide a capacitor **C18** parallel to the measuring feelers **21**, whereby the operating and amplification conditions of the input stage are made considerably independent of the number of connected feelers **21** and independent of the length of the measuring conductors **24, 25**.

The lowest frequency of response of the amplification is determined by the RC-member **R15, C17.** The RC member is dimensioned in such a manner that gradual changes at the feelers, for instance, those brought about by variations in temperature, moisture or dust, and so forth, and those which extend for periods of time of several seconds and more are not transmitted to the control electrode G as actual signal variations. The coupling relationship via capacitor **C17** also increases with increasing signal frequency as the impedance decreases for a corresponding increase in frequency. This capacitor functions as a high-pass filter so that signal components with frequencies of several cycles per second and upwards appear more strongly at the control electrode G, whereas lower frequencies are suppressed or removed. As a result, the circuit selectively responds to different flank steepnesses of the signal impulses.

Further processing of the signals amplified in the input stage of FIGURE 1 can take place in a subsequent non-illustrated evaluation circuit approximately as follows: At later preamplifier stages coupled via the conductor 22, there is connected a tripping stage (Schmitt trigger) which transforms the incoming signal impulses to square wave pulses, provided that the signal amplitude exceeds an adjustable threshold value. Accordingly, the previously mentioned disturbing peaks of the signal, brough about by the fly and so forth, are eliminated. The square wave impulses are subsequently integrated in an integration stage to an increasing peak value. In the event that this peak value exceeds a second threshold value within a predetermined period of time, a further tripping stage will respond, whereby a relay is energized so as to stop the machine or the spindle drive or to set off an alarm or the like. Consequently, a monitoring device is provided which does not respond to individual impulses caused by loose, short slubbing pieces. Rather, the device only responds to a series of pulses as such occur upon rupture of the slubbing.

The above generally described evaluation circuit, which can be formed of known stages, is particularly suitable for the previously mentioned applications where, at each spinning location of a roving frame or the like, the slubbing traveling from the drafting frame to the flyer is to be monitored for "rupture." There is further provided a pneumatic suction device which, in the event of rupture of the slubbing or the like, seizes the broken slubbing piece and wherein the capacitive feeler or feelers 21 are arranged in an air conduit of the suction installation. It should be appreciated, however, and as will be more fully developed below, that many different types of monitoring devices and operations at textile machines should be taken into consideration. The associated signal evaluation circuit can then be constructed in a different manner depending upon the form of the signals which are to be expected upon interruption or rupture of the fiber strand and with regard to which the apparatus should respond.

Below, there is given the values of the individual components of an input stage of the type shown in FIGURE 1 which have proven to be desirable:

Field effect transistor 10		Type 2N2386
Supply between conductors 26 and 27	volts	27
Resistor R12 (adjustable)	ohms	10–30K
Resistor R13	do	12K
Resistor R14	do	120K
Resistor R15	do	1M
Resistor R16	do	680K
Capacitor C17	nf	8.2
Capacitor C18	nf	1
Capacitor C19	microfarads	100
Capacitor C20	do	100

Total capacitance of the measuring feeler and conductors are in the order of magnitude of several hundred pf.

With the circuit of FIGURE 1, the actual signal of the measuring feeler may be determined considerably independently of temperature and moisture fluctuations, vibrations and dust. The circuit also enables the use of relatively long measuring conductors 24, 25 which increase the freedom of placement of the feelers at the machine. Since the feelers generally can be arranged closer to the rupture or suction locations, a quicker response time of the monitoring device is effected due to the shortening of the flight path of the broken slubbing pieces or the like to the feeler. This is of considerable importance with modern, high-speed machines.

FIGURE 2 schematically depicts the arrangement of a monitoring device in conjunction with a pneumatic suction installation at a roving or fly frame, wherein only a single spinning location of the machine has been illustrated. The fiber strand 30, which is to be processed and monitored, comes out of a can 31 readily provided for each spinning location. This fiber strand 30 or the like is pulled via a guide 32 into the drafting or drawing frame 33. Upon leaving the drafting frame 33, the fiber strand or slubbing 30 travels into the head of the rotating flyer 34 which winds the processed slubbing into a spool or package 35.

The fly frame is provided with a suction device, in which there are illustrated continuous suction-collecting channels 41 in cross-section and a suction nozzle 40. Each spinning location or station is equipped with such a suction nozzle 40, and all of these nozzles are operably coupled with the collecting channel 41. In the collecting channel 41 a negative pressure is maintained so that air is continuously withdrawn from the surrounding atmosphere at all of the nozzles. In the event of rupture of the slubbing or the like between the drafting or drawing frame 33 and the flyer 34, the broken slubbing ends are displaced by the suction air current into the relevant nozzles and transported away through the collecting channel 41.

As a general rule, not every nozzle 40 opens directly into the collecting channel 41. Rather, a number of nozzles, six for instance, are combined with a connecting tube 40′ into a so-called suction pipe, wherein the connecting tube 40′ initially opens into the connecting channel 41. A fly frame with ninety spinning stations, for example, therefore possesses fifteen connecting tubes 40′ or connecting pipes, each with six nozzles 40. The details of this have been omitted from the drawing to preserve clarity, particularly since illustration is not necessary for an understanding of the invention.

Each pipe, for instance, has associated therewith a measuring feeler 21. This is advantageously placed at the opening location of the connecting tube 40′ with the collecting channel 41. In this regard, portions of the channel or tube walls can serve as the ground electrode, whereby such electrodes for all of the feelers are connected with one another via the machine frame, and so forth. The counter-electrode of the feeler has the form of an isolated fixed needle 44. All fifteen feelers are then connected in parallel to an input circuit according to FIGURE 1 which, together with the entire amplifier and evaluation circuit, has been designated by reference numeral 46. Of course, the placement of the feelers with regard to one or more amplifier and evaluation circuits can be differently selected depending upon requirements.

A further inventive monitoring device of a similar type is shown in FIGURE 2 in conjunction with a fly frame. It might be desired, with a fly frame (or a different textile machine), to determine at the side of the infeed of the fiber strand or the fiber strands when an interruption occurs or when the can 31 (or a spool or the like) has become depleted. For this purpose, a capacitive measuring feeler 21*a* is arranged at a spacing beneath each strand 30. Now, if the strand 30 at this side of the machine breaks or its supply is depleted, there results a hanging portion, as shown in phantom lines by reference numeral 30′, whereby a strand portion arrives at the region of the feeler 21*a* and brings about a characteristic change in capacitance. The feeler 21*a*, or other similar type feelers, is connected with an input circuit of FIGURE 1 contained in an amplifier and evaluation circuit 46*a*. The mentioned capacitance change determines an interruption.

A further construction of the inventive monitoring device is depicted in FIGURE 3. A capacitive feeler 21*b*, which is also connected to an amplifier and evaluation circuit 46*b* with an input stage according to FIGURE 1, is arranged at the region above or laterally of the head of a flyer 54. The ground electrode of the feeler 21*b* is formed by portions of the flyer 54, whereas the counterelectrode 54 is preferably formed as a needle or tip which is seated at an isolated holder 56 which can be tilted open, for example. In this construction, the electrode 55 is disposed somewhat eccentric to the axis 53 of the flyer 54.

During normal infeed of the fiber strand **50** which is to be monitored, for instance a yarn or a slubbing, into the rotating flyer head, the capacitance of the feeler **21*b*** remains practically constant. However, when a disturbance appears, there is generated from the fiber material at the flyer head, a collection in the form of a so-called cap or nest **52** or simple loop formations. A disturbance of this type, as a general rule, signifies an interruption or rupture of the fiber strand which is about to occur at any moment. Such a collection of the fiber material practically always is located eccentric to the flyer head and produces, during the quick rotation of the head, a relatively strong, pulsating change in capacitance in the feeler, and therefore, a signal characteristic for the disturbance. The determination of this signal in the circuit **46*b*** brings about the early realization of an imminent interruption or rupture.

What is claimed is:

1. A monitoring device in textile machines for determining interruptions of moving fiber strands, said device comprising:

at least one capacitive measuring feeler means disposed at said textile machine, such that a moving fiber strand forms a portion of the dielectric of said measuring feeler means, said measuring feeler means exhibiting a change in capacitance in response to a change in said portion of said dielectric;

a field effect transistor having an input signal circuit and an output amplification circuit;

a series capacitor connected in said input signal circuit to said feeler means; and

evaluation circuit means connected to said output amplification circuit for evaluating said change in capacitance.

2. A monitoring device in textile machines according to claim **1**, further including an additional capacitor connected in parallel to said measuring feeler means.

3. A monitoring device in textile machines according to claim **1**, wherein said field effect transistor includes a control electrode connected in said input signal circuit; and resistor means connected to said control electrode for supplying biasing potential to said field effect transistor so as to determine the operating point of the control electrode, said series capacitor being connected between the control electrode of said field effect transistor and said capacitive measuring feeler means for blocking said biasing potential from said feeler means.

4. A monitoring device in textile machines according to claim **3**, wherein said resistor means and said series

capacitor provides a time constant circuit means for determining the lower boundary frequency of amplification response.

5. A monitoring device in textile machines according to claim **1**, wherein said textile machine includes a pneumatic suction device, said measuring feeler means being disposed in said suction device.

6. A monitoring device in textile machines according to claim **5**, wherein said pneumatic suction device includes a connecting tube opening into a suction-collecting channel, said measuring feeler means being arranged at the opening between said connecting tube and said channel.

7. A monitoring device in textile machines according to claim **1**, wherein said measuring feeler means is located at an inlet side of said textile machine whereby said measuring feeler means monitors the presence of hanging portions of said fiber strands.

8. A monitoring device in textile machines according to claim **1**, wherein said textile machine includes a flyer having a head, said measuring feeler means being located in the region of said head of the flyer to determine collection of fiber material.

9. A monitoring device in textile machines according to claim **8** wherein said measuring feeler means comprises a needle-like electrode, isolated and fixedly arranged offset to said flyer axis.

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