April 22, 1969 S. MAURMANN ETAL 3,440,634

SYSTEM FOR MONITORING MOVING THREADS IN TEXTILE MACHINERY

Filed Oct. 8, 1965 Sheet 1 of 3

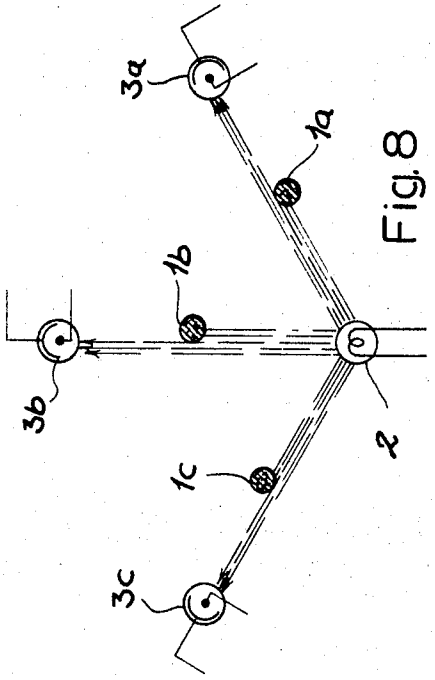


Fig. 8

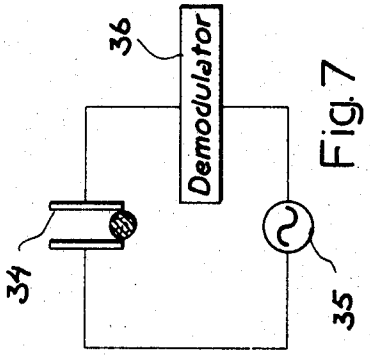


Fig. 7

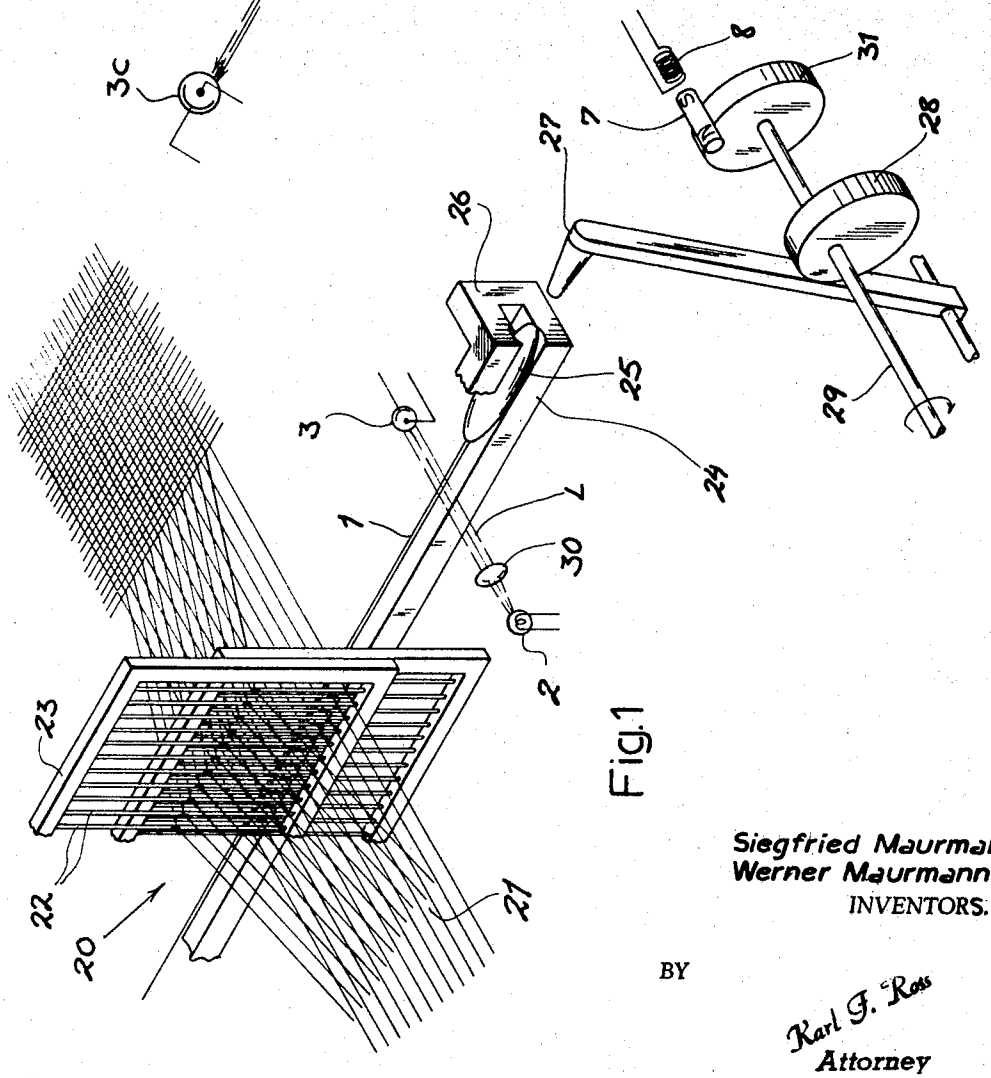


Fig. 1

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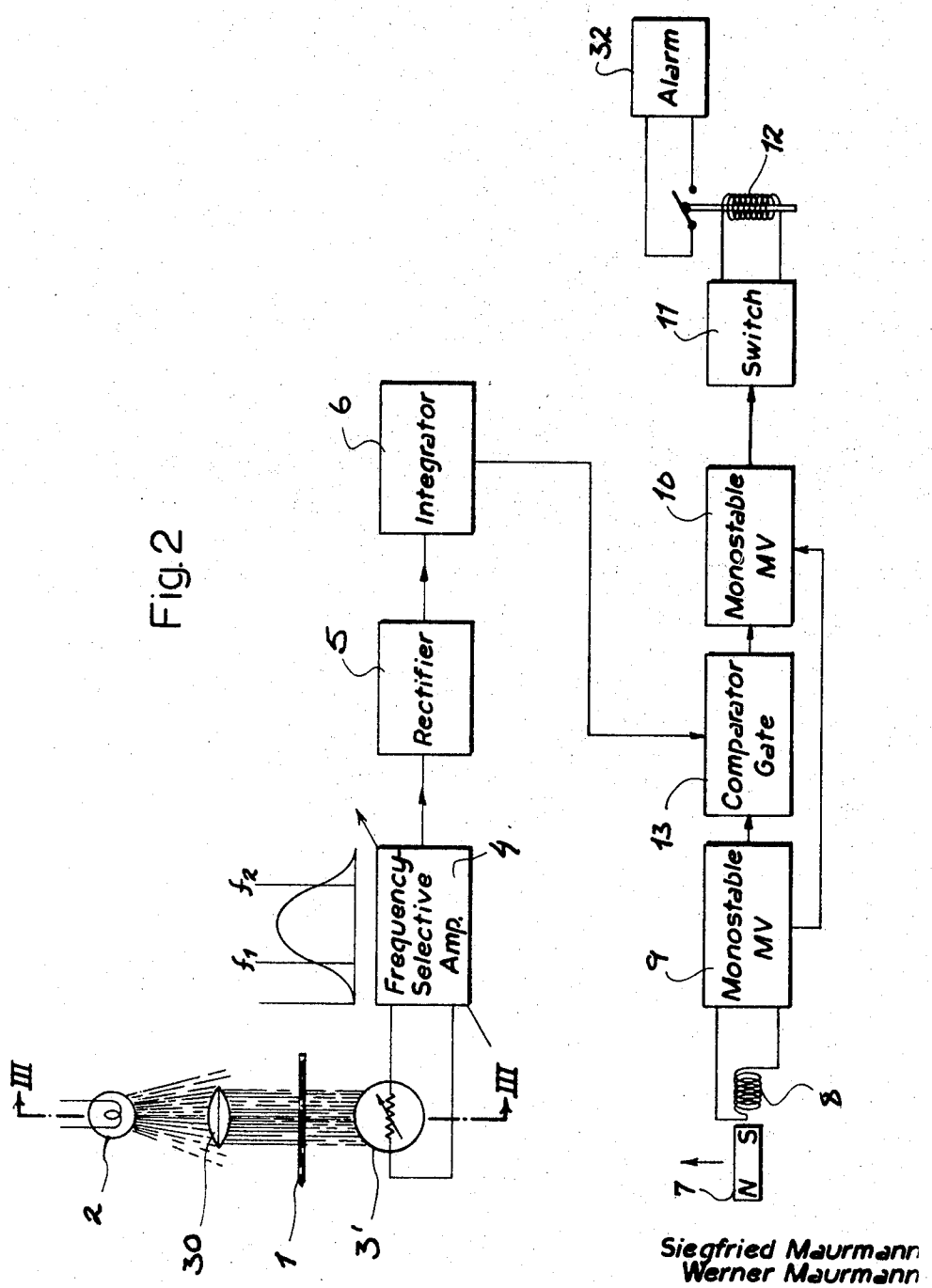
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Fig. 2



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Fig. 3

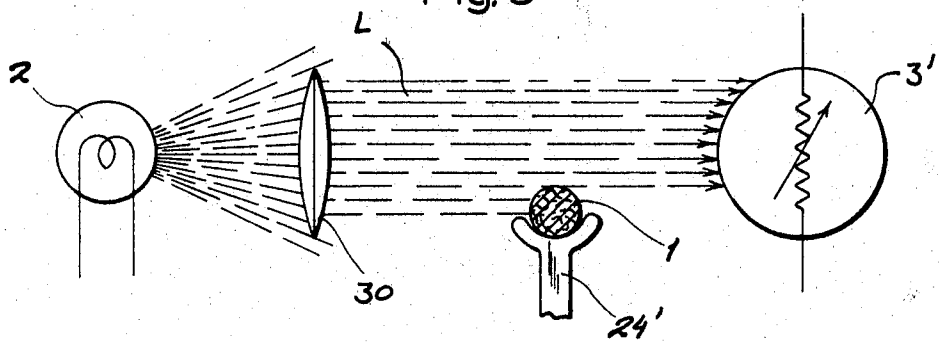
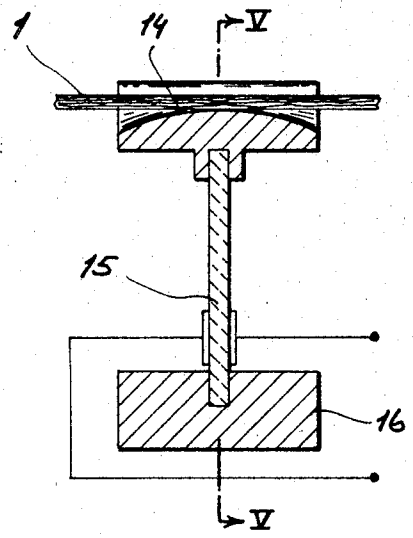


Fig. 4



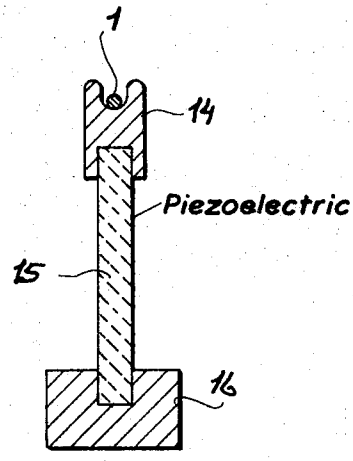


Fig. 5

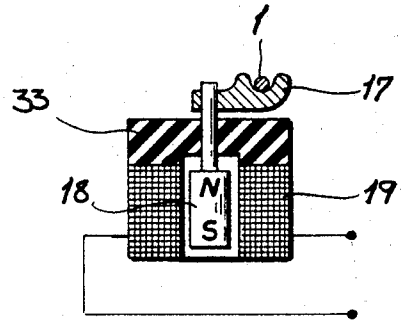


Fig. 6

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SYSTEM FOR MONITORING MOVING THREADS IN TEXTILE MACHINERY

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Int. Cl. G08b 21/00
U.S. Cl. 340—259 9 Claims

ABSTRACT OF THE DISCLOSURE

Thread-monitoring device in which a timing system periodically enables a comparator to match a reference pulse against the integrated output of a photoelectric or other transducer sensing the vibrations or recurrent surface deformations of a thread, rupture of that thread causing the vibrations to cease and resulting in the actuation of an alarm by the comparator.

Our present invention relates to textile machinery, such as looms, in which it is desired to monitor one or more moving threads (e.g. weft threads) in order to determine their continuity and, in the event of a rupture, to give an alarm signal which alerts an operator or directly arrests the machine.

A variety of devices for thus supervising a running thread have already been proposed. For the most part, these prior arrangements are sluggish in operation, unreliable in performance and/or difficult to install in existing machinery.

The general object of our invention is to provide a system of this character which avoids the above disadvantages.

A more particular object of this invention is to provide means for determining the continuity of a supervised thread in such manner that the sensing element employed for this purpose has only very slight contact or no contact at all with the thread itself so as to interfere to any appreciable extent with the thread motion.

A further object of the instant invention is to provide monitoring means of this nature adapted to be used with threads of virtually and description, particularly including heavy threads which cannot readily be supervised by conventional sensing means.

Our invention is based upon the discovery that threads continuously taken from a bobbin or other supply source in textile machinery, such as threads trailing a shuttle or similar weft carrier in a loom, exhibit recurrent surface deformations which, when observed at a given point, have a recurrence rate which usually lies in the upper audio-frequency range and which can be converted into corresponding electrical oscillations by suitable transducers, the frequency of these oscillations depending not only upon the type of thread but also upon its speed as well as its tension. The output frequency of the transducer, accordingly, remains substantially constant or at least within a predetermined range as long as operations are normal, but drops sharply when either of the two aforementioned parameters (speed and tension) falls off as will always be the case when the thread breaks either before or behind the observation point.

In general, the recurrent surface deformations to be sensed in a system according to our invention may be temporary or permanent, i.e. they may be due to transverse vibrations of the thread or they may result from periodic knots, loops or thickened portions formed thereon. The transverse vibrations can be sensed whether or not there is longitudinal thread motion at the observation point. In the case of a weft thread payed out by a cop on a moving shuttle, for instance, only the forward end of the thread moves along with the shuttle whereas its trailing part, while still vibrating, does not appreciably advance along its path. In other instances, e.g. in looms of the shuttleless type where the filling is entrained through the shed by a gripper rod or the like, recurrent permanent surface deformations of the thread may be converted into electrical oscillations as they slide past the senser; naturally, the aforedescribed transverse vibrations could be utilized also in this case, particularly in the absence of such permanent deformations.

In an advantageous embodiment of our invention, the transducer is of the photoelectric type and includes a photocell or other photosensitive circuit element upon which a beam of light is trained so as to be partly intercepted by the thread to be supervised; the light rays may be focused and/or deflected along their path by lenses, mirrors etc. as is well known per se. Except in the case where the thread is thickened or reduced at uniform intervals and moves longitudinally past the senser, the beam should be directed only across one edge of the thread which, owing to transverse vibrations and/or structural deformations, recurrently deviates from a straight line so that periodically a substantial part of the beam is cut off by the body of the thread; during the intervening periods, the obstruction of the light path by the thread is reduced or even completely eliminated. The transducer, therefore, produces a pulsating output whose frequency, in practice, may lie between about 5 and 10 kc./sec. A detector circuit associated with the transducer advantageously includes a frequency-selective amplifier whose gain decreases sharply at the lower limiting frequency of the range; such a decrease will also take place at the upper limiting frequency but will usually be without significance at that point since a sharp increase in the output frequency of the transducer is ordinarily not to be expected. Upon subsequent rectification and integration of the amplifier output there is thus produced a D-C signal whose magnitude depends upon the input frequency and which may be matched with a constant reference voltage by a suitable comparison circuit. If the comparison fails, i.e. if the output voltage of the detector significantly falls below the reference voltage, the alarm is actuated.

Other kinds of transducers, e.g. of the capacitive, inductive or piezoelectric type, may also be used and will be described in detail hereinafter.

The monitoring system according to our invention may operate continuously if its senser is used to supervise a thread moving uninterruptedly past an observation point and taken from a bobbin for twisting, doubling or rewinding. In the case of a loom in which the system is to serve for the supervision of the weft threads, however, the thread is in sensing position only during a small fraction of an operating cycle. In such instances, therefore, we prefer to provide a timer controlled by the loom drive for rendering the detector operative only during such a fraction of a cycle, e.g. at the instance when the shuttle leaves the shed or when the gripper-entrained thread has been substantially fully drawn into the shed.

The invention will be described in greater detail hereinafter with reference to the accompanying drawing in which:

FIG. 1 is a somewhat diagrammatic perspective view of a loom equipped with a monitoring system according to the invention;

FIG. 2 is a diagram, mostly in block form, of the transducer and detector circuits forming part of a monitoring system similar to the one shown in FIG. 1;

FIG. 3 is a cross-sectional view taken on the line III—III of FIG. 2;

FIG. 4 is a sectional elevational view of a piezoelectric transducer adapted to be used in a system of the general type shown in FIGS. 1–3;

FIG. 5 is a cross-sectional view taken on the line V—V of FIG. 4;

FIG. 6 is a view similar to FIG. 4, showing an inductive type of transducer;

FIG. 7 diagrammatically illustrates a capacitive type of transducer; and

FIG. 8 diagrammatically illustrates a multiple senser for a plurality of threads.

In FIG. 1 we have shown part of a loom **20** comprising warp threads **21** engaged in the usual manner by the heddles **22** of several harnesses **23** to form a shed. A sley **24** supports a shuttle **25** about to enter a shuttle box **26** (shown only in part); a picker **27** co-operates with the sley **24** to launch the shuttle **25** through the shed to the opposite side where another picker (not shown) returns it to the box **26** as is well known per se. Picker **27** is periodically operated by a cam **28** on a shaft **29** continuously rotated from a motor (not shown) in step with other elements of the loom.

A weft thread **1** trails behind the shuttle **25** and is payed out by a cop (not shown) on the shuttle. A lamp **2** trains a beam of light L upon a photocell **3** across the upper edge of thread **1**, the beam being sharply focused upon the edge by a lens **30**. Shaft **29** carries a disk **31** on which a permanent bar magnet **7** periodically moves past an inductance coil **8** to produce an enabling pulse for the evaluation of the output of photocell **3**, in a manner more fully described hereinafter, at the instant when the shuttle **25** has moved across the beam L upon leaving the shed of warp threads **21**.

Reference will now be made to FIGS. 2 and 3 for a description of the manner in which the output of thread senser **2**, **3** is utilized to supervise the thread **1**. In FIGS. 2 and 3, however, the photocell **3** of FIG. 1 has been replaced by an equivalent photoelectric transducer **3'** illustrated as a photoresistor.

Transducer **3'** is shown connected across the input of a frequency-selective amplifier **4** which, as diagrammatically indicated, may have a gain/frequency characteristic dropping off sharply at a lower limiting frequency f_1 (e.g. of 5 kc.) and at an upper limiting frequency f_2 (e.g. of 10 kc.). The frequency range f_1–f_2 is preferably adjustable to allow for the supervision of different types of thread and/or different operating speeds.

As shown in FIG. 3, thread **1** may be cradled on a supporting rail **24'** atop sley **24**, this rail forming an upwardly open guide channel of a depth less than the thread thickness so that only a relatively small part of the thread body projects into the path of the light beam L as long as the thread rests on its support. Unavoidably, however, the thread **1** is subject to transverse vibrations when the associated shuttle **25** is in motion. The frequency of these vibrations depends on the thickness, weight, stiffness etc. of a given thread as well as on its tension and, for this reason, should be substantially the same at corresponding points of successive loom cycles, e.g. whenever the shuttle **25** has moved across the beam L and the magnet **7** confronts the coil **8**. Naturally, the lower cut-off frequency f_1 of amplifier **4** must be chosen to be well below this normal vibration frequency. In this event, as the thread **1** rises intermittently above its cradle **24'**, its upper edge cuts off additional rays of the beam L so that the output of photoelectric element **3'** is amplitude-modulated in step with the vibration of the thread. A similarly modulated electrical output is produced by the amplifier **4**, the amplitude of its oscillations being relatively large within the frequency range f_1–f_2 but decreasing sharply beyond that range. If, now, the thread breaks between shuttle **25** and the location of transducer **3** or **3'**, the fragment remaining on cradle **24'** will cease to vibrate and the electrical oscillations will stop; similarly, a rupture just behind the path of beam L will discontinue the oscillations as the thread residue is pulled off the support **24'** by the advancing shuttle. If, on the other hand, a rupture occurs well beyond the sensing point, e.g. at the remote side of the shed, the resulting drop in thread tension will instantly reduce the vibration frequency below the lower limit f_1 of the amplifier range so that, again, the output of the amplifier will substantially disappear.

The oscillations normally produced by amplifier **4** are delivered to a rectifier **5** and thence to an integrating network **6** having a time constant which is large compared with a cycle length at the lower limiting frequency f_1. A signal in the form of a D-C voltage is applied by the integrator **6** to a comparison circuit **13** which simultaneously receives a reference voltage of predetermined magnitude from a monostable multivibrator **9** when the latter is triggered into an unstable alternate condition by a timer constituted by magnet **7** and coil **8**. Thus, a movement of magnet **7** past the coil **8** gives rise to a trigger pulse which may have a duration of, say, 10 ms., the duration of this pulse determining the length of an operating interval during which the reference voltage is applied to comparator **13**. At the same time, i.e. in the unstable condition of multivibrator **9**, another multivibrator **10** connected to the output of comparator **13** is enabled and, if the comparator output indicates a major mismatch between the two voltages delivered thereto from circuit **6** and **9**, is triggered vibrator **10** into its alternate condition in which it trips a switching stage **11** connected across a relay **12**. An alarm circuit **32** is closed by the operation of relay **12** and may either give a visual or audible signal or directly stop the drive of shaft **29** and other parts of the loom **20** (FIG. 1). The response time of the controlled switching system **11**, **12**, **32** may be approximately 350 ms. and should be large in comparison with the time constant of integrator **6**.

In FIGS. 4 and 5 we have shown an alternate thread senser comprising a piezoelectric crystal **15** which is supported by a fixed lower mount **16** and clamped in a movable upper mount **14** contacting the lower edge of thread **1**. The vibrations of the thread are therefore imparted to the crystal **15** whose output may be substituted for that of photoresistor **3'** in the input of amplifier **4**.

In FIG. 6 we show a generally similar arrangement wherein the lower edge of thread **1** bears upon a movable support **17** rigid with a permanent magnet **18**, the latter being slidably guided in a housing **33** for axial motion relative to an inductance coil **19**. Again, the output of coil **19** may be connected to the input of amplifier **4**.

FIG. 7 shows a condenser **34** whose plates are spaced apart to a sufficient extent to accommodate the thread **1** which may again be guided on a support in the manner shown in FIG. 3. As the dielectric constant of thread **1** will generally be different from unity, the capacitance of condenser **34** depends on the extent to which the thread penetrates into the space between its plates. A source of alternating voltage **35** is connected in series with condenser **34** across a demodulator **36** whose output may again be applied to the input of amplifier **4** in lieu of that of the transducers previously described. The frequency of oscillator **35** should be high compared with that of the vibrations to be detected; these vibrations will then modulate the amplitude of the carrier wave produced by the oscillator, the envelope of the modulated carrier wave being detected by demodulator **36**.

It will be apparent that a thread senser according to the invention, e.g. one comprising a transducer of one of the types shown in FIGS. 4–7, may be miniaturized for mounting directly on the shuttle rather than alongside the path of the weft thread. In this case, the thread **1** will move longitudinally past the senser so that oscillations may also be produced by permanent surface deformations of the thread.

If several threads are to be monitored simultaneously, e.g. weft threads 1*a*, 1*b*, 1*c* of different colors, they may be grouped around a single light source 2 positioned as shown in FIG. 8, to illuminate respective photoelectric elements 3*a*, 3*b*, 3*c*. The outputs of all these photoelectric elements can be fed into a single evaluation circuit of the kind shown at 9–12 in FIG. 2 if the operating periods of the several sensers are suitably staggered, e.g. if their respective trigger coils 8 are aligned with the magnet 7 for successive excitation thereby.

We claim:

1. In a loom having drive means for passing a weft carrier through a shed of warp threads, the combination therewith of monitoring means for sensing the location of an edge of a weft thread trailing said carrier and for producing an electric output amplitude-modulated by recurrent deformation of said thread along said edge; detector means connected to said monitoring means for producing a signal indicative of the modulation frequency of said output; timer means controlled by said drive means; pulse-generating means jointly controlled by said detector means and said timer means for producing an output pulse during a predetermined fraction of a loom cycle in response to failure of said signal to reach a predetermined magnitude; and alarm means responsive to said output pulse.

2. The combination defined in claim 1 wherein said monitoring means comprises frequency-selective amplifier means having a variable gain which decreases sharply with input frequencies falling below a predetermined limit.

3. The combination denfied in claim 2 wherein said amplifier means is provided with an adjustable input circuit for varying said limit.

4. The combination defined in claim 2 wherein said amplifier means has a lower cutoff frequency on the order of 5 kilocycles per second.

5. The combination defined in claim 1 wherein said alarm means is operative to arrest said drive means with a predetermined delay, said monitoring means comprising frequency-selective amplifier means having a markedly reduced gain at a predetermined lower limiting frequency, said detector means including an integrating network with a time constant which is large with reference to a cycle at said limiting frequency but small with reference to said delay.

6. The combination defined in claim 1 wherein said pulse-generating means comprises a comparison circuit for matching the output of said integrating network with a constant reference voltage.

7. The combination defined in claim 6 wherein said comparison circuit includes a monostable multivibrator periodically triggerable by said timer means into an unstable condition, said reference voltage being the output of said multivibrator in said unstable condition.

8. The combination defined in claim 1, further comprising support means for said thread, said monitoring means including a source of a light beam trained upon an upper edge of said thread remote from said support means and photoelectric transducer means beyond said support means in the path of said light beam.

9. A system for monitoring a moving thread in textile machinery, comprising a support for a thread to be supervised, said support forming an upwardly open thread-guiding channel of a depth less than the thickness of the thread whereby the upper thread edge projects above said channel with freedom of relative upward displacement; a source of light trained upon said upper thread edge; photoelectric transducer means positioned beyond said support to receive a beam of light from said source passing across said upper edge, said beam being intensity-modulated by recurrent deviations of said edge from a straight line; detector means connected to the output of said transducer means for producing a signal indicative of the modulation frequency of said beam; and alarm means connected to said detector means for registering a fault condition in response to failure of said signal to reach a predetermined magnitude.

References Cited

UNITED STATES PATENTS

2,896,196	7/1959	Hartford et al.	340—259
3,010,273	11/1961	Bailey.	
3,106,762	10/1963	Riera.	
3,158,852	11/1964	Schacher	340—259
3,287,887	11/1966	Dornberger	340—259 X
3,139,911	7/1964	Breitmeier	139—370

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