

- [54] ELECTRONIC SYSTEM DISTINGUISHING
BETWEEN GOOD KNOTS AND DEFECTS IN
A MOVING STRAND

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250/219 DF, 219 S; 356/238, 200; 66/163
73/160;

- [56] **References Cited**
UNITED STATES PATENTS

3,371,568	3/1968	Felix	28/64
3,106,762	10/1963	Riera	340/259
3,557,615	1/1971	Seymour, Jr. et al.....	340/259
T886.007	5/1971	Harvey et al.	73/160

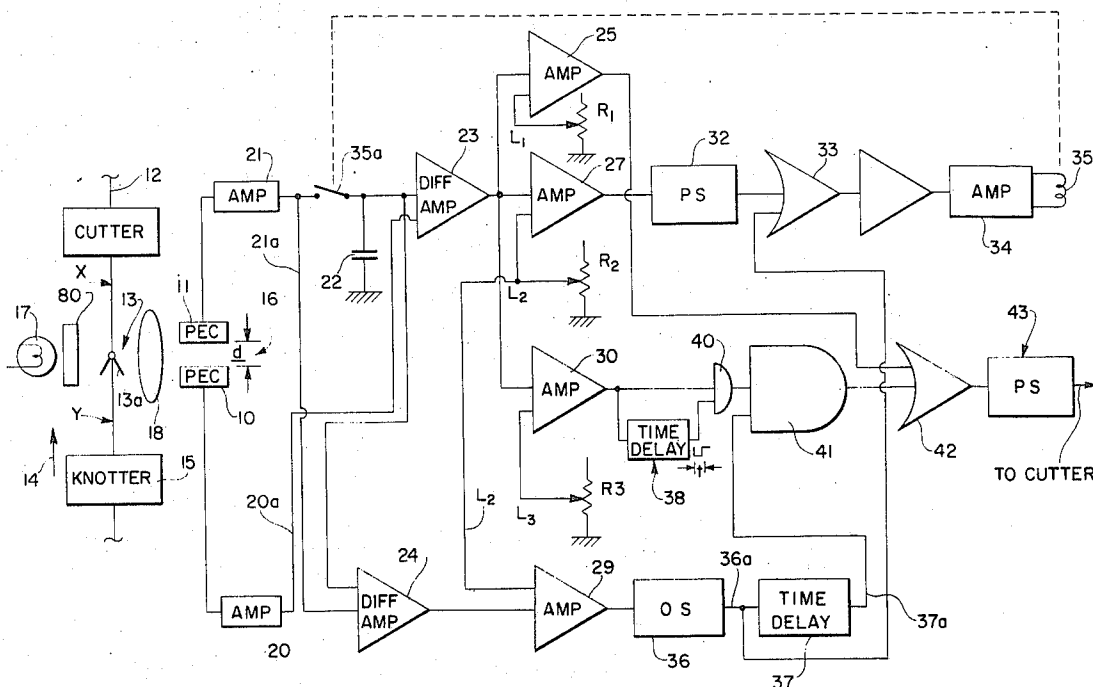
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[57] ABSTRACT

Two photocell detectors are spaced along a path of a moving strand with a gap of known fixed distance therebetween. The photocells view a length of the strand on each side of a knot or defect in the strand when the knot is presented in the gap.

An inspection cycle is started by entry into the detectors of a knot or defect and a defective knot or defect is determined by comparing the dynamic signal status of a photocell spaced some distance behind the knot with the signal taken from a photocell ahead of the defect and stored. The existence of a signal at this position or of an exceptionally large signal indicated by comparison at the time of initiation of the cycle indicates the presence of a defective knot.

11 Claims, 4 Drawing Figures



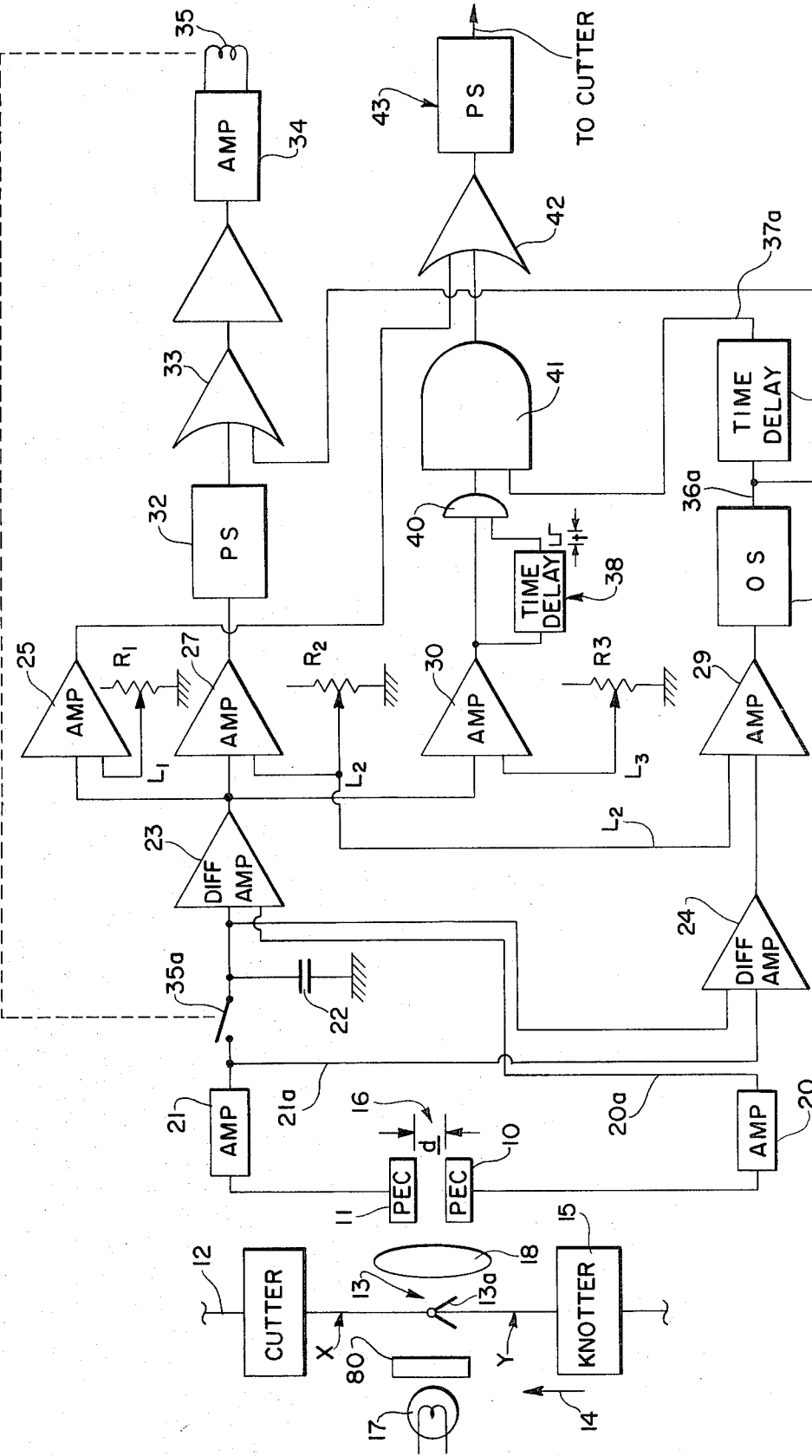


FIG. 1

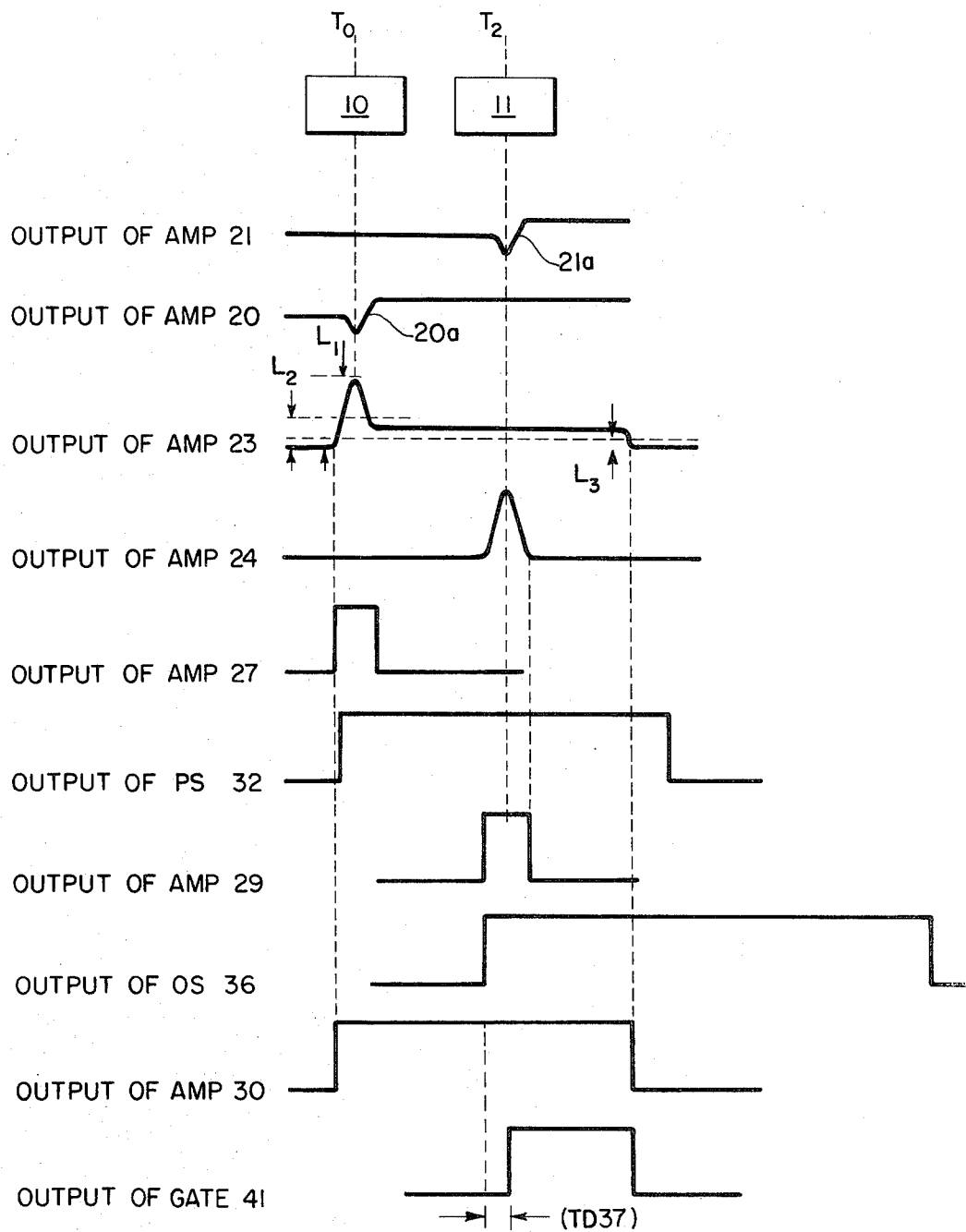
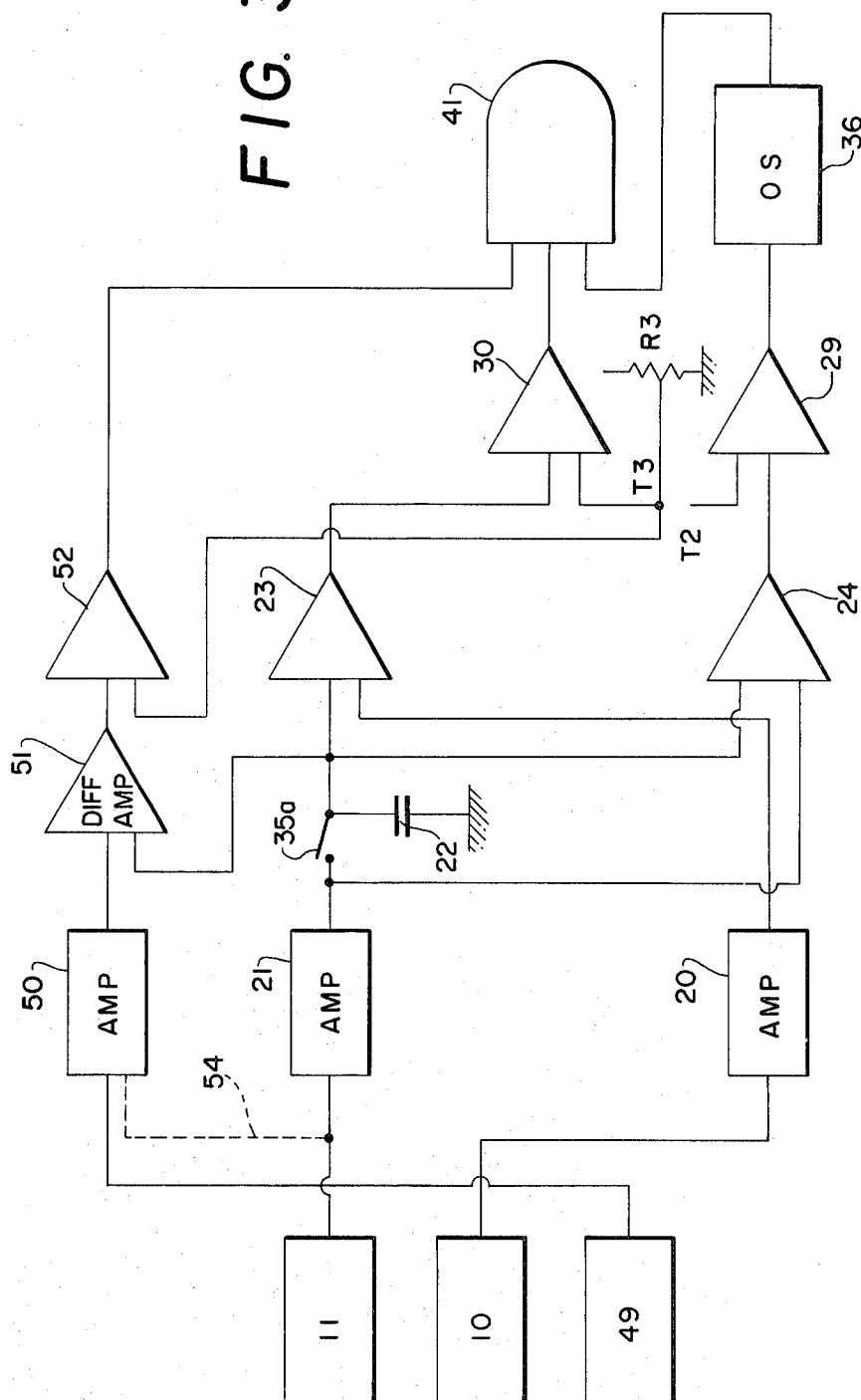


FIG. 2

FIG. 3



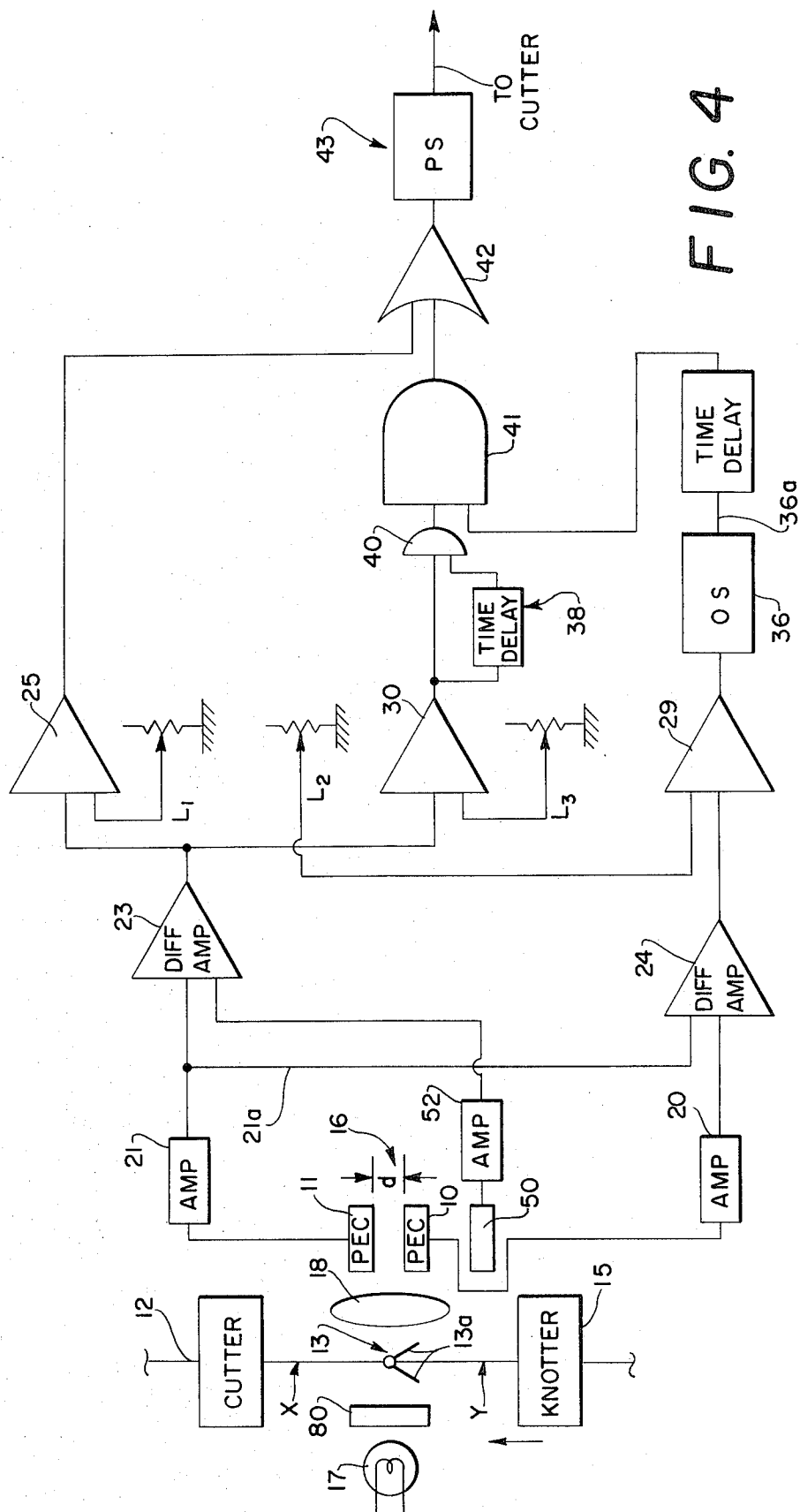


FIG. 4

ELECTRONIC SYSTEM DISTINGUISHING BETWEEN GOOD KNOTS AND DEFECTS IN A MOVING STRAND

BACKGROUND OF THE INVENTION

This invention relates to electronic apparatus for detecting defects along a moving strand, and more particularly it relates to apparatus distinguishing between good knots provided by a knotter mechanism and defects in a moving yarn.

THE PRIOR ART

In textile machinery such as yarn winders it is customary to produce large bobbins from a number of smaller bobbins. Automatic knotting mechanisms are used for piecing together the ends of the yarn such as obtained from two smaller bobbins or otherwise in order to make a continuous strand on the large bobbin. It is, therefore, desirable to monitor the knotting mechanism to assure that a good knot is tied, and furthermore, it is desirable to monitor the strand to cut out defective portions such as slubs which may have no relationship to the knotter. In general, textile equipment using the large bobbins can process a good knot or a short thin slub or other strand defect, but must not receive thick slubs, doubled or wild yarn or long defects that would foul needles or cause a defective fabric. Particularly for doubled yarn it is difficult to distinguish by amplitude of a detected signal the defective areas while handling yarns that may have different diameters from time to time. Also, a good knot may trigger an amplitude sensitive defect detector depending upon the position of the loose tails.

In addition, a detection device should not be time sensitive and require integration or such techniques, since a good knot may be presented while the yarn is accelerating. Therefore, prior art devices have not reliably distinguished between good knots and other non-acceptable defects which have some of the characteristics of good knots.

OBJECTS OF THE INVENTION

Accordingly, it is a general object of this invention to provide an improved defect detector operable with a moving strand of various dimensions and changing speeds.

A further object of this invention is to provide improved detector methods and apparatus for distinguishing reliably between good knots and the unwanted strand defects.

THE DRAWINGS

Other objects, features and advantages of the invention will be found in the following detailed description of the invention and the various embodiments shown in the accompanying drawing, wherein:

FIG. 1 is a block circuit diagram of an electronic textile strand defect distinguishing system embodiment afforded by this invention,

FIG. 2 is a waveform chart showing the relative timing of waveforms used in operation of the various circuits of FIG. 1.

DETAILED DESCRIPTION

The general operation principle of the detection system afforded in one embodiment of this invention may

be observed by reference to FIG. 1. To process a strand, hereinafter termed yarn 12, a knotter 15 is provided such as that described in U. S. Pats. Nos. 2,670,230 and 3,314,620 issued respectively to W. V. Goodhue et al. on Feb. 23, 1954 and T. E. Pitts et al. on Apr. 18, 1967. The strand 12 passes in the direction of the arrow 14 so that a knot 13 may pass cell 10 at a time T_0 , the gap 16 at the time T_1 and the cell 11 at the time T_2 . A region of the strand passing the gap 16 before the knot is identified as X and a region passing the gap 16 after the knot is identified as Y. Preferably, the spacing d of the gap 16 is just enough to pass a good knot 13 with its trailing tails 13a passing the first cell 10 when the knot is presented to the second cell 11. The system afforded by this invention, therefore, should pass good knots, but should detect bad knots which have tails which are too long or which have other strand defects such as doubles, wild yarn and slubs either while the yarn 12 is passing at substantially constant speed between knots or while accelerating after a knot 13 is tied by knotter 15. Accordingly, the system should be relatively speed insensitive within these different strand speed limits.

To distinguish the good knots 13 from unwanted defects, the two photocells 10, 11 are spaced with a gap 16 therebetween, and thus, sequentially observe the strand thickness along yarn 12 by means of a suitable optical array including preferably a single light source 17 and some suitable lens and slit system 18. Thus, in the position shown for yarn 12 and knot 13, the photocell 10 will observe the region Y behind the knot 13 and the photocell 11 will observe the region X ahead of the knot 13 at the time T_1 at which the knot is within the gap 16. The gap 16 has a spacing d of such length that when a good knot 13 enters cell 11 no significant part of it remains within the view of cell 10.

To prevent obscuring the nature of the invention with electronic circuit details, the circuits are shown in single line block diagram form. Those units within the blocks are currently available in units such as integrated circuit chips and the like, which may be interconnected by those skilled in the art to provide appropriate interlock connections and voltages, etc., in the normal course of routine work.

In general, the system operates to inspect the strand when a knot or defect along the strand triggers an inspection cycle. Initially, yarn may be placed on cells 10 and 11, without triggering a cycle, by moving it in parallel to the axis of yarn travel into view of both cells 10 and 11 simultaneously so that they see the same relative signals. The information relating to region X as read by cell 11 is stored at capacitor 22 when the knot or defect 13 passes cell 10 at time T_0 . Should a signal be observed during this comparison of cell 10 to cell 11 which exceeds threshold level L_1 then an error condition is indicated and a pulse stretcher 43 is energized which maintains a signal long enough to initiate cutter C to complete a cutting cycle.

If this threshold level L_1 is not exceeded, the knot or defect will continue to cell 11 at which time threshold level L_2 at amplifier 29 will be exceeded indicating the existence of a knot or defect at cell 11 and not at cell 10. The output from amplifier 29 will initiate an inspection cycle during which the output 20a of amplifier 20 and the stored information are compared. To insure that when a good knot is viewed at cell 11 no good tails,

etc., exist at cell 10, the occurrence of the interrogation signal 36a is delayed by time delay 37.

During the interrogation period signals of very short duration, as may occur from fuzz on the yarn, are blocked by time delay 38. Conversely, if during the inspection period a signal is passed through differential amplifier 23 which exceeds threshold level L_3 at amplifier 30 and time t set at time delay 38, then pulse stretcher 43 is energized to operate the cutter, thereby cutting out the bad knot.

Thus, the system of FIG. 1 processes signals identifying the strand thickness detected at different positions along the length of the strand by photodetector cells 10, 11. Detected signals derived at different times T_0 and T_2 are compared to thereby identify defects along the strand at the knot 13 and over region X ahead of the knot 13 and region Y behind the knot.

Amplifiers 20 and 21 are high impedance amplifiers which have unity gain isolating photodetector cells 10 and 11 respectively, and provide on bus leads 20a and 21a dynamic signals identifying strand thickness characteristics detected at the respective photocell locations providing inputs to the following circuits.

The relative timing of the waveforms to be discussed are shown in FIG. 2 with reference to time periods T_0 and T_2 when the knot 13 passes cells 10 and 11.

As the knot or defect passes cell 10 light is reduced so that the output 20a of amplifier 20 falls below the output 21a of amplifier 21. Differential amplifier 23 subtracts the two signals and amplifies the difference. Amplifiers 25 and 27 are threshold devices which compare the output of differential amplifier 23 to threshold levels L_1 and L_2 respectively as set by their respective potentiometers R_1 and R_2 . If threshold level L_1 is exceeded then as mentioned earlier, the cutter is energized. If threshold level L_2 is exceeded and not level L_1 , then the output of amplifier 27 switches from an off state "0" to an on state "1" corresponding to the time threshold level L_2 is exceeded. This triggers pulse stretcher 32 which de-energizes coil 35 opening contact 35a for a period of time greater than that required for the knot or defect to reach cell 11.

Upon reaching cell 11 at time T_2 the output 21a of amplifier 21 drops below the level stored on capacitor 22 and the difference between the signals is amplified by differential amplifier 24. If the knot or defect had been large enough to turn amplifier 27 on then amplifier 29 which also compares the output of amplifier 24 to threshold level L_2 will turn on. In switching from an "0" to "1" state amplifier 29 sets one shot 36. This keeps switch 35a open for a period of time in excess of that set by pulse stretcher 32. After a time delay, designated TD37 in FIG. 2, which is long enough to insure that an acceptable knot is not also viewed by cell 10, as set by time delay 37, signal 37a will interrogate the output of amplifier 30 through AND gate 41, providing the output of amplifier 30 exceeds the time set by time delay 38. If the spacing between cells 10 and 11 is large enough and the length of the fuzz to be eliminated is small then the times associated with time delays 37 and 38 may be kept sufficiently small so as to keep the sensing relatively speed insensitive.

The output of cell 11 (Amp. 21) in FIG. 2 is shown to remain low indicating a long tail. Since under these conditions the output of differential amplifier 23 exceeds threshold level L_3 during the interrogation cycle

set by one shot 36 an output occurs at AND gate 41 causing the cutter to cut out the defective knot.

It is to be noted that in addition to prohibiting a signal when the yarn is placed between cells 10 and 11, differentially connecting cells 10 and 11 minimizes variation due to fluctuations in light level and yarn movement providing the period of movement is large compared to the spacing between cells. Also, the dual cell and differentiating arrangement removes errors due to lint which may accumulate on both cells substantially evenly, and varying diameters of yarn or changes in ambient light or temperature.

The field of view of the photocells 10, 11 also may be shaped to aid detection of certain errors. If a long narrow cell area is presented along strand 12, then strand doubles may be detected while eliminating short defects or double yarn thickness, for example.

A diffuser lens 80 scattering light from light source 17 can be used to generate a uniform area of randomized light rays making strand orientation as viewed by cells 10, 11 less critical.

Other modes of comparison may be introduced to produce error signals if such conditions of defective yarn occur where a fault precedes the knot 13, i.e., the cell 11 signal is greater than that of cell 10.

In practice with the present invention if the speed of advance of strand 12 is constant, then the intervals associated with time delays 37 and 38 may be lengthened. This means that the relationship between the effective spacing between cells 10 and 11 and length of knots or defects to be detected by the cells can be set solely in terms of time. Furthermore if the time and consequently the length associated with delay 38 is large compared to the effective spacing between cells 10 and 11, time delay 37 becomes unnecessary thus simplifying the circuit.

What is claimed is:

1. Electronic apparatus processing a moving knotted strand such as yarn to detect defects therein and pass good knots comprising in combination, a pair of detection means sampling the strand at two positions successively along its path of movement with a gap therebetween, means responsive to the entry of a knot or defect when it enters a first of said positions to initiate an inspection cycle, means storing a signal derived from the entry of a knot by one of said detection means, and means comparing during said inspection cycle the stored signal with the current signal being received from said strand by the other of said detection means to derive a defect signal upon a signal imbalance when one of said signals is significantly greater than the other.

2. Apparatus as defined in claim 1 wherein the pair of detection means comprises a pair of photoelectric cells and including means detecting entry of the knot or defect at each of the cells and producing therefrom a defect signal, and means eliminating the defect signal during the time the defect is viewed only by the first detection means.

3. Apparatus as defined in claim 2 including a timing circuit generating a signal used to control said means eliminating the defect signal, said timing circuit producing said signal a predetermined time after said defect is first viewed by the second successive one of said detection means.

4. Apparatus as defined in claim 3 including further timing means for processing said defect signal when

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said signal imbalance persists beyond a predetermined time.

5. Apparatus as defined in claim 1 wherein the comparing means include timing means for producing the imbalance signal only when the defect persists beyond a predetermined time span during which a good knot is expected to pass.

6. Apparatus as defined in claim 5 including separate amplifying channels processing the signals from each detection means to provide signals to said comparison means.

7. Apparatus as defined in claim 1 wherein said stored signal is derived from one of said detection means and the comparing means compares the stored signal with the current signal on the other detection means.

8. The method of distinguishing between a good knot and an unacceptable defect in a moving strand such as yarn, comprising the steps of, detecting in a moving strand enlarged portions presented at a detection sta-

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tion, timing the duration of the presence of the enlarged portions detected, and producing an alarm only when the enlarged portions are present for a period beyond a predetermined time span approximating the time span during which good knots pass said detection station.

9. The method defined in claim 8 wherein the step of detecting the enlarged portions of the strand includes sensing the strand at two successive detection station positions along the path of movement of the strand.

10. The method defined in claim 9 including the step of piecing up two broken ends in a knotter away from said two successive positions and thereafter moving the pieced up strand into both said detection station positions simultaneously.

11. The method defined in claim 8, wherein the detecting step includes impinging diffused light on the moving strand and processing collimated diffused light leaving the strand at said detection station.

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