Jan. 9, 1968 J. H. MARTIN, JR 3,363,107

TOW FLAW APPARATUS WHEREIN THE FLAW VIBRATES A PIVOTED ELEMENT BETWEEN A LIGHT SOURCE AND PHOTOCELL

Filed Dec. 7, 1964 3 Sheets-Sheet 1

FIG. 1

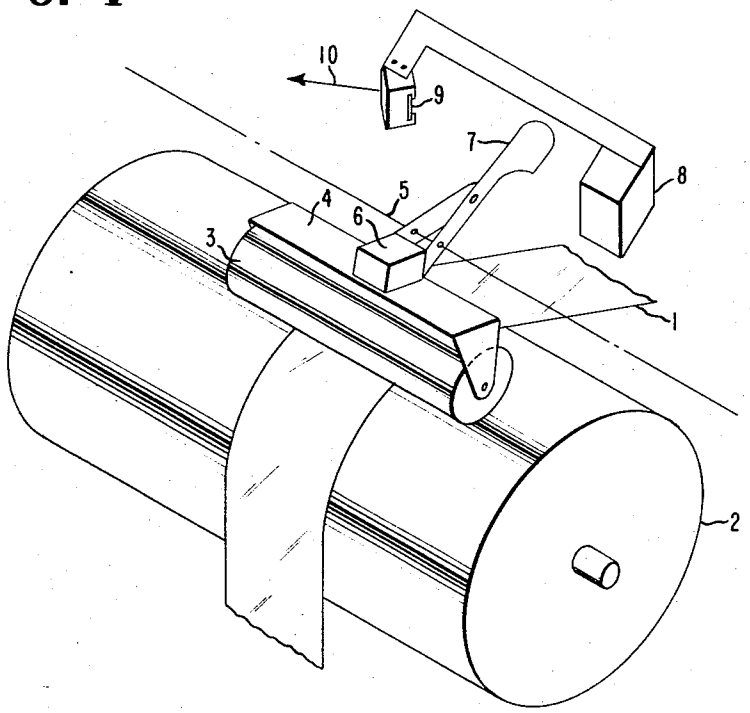
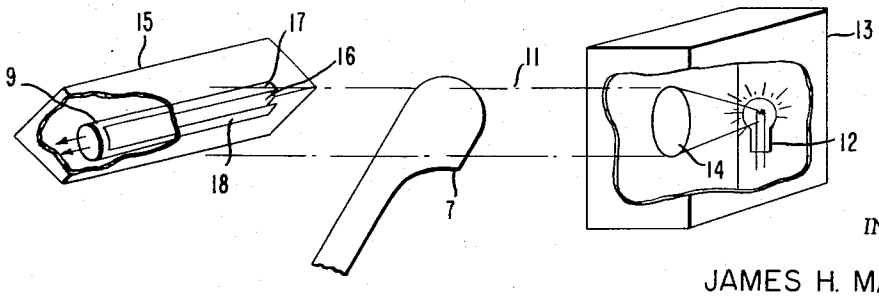


FIG. 2



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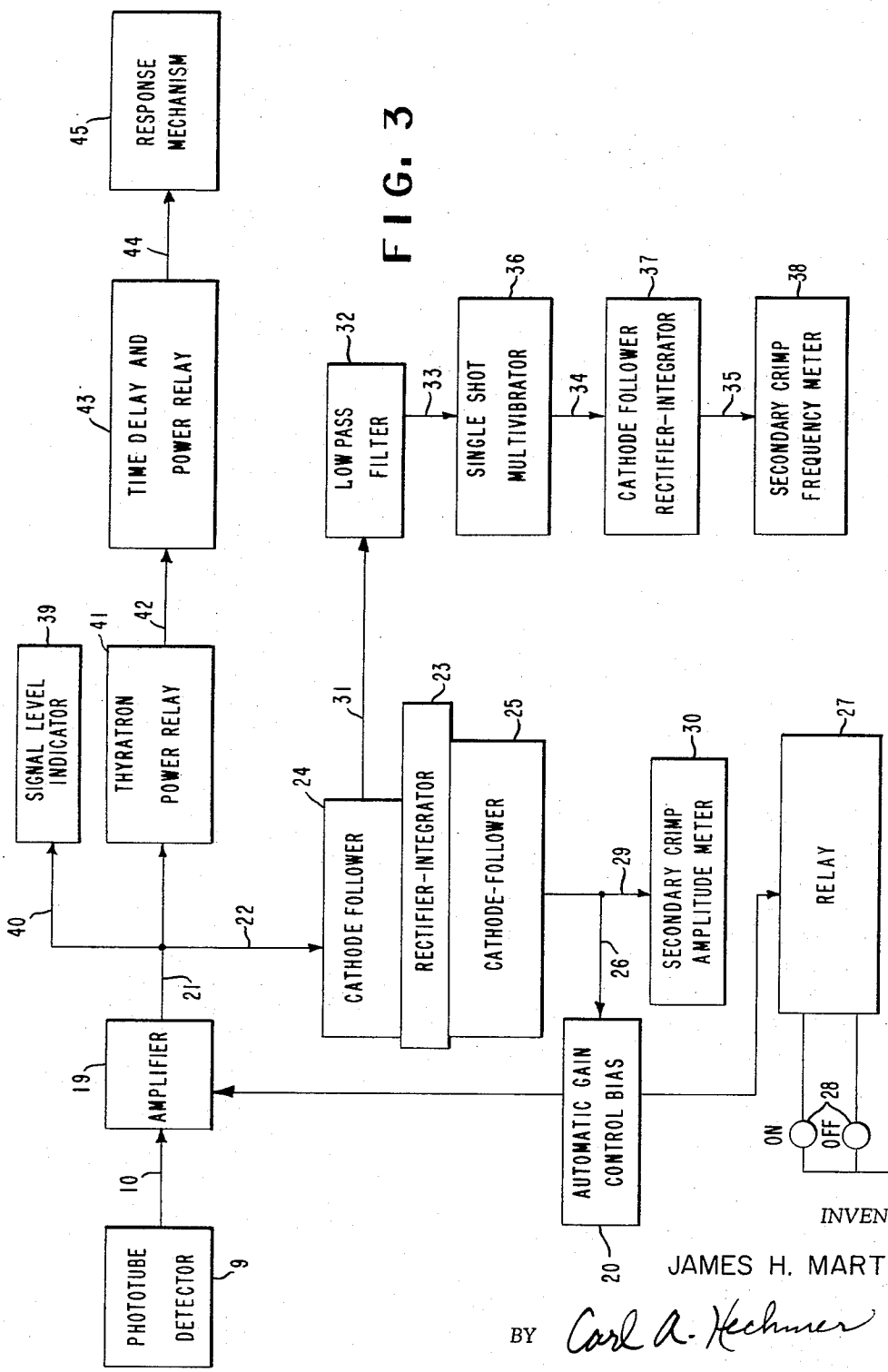
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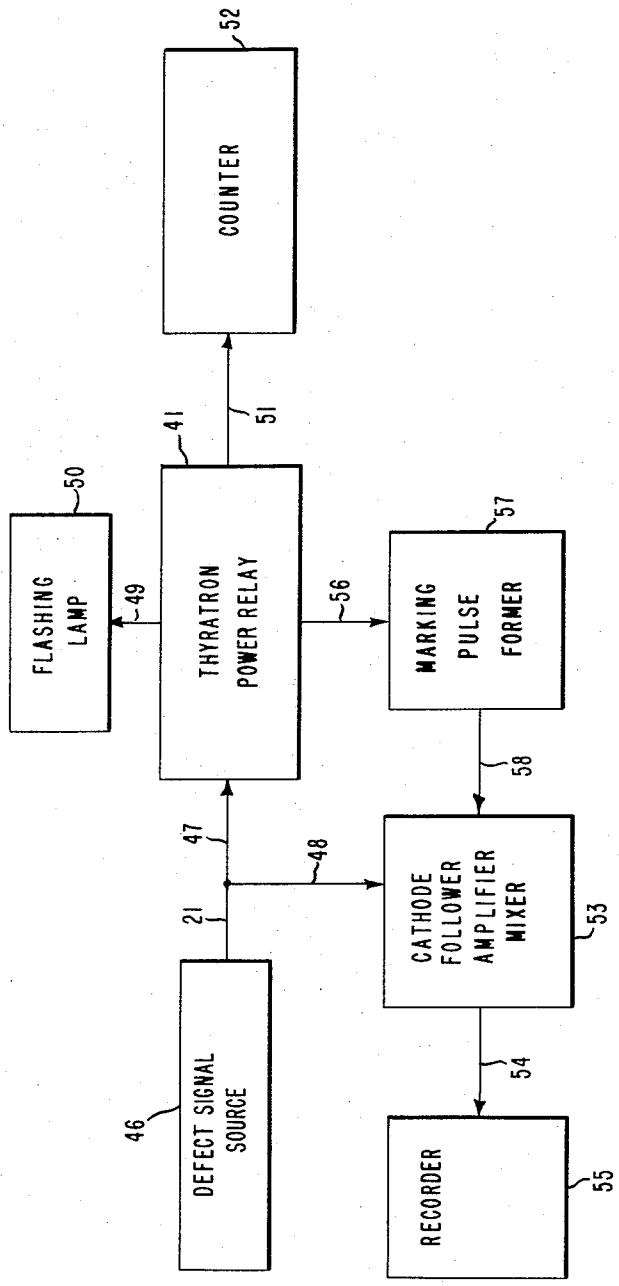
FIG. 3



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FIG. 4



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TOW FLAW APPARATUS WHEREIN THE FLAW VIBRATES A PIVOTED ELEMENT BETWEEN A LIGHT SOURCE AND PHOTOCELL

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4 Claims. (Cl. 250—219)

ABSTRACT OF THE DISCLOSURE

A device for monitoring irregularities in moving crimped textile tow and discriminating between hard defects and secondary crimp comprising a dancer roll mounted to ride on the moving tow as it passes over a mandrel roll, photoelectric means to generate signals resulting from axial motion of the dancer roll and electronic circuitry to analyze and record the characteristics of the electric signal.

This invention is an apparatus for monitoring irregularities in moving crimped textile materials. More specifically the apparatus of the present invention detects and records the amplitude and frequency of secondary crimp and occurrences of hard defects (such as fused spots, foreign matter, and crimper damage) from any cause occurring in crimped textile rope or tow.

Textile rope or tow, as herein used, is defined as a non-twisted strand of many parallel continuous filaments combined to be processed together such as by drawing, heat treating, crimping and cutting to staple fibers or direct spinning into spun (non-continuous filament) yarn. The strand may be processed as a relatively flat or belt-like form or as a round strand often called a rope. The strand may have a weight per unit length of several hundred denier or up to many thousand denier and more. By a "crimped" textile rope or tow is meant one in which a fixed undulous variation of relatively low amplitude and relatively high and uniform frequency has been impressed along its length. The term is well understood in the textile art and is used herein in its normal sense. Generally a crimp is applied to a tow by forcing it into a "stuffer box," subjecting it to a crimp inducing atmosphere, such as steam, and then permitting it to force its way out past a weighted door under the pressure of the stuffing feed. Primary crimp applied in the usual commercial operations results in folds along the linear axis at about ⅛ inch intervals. Although such folds affect dyeability of the fiber at the fold thereby creating non-uniformity, the folds of primary crimp are so close that the variations are not noticeable to the naked eye. After the tow, which enters the stuffer box in a ribbon-like form, acquires a primary crimp, the ribbon itself folds back and forth upon itself impressing a secondary crimp on the fiber. Secondary crimp appears as "fold marks" over the crimped ribbon of tow emerging from the stuffer box. These marks are generally ⅝ to 1½ inches apart, representing a frequency ¼ to ⅙ that of the primary crimp. Some secondary crimp can be tolerated depending upon the particular end use for which the tow is intended. While the secondary crimp is of a non-permanent type, it can cause dye variation and knotting of the tow due to crossover filaments. The production of high quality tow requires maintenance of secondary crimp at as low an incidence as possible.

The device of the present invention operates to examine rapidly moving textile tow to detect "lumps," including those within the body of the tow and those which may not vary the total tow denier, and furnish electrical signals which may be used to operate an electromechanical counter, a recorder, or process regulating devices and

combinations of these. Since secondary crimp is in the nature of a "lump," unless the device can discriminate between lumps due to secondary crimp and lumps due to knotting, foreign bodies, fused fibers or the like, the sensitivity of the device must be reduced to ignore secondary crimp. However, the device of the present invention discriminates secondary crimp and other lump type defects. It also monitors the amplitude and frequency of the secondary crimp to avoid production of defective tow resulting from unusually high secondary crimp.

In the device of the present invention, occurrences of hard defects larger than a preselected minimum in a continuous crimped rope or tow are detected by running the rope or tow through the nip provided by the contacted rotating surfaces of a dancer roll, rotatably mounted on a pivoted frame and a rotatable anvil roll. Pressure is applied to the dancer roll to maintain a compressive force at the nip which will yield to secondary crimp and to hard defects in the tow. A shutter, mounted on the pivoted frame of the dancer roll, is situated to intercept a light beam directed upon a photoelectric cell in such a manner that motion of the frame and shutter causes variations in intensity of the light reaching the cell. The variations are then translated into an electric signal proportional to the variations in the conventional manner. The signal so generated, is thereafter fed to an adjustable amplifier which is adjusted to provide one signal responsive to the secondary crimp, hereinafter referred to as the "crimp" signal and a second signal, of greater magnitude, responsive to hard defects in the tow, hereinafter referred to as a "defect" signal. The amplifier is biased to a preselected gain by the crimp signal to maintain the signals from "gradual" variations in tow quality, characteristic of secondary crimp, below the intensity of "sudden" variations in tow quality, characteristic of hard defects. The bias voltage may conveniently be employed to trigger a relay controlling "on" and "off" indicator lights to provide positive evidence to operating personnel of the proper functioning of the equipment even absent a signal producing defect. The magnitude of the crimp signal, after being rectified and integrated, may be employed to indicate and/or record the amplitude of secondary crimp to which it is directly proportional. Similarly, the frequency of secondary crimp may be indicated and/or recorded by applying the crimp signal to a filter circuit which feeds a single shot multivibrator, the frequency of the triggering of this circuit being proportional to the crimp frequency.

The bias upon the amplifier is so chosen that it fails to suppress signals from sudden variations. Thus the signal from a hard defect in the tow, since it produces a sudden variation, can be detected and utilized, as for instance to fire a thyratron, which in conjunction with conventional circuitry may be employed to indicate it, record it, and/or to control whatever machine response is desired.

The invention will be more readily understood by reference to the drawings.

FIGURE 1 is a perspective of the arrangement of the mechanical components of the defect sensing mechanism.

FIGURE 2 is a detailed perspective, partly in section, of the light path generating and detecting mechanism with the light beam interrupting shutter in place.

FIGURE 3 is a block diagram showing an embodiment for discriminating and utilizing of the "crimp" and "defect" signals generated in the sensing mechanism.

FIGURE 4 is a block diagram which illustrates a preferred embodiment wherein "defect" signals may be counted, recorded and indicated.

Referring particularly to FIGURE 1, a running tow **1** is fed through the nip formed at the point of contact of the cylindrical surfaces of anvil roll **2** and dancer roll **3**. Dancer roll **3** is rotatably mounted in frame **4** which in turn is pivotally mounted on axis **5**. Weight **6** provides a

compressive force of such magnitude at the nip that frame 4 pivots on axis 5 in response to both secondary crimp and hard defects which may occur in tow 1. Frame 4 has mounted upon it a shutter 7 which intercepts a beam of light generated at light source 8 and detected by phototube detector 9. Variations in light intensity received by phototube detector 9 will occur due to the rocking motion of shutter 7 as it responds to variations caused by secondary crimp and defects in tow 1. Lead 10 transmits the electrical output signal of phototube detector 9 to cooperating circuitry more completely described hereinafter.

FIGURE 2 illustrates the positioning of shutter 7 across the beam of light 11. Light source 12 in housing 13 is focused by lens 14. That part of light beam 11 that passes shutter 7 is directed upon phototube detector 9 which is contained in cell housing 15. Access of light beam 11 to phototube detector 9 is through slit 16 which is shielded from extraneous light source by masking elements 17 and 18.

Referring to FIGURE 3, the signal generated by phototube detector 9 is fed into amplifier 19 through lead 10. Amplifier 19 is equipped with a manual gain adjustment and with an automatic gain control bias 20 provided by its rectified and integrated output signal. In providing the AGC bias, the amplified signal impressed on line 21 is fed through lead 22 into a rectifier integrator 23 along with its associated cathode follower, power amplifiers 24 and 25 and finally through lead 26 to apply the bias voltage to amplifier 19. In a preferred embodiment, bias voltage is also supplied to sensitive relay 27 which activates indicator lamps 28 to inform operational personnel whether or not the equipment is generating a detectable signal. Measurement of the magnitude of the signal from cathode follower 25 may be employed to indicate and/or record secondary crimp amplitude at meter 30 since such signals are proportional to the secondary crimp of the tow.

The AGC circuit can also be modified to indicate or record secondary crimp frequency. As shown in FIGURE 3, lead 31 from cathode follower 24 carries the secondary crimp signal to a low pass filter 32 that removes spurious primary crimp signals. The resulting crimp signal then proceeds by leads 33, 34 and 35, in turn, through a single shot multivibrator 36, cathode follower and rectifier-integrator 37 to secondary crimp frequency meter 38. Meter 38 reads out a number proportional to secondary crimp frequency and is calibrated for the normal tow speed. By reading the secondary crimp frequency only while the auto tow take-off current meter is on normal-speed current, a correct secondary crimp frequency reading is assured. A speed controlled indicator lamp may be provided adjacent to meter 38 to assure the correctness of tow speed during the crimp frequency reading intervals.

Signal level indicator 39 receives the amplified signal from amplifier 19 through lead 40. In the start-up of operation, amplifier 19 is manually adjusted until signal level indicator 39 indicates that the desired level of sensitivity of the equipment has been reached. At this level, although secondary crimp can be monitored and recorded in the bias circuit, because of their relatively "gradual" increase permitting biasing, such signals will not be of sufficient magnitude to fire thyratron 41 which also receives the signal from amplifier 19 through lead 21. Defects of a "hard" nature, such as a knot or a fused area, causes a sudden signal to be transmitted through amplifier 19 and because of the time delay in biasing, firing of thyratron 41 occurs. From thyratron power relay 41, employing, for example, a thyratron tube type 2050, lead 42 carries the signal to a time delay and second power relay 43 from which, through lead 44, signals are passed to response mechanism 45 which may include a tow drive motor controller to shut down the tow drive motor.

A second embodiment of circuitry is shown in FIGURE 4, wherein lead 21 from amplifier 19 and photo detector 9 (constituting the defect signal source 46) divides with one lead 47 going to a thyratron power relay 41 which furnishes a signal over lead 49 to a flashing lamp 50 and over lead 51 to a counter 52. The other lead 48, from lead 21 furnishes the amplified phototube signal to a cathode-follower amplifier 53. Output from amplifier 53 is then impressed over lead 54 on a strip recorder 55. An additional lead 56 connects thyratron relay 41 to pulse former 57 which, in turn, is connected over lead 58 to the cathode-follower circuit 53.

In operation, the detector-sensor portions of the two embodiments of this invention are the same. Tow or rope 1 is rapidly drawn between anvil roll 2 and dancer roll 3 by means of pull rolls, driven by a motor, not shown. The dancer roll and its frame 4 is rocked about pivot axis 5 by secondary crimp or a flaw causing a variation in thickness of the tow or rope. As the dancer roll 3 is forced upward, rotating about axis 5, shutter 7 modulates the light from light source 8 to photo detector 9 in housing 13. The amount and rapidity of motion of the dancer roll, and consequently that of the shutter, depends upon the nature, size and hardness of the crimp or lump passing between the dancer and idler rolls. This motion is adjustable by means of weight 6. This weight is adjusted to give optimum performance without damaging the tow or the crimp in the tow as it is passed between the two rolls. In some cases it has been found advantageous to employ spring loading, in place of weight 6, to adjust pinch pressure in order to assure a livelier detector, less crimp roll-down and lower inertia in the detector. Then flaws can be detected which are smaller than possible with a heavier inertially loaded dancer roll.

The size and shape of shutter 7 and the width and length of the slit 16, are so adjusted that motion of the shutter causes proportional change in the output of phototube detector 9. Since the motion of shutter 7 is proportional to the motion of dancer roll 3 which, in turn, depends upon the nature, hardness and the size of the crimp, lump or flaw passing between the dancer and idler rolls, the phototube output will be proportional to the nature, size and hardness of the lump passing beneath the dancer roll. At times, in addition to secondary crimp, the tow will have some interlacing of filaments which will cause smaller vibrations of the dancer roll. This causes a background signal in the phototube output commonly called "noise." The signal from phototube detector 9 is passed through lead 10 to amplifier 19 which contains a manual gain adjustment. The gain adjustment is used to adjust the level of signal output from the amplifier such that the secondary crimp and noise level signals in line 21 will be just insufficient to trigger the thyratron in the thyratron power relay 41. In making the adjustment, the signal from amplifier 19 is fed also to a signal level indicator 39 which the operator can watch to determine the general level of noise coming from the sensor rolling over normal crimp and can observe any occurrences of lumps. Since the thyratron is fired only on occurrence of a defect of preselected size, as adjusted by the amplifier gain, thyratron relay 41 may be used to disconnect the tow drive motor power. In many cases, the location of the sensor equipment is removed a considerable distance from the position of the machine operator who must remove the defect from the tow when it is stopped. Thus, it is necessary to delay disconnecting the tow drive motor for sufficient time so that the detected lump can progress to the operator's inspection station. This is done by means of a time delay and second power relay 43 interposed between the thyratron relay 41 and response mechanism 45.

In the embodiment shown in FIGURE 4, the amplifier and gain adjust are essentially the same as in the above described embodiment. However, the defect signal from signal source 46 is fed through a cathode-follower amplifier 53 and thence to a strip recorder 55. In addition, the defect signal is transmitted to thyratron power relay 41 containing a bleeder circuit to make the thyratron self-extinguishing. Here again, the thyratron is fired when a lump above a specific size and hardness passes between the

dancer and anvil rolls. The firing of the thyratron operates a relay which in turn is employed to operate a flashing lamp **50** and a counter **52**. In addition, the firing of the thyratron is used to operate a capacitor discharge circuit which sends a pulse over lead **58** through cathode-follower amplifier and mixer **53** to recorder **55**. This pulse is so adjusted to be electrically opposite in sign to the normal signal given to the recorder from defect source **46**. Thus, in this case, every small defect irregularity in the tow, within the sensitivity of the phototube and amplifier is impressed upon the recorder and recorded as a band in the positive direction of indications of the tow irregularities. When an irregularity above a preselected size occurs, which is sufficient to fire the thyratron, this is recorded as a trace in the normal (positive) direction and, due to the marking pulse former circuit **57**, is recorded also by a large trace in the opposite (negative) direction on the recorder chart. Thus an operator is able to observe the general level of irregularities and his attention is particularly called to each occurrence of lumps above a preset magnitude.

Many equivalent modifications of the present invention will be apparent to those skilled in the art without a departure from the inventive concept.

What is claimed is:

1. A device for detecting both secondary crimped occurrences of hard defects larger than a preselected minimum in a continuous running crimped rope or tow comprising, on parallel longitudinal axes, (1) a dancer roll, extending across substantially the full tow width and rotatably mounted on a pivoted frame, and (2) a rotatable anvil roll, the said dancer and anvil rolls forming therebetween a nip adapted to receive a continuous rope or tow, pressure means on the said dancer roll to maintain a constant compressive force at the said nip yielding to crimp and to the said hard defects in the said continuous rope or tow, shutter means mounted on the frame for motion in proportion to the motion about the pivot of the said frame of the said dancer roll, light source and projection means to project a beam of light of substantially constant intensity from one side of the path of motion of the said shutter means toward a photoelectric detector means located on the other side of the said path to detect fluctuations in light intensity caused by motion of the said shutter means and to generate an electric signal proportional to the said fluctuations, amplifying means responsive to such signals, said amplifying means being adjustable to provide (a) a crimp signal responsive to secondary crimp of the said rope or tow, the said amplifying means being biased to a preselected gain by the said crimp signal, and (b) a defect signal beyond the said preselected gain control of the said amplifying means, the said defect signal being responsive to hard defects, means to discriminate the said crimp signal and the said defect signal and response means, responsive to said defect signals.

2. The device of claim **1** wherein secondary crimp indicating means is provided by means to measure amplitude and occurrence of the signal providing bias voltage to the said amplifying means.

3. The device of claim **1** wherein the said response means is a machine cut-off mechanism.

4. The device of claim **1** wherein the said response means is a strip recorder mechanism.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,363,107 January 9, 1968

James H. Martin, Jr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 26, for "crimped" read -- crimp and --.

Signed and sealed this 18th day of March 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents