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WEB BREAK DETECTOR

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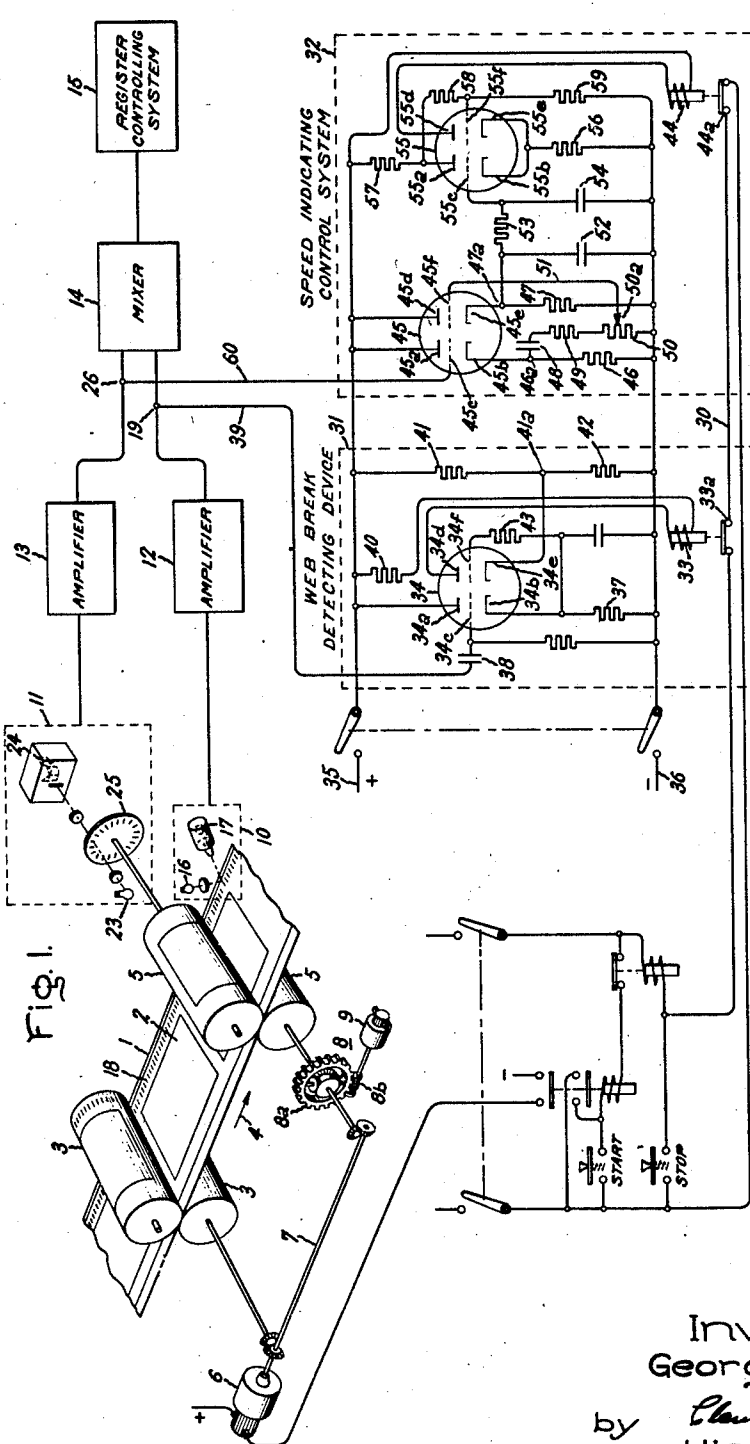
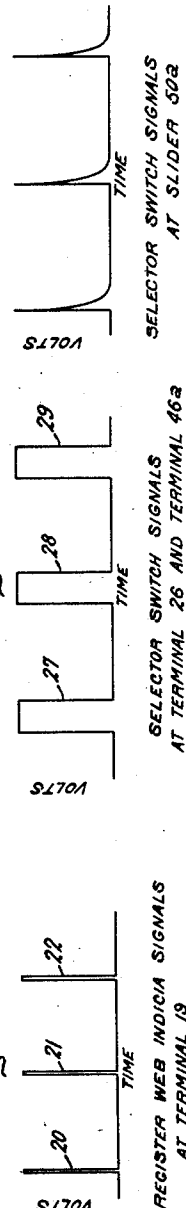


Fig. 1.

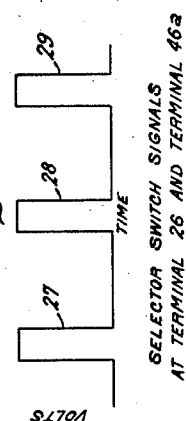
Fig. 2.

Fig. 3.

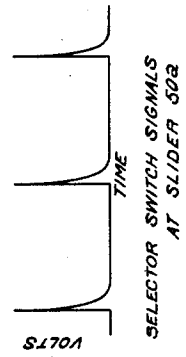
Fig. 4.



REGISTER WEB INDICIA SIGNALS
AT TERMINAL 19



SELECTOR SWITCH SIGNALS
AT TERMINAL 26 AND TERMINAL 46a



SELECTOR SWITCH SIGNALS
AT SLIDER 50a

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WEB BREAK DETECTOR

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1 This invention relates to devices for detecting breaks in a length of moving material such for example as paper, and it has for an object the provision of a simple, reliable, inexpensive and improved device of this character. Such devices are known as web break detectors.

In certain machines having an element which operates on a length of material, photoelectric register control systems are provided for maintaining accurate positional register between reference marks on the length of material and the element which operates. For example in some high speed rotary web multicolor printing presses a photoelectric control system is provided for maintaining each color printing cylinder in accurate register with indicia i. e. reference marks which are printed on the web. A system of this character is disclosed and claimed in U. S. Patent 2,230,715 Cockrell. It comprises a photoelectric scanning means which responds to the indicia on the paper web to produce a succession of positive voltage pulses together with a photoelectric type selector switch mechanism actuated by one of the printing cylinders for producing a succession of pulses which have a predetermined timed relationship with respect to the pulses produced by the reference indicia when the operating element is in register with the indicia. The pulses from the web scanning head and those from the selector switch are amplified by separate amplifiers and the amplified pulses are supplied to a mixing valve circuit which detects any out of register condition and furnishes a signal of such condition to a register correcting system. This correcting system usually comprises electric valve control circuits and a correction motor controlled thereby for restoring the condition of register.

A further object of the invention is the provision of means for detecting breaks in a moving web on which reference indicia have been printed for use in a register control system.

In rotogravure color register control systems it is generally a specified requirement that the photoelectric scanning heads shall be explosion proof equipment owing to the highly inflammable characteristic of the rapidly drying inks which are employed in this process. Explosion proof equipment of this character is very bulky and is also very expensive. Consequently in many installations in which a web break detector is necessary or desirable there is no available space for the additional explosion proof scanner. Consequently, the space factor and the expense of such equipment make it desirable to obtain web break detection and protection without the use

2 of an additional scanner. Accordingly, a further object of the invention is the provision of a control system which utilizes the photoelectric scanning heads of the register control system for detecting web breaks.

In carrying the invention into effect in one form thereof, an alarm circuit is provided for a machine which has an element operating upon a length of material having register marks i. e. indicia printed thereon at successive intervals. Means responsive to the speed of the element which operates on the length of material are provided for preparing the alarm circuit for actuation only at speeds in excess of a predetermined value. Photoelectric means responsive to the indicia on the web complete the alarm circuit in response to a breakage of the web as indicated by a decrease in the rate of passage of the indicia at speeds of the operating element in excess of a predetermined value. The alarm circuit may be utilized to give a visual or audible alarm or to disconnect the driving motor of the machine.

For a better and more complete understanding of the invention reference should now be had to the following specification and to the accompanying drawings of which Fig. 1 is a simple diagrammatic sketch of an embodiment of the invention in a web register control system and Figs. 2, 3, and 4 are characteristic curves which serve to illustrate the operation of the invention and to facilitate an understanding of its operation.

Referring now to the drawings, a length of material 1 such as a web of paper having a color impression 2 printed thereon by printing cylinder 3, travels in the direction of the arrow 4 to a succeeding element operating on the material, illustrated as comprising a pair of printing cylinders 5 which print a second impression of a different color on the web. It is desired that this second color impression shall be made in exact register with the first impression which is made by the cylinders 3. Although only two pair of color impression cylinders are illustrated, frequently as many as six pairs are used in practice.

The printing cylinders are driven by suitable driving means illustrated as an electric motor 6 which is connected to the drive shaft of cylinder 3 by means of suitable gearing and to the drive shaft of cylinders 5 by means of suitable driving connections including the shaft 7.

A mechanical differential device 8 is included in the driving connections between the motor 6 and the cylinders 5. The ring gear 8a of this device is driven by a small direct current motor 9 to

the drive shaft to which it is connected by means of worm gearing 8b. When the motor 9 is stopped the pairs of cylinders 3 and 5 rotate at equal speed.

The correcting motor receives power from any suitable source under the control of the register control system illustrated in the block diagram of Fig. 1 which comprises the photoelectric web scanner 10, and the photoelectric selector switch 11, the amplifiers 12 and 13, the mixing valve circuit panel 14 and the register correcting apparatus 15. The scanning head 10 includes a source of light 16, and a light sensitive device 17 such as a photoelectric cell. This scanning head detects the passage of indicia or register marks 18 printed on the web 1 by the cylinders 3 which print the first color impression. It is connected to the electric valve amplifier 12. Both the scanning head and the amplifier are standard devices which are obtainable on the market. Consequently, detailed descriptions of these devices are omitted. It is sufficient to understand that when indicia 18 pass the photoelectric cell 17, positive voltage pulses are produced at the terminal 19 which are represented diagrammatically in Fig. 2 by the successive pulses 20, 21, and 22.

A second scanning head comprises a light source 23 and a photoelectric cell 24. This scanning head observes the motion of a disc 25 which is mechanically coupled to the second pair of impression cylinders 5. This disc has a series of slits cut in it. The disc has the same number of slits as the number of register marks 18 corresponding to one revolution of the impression cylinders. For example, 16 marks and slits per revolution of the disc are satisfactory for web speeds of 500 to 1,000 ft. per minute. These marks and slits must be equally spaced to an accuracy equal to or better than that of the error which can be tolerated. A register mark .02 in. wide in the direction of paper travel and 1/2 in. long and a disc slit width of 1/4 in. may be used. The lamp 23 projects a beam of light through each slit in the disc 25 as it passes between the lamp and the photoelectric cell 24.

The scanning head 11 of the selector switch and its amplifier 13 are standard devices which may be purchased on the market and accordingly a detailed description of these items is omitted. It is sufficient to understand that the chopping of the light beam by the slitted disc 25 produces positive voltage pulses at the terminal 26 which are represented diagrammatically in Fig. 3 by the pulses 27, 28, 29, etc.

For the purpose of providing an indication of a web break, an alarm circuit 30 is provided. The completion of this circuit is controlled by a web break detecting device 31 and speed indicating control system 32. The details of the web break detecting device and the speed indicating control system are shown within the dotted rectangles in Fig. 1. The web break detecting device includes a magnetic control relay 33 having normally closed contacts 33a in the alarm circuit. As shown in the block diagram, the web register indicia voltage pulses 20, 21, and 22, etc., at the terminal 19 are supplied to the web break detector device. This break detector device maintains the relay 33 energized as long as register indicia signals are received from the scanning head 10. The instant a web breakage occurs register indicia cease to pass under the scanning head and thus no register mark signals are received.

The web break detecting device comprises a

two stage electric valve amplifier 34 of which both the first and second stage valves are preferably included within the same envelope. The first stage valve is provided with an anode 34a, a cathode 34b, and a control grid 34c. Similarly a second stage valve has an anode 34d, a cathode 34e, and a control grid 34f. The two valves are supplied from a suitable source of direct voltage which is represented by the two supply conductors 35 and 36.

As shown, the anode 34a is directly connected to the positive supply conductor 35, and the cathode 34b is connected through a resistor 37 to the negative supply conductor 36. Cathode follower operation of the first stage valve is provided by means of the cathode circuit resistor 37.

The control grid 34c of the first stage valve is connected through a capacitor 38 and conductor 39 to the terminal 19 between the amplifier 12 and the mixing valve panel 14.

The anode 34d of the second stage valve is connected through the operating coil of the relay 33 and a resistor 40 to the positive conductor 35, and the control grid 34f is connected to the cathode 34b of the first stage valve. A voltage divider comprising resistors 41 and 42 is connected across the source 35, 36, and the cathode 34e of the second stage valve is connected to an intermediate point 41a of the divider such that the second stage valve is normally biased to cutoff by the cathode bias obtained from the voltage divider. A grid current limiting resistor 43 is included in the connection between the grid 34f and the cathode 34b of the first stage valve.

In the operation of the system the web break detector device 31 maintains the magnetic relay 33 energized as long as register mark signals are received from the scanning head 10 at sufficiently frequent intervals. The instant a web break occurs, the register indicia cease to pass beneath the scanning head and thus no register mark signals are received thereby causing the relay 33 to become deenergized. The normally closed contacts 33a of the relay then open and shut down the web drive motor, or sound an alarm, or give some visual indication of the break. At zero and very low speeds it is necessary to bypass the web break detector relay because the frequency of the voltage pulses produced by the reference indicia is so low that the second stage valve does not remain continuously conducting, and consequently the contacts 33a close. This operation would give a false indication of a web break when none existed.

The bypassing of the web break detecting device at low speeds is accomplished by means of a pair of contacts 44a on a magnetic relay 44. These contacts are connected in series with the normally closed contacts 33a of relay 33. The relay 44 is controlled by means of the speed indicating device 32 which is operated by the selector switch signals obtained from the terminal 26 between the amplifier 13 and the mixing valve circuit 14. As illustrated in Fig. 1 the speed indicating device 32 comprises a two stage electric valve amplifier. This amplifier is preferably a twin triode electric valve 45. The first stage valve comprises an anode 45a, a cathode 45b, a control grid 45c, and the second stage valve comprises an anode 45d, a cathode 45e, and a control grid 45f. The anodes 45a and 45d are connected to the positive supply conductor 35 and the cathodes 45b and 45e are connected through resistors 46 and 47 respectively to the negative supply conductor 36. Cathode follower operation of both

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first and second stage valves is provided by the resistors 46 and 47 in the cathode circuits. In parallel with resistor 46 is a circuit which comprises a capacitor 48, a fixed resistor 49 and a variable resistor 50 having a slider 50a to which the grid 45f of the second stage is connected by means of conductor 51.

The capacitor 52 is connected in parallel with resistor 47. The ohmic value of resistor 47 is chosen very large in comparison with the plate resistance of the second stage valve with the result that the discharge time of capacitor 52 is very much longer than its charging time.

The control grid 45c of the first stage valve is connected by means of a conductor 60 to the terminal 26 between the selector switch amplifier 15 and the mixing valve 14. The signal input to the grid 45c is, as shown in Fig. 3, a positive square wave voltage of which the width or period varies inversely with the speed of the disc 25 and thus inversely with the speed of the printing cylinders 5. The wave shape of the amplified signals appearing at the cathode terminal 46a is identical with that of the signals supplied to the control grid. The time constant of the circuit including capacitor 48 and resistors 49 and 50 is selected so that the wave form at the slider 50a is always the same for all speeds below the rated speed of the web. The form of these signals is illustrated in Fig. 4. Each time a positive pulse is received at the slider 50a, the capacitor 52 charges up through the low plate resistance of the second stage valve in a very short time and discharges through the high ohmic value resistor 47 when the pulse has passed. Since the number of pulses received per second vary directly with the speed of the selector switch disc 25 and likewise with the speed of the web itself, the voltage across the capacitor 52 will increase directly with the speed of the web within a predetermined range. The voltage at the cathode terminal 47a is filtered by a resistor 53 and a capacitor 54 and fed into the grid of the first stage of a phase inverter and amplifier comprising a twin triode valve 55 of which the first stage valve has an anode 55a, a cathode 55b, and a control grid 55c, and the second stage valve has an anode 55d, a cathode 55e, and a control grid 55f. The two cathodes 55b and 55e are connected through a common cathode resistor 56 to the negative supply conductor 36. A voltage dropping resistor 57 is included in the connection of the anode 55a of the first stage valve and of the positive supply conductor 35. The voltage at the anode 55a is divided by a means of a voltage divider which comprises two resistors 58 and 59 which are connected in series between the anode 55a and the negative supply conductor 36. The control grid 55f of the second stage valve is connected to an intermediate point on the voltage divider such that at zero speed of the web the second stage valve is conducting and the relay 44 is energized.

With the foregoing understanding of the elements and their organization the operation of the system will readily be understood from the following detailed description. When the printing cylinders and the web are at a standstill, no pulses are supplied to the grid 34c of the first stage valve of the web break detecting device and consequently the second stage valve is nonconducting and the relay 33 is deenergized. In response to the deenergization, the contacts 33a of the relay are closed. Similarly no positive pulses are supplied to the grid 45c of the first

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stage valve of the speed indicating device. Consequently the second stage valve of the phase inverter 55 is conducting with the result that the operating coil of the relay 44 is energized and the relay is picked up to open its normally closed contacts 44a.

As the printing cylinders and the web are brought up to speed, the register indicia 18 passing the web scanning head 10 produce positive voltage pulses which are supplied to the grid 34c. As a result of these positive pulses the conductivity of the first stage valve is increased and the second stage valve is rendered conducting, and at a predetermined low speed N1 the conduction of the second stage valve is insufficient to keep the relay 33 picked up and its normally closed contacts remain closed.

At a slightly higher speed N2, the positive voltage pulses supplied from the selector switch mechanism to the grid 45c of the first stage valve of the speed indicating device have sufficient frequency to render the second stage valve of the phase inverter nonconducting thereby deenergizing the operating coil of the relay 44. In response to deenergization, this relay drops out and closes its normally closed contacts 44a thereby preparing the alarm circuit for completion.

If the web breaks at any speed above N2, no web indicia will pass the web scanning head 10 and no positive voltage pulses will be supplied to the control grid 34c of the first stage valve of the web break detecting device. As a result, the first and second stage valves become nonconducting and the operating coil of the relay 33 is deenergized. Responsively to deenergization, the relay 33 drops out and closes its normally closed contacts 33a thereby to complete the alarm circuit 30 which was prepared or partially completed at the speed N2 by the closing of the contacts 44a. The completion of the alarm circuit 30 causes either a visual or an audible alarm to be given or it may be utilized to disconnect the press drive motor from its source.

The speed at which the speed indicating relay 44 drops out is determined by the setting of the potentiometer 50.

Although in accordance with the provisions of the patent statutes this invention is described as embodied in concrete form and the principle thereof has been explained together with the best mode in which it is now contemplated applying that principle, it will be understood that the apparatus shown and described is merely illustrative and that the invention is not limited thereto since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of the invention or from the scope of the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A web detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, a normally inactive alarm circuit, means responsive to speeds of said element greater than a predetermined speed for preparing said alarm circuit for actuation, and photoelectric means responsive to non-passage of said indicia for actuating said prepared alarm circuit to indicate a break in said length of material.

2. A web break detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distrib-

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 uted along its length comprising, a normally open alarm circuit, means responsive to speeds of said element greater than a predetermined speed for partially completing said alarm circuit, and photoelectric means responsive to non-passage of said indicia for completing said alarm circuit.

3. A web break detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, a normally open alarm circuit, means responsive to speeds of said element greater than a predetermined minimum speed and a relay controlled thereby for partially completing said alarm circuit, and photoelectric means responsive to non-passage of said indicia and a relay controlled thereby for completing said alarm circuit.

4. A web break detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, an alarm circuit, means responsive to the speed of said element for preparing said alarm circuit for actuation, an amplifier comprising a first stage electric valve and a second stage electric valve each provided with an anode, a cathode and a control grid, a resistor connected in the cathode circuit of the first stage valve to provide cathode follower operation, a connection from the cathode terminal of said resistor to the grid of said second stage valve, photoelectric means responsive to the passage of said indicia for supplying successive signal voltage impulses to the grid of said first stage valve to increase the conductivity of said first stage valve during each of said impulses, a capacitor connected in parallel with said resistor for varying the conduction of said second stage valve during the passage of said indicia, and a relay responsive to the condition of conduction of said second stage valve during nonpassage of said indicia for actuating said prepared alarm circuit to indicate a break in said length of material.

5. A web break detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, an alarm circuit, means responsive to the speed of said element for preparing said alarm circuit for actuation, an amplifier comprising a first stage electric valve and a second stage electric valve each provided with an anode, a cathode and a control grid, means supplying a biasing voltage to the grid of said second stage valve to effect a normal condition of non-conduction of said second stage valve when said first stage valve is non-conducting, a resistor connected in the cathode circuit of said first stage valve to provide cathode follower operation, a connection from the cathode terminal of said resistor to the grid of said second stage valve, photoelectric means responsive to the passage of said indicia for supplying successive signal voltage impulses to the grid of said first stage valve to increase the conductivity of said first stage valve during each of said impulses, a capacitor connected in parallel with said resistor and becoming charged in response to conduction of said first stage valve to vary the conduction of said second stage valve, and a relay responsive to said normal condition of non-conduction of said second stage valve for actuating said prepared alarm circuit to indicate a break in said length of material.

6. A web break detector for use on a machine having an element operating on a length of moving

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 ing material having a plurality of indicia distributed along its length comprising, an alarm circuit, means responsive to the speed of said element for preparing said alarm circuit for actuation, an amplifier comprising a first stage electric valve and a second stage electric valve each provided with an anode, a cathode and a control grid, means biasing said second stage valve to cutoff when said first stage valve is non-conducting, a resistor connected in the cathode circuit of said first stage valve to provide cathode follower operation, a connection from the cathode terminal of said resistor to the grid of said second stage valve, photoelectric means responsive to the passage of said indicia for supplying successive signal voltage impulses to the grid of said first stage valve to render said first stage valve conducting during each of said impulses, a capacitor connected in parallel with said resistor and becoming charged in response to conduction of said first stage valve to render said second stage valve conducting, and a relay responsive to the cutoff condition of said second stage valve for actuating said prepared alarm circuit to indicate a break in said length of material.

7. A web detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, an alarm circuit, means for partially completing said alarm circuit at a predetermined speed of said element comprising means responsive to the speed of said element for producing voltage pulses having a frequency proportioned to the speed of said element, a capacitor, electric valve means responsive to said voltage pulses for charging said capacitor, a discharge circuit for said capacitor having a resistance that is relatively high with respect to the resistance of the charging circuit to effect a charge on said capacitor proportional to the frequency of said pulses, a relay and an electric valve phase inverter responsive to the charge on said capacitor for effecting operation of said relay at a predetermined speed of said element, and photoelectric means responsive to the non-passage of said indicia for actuating said prepared alarm circuit to indicate a break in said length of material.

8. A web detector for use on a machine having an element operating on a length of moving material having a plurality of indicia distributed along its length comprising, an alarm circuit, means for partially completing said alarm circuit at a predetermined speed of said element comprising means responsive to the speed of said element for producing voltage pulses having a frequency proportioned to the speed of said element, a capacitor, electric valve means responsive to said voltage pulses for charging said capacitor, a discharge circuit for said capacitor having a resistance that is relatively high with respect to the resistance of the charging circuit to effect a charge on said capacitor proportional to the frequency of said pulses, a relay having normally closed contacts and an electric valve phase inverter responsive to the charge on said capacitor for deenergizing said relay at a predetermined speed of said element, and photoelectric means responsive to the non-passage of said indicia for actuating said prepared alarm circuit to indicate a break in said length of material.

9. For use on a machine having a driving motor and an element operating on a length of material provided with a plurality of indicia distributed along its length comprising, an alarm circuit,

means responsive only to speeds of said element greater than a predetermined minimum speed for preparing said alarm circuit for actuation, photoelectric means responsive to non-passage of said indicia for actuating said prepared alarm circuit and means responsive to actuation of said alarm circuit for deenergizing said driving motor.

10. For use on a machine having a driving motor and an element operating on a length of moving material having a plurality of indicia distributed along its length comprising a normally open alarm circuit, means responsive only to speeds of said element greater than a predetermined minimum speed for partially completing said alarm circuit at a predetermined speed of said element, photoelectric means responsive to

non-passage of said indicia for completing said alarm circuit, and means responsive to the completion of said circuit for deenergizing said driving motor.

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