

July 30, 1963

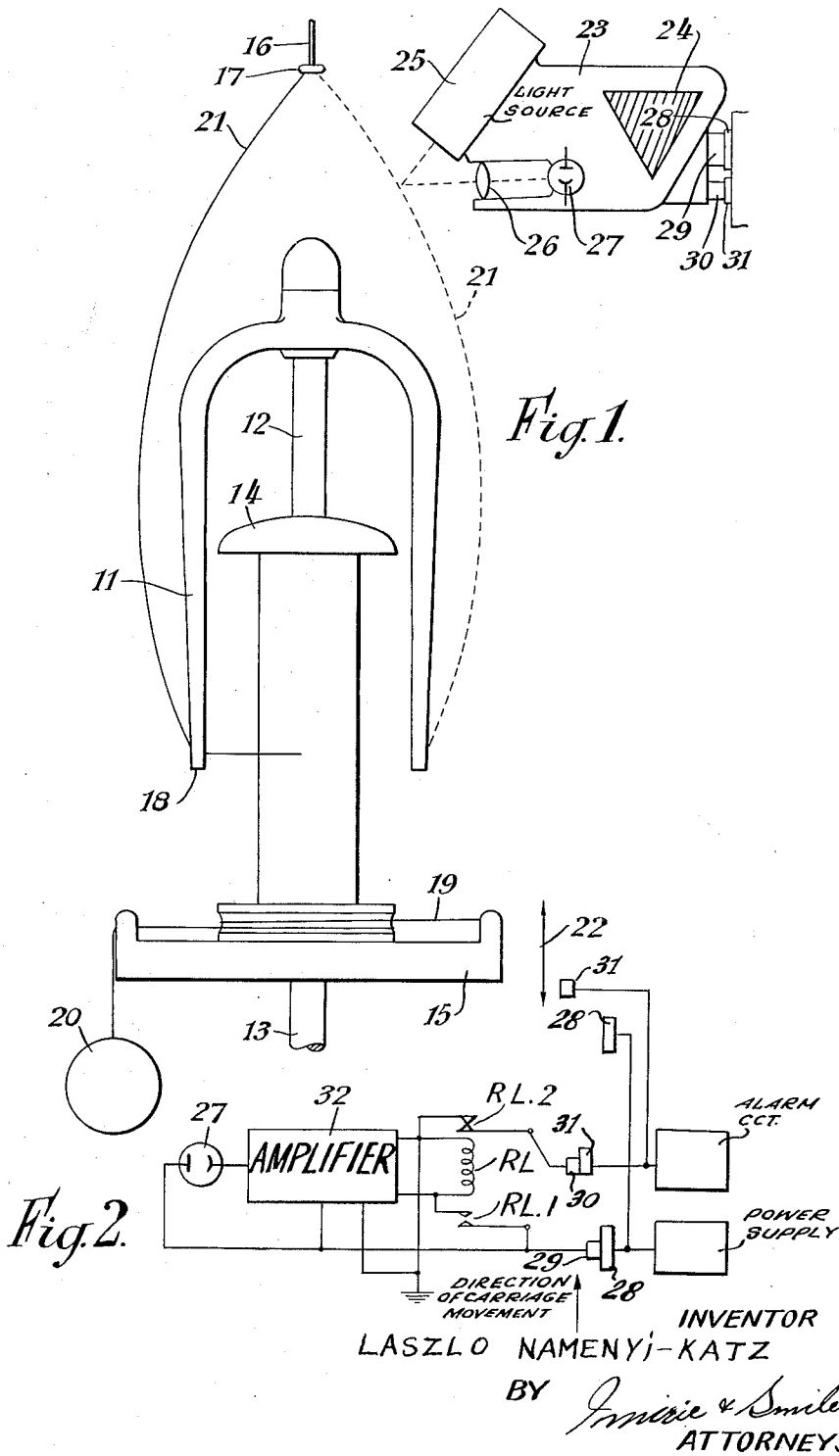
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3,099,829

YARN BREAK DETECTOR

Filed May 23, 1960

2 Sheets-Sheet 1



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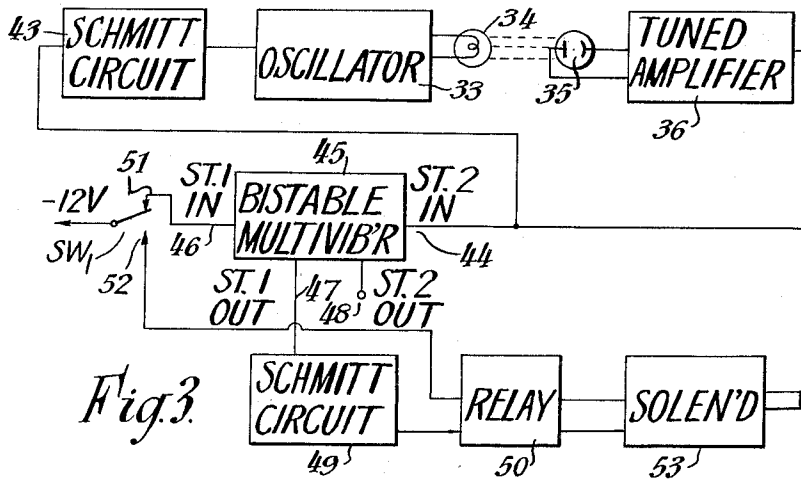
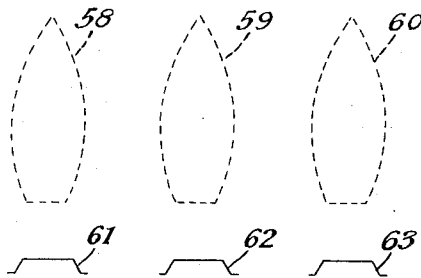
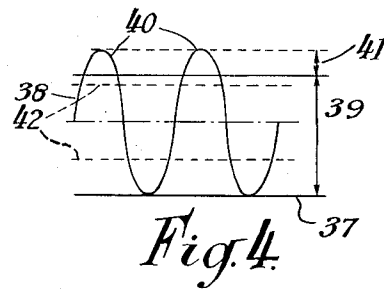
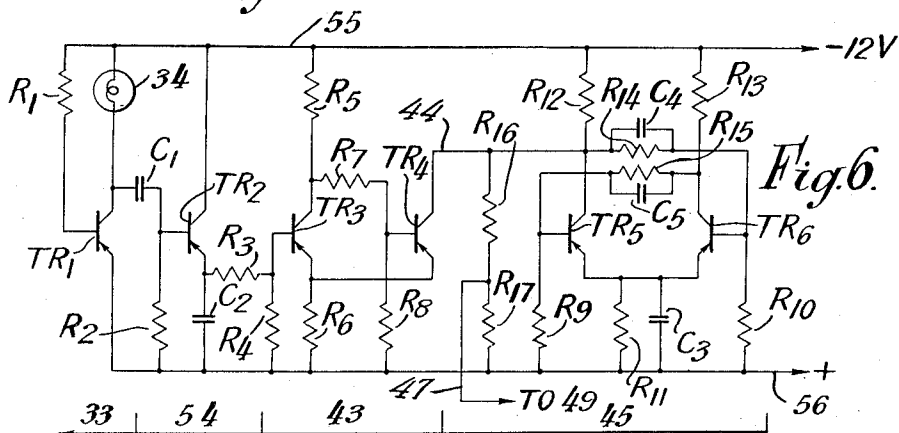
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2 Sheets-Sheet 2



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YARN BREAK DETECTOR

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This invention relates to spinning, twisting or other textile machines, and more particularly to apparatus for detecting breaks in yarns being fed to the spindles or other operating elements of such machines and for actuating an alarm or an indicator when a break is detected. It will be described especially in relation to conventional spinning machines but the manner in which it may be adapted to other types of textile machine will become evident from this description.

In spinning yarn from textile fibres, the fibres are cleaned and treated in such a manner that they are laid in more or less parallel formation and they are then drawn out to form a soft, fluffy cord called a roving. The roving is passed to a spinning spindle in which it is spun—that is to say, twisted—into yarn.

In the most commonly used spinning processes the roving is fed through an eye to a rotating flier arm which rotates around a bobbin. The bobbin is free to rotate and it is usually pulled round by the tension of the spun yarn being fed to it. The speed of rotation of the bobbin is controlled by a braking device so that it is compelled to rotate more slowly than the spindle and, in consequence, the spun yarn is wound upon it. The closeness of the twist applied to the yarn and the rate of feed are dependent upon the difference in rotational speed between the flier arm and the bobbin. The bobbin is moved up and down inside the flier arm while rotating so that the spun yarn is wound evenly along the length of the bobbin. As the bobbin is filled up the diameter upon which the new yarn is being wound increases and it is usual to adjust the brake load on the bobbin from time to time to prevent the tension from varying unduly.

As the flier arm rotates at a very high speed, the yarn being fed to it is thrown out by centrifugal force to form a so-called balloon. The tension on the partly spun yarn is quite considerable and breaks occur from time to time. These yarn breaks are not infrequent where a large number of spindles is in operation and it is necessary that all the spindles be regularly inspected to see that no break has occurred because an undetected break involves loss of production. In other types of textile machine unspun, partly spun or spun yarns are fed to operative elements of the machine and a degree of tension is necessarily applied. In these cases also, breaks occur from time to time and inspection is necessary to detect broken yarns and to remedy the breaks. The principal object of the invention is to provide means to carry out these inspections automatically and give an audible, visible or other alarm when a break is detected. In a spinning machine the alarm device may also indicate the spindle at which the break has occurred and stop it.

The invention consists of a method of detecting breaks in yarns in textile machines in which a field of electro-magnetic waves is brought into proximity in turn with each yarn, the change in the field caused by the presence of the yarn is caused to activate a device adapted to inhibit means to produce an alarm signal, and the alarm signal producing means are subsequently conditioned for operation, whereby the presence of the yarn prevents the production of the alarm signal and the absence of the yarn due to yarn breakage prevents operation of the inhibiting device and allows the alarm signal to be produced.

The field of electro-magnetic waves may be a beam of

2

light, the light reflected from the yarn activating the alarm-inhibiting device.

The invention includes a yarn break detector comprising a carriage adapted to travel along a row of yarns in a textile machine, means to produce a field of electro-magnetic waves in the vicinity of each yarn, detecting means on the carriage responsive to a change in the field caused by the presence of the yarn, an amplifier to amplify the signal from the detecting means in response to the change in the field, a device settable to two states, means to set the device to its first state as the carriage approaches each yarn, the amplifier output being adapted to set the device to its second state, and means conditioned for operation when the carriage is moving away from the spindle and responsive to the first state of the device to produce an alarm signal.

The means to produce the field of electro-magnetic waves may consist of a light source and the detecting means may consist of a photo-electric device which receives light reflected from the yarn.

Conveniently the light source, where such is used, is modulated, and the amplifier is tuned to the modulating frequency. Means may be included in the light source circuit to prevent the alarm from being operated in case of lamp failure.

Conveniently the carriage is arranged to travel on one or more rails arranged behind the yarns and along the length of the row. Short lengths of electrical contact strip may be arranged behind each yarn, the contact strips being engaged by a contact moving with the carriage to energize the electrical circuits of the carriage while it is passing each yarn. The photo-electric device may be a photo-transistor and the amplifier may be transistorized. The device settable to two states may be electronic, such as a multivibrator, or it may consist of an electro-magnetic relay and the holding means may consist of a normally open contact of the relay which is closed when the relay is operated and which holds it in the operated condition.

The means to inhibit the alarm signal may be an additional contact on the relay which is normally closed but it opened when the relay operates. The alarm circuit may be made by means of an auxiliary contact on the carriage which engages a stationary contact immediately after the carriage has passed the yarn and before the electrical circuits of the carriage are de-energized. The alarm circuit may include holding means which continue to operate the alarm after the carriage has moved on to the next yarn.

In order that the invention may readily be understood one embodiment thereof will now be described, by way of example, with reference to the accompanying drawings.

In the drawings:

FIGURE 1 shows one arrangement of the yarn break detector according to the invention;

FIGURE 2 is a schematic electrical circuit diagram;

FIGURE 3 shows in block schematic form a more complex arrangement suitable for high speed operation and containing certain safeguards;

FIGURE 4 is a diagram showing the limiting of the amplifier output;

FIGURE 5 shows diagrammatically an arrangement of cams or the like for operating a switch on the carriage; and

FIGURE 6 is a circuit diagram showing parts of the arrangement of FIGURE 3.

FIGURE 1 shows diagrammatically a conventional arrangement of a spinning spindle consisting of a flier arm 11 adapted to rotate with a vertical spindle 12 having a drive (not shown) applied to its lower end 13. A coaxial bobbin 14 is mounted inside the flier arm and is rotatably supported on a bobbin frame 15. The roving 16 which is to be spun into thread passes through an eye

17, through an aperture at the end 18 of the flier arm and thence to the bobbin. A brake cord 19 anchored to the bobbin frame 15 passes round a groove in the lower bobbin flange and through a notch in the front of the bobbin frame to a weight 20 attached to its end. The spindle 12 is rotated at high speed so that the flier arm 11 rotates around the bobbin. Due to the high speed of rotation the partly spun yarn is thrown out by centrifugal force to form a balloon 21. The bobbin is free to rotate but is restrained by the friction of the cord 19 due to the weight 20 so that the bobbin is pulled round by the spun yarn but rotates more slowly than the flier arm. The roving is spun while passing from the eye 17 to the aperture 18 and is then wound on to the bobbin. The frame 15 moves up and down as indicated by the double headed arrow 22 in order that the spun yarn may be wound evenly along the length of the bobbin.

A spinning frame consists of a substantial number of spindles and bobbins, all the latter being carried on the bobbin frame 15. There is considerable tension in the partly spun yarn due to the braking effect of the cord 19 and the formation of the balloon 21 so that the partly spun yarn on one or other of the spindles breaks on occasion. Where a large number of spinning spindles is involved these breaks are sufficiently frequent to necessitate continual inspection of the spindles, so that remedial action may be taken as breaks occur.

According to one embodiment of the invention a carriage 23 is arranged to travel along the length of the row of spindles, behind the spindles, on a triangular rail 24. Other shapes of rail may, of course, be used. The carriage 23 may be moved by any convenient means and may have its own motor. It may either reciprocate from one end of the row to the other or, where the layout of the spindles is suitable, it may be arranged to travel continuously around a framework containing a large number of spindles.

A light source 25, which may consist of a lamp and a condenser lens, is arranged to throw a beam of light on to the balloon of each spindle as the carriage travels past it. A certain amount of light is reflected from each balloon and this is conveyed by a lens 26 to a photo-electric device 27, which may conveniently consist of a photo-transistor.

A series of contact strips 28 is disposed along a convenient path on the framework and the strips 28 are engaged by a travelling contact 29 on the carriage 23. The strips are so arranged that the carriage circuits are electrically energized to switch on the lamp and bring the electronic circuits into operation just before the carriage reaches each spindle, and de-energized sometime after the carriage has passed the spindle.

Light reflected from the balloon 21 causes the photo-electric device 27 to deliver a signal which is fed to the input terminals of an amplifier 32 as shown in FIGURE 2. The circuitry of FIGURE 2 is also conveniently mounted in the carriage 23. The output signal of the amplifier is passed to the coil RL of an electro-magnetic relay and it operates the relay. A normally open holding contact RL.1 is provided on the relay and is closed by operation thereof so that the relay coil RL is independently energized from the power supply. Thus, once light has been reflected from the balloon 21 and the photo-electric device 27 has delivered a signal to operate the relay, the relay remains in the operated condition until the travelling contact 29 reaches the end of the contact strip 28 after the carriage has passed the spindle. The electrical circuits are then de-energized and the relay returns to the unoperated condition.

The relay has a second contact RL.2 which is normally closed but which is opened when the relay is operated. An auxiliary travelling contact 30 on the carriage 23 is connected to the contact RL.2 and engages a fixed contact 31 after the carriage 23 has passed the spinning spindle and before the circuits are de-energized by the

travelling contact 29 passing the end of the contact strip 28.

The operation of the apparatus is as follows.

The carriage 23 travels along the length of the rail 24 and just before it reaches each spinning spindle, the contact 29 engages the contact strip 28, so that the lamp is illuminated and the electronic circuitry is energized. If the spindle is operating properly and the roving is being fed through the eye 17 to form the balloon 21 then light from the source 25 is reflected through the lens 26 to the photo-transistor 27. The signal from the photo-transistor is amplified and operates the relay RL, which is then held in the operated condition by the holding contact RL.1. Operation of the relay opens the contacts RL.2 so that contact between the travelling contact 30 and the fixed contact 31 has no effect. If, on the other hand, the yarn is broken then the balloon 21 is not formed so that the relay RL remains in the unoperated condition and the contacts RL.2 are closed. When the travelling contact 30 engages the stationary contact 31 an alarm circuit is completed so that current flows from contact 31 to earth. This causes an alarm to go into action. The alarm may consist of an indicator lamp, a hooter or any other desired device. The alarm circuit may include holding means so that the alarm continues to operate even after the carriage 23 has passed to the next spindle and the contacts 30, 31 have separated. The alarm circuit is then reset after the yarn break has been attended to. An indicator may be included to indicate which spindle requires attention and to stop the spindle.

The simple arrangement just described exhibits certain imperfections. The spindles of a spinning machine are arranged quite close together and the spacing between them may be as little as three inches. The detectors according to the invention is capable of operation at high speed and it is possible to arrange for the carriage to move at such a rate that it will inspect one spindle approximately each second. In rapid operation it is desirable to avoid the switching surges which occur when the members on the carriage are switched on and off, and to have the carriage continuously energized. If the overall illumination of the room containing the spinning machine is sufficiently strong, it is possible for the arrangement shown in FIGURES 1 and 2 to be continuously actuated by the general lighting. Since the circuitry is fully transistorized a high degree of reliability may be expected and the lamp becomes the weakest point in the chain. With the carriage travelling at high speed a lamp failure will cause a "broken yarn" indication to be given as the carriage passes each spindle since the photo-transistor will receive no light signals. It is convenient to arrange for the alarm circuit to stop each spindle with a broken yarn as it is detected, in addition to giving an indication of a break, and in case of a lamp failure the carriage will travel along the machine stopping each spindle as it passes, at the rate of about 60 per minute, thus progressively shutting down the whole machine. It is therefore desirable to guard against lamp failure. All these features are contained in a more elaborate arrangement which will now be described with reference to FIGURES 3 to 6.

In order to guard against actuation of the detector by a high level of general illumination, it is arranged to modulate the light of the lamp, and this is achieved by means of an oscillator 33 which may conveniently be an astable multivibrator tuned to about 800 c./s., having the lamp connected in the output circuit. In order that the lamp may follow oscillations of this frequency, it is necessary to use a lamp having a filament with a very small thermal inertia and this necessitates a low-power lamp with a thin filament. The photo-transistor 35 receives the light of the lamp reflected from the balloon and its output is applied to an amplifier 36 which is tuned to the oscillator frequency. It is found that even with a low-power lamp the invention works effectively despite a very high level of general illumination, but the signal-

to-noise ratio is high. The amplifier therefore contains circuitry which clamps the output in order to provide a D.C. zero reference level, 37 in FIGURE 4, and a limiting circuit is employed which operates to suppress the portion of the output wave 38 contained within the dimension line 39, so that the amplifier output consists of a series of pulses 40 having an amplitude indicated by the dimension line 41. The noise level is indicated by the dotted lines 42.

The oscillator has its output circuit connected to a Schmitt circuit 43 the purpose of which will be explained later. The output of the amplifier and the output of the Schmitt circuit are applied to an input connection 44 of a bistable multivibrator 45. A potential applied to connection 44 will set the multivibrator to one of its states, which will hereinafter be referred to as state 2. The other input 46 of the multivibrator is connected to a fixed contact 51 of change-over switch SW1, the moving contact of which is connected to the negative terminal of the power supply for the whole of the circuitry. When a potential is applied to input connection 46 via the switch SW1 the multivibrator is set to its state 1, whereas the output of the amplifier applied to the input connection 44 will set the multivibrator to its state 2. The state 1 output 47 of the multivibrator is connected to the input of a second Schmitt circuit while the state 2 output 48 from the multivibrator is unconnected. The output of the Schmitt circuit 49 is connected to one terminal of a relay 50, the other terminal of which goes to the second fixed contact 52 of the switch SW1. The contacts on the relay are connected to energize a solenoid 53.

A portion of the output stage of the oscillator 33, the Schmitt circuit 43, the bistable multivibrator 45 and an A.C. to D.C. converter 54 are shown in FIGURE 6, the small diagram below the circuit indicating which parts of the circuit relate to the elements shown in FIGURE 3.

The Schmitt circuit is known in itself, and consists of an arrangement of two transistors (or valves) which provides full output or no output, depending on whether the input potential is above or below a certain level.

Referring to FIGURE 6, the final stage of the oscillator 33 comprises a transistor TR1 having a resistance R1 connected between the common negative line 55 and its base. The collector of TR1 is connected to the line 55 through the lamp 34 so that the oscillating output of TR1 passes through the filament thereof. The emitter of TR1 is connected to the common positive line 56. The collector of TR1 is also connected through a capacitor C1 to the base of another transistor TR2 and there is a resistance R2 connected between the base of TR2 and the common positive line 56. The oscillator output is fed through C1 to the base of TR2 and, due to the capacitance C1 and resistance R2, the base is maintained at a steady negative potential with respect to the line 56. The collector of TR2 is connected directly to the negative line 55 while the emitter of TR2 is connected to the positive line 56 through the two resistances R3 and R4 in series, having a capacitor C2 in parallel with them. The potential at the junction of R3 and R4 is applied to the base of a transistor TR3. The transistor TR3 has its collector connected through a resistance R5 to the negative line 55 and has its emitter connected through a resistance R6 to the positive line 56. The collector of TR3 is also connected through two resistances, R7 and R8, to the positive line 56. These last resistances form another potential divider and the potential at their junction is applied to the base of a transistor TR4. The emitter of TR4 is connected to the emitter of TR3 and the collector of TR4 is connected to the collector of a transistor TR5 which, together with a further transistor TR6 constitutes the multivibrator, which requires no further description at this stage.

The operation of the circuitry is as follows. Assuming that the oscillator 33 is working and the lamp 34 is in order, a steady potential is maintained at the base of

TR2. Current flows through the resistances 3 and 4 so that a steady potential is maintained at the base of TR3 and the collector current of TR3 flows through R5. A part of the current through R5 also flows through R7 and R8 so that the base of TR4 is maintained at a steady potential.

If the lamp 34 should fail, then the collector current of TR1 is interrupted and the potential of the base of TR2 will become equal to that of the line 56. This causes TR2 to be cut off, so that no current flows through R3. In consequence TR3 is also bottomed and takes no current. This causes the potential at the junction of R5 and R7 to move negatively due to the reduction in current through R5 and the base of TR4 moves negatively, so that TR4 takes a heavier current and thus applies a pulse to the collector of TR5. This sets the multivibrator to its state 2 condition.

The connections of TR5 and TR6 are of the conventional type for a multivibrator configuration. The bases of the two transistors are connected respectively through resistances R9 and R10 to the positive line 56. The two emitters are together connected through a resistance R11 and a capacitor C3 to the positive line 56. The two collectors are connected respectively through resistances R12 and R13 to the negative line 55. The collector of TR5 is connected through a resistance R14 in parallel with a capacitor C4 to the base of TR6 while the collector of TR6 is connected through a resistance R15 in parallel with a capacitor C5 to the base of TR5.

The potential of the emitter of TR5 will depend upon the state of the multivibrator 45 and this potential is applied to two resistances R16 and R17 connected between the collector of TR5 and the positive line 56. A proportion of this potential is tapped off through the line 47 and applied to the Schmitt circuit 49.

FIGURE 5 shows the balloons 58, 59 and 60 of three adjacent spindles. Below each balloon is a cam or other projection, respectively 61, 62 and 63, adapted to change over the switch SW1 as the carriage passes the respective balloon.

The operation of the arrangement may now be followed by reference to FIGURE 3 and is as follows. Assuming that the carriage is moving between two of the balloons the switch SW1 is in the downward position with the contact 52 connected to the -12 volt line. As the carriage approaches the next spindle the switch SW1 is changed over to the other position, shown in FIGURE 3, in which the contact 51 is connected to the -12 volt line. This sets the multivibrator 45 into its state 1, in which the alarm would normally be sounded, but the connection from the relay 50 to the -12 volt supply is broken at the contact 52. If everything is in order, the balloon is present and the lamp is operating, then the photo-transistor 35 receives a light signal which is translated into an electrical signal and applied to the amplifier 36. The amplifier 36 provides an output which re-sets the multivibrator 45 to its state 2 and thus inhibits the Schmitt circuit 49. After the carriage has passed the balloon and the cam 61, 62 or 63 disengages the switch SW1 the latter is returned to its former position in which contact 52 is connected to the -12 volt supply, but as the Schmitt circuit 49 is inhibited, no current flows through the relay 50. If, on the other hand, the yarn is broken and there is no balloon, then the amplifier delivers no signal to set the multivibrator 45 into its state 2, so that the Schmitt circuit 49 is not inhibited. In consequence the change-over of the switch SW1 completes the circuit of the relay through contact 52, the relay coil and the Schmitt circuit 49. The relay 50 then operates and, in turn, energizes the solenoid 53. This shuts down the spindle which has just been passed and at the same time gives the alarm or other indication, according to the particular arrangement employed.

As previously stated the Schmitt circuit 43 is inhibited when the lamp 34 is active. If it should fail, then the

Schmitt circuit 43 becomes active and applies a signal to the state 2 input of the multivibrator 45 to maintain it in its state 2, so that the Schmitt circuit 49 is always inhibited and the relay 50 is prevented from operating.

It will be understood that various modifications may be made to the embodiments described without departing from the scope of the invention as defined in the appended claims.

I claim:

1. A yarn break detector comprising a carriage movable to travel along a row of yarns in a textile machine, means to direct a light beam in turn upon each yarn, light detecting means on the carriage responsive to light reflected from the yarn, an amplifier connected to the detecting means to amplify the signal from the detecting means, a device settable to two states, the first of which will energize an alarm and the second of which will inhibit such energization, automatic means to set the device to its first state as the carriage approaches each yarn, the amplifier output being connected to the device and operable to set the device in said second state, and means conditioned for operation when the carriage is moving away from the yarn and responsive only to the first state of the device to produce an alarm signal.

2. A yarn break detector as claimed in claim 1, wherein the means to direct light comprises a light source and the detecting means is a photoelectric device which receives light reflected from the yarn.

3. A detector as claimed in claim 2 comprising an oscillator to feed said light source, whereby the light therefrom is modulated, said amplifier being tuned to the oscillator frequency.

4. A yarn break detector comprising a carriage movable along a row of yarns in a textile machine, a light source on said carriage to direct a beam of light on to each yarn in turn, an oscillator connected to said light source for modulating the light at the oscillator frequency, photoelectric means mounted to receive light reflected from each said yarn and deliver a signal responsive to said reflected light, an amplifier connected to the output of said photoelectric means, said amplifier being tuned to the frequency of said oscillator, a device connected to the output of said amplifier and settable to two states, the first of which will energize an alarm and the second of which will inhibit such energization, means other than said amplifier to set the device to its first state as the carriage approaches each yarn, the amplifier output signal being effective to set the device to its second state, and means conditioned for operation when said carriage is moving away from the yarn and responsive to the first state of said device to produce an alarm signal.

5. A detector as claimed in claim 4 comprising means connected with the light source and said device to produce a continuous signal to maintain said device in its second state when said light source fails.

6. A detector as claimed in claim 4, wherein said device is a relay having a holding contact, which in its first state is unoperated, and which is operated and thereby set to its second state by the signal from said amplifier.

7. A detector as claimed in claim 4, wherein said means to set the device in its first state comprises individual contact strips in a series spaced apart to correspond with the spacing of said yarns and a contact on the carriage engageable with said strips to energize the light source and its connected elements on the carriage when said carriage is approaching a yarn, said strips and contacts disengaging when said carriage is moving away from said yarn.

8. A detector as claimed in claim 7 comprising a further series of individual contact strips spaced to correspond to the spacing of the yarns, and a further contact on said carriage engageable with each of said further strips when the carriage is moving away from a yarn and before said first named contact and strip for the corresponding yarn are disengaged, said further contact strips and further contact forming a part of an alarm circuit.

9. A detector as claimed in claim 6 comprising contacts on the relay which are closed when said relay is in its first state and open when said relay is in its second state, said contacts being connected by a contact moving with the carriage to fixed contacts in an alarm circuit.

10. A detector as claimed in claim 4, wherein said device is a bistable multivibrator settable to its first state by a potential applied when said carriage is approaching the yarn.

11. A yarn break detector comprising a carriage movable to travel along a row of yarns in a textile machine, a light source on the carriage to direct a beam of light in turn onto each yarn, photoelectric means on the carriage to receive light reflected from each said yarn and produce a signal in response to the reflected light, an amplifier connected to the output of said photoelectric means to amplify the signal from the photoelectric means, a bistable multivibrator connected to the output of said amplifier, means other than said amplifier to set said multivibrator to its first state as said carriage approaches each yarn, the output signal of said amplifier being effective to set said multivibrator to its second state, and means conditioned for operation when said carriage is moving away from said yarn and responsive to the first state only of said multivibrator to produce an alarm signal.

12. A detector as claimed in claim 11 comprising circuitry connected to produce an alarm output signal when said multivibrator is in its first state, a relay in series with said circuitry, a changeover switch movable between a first and second position, means for moving the said switch to its second position when said carriage is approaching a yarn and to its first position when said carriage has passed a yarn, said switch being connected so that in its first position it completes a circuit through said relay and in its second position applies a potential to said multivibrator to set the same in its first state, the relay circuit being completed to activate the alarm circuit if, when said switch is returned to its first position, said multivibrator has not been set to its second state by the detection of a yarn.

13. A detector as claimed in claim 12 comprising a solenoid connected with said relay to carry out required functions when said relay is operated.

14. A detector as claimed in claim 11 comprising means to modulate the light from said light source, said means comprising an oscillator, said amplifier being tuned to the frequency of said oscillator.

15. A detector as claimed in claim 14 comprising means connected with said light source and said multivibrator to produce a continuous signal to maintain the multivibrator in its second state when said light source fails.

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