SCANNING HEADS FOR STOP-MOTION DEVICES FOR KNITTING MACHINES

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Fig. 1.

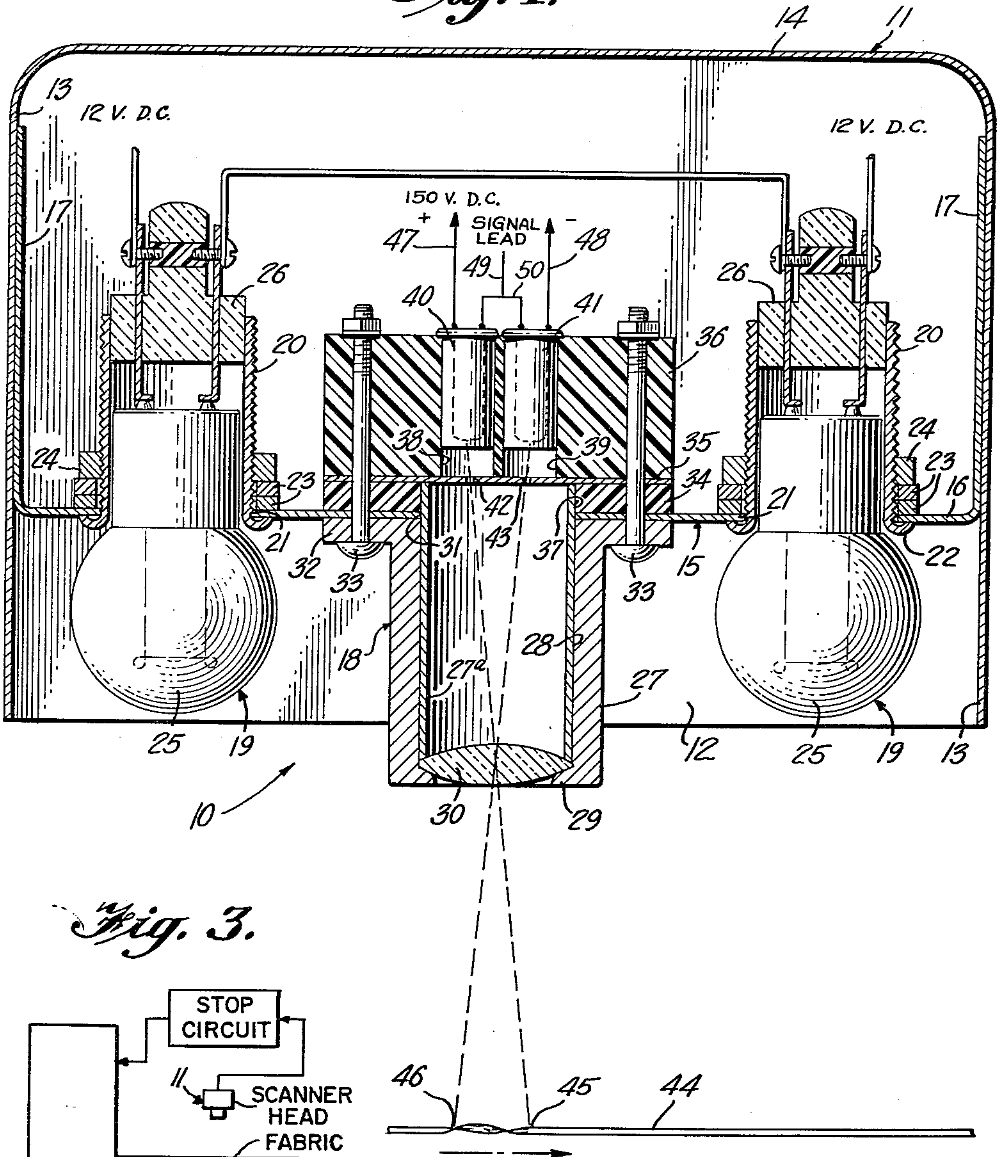

Fig. 3.

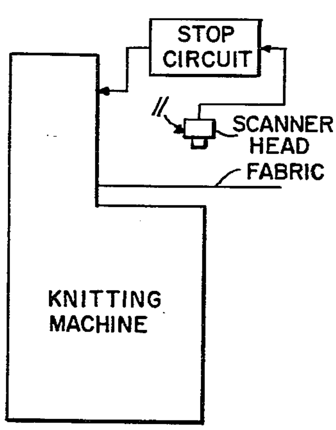

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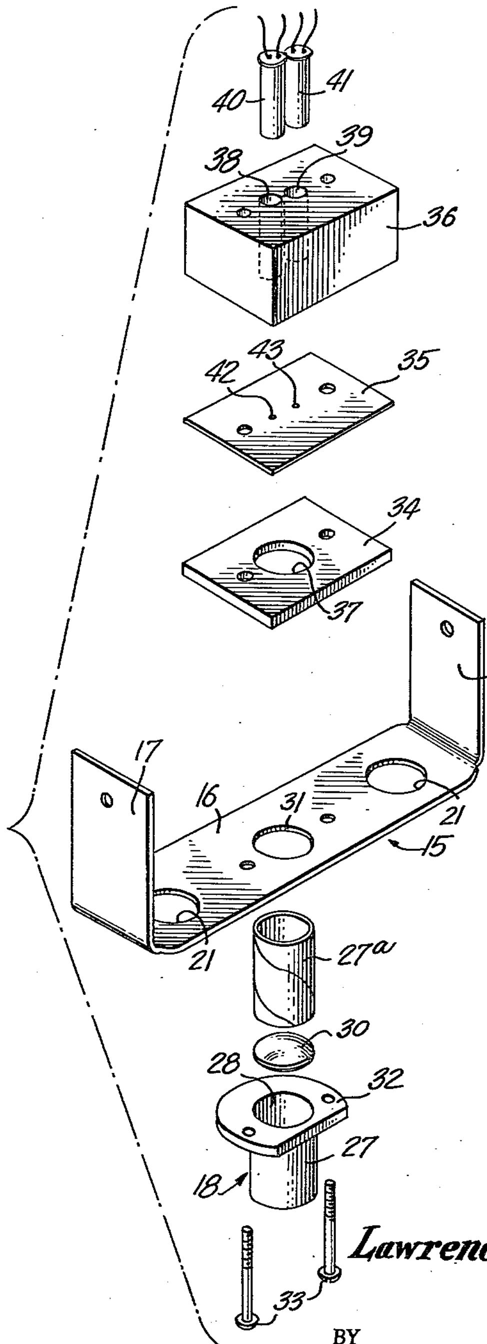
Fig. 2.



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The present invention relates in general to scanning heads for photoelectric stop motions for textile knitting machines, especially warp knitting machines such as tricot knitting machines.

In textile machines of the general type referred to wherein fabrics are being produced, it is desirable to provide a stop-motion which will give a warning or stop the machine whenever a fabric defect occurs. The fabric defects are usually caused by ends out, broken yarn filaments or a broken needle. Obviously, if such a defect occurs and goes undetected for even a short period of time, the knitted fabric shows a continuing defect over a substantial length of the fabric.

Originally, stop-motions produced for this purpose were designed to be actuated by the breakage of a yarn going into the fabrics, and as a result, they failed to operate when a fabric defect was produced by any cause other than a broken yarn.

More recently, automatic stop-motion devices were developed employing a photoelectric cell which was scanned repeatedly across the width of the fabric as it emerges from the knitting machine to continuously examine the fabric close to the needle bar and respond to variations in light reflected from the fabric. By this arrangement, the whole width of the fabric could be traversed by the cell, and if a defect should be encountered at any point in the fabric due to a missing thread or other fault, the light reflected from the fabric and consequently the light entering the photocell would alter the intensity and produce a signal which could be amplified and used to either stop the machine or give a warning signal. Such devices, however, employing a single photocell were found to frequently produce false stops of the knitting machine due to response of the photoelectric stop motion to spurious signals. Such spurious signals or false activation of the stop circuit for the machine would arise, for example, from electrical surges, produced by the starting and stopping of other machines, line voltage fluctuations, cyclic variations in lamp current of the illuminating lamps employed to direct light onto the fabric, mechanical shocks and vibrations, and the like. In addition, frequent readjustment of the photoelectric stop-motion was required to compensate for the aging of the light source and the tubes in the amplifier, which aging reduced the intensity of the light beam directed onto the fabric and altered the effective sensitivity of the amplifying circuit. However, if the sensitivity of the photoelectric stop-motions were reduced so that they would no longer respond to spurious signals, they would often fail to operate when a yarn did break.

In order to remedy this defect, photoelectric stop-motions were designed employing two phototubes, each supplied with its own lens and a companion light source for illuminating the fabric, the phototubes being arranged in a scanning head in spaced relation to each other along the scanning axis extending transversely across the fabric to be examined so that the phototubes would respond to the light intensity at two points spaced along the scanning line extending transversely of the fabric. The phototubes were positioned in line with each other along the line of scan or line of traverse of the fabric to examine fabric arising a sufficient distance apart so that a fabric defect which comes into view of one of the phototubes does not simultaneously come into view of the other phototube.

The signals produced by the two phototubes were applied to an amplifier circuit constructed so that the amplifier was responsive to the difference in the signals in the phototubes caused by the variation in the intensity of the light reflected from the fabric to the phototubes when one of the phototubes scanned a fabric defect. This was accomplished by means of a comparison circuit wherein electrical surges, line voltage fluctuations, cyclic variations in lamp current, aging of the phototubes or amplifier tubes and the like were balanced out since they affected both phototubes and their respective amplifiers in the same way. With this arrangement, each phototube acted in effect as a reference for the other, so that so long as both phototubes were affected in the same manner, the spurious signals would be cancelled out.

It was later discovered, however, that such an arrangement still permitted false stopping of the knitting machine arising from vibration and flutter of the fabric at the area of inspection, since the physical limitations on the closeness with which the phototubes and their separate optical systems could be brought together would not permit the phototubes to inspect areas sufficiently close together to avoid the effects of fabric waves inherently set up by vibration and flutter of the fabric on the light intensities sensed by the two phototubes. It was found that the waves produced in the fabric as a result of vibration and flutter may have a peak-to-peak distance as short as two to four inches, so that in some instances one of the photocells would be responding to a fabric area at the bottom of a fabric wave and the other photocell examining an area at the top of a wave, producing such difference in reflected light intensity as to generate a false indication of a defect and cause unnecessary stoppage of the knitting machine.

Further development sought to eliminate false stopping of the knitting machine from this cause by providing a scanning device having an optical system comprising two lamps directing light beams onto the fabric area to be examined, a single optical lens system for receiving reflected light from the fabric, a semitransparent mirror or other beam-splitting device for transmitting a portion of the incident light therethrough along the incident optical axis, and reflecting a portion of the incident light along an axis at substantially right angles to the incident light axis, a pair of photocells disposed to receive the transmitted and reflected light from the semi-transparent mirror, and masks associated with each of the photocells to restrict the photocells to examination of two separate fabric areas spaced sufficiently close together to avoid substantial variation in light intensity reflected to the two photocells arising from such fabric waves. In practice, avoidance of variation in the relative light intensity reflected to the two photocells in the presence of fabric waves can be achieved by examining fabric areas spaced apart about one-half inch or less. However, scanning heads of this last-mentioned type were rather bulky in size due to the necessity of using the beam-splitting mirror and masked photocell units disposed to intercept the two beams of reflected light emanating from the beam-splitting mirror, and were expensive to produce and difficult to maintain an accurate adjustment.

An object of the present invention, therefore, is the provision of a novel and improved scanning head for stop-motion devices which is simple in construction, relatively inexpensive to manufacture, and which senses closely adjacent areas of knitted fabrics in a manner to avoid false activation of the stop-motion arising from vibrations and fluttering of the fabric.

Another object of the present invention is the provision of a novel scanning head for photoelectric stop-motion devices for textile knitting machines wherein a pair of photocells are exposed to adjacent areas of the fabric to be examined through a single optical lens, and wherein the components are rigidly held in appropriate positions relative to each other by means providing a rugged, simple scanning head assembly which will maintain high operating efficiency over long periods of time.

Another object of the present invention is the provision of a novel scanning head for photoelectric stop-motion devices for textile knitting machines wherein the need for a preamplifier or any electronics in the scanning head assembly other than a pair of photocells is eliminated, to provide a low impedance scanning head assembly so as to minimize the possibility of lines connecting the scanning head with the amplifier unit from picking up stray induced voltages.

Other objects, advantages and capabilities of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings illustrating one preferred embodiment of the invention.

In the drawings:

FIGURE 1 is a vertical longitudinal section view of a scanning head for stop-motion devices embodying the present invention;

FIGURE 2 is an exploded perspective view of the principal components of the scanning head; and

FIGURE 3 is a diagrammatic illustration of a scanning head embodying the present invention illustrated in operative association with a stop circuit and a knitting machine.

Referring to the drawings, an exemplary practical embodiment of the scanning head of the present invention, indicated generally by the reference character **10**, comprises a drawn aluminum outer casing or housing **11** in the form of a downwardly opening box having vertical sides **12** and ends **13** and a horizontal top wall **14**. The casing **11** may, for example, be approximately 4½ inches long, 3 inches wide and 3 inches high. A mounting and reflector plate **15** is secured within the casing to form a supporting platform spaced above the lower edge of the casing for the elements of the scanning head, and includes a horizontal panel **16** corresponding to the internal horizontal cross-section of the casing and integral, ascending mounting legs **17** at the opposite ends of the panel **16** to be secured to the ends **13** of the casing **11** by suitable mounting screws. The plate **15** may be formed of 20 gauge stainless steel and is designed to support a photocell and optical assembly **18** substantially midway between the ends **13** of the casing and a pair of longitudinally spaced lamp assemblies **19** flanking the photocell and optical assembly **18**.

The lamp assemblies **19** are of identical construction and include a tubular light bulb socket member **20** which extends through an accommodating aperture **21** in the panel **16** of the plate **15**, the socket member **20** having an annular flange **22** at its lower end to engage the portions of the panel **16** bounding the aperture **21** and limit upward movement of the socket member and a group of lock washers **23** and threaded nut **24** fitted onto the threaded exterior surface of the socket member **20** to fix the socket member onto the plate **15**. The socket member **20** is constructed in the usual manner to removably mount the base of its associated lamp **25** and houses the usual insulated terminal block **26** having conductor strips for engaging the base contacts of the lamp **25** and terminal screws for securing the electrical supply leads to the conductor strips. The lamps **25** may, for example, be 6 candlepower lamps of the incandescent type having high thermal inertia to avoid rapid change of light output with lamp voltage variations.

The photocell and optical assembly **18** includes a lens mounting tube **27** having an internal bore **28** extending therethrough and terminating at its lower end in an inwardly projecting lip **29** forming a shoulder bounding the lower end of the bore **28** for supporting the lens **30**, which is held in place by a fiber liner tube **27***a*. The lens **30** may be a simple double-convex lens having a focal length of about 1⅓ inches and a diameter of about ¾ inch. The bore **28** of the lens mounting tube **27** is disposed in precise registry with an aperture **31** in the panel **16** of the mounting and reflector plate **15**, and the tube **27** has a mounting flange **32** at its upper end suitably apertured to receive mounting screws **33**. Supported in vertical alignment above the panel **16** of the mounting and reflector plate **15** are a plastic spacer block **34**, a masking plate **35** and a plastic cell block **36**. The spacer block **34**, masking plate **35** and cell block **36** may each be approximately 1½ inches long by 1 inch wide, the spacer block **34** having a central aperture **37** therein corresponding in diameter to and in precise registry with the bore **28** of the lens mounting tube **27** and the aperture **31** in the panel **16**. The cell block **36** has formed vertically therethrough a pair of longitudinally spaced holes **38** and **39** disposed in parallelism with each other on a vertical axis and of a suitable aperture to accommodate a pair of photocells **40** and **41**. In the exemplary embodiment herein described, the photocell housing holes **38** and **39** are ¼ inch in diameter and are located symmetrically with respect to the center of the block **36** with their centers spaced 5/16 inch apart. The cell block **36** and spacer block **34** are preferably formed of a suitable plastic such as Synthane, and the masking plate **35** interposed therebetween may be formed of 1/64 inch sheet brass. The masking plate **35** is provided with two light-admitting apertures **42** and **43** which, for example, are formed of approximately .063 inch diameter by a No. 52 drill bit and are located with their centers spaced 5/16 inch apart so that they precisely register with the centers of the cell housing holes **38** and **39** in the cell block **36**. The photocells **40** and **41** should be of the miniaturized variety, which in this exemplary embodiment are in cylindrical form and have a diameter of ¼ inch, suitable photocells for this purpose being Clairex CL–3 photocells of the type manufactured by Clairex Corporation of New York City.

As will be apparent from the drawings, the lens mounting tube **27**, spacer block **34**, masking plate **35** and cell block **36** will be arranged in vertically stacked relation with the portions of the mounting and reflector plate **15** bounding the aperture **31** therein sandwiched between the spacer block **34** and the mounting flange **32** of the lens mounting tube **27**, and the mounting screws **33** extend vertically through this entire stack of elements and are secured at their upper ends by suitable nuts.

The photocells **40** and **41** are thus arranged in parallelism with each other and in parallelism with the principal axis of the lens **30**, and since the scanning head **10** in accordance with usual practice will be mounted on a traverse rail so as to scan transversely across the width of the fabric with the lens **30** located about 1½ inches above the surface of the fabric, indicated generally by the reference character **44**, the lens will image two slightly spaced apart regions of the fabric **14**, indicated by the reference characters **45** and **46** onto the light sensitive elements of the photocells **40** and **41** through the light admitting apertures **42** and **43** in the masking plate **35**.

As is schematically illustrated in FIGURE 1, the two photocells **40** and **41** are connected in series with each other across a 150 volt D.C. power supply, one of the cells being connected through the lead **47** to plus 150 volts, the other photocell being connected through the lead **48** to ground, and a signal lead **49** being connected to the common lead **50** between the two photocells. The circuit system which is controlled by the signal coupled through the lead **49** does not constitute part of the present invention and thus need not be described or shown in detail, it being sufficient to state that the signals derived from the lead **49** are applied through a suitable D.C. blocking capacitor and a voltage divider network including a suitable sensitively controlled potentiometer to the control grid of the first amplifier stage to effect ultimate energization of a relay which stops the knitting machine when a flaw passes through the field imaged by the optical system onto the two photocells. Circuits suitable for reception and amplification of the signal produced by the scanning head to energize the relay and stop the knitting machine when the difference in reflectivity of the two areas sensed by the photocells exceeds a selected amount are fully described in U.S. Patent No. 2,711,094 issued June 21, 1955. By arranging the photocells in series, loss of light from both photocells simultaneously tends to balance out, whereas loss of light sequentially tends to cause an unbalance which stops the knitting machine. The photocells **40** and **41** are carefully selected by previously matching the amount of current they draw and their gain factors, and cells of the greatest gain factor are preferably positioned between the ground lead **48** and common lead **50** while weaker cells are preferably placed between the common lead **50** and the 150 volt supply lead **47** so that the photocell system leads gainwise in a positive direction. That is to say, since the greater gain is present in the photocell **41** between the signal lead **49** and the ground lead **48** it is found that the flutter of the current will produce a positive signal to be applied to the first amplifier stage whereas the first amplifier stage is biased so that it will effect energization of the relay which controls stopping of the knitting machine only when negative signals are applied to the first amplifier stage.

While but one preferred example of the present invention has been particularly shown and described, it is apparent that various modifications may be made therein within the spirit and scope of the invention, and it is desired, therefore, that only such limitations be placed on the invention as are imposed by the prior art and set forth in the appended claims.

What is claimed is:

1. A scanning head for a stop-motion device of the type wherein a scanning means is traversed repeatedly across the width of an illuminated fabric to inspect the fabric as it emerges from a knitting machine and produce output signals for stopping the knitting machine upon detection of a defect in the fabric, the scanning head comprising a lens arranged on a vertical optical axis to produce an image of the fabric area under inspection, a pair of laterally spaced photocells arranged in parallelism with the optical axis of said lens and disposed symmetrically with respect to said optical axis and on opposite sides thereof to receive light directly from said lens, said lens being focused substantially on said photocells, a mask disposed in the path of light from said lens to said photocells having a pair of light admitting apertures therein to pass light to a respective one of said photocells, said light admitting apertures being spaced apart a distance to render said photocells responsive to light reflected from closely adjacent but different discrete zones of the fabric to produce an output signal indicative of the relative reflectivity of the respective fabric zones for activating a stop circuit to stop a knitting machine responsive to an unbalance in the light received by said two photocells from said adjacent fabric zones.

2. A scanning head for a stop-motion device of the type wherein a scanning means is traversed repeatedly across the width of an illuminated fabric to inspect the fabric as it emerges from a knitting machine and produce output signals for stopping the knitting machine upon detection of a defect in the fabric, the scanning head comprising a downwardly opening boxed shaped casing having side and end walls, a supporting platform forming a partition transversely spanning the interior of the casing and spaced upwardly from the lower edge of the side and end walls, a lens tube depending from said platform at substantially the center thereof supporting a lens at the lower end of the tube having a vertical optical axis, a pair of lamps mounted in depending relation on said platform in laterally flanking relation to said lens tube for illuminating a fabric area to be inspected, a pair of laterally spaced miniature photocells of generally elongated cylindrical configuration arranged in parallelism with the optical axis of said lens and supported in said casing above said lens at positions to receive light simultaneously directly from said lens, said lens being focused substantially on said photocells, a mask supported on said platform in the path of light from said lens to said photocells having a pair of laterally spaced light admitting apertures therein to pass light to a respective one of said photocells, said light admitting apertures being spaced apart a distance to render said photocells responsive to light reflected from adjacent but different discrete zones of the fabric located about one-half inch apart, means coupling said pair of photocells in series circuit relationship across a selected voltage source and a signal lead intercoupled with the series circuit including said photocells at a point between said photocells to produce an output signal indicative of the relative reflectivity of the respective fabric zone for activating a stop circuit to stop a knitting machine responsive to an unbalance in the light received by the two photocells from said adjacent fabric zones.

3. A scanning head for a stop-motion device of the type wherein a scanning means is traversed repeatedly across the width of an illuminated fabric to inspect the fabric as it emerges from a knitting machine and produce output signals for stopping the knitting machine upon detection of a defect in the fabric, the scanning head comprising a downwardly opening boxed shaped casing having side and end walls, a supporting platform forming a partition transversely spanning the interior of the casing and spaced upwardly from the lower edge of the side and end walls to define with said side and end walls a lower downwardly opening well and an upper chamber in said casing, a lens mounting tube depending from said platform into said well at substantially the center of said platform having a bore extending therethrough and a lens supported in said bore in alignment with a vertical optical axis, a pair of lamps mounted in depending relation on said platform in laterally flanking relation to said lens mounting tube and projecting into said well for illuminating an area of the fabric to be inspected, said platform having an opening conforming to and registering with the bore of said lens mounting tube, a spacer block supported within said chamber on said platform having an aperture conforming to and aligned with the bore of said lens mounting tube, a light shielding mask surmounted on said spacer block having a pair of light admitting apertures therein located within the projected cross sectional area of the bore of said lens mounting tube, a cell block surmounted on said mask having a pair of cylindrical bores extending vertically therethrough along axes paralleling the optical axis of said lens and located symmetrically with respect to said optical axis and on opposite sides thereof within the projected cross sectional area of said lens mounting tube bore, a pair of photocells supported in said cell block bores in substantially vertical alignment with said light admitting apertures of said mask, said lens being focused substantially on said photocells, said light admitting apertures being spaced apart a distance to render said photocells responsive to light reflected from closely adjacent but different discrete zones of the fabric, and means intercoupling said photocells in circuit relation to produce an output signal indicative of the relative reflectivity of the respective fabric zones for activating a stop circuit to stop a knitting machine responsive to an unbalance in the light received by said two photocells from said adjacent fabric zones.

4. A scanning head for a stop-motion device of the type wherein a scanning means is traversed repeatedly across the width of an illuminated fabric to inspect the fabric as it emerges from a knitting machine and produce output signals for stopping the knitting machine upon detection of a defect in the fabric, the scanning head comprising a lens arranged on a vertical optical axis to produce an image of the fabric area under inspection, a pair of laterally spaced photocells arranged in parallelism with the optical axis of said lens and disposed symmetrically with respect to said optical axis and on opposite sides

thereof to receive light directly from said lens, the photosensitive elements of said photocells each being located wholly within the projection of the periphery of the lens along the optical axis thereof, said lens being focused substantially on said photocells, a mask disposed in the path of light from said lens to said photocells having a pair of light admitting apertures therein spaced traversely of the optical axis of the lens and located within said projection of the periphery of the lens along the optical axis to pass light to a respective one of said photocells, said light admitting apertures being spaced apart a distance to render said photocells responsive to light reflected from closely adjacent but different discrete zones of the fabric, means

intercoupling said photocells in series circuit relation across a voltage of selected value, and a signal lead intercoupled with the series circuit including said photocells at a point between said photocells to produce an output signal whose voltage level varies in accordance with variation in the relative reflectivity of the respective fabric zones for activating a stop circuit to stop a knitting machine responsive to an unbalance in the light received by said two photocells from said adjacent fabric zones.

References Cited in the file of this patent

UNITED STATES PATENTS

2,711,094 Edelman et al. ---------- June 21, 1955