

July 11, 1961

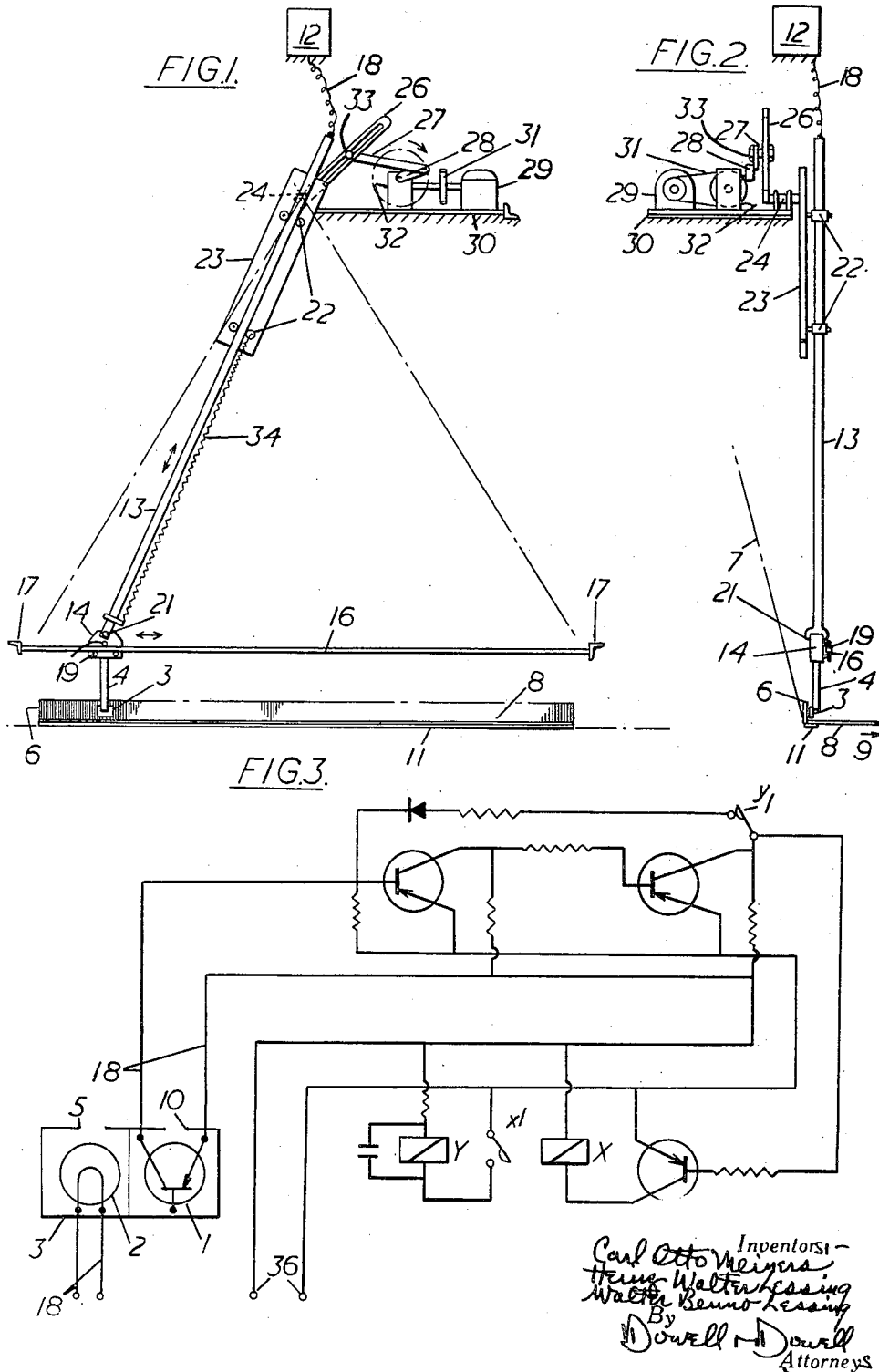
C. O. MEINERS ET AL

2,991,639

FAULT FINDER

Filed Dec. 11, 1957

2 Sheets-Sheet 1



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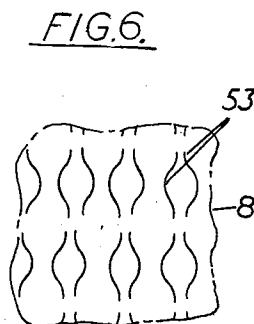
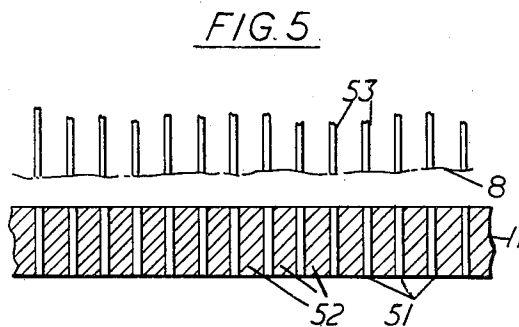
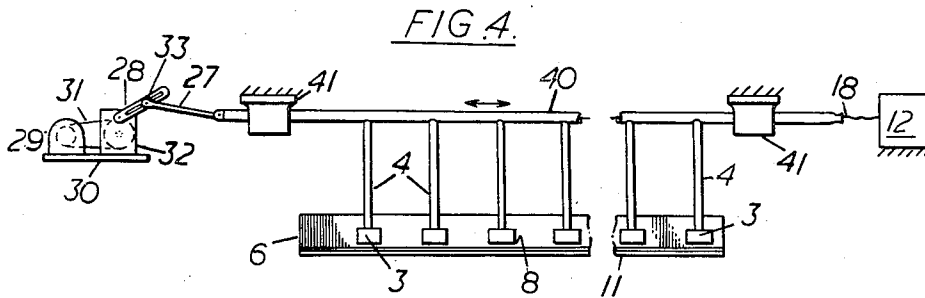
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Carl Otto Meiners Inventor:-
Heinz Walter Lessing
Walter Bruno Lessing
By
Dwight D. Dwell
Attorneys

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2,991,639

FAULT FINDER

Carl Otto Meiners, Stuttgart, Germany, and Walter Benno Lessing and Heinz Walter Lessing, London, England, assignors to Meiners Optical Devices Limited, London, England

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The invention relates to fault finders for straight-bar and flat knitting machines including warp knitting machines such as Raschel and cotton knitting machines as well as for lace-lever, embroidery and inspection machines.

The commonest fault occurring in the fabric produced on such textile machines is that due to a missing warp or a duplicated warp. In either case, the fault appears as a line in the fabric which goes on lengthening as the machine continues to operate. It is, therefore, essential that a stop motion or warning device be provided for stopping the machine or allowing it to be stopped as soon as possible after the fault has started to occur.

For this purpose, there can be used a photo-electric cell which is traversed across the fabric together with one or more sources of light, an amplifier and perhaps a relay for controlling the stop motion or warning device and the actual traversing or oscillating mechanism for the cell. The source of light casts a beam on to a mirror arranged behind the fabric and the cell receives the beam reflected from the mirror. In such an arrangement, however, the weight of the assembly which is traversed across the fabric imposes a severe limitation on the traversing speed. Consequently, a considerable time—as much perhaps as 8 seconds or even more—may elapse between successive scanings of a particular warp which, in that time, will have moved through a substantial length and have produced a fault of that length. Clearly, the higher the speed of the machine, the longer may be the fault which can occur before remedial action is taken. In practice, a fault finding device which enables faults to be kept as short as three inches on a fast-running machine is considered to be very good.

Another difficulty is that the traversed assembly is bulky and cannot be made to travel very close to the fabric and to the needles. This leads to an undesirable lack of sensitivity of the photoelectric cell and also to the detection of a fault only a substantial time after the fault has started to occur.

This lack of sensitivity can be remedied by the provision of an optical system between the source of light and the fabric and the fabric and the photoelectric cell. However, that adds to the weight of the traversed assembly and to magnification of the difficulty referred to above of moving the assembly at an acceptably high speed.

The invention avoids all these difficulties.

In accordance with the invention, a textile machine of the kind referred to is provided with a fault finder comprising a light sensitive element which operates a warning device or a stop motion as a result of variation in the degree to which it is illuminated. The light sensitive element is a phototransistor or other photo-cell of the kind incorporating a semi-conductor such as germanium. In what follows the terms phototransistor and transistor are used in a generic sense. The transistor is mounted in a casing together with a small source of light and is connected to the warning device or the stop motion through an amplifier and a relay which are fixed on the machine and are not traversed with the element.

A phototransistor can be made very small and of very light weight indeed and is very light-sensitive, particularly to light in the infra-red range of the spectrum. A lamp

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emitting light including a substantial proportion of infra-red rays can be made of very small dimensions and weight—for example, as a so-called “pea lamp” which is a low-voltage incandescent lamp. Consequently the light sensitive element and its associated source of light can be mounted in a very small casing and form therewith an assembly of such small bulk and weight that it can be traversed across the machine at very high speed and very close to the needle bar and the fabric. This, in turn, leads to the further advantage that no optical system need be provided for focussing the beam from the lamp on to the fabric and the reflected beam on to the transistor. A further saving in weight and bulk ensues.

It is an object of this invention to provide a fault detector for textile machines wherein a plurality of scanning heads are traversed to-and-fro across the fabric, these heads being spaced from one another in the direction of traverse so that each scans or supervises a different portion of the width of the fabric, all the scanning heads being connected to a common switching network whereby detection of a fault in the fabric by any one of the scanning heads initiates through the common switching network the actuation of a stop motion or warning device. By this means greater frequency of scanning is obtained without an increase in traverse speed.

By use of the invention, it is possible to limit the length of faults to a fraction of an inch. Even if the machine operates at very high speed producing, for example, twenty-five inches of fabric per minute, it is possible to detect faults before they have reached a length of half an inch.

The invention will be described in more detail with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 shows in front elevation the needle bar of a flat-bar knitting machine and a mechanism for traversing a fabric scanning device;

FIGURE 2 is a side elevation of FIGURE 1;

FIGURE 3 is a diagram of an amplifier and relay circuit;

FIGURE 4 is a fragmentary front elevation of a knitting machine fitted with a fault-detector in accordance with the invention;

FIGURE 5 is an enlarged fragmentary plan view of a mirror over which openwork or net fabric is scanned, and

FIGURE 6 is an enlarged fragmentary plan view of openwork knitted with a pattern.

FIGURES 1 and 2 show a needle bar 6 on the bed of a knitting machine. The web of fabric material 8 knitted by the needle travels in the direction of the arrow 9 (forwards in FIGURE 1) and is wound on a suitable roller or beam (not shown). A warp 7 is indicated in FIGURE 2 extending towards the needles but for the sake of clarity all guiding and other knitting elements have been omitted.

The scanner comprises a casing 3 carried at the end of a tube 4 and traversed across the bed, as hereinafter described, in front of the needle bar 6. It houses a semiconductor type photosensitive detector cell in the form of a germanium phototransistor 1 (FIGURE 3), and a light source that may be an incandescent lamp 2 of low voltage, the cell and lamp being mounted side by side and separated from each other by a partition.

Light from the lamp can be cast onto the fabric 8 through a slit 5 in the casing and is reflected by a chromium plated or other reflective strip 11 through a narrow aperture or slit 10 onto the transistor 1 which is connected in the amplifier and relay circuit shown in FIGURE 3 with its base electrode left unconnected. The amplifier and relay are housed in a control box 12 (FIGURE 1) fixed to the machine and not traversed across the bed.

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A suitable traversing mechanism for the scanning device in the form of a pendulum drive is illustrated in FIGURES 1 and 2. It comprises a hollow pendulum arm 13 pivotally connected at 21 to a carriage 14 mounted on rollers 19 for movement to and fro along a rail 16 which extends parallel to the needle bar 6 and is slightly longer than the needle bar. The rail 16 is fixed by brackets 17 to the frame of the machine and should be at about 8 inches above the fabric so that the needle bar may be readily accessible for servicing.

The tube 4 which carries the casing 3 is rigidly suspended from the carriage 14 and accommodates the lamp and transistor leads 18 which are further led through the pendulum arm 13 and out to the stationary control box 12.

The pendulum arm is oscillated by a plate 23 and is free to slide axially relatively thereto between two pairs of rollers 22 mounted on the plate. The plate is oscillated about a shaft 24 driven from a motor 29 on a fixed platform 30, through a belt and pulley drive 31 and a reduction gear 32 which turns a crank 28. The crank is pivoted to a connecting rod 27 engaging a slotted lever 26 fixed to one end of the shaft 24. A pivotal connection 33 between the connecting rod 27 and the lever 26 is adjustable lengthwise of the slot in the lever. By adjusting the position of the connection 33 the stroke of the lever 26, and thus of the pendulum arm 13, can be varied to suit the length of the machine bed to be traversed.

Since the pendulum arm must be displaced upwardly whenever it proceeds from an end of its stroke towards the vertical position, a tension spring 34 is stretched between the arm 13 and the plate 23 to assist in lifting it.

In operation, the casing 3 is reciprocated in front of the needle bar 6 at a speed which is determined by the pulley and gear ratios of the drives 31 and 32. Current for the lamp 2 is supplied via the control box 12 through the leads 18. If, during its travel, the transistor 1 detects a fault, flow or discontinuity in the fabric, that is to say, if the degree of illumination of the transistor changes by reason of variation in the texture of the fabric caused by a fault occurring in the area or field scanned or superimposed, then the transistor generates a signal. This signal is transmitted through the leads 18 to the control box 12, is amplified and then used to actuate a relay X (FIGURE 3) for operating a warning system or stop motion or both, connected to terminals 36.

The light sensitive element and the lamp, which are the only circuit elements housed in the casing, are very small. Consequently, the casing 3 can also be made very small—as small as 0.8 x 0.6 x 0.3 inch—and can thus be arranged to follow a path which lies very close to the line at which the fabric is knitted, i.e. close to where a fault would first occur. In the arrangement as illustrated in FIGURES 1 and 2, the casing would be about a quarter of an inch from the needle bar and one third of an inch from the fabric.

The weight of the casing 3 and its contents can be as small as a fraction of an ounce and this allows the fabric to be scanned at very high speeds of about 15 to 30 ft./sec. or even higher. The faster the machine operates, the more important it is that the scanner be traversed at high speed across it. If the width of the bed is, for example, 6 feet and the machine produces 24 inches of knitted fabric a minute, a scanning speed of 30 feet a minute will, in an arrangement in accordance with the invention, allow the length of a fault to be restricted to no more than half an inch. This assumes that the transistor casing is about one quarter of an inch from the needle bar. Any excess over that distance must be added to the length of the fault. The higher the speed of the scanner the shorter will be the duration of the signals generated by the transistor. It is important that these signals be sufficiently prolonged to permit the system to operate the warning device or stop the machine.

The feed-back circuit shown in FIGURE 3 included between the transistor 1 and the terminals 36 permits this to be done.

The phototransistor is particularly responsive to radiations in the infra-red range emitted by the incandescent lamp. For this reason, and also because the transistor can be brought very close to the fabric, disturbing influences caused by natural light or the mill illumination are reduced to a minimum.

FIGURE 4 shows a flat bar knitting machine equipped with a fabric fault-detector comprising a number of scanners which are moved over the machine bed above the knitted fabric by a common traversing mechanism and the signals from the light sensitive elements of which are fed to a common signal channel comprising an amplifier and relay circuit.

Each casing 3 is carried at the end of a tube 4 and is reciprocated parallel to and in front of the rectilinear row of fabric-producing needles provided by the needle bar 6 over the fabric 8, the reflector 11 being located under the fabric close to the needle bar.

The tubes 4 are parts of a movable frame of the fault-detector which frame comprises also a hollow push rod 40 to which the tubes 4 are rigidly connected and which is mounted to reciprocate to-and-fro in stationary mounting means of the fault-detector comprising guide bearings 41. The rod 40 is driven by the motor 29, through the belt and pulley drive 31 and reduction gearing 32 mounted on the fixed platform 30. The crank arm 28 driven by the gearing 32 is adjustably hinged at 33 to the connecting rod 27 pivoted to the push rod 40. Any other suitable reciprocating mechanism for the push rod may be used.

The leads 18 from the individual lamps and transistors in the casings 3 have circuit connections led through the respective tubes 4 and through the rod 40 to the control box 12 mounted on the machine in fixed relationship thereto and housing a common amplifier and relay switching network of the kind shown in FIGURE 3.

In contrast to the arrangement described with reference to FIGURES 1 and 2, each of the plurality of scanning units shown in FIGURE 4 scans only a portion of the width of the fabric 8, the scanning units being spaced from one another in the direction of reciprocation for this purpose. While different parts of the fabric width are scanned by the different scanning units, the individual scanning paths preferably overlap, i.e. each path is made to be somewhat longer than the spacing of the casings 3 in order to ensure that the entire fabric width is traversed during each stroke of the push rod 40.

As before, each casing 3 can be made to follow a path which lies very close to the fabric and to the needle bar. Since the casings are also very light in weight, it is possible to provide a number of them, as shown in FIGURE 4, without detrimentally affecting the high speeds at which they can be moved. Further, since each casing in FIGURE 4 need only traverse a portion of the fabric width, the time taken to traverse the entire fabric once is shortened proportionally to the number of casings installed. For this reason, this arrangement is particularly suitable for wide machines. Conversely, such an arrangement when used with small machines, permits the fabric to be scanned at lower speeds but still detecting faults of the same length.

The arrangement of FIGURE 4 can also be applied to machines in which a number of fabrics are produced side by side, each fabric being traversed by one or more casings suspended from a common push rod.

The reflector 11 which is placed under the fabric below the scanning device can be modified to permit the invention to be used on machines for producing open-work or net fabric. Such a reflector is shown in FIGURE 5. It comprises a strip 11 in which mat or non-reflecting areas 52 separate thin reflecting areas 51. The number, wide and spacing of the reflecting areas 51 correspond

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to the number, width and spacing of the warps 53 in the fabric 8. During normal operation of the machine the fabric passes over the mirror as it emerges from the needles so that the warps 53 cover the reflecting areas 51, the uncovered areas matching the warps in reflectivity. If a warp 53 happens to be missing, the transistor in the scanning device reacts to the increased reflection from the strip 11 and actuates the warning device or stop motion.

If the net fabric has a pattern knitted into it, such as the one shown in FIGURE 6, the reflector can be in the form of a roller arranged to rotate close to the needle bar at a speed equal to that of the fabric 8 knitted by the needles. The surface of the roller is formed with reflecting areas corresponding in shape, size and spacing to the shape, size and spacing of the warps 53 in the fabric. The phototransistor is adapted to react to an increase in illumination reflected from a reflecting area left uncovered by a missing warp.

We claim:

1. A textile machine having a rectilinear row of fabric-producing needles and a fabric fault detector comprising photo-electric means mounted and arranged so as to be reciprocated close to the fabric and said needles so as to scan the fabric for faults therein, said photo-electric means comprising a plurality of units each comprising a source of light and a photocell, said units being arranged in line parallel to the row of needles and being reciprocated in unison with a stroke which is small in comparison with the length of the said row, and a common stationary amplifier circuit through which all said units are connected to a warning device or stop motion.

2. A textile machine having a rectilinear row of fabric-producing needles and a fabric fault detector comprising stationary mounting means fixed to the machine, a movable frame mounted to reciprocate to and fro on the stationary mounting means in a direction parallel to the row of needles, drive means for reciprocating the movable frame, a plurality of scanning units mounted on said frame and spaced from one another in the direction of reciprocation to each scan a different part of the width of the fabric as the movable frame reciprocates, each scanning unit comprising a semi-conductor type photo-sensitive detector cell, separate electrical leads on the movable frame for each of the detector cells, a common electrical switching network mounted on the machine in fixed relationship and operative to actuate a stop motion or warning device, and electrical circuit connections between the leads of each detector cell and the common switching network whereby the signal resulting from detection of a fault by any of the detector cells operates the common switching network.

3. Flaw-detecting apparatus, for the supervision by scanning of a given area or field, comprising a frame, a plurality of photoelectric scanners mounted thereon for movement transversely of the area or field, the scanners being spaced in the direction of movement to simultaneously traverse different parts of the area or field and each scanner having a narrow aperture to receive light from a small portion of the area or field at a time, and electrical connections provided from each scanner to a common signal channel whereby reaction to a flaw or discontinuity by any of the scanners produces a signal in the common channel for use in bringing about actuation of means such as a warning or stop motion device.

4. Apparatus for the detection of flaws or discontinuities in a travelling web of material, comprising a plurality of photoelectric scanners mounted for movement in unison close to the web and transversely of the direction of travel thereof, the scanners being spaced from one another in the direction of movement to traverse different parts of the width of the web, and each scanner having a narrow aperture to receive light reflected from or transmitted through a small portion of the web mate-

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rial at a time and being sensitive to variation due to the presence of a flaw or the like in the material, and electrical connections from each scanner to a common signal channel whereby reaction to a flaw or the like by any of the scanners produces a signal in the common channel bringing about actuation of means such as a warning or stop motion device.

5. Apparatus as claimed in claim 4, and further comprising at least one light source to illuminate the part of the web length that is scanned, said source being disposed on the same side of the web as the scanners.

6. Apparatus as claimed in claim 5 further comprising a strip reflector extending across the travelling web on the opposite side to the scanners and light source to reflect toward the scanners light passing through the web material and increase the variation in the light falling on a scanner at a flaw or the like.

7. Apparatus as claimed in claim 6, wherein the web material is of an openwork character, and the reflector strip has portions opposite the normal openings in the web which match the web in reflectivity.

8. Apparatus as claimed in claim 7, wherein the web material has an openwork pattern with a variation in the direction of travel of the web, and the reflector strip is in the form of a roller which rotates with a peripheral speed equal to the speed of travel of the web and has the pattern reproduced by areas on its surface matching the web in reflectivity.

9. A flat bar knitting machine having apparatus for the detection of faults or other discontinuities in the web of knitted fabric issuing from the needles, comprising stationary guide means fixed to the machine, a plurality of spaced scanning heads arranged in a horizontal row extending at right angles to the direction of travel of the knitted fabric and mounted on the guide means for travelling to and fro in unison in the horizontal direction in which the row extends, and drive means to traverse the scanning heads only a fraction of the width of the fabric with each scanning head traversing a different part of the width so that all the scanning heads together scan the whole width, and wherein each scanning head is maintained at small distances from the knitted fabric and from the needles and comprises a photoconductive cell and a low-power light source, the cell receiving light reflected from a small portion of the fabric at a time and being sensitive to variation due to the presence of a fault or the like in the fabric while the light source is disposed to illuminate the small portion of the fabric scanned by the cell at any time, and electrical connections are provided from each scanning cell to a common signal channel whereby reaction to a fault or the like by any of the scanners produces a signal in the common channel to bring about actuation of a warning or stop motion device.

10. A machine as claimed in claim 9, wherein the common signal channel includes an electronic amplifier to which signals from all the scanners are fed, and a relay actuable by the amplifier output, said amplifier and relay having a stationary mounting.

11. A machine as claimed in claim 9 wherein the scanners are mounted to travel above the knitted fabric.

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