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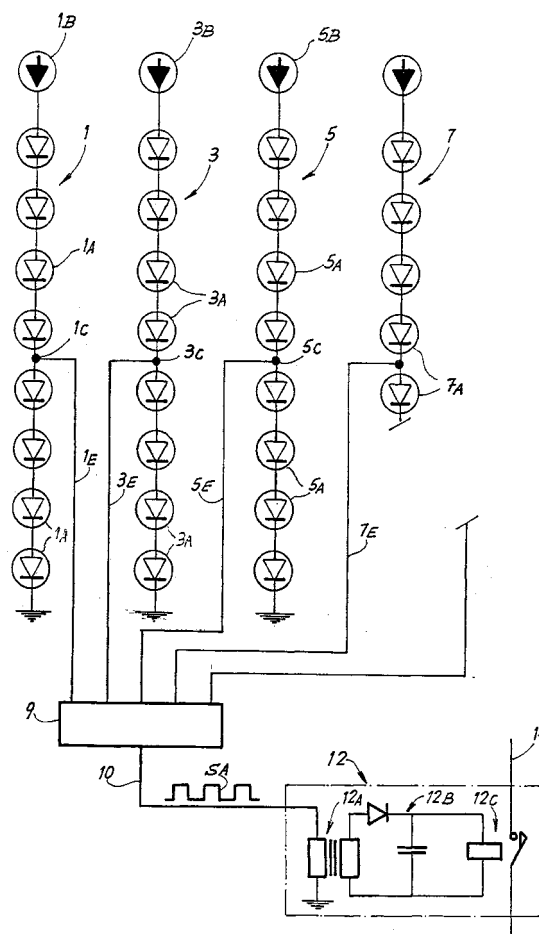
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(54) **System for monitoring a lighting installation or light signaling equipment having a plurality of light points of the led or similar type**

(57) The system comprises groups (1, 3, 5) of LEDs, the LEDs of each of the groups being connected in series with each other; a direct current power supply (1B, 3B, 5B) is provided for each series; in a microprocessor (9) each of a plurality of inputs is connected to an intermediate point (1C, 3C, 5C) of one of the series of LEDs, so that an interruption of current in one of the series of LEDs or a short-circuit in one LED causes a change in the voltage at the corresponding input of the microprocessor, and a scanning means is used for monitoring the individual inputs by scanning; at the output of said microprocessor, a detector (12) signals this change, during scanning, by means of a relay (12C).



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Description

[0001] The invention relates to an intrinsically safe system for monitoring the operation of lighting installations or signaling equipment in general, comprising a plurality of light points, for example LEDs. A possible application of said system is for monitoring signaling lamps for air navigation, such as those with 360° illumination, comprising matrices of LEDs extending over a truncated pyramidal theoretical surface or similar. Another application is for LED signals for railroad use. In these cases, the LEDs are frequently divided into groups (or "strings") in each of which the LEDs are connected in series with each other; the various groups of LEDs can be supplied in parallel with each other by means of a stabilizing circuit.

[0002] The invention can be used for monitoring the integrity of emitters made from a large number of LEDs, this monitoring being of the intrinsically safe type.

[0003] The applications may relate to lamps signaling obstacles to air navigation, but also to other types of signaling equipment for applications in the railroad or marine fields, for example.

[0004] The invention relates to a system of monitoring the regularity of operation of a lighting installation or light signaling equipment of the type comprising at least one group of light points of the LED or similar type, supplied in series with direct current. Said system according to the invention comprises:

- a microprocessor, one of whose inputs is connected to an intermediate point of the series of light points or LEDs, so that an interruption of current in the series of light points or LEDs or a short-circuit in a light point or LED causes a change in the voltage at the microprocessor;
- and, at the output of said microprocessor, a detector which signals this change.

[0005] In one practical embodiment, the monitoring system is applicable to a lighting installation or light signaling equipment of the type comprising a plurality of groups or "strings", in other words series, of light points of the LED or similar type, the light points or LEDs of each of the groups being connected in series with each other. In this case, the system comprises:

- a direct current power supply which may, if necessary and advantageously, be independent for each group or "string";
- a microprocessor, with an output and a plurality of inputs, each of the inputs being connected to an intermediate point of one of the series of light points or LEDs, so that an interruption of current in one of the series of light points or LEDs or a short-circuit in a light point or LED causes a change in the voltage at the corresponding input of the microprocessor;

- a scanning means for monitoring the individual inputs by scanning;
- and, at the output of said microprocessor, a detector which signals this change during the scanning.

[0006] At its output, the microprocessor is capable of generating pulses at a predetermined frequency, with an interruption in case of a change at one of the inputs; the detector in turn comprises a relay associated with a rectifier and a transformer; the relay changes its state if there is an interruption of the pulses at the predetermined frequency, and this triggers an appropriate alarm. More particularly, the relay can cause the opening of an alarm circuit, in case of an interruption of the pulses at the predetermined frequency or any other anomaly, including the interruption of the power supply to the light points and/or to the microprocessor.

[0007] The monitoring system in question may also comprise at least two microprocessors, each of which monitors part of the groups, or strings, of light points; in this case, the relays connected to said microprocessors may be arranged in series in a single circuit, which is opened by the release of any one of the relays.

[0008] Finally, intrinsic safety is achieved by means of the circuit, connected to the microprocessor, which monitors the integrity of the strings of LEDs, keeping the electromechanical relay energized only if the LEDs are unimpaired and/or if the monitoring circuit itself is also unimpaired.

[0009] The invention will be more clearly understood from the description and the attached drawing, which shows a practical and non-restrictive example of the invention. The drawing shows a circuit diagram which implements the monitoring of a plurality (strings) of light points, of the LED type for example.

[0010] In the drawing, the numerals 1, 3, 5, 7, etc. indicate a plurality of groups or "strings" of light points, in practice LEDs or similar; in the drawing, each group comprises corresponding LEDs 1A, 3A, 5A, etc., the total number being, for example, eight; 1 B, 3B, 5B, etc. indicate corresponding individual direct current generators for the individual groups, which are then connected to a ground. At an intermediate position in the series of LEDs of each group, at a point 1 C, 3C, 5C respectively, lines 1 E, 3E, 5E, 7E, etc., are branched off and run to the same number of inputs of a microprocessor 9. The program of the microprocessor 9, using an analog/digital converter, monitors by scanning the power received from the various lines 1 E, 3E, 5E, 7E, etc. The microprocessor 9 is programmed to supply at the output 10 an alternating signal, such as that indicated by SA, which is sent to a detector indicated in a general way by 12. According to the drawing, this detector 12 comprises a step-up transformer 12A, a rectifier 12B and a relay 12C; the contacts of the relay provide continuity for a signaling or alarm circuit 14, which is open when the relay is not energized, and in practice when there is an interruption in the alternating signal SA or when the sig-

nal SA becomes static as a result of a fault in the microprocessor following the short-circuiting or cut-off of an LED.

[0011] For the manufacture of a lamp or other LED emitter consisting of light points (LEDs), the latter are generally divided into $Y = N/X$ groups, each having X LEDs, these groups being called "strings" of LEDs; the X LEDs of each "string" are arranged in series. An emitter uses the Y strings in parallel, supplied independently with direct current. In the drawing, each group or string 1, 3, 5, etc. comprises eight LEDs ($X = 8$) 1A, 3A, 5A, etc., with power supplies 1 B, 3B, 5B, etc.

[0012] With this arrangement, if one LED is cut off, the power supply to all the other LEDs in the same "string" is lost. In a system with Y "strings", if one LED in one "string" fails, the remaining $Y-1$ "strings" remain in operation.

[0013] In the solution shown in the drawing, use is made of the microprocessor 9, which by means of an analog/digital converter monitors by scanning the continuity of the power supply of each of the strings 1, 3, 5, etc. In these conditions, the microprocessor 9 emits at its output 10 a high logical signal SA (for example, a voltage of 5 V which is periodically brought to the zero value by the program); this alternating signal SA supplies - with pulses whose frequency is predetermined by the resident program - the primary of the transformer 12A. Thus an alternating voltage is induced across the terminals of the secondary of the transformer 12A, and this voltage is rectified by means of the diode rectifier 12B so that the coil of the electromechanical relay 12C is supplied with virtually direct current.

[0014] In normal conditions, the relay 12C remains energized and the circuit 14 is not interrupted.

[0015] If the current in any of the "strings" of LEDs is interrupted, or if the voltage supplied to the microprocessor from one of the lines 1 E, 3E, 5E, etc. varies, this is immediately recognized by the microprocessor, which ceases to send the logical signal SA pulsed according to the program to the primary of the transformer, thus causing the release of the relay. If the microprocessor is faulty, it is no longer capable of running the program, and therefore the pulsed signal is lost in this case also.

[0016] This makes it possible to achieve intrinsic safety.

[0017] The method by which the microprocessor identifies a fault in the LEDs may be: (I) a faulty LED which may cut itself off (the most frequent condition overall) or become short-circuited (a fairly rare condition). In each case, there is a change at an input of the microprocessor.

[0018] A string consisting, according to the example, of eight LEDs arranged in series and supplied with a direct current of 20 mA, has a voltage of approximately 12 V at the point 1 C or 3C or 5C at the mid-point of the string in normal conditions. If any of the LEDs of the string in question is cut off, this voltage takes a permanent value. However, if an LED becomes short-circuited,

the voltage increases to approximately 14 V. The microprocessor 9 continuously measures, by regular scanning in a predetermined cycle, the voltage present at the mid-point of the string (points 1C, 3C, 5C, etc.); if the voltage takes a value other than 12 V, such as 0 V or 14 V, the microprocessor detects the fault, and the supply to the primary of the transformer 12A ceases.

[0019] The supply to the primary of the transformer 12A is generated by a logical signal at the output of the microprocessor, which, in normal operating conditions, varies from high to low with a frequency which is determined by the resident program which controls the operation of the microprocessor. The program is responsible for continuously varying the state of the logical signal which is high if the LEDs are sound and becomes low if any LED goes out of service. Any fault in the microprocessor stops the running of the program and consequently prevents the switching of the logical state at the output from high to low. The logical output of the microprocessor, in case of a fault, may remain permanently in a high or a low state, but cannot vary with the same frequency as that present if the component is unimpaired.

[0020] In all cases, if the signal at the output of the microprocessor 9 remains at the value 0 or 5 V, no voltage is induced in the secondary of the transformer; the coil of the relay is therefore not energized and the circuit 14 is opened, which generates a desired alarm signal and/or other appropriate operation.

[0021] It is also possible to construct systems having more than one microprocessor, each of which is dedicated to monitoring a certain number of "strings" of LEDs. In this case, the contacts of the individual relays will be arranged in series in a circuit 14, in such a way as to determine the logical condition of the logical product (AND) which meets the requirements of intrinsic safety in each case, given that when a relay becomes de-energized the contacts will remain open and the circuit 14 will be interrupted.

[0022] It is to be understood that the drawing shows only an example provided solely as a practical demonstration of the invention, and that this invention may be varied in its forms and dispositions without departure from the scope of the guiding principle of the invention.

Claims

1. System for monitoring the regularity of operation of a lighting installation or light signaling equipment, comprising at least one group of light points of the LED or similar type, supplied in series with direct current, characterized in that it comprises: a microprocessor, one of whose inputs is connected to an intermediate point of the series of light points or LEDs, so that an interruption of current in the series of light points (or LEDs) or a short-circuit in a light point (or LED) causes a change in the voltage at the microprocessor; and, at the output of said micro-

processor, a detector which signals this change.

above and represented by way of example in the attached drawing.

2. System for monitoring the regularity of operation of a lighting installation or light signaling equipment comprising a plurality of groups or "strings", in other words series, of light points of the LED or similar type, the light points or LEDs of each of the groups being connected in series with each other, characterized in that it comprises: a stable direct current power supply for each group or "string"; a microprocessor, with an output and a plurality of inputs, each of the inputs being connected to an intermediate point of one of the series of light points or LEDs, so that an interruption of current in one of the series of light points or LEDs or a short-circuit in a light point or LED causes a change in the voltage at the corresponding input of the microprocessor; a scanning means for monitoring the individual inputs by scanning; and, at the output of said microprocessor, a detector which signals this change during the scanning. 5 10 15 20
3. Monitoring system as claimed at least in claim 2, characterized in that, at its output, the microprocessor is capable of generating pulses at a predetermined frequency, with an interruption in case of a change at one of the inputs; and in that said detector comprises a relay associated with a rectifier and a transformer, the relay changing its state if there is an interruption of the pulses at the predetermined frequency. 25 30
4. Monitoring system as claimed in claim 3, characterized in that the relay causes the opening of an alarm circuit, in case of an interruption of the pulses at the predetermined frequency or any other anomaly, including the interruption of the power supply to the light points and/or to the microprocessor. 35
5. Monitoring system as claimed in claim 4, characterized in that if there is any anomaly in the rectifier diode connected to the secondary of the transformer the signaling relay is de-energized. 40
6. Monitoring system as claimed at least in claim 1, characterized in that it comprises at least two microprocessors, each of which monitors part of the groups, or strings, of light points. 45
7. Monitoring system as claimed at least in claim 6, characterized in that the relays connected to said microprocessor are arranged in series in a single circuit, which is opened by the release of any one of the relays. 50 55
8. System for monitoring a lighting installation or light signaling equipment having a plurality of light points of the LED or similar type, the whole as described

