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(72) Inventor: **Aalto, Veijo**
13600 Hämeenlinna (FI)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

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(71) Applicant:
Ahlström
Sähkötarvikkeet Oy i-VALO
07970 Ruotsinpyhtää (FI)

(54) Method and arrangement for observing the operational status of an electrical device

(57) The present invention relates to a method of monitoring and/or controlling the operation status of an electrical apparatus (1) from a distance from the apparatus. Factors having an effect on the various operation statuses of the electrical apparatus, such as various components causing the fault condition, are identified by means of suitable transducers (10) and wirelessly

indicated by means of transmitters using electromagnetic signals. The invention also relates to an apparatus performing the method.

Industrial lighting fixtures are an advantageous application of the invention.

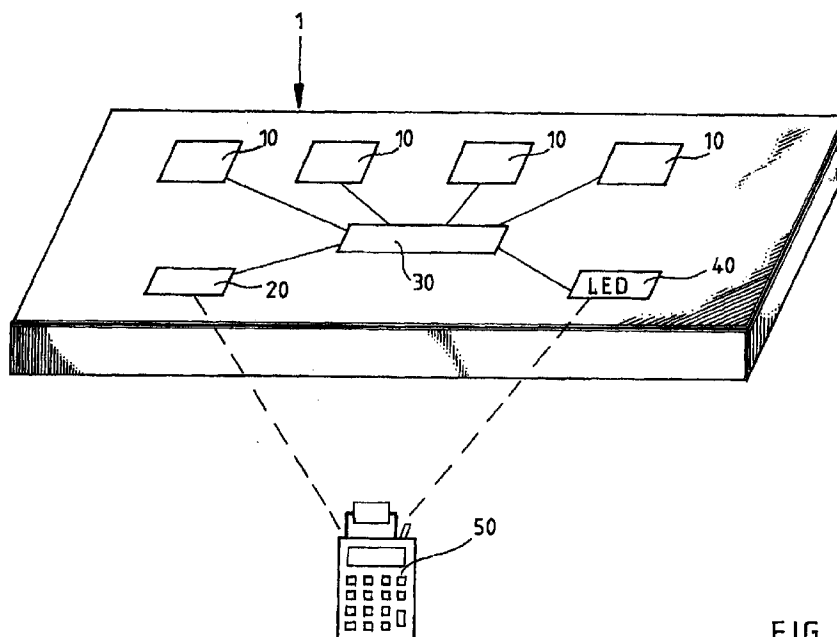


FIG. 1

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Description

[0001] The present invention relates to a method and arrangement for remotely monitoring and/or controlling the operation status of an industrial lighting fixture. The invention is especially suitable for use in connection with lighting fixtures, such as industrial lighting fixtures, located on the ceiling of high industrial buildings, or in connection with other lighting fixtures that are not easily accessible, such as street lamps.

[0002] In the previously known solutions there has not been an adequate method of monitoring the condition of, for example, industrial lighting fixtures. Any need for service has only been detected when the lighting fixture has already failed and there has been no way of ascertaining the reason for failure until the lighting fixture has been inspected in its installation location. In the context of this invention, the term industrial lighting fixture is used to describe, in addition to lighting fixtures used in industrial buildings, also lighting fixtures used in warehouses, buildings for commercial purposes, hospitals and other large buildings as well as street lamps and, more generally, lighting fixtures that are not easily accessible.

[0003] The solution according to Japanese patent publication JP 07320880 in which the light energy of the lamp is measured and kept constant by controlling the voltage on the basis of the measurement results, can be mentioned as an example of prior art methods of monitoring for example the service life of a lamp. As the lamp deteriorates with wear and the voltage exceeds a preset limit, an LED is lit to signal the end of the operation life of the lamp.

[0004] Another example of solutions for monitoring the condition of various devices is the Swedish patent publication SE 458 634, in which a monitoring lamp has been installed on the dashboard of a vehicle for indicating the fault conditions of various devices of the vehicle. In the solution according to the publication the monitoring lamp indicates two different states of the device to be monitored: either the device is working normally or there is a fault in the device. The lamp being unlit indicates the normal state; the lamp burning continuously and later by flashing for catching the attention better first indicates a fault. One problem of this solution is that one lamp can only be used for indicating the state of one device and thus there must be a number of lamps in the instrument panel. Realizing such a "wired" arrangement is, nevertheless, difficult or unreasonably expensive in installations with a long distance between the monitored electrical device and the indicator connected thereto and the observer, as is the case with industrial lighting fixtures. In industrial buildings and other installations with a long distance to the monitored devices, separate control lamps installed in connection with the lighting fixtures can not be distinguished as well as in installations to be watched from a close distance, such as a car instrument panel.

[0005] Another downside of prior art technology is that the current solutions are only capable of monitoring and indicating one component of the lighting fixture. Further, if a lighting fixture malfunctions in an industrial building the service personnel must go up, to near the ceiling of the building, and spare parts must be provided for all parts that might have caused the fault. This causes a lot of service work, and a number of spare parts must be provided for the service work, even though it is usually only one failed component that has caused the malfunction. Current prior art solutions can't be used for unambiguously pointing out the cause of the fault. Repairing even a simple fault is a time-consuming task, which increases the time the service personnel will have to spend up, near the lighting fixture, thus also increasing the risk for accidents caused by the nature of the tasks.

[0006] So far, implementing systematic and easy maintenance surveillance and viewing a statistical fault frequency listing of a large device network has either been inadequate or even completely impossible. Monitoring and investigating any features of a large device network that can only be noticed statistically has earlier either been manual or it has been based on the service person's acquired skill that has only been available to and used by the person. Most probably a planned and systematic surveillance has not even been possible in this context.

[0007] The object of the present invention is to state a method and arrangement for avoiding the problems and deficiencies of the prior art systems and to simultaneously facilitate an improved method and arrangement for remotely monitoring and/or controlling the operation of an industrial lighting fixture. Another object of the invention is to facilitate a systematic and documentable - and thereby a statistically valid - system for monitoring the condition of industrial lighting fixtures and servicing them.

[0008] The characterizing features of the present invention are disclosed in more detail in the appended claims.

[0009] The invention is based on the idea that in order to remotely monitor the operation status of an industrial lighting fixture suitable transducers are used for identifying the factors affecting at least two different operation statuses of a single industrial lighting fixture, such as various components causing a fault condition and/or factors or components affecting or disturbing the optimal operation status and that the fault condition with its cause is indicated wirelessly by means of suitable transmitters using electromagnetic signals, such as LEDs, extra bright LEDs or infrared transmitters etc.

[0010] The reduction of time required for performing service work is one advantageous feature of our invention. Utilizing the invention will cause an improved flow of information for service work, thus also improving safety during maintenance. The need to actually physically go to the lighting fixture will be reduced, because in a fault condition the lighting fixture need only be

accessed once, and only the component to be replaced must be taken along. The invention eliminates the need for the service person to first go and verify the faulty component, then to order the part and to actually repair the problem only after all this. The invention uses the idea that the condition of an industrial lighting fixture can be monitored by means of durable transmitters or indicators, such as LEDs. Using such a durable indicator will solve the problem of unreliable indicators. For example, a failure in the operation of a lighting fixture located on the ceiling of an industrial building and its cause can be identified from the floor, whereby the service person can prepare for repairing the lighting fixture without the need to access the device for identifying the problem. In high industrial buildings and other places that are not easily accessible it is difficult and labour-intensive to check and identify the fault of a lighting fixture. The invention will greatly reduce, for example, the amount of necessary service work, because the device will indicate the problem. Sometimes the normal operation in an industrial building will have to be ceased for the duration of servicing the lighting fixtures. The present invention will reduce the time needed for servicing the lighting fixtures, whereby the time available for the actual work in the hall is increased.

[0011] One of the advantages of the present invention is the ability to perform pre-emptive maintenance. When the service person is near the ceiling of the building to repair a faulty lighting fixture, another lighting fixture might be nearby for which it is reasonable to change a component, even if there has so far not been an actual fault. If the still operational component that would have to be replaced soon in any case, can be identified in time and replaced together with other maintenance work, the number of service accesses can be clearly reduced. Thus, existing operation problems can be dealt with by replacing correct components while any future faults can be dealt with by replacing any necessary components in time.

[0012] A systematic wireless service and/or surveillance system presents remarkable advantages in modern industrial plants and other large buildings, such as malls, hospitals or in connection with the street lamp network. Service and spare part costs will be reduced as the targeting and anticipating of service work is improved. Any systematic faults or other factors affecting the optimal use of the monitored lighting fixtures can be identified with statistical methods by using the data collected from each lighting fixture. It has previously been impossible to utilize the advantages of such systematic wireless data acquisition for monitoring industrial lighting fixtures and assessing their operation.

[0013] One of the advantages brought forth by the invention is simplicity. The apparatus to be installed in connection with the lighting fixture is a complete, independent unit that does not require an external computer or other unit, but the apparatus is capable of stand-alone operation. Regardless of this, another advantage

geous embodiment of the invention utilizes a receiving apparatus for receiving and, for example, systematically recording the data. One of the advantages of the method and arrangement according to the invention is that the apparatus does not require a separate battery for operation, but it takes the necessary power from the electrical network of the lighting fixture.

[0014] Our invention is also based on the idea that, for example, an LED or other transmitter will wirelessly indicate the condition of various parts of the lighting fixture by being either continuously or intermittently lit. The LED can for example indicate various fault conditions of different components by emitting various signals. The indicated faults can, for example, be overheating of the reactor, breaking of the starter of the lamp or breaking of the lamp. In addition to this, the apparatus will disconnect, if necessary, the lighting fixture from the electrical network.

[0015] A lighting fixture according to the invention can also be connected to or provided with a component for connecting it to and disconnecting it from the electrical network at exactly the zero point of the voltage and/or current. The sine wave form of AC electrical power causes voltage and current to be zero 100 times per second. The advantage of connecting the lighting fixture to the electrical network at exactly the zero point of the voltage and/or current is that as there will be no arcing over the points during connection, the contactor (relay) connecting the lighting fixtures to the network will be operating under a lighter load. The advantage of disconnecting during the voltage zero point is that the compensation capacitor (if any) in the lighting fixture does not retain any residual voltage, whereby there will be no voltage in the plug of a lighting fixture having a plug after disconnecting. This improves safety.

[0016] In the following, the method and apparatus according to the invention is disclosed in more detail, with reference to the appended figure 1 illustrating an apparatus according to an embodiment of the invention.

[0017] An apparatus according to one advantageous embodiment of the invention comprises, as illustrated in figure 1, transducers 10 monitoring the status of an industrial lighting fixture 1, a transmitter 40 for indicating the cause of the fault, the electronics unit 30 for coordinating the function of the cause of the fault status, transducers and transmitters, means 20, such as a relay, for disconnecting the electrical device from the network, and if desired, a receiver 50 for receiving the signal indicating the operation status.

[0018] The invention is based on the idea that a durable transmitter, such as an LED or an infrared transmitter will start transmitting a signal intermittently, continuously or when desired, upon activating the transmitter subsequent to the occurrence of the fault. The transmitter utilizes different signals for indicating the cause of the fault. In the case of an industrial lighting fixture the causes to be indicated and the corresponding signals could be, for example, overheating of the reac-

tor, indicated by fast blinking of the LED, breaking of the starter, indicated by slow blinking of the LED, and breaking of the lamp, indicated by the LED being continuously lit.

[0019] The phrase "different operation statuses" means in this context the normal operation of the lighting fixture or fault conditions caused by various factors or conditions affecting the optimal operation status of the lighting fixture. The components causing the fault condition can be various components of the lighting fixture, and the factors affecting or disturbing the optimal operation of the lighting fixture can either be various components of the lighting fixture or changes caused by an external factor, such as a change in the ambient temperature. According to the invention it is therefore also possible to monitor and detect external factors and to indicate fault conditions or a non-optimal operation status caused by them. A fault condition or a non-optimal operation status and the cause thereof will be wirelessly indicated by means of transmitters utilizing electromagnetic signals. In this context, the term transmitters is understood to cover a wide array of transmitters, transmitter-receivers or the like. A transmitter of this kind is, for example, an LED transmitting a light signal, and an infrared transmitter.

[0020] According to the invention, the lighting fixture can, if necessary, be controlled to disconnect from the electrical network or to connect to the network at advantageously exactly on the zero point of the current and/or voltage. It is often advantageous to disconnect the lighting fixture from the electrical network in case of a fault condition, depending on the component causing the fault. The lighting fixture is reconnected to the network when needed, for example after identifying and repairing the problem or when the pre-emptive maintenance has been performed. Disconnecting from and connecting to the electrical network at zero point of the voltage will reduce the wear of the contactor (relay) connecting the lighting fixture to the network by reducing its load, as there will be no light arc over the points during connection.

[0021] Further, monitoring of the lighting fixture to be monitored is performed continuously, as online monitoring. The current operation status is sent to the receiver by means of a suitable transmitter, whereby the identifying data for the cause of the fault or the component affecting the optimal operation of a lighting fixture located on the ceiling of, for example, an industrial building, are transmitted to a receiver located on floor level. In this context, a receiver means any suitable receiving apparatus, a transmitter-receiver or the like, and the receiver can, for example, be the human eye or receiver/data recorder suitable for receiving and storing an infrared signal. According to an advantageous embodiment of the invention the transmitter is an LED, which emits a light signal that is detected by a person on the floor level.

[0022] According to an advantageous embodiment of

the invention the transmitter indicating the operation status will only transmit the operation status report to the receiver when necessary, for example, when activated by an activating apparatus installed in the receiver.

[0023] An advantageous embodiment of a system for remotely monitoring the operation status of a lighting fixture according to the invention comprises

- at least one transducer for identifying the causes/components of at least two fault conditions of a single industrial lighting fixture and/or a factor or component affecting or disturbing the optimal operation status thereof and identifying and/or measuring the status of the factor or component, and
- a wireless transmitter utilizing suitable electromagnetic signals, such as an LED, an infrared transmitter or other suitable indicator.

[0024] In addition to this, the system can comprise an electronics unit for coordinating the operation of the transducers and transmitters as well as means for disconnecting the lighting fixture from and connecting it to the electric network at exactly the zero point of the voltage and/or current. The means can be, for example, a relay.

[0025] Further, the system can comprise a receiver for receiving the status indicator signal. In the case of a lighting fixture located on the ceiling of an industrial building, the identifying data of the cause of the fault condition or the component affecting the optimal operation status are received by a receiver located on floor level.

[0026] A separate identifying code can be arranged for each monitored lighting fixture. The code can for example be an identifying number that is transmitted to the receiver in connection with each status report. The receiver will store, and if necessary, print out a status report for each monitored lighting fixture. Thus, when printing status reports for a number of monitored lighting fixtures, it will be easy to keep the reports in good order, whereby the actual maintenance work will be facilitated due to good instructions. When the status reports of the receiver are stored on a computer, the data contained by the reports can be processed with the desired statistical and/or other methods, whereby it is possible to get an overall impression of the operation of a large number of lighting fixtures in various places and during different periods.

[0027] In order to send the status report at the desired time, the transmitter indicating operation status comprises suitable means for activating the transmission of a status report, for example by means of an activation signal sent by the receiver.

[0028] The system according to the invention is arranged essentially in connection with the lighting fixture to be monitored for controlled. The system is easy

to fasten on the lighting fixture by means of suitable components, whereby the system can be easily attached to the desired lighting fixtures as an accessory. The system can also be easily removed from the lighting fixture if necessary. Thus it is easy to manufacture a basic model of the lighting fixture with the necessary transducers always included. The transmitter unit can later be attached either permanently or for a certain period of time.

[0029] According to an advantageous embodiment of the invention, at least one LED is utilized for monitoring the operation status of an industrial lighting fixture and/or identifying the component causing the fault, whereby one LED is used for indicating at least two statuses: for example, overheating of the reactor is indicated by a fast blinking of the LED, while breaking of the starter of the lamp is indicated by a slow blinking and the breaking of the lamp is indicated by the LED being continuously lit.

[0030] The invention will also improve the safety of industrial lighting fixtures, as they can be disconnected from the electrical network, when necessary, whereby the broken component will not cause additional hazards to the lighting fixture or the environment. When the lighting fixture or fixtures are out of order or if the lighting efficiency is below optimal, the reduced lighting efficiency can increase accident risk. The invention expedites recommissioning of the lighting fixture. In addition to this, excessive reducing of lighting efficiency can be detected in time, and so maintenance and repair work can be performed on time. In a solution according to the invention a relay or some other device will disconnect the lighting fixture from the electrical network when the transducers detect a problem, whereby any dangers caused by overheating can be avoided. Some prior art solutions have used the reactor's own thermal relay for disconnecting the reactor in case of a problem. When using an apparatus according to the invention, a separate thermal relay for the reactor is unnecessary.

[0031] An advantageous embodiment of the invention is the use in lighting fixtures used in high industrial buildings. The invention can especially be utilized in lighting fixtures that are not easily accessible, but it can also be utilized in groups of lighting fixtures with a number of lighting fixtures to be monitored. The method and apparatus are especially well suited for use in discharge lamps lighting fixtures, such as high-pressure sodium lamps, multi-metal lamps and mercury lamps.

[0032] The above description describes only some of the advantageous embodiments of the invention, and it is not meant to limit the scope and protection of the invention, which is defined by the appended patent claims.

Claims

1. A method of remotely monitoring and/or controlling the operation status of an industrial lighting fixture

(1), **characterized** in that factors having an effect on at least two different operation statuses of a single industrial lighting fixture, such as various components causing a fault status and/or factors or components affecting or disturbing the optimal operation status are identified by means of suitable transducers (10) and indicated wirelessly by means of suitable transmitters (40), such as LED's or infrared transmitters or the like, utilizing electromagnetic signals, and the industrial lighting fixture (1) is controlled, when necessary, depending on the component causing the fault, to be disconnected from the electrical network or to be reconnected to the network.

2. A method according to claim 1, **characterized** in that the industrial lighting fixture (1) is controlled, when necessary, to be disconnected from the electrical network or to be reconnected to the electrical network at advantageously exactly on the zero point of the voltage and/or current.
3. A method according to claim 1 or 2, **characterized** in that the monitoring of the operation status is performed continuously as online monitoring.
4. A method according to claim 1, 2 or 3, **characterized** in that the operation status is indicated or sent by means of a suitable transmitter (40) to a receiver (50), whereby the identifying data of the cause of a fault of a lighting fixture located on, for example, the ceiling of an industrial building, or the component affecting the optimal operation status of the lighting fixture are sent to a receiver (50) located on floor level, the receiver being for example the human eye or a suitable receiving apparatus.
5. A method according to any of the claims 1 - 4, **characterized** in that the transmitter (40) indicating the operation status sends a status report to the receiver (50) only when needed, for example when activated by an activating apparatus installed in the receiver (50).
6. An arrangement for remotely monitoring the operation status of an industrial lighting fixture (1), **characterized** in that the arrangement comprises
 - at least one transducer (10) for identifying and/or measuring the operation status of the cause of at least two different fault conditions or components and/or factors or components affecting or disturbing the optimal operation status of a single industrial lighting fixture (1),
 - a transmitter (40) utilizing suitable electromagnetic signals, such as an LED, and infrared transmitter or other suitable transmitter and
 - means (20) for disconnecting the lighting fix-

ture from the electrical network and reconnecting it to the network.

7. An arrangement according to claim 6, **characterized** in that it additionally comprises an electronics unit (30) coordinating the operation of the transducers (10) and the transmitters (40). 5
8. An arrangement according to claim 6 or 7, **characterized** in that it additionally comprises a receiver (50), for example, the human eye or a suitable receiving apparatus located on floor level for receiving the operation status indicator signal, for example the identifying data of the cause of the fault of a lighting apparatus located on the ceiling of an industrial building or the component affecting the optimal operation. 10
9. An arrangement according to claim 6, 7 or 8, **characterized** in that the means (20) are means for disconnecting the lighting apparatus from the electrical network and reconnecting it to the network at advantageously exactly on the zero point of the voltage. 15
10. An arrangement according to claim 6, 7, 8 or 9, **characterized** in that each monitored industrial lighting fixture (1) has its own identifying code, for example an identifying number that is transmitted to the receiver (50) together with the status report of the industrial lighting fixture (1). 20
11. An arrangement according to any of claims 6 - 10, **characterized** in that the receiver (50) stores and, when necessary, prints out the status report for each monitored industrial lighting fixture (1). 25
12. An arrangement according to any of claims 6-11, **characterized** in that the transmitter (40) indicating the operation status comprises suitable means for initiating the transmission of a status report by means of, for example, an activation signal sent by the receiver (50). 30
13. An arrangement according to any of the above claims 6 - 12, **characterized** in that at least one LED is used for monitoring the operation status and/or identifying the part or component causing the fault of an industrial lighting fixture, whereby one LED is used for indicating at least two various operation statuses, of which, for example, the overheating of the reactor is indicated by a fast flashing of the indicator, the breaking of the starter is indicated by a slow flashing of the indicator and the breaking of the lamp is indicated by the LED being continuously lit. 35
14. An arrangement according to any of the above 40

claims 6 - 13, **characterized** in that it is essentially arranged in connection with the monitored and/or controlled industrial lighting fixture (1).

15. An arrangement according to claim 14, **characterized** in that the applicable parts of the system arranged in connection with the monitored and/or controlled industrial lighting fixture (1) can be detached from the industrial lighting fixture (1) or attached to the industrial lighting fixture (1), whereby the system can be easily attached as an accessory to the desired industrial lighting fixtures (1) or detached from them. 45
16. The use of a method according to any of the above claims 1 - 5 for systematically monitoring and analysing the operation status of an industrial lighting fixture and/or identifying the component causing the fault condition. 50

