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(54) **Light signaling device for railway systems or the like**

Lichtsignal für Eisenbahnsysteme

Signal lumineux pour systèmes ferroviaires

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Description

[0001] The present invention relates to a light signaling device for railway systems or the like, comprising:

a unit for generating/emitting a light signal, which is provided in combination with:

means for generating/feeding a trigger signal for actuating said signaling device;

means for checking the functional status of said unit for generating/emitting said light signal, which means measure the intensity of the current absorbed by the light signal generating/emitting when said unit is on;

said means for functionally checking the light signal generating/emitting unit compare the detected absorbed current value with a predetermined threshold value and control functional status signaling means and/or safety feature control means according to the result of this comparison;

said light signal generating/emitting unit being equipped with a light radiation source of the type known as LED and control and power electronics;

said control and power electronics being provided in combination with optoelectronic means for detecting the light signal emitted by the light radiation emitting source and for generating an electric signal corresponding to said detected light radiation, which signal is fed to said control electronics;

said control and power electronics having means for changing the current absorbed by the light signal generating/emitting unit, which current changing means are controlled by said control and power electronics according to the electric signal corresponding to the light intensity emitted by the light radiation emitting source and generated by said optoelectronic means.

[0002] Light signaling devices for railway systems or the like of the above mentioned type are known and are generally used when new generation lamps of the so-called LED (Light Emitting Diode) type are used instead of traditional incandescent light radiation sources.

[0003] As an example the document US 6,392,553 disclose an apparatus and method for interfacing railway controllers with light units, such as LED light unit arrays, to shunt and disable test signals not traditionally intended to test non-incandescent light unit arrays.

[0004] The means for checking the absorbed current are generally placed in a remote central control unit known in the field as cab. The central control unit also comprises the means for generating a control signal and the trigger signal for actuating the light signal generating/emitting unit, which is generally placed at a predeter-

mined distance from the remote central unit along the railway line.

[0005] Traditional semaphores or traditional light signaling systems used incandescent lamps. Since these light signaling devices are used for optical transmission of information to the train to enable its transit or control it to stop or run at reduced speed, and since light radiation sources, such as semaphores or the like are arranged along the railway line, generally far from the premises in which the remote central control and power units are located, the controlled light should be checked, once it has been controlled to turn on, to see whether it actually turned on, i.e. whether it actually emits the required light radiation.

[0006] In light signaling devices having sources such as incandescent lamps, this is relatively simple, because whenever a lamp fails to turn on, this means that the filament is broken and that no current circulates in the lamp power circuit. Here, the filament of the incandescent lamp somewhat operates like a fuse.

[0007] Therefore, in traditional systems lamp operation is checked by equipping the remote control cabins with means for measuring the current absorbed by the lamp power circuit. Namely, these are amperometric relays which switch between contact closing and opening states, according to the current intensity in the power circuit of the light signal generating/emitting unit, which contact opening and closing states are equivalent to respectively enabling or disabling of additional units for setting the railway network in safety mode, whenever the light signaling devices fails to operate.

[0008] With the particular construction of incandescent lamps, any current intensity drop in the power circuit directly causes failed operation of the lamp in terms of light radiation emission, i.e. causes the lamp to fail to turn on or be poorly turned on.

[0009] High-brightness LED lamps have been increasingly used instead of incandescent lamps. This type of light radiation sources have several advantages as compared with incandescent lamps, but what has been described above for incandescent lamps does not apply to this type of lamps. Due to the particular construction features of LED lamps, a LED lamp may absorb current, which means that the current circulating therein may be sufficient to simulate proper operation, even when no light radiation is actually emitted.

[0010] The typical amperometric check as described above, i.e. measurement of the intensity of current circulating in the power circuit of the light source is not sufficient to safely define an operating condition of the LED lamp in terms of light radiation emission.

[0011] Referring to the above described device, in prior art devices control and power electronics are provided for controlling and powering the LED lamp, which electronics are combined with means for measuring the light radiation emitted by the LED lamp and for generating a corresponding electric signal, the latter being processed by a checking section and actually compared with a ref-

erence signal corresponding to a predetermined light intensity threshold, which is the minimum limit value for the intensity of the emitted radiation. On the other hand, the power circuit or the control and power electronics are equipped with means for changing the current absorbed by the light signal generating/emitting unit, which means are controlled by said control and power electronics, to simulate current absorption by an incandescent lamp as a function of operation assessments on the light signal generating/emitting unit, which are obtained by measuring the intensity of the light radiation emitted by the LED lamp.

[0012] Thus, when no light radiation is found to be emitted by the LED lamp, or when the latter is below a predetermined minimum intensity threshold, the control electronics control the means for changing the intensity of current absorbed by the light signal generating/emitting unit so that the current intensity absorbed in the power circuit and detected by the amperometric means in said remote central control unit is lower than a predetermined threshold value. Such threshold value corresponds to the minimum current value acceptable for the light signal generating/emitting unit to be deemed as properly operating, in terms of emitted light radiation. Following this state, the control means generally located in the remote cabin, which generate the signal for controlling the light signaling device to be powered and turned on, generate a check signal to indicate failed or wrong operation of the light signaling device, which is transmitted to the interlocking unit, to start safety operations that set the railway line in response to the established danger state. The type of action to be made to set the railway line to safety mode depends on the particular situation and is accurately coded in the operating rules for the railway system and the railway network, to minimize or eliminate the danger of accidents.

[0013] It shall be understood that the above construction has been designed to meet the requirement of replacing incandescent lamps with LED lamps in existing light signaling devices, without requiring any upgrade or change of the units designed to control the lamps on and off, and to power and functionally check such lamps. Therefore, as mentioned above, since functional checks have traditionally been of amperometric type, then any functional check substantially based on detection of actual emission of a light radiation by the lamp causes the generation of a check signal whose current intensity corresponds to the detected light radiation emission state and simulates the current intensities typically absorbed during operation of incandescent lamps.

[0014] While this arrangement operates properly, a failsafe state for SIL 4 level is difficultly reached, although this is required in railway traffic control and particularly for this type of light signaling devices.

[0015] Particularly, in prior art light signaling devices and particularly in prior art light signal generating/emitting units that operate with LED lamps, the current intensity that simulates the current that a properly operating in-

candescent lamp would have absorbed, which is used to power the amperometric check means located in the remote control and power cabin of the light signaling device, is set by inserting a ballast resistor in the power circuit, in parallel connection with the load consisting of the LED lamp and the power circuit thereof, which resistor causes absorption of the current required to simulate the proper operation state of the incandescent lamp in the power circuit.

[0016] Such ballast resistor is disconnected when light emission is insufficient, i.e. below the threshold that is considered as the lower limit for proper operation of the LED lamp.

[0017] Nevertheless, the use of a ballast resistor connected in parallel with the load of the LED lamp in the power circuit is no sufficient guarantee of safe detection of the LED lamp's functional status. Any failure in the electronic control and power circuit of the LED that generates conditions electrically comparable to those of the insertion of a ballast resistor in parallel with the LED lamp load may simulate the insertion of the ballast resistor even when the operating conditions of the lamp would not allow that. Such condition often occurs due to the failure of only one of the components of the control and power circuit of the LED lamp, whereby this prior art solution does not meet the SIL 4 safety requirements.

[0018] The object of the invention is to provide a light signaling device as described hereinbefore, that allows the use of LED-type lamps or light radiation emitting sources in combination with the use of both traditional existing remote light signal feeding units and amperometric-type checking units for checking the operating conditions of said light signal, and also provides the high operational safety levels required in this type of light signaling systems for railway traffic control.

[0019] The invention has further object that will appear more clearly hereinafter.

[0020] The invention achieves the above objects by providing a device as described hereinbefore, in which:

said control and power signal acts both as an actuating control signal and as a power supply signal for said light signal generating/emitting unit;

the means for changing the current absorbed by the light signal generating/emitting unit consist of a limiting resistor that can be series-connected alternatively with a bypass line at the input of said light signal generating/emitting unit, to the control and power signal feeding line and to the light signal generating/emitting unit;

said resistor being of such a size as to limit the intensity of the current absorbed by said generating/emitting unit to a value below the minimum threshold value corresponding to the one at which the light signal generating/emitting unit is deemed to operate properly;

switch means being provided for switching the state of alternate series-connection of the by-pass line and

said limiting resistor to the input of the light signal generating/emitting unit, which means are controlled according to the signal of detection of the light emission generated by the light radiation emitting source detected by the control and power electronics; and power accumulation and temporary power supply means being provided, which are actuated for a predetermined time for temporary power supply to the control and power electronics while the limiting resistor is inserted in series with the input of the light signal generating/emitting unit.

[0021] Due to the above feature and as better explained below, the provision of the limiting resistor in series between the control and power signal feeding line and the input of the light signal generating/emitting unit obviates the drawback that, in case of malfunctioning of any component of said light signal generating/emitting unit, an absorption current for said unit is generated, which exceeds the current threshold value whereby, although the light signal generating/emitting unit operates improperly, proper operation is simulated, and the feedback to the control unit is a check signal indicating a proper operation status.

[0022] The arrangement suggested by the present invention is not trivial at all, because power signal also acts as a control signal. Upon transmission of a start-up control to the control signal generating/emitting unit, the latter is completely disabled and unpowered, also concerning the control electronics. Therefore, safety considerations typically require the disabled unit functional status to correspond to the condition in which the limiting resistor is inserted in series at the input of the light signal generating/emitting unit.

[0023] This requires pre-charging of an electric energy accumulator to supply the control electronics with the power required for its actuation and for performing procedures for initiation of programmable components, such as the bootload of microprocessors or other electronic and control sections of the switches that directly connect the power line to the input by means of the bypass, and disconnect the limiting resistor.

[0024] Once the control and power electronic unit has been temporarily enabled and has disconnected the limiting resistor, the full power of the power control signal will be available to the light signal generating/emitting unit, and the checking step by absorption current simulation will be started under the control of the control and power unit, essentially based on the measurement of the light radiation actually emitted by the light radiation emitting source, i.e. the LED lamp.

[0025] According to an improvement of the invention, the power accumulation and temporary power supply means of the control and power unit consist of capacitive means having such a size as to accumulate and release a signal whose voltage and power are sufficient to power for a predetermined time the control electronics and the switch means for switching the state of alternate series-

connection of the by-pass line and said limiting resistor to the input of the light signal generating/emitting unit, which means, as start-up is completed, are controlled by the control electronics according to the correctness of the signal of detection of the light emission generated by the corresponding source.

[0026] Said predetermined time for power supply to the control electronics and the switch means for switching the state of alternate series-connection of the by-pass line and said limiting resistor to the input of the light signal generating/emitting unit is equal to or longer than the time required for steady-state actuation of the control and checking electronics and for the switch means to assume the switch state in which the input of the light signal generating/emitting unit is directly connected by the by-pass to the power line.

[0027] According to a further feature, in order to allow proper operation during signal flashing and hence to prevent power failure to the control and power electronics while the light radiation emitting source is off, second power accumulation and temporary power supply units are provided in the control and power unit, which have such a size that temporary power supply occurs during a second predetermined time, substantially corresponding to the time during which the light source is off during the flashing cycle.

[0028] According to yet another improvement, in combination with the limiting resistor adapted to be inserted and disconnected in series with the power input of the light signal generating/emitting unit, second means for changing the absorption current of the light signal generating/emitting unit are provided, which consist of a ballast resistor adapted to be inserted and disconnected in the power circuit in parallel with the load of the light signal generating/emitting unit, by switch means controlled by the control and power electronics.

[0029] The control for insertion of said ballast resistor in parallel with the load of the light radiation emitting source occurs upon control for bypassing the limiting resistor in series with the input of the signal generating/emitting unit.

[0030] According to yet another feature, which affords more reliable signaling of a wrong operating condition of the light signal generating/emitting unit, particularly the light radiation emitting source, said unit has means for irreversibly preventing power supply to said light signal generating/emitting unit and particularly the control electronics, which means can be actuated by the control electronics itself.

[0031] Said means consist of a fuse in the power line of the control and power electronics and a switch for connecting said fuse upon short circuit of the control and power signal to generate a current of such level as to burn said fuse out.

[0032] Said switch means are designed to be controlled by the control and power electronics according to the input signal to said control and power electronics, which is provided at least by the optoelectronic sensor that

measures the light radiation actually emitted by the light radiation emitting source, i.e. the LED lamp.

[0033] Due to the above arrangements, whenever undue flashing of the light radiation emitting source, i.e. the LED lamp, is detected, or whenever all the tests on the relays and the fuse are unsuccessful, or in case of mismatch of the two microcontrollers on the values of certain vital parameters, at first the control and power electronics switches off all the power circuits and then, before controlling the means for inserting the limiting resistor at the input, it controls the means that short circuit the control signal, to cause fuse interruption and permanent lack of power supply to the control electronics. As a result, the control and power electronics no longer supplies the control signal to the switches which maintain the limiting resistor disconnected in series with the input of the signal generating/emitting unit, whereby the current absorbed by said unit drops below the current intensity threshold value above which the light signal generating/emitting unit is deemed to be properly operating.

[0034] Since power is no longer supplied to the control and power electronics and the power of the control and power signal is considerably reduced due to series-insertion of the limiting resistor, the power signal to the light radiation emitting source is also strongly attenuated in a safe manner, whereby the possibility will be safely avoided that a current signal having such an intensity as to wrongly simulate proper operation might be detected in the remote control unit by the amperometric means thereof.

[0035] Further functional details will appear more clearly from the following detailed description of one embodiment.

[0036] In terms of construction and components, the switches for inserting/disconnecting the limiting resistor consist of the switch contacts of at least one force guided relay.

[0037] According to a preferred embodiment, two controllable switches may be provided to control series-insertion and disconnection of the limiting resistor at the input of the light signal generating/emitting unit.

[0038] These two controllable switches may consist of the switch contacts of two different relays, each of such relays being connected to a control output of the control and power electronics.

[0039] In a preferred embodiment, two jumpers for bypassing the limiting resistor are provided, which are connected in parallel with each other and with said resistor and are closed or opened each by at least one switch contact of a different relay.

[0040] According to another improvement, two bypass jumpers for the limiting resistor are provided, each being connected in parallel with the other and both in parallel with the limiting resistor, whereas four different relays are provided, the switch contacts of two relays being series-connected in one by-pass jumper, and the contacts of the other two relays being series-connected in the second by-pass jumper.

[0041] Each of said relays being controlled by an output of the control and power electronics.

[0042] The control and power electronics further has a control section with a 2oo2 architecture, which has two control microprocessors with control software loaded in each of them, for parallel performance of control processes, each microprocessor having power accumulation and temporary power supply means connected thereto, and the signal corresponding to the light radiation detected by the optoelectronic sensors, and said microprocessors having each at least one control output for switching at least one relay.

[0043] Referring to the embodiment in which four relays are provided, each microprocessor has at least two control outputs for energizing one relay, each being connected with one of the four relays.

[0044] According to yet another improvement, the relays are of the force guided type and are so designed that the switch contacts in the by-pass lines of the four relays are normally open when the relays are not energized.

[0045] Concerning the ballast resistor, it is inserted in parallel with the load of the light radiation emitting source by means of further switch contacts of at least two of the four relays that control the bypass lines of the limiting resistor to close or open, said contacts of said two relays being connected in parallel with each other and having a reversed closed-open configurations as compared with the switch contacts in the bypass jumpers of the limiting resistor.

[0046] According to a further feature of the invention, the light signal generating/emitting unit has means for actuating the transmission of the functional status thereof (concerning light signal emission) to trains, which means consist of switches adapted to be controlled by the control and power electronics and particularly by the control section thereof, and which switches consist of further switch contacts of the four relays, which are designed to open and close the bypasses of the limiting resistor.

[0047] When these relays are of force guided type, the switch contacts for controlling actuation of transmission of the operating status of the light signal generating/emitting unit to trains are of the type whose operation matches that of the switch contacts in the bypasses of the limiting resistors.

[0048] According to a further improvement, the light signal generating/emitting unit has means for calibrating the supply current required for the intensity of the light radiation emitted by the emitting source to be as desired, and for detecting the parameters of the corresponding electric signal generated by the optoelectronic sensor, which calibrating means include means for changing the supply current and external means for measuring the light flux being generated, and further includes, in the control and power electronics, means for storage of the supply current for the light radiation emitting source that corresponds to the desired brightness and parameters of the signal for measurement of the brightness of the light ra-

diation signal emitted by the emitting source.

[0049] According to a further feature, in order to adapt the supply current for the light radiation emitting source and the parameters of the signal for measurement of the brightness emitted by said source, which are generated by the optoelectronic sensor, without changing preliminary calibration data, a supply current adaptation section is provided, which includes at least one programmable resistor, an auxiliary variable duty-cycle fixed period square wave generator, said square wave generator being connected with the light radiation emitting source during a half-period of the duty-cycle of the square wave generator, the supply current supplied to the light radiation emitting source being changed due to the variation of the duty-cycle of the square wave generator, whereas the parameters of the emitted light radiation measuring signal generated by the optoelectronic sensor are compared with the theoretical parameters stored in the control and power electronics and are automatically changed by operating on said sensor when they are different from the reference parameters stored in the control and power electronics.

[0050] With this feature, no action is required on the light signal generating/emitting unit to set a power signal having a preset current adapted to the light radiation emitting source that is installed from time to time in the signaling device. This will avoid the need to change the preliminary settings to ensure consistent light fluxes even in case of replacement of the light radiation emitting source.

[0051] This feature is even more important when the light signaling device has a light signal generating/emitting unit divided into two subunits, one of which is placed in a separate case mounted to the mechanical signal-supporting structure and comprising the control and power electronics with the limiting resistor, the bypasses and the switch means for insertion/disconnection thereof, the accumulation and temporary power supply means, the fuse and the means for short-circuit connection thereof, the ballast resistor and the switches for insertion/disconnection said ballast resistor in the circuit, the power signal generating section for powering the light radiation emitting source and possibly the switches for actuating the transmission of the operating status of the signaling device to trains, whereas the other subunit comprises the light radiation emitting source, the optoelectronic sensors, possibly the temperature sensors and the section for adaptation of the supply current for the light radiation emitting source, said second subunit being designed to be mounted in the lamp holder, i.e. the so-called hood, said two subunits being connected together by a multipolar cable comprising the lines for transmission of the power signal from the first subunit to the second subunit and the lines for transmission of the signal for measuring the emitted light radiation and the temperature from the second subunit to the first subunit.

[0052] The invention also relates to further improvements, which form the subject of the dependent claims.

[0053] The features of the invention as disclosed

above, as well as further features and the advantages derived therefrom will appear more clearly from the following description of a few non limiting embodiments as shown in the accompanying drawings, in which:

Figure 1 is a general diagram of a light signaling device of the present invention.

Figure 2 is a block diagram of a light signal generating/emitting unit of the present invention.

Figure 3 is a block diagram of a variant embodiment of the light signal generating/emitting unit.

Figure 4 is a more detailed wiring diagram of a the embodiment of the light signal generating/emitting unit of Figure 3.

Figure 5 is a chart of the start-up procedure for the light signal generating/emitting unit of the present invention, and particularly as shown in Fig. 4.

Figure 6 shows the generating/emitting unit as it is installed along the railway line.

Figure 1 shows a general light signaling device, whose basic structure also applies to the device of the present invention.

[0054] These devices include remote cabins, containing control and power units, and at least one light signal, such as a semaphore or the like, which is installed next to the track of a railway line.

[0055] The power signal for a light signal generating/emitting unit (said semaphore or the like), designated by numeral 300 is generated in a remote cabin. The feeding line 200 is connected via a transformer 201 and a protection fuse 1 to the input of the light signal generating/emitting unit 300. The latter includes control and power electronics 301 and a light radiation emitting source 302, namely a semiconductor lamp also known as LED lamp. The light signal generating/emitting unit 300 also has a section for transmitting information about the operating state thereof to the trains, which is designated by numeral 303 and is known in the railway field as INDUSI.

[0056] The remote cabin 100 contains a current transformer 101 which supplies power to a relay 102. The relay 102 is controlled to set a switch status of its contacts according to the current that circulates in the power line 200, which matches the current absorbed by the light signal generating/emitting unit 300. The switch status of the contacts of the relay 102 corresponds to an indication of proper operation or improper operation of the light signal generating/emitting unit 300, which is transmitted to a central control unit, not shown in detail, that manages the railway traffic and also the remote cabin.

[0057] It will be understood that multiple remote cabins are provided in a railway network, each controlling multiple light signal generating/emitting units, i.e. multiple semaphores disposed along the railway line, for which the remote cabin has dedicated control and power means, as well as dedicated means for detection of the supply current absorbed by the corresponding light signal generating/emitting unit, which means are also known

as amperometric means for detection of proper operation of the light signal generating/emitting unit.

[0058] As mentioned above, proper operation of the light signal generating/emitting unit, namely the light radiation emitting source 302, which is a LED lamp in the present example, is indicated by the presence of a given current intensity in the power line. This condition is imposed because incandescent lamps were traditionally used, whereby failed emission of the light signal (failed start-up) was unequivocally caused by a drop, i.e. dramatic reduction of the supply current. Any filament break causes the lamp to operate as a fuse, with no supply current being absorbed, as the power circuit is open.

[0059] The block diagram of Figure 2 shows a general construction of a light signal generating/emitting unit of the present invention. In addition to the provision of the control electronics 301 and the lamp 302 as well as the network for interface with the INDUSI system 303, the circuit has a limiting resistor 304 at its input, which is series-connected to the power line and to the input of the light signal generating/emitting unit.

[0060] One signal acts both as an start-up control signal and as a power signal for powering said light signal generating/emitting unit. This signal is transmitted to a temporary power supply unit of the control electronics, which is designated by numeral 305. It is connected to the control electronics 301 via a fuse 2. A power signal generating section 307, here of the PWM type, is controlled by the control electronics 301, in that the latter controls both said section 307 and a switch 308 that connects said section 307 to the input power signal. The LED lamp 302 is connected to said section 307. A ballast resistor 309 is designed to be inserted in parallel with the power signal generating section 307 for powering the lamp 302, by a control from the control electronics 301. The fuse 2 for interrupting power to the control electronics is designed to be controlled thereby in its actuation. At least one bypass jumper 310 is provided in parallel with the limiting resistor 304, which is normally open and is closed by a control from the control electronics 301. The control electronics 301 also has the INDUSI section 303 connected thereto.

[0061] Proper operation of the LED lamp 302 is detected by a section for optical detection of the intensity of the emitted light radiation, which is designated by numeral 311.

[0062] Unlike prior art power signal generating/emitting units, in the present invention the intensity of the current absorbed by said unit is changed by series-connection of the limiting resistor 304 at the input of the light signal generating/emitting unit. This obviously involves advantages, in that it is highly unlikely that any failure in components of the light signal generating/emitting unit will cause the current absorbed by said unit to stay at the same level as that absorbed in case of proper operation of said unit, even when malfunctioning actually occurs, and hence current should be reduced below a predetermined threshold value corresponding to a malfunctioning

status.

[0063] On the other hand, during initiation of the light signal generating/emitting unit upon start-up, the limiting resistor 304 prevents the light signal generating/emitting unit from immediately having the required signal power available, whereby power accumulation and provisional, i.e. temporary power supply means 305 are required, which provide the power required for operation at least of the control electronics 301 and a few relevant members, namely the means for closing/opening the bypass jumper 310, for at least a given predetermined time. Said power accumulation and temporary power supply means 305 provide energy for actuation and initiation of the control electronics 301 and for the bypass jumper closing control. Under these conditions, the resistor 304 is bypassed and the control and power signal is available in its full power at the input of the light signal generating/emitting unit.

[0064] Then, the control electronics 301 controls the signaling means 303 that send information to the train, the static switch 308 for connection of the power signal generating section 307, the means 302 for insertion of the ballast resistor 309 in parallel with the LED lamp load 302. Therefore, the LED lamp 302 is powered, whereas the sensors 311 for LED lamp functional checking and particularly the optoelectronic brightness sensor, and possibly the temperature sensor provide their signals to the control electronics 301.

[0065] In case of malfunctioning of the LED lamp 302, no signal is transmitted by the sensors 311 for LED functional checking, and the control electronics 301 controls the fuse 2 to prevent power supply, disconnect the ballast resistor 309, insert the limiting resistor 304, disable the signaling section 303 that sends information to the train, and possibly set the switch 308 to disable connection of the power signal generating section 307 with the power line.

[0066] Thus, the current absorbed by the light signal generating/emitting unit is reduced below the threshold value that discriminates between the proper and wrong operating conditions, and is detected by the amperometric sensors in the remote control unit (transformer 101 and relay 102).

[0067] Figure 3 shows a variant embodiment of the light signal generating/emitting unit of Figure 2. In this case, the limiting resistor and the bypass means, as well as the control means are indicated by the blocks designated as protection, with numeral 304. The power accumulation and temporary power supply means 305 are designated as input, whereas the switch 308 is indicated by the functional block designated as control consent and the control of the power signal generating section 307 is indicated by the functional block 312 designated as power consent. The section 307 is known as "optical unit power supply", whereas the functional checking sensors 311 are shown to be divided into temperature check and optical check. The control electronics 301 comprises a functional part, designated as protection, the power sup-

ply and power consent part and the logical control part, said parts being designated by 301a, 301b, 301c, 301d respectively.

[0068] Figure 4 shows the construction of the light signal generating/emitting unit of Figure 3 in greater detail.

[0069] When a sine, pulsed or continuous signal is at the input, the capacitor C1 may charge through Rlim to about the peak value of the input signal, rectified by the Graetz bridge, in case of AC voltage. A circuit, not shown, maintains the DC/DC converters 7 and 10 disabled, to prevent absorption by the electronics in this step. Furthermore, the static switch 1 stops the charge of the capacitor of the low-pass filter contained in the block 3 and all the other devices connected to the input circuit are disabled. Therefore, since the forced guide relays K1, K2, K3 and K4 are low, the only current that circulates at the start is the charge current C1. When the voltage thereat exceeds a given threshold, which is not lower than 80-85% the steady-state value in case of minimum operating voltage, and does not decrease once it has been exceeded (hysteresis comparator), the converters 7 and 10 are enabled and the two μ Cs (6 and 11) receive the power voltages, i.e. 5V and 3.3V respectively. After the bootload, once the rereading contacts have confirmed that the relays K1, K2, K3 and K4 are actually low, the μ C1 controls the amplifier 18 with a square wave having a frequency of, for instance, 20kHz, to energize the relay K1 only, and the same is done by μ C2 with the amplifier 16 and the relay K2. After about 25 ms, the relays K1 and K2 establish the high contacts, and the limiting resistor at the input, which prevents current from rising above the safety limit value imposed by the cabin control circuit, is short circuited. Thus, the capacitor C1, which partially discharged into the electronics and into the relays K1 and K2, starts to charge again.

[0070] At the same time, C2 starts charging, which allows the power voltages of the electronics and the relays to be also maintained during the OFF half-periods of the flashing state if the light signal generating/emitting unit is actuated in flashing mode.

[0071] The time after which the shutdown of the converters 7 and 10 is removed, which may be assumed to be of the order of 200 ms, depends on the value of C1, which cannot be lower than a given value, so that during the discharge transient, mainly caused by the sum of the bootload time and the delay at relay energization, voltage ad C1 is prevented from falling below the voltage that allows the converters 7 and 10 to generate proper power supply voltages.

[0072] As a rule, shutdown removal should occur with as little a delay as possible, especially when a first OFF half-period of the flashing state may start after a 0.5 interval from the start of the control. In order to minimize such delay, the electronics must initially absorb as little power as possible, and the relays must consume as little as possible.

[0073] At this stage μ C2 6 controls the static switch 1 and allows the capacitor in the low-pass filter 3 to charge.

Meanwhile both μ C 6, 11 use the squaring circuits contained in block 5 to read the frequency of the input signal, in case of an AC control, and if such frequency falls within the admitted range (considering that voltage may or may not be present at the input ports actuated by an external jumper to be inserted in case of a frequency other than 50 Hz, e.g. 75 Hz), the μ C1 11 transmits two 180° phase shifted PWM signals to the amplifier 4. The variable duty-cycle, which allows current stabilization in the LED lamp 27, is fixed to a value that is a function of the rectified input voltage and temperature. Thus, the lamp turns on and the output current of the amplifier 4, which is proportional to the current that circulates in the LED, is reread by both μ C 6, 11.

[0074] The light flux is checked by a circuit section composed of the blocks 25, 28, 31 and 32. If such flux and the delivered current fall within the admitted ranges, the relays K1 and K2 are kept in an energized state and the μ Cs 6, 11 actuate the relay K3 through the blocks 20 and 21, and the relay K4 through the blocks 14 and 15. The relays K3 and K4 allow the external repetition system known as Indusi to be enabled onboard, i.e. on the train, and cause the actuation of the linear current generator 2, which powers the ballast load Rz and is controlled by a PWM generator or by a D/A converter, placed inside the μ C1 11. The load Rz conveniently increases the absorbed current, thereby allowing the amperometric control circuit, located in the station or at the cabin, i.e. the remote control unit 100, to energize the corresponding relay 102.

[0075] Figure 5 is a chart that shows the succession of the above described steps for initiation of the light signal generating/emitting unit.

[0076] The relays K3 and K4 are energized as a last step of the start-up process. Then, the operation logic is reversed, which means that, while the relays K1 and K2 are initially energized by the μ Cs 6, 11, when no brightness check signal is generated by the sensor 28 and the electronics associated therewith, after start-up these relays remain in the energized state as long as the light flux and the current emitted by the amplifier 4 fall within the predetermined range, which can change as a function of input voltage.

[0077] The input voltage may fall within two ranges, which define the "Day" operation (higher range, centered at 15 VAC or 12 Vm, providing a constant value of about 700 mA in the lamp) or the "Night" operation (lower range, centered at 12VAC or 9.5 Vm, with the lamp current being about 350 mA).

[0078] Therefore, the light signal generating/emitting unit has an open loop operation, with the lack of a brightness check causing permanent removal of the control.

[0079] If there are no proper operating conditions, i.e. if the signal provided to the microprocessor 11 by temperature and brightness sensors is insufficient, before setting K1 and K2 to a de-energized state, the μ Cs 6, 11, disable the power circuits and simultaneously transmit a 1 sec. pulse to the block 8, which acts as a MOSFET

switch, and is designed to considerably decrease the impedance of the circuit downstream from the fuse 2, to cause its actuation. This will permanently interrupt power supply to the electronics, and will not allow restoration thereof from the outside.

[0080] Immediately after, the relays K1 and K2 will be de-energized and the input limiting resistor Rlim 304 will be inserted.

[0081] It shall be noted that under these conditions (presence of the control and off signal) an improper check might be made in the cabin, i.e. there might be current absorption comparable to the one that would be found in case of proper operation of the light signal generating/emitting unit, if three or four failures occurred. Two of these failures always consist in undue energizing of the relays K1 and K2 or K3 and K4, which might be caused by deterioration of these relays, i.e. by mechanical reasons only, the third failure requires a loss resistance of a diode of the Graetz bridge at the input, or of the capacitors C1 and/or C2. The critical area of the three failures is limited to a few (six or seven) elements.

[0082] Considering the power section, at least two failures should occur therein: a loss at the series-connected switch 1 or a parallel loss in the filter 3 or the amplifier 4. Of course, these losses should be of such a level as to cause a current absorption that could actuate the amperometric relay 102 of the cabin, i.e. the remote control unit 100.

[0083] The most problematic safety situation occurs in the control step, after a relatively long off time, if the electronics cannot be started up for some reason, and hence is unable to monitor the system. During the off time, no check could be made due to the lack of any power supply, and unsafe failures might have occurred. The above considerations also apply to this situation, if the current that causes the fuse 2 to be triggered, e.g. within 0.5 sec is of such level as to still prevent the acquisition of an undue check (assuming a lamp failure), when the relays K1 and K2 or K3 and K4 are both abnormally energized. By this arrangement, a third relevant failure (parallel loss) can be prevented from occurring in the control electronics section. This is possible because the fuse 2 is not inserted in the power circuit, unlike the fuse 1 that only has a protective function and no safety task. For instance, if the trigger current for the fuse 2 does not exceed 700 mA, the check at the cabin should be acquired with at least 1 A input current at the light signal generating/emitting unit, at which the fuse trigger time drops definitely below the amperometric relay energizing time.

[0084] In normal operation, the ballast load 309 would increase such current, e.g. to 1.2 A, and hence, assuming for instance an AC control in "Day" operation and an effective input voltage of about 15 eff V, a nominal power absorption of about 18 W would be obtained, which is still acceptable, considering the constrictions and precautions required to improve the safety of the apparatus.

[0085] With no ballast load 309, which also decreases the distortion rate of the absorbed current, such power

might be considerably lower and not exceed 10 W.

[0086] As K1 and K2 are energized, if there is no failure in the electronics, the ballast load allows no check acquisition at the cabin, in case of lamp failure. In these conditions, as the relays are energized, should a parallel loss (e.g. at C1, C2 or in the block 3) occur, that might raise the current above the limit value for the acquisition of amperometric checks, a transient would occur, whose duration depends on the overall response time of the power/brightness check connection, during which said current stresses the control relay. If the energizing time thereof is shorter than the transient, a short initial undue control pulse would occur.

[0087] In view of the above considerations, from the safety point of view the ballast load 309 shall be deemed to have an auxiliary, not decisive function, unlike prior art devices, in which no input limiting resistor 304 is provided. Furthermore, these prior art devices require a differential detector in the cabin, i.e. the remote control unit 100, for measuring the delivered current, which detector only actuates its output if said current falls within a range from a maximum value to a minimum value. This will prevent any parallel loss in the electronics from going undetected, with the lamp controlled, and thus from masking the disconnection of the ballast load in case of lamp failure. A grey zone still remains from the safety point of view, if the lamp has a failure (e.g. if it absorbs power without emitting light) and the parallel loss is already present.

[0088] It shall be noted that the block 3 is a LC-type low-pass filter, which has the task of filtering out the audiofrequency harmonics generated by the amplifier 4 and decreasing the distortion rate of the input current (under AC control), which distortion is actually only caused by the electronics of the μ Cs 6, 11, whose maximum absorption is slightly higher than 2 W.

[0089] An amperometric transformer is provided downstream from the amplifier 4, the latter generating a pulsed signal +/- that can be transmitted through the transformer 22, a galvanic insulation being required in this location. The current cannot be read upstream from the filter 3 by a pull-down resistor, because no accurate detection of the level of transient pulses, whose duration is shorter than the half-period of the supply voltage, would be possible.

[0090] The broken line L1 on the right side of the block diagram indicates that the light signal generating/emitting unit is generally composed of two subunits, the first whereof is located in a pole-mounted box, designated by U1 in Figure 6, and the second, designated by U2 and containing the blocks located on the right of the line L1, is located in the hood 50 of the signal 51 which is itself mounted to the pole 52. This division may be imposed both by space requirements in the hood and by heat problems, in that the ballast load 309 contributes in increasing the temperature of the assembly, whereby it should be maintained apart from the LED lamp 302, to extend its life.

[0091] The two subunits U1, U2 of the light signal generating/emitting unit are connected together by a four-

wire cable 53. Two of such wires are for "forth" transmission and carry the PWM power signal adapted for controlling the lamp and for supplying power to the electronics of the hood, and the other two are for "back" transmission, and carry a low power analog signal, which contains (vital) brightness information and (non vital) temperature information.

[0092] The block 22 is an audiofrequency transformer which adapts the output voltage to the loads, the block 23 is a dual half-wave rectifier directly connected to the block 24 and connected to the blocks 25, 28, 30 and 31 with the interposition of a stabilizer. The block 24 is a low-pass filter, which determines the mean value of the variable duty-cycle pulsed signal at its input and also allows reduction of the power signal harmonics, as the two wires of the cable may be considered as an antenna having a maximum length of the order of about ten meters.

[0093] The outputs of the temperature sensors 26 and the brightness sensors 28 are continuous signals, the former being directly transmitted to the cable 53 via the low-pass filter 29, which prevents back transmission of the signal from the block 32, whereas the later is the modulating signal of an amplitude modulator 31, whose carried may be generated by dividing (block 25) the frequency of the power signal by two, which is stable against any change of temperature and HW components.

[0094] The modulated signal is transmitted to the cable 53 via the high-pass filter 32, which filters out the CC component that comes from the block 29. The temperature dependent CC voltage is received by the high-pass filter 12 and transmitted to the A/D converters inside the μ Cs 6, 11, whereas the brightness dependent AC voltage is received through the pass band filter 13 and transmitted to the same converters, which are tested through reading of a known voltage generated by the block 9.

[0095] The μ Cs set the controls of the power section, the relays and the block 8 and control the three basic parameters: input voltage (amplitude and frequency), lamp brightness and current delivered to the load, and further carry out the following steps:

The periodically control K1, K2, K3 and K4 to a de-energized state to continuously test the ability of the four relays to assume a restrictive state, to ensure safe operation of the light signal generating/emitting unit.

[0096] Once the relays have been controlled to the de-energized state, each μ C waits for a re-reading contact to establish with low relays, and for a 1 to occur at the input of the corresponding port, which immediately actuates a re-energizing control.

[0097] Once a force guided relay has been de-energized it requires not less than 25 ms to establish contacts in the opposite position, and during such time the absorbed current would drop to very low values due to the lack of the shunt of the Rlim 304, if a further series of two contacts, actuated by the relays K3 and K4 were not in-

serted in parallel with the series of the contacts of K1 and K2.

[0098] A similar arrangement, i.e. a series of two parallels, has to be provided at the interface with the Indusi system. By testing the four relays at different times, no discontinuity will be caused in current absorption and in the connection with the Indusi 303.

[0099] The presence of the relay K4 is required by the need of preventing periodic circuit interruptions in the Indusi 303. An application that requires no interface with the Indusi would require three relays only, as well as a change in the configuration of the contacts in parallel with Rlim 304 and an arrangement required by functional safety reasons, in which both μ Cs 6, 11 would enable the relay K3 to be energized.

[0100] Once the re-reading test has been completed, the relay shall also be re-energized, even when the test has failed, of when a failure has occurred in the meantime that caused a loss of amperometric control. High relays are required to trigger the fuse 2 and permanently shut down the control electronics.

[0101] Concerning the relay testing time, assuming a limit of 5×10^5 switching events under load in 20 years with the lamp always on, each relay must be de-energized once every 20 min. Therefore, a switching event would be controlled every 5 minutes. Since the test cycle extends for a relatively long time, alternate control of the amplifiers 14, 16, 18 and 20 is preferred, so that any short circuit at the static switches cannot keep the relay in the energized state. Furthermore, the use of small transformers in the blocks 15, 17 and 19 allows to raise the voltage at the relay to the required level. This voltage, that requires stabilization, is generally higher than the voltage supplied to the, μ Cs 6, 11, depending on the selected types of relays, which must have special features (long thermal range, low consumption, high vibration resistance, etc.).

[0102] The μ Cs 6, 11 also periodically perform, through the block 8, a test on the breaking current of the fuse 2 and the circuit designed to cause it to trigger, as required. The current test is carried out by raising the current that circulates through the fuse 2 for a very short time (e.g. 0.5 ms) and by checking, by means of an optoisolator circuit, that it never falls, for instance, below twice the nominal current of the fuse (of fast type).

[0103] Static switches, which close the circuit for power supply to the electronics at low impedance, are duplicated for safety, and the re-reading circuit consists of a H bridge having two outputs, each alternately having a 0/1 pulse, slightly delayed with respect to control pulses, if the current check was successful.

[0104] Hardware integrity at block 8 is constantly checked during the control step, nevertheless the effectiveness of the fuse 2 depends on the impedance of the source, on the relays and on the correctness of the software process. In case of lamp failure, while failed removal of the shunt of the Rlim 304 is quite unlikely, as it would involve the occurrence of two simultaneous failures (re-

lays K1 and K2, or K3 and K4 unduly high), failed triggering of the fuse cannot be deemed to be improbable. A hardware failure undetectable to a certain extent (increase of the series resistance of the source upstream from C1 or the fuse itself), or a software error might prevent fuse triggering.

[0105] In addition to the above, the two microprocessors 6, 10 manage the four basic states of the light signal generating/emitting unit, i.e. fixed light and daytime brightness level, fixed light and nighttime brightness level, flashing light and daytime brightness level, flashing light and nighttime brightness level.

[0106] The light intensity is established according to the voltage read downstream from the bridge P1 because, with an AC control, the station delivers 220VAC during the daytime and 180 VAC during the nighttime whereas, with a DC control there are 12 Vm (or 12 VDC) at the input during the daytime and 9.6 Vm (or 9.6 VDC) during the nighttime. The above are nominal values; to avoid any confusion, tolerances cannot exceed +5% and the voltage drop caused by the wayside cable in case of AC control, is still compensated for through the sockets of the lamp transformer. It shall be also considered that the start-up of the light signal generating/emitting unit occurs at no load or with a power absorption not exceeding 1.5 W. Therefore, at steady state, there may be a load effect that can decrease the pulsating voltage by 10-15% at the reading point. This occurs when long cables are used, in case of AC control, and always in case of DC control, in "nighttime operation", for which the input voltage decrease is obtained by resistive drop, and not by imparted voltage change, like in the case of AC control.

[0107] In this case, the light signal generating/emitting unit will be always started with the "Daytime" operation parameters and then, as the input voltage reaches the steady state, these parameters will be either confirmed or changed to "nighttime" operation.

[0108] Concerning the flashing operation, the μ Cs 6, 11 and the relays K1, K2, K3, K4 must be powered for at least 750 ms from the moment in which voltage failure occurs downstream from P1 (as well as all enabling features of the power section), so that the μ Cs 6, 11 may discriminate between the removal of a fixed light control and the start of flashing operation, during which the OFF half-period may last from 500 ms to 700 ms.

[0109] With a flashing light control, the μ Cs 6, 11 shall be continuously powered and shall check the correctness of the parameters of the modulating square wave (frequency and duty-cycle), as well as the synchronism of the ON and OFF states of the voltage that reaches the wayside cable 200 and the similar states of the brightness check signal from the lamp.

[0110] This check both ensures that the lamp is properly flashing in case of ON-OFF control, and reduces the probability, with fixed light being required by the cabin logic, of acceptance of a false control caused by an intermittent failure of the overall circuit (including the power source) upstream from the voltage reading point.

[0111] A protection against undue flashing having a frequency below 0.5 Hz may be easily non vitally implemented, which would cause intermittent power supply to the electronics and the lamp. For this purpose, if control voltage is detected after more than 1s voltage failure, the two μ Cs 6, 11 should simply read the DC voltage downstream from the block 3 and check that it is lower than a given value, e.g. 1VDC. During the OFF stage of the control, the controls of the amplifier 5 are removed, whereby the output capacitor of the low-pass filter cannot release power to the load. Such power may be discharged very slowly on a resistor, so that a delay time may be provided with respect to the control removal time, which is, for instance of the order of 4-5 seconds.

[0112] Finally, the microprocessors 6, 11 provide a dynamic check of the lamp brightness. Such check requires the duty-cycle of the controls of the block 4 to be adjusted, so that a DC current of known and controlled value is caused to circulate in the lamp, which depends on the control mode (D/N) and on the temperature that is measured in the hood. Such current will cause a light flow falling within the range of admitted preset values. The lamp current shall be periodically reduced by a given percentage, which mainly depends on the amplitude of the admitted brightness range, so that it can also decrease, within a time interval not exceeding 3-4 ms, just below the value that brings the light flux to a level slightly lower than the minimum admitted level. Under these conditions, each of the two μ Cs 6, 11 must measure the new current and brightness values and check them against the admitted tolerances, and shall also check switching of the output of the corresponding software comparator, which is vital for maintenance of lamp control and amperimetric control in the cabin. This test particularly checks the dynamic properties of the outputs of the blocks 28 and 31. In addition to the test that checks the efficiency of the light sensor/s, a second test is required, which periodically eliminates, for a time of not more than a few ms, the current in the lamp, to measure the contribution given by outside noise sources, particularly sunlight, which contribution may be subtracted from the overall brightness value as measured by the sensor/s 28.

[0113] The microprocessors 6, 11 will finally perform calibration before start-up and inspection of the apparatus, with the help of an external PC, whose connection link is not indicated in the diagram. Calibration is designed to remove dispersion of the parameters mainly concerning the LED lamp and the light sensors. For this purpose, for instance, the μ C1 might gradually increase the current in the lamp until the latter reaches the nominal brightness value, that is typical of D or N operation, as appropriate. Nevertheless, the light flow shall be detected with the help of an external sample meter, preferably equipped with a logic input (connected to an input of μ C1, outlined by a broken line in the diagram), which is switched as the desired brightness is reached, which desired brightness can be manually set. At this time, increase of current to the lamp is stopped, so that both μ Cs

and/or the external PC may store the value of such current and the brightness value that is measured by the sensor/s of the light signal generating/emitting unit.

[0114] Two different modes may be further used:

In a first mode, the above process has to be repeated at two minimum brightness levels (Daytime/Night-time) admitted for control, so that the μ Cs 6, 11 may acquire the real limits of the range of preset values accepted for the light flux. Thus, each signal hood assembly, which is basically composed of the LED lamp and its control card, is defined by a set of values, that must always be known by the μ Cs in the pole-mounted box. By this arrangement, calibration of the brightness sensor 28 may be avoided, and the dispersion of its response curve values may be accepted.

[0115] Nevertheless, what is done during calibration must be also repeated upon maintenance, during which the values concerning, for instance, a new subunit U2 to be mounted in the hood to replace a broken subunit must be transmitted to the μ Cs 6, 11 via the external PC. Such step can be only ensured (which means that if it is not performed, the light signal generating/emitting unit cannot operate properly) by providing significant changes to the operating properties and a different management of the modulator 31, which should generate a different pattern for each optical assembly and transmit it to the μ Cs (e.g. by FSK).

[0116] A second mode differs from the first mode in that it requires the addition of the hardware block 30. Through a serial line bus I2C) and with the help of digitally programmable resistors, two components are calibrated: an auxiliary variable duty-cycle square wave generator having a fixed period T (where $T = t_1 + t_2$), designated as block 30, and the Light Sense 28. The generator 30 allows the DC current to flow from the output of the block 24 at a known constant value, to the LED lamp, during t_1 , or to a resistor during t_2 . This resistor has a value that corresponds to the sum of the R_{lim} of the lamp and the R_{eq} of the LED/s.

[0117] Thus, adjustment of the duty-cycle of the generated pulse wave and use of the outputs Q and Qn of the oscillator 30 allows the nominal brightness to be reached through a preset value of delivered current, which applies to all the subunits U2 that compose the optical component of the light signal generating/emitting unit.

[0118] Now, the corresponding digital value generated by μ C1 11 is permanently stored in it.

[0119] The nominal brightness shall match a well defined value that comes from the block 12 and the light flux measuring chain. If the acquired value is different from the theoretical value, the programmable element of the block 28 shall be addressed through the I2C bus to correct the error. Therefore, there will be no need to associate a set of parameters with each subunit U2 be-

cause, at least in the Daytime operating state at nominal input, the delivered current, the brightness and the flux measure are uniquely defined.

[0120] It shall be noted that this control may generally be not as accurate as the mode described before, because the lower limits are affected by an error caused by the dispersion of the characteristics of the response curve of the measurement, transmission and filtering chain. Furthermore, while in the first method the lamp brightness cannot increase if current is set to the nominal value, with the second method any change of the duty-cycle of the generator, due to a failure, may increase the light flux by a percentage depending on the dispersion of the emission value, which is at the best of the order of 30% max (+/- 15%). Finally the second method provides an increase of the power absorption by the load to a maximum value up to the 30%.

[0121] When the light source holding structure, known as hood, is of small size, the generating/emitting unit may be mechanically divided into two parts: one of them, namely containing the μ Cs, the relays and the power adjusting PWM amplifier, is designed to be housed in a box connected to the load bearing structure of said signal. Such structure may be a pole or other support means, such as masts, bridge girders or masonry works against which the signal is fixed in its operating position. The other part comprises the LED optical unit, the lamp switch and the brightness sensor, and has such a size and shape as to be received in the hood. The two parts are obviously connected to each other by an electrical communication line, for transmitting and receiving the signals required for operation of the device in at least one of the above modes.

[0122] The device of the present invention is particularly suitable to replace the traditional light sources with LED type optical units. In this case, according to the size of the existing hood, the integral or two-part form, and in the latter case, the second part that comprises, amongst other things, the LED optical unit, is formed of such a shape and size and with such fastening and electrical connection means as to allow it to be mounted in the hood instead of an existing lamp of different type, such as an incandescent lamp.

[0123] According to the existing construction, said second part of the light signal generating/emitting unit or the whole unit may have connection sockets that match those of the incandescent lamp and of any other electric circuits.

[0124] Otherwise, such replacement requires removal of the existing traditional lamp with the electric connector or socket, and replacement of the later with a dedicated connector for the light signal generating/emitting unit.

[0125] It will be appreciated from the above that the skilled person will be allowed any possible structural choice, in response to particular conditions, as suggested by his/her basic technical knowledge.

Claims

1. A light signaling device for railway systems or the like, comprising:

a unit for generating/emitting a light signal, which is provided in combination with:

means for generating/feeding a trigger signal for actuating said signaling device;
 means for checking the functional status of said unit for generating/emitting said light signal, which means measure the intensity of the current absorbed by the light signal generating/emitting when said unit is on;
 said means for functionally checking the light signal generating/emitting unit compare the detected absorbed current value with a predetermined threshold value and control functional status signaling means and/or safety feature control means according to the result of this comparison;
 said light signal generating/emitting unit being equipped with a light radiation source of the type known as LED and control and power electronics;
 said control and power electronics being provided in combination with optoelectronic means for detecting the light signal emitted by the light radiation emitting source (302) and for generating an electric signal corresponding to said detected light radiation, which signal is provided to said control electronics (301);
 said control and power electronics having means for changing the current absorbed by the light signal generating/emitting unit, which current changing means are controlled by said control electronics (301) according to the electric signal corresponding to the light intensity emitted by the light radiation emitting source (302) and generated by said optoelectronic means,

characterized in that

said control and power signal acts both as an actuating control signal and as a power supply signal for said light signal generating/emitting unit;

the means for changing the current absorbed by the light signal generating/emitting unit consist of a limiting resistor (304) that can be series-connected alternatively with a bypass line at the input of said light signal generating/emitting unit, to the control and power signal feeding line and to the light signal generating/emitting unit;
 said resistor being of such a size as to limit the intensity of the current absorbed by said gener-

ating/emitting unit to a value below the minimum threshold value corresponding to the one at which the light signal generating/emitting unit is deemed to operate properly;

switch means being further provided for switching the state of alternate series-connection of the by-pass line and said limiting resistor (304) to the input of the light signal generating/emitting unit, which means are controlled by the control and power electronics according to the signal of detection of the light emission generated by the light radiation emitting source (302);
 and power accumulation and temporary power supply means (305) being provided, which are actuated for a predetermined time for temporary power supply to the control and power electronics while the limiting resistor (304) is inserted in series with the input of the light signal generating/emitting unit (300).

2. A device as claimed in claim 1, **characterized in that** the power accumulation and temporary power supply means (305) of the control and power unit consist of capacitive means having such a size as to accumulate and release a power signal whose voltage and power are sufficient to power for a predetermined time the control electronics (301) and the switch means for switching the state of alternate series-connection of the by-pass line and said limiting resistor (304) to the input of the light signal generating/emitting unit (300), which means, as start-up is completed, are controlled by the control electronics (301) according to the signal of detection of the light emission generated by the light radiation emitting source (302).
3. A device as claimed in claim 1 or 2, **characterized in that** said predetermined time for power supply to the control electronics (301) and the switch means for switching the state of alternate connection of the by-pass line and said limiting resistor (304), in series with the input of the light signal generating/emitting unit (300), is equal to or slightly longer than the time required for steady-state actuation of the control and checking electronics and for the switch means to assume the switch state in which the input of the light signal generating/emitting unit (300) is directly connected by the by-pass to the power line (200).
4. A device as claimed in one or more of the preceding claims, **characterized in that**, in order to allow proper operation during signal flashing and hence to prevent power failure to the control and power electronics while the light radiation emitting source (302) is off, second power accumulation and temporary power supply units (305) are provided in the control and power unit, which have such a size that temporary power supply occurs during a second predetermined

time, substantially corresponding to the time during which the light source is off during the flashing cycle.

5. A device as claimed in one or more of the preceding claims, **characterized in that**, in combination with the limiting resistor (304) adapted to be inserted and disconnected in series with the power input of the light signal generating/emitting unit (300), second means for changing the absorption current of the light signal generating/emitting unit (300) are provided, which consist of a ballast resistor (309) adapted to be inserted and disconnected in the power circuit in parallel with the load of the light signal generating/emitting unit (300), and particularly in parallel with the light signal emitting source, by switch means controlled by the control and power electronics.
6. A device as claimed in claim 5, **characterized in that** the control for insertion of said ballast resistor (309) in parallel with the load of the light radiation emitting source (302) occurs upon control for disconnection of the limiting resistor (304) in series with the input of the signal generating/emitting unit, and particularly in series with the load of the light radiation emitting source (302).
7. A device as claimed in one or more of the preceding claims, **characterized in that** the light signal generating/emitting unit (300) has means for irreversibly preventing power supply to said light signal generating/emitting unit (300) and particularly the control electronics (301), which means can be actuated by the control electronics (301) itself.
8. A device as claimed in claim 7, **characterized in that** said means consist of a fuse (2) in the power line (200) of the control and power electronics (301) and a switch (308) for connecting said fuse (2) upon short circuit of the control and power signal to generate a current of such level as to burn said fuse (2) out.
9. A device as claimed in claim 8, **characterized in that** said switch means are designed to be controlled by the control and power electronics according to the input signal to said control and power electronics, which is provided by the optoelectronic sensor (26, 28) that measures the light radiation actually emitted by the light radiation emitting source, i.e. the LED lamp (302), in case of undue flashing, or according to the signal provided by the relay (102) testing and fuse (2) testing device if such tests are unsuccessful, or finally according to the consistency of the measurements of a few vital parameters, as performed by the two microcontrollers in case of mismatch of the results thereof.
10. A device as claimed in claims 8 and 9, **characterized**

in that it includes fuse (2) testing means that are designed to be periodically actuated for checking the integrity and functionality of the source short-circuiting means, as well as the impedance value of the source, with the purpose of providing a sufficient current to burn the fuse (2) out, when required, whereas if the test has a negative result, particularly if the short-circuit current is insufficient to trigger the fuse (2), means are provided for interdicting relay (102) control by the μ Cs, which cause the insertion of the limiting resistor (304), and hence allow detection of failures concerning the fuse (2) control hardware section.

11. A device as claimed in one or more of the preceding claims, **characterized in that** two by-pass jumpers for the limiting resistor (304) are provided, each being connected in parallel with the other and both in parallel with the limiting resistor (304), whereas four different relays (K1, K2, K3, K4) are provided, the switch contacts of two relays being series-connected in one by-pass jumper, and the contacts of the other two relays being series-connected in the second by-pass jumper, each of said relays being controlled by one output of the control and power electronics.
12. A device as claimed in one or more of the preceding claims, **characterized in that** the control and power electronics has a control section with a 2oo2 architecture, which has two control microprocessors (6, 11) with control software loaded in each of them, for parallel performance of control processes, each microprocessor (6, 11) having power accumulation and temporary power supply means (305) connected thereto, the signal corresponding to the light radiation detected by the optoelectronic sensors, and said microprocessors (6, 11) having each at least one control output for switching at least one relay (102).
13. A device as claimed in claims 11 and 12, **characterized in that** each microprocessor (6, 11) has at least two control outputs for energizing one relay (102), each being connected with one of the four relays (K1, K2, K3, K4).
14. A device as claimed in one or more of the preceding claims, **characterized in that** the relays are of the force guided type and are so designed that the switch contacts in the by-pass lines of the four relays (K1, K2, K3, K4) are normally open when the relays are not energized.
15. A device as claimed in one or more of the preceding claims, **characterized in that** the ballast resistor (309) is inserted in parallel with the load of the light radiation emitting source (302) by means of further switch contacts of at least two of the four relays (K1, K2, K3, K4) that control the bypass lines of the lim-

iting resistor (304) to close or open, said contacts of said two relays being connected in parallel with each other and having a reversed closed-open configurations as compared with the switch contacts in the bypass jumpers (310) of the limiting resistor (304).

16. A device as claimed in one or more of the preceding claims, **characterized in that** the light signal generating/emitting unit (300) has means for actuating the transmission of the functional status thereof, concerning light signal emission, to trains, which means consist of switches adapted to be controlled by the control and power electronics and particularly by the control section thereof, and which switches consist of further switch contacts of the four relays (K1, K2, K3, K4), which are designed to open and close the bypasses of the limiting resistor (304).
17. A device as claimed in one or more of the preceding claims, **characterized in that** each microprocessor has means for controlling the test procedures of the four relays (K1, K2, K3, K4) and controls said relays to open the switch contacts, said four relays (K1, K2, K3, K4) undergoing periodic switching for checking that contacts are not stuck and that they are able to assume a de-energized state.
said switching being actuated in synchronized alternate pairs, so that at least one bypass jumper (310) of the limiting resistor (304) is always held closed, and that both the ballast resistor (309) and the control of actuation of the device section for transmission of the operating state to trains are always held inserted.
18. A device as claimed in one or more of the preceding claims, **characterized in that** each microprocessor (6, 11) performs tests on the brightness control chain, to check both the integrity of the optoelectronic sensor (26, 28) and the chain for amplification/transmission of the electric signal that measures the light flux of the LEDs, and the noise on the control chain that comes from light sources external to the railway signalling unit.
19. A device as claimed in one or more of the preceding claims, **characterized in that** for flashing control management, the μ Cs permanently perform both a check of alignment between the imparted control and the lamp (302) status, and a check of the correctness of the control signal, by measuring the period and duty-cycle of the modulating square wave, having a frequency of 1 to 1.5Hz, whereas if such checks provide a negative result, the logic unit controls power shutdown.
20. A device as claimed in one or more of the preceding claims, **characterized in that** the μ Cs perform an undue flashing check, and switch off the lamp (302) whenever periodic and abnormal interruptions of the

light flux occur, in case of fixed light control.

21. A device as claimed in one or more of the preceding claims, **characterized in that** the light signal generating/emitting unit (300) has means for calibrating the supply current required for the intensity of the light radiation emitted by the emitting source to be as desired, and for detecting the parameters of the corresponding electric signal generated by the optoelectronic sensor, which calibrating means include means for changing the supply current and external means for measuring the light flux being generated, and further includes, in the control and power electronics, means for storage of the supply current for the light radiation emitting source (302) that corresponds to the desired brightness and parameters of the signal for measurement of the brightness of the light radiation signal emitted by the emitting source.
22. A device as claimed in claim 21, **characterized in that** the light signal generating/emitting unit (300) has a supply current adaptation section, which includes at least one programmable resistor, an auxiliary variable duty-cycle fixed period square wave generator (30), said square wave generator (30) being connected with the light radiation emitting source (302) during a half-period of the duty-cycle of the square wave generator (30), the supply current supplied to the light radiation emitting source (302) being changed due to the variation of the duty-cycle of the square wave generator (30), whereas the parameters of the emitted light radiation (311) measuring signal generated by the optoelectronic sensor (26, 28) are calibrated against theoretical parameters, said sensor (26, 28) being acted upon when they are different from the reference parameters stored in the external signal measuring means.
23. A device as claimed in one or more of the preceding claims, **characterized in that** the generating/emitting unit is mechanically divided into two parts: one of them, namely containing the μ Cs, the relays and the power adjusting PWM amplifier, and designed to be housed in a box connected to the load bearing structure of a signal, and the other, particularly containing the LED optical unit, the lamp switch (308) and the brightness sensor, designed to be received in the hood (50) of the signal (51), i.e. in the housing of a traditional lamp (302), said two parts being electrically connected to each other by a communication line.
24. A device as claimed in claim 23, **characterized in that** the part particularly containing the LED optical unit, the lamp switch and the brightness sensor, designed to be received in the hood (50) of the signal is formed of such a shape and size and with such fastening means as to allow it to be mounted in the

signal hood (50) instead of an existing lamp (302) of different type, such as an incandescent lamp (302).

Patentansprüche

1. Lichtsignalisierungsvorrichtung für Eisenbahnsystem oder dergleichen, umfassend:

eine Einheit zum Erzeugen/Emittieren eines Lichtsignals, welche in Kombination vorgesehen ist mit:

Mitteln zum Erzeugen/Zuführen eines Auslösesignals zum Auslösen der Signalisierungsvorrichtung;

Mitteln zum Kontrollieren des Funktionsstatus der Einheit zum Erzeugen/Emittieren des Lichtsignals, wobei die Mittel die Stärke des Stroms messen, der durch die Lichtsignalerzeugung/-emission absorbiert wird, wenn die Einheit eingeschaltet ist;

die Mittel zur Funktionskontrolle der Lichtsignalerzeugungs/-emissionseinheit den Wert des detektierten absorbierten Stroms mit einem vorbestimmten Schwellenwert vergleichen und Funktionsstatussignalisierungsmittel und/oder Sicherheitsmerkmalssteuerungsmittel gemäß dem Ergebnis dieses Vergleichs steuern;

die Lichtsignalerzeugungs/-emissionseinheit mit einer Lichtstrahlungsquelle von dem Typ, der als LED bekannt ist, sowie Steuer- und Leistungselektronik ausgestattet ist;

die Steuer- und Leistungselektronik in Kombination mit optoelektronischen Mitteln zum Detektieren des durch die Lichtstrahlungsemissionsquelle (302) emittierten Lichtsignals und zum Erzeugen eines elektrischen Signals vorgesehen ist, das der detektierten Lichtstrahlung entspricht, wobei das Signal der Steuerelektronik (301) zugeführt wird; die Steuer- und Leistungselektronik Mittel zum Ändern des durch die Lichtsignalerzeugungs/-emissionseinheit absorbierten Stroms aufweist, wobei die Stromänderungsmittel durch die Steuerelektronik (301) gemäß dem elektrischen Signal gesteuert werden, das der durch die Lichtstrahlungsemissionsquelle (302) emittierten Lichtintensität entspricht und durch die optoelektronischen Mittel erzeugt wird,

dadurch gekennzeichnet, dass

das Steuer- und Leistungssignal sowohl als ein Auslösungssteuersignal als auch als ein Leistungsversorgungssignal für die Lichtsignalerzeugungs/-emissionseinheit fun-

giert;

die Mittel zum Ändern des durch die Lichtsignalerzeugungs/-emissionseinheit absorbierten Stroms aus einem Begrenzungswiderstand (304) bestehen, der alternativ mit einer Umgehungsleitung am Eingang der Lichtsignalerzeugungs/-emissionseinheit zur Steuer- und Leistungssignalführung und zur Lichtsignalerzeugungs/-emissionseinheit in Reihe geschaltet werden kann;

der Widerstand von solch einer Größe ist, dass er die Stärke des durch die Erzeugungs-/Emissionseinheit absorbierten Stroms auf einen Wert unter dem Mindestschwellenwert begrenzt, der demjenigen entspricht, bei welchem erachtet wird, dass die Lichtsignalerzeugungs/-emissionseinheit korrekt funktioniert;

ferner Schaltermittel zum Umschalten des Zustands von abwechselnder Reihenschaltung der Umgehungsleitung und des Begrenzungswiderstands (304) zum Eingang der Lichtsignalerzeugungs/-emissionseinheit vorgesehen sind, wobei die Mittel durch die Steuer- und Leistungselektronik gemäß dem Signal der Detektion der durch die Lichtstrahlungsemissionsquelle (302) erzeugten Lichtemission gesteuert werden; und Mittel zur Leistungsspeicherung und temporären Leistungsversorgung (305) vorgesehen sind, welche für eine vorbestimmte Zeit zur temporären Leistungsversorgung der Steuer- und Leistungselektronik ausgelöst werden, während der Begrenzungswiderstand (304) mit dem Eingang der Lichtsignalerzeugungs/-emissionseinheit (300) in Reihe zwischengeschaltet ist.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Mittel zur Leistungsspeicherung und temporären Leistungsversorgung (305) der Steuer- und Leistungseinheit aus kapazitiven Mitteln mit solch einer Größe bestehen, dass sie ein Leistungssignal speichern und freigeben, dessen Spannung und Leistung ausreichen, um die Steuerelektronik (301) und die Schaltermittel zum Umschalten des Zustands von abwechselnder Reihenschaltung der Umgehungsleitung und des Begrenzungswiderstands (304) zum Eingang der Lichtsignalerzeugungs/-emissionseinheit (300) für eine vorbestimmte Zeit zu speisen, wobei die Mittel bei Abschluss des Starts durch die Steuerelektronik (301) gemäß dem Signal der Detektion der durch die Lichtstrahlungsemissionsquelle (302) erzeugten Lichtemission gesteuert werden.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch ge-**

- kennzeichnet, dass** die vorbestimmte Zeit zur Leistungsversorgung der Steuerelektronik (301) und der Schaltermittel zum Umschalten des Zustands von abwechselnder Reihenschaltung der Umgehungsleitung und des Begrenzungswiderstands (304) mit dem Eingang der Lichtsignalerzeugungs-/emissionseinheit (300) gleich wie oder etwas länger als die Zeit ist, die zur stationären Auslösung der Steuer- und Kontrollelektronik und für die Schaltermittel erforderlich ist, um den Schalterzustand anzunehmen, in welchem der Eingang der Lichtsignalerzeugungs-/emissionseinheit (300) durch die Umgehungsleitung direkt mit der Leistungsleitung (200) verbunden wird.
4. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass**, um während des Blinkens des Signals einen korrekten Betrieb zu ermöglichen und infolgedessen Ausfall der Leistung für die Steuer- und Leistungselektronik zu verhindern, während die Lichtstrahlungsemissionsquelle (302) ausgeschaltet ist, zweite Einheiten zur Leistungsspeicherung und temporären Leistungsversorgung (305) in der Steuer- und Leistungseinheit vorgesehen sind, welche solch eine Größe aufweisen, dass eine temporäre Leistungsversorgung während einer zweiten vorbestimmten Zeit stattfindet, die im Wesentlichen der Zeit entspricht, während der die Lichtquelle während des Blinkzyklus ausgeschaltet ist.
5. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** in Kombination mit dem Begrenzungswiderstand (304), der so ausgelegt ist, dass er mit dem Leistungseingang der Lichtsignalerzeugungs-/emissionseinheit (300) in Reihe zwischengeschaltet und davon getrennt wird, zweite Mittel zum Ändern des Absorptionsstroms der Lichtsignalerzeugungs-/emissionseinheit (300) vorgesehen sind, welche aus einem Ballastwiderstand (309) bestehen, der so ausgelegt ist, dass er in der Leistungsschaltung durch Schaltermittel, die durch die Steuer- und Leistungselektronik gesteuert werden, parallel zur Last der Lichtsignalerzeugungs-/emissionseinheit (300) und insbesondere parallel zur Lichtsignalemissionsquelle zwischengeschaltet und davon getrennt wird.
6. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Steuerung zur Parallelzwischenschaltung des Ballastwiderstands (309) zur Last der Lichtstrahlungsemissionsquelle (302) bei Steuerung zur Trennung des Begrenzungswiderstands (304) aus der Reihenschaltung mit dem Eingang der Signalerzeugungs-/emissionseinheit und insbesondere aus der Reihenschaltung mit der Last der Lichtstrahlungsemissionsquelle (302) erfolgt.
7. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Lichtsignalerzeugungs-/emissionseinheit (300) Mittel zum irreversiblen Verhindern der Leistungsversorgung der Lichtsignalerzeugungs-/emissionseinheit (300) und insbesondere der Steuerelektronik (301) aufweist, wobei die Mittel durch die Steuerelektronik (301) selbst ausgelöst werden können.
8. Vorrichtung nach Anspruch 7, **dadurch gekennzeichnet, dass** die Mittel aus einer Sicherung (2) in der Leistungsleitung (200) der Steuer- und Leistungselektronik (301) und einem Schalter (308) zum Verbinden der Sicherung (3) bei Kurzschluss des Steuer- und Leistungssignals bestehen, um einen Strom solch eines Pegels zu erzeugen, dass die Sicherung (2) durchbrennt.
9. Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** die Schaltermittel so konzipiert sind, dass sie durch Steuer- und Leistungselektronik gemäß dem Eingangssignal in die Steuer- und Leistungselektronik, das durch den optoelektronischen Sensor (26, 28) bereitgestellt wird, der die Lichtstrahlung misst, die durch die Lichtstrahlungsemissionsquelle, d. h. die LED-Lampe (302), im Falle unzulässigen Blinkens tatsächlich emittiert wird, oder gemäß dem Signal, das durch die Relais (102)- und Sicherungs (2)-Prüfvorrichtung bereitgestellt wird, falls solche Prüfungen erfolglos sind, oder schließlich gemäß der Beständigkeit der Messungen einiger entscheidender Parameter, die durch die zwei Mikrocontroller im Falle einer Nichtüberstimmung der Ergebnisse davon durchgeführt werden, gesteuert werden.
10. Vorrichtung nach Anspruch 8 und 9, **dadurch gekennzeichnet, dass** die Sicherungs (2)-Prüfmittel umfasst, die so konzipiert sind, dass sie periodisch zum Kontrollieren der Integrität und Funktionalität der Quellen-Kurzschließmittel sowie des Impedanzwerts der Quelle ausgelöst werden, um nötigenfalls einen ausreichenden Strom bereitzustellen, damit die Sicherung (2) durchbrennt, während, wenn die Prüfung ein negatives Ergebnis aufweist, insbesondere wenn der Kurzschlussstrom nicht ausreicht, um die Sicherung (2) auszulösen, Mittel zum Untersagen der Relais (102)-Steuerung durch die Mikrocontroller vorgesehen sind, welche die Zwischenschaltung des Begrenzungswiderstands (304) bewirken und infolgedessen die Detektion von Fehlern in Bezug auf den Sicherungs (2)-Steuerungs-Hardwareabschnitt ermöglichen.
11. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** zwei Umgehungsbrücken für den Begren-

- zungswiderstand (304) vorgesehen sind, die jeweils parallel zueinander und beide parallel zum Begrenzungswiderstand (304) geschaltet sind, während vier verschiedene Relais (K1, K2, K3, K4) vorgesehen sind, wobei die Schalterkontakte von zwei Relais in einer Umgehungsbrücke in Reihe geschaltet sind, und die Kontakte der beiden anderen Relais in der zweiten Umgehungsbrücke in Reihe geschaltet sind, wobei jedes der Relais durch einen Ausgang der Steuer- und Leistungselektronik gesteuert wird.
12. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Steuer- und Leistungselektronik einen Steuerabschnitt mit einer 2002-Architektur aufweist, der zwei Steuerungs-Mikroprozessoren (6, 11) mit Steuerungssoftware, die in jeden von ihnen geladen ist, zur parallelen Durchführung von Steuerungsprozessen aufweist, wobei jeder Mikroprozessor (6, 11) Mittel zur Leistungsspeicherung und temporären Leistungsversorgung (305) damit verbunden aufweist, wobei das Signal der durch die optoelektronischen Sensoren detektierten Lichtstrahlung entspricht, und die Mikroprozessoren (6, 11) jeweils mindestens einen Steuerausgang zum Schalten mindestens eines Relais (102) aufweisen.
13. Vorrichtung nach Anspruch 11 und 12, **dadurch gekennzeichnet, dass** jeder Mikroprozessor (6, 11) mindestens zwei Steuerausgänge zum Erregen eines Relais (102) aufweist, wobei jeder mit einem der vier Relais (K1, K2, K3, K4) verbunden ist.
14. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Relais vom zwangsgeführten Typ und so konzipiert sind, dass die Schalterkontakte in den Umgehungsleitungen der vier Relais (K1, K2, K3, K4) normalerweise offen sind, wenn die Relais nicht erregt werden.
15. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Ballastwiderstand (309) mittels weiterer Schalterkontakte von mindestens zweien der vier Relais (K1, K2, K3, K4), welche das Öffnen und Schließen der Umgehungsleitungen des Begrenzungswiderstands (304) steuern, parallel zur Last der Lichtstrahlungsemissionsquelle (302) zwischen geschaltet wird, wobei die Kontakte der beiden Relais parallel zueinander geschaltet sind und eine umgekehrte Geschlossen-Offen-Konfiguration gegenüber den Schalterkontakten in den Umgehungsbrücken (310) des Begrenzungswiderstands (304) aufweisen.
16. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Lichtsignalerzeugungs-/emissionseinheit (300) Mittel zum Auslösen der Übertragung des Funktionsstatus davon in Bezug auf Lichtsignalemission an Züge aufweist, wobei die Mittel aus Schaltern bestehend, die so ausgelegt sind, dass sie durch die Steuer- und Leistungselektronik und insbesondere durch den Steuerabschnitt davon gesteuert werden, und wobei die Schalter ferner aus weiteren Schalterkontakten der vier Relais (K1, K2, K3, K4) bestehen, welche so konzipiert sind, dass sie die Umgehungen des Begrenzungswiderstand (304) öffnen und schließen.
17. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder Mikroprozessor Mittel zum Steuern von Prüfvorgängen der vier Relais (K1, K2, K3, K4) aufweist und die Relais zum Öffnen der Schalterkontakte steuert, wobei die vier Relais (K1, K2, K3, K4) periodischem Schalten unterzogen werden, um zu kontrollieren, dass die Kontakte nicht steckenbleiben und dass sie fähig sind, einen unerregten Zustand anzunehmen, wobei das Schalten in synchronisierten abwechselnden Paaren ausgelöst wird, so dass mindestens eine Umgehungsbrücke (310) des Begrenzungswiderstands (304) stets geschlossen gehalten wird, und dass sowohl der Ballastwiderstand (309) als auch die Steuerung der Auslösung des Vorrichtungsabschnitts zur Übertragung des Betriebszustands an Züge stets zwischengeschaltet gehalten werden.
18. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder Mikroprozessor (6, 11) Prüfungen an der Helligkeitssteuerungskette durchführt, um sowohl die Integrität des optoelektronischen Sensors (26, 28) und der Kette zur Verstärkung/Übertragung des elektrischen Signals, das den Lichtstrom der LEDs misst, als auch das Rauschen an der Steuerungskette zu kontrollieren, das von Lichtquellen außerhalb der Eisenbahnsignalisierungseinheit kommt.
19. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mikrocontroller zur Verwaltung der Blinksteuerung permanent sowohl eine Kontrolle der Ausrichtung zwischen der vermittelten Steuerung und des Lampen (302)-Status als auch eine Kontrolle der Korrektheit des Steuersignals durch Messen der Periode und des Tastverhältnisses der Modulationsrechteckwelle mit einer Frequenz von 1 bis 1,5 Hz durchführt, während, wenn solche Kontrollen ein negatives Ergebnis liefern, die Logikeinheit eine Leistungsabschaltung steuert.
20. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet,**

dass die Mikrocontroller im Falle einer festgelegten Lichtsteuerung eine Kontrolle auf unzulässiges Blinken durchführen und die Lampe (302) ausschalten, wann immer periodische und anomale Unterbrechungen des Lichtstroms auftreten.

21. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Lichtsignalerzeugungs-/emissionseinheit (300) Mittel zum Kalibrieren des Versorgungsstroms, der erforderlich ist, damit die Intensität der durch die Emissionsquelle emittierten Lichtstrahlung so wie gewünscht ist, und zum Detektieren der Parameter des entsprechenden, durch den optoelektronischen Sensor erzeugten elektrischen Signals aufweist, wobei die Kalibriermittel Mittel zum Ändern des Versorgungsstroms und externe Mittel zum Messen des Lichtstroms umfassen, der erzeugt wird, und ferner in der Steuer- und Leistungselektronik Mittel zur Speicherung des Versorgungsstroms für die Lichtstrahlungsemissionsquelle (302) umfassen, welcher der gewünschten Helligkeit und Parametern des Signals zur Messung der Helligkeit des durch die Emissionsquelle emittierten Lichtstrahlungssignals entspricht.

22. Vorrichtung nach Anspruch 21, **dadurch gekennzeichnet, dass** die Lichtsignalerzeugungs-/emissionseinheit (300) einen Versorgungsstromanpassungsabschnitt aufweist, der mindestens einen programmierbaren Widerstand umfasst, einen Hilfs-Rechteckwellengenerator (30) mit fester Periode und veränderlichem Tastverhältnis, wobei der Rechteckwellengenerator (30) während einer Halbperiode des Tastverhältnisses des Rechteckwellengenerators (30) mit der Lichtstrahlungsemissionsquelle (302) verbunden wird, der Versorgungsstrom, mit dem die Lichtstrahlungsemissionsquelle (302) versorgt wird, infolge der Änderung des Tastverhältnisses des Rechteckwellengenerators (30) geändert wird, während die Parameter des durch den optoelektronischen Sensor (26, 28) erzeugten Signals, das die emittierte Lichtstrahlung (311) misst, gegen theoretische Parameter kalibriert werden, wobei auf den Sensor (26, 28) eingewirkt wird, wenn sie sich von den Referenzparametern unterscheiden, die in den externen Signalmessungsmitteln gespeichert sind.

23. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Erzeugungs-/Emissionseinheit mechanisch in zwei Teile geteilt ist: einen von ihnen, nämlich den, der die Mikrocontroller, die Relais und den Leistungsanpassungs-PWM-Verstärker enthält und so konzipiert ist, dass er in einem Kasten untergebracht ist, der mit der Last tragenden Struktur eines Signals verbunden ist, und den anderen, der insbe-

sondere die optische LED-Einheit, den Lampenschalter (308) und den Helligkeitssensor enthält und zur Aufnahme in der Haube (50) des Signals (51), d. h. im Gehäuse einer herkömmlichen Lampe (302), konzipiert ist, wobei die beiden Teile durch eine Kommunikationsleitung elektrisch miteinander verbunden sind.

24. Vorrichtung nach Anspruch 23, **dadurch gekennzeichnet, dass** der Teil, der insbesondere die optische LED-Einheit, den Lampenschalter und den Helligkeitssensor enthält und zur Aufnahme in der Haube (50) des Signals konzipiert ist, in solch einer Form und Größe und mit solchen Befestigungsmitteln ausgebildet ist, dass sie seine Montage in der Signalhaube (50) anstelle einer bestehenden Lampe (302) eines anderen Typs, wie beispielsweise einer Glühlampe (302), ermöglichen.

Revendications

1. Dispositif de signalisation lumineuse destiné à des systèmes ferroviaires ou analogues, comprenant :

une unité de génération / émission d'un signal lumineux, laquelle est délivrée conjointement avec :

des moyens pour générer / alimenter un signal de déclenchement destiné à actionner ledit dispositif de signalisation ;
des moyens pour vérifier l'état fonctionnel de ladite unité de génération / émission du dit signal lumineux, lesquels moyens mesurent l'intensité du courant absorbé par la génération / émission de signal lumineux lorsque ladite unité est sous tension ;
lesdits moyens de vérification fonctionnelle de l'unité de génération / émission de signal lumineux comparent la valeur de courant absorbé détectée à une valeur seuil prédéterminée, et commandent des moyens de signalisation d'état fonctionnel et/ou des moyens de commande de fonction de sécurité en fonction du résultat de cette comparaison ;
ladite unité de génération / émission de signal lumineux étant équipée d'une source de rayonnement lumineux du type connu sous le nom de diode électroluminescente, LED, et d'un équipement électronique d'alimentation et de commande ;
ledit équipement électronique d'alimentation et de commande étant fourni conjointement avec des moyens optoélectroniques destinés à détecter le signal lumineux émis par la source d'émission de rayonnement

lumineux (302), et à générer un signal électrique correspondant audit rayonnement lumineux détecté, lequel signal est fourni audit équipement électronique de commande (301) ;

ledit équipement électronique d'alimentation et de commande présentant des moyens pour modifier le courant absorbé par l'unité de génération / émission de signal lumineux, lesquels moyens de modification du courant sont commandés par ledit équipement électronique de commande (301) selon le signal électrique correspondant à l'intensité lumineuse émise par la source d'émission de rayonnement lumineux (302) et générée par lesdits moyens optoélectroniques ;

caractérisé en ce que :

ledit signal d'alimentation et de commande agit à la fois comme un signal de commande d'actionnement et comme un signal d'alimentation électrique pour ladite unité de génération / émission de signal lumineux ;

les moyens pour modifier le courant absorbé par l'unité de génération / émission de signal lumineux se composent d'une résistance de limitation (304) qui peut être connectée en série en alternance avec une ligne de dérivation au niveau de l'entrée de ladite unité de génération / émission de signal lumineux, à la ligne d'alimentation de signal d'alimentation et de commande et à l'unité de génération / émission de signal lumineux ;

ladite résistance étant d'une taille de nature à limiter l'intensité du courant absorbé par ladite unité de génération / émission à une valeur inférieure à la valeur seuil minimale correspondant à celle à laquelle l'unité de génération / émission de signal lumineux est censée fonctionner correctement ;

des moyens de commutation étant en outre délivrés en vue de commuter l'état de la connexion en série alternative de la ligne de dérivation et de ladite résistance de limitation (304) à l'entrée de l'unité de génération / émission de signal lumineux, lesquels moyens sont commandés par l'équipement électronique d'alimentation et de commande selon le signal de détection de l'émission lumineuse générée par la source d'émission de rayonnement lumineux (302) ; et des moyens d'accumulation de puissance et d'alimentation électrique temporaire (305) sont fournis, qui sont actionnés pendant une durée prédéterminée en vue d'une

alimentation électrique temporaire de l'équipement électronique d'alimentation et de commande tandis que la résistance de limitation (304) est insérée en série avec l'entrée de l'unité de génération / émission de signal lumineux (300).

2. Dispositif selon la revendication 1, **caractérisé en ce que** les moyens d'accumulation de puissance et d'alimentation électrique temporaire (305) de l'unité d'alimentation et de commande se composent de moyens capacitifs ayant une taille de nature à accumuler et à libérer un signal d'alimentation dont la tension et la puissance sont suffisantes pour alimenter, pendant une durée prédéterminée, l'équipement électronique de commande (301) et de moyens de commutation pour commuter l'état de connexion en série alternative de la ligne de dérivation et de ladite résistance de limitation (304) à l'entrée de l'unité de génération / émission de signal lumineux (300), lesquels moyens, lorsque le démarrage est achevé, sont commandés par l'équipement électronique de commande (301) selon le signal de détection de l'émission lumineuse générée par la source d'émission de rayonnement lumineux (302).

3. Dispositif selon la revendication 1 ou 2, **caractérisé en ce que** ladite durée prédéterminée de l'alimentation électrique vers l'équipement électronique de commande (301) et les moyens de commutation pour commuter l'état de connexion alternative de la ligne de dérivation et de ladite résistance de limitation (304), en série avec l'entrée de l'unité de génération / émission de signal lumineux (300), est égale ou légèrement supérieure à la durée nécessaire à un actionnement état d'équilibre de l'équipement électronique d'alimentation et de commande et afin que les moyens de commutation endossent l'état de commutation dans lequel l'entrée de l'unité de génération / émission de signal lumineux (300) est directement connectée par la dérivation à la ligne d'alimentation (200).

4. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que**, afin de permettre un fonctionnement correct au cours d'un clignotement de signal et par conséquent d'éviter la défaillance de l'alimentation en énergie vers l'équipement électronique d'alimentation et de commande tandis que la source d'émission de rayonnement lumineux (302) est hors tension, des secondes unités d'alimentation électrique temporaire et d'accumulation de puissance (305) sont fournies dans l'unité d'alimentation et de commande, lesquelles présentent une taille telle que l'alimentation électrique temporaire se produit pendant une seconde durée prédéterminée qui correspond sensiblement à la durée pendant laquelle la source lumineuse est

hors tension au cours du cycle de clignotement.

5. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que**, conjointement avec la résistance de limitation (304) apte à être insérée et déconnectée en série avec l'entrée d'alimentation de l'unité de génération / émission de signal lumineux (300), des seconds moyens pour modifier le courant d'absorption de l'unité de génération / émission de signal lumineux (300) sont délivrés, lesquels se composent d'une résistance de stabilisation (309) apte à être insérée au sein du, et déconnectée du circuit d'alimentation en parallèle avec la charge de l'unité de génération / émission de signal lumineux (300), et en particulier en parallèle avec la source d'émission de signal lumineux, par des moyens de commutation commandés par l'équipement électronique d'alimentation et de commande.
6. Dispositif selon la revendication 5, **caractérisé en ce que** la commande d'insertion de ladite résistance de stabilisation (309) en parallèle avec la charge de la source d'émission de rayonnement lumineux (302) se produit lors d'une commande de déconnexion de la résistance de limitation (304) en série avec l'entrée de l'unité de génération / émission de signal, et en particulier en série avec la charge de la source d'émission de rayonnement lumineux (302).
7. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** l'unité de génération / émission de signal lumineux (300) présente des moyens pour empêcher de manière irréversible l'alimentation électrique vers ladite unité de génération / émission de signal lumineux (300) et en particulier vers l'équipement électronique de commande (301), lesquels moyens peuvent être actionnés par l'équipement électronique de commande (301) lui-même.
8. Dispositif selon la revendication 7, **caractérisé en ce que** lesdits moyens se composent d'un fusible (2) dans la ligne d'alimentation (200) de l'équipement électronique d'alimentation et de commande (301) et d'un commutateur (308) pour connecter ledit fusible (2) suite à un court circuit du signal d'alimentation et de commande en vue de générer un courant dont le niveau est de nature à griller ledit fusible (2).
9. Dispositif selon la revendication 8, **caractérisé en ce que** lesdits moyens de commutation sont conçus de manière à être commandés par l'équipement électronique d'alimentation et de commande selon le signal d'entrée au niveau dudit équipement électronique d'alimentation et de commande, lequel est fourni par le capteur optoélectronique (26, 28) qui mesure le rayonnement lumineux réellement émis

par la source d'émission de rayonnement lumineux, à savoir la lampe à LED (302), en cas de clignotement injustifié, ou selon le signal fourni par le dispositif de test de relais (102) et de test de fusible (2), si de tels tests échouent, ou enfin selon la cohérence des mesures de quelques paramètres vitaux, mises en oeuvre par les deux microcontrôleurs en cas de non-concordance des résultats de celles-ci.

10. Dispositif selon les revendications 8 et 9, **caractérisé en ce qu'il** comprend des moyens de test de fusible (2) qui sont conçus de manière à être actionnés périodiquement en vue de vérifier l'intégrité et la fonctionnalité des moyens de court-circuitage de source, ainsi que la valeur d'impédance de la source, dans le but de fournir un courant suffisant pour griller le fusible (2), le cas échéant, tandis que si le test donne un résultat négatif, en particulier si le courant de court-circuit n'est pas suffisant pour déclencher le fusible (2), des moyens sont fournis pour interdire la commande de relais (102) par les microprocesseurs, lesquels occasionnent l'insertion de la résistance de limitation (304), et permettent par conséquent la détection des défaillances concernant la section matérielle de commande du fusible (2).
11. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** deux cavaliers de dérivation pour la résistance de limitation (304) sont délivrés, chacun étant connecté en parallèle avec l'autre, et tous les deux en parallèle avec la résistance de limitation (304), tandis que quatre relais différents (K1, K2, K3, K4) sont délivrés, les contacts de commutation de deux relais étant connectés en série dans un cavalier de dérivation, et les contacts des deux autres relais étant connectés en série dans le second cavalier de dérivation, chacun desdits relais étant commandé par une sortie de l'équipement électronique d'alimentation et de commande.
12. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** l'équipement électronique d'alimentation et de commande présente une section de commande présentant une architecture « 2oo2 », laquelle présente deux microprocesseurs de commande (6, 11) avec un logiciel de commande chargé dans chacun d'eux, en vue de l'exécution en parallèle de processus de commande, chaque microprocesseur (6, 11) ayant des moyens d'accumulation de puissance et d'alimentation électrique temporaire (305) qui lui sont connectés, le signal correspondant au rayonnement lumineux détecté par les capteurs optoélectroniques, et lesdits microprocesseurs (6, 11) ayant chacun au moins une sortie de commande en vue de commuter au moins un relais (102).

13. Dispositif selon les revendications 11 et 12, **caractérisé en ce que** chaque microprocesseur (6, 11) présente au moins deux sorties de commande pour exciter un relais (102), chacune étant connectée à l'un des quatre relais (K1, K2, K3, K4). 5
14. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** les relais sont du type à guidage forcé et sont conçus de manière à ce que les contacts de commutation dans les lignes de dérivation des quatre relais (K1, K2, K3, K4) sont normalement ouverts lorsque les relais ne sont pas excités. 10
15. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** la résistance de stabilisation (309) est insérée en parallèle avec la charge de la source d'émission de rayonnement lumineux (302) au moyen de contacts de commutation supplémentaires d'au moins deux des quatre relais (K1, K2, K3, K4) qui commandent l'ouverture ou la fermeture des lignes de dérivation de la résistance de limitation (304), lesdits contacts desdits deux relais étant connectés en parallèle les uns avec les autres et ayant des configurations ouvertes / fermées inversées par rapport aux contacts de commutation dans les cavaliers de dérivation (310) de la résistance de limitation (304). 15 20 25
16. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** l'unité de génération / émission de signal lumineux (300) comporte des moyens pour actionner la transmission de l'état fonctionnel de celle-ci, en ce qui concerne l'émission de signal lumineux, à des trains, lesquels moyens sont constitués de commutateurs aptes à être commandés par l'équipement électronique d'alimentation et de commande, et en particulier par la section de commande de celui-ci, et lesquels commutateurs sont constitués de contacts de commutation supplémentaires des quatre relais (K1, K2, K3, K4), lesquels sont conçus pour ouvrir et fermer les dérivation de la résistance de limitation (304). 30 35 40
17. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** chaque microprocesseur présente des moyens pour commander les procédures de test des quatre relais (K1, K2, K3, K4), et commande lesdits relais en vue d'ouvrir les contacts de commutation, lesdits quatre relais (K1, K2, K3, K4) étant soumis à une commutation périodique permettant de vérifier que les contacts ne sont pas bloqués et qu'ils sont en mesure d'endosser un état désexcité ; ladite commutation étant actionnée dans des paires alternées synchronisées, de sorte qu'au moins un cavalier de dérivation (310) de la résistance de limitation (304) est toujours maintenu fermé, et de sorte que la résistance de stabilisation (309) et la commande d'actionnement de la section de dispositif pour la transmission de l'état d'exploitation à des trains sont toujours maintenues insérées. 45 50 55
18. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** chaque microprocesseur (6, 11) met en oeuvre des tests sur la chaîne de commande de luminosité, en vue de vérifier à la fois l'intégrité du capteur optoélectronique (26, 28) et de la chaîne d'amplification / transmission du signal électrique qui mesure le flux lumineux des DEL, et le bruit sur la chaîne de commande qui provient de sources lumineuses extérieures à l'unité de signalisation ferroviaire.
19. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que**, pour la gestion de commande de clignotement, le microprocesseur met en oeuvre, en permanence, à la fois une vérification de la cohérence entre la commande transmise et l'état de la lampe (302), et une vérification de l'exactitude du signal de commande, en mesurant la période et le cycle de service de l'onde carrée de modulation, ayant une fréquence de 1 à 1,5 Hz, tandis que si ces vérifications produisent un résultat négatif, l'unité logique commande l'arrêt de l'alimentation.
20. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** les microprocesseurs mettent en oeuvre une vérification de clignotement injustifié, et mettent la lampe (302) hors tension chaque fois que des interruptions périodiques et anormales du flux lumineux sont rencontrées, en cas de commande de lumière fixe.
21. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** l'unité de génération / émission de signal lumineux (300) comporte des moyens pour étalonner, sur la valeur désirée, le courant d'alimentation électrique requis pour l'intensité du rayonnement lumineux émis par la source émettrice, et pour détecter les paramètres du signal électrique correspondant généré par le capteur optoélectronique, lesquels moyens d'étalonnage comprennent des moyens pour modifier le courant d'alimentation électrique et des moyens externes pour mesurer le flux lumineux généré, et comprennent en outre, dans l'équipement électronique d'alimentation et de commande, des moyens de stockage du courant d'alimentation électrique pour la source d'émission de rayonnement lumineux (302) qui correspond à la luminosité souhaitée, et de stockage des paramètres du signal pour la mesure de la luminosité du signal de rayonnement lumineux émis par la source émettrice.

22. Dispositif selon la revendication 21, **caractérisé en ce que** l'unité de génération / émission de signal lumineux (300) présente une section d'adaptation de courant d'alimentation électrique, laquelle comprend au moins une résistance programmable, un générateur d'ondes carrées à périodes fixes de cycle de service variable auxiliaire (30), ledit générateur d'ondes carrées (30) étant connecté à la source d'émission de rayonnement lumineux (302) pendant une demi-période du cycle de service du générateur d'ondes carrées (30), le courant d'alimentation électrique fourni à la source d'émission de rayonnement lumineux (302) étant modifié en raison de la variation du cycle de service du générateur d'ondes carrées (30), tandis que les paramètres du signal de mesure de rayonnement lumineux émis (311) généré par le capteur optoélectronique (26, 28) sont étalonnés en fonction de paramètres théoriques, ledit capteur (26, 28) étant sollicité lorsque les paramètres sont différents des paramètres de référence stockés dans les moyens de mesure de signal externes.
23. Dispositif selon l'une quelconque ou plusieurs des revendications précédentes, **caractérisé en ce que** l'unité de génération / émission est mécaniquement divisée en deux parties : l'une d'elles contenant les microprocesseurs, les relais et l'amplificateur PWM de réglage de la puissance, et étant destinée à être logée dans un boîtier connecté à la structure de support de charge d'un signal, et l'autre contenant en particulier l'unité optique à LED, le commutateur de lampe (308) et le capteur de luminosité, et étant destinée à être reçue dans la visière (50) du signal (51), c'est-à-dire dans le boîtier d'une lampe traditionnelle (302), lesdites deux parties étant connectées électriquement l'une à l'autre par une ligne de communication.
24. Dispositif selon la revendication 23, **caractérisé en ce que** la partie contenant en particulier l'unité optique à LED, le commutateur de lampe et le capteur de luminosité, destinée à être reçue dans la visière (50) du signal, présente une forme et taille, ainsi que des moyens de fixation, lui permettant d'être montée dans la visière du signal (50) à la place d'une lampe existante (302) de type différent, par exemple une lampe à incandescence (302).

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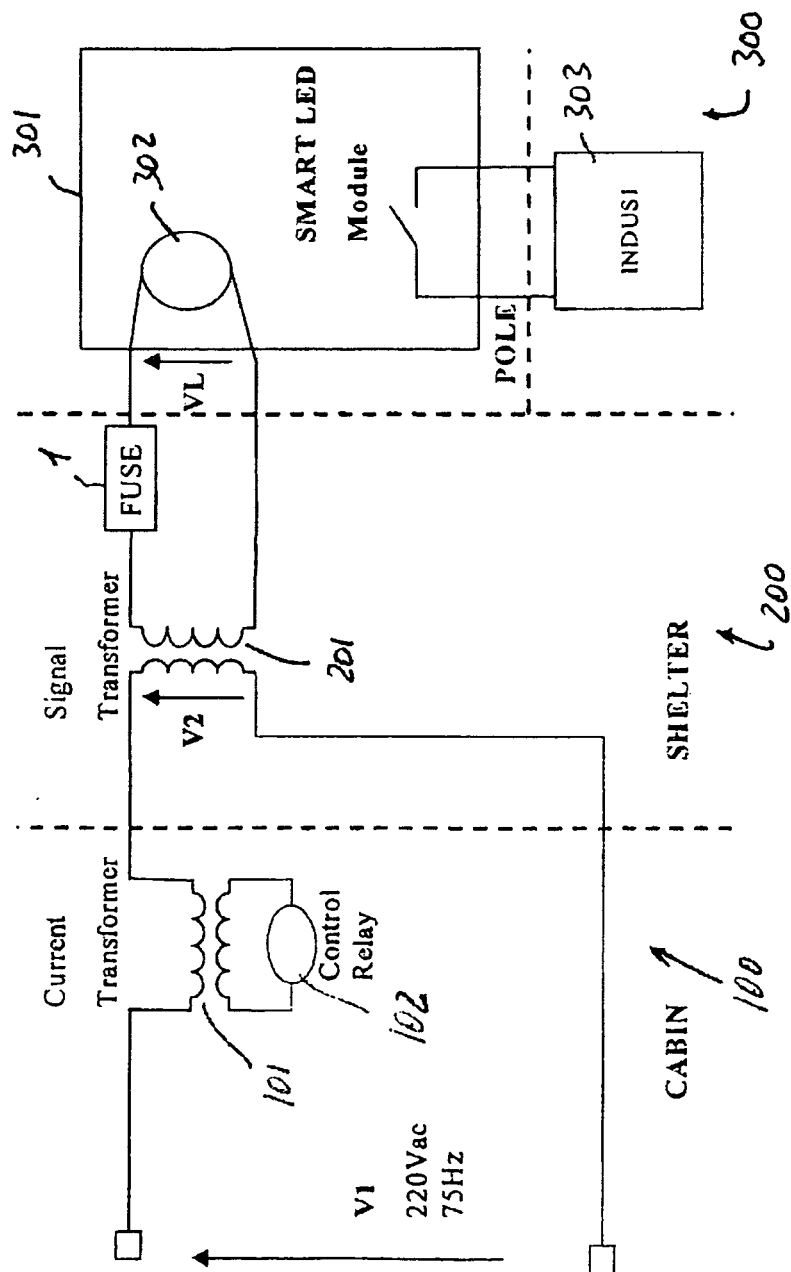


Fig. 1

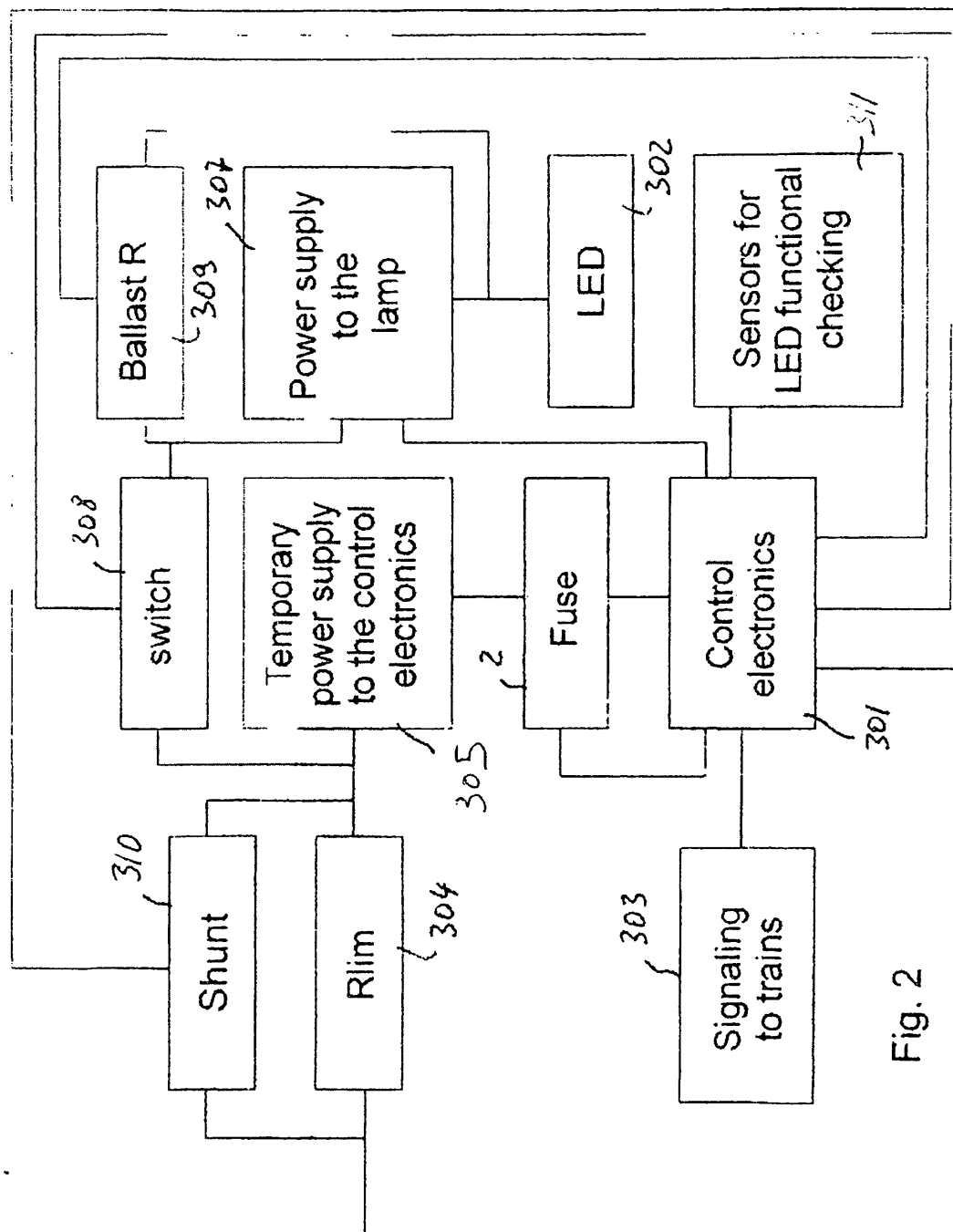


Fig. 2

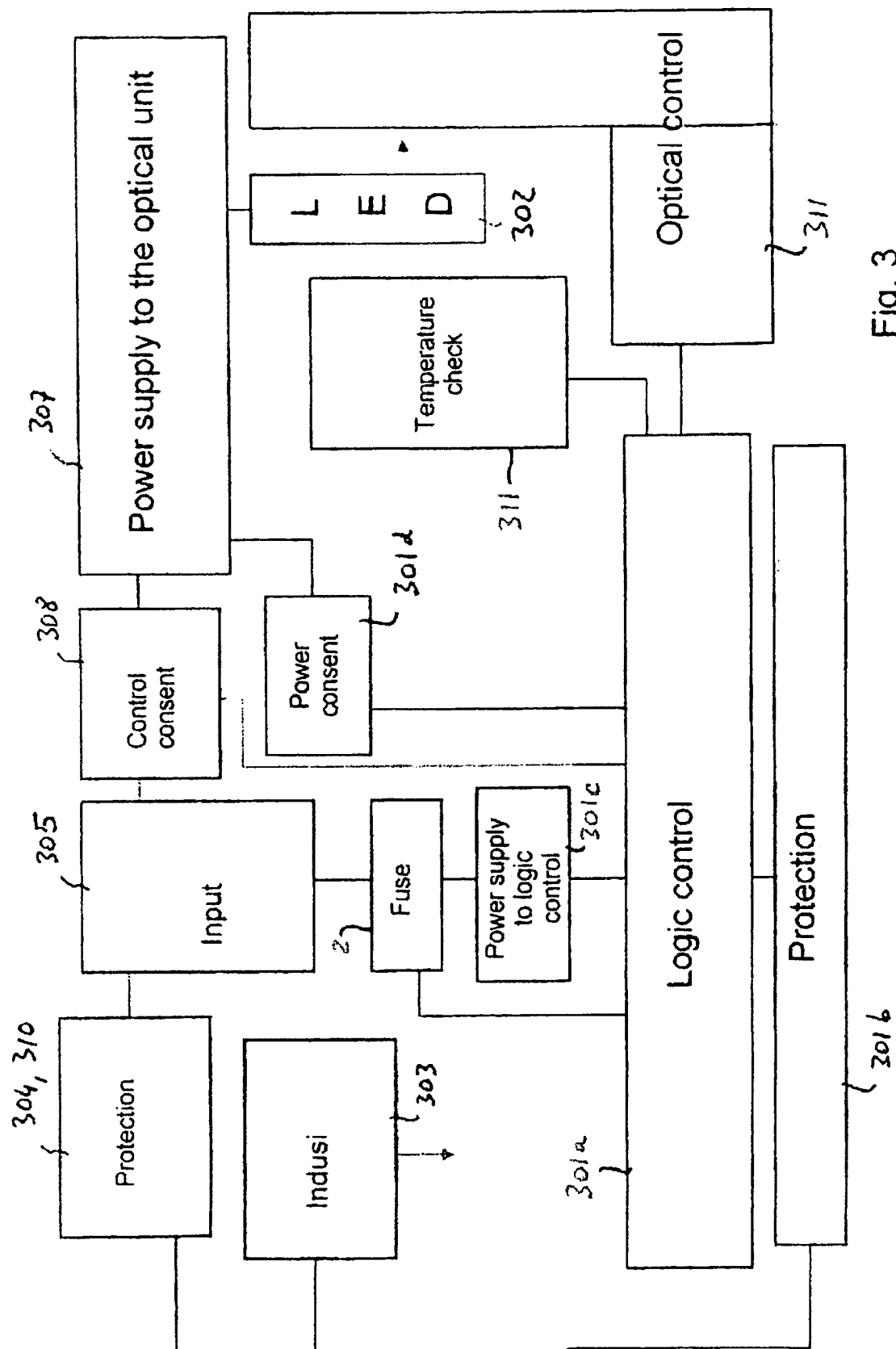


Fig. 3

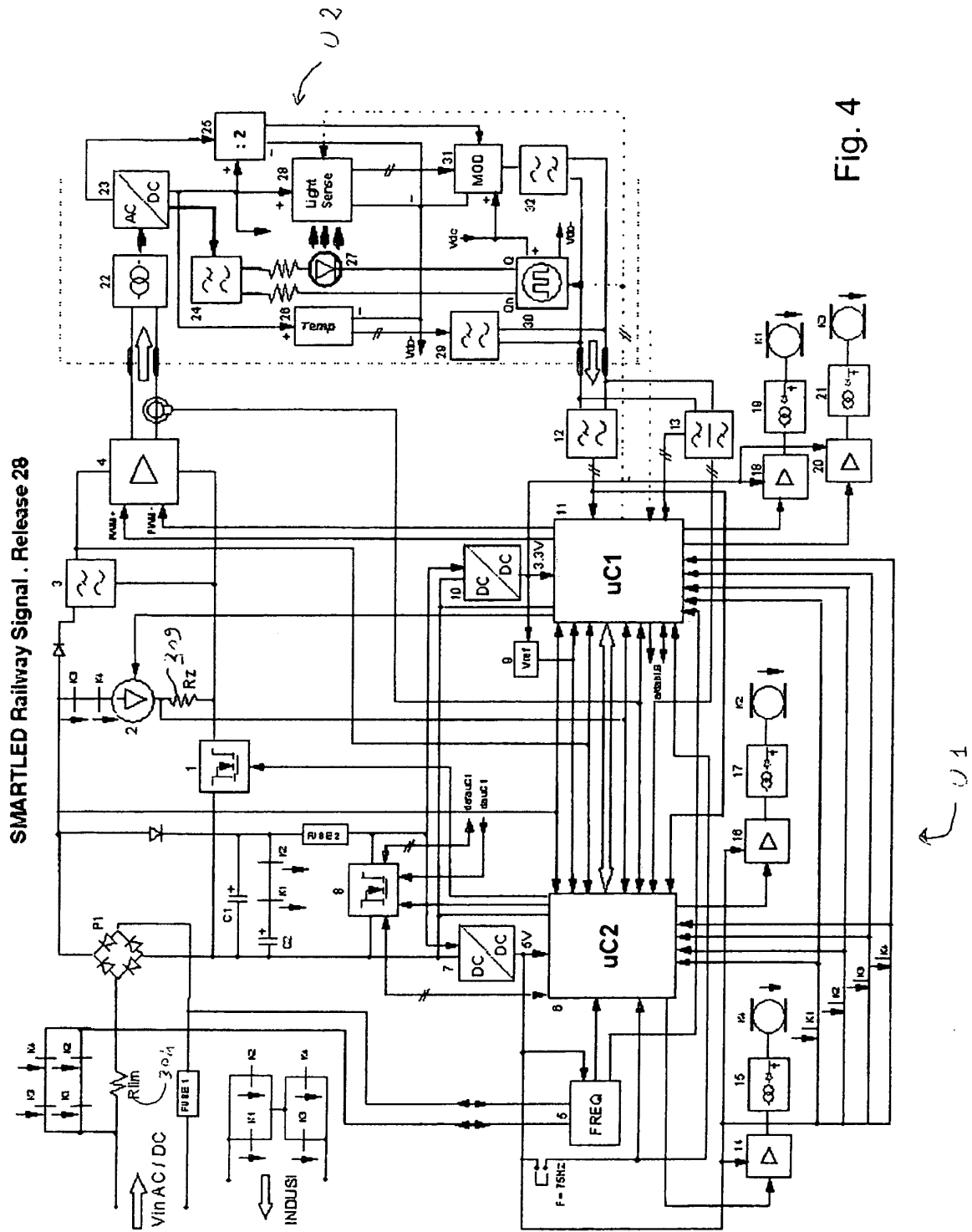


Fig. 4

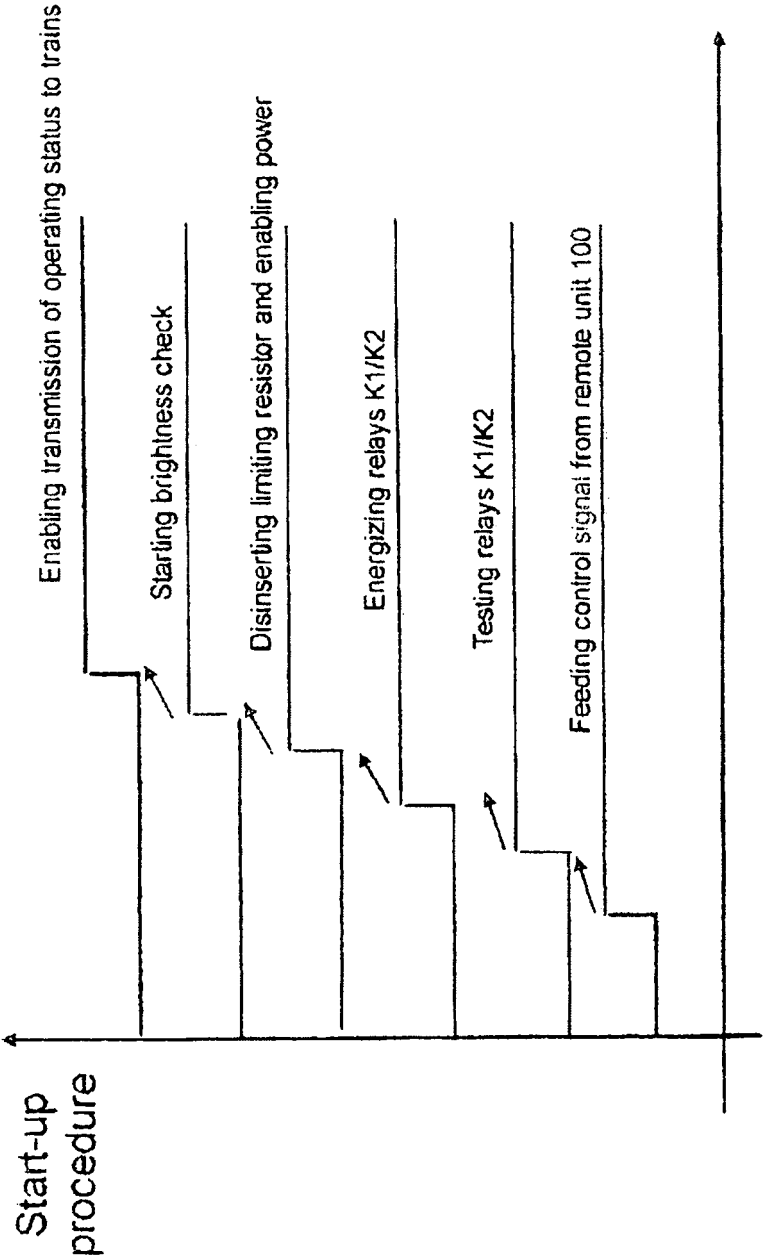


Fig. 5

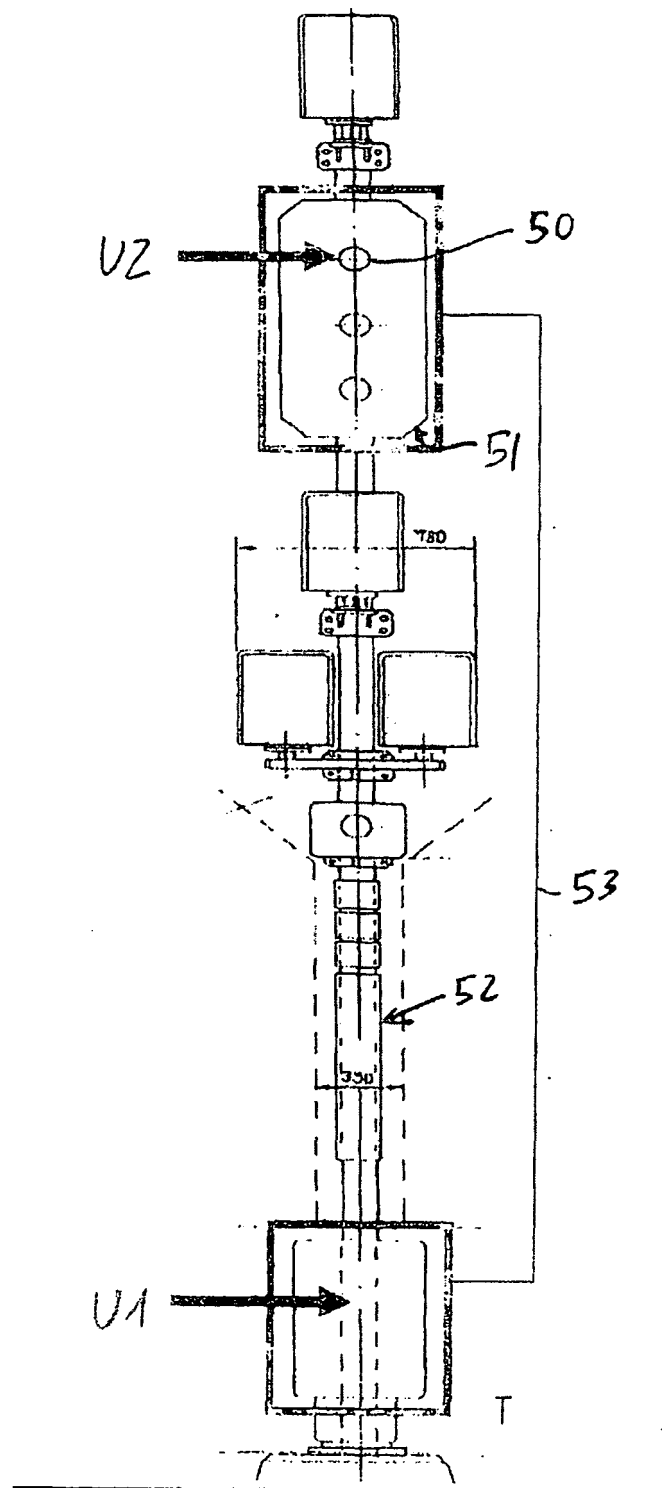


Fig. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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