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Magdalena Kawalkowski

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Friday, November 06, 2015

Signature, Notary Public

AMY LEONG
Notary Public - State of New York
No. 01LE6314554
Qualified in Richmond County
Commission Expires Nov 10, 2018

Stamp, Notary Public

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(71) Applicant 000002303
STANLEY ELECTRIC K.K.
2-9-13 Naka Meguro, Meguro-ku, Tokyo-to

(72) Inventor NOBUHARU FUKUWA
1790-13 Takagasaka, Machida-shi, Tokyo-to

(72) Inventor KATSUTOSHI FUKAZAWA
5-15-20-302 Higashi Kashiwagaya, Ebina-shi, Kanagawa-shi

(72) Inventor HIDEKI KITAMURA
39-6-207 Umegaoka, Aoba-ku, Yokohama-shi, Kanagawa-ken

(74) Agent 100066061 Patent attorney HIROYUKI TANBA

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(54) (TITLE OF THE INVENTION) VEHICLE LAMP CONTROL DEVICE

(57) [ABSTRACT]

[PROBLEM] To simplify circuitry and increase output precision at low cost and be able to respond to errors in a lighting control device for vehicle lamps, in particular for cases where discharge lamps are used as headlamps, for example.

[Means for Solving the Problem] A lighting circuit of a discharge lamp 5 having a DC/DC converter 2, which is a DC voltage boosting circuit, a DC/AC inverter 3, and a launch circuit 4 is controlled by a lighting control circuit 19, and vertical and horizontal optical axis adjustment, etc., of the discharge lamp 5 is controlled by a microcomputer 20. The microcomputer 20 outputs to a lighting control circuit 19 a setting value of a lamp current based on a lamp voltage detected by a voltage detection circuit 22, and the lighting control circuit 19 controls output of the lighting circuit on the basis of the setting value of the lamp current and the detection value of the lamp current detected by a current detection circuit 21.

[SCOPE OF PATENT CLAIMS]

[CLAIM 1] A vehicle lamp control device, comprising a lamp control circuit that performs optical axis adjustment of a lamp, a lighting circuit that supplies lighting power to a lamp, a lighting control circuit that controls the lighting circuit, a voltage detection circuit that detects a lamp voltage, and a current detection circuit that detects a lamp current, wherein the lamp control circuit outputs to the lighting control circuit a setting value of the lamp current on the basis of the lamp voltage detected by the voltage detection circuit and the lighting control circuit controls output of the lighting circuit on the basis of the setting value of the lamp current and a detection value of the lamp current detected by the current detection circuit.

[CLAIM 2] The vehicle lamp control device as claimed in claim 1, wherein the lighting circuit has a direct current voltage boosting circuit that boosts the current from a direct current source and a direct current–alternating current inverter that converts direct current into alternating current and supplies lighting current to a lamp, and a headlamp using a discharge lamp is lighted as the lamp.

[CLAIM 3] The vehicle lamp control device as claimed in claim 1 or claim 2, wherein the lamp control circuit is provided with at least either leveling functionality whereby a vertical optical axis of the lamp is controlled or cornering light distribution functionality that adjusts a horizontal optical axis.

[CLAIM 4] The vehicle lamp control device as claimed in claim 2 or claim 3, wherein the lamp control circuit is constituted by a microcomputer and a polarity-switching control signal for alternating current lighting is output to the direct current–alternating current inverter.

[CLAIM 5] The vehicle lamp control device as claimed in any one of claims 2–4, wherein the lighting control circuit compares detection values of output voltage and output current from the direct current voltage boosting circuit and setting values for limiting output thereof, and controls output of the direct current voltage boosting circuit on the basis of results of the comparison.

[CLAIM 6] The vehicle lamp control device as claimed in any one of claims 1–5, wherein operation of the lighting circuit is stopped when the lamp control circuit detects an error on the basis of the detection value of the lamp voltage and the detection value of the lamp current.

[CLAIM 7] The vehicle lamp control device as claimed in any one of claims 1–6, wherein the lighting control circuit is constituted by a CMOS transistor, and the lighting control circuit and the lamp control circuit are formed on one semiconductor chip in an integrated manner.

[CLAIM 8] The vehicle lamp control device as claimed in any one of claims 1–7, wherein the lamp control circuit has two systems for left and right lamps, one of the control circuits adjusting the vertical optical axis of both of the lamps and another of the control circuits adjusting the horizontal axis of both of the lamps.

[CLAIM 9] The vehicle lamp control device as claimed in claim 8, wherein the two lamp control circuits comprise microcomputers having memory with identical content, and control is performed by using an external signal to selecting either a control program that adjusts the vertical optical axis or a control program that adjusts the horizontal optical axis.

[CLAIM 10] The vehicle lamp control device as claimed in claim 8 or claim 9, wherein the two lamp control circuits perform at least either mutual information exchange through a communication port or information exchange with another external device.

[CLAIM 11] The vehicle lamp control device as claimed in any one of claims 8–10, wherein, if there are two lamps, left and right, the left and right lamps have functionality for light distribution switching control between a traveling beam and a passing beam.

[CLAIM 12] The vehicle lamp control device as claimed in any one of claims 1–11, wherein the lamp control circuit has a common memory that stores parameters for correcting output characteristics of optical axis adjustment sensors that differ by vehicle model.

[CLAIM 13] The vehicle lamp control device as claimed in any one of claims 1–12, wherein the lamp control circuit has an added control function other than an adjustment function for the vertical and horizontal optical axes.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD TO WHICH THE INVENTION BELONGS] The present invention relates to a vehicle lamp control device particularly suited to automobile headlights using discharge lamps.

[0002]

[PRIOR ART] Lighting devices in which discharge lamps are used as automobile headlights and are instantly lighted by applying a starting current that is several multiples of the rated current when starting the discharge lamps have been proposed. FIG. 3 is a block diagram showing a circuit configuration of a discharge lamp lighting device.

[0003] This type of lighting device comprises a DC/DC converter 2 that inputs a DC voltage from a DC power source 1 such as a battery and boosts the DC voltage, a DC/AC inverter 3 that converts the DC into AC and supplies the AC to a discharge lamp 5, and a launch circuit 4 that generates a high-voltage pulse for launching that initiates discharge when lighting the discharge lamp 5 (when starting). Output of the DC/DC converter 2 is detected by a current detection element 6 and a voltage detection element 7, a control circuit 8 controls the DC/DC converter 2 on the basis of the detection values, and the DC/AC inverter 3 is controlled by an inverter driver 9.

[0004] In the lighting device thus configured, lamp power from starting of the discharge lamp 5 until stabilization is achieved is controlled by a lighting control portion inside the DC/DC converter 2 in accordance with lamp voltage and lamp current. If an error occurs in input voltage, output voltage, or output current, functionality is provided for stopping operation by means of a protection circuit.

[0005] In order to perform this control operation, a control circuit 8 constituted mainly by an analog circuit or a microcomputer is provided. Specifically, a setting value of the lamp power is found

as computation output by the control circuit 8 on the basis of which the DC/DC converter 2 is subjected to power output control such as PWM or the like to perform lamp power control, and if an input or output error occurs operation is stopped in the form of a protection operation.

[0006] Thus, with the control circuit of an illumination discharge lamp lighting device for an automobile, there are protection items such as output short currents that are limited by each cycle of the PWM oscillation frequency in a PWM controller that requires rapid feedback control for which analog circuitry is more suited and there are protection items that have a long monitoring cycle, such as computation of power setting values and output open stopping that are possible with microcomputer control, and therefore it cannot be said in general that one or the other is more advantageous as a control circuit configuration of a discharge lamp lighting device. There are also cases where dedicated ICs are used in which the analog control circuitry is customized.

[0007] There have been practical implementations of automatic optical axis adjustment functions whose purpose is to prevent glare against oncoming vehicles through active control of the optical axis of the headlamps. FIG. 4 shows an example of a circuit configuration of this auto leveling.

[0008] In FIG. 4, 10 is a headlamp unit onto which the discharge lamp 5 is mounted, and into which a reflector 11 and a motor 12 for optical axis adjustment are incorporated. 13 is a motor driver that drives the motor 12, and 14 is a microcomputer into which are input signals from a lamp switch 15, a vehicle speed sensor 16, and vehicle height sensors 17 and 18 in front and back of a vehicle.

[0009] There are large advantages in including this auto leveling function in discharge lamp headlamps, which are at least twice as bright as halogen bulbs, increasing their marketability. As a control circuit for implementing an auto leveling function that performs automatic adjustment of the optical axis, an amount of control of an actuator that moves the optical axis can be varied in accordance with signals input from the vehicle height sensors 17 and 18, the vehicle speed sensor 16, the lamp switch 15, and so on. The detection level of the vehicle height sensors 17 and 18 has to be set according to where they are installed on the suspension. Microcomputers are generally more suited to cases where accurate control values are required for various inputs like this, and optimization is relatively easy.

[0010] It is effective to use a common housing for device units in cases where combination of the discharge lamp lighting device attached to a headlamp unit 10 and the auto leveling device is considered. FIG. 5 shows a configuration of a conventional discharge lamp lighting device with added auto leveling function. When a combined control unit is attached to the headlamp unit 10, a single unit results, which can reduce the number of process steps involved and is effective in reducing costs. Combination of these lamp control units is therefore moving forward. In FIG. 5, 19 is a lighting control circuit that controls lighting of the discharge lamp 5.

[0011] For example, JP H10-35358 A describes a discharge lamp lighting device in which a leveling function, etc., is provided that adjusts light distribution of the headlamps. It also states that control is easily done when using a microcomputer in cases where vehicle height sensor information, etc., differs from model to model depending on factors such as the tightness of the suspension. Aside from the auto level function, a lamp cleaner is described as a third function and adding a function for cornering light distribution in parallel as a fourth function, as well as the microcomputer of the lighting device sending malfunction data out of the device, and so on.

[0012]

[PROBLEMS TO BE SOLVED BY THE INVENTION] The following problems have existed in conventional vehicle lamp control devices with this type of auto leveling functionality.

[0013] (1) A microcomputer control portion of the auto leveling device was simply added to a conventional discharge lamp lighting device which performed control operations for boosting circuits using dedicated IC's, protection operations when errors occur, meaning that the dedicated control IC and the microcomputer have been needed in order to combine control functionality, and therefore costs have not fallen even when circuits have been integrated.

[0014] (2) Combination is impossible involving circuit functionality if lighting of discharge lamps is controlled using only the dedicated IC. Moreover, in cases where lighting control is done using only the microcomputer power source control of the boosting circuit has also been necessary, which makes the processing load on the microcomputer larger. There is therefore a need to select a high-performance microcomputer, which eliminates any cost-related advantages.

[0015] (3) When adding functionality other than auto leveling functionality to the discharge lamp lighting device, such as cornering light distribution control designed to control an angle of illumination to the right and left when going around a curve, or headlamp cleaner functionality, a second circuit (leveling), a third circuit (cleaner), and a fourth circuit (light distribution control) which perform these various control operations are added in parallel to one of the discharge lamp lighting devices for the left and right lamps, meaning that the processing load is focused on the microcomputer for the lighting device control on one of the lamps, and therefore a high-performance microcomputer must be used, which is disadvantageous in terms of cost.

[0016] (4) Since malfunction data is only sent outside the microcomputer, operations responding thereto by compensating cannot be done by the functional lamp if the other one has malfunctioned.

[0017] The present invention was devised in light of these problems and has as an object to provide a vehicle lamp control circuit with which circuitry can be simplified and high precision output can be realized at low cost thanks to an optimized control configuration, and which is capable of responding to errors.

[0018]

[MEANS FOR SOLVING THE PROBLEM] A vehicle lamp control device according to the present invention is configured as follows.

[0019] (1) A vehicle lamp control device comprises a lamp control circuit that performs optical axis adjustment of a lamp, a lighting circuit that supplies lighting power to a lamp, a lighting control circuit that controls the lighting circuit, a voltage detection circuit that detects a lamp voltage, and a current detection circuit that detects a lamp current, and the lamp control circuit outputs to the lighting control circuit a setting value of the lamp current on the basis of the lamp voltage detected by the voltage detection circuit and the lighting control circuit controls output of the lighting circuit on the basis of the setting value of the lamp current and a detection value of the lamp current detected by the current detection circuit.

[0020] (2) In the configuration of (1) above the lighting circuit has a direct current voltage boosting circuit that boosts the current from a direct current source and a direct current–alternating current inverter that converts direct current into alternating current and supplies lighting current to a lamp, and a headlamp using a discharge lamp is lighted as the lamp.

[0021] (3) In the configuration of (1) or (2) above, the lamp control circuit is provided with at least either leveling functionality whereby a vertical optical axis of the lamp is controlled or cornering light distribution functionality that adjusts a horizontal optical axis.

[0022] (4) In the configuration of (2) or (3) above, the lamp control circuit is constituted by a microcomputer and a polarity-switching control signal for alternating current lighting is output to the direct current–alternating current inverter.

[0023] (5) In one of the configurations in (2)–(4) above, the lighting control circuit compares detection values of output voltage and output current from the direct current voltage boosting circuit and setting values for limiting output thereof, and controls output of the direct current voltage boosting circuit on the basis of results of the comparison.

[0024] (6) In one of the configurations in (1)–(5) above, operation of the lighting circuit is stopped when the lamp control circuit detects an error on the basis of the detection value of the lamp voltage and the detection value of the lamp current.

[0025] (7) In one of the configurations in (1)–(6) above, the lighting control circuit is constituted by a CMOS transistor, and the lighting control circuit and the lamp control circuit are formed on one semiconductor chip in an integrated manner.

[0026] (8) In one of the configurations in (1)–(7) above, the lamp control circuit has two systems for left and right lamps, one of the control circuits adjusting the vertical optical axis of both of the lamps and another of the control circuits adjusting the horizontal axis of both of the lamps.

[0027] (9) In the configuration of (8) above, the two lamp control circuits comprise microcomputers having memory with identical content, and control is performed by using an external signal to selecting either a control program that adjusts the vertical optical axis or a control program that adjusts the horizontal optical axis.

[0028] (10) In the configuration of (8) or (9) above, the two lamp control circuits perform at least either mutual information exchange through a communication port or information exchange with another external device.

[0029] (11) In the configuration of (8) or (10) above, if there are two lamps, left and right, the left and right lamps have functionality for light distribution switching control between a traveling beam and a passing beam.

[0030] (12) In one of the configurations in (1)–(11) above, the lamp control circuit has a common memory that stores parameters for correcting output characteristics of optical axis adjustment sensors that differ by vehicle model.

[0031] (13) In one of the configurations in (1)–(12) above, the lamp control circuit has an added control function other than an adjustment function for the vertical and horizontal optical axes.

[0032]

[EMBODIMENTS OF THE INVENTION] FIG. 1 is a block diagram showing a configuration of embodiment 1 of the present invention. The same reference numerals as in FIGs. 3–5 show the same constituent elements.

[0033] In FIG. 1, 1 is a DC power source such as a car battery or the like, 2 is a DC/DC converter (DC voltage boosting circuit) that boosts the DC, 3 is a DC/AC (direct current–alternating current) inverter that converts the boosted DC into AC and supplies lighting power to a discharge lamp 5 which is a headlamp, 4 is a launch circuit that applies a high-voltage pulse for launching when starting the discharge lamp 5 and, together with the DC/DC converter 2 and the DC/AC inverter 3, constitutes a lighting circuit for the discharge lamp 5.

[0034] 10 is a headlamp unit on which the discharge lamp 5 and the lighting circuit are mounted, 11 is a reflector, 12 is a motor for optical axis adjustment of the discharge lamp 5, 13 is a motor driver that drives the motor 12, 19 is a lighting control circuit that controls the DC/DC converter 2, and 20 is a microcomputer that constitutes a lamp control circuit that performs the optical axis adjustment, receives as inputs signals from a lamp switch 15, a vehicle speed sensor 16, and vehicle height sensors 17 and 18 at a front and a back of a vehicle, and outputs a polarity-switching control signal for AC lighting to the DC/AC inverter 3.

[0035] 21 is a current detection circuit that detects a lamp current, here detecting a current output by the DC/DC converter 2 with a current detection element 6. 22 is a voltage detection circuit that detects a lamp voltage, here detecting a voltage output by the DC/DC converter 2 with a voltage detection element 7. 23 is a dedicated control IC chip 23 that is a semiconductor chip on which are formed the lighting control circuit 19 and the microcomputer 20 in an integrated fashion, configured by CMOS transistors.

[0036] In the aforementioned configuration, the microcomputer 20 outputs to a lighting control circuit 19 a setting value of a lamp current based on a lamp voltage detected by a voltage detection circuit 22, and the lighting control circuit 19 controls output of the lighting circuit on the basis of the setting value of the lamp current and the detection value of the lamp current detected by a current detection circuit 21.

[0037] Further, the microcomputer 20 is provided with leveling functionality that controls a vertical optical axis of the discharge lamp 5 and cornering light distribution functionality that adjusts

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