(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 749 131 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.02.2018 Bulletin 2018/09

(21) Application number: **12806689.1**

(22) Date of filing: **22.11.2012**

(51) Int Cl.:
H05B 33/08 *(2006.01)*

(86) International application number:
PCT/IB2012/056638

(87) International publication number:
WO 2013/076684 (30.05.2013 Gazette 2013/22)

(54) **DRIVER CIRCUIT AND METHOD FOR VEHICLE LIGHT**

TREIBERSCHALTUNG UND ENTSPRECHENDES VERFAHREN FÜR FAHRZEUGLEUCHTE

CIRCUIT DE COMMANDE ET PROCÉDÉ CORRESPONDANT POUR LAMPE DE VÉHICULE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **23.11.2011 IT PD20110370**

(43) Date of publication of application:
02.07.2014 Bulletin 2014/27

(73) Proprietor: **Automotive Lighting Italia S.p.A. A Socio Unico**
10078 Venaria Reale, (TO) (IT)

(72) Inventors:
- **BACCARIN, Davide**
  I-10078 Venaria Reale (TO) (IT)
- **ENGLARO, Andrea**
  I-10078 Venaria Reale (TO) (IT)
- **MARCORI, Franco**
  I-10078 Venaria Reale (TO) (IT)

(74) Representative: **Chimini, Francesco**
c/o Jacobacci & Partners S.p.A.
Via Berchet, 9
35131 Padova (IT)

(56) References cited:
DE-A1- 10 201 906
DE-A1- 19 950 135
DE-A1-102005 012 625
US-A1- 2004 036 418

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention concerns a driver circuit of lighting sources, in particular LEDs, and a vehicle light comprising such driver circuit. More specifically, the subject of the invention is a driver circuit of at least two lighting branches, connected together in parallel, each comprising one or more lighting sources connected together in series.

[0002] In a general known embodiment, the driver circuit comprises a plurality of lighting switching elements, each suitable for driving a branch electric signal which powers the lighting sources, e.g., a current, of a respective lighting branch. For example, said lighting switching elements are transistors.

[0003] The lighting switching elements are controlled by a polarization circuit which, in a usual embodiment, comprises a voltage and/or current regulator suitable for applying to each switching element a constant command signal, e.g., a constant reference voltage at the base of the lighting transistors, so as to switch on / switch off all the lighting sources simultaneously, and thus produce a lighting effect similar to that of a traditional lamp. US2004/0036418 discloses a circuit with closed loop control of a plurality of LED chains in parallel configuration.

[0004] Nevertheless, in the event of a vehicle light being made with LED lighting sources, and of a lighting branch of said light switching off due to an open circuit fault of a LED lighting source, the remaining lighting branches of the light continue to remain on. It is evident that such situation is not acceptable for a vehicle light.

[0005] The object of the present invention is to propose a driver circuit of lighting sources, in particular LEDs, of the above-mentioned type, able to overcome such a drawback, simulating, in case of an open-circuit fault of a lighting branch, the behaviour of a traditional light bulb.

[0006] Said object is achieved with a circuit according to the claim 1, with a driving method according to the claim 18, and with a vehicle light according to the claim 21. The dependent claims describe preferred embodiments of the invention.

[0007] The characteristics and the advantages of the circuit, of the driving method and of the vehicle light according to the invention will in any case be evident from the description given below of its preferred embodiments, provided indicatively and without being limitative, with reference to the attached illustrations, wherein:

- figure 1 is a circuit diagram of the driver circuit according to the invention;
- figure 2 is a circuit diagram relating to the control means of the lighting transistors, for a lighting transistor;
- figure 3 is a diagram of the voltage/current characteristics superimposed in two lighting branches, one of which faulty due to the short circuit of a LED lighting source; and
- Figure 4 is an example of a vehicle light, the LEDs of which are driven by a driver circuit according to the invention.

[0008] In the following description, the term "connected" refers both to a direct power connection between two circuit elements and to an indirect connection through one or more active or passive intermediate elements. The term "circuit" can indicate both a single component and a plurality of components, active and/or passive, connected together to obtain a pre-established function. Furthermore, where a bipolar joint transistor (BJT) or a field effect transistor (FET) can be used, the meaning of the terms "base", "collector", "emitter" comprises the terms "gate", "drain" and "source", and vice versa. Finally, unless otherwise indicated, type NPN transistors can be used instead of PNP transistors, and vice versa.

[0009] The driver circuit of the lighting sources according to the invention, generally indicated by 100, will now be described with reference to the circuit diagram of figure 1. In the illustrated example, said driver circuit is suitable for driving three strings of LEDs D1, D2; D3,D4; D5,D6, each comprising two LEDs. The circuit is suitable for connecting to a power generator with continuous Vbat supply, e.g. comprising a battery of a vehicle or an alternator. The driver circuit therefore has a positive power terminal 1, connectable to the positive pole of the power generator, and a negative power terminal 2, connectable to the negative pole of the power generator, e,g., the ground. The strings of LEDs are arranged on respective lighting circuit branches A, B, C connected in parallel between said positive and negative terminals of the driver circuit.

[0010] Between the Vbat power generator and the supply terminals 1,2 of the driver circuit an inlet filter F can be placed also comprising an anti-inversion diode Din.

[0011] A lighting transistor TLEDA; TLEDB; TLEDC is connected to each string of LEDs. For example, said lighting transistor has the collector connected to the string of LEDs and the emitter connected to the ground by means of a driving resistance RA, RB, RC. The state of the lighting transistors, and therefore the flow of current through the strings of LEDs, is determined by the Vref voltage value on the base of the transistors, henceforth herein called driving voltage.

[0012] In a general embodiment, said voltage driving value Vref is defined by a reference voltage regulator 10 suitable for maintaining a constant reference voltage applied to the base of the lighting transistors, for a determinate input voltage applied to the voltage regulator itself. For example, the driving voltage is established through a zener diode DZ.

[0013] Between the reference voltage regulator 10 and the bases of the lighting transistors Tled is placed a power driver 20 suitable for supplying to said lighting transistors the base current needed for their operation.

[0014] The described driver circuit is therefore a current stabilized circuit, i.e., one wherein a constant driving voltage Vref is injected on the base of the lighting transistors and the driving current which flows in the lighting branches is constant, starting from a certain supply voltage value. To operate this way, the lighting transistors operate in linear zone.

[0015] In case of an open circuit fault, the lighting transistor of the faulty branch, in the presence of a driving voltage Vref on its base, not being able to allow the flow of a collector current proportionate to the base current, lowers its collector voltage and tends to reach saturation levels.

[0016] According to the invention, the driver circuit comprises transistor control means 30 suitable for forcing the lighting transistors to always work in linear zone. In other words, said control means force the lighting transistors to switch from state of operation in saturation to state of operation in linear zone, or to remain in the state of operation in linear zone in case of tending to switch towards the state of operation in saturation, e.g., in case of a fault.

[0017] In a general embodiment, said control means 30 are suitable for detecting the operation in saturation of at least one of the lighting transistors and, in response to such detection, for reducing the driving voltage of all the lighting transistors.

[0018] In one embodiment, the control means comprise a linear regulation block 40, comprising, for example, a regulation transistor Treg, connected between the positive supply terminal 1 and the reference voltage regulator 10. When activated, said linear regulation block regulates the driving voltage Vref reducing it to a lower value with respect to that set, e.g. by means of the zener diode DZ, by the voltage regulator 10, in fact bypassing said voltage regulator 10. The control means 30 are suitable for activating said linear regulation block 40. When it is not active, the linear regulation block 40 can be assimilated to a direct polarized diode, i.e, it does not affect the reference voltage regulator 10.

[0019] In one embodiment, the control means 30 are connected in feedback between the collector terminal of each of the lighting transistors and the linear regulation block 40, in such a way that, when the voltage on said collector terminal takes on a value corresponding to a state of saturation of the transistor, the control means 30 polarize the regulation transistor Treg of the linear regulation block.

[0020] More in detail, for each lighting transistor, the control means 30 comprise a feedback transistor TRA; TRB; TRC having the base terminal connected to the collector of a respective lighting transistor by means of a base resistance, the emitter connected to the base of the transistor TP of the power driver 20 and the collector connected to the base of a voltage control transistor TC, the collector of which is connected to the linear regulation block 40.

[0021] In a preferred embodiment, the feedback transistors TRA; TRB; TRC are arranged on respective circuit branches connected together in parallel, between the base of the power transistor TP and the base of the control transistor TC.

[0022] The operation of the transistor control means 30 will now be illustrated in greater detail. Consider the transistor control circuit shown in figure 2, for simplicity relating to just one of the lighting transistors, e.g., TLEDA.

[0023] The feedback transistor TRA comes on when it has an emitter-base Veb(TRA) voltage of around 0.7 V. By applying the Kirchoff law to the mesh M shown in figure 2, therefore it can be obtained:

[0024] Vbc (TLEDA) + Vbe(TP) = Veb(TRA) + VRb, where Rb is the base resistance of the feedback transistor TRA, meaning

[0025] TRA only comes on for: Veb(TRA)+VRb > 0.7 V, which can be rewritten as:

$$\mathrm{Vbc(TLEDA)} + \mathrm{Vbe(TP)} > 0.7\ \mathrm{V}$$

[0026] Because Vbe(TP) is about equal to 0.7 V, and ignoring the negligible voltage drop at the ends of the resistance Rb on the base of the feedback transistor, we have:

[0027] TRA only comes on if

$$\mathrm{Vbc(TLEDA)} > 0.$$

[0028] Consequently, the feedback transistor only comes on when the lighting transistor comes close to the saturation zone, i.e., when its collector voltage drops below base voltage.

[0029] When the feedback transistor comes on, a collector current starts to flow in this transistor, and this current enters the base of the control transistor TC, switching it on. The start of the control transistor, as said, in turn causes the start of the linear regulation block 40, and therefore a reduction in the driving voltage. Said driving voltage is reduced until the lighting transistor which was at saturation level enters the linear zone, switching off the feedback transistor TRA.

[0030] As has been said above, in case of an open circuit fault, the lighting transistor of the faulty branch, in the presence of a driving voltage on its base, not being able to make flow a collector current proportionate to the base current, lowers its collector voltage trying to reach saturation level. But as soon as its collector-base VCB voltage falls below zero, the transistor control means 30 come into play which, as explained above, not only cut the driving voltage of the transistor tending towards saturation level to make it stay in linear zone, but also the base voltage of all the other lighting transistors.

[0031] The lighting transistor relating to the faulty lighting branch then remains working in the linear zone, because it has a collector current given by the sole base current of the feedback transistor, while the base current of the lighting transistor is limited by the feedback of the transistor control means 30.

[0032] In case of an open circuit fault, therefore, the lighting transistor of the relative branch can never exit from the limited base current situation. Because such limited base current is the same for all the lighting transistors, not even the LEDs of the correctly-operating branches come on.

[0033] Such effect of the open circuit fault of a LED thus simulates the effect of the fault of a traditional bulb, inasmuch as the lighting device, e.g., the vehicle light, appears completely off. Besides the visual effect, the absence of current absorption on all the lighting branches can trigger an alarm signal.

[0034] It should be noted that the minimum base current flowing in all the lighting transistors is in any case enough to ensure the lighting transistors remain in a state of activation. If the faulty LED were to start operating again, all the branches of the LED can return to their normal operation.

[0035] In a preferred embodiment of the transistor control means 30, the base of each feedback transistor TRA; TRB; TRC and the emitter of the other feedback transistors are connected together by means of a feedback diode DRA; DRB; DRC.

[0036] This advantageously permits the transistor control means 30 to also detect a fault of a lighting branch due to a short circuit.

[0037] In case of a fault due to short circuit, in fact, a difference in potential is created between the base of the feedback transistor relating to the faulty branch and the bases of the remaining feedback transistors (i.e., relating to the correctly-operating lighting branches). Such difference in potential favours the occurrence of an electric current which flows across the feedback diode DR connected to the base of the feedback transistor relating to the faulty branch, reaching the emitter of the other feedback transistors.

[0038] Such current, thus entering the emitters of the other feedback transistors, polarizes such transistors in active linear zone. In other words, said feedback transistors have a determinate voltage applied to the respective base and a determinate voltage applied to the respective emitter, which polarize them in linear active zone.

[0039] Consequently, an electric current flows through the collectors of the feedback transistors relating to the correctly-operating lighting branches. Such collector currents flow towards the base of the control transistor TC and discharge to the ground.

[0040] Such collector currents applied to the base of the control transistor TC cause said transistor to switch on and this, in turn, activates the linear regulation block 40, thus reducing the input voltage of the voltage regulator 10 and, therefore, the voltage Vref applied to the base of the lighting transistors.

[0041] The driver circuit therefore finds itself in the same condition described above due to an open circuit fault, i.e., with a very limited base current on the lighting transistors, to which corresponds a branch current which is insufficient for lighting the lighting sources.

[0042] Such situation is maintained until the electric potential difference between the bases of the feedback transistors TRA; TRB; TRC drops below a determinate value, such that the feedback transistors which produced the activation current for the control transistor TC switch off.

[0043] More in detail, until the potential difference between the bases of the feedback transistors is high enough, the feedback transistors are switched on and conduct enough current to activate the control transistor TC. The latter, in turn, activates the linear regulation block 40, which reduces its output voltage, and therefore also the driving voltage Vref, to zero.

[0044] With reference to the diagram in figure 3, which shows, superimposed, the voltage/current characteristics on the LED strings of the two branches A, B', where the branch B' has a faulty LED due to short circuit,we have that, when the driving voltage Vref drops towards zero, there is a reduction in the driving current of the LEDs on the lighting branches and therefore, by virtue of the characteristic voltage/current at the ends of the LEDs, a reduction in the potential difference ΔV between the collectors of the lighting transistors, i.e., between the bases of the feedback transistors.

[0045] When such potential difference is reduced, the linear regulation block 40 tends to switch off, increasing the driving voltage Vref, which from zero starts to rise, causing an increase in the LED driving current.

[0046] The feedback control implemented by the transistor control means 30 reaches a balance condition when the potential difference between the bases of the feedback transistors is enough to keep the linear regulation block 40 active, but at such a level as to define a low but not zero driving voltage Vref, generally between zero and the driving voltage set by the voltage regulator 10. To said driving voltage corresponds a LED driving current such as not to allow the LEDs to emit a light radiation perceivable to the human eye, e.g., through a lens of the light. Such driving current, nevertheless, represents a sufficient activation current to permit reactivating the LEDs in the event of the faulty LED due to short circuit returning to normal operation.

[0047] So that the electric current, in response to the potential difference between the bases of the feedback transistors, flows from one of such bases towards the emitters of the feedback transistors relating to the correctly-operating lighting branches, and does not flow instead towards the power driver 20 and/or the zener diode DZ of the voltage regulator, discharging on the ground, current blockage means for blocking the current in this direction will have to be provided.

[0048] In one embodiment, said current blockage means comprise a first anti-inversion diode DAI which permits the flow of current only from the output terminal of the voltage regulator 10, i.e., from the base of the power driver 20, to the emitters of the feedback transistors TRA; TRB; TRC, and not vice versa. Furthermore, said current blockage means comprise a second compensation diode DC that cancels the voltage drop introduced by the first anti-inversion diode DI, which would otherwise affect the calculation of the mesh voltage M of the figure 2.

[0049] It must be noted that, in a variation embodiment of the control means for the detection of a fault due to short circuit, instead of obtaining a current in the control means 30 from the potential difference between the bases of the feedback transistors, the control means can comprise a voltage comparator circuit suitable for comparing the voltage on the base of the feedback transistors with a pre-established control activation voltage, so as to generate a driving current of the control transistor TC in accordance with the result of such comparison.

[0050] With reference to the figure 4, the present invention concerns a vehicle light 200 wherein at least one light of the light is made with LED lighting sources driven by the driver circuit described above. The vehicle light 200 can be a front light, rear light or the third rear light of the vehicle. The light of this light can be, for example, the side light, the stop light, the rear fog light.

[0051] To the embodiments of the circuit and of the driving method according to the invention, a skilled person, to satisfy contingent needs, can make changes, adaptations and replacements of elements with others having equivalent operation, without departing from the scope of the invention as defined by the appended claims.

[0052] For example, the control of the lighting transistors can be implemented, besides using the electric circuit control means 30 described above, in software mode, using a processing unit, e.g., a micro controller or a DSP.

Claims

1. Driver circuit for lighting sources (D1-D6), in particular LEDs, comprising:

   - a positive power supply terminal (1) connectable to the positive pole of a direct voltage power supply generator (V_{bat}) and a negative terminal (2) connectable to the negative pole of said generator;
   - a plurality of lighting branches (A, B, C) connected in parallel between said power supply terminals, each of said plurality of lighting branches comprising one or more lighting sources (D1,D2; D3,D4; D5,D6) connected in series to each other and being supplied by a respective branch driving current,
   - a plurality of lighting transistors (T_{LEDA}, T_{LEDB}, T_{LEDC}) each able to operate in a linear zone functioning state and in a saturation functioning state, each configured for driving said branch driving current of the respective lighting branch by means of a driving voltage (V_{ref}) applied to each of the bases of the lighting transistors and
   - control means (30) for controlling said lighting transistors;

   characterised in that said control means (30) are configured for detecting the saturation functioning state, or a commutation from the linear zone functioning state to the saturation functioning state, by any one of the lighting transistors and, in response to such detection, for reducing the driving voltage of all the lighting transistors so as to force said lighting transistors to operate in the linear zone functioning state.

2. Driving circuit according to claim 1, wherein said control means (30) are configured to force said lighting transistors to remain operating in said linear zone functioning state, when said lighting transistors tend to pass from said linear zone functioning state to said saturation functioning state.

3. Circuit according to the preceding claim, wherein the control means (30) are suitable for detecting said saturation state of functioning and, in response to a detection of said saturation state of functioning, for modifying said driving voltage in such a way that all the lighting transistors drive a branch driving current insufficient to cause the lighting sources to be turned on.

4. Circuit according to anyone of the preceding claims, comprising a reference voltage regulator (10) suitable for generating a reference voltage on which the driver voltage of the lighting transistors depends.

5. Circuit according to the preceding claim, wherein a power driver (20) is placed between said reference voltage regulator and the lighting transistors suitable for supplying said transistors with the current needed for them to function.

6. Circuit according to the preceding claim, wherein the control means comprise a linear regulation block (40) connected between the positive power supply terminal (1) and the reference voltage regulator (10) and activatable to regulate the driver voltage (V_{ref}) reducing it to a lower value than that set by the reference voltage regulator (10).

7. Circuit according to the preceding claim, wherein the control means (30) are connected by feedback means between the collector terminal of each of the lighting transistors and the linear regulation block (40), in such a way that, when the voltage on any of said collector terminals assumes a value corresponding to a state of saturation of the transistor, the control means (30) activate the linear regulation block (40).

8. Circuit according to the preceding claim, wherein, for each lighting transistor, the control means comprise a feedback transistor (T_{RA}; I_{RB}; T_{RC}) having the base terminal connected to the collector of a respective lighting transistor, the emitter connected to the base of the power driver (20) and the collector connected to the base of a control transistor (T_C), the collector of which is connected to the linear regulator block (40).

9. Circuit according to the preceding claim, wherein the feedback transistors are positioned on respective circuit branches connected in parallel to each other between the base of the power driver (20) and the base of the control transistor (T_C).

10. Circuit according to the preceding claim, wherein the base of each feedback transistor and the emitter of the other feedback transistors are connected to each other by means of a feedback diode (D_{RA}; D_{RB}; D_{RC}).

11. Circuit according to the preceding claim, wherein an anti-inversion diode (D_{AI}) suitable for preventing a flow of current from the emitters to the base is placed between said emitters of the feedback transistors and said base of the power driver.

12. Circuit according to claim 8, wherein the control means comprise a voltage comparator circuit suitable for comparing the voltage on the base of the feedback transistors with a control activation voltage, so as to generate a driver current of the control transistor depending on the outcome of such comparison.

13. Driver method of lighting sources, in particular LED, comprising:

- providing a driver circuit, comprising a positive power supply terminal connectable to the positive pole of a power supply voltage generator and a negative power supply terminal connectable to the negative pole of said generator, a plurality of lighting branches connected in parallel between said power supply terminals, each of said plurality of lighting branches comprising at least one respective light source and being supplied by a respective branch driving current;
- driving each of said branch driving currents of the lighting branches by means of a plurality of respective lighting transistors, each transistor being able to operate in a linear zone functioning state and a saturation functioning state,

the method being **characterised by**:

- controlling said lighting transistors so as to detect the saturation functioning state, or a commutation from the linear zone functioning state to the saturation functioning state, by any one of the lighting transistors and, in response to such detection, for reducing the driving voltage of all the lighting transistors so as to to force said lighting transistors to operate in said linear zone functioning state.

14. Method according to the preceding claim, wherein the operation of controlling said lighting transistors comprises forcing said lighting transistors to remain operating in said linear zone functioning state, when said lighting transistors tend to pass from said linear zone functioning state to said saturation functioning state.

15. Vehicle light (200) **characterised by** the fact of comprising a LED driver circuit according to any of the claims from 1 to 12.

Patentansprüche

1. Treiberschaltung für Lichtquellen (D1-D6), insbesondere für LEDs, aufweisend:

- einen positiven Energieversorgungsanschluss (1), der sich mit dem positiven Pol eines Gleichstromgenerators (V_{bat}) verbinden lässt, und einen negativen Anschluss (2), der sich mit dem negativen Pol des Generators verbinden lässt;
- mehrere Beleuchtungszweige (A, B, C), die in Parallelschaltung zwischen den Energieversorgungsanschlüssen verbunden sind, wobei jeder der mehreren Beleuchtungszweige eine oder mehrere Lichtquellen (D1,D2; D3,D4; D5,D6) aufweist, die miteinander in Serie verbunden sind und mit jeweils einem Zweigtreiberstrom versorgt werden,
- mehrere Beleuchtungstransistoren (T_{LEDA}, T_{LEDB}, T_{LEDC}), die jeweils in der Lage sind, in einem linearen Zonenbetriebszustand und in einem Sättigungsbetriebszustand zu arbeiten, und jeweils dafür vorgesehen sind, den Zweigtreiberstrom des entsprechenden Beleuchtungszweigs mittels einer Treiberspannung (V_{ref}) anzusteuern, die an jeder der Basen der Beleuchtungstransistoren anliegt, und
- Steuerungsmittel (30) zum Steuern der Beleuchtungstransistoren; **dadurch gekennzeichnet, dass**

die Steuerungsmittel (30) dazu eingerichtet sind, den Sättigungsbetriebszustand oder einen Wechsel eines beliebigen der Beleuchtungstransistoren von dem linearen Zonenbetriebszustand in den Sättigungsbetriebszustand zu erfassen, und in Antwort auf ein derartiges Erfassen die Treiberspannung sämtlicher Beleuchtungstransistoren zu reduzieren, um zu erzwingen, dass die Beleuchtungstransistoren in dem linearen Zonenbetriebszustand arbeiten.

2. Treiberschaltung nach Anspruch 1, wobei die Steuerungsmittel (30) dazu eingerichtet sind, zu erzwingen, dass die Beleuchtungstransistoren weiter in dem linearen Zonenbetriebszustand zu arbeiten, wenn die Beleuchtungstransistoren dazu neigen, von dem linearen Zonenbetriebszustand in den Sättigungsbetriebszustand überzugehen.

3. Schaltung nach dem vorhergehenden Anspruch, wobei die Steuerungsmittel (30) in der Lage sind, den Sättigungsbetriebszustand zu erfassen, und in Antwort auf ein Erfassen des Sättigungsbetriebszustands die Treiberspannung so zu modifizieren, dass sämtliche Beleuchtungstransistoren einen Zweigtreiberstrom steuern, der nicht dazu ausreicht, ein Einschalten der Lichtquellen zu veranlassen.

4. Schaltung nach einem beliebigen der vorhergehenden Ansprüche, mit einem Referenzspannungsregler (10), der in der Lage ist, eine Referenzspannung zu erzeugen, von der die Treiberspannung der Beleuchtungstransistoren abhängt.

5. Schaltung nach dem vorhergehenden Anspruch, wobei zwischen dem Referenzspannungsregler und den Beleuchtungstransistoren ein Leistungstreiber (20) angeordnet ist, der in der Lage ist, den Transistoren den für ihren Betrieb erforderlichen Strom zuzuführen.

6. Schaltung nach dem vorhergehenden Anspruch, wobei die Steuerungsmittel einen linearen Regelungsblock (40) aufweisen, der zwischen dem positiven Energieversorgungsanschluss (1) und dem Referenzspannungsregler (10) verbunden ist, und zu aktivieren ist, um die Treiberspannung (V_{ref}) zu regeln, um sie auf einen Wert zu verringern, der kleiner ist als derjenige, der durch den Referenzspannungsregler (10) eingestellt ist.

7. Schaltung nach dem vorhergehenden Anspruch, wobei die Steuerungsmittel (30) über Rückkopplungsmittel zwischen dem Kollektoranschluss jedes der Beleuchtungstransistoren und dem linearen Regelungsblock (40) in der Weise verbunden sind, dass die Steuerungsmittel (30), wenn die Spannung an jedem der Kollektoranschlüsse einen Wert annimmt, der einem Sättigungszustand des Transistors entspricht, den linearen Regelungsblock (40) aktivieren.

8. Schaltung nach dem vorhergehenden Anspruch, wobei die Steuerungsmittel für jeden Beleuchtungstransistor einen Rückkopplungstransistor (T_{RA}; T_{RB}; T_{RC}) aufweisen, bei dem der Basisanschluss mit dem Kollektor eines entsprechenden Beleuchtungstransistors verbunden ist, bei dem der Emitter mit der Basis des Leistungstreibers (20) verbunden ist, und bei dem der Kollektor mit der Basis eines Steuertransistors (T_c) verbunden ist, dessen Kollektor mit dem linearen Regelungsblock (40) verbunden ist.

9. Schaltung nach dem vorhergehenden Anspruch, wobei die Rückkopplungstransistoren jeweils auf Schaltungszweigen angeordnet sind, die miteinander in Parallelschaltung zwischen der Basis des Leistungstreibers (20) und der Basis des Steuertransistors (T_c) verbunden sind.

10. Schaltung nach dem vorhergehenden Anspruch, wobei die Basis jedes Rückkopplungstransistors und der Emitter der übrigen Rückkopplungstransistoren miteinander mittels einer Rückkopplungsdiode (D_{RA}; D_{RB}; D_{RC}) verbunden sind.

11. Schaltung nach dem vorhergehenden Anspruch, wobei zwischen den Emittern der Rückkopplungstransistoren und der Basis des Leistungstreibers eine Antiinversionsdiode angeordnet ist, die in der Lage ist, einen Stromfluss von den Emittern zu der Basis zu verhindern.

12. Schaltung nach Anspruch 8, wobei die Steuerungsmittel einen Spannungsvergleicherschaltkreis aufweisen, geeignet um die Spannung an der Basis der Rückkopplungstransistoren mit einer Steuerungsaktivierungsspannung zu vergleichen, um in Abhängigkeit von dem Ergebnis eines solchen Vergleichs einen Treiberstrom des Steuertransistors zu erzeugen.

13. Teiberverfahren für Lichtquellen, insbesondere für LEDs, umfassend:

- Vorsehen einer Treiberschaltung, die einen positiven Energieversorgungsanschluss, der sich mit dem positiven Pol eines Energieversorgungsspannungsgenerators verbinden lässt, und einen negativen Energieversorgungsanschluss aufweist, der sich mit dem negativen Pol des Generators verbinden lässt, wobei zwischen den Energieversorgungsanschlüssen mehrere Beleuchtungszweige in Parallelschaltung verbunden sind, wobei jeder der mehreren Beleuchtungszweige wenigstens eine entsprechende Lichtquelle aufweist und mit einem entsprechenden Zweigtreiberstrom versorgt wird;
- Ansteuern jedes der Zweigtreiberströme der Beleuchtungszweige mittels mehrerer entsprechender Beleuchtungstransistoren, wobei jeder Transistor in der Lage ist, in einem linearen Zonenbetriebszustand und in einem Sättigungsbetriebszustand zu arbeiten,

wobei das Verfahren **gekennzeichnet ist durch**:

- Steuern der Beleuchtungstransistoren, um den Sättigungsbetriebszustand oder einen Wechsel eines beliebigen der Beleuchtungstransistoren von dem linearen Zonenbetriebszustand in den Sättigungsbetriebszustand zu erfassen, und in Antwort auf ein derartiges Erfassen, die Treiberspannung sämtlicher Beleuchtungstransistoren zu reduzieren, um zu erzwingen, dass die Beleuchtungstransistoren in dem linearen Zonenbetriebszustand arbeiten.

14. Verfahren nach dem vorhergehenden Anspruch, wobei der Vorgang des Steuerns der Beleuchtungstransistoren erzwingt, dass die Beleuchtungstransistoren weiter in dem linearen Zonenbetriebszustand arbeiten, wenn die Beleuchtungstransistoren dazu neigen, von dem linearen Zonenbetriebszustand in den Sättigungsbetriebszustand überzugehen.

15. Fahrzeugleuchte (200), **dadurch gekennzeichnet, dass** sie eine LED-Treiberschaltung nach einem beliebigen der Ansprüche von 1 bis 12 aufweist.

Revendications

1. Circuit de commande pour des sources d'éclairage (D1-D6), en particulier des DEL, comprenant :

- une borne d'alimentation électrique positive (1) pouvant être raccordée au pôle positif d'un générateur d'alimentation électrique de tension continue (V_{bat}) et une borne négative (2) pouvant être raccordée au pôle négatif dudit générateur ;
- une pluralité de dérivations d'éclairage (A, B, C) raccordées en parallèle entre lesdites bornes d'alimentation électrique, chacune de ladite pluralité de dérivations d'éclairage comprenant une ou plusieurs sources d'éclairage (D1, D2 ; D3, D4 ; D5, D6) raccordées en série les unes aux autres et étant alimentées par un courant de commande de dérivation respectif,
- une pluralité de transistors d'éclairage (T_{LEDA}, T_{LEDB}, T_{LEDC}) chacun étant apte à fonctionner dans un état de fonctionnement de zone linéaire et dans un état de fonctionnement de saturation, chacun étant configuré pour commander ledit courant de commande de dérivation de la dérivation d'éclairage respective au moyen d'une tension de commande (V_{ref}) appliquée à chacune des bases des transistors d'éclairage et
- des moyens de commande (30) pour commander lesdits transistors d'éclairage ;

caractérisé en ce que lesdits moyens de commande (30) sont configurés pour détecter l'état de fonctionnement de saturation ou une commutation de l'état de fonctionnement de zone linéaire à l'état de fonctionnement de saturation par l'un quelconque des transistors d'éclairage et, en réponse à une telle détection, pour réduire la tension de commande de tous les transistors d'éclairage de sorte à forcer lesdits transistors d'éclairage à fonctionner dans l'état de fonctionnement de zone linéaire.

2. Circuit de commande selon la revendication 1, dans lequel lesdits moyens de commande (30) sont configurés pour forcer lesdits transistors d'éclairage à rester opérationnels dans ledit état de fonctionnement de zone linéaire, lorsque lesdits transistors d'éclairage tendent à passer dudit état de fonctionnement de zone linéaire audit état de fonctionnement de saturation.

3. Circuit selon la revendication précédente, dans lequel les moyens de commande (30) sont adaptés pour détecter ledit état de fonctionnement de saturation et, en réponse à une détection dudit état de fonctionnement de saturation, pour modifier ladite tension de commande de telle manière que tous les transistors d'éclairage commandent un courant de commande de dérivation insuffisant pour amener les sources d'éclairage à s'allumer.

4. Circuit selon l'une quelconque des revendications précédentes, comprenant un régulateur de tension de référence (10) adapté pour générer une tension de référence de laquelle dépend la tension de commande des transistors d'éclairage.

5. Circuit selon la revendication précédente, dans lequel un élément de commande de puissance (20) est placé entre ledit régulateur de tension de référence et les transistors d'éclairage adaptés pour alimenter lesdits transistors en courant nécessaire à leur fonctionnement.

6. Circuit selon la revendication précédente, dans lequel les moyens de commande comprennent un bloc de régulation linéaire (40) raccordé entre la borne d'alimentation électrique positive (1) et le régulateur de tension de référence (10) et pouvant être activé pour réguler la tension de commande (V_{ref}) la réduisant à une valeur inférieure à celle réglée par le régulateur de tension de référence (10).

7. Circuit selon la revendication précédente, dans lequel les moyens de commande (30) sont raccordés par des moyens de rétroaction entre la borne de collecteur de chacun des transistors d'éclairage et le bloc de régulation linaire (40) de telle manière que lorsque la tension sur l'une quelconque desdites bornes de collecteur adopte une valeur correspondant à un état de saturation du transistor, les moyens de commande (30) activent le bloc de régulation linéaire (40).

8. Circuit selon la revendication précédente, dans lequel pour chaque transistor d'éclairage, les moyens de commande comprennent un transistor de rétroaction (T_{RA}; T_{RB} ; T_{RC}) présentant la borne de base raccordée au collecteur d'un transistor d'éclairage respectif, l'émetteur étant raccordé à la base de l'élément de commande de puissance (20) et le collecteur étant raccordé à la base d'un transistor de commande (T_C), dont le collecteur est raccordé au bloc de régulateur linéaire (40).

9. Circuit selon la revendication précédente, dans lequel les transistors de rétroaction sont positionnés sur des dérivations de circuit respectives raccordées en parallèle les unes aux autres entre la base de l'élément de commande de puissance (20) et la base du transistor de commande (T_c).

10. Circuit selon la revendication précédente, dans lequel la base de chaque transistor de rétroaction et l'émetteur des autres transistors de rétroaction sont raccordés l'un à l'autre au moyen d'une diode de rétroaction (D_{RA} ; D_{RB} ; D_{RC}).

11. Circuit selon la revendication précédente, dans lequel une diode anti-inversion (D_{AI}) adaptée pour empêcher un flux de courant des émetteurs à la base est placée entre lesdits émetteurs des transistors de rétroaction et ladite base de l'élément de commande de puissance.

12. Circuit selon la revendication 8, dans lequel les moyens de commande comprennent un circuit de comparateur de tension adapté pour comparer la tension sur la base des transistors de rétroaction avec une tension d'activation de commande de sorte à générer un courant de commande du transistor de commande selon le résultat d'une telle comparaison.

13. Procédé de commande de sources d'éclairage, en particulier de DEL, comprenant :

- la fourniture d'un circuit de commande, comprenant une borne d'alimentation électrique positive pouvant être raccordée au pôle positif d'un générateur de tension d'alimentation électrique et une borne d'alimentation électrique négative pouvant être raccordée au pôle négatif dudit générateur, une pluralité de dérivations d'éclairage raccordées en parallèle entre lesdites bornes d'alimentation électrique, chacune de ladite pluralité de dérivations d'éclairage comprenant au moins une source de lumière respective et étant alimentée par un courant de commande de dérivation respectif ;
- la commande de chacun desdits courants de commande de dérivation des dérivations d'éclairage au moyen d'une pluralité de transistors d'éclairage respectifs, chaque transistor étant apte à fonctionner dans un état de fonctionnement de zone linéaire et un état de fonctionnement de saturation,

le procédé étant **caractérisé par** :

- la commande desdits transistors d'éclairage de sorte à détecter l'état de fonctionnement de saturation ou une commutation de l'état de fonctionnement de zone linéaire à l'état de fonctionnement de saturation, par l'un quelconque des transistors d'éclairage, et en réponse à une telle détection pour la réduction de la tension de commande de tous les transistors d'éclairage de sorte à forcer lesdits transistors d'éclairage à fonctionner dans ledit état de fonctionnement de zone linéaire.

14. Procédé selon la revendication précédente, dans lequel l'opération de commande desdits transistors d'éclairage comprend le forçage desdits transistors d'éclairage à rester opérationnels dans ledit état de fonctionnement de zone linéaire lorsque lesdits transistors d'éclairage tendent à passer dudit état de fonctionnement de zone linéaire audit état de fonctionnement de saturation.

15. Lampe de véhicule (200) **caractérisée par le fait qu'**elle comprend un circuit de commande de DEL selon l'une quelconque des revendications 1 à 12.

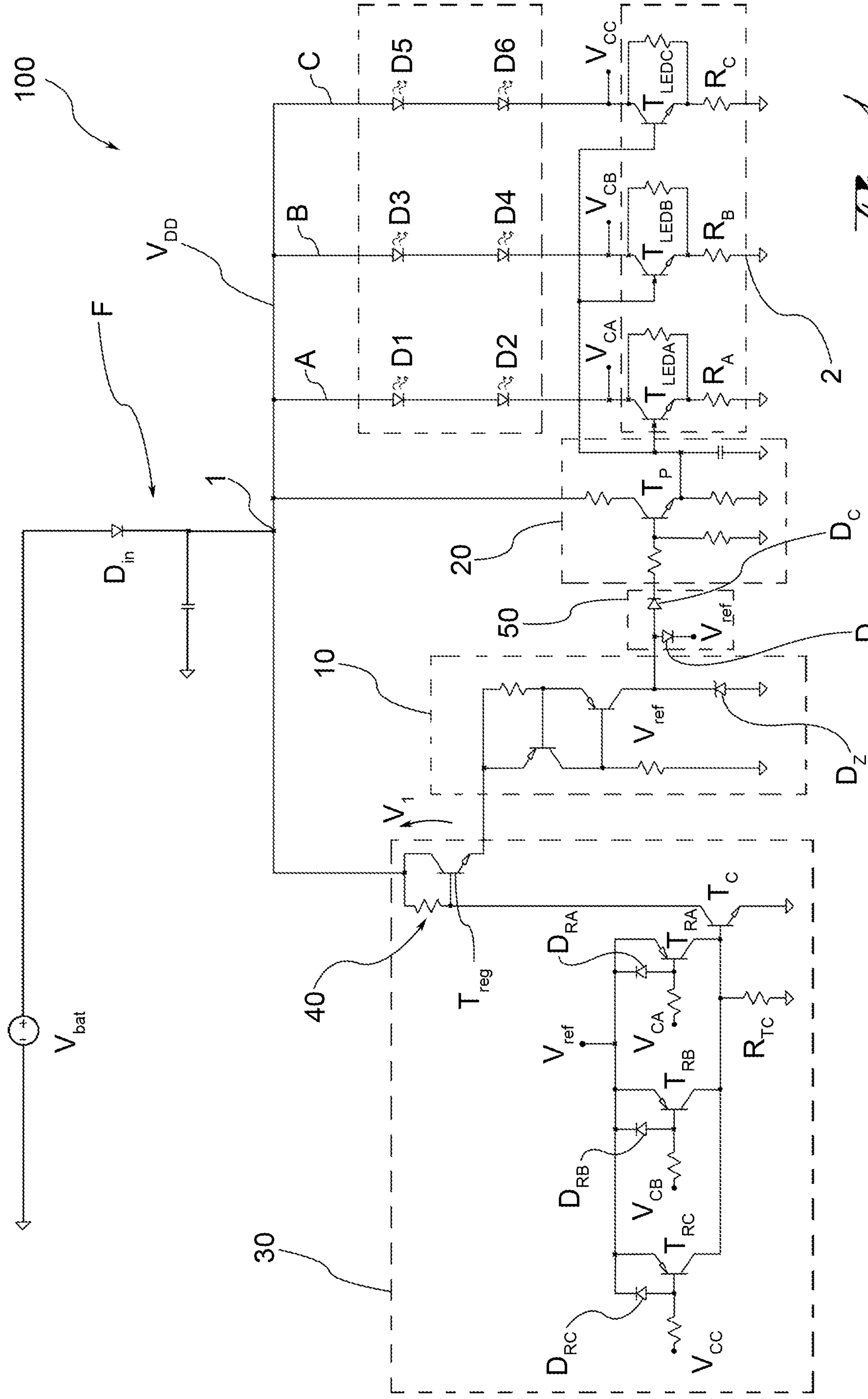
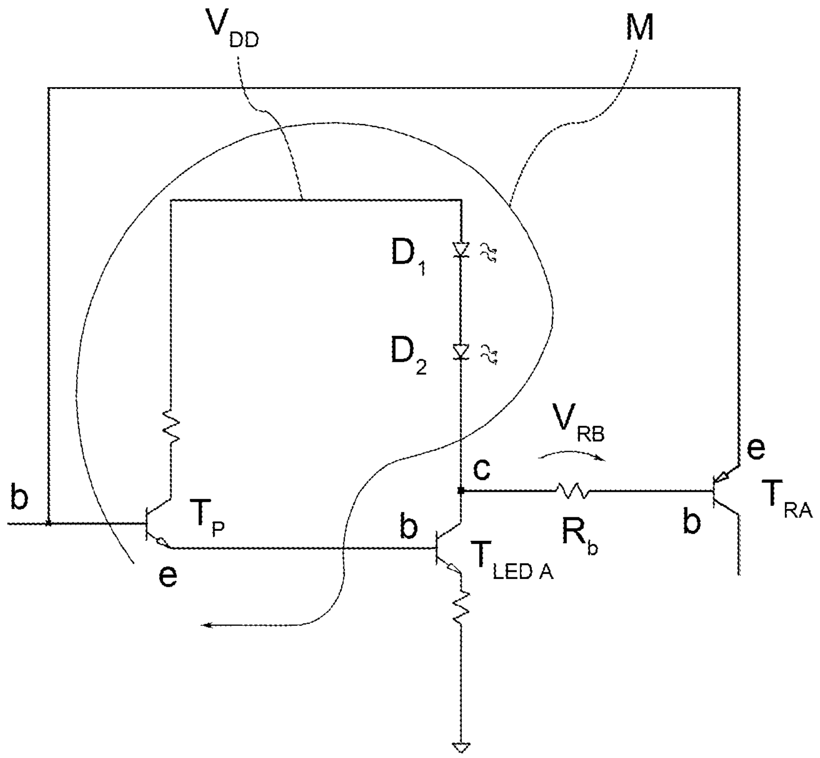
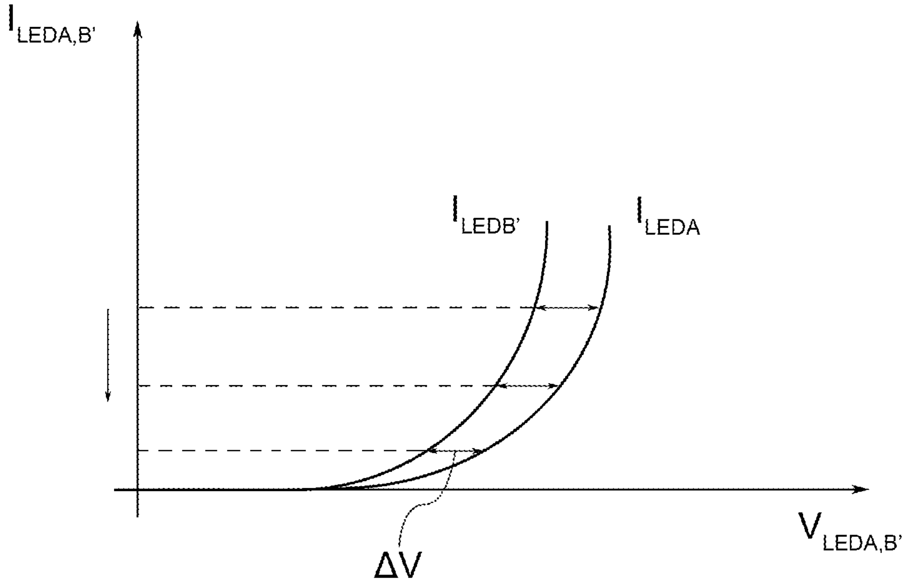

100
F
1
V_DD
A
B
C
D1
D2
D3
D4
D5
D6
V_CA
V_CB
V_CC
T_LEDA
T_LEDB
T_LEDC
R_A
R_B
R_C
2
T_P
20
D_C
50
V_ref
D_Al
10
D_Z
V_1
D_in
V_bat
30
40
T_reg
T_C
D_RA
T_RA
R_TC
T_RB
D_RB
T_RC
D_RC

Fig. 1



V_{DD}
M
D_1
D_2
V_{RB}
c
e
b
T_P
b
$T_{LED\ A}$
R_b
b
T_{RA}
e

Fig. 2



$I_{LEDA,B'}$
$I_{LEDB'}$
I_{LEDA}
$V_{LEDA,B'}$
ΔV

Fig. 3

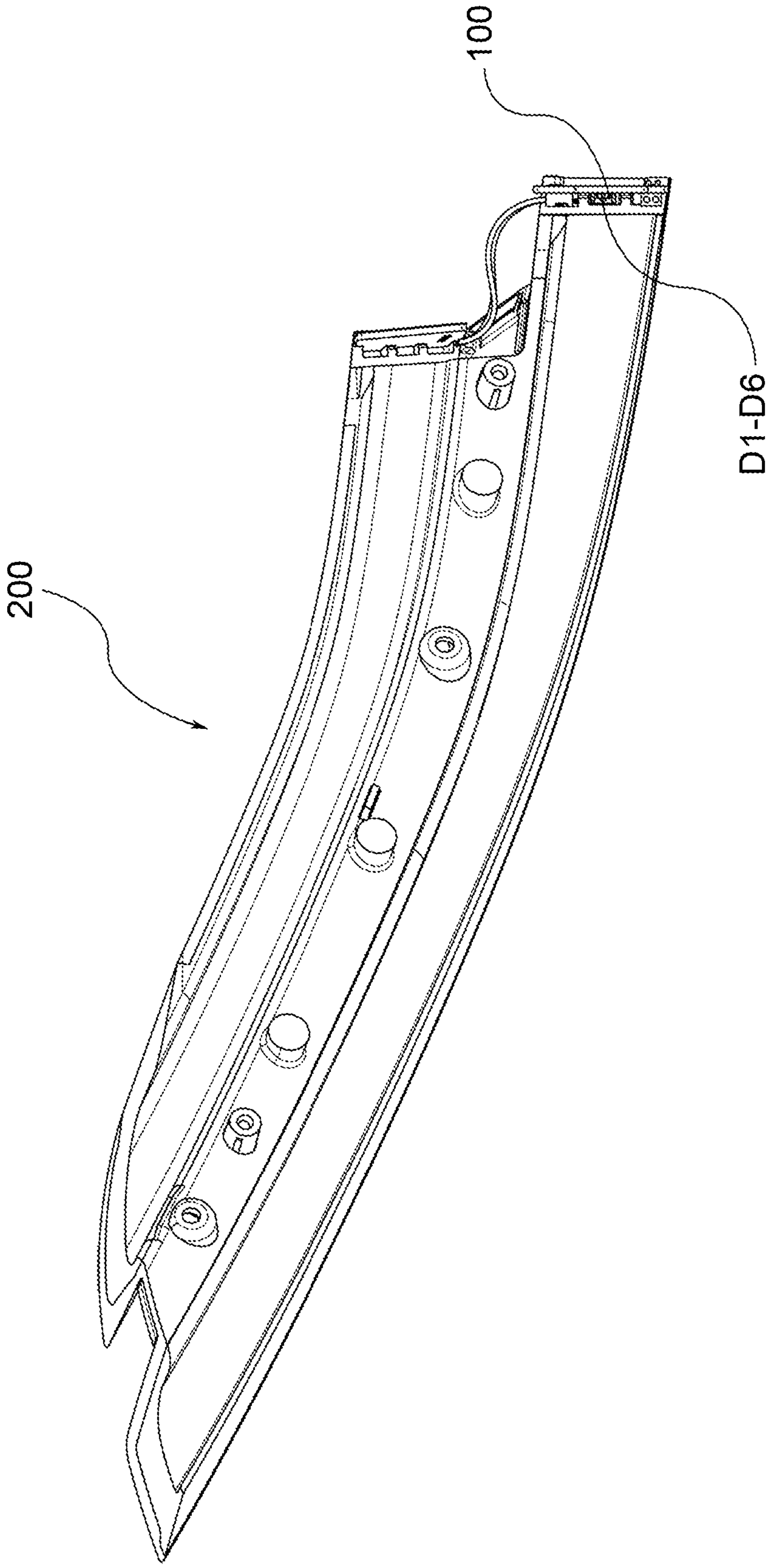


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20040036418 A **[0003]**