



(86) Date de dépôt PCT/PCT Filing Date: 2014/01/07
(87) Date publication PCT/PCT Publication Date: 2014/07/17
(85) Entrée phase nationale/National Entry: 2015/07/03
(86) N° demande PCT/PCT Application No.: FI 2014/050010
(87) N° publication PCT/PCT Publication No.: 2014/108600
(30) Priorité/Priority: 2013/01/08 (FI20135024)

(51) Cl.Int./Int.Cl. *H02J 13/00* (2006.01),
B60Q 5/00 (2006.01), *B60Q 7/00* (2006.01),
G08B 23/00 (2006.01)
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(54) Titre : INDICATEUR DE COMMUTATION D'UN CABLE ELECTRIQUE
(54) Title: A SWITCHING INDICATOR OF A POWER CABLE

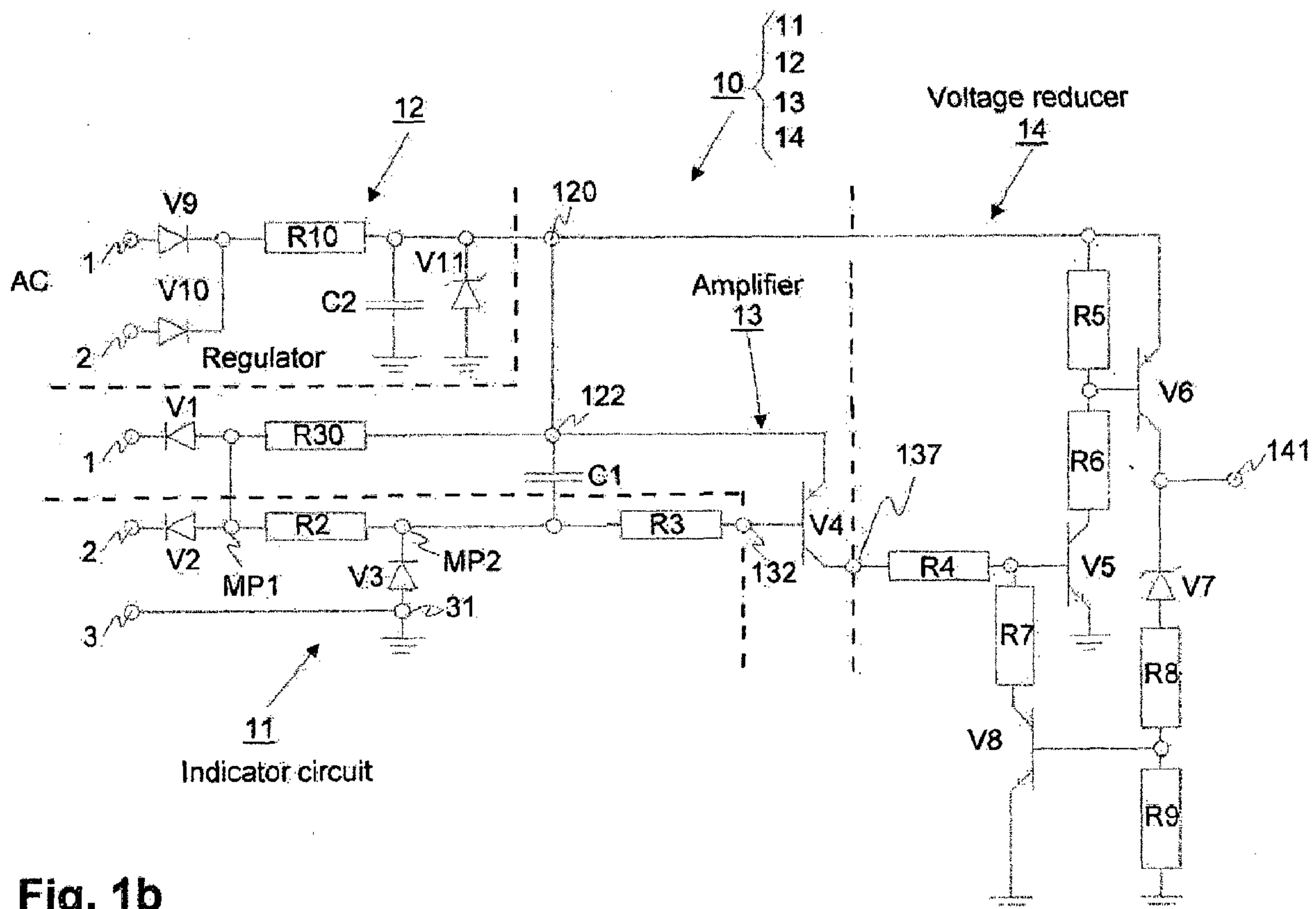
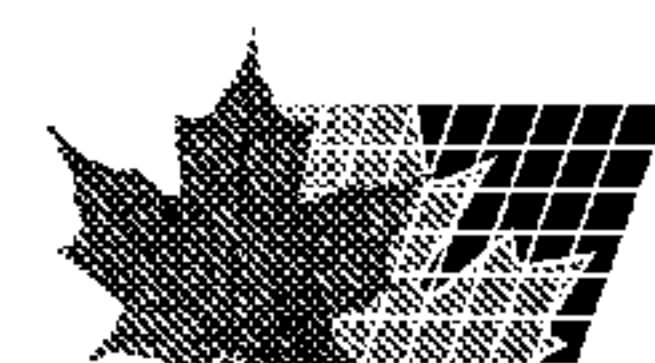


Fig. 1b

(57) Abrégé/Abstract:

The switching indicator (10) according to the invention of a grounded power cable of a vehicle (100) has an indicator circuit (11), a direct voltage regulator (12) for generating direct voltage and an amplifier (13). The indicator circuit (11) is configured to supply



(57) **Abrégé(suite)/Abstract(continued):**

base current of a transistor (V4) belonging to the amplifier (13) via a high-impedance connection at least to the neutral conductor (2) of the power cable, when the power cable is connected to the electrical network. The passage of the base current of the transistor (V4) through the power cable to the grounding point of the electrical network causes a change in the operative state of the transistor (V4). The change in the transistor's operative state is configured to indicate whether the power cable is connected to the alternating voltage network or not. Instead of a transistor amplifier, either an operational amplifier or a comparator can also be utilized.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau(10) International Publication Number
WO 2014/108600 A1(43) International Publication Date
17 July 2014 (17.07.2014)

(51) International Patent Classification:

H02J 13/00 (2006.01) *B60Q 5/00* (2006.01)
B60Q 7/00 (2006.01) *G08B 23/00* (2006.01)

(21) International Application Number:

PCT/FI2014/050010

(22) International Filing Date:

7 January 2014 (07.01.2014)

(25) Filing Language:

Finnish

(26) Publication Language:

English

(30) Priority Data:

20135024 8 January 2013 (08.01.2013) FI

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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
 BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
 DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
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 SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
 TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
 ZW.

(84) Designated States (unless otherwise indicated, for every
 kind of regional protection available): ARIPO (BW, GH,
 GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
 UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
 TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
 EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
 MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
 TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
 KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(81) Designated States (unless otherwise indicated, for every
 kind of national protection available): AE, AG, AL, AM,

(54) Title: A SWITCHING INDICATOR OF A POWER CABLE

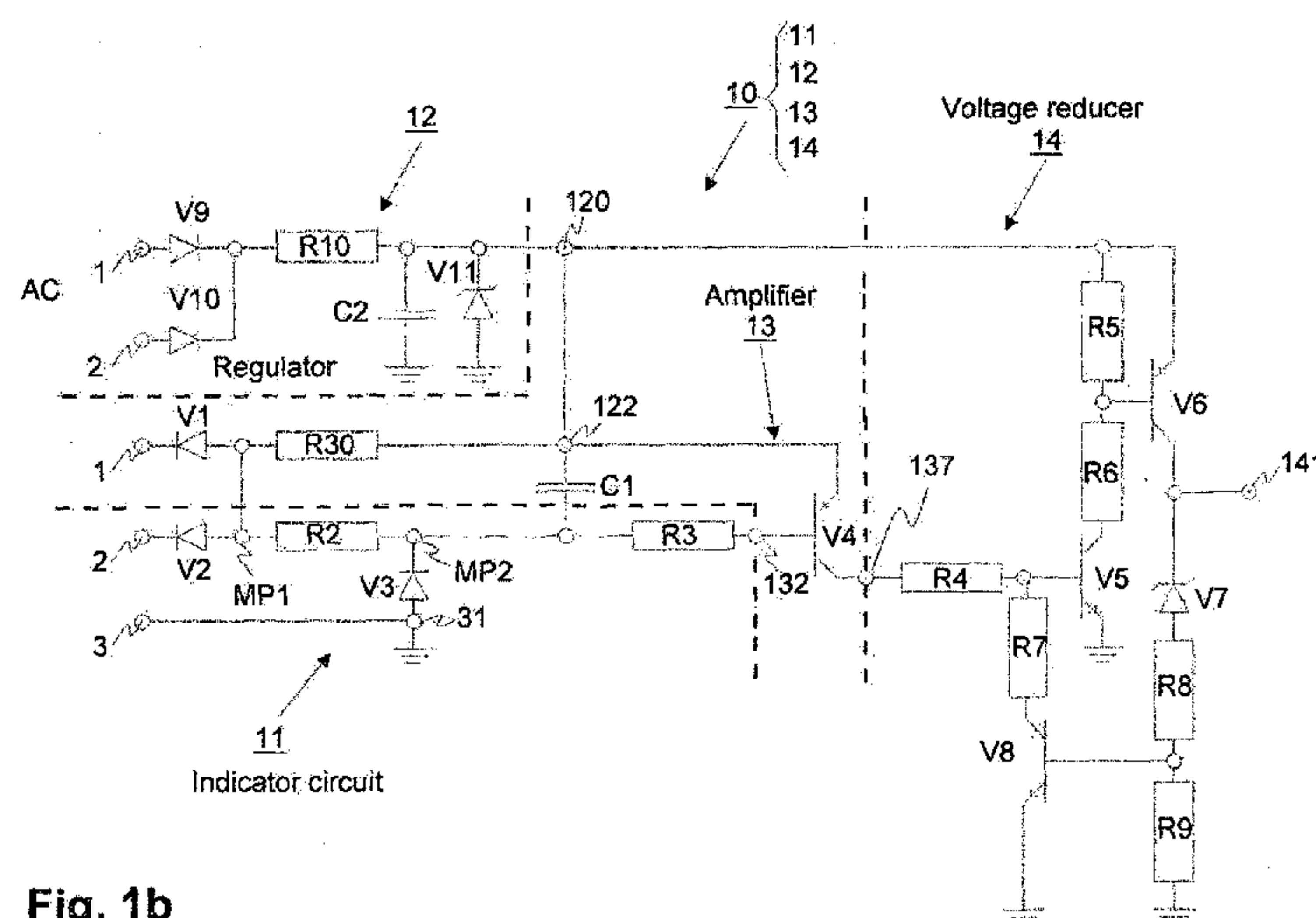


Fig. 1b

(57) Abstract: The switching indicator (10) according to the invention of a grounded power cable of a vehicle (100) has an indicator circuit (11), a direct voltage regulator (12) for generating direct voltage and an amplifier (13). The indicator circuit (11) is configured to supply base current of a transistor (V4) belonging to the amplifier (13) via a high-impedance connection at least to the neutral conductor (2) of the power cable, when the power cable is connected to the electrical network. The passage of the base current of the transistor (V4) through the power cable to the grounding point of the electrical network causes a change in the operative state of the transistor (V4). The change in the transistor's operative state is configured to indicate whether the power cable is connected to the alternating voltage network or not. Instead of a transistor amplifier, either an operational amplifier or a comparator can also be utilized.



WO 2014/108600 A1

A switching indicator of a power cable

The invention relates to a switching indicator of a power cable.

5 Prior art

Both engine and interior heaters are commonly used in the winter in cold countries. The heaters usually function with electricity. The electricity is supplied into these heaters from the electrical network through a special power cable. On the
10 electrical network side the power cable is installed into a grounded socket, a so-called Schuko socket, using a Schuko plug. The power cable has three conductors: a phase conductor, a neutral conductor and a protective (ground) conductor (a yellow-green conductor). The protective ground of the electrical network in the Schuko socket and the protective conductor of the Schuko plug are configured to
15 be coupled together so that the protective ground of the electrical network always connects to the protective ground conductor of the power cable, when the Schuko plug is installed in the Schuko socket. Because the Schuko plug can in certain countries be installed in the Schuko socket in two alternative ways, the phase conductor and the neutral conductor of the power cable can be connected either
20 to the corresponding conductors of the electrical network or contrariwise. The connecting alternatives have no effect on the electricity supply of the heater.

A vehicle has a special switching box, in order for the power cable required by the heater to be connected. It is usually located in the front part, for example the
25 bumper, of the vehicle, such as a car. It is common that the switching box is designed so that the power cable can be connected to the switching box in only one way. Thus it is ensured that the protective conductor of the power cable is always connected to the metal body of the vehicle. Electrical wires depart from the switching box at least to the engine heater. A cable often departs from the switch-
30 ing box also to the interior of the body of the car, where a Schuko socket is installed for installing an interior heater.

The attaching and detaching of the power cable used in heaters for connecting the vehicle and the electrical network is the responsibility of the user. Sometimes
35 the detaching of the power cable is forgotten when leaving with the car. Thus both the Schuko socket belonging to the electrical network, the power cable and those mechanical parts of the vehicle where the switching box is installed can be damaged.

One solution to the problem is disclosed in patent FI91951. In the solution disclosed therein, a separate mechanical switch is also included in the switching box, which switch switches on a described alarm device, when the plug on the vehicle side of the power cable is installed in the switching box. Connecting the ignition circuit of the vehicle also switches on the power of the alarm device according to patent FI91951, if the switch in the connecting box is in the on-position. When the power circuit of the alarm device is connected, a buzzer of the alarm device gives an audible alarm of the situation. In order to function, the solution described in patent FI91951 requires the installation of a special switching box described in the patent, and also additional installations in the engine space of the vehicle. The installation of the described alarm device thus requires a professional installation worker to perform the installation.

15 **Objects of the invention**

It is an object of the invention to present a switching indicator of a power cable, which indicator indicates the connection of the power cable at any time when the power cable is connected either to a vehicle and a Schuko socket or just to a vehicle. The switching indicator indicates the connection of the power cable, when the protective ground of the power cable and either or both of the phase conductors are connected to the electrical network. The switching indicator also indicates the connection of a special power cable, when it is connected to the vehicle. Because the switching indicator of the power cable does not need a special switching box equipped with a switch, it can advantageously be connected by the vehicle user in a simple and safe manner inside the vehicle.

The objects of the invention are obtained with a switching indicator of a power cable, which indicator can advantageously be connected to the Schuko socket of an interior heater in a vehicle. When the engine or interior of the vehicle is heated with electricity, the switching indicator of a power cable according to the invention advantageously gets its energy from the electrical network via the Schuko socket of the interior heater installed in the vehicle. Alternatively the electric energy needed by the switching indicator can also be taken from the accumulator of the vehicle, for example through the ignition switch.

When the switching indicator of a power cable according to the invention is in contact with the electrical network via the phase and/or neutral conductor and pro-

5 tective ground of the power cable connected to the Schuko socket, the reference voltage point included in the switching indicator can supply power through either one of the conductors of the power cable to the grounding point of the electrical network. Due to the load generated thereby, the reference voltage supplied into the cable moves toward the ground potential of the switching indicator, because it is in galvanic contact with the grounding point of the electrical network via the protective ground conductor of the power cable. This loading of the reference voltage point of the switching indicator is indicated and shown as a warning to the vehicle user.

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The switching indicator according to the invention can also be utilized with a special power cable, which generates an alarm also when the power cable is only connected to the switching box of the vehicle.

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An advantage of the switching indicator according to the invention is that the switching indicator indicates the connection of the power cable at any time when the power cable connects both the protective grounds of the switching indicator and the electrical network together and their phase conductors together. The switching indicator thus gives switching data about the connection of at least one of the electric conductors of the power cable to the electrical network. By summing (logical OR) the switching data of both phase conductors of the power cable, information is obtained about whether either or both of the phase conductors of the power cable are connected to the electrical network. Thus the vehicle user can be informed about the situation already before the vehicle is started.

20

A further advantage of the invention is that the switching indicator can be installed by the vehicle user by connecting the switching indicator to a Schuko socket intended for the vehicle's interior heater (with a Plug and Play method).

25

Still another advantage of the invention is that the vehicle user can connect the switching indicator without disruptive cables.

30

A further advantage of the invention is that in the Schuko socket on the electrical network side, the installation position of the Schuko plug does not affect the operation of the switching indicator.

35

The switching indicator according to the invention for a power cable of a device, which indicator comprises a voltage source, an amplifier and an indicator circuit,

is characterised in that the switching indicator is configured to measure a loading of a reference voltage of a reference voltage point against the protective ground in the switching indicator at least via the neutral conductor of the power cable to the protective ground, the result of which measurement is configured to indicate
5 the connection of the power cable to the device.

The basic idea of the invention is as follows: The switching indicator of a power cable according to the invention utilizes the fact that on the electrical network side, the neutral conductor, phase conductor and protective ground of the electrical network are not galvanically separated (PEN bar), whereby resistance or voltage can be measured between them. The resistance can be measured between
10 the neutral conductor and the protective conductor and the voltage between the phase conductor and the protective conductor.

15 The switching indicator of a power cable according to the invention is configured to change the resistance measurement to a load measurement with the aid of the voltage source in the switching indicator. The switching indicator measures whether the reference voltage point of the indicator circuit included in the switching indicator is loaded. Loading of the reference voltage point is configured to indicate that either or both of the phase conductors of the power cable are connected to the electrical network. Overloading of the output of the indicator circuit due to the mains voltage is limited with protective diodes, so that loading of the reference voltage point of the indicator is not prevented. The switching indicator of a power cable according to the invention utilizes both an indication of the switching
20 data of the neutral and phase conductor and advantageously also their summing. The switching indicator of a power cable according to the invention is configured to change the magnitude of the current passing through the indicator circuit between the reference voltage point and the protective ground. Said current controls the output of an amplifier belonging to the switching indicator. Measuring of the load occurs either by measuring the current departing from the reference voltage point or by measuring the voltage of the series resistance of the reference voltage point.
25 30

In an advantageous embodiment the operating voltage of the switching indicator functions as a reference voltage in the load measuring. In this embodiment current is fed from the reference voltage point via a resistor to the power cable and at the same time to the amplifier included in the switching indicator. In an embodiment a transistor stage functions as the amplifier, to the base of which current is
35

supplied. When the power cable is not connected, the voltage of the power cable remains such that the transistor remains in a conductive state.

5 When the indicator circuit of the switching indicator is connected via the neutral conductor of the power cable to the electrical network, then the voltage fed to the power cable from the indicator circuit decreases and at the same time the state of the transistor amplifier changes.

10 When the indicator circuit of the switching indicator is connected via the phase conductor to the electrical network, then the diodes belonging to the indicator circuit cut the voltage measured in the indicator circuit, which voltage, being directed to the amplifier, is configured to indicate that the power cable is connected. If for example a transistor amplifier is used as the amplifier, then the load current generated by the voltage of the reference voltage point of the indicator circuit causes
15 a change in the bias voltage of the base of the transistor, as a result of which change the state of the output of the transistor amplifier changes. A change in the state of the output of the transistor amplifier is configured to indicate that the power cable is connected for example to a vehicle user.

20 In an advantageous embodiment an alternating voltage influences in the reference voltage point of the switching indicator, which alternating voltage the power cable connected to the device loads.

25 In the arrangement according to the invention the installation direction of the plug of the power cable in the Schuko socket does not affect the operation of the indicator arrangement, because either one of the conductors of the power cable can cause loading of the reference voltage point at least during one of the half-cycles of the phase voltage.

30 Some advantageous embodiments of the invention are presented in the dependent claims.

In the following, the invention will be described in detail. The description refers to the enclosed drawings, in which

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Figure 1a shows as an example the installation of a switching indicator according to the invention in a vehicle,

Figure 1b shows as an example the principled circuitry of a switching indicator according to a first embodiment of the invention,

5 Figure 1c shows as an example the principled circuitry of a switching indicator according to a second embodiment of the invention,

Figure 1d shows as an example the principled circuitry of a switching indicator according to a third embodiment of the invention,

10 Figure 2a shows as an example the principled circuitry of a switching indicator according to a fourth embodiment of the invention,

Figure 2b shows as an example the principled circuitry of a switching indicator according to a fifth embodiment of the invention,

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Figure 2c shows as an example the principled circuitry of a switching indicator according to a sixth embodiment of the invention,

Figure 2d shows as an example the principled circuitry of a switching indicator according to a seventh embodiment of the invention,

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Figure 3a shows as an example the principled circuitry of a switching indicator according to an eighth embodiment of the invention,

25 Figure 3b shows as an example the principled circuitry of a switching indicator according to a ninth embodiment of the invention,

Figure 3c shows as an example the principled circuitry of a switching indicator according to a tenth embodiment of the invention, and

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Figure 3d shows as an example the principled circuitry of a switching indicator according to an eleventh embodiment of the invention.

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The embodiments in the following description are intended as examples only and someone skilled in the art can implement the basic idea of the invention also in some other way than the one presented in the description. Though the description may refer to a certain embodiment or embodiments in several places, this does not mean that the reference would be directed only towards one described em-

bodiment, or that the described characteristic would be usable only in one described embodiment. The individual characteristics of two or more embodiments can be combined and thus new embodiments of the invention can be achieved.

5 In the following, the structure and operation of the switching indicator of a power cable according to the invention is described with examples, in which the power cable is used for connecting the electric heating elements of a vehicle to the external electrical network. For someone skilled in the art it is obvious that the invention can be applied for the switching indication of all such power cables of
10 electrical devices, where the electrical device can be connected by using a power cable to the external electrical network. The amplifier associated with the operation of the switching indicator is in the examples implemented with exemplary transistor amplifiers or operational amplifiers. For someone skilled in the art it is obvious that for example a comparator can be used instead of the transistor amplifier, without affecting the principled operation of the switching indicator according to the invention.
15

Figure 1a shows as an example the installation of a switching indicator 10 of a power cable according to the invention in a vehicle 100, for example a car. The
20 power cable, which comprises a phase, neutral and protective conductor, is connected to a switching box 101 for example in the bumper of the car 100. The switching box 101 has three connectors. The connector 3 is in this example a connector for the protective conductor, which connector is connected both to the metal parts of the vehicle body and to the protective conductor of the cable 102 running from the switching box 101 to the socket 103 of the vehicle's interior
25 heater. The other two connectors 1 and 2 of the switching box 101 can for example be the phase conductor 1 and the neutral conductor 2. Which conductor is in practice the phase conductor and which the neutral conductor is determined by how the Schuko plug of the power cable is installed in the Schuko socket in the
30 electrical network.

There is a cable connection 104 from the switching box 101 advantageously also to the engine heater 105.

35 The Schuko socket 103 inside the car correspondingly has connectors 1, 2 and 3, of which connector 3 is always the connector of the protective conductor. The switching indicator 10 of a power cable according to the invention is advantageously connected with a Schuko plug to the Schuko socket 103 inside the vehi-

cle. The switching indicator 10 of a power cable can advantageously also have a Schuko socket for the interior heater 107. From the socket 103 there is an electric coupling at least to the indicator circuit according to the invention (e.g. reference 11 in Figure 1b) and advantageously also to the power source of the switching in-
5 dicator 10. In an advantageous embodiment the power source (reference 12 in Figure 1b) produces operating voltage for the indicator circuit, amplifier, logic circuit, ignition indicator and alarm means from supply voltage, which operating voltage is advantageously approximately 5.1 Volts. In this embodiment direct voltage, which is generated from supply voltage with a rectifier and regulated, can advantageously be used as the power source.
10

In another advantageous embodiment direct voltage obtained from the electrical system of the vehicle is utilized as the power source (e.g. reference 12a in Figure 1c) for example through the ignition switch of the vehicle. Thus the magnitude of
15 the voltage is advantageously 12 V or 24 V direct voltage.

The power source of the switching indicator can advantageously take the electric energy it needs from the electrical network at any time when mains voltage is available. This is the situation when the power cable is connected to the sockets
20 of the vehicle and electrical network. When the power cable is not connected to a energized electrical network, the power source (e.g. reference 12 in Figure 1b) of the switching indicator according to the invention can advantageously take its power from an accumulator/super capacitor or a battery.

25 If mains voltage is not used, then direct voltage can be supplied into the switching indicator 10 of the power cable advantageously through the vehicle's ignition switch. In this advantageous embodiment the switching indicator 10 of a power cable according to the invention is connected into operational readiness when the ignition key is turned in the vehicle's ignition switch, the accumulator voltage is
30 connected at the same time also to the switching indicator according to the invention (e.g. 10a in Figure 1c), whereby separate data regarding the starting of the vehicle is not needed and information about a danger situation is immediately available from the switching indicator. A danger situation indicated by the switching indicator is registered and it is advantageously amplified for example with a
35 buzzer.

In an advantageous embodiment the switching indicator of a power cable has a signal light as a signal that mains voltage is available.

In another embodiment according to the invention the switching indicator 10 of a power cable can also comprise a separate wireless transmitter-receiver pair, a sort of ignition indicator. In an embodiment of the invention information about the ignition event can be obtained either by wire or wirelessly from the ignition switch to the ignition indicator.

The ignition indicator can for example be an acceleration sensor. In this embodiment a battery or an accumulator charged by supply voltage or a super capacitor can advantageously be used as a power source for the switching indicator. Thus the switching indicator according to the invention is usable even though it is not connected to the electrical system of the vehicle. When the engine of the vehicle 100 is started, as a result thereof the vibration of the engine of the vehicle is transferred to the vehicle body. The vibration of the body generated by the running of the engine can thus be indicated with the acceleration sensor. The signal obtained from the acceleration sensor is advantageously taken to the logic unit of the switching indicator, which unit advantageously further controls the operation of the actual alarm device based on the signal from the acceleration sensor.

In an advantageous embodiment the switching indicator according to the invention controls the operating voltage of the ignition indicator. When the ignition indicator gets its operating voltage, the cable is connected and an alarm is given based thereon.

The switching indicator of a power cable according to the invention makes it possible to receive information about a danger situation when starting to move. The situation is dangerous for example when the power cable of a vehicle's electrical heating or charging system is connected and moving with the vehicle is at least being planned.

In Figure 1a the switching indicator according to the invention is shown as its own separate device to be retrofitted. The switching indicator according to the invention can also be integrated as a part of the interior heater or the Schuko socket of the interior heater.

In an advantageous embodiment the switching indicator according to the invention is part of either the wire set of the engine heater or the wire set of the interior heater. At the vehicle's manufacturing stage the switching indicator of a power

cable can be integrated as a part of the vehicle's electrical circuitry, whereby the switching indicator is part of the car's electrical circuitry and can advantageously prevent the car from starting.

- 5 **Figure 1b** shows the essential operational parts of a switching indicator of a power cable, with regards to an advantageous embodiment 10. Figure 1b shows an advantageous embodiment of the indicator circuit 11, an analogue amplifier 13, a voltage reducer circuit 14 and a regulator connection 12. In Figure 1b the numbering and purpose of connectors 1, 2 and 3 correspond to the markings shown in
10 connection with Figure 1a.

Figure 1b does not show logic units shown in Figure 1a, and actual alarm means, which can be implemented in some suitable prior art manner. The output signal 141 of Figure 1b can advantageously be led to the logic circuit of the switching indicator 10 of the power cable or to the used sound or light alarm device.
15

The switching indicator 10 contains resistors R30 and R2, via which the indicator circuit 11 of the switching indicator 10 is in contact with the electrical network. They are advantageously at least of a magnitude of 1.5 MΩ. Thus the operating
20 voltage point 120 of the switching indicator 10 and the output 132 of the indicator circuit 11 are touch-safe. The magnitude of the resistor R10 belonging to the regulator circuit 12 is 38 kΩ. The current supplied by the switching indicator 10 through the regulator circuit into the electrical network is to its magnitude always below the value of the conventional trigger current set for the fault current switch
25 of the electrical network, which value is 30 mA.

When mains voltage is available, the operating voltage of the switching indicator 10 is advantageously processed in the regulator circuit 12. The operating voltage is advantageously obtained by half-wave rectification of the phase voltage of a
30 230 Volt alternating voltage network with diodes V9 and V10 into a direct voltage of for example 5.1 V. The phase voltage is obtained from the connectors 1 and 2 of the phase conductor and neutral conductor of the power cable, to which connectors the diodes V9 and V10 are connected. The protective conductor 3 of the power cable is connected to the ground potential of the vehicle 100 in a point 31.
35 The rectified voltage is taken via the resistor R10 to a super capacitor C2, one of the poles of which is connected to the ground potential. A Zener diode V11 connected next to the capacitor C2 limits the voltage of the capacitor C2 as desired against the ground (5.1 V).

The direct voltage 120, advantageously 5.1 V, utilized in the switching indicator 10 is due to the non-ideality of the transistor V4 supplied from a point 122 via the resistor R30 to the base of the transistor. Thus the bias voltage is sufficient to
5 keep the transistor V4 in the non-conductive state. The loading to be indicated with the switching indicator is indicated with a current measuring. In practice the current passing through the output of the indicator circuit 11, the reference voltage point 132, determines the magnitude of the current passing from the emitter of the transistor V4 to the collector and at the same time the operative state of the
10 transistor.

In the example of Figure 1b the amplifier 13 advantageously uses a PNP transistor V4. The emitter of the transistor V4 is connected to the feed point 122 for operating voltage. A capacitor C1 and a resistor R3, the magnitude of which is approximately 1.5 M Ω , are connected in series between the emitter and base of the
15 transistor V4.

If the power cable is not connected between a vehicle and the electrical network, then the current does not circulate from the emitter to the collector in the transistor
20 V4, because the bias voltage between the base and the emitter is sufficient to keep the transistor V4 in the non-conductive state.

When the operating voltage of the switching indicator 10 is connected, the high-impedance resistors R30 and R2, which are connected in series and are of a
25 magnitude of approximately 1.5 M Ω , strive to increase the voltage of the measuring point MP1 included in the indicator circuit 11, and at the same time of the output of the indicator circuit 11, the reference voltage point 132, to the level of the operating voltage obtained from the feed point 122. In the thus used connection the base voltage of the transistor V4 also rises to the operating voltage and the
30 PNP transistor V4 shown in the example is in the non-conductive state.

In the example of Figure 1b the switching data of the neutral and phase conductors are summed in an exemplary manner after one conductor-specific component, diode V1 or V2, in measuring point MP1. The summing of the switching data
35 can be done in other switching points of the indicator chain or at the latest in the logic part by adding conductor-specific components.

The transistor V4 of the amplifier 13 shifts to the conductive state when the connection of either the phase conductor 1 or the neutral conductor 2 of the power cable to the electrical network loads the voltage of the measuring point MP1 and at the same time the output of the indicator circuit 11, the reference voltage point 132, toward the ground potential of the electrical network. Thus the bias voltage in the transistor V4 between the base and the emitter changes to such that the base current of the transistor V4 starts to circulate via the resistors R3 and R2, the diodes V1 and/or V2 and at least either of the conductors 1 or 2 of the power cable to the grounding point of the electrical network. The circulation of the base current toward the grounding point opens the PNP transistor V4, whereby the main part of the emitter current is steered to the collector and from there onwards via the output 137 of the amplifier 13 to the transistor V5 of the voltage reducer circuit 14.

The voltage reducer 14 advantageously comprises an NPN transistor V5, which amplifies the current coming via the resistor R4 from the transistor V4 and connects the voltage to the voltage output 141 via the PNP transistor V6. The Zener diode V7 and the resistors R8 and R9 limit the current passing through the NPN transistor V8 and the resistor R7 to the base of the NPN transistor V5. Limiting the base current of the NPN transistor V5 limits the voltage of the voltage output. The shown voltage reducer circuit is shown as an example. Someone skilled in the art can utilize also some other suitable circuitry for achieving the voltage output 141 when implementing the voltage reducer circuit.

The voltage output 141 can advantageously be the feed voltage for the motion detection part of the logic circuit, which when it detects that the motor is running switches on the actual audible or visual alarm device. The voltage reduction is advantageous to realize in logic unit connections, where the operating voltage of the logic unit connected to the point 141 differs from the operating voltage of the switching indicator 10, for example +3.3 V.

In situations where the neutral conductor of the power cable has "broken", but the phase conductor is connected to the electrical network, the switching indicator 10 according to the invention functions in the following manner. In this situation the voltage of the measuring point MP1 of the indicator circuit 11 is at the most -325 V during the negative half-cycle. The second resistor R2 and the reverse-biased diode V3 however limit the voltage of the measuring point MP2 to the level -0.6 V of the threshold voltage of the diode V3. The base current of the transistor generated by this voltage passes through the resistor R3. The capacitor C1 charges to

the level -0.6 V of the threshold voltage of the diode V3 during the negative half-cycle. During the positive half-cycle the charge of the capacitor C1 is discharged through the resistors R3, R30 and R2. The charge of the capacitor C1 ensures that the PNP transistor V4 remains in the conductive state also during the positive
5 half-cycle.

In an advantageous embodiment of the invention an alarm is also received when only the power cable is connected to the heating socket of the car, but is not connected to a socket of the electrical network. In this advantageous embodiment of
10 the invention the power cable is a special cable, which is provided with high-impedance resistors (approximately 1.5 M Ω) from the phase conductor and/or neutral conductor to the protective conductor, either in the cable itself or in an additional part added to the cable. In this embodiment the above-described base current of the transistor can be made to circulate at least from the conductor functioning as the neutral conductor of the power cable to the protective conductor
15 and from the protective conductor 3 via the switching point 31 to the grounding point of the vehicle. The switching point 31 is between the anode of the diode V3 and the grounding point of the vehicle. The circulation of the base current via the switching point 31 to the ground potential opens the PNP transistor V4, whereby
20 most of the emitter current is steered to the collector and from there onwards to the transistor V5 of the voltage reducer circuit 14 in the above-described manner.

Figure 1c shows the essential operational parts of a second advantageous embodiment 10a of the switching indicator of a power cable. The connection of the
25 indicator circuit 11 in Figure 1c corresponds to the connection of the indicator circuit in Figure 1b. The power source, which advantageously connects to the switching indicator, when the vehicle is started, is not shown other than showing the supply point 12a for operating voltage. For example an accumulator, a battery, a super capacitor or a vehicle battery (+12 V or +24 V) can be utilized as the voltage source, either as such or protection separated. Because the output 120 of the
30 operating voltage source is connected to the feed point 122, the direct voltage of the feed point 122 depends on the used direct voltage source.

Reference 13a shows an advantageous combined amplifier and buzzer circuit. In
35 the example of Figure 1c the amplifier 13a advantageously uses a PNP transistor V4. The emitter of the transistor V4 is connected to the feed point 122 for operating voltage. A capacitor C1 and a resistor R3, the magnitude of which is approxi-

mately $1.5\text{ M}\Omega$, are connected in series between the emitter and base of the transistor V4.

If a power cable is not connected between the device and the electrical network, then the current does not circulate from the emitter to the collector in the transistor V4, because the bias voltage between the base and the emitter is sufficient to keep the transistor V4 in the non-conductive state.

The transistor V4 of the amplifier 13a shifts to the conductive state when either the phase conductor 1 or the neutral conductor 2 of the power cable loads the reference voltage at the base of the transistor V4, which voltage is lower than the feed voltage by the magnitude of the threshold voltage, at the reference voltage point 132. Thus the bias voltage between the base and the emitter changes to such that the base current of the transistor V4 starts to circulate via the resistors R3 and R2, the diodes V1 and V2 and either of the conductors 1 or 2 of the power cable functioning as the neutral conductor to the grounding point of the electrical network. The circulation of the base current toward the grounding point opens the PNP transistor V4, whereby most of the emitter current is steered to the collector and from there onwards via the resistors R4 and R11 to the ground. The voltage division provided by the resistors R4 and R11 in the output of the amplifier 13a changes the bias voltage of the base of the transistor V5, whereby the transistor V5 opens. As a result thereof, current can pass through the buzzer X1, which current makes the buzzer generate and alarm sound.

Figure 1d shows the essential operational parts of a third advantageous embodiment 10b of the switching indicator of a power cable according to the invention. Figure 1d shows an advantageous embodiment of the indicator circuit 11a, which comprises a first resistor R1 feeding reference voltage to the measuring point MP1, an analogue amplifier + a buzzer 13b and a power source 12a. In Figure 1d the numbering and markings of the connectors 1, 2 and 3 correspond to the markings shown in connection with Figure 1a. When the vehicle is started, the power source, of which the supply point 12a for operating voltage is shown, is connected automatically. For example an accumulator, a battery, a super capacitor or a vehicle battery (+12 V or +24 V) can be utilized as the voltage source, either as such or protection separated. The direct voltage used as reference voltage in the input of the indicator circuit 11a, the reference voltage point 123, depends on the direct voltage source used in the switching indicator 10b.

Reference 13b shows an advantageous combined amplifier and buzzer circuit. In the example of Figure 1d the amplifier 13b advantageously uses an NPN transistor V9. The collector of the transistor V9 is connected via the resistor R12 to the supply point 120 for operating voltage. The base of the transistor V9 is connected
5 to the output 131 of the indicator circuit 11a via the resistor R22.

In this advantageous embodiment the loading status of the switching indicator is indicated from the voltage of the measuring point MP1 following the first resistor R1, which supplies reference voltage.

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If a power cable is not connected between the device and the electrical network, then the voltage obtained from the measuring point MP1 depending on the loading is so high that the bias voltage between the base and the emitter is sufficient to keep the transistor V9 in the conductive state. The output 131 of the indicator
15 circuit 11a represents the voltage source, the voltage of which is the voltage of the measuring point MP1 and the output impedance of which is R2. The voltage of the measuring point MP1 and the resistor R22 in this connection determine the base current of the transistor V9. The resistor R2 also functions as a bias resistor of the diode V3 limiting the voltage to be measured.

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The transistor V9 of the amplifier 13b shifts to the non-conductive state when either the phase conductor 1 or neutral conductor 2 of the power cable connects to the ground potential of the electrical network and loads the reference voltage of the measuring point MP1 by pulling it towards the ground potential.

25

If the status of the output 137 of the NPN transistor V9 13b has changed in the above-described manner, then the bias voltage of the base of the transistor V5 changes to such that the NPN transistor V5 opens. As a result thereof, current can pass through the buzzer X1, which current makes the buzzer generate an
30 alarm sound.

30

The structures of the exemplary switching indicators shown in the following show the coupling of different indicators to the switching indicator at a principled level. An "ideal" operational amplifier has been used as the amplifier in order to clarify
35 the operation. The figures additionally show exemplary summations of switching data and resistor/diode connections for limiting the voltage and current, which do not affect the principled operation of the indicator. Making or not making the summation does not affect the operation of the principled indicator. The principled

comparator controlled by the output voltage of the operational amplifier, the switching point 137, is not shown.

In Figures 2a–2d the loading status of the reference voltage point is indicated using the current passing through the resistor R3 included in the switching indicator, which current in the shown operational amplifier connections controls the output voltage 137 of the operational amplifier. The amount of current changes if the power cable is connected to the electrical network. The change in the amount of current provides a change in the status of the output of the operational amplifier connection, which change indicates the connection status of the power cable.

In Figures 2a-2d and 3a-3d the amplifier connections include an exemplary operational amplifier 200. The operating voltage utilized by the operational amplifier is indicated either with reference 122 or 122a and the connection of the operational amplifier to the ground potential is shown with a grounding symbol.

Figure 2a shows a fourth advantageous embodiment 20 of the switching indicator. In this embodiment the loading status of the reference voltage caused by the connection of the power cable is indicated by measuring the loading current generated in the indicator circuit 11 with the reference voltage. The reference voltage 121 is connected to the non-inverting input of the operational amplifier 200 included in the amplifier connection 23 via the first supply resistor R135. The current passing through the resistor R137 from the output 137 of the operational amplifier makes the voltage of the inverting input of the operational amplifier 200, the reference voltage point 132, the same magnitude as the reference voltage 121. The current passing through the resistor R137 is the same as the current passing through the resistor R3 to the ground potential of the electrical network that loads the reference voltage point 132

The current passing through the resistor R3 is determined by the voltage between the reference voltage, the reference voltage point 132 and the measuring point MP2. The voltage of the measuring point MP2 in its turn depends on whether it is loaded through the power cable, i.e. whether either conductor 1 and/or 2 of the power cable is connected to the electrical network.

The current output of the indicator circuit 11, the reference voltage point 132, is connected via the resistor R3 to the measuring point MP2 and onwards both to the cathode of the reverse-biased diode V3 and configured to be connected via

the resistor R2 to the anode of the forward-biased diode V2 and advantageously also to the anode of the second forward-biased diode V1.

The cathode of the first diode V1 is advantageously configured to be connected to the first conductor (e.g. the phase conductor 1) of the power cable and the cathode of the second diode V2 is configured to be connected to the second conductor (e.g. the neutral conductor 2) of the power cable. The measuring point MP2 of the indicator circuit is configured to be connected with the resistor R3 via the reference voltage point 132 to the inverting input of the operational amplifier 200.

The measuring point MP2 is also connected to the cathode of the reverse-biased third diode V3, the anode of which third diode V3 is connected to the ground potential of the vehicle or electrical device. The protective conductor 3 of the power cable is connected to a point 31 between the anode of the third reverse-biased diode V3 and the ground potential of the vehicle or electrical device.

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Figure 2b shows a fifth advantageous embodiment 20a of the switching indicator. What is special in the connection of Figure 2b is the operating voltage/reference voltage 121a of the switching indicator 20a, which voltage is negative in relation to the ground. In addition the switching order of the resistor R202 and the diode V2a differs from the order in Figure 2a. Additionally the summation point of the switching data differs from the embodiment of Figure 2a and occurs at the measuring point MP2. The shown order of the components and summation point do not change the principled operation of the indicator. Also in this embodiment the loading status of the reference voltage is indicated by measuring the loading current achieved with the reference voltage. The reference voltage 121a is connected via the first supply resistor R135 to the non-inverting input of the operational amplifier 200 included in the amplifier connection 23a. The current passing through the resistor R137 from the output 137 of the operational amplifier makes the voltage of the inverting input of the operational amplifier 200, the reference voltage point 132, the same magnitude as the reference voltage 121a. The current passing through the resistor R137 is the same as the current passing through the resistor R3 from the ground potential of the electrical network that loads the reference voltage point 132.

The current passing through the resistor R3 is determined by the voltage between the reference voltage point 132 and the measuring point MP2. The voltage of the measuring point MP2 in its turn depends on whether it is loaded via the power ca-

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ble, i.e. if either conductor 1 and/or 2 of the power cable is connected to the electrical network.

The current input of the indicator circuit 21, the reference voltage point 132, is connected via the resistor R3 to the measuring point MP2 and onwards both to the anode of the forward-biased diode V3a and configured to be connected to the cathodes of the reverse-biased diodes V1a and V2a. The anode of the diode V1a is connected to the resistor R201. The anode of the diode V2a is attached to the resistor R202.

The anode of the first diode V1a is advantageously configured to be connected via the resistor R201 to the first conductor (e.g. the phase conductor 1) of the power cable and the anode of the second diode V2a is configured to be connected via the resistor R202 to the second conductor (e.g. the neutral conductor 2) of the power cable. The measuring point MP2 of the indicator circuit is configured to be connected with the resistor R3 via the reference voltage point 132 to the inverting input of the operational amplifier 200. The measuring point MP2 is also connected to the anode of the forward-biased third diode V3a, the cathode of which third diode V3a is connected to the ground potential of the vehicle or the electrical device. The protective conductor 3 of the power cable is connected to a point 31 between the cathode of the third forward-biased diode V3a and the ground potential of the vehicle or electrical device.

Figure 2c shows a sixth advantageous embodiment 20b of the switching indicator. In this embodiment the loading status of the reference voltage point 132 caused by the connection of the power cable is indicated by measuring the loading current generated with the reference voltage in the indicator circuit 21a. The reference voltage 121 is connected via the first supply resistor R135 to the non-inverting input of the operational amplifier 200 included in the amplifier connection 23b. The current passing through the resistor R137 from the output 137 of the operational amplifier makes the voltage of the inverting input of the operational amplifier 200, the reference voltage point 132, the same magnitude as the reference voltage 121. The current passing through the resistor R137 is the same as the current passing through the resistor R3 that loads the reference voltage point 132.

The current passing through the resistor R3 is determined by the voltage between the reference voltage point 132 and the measuring point MP2. The voltage of the measuring point MP2 in its turn depends on whether it is loaded through the pow-

er cable, i.e. whether either conductor 1 and/or 2 of the power cable is connected to the electrical network.

5 The current output of the indicator circuit 21a, the reference voltage point 132, is connected via the third resistor R3 to the measuring point MP2 and to the cathode of the reverse-biased diode V3, to the resistors R201, R202 and configured to be connected to the anode of the forward-biased diode V20 and advantageously onwards to the operating voltage 122 of the switching indicator 20a. The diodes shown in the connections for limiting the voltage can also be integrated inside the
10 operational amplifier.

The measuring point MP2 is advantageously configured to be connected via the resistor R201 to the first conductor (e.g. the phase conductor 1) of the power cable and via the second resistor R202 to the second conductor (e.g. the neutral
15 conductor 2) of the power cable. The measuring point MP2 of the indicator circuit 21a is configured to be connected both to the resistor R3 and further to the inverting input of the operational amplifier, the reference voltage point 132, and to the cathode of the reverse-biased second diode V3, the anode of which second diode V3 is connected to the ground potential of the vehicle or electrical device. The
20 protective conductor 3 of the power cable is connected to a point 31 between the anode of the second reverse-biased diode V3 and the ground potential of the vehicle or electrical device.

Figure 2d shows a seventh advantageous embodiment 20c of the switching indicator. In the connection of Figure 2d the operating voltage 122 of the switching indicator 20c can be either positive or negative. This embodiment is used for power cables, the Schuko plug of which cannot be turned in the Schuko socket. Also in this embodiment, the loading status of the reference voltage point 132 caused by the connection of the power cable is indicated by measuring the loading
25 current generated in the indicator circuit 21b with the reference voltage. The reference voltage 121 is connected to the non-inverting input of the operational amplifier 200 included in the amplifier connection 23 via the first supply resistor R135. The current passing through the resistor R137 from the output 137 of the operational amplifier makes the voltage of the inverting input of the operational
30 amplifier 200, the reference voltage point 132, the same magnitude as the reference voltage 121. The current passing through the resistor R137 is the same as the current passing through the resistor R3 that loads the reference voltage point 132.

The current passing through the resistor R3 is determined by the voltage between the reference voltage 121, the reference voltage point 132 and the measuring point MP2. The voltage of the measuring point MP2 in its turn depends on whether it is loaded via the power cable, i.e. if either conductor 1 and/or 2 of the power cable is connected to the electrical network.

The current output of the indicator circuit 21b, the reference voltage point 132, is connected via the resistor R3 to the measuring point MP2, which is configured to be connected to the neutral conductor 2 of the power cable.

In Figures 3a-3d the loading status of the reference voltage point 123, 123a is indicated with the voltage measured from the measuring point 131 following the first resistor R1 supplying reference voltage, which voltage measured from the measuring point in the shown operational amplifier connections controls the voltage of the output 137 of the operational amplifier 200. The status of the output of the operational amplifier 200 depends on whether the power cable is connected to the electrical network or not.

Figure 3a shows an eighth advantageous embodiment 20d of the switching indicator. In this embodiment the loading status of the reference voltage point 123 caused by the connection of the power cable is indicated by measuring the voltage loss generated in the first resistor R1, which supplies reference voltage into the power cable. The reference voltage point 123 is connected via the first resistor R1 either to the voltage output of the indicator circuit 21c, the switching point 131, or the measuring point MP1 included in the indicator circuit 21c. The voltage output 131 of the indicator circuit 21c is connected via the resistor R135 to the non-inverting input of the operational amplifier 200 included in the amplifier connection 24. The operational amplifier 200 functions as a non-inverting amplifier and its output is the switching point 137. The output voltage is amplified from the reference voltage by the operational amplifier connection and the status of the amplifier output is configured to indicate the load caused by the power cable on the reference voltage.

The cathode of the first diode V1 is advantageously configured to be connected to the first conductor (e.g. the phase conductor 1) of the power cable and the cathode of the second diode V2 is configured to be connected to the second conductor (e.g. the neutral conductor 2) of the power cable. The anodes of the diodes V1

and V2 are connected together to sum up the switching data at the measuring point MP1. Either the diode V1 or V2, depending on the connecting direction of the power cable, prevents the positive cycle of a possible phase conductor from affecting the measuring. The measuring point MP1 is further connected to a voltage limiter, which comprises a resistor R2 and a diode V3, which limit the effect of the negative half-cycle on the measuring. In this measuring arrangement a voltage of the magnitude of the neutral conductor is sufficient for indicating the connection of the power cable.

The voltage output 131 of the indicator 21c is connected to the cathode of the reverse-biased third diode V3, the anode of which third diode V3 is connected to the ground potential of the vehicle or electrical device. The protective conductor 3 of the power cable is connected to a point 31 between the anode of the third reverse-biased diode V3 and the ground potential of the vehicle or electrical device.

Figure 3b shows a ninth advantageous embodiment 20e of the switching indicator. In the connection of Figure 3b the operating voltage 122a of the switching indicator and the voltage of the reference voltage point 123a are negative in relation to the ground. In addition the switching order of the resistor R202 and the diode V2a differs from the order in Figure 3a. In addition the summation point of the switching data differs from the embodiment of Figure 3a and occurs in the voltage output 131 of the indicator 21d. The component order and the summation point do not alter the principled operation of the indicator. Also in this embodiment, the loading status of the reference voltage point 123a caused by the connection of the power cable is indicated by measuring the voltage loss generated in the first resistor R1, which supplies reference voltage to the power cable. The reference voltage point 123a is connected via the resistor R1 to the voltage output 131 of the indicator circuit 21d. The operational amplifier 200 amplifies the voltage in point 131, according to the description of Figure 3a.

The anode of the diode V1a is advantageously configured to be connected via the resistor R201 to the first conductor (e.g. the phase conductor 1) of the power cable and the anode of the second diode V2a is configured to be connected via the resistor R202 to the second conductor (e.g. the neutral conductor 2) of the power cable. The cathodes of the diodes V1a and V2a are connected together to sum up the switching data in the voltage output 131 of the indicator circuit 21d. Either the diode V1a or V2a, depending on the connecting direction of the power cable, prevents a possible negative cycle of the phase conductor from affecting the measur-

ing. The resistors R201 and R202 and the diode V3a function as limiters of the positive voltage, which limit the effect of a possible positive half-cycle on the measuring, where a voltage of the magnitude of the neutral conductor is sufficient for indicating the connection of the power cable.

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The switching point, the voltage output 131 of the indicator circuit, is connected to the anode of the forward-biased third diode V3a, the cathode of which third diode V3a is connected to the ground potential of the vehicle or electrical device. The protective conductor 3 of the power cable is connected to a point 31 between the

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Figure 3c shows a tenth advantageous embodiment 20f of the switching indicator. Also in this embodiment, the loading status of the reference voltage point 123 caused by the connection of the power cable is indicated by measuring the voltage loss generated in the first resistor R1, which supplies reference voltage to the power cable. The reference voltage point 123 is connected via the first resistor R1 to the voltage output 131 of the indicator circuit 21e. The voltage output 131 of the indicator circuit 21e is connected to the non-inverting input of the operational amplifier 200. The operational amplifier amplifies the voltage in the switching point 131, according to the description of Figure 3a.

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The voltage output 131 of the indicator circuit 21e is advantageously configured to be connected via the resistor R201 to the first conductor (e.g. the phase conductor 1) of the power cable and via the second resistor R202 to the second conductor (e.g. the neutral conductor 2) of the power cable. The resistors R201 and R202 and the diodes V3 and V20 function as voltage limiters, which limit the effect of a possible phase conductor on the measuring, where a voltage of the magnitude of the neutral conductor is sufficient for indicating the connection of the power cable. The diodes shown in the connections for limiting the voltage can also be integrated inside the operational amplifier.

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The voltage output 131 of the indicator circuit is thus connected both to the cathode of the reverse-biased first diode V3, the anode of which first diode V3 is connected to the ground potential of the vehicle or electrical device, and to the anode of the forward-biased second diode V20, the anode of which second diode V20 is advantageously connected to the operating voltage 122 of the switching indicator.

The protective conductor 3 of the power cable is connected to a point 31 between the anode of the first reverse-biased diode V3 and the ground potential of the vehicle or electrical device.

5 **Figure 3d** shows an eleventh advantageous embodiment 20g of the switching indicator. In the connection of Figure 3d the operating voltage 122 of the switching indicator can be either positive or negative. This embodiment is suitable for power cables, the Schuko plugs of which cannot be turned in the Schuko socket. In this embodiment, the loading status of the reference voltage point 123 caused by the
10 connection of the power cable is indicated by measuring the voltage loss generated in the first resistor R1, which supplies reference voltage to the neutral conductor 2 of the power cable, from the voltage output 131 of the indicator circuit 21f.

The reference voltage point 123 of the switching indicator 20g is connected via
15 the first resistor R1 to the voltage output 131 of the indicator circuit 21f. On the other hand the voltage output 131 of the indicator circuit 21f is connected to the non-inverting input of the operational amplifier 200 via the resistor R135. The operational amplifier 200 amplifies the voltage of the voltage output 131 of the indicator circuit 21f according to the description of Figure 3a.

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Some exemplary switching indicators of a power cable have been described above, in which the amplifier included in the switching indicator is implemented with transistor amplifiers or operational amplifiers. For someone skilled in the art it is obvious that the described amplifiers can be replaced either partly or completely
25 also with a comparator without altering the principled operation of the invention.

In an advantageous embodiment of the invention the voltage measuring is performed advantageously by measuring an attenuation of the frequency differing from the network frequency, when it is supplied into the reference voltage input of
30 the indicator circuit. In the switching indicator the frequency is thus advantageously measured from measuring point 131 or 132.

Some advantageous embodiments of the switching indicator of a power cable according to the invention have been described above. The switching indicator of a
35 power cable according to the invention can be utilized for example in conventional cars, electric cars, tractors and boats. Status data regarding the switching indicator of a power cable according to the invention can be utilized also in connection with other devices, which can be connected with a power cable via a Schuko

socket to the electrical network. With the aid of the switching indicator according to the invention it is for example possible to find out via remote access whether the power cable of a device is connected to the electrical network or not. The invention is not limited to the just described solutions, but the inventive idea can be

5 applied in several ways within the scope of the claims.

Claims

1. A switching indicator (10-10b, 20-20g) of a power cable of a device, which comprises:

- 5 – an amplifier (13, 13a-13b, 23, 23a-23b, 24)
- a direct voltage source (12, 12a) and
- an indicator circuit (11, 11a, 21, 21a-21f),

characterized in that the switching indicator is configured to measure the loading of a reference voltage of a reference voltage point (123, 123a, 132) against the protective ground in the switching indicator, at least via a neutral conductor (2) of the power cable to the protective ground, the result of which measuring is configured to indicate that the power cable is connected to a device.

2. The switching indicator according to claim 1, **characterized** in that when at least the neutral conductor (2) of the power cable is connected to the electrical network, the current passing through an output of the indicator circuit (11, 21, 21a, 21b) is configured to control the amplifier (13, 13a, 23, 23a, 23b), the status of which output (137) is configured to indicate the connection of the power cable to the device.

3. The switching indicator according to claim 2, **characterized** in that:

- an input (122) of the indicator circuit is connected both to a direct voltage (120) and via a first resistor (R30) to an anode of a first diode (V1) and an anode of a second diode (V2), a cathode of which first diode (V1) is configured to be connected to a first conductor (1) of the power cable and a cathode of which second diode (V2) is configured to be connected to a second conductor (2) of the power cable,
- the output of the indicator circuit (11) is connected:
 - to a base of a transistor (V4), and
 - via a third resistor (R3)
 - to a cathode of a third diode (V3), an anode of which third diode (V3) is connected to the ground, and
 - to a second resistor (R2) and through it both to the anode of the first diode (V1) and the anode of the second diode (V2).

4. The switching indicator according to claim 2, **characterized** in that:

- the output of the indicator circuit (11) is connected:

– to an inverting input of an operational amplifier (200), to a non-inverting input of which operational amplifier is connected a reference voltage (121) through a first supply resistor (R135), and

– via a third resistor (R3)

5 – to a cathode of a third diode (V3), an anode of which third diode (V3) is connected to the ground, and

 – to a second resistor (R2) and through it both to an anode of a first diode (V1) and an anode of a second diode (V2), a cathode of which first diode (V1) is configured to be connected to a first conductor (1) of the power cable and a cathode of which second diode (V2) is configured to be connected to a second conductor (2) of the power cable.

5. The switching indicator according to claim 1, **characterized** in that when at least a neutral conductor (2) of the power cable is attached to an electrical network, a voltage of an output (131) of the indicator circuit (11a, 21c, 21d, 21e, 21f) is configured to control the amplifier (13b, 24), the status of an output (137) of which is configured to indicate a connection of the power cable to the device.

6. The switching indicator according to claim 5, **characterized** in that:

20 – the input of the indicator circuit (11a) is connected both to a direct voltage (120) via a first resistor (R1) to an anode of a first diode (V1) and to an anode of a second diode (V2), a cathode of which first diode (V1) is configured to be connected to a first conductor (1) of the power cable and a cathode of the second diode (V2) is configured to be connected to a second conductor (2) of the power cable

25 – the output (131) of the indicator circuit (11a) is connected:

 – via a third resistor (R22) to an input of the amplifier (13b)

 – via a resistor (R2) to an anode of a first diode (V1) and an anode of a second diode (V2), and

30 – to a cathode of the third diode (V3), an anode of which third diode (V3) is connected to the ground.

7. The switching indicator according to claim 5, **characterized** in that:

– the reference voltage point (123) in the input of the indicator circuit (21c) is connected:

35 – to the inverting input of an operational amplifier (200) via a second supply resistor (R136), and

 – via a first resistor (R1) to an anode of a first diode (V1) and an anode of a second diode (V2) either directly or via a second resistor (R2), a cathode of

which first diode (V1) is configured to be connected to a first conductor (1) of the power cable and a cathode of which second diode (V2) is configured to be connected to a second conductor (2) of the power cable, and

– an output (131) of the indicator circuit (21c) is connected:

5 – to a cathode of a third diode (V3), an anode of which third diode (V3) is connected to the ground,

 – to a non-inverting input of an operational amplifier (200) via a second supply resistor (R135), and

10 – via a second resistor (R2) to the anode of the first diode (V1) and the anode of the second diode (V2).

8. The switching indicator according to claim 1, **characterized** in that the direct voltage source (12, 12a) is a direct voltage regulator connection, a protection separated power supply, an accumulator, a battery or a capacitor.

15 9. The switching indicator according to claim 1, **characterized** in that it further comprises an ignition indicator, which is configured to generate a signal to the switching indicator (10) indicating that the engine is running.

20 10. The switching indicator according to claim 1, **characterized** in that the power cable is a special cable, which has high-impedance resistors from a phase conductor and/or neutral conductor to a protective conductor.

25 11. The switching indicator according to any of the claims 1–10, **characterized** in that the switching indicator (10) is connected to a vehicle (100), such as a car, an electric car, a tractor, a boat or an electrical device, the connection of the power cable of which to the electrical network is configured to be indicated with the switching indicator.

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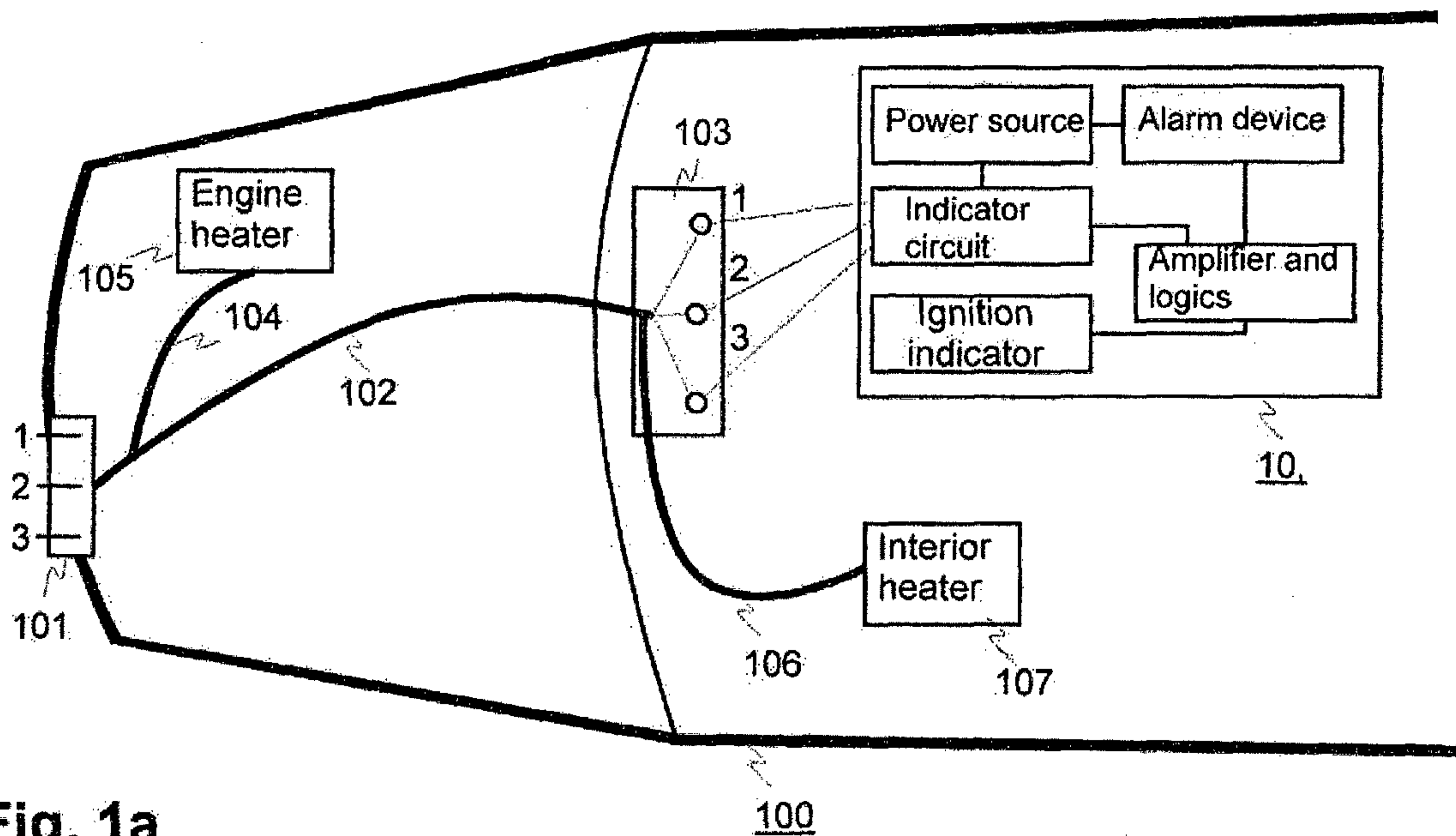


Fig. 1a

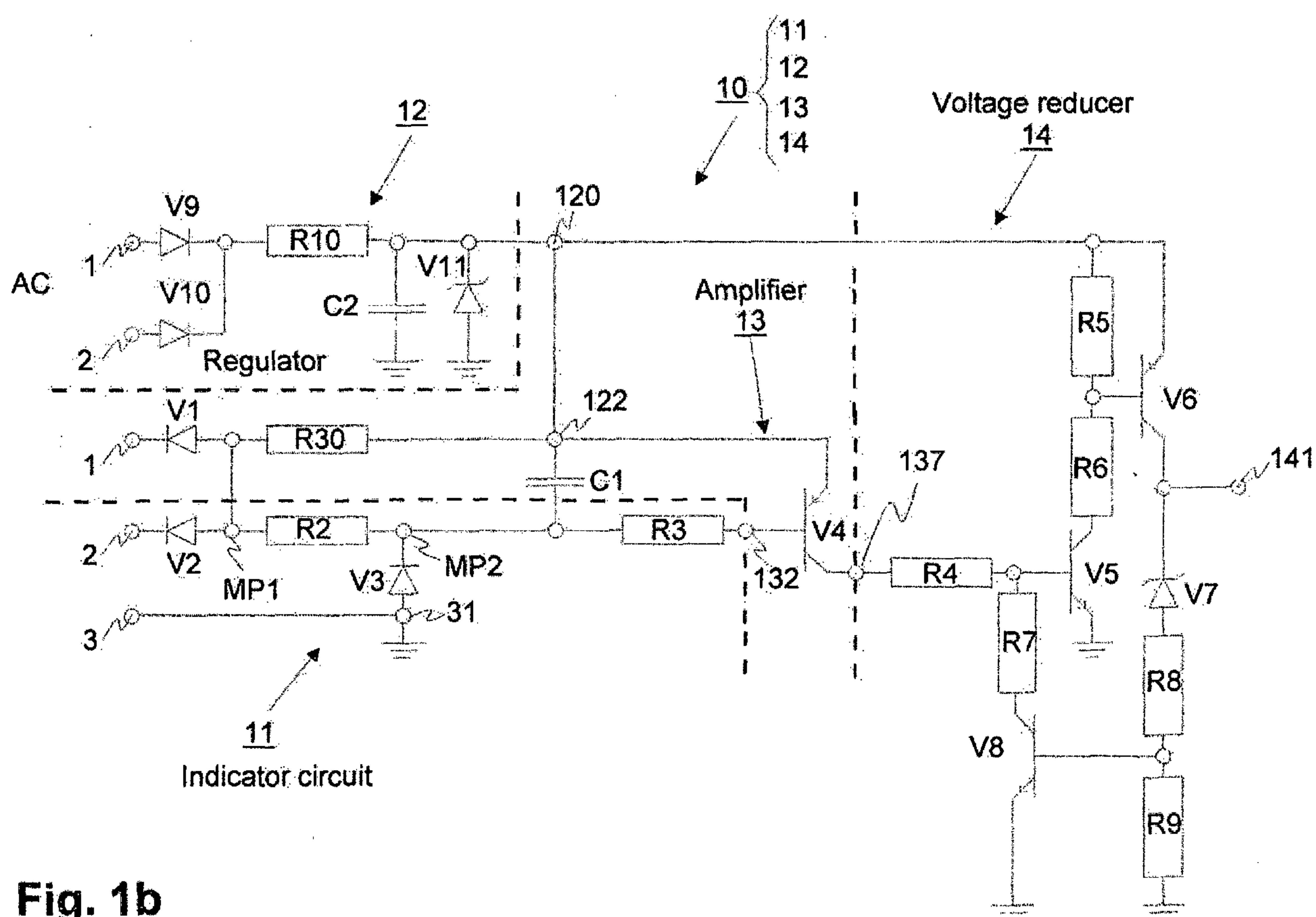


Fig. 1b

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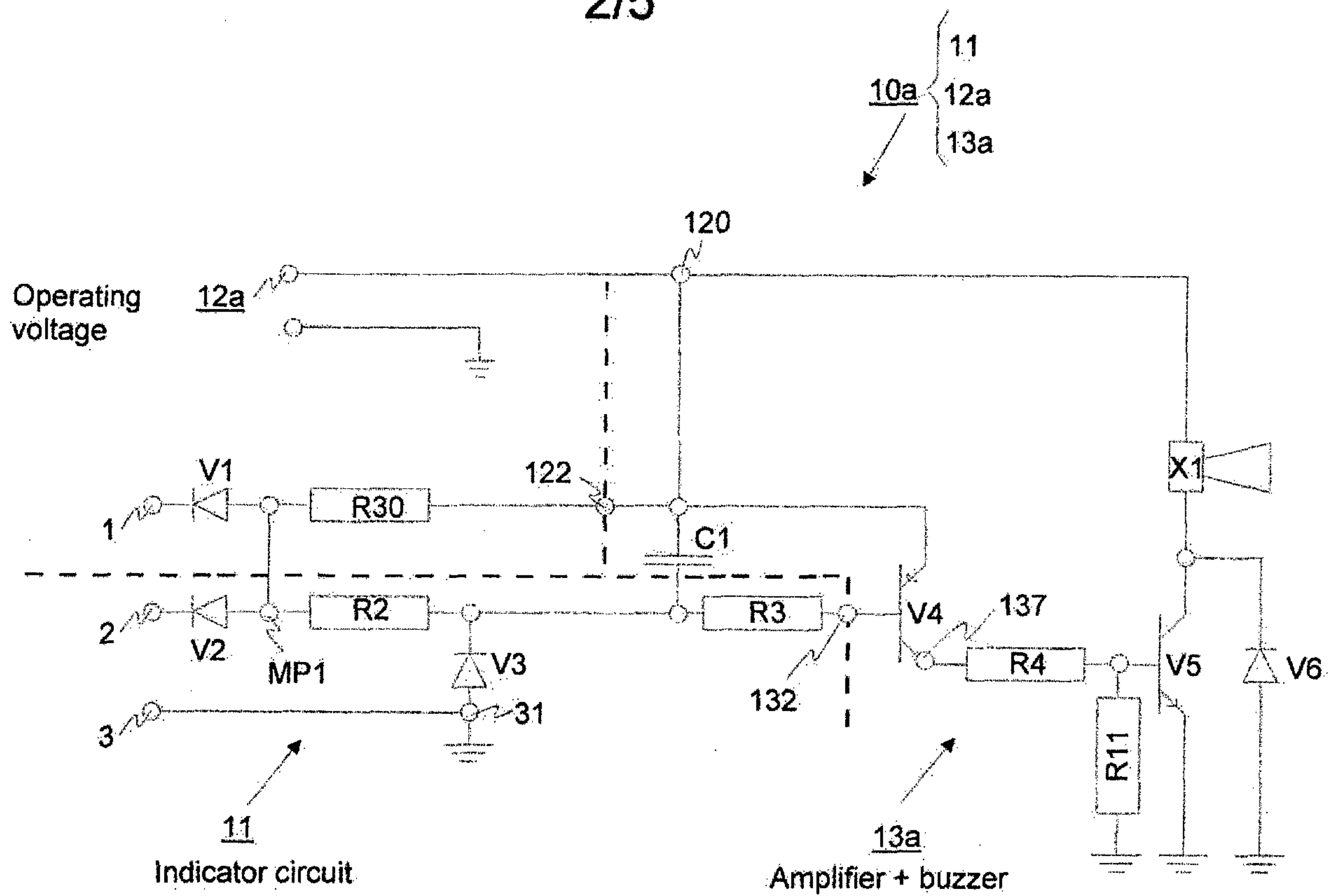


Fig. 1c

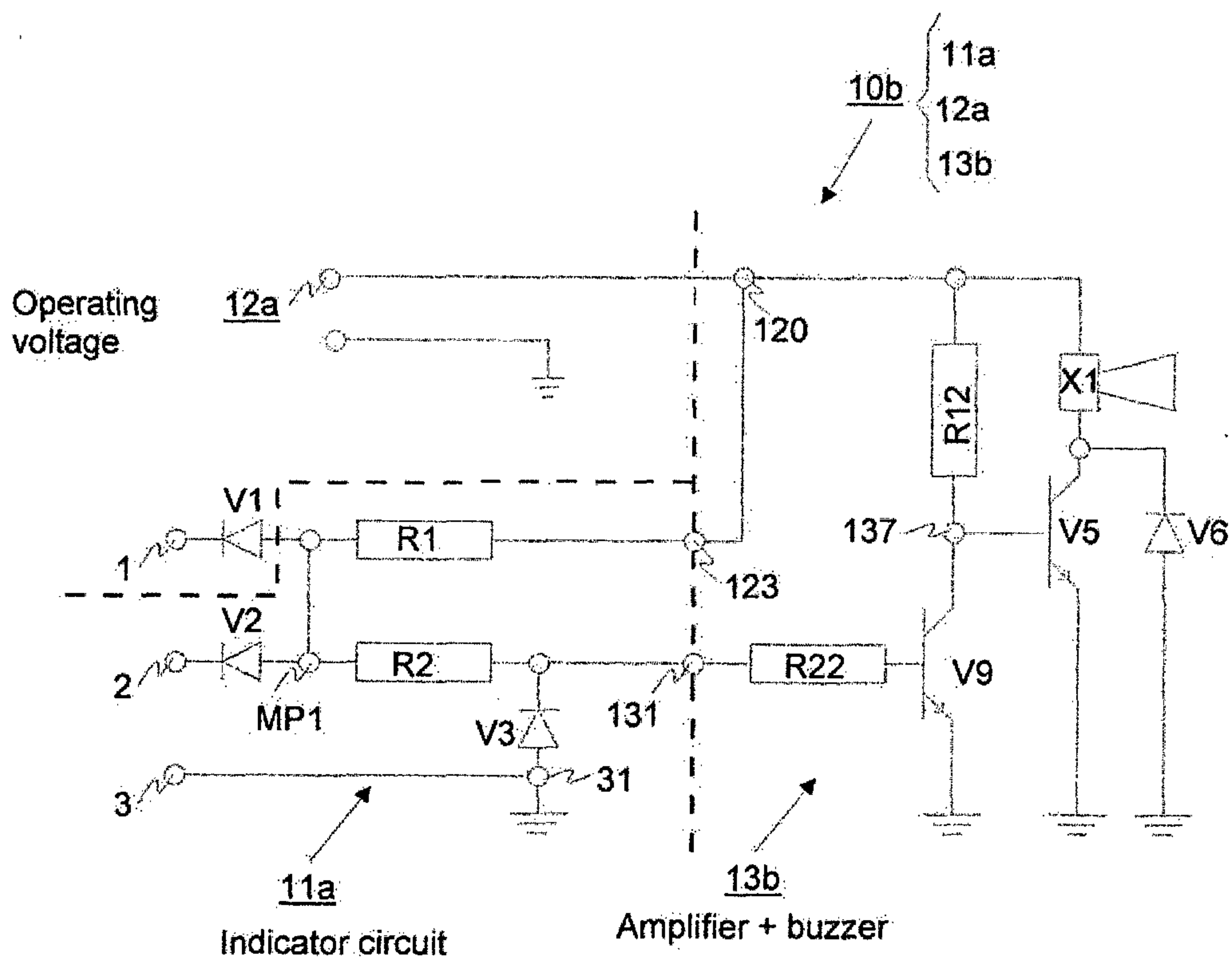
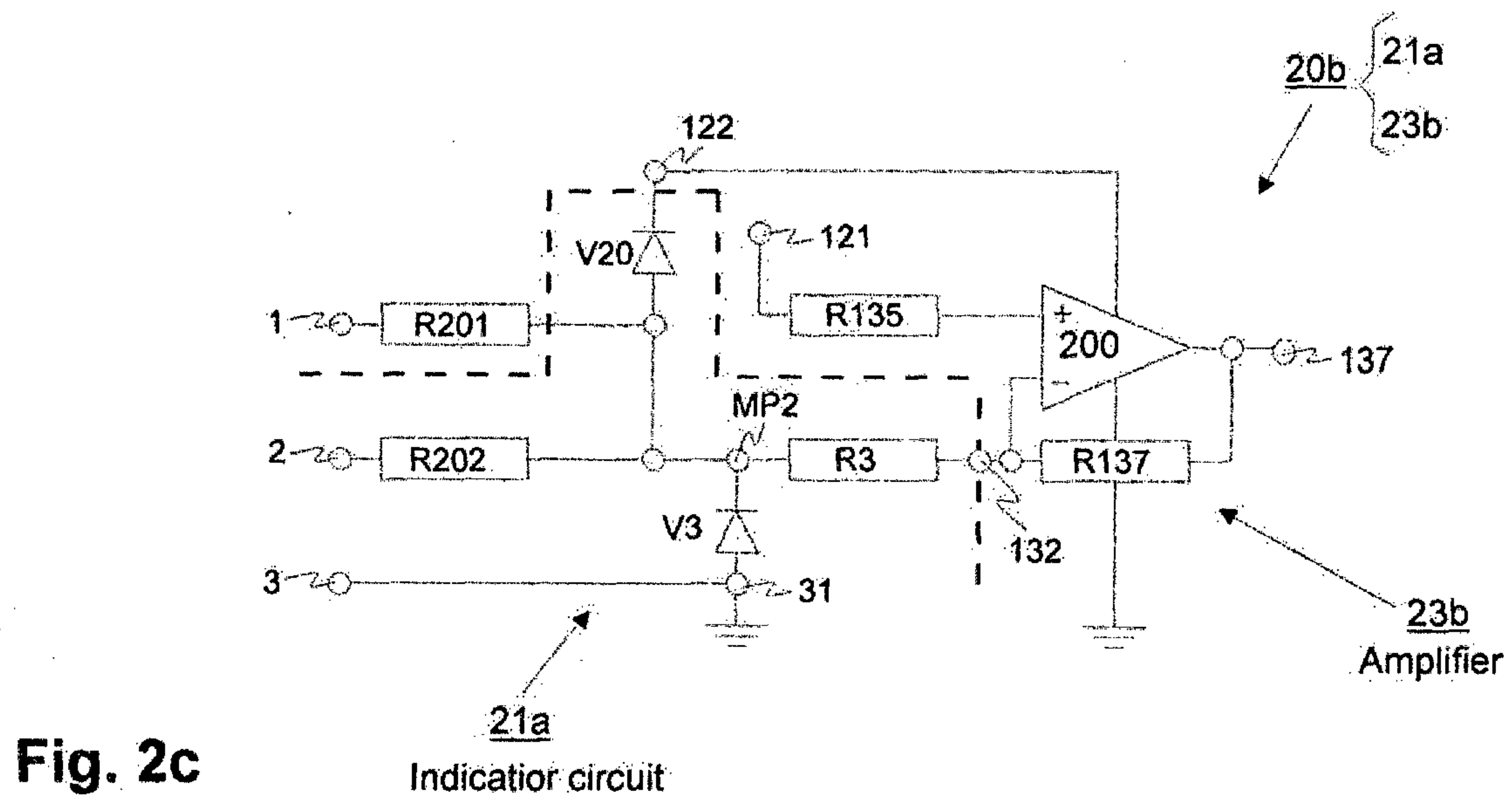
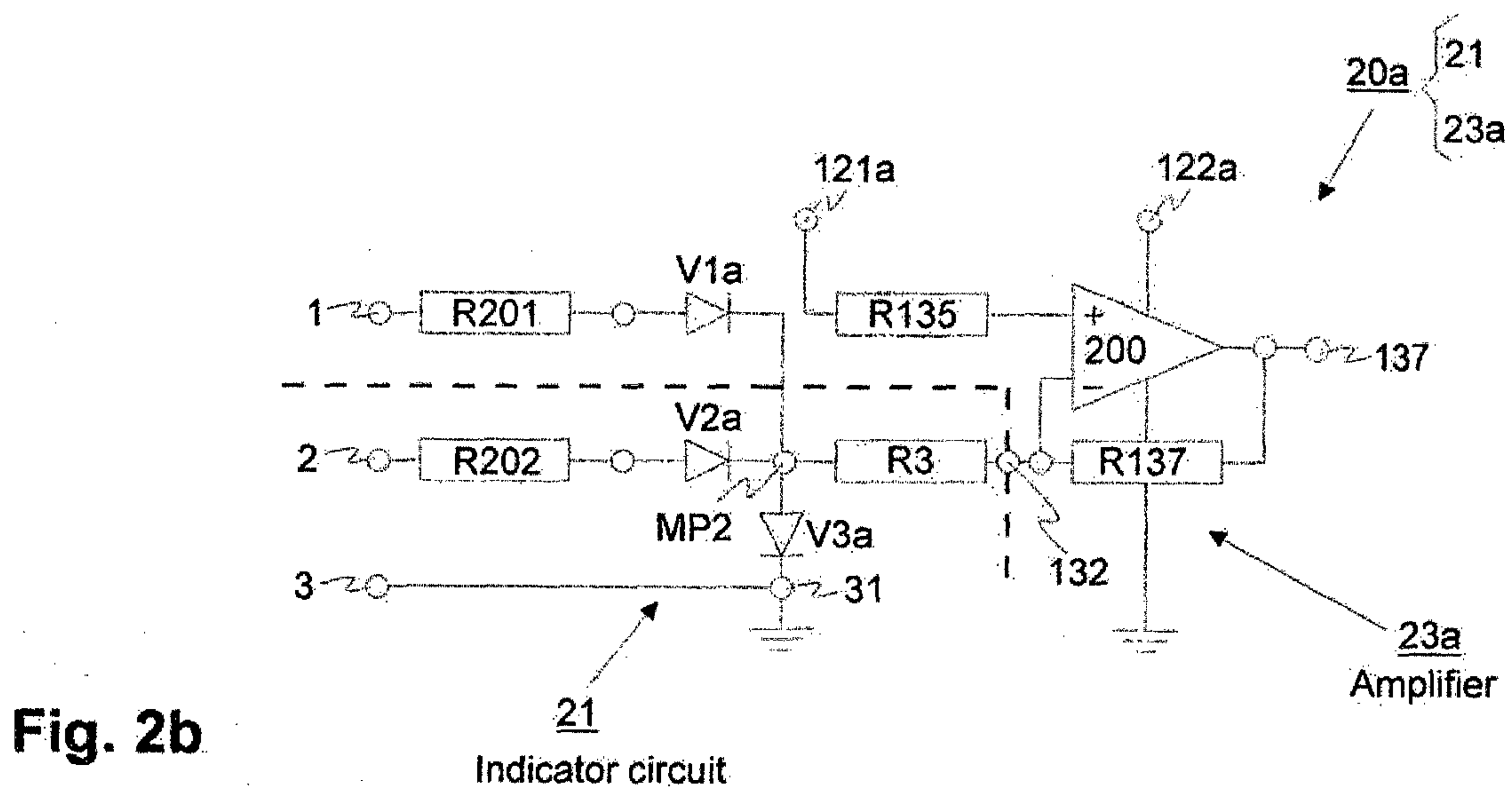
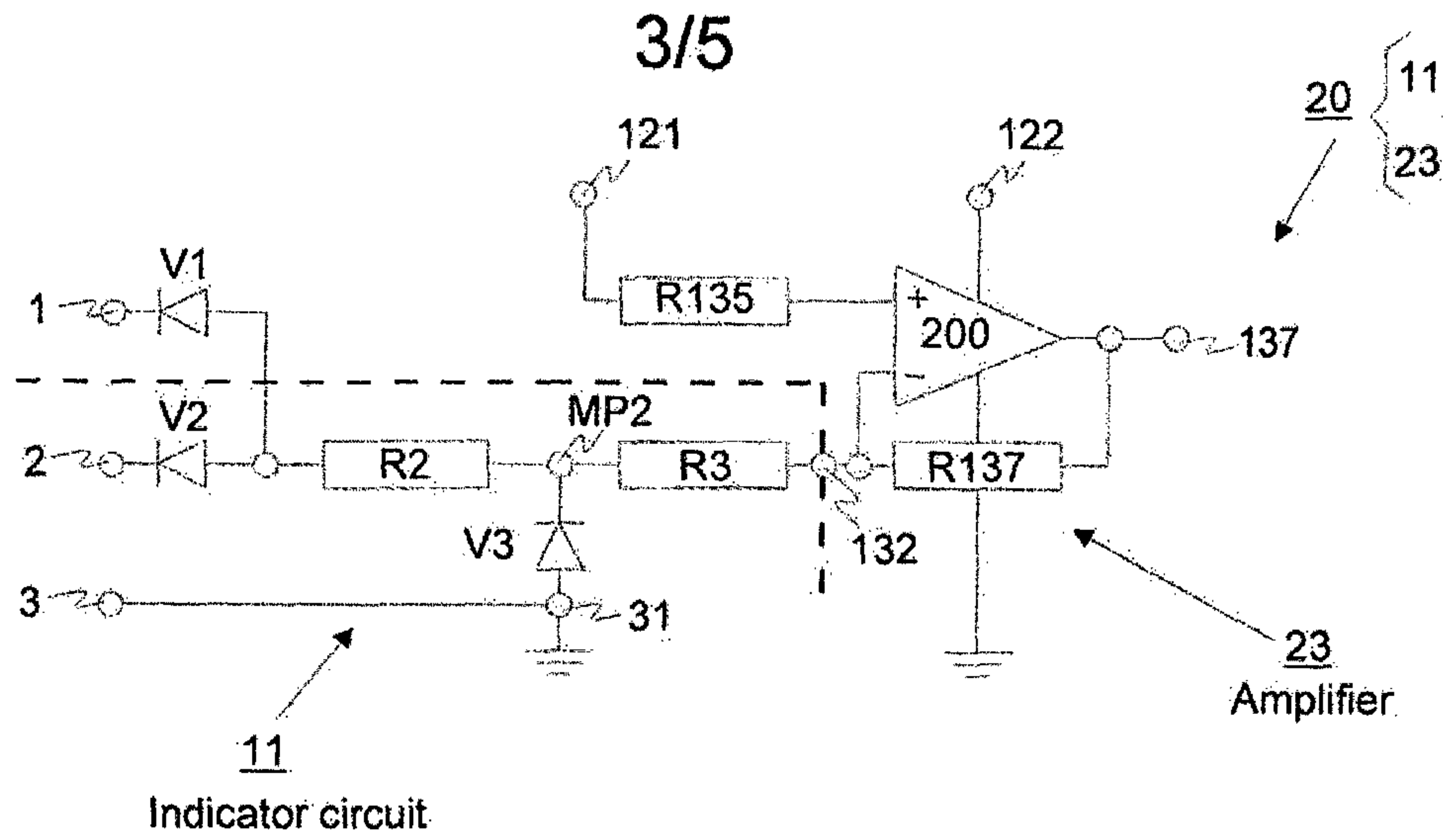
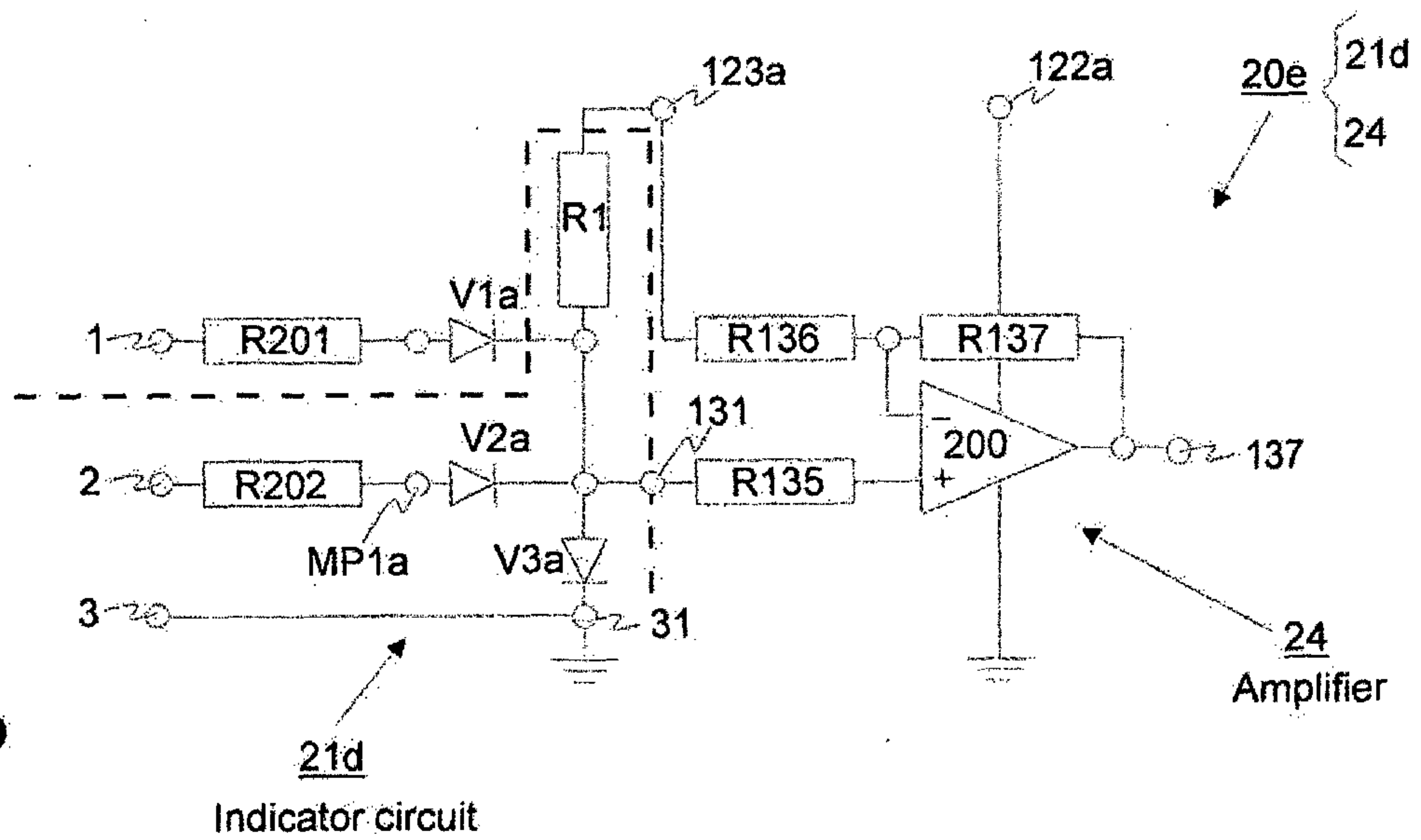
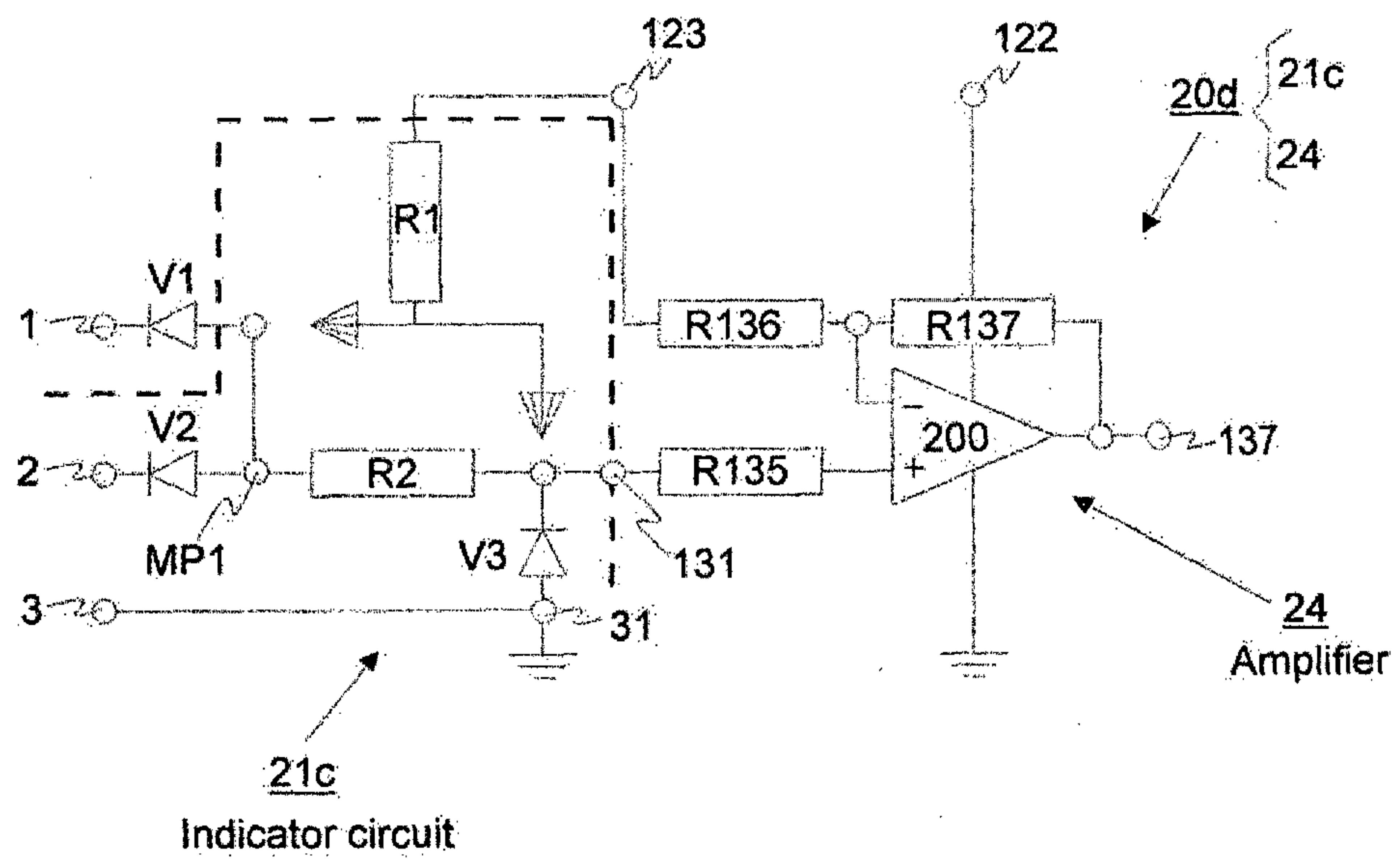
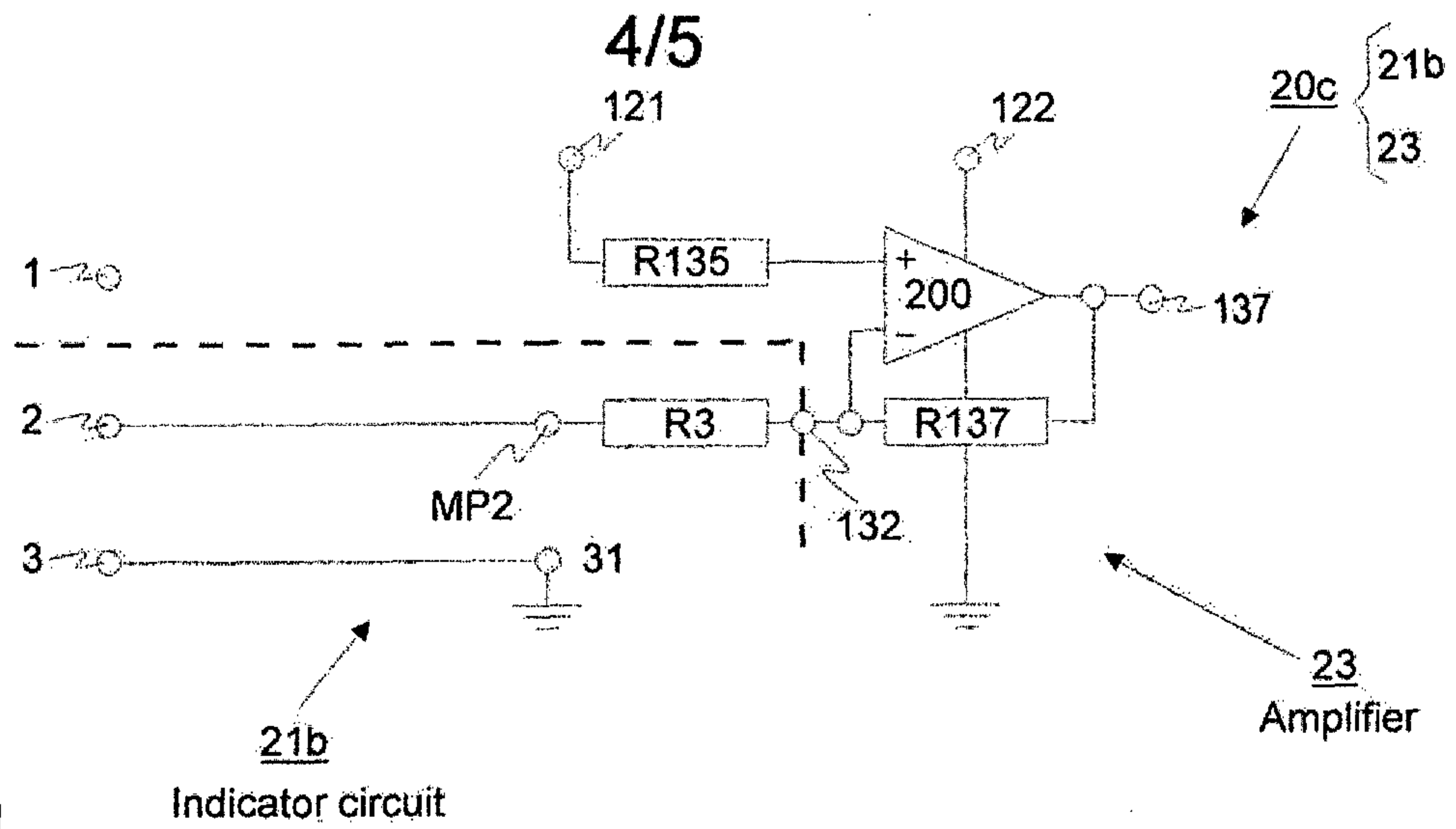
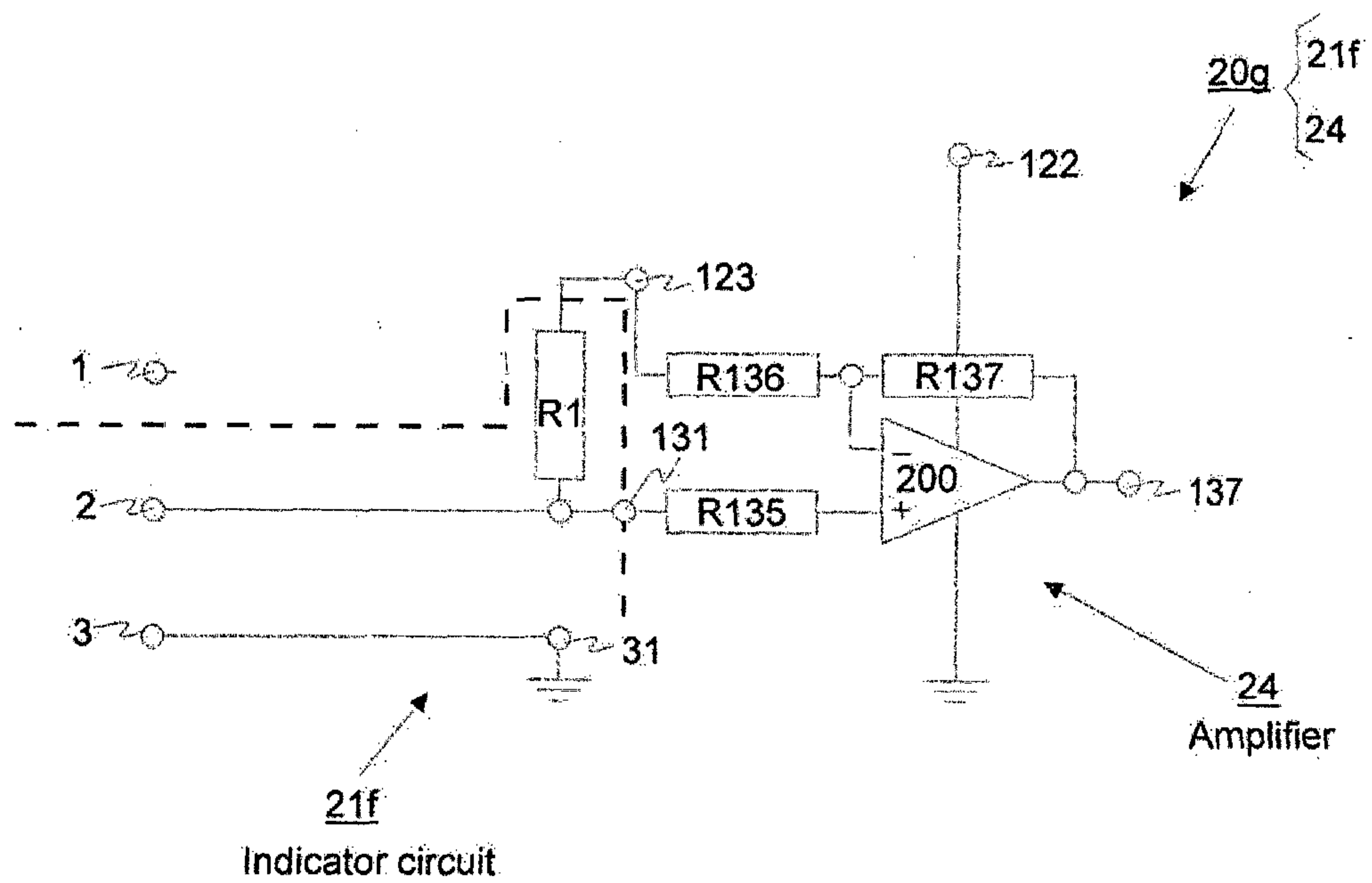
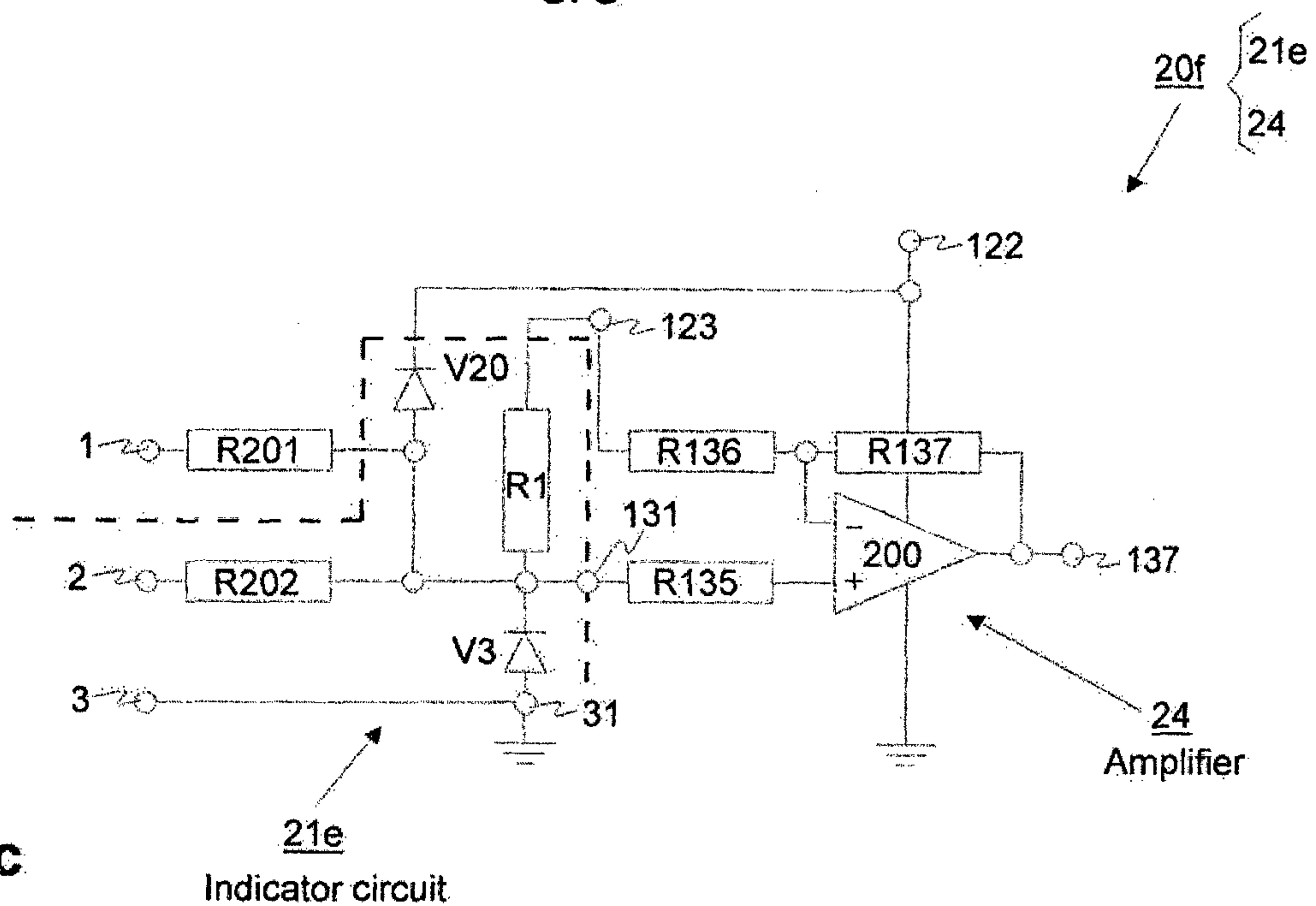


Fig. 1d





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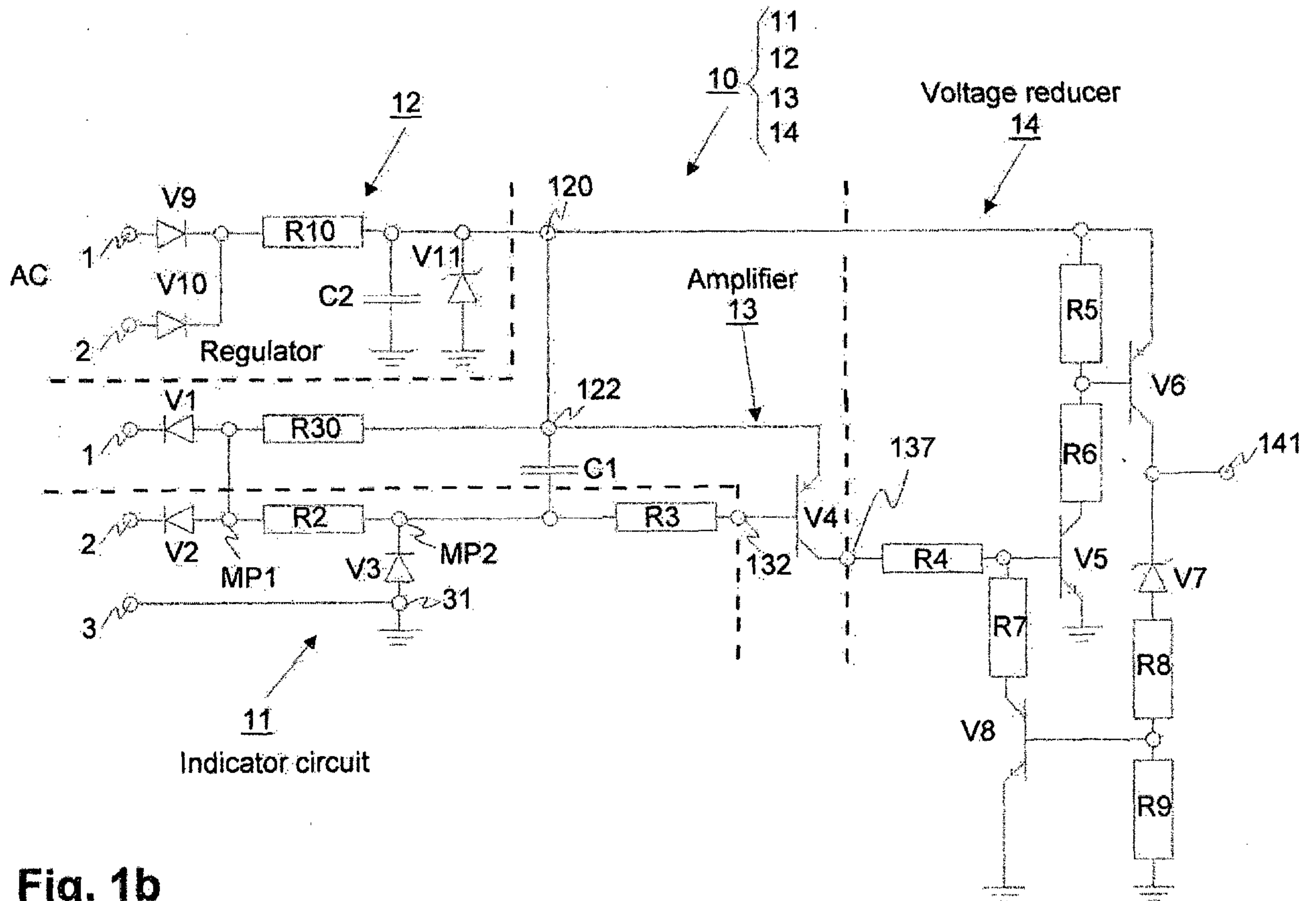


Fig. 1b