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(54) LIGHTING CIRCUIT ASSEMBLY

(57) A lighting circuit assembly, in particular for lighting or signaling devices of motor vehicles, comprising a first lighting circuit and a second lighting circuit, configured and/or controlled so as to perform different lighting functions. The two lighting circuits comprise, on respective electronic printed circuit boards, respective matrices of LED lighting sources and respective networks of resistor elements configured so as to determine the driving current of the respective matrices of LEDs.

At least some resistor elements of a first network of resistor elements are mounted on the second electronic board and at least some resistor elements of the second network of resistor elements are mounted on the first electronic board.

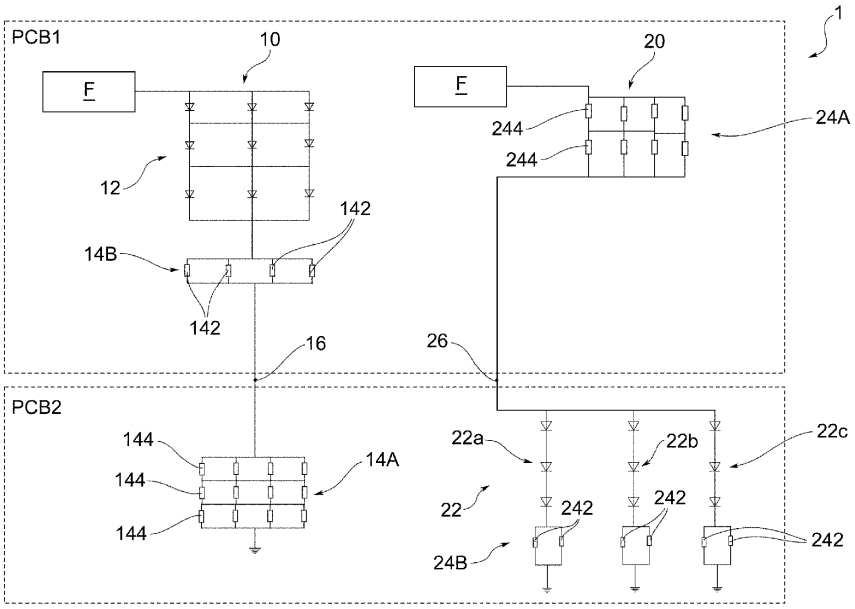

FIG.5

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Description

Field of the invention

[0001] The present invention relates to a LED lighting circuit assembly, in particular for making two or more lighting or signaling devices of motor vehicles, for example, turn signaling devices, rear light, stop light, etc.

[0002] The invention is intended, more specifically, to the lighting circuits of the LED type, in which the LEDs are arranged in matrix configurations and in which the current circulating in the LED matrix is defined by a network of resistor elements, for example, resistors, also known as "binning" resistors, since at least some of the resistors of this network are selected according to the electrical features of the LEDs of the matrix.

[0003] Other resistors of the network of resistor elements mainly have a function of thermal dissipation of the power absorbed and are not necessarily linked to the type of LEDs of the LED matrix.

Background art

[0004] Furthermore, in a circuit architecture of this type, usually, the LED matrix, the network of resistor elements and other components which contribute to performing a luminous function are mounted on an electronic printed circuit board (PCB).

[0005] Figure 1 diagrammatically shows an example of two electronic printed circuit boards, each of which mounting an LED matrix, a network of current setting resistors, and an input filter. For example, the PCB1 may be related to a stop light and the PCB2 may form a turn signaling light.

[0006] In Figures 1 and 2 it can be further noticed that the two LED matrices and the related resistor networks have different configurations.

[0007] In particular, the LED matrix of PCB1 is a matrix in which the LEDs of each row of the matrix have in common both the cathode and the anode. This type of matrix is also known as a "pure matrix". In this case, the resistor network, for example also in the form of a matrix in which the resistors of each row have both terminals in common, is connected to the common cathode of the LEDs of the last row of the matrix.

[0008] The LED matrix of the PCB2 is formed by LED strings, in each of which the LEDs are in series with one another and only the cathodes of the first LEDs of each string are in common. In this second configuration, the network of resistor elements is comprised of independent matrices of resistors, each matrix being connected in series to a respective LED string.

[0009] As it is known, even against significant and numerous advantages with respect to conventional lighting sources, LED sources are affected by a significant decline in performance when the temperature increases.

[0010] In fact, one of the design requirements of LED lighting devices is thermal dissipation. However, such a requirement often clashes with the miniaturization needs of LED devices.

[0011] For example, in the case of automotive lamps, the trend is to produce electronic printed circuit boards which are ever smaller and/or with particular shapes, dictated by the aesthetic appearance of the headlight.

Summary of the invention

[0012] It is the object of the present invention to propose a lighting circuit assembly, in particular for lighting or signaling devices of motor vehicles, capable of at least partially obviating the problem of performance deterioration of LED lighting sources caused by temperature.

[0013] It is another object of the invention to devise a way to create a lighting circuit assembly which allows to overcome the aforementioned issue, and, at the same time, which is optimized in terms of electrical connections between the circuits of the proposed assembly.

[0014] Such objects are achieved by means of a lighting circuit assembly in accordance with claim 1 and by means of an automotive lamp according to claim 9. The dependent claims describe preferred or advantageous embodiments of the invention.

[0015] In accordance with a general embodiment, the issue underlying the present invention is solved by means of a lighting circuit assembly, in particular for lighting or signaling devices of motor vehicles, comprising a first lighting circuit and a second lighting circuit, which are configured and/or controlled so as to perform different lighting functions.

[0016] The first lighting circuit comprises a first matrix of LED lighting sources and a first network of resistor elements connected to the first matrix of LED lighting sources and configured so as to determine the driving current of the first matrix of LED lighting sources or more driving currents of respective groups of LED lighting sources of the first matrix of LED lighting sources.

[0017] The second lighting circuit comprises a second matrix of LED lighting sources and a second network of resistor elements connected to the second matrix of LED lighting sources and configured so as to determine the driving current of the second matrix of LED lighting sources or more driving currents of respective groups of LED lighting sources of the second matrix of LED lighting sources.

[0018] The first matrix of LED lighting sources is mounted on a first electronic printed circuit board, the second matrix of LED lighting sources is mounted on a second electronic printed circuit board.

[0019] At least some resistor elements of the first network of resistor elements are mounted on the second electronic board and at least some resistor elements of the second network of resistor elements are mounted on the first electronic board.

Brief description of the drawings

[0020] The features and advantages of the lighting circuit assembly and of the automotive lamp according to the invention will in any case become apparent from the following description of preferred embodiments thereof, given only by way of non-limiting, indicative example, with reference to the accompanying drawings, in which:

- Figure 1 shows a diagrammatic representation of two electronic printed circuit boards which implement two respective different lighting circuits, according to the prior art;
- Figure 2 shows the electronic boards of Figure 1, in which the resistor networks connected to the LED matrices have been exemplified;
- Figure 3 shows a diagrammatic representation of one of the two lighting circuits of the previous figures which is distributed on both electronic printed circuit boards;
- Figure 4 shows a diagrammatic representation of the other lighting circuit which is distributed on both electronic printed circuit boards;

Figure 5 shows a diagrammatic representation of an example of a lighting circuit assembly according to the invention;

Figure 6 shows the two electronic boards connected to an electronic control unit; and

Figure 7 shows an example of an automotive lamp comprising a lighting circuit assembly according to the invention.

Detailed description

[0021] The present invention finds application in a lighting assembly comprising two or more electronic printed circuit boards ("PCBs") which implement respective LED lighting circuits, in which the current flowing in the LEDs is determined by a network of resistors. The LED lighting circuits are configured and/or controlled to perform different lighting functions.

[0022] In case of automotive lamps, for example, the lighting circuits can perform vehicle lighting and/or signaling functions, in particular selected among: turn function, stop function, positioning function, fog light function, reverse function, and the like, in which the automotive lamps can be installed in the body, or even in the trunk door or rear window of the vehicle.

[0023] The present invention is based on the observation that, in these situations, the lighting functions are almost never simultaneously active and consequently the LEDs of the different lighting circuits are almost never simultaneously powered.

[0024] As anticipated above, the invention is intended, specifically, to the lighting circuits of the LED type, in which the LEDs are arranged in matrix configurations and in which the current circulating in the LED matrix is defined by a network of resistor elements, for example, resistors, also known as "binning" resistors.

[0025] In fact, at least some of the resistors of this network are selected according to the electrical features of the LEDs of the matrix.

[0026] Other resistors of the network of resistor elements mainly have a function of thermal dissipation of the power absorbed and are not necessarily linked to the type of LEDs of the LED matrix.

[0027] A conventional LED lighting circuit assembly, for example, for an automotive lamp, is shown in Figures 1 and 2.

[0028] Figure 1 diagrammatically shows two electronic printed circuit boards (PCB1, PCB2), each of which mounting a LED matrix (M1, M2), a network of current setting resistors (R1, R2), and an input filter (F), for example, an electromagnetic interference suppression filter, or a reverse polarity protection filter. For example, the PCB1 may be related to a stop light and the PCB2 may form a turn signaling light.

[0029] In Figures 1 and 2 it can also be noticed that the two LED matrices (M1, M2) and the relative resistor networks (R1, R2) have different configurations.

[0030] In particular, the LED matrix (M1) of the electronic board PCB1 is a matrix in which the LEDs of each row of the matrix have in common both the cathode and the anode. This type of matrix is also known as a "pure matrix".

[0031] In this case, the resistor network (R1), for example also in the form of a matrix in which the resistors of each row have both terminals in common, is connected to the common cathode of the LEDs of the last row of the matrix.

[0032] The LED matrix (M2) of the electronic board PCB2 is formed by LED strings ($M2_1$, $M2_2$, $M2_3$), in each of which the LEDs are in series with one another and only the cathodes of the first LEDs of each string are in common. In this second configuration, the network of resistor elements (R2) is comprised of independent matrices of resistors, each matrix being connected in series to a respective LED string.

[0033] A lighting circuit assembly 1 according to the invention will now be described.

[0034] In a general embodiment, the lighting circuit assembly 1 comprises at least one first lighting circuit 10 and a second lighting circuit 20.

[0035] The first lighting circuit 10 and the second lighting circuit 20 are configured and/or controlled so as to perform different lighting functions.

[0036] The first lighting circuit 10 comprises a first matrix of LED lighting sources 12 and a first network of resistor elements 14 connected to the first matrix of LED lighting sources 12.

[0037] The first network of resistor elements 14 is configured so as to determine the driving current of the first matrix of LED lighting sources 12 or more driving currents of respective groups of LED lighting sources of the first matrix of LED lighting sources 12.

[0038] The second lighting circuit 20 comprises a sec-

ond matrix of LED lighting sources 22 and a second network of resistor elements 24 connected to the second matrix of LED lighting sources 22.

[0039] The second network of resistor elements 24 is configured so as to determine the driving current of the second matrix of LED lighting sources 22 or more driving currents of respective groups of LED lighting sources of the second matrix of LED lighting sources 22.

[0040] The first matrix of LED lighting sources 12 is mounted on a first electronic printed circuit board PCB1.

[0041] The second matrix of LED lighting sources 22 is mounted on a second electronic printed circuit board PCB2.

[0042] In accordance with an aspect of the invention, at least some resistor elements 14A of the first network of resistor elements 14 are mounted on the second electronic board PCB2 and at least some resistor elements 24A of the second network of resistor elements 24 are mounted on the first electronic board PCB2.

[0043] Therefore, at least one part of the thermal dissipation of each circuit is realized on the electronic board on which another circuit is implemented, exploiting the fact that the LED lighting sources of the different circuits will never or almost never be powered simultaneously.

[0044] In other words, at least some of the resistor elements which are dissipating power are mounted on an electronic board different from that of the respective LED lighting sources and, in particular, on an electronic board whose lighting sources are most likely off.

[0045] The LED lighting sources which are powered are therefore not affected by the heating produced by the power dissipating elements, since they are placed on another board; the power dissipating elements do not affect the performance of the lighting sources of the board on which they are mounted, since such lighting sources are off.

[0046] Since, in a typical embodiment, each network of resistor elements 14, 24 comprises binning resistors 14B, 24B, selected according to the electrical features of the LED lighting sources, and dissipation resistor elements 14A, 24A suitable to dissipate the power absorbed by the respective lighting circuit, at least the dissipation resistor elements 14A, 24A of the first and second network of resistor elements 14, 24 are mounted on the second (PCB2) and first (PCB1) electronic printed circuit board, respectively.

[0047] In some embodiments, also the binning resistors 14B, 24B of a lighting circuit 10; 20 can be mounted on the electronic board of the other lighting circuit 10; 20.

[0048] However, when the mounting of the electronic components is carried out automatically, for example, by means of "pick and place" machines, the machine which is making a lighting circuit on an electronic board is capable of selecting the binning resistors on the basis of a detection of the type of lighting sources positioned or to be positioned on that board. In these cases, therefore, it is preferable to maximize the assembly speed of the board, and the binning resistors are mounted on the same board as the lighting sources to which they are connected.

[0049] In accordance with another aspect of the invention, the resistor elements 14A, 24A connected to a matrix of LED lighting sources 12, 22, and mounted on the PCB of the other matrix of LED lighting sources, are connected upstream or downstream of the respective matrix 12, 22 according to the configuration of such matrix.

[0050] The choice of the upstream or downstream connection with respect to the matrix allows to reduce the number of electrical connections 16, 26, or of cables, between the two electronic boards PCB1, PCB2.

[0051] Figures 2-5 show two lighting circuits 10, 20 whose LED matrices 12, 22 have a different configuration, on the basis of which the connection between the LED matrix and the network of resistors is determined.

[0052] The first LED matrix 12 is formed by two or more rows of LEDs 12a, 12b, 12c, in which the LEDs of each row have the anodes in common with one another and the cathodes in common with one another ("pure" matrix). In this case, to reduce the number of connections between the two electronic boards PCB1, PCB2, the resistor elements 14A mounted on the PCB of the other LED matrix are connected downstream of the respective matrix 12.

[0053] The second LED matrix 22 of PCB2 is formed by two or more columns or strings of LEDs 22a, 22b, 22c, in which the LEDs of each column or string are connected in series with one another. In this case, the resistor elements 24A mounted on the PCB of the other LED matrix (PCB1) are connected upstream of the respective LED matrix 22.

[0054] Figure 5 shows the two electronic boards PCB1, PCB2 on which the two lighting circuits 10, 20, connected as described above, are assembled.

[0055] In the example shown, the first resistor network 14 is comprised of a matrix of resistors arranged in 4 rows and 4 columns. The first row 14B is formed by binning resistors 142 and is placed on the first electronic board PCB1; the other three rows, which form the network portion of dissipation resistors 14A, are formed by dissipation resistors 144 and are therefore placed on the second electronic board PCB2.

[0056] The second network of resistors 24, as also shown in Figure 2, is comprised of three 2X3 matrices of resistors, each matrix connected to a respective string of LEDs 22a, 22b, 22c. The first 2x1 row of each matrix is formed by binning resistors 242 and is maintained on the second electronic board PCB2, downstream of the second LED matrix 22. The other two rows, which form the network portion of dissipation resistors 24A, are formed by dissipation resistors 244 and are therefore placed on the first electronic board PCB1, connected upstream of the second LED matrix 22.

[0057] It should be noted that the portion of resistor network of a lighting circuit which is moved to the electronic board of another lighting circuit, can exploit the ground terminal already present on the other electronic

board.

[0058] Each lighting circuit can be provided with an input filter F, for example, an electromagnetic interference suppression filter, or a reverse polarity protection filter.

[0059] In one embodiment, as shown in Figure 6, the lighting circuit assembly 1 comprises an electronic control unit 30 ("ECU") programmed to control the first and second lighting circuits 10, 20 so that the first and second lighting circuits 10, 20 perform different lighting functions.

[0060] For example, the first lighting circuit and the second lighting circuit are configured and/or controlled so as to perform respective lighting and/or signaling functions, in particular selected among: turn indicator function, stop function, positioning function, fog light function, reverse function, and the like.

[0061] It is the object of the present invention also an automotive lamp 50, in particular, but not necessarily, located in the rear part of the vehicle, comprising a lighting circuit assembly 1 according to the invention, as described above.

[0062] Those skilled in the art may make changes and adaptations to the embodiments of the lighting circuit assembly and the automotive light according to the invention or can replace elements with others which are functionally equivalent in order to meet contingent needs without departing from the scope of the following claims.

[0063] For example, the number of LEDs or resistors can vary depending on the type and on the current set on the LEDs and therefore on the basis of the power to be dissipated.

[0064] All of the features described above as belonging to one possible embodiment can be implemented independently of the other described embodiments.

Claims

1. A lighting circuit assembly, in particular for lighting or signaling devices of motor vehicles, comprising:

   - a first lighting circuit; and
   - a second lighting circuit,

   in which said first lighting circuit and second lighting circuit are configured and/or controlled so as to perform different lighting functions, and in which:

   - the first lighting circuit comprises a first matrix of LED lighting sources and a first network of resistor elements connected to the first matrix of LED lighting sources and configured so as to determine the driving current of the first matrix of LED lighting sources or more driving currents of respective groups of LED lighting sources of the first matrix of LED lighting sources,
   - the second lighting circuit comprises a second matrix of LED lighting sources and a second network of resistor elements connected to the second matrix of LED lighting sources and configured so as to determine the driving current of the second matrix of LED lighting sources or more driving currents of respective groups of LED lighting sources of the second matrix of LED lighting sources,

   in which the first matrix of LED lighting sources is mounted on a first electronic printed circuit board, the second matrix of LED lighting sources is mounted on a second electronic printed circuit board,
   the assembly being **characterized in that** at least some resistor elements of the first network of resistor elements are mounted on the second electronic board and at least some resistor elements of the second network of resistor elements are mounted on the first electronic board.

2. An assembly according to claim 1, wherein each network of resistor elements comprises binning resistors selected according to the electrical features of the LED lighting sources and dissipation resistor elements suitable to dissipate the power absorbed by the respective lighting circuit, at least the dissipation resistor elements of the first and second network of resistor elements being mounted on the second and first PCB, respectively.

3. An assembly according to claim 1 or 2, wherein the resistor elements connected to a matrix of LED lighting sources and mounted on the PCB of the other matrix of LED lighting sources, are connected upstream or downstream of the respective matrix according to the configuration of said matrix.

4. An assembly according to claim 3, wherein, if the matrix is formed by two or more rows of LEDs, in which the LEDs of each row have the anodes in common with one another and the cathodes in common with one another, the resistor elements mounted on the PCB of the other LED matrix are connected upstream of the respective matrix.

5. An assembly according to claim 3 or 4, wherein, if the matrix is formed by two or more columns or strings of LEDs, in which the LEDs of each column or string are connected in series with one another, the resistor elements mounted on the PCB of the other matrix of LEDs are connected downstream of the respective matrix of LEDs.

6. An assembly according to any one of the preceding claims, comprising an electronic control unit programmed to control the first and second lighting circuits so that the first and second lighting circuits perform different lighting functions.

7. An assembly according to any one of the preceding

claims, in which the first lighting circuit and the second lighting circuit are configured and/or controlled so as to perform respective lighting and/or signaling functions selected among: turn indicator function, stop function, positioning function, fog light function, reverse function.

8. An assembly according to any one of the preceding claims, wherein each lighting circuit comprises an input filter circuit.

9. An automotive lamp, comprising an assembly of lighting circuits according to any one of the preceding claims.

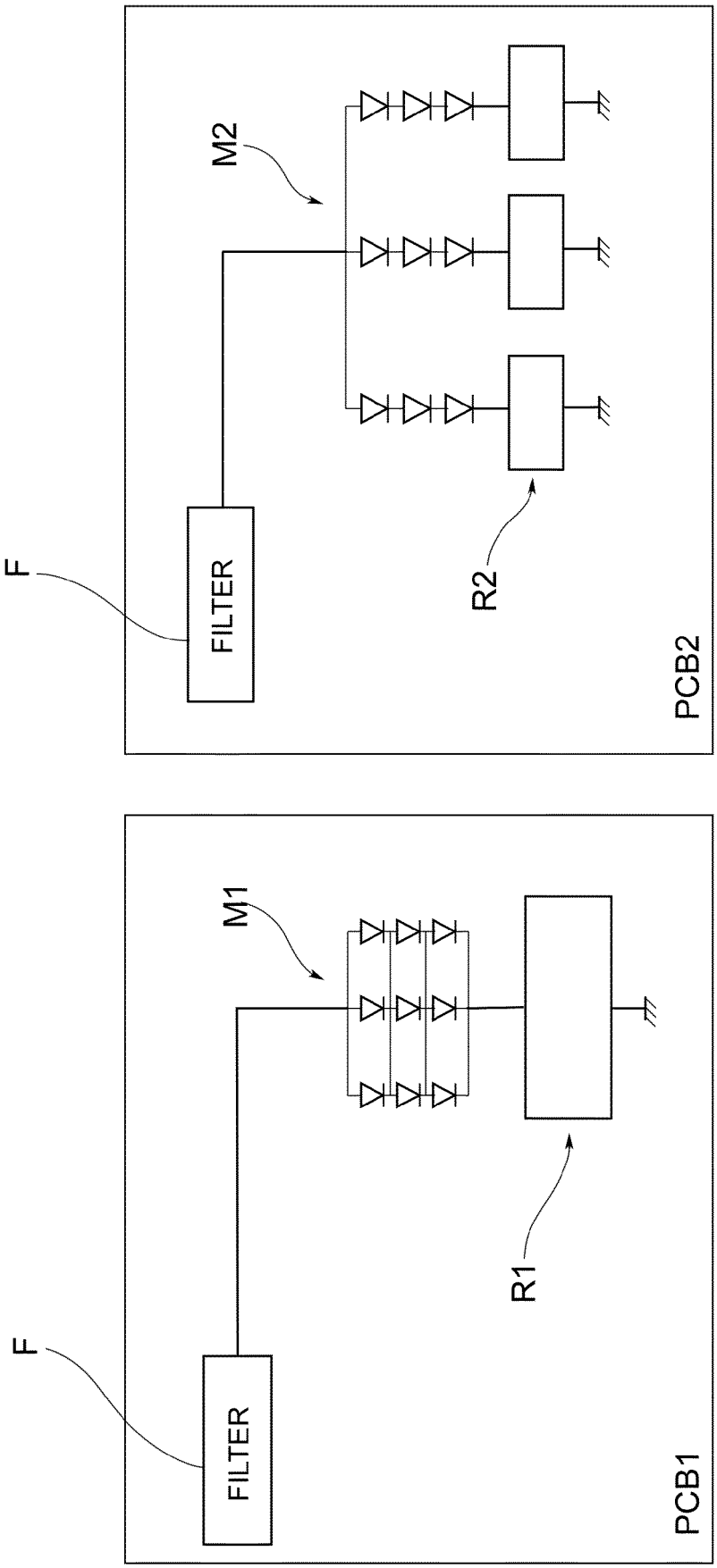

FIG.1

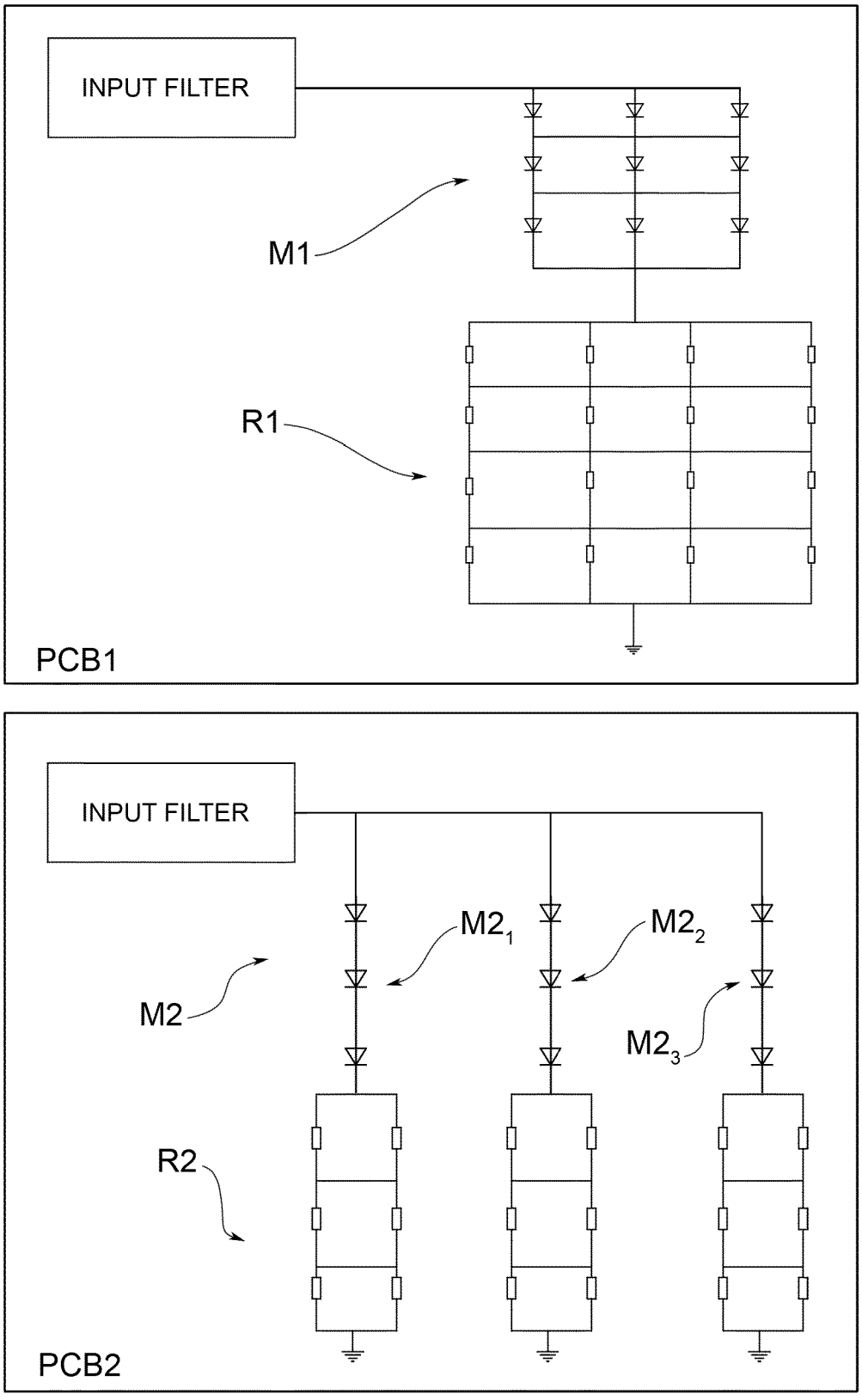

FIG.2

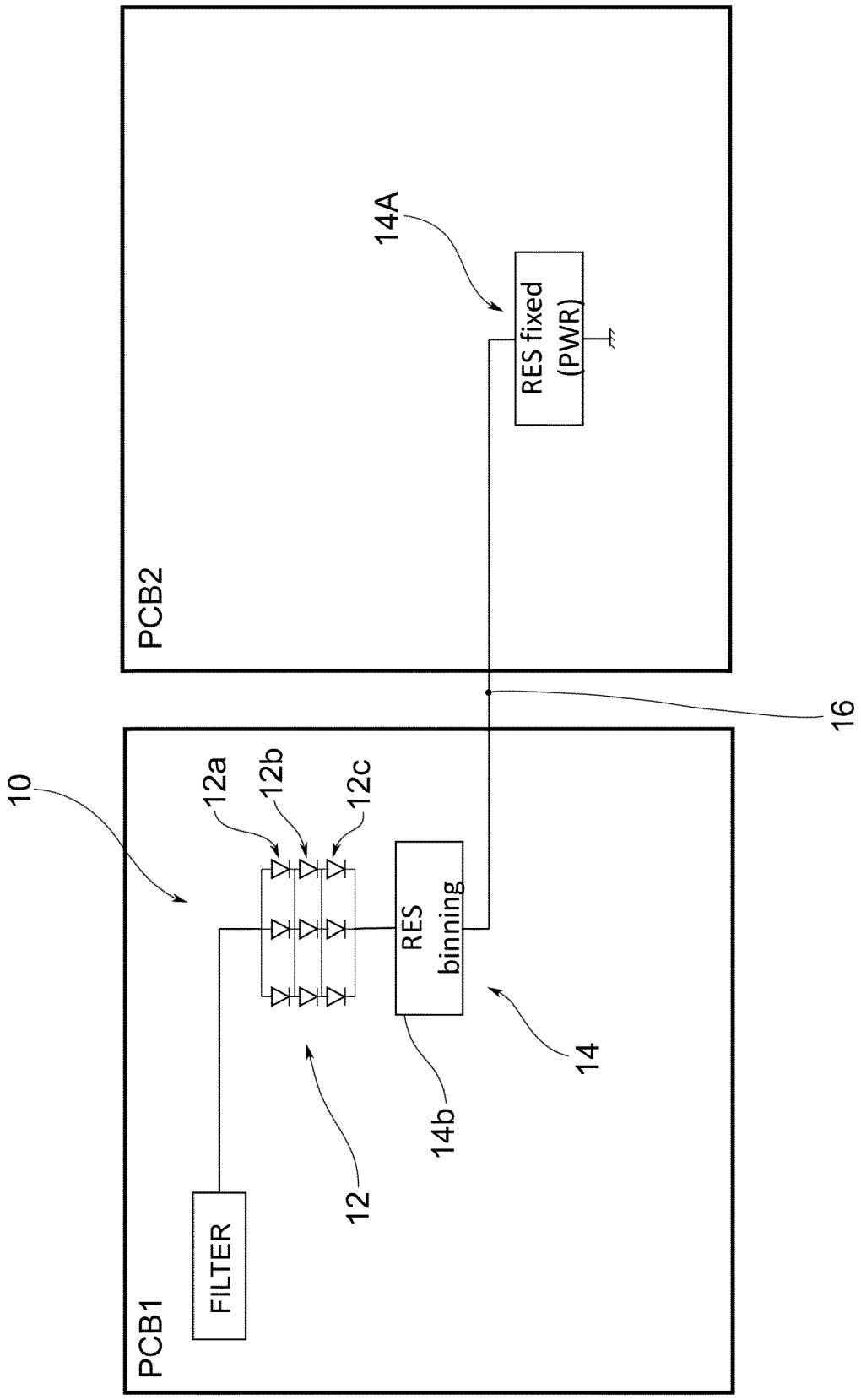
PCB2
14A
RES fixed (PWR)
16
10
12a
12b
12c
RES binning
14
14b
12
FILTER
PCB1

FIG.3

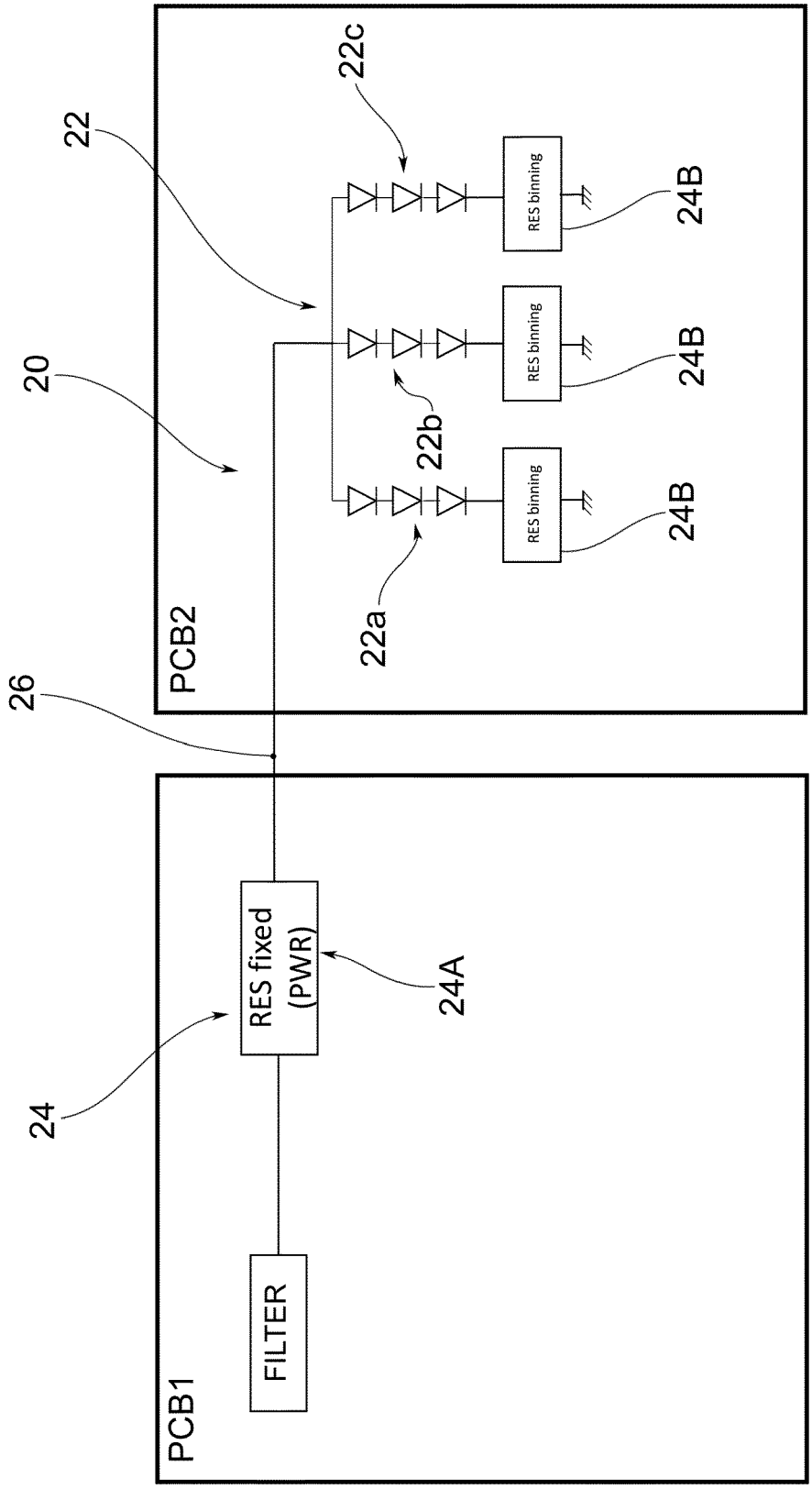
PCB1
FILTER
RES fixed (PWR)
24A
24
26
PCB2
22
20
22c
22b
22a
RES binning
24B
RES binning
24B
RES binning
24B

FIG.4

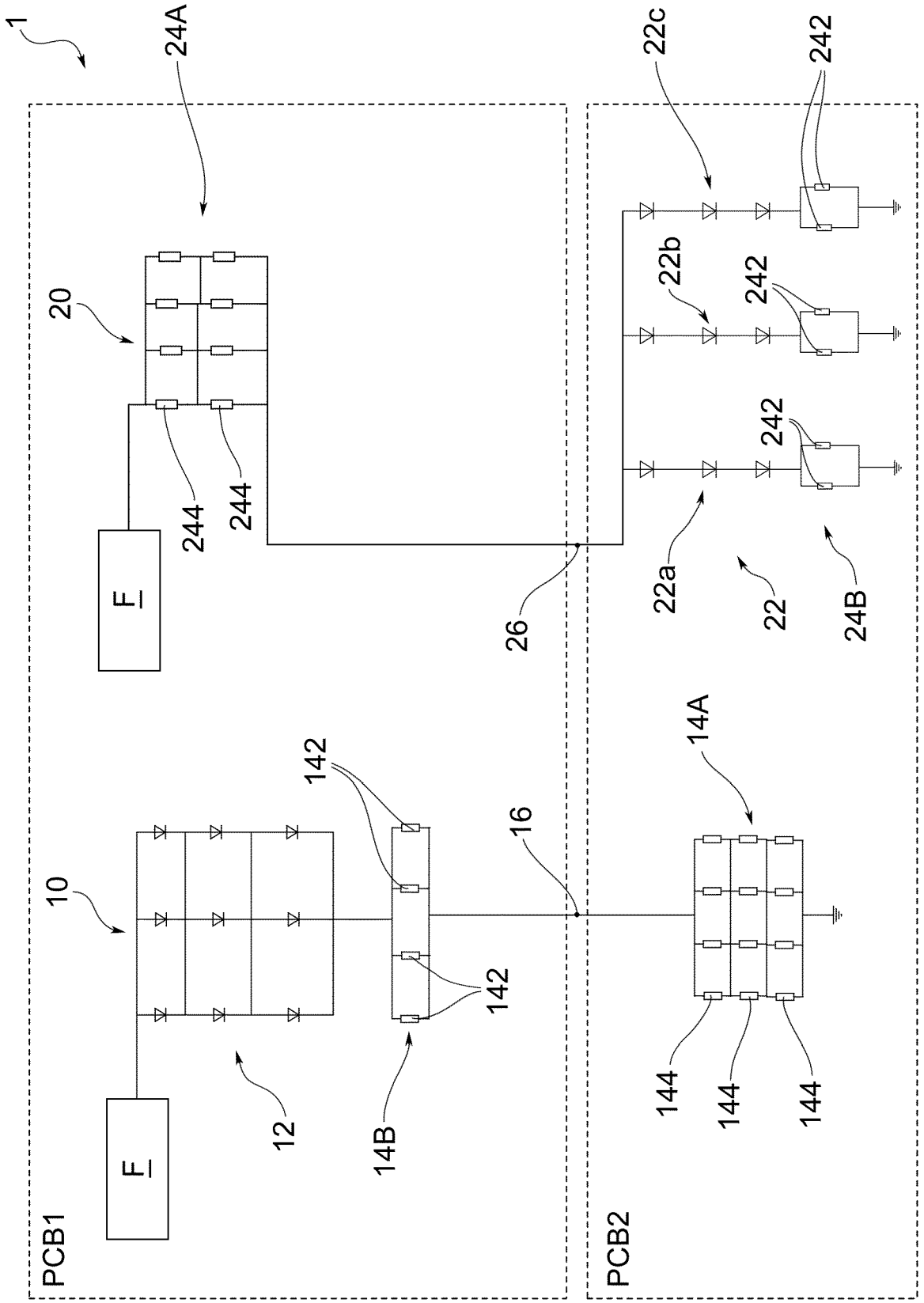
1
24A
22c
242
22b
242
242
20
244
244
F
26
22a
22
24B
142
16
14A
10
142
144
144
144
12
14B
F
PCB1
PCB2

FIG.5

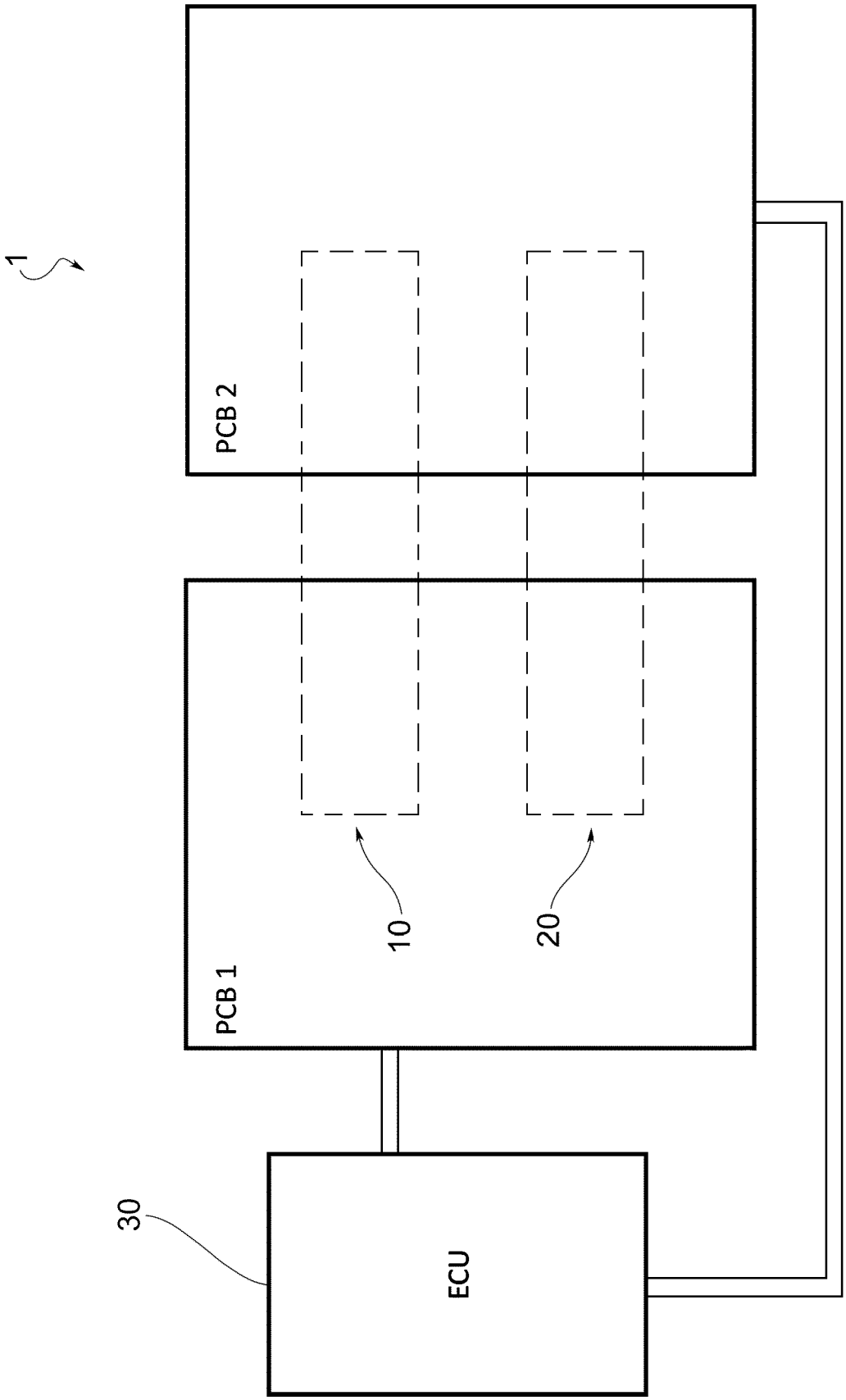

FIG.6

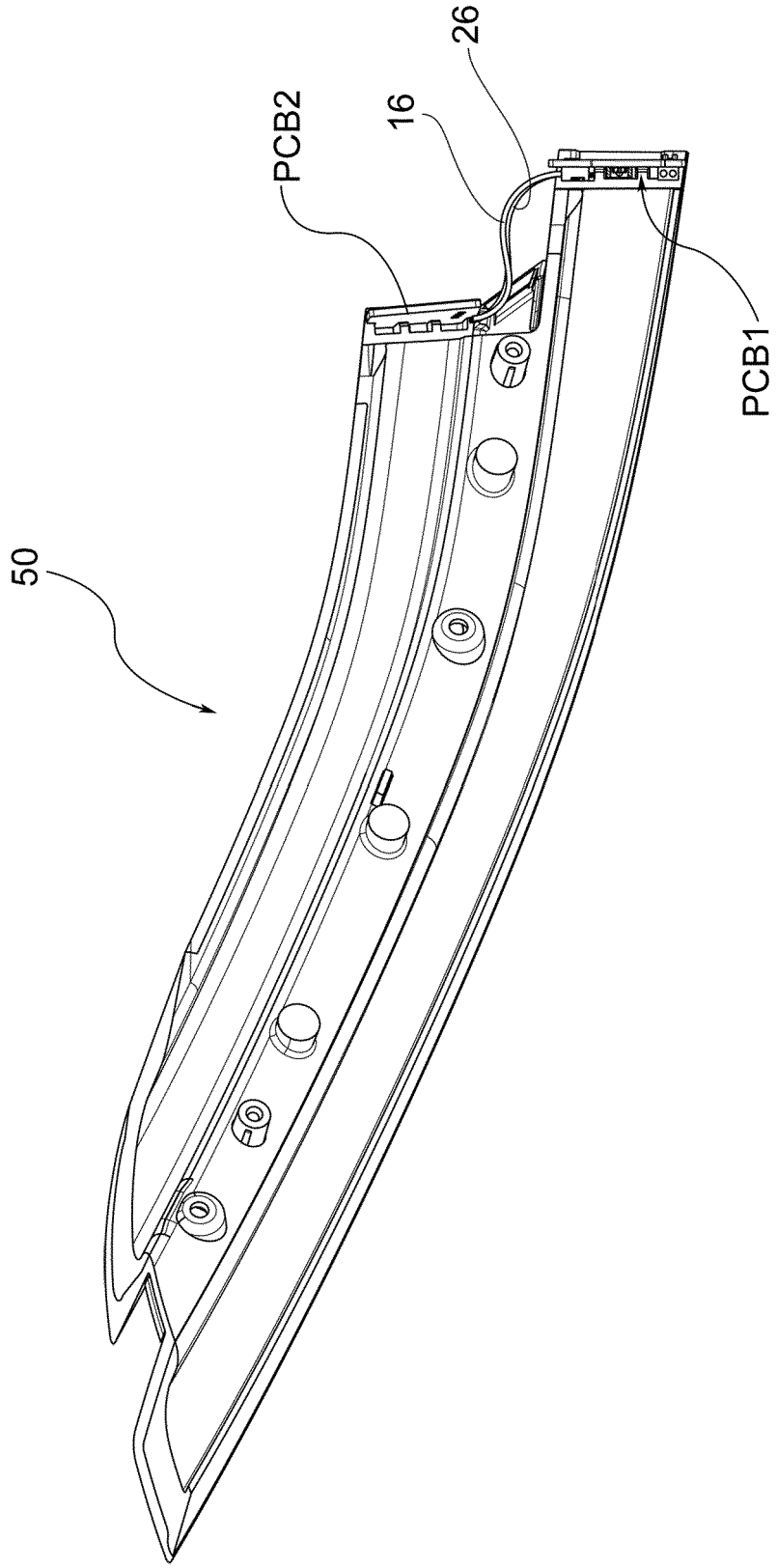

FIG.7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 42 5062

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	US 6 598 996 B1 (LODHIE PERVAIZ [US]) 29 July 2003 (2003-07-29) * column 1, lines 18-19; column 4, lines 38-41; figures 8,9 *	1,3-5, 7-9 2 6	INV. H05B45/345 B60Q1/26
X A	DE 10 2009 053418 A1 (HELLA KGAA HUECK & CO [DE]) 26 May 2011 (2011-05-26) * paragraphs [0008], [0013], [0023]; figure 1 *	1,3-9 2	
Y	EP 2 699 056 A2 (SPAAPEN HANDELMIJ B V [NL]; DIETAL SA [FR]) 19 February 2014 (2014-02-19) * paragraphs [0035], [0038]; figures 12-13 *	2	

TECHNICAL FIELDS SEARCHED (IPC)

H05B
B60Q
F21K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 April 2021	Erskine, Andrew

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16-04-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6598996	B1 29-07-2003	NONE	
DE 102009053418	A1 26-05-2011	NONE	
EP 2699056	A2 19-02-2014	EP 2699056 A2	19-02-2014
		WO 2014023742 A2	13-02-2014

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