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(54) **LED Lighting Device**

(57) There is described a LED lighting device (1) for compartments (N) having a movable closing member (P, C), the device (1) having at least one lighting module (2) having one or more LEDs (21); at least one battery (3) for powering the lighting module (2); and a switch (4)

connected electrically to the battery (3) and the lighting module (2).

The switch (4) advantageously switches as a function of the position of the closing member (P, C), with no direct contact with the closing member (P, C).

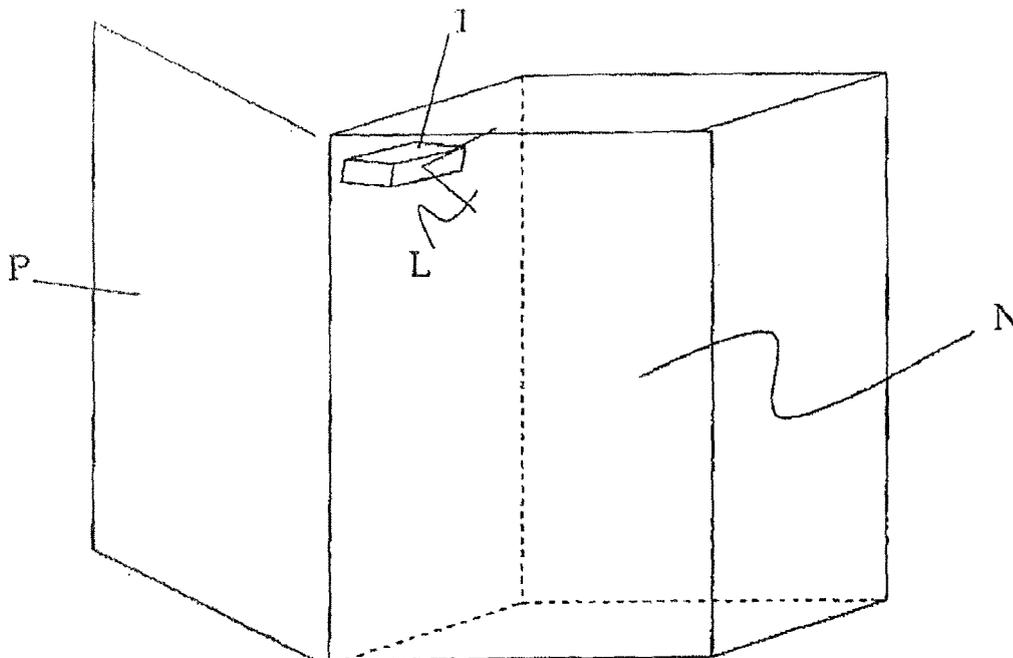


Fig. 1a

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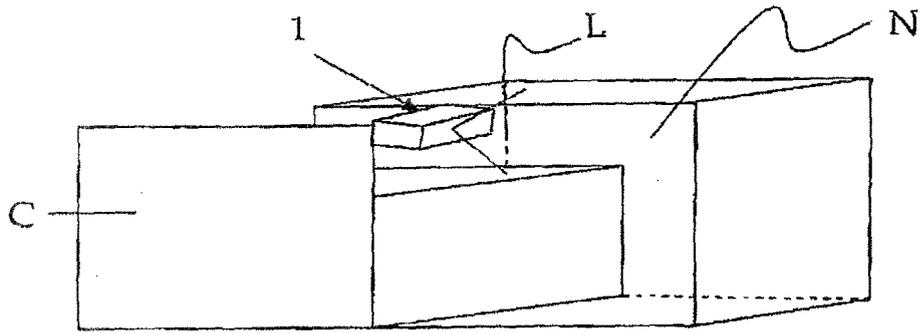


Fig. 1b

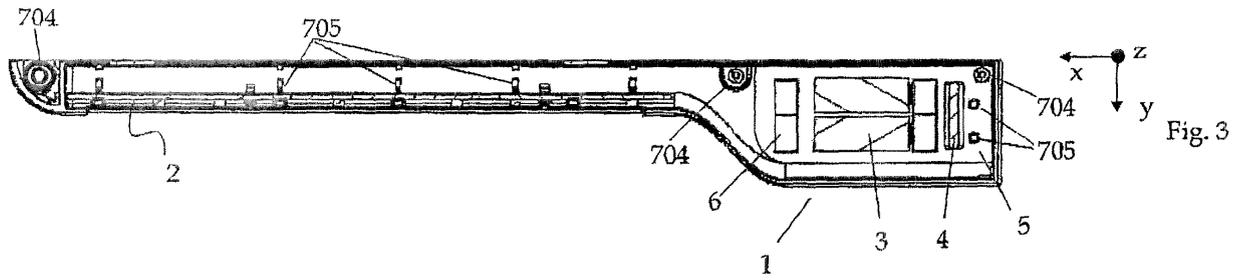


Fig. 3

Description

[0001] The present invention relates to a LED lighting device for compartments having a movable closing member, as stated in the introduction to Claim 1.

[0002] As is known, many items, ranging from furniture to electric household appliances, have compartments which light up when a closing member is moved from a closed position closing the compartment, to an open position permitting access to the inside of the compartment.

[0003] Examples of such compartments are the compartments inside chests of drawers, wardrobes, refrigerators, and ovens.

[0004] Many types of compartment lighting devices are known, in particular for wardrobes, in which, when a door of the wardrobe is opened, a mechanical switch is activated, which closes an electric circuit and turns on a lamp.

[0005] Known solutions, however, have numerous drawbacks.

[0006] Firstly, a mechanical switch poses restrictions as to the location of the lighting device, which must be located close to the compartment opening.

[0007] Secondly, known solutions employing bulbs have the drawback of overheating, which is incompatible with applications such as wardrobes and drawers, in which prolonged contact with clothing may damage the clothing or cause fires.

[0008] Thirdly, the lighting device must be compact and so locatable as not to reduce the usable space inside the compartment; usable space being intended to mean the normally unoccupied portion of the volume of the compartment.

[0009] To solve the size problem, some solutions comprise two separate modules : a lighting element (e.g. a lamp) and a mechanical switch.

[0010] Known solutions of this sort, however, have the drawback of involving extensive work on furniture.

[0011] Moreover, known solutions require connection to the electricity mains to power the lighting element.

[0012] These solutions also have the drawback of failing to allow the lighting element to be moved freely, and, in the event of short-circuiting or poor wiring insulation, may damage any clothes they are placed in contact with, and may even cause fires.

[0013] It is an object of the present invention to provide a lighting device designed to eliminate the drawbacks of known solutions.

[0014] In particular, it is an object of the present invention to provide a lighting device which is compact and can be installed quickly.

[0015] These and other objects of the present invention are achieved by an invention embodying the characteristics in the accompanying Claims, which form an integral part of the present description.

[0016] The present invention is based mainly on operating the lighting device with no contact between the closing member of the compartment and the lighting device itself.

[0017] In a preferred embodiment of the present invention, the lighting device must be compact and, at the same time, provide for adequately lighting compartments of widely differing sizes (e.g. drawers and wardrobes).

[0018] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figures 1a and 1b show two typical applications of a compartment lighting device in accordance with the present invention;

Figures 2a-2c show three views in perspective of a lighting device in accordance with the present invention;

Figure 3 shows a section of a lighting device in accordance with the present invention;

Figure 4 shows an exploded view of a lighting device in accordance with the present invention;

Figure 5 shows schematically the arrangement of various component parts of a lighting device in accordance with one embodiment of the present invention;

Figure 6 shows a circuit diagram of a lighting device in accordance with the present invention.

[0019] In the following description, and to simplify the drawings, the same reference numbers are used for the same component parts.

[0020] Figures 1a and 1b show two examples of compartments N with closing members.

[0021] Figure 1a shows a wardrobe, in which the clothes section defines a compartment closable by a door P.

[0022] Figure 1b shows an item of furniture comprising a compartment N closable by a drawer C.

[0023] In both Figures 1a and 1b, a lighting device 1 in accordance with the invention is located inside the compartment, and, when the closing member of the compartment (the door and the drawer in the Figure 1a and 1b examples) is opened, the device generates a light beam to light the inside of the compartment.

[0024] Figures 2 to 4 show a preferred embodiment of a lighting device in accordance with the present invention.

[0025] The LED lighting device according to the invention comprises:

- at least one lighting module 2 comprising one or more LEDs 21;
- at least one battery 3 for powering said lighting module 2; and
- a switch 4 connected electrically to said at least one battery and said lighting module.

[0026] The switch is advantageously electronic, and switches as a function of the position of a movable closing member of the compartment, with no direct contact with said movable closing member. The switch may, for ex-

ample, be a reed switch or a Hall-effect switch; in which case, the compartment closing member is fitted with a magnetic member, the movement of which activates switch 4.

[0027] Other types of switches may be obtained using an optical transmitter/receiver pair, wherein the compartment closing member opens or closes the optical path between the transmitter and receiver (e.g. by means of a mirror).

[0028] In the preferred embodiment, which has the advantage of being cheaper, while still ensuring satisfactory performance for applications such as lighting wardrobes or drawers, the switch is a reed switch.

[0029] Device 1 extends substantially in one direction x coincident with the direction of lighting module 2 with LEDs 21, while maintaining a highly compact dimension z crosswise to x and to the maximum-lighting direction y.

[0030] In the preferred embodiment, the LEDs are the surface-mounted type.

[0031] This solution has a number of advantages over conventional (so-called "Through Hole Technology" or THT) LEDs with pins which fit inside through holes in a plate.

[0032] Firstly, the absence of pins reduces the size of the lighting device. And secondly, if the lighting device is used in wardrobes or drawers containing clothes, the clothes could catch on and break the pins when being removed.

[0033] In the preferred embodiment shown in Figures 2 to 4, LEDs 21 are mounted on a first plate 22 connected electrically to a second plate 5 comprising a seat 6 for batteries 3.

[0034] Second plate 5 is substantially perpendicular to first plate 22, and defines the maximum dimension in direction y, corresponding to the maximum-lighting direction and perpendicular to directions x and z described above.

[0035] Lighting device 1 comprises a casing 7 housing the lighting module, the battery, and the switch.

[0036] The casing comprises two complementary shells 701 and 702 fitted together by releasable fastening means, such as screws 703 and threads 704, or joints.

[0037] The two shells 701 and 702 have appropriate supporting means 705 - in particular, brackets or stands - for supporting the two plates 22 and 5 with little or no movement.

[0038] One of the two shells - indicated 701 - has an opening 706 closed by a sliding cover 707. The opening is located at battery seat 6 to permit fast battery replacement without dismantling the whole device, which, apart from being unpractical and time-consuming, would also expose delicate parts such as the reed switch or any wire soldering in the device.

[0039] The two shells 701 and 702 are designed so that, once fitted together, casing 7 has a longitudinal opening 708 aligned with LEDs 21, and which provides for airing the LEDs and improved lighting.

[0040] Using surface-mounted LEDs prevents clothes

from catching on the LEDs through longitudinal opening 708 and so damaging the electric circuit.

[0041] The device as described above is extremely lightweight, and may therefore be fixed to any wall of the compartment using two-sided adhesive tape or Velcro®.

[0042] Fastening means of this sort, however, have the drawback of requiring a certain amount of force to detach the device from the wall, and which may result in damage to the device.

[0043] To detach the lighting device quickly and easily, therefore, the device according to the invention advantageously comprises fastening means by which to fasten the device to an external body, in particular a compartment.

[0044] Said fastening means preferably comprise at least one fastening opening on the opposite side to said first opening.

[0045] As shown partly in the Figure 4 exploded view, in the preferred embodiment, the fastening openings are in the form of two asymmetrical slots 709.

[0046] As stated, plate 5 supporting reed switch 4 and battery seat 6 is perpendicular to plate 22.

[0047] To prevent opaque parts of the lighting device (such as the casing, if opaque, or the component parts of the device, if the casing is transparent) from interfering with the light emitted by LEDs 21 (and so producing a shadow), substantially all the opaque parts of the lighting device must be located outside the LED-generated light cone.

[0048] For example, if LEDs 21 are selected to illuminate an angle θ of 120° , the device must be designed so that the opaque point β projecting furthest in the main lighting direction y does not interfere with the 120° light beam from the LEDs, as shown schematically in Figure 5, in which γ indicates an opaque part extending in direction y.

[0049] Figure 6 shows, schematically, the electric circuit of the lighting device according to a preferred embodiment of the present invention.

[0050] Two 9V batteries 3 are series-connected and supply a no-load voltage of 24 V. Batteries of this sort are marketed by Duracell® under the trade name MN21.

[0051] A switch, in particular a reed switch, is series-connected to the batteries, and opens and closes the circuit to power one or more lighting modules. The Figure 5 example has two parallel-connected lighting modules 2.

[0052] In a preferred solution, one lighting module 2 comprises a current regulator 23 powering a series of LEDs 21.

[0053] The current regulator is substantially a three-pole, which is connected between the two (positive and negative) voltage lines to receive power and supply the series of LEDs with current of controlled value.

[0054] One example of a current regulator is an Infineon BCR402R integrated circuit, though other circuit solutions may be adopted, e.g. using discrete components.

[0055] Current to the LEDs is thus supplied and cut off by closing and opening switch 4.

[0056] A current regulator 23 has the advantage of controlling current supply to the series of LEDs 21 and so reducing the sensitivity of LEDs 21 to the natural variation (caused by consumption) in voltage supply by the batteries.

[0057] In other words, the current regulator provides for maintaining stable lighting throughout the working life of the batteries.

[0058] In an alternative solution, which further reduces the cost of the lighting device, the LEDs of each lighting module may be series-connected directly between switch 4 and batteries 3. In which case, the batteries and the number of LEDs must be appropriately selected to ensure correct operating voltages and currents (typically 3V and 20mA per LED).

[0059] Tests show that, for applications such as drawers, good, homogeneous lighting can be achieved using ten LEDs 21, each with roughly 500 mcd lighting power (though $\pm 20\%$ still gives satisfactory results) and a 120° lighting cone, and placing the LEDs side by side roughly half an inch apart.

[0060] Testing was conducted with the drawer open and no ambient lighting, seeing as, even at night, the user must be able to distinguish between the colours of the items inside the drawer.

[0061] Tests, conducted using ten OSRAM® LW T67C LEDs powered by two Duracell® MN21 batteries, showed the above combination of LEDs 21 provides for easily distinguishing the colours of the items inside the drawer, while at the same time ensuring a good working life of the batteries.

[0062] The above configuration provides for obtaining a lighting module with a total luminous intensity of roughly 5cd, sufficient for applications such as drawers and wardrobes.

[0063] To anyone skilled in the art, numerous variations may obviously be made without, however, departing from the scope of the present invention as defined in the accompanying Claims.

[0064] For example, the lighting device may be made of numerous materials, and using different means for connecting the two shells of the casing.

[0065] In particular, the lighting device may be made of material transparent to the light emitted by the LEDs, so that the device casing produces substantially no shadow by interfering with the light emitted by the LEDs.

Claims

1. A LED lighting device (1) for compartments (N) having a movable closing member (P, C), said device (1) comprising:

- at least one lighting module (2) comprising one or more LEDs (21);
- at least one battery (3) for powering said lighting module (2); and

- a switch (4) connected electrically to said battery (3) and said lighting module (2);

wherein said switch (4) switches as a function of the position of said closing member (P, C), with no direct contact with said closing member (P, C).

2. A device as claimed in Claim 1, **characterized in that** said LEDs (21) are surface-mounted devices.

3. A device as claimed in Claim 1 or 2, **characterized in that** said switch (4) is a reed switch.

4. A device as claimed in Claim 1 or 2, **characterized in that** said switch (4) is a Hall-effect switch.

5. A device as claimed in one of the foregoing Claims, **characterized in that** said LEDs are arranged in one direction (x).

6. A device as claimed in one of the foregoing Claims, **characterized in that** said LEDs are assembled on a first plate (22) connected electrically to a second plate (5) comprising a seat (6) for said battery; said second plate (5) being substantially perpendicular to said first plate (22).

7. A device as claimed in one of the foregoing Claims, wherein said LEDs (21) generate a light cone, and wherein substantially all the opaque parts of said device are located outside said light cone.

8. A device as claimed in Claim 6, **characterized in that** said switch (4) is fitted to said second plate (5), at the opposite end to said first plate (22).

9. A device as claimed in one of the foregoing Claims, wherein said device comprises a casing (7) housing said lighting module (2), said battery (3), and said switch (4); said casing having a first opening (708) aligned with said LEDs (21).

10. A device as claimed in one of the foregoing Claims, wherein said device comprises a casing (7) housing said lighting module (2), said battery (3), and said switch (4); said casing comprising fastening means (709) for fastening said device to an external body.

11. A device as claimed in Claim 10, wherein said fastening means comprise at least one fastening opening (709), in particular two asymmetric slots.

12. A device as claimed in Claim 11, wherein said at least one fastening opening is located on the opposite side to a first opening (708) aligned with said LEDs (21).

13. A device as claimed in one of the foregoing Claims,

characterized in that said at least one battery (3) is a 9V battery.

14. A device as claimed in Claim 13, **characterized by** comprising 9 to 11 LEDs powered by two 9V batteries (3). 5

15. A device as claimed in one of the foregoing Claims, wherein said lighting module comprises ten LEDs (21), each of substantially 500 mcd ± 20% lighting power and having a 120° light cone; said LEDs (21) being arranged side by side substantially half an inch apart. 10

16. A device as claimed in one of the foregoing Claims, wherein said LEDs generate a total luminous intensity of over 5 cd. 15

17. A device as claimed in one of the foregoing Claims, wherein said casing has an opening (706) closed by a sliding cover (707); said opening (706) being located at a seat (6) for said at least one battery (3). 20

18. A device as claimed in one of the foregoing Claims, wherein said device comprises a casing housing said lighting module, said battery, and said switch; said casing being made at least partly of material transparent to the light emitted by said LEDs. 25

19. A device as claimed in one of the foregoing Claims, wherein said device comprises a casing housing said lighting module, said battery, and said switch; said casing comprising two shells (701, 702) having supporting members inside for said lighting module (2). 30

20. A furniture defining a compartment (N) and comprising a closing member (P; C) for selectively closing and opening said compartment (N); the furniture being **characterised by** comprising a device as claimed in any one of the foregoing claims. 35 40

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Fig. 1a

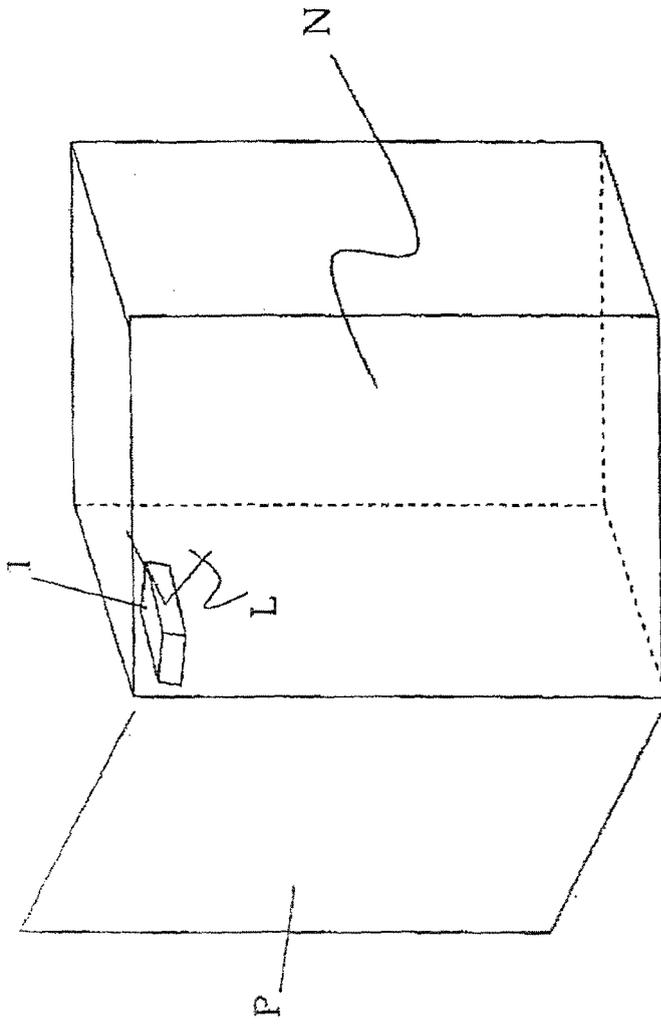
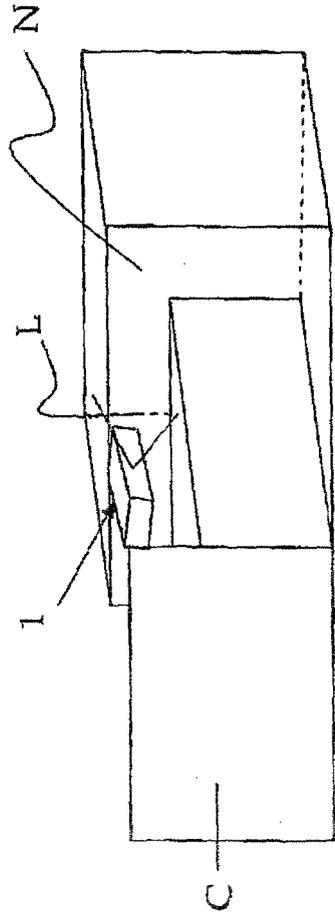
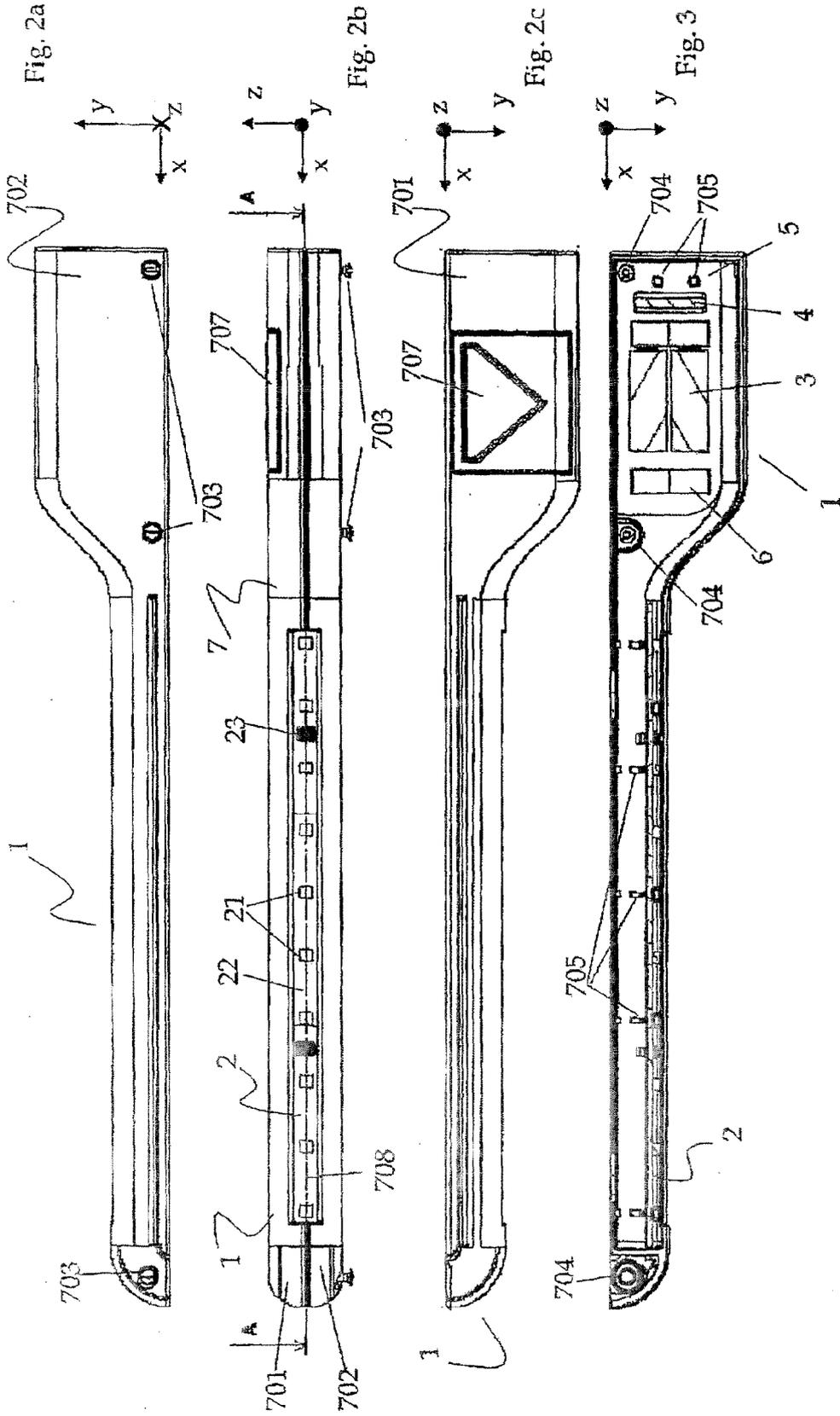


Fig. 1b





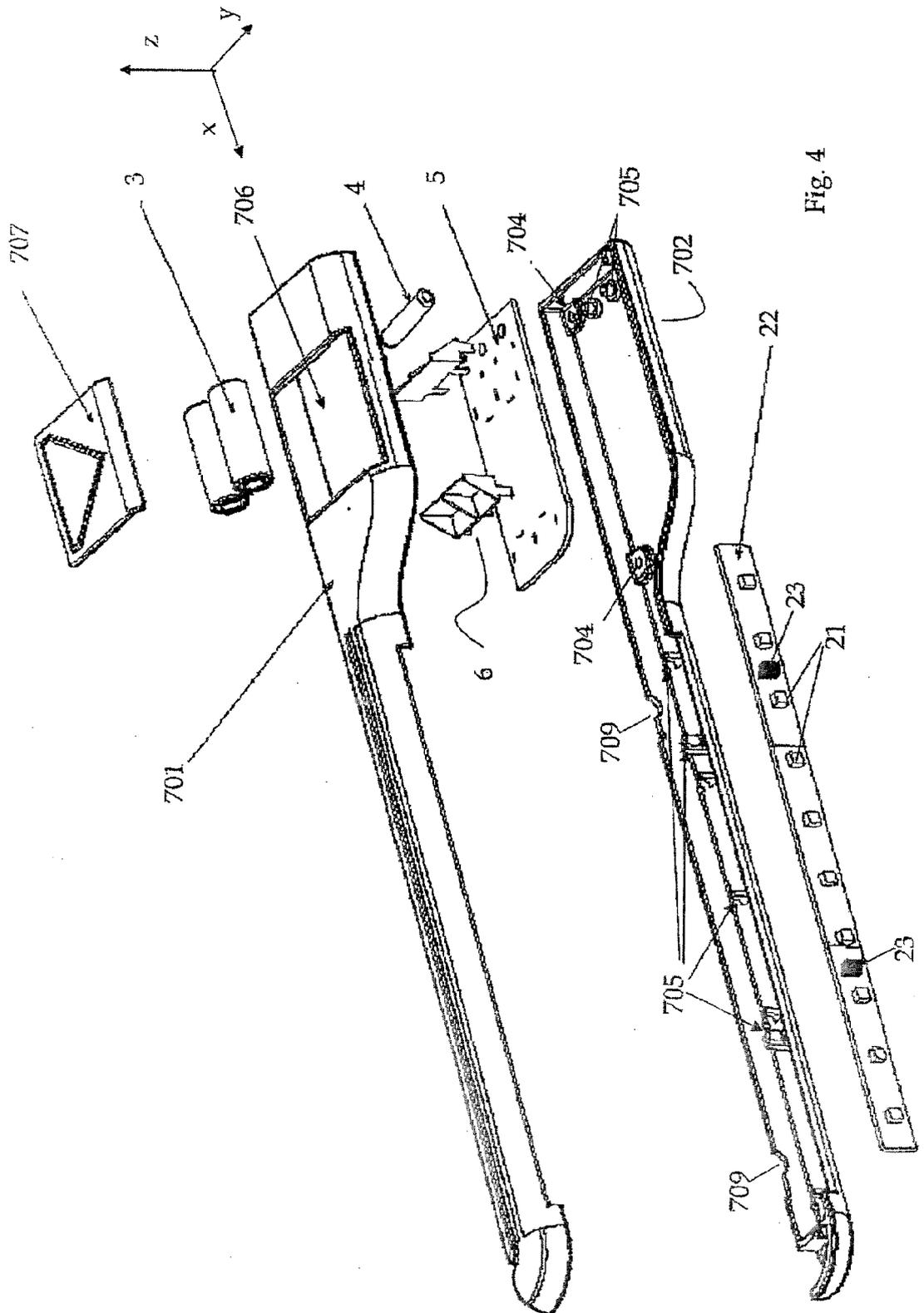


Fig. 4

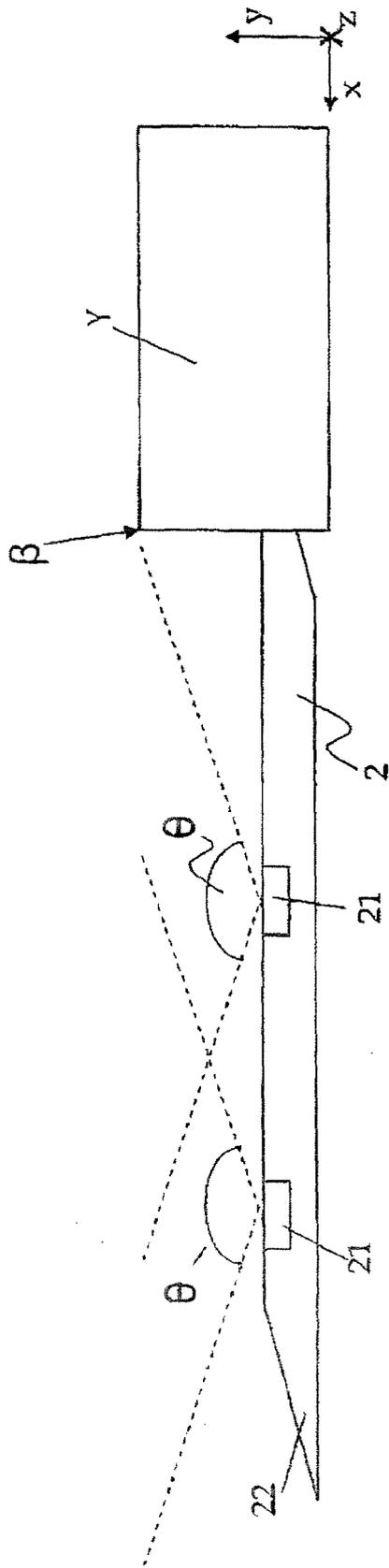


Fig. 5

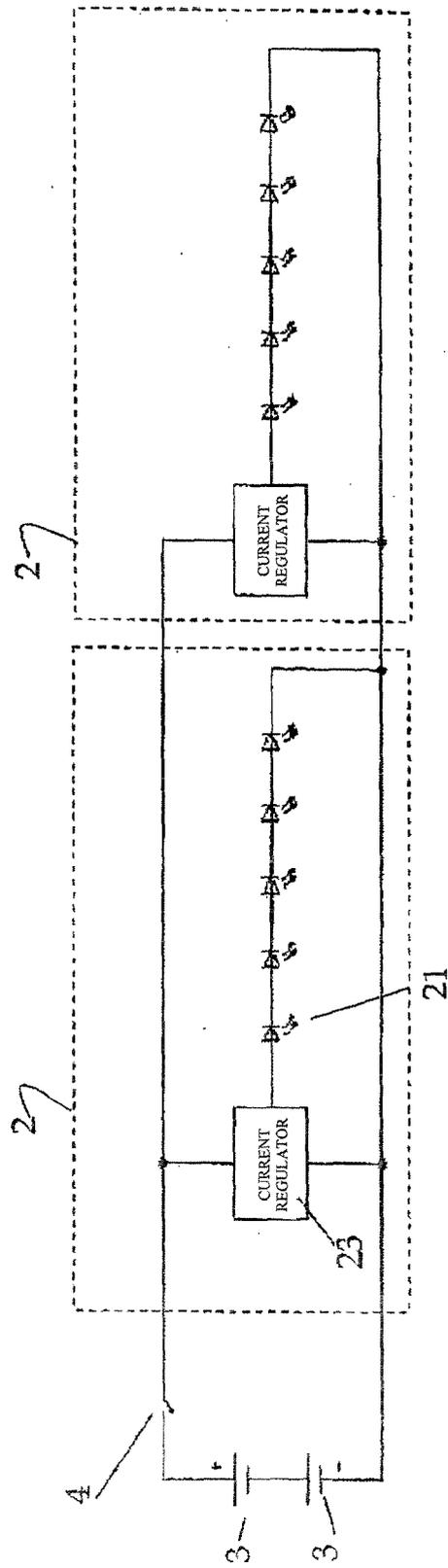


Fig. 6



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The present search report has been drawn up for all claims			
3	Place of search The Hague	Date of completion of the search 23 May 2007	Examiner Allen, Katie
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			



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Place of search		Date of completion of the search	Examiner
The Hague		23 May 2007	Allen, Katie
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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