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(54) Display module configuring a large-scale see-through display

(57) The invention relates to a LED display module for configurable large-scale see-through LED display. Particularly, such display modules are applicable in multiple-assembly stage decoration or fixed architectural installation.

The display module 1 according to the invention is made of several elementary panels 4, in the preferred embodiment it is four panels. Each elementary panel is made on the basis of a monolithic printed circuit board.

The light emitting elements are disposed at one side of the printed circuit board and controlling drivers of the said light emitting elements are disposed at the opposite side of the printed circuit board. Each elementary panel is mounted on a support frame 2 whose ribs are sufficiently narrow so as not to deteriorate the panel see-through visibility.

Mechanical strength of such structure allows making the windows as extended rectangles (vertical or horizontal). In comparison with the prior art technique it increases visibility of the system and wind and sound transmission of the structure.

Each display module is equipped with a local control unit 3, including a data distribution circuit. The control unit with the data distribution circuit inside is installed directly in the display module so as not to deteriorate the system see-through visibility.

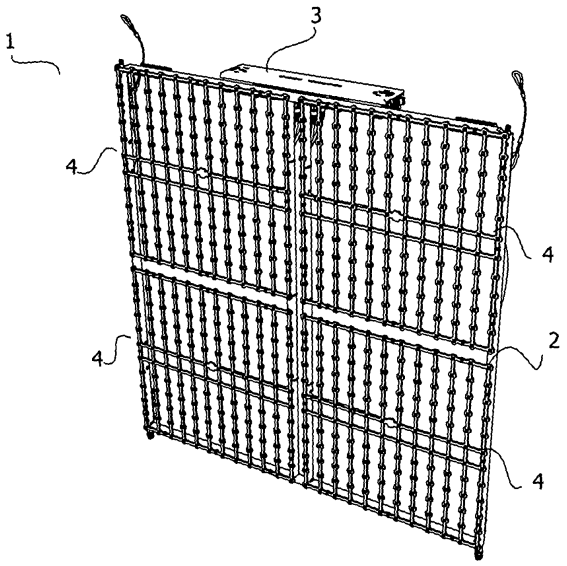


Fig. 1a

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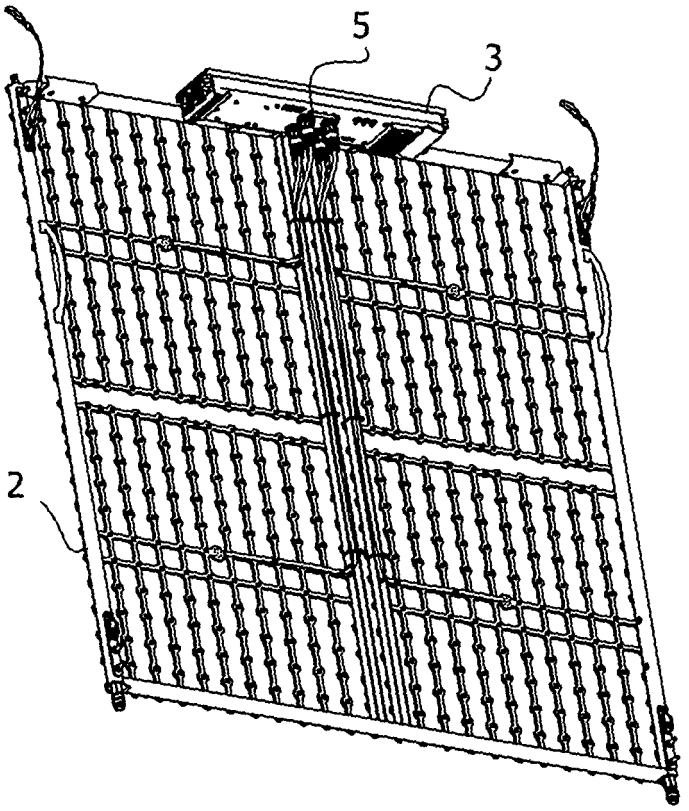


Fig. 1b

Description

FIELD OF THE INVENTION

[0001] This invention relates to a display module for configurable large-scale see-through display. Particularly, such display modules are applicable in multiple-assembly stage decoration or fixed architectural installation. The module may be also used as a comparatively small separate display.

BACKGROUND OF THE INVENTION

[0002] Large-scale image display systems have been widely used for displaying pictures and information in sports fields, recreation grounds, outdoor and indoor advertisements, and in the decoration of events and shows. These large-scale image display systems are used to communicate animations, texts, and video to large audiences to enhance the entertainment or marketing activities.

[0003] An example of a large-scale image video display system is described in US patent 6,690,341, entitled "Method of displaying high-density dot-matrix bitmapped image on low-density dot-matrix display and system therefore". This patent details a dot-matrix display device comprising a plurality of cross members intersecting with each other at such intervals as substantially larger than a width of each of the cross members, a plurality of light emitting elements disposed at the intersecting points of the cross members respectively, each of the light emitting elements being shaped so as not to deteriorate transparency of a structure configured by the intersecting members, each of the light emitting element being so disposed that an optical axis thereof is oriented substantially perpendicular to a surface of the structure formed by the intersecting cross members, and means for controlling drive of the light emitting elements respectively, the controlling means being distributed in the cross members.

[0004] The module of the aforesaid large-scale display system comprises a panel with eight cross members forming a lattice structure. Each panel has 16 electrical and mechanical connections, and thus the proposed display system requires a large number of electrical and mechanical connections. Therefore it is difficult to suitably change the conditions of setting in accordance with the on-site situation. Great number of electrical and mechanical connections in each assembly-dismantling cycle decreases general reliability of the system. Te apparatus is difficult to be used as, for example, for a stage decoration, in which various setting conditions are required. The time needed for construction of such a display system is great, which make this display system unsuitable for use at temporary events.

[0005] Another disadvantage of the prior art display panel is limited wind and light transmission. The crosspieces combined with each other lengthwise and widthwise increase their visibility and wind load.

SUMMARY OF THE INVENTION

[0006] It is therefore an object of the present invention to provide a display module of increased see-through visibility and wind and sound transmission.

[0007] The display module according to the invention is made of several elementary panels, in the preferred embodiment it is four panels. Each elementary panel is made on the basis of a monolithic printed circuit board.

[0008] A one-piece sheet for the monolithic printed circuit board is made of fibreglass or other suitable material. See-through windows are made in the sheet by milling or other known technique.

[0009] The printed circuit board is provided with a protective cover, attached to the side of the printed circuit board, where the light emitting elements are located.

[0010] The light emitting elements are disposed at one side of the printed circuit board and controlling drivers of the said light emitting elements are disposed at the opposite side of the printed circuit board. Each elementary panel is mounted on a support frame whose ribs are sufficiently narrow so as not to deteriorate the panel see-through visibility.

[0011] Mechanical strength of such structure allows making the windows as extended rectangles (vertical or horizontal). In comparison with the prior art technique it increases visibility of the system and wind and sound transmission of the structure, thus eliminating the prior art disadvantage. In the preferred embodiment of the offered invention the transmission is increased by 25-30%.

[0012] Another object of the present invention is to provide the display modules of increased reliability in configuring a large-scale see-through display.

[0013] Each display module is equipped with a local control unit, including a data distribution circuit. In contrast to the prior art, the control unit with the data distribution circuit inside is installed directly in the display module so as not to deteriorate the system see-through visibility. For that purpose the control unit is made not wider than the support frame rib. During the large-scale system assembly/dismantling processes there is no need to connect/disconnect a lot of electrical contacts, as in the prior art. It improves the system reliability.

[0014] Still another object of the present invention is to provide the display modules for easy multiple assembly and dismantling in configuring a large-scale see-through display and to improve their changeability.

[0015] The local control unit is connected to each elementary panel with a cable, which is soldered directly to the printed circuit board, preferably in the panel central zone, so as to provide full changeability of all elementary panels within the whole large-scale display. The structure of the display modules with the support frames, soldered cables and no electrical pin contacts facilitates easy assembly of a large-scale display and its high maintainability: in case of any problems with an elementary panel

in the whole large-scale display it may be quickly changed for a spare one without the need of dismantling the whole display system.

[0016] Thus, the offered display module may be easy installed in configuring large-scale see-through displays, conveniently maintained within the whole structure and easy dismantled, while these processes may be multiply repeated, which is especially convenient for use in temporary events.

[0017] Novel features and advantages of the present invention in addition to those noted above will become apparent to those of ordinary skills in the art from a reading of the following detailed description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In order to better explain the characteristics of the invention, a following preferred embodiment of a display module according to the invention is described as an example only without being limitative in any way, with reference to the accompanying drawings, in which:

Fig. 1a illustrates a front perspective view of the display module
Fig. 1b illustrates a perspective back view of the display module
Fig. 2 illustrates a functional block diagram of the display module
Fig. 3a illustrates a perspective left side bottom view of the control unit
Fig. 3b illustrates a perspective right side bottom view of the control unit
Fig. 4 illustrates electrical connection of the display modules
Fig. 5a illustrates a perspective front view of the elementary panel
Fig. 5b illustrates a perspective back view of the elementary panel
Fig. 5c illustrates an exploded perspective front view of the elementary panel
Fig. 6a illustrates a perspective front view of the printed circuit board
Fig. 6b illustrates a perspective back view of the printed circuit board
Fig. 7 illustrates a perspective front view of the protective cover
Fig. 8a illustrates a magnified exploded back view of the elementary panel
Fig. 8b illustrates a magnified exploded front view of left corner of the elementary panel
Fig. 9 illustrates a network of controlling drivers
Fig. 10a illustrates a support frame of the display module
Fig. 10b illustrates a construction of the middle part of the display module
Fig. 11 illustrates a front view of the display module
Fig. 12 illustrates a circuitry of power, data and lighting cables
Fig. 13 illustrates a magnified left side back view of a mechanical joint of the display modules
Fig. 14 illustrates a large-scale see-through display system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Fig. 1a illustrates the perspective front view of the display module 1. The display module 1 includes a support frame 2 with mounted control unit 3, four elementary panels 4.

[0020] Fig. 1b illustrates the perspective back view of the display module 1. Each elementary panel 4 is connected to the display module control unit 3 by a cable 5. The cables 5 have multiply conductors that carry 5V DC power and serial modulated data for elementary panels 4.

[0021] Fig. 2 illustrates a functional block diagram of the display module 1.

[0022] The control unit 3 comprises a power input 6, power output 7, serial data input 8, serial data output 9, lighting data input 10, lighting data output 11 and data distribution circuit 12.

[0023] Power input 6 is connected electrically to DC-DC converter 13, which converts 48 V DC power to 5 V DC power, which is necessary for operation of the data distribution circuit 12 and elementary panels 4. The power output 7 is a pass-through line to supply power to a next display module connected in series.

[0024] The serial data input 8 contains control signals and display image data, which comprise, for example: a pixel location address and values for red, green, and blue components of the pixel colour; horizontal and vertical blanking intervals and pixel clock data. However, numerous other colour definitions and standards are possible for the serial data, as it is well known to those skilled in the art. The serial data output 9 is an output line that is used to supply the pixel image data to the next display module, connected in series.

[0025] The lighting data input 10 is a digital serial input, for example, with DMX protocol data, as it is well known to those skilled in the art, which controls digital lighting effects, such as switching, dimming, fading. Other communication protocols are possible, including custom lighting protocols.

[0026] The lighting data output 11 is a pass-through line to supply lighting control data to the next display module, connected in series.

[0027] The data distribution circuit 12 provides power regulation, processing of image data, processing control data, which is necessary for proper operation of the display module. The data distribution circuit 12 comprises output connectors 14. The output connectors 14 are used to deliver 5 V DC power and serial modulated data signals to the elementary panel 4 through the cable 5. The data distribution circuit 12 further comprises standard electronic components, necessary for correct operation of

the display module 1, for example, a field programmable gate array, buffers, tri-state line drivers, memory, and electronic filtering components, such as capacitors and resistors.

[0028] The serial data input 8 and serial data output 9 are connected to a communication unit 15, which is a part of the data distribution circuit 12. The communication unit 15 receives control signals and pixel image data and delivers them for further processing by the data distribution circuit 12. The communication unit 15 also functions as a data repeater and retransmits control signals and pixel image data to the next display module.

[0029] The lighting data input 10 and lighting data output 11 are connected to a lighting control unit 16, which is a part of the data distribution circuit 12. The lighting control unit 16 receives lighting control data and delivers them for further processing by the data distribution circuit 12.

[0030] Fig. 3a and Fig. 3b illustrate the perspective left side bottom view of the control unit 3 and the perspective right side bottom view of control unit 3 respectively. The control unit 3 is attached to the display module support frame 2 with bolts 17, which enabling fast and easy changeover of the control unit 3 in case of damage or incorrect functionality of the same. This is often necessary at events due to nature of equipment rental business.

[0031] Fig. 4 illustrates electrical connection of the display modules 1. Power may originate from an external power supply unit 18, lighting data may originate from any standard lighting controller 19 and serial data may originate from, for example, a display controller 20. Power, lighting data and serial data may originate from one display module outputs to another display module inputs as shown. This allows connecting the display modules in daisy chain manner and reducing a number of cables necessary for construction of the large-scale display.

[0032] Fig. 5a illustrates the perspective front view of the elementary panel 4, Fig. 5b illustrates the perspective back view of the elementary panel 4 and Fig. 5c illustrates an exploded perspective front view of the elementary panel 4, respectively. As it is seen from the drawings, the elementary panel 4 comprises a printed circuit board 21, protective cover 25, cable 5, bolts 26 and nuts 27. The bolts 26 and nuts 27 are used to connect the elementary panel 4 to the support frame 2.

[0033] Fig. 6a illustrates the perspective front view of the printed circuit board 21 and Fig. 6b illustrates the perspective back view of the printed circuit board 21, respectively. The printed circuit board 21 is made of monolith single piece fibreglass material. The board has see-through windows 24, made by milling or other method, known to those skilled in the art. The front side of the printed circuit board 21 is populated with light emitting diodes 22. The backside of printed circuit board 21 is populated with controlling drivers 23 and provided with the cable 5. A receptacle 5b for the data and power inputs is provided in the central zone of the board.

[0034] Fig. 7 illustrates the perspective front view of the protective cover 25. The protective cover 25 is made of single piece fibreglass or plastic material. The material may have black matt finish surface to increase contrast of see-through display.

[0035] The protective cover thickness is equal to the thickness of the light emitting diodes 22 so as not to reduce the emission angle of the diodes, but to protect the diodes against mechanical damage. The protective cover 25 has see-through windows 24a, made e.g. by milling method, and holes 28. The see-through windows 24a of the protective cover 25 are equal in size and position to the see-through windows 24 of the printed circuit board 21. The light emitting diodes 22 are located within holes 28 of the protective cover 25.

[0036] Fig. 8a illustrates the magnified exploded back view of the elementary panel 4 and Fig. 8b illustrates the magnified exploded front view of the left corner of the elementary panel 4, respectively.

[0037] Arrangement of the printed circuit board 21, controlling drivers 23, light emitting diodes 22, protective cover 25, bolts 26, nuts 27 and holes 28 can be seen in these drawings more in detail.

[0038] Fig. 9 illustrates the network of the controlling drivers 23. The network is arranged as a zigzag-connected circuit. The cable 5 may be directly soldered or connected with quick-disconnect connector in the centre of printed circuit board 21. The printed circuit board has copper path 5a, which transfers modulated data signals from the centre of the printed circuit board 21 to the right upper corner of the board, to the first controlling driver 23 in the network of the controlling drivers. The said arrangement of the controlling drivers network allows full interchangeability of all elementary panels 4 within the whole large-scale display. The controlling driver 23 is a standard DC driver integrated circuit for light emitting diodes, for example DM412 of Silicon Touch Technology, Taiwan.

[0039] The light emitting diodes 22 are preferably RGB LEDs in a single surface mount ceramic package, for example, NSSM016A manufactured by Nichia, Japan. As an alternative, the light emitting diodes 22 may be single-colour LEDs of red, green, blue, yellow, amber or white colour.

[0040] Fig. 10a and 10b illustrate the support frame 2. The support frame 2 consists of the number of metal tubes, mechanically joined together to form a strong and stable construction. Vertical tubes 29 hold lock devices 30 at the their bottom, lock pins 31 and safety wire 36 at their top. The vertical tubes 32 are used to increase mechanical stability of the overall structure of the support frame 2, used to hold the elementary panels 4 (Fig.10a) and the cables 5 (Fig.10b). Horizontal tubes 33 are mechanically connected with the tubes 29 and tubes 32 in points 34. The tube 33, located at the top of the support frame 2, has two cable holders 35.

[0041] The support frame 2 may be made of thin, rigid, lightweight material, such as metal, to make the entire

frame lightweight. Such metals can include aluminium or other lightweight metals. In addition, plastic, fibreglass, carbonaceous materials and other lightweight materials and combination of thereof can be used.

[0042] Fig. 11 illustrates the front view of the display module 1. The control unit 3 is located in horizontal plane behind the top horizontal tube 33 of the support frame. The control unit mechanical structure is sufficiently thin to not reduce transparency of the display module when located in the described way.

[0043] Fig. 12 illustrates the cable holders 35. The cable holder 35 holds power, lighting and data cables in horizontal plane behind the top horizontal tube 33 of the support frame. As a result, the power, data and lighting cables are invisible for observers looking from the front of the display module 1. Thus, the power, data and lighting cables do not deteriorate transparency of the display module 1.

[0044] Fig. 13 illustrates the magnified left side back view of the display module 1 mechanical connection. The lock devices 30 and lock pins 31 connect mechanically the display modules 1 together in vertical direction. The safety wires 36 are securing connection of the display module 1 according to the requirements of the stage equipment safety standard. The enlarged vertical tube 29 and cable holder 35 are also shown here.

[0045] Fig. 14 illustrates the large-scale see-through display system 37. The display system 37 is shown erected at the conventional truss type construction 38. The display system 37 comprises a plurality of the display modules 1.

[0046] In the preferred embodiment the plurality of the display modules 1 are arranged in two columns and two rows per column.

[0047] However, those skilled in the art will recognize that various other combinations of the display modules 1 may be connected to each other to provide other configurations of the overall display. In certain applications, the display system may be made up of just one display module 1.

[0048] During assembly of the large-scale display system the first row of the modules is hanged up to a top support of some known type, e.g. a truss. The control units are connected between each other and to the power supply unit 18, lighting controller 19 and display controller 20 and the daisy chain of the display modules is created.

[0049] Then the truss is elevated to the height sufficient enough to hang up the second row of the display modules. The second row of the modules is hanged up to the first row. The connection process is made by usual cable connections and does not require multiple pin connections as in the prior art. It also facilitates the system dismantling. So, the offered invention provides easy and simple multiple cycles of assembly/dismantling.

[0050] In accordance with the present invention, the size of the display module 1 can vary in accordance with weight and easy of handling, lifting, assembling, disassembling and transporting. The display module 1 of the preferred embodiment has the following metric dimensions and weight: width 940 mm, height 960 mm, weight 10 kg. The distance between centres of light emitting diodes 22 is 40 mm. These dimensions and weight can vary within the scope of the invention.

[0051] The background behind the display system is visible to an audience and the display system can be illuminated from behind, so that more extraordinary stage effects can be created in addition to the video displayed on the display system. For example, stage lasers or moving headlights can be placed behind the display system to light through the system.

[0052] In operation, the display module 1 receives pixel image data on serial data input 8, lighting data on lighting input 10, and power on power input 6. The pixel image data are then processed by the data distribution circuit. The data distribution circuit 12 takes all necessary image data from the pixel image data flow according to cropping area coordinates, process image data and output serial modulated data signals, which are then sent to each elementary panels 4 through the cables 5. The modulated data signals are delivered to the network of the controlling drivers 23. Each of the controlling drivers 23 makes the light emitting diode 22 to turn on or off according to pulse width modulation, thus makes possible static and dynamic image in various of colours to be displayed.

[0053] In accordance with the present invention, the size of the display module 1 can vary in accordance with weight and easy handling, lifting, assembling, disassembling and transporting.

Claims

1. A display module for configuring a large-scale see-through display, comprising a number of elementary panels with a network of light emitting elements and see-through windows, a data distribution circuit, data and power inputs, **characterized in that** a local control unit is mounted on the display module so as not to deteriorate transparency of the module, while the said data distribution circuit is installed within the said control unit.

2. A display module according to claim 1, **characterized in that** it is provided with receptacles of the said data and power inputs in central zones of the said elementary panels.

3. A display module according to claim 2, **characterized in that** the said data and power inputs are provided with multiconductor cables, soldered directly to the said receptacles.

4. A display module according to claim 2, **characterized in that** the said data and power inputs are provided with multiconductor cables, connected to the said receptacle with quick-disconnect connectors.

5. A display module according to claim 1, **characterized in that** the said network of light emitting elements is arranged as a zigzag-connected circuit.

6. A display module according to claim 1, **characterized in that** each of the said elementary panels is made as a monolith printed circuit board.

7. A display module according to claim 6, **characterized in that** the light emitting elements are disposed at one side of the printed circuit board and drivers are disposed at the opposite side of the printed circuit board.

8. A display module according to claim 6, **characterized in that** the said elementary panel is provided with a protective cover, attached to the side of the printed circuit board.

9. A display module according to claim 1, **characterized in that** it comprises four elementary panels and forms a square.

10. A display module according to claim 1, **characterized in that** the said elementary panels are mounted on a support frame.

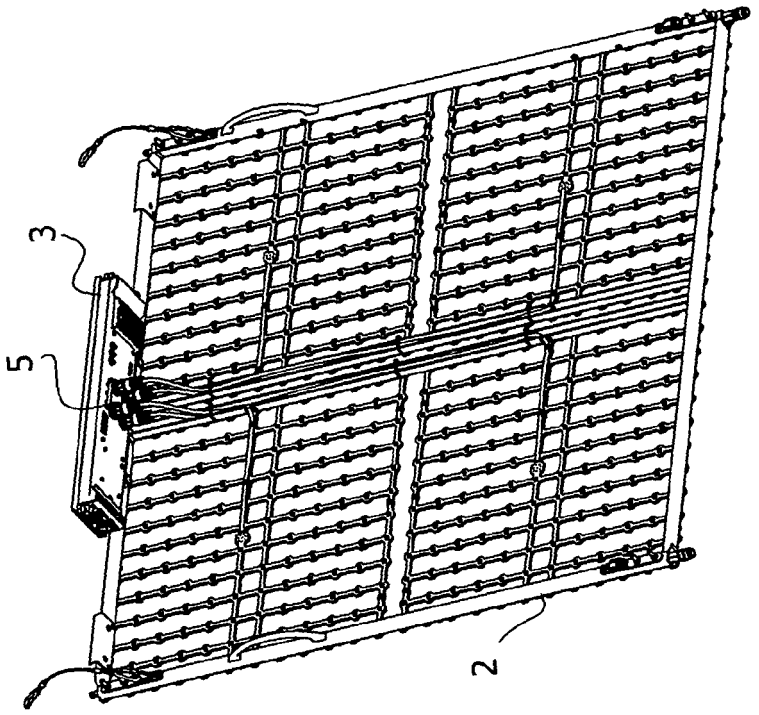


Fig. 1b

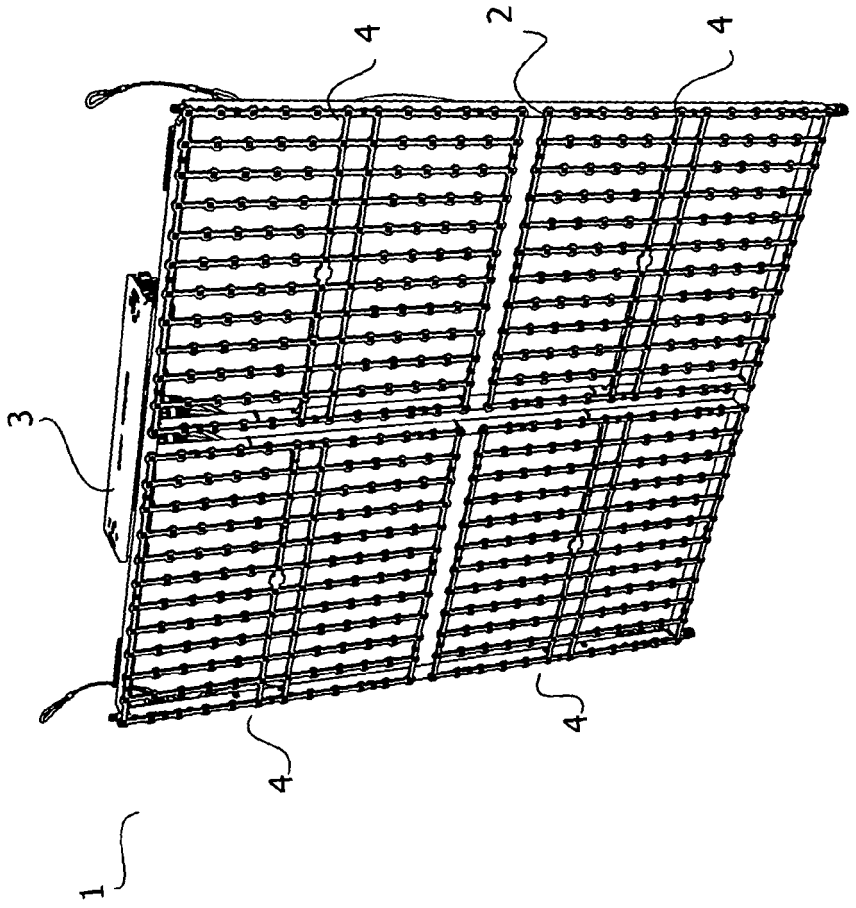


Fig. 1a

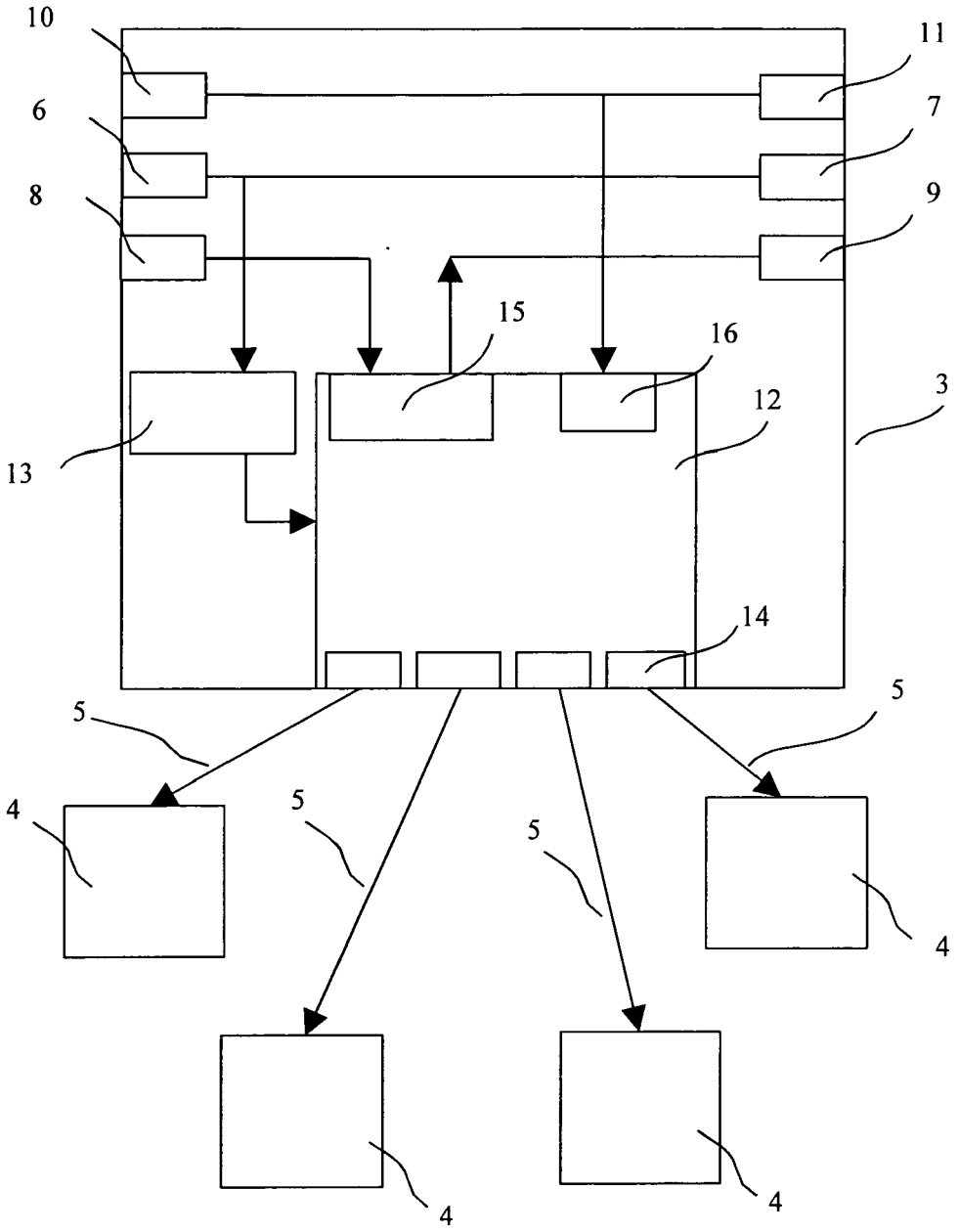


Fig. 2

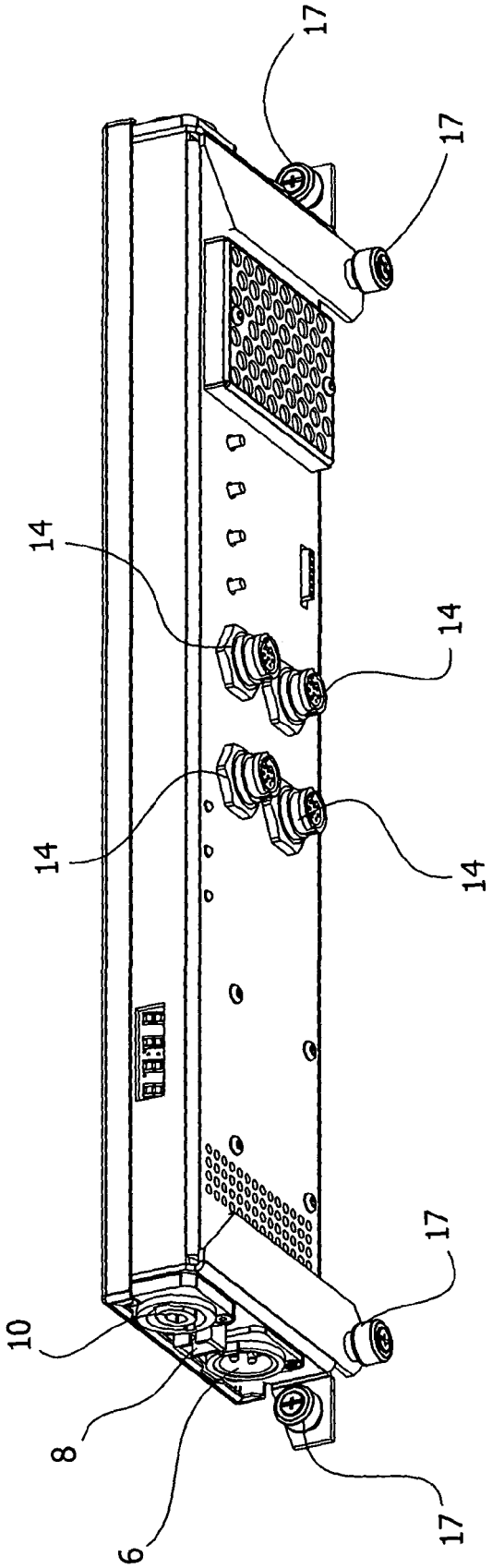


Fig. 3a

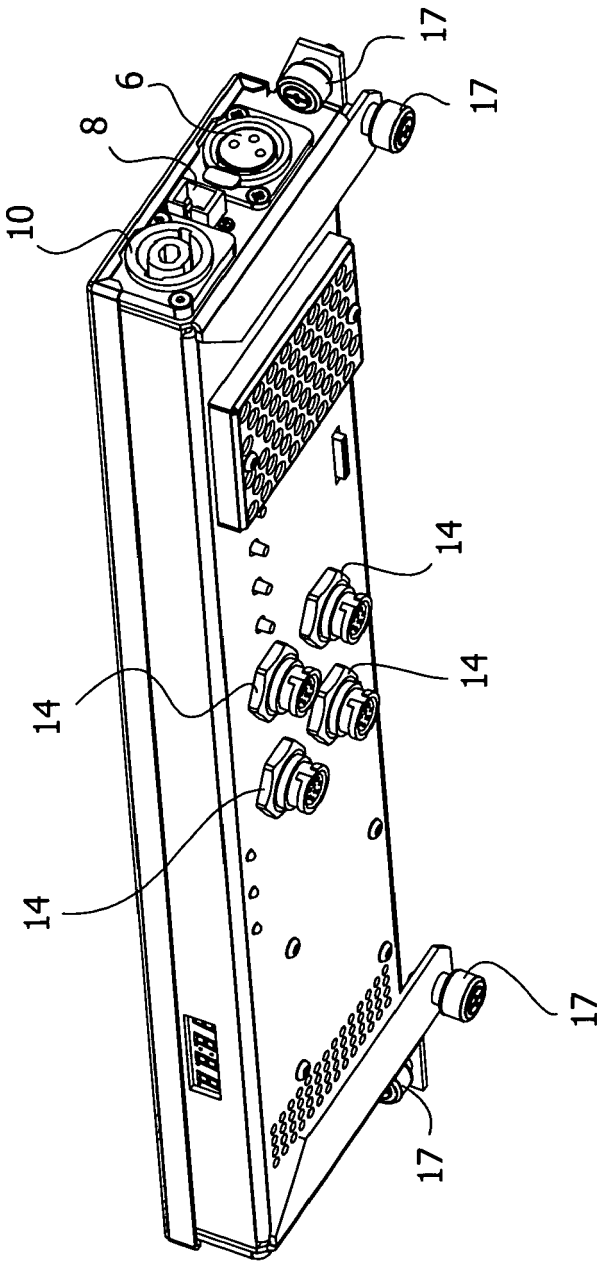


Fig. 3b

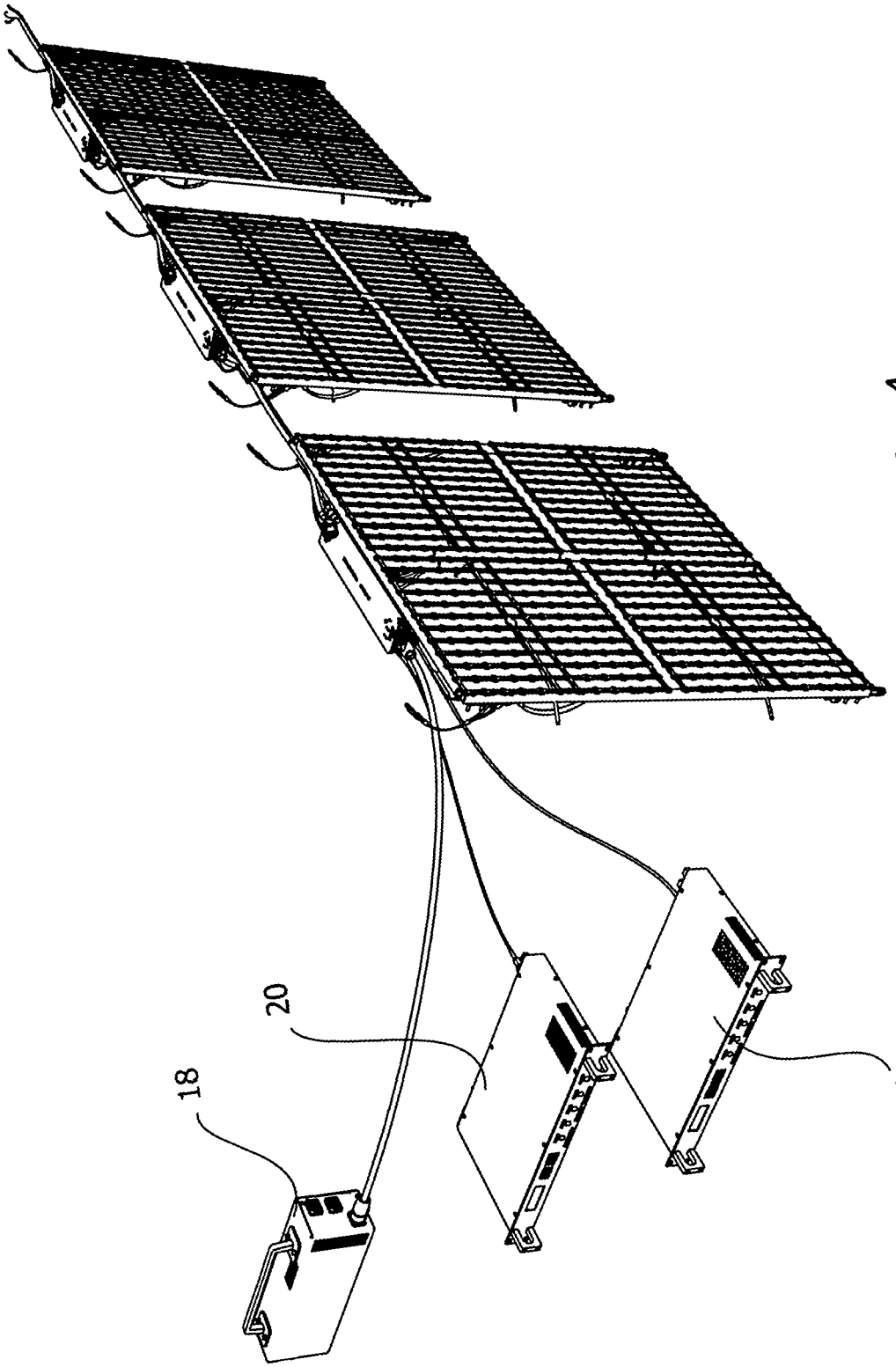


Fig. 4

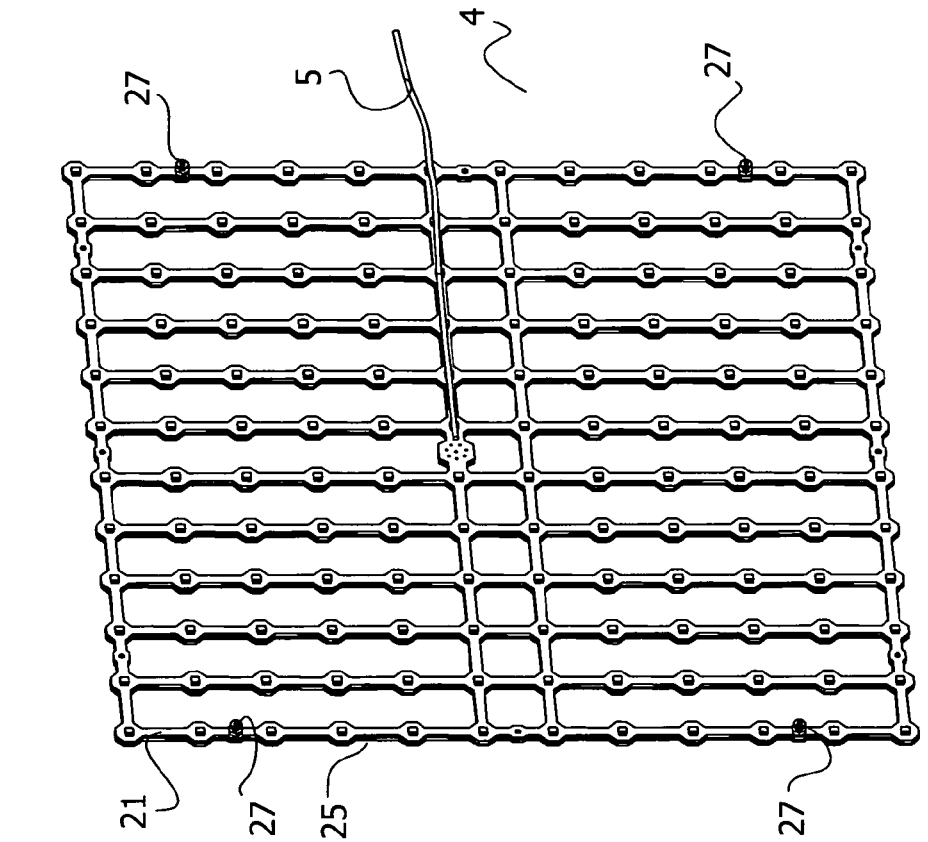


Fig. 5b

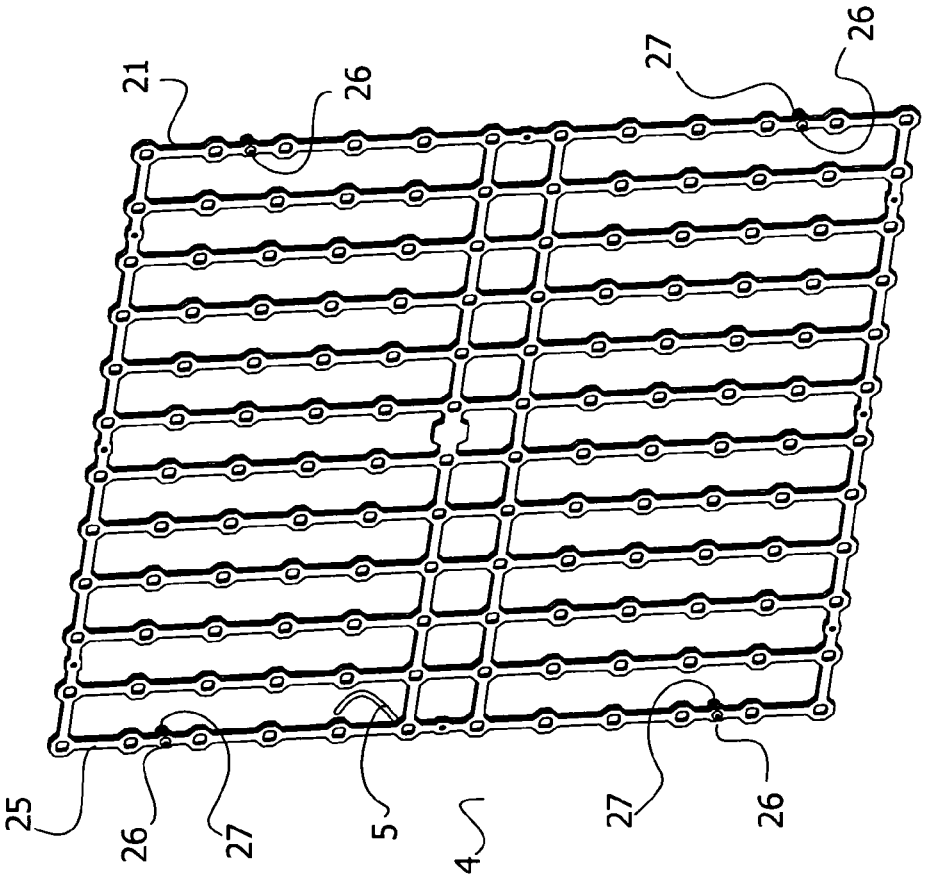


Fig. 5a

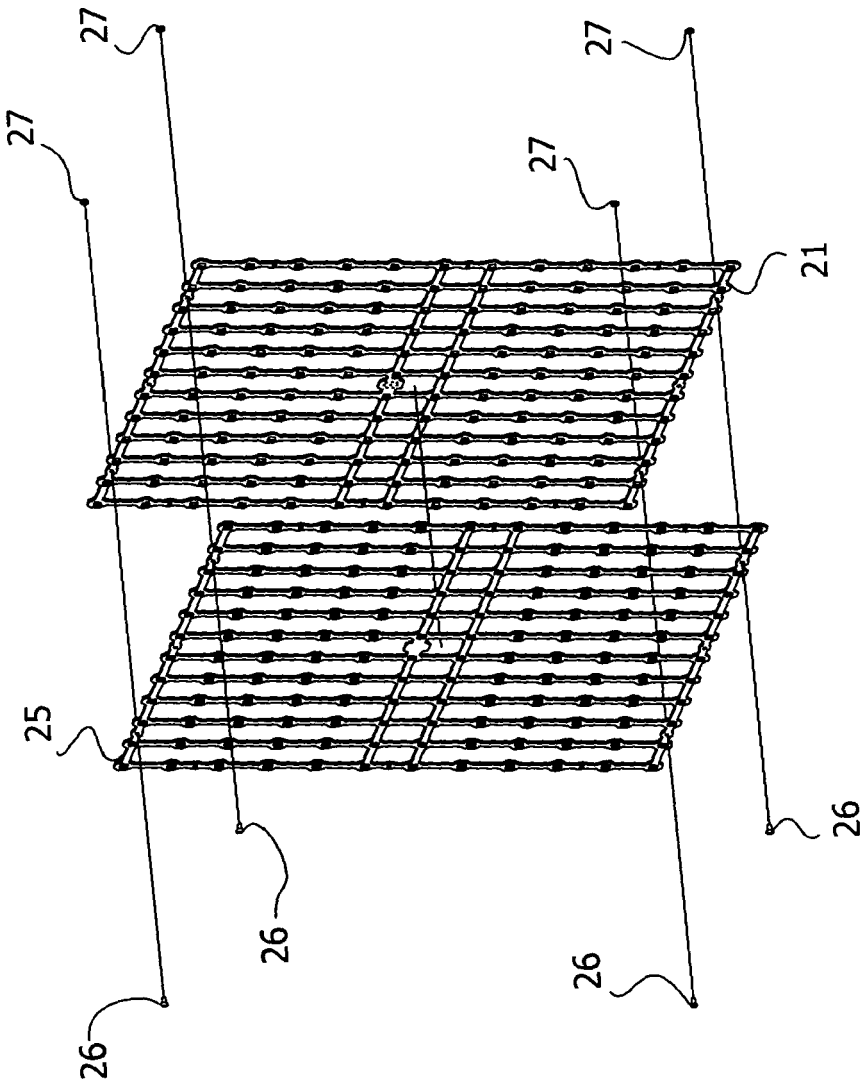


Fig. 5c

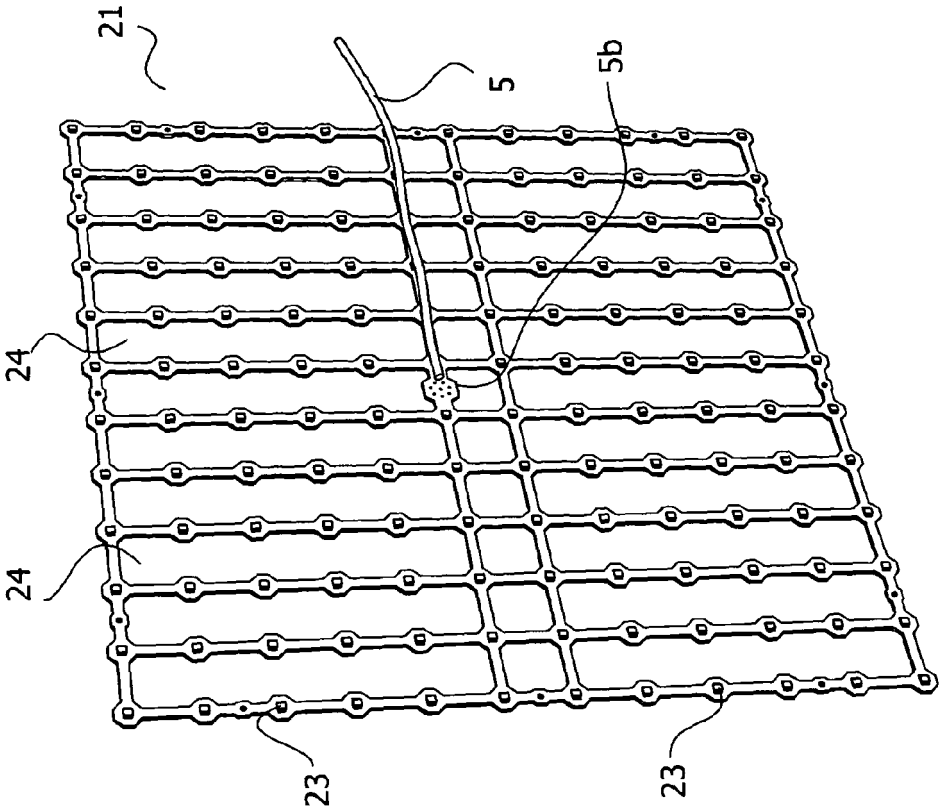


Fig. 6b

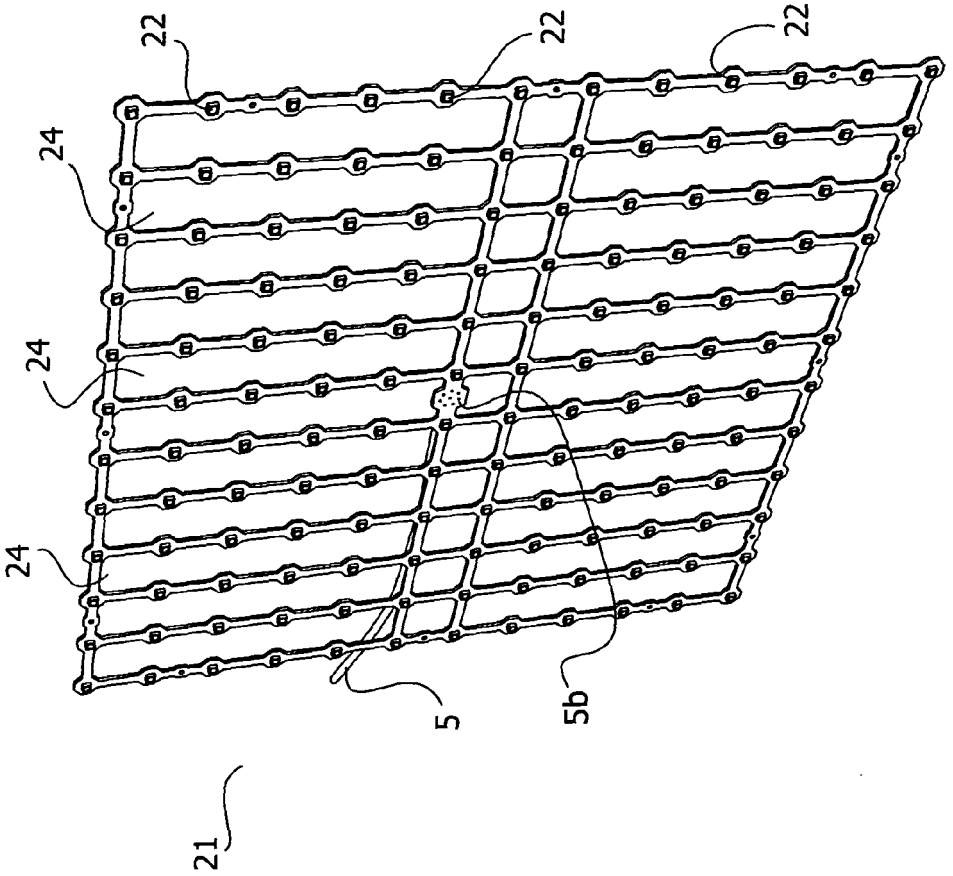


Fig. 6a

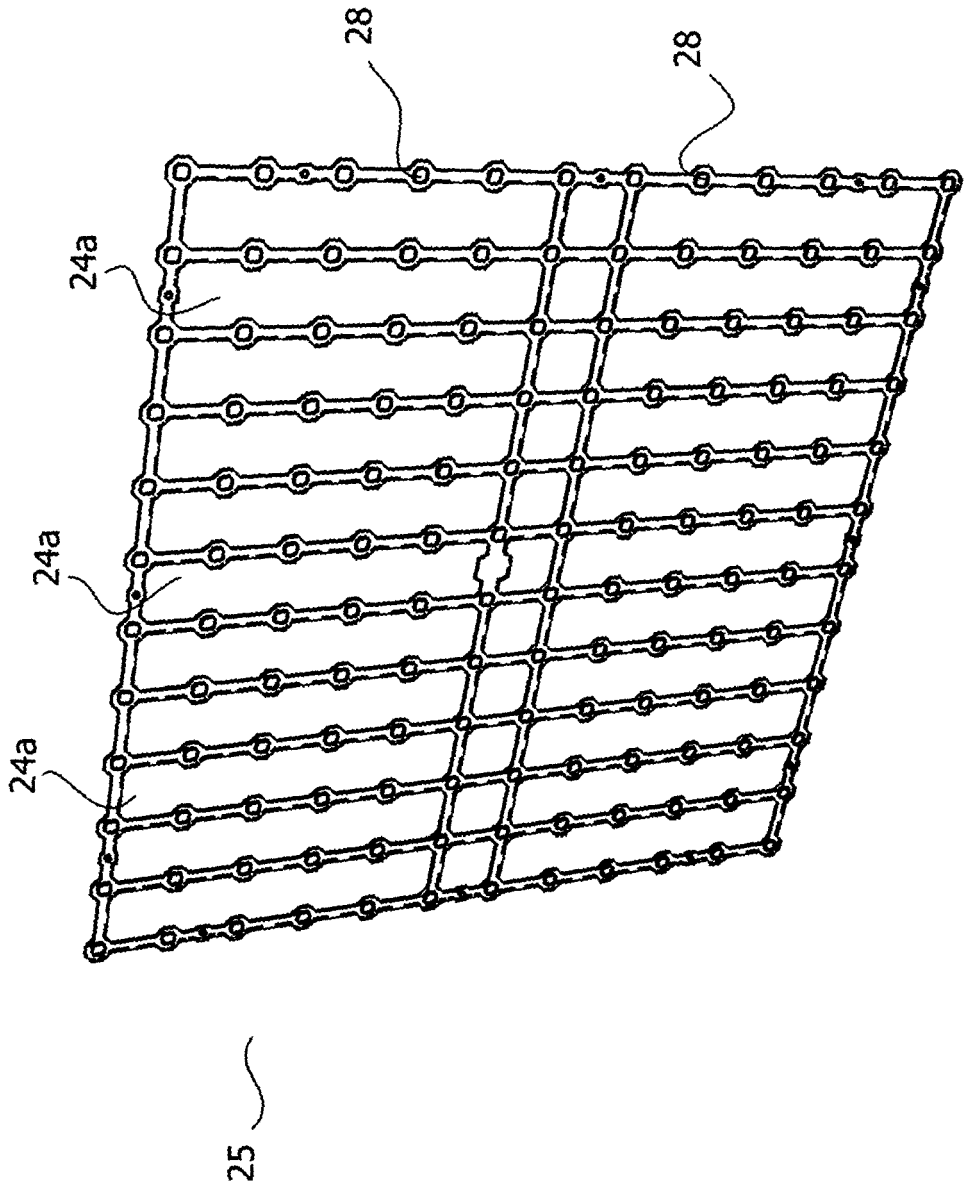


Fig. 7

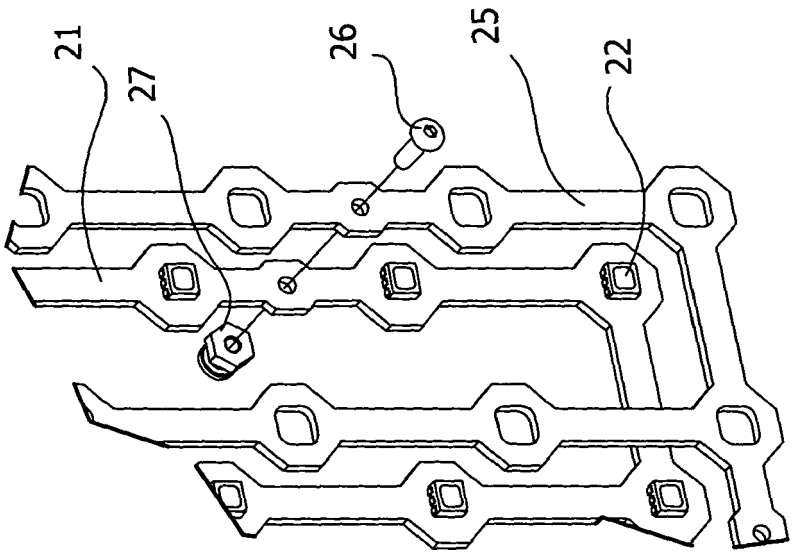


Fig. 8b

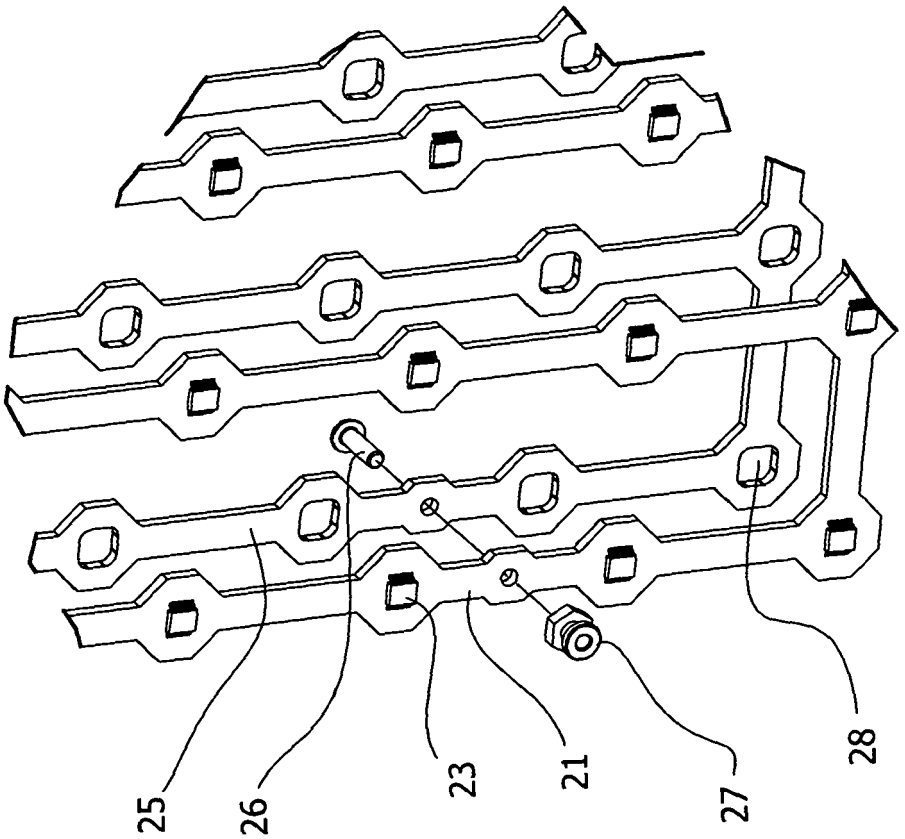


Fig. 8a

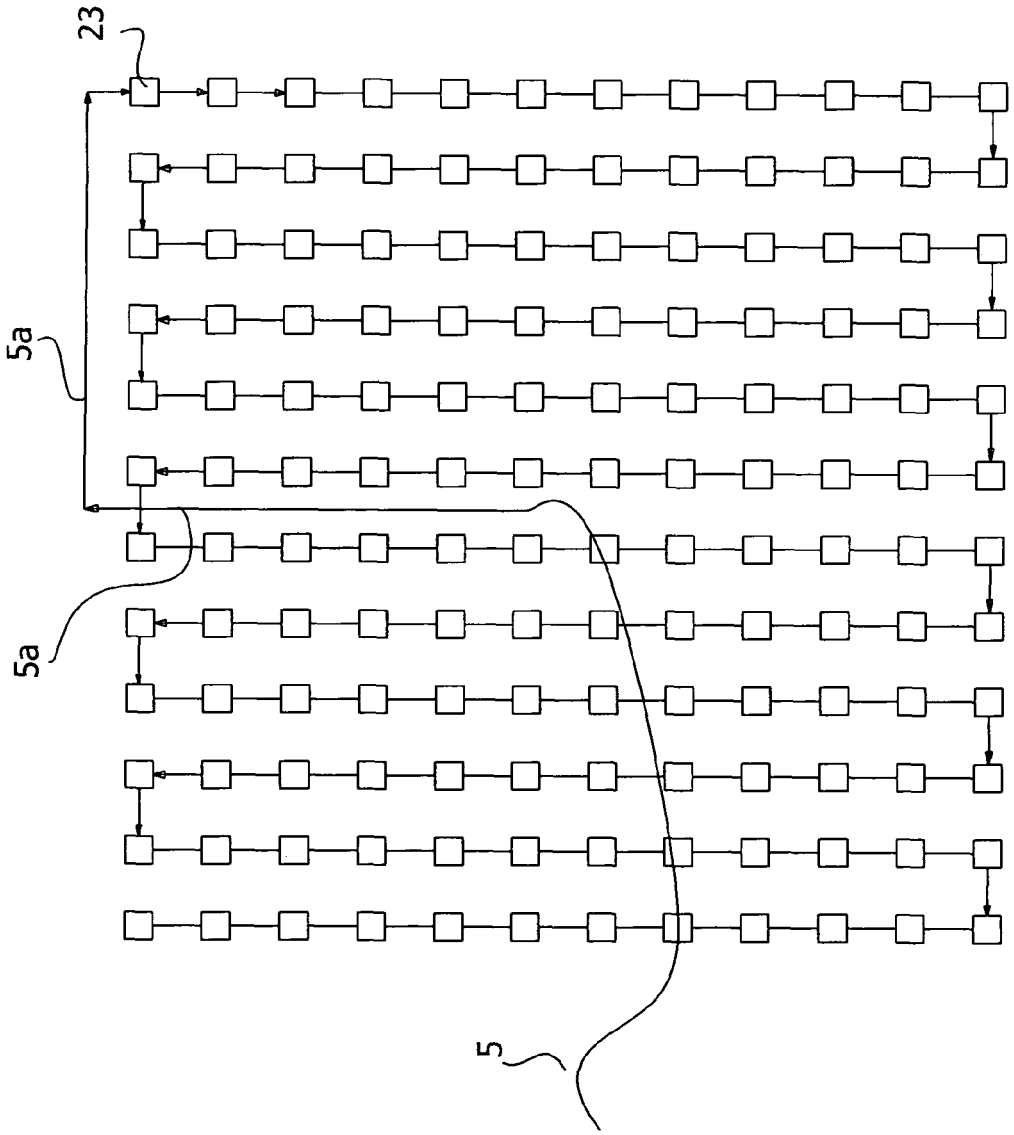


Fig. 9

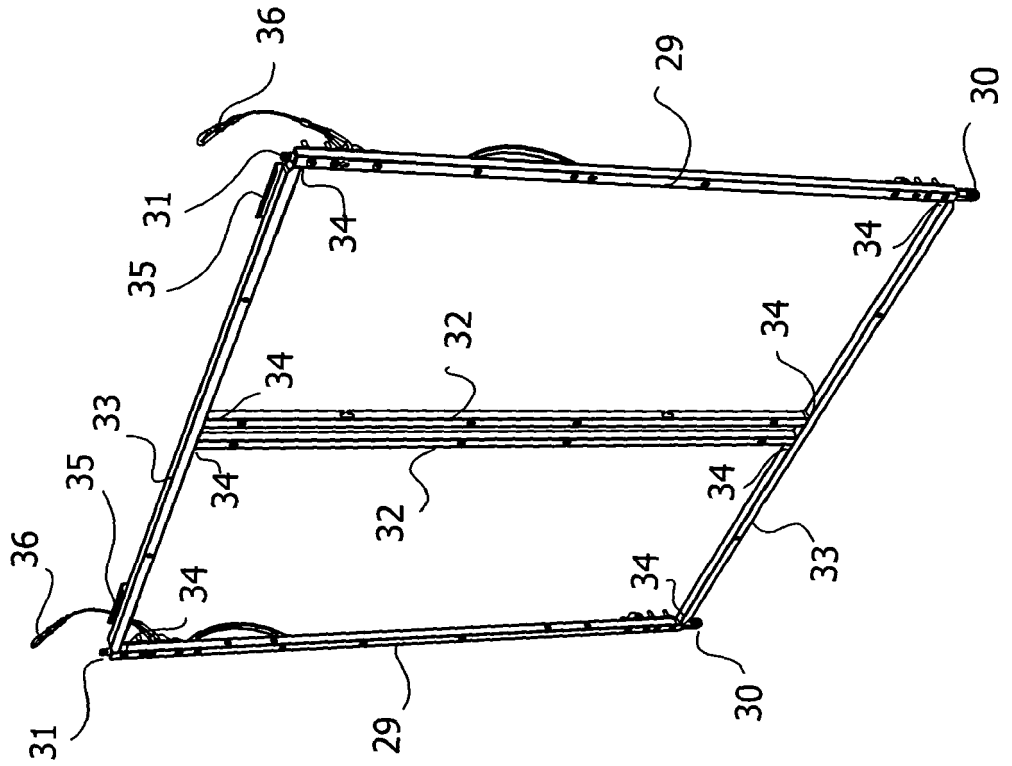


Fig. 10a

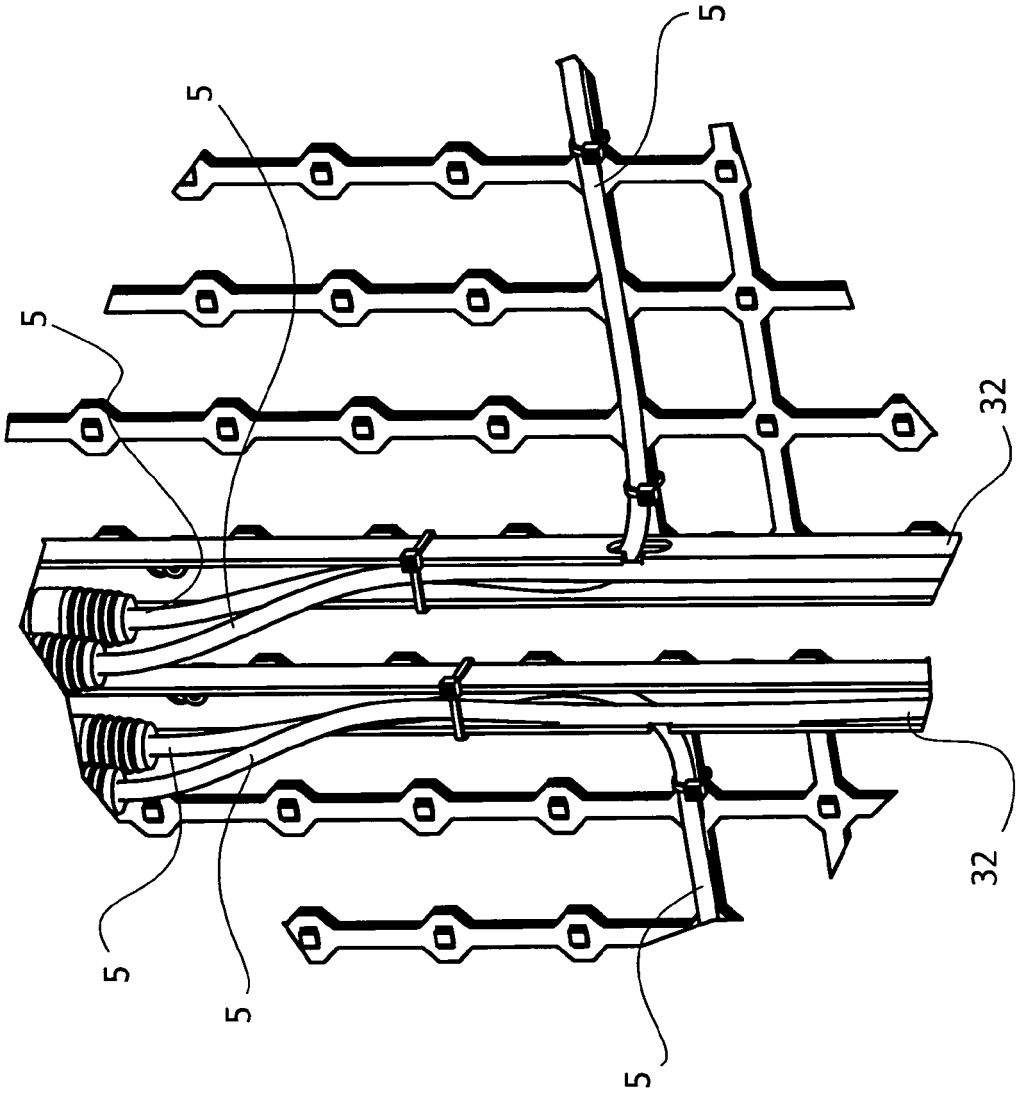


Fig. 10b

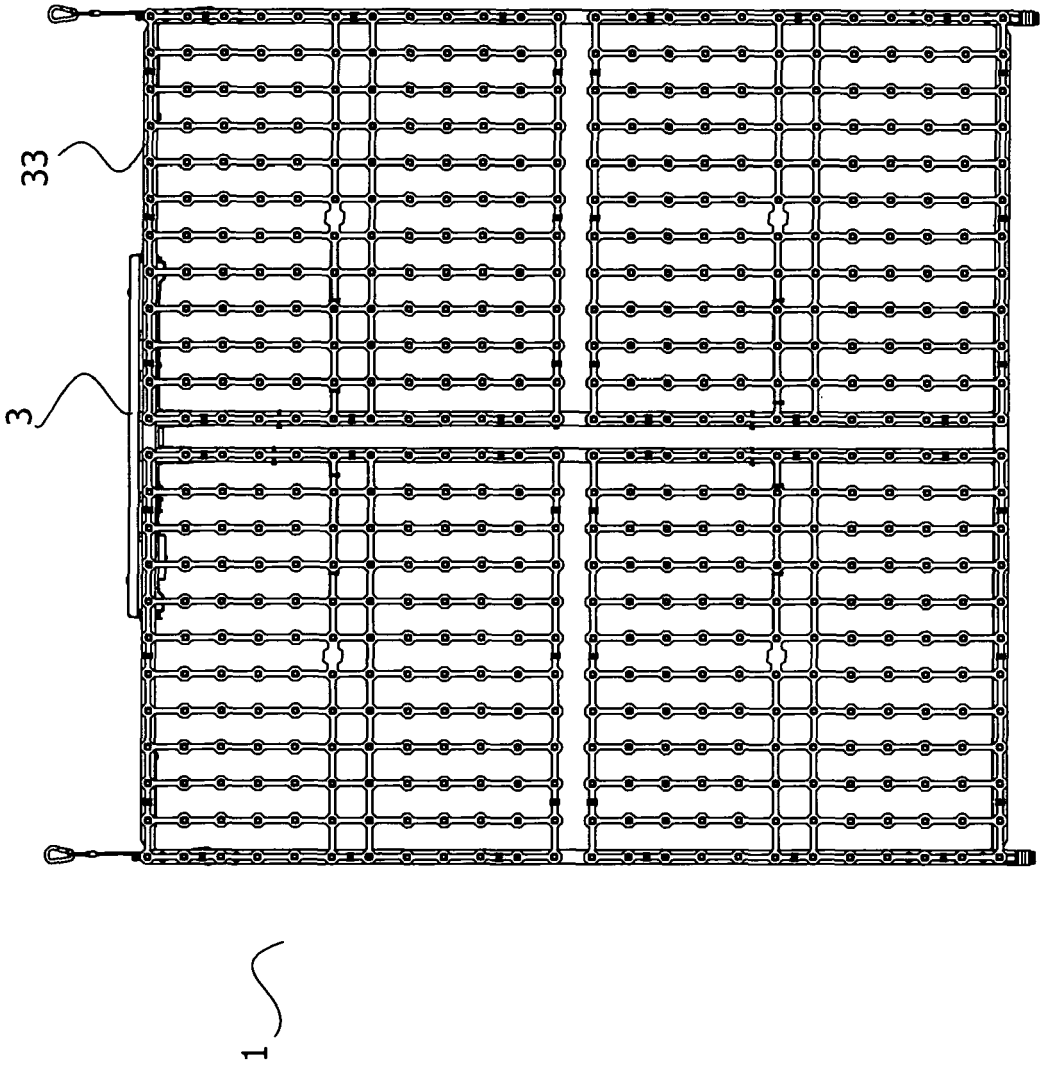


Fig. 11

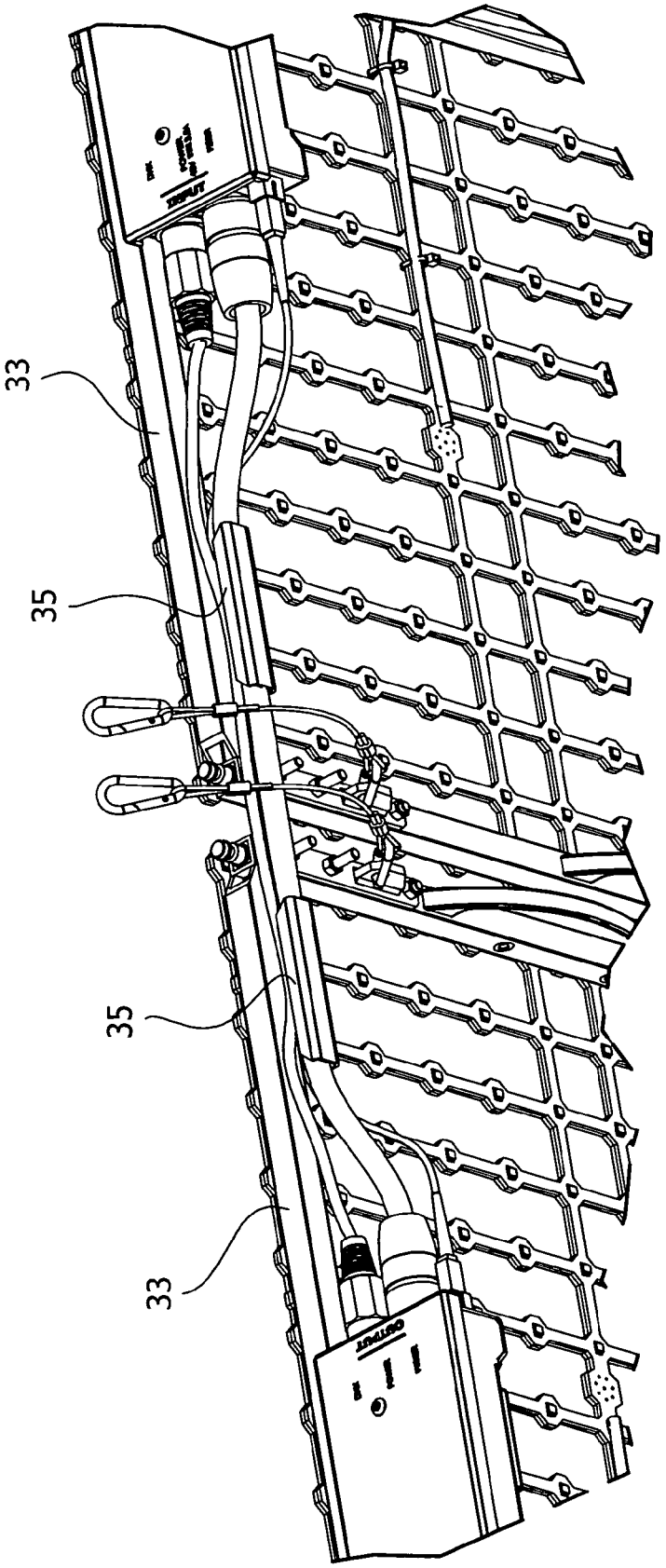


Fig. 12

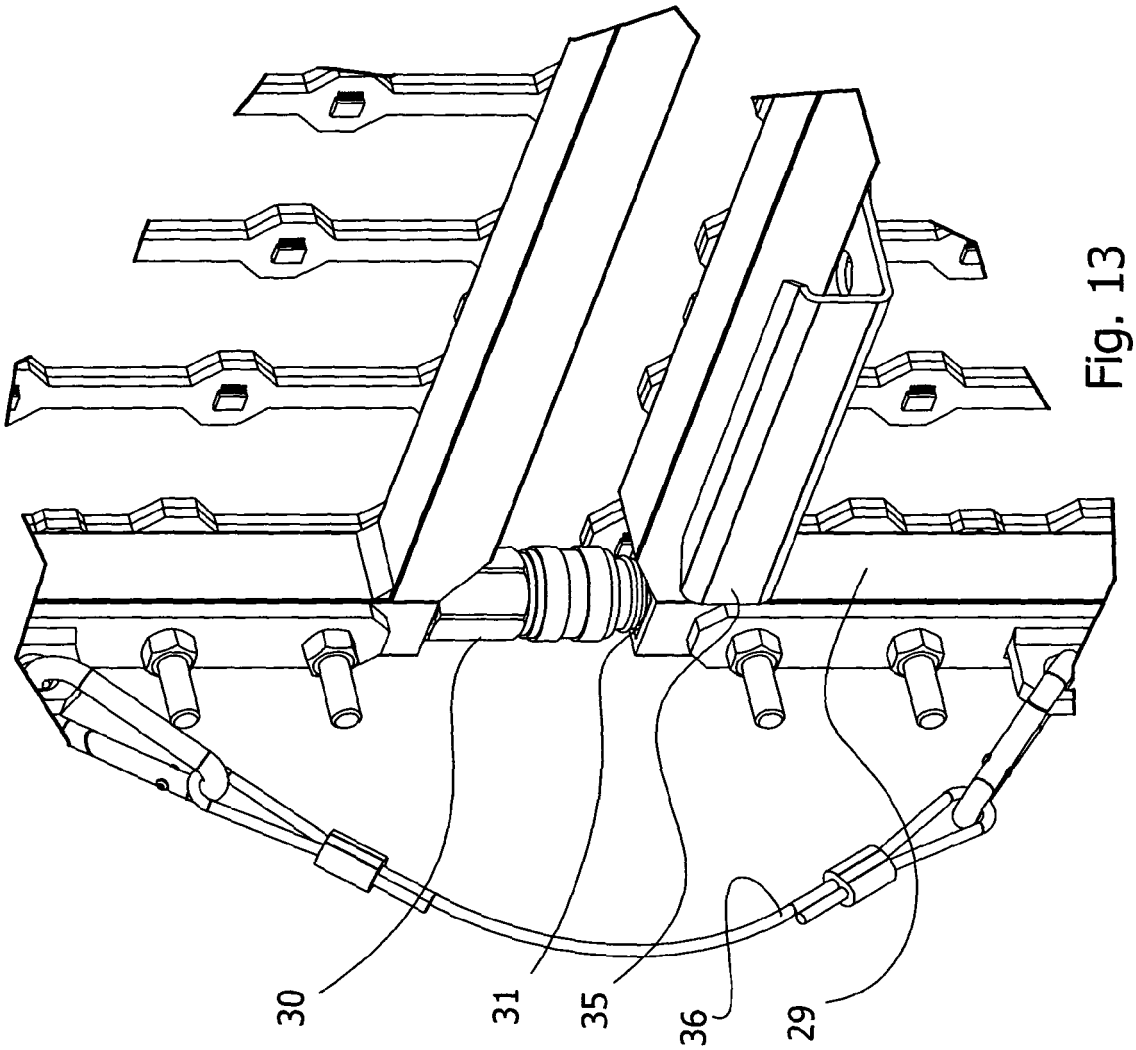


Fig. 13

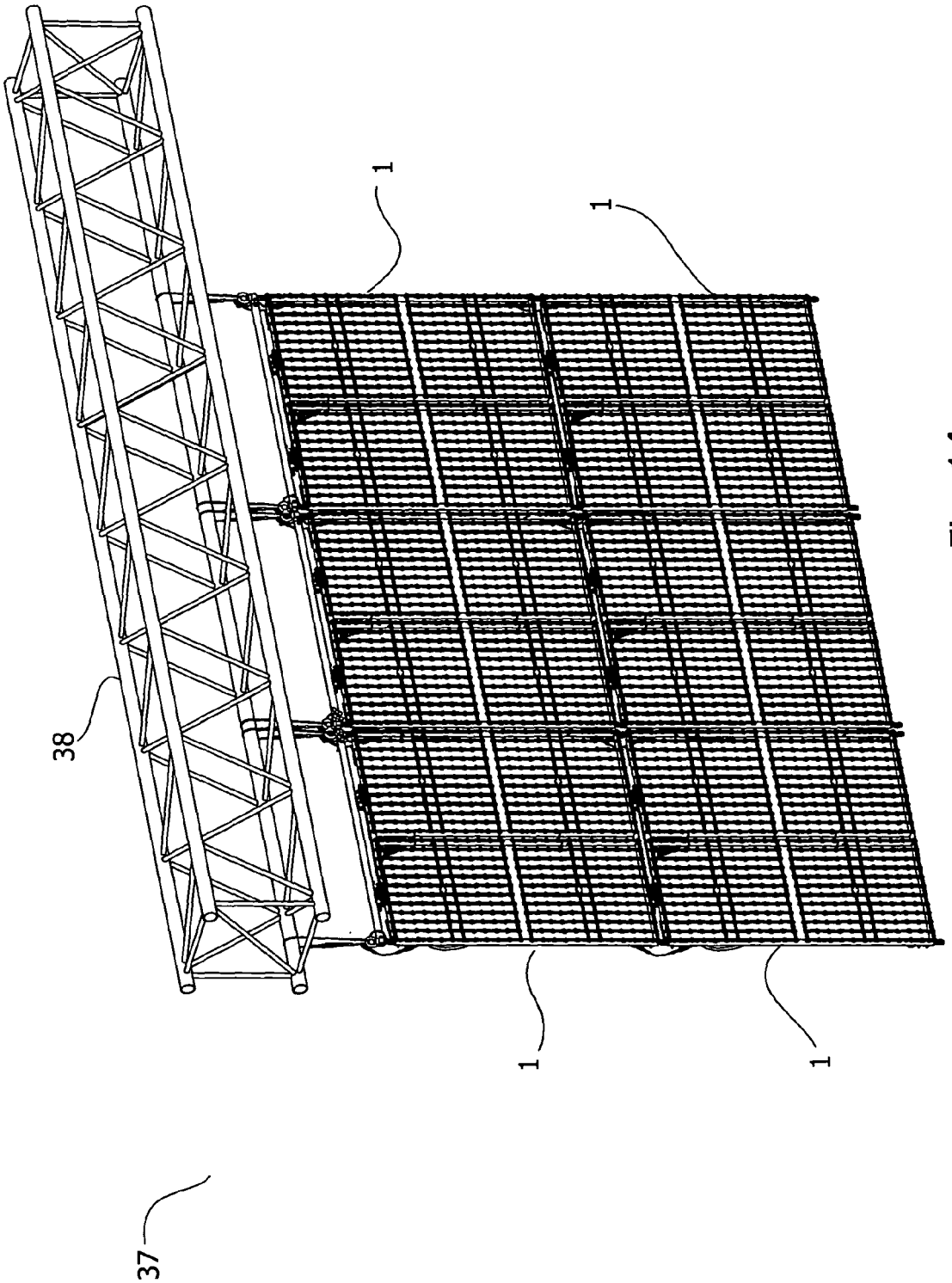


Fig. 14

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EUROPEAN SEARCH REPORT

Application Number
EP 07 01 7950

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2007/068055 A1 (SEGAN MARC H [US] ET AL) 29 March 2007 (2007-03-29) * paragraphs [0033], [0039], [0122]; figures 1,3,5 * -----	1-10	INV. G09G3/32 G09F9/33
Y	EP 1 460 609 A (INFOSIGHT CORP [US]) 22 September 2004 (2004-09-22) * paragraph [0015] * -----	1-10	

TECHNICAL FIELDS SEARCHED (IPC)

G09G
G09F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 January 2008	Gundlach, Harald

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31-01-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007068055 A1	29-03-2007	NONE	
EP 1460609 A	22-09-2004	CN 1530897 A	22-09-2004

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Patent documents cited in the description

- US 6690341 B **[0003]**