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(54) AUTOMATIC PROGRAMMABLE WIRING BOARD

(57) The invention relates to a wiring board (1) that enables the production of cable harnesses (9) on it, and basically comprises a work surface (2) with a perforated matrix structure located on the wiring board (1), at least one projector (3) that is connected to the wiring board (1) by means of a connection member (3.1) located behind the wiring board (1), reflecting the technical drawing of the cable harness (9) to be produced on the work surface (2), plurality of pins (8) that are moved by raising and lowering in the pin slots (8.1) on the working surface (2), at least one sensor (4) that detects the image reflected on the work surface (2) and transmits the detected data as a result of the detection and a control unit that processes the data transmitted from the sensor (4), determines the pins (8) located at the closest point to the detected image and enables the determined pins (8) to rise automatically.

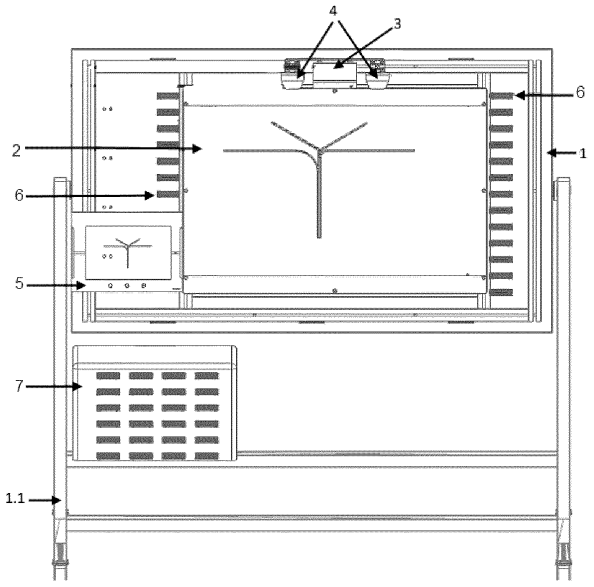

Figure 6

EP 3 886 123 A1

Description

Technical Field

[0001] The invention relates to a wiring board used in cable harness production.

[0002] In particular, the invention relates to a programmable wiring board, where the cable laying locations are determined by the automatic rise and fall of the nails in the working area according to the shape of the image that is projected on it by means of a projector and thus facilitates the production of the cable harness.

Background Art

[0003] Today, wiring boards are used to ensure that cable harnesses can be produced by creating various designs according to production requirements. In the standard cable harness production workshops, a separate wiring board and 1:1 production technical drawing of the cable harness is used for each cable harness to be produced. The technical drawing is taken as a printout and laid on the working area on the wiring board. There are holding elements such as nails on the work area. The cables are fixed to the holding elements in the work area according to the technical drawing and the cable harness is produced at the end of the process. With the same wiring board, the length information of the cable harness is checked and supervised. In this method, since it is necessary to prepare a separate technical drawing for each cable harness and a hole matrix structure consisting of nails, the manufacturer suffers economic loss. Printing out the technical drawing each time causes paper expense, environmental damage, and also increases labor force.

[0004] In an existing application, the drawing of the cable harness to be produced is projected on the work area in the perforated matrix structure on the wiring board with the projector. Based on the image projected on the work area, the cables are fixed to the pins here and the cable harness is produced. With this method, the problem of printing out the technical drawing has been eliminated, but since the wiring board is prepared by moving the nails by the technical operator, the required amount of work cannot be reduced. In the works prepared with classical projection reflection shown in Figure 1, since the projected image comes from the back of the operator performing the work, shadowed areas and dark spots occur on the work area. If a part of the image falls on the working operator's body, it causes the reflection to be interrupted. The interrupted reflection is shown in Figure 2 and the shaded area is shown in Figure 3. These negative issues cause the drawing not to be understood. The method mentioned at http://projectionworks.com/products/harness/ can be given as an example of reflecting with classical projection.

[0005] In another existing application, the method of displaying the image from a panel screen such as LED, LCD TV monitor is used. The matrix structure on the wiring board is installed on a glass screen with vacuum using large, non-precise fasteners. This installation is not suitable for cable types with high dimensional accuracy, as there is a loss of length accuracy due to equipment. The disadvantages of the classical projection method have been eliminated since there is no shadowing in the reflection in the studies performed on the screen. However, the operator working according to the reflection manually adjusts the necessary arrangement for the respective cable harness on the glass. After the adjustment, the cable harness is produced on this intermediate equipment, not on the floor. In this method, since the wiring boards are prepared by the user, it causes additional labor. The method mentioned in the link http://www.laselec.com/en/product/the-interactive-harness-assembly-board/ can be given as an example of projecting images on the screen.

[0006] As a result of the research on the subject, the application numbered EP2575147B1 was found. The application relates specifically to a work bench used for the production and checking of electrical harnesses used in the aviation, shipping and automotive industries. The said work bench; includes the wiring board, projectors, optical sensors, cameras and a computer. Sensors are positioned around the wiring board to receive the position information of the image to be projected and transmit it to the computer. The 1:1 scale image of the electrical harness is reflected on the work surface by the projection. Computers comprising software are used in the application to provide automatic programming of the cabling production. In the said application, the cable routing according to the incident reflection cannot be determined automatically, but is created manually by the technician. Furthermore, the subject application does not include a test device that enables the cable harness produced by being attached to the work surface to be tested on the wiring board.

[0007] The systems mentioned in the applications numbered TR2017/23043 and TR2018/01092 have been presented as a solution to the problems encountered in current applications in cable harness production. The application numbered TR2017/23043 relates to the automatic wiring board that reduces various number of wiring boards to a single programmable structure used in the production of wiring. The application numbered TR2018/01092 is related to the system that enables the projection of images without creating a user shadow with the projector device without using paper on the wiring boards in the workshops producing cable harness. In these two applications, the production operator cannot be guided automatically, as the instructions for production are only visually presented on the work area. In the applications, programming is done manually and the operator is not supported during the production phase. Every laying step made by the operator is not checked in detail.

[0008] As a result, it was required to make an improve-

ment in the relevant technical field due to the above - mentioned problems and the inadequacy of existing solutions.

Objects of the Invention

[0009] The invention is created by being inspired by the current situations and aims to solve the problems mentioned above.

[0010] The main object of the invention is to determine the routing areas by automatically raising and lowering of the nails in the working area according to the shape of the image reflected on it by the projector.

[0011] Another object of the invention is to prevent the operator from making mistakes by visually checking the cables laid during production and to provide feedback to the operator in case of making mistakes.

[0012] Another object of the invention is to provide convenience to the operator making the cable production during production by automatically determining the routing areas.

[0013] Another object of the invention is to show the operator where the error is located after the test and ensure that the error is immediately intervened in the event an error is detected in the production, by means of the testing of the produced cable harness at the location of production.

[0014] Another object of the invention is to produce more than one different cable set with a single wiring board.

[0015] The structural and characteristic features and all the advantages of the invention will be understood more clearly by means of the figures given below and the detailed explanation made by referring to these figures, and therefore the evaluation should be made by taking into consideration these figures and detailed explanations.

Drawings to Help Understand the Invention

[0016]

Figure 1 is a linear view of the incoming and interrupted image in the prior art.

Figure 2 is the view of the image created and projected on the work area with the projection method of the current technique.

Figure 3 is the view of the shadow formed on the working area in the projection method of the prior art.

Figure 4 is the side view of the image projection method on the wiring board of the present invention.

Figure 5 is the representative view of the working surface where wiring is made in the wiring board of the present invention.

Figure 6 is the representative view of the system forming the wiring board of the present invention.

Figure 7 is another representative view of the system forming the wiring board of the present invention.

Figure 8 is the view of the image reflected from the projector on the work surface.

Figure 9 is the representative view of the pin and pin socket on the working surface.

Description of the Part References

[0017]

1. Wiring board
   - 1.1. Support platform
   - 2. Work surface
   - 3. Projector
   - 3.1. Connection member
   - 4. Sensor
   - 5. Display
   - 6. Test point
   - 7. Test device
   - 8. Pin
   - 8.1. Pin socket
   - 9. Cable harness
   - G. Incident image

S. Limit of image on work surface

K. Interrupted image

Detailed Description of the Invention

[0018] In this detailed description, preferred embodiments of the automatic programmable wiring board subject of the present invention are explained only for a better understanding of the subject.

[0019] The invention relates to a wiring board (1) that enables the production of cable harnesses (9) on it, and basically comprises the following:

- Transparent work surface (2) with a perforated matrix structure, coated with film and/or paint, located on the wiring board (1),
- At least one projector (3) that is connected to the wiring board (1) by means of a connection member (3.1) located behind the wiring board (1), reflecting the technical drawing of the cable harness (9) to be produced on the work surface (2)
- Plurality of pins (8) that are moved by raising and lowering in the pin slots (8.1) on the working surface (2),
- At least one sensor (4) that detects the image reflected on the work surface (2) and transmits the detected data as a result of the detection
- A control unit that processes the data transmitted from the sensor (4), determines the pins (8) located

at the closest point to the detected image and enables the determined pins (8) to rise automatically.

[0020] In an alternative embodiment, the invention comprises a display (5) that digitally presents the drawing and production steps of the production to the operator who produces the cable harness (9).

[0021] In an alternative embodiment, the invention comprises the following:

- At least one sensor (4) that detects the image projected on the work surface (2) and the cables laid on the work surface (2) by the operator producing the cable harness (9) and transmits the detected data as a result of the detection.

- A control unit that processes the data transmitted from the sensor (4) and detects whether there is any incompatibility between the technical drawing reflected on the work surface (2) and the cable laid by the operator.

- At least one display (5) showing the discrepancy to the operator as an error, in case a discrepancy is detected by the control unit.

[0022] In another alternative embodiment of the invention, it comprises a test device (7) connected to the test points (6) on the work surface (2) in order to determine whether the produced cable harness (9) works or not.

[0023] The wiring board (1) of the present invention is connected on a support platform (1.1) with a movable structure that enables it to be carried. The support platform (1) is a mechanical structure/fixed framework that helps to adjust the working angle and height according to the operator who produces the cable harness (9). The support platform (1) can be moved easily by means of the wheels it comprises.

[0024] On the wiring board (1), there is a work surface (2) that is transparent, translucent to light, semi-permeable or can be turned into opaque structure thanks to the paint and film coating. The said work surface (2) is made of a transparent material coated with film and/or paint. This transparent work surface (2) is prepared to refract the light on it, to be translucent and to pass the light to a certain extent. The work surface (2) can be prepared by various methods such as reverse projection film, frosting effect on the surface and using silver-based translucent paint. This way, the image coming from the projector (3) is enabled to be seen on the transparent working surface (2) and the light is prevented from coming directly to the operator performing the work.

[0025] The paths created for directing the production of the cable harness (9) are determined on the work surface (2). During the preparation of the work surface (2), the hole matrix structure shown in Figure 5 is formed. This structure must meet the precise length and size requirements of the cable harness (9). The holes on the working surface (2) are pin sockets (8.1). The pins (8) rise and fall in the pin slots (8.1) located on the working surface (2), as seen in Figure 9, according to the geometric shape of the cable harness (9) to be produced. The mechanical interface for the nails in the area to be inserted is in this element. Mechanical interface can be made using clips, helicoids, inserts etc. fastening members. The said mechanical interface is the unit formed by pin slots (8.1) and pins (8) on the working surface (2).

[0026] In alternative embodiments of the invention, said pins (8) can be of different types depending on their usage. Their geometries, angles etc. may change according to the work surface (2) and the shape of the pin sockets (8.1) on the work surface (2). In the wiring board (1) of the present invention, any pin (8) can be removed manually from the pin slot (8.1) and inserted into another desired pin slot (8.1).

[0027] The image reflected on the work surface (2) is provided by a projector (3). Technical drawing of the cabling harness (9), image of the cabling harness test adapters, production information, etc. are reflected on the work surface (2) by the projector. The projector (3) is connected to the wiring board (1) by means of a connection apparatus (3.1) so that it stays behind the wiring board (1) as seen in Figure 4. The projector (3) can be adjusted according to the desired focal point in order to focus the image in various sizes and to provide user comfort. The working surface (2) passes the image coming from the projector (3) and the image remains fixed on the work surface (2), which is at the point where the light is refracted.

In a preferred embodiment of the invention, the principle of operation is as follows:

[0028] As seen in Figure 8, the image of the cable harness (9) to be produced is projected on the work surface (2) in the form of technical drawing. The projected image is detected by the sensors (4) and the detected data is transmitted to the control unit. The control unit determines the pins (8) closest to the detected image according to the drawing of the cable harness (9) to be produced by processing the data transmitted from the sensors (4). The pins (8) determined by the control unit rise as seen in Figure 7 in line with the command generated by the control unit and form the geometric shape of the cable harness (9) to be produced. The pins (8) can rise at the turns of the cables, at the separation of the branches and at places where the connectors come. The points at which the pins (8) will rise in the image are determined according to the general rules previously defined to the control unit. For example, if the lines continue uninterruptedly at the corners of the cable, a nail can be removed every 5 cm and the cable can be kept fixed between these pins. As another example, the junctions on the lines where the cables in the projected drawing are represented are determined and the pins come out according to the instructions from the joint.

[0029] On the screen (5) connected to a part of the wiring board (1), the operator is shown from which pin (9) to which pin (9) the cable will be laid. At the same time, in the image projected from the projector (3), it is shown from where the cable will be laid to where on the work surface (2).

[0030] The laying of the cable on the work surface (2) is monitored in each laying step by the sensors (4). The sensors (4) transmit each detected laying action to the control unit. These transmitted data are processed by the control unit. If there is a difference between the image on the work surface (2) and the data transmitted by the sensor (4), the control unit detects the difference. The detected difference is transferred to the operator via the display (5). It is not possible to proceed to the next laying step until the difference is eliminated. If there is no difference between the image reflected from the projector (3) and the data transmitted by the sensor (4), the next laying step is shown on the display (5). Showing each laying step to the operator on the display (5) in order of operation provides convenience for the operator during cable laying. After the production is finished, the system resets itself and prepares for the next production.

[0031] The advantage of the wiring board (1) of the present invention over existing techniques is explained in detail with the following example. In a current application, all branches are marked for the laying of a harness of multiple branches. The marked cables are handled sequentially by the operator and read into a barcode and the information on where the cable will be laid is given to the operator according to the data received from the barcode. After the cables are laid in the relevant area by the operator, the accuracy is controlled manually by the operator. With the wiring board (1), of the present invention, since there is no separate marking of each branch and the reading of the marked branches, and the accuracy of the laying is automatically checked after the process, a significant gain is achieved in labor.

[0032] In the wiring board (1) of the present invention, the technical drawing of the cable harness (9) transferred to the working surface (2) by projection is detected by image processing technology by means of the sensors (4) and the pins (8) automatically rise and fall according to the rules created. During cable laying, it is determined whether the image on the work surface (2) and the image created by the cables laid by the operator are the same or not, and where the laying began and ended by the control unit by various methods. Machine Learning, Optical Thickness and Length Measurement, Color Based Analysis Skill are some of the methods used. For example, when the cable is laid from point A to point B, its difference can be seen from the image difference. The change in the wiring harness on the wiring board (1) can be understood by performing a yes or no analysis, or when a different color cable is laid, the difference can be determined by performing a color difference analysis.

[0033] In an alternative embodiment of the invention, after the cable laying and other assembly processes are completed, where to where (pin to pin), high voltage, insulation test and resistance test are performed. Automatic test devices (7) and test programs that perform these tests are integrated into the wiring board (1). The technical drawing showing the connector controls and test responses and the adapters to be used are projected on the connector ends of the produced cable harness (9). Afterwards, intermediate adapters connecting the cable harness (9) to the test device (7) are connected to the test device (7) from the test point (7) according to the projected technical drawing. The schematic information of the cable is transmitted to the test device (7) software. Thus, the required points on the cable are learned by the device. Afterwards, the test method to be applied is selected and the test software is run in the test device (7). While performing the test, the cable harness (9) is supplied with appropriate volt and ampere values for the device to be used. These values are analyzed by mutual reading and success-failure information is given to the operator with the test software. Standard anonymous test devices (7) and standard software are used in tests.

[0034] In another alternative embodiment of the invention, a projection device can be used, especially if it is desired to make the image projection at short distances, preferably a short range ratio (e.g. 0.46) projection device can be used. In the absence of a short range projection device, the image can also be reflected on the work surface (2) by using the mirroring method used in existing systems. The number of reflectors (3) can be increased according to the size of the wiring board (1).

[0035] By means of the automatic programmable wiring board (1) of the present invention, the need for a separate cabling board for each cable production is eliminated. The wiring board (1) of the invention is not specific to a single production, it is reconfigured for each production. Therefore, it is possible to produce more than one cable harness (9) with a single wiring board (1).

Claims

1. A wiring board (1) that enables the production of cable harnesses (9) on it, wherein the board comprises the following:

    • A work surface (2) with a perforated matrix structure located on the wiring board (1),
    • At least one projector (3) that is connected to the wiring board (1) by means of a connection member (3.1) located behind the wiring board (1), reflecting the technical drawing of the cable harness (9) to be produced on the work surface (2),
    • Plurality of pins (8) that are moved by raising and lowering in the pin slots (8.1) on the working surface (2),
    • At least one sensor (4) that detects the image reflected on the work surface (2) and transmits

the detected data as a result of the detection,
• A control unit that processes the data transmitted from the sensor (4), determines the pins (8) located at the closest point to the detected image and enables the determined pins (8) to rise automatically.

2. The wiring board (1) according to claim 1, wherein it comprises a transparent work surface (2) coated with film and/or paint.

3. The wiring board (1) according to claim 1, wherein it comprises a display (5) that digitally displays the drawing of the production to the operator producing the cable harness (9) and from which pin (9) to which pin (9) the operator will lay the cable.

4. The wiring board (1) according to claim 1, wherein it comprises;

• at least one sensor (4) that detects the image reflected on the work surface (2) and the cables laid on the work surface (2) by the operator producing the cable harness (9) and transmits the detected data as a result of the detection,
• a control unit that processes the data transmitted from the sensor (4) and detects whether there is a discrepancy between the technical drawing reflected on the work surface (2) and the cable laid by the operator, and
• in case a discrepancy is detected by the control unit, at least one display (5) showing this discrepancy to the operator as an error.

5. The wiring board (1) according to claim 1, wherein it comprises a test device (7) connected to the test points (6) on the work surface (2) in order to determine whether the produced cable harness (9) works or not after the production of the cable harness (9) is completed.

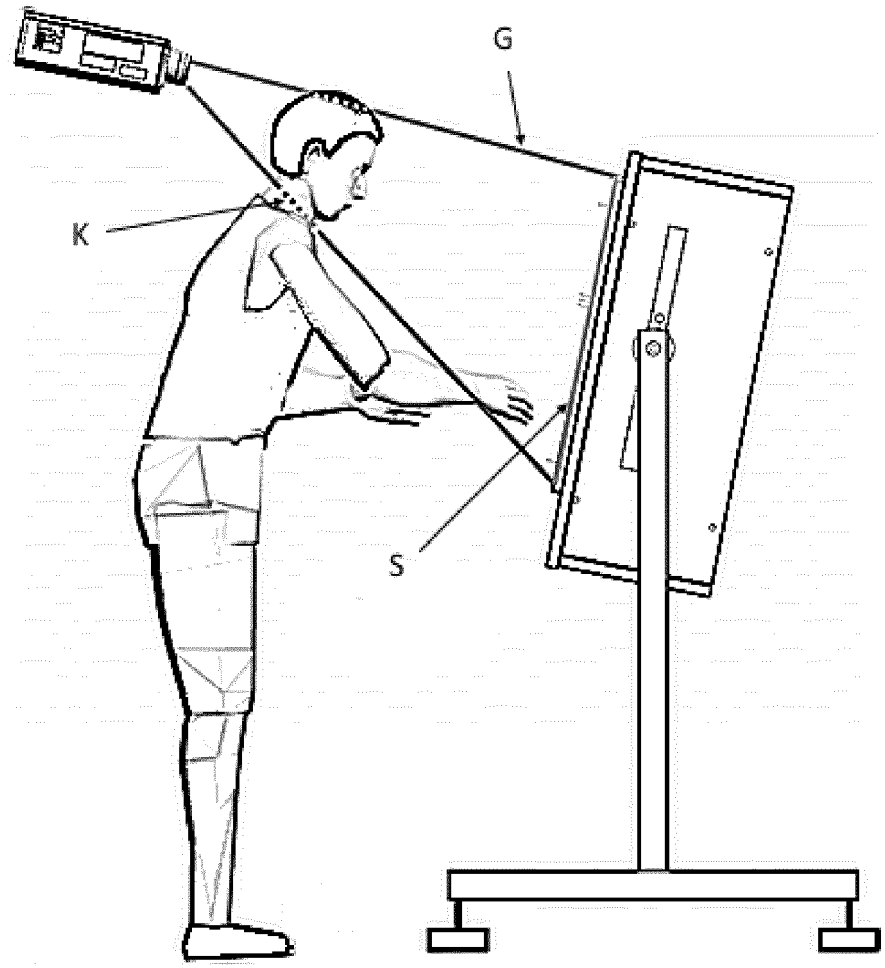

Figure 1

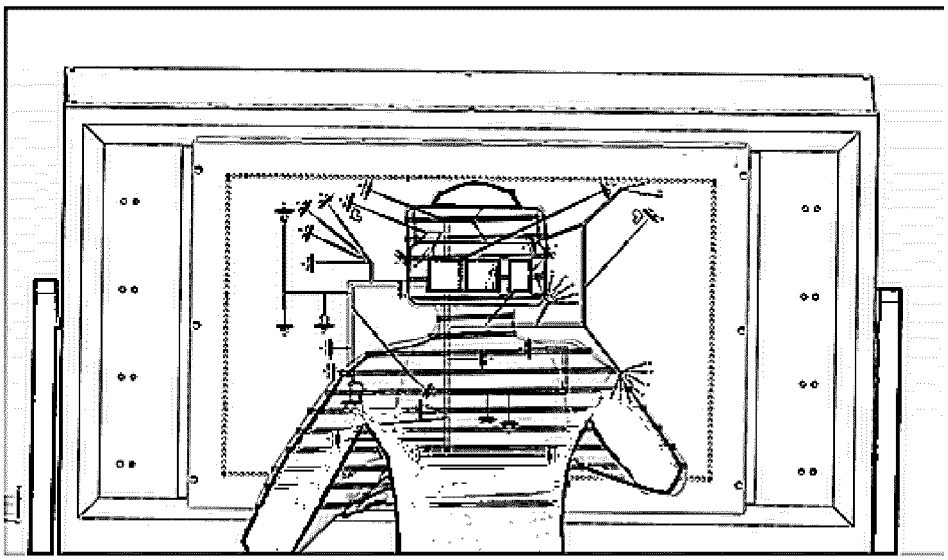

Figure 2

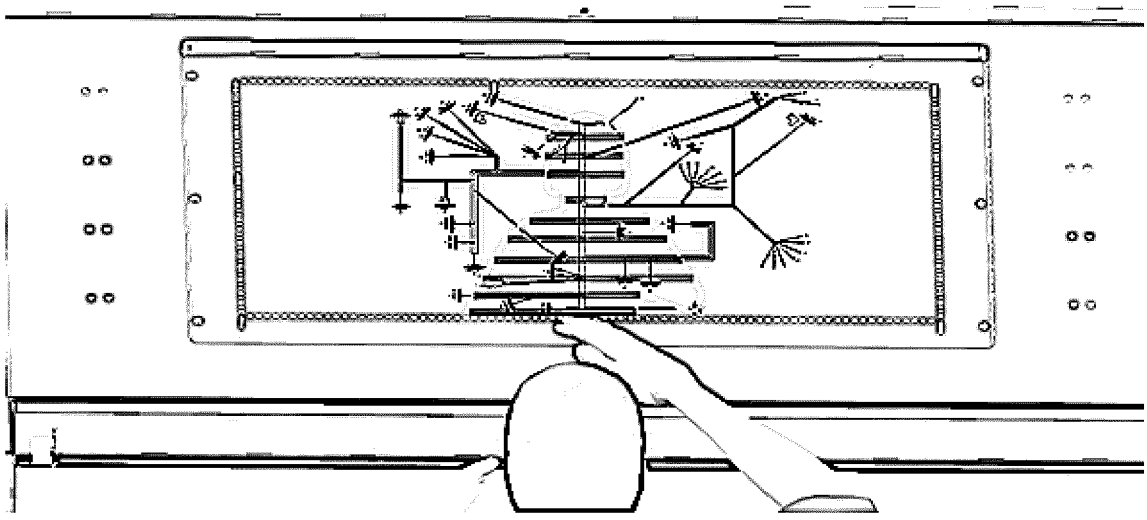

Figure 3

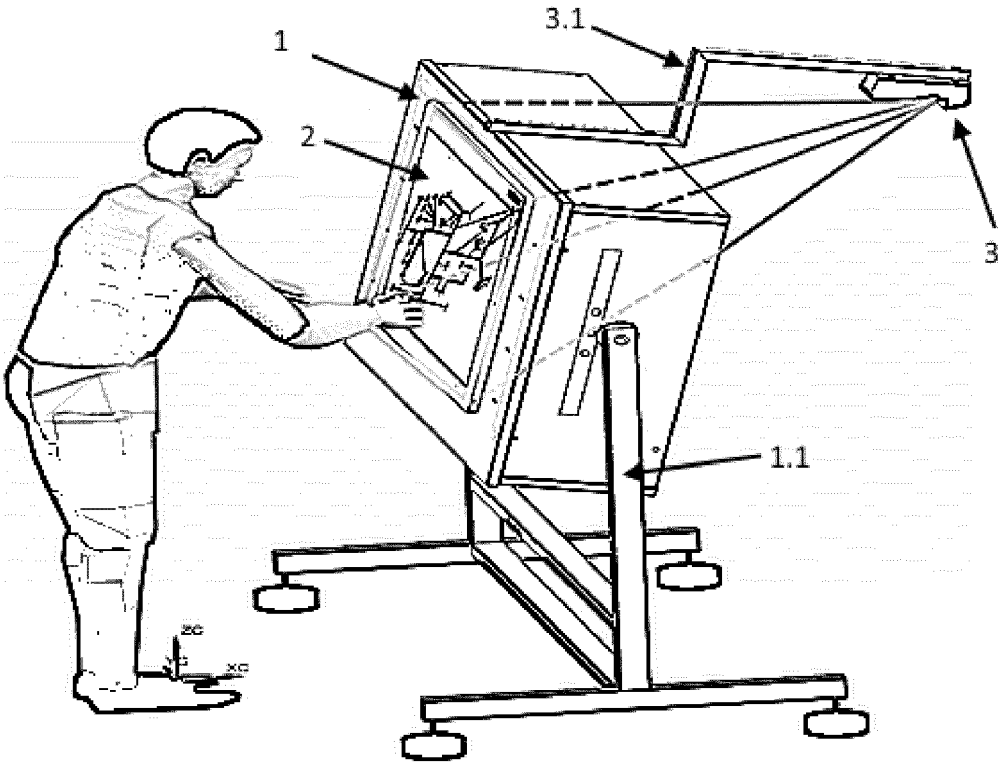

Figure 4

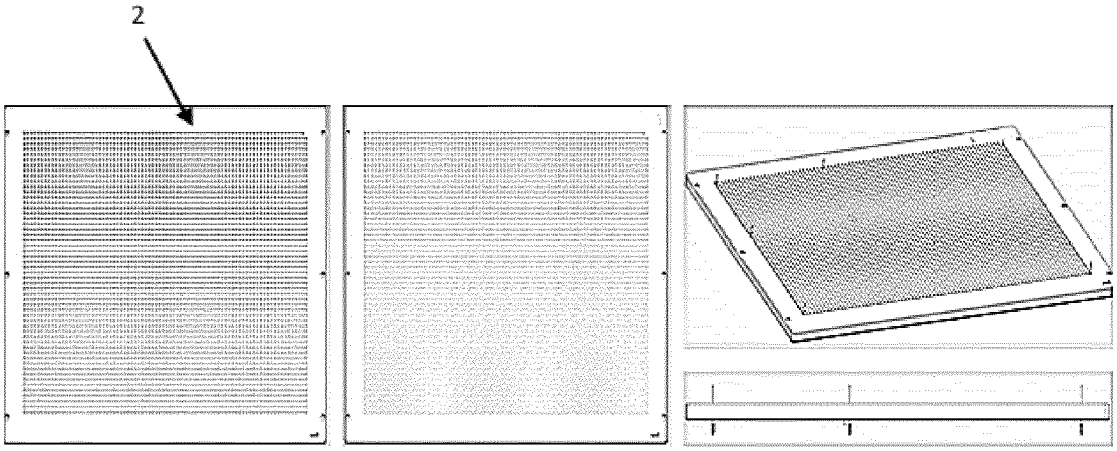

Figure 5

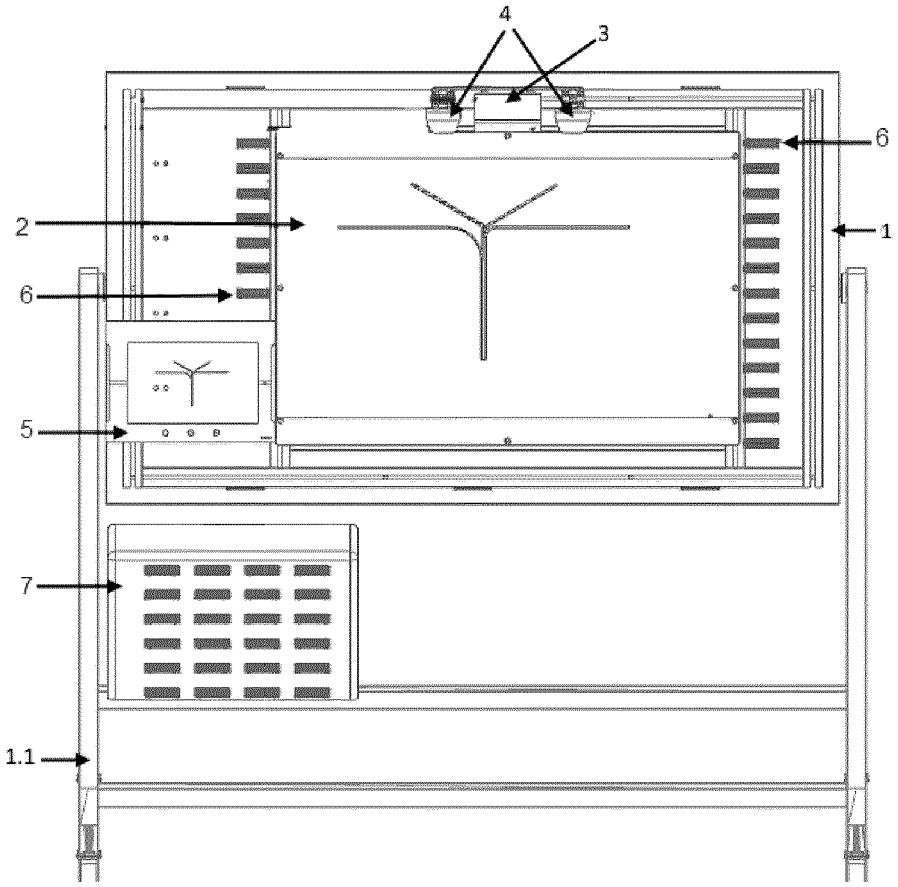

Figure 6

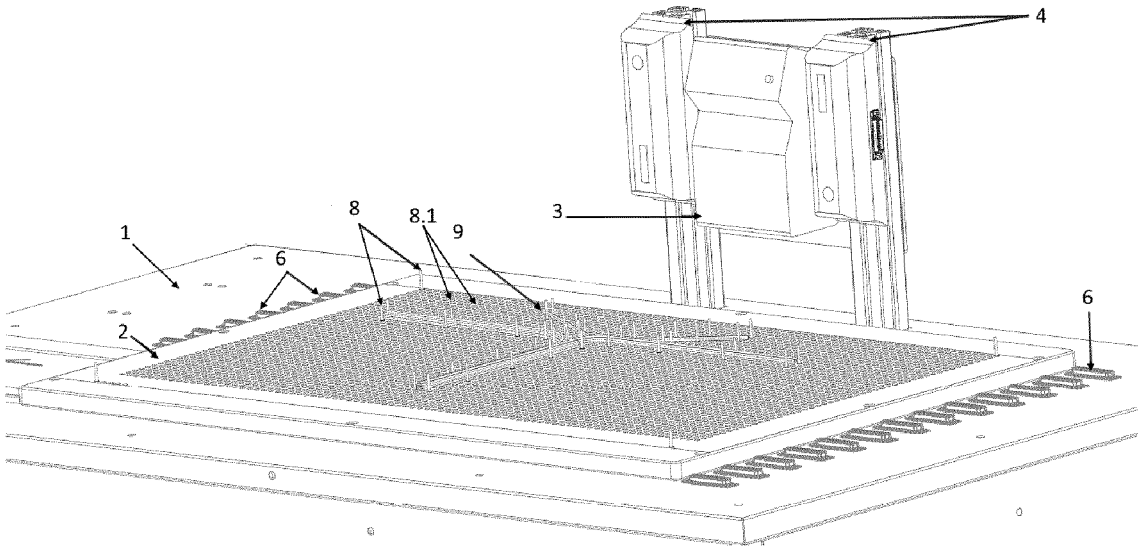

Figure 7

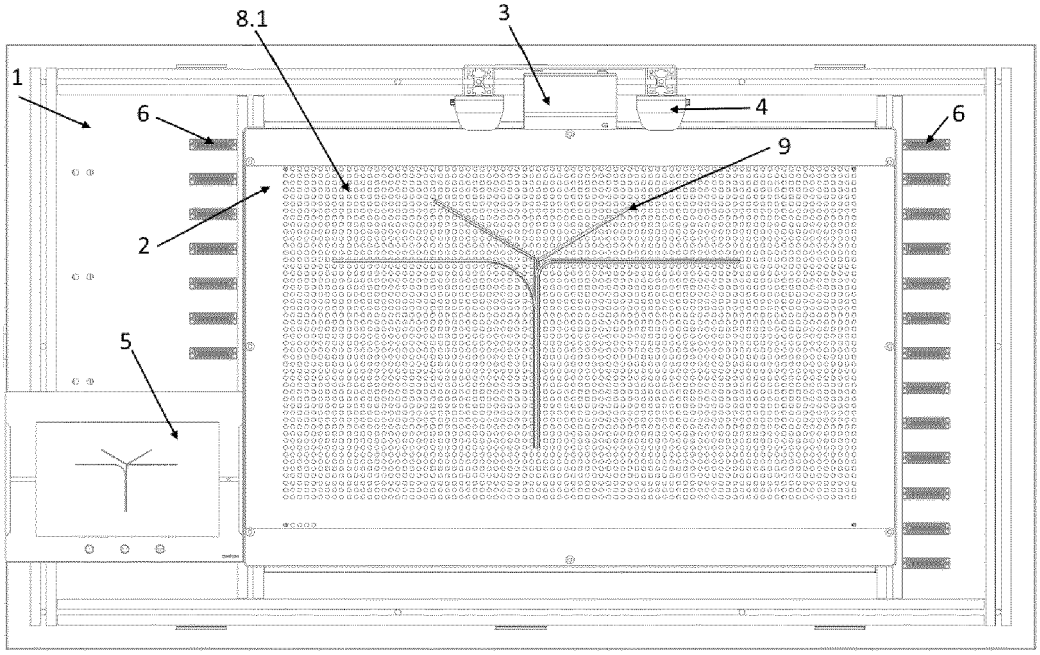

Figure 8

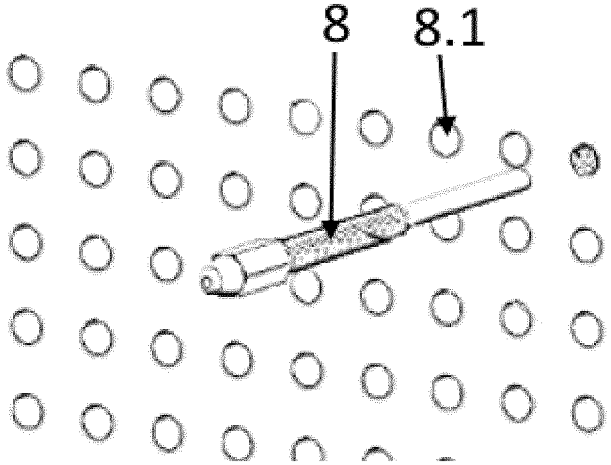

Figure 9

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EUROPEAN SEARCH REPORT

Application Number
EP 21 15 9827

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 03/031094 A1 (LASER PROJECTION TECHNOLOGIES [US]; KAUFMAN STEVEN P [US] ET AL.) 17 April 2003 (2003-04-17) * page 6, line 12 - page 8, line 16; figure 2 *	1-5	INV. H01B13/012
A	DE 10 2011 084786 A1 (S Y SYSTEMS TECHNOLOGIES EUROP GMBH [DE]) 25 April 2013 (2013-04-25) * paragraph [0017] - paragraph [0026]; figure 1 *	1-5	
A	DE 10 2016 119867 A1 (KROMBERG & SCHUBERT GMBH [DE]) 19 April 2018 (2018-04-19) * paragraph [0013]; figures 1, 2 * * paragraph [0036] - paragraph [0041] *	1-5	
A	US 4 979 544 A (SWINDLEHURST WILLIAM S [US]) 25 December 1990 (1990-12-25) * column 1, line 28 - line 48; figures 1-3 *	1-5	TECHNICAL FIELDS SEARCHED (IPC)
A	DE 10 2015 011822 A1 (DAIMLER AG [DE]) 31 March 2016 (2016-03-31) * paragraphs [0009], [0018]; figure *	1-5	H01B G06F H05K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 August 2021	Starck, Thierry

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 15 9827

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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20-08-2021

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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- TR 201723043 **[0007]**
- TR 201801092 **[0007]**