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(54) **PRINTER AND GUIDANCE RAIL FOR A PRINT HEAD CARRIAGE**

(57) 1. A guidance rail (20) for a print head carriage and a printer having a guidance rail (20) are provided. The guidance rail (20) has mounting sites (12-1, 12-2) arranged essentially in a row and configured for applying mounting elements for mounting the guidance rail (20) to a printer. At least two distances (d12, d23, d34) between any adjacent mounting sites (12-i, 12-(i+1)) are non-equal, in order to reduce the susceptibility of the guidance rail (20) to vibrations induced by movements of the print head carriage.

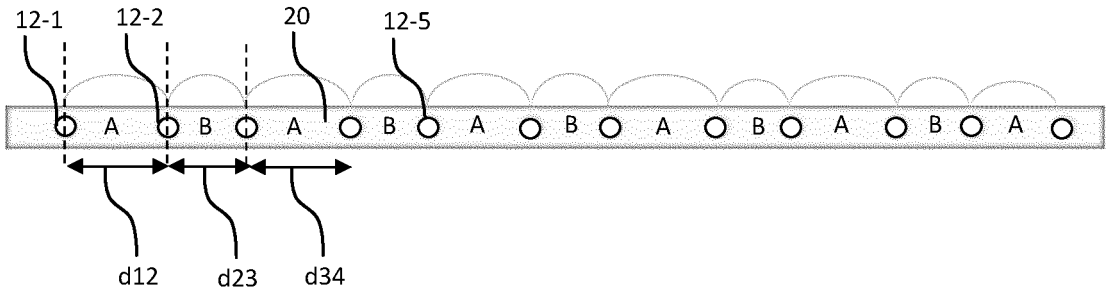

Fig. 5

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Description

FIELD OF THE INVENTION

[0001] The present invention generally pertains to a guidance rail for a print head carriage with reduced susceptibility to vibrations as well as to a printer comprising such a guidance rail.

BACKGROUND ART

[0002] In many types of printers, a print head carriage is moved relative to a medium such as a sheet or a roll of paper or foil of plastic or the like. Such printers are also sometimes designated as "scanning printing systems". The "scanning printing systems" comprise a carriage configured to, in printing operation, move in reciprocation in a main scanning direction over the medium. The print head carriage carries a print head, which marks the medium with a marking agent such as ink or a conductive paste in order to create text, patterns, colors, images, electrical circuits and/or the like on the medium.

[0003] The print head carriage typically moves bidirectionally along a linear path and is typically mounted between two so-called runner blocks, which in turn are moveably arranged on a respective one of two guidance rails installed in parallel in the printer. The mounting of such a guidance rail in a carriage printing system is usually designed to be equidistant, for example with a mounting pitch of 60 millimeters.

[0004] EP 3 564 038 A1 discloses a guiding structure for a print head carriage in which equidistant mounting sites are provided for an array of mounting bodies for mounting the guiding structure to the rest of the printer.

[0005] US 2018 /079 240 A1 describes an assembly for moving a carriage of a printer. Regarding a vibration problem that may arise when the carriage moves, it is suggested to include a flexible support element and a tensioner assembly for tensioning the flexible support element. By controlling the tension of the flexible support element, it is endeavored to dampen vibrations of the assembly caused by the movement of the carriage.

SUMMARY OF THE INVENTION

[0006] It has been found by the inventors that the typical equidistant arrangement of the mounting sites of the guidance rail may lead to an undesired increase in vibration in and of the guidance rail due to the movement of the print head carriage. In particular, when the print head carriage is moving with a constant speed along the guidance rail for an extended period of time, this induces vibrations in the guidance rail. Since the guidance rail is fixated at each of the mounting sites which are equidistant in the prior art, this creates a regular pattern of fixed points. Between these fixed points at the mounting sites, the guidance rail is comparatively freer to shift. Consequently, such a guidance rail installed in a printer is susceptible to particular vibration frequencies induced by the print head carriage, in particular to frequencies that are integer multiplies of the base distance between the mounting sites. Vibrations in the guidance rail, in turn, negatively affect the longevity and the precision of the print head carriage.

[0007] It is therefore an objective of the present invention to provide a guidance rail, and a printer with a guidance rail, which are less susceptible to these types of vibrations.

[0008] These objectives are fulfilled by the subject matter of the independent claims.

[0009] Accordingly, the invention provides a guidance rail for a print head carriage, the guidance rail having mounting sites arranged essentially in a row. The mounting sites are configured for applying mounting elements for mounting the guidance rail to a printer. At least two distances between any adjacent mounting sites are non-equal.

[0010] In other words, the mounting sites of the guidance rail are non-equidistant overall as there is at least one distance between one pair of adjacent mounting sites which is different from at least one other distance between one other pair of adjacent mounting sites (wherein the one pair and the other pair may have at most one mounting site in common).

[0011] Advantageously, by arranging the mounting sites non-equidistant, the strict regularity of the arrangement of mounting sites is removed and the susceptibility of the guidance rail to vibrations is reduced. It is preferred that there is a plurality of first distances between adjacent mounting sites which are different from a plurality of second distances between adjacent mounting sites. In general, the less regular the arrangement of mounting sites on the guidance rail is, the less susceptible the guidance rail is to vibrations.

[0012] The mounting site being arranged essentially in a row may be understood to mean that they are arranged in a strict row as much as usual tolerances allow or that they are arranged in a row with perpendicular deviations of each mounting site from an ideal, strict row between (including) zero and a maximum deviation value, MDV. The MDV may as low as zero and as large as, for example, the size of the mounting site in the direction perpendicular to the ideal, strict row. This direction may also be simply designated as the "perpendicular direction", i.e., perpendicular to the longitudinal direction along which the guidance rail itself extends. Thus, the maximum distance between any two mounting sites in the perpendicular direction may be two times MDV, in case that one of the mounting site is maximally deviated in the positive perpendicular direction and another one of the mounting sites is maximally deviated in the negative perpendicular direction.

[0013] In some advantageous embodiments, refinements, or variants of embodiments, equidistant center positions for the mounting sites are defined, each mounting site is arranged within a predefined tolerance interval

around a respective one of the center positions, and the relative position of each mounting site to the respective center position is different for at least two of the mounting sites. In each tolerance interval, there is only a single center position and only a single mounting site.

[0014] The equidistant center positions have the effect that the guidance rail is, on average, fastened to the printer at regular (equidistant) intervals such that at no point of the guidance rail there is an excess of play. On the other hand, since the mounting sites are not arranged exactly at the center positions but at (at least partially, i.e., at least for some mounting sites) different relative positions thereto, the strict regularity of the mounting sites is advantageously broken, and the guidance rail is less susceptible to vibrations.

[0015] Taking this idea further, more preferably each mounting site is randomly arranged within the predefined tolerance interval around its respective center position. This strongly reduces the chances that the guidance rail has any resonance frequency that can be excited by the movement of the carriage. The term "randomly" shall here be understood to include both true randomness as well as pseudo-randomness in the mathematical sense.

[0016] In some advantageous embodiments, refinements, or variants of embodiments, each distance between any two adjacent mounting sites is different. This is another way to strongly reduce the chances that the guidance rail has any resonance frequency that can be excited by the movement of the print head carriage.

[0017] In some advantageous embodiments, refinements, or variants of embodiments, at least two different distance values are defined for adjacent mounting sites, and wherein the at least two different distance values alternate regularly along the row of mounting sites. It should be noted that whenever herein distances between mounting sites are discussed, this pertains to distances between adjacent mounting sites unless explicitly specified otherwise. Two different distances values A, B mean that the distances between pairs of adjacent mounting sites along the longitudinal direction vary as A-B-A-B-A... and so on. For three different distances values A, B, and C, the order may be A-B-C-A-B-C-A ... and so on. The largest resonance frequency would be the largest common divisor of A, B, C, ... and so on which will in general be the smaller, the more different distance values, A, B, C, D, ... and so on are present.

[0018] Advantageously, the ratio of adjacently applied distance values (i.e. the ratio of A:B, of B:C, .. and so on) is between 1:1 and 1:5, preferably between 1:2 and 1:4, more preferably between 1:3 and 1:4. These values empirically provide a good balance between the advantages of fixing the guidance rail at equidistant mounting sites for reasons of stability and the advantages of reducing its susceptibility to vibrations.

[0019] In some advantageous embodiments, refinements, or variants of embodiments, the mounting sites are configured as holes or bores through which mounting elements for mounting the guidance rail to the printer can be inserted. The mounting elements may in particular be mounting means such as screws, bolts, and/or the like. The extent of the hole or bore in the perpendicular direction, as a percentage of the extent of the guidance rail itself along the perpendicular direction, is preferably larger than 50%, more preferably larger than 70%.

[0020] The invention further provides a printer comprising at least one guidance rail according to an embodiment of the present invention, the at least one guidance rail being mounted to the printer by mounting elements attached at the mounting sites of the guidance rail. Preferably, at least (or exactly) two guidance rails are provided and mounted to the printer, more preferably in parallel for providing additional stability to the moving print head carriage.

[0021] In some advantageous embodiments, refinements, or variants of embodiments, the printer comprises a print head cartridge, wherein two guidance rails according to any embodiment of the present invention are arranged in parallel. At least one runner block is movably mounted on each guidance rail, and the print head carriage is mounted on the at least two runner blocks.

[0022] It is further preferred that the first, second, third, ... and so on mounting sites of the first guidance rail are positioned at different positions along the longitudinal direction than the respective first, second, third, ... and so on mounting sites of the second guidance rail. This will further reduce the susceptibility of the assembly of the guidance rails and the print head carriage to vibrations. In other words, starting from a mounting site of a first guidance rail and moving towards another guidance rail along the perpendicular direction, it is preferred if no other mounting site is encountered at the same position with respect to the longitudinal direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying schematic drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 schematically illustrates a part of a printer according to an embodiment of the present invention, which comprises two guidance rails according to further embodiments of the present invention;

Fig. 2 schematically illustrates a guidance rail of Fig. 1 in more detail;

Fig. 3 schematically illustrates a guidance rail according to the prior art;

Fig. 4 schematically illustrates a guidance rail according to an embodiment of the present invention; and

Fig. 5 schematically illustrates a guidance rail according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0024] The present invention will now be described with reference to the accompanying drawings, wherein the same reference numerals have been used to identify the same or similar elements throughout the several views, and in some instances throughout the several embodiments.

[0025] Fig. 1 schematically illustrates a part of a printer 100 according to an embodiment of the present invention. Parts of the printer 100 which are well known but not essential for the description of the present invention are omitted for the sake of clarity. For example, no housing, medium transport system, print head and so on are shown although they will typically be present in the printer 100.

[0026] What is shown in Fig. 1 is that the printer comprises, among other parts, two guidance rails 10 arranged in parallel to one another, each extending along a (the same) longitudinal direction L but at a perpendicular distance from one another. Along each guidance rail 10, mounting sites 12 are provided which will be described in more detail in the following. A print head carriage 150 is moveably mounted between the guidance rails 10 such as to be moveable by an actuator (not shown) bidirectionally in the longitudinal direction L. In the shown depiction, the print head carriage 150 would carry a print head configured to eject the marking agent (e.g. ink) in the downward direction. The distances between the mounting sites 12 are not shown to scale in Fig. 1.

[0027] Fig. 2 shows further details of the assembly shown in Fig. 1, with the print head carriage 150 now left out. In this embodiment, the mounting sites 12 are provided as holes or bores in the guidance rail 10. The holes or bores may be punched out of a blank metal strip to produce a metal guidance rail 10, or they may be bored out of a blank metal strip. The guidance rail 10 could also be made from plastic in which case the mounting sites 12 may be cut into a blank plastic strip to produce a plastic guidance rail 10, or the guidance rail 10 may be produced by injections molding as already comprising the holes, or the guidance rail 10 may be produced by additive manufacturing (e.g. "3D printing") from a material comprising (or consisting of) metal, plastic and/or ceramics as already comprising the holes.

[0028] Fig. 2 also shows that the guidance rail 10 may be mounted to a framework 110 of the printer 100 (or any other part of the printer 100) using mounting elements 13. These mounting elements 13 may be any type of mounting means, for example, screws or bolts. A runner block 14 is moveably mounted to the guidance rail 10 such as to be able to move along the longitudinal direction L. The print head carriage 150 may be mounted on at least one runner block 14 on each guidance rail 10.

[0029] Fig. 3 schematically illustrates a guidance rail 1 according to the prior art (e.g. according to EP 3 564 038 A1), wherein mounting sites 4 are arranged at equidistant intervals. A schematic graph 5 indicates in an exaggerated manner how much play the different portions of the guidance rail 1 have due to the positioning of the mounting sites 4: the play is minimal at each mounting site 4, increases up towards a maximum precisely halfway between that mounting site 4 and the next, and then decreases again to the minimum. The regularity of this graph 5 indicates the susceptibility of the guidance rail 1 of the prior art to vibrations, as the graph 5 can also be interpreted to show the fundamental vibration mode between adjacent mounting sites 4.

[0030] Fig. 4 schematically illustrates a guidance rail 10 according to an embodiment of the present invention. Along the guidance rail 10, equidistant center positions 16-1, 16-2, 16-3, ... (in short: 16-i) are defined for the mounting sites 12-1, 12-2, ... (in short: 12-i). The center positions 16-i are marked by diamond symbols and the mounting sites 12-1 by circles. Each center position 16-i is at the center of a periodically repeating cell 15. Both the center positions 16-i and the cell 15 are not necessarily marked on the guidance rail in any way but are defined and described in order to understand the embodiment better.

[0031] Each mounting site 12-i is arranged within a predefined tolerance interval around a (or: its) respective one of the center positions 16-i. The tolerance interval in this respect is preferably only considered along the longitudinal direction L. The tolerance interval is preferably arranged symmetrically around its respective center position 16-i, or, in other words, each center position 16-i is arranged at the center (in the longitudinal direction L) of its respective tolerance interval.

[0032] The relative position of each mounting site 12-i to the (or: its) respective center position 16-i is different for at least two of the mounting sites 12-i. As an example, Fig. 4 shows a distance d12 between a first mounting site 12-1 and a second mounting site 12-2 being smaller than a distance d23 between the second mounting site 12-2 and a third mounting site 12-3.

[0033] The tolerance interval may extend up to half the distance between the center position 16-i and the respective next center position 16-j, with $j=i+1$ or $j=1-i$. Preferably, the total width of the tolerance interval is smaller than the (constant and equal throughout the guidance rail 10) distance between two adjacent center positions 16-i, 16-(i+1), more preferably smaller than 75% of that distance, most preferably smaller than 50% of that distance. Again, this provides a suitable balance between the advantages of different distances d12, d23, ... between the mounting sites 12-1, 12-2, ...(in order to reduce vibration) and the advantages of equidistant distances (in order to provide stability of the mounting of the guidance rail 10 to the printer 100). Preferably, each mounting site 12-i (and only one) is randomly arranged within the

predefined tolerance interval around its respective center position 16-i.

[0034] In Fig. 4 a graph 5 has been included as well which, as in Fig. 3, indicates (in an exaggerated manner) the play that the guidance rail 10 has in the perpendicular direction P and, consequently, also the fundamental mode of vibration. Because of the different distances d12, d23, ... it is evident that also these fundamental modes of graph 5 in Fig. 4 are (preferably) all different and that therefore no vibrational mode of the guidance rail 10 as a whole can be induced.

[0035] Fig. 5 schematically illustrates a guidance rail 20 according to another embodiment of the present invention.

[0036] In the guidance rail 20 of Fig. 5, two different distance values (e.g. designated as A and B) are defined for adjacent mounting sites 12-i, and the two different distance values A and B alternate regularly along the row of mounting sites 12-i. This means that d12=A, d23=B, d34=A, ... and so on. The ratio of adjacently applied distance values (here: the ratio of A:B) is between 1:1 and 1:5, preferably between 1:2 and 1:4, more preferably between 1:3 and 1:4. Although the guidance rail 20 of the embodiment of Fig. 5 (or any other embodiment with a larger number of regularly alternating distance values A, B, C, ...) will in general be more susceptible to vibrations than the still less regular embodiment of Fig. 4, it has the advantage that its manufacture may be easier, as also in the manufacturing, the present regularities can be exploited to reduce the manufacturing effort.

[0037] While detailed embodiments of the present invention are disclosed herein, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. In particular, features presented and described in separate dependent claims may be applied in combination and any advantageous combination of such claims are herewith disclosed.

[0038] It will be evident that the described embodiments may be varied in many ways. All such modifications as would be evident to one skilled in the art starting from what is explicitly described are intended to be included.

[0039] One basic idea of the invention may be summarized as follows: distances between mounting sites of a guidance rail for a print head carriage are provided non-equidistantly in order to reduce vibration modes and therefore reduce the chances and intensity of vibrations induced the in the guidance rail by the dynamic movement of the print head carriage.

List of reference signs

[0040]

1	guidance rail of the prior art
4	mounting site of the prior art
5	graph showing play of guidance rail
10	guidance rail
12	mounting site
12-i	mounting site
13	mounting element
14	runner block
15	cell
16-i	center position
20	guidance rail
100	printer
110	framework
150	print head carriage
L	longitudinal direction
P	perpendicular direction

Claims

1. A guidance rail (10; 20) for a print head carriage (150), having mounting sites (12-i) arranged essentially in a row and configured for applying mounting elements (13) for mounting the guidance rail (10; 20) to a printer (100),
characterized in that
at least two distances (d12, d23, d34) between any adjacent mounting sites (12-i, 12-(i+1)) are non-equal.

2. The guidance rail (10; 20) of claim 1,
wherein equidistant center positions (16-i) for the mounting sites (12-i) are defined, each mounting site (12-i) is arranged within a predefined tolerance interval around a respective one of the center positions (16-i), and the relative position of each mounting site (12-i) to the respective center position (16-i) is different for at least two of the mounting sites (12-i).

3. The guidance rail (10; 20) of claim 2,
wherein each mounting site (12-i) is randomly arranged within the predefined tolerance interval around its respective center position (16-i).

4. The guidance rail (10; 20) of any of claims 1 to 3,
wherein each distance (d12, d23) between any two adjacent mounting sites (12-1, 12-2) is different.

5. The guidance rail (10; 20) of claim 1,
wherein at least two different distance values (A, B) are defined for adjacent mounting sites (12-i), and wherein the at least two different distance values (A, B) alternate regularly along the row of mounting sites

(12-i).

6. The guidance rail (10; 20) of claim 5, wherein the ratio of adjacently applied distance values (A, B) is between 1:1 and 1:5, preferably between 1:2 and 1:4, more preferably between 1:3 and 1:4.

7. The guidance rail (10; 20) of any of claims 1 to 5, wherein the mounting sites (12-i) are configured as holes or bores through which mounting elements (13) for mounting the guidance rail (10; 20) to the printer (100) can be inserted.

8. A printer (100) comprising at least one guidance rail (10; 20) according to any of claims 1 to 7, the at least one guidance rail (10; 20) being mounted to the printer (100) by mounting elements (13) attached at the mounting sites (12-i) of the guidance rail (10; 20).

9. The printer (100) of claim 8, comprising a print head cartridge (150), wherein two guidance rails (10; 20) according to any of claims 1 to 7 are arranged in parallel, at least one runner block (16) is movably mounted on each guidance rail (10; 20), and the print head carriage(150) is mounted on the at least two runner blocks (16).

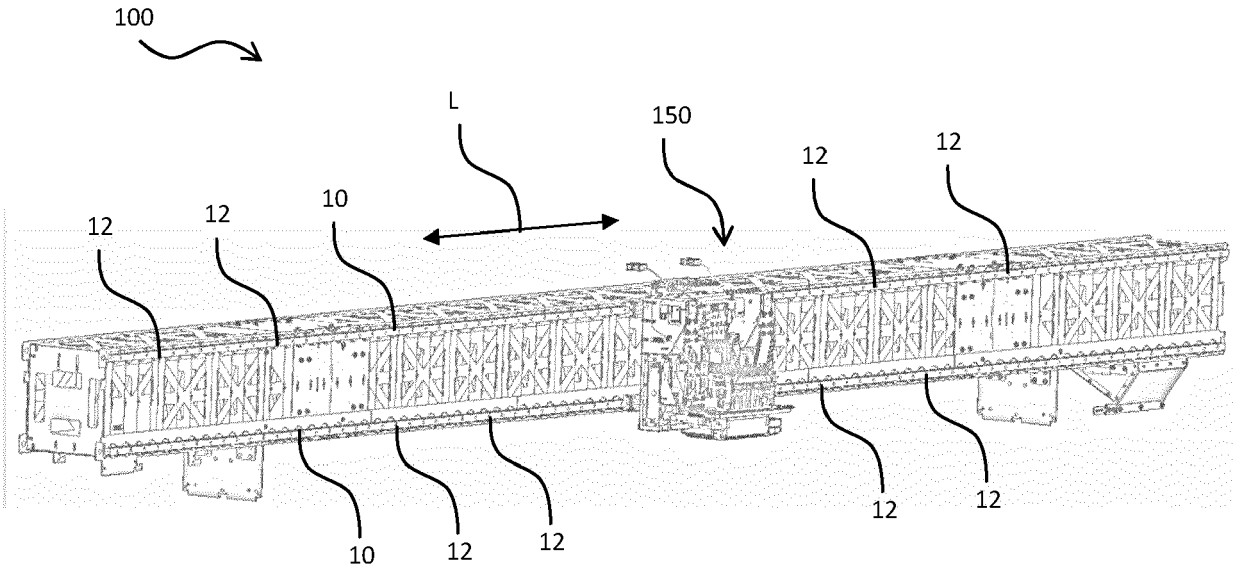

Fig. 1

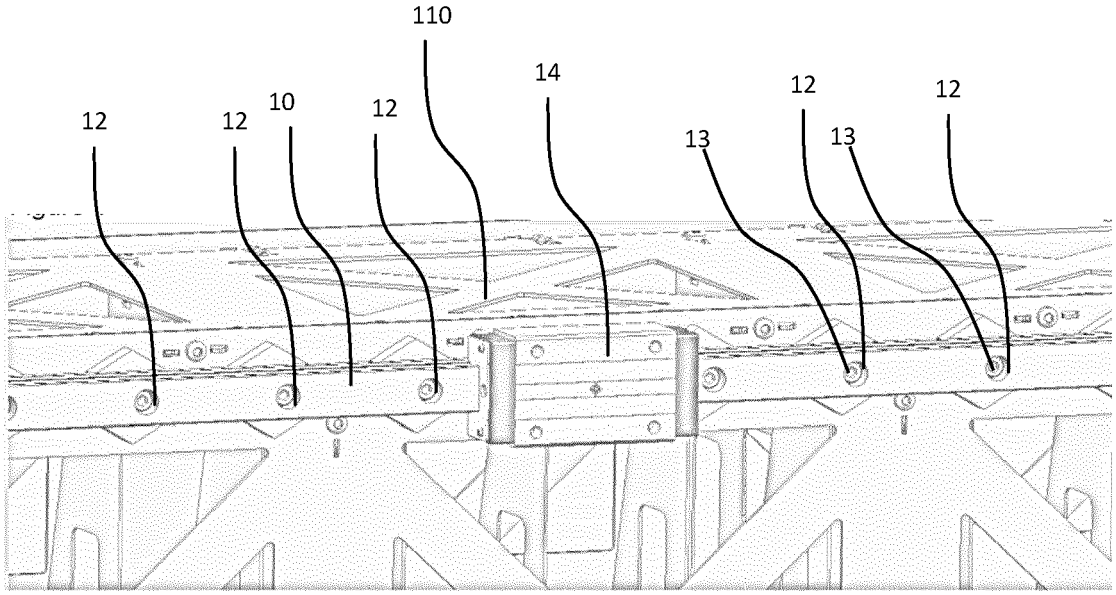

Fig. 2

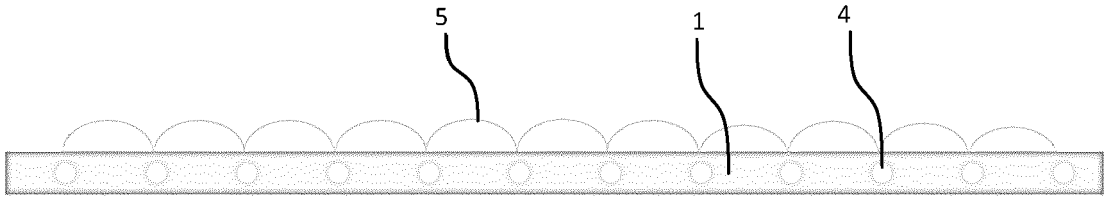

Fig. 3

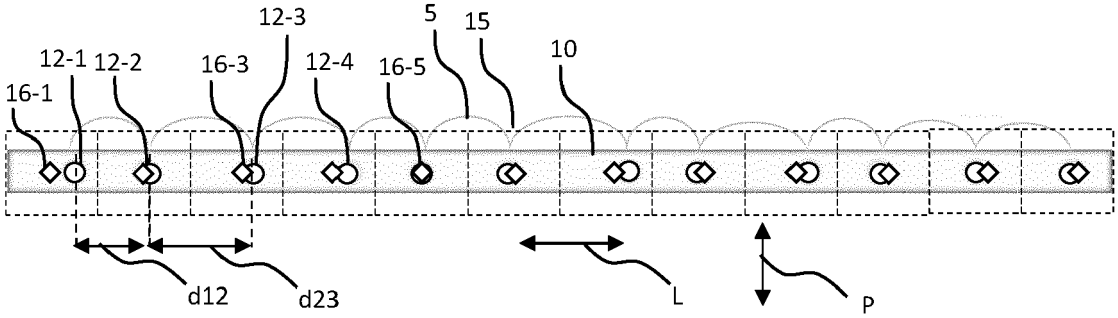

Fig. 4

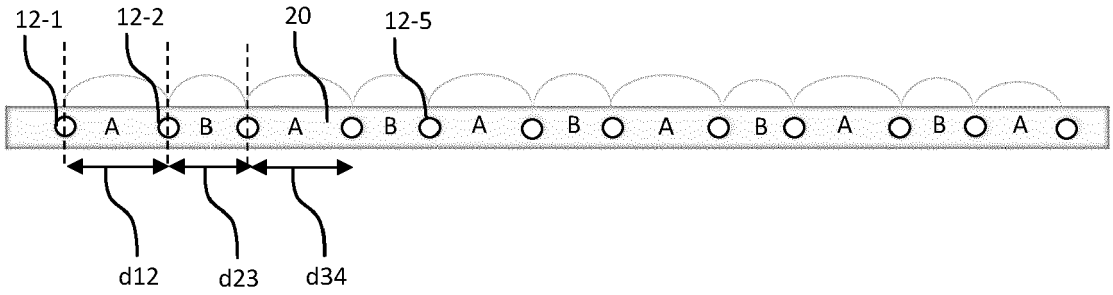

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 21 21 6158

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	US 2020/047527 A1 (ROSENBOOM FABIAN T [NL] ET AL) 13 February 2020 (2020-02-13) * figures 1-2 *	9	TECHNICAL FIELDS SEARCHED (IPC) B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11 May 2022	João, César

CATEGORY OF CITED DOCUMENTS

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