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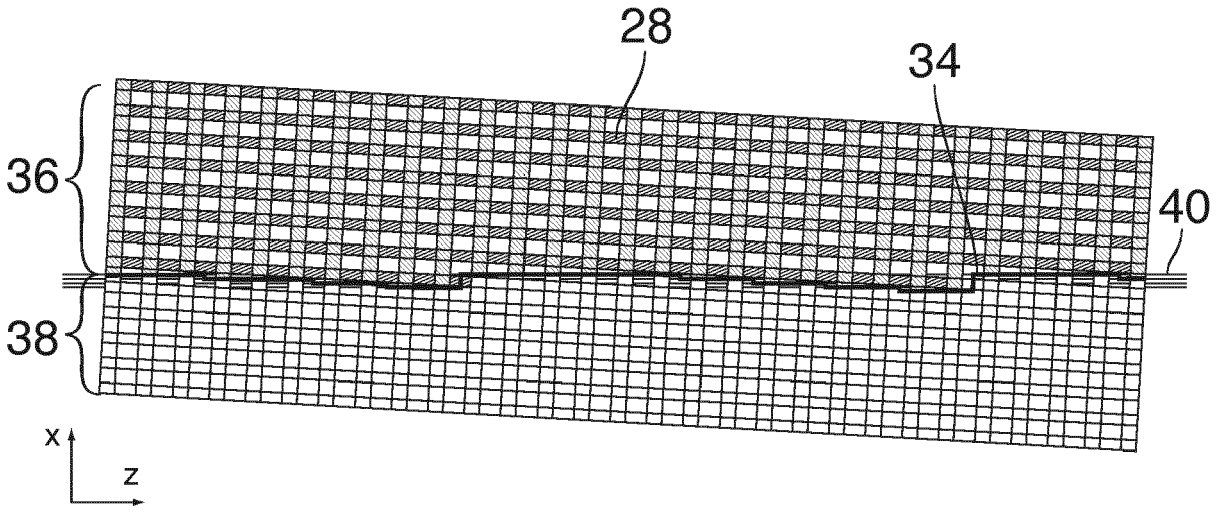
(54) **A METHOD FOR PRINTING SWATHS OF AN IMAGE ON A SUBSTRATE**

(57) A method of printing on a substrate (12) that has a texture in the form of repetitive surface features (28) extending in a predetermined direction, in which method a scanning-type printer is used for printing an image on the substrate in a plurality of successive and adjacent swaths (36, 38), characterized by a step of determining positions of a boundary (34) between the adjacent swaths such that the boundary (34) is aligned with said predetermined direction and has a predetermined spatial relationship to the repetitive surface features (28).

Fig. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The invention relates to a method of printing on a substrate that has a texture in the form of repetitive surface features extending in a predetermined direction, in which method a scanning-type printer is used for printing an image on the substrate in a plurality of successive and adjacent swaths.

[0002] More particularly, the invention relates to a method of printing on textile, wherein the textile fabric forms a repetitive structure wherein the warp yarns or the weft yarns can be considered as surface features that extend in a predetermined direction.

[0003] However, the invention is also applicable for printing on other structured media such as wood, for example, wherein the texture of the wood forms a repetitive pattern of darker and brighter stripes.

2. Description of the Related Art

[0004] As is well known in the art, a scanning-type printer typically has a carriage that is driven to move in a main scanning direction across a print surface on which the substrate is placed, and an advance mechanism controls a relative movement of the substrate and the carriage in a sub-scanning direction normal to the main scanning direction and relative to the path of travel of the carriage in the main scanning direction.

[0005] The carriage has at least one print head with a plurality of print elements aligned in the sub-scanning direction, so that a swath of an image can be printed in each scan pass of the carriage, with the width of the swath being determined by the number of successive print elements that are used for printing. Then, the substrate is advanced relative to the carriage by the width of the swath so that a next swath can be printed.

[0006] In order to avoid visible artefacts at the boundaries between adjacent swaths, it is important to control the advance of the substrate with high precision so that the swaths will neither overlap nor be separated by a gap.

[0007] In certain applications it is difficult, however, to control the advance of the substrate with sufficient accuracy, especially when the substrate has some resiliency as in the case of textiles.

[0008] It is an object of the invention to provide a printing method which permits to suppress visible artefacts at the boundaries between adjacent swaths.

SUMMARY OF THE INVENTION

[0009] In order to achieve this object, the method according to the invention is characterized by a step of determining a position of a boundary between adjacent swathes such that the boundary is aligned with said predetermined direction and has a predetermined spatial relationship to the repetitive surface features.

[0010] In this method, the positions of the boundaries may be selected such that they are formed in stripe-shaped areas of the repetitive surface features where defects such as gaps or overlaps are less visible than in other surface areas. This method thus prevents that the boundaries between adjacent swathes interfere with the texture in the form of repetitive surface features. Instead these boundaries are aligned with these features, making them indiscernible from each other.

[0011] For example, when printing on textile, the weft and warp yarns of the textile will frequently form a repetitive and regular pattern of voids between the threads. These voids are parts of the substrate that cannot be printed on. When the substrate is aligned such that the voids are aligned in the main scanning direction of the printer, it is possible to form the swath boundaries at positions which coincide with a line of voids in the textile. Along these lines, the optical density of the printed image will be low because the image is formed only on the threads but not on the voids there between. Consequently, defects at the swath boundaries are less visible than would be the case if the boundary would extend along a thread where the image density is high.

[0012] Similarly, in applications where the substrate is wood or the veneer or the like, the boundaries may be placed on a stripe-shaped area of the wood texture where the contrast between the substrate surface and the printed image is small, so that defects are difficult to perceive.

[0013] More specific optional features of the invention are indicated in the dependent claims.

[0014] The step of determining the positions of the boundaries may comprise a step of aligning the substrate on a print surface of the printer such that the stripe-shaped surface features extend in the main scanning direction of the printer.

[0015] In order to determine a suitable spatial relationship between the repetitive surface features on the substrate and the swath boundaries, it is possible to scan the surface of the substrate with an optical scanner before printing, so that the repetitive surface features can be identified in the scanned image by means of electronic image processing. It may also be necessary to obtain information on the height of the surface features to be able to accurately print ink by adjustment of the timing. This height is determined by combining scans of the surface taken from different angles, either by two scanners or by scanning the surface twice with a different angle.

[0016] The boundary between two adjacent swathes of the printed image does not have to be a straight line. Although each segment of the boundary has to extend in the main scanning direction, the position of the boundary in the sub-scanning direction may jump abruptly from one surface feature of the substrate to another. This is useful in order to avoid that the boundary crosses a surface feature where defects would be more visible, especially in the case that inevitable alignment errors have

resulted in a slightly skewed position of the substrate relative to the main scanning direction or in cases where the surface features on the substrate do not extend along perfectly straight lines but are slightly curved, as in the case of a wood texture.

[0017] The invention also relates to a printer, in particular an ink jet printer that is configured for carrying out the method described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Embodiment examples of the invention will now be described in conjunction with the drawings, wherein:

Fig. 1 is a schematic top plan view of an ink jet printer used for printing on a textile substrate;

Fig. 2 is an enlarged view of a portion of the textile substrate at a boundary between two adjacent swathes of a printed image; and

Fig. 3 is a view similar to Fig. 1, illustrating a method of printing on a substrate that has a repetitive pattern of line-shaped surface features.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] The present invention will now be described with reference to the accompanying drawings, wherein the same or similar elements are identified with the same reference numeral.

[0020] Fig. 1 shows an ink jet printer having a conveyer 10 in the form of an endless belt that may be driven to advance a print substrate 12 in a sub-scanning direction x relative to a gantry 14 that extends across the entire width of the conveyer. A carriage 16 is driven for reciprocating movement along the gantry 14 in a main scanning direction $\pm$z. A number of ink jet print heads 18 are mounted on the carriage 16 to face the top surface of the print substrate 12. Each print head 18 has a linear array of print elements 20 (nozzles) extending in the sub-scanning direction x.

[0021] An electronic controller 22 is provided for controlling the advance movement of the conveyer 10, the movements of the carriage 16 and the operations of the print elements 20 of the print heads 18.

[0022] When the carriage 16 moves in +z-direction, for example, the print elements 20 may be activated in accordance with image information of an image to be printed in order to print a swath of the image onto the substrate 12. The maximum width of the swath is given by the length of the array of print elements 20 in the sub-scanning direction. However, it is possible to print a swath with a smaller width by leaving one or more print elements and the ends of each array silent. When a swath of the image has been completed, the conveyer 10 is driven to advance the substrate 12 by the width of the swath in the sub-scanning direction x, and the carriage then moves in the opposite direction -z in order to print a subsequent swath of the image.

[0023] In the example shown, the carriage 16 has two optical scanners 24 disposed on opposite sides of the row of print heads 18. Thus, no matter whether the carriage 16 moves in +z-direction or -z-direction, one of the scanners 24 is always capable of scanning a swath of the print substrate 12 before the print elements 20 are activated for printing an image on that swath. In this case, the field of view of the scanners 24 in the sub-scanning direction x is larger than the maximum width of the swathes to be printed, but it is sufficient that an area around the swath boundary is in the field of view of the scanners. The optical images of the surface of the substrate 12 as captured by the scanners 24 are processed and analyzed in an image processor 26 within the controller 22.

[0024] In the example shown here, the print substrate 12 is a square sheet of a textile material having weft threads 28 and warp threads 30 with voids 32 being lift between each pair of adjacent threads. Further, in this example, the weft threads 28 and warp threads 30 are inclined at an angle of 45° relative to the edges of the square contour of the substrate 12. The substrate 12, on the other hand, has been placed on the conveyer 10 in an orientation rotated by 45°, so that not the edges of the substrate but the weft threads 28 extend (essentially) in the main scanning direction z.

[0025] During each scan pass of the carriage 16, the image processor 26 analyses the image captured by the leading one of the scanners 24 to detect the positions of the weft threads 28 and warp threads 30 in the portion of the substrate on which an image is going to be printed. On the basis of these positions, the controller 22 determines the position and shape of the boundaries of the swath that is going to be printed. It will be understood that a neighboring swath, on the top side of the gantry 14 in Fig. 1, has already been printed in the preceding scan pass, so that the boundary between that previous swath and the swath that is to be printed now is fixed already. However, there is still freedom of choice to determine the position and shape of the lower boundary in Fig. 1, i.e. the boundary between the present swath and the swath to be printed in the next scan pass.

[0026] The controller 22 determines the position and shape of that boundary so as to avoid the positions where a weft thread 28 is present. The print elements 20 will be controlled so as to print ink dots only on the weft threads 28 and the warp threads 30 of the substrate but not in the areas of the voids 32, because the ink jetted into the voids 32 would not be applied to the substrate 12 anyway, but would only stain the belt of the conveyer 10. Consequently, the boundaries between adjacent swaths of the image will be visible only on the warp threads 30, and the boundary line will be disrupted by the voids 32 and will consequently consist only of a series of non-connected small segments, each segment having only the width of a single warp thread 30.

[0027] This has the advantage that, in case that the width of the advance step performed by the conveyer 10

is not exactly equal to the width of the swath that has actually been printed, the resulting defects, such as a gap being left between the two swaths or an overlap of the two swaths, will hardly be visible, because these defects will also be present only on the warp threads 30 but not on the weft threads 28.

[0028] Fig. 2 illustrates a case where, due to an alignment error (which has been exaggerated in the drawing), the weft threads 28 are not exactly parallel to the main scanning direction z but form a small angle therewith. Fig. 2 further shows, as a bold line, a boundary 34 between a swath 36 that has just been printed and a swath 38 that is going to be printed next. Would the boundary 34 be a straight line, then the boundary would inevitably cross one or more of the weft threads 28 where any possible defects would be more visible. This is why, in this case, the boundary 34 has been determined to have a staircase shape constituted by segments that are offset relative to one another in the x-direction so as to avoid the positions of the weft threads 28.

[0029] Horizontal lines 40 in Fig. 2 indicate the x-positions of some of the print elements 20 of the print heads near the bottom end of the arrays in the swath 36. Naturally, the x-position of the boundary 34 can only vary in the raster of the lines 40. If one follows the boundary 34 in the direction from left to right in Fig. 2, it can be seen that, whenever the boundary 34 approaches one of the weft threads 28, it is shifted to the next lower line 40 so as to remain in the gap between the two neighboring weft threads. If the boundary cannot be lowered further, because the end of the array of print elements 20 has been reached, it "jumps" upwards into the next higher gap between the weft threads 28.

[0030] Fig. 3 illustrates an example where a substrate 12, e.g. a veneer, has a repetitive pattern of stripe-shaped surface features 42 that differ in color and/or brightness. An image to be printed on that substrate has, at least on the average, a relatively dark color, so that there is only little contrast between the image and the dark stripes of the surface features 42, whereas the contrast is significantly higher in the bright stripes of the surface features. Therefore, in order to reduce the visibility of any possible defects, the widths of swaths 44 - 54 to be printed in subsequent scan passes have been determined such that the boundaries 34 between these swaths are always located in the dark stripes. In the situation shown in Fig. 3, the swaths 44 and 46 have been printed already whereas the swath 48 is just in the process of being printed. Since the center line of the topmost dark stripe of the surface features 42 does not coincide with the top edge of the substrate 12', the first swath 44 has a larger width than the other swaths.

[0031] The width of the swath that is actually printed can always be adapted to the surface features 42 by appropriately selecting the number of print elements that contribute to the swath.

[0032] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A method of printing on a substrate (12; 12') that has a texture in the form of repetitive surface features (28; 42) extending in a predetermined direction, in which method a scanning-type printer is used for printing an image on the substrate in a plurality of successive and adjacent swaths (36, 38; 44-54), **characterized by** a step of dynamically determining a position of a boundary (34) between adjacent swaths such that the boundary (34) is aligned with said predetermined direction and has a predetermined spatial relationship to the repetitive surface features (28; 42).

2. The method according to claim 1, comprising a step of placing the substrate (12; 12') on a print surface (10) of the printer in an orientation in which said predetermined direction of the surface features (28; 42) is parallel with a main scanning direction (z) of the printer.

3. The method according to claim 2, wherein the positions of the swath boundaries (34) are determined by controlling print elements (20) of the printer, said print elements being arranged in an array that extends in a sub-scanning direction (x) normal to the main scanning direction (z) and by determining a number of print elements (20) in the array that are used for printing the swath.

4. The method according to claim 3, wherein the swath boundaries (34) are determined to have a staircase shape constituted by segments that are parallel with the main scanning direction and offset relative to one another in the sub-scanning direction (x).

5. The method according to any of the preceding claims, for printing on a substrate having parts that cannot be printed on (32) and that are aligned in said predetermined direction, wherein the boundaries (34) are determined so as to maximize a fraction of the boundary that extends over said substrate parts (32).

6. The method according to any of the claims 1 to 4, for printing on a substrate (12') that has stripe-shaped surface features (42) that differ in color and/or brightness, wherein the boundaries (34) are formed at positions with minimal contrast between image pixels to be printed at the boundary and the background on the surface of the substrate (12').

7. The method according to any of the claims 1 to 5, wherein furthermore a height of the surface features is determined in order to adapt the timing of the ink application for a more accurate landing of the ink drops.

8. A scanning-type printer comprising:

- a carriage (16) movable relative to a substrate (12; 12') in a main scanning direction (z) and having print elements (20) for printing on the substrate;
- an advance mechanism (10) controlling a relative movement of the carriage (16) and the substrate (12; 12') in a sub-scanning direction (x) normal the main scanning direction (z); and
- a controller (22) for controlling operations of the carriage (16), the print elements (20), and the advance mechanism (10),

characterized in that the controller (22) is configured to perform a method according to any of the claims 1 to 7.

9. The printer according to claim 8, comprising a scanner (24) arranged to san the substrate (12; 12') before an image is printed thereon.

10. The printer according to claim 9, wherein the scanner (24) is mounted on the carriage (16).

11. The printer according to claim 10, wherein two scanners (24) are mounted on the carriage (16) on opposite sides, in the main scanning direction (z), of an assembly of print heads (18) having the print elements (20).

12. A software product having program code on a machine-readable non-transitory medium, the program code, when run on a controller of a printer according to claim 8, causing the controller to perform a method according to any of the claims 1 to 7.

Fig. 1

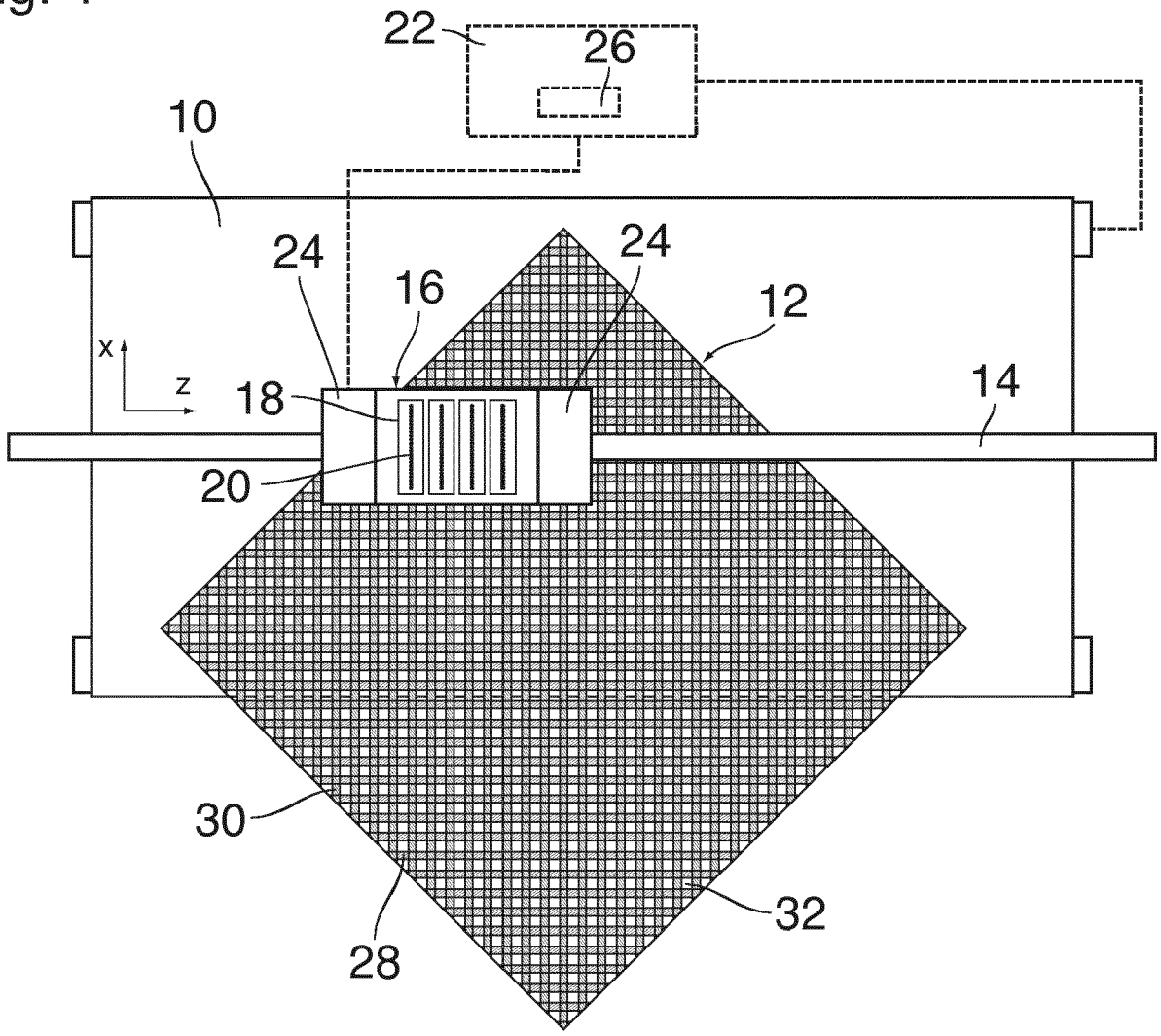


Fig. 2

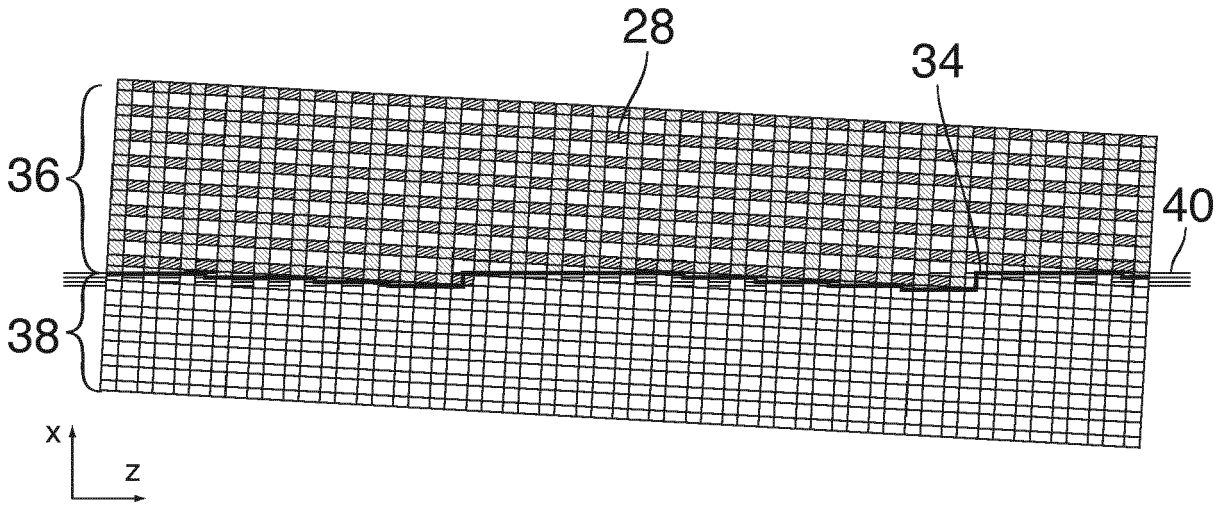
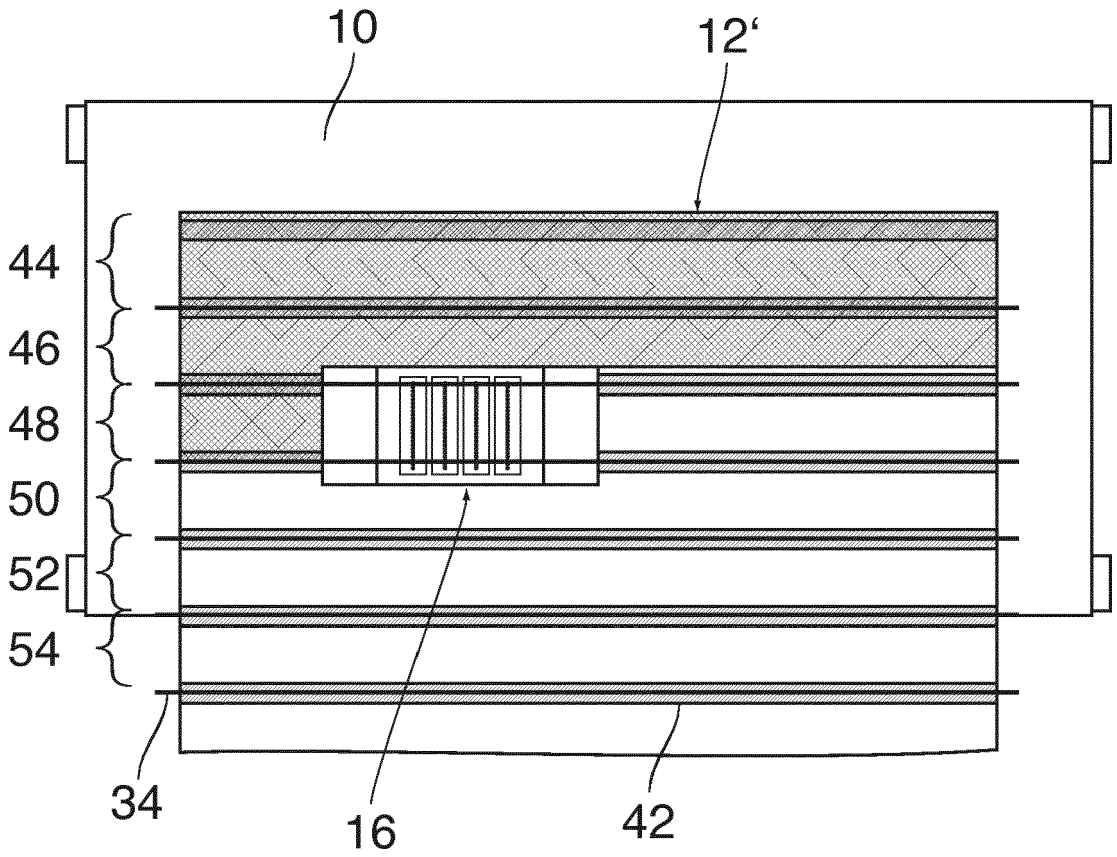


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 18 21 0373

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2017/043065 A1 (CANON KK [JP]) 16 March 2017 (2017-03-16) * figures 2-4 * * paragraph [0027] * * paragraph [0014] * * paragraph [0019] *	1-12	INV. B41J2/21 B41J3/407 B41J11/00 H04N1/00
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A	US 2004/179077 A1 (SAMII MOHAMMAD M [US] ET AL) 16 September 2004 (2004-09-16) * figures 19-20 * * paragraph [0097] - paragraph [0099] *	1-12	

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	17 April 2019	João, César

CATEGORY OF CITED DOCUMENTS

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