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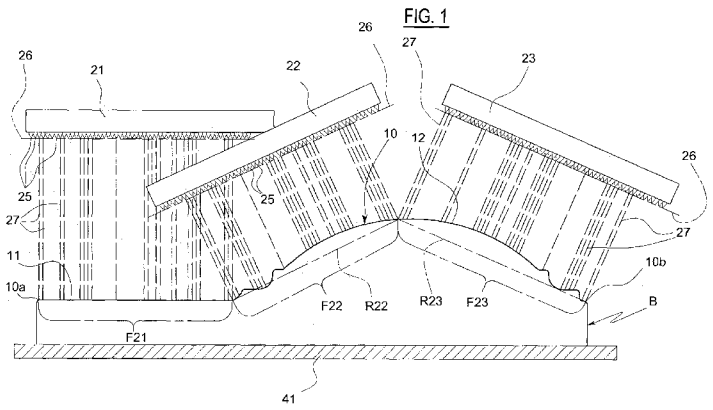
(54) **Title**: A DEVICE AND METHOD FOR INK-JET PRINTING ON SURFACES EXHIBITING RELIEFS OR RECESSES

FIG. 1



(57) **Abstract**: An ink-jet device (20) exhibits at least a group of printing heads (21, 22, 23) which are independent of one another, where each head (21, 22, 23) comprises a plurality of ejector nozzles (25) of ink, aligned to form a line of action (26), a direction of the ink jets (27) issued from the nozzles (25) being perpendicular to the line of action (26), the lines of action (26) of the heads being arranged, in a plan view, parallel to one another. The surface (10) to be printed is moved in relation to the printing device (20), in a transversal direction with respect to the direction of the lines of action (26), internally of a field of action of the device (20). Each head (21, 22, 23) is assigned a respective strip of action (F21, F22, F23) on the surface (10), such that together the heads of the group interest a whole transversal dimension of the surface (10) to be printed on, and each head (21, 22, 23) is arranged with such an inclination that the respective line of action (26) is orientated practically parallel to a mean line of inclination of a transversal profile of the portion (10) of surface subjected to the strip of action (F21, F22, F23) of the head. The method enables printing on surfaces by means of an ink-jet printing device, in particular for ceramic tiles or other modular elements exhibiting reliefs or recesses having heights or depths which are of a relatively large entity, providing results which up to now have not been obtained.

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A DEVICE AND METHOD FOR INK-JET PRINTING ON SURFACES EXHIBITING RELIEFS OR RECESSES

TECHNICAL FIELD

The present invention relates to a device and a method for ink-jet printing on surfaces exhibiting reliefs or recesses, in particular on surfaces to be decorated having at least a tract exhibiting a transversal tract with a geometric arc shape, substantially an arc of circumference, ellipse or parabola.

A typical application of the invention is for ceramic tiles or other like modular elements which might be combinable with tiles.

More in general, the invention is typically applicable in decoration of in-view surfaces which exhibit reliefs or recesses which may even be of considerable thickness or depth.

BACKGROUND ART

Ink-jet devices have been applied for some time, including in the sector of ceramic tiles, which comprise one or more printing heads; these heads are formed by a plurality of nozzles, located along at least a line, typically a straight line, which nozzles issue controlled jets of micro-drops of ink, collected from a well or a cartridge.

The printing head is commanded by an electronic processor which imparts a succession of printing commands to the various nozzles, according to the image to be obtained and the relative position between the head and the surface to be printed on, either activating or leaving the nozzles inactive.

During the printing process, the heads each exhibit at least a series of nozzles which are aligned according to a line of action and the surface to be printed on is translated below the printing heads, for example by placing the surface on a conveyor belt, where it has a lie that is perpendicular to the direction of the jets, while it advances along a transversal direction with respect to the alignment direction of the nozzles, staying within the lie plane;

the surface to be printed on passes entirely into the field of action of the nozzles such that the printing device can print on the whole useful surface.

In the case of colour printing, several printing heads are used in succession, each for a determined colour of which the desired final image is composed, and the above-described printing process is repeated by the various heads available for colour printing, each head being commanded autonomously by the software program according to the final image to be obtained.

A technical problem arises in a case in which the surface to be printed on exhibits reliefs or recesses. If the reliefs or recesses have a thickness or depth of considerable entity, the micro-drops of ink strike the surface at inclinations which are significantly different from point to point, and consequently produce different effects in terms of extension, shape and intensity of the sign produced on the surface by the micro-drop, with final results that are mostly disappointing and unacceptable in terms of quality.

This technical problem is obviated by the device and the ink-jet printing method according to the appended claims.

DISCLOSURE OF INVENTION

This problem is obviated with the device and method for ink-jet printing of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in detail in the following, with the aid of the accompanying figures of the drawings which illustrate a non-exclusive embodiment by way of example, and in which:

figure 1 is a schematic section of the surface to be printed on and the printing heads, in a vertical and transversal plane (perpendicular to the direction A of the reciprocal displacement between the surface and the device);

figure 2 is a schematic plan view from above of figure 1;

figure 3 is a plan view from above in detail of a printing device exhibiting four groups of heads, such as the device of figure 1;

figure 4 is a perspective view of the lower part of the device of figure 3.

BEST MODE FOR CARRYING OUT THE INVENTION

The method of the invention is for printing on surfaces 10 with reliefs or recesses, in particular for ceramic tiles or other like modular elements which can be combined with tiles.

The method is typically suitable for printing on surfaces 10 having a transversal profile maintained constant by displacing the section in the advancement direction A, parallel to the relative movement between the surface and the device; a classic case is the surface of an object obtained by extrusion.

The invention is typically for decorating the in-view surface of ceramic tiles known as structured, i.e. provided with recesses or reliefs, having at least a tract with a transversal profile in a geometric arc, preferably an arc of circumference, ellipse or parabola.

Obviously the invention is also applicable for decorating surfaces of other physical or chemical natures.

With reference to the figures of the drawings, 10 denotes in its entirety a surface to be printed on, for example a tile B, on which the printing device of the invention acts.

The illustrated surface 10 exhibits, in the transversal section, as represented in figure 1, a first end point 10a and a second end point 10b: the surface to be printed is the surface delimited between the points 10a and 10b. The surface comprises a substantially flat zone 11 and a relief zone 12, the transversal section of which exhibits a geometric arc; between the flat zone 11 and the relief zone 12 there is a concave zone, with respect to a straight line (not shown in the figures) passing through the point 10a and tangential to the relief zone 12.

Obviously the invention is applicable for operating on surfaces with a different shape from the one described herein above, i.e. having a non-constant transversal section, which exhibits reliefs and/or recesses of relevant entity.

The method comprises the use of an ink-jet printing device 20 having at least a group of printing heads 21, 22, 23, independent of one another, where each head comprises a plurality of ejector nozzles 25 able to issue jets 27 of

micro-drops of ink, which nozzles are aligned to form a line of action 26. The direction of the ink jets 27 emitted by the nozzles 25 is perpendicular to the line of action 26, and the lines of action 26 of the various heads 21, 22, 23 are arranged, according to the plan view (see figure 2) parallel to one another and staggered to one another such as to exhibit tracts of end that are parallel, two by two and flanked to one another.

In the example of figure 2, the head 22 is located in an intermediate transversal position between the heads 21, and 23; the head 21 exhibits an end portion 21b that is parallel to and flanked by a portion of end 22a of the head 22; the end portion 21b exhibits a second end portion 22b, parallel and flanked by an end portion 23a of the head 23.

A displacing means is provided for displacing the surface to be printed 10, destined to move the surface in relation to the printing device 20, in a longitudinal advancement direction (A) (transversal with respect to the direction of the lines of action 26), internally of the field of action of the device 20. For example, the displacing means is defined by a conveyor belt, with a horizontal-lie conveyor belt 41, able to move the tile B (and therefore the surface 10 thereof) in the field of action of the device 20.

The method comprises assigning to each head 21, 22, 23, a respective area of action on the part of the jets 27 exiting from the head, on the surface 10, such that the group of heads 21, 22, 23 interests the whole transversal dimension of the surface to be printed 10.

In detail, as illustrated in figures 1 and 2, the head 21 exhibits a strip of action F21 which develops over an indefinite length in a longitudinal direction (a direction which is parallel to the advancement direction A of the surface 10 with respect to the device 20), the width of which (dimension in the transversal plane) interests a portion of the width (dimension in a transversal plane) of the surface 10; similarly the head 22 exhibits a strip of action F22 and the head 23 exhibits a strip of action F23; the three strips of action are complementary to one another and together interest the whole surface 10 to be printed, without reciprocal superpositioning.

In the respective strip of action, each head issues micro-jets of ink 27 (denoted symbolically, with grey circles of much greater size than in reality, in figure 2) in the strip of action F21, F22, F23 thereof. The nozzles 25 which are active are denoted in figure 2 by a small circle barred with an x, while the inactive nozzles 25 are denoted with a small empty circle.

Normally, the length of the lines of action 26 of the heads is not used completely, in order to prevent superposing between the nozzles in the end tracts of the heads.

The method comprises arranging each head 21, 22, 23 with an inclination such that, in at least one of the heads the distances between the ejector nozzles 25 from the points of surface 10 struck thereby are different: in other words, the length of the ink jets 27 are different from the head; further, the respective line of action 26 is orientated, in the transversal vertical plane (as illustrated in figure 1), in a way which is more or less parallel to the mean inclination line (R22, R23), with respect to the horizontal plane, of the profile that is transversal to the portion of surface 10 subjected to the strip of action F21, F22, F23 of the head 21, 22, 23 itself.

For example, as illustrated in figure 1:

the line of action 26 of the head 21 is arranged with a zero angle of inclination as the respect strip of action F21 operates on a portion of surface (zone 11) the profile of which in the transversal plane is horizontal or more or less horizontal;

the line of action 26 of the head 22 is on the other hand inclined with respect to the horizontal line, parallel to a straight line R22 (imaginary) an inclination of which represents a mean of the inclinations of the (imaginary) lines tangential to the surface profile 10 in the portion subjected to the strip of action F22 produced by the head 22 itself;

the line of action 26 of the head 23 is also inclined with respect to the horizontal line, parallel to a straight line R23 (imaginary) an inclination of which represents a mean of the inclinations of the (imaginary) lines tangential

to the surface 10 in the portion subjected to the strip of action F23 produced by the head 23 itself.

The tract of surface 12 having a section with an arc profile is shared between at least two consecutive strips of action (F22, F23).

The described method enables printing, via an ink-jet printing device, on surfaces, in particular of ceramic tiles or other modular elements, having reliefs or recesses exhibiting rises or respective depths that are relatively large, obtaining results that up to now have not been available.

This is because the ink jets 27 issued by the heads 21, 22, 23 are able to strike the various transversal portions of surfaces 10 in a differentiated way, each at optimal angles (i.e. perpendicularly), or practically so.

Figures 3 and 4 illustrate an embodiment of the printing device 20 in a version comprising four groups G1, G2, G3 and G4 of heads 21, 22, 23, each group G having the above-described characteristics with reference to figures 1 and 2, in particular in order to enable printing with four different colours.

The device 20 exhibits a support frame 3 having a fixed horizontal plate 30 arranged substantially parallel to the upper surface of the conveyor belt 41. All the heads 21, 22, 23 of the four groups G are fixed to the surface of the plate 30.

Each group G is formed by heads 21, 22, 23 reciprocally arranged as illustrated with reference to figures 1 and 2, i.e., briefly, with each head comprising a plurality of ejector nozzles 25 aligned to form a line of action 26, the direction of the ink jets 27 issued by the nozzles 25 being perpendicular to the line of action 26, and the lines of action 26 of the heads being arranged, according to the plan view, parallel to one another and reciprocally staggered such as to exhibit end tracts in twos that are parallel and flanked to one another.

The heads 21, 22, 23 are fixed to the plate 30 at openings in the plate 30 which enable the heads to exhibit the nozzles 25 thereof on the lower surface of the plate 30, facing downwards.

The heads 21 of the four groups G are aligned with one another in a longitudinal direction (parallel to direction A) and are fixed to a portion 31 of plate 30, which is fixed.

The heads 22 of the four groups G are aligned with one another in a horizontal and transversal direction and are fixed to a mobile portion 32 of plate (this portion is indicated by a series of crossed, horizontal and vertical lines in figure 3) which is separated from the fixed portion 31; similarly the heads 23 of the four groups G are aligned with one another in a horizontal and transversal direction and are fixed to a mobile portion 33 of plate (this portion is indicated by a series of crossed and 45°-inclined lines in figure 3) which is separated from the fixed portion 31.

The portion 32 is constrained, by hinge pins 42, to the fixed portion 31 such as to be able to oscillate about a horizontal and transversal rotation axis (parallel to the advancement direction A) defined by the pins 42; similarly, the portion 33 is constrained by hinge pins 43 to the fixed portion 31 such as to be able to oscillate about a horizontal and longitudinal rotation axis (parallel to the advancement direction A) defined by the pins 43.

The inclination of the portion 32 of plate can be varied such as to arrange the four heads 22, located on the same portion of plate 32, each having an inclination such as to respect the above-cited criterion relating to the head 22 of figure 1, i.e. with the respective line of action 26 orientated, in the transversal vertical plane (as illustrated in figure 1) such as to be practically parallel to the mean line of inclination, with respect to the horizontal plane, of the transversal profile of the portion 10 of surface subjected to the strip of action F22 of the head 22 itself.

The same is true for the portion 33 of plate, the inclination of which can be varied to arrange the four heads 23, located on the same portion 33 of plate 33, each having an inclination which is such as to respect the above-cited criterion in relation to the head 22.

The movement of the surface 10 with respect to the device 20 is such as to bring each transversal section of surface below the action of each group G of heads 21, 22, 23 in succession.

Obviously numerous modifications of a practical-applicational nature can be brought to the invention without its forsaking the ambit of the inventive idea as claimed herein below.

CLAIMS

1). A method for ink-jet printing, comprising:

providing an ink-jet printing device (20) having at least a group of printing heads (21, 22, 23) which are independent of one another, where each head (21, 22, 23) comprises a plurality of ejector nozzles (25) of ink, aligned to form a line of action (26), a direction of the ink jets (27) issued from the nozzles (25) being substantially perpendicular to the line of action (26);

subjecting objects having a surface (10) to be decorated exhibiting reliefs and/or recesses to the action of the printing device (20),

moving a surface (10) to be printed on in relation to the printing device (20), in an advancement direction (A) which is perpendicular to the direction of the lines of action (26), internally of the field of action of the device (20);

assigning each head (21, 22, 23) with a respective strip of action (F21, F22, F23) on the surface (10), such that together the heads of the group interest a whole transversal dimension of the surface (10) to be printed;

arranging the heads (21, 22, 23) with such an inclination that, in at least one thereof, the distances between the ejector nozzles (25) from the points of the surface (10) to be struck are different, and the respective line of action (26) is orientated practically parallel to a mean line of inclination of a transversal profile of the portion (10) of surface subjected to the strip of action (F21, F22, F23) of the head.

2). The method of claim 1, characterised in that the objects to be subjected to the action of the printing device (20) have surfaces (10) to be decorated having at least a tract with a profile that is transversal and in a geometric arc, preferably an arc of circumference, ellipse or parabola.

3). The method of claim 2, wherein the tract with an arc of profile is shared between at least two strips of action (F21, F22, F23) that are consecutive.

4). The method of claim 1, wherein a mean inclination (R22, R23) of the strip of action (F21, F22, F23) is identified by a line uniting two end points of the profile of the transversal section of the surface (10).

5). An inkjet printing device for realising the method of the preceding claims, operating on objects having surfaces exhibiting reliefs or recesses, the objects being activated to translate with respect to the device having the advancement direction (A), characterised in that it comprises:

at least a group (G1, G2, G3, G4) of printing heads (21, 22, 23), independent of one another, in which each head (21, 22, 23) comprises a plurality of nozzles (25) for ejecting ink, aligned to form a line of action (26), a direction of the ink jets (27) issued by the nozzles (25) being perpendicular to the line of action (26);

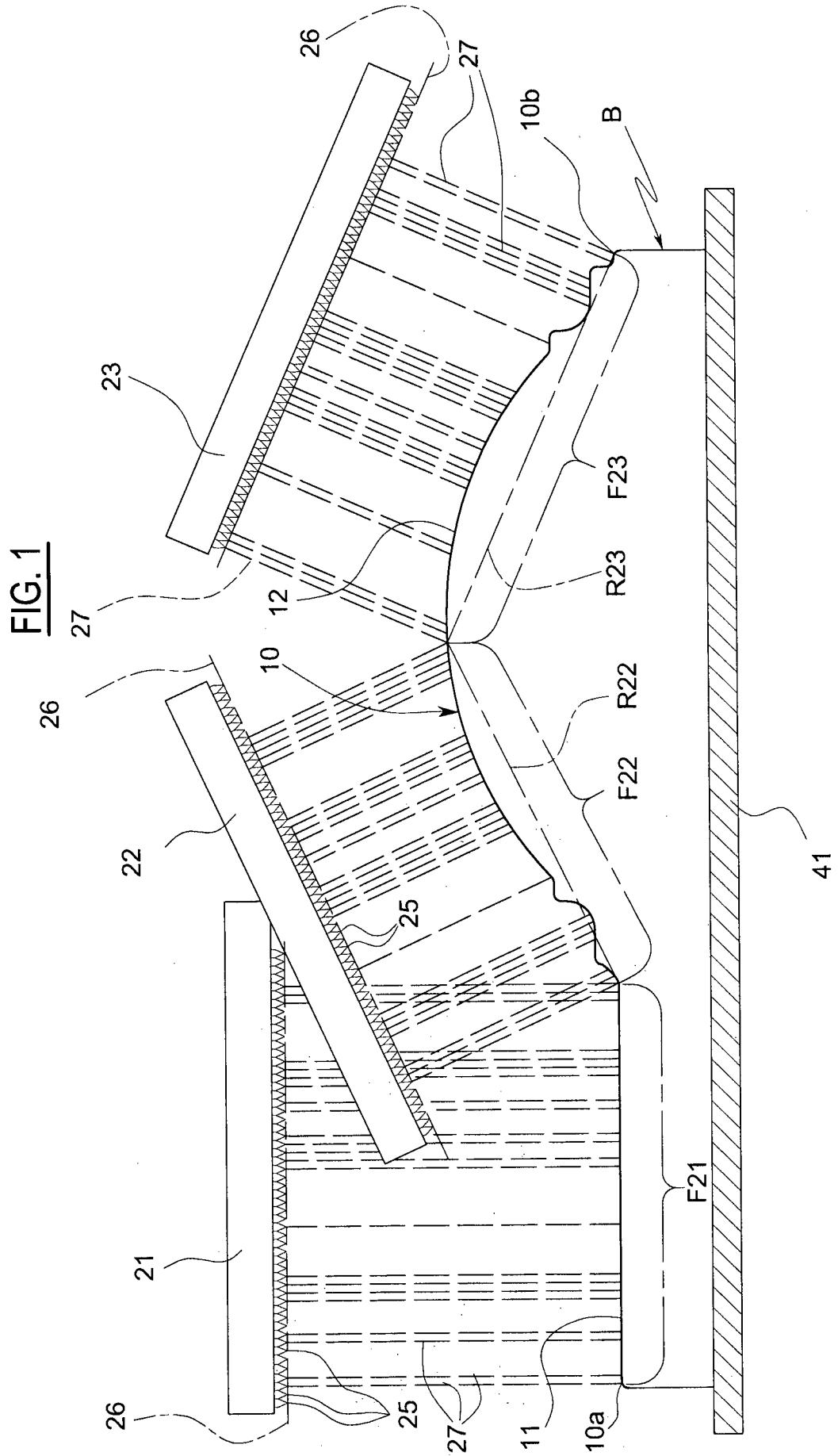
each printing head (21, 22, 23) having a respective strip of action (F21, F22, F23) on the surface to be printed, such that together the printing heads (21, 22, 23) of the group interest a whole transversal dimension of the surface (10) to be printed,

the heads (21, 22, 23) being orientated with an inclination which is such that in at least one thereof the distance between the ejector nozzles (25) from the points of the surface (10) struck thereby are different, and the respective line of action (26) is orientated practically parallel to the mean line of inclination of the surface (10) subjected to the strip of action (F21, F22, F23) of the head.

6). The device of claim 5, characterised in that the heads (21, 22, 23) are orientable with a variable inclination according to a rotation axis which is parallel to the advancement direction (A) of the surface (10) with respect to the device, such that the respective line of action (26) is orientated practically parallel to the mean line of inclination of the surface (10) subjected to the strip of action (F21, F22, F23) of the head.

7). The device of claim 5, characterised in that the printing heads (21, 22, 23) are staggered with respect to one another such as to exhibit end tracts which are two-by-two, parallel and flanked to one another.

FIG. 1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10a

FIG. 2

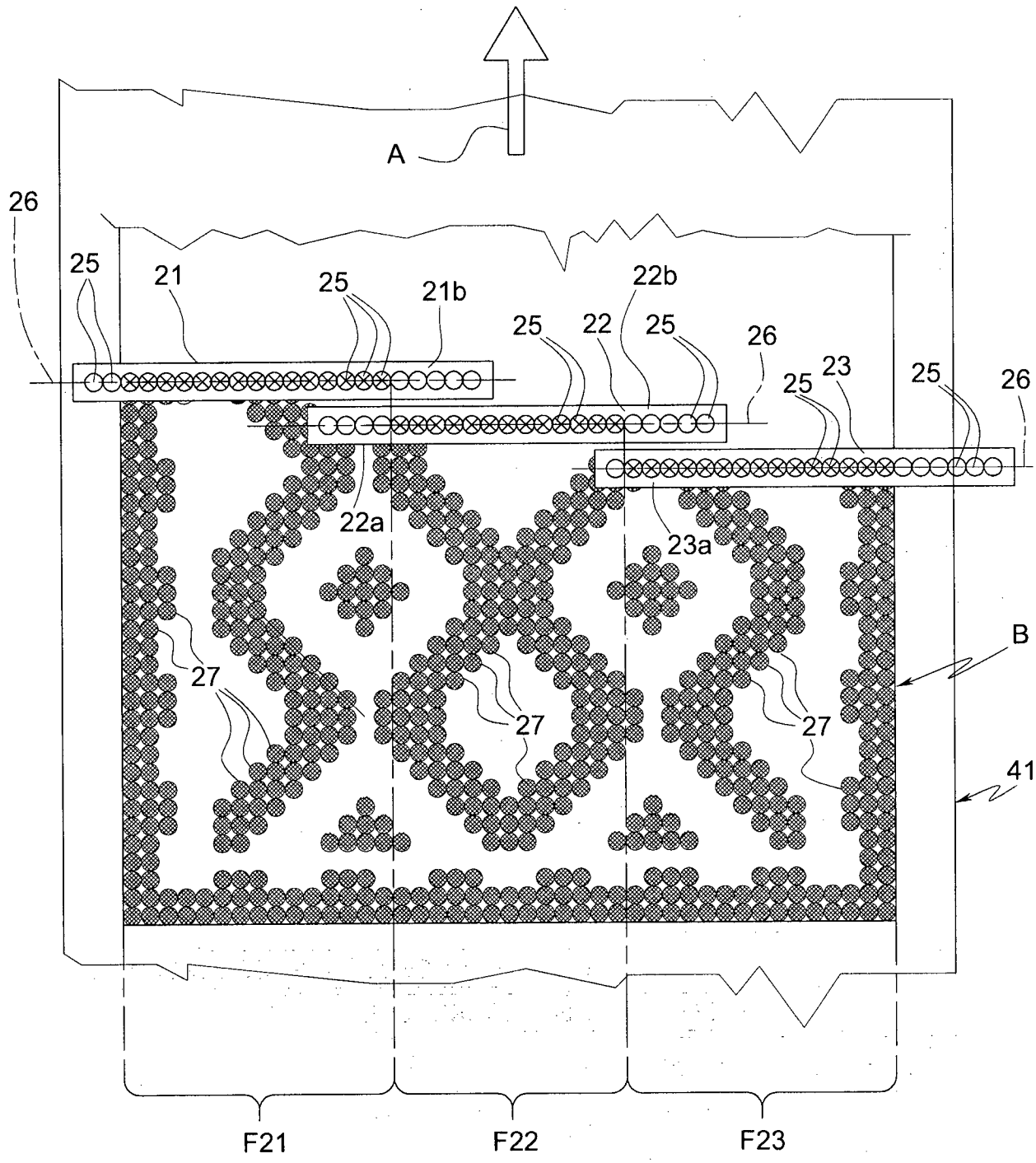
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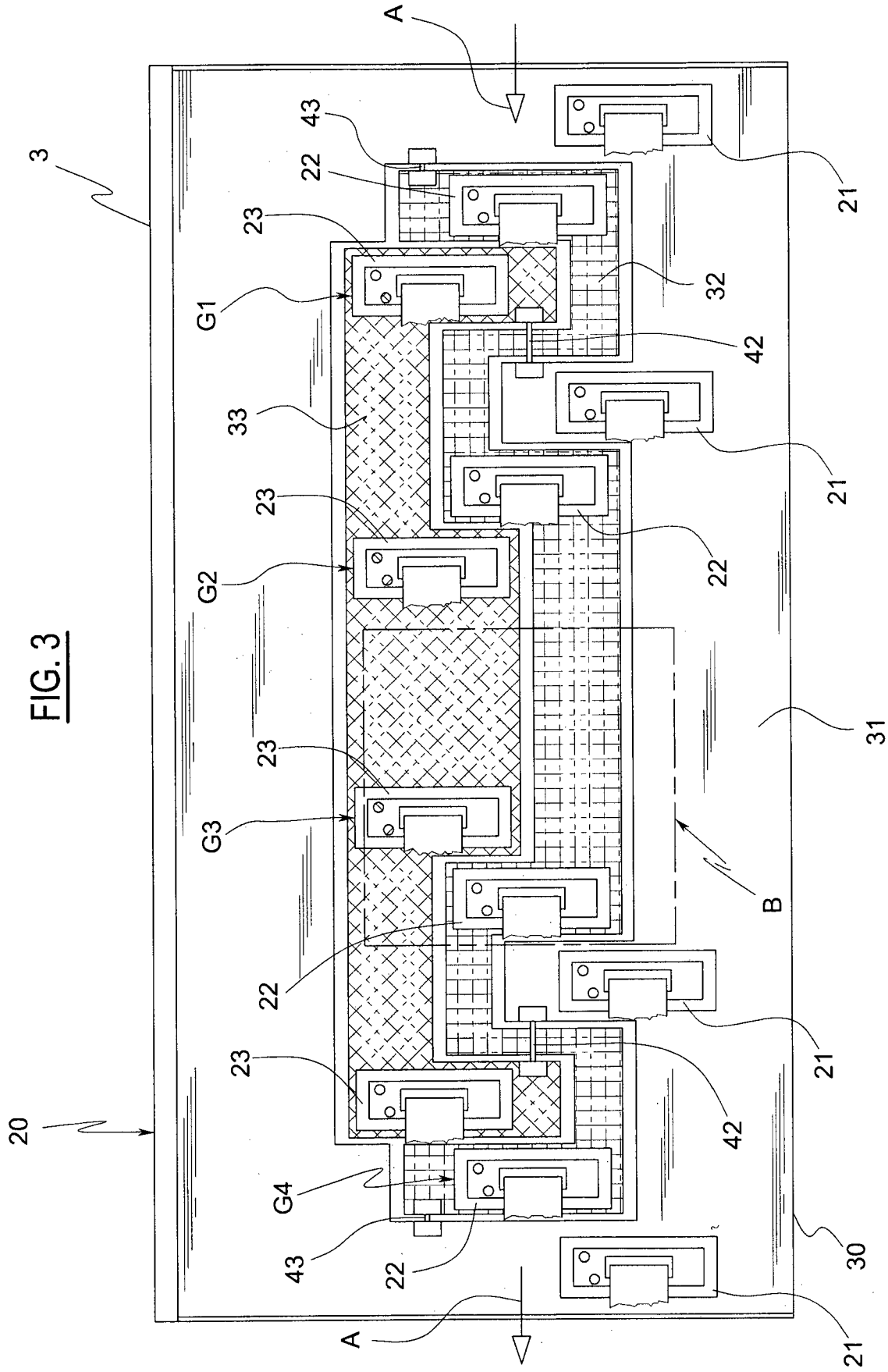
FIG. 3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G2
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G3
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G4
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A
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FIG. 4