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(54) **METHOD FOR THE DIGITAL PRINTING OF IMAGES ON GLASS AND SYSTEM USING SAID PRINTING METHOD**

(57) The invention is a method for the digital printing of words and/or images on a glass pane (V) by means of dedicated software that interprets digital information recorded on special memory supports which define the words and/or images to be printed and controls an ink jet printing head, the digital printing of the words and/or images being obtained by superimposing a plurality of printing surfaces (1; 2) on each other through the following operations: preparing each printing surface (1; 2) by

printing a plurality of coplanar printing strips (1a; 2a) placed side by side, wherein each printing strip (1a; 2a) is in contact with the adjacent printing strip along a common longitudinal edge (1b; 2b); superimposing the printing surfaces (1; 2) in such a way that each common longitudinal edge (1b; 2b) belonging to any of the printing surfaces (1; 2) is arranged facing and in contact with a printing strip (1a; 2a) belonging to the overlying and/or underlying printing surface (1; 2).

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Description

[0001] The invention concerns a method for the digital printing of images on glass. The invention concerns also a system which carries out said digital printing using said method.

[0002] As is known, the process of digital printing on glass is a technology that uses dedicated software which reads the information related to images stored in digital supports and manages an ink jet printer which prints said images on a glass substrate.

[0003] A system implementing said printing process substantially comprises a work surface on which the glass pane to be printed is positioned and a printing head provided with a plurality of spray heads designed to spray inks of different colours.

[0004] Spraying inks of different colours combined with one another makes it possible to obtain the composite colours of the images stored in the digital support.

[0005] The work surface is usually constituted by a suctioned surface on which the glass pane is fixed through negative pressure, while the printing head is associated with Cartesian linear guides along which it is moved by drive means.

[0006] The printing head is then moved according to a Cartesian movement and carries out the printing operation on the underlying glass pane, covering it with strips that are laid adjacent to one another.

[0007] Each strip thus constitutes a part of the final image, in the colour defined by the colour combination created by the ink jet heads which are selected by the dedicated software during the printing process.

[0008] One of the problems found during printing is constituted by the fact that ink, especially when laid forming a thick layer, tends to spread spontaneously and to expand beyond the perimeter of the drawing or the figure and once the drying process has been completed the printed image is scarcely defined and has blurs along its perimeter edge.

[0009] In the attempt to eliminate said problem and thus obtain high quality prints, methods have been conceived according to which the image is printed by superimposing several printing layers, each having a thickness that is proportionally reduced with respect to the total thickness, so that each layer dries before the successive layer is laid down.

[0010] In this way each layer, being laid with a thin thickness, dries rapidly without spreading beyond the perimeter of the image and substantially serves the function of a primer, which favours the gripping and stabilization of the successive ink layer superimposed to it.

[0011] According to a known printing method, the software reads the information stored in the digital supports and manages the printing head in such a way that the image or images to be printed is/are composed by covering the surface of the glass pane with a plurality of printing strips, where each strip covers part of the previously laid strip and in turn is partially covered by the suc-

cessive strip. This situation is schematically represented by way of example in Figure 1, in which it is supposed that the image be printed on the underlying glass pane **V** using printing strips arranged crosswise with respect to the glass pane along the transverse axis **X** and partially superimposed on each other in bands moving along the longitudinal axis **Y** orthogonal to the transverse axis **X**.

[0012] In the situation shown in Figure 1, in order to make it easier to understand the printing process that is described here below, the printing strips are shown slightly staggered with respect to one another.

[0013] Therefore, supposing to compose the print by superimposing three printing strips, each strip will be defined with a quantity of ink equal to 1/3 of the total quantity.

[0014] According to the process, the first strip **a** is printed, the second strip **b** is partially superimposed on it and the third strip **c** is partially superimposed on the latter, spacing the strips from one another according to the longitudinal direction **Y** by a pitch **p** equal to 1/3 of the width of each strip.

[0015] Once the printing of the third strip **c** has been completed, the superimposed strip **s**, which derives from the superimposition of the common sections of strips **a**, **b**, **c**, will have the desired thickness, equal to the sum of the thicknesses of the three strips **a**, **b**, **c**.

[0016] The process is then repeated by printing again, in the same superimposition succession and with the same criterion, further strips **d**, **e**, **f** and so on, which are represented in Figure 2.

[0017] For each strip laid, a superimposed strip **s'**, **s''**, **s'''** is obtained, whose thickness is equal to the sum of the thicknesses of three strips and equal to the thickness of the superimposed strip **s** previously obtained.

[0018] The printing operation continues in a repetitive manner according to the criterion described above, until covering the surface of the glass pane **V** completely, and at the end of the process a print will be obtained which results from the superimposition of three printing surfaces, each one of which has a thickness equal to 1/3 of the total thickness of the final print.

[0019] This printing method, however, poses the drawback that the printing time of each strip is rather short and therefore it occurs that a strip is printed when the ink of the underlying strip has not dried completely yet.

[0020] In this case the "primer" effect described above cannot be obtained, or it can be obtained to a very limited degree, and consequently the quality of the final print is not improved significantly.

[0021] The document US 2017/107388 A1 describes an ink composition comprising a component that is suited to polymerize under the action of UV rays for printing images on various materials, among which glass, and also describes a printing system in which a printing head is moved with respect to a support according to a Cartesian system.

[0022] The document US 2013/222498 A1 describes a digital printer for glass panes comprising means for moving a printing head according to a Cartesian system.

The present invention, therefore, intends to solve the problem illustrated above by providing a method for the digital printing of words and/or images on glass which, compared to the prior art, significantly reduces the presence of blurs along the edge that delimits said words or images.

[0023] It is also an object of the invention to provide a system that can print digitally on glass using the above mentioned method.

[0024] Advantageously, said method improves the overall quality of glass printing compared to the known methods, since it makes it possible to obtain sharper and more defined images.

[0025] The objects and advantages listed above are highlighted in greater detail below, in the descriptions of the printing method and of the system using said method which constitute both the subject of the present invention; these descriptions are provided by way of non-limiting example with reference to the attached drawings, wherein:

- Figures 1 and 2 schematically show a printing method known in the art;
- Figures from 3 to 7 show the successive steps of the printing method that is the subject of the invention;
- Figures from 8 to 10 show different views of the printing system using the printing method of the invention, which also constitutes the subject of the invention.

[0026] The method that is the subject of the invention makes it possible to digitally print words and/or images on a glass pane which is schematically represented in Figure 3, where it is indicated as a whole by **V**, by means of an ink jet printing head.

[0027] The printing method uses dedicated software which is configured to interpret digital information recorded in apposite memory supports and defining the words and/or images to be printed, and to control the printing head in order to print said words and/or images on the glass pane **V**.

[0028] According to the invention, the digital printing of the words and/or images is obtained by superimposing a plurality of printing surfaces **1; 2** on each other and requires the following operations:

- preparing each printing surface **1; 2** by printing a plurality of coplanar printing strips **1a; 2a** placed side by side, wherein each printing strip **1a; 2a** belonging to a printing surface **1; 2** is in contact with the adjacent printing strip along a common longitudinal edge **1b; 2b**;
- superimposing the printing surfaces **1; 2** in such a way that each common longitudinal edge **1b; 2b** belonging to any of the printing surfaces **1; 2** is arranged facing and in contact with a printing strip **1a; 2a** belonging to the overlying and/or underlying printing surface **1; 2**.

[0029] By way of example, Figure 3 shows two printing surfaces of the glass pane **V** which are respectively indicated by the reference numerals **1** and **2** and are shown slightly staggered with respect to each other in order to make the drawing easier to understand, and each one of which is obtained by means of printing strips, respectively **1a** and **2a**, wherein the printing strips of the same printing surface are in contact with each other along a common edge, respectively **1b** and **2b**.

[0030] Furthermore, it should be noted that each common edge **1b** and **2b** is facing and in contact with the printing strip belonging to the adjacent printing surface. Described in detail, the method of the invention comprises a plurality of preparatory operations which are carried out before printing the printing surfaces digitally.

[0031] These preparatory operations are illustrated in Figure 4 and start with the positioning of the glass pane **V** on a work surface **3** where a Cartesian reference system is defined which is constituted by a first axis **X** and a second axis **Y**.

[0032] An initial reference point is then defined, for example the origin **O** of the Cartesian reference system and thus the point of intersection of the axes **X** and **Y**, however any other point different from the origin **O** can be selected as initial reference point.

[0033] Then, the printing head is positioned at the level of the initial reference point **O** shown in Figure 4 and is moved forward along one of the axes, for example along the first axis **X**, to print a printing strip **1a** with width **1c**, as shown in Figure 4.

[0034] Then, the printing head is repositioned at the level of the initial reference point **O** and moved along the second axis **Y** by a pitch equal to the width **1c** of the previous printing strip **1a**.

[0035] The printing head is then moved forward once again, along the direction of the first axis **X**, to obtain another printing strip **1a**, as can be observed in Figure 5, wherein said printing strip, given that the pitch and the width **1c** of the previously printed printing strip **1a** are the same, will be adjacent to and in contact with the latter along the common edge **1b**.

[0036] By repeating the operations described above, that is, by making the printing head advance, repositioning it and moving it forward again several times, it is possible to print a plurality of printing strips **1a** which are positioned side by side and in contact two by two along the common edge **1b**, until completing the printing surface **1**, as shown in Figure 6.

[0037] The operations described above are then repeated to obtain another printing surface **2** superimposed on the previous one and equally made up of a plurality of printing strips **2a**, as can be observed in Figure 7, however each time it is necessary to take care to reposition the printing head, which was moved along the axis **Y** and with respect to the initial reference point **O** at a distance **4** shorter than the width **1c** of the printing strip **1a**, as can be observed in Figure 7.

[0038] In this way, each common contact edge **1b** be-

tween the printing strips **1a** of the printing surface **1** will be covered by a respective printing strip **2a** of the overlying printing surface **2** and in the same way each common contact edge **2b** between the printing strips **2a** of the overlying printing surface **2** will be in contact with a corresponding printing strip **1a** of the underlying printing surface **1**.

[0039] The same situation represented in Figure 3 is thus obtained.

[0040] Obviously, the user can decide the number of printing surfaces which he intends to use to print the image on the glass pane **V** and conveniently distribute the total thickness of the ink used for the final image among the various printing surfaces.

[0041] Differently from the known art, therefore, the time necessary to obtain the printing surface **1** is sufficiently long to ensure that, in combination with the limited thickness of the ink used to print said printing surface **1**, each printing strip **2a** of the overlying printing surface **2** is laid over underlying printing strips **1a** that are already dry.

[0042] In this way, each printing surface serves as a primer for the printing surface that is placed over it and this makes it possible to eliminate almost completely the presence of blurs along the edge that delimits the words and/or images to be printed.

[0043] The method of the invention thus achieves the object of the invention to significantly improve the quality of the final print.

[0044] Preferably but not necessarily, all the printing strips that define the same printing surface have the same print thickness and all the printing surfaces are defined by printing strips that have the same print thickness.

[0045] According to another embodiment, one or more of said printing surfaces are defined by printing strips having different print thicknesses compared to the printing strips that define the adjacent printing surface.

[0046] Generally, the number of printing surfaces and the thickness of the ink with which each of them is printed are selected by the operator in order to optimize the quality of the final print.

[0047] The digital printing method described above is implemented in a system for the digital printing of images and/or drawings and/or words on glass panes which is illustrated as a whole in the axonometric view of Figure 8 and in the detailed views of Figures 9 and 10, where it is indicated as a whole by **50**. The system comprises a work surface **51** configured to support a glass pane **V** suited to be digitally printed with said images and/or words and/or said drawings which are printed thereon by means of a printing head **52** provided with ink jet spray heads **52a**.

[0048] The glass pane **V** is placed in the desired printing position through optical means **53**, preferably but not necessarily laser emitters, which are associated with the printing head **52**, as can be observed in Figure 9.

[0049] Above and coplanar with the glass pane **V** and thus with the work surface **51** that supports it, there is a

Cartesian structure **54** comprising one pair of parallel longitudinal ways **55** spaced from each other and a transversal carriage **56** supported at its ends by the longitudinal ways **55** and in turn supporting the printing head **52**.

[0050] Furthermore, the system is provided with drive means designed to move the transversal carriage **56** along the longitudinal ways **55** that define the longitudinal axis **Y** and the printing head **52** along the transversal carriage **56** that defines the transverse axis **X**.

[0051] The transversal carriage **56** is associated with drying means **59** which are arranged along the transversal carriage **56** and are preferably but not necessarily constituted by infrared lamps.

[0052] The drying means **59** occupy the whole width of the work surface **51** along the transverse axis **X** and during the movement of the transversal carriage **56** along the longitudinal ways **55** dry the ink that has been laid on the glass pane **V**.

[0053] Operatively, therefore, the transverse drive means move the printing head **52** according to the transverse axis **X** to print each printing strip **1a**, **2a** on the glass pane **V**, while the longitudinal moving means move the transversal carriage **56** according to the longitudinal axis **Y** to arrange the printing strips one after the other according to the direction defined by said longitudinal axis **Y** until the glass pane **V** has been completely covered according to the described method.

[0054] Furthermore, before starting the printing operations, the combination of the movements produced by the transverse and longitudinal drive means **57** makes it possible to manoeuvre the optical means **53** to position the glass pane **V** correctly in the desired operating position and to define the coordinates of the initial reference point **O**.

[0055] A numerical control device, not shown in the figures, manages the printing process through dedicated software which reads the information related to the words and/or images to be printed which are stored in digital supports and prints said words and/or images on the glass pane **V**, controlling the drive means that move the printing head **52** and manage the ejection of ink by the spray heads **52a** according to the method of the invention described above. According to what has been explained above, the digital printing method and the system operating according to said method achieve the set objects, that is, the objects to improve the quality of the printed word and/or image.

[0056] During the operating step, the method and the system of the invention can be subjected to modifications and/or variants that are not included in the attached drawings and in the supporting description.

[0057] It is understood, however, that said possible modifications and/or variants must all be considered protected by the present patent, provided that they fall within the scope of the claims expressed below.

Claims

1. Method for the digital printing of words and/or images on a glass pane (V) by means of dedicated software that interprets digital information recorded on special memory supports which define said words and/or said images to be printed and controls an ink jet printing head in order to print said words and/or images on said glass pane (V), said digital printing of said words and/or images being obtained by superimposing a plurality of printing surfaces (1; 2) on each other through the following operations:

- preparing each of said printing surfaces (1; 2) by printing a plurality of coplanar printing strips (1a; 2a) placed side by side, wherein each of said printing strips (1a; 2a) is in contact with the adjacent printing strip along a common longitudinal edge (1b; 2b);
- superimposing said printing surfaces (1; 2) in such a way that each common longitudinal edge (1b; 2b) belonging to any of said printing surfaces (1; 2) is arranged facing and in contact with a printing strip (1a; 2a) belonging to the overlying and/or underlying printing surface (1; 2),

said method comprising a plurality of preparatory operations that are carried out before digitally printing said printing surfaces (1; 2) and comprise the following operations:

- placing said glass pane (V) on a work surface;
- defining for said glass pane (V) a Cartesian reference system constituted by a first axis (X) and a second axis (Y);
- defining an initial reference point (O);
- positioning said printing head at the level of said initial reference point (O)

wherein each of said printing surfaces (1; 2) is obtained through the following operations:

- making said printing head advance along said first axis X/second axis Y to print a printing strip (1a; 2a) on said glass pane (V);
- repositioning said printing head at the level of said initial reference point (O);
- moving said printing head along said second axis Y/first axis X by a pitch equal to the width (1c) of said printing strip (1a; 2a);
- making the printing head advance, repositioning it and moving it again several times until completing the printing of said printing surface (1; 2) on said glass pane (V),

characterized in that the operation of preparing one of said printing surfaces (1; 2) superimposed to a previous printing surface (1) comprises the operation

of repositioning each time said printing head moved along said second axis Y/first axis X with respect to said initial reference point (O) at a distance (4) that is shorter than said width (1c) of a strip (1a) belonging to said previous printing surface.

2. Method according to claim 1, **characterized in that** all the printing strips (1a; 2a) defining the same printing surface (1; 2) have the same print thickness.
3. Method according to any of the preceding claims, **characterized in that** all the printing surfaces (1; 2) are defined by printing strips (1a; 2a) having the same print thickness.
4. Method according to any of the preceding claims, **characterized in that** one or more of said printing surfaces (1; 2) is defined by printing strips (1a; 2a) having different print thicknesses compared to the printing strips (1a; 2a) defining the adjacent printing surface (1; 2).
5. Method according to any of the preceding claims, **characterized in that** it comprises the following operations:

- defining the number of said printing surfaces (1; 2) for printing the image on said glass pane (V);
- conveniently distributing the total thickness of the ink constituting the final image among said printing surfaces (1; 2);

said operations being configured in such a way that the printing strips (1a) belonging to a printing surface (1) dry before a printing strip (2a) belonging to the overlying printing surface (2) is laid on said printing strips (1a).

6. System (50) for the digital printing of words and/or images on glass, comprising:

- a work surface (51) configured to support a glass pane (V) suited to be digitally printed with words and/or images;
- optical means (53) configured to position said glass pane (V) on said work surface (51) before said printing operation of said words and/or images is carried out;
- a printing head (52) provided with ink jet spray heads (53a);
- a Cartesian structure (54) arranged on said work surface (51) and coplanar with it, configured to support said printing head (52);
- drive means configured to move said printing head (52) on said Cartesian structure (54) and above said glass pane (V);
- drying means (59) belonging to said Cartesian

structure (54) and configured to dry said ink once it has been laid on said glass pane (V);
 - a numerical control device configured to manage the printing process by means of dedicated software designed to read the information related to said words and/or said images to be printed and recorded on digital supports and to control said drive means and said spray heads (53a),

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characterized in that said numerical control device is configured to implement a digital printing method according to any of the preceding claims.

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7. System (50) according to claim 6, **characterized in that** said Cartesian structure (54) comprises one pair of spaced and parallel longitudinal ways (55) and a transversal carriage (56) supported at its ends by said longitudinal ways (55) and supporting said printing head (52), said drive means being associated with said Cartesian structure (54).

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8. System (50) according to any of claims 6 or 7, **characterized in that** said drive means comprise:

- longitudinal drive means configured to move said transversal carriage (56) along said longitudinal ways (55);
 - transversal drive means configured to move said printing head (52) along said transversal carriage (56).

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9. System (50) according to any of the claims from 6 to 8, **characterized in that** said optical means (53) are laser emitters.

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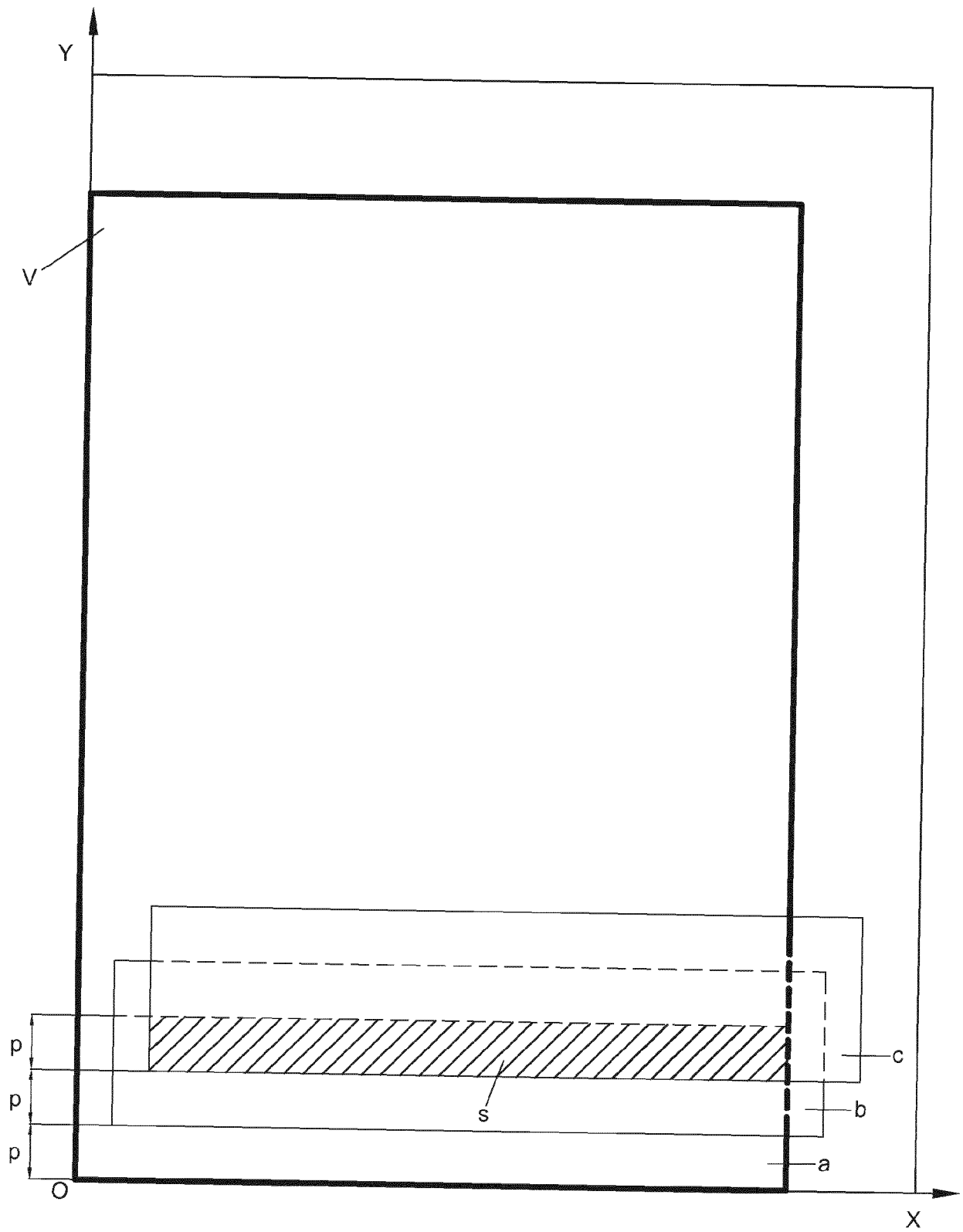


Fig.1- PRIOR ART

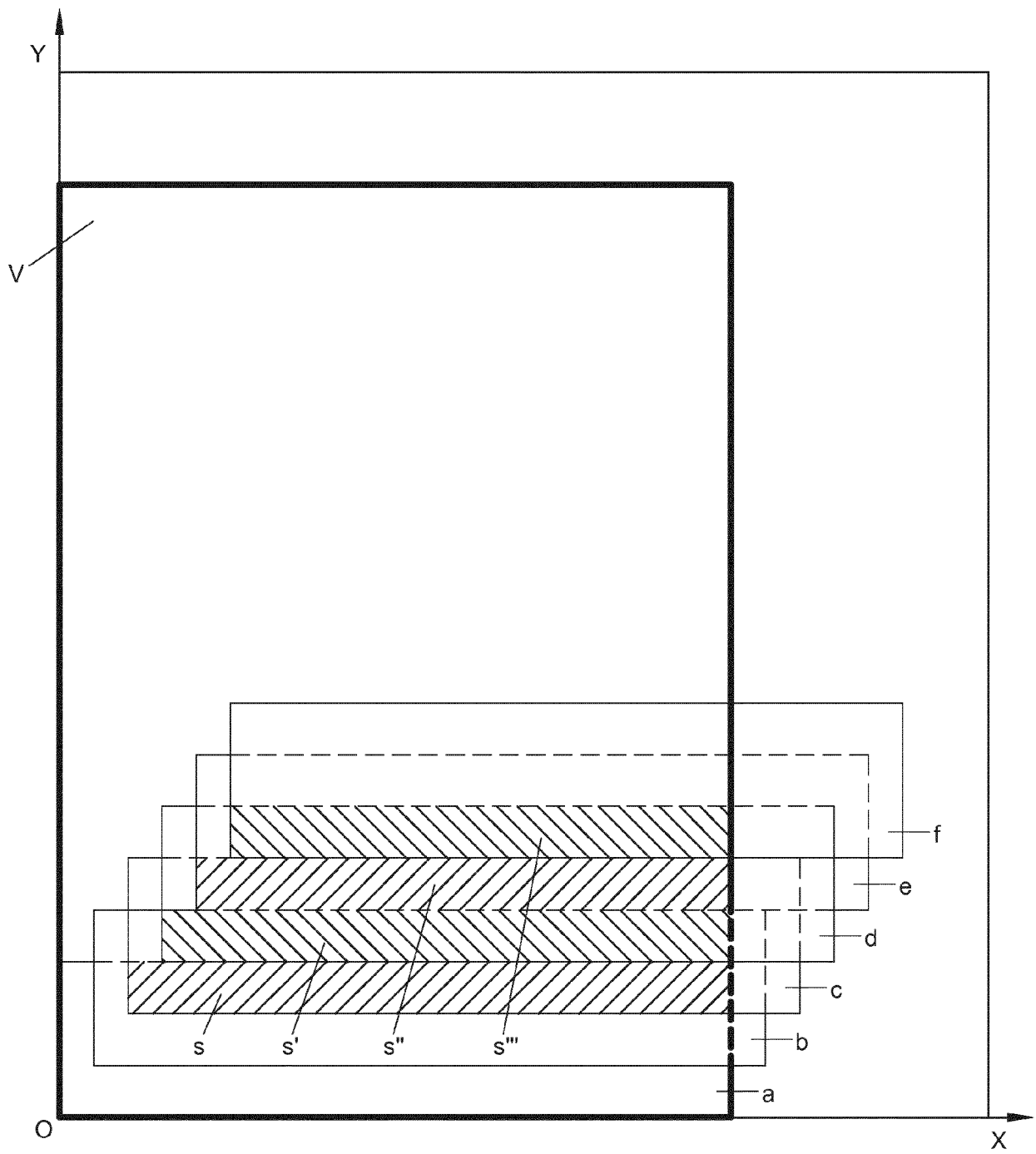


Fig.2- PRIOR ART

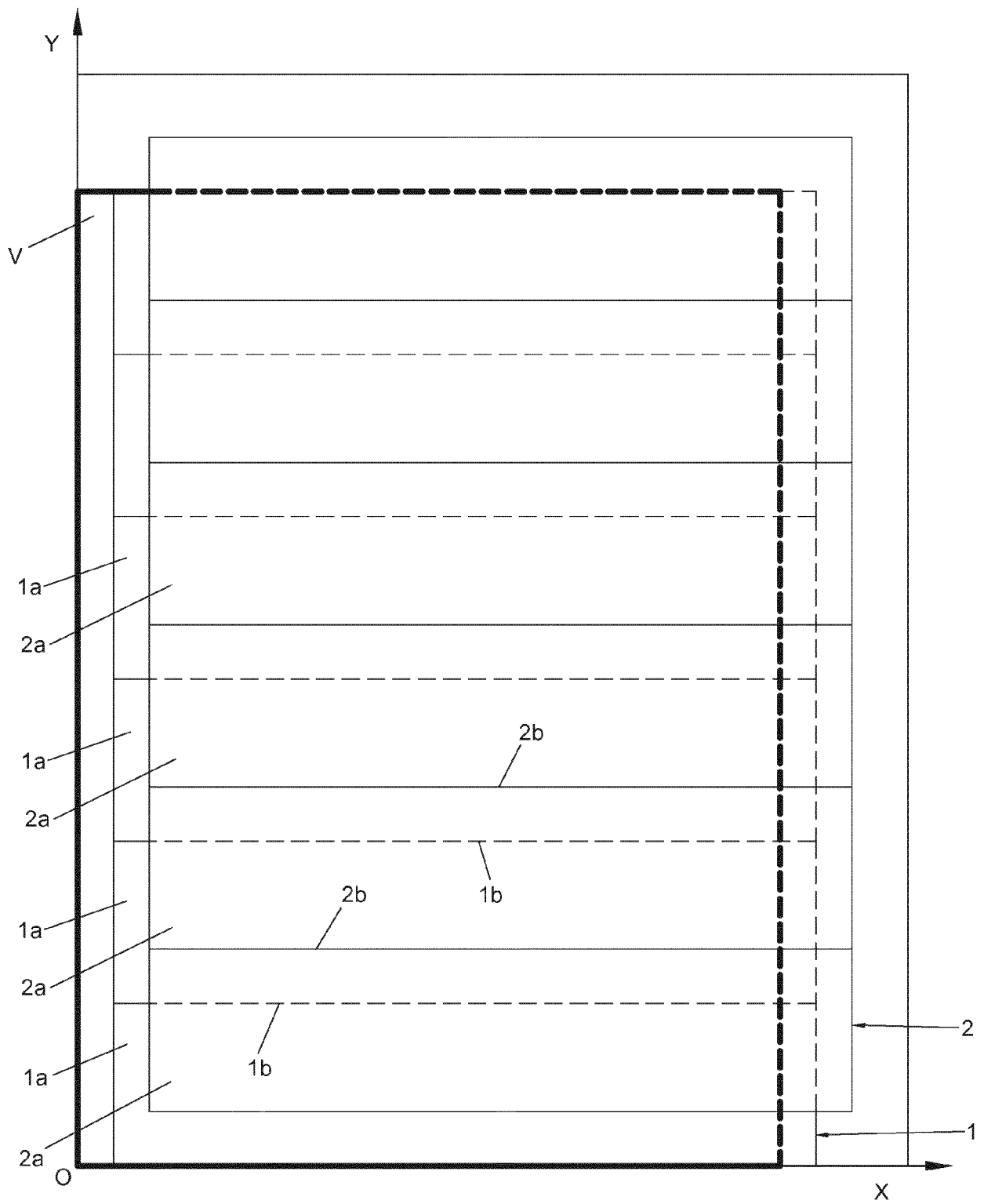


Fig.3

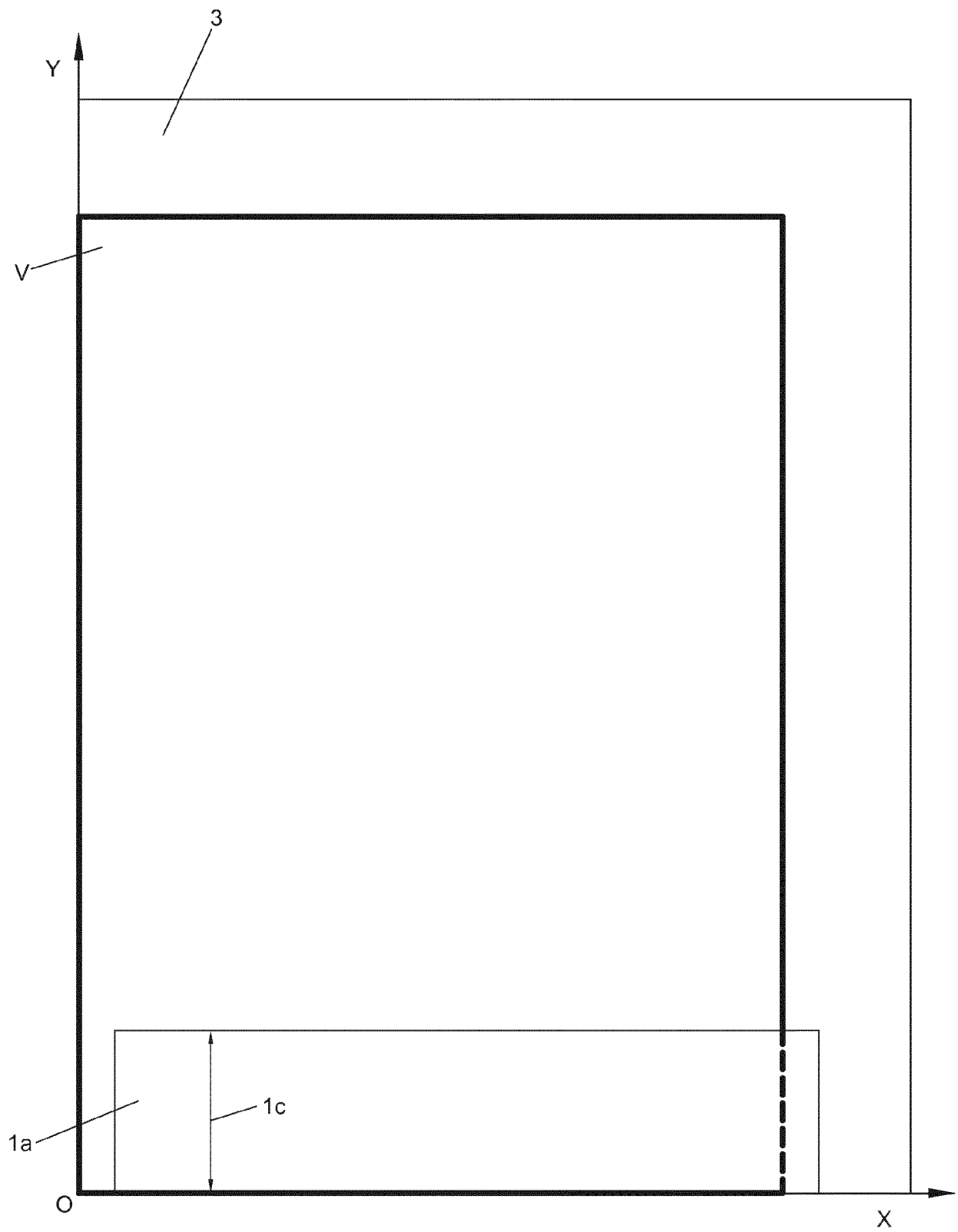


Fig.4

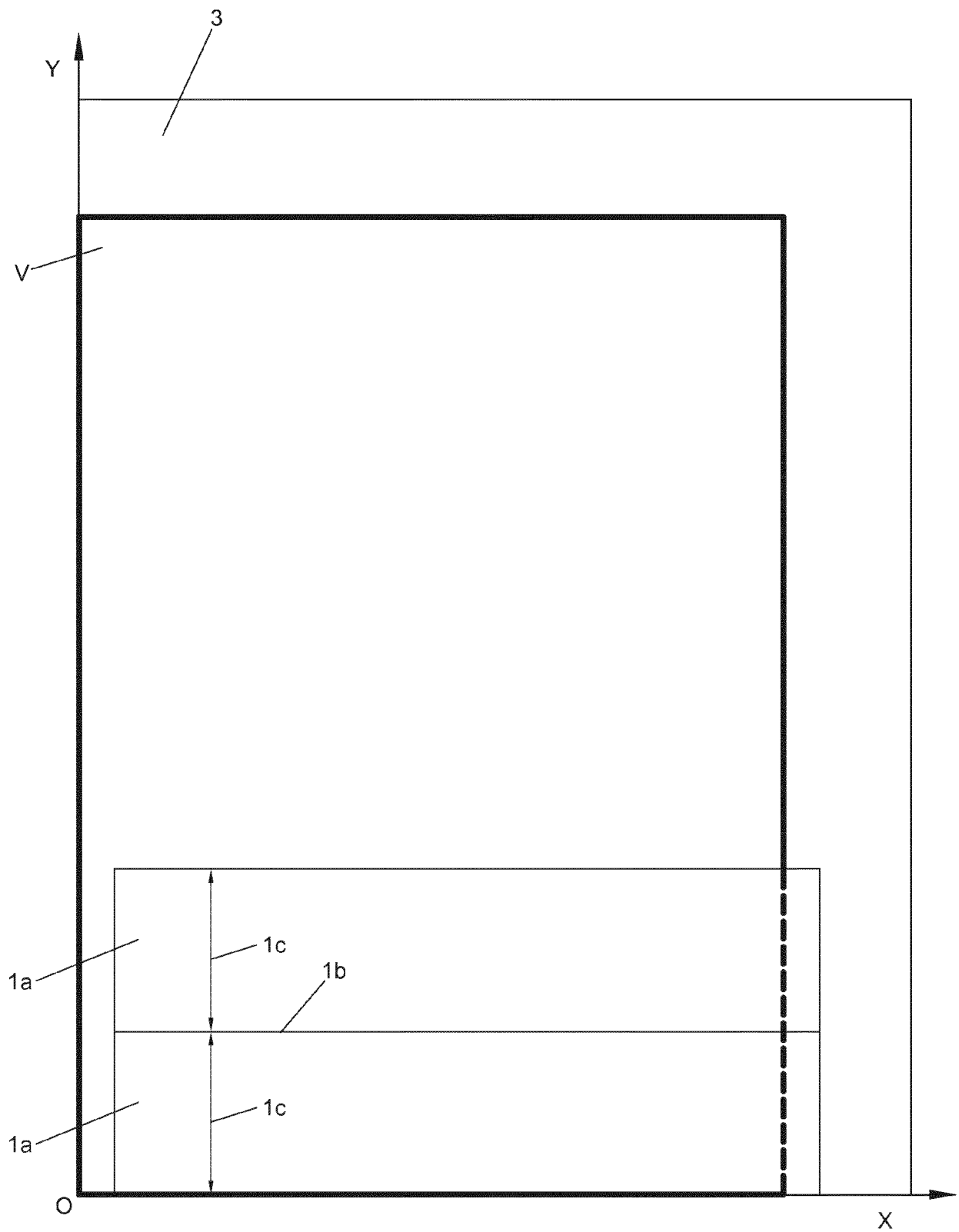


Fig.5

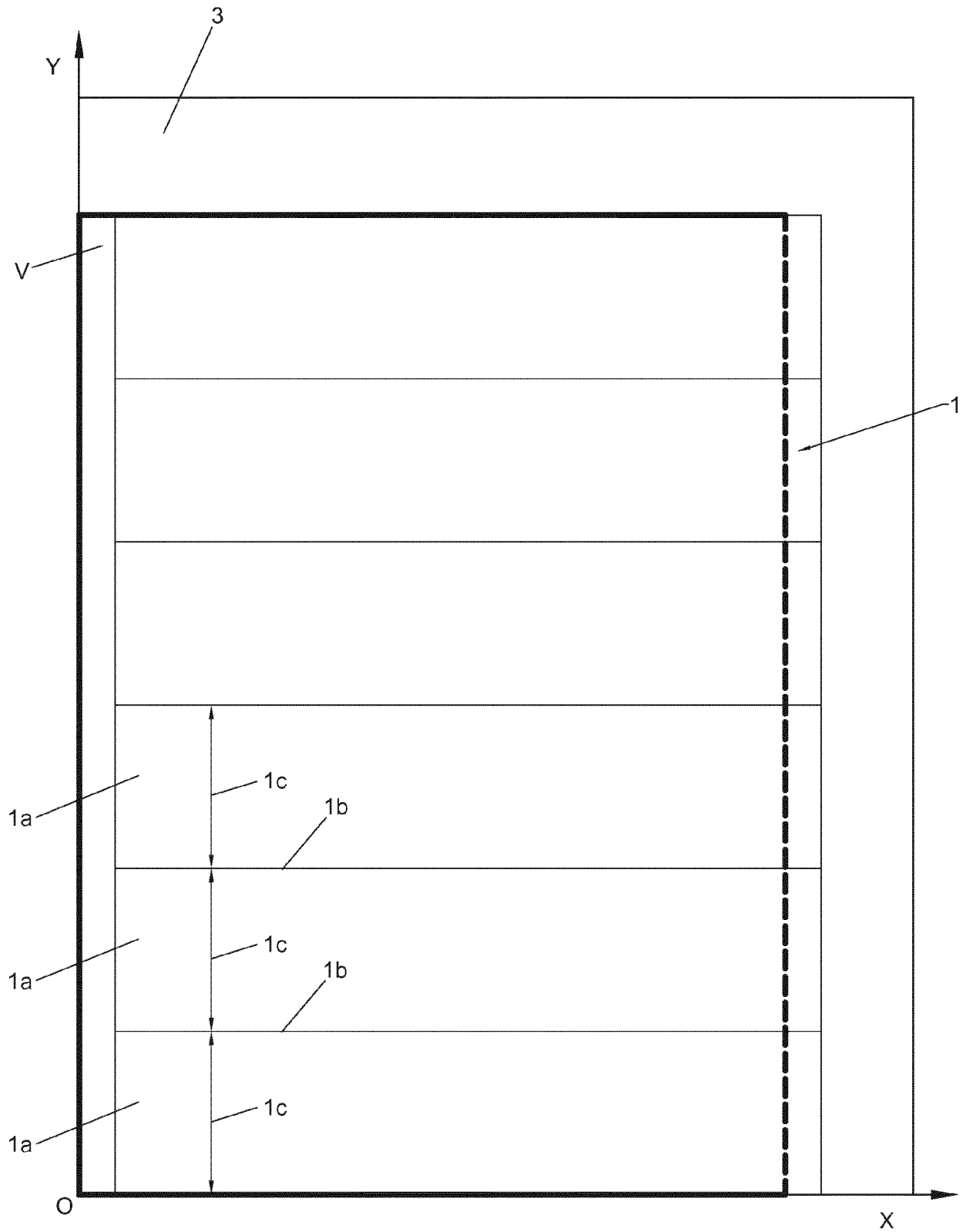


Fig.6

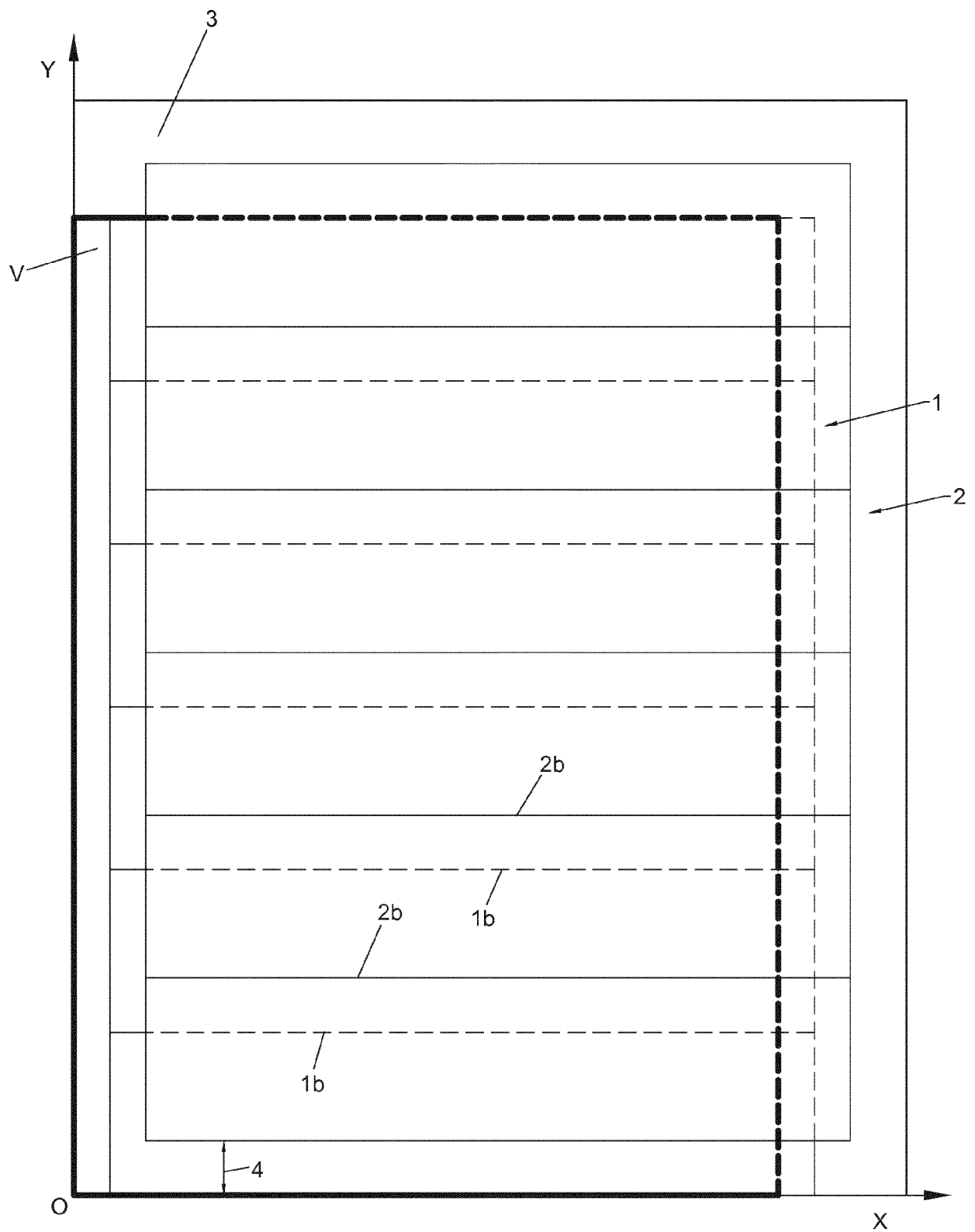


Fig.7

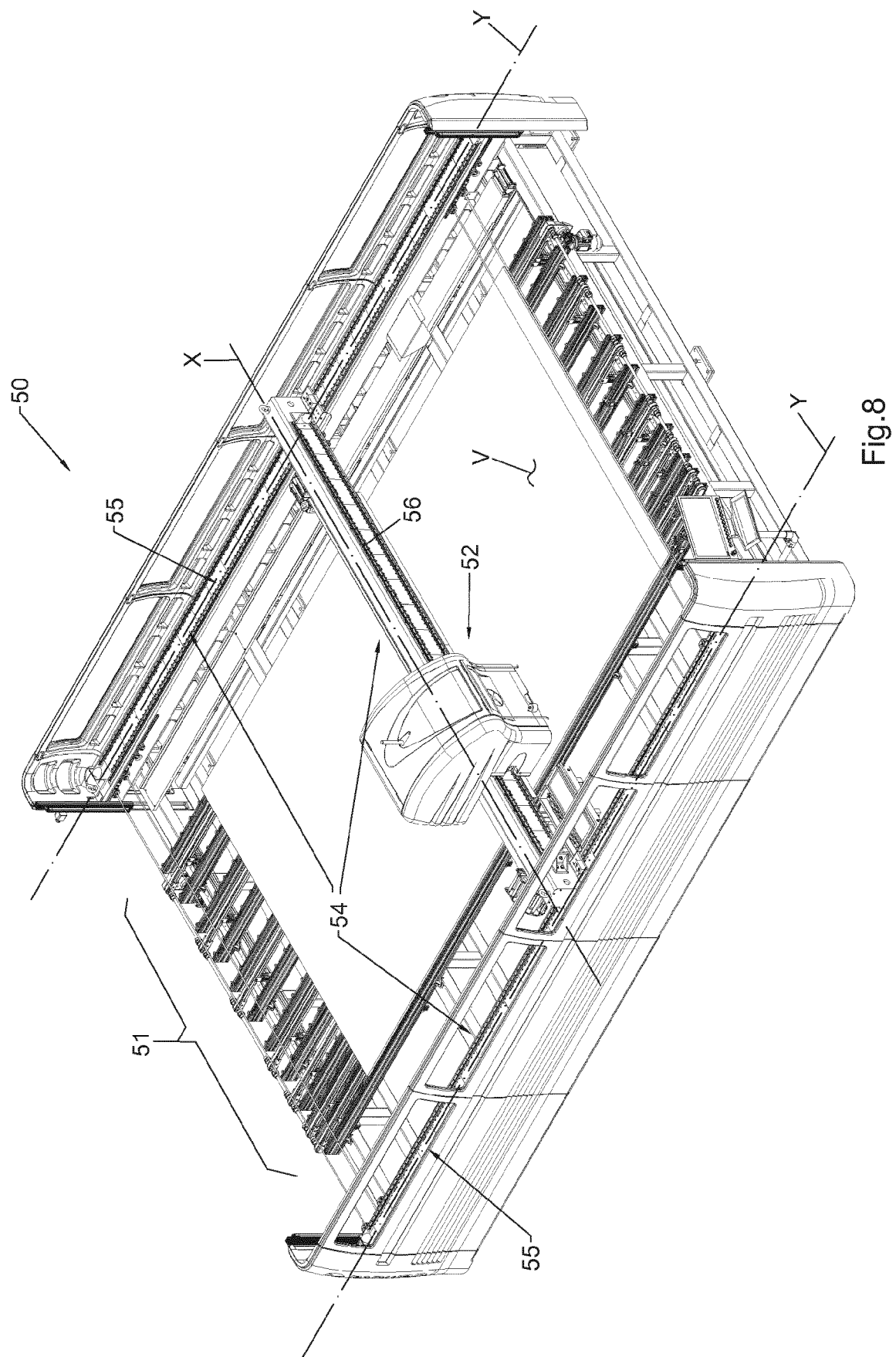


Fig. 8

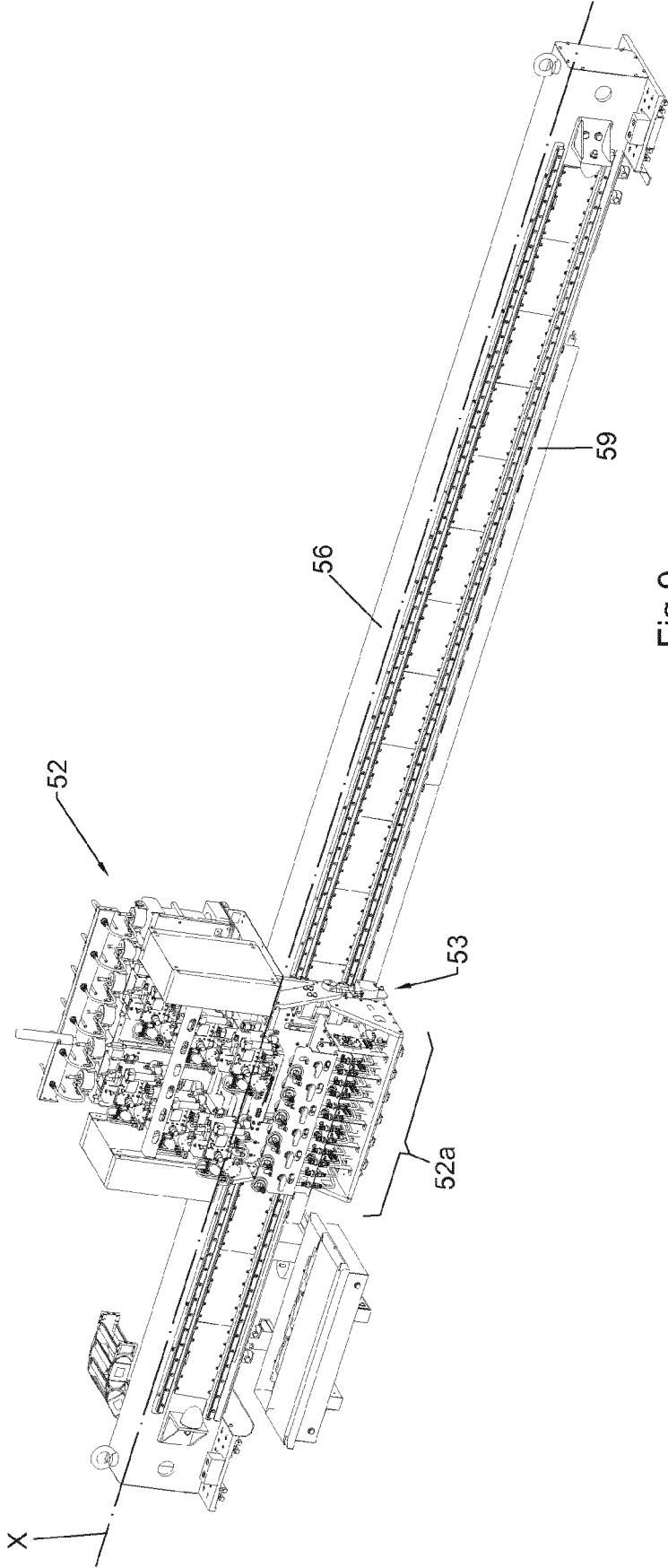


Fig.9

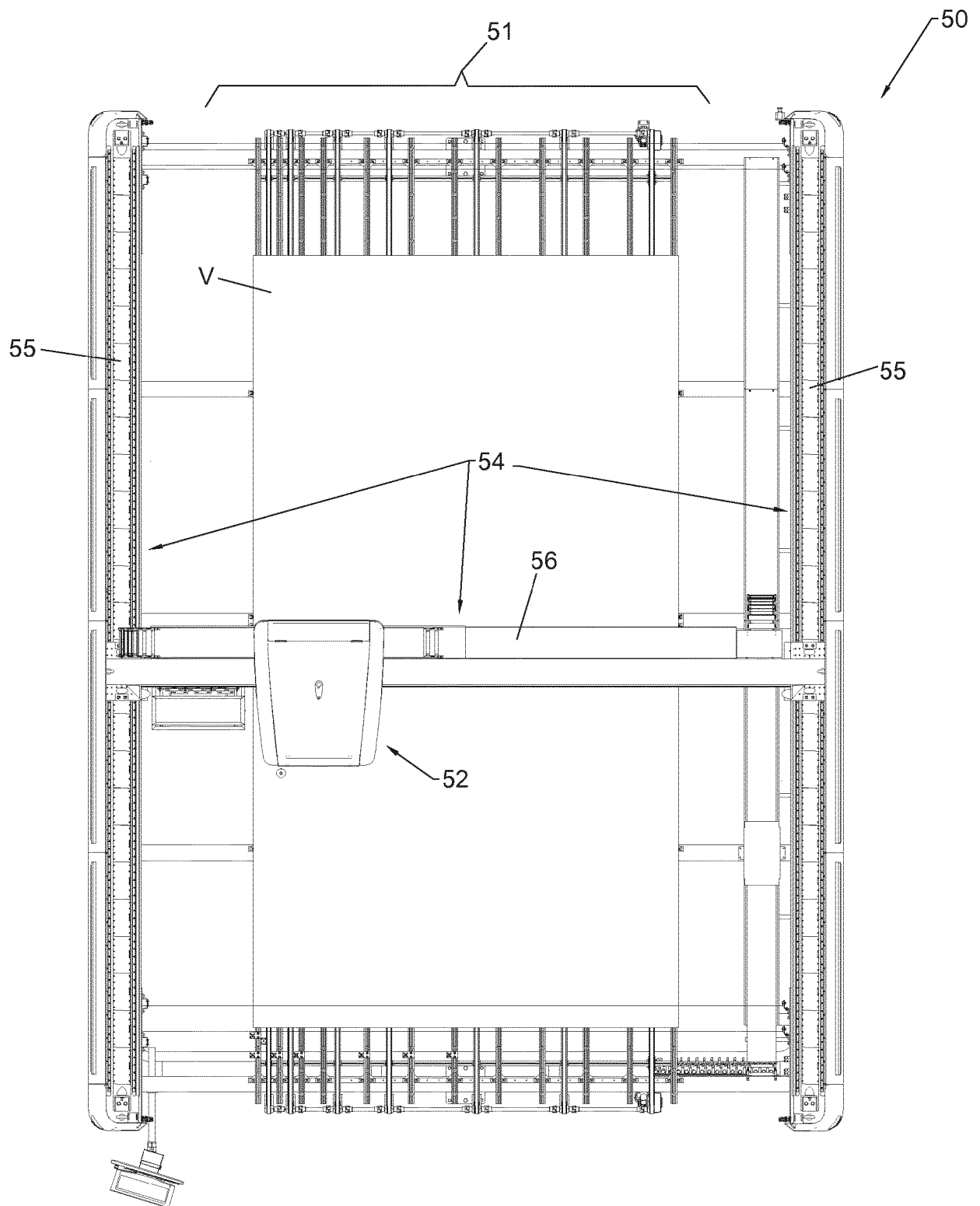


Fig.10



EUROPEAN SEARCH REPORT

Application Number
EP 19 19 8398

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A	* paragraph [0069] - paragraph [0089]; figures 2-4 *	6-9	
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 February 2020	Examiner Patosuo, Susanna
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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