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(54) INKJET PRINTER FOR PRINTING MULTIPLE SUBSTRATES IN PARALLEL

(57) To maintain high productivity and to reduce waste in a wide format printer, a method is provided, which comprises the steps of:
- conveying a plurality of print substrates (M1-M14) in parallel past a printing assembly (7) in a transport direction (X),
characterized by the steps of:
- determining an orientation of each substrate (M1-M14) with respect to a respective reference,
- preventing printing on those (M2) of the parallel print substrates (M1-M14) of which the orientation has been determined to substantially deviate from the respective reference as they pass the printing assembly (7).

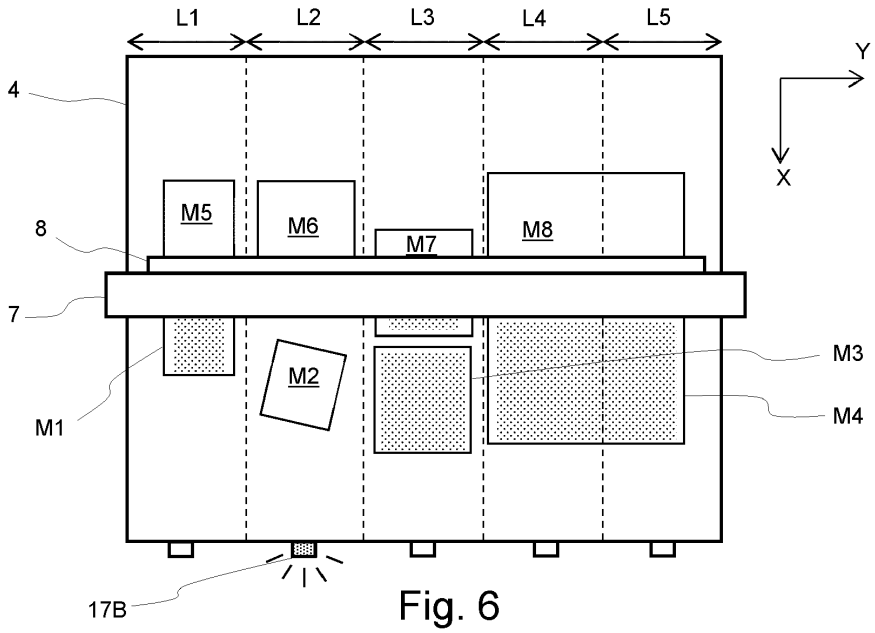

Fig. 6

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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The invention relates to a method of printing, a printer, and computer readable medium in application with the before mentioned method and printer.

2. Description of Background Art

[0002] Large format media printers may comprise a conveyor of sufficient width to conveying multiple print substrates of smaller formats in parallel past a printing assembly in a transport direction. Therein a plurality of such small format print substrates are conveyed in parallel past a printing assembly in the transport direction, such that these print substrates can be together printed as they pass in parallel through a print region of the printing assembly. While loading the print substrates onto the conveyor, the print substrates are aligned with respect to the printing assembly, so that each image will be printed on its respective print substrate in the correct orientation and/or position and/or has the correct dimension(s). It was found that in practice it may occur that one or more print substrates become mispositioned or erroneously loaded during loading, resulting in the image being printed incorrectly (e.g. skewed or mispositioned) on the respective print substrate. Generally, such incorrectly printed prints are discarded as waste and a re-print is required.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide an improved method of printing of multiple print substrates provided in parallel, specifically wherein the amount of waste material is reduced, preferably while maintaining high productivity.

[0004] In accordance with the present invention, a method of printing according to claim 1, a printer according to claim 9, and a computer-readable medium according to claim 12 are provided. The method comprises the steps of:

- conveying a plurality of print substrates in parallel past a printing assembly in a transport direction.

[0005] The method is characterized by the steps of:

- determining an orientation, dimension, and/or position of each substrate with respect to a respective reference; and
- preventing printing on those of the parallel print substrates of which the orientation, dimension, and/or position has been determined to substantially deviate from the respective reference as they pass the printing assembly.

[0006] It is the insight of the inventors that productivity may be maintained, while reducing waste material if incorrectly oriented, positioned, and/or dimensioned print substrates are allowed to pass the printing assembly without printing an image thereon, while allowing for printing on correctly oriented print substrates provided in parallel. By determining the orientation, dimension, and/or position of each print substrate before or as it reaches the printing assembly, it is possible determine whether a respective print substrate is incorrectly oriented , positioned, and/or dimensioned with respect to the printing assembly. Any suitable reference with respect to the printing assembly, such as the transport direction and/or lateral direction may be used for determining an angle, position, or dimensions of a substrate. If it is found that the orientation, dimension, and/or position of a print substrate deviates substantially from the reference, printing on the respective print substrate is prevented. The respective, deviating print substrate passes the printing assembly without being printed on, while respective images are printed on other print substrates parallel to the respective deviating print substrate, if these other print substrates were determined to be orientated, positioned, and/or dimensioned in correspondence with the reference with respect to the printing assembly. Printing on non-deviating print substrates thus continues without interruption (i.e. without stopping or pausing the print process as compared to regular operation), while any deviating print substrate remains blank, so that it can be reused for printing. Thereby, waste is prevented or reduced without reducing productivity. An additional advantage is that printing on non-deviating substrates may continue uninterrupted, so that print artifacts due to stopping or pausing the print operation are avoided. Thereby the object of the present invention has been achieved.

[0007] More specific optional features of the invention are indicated in the dependent claims.

[0008] In an embodiment, the print substrates are provided in parallel, such that these, at least partially, overlap with one another when viewed in a lateral direction of the conveyor perpendicular to the transport direction. The lateral direction is further perpendicular to a support plane of the conveyor and/or to a print surface of the planar print substrates. The print substrates are positioned besides one another in the lateral position, such that at least one point on a print substrate has a same position in the transport direction as at least one point on another print substrate. Preferably, the plurality of print substrates provided on the conveyor in this matter is greater than two, more preferably greater than three, and even more preferably greater than four. This provides a space-efficient packing of the print substrates on the conveyor, allowing for highly productive printing. It will be appreciated that occasionally print substrates may be positioned without overlapping when viewed in the lateral direction, if required.

[0009] In an embodiment, substrates being transported in parallel to the deviating print substrate and conforming to the respective reference are printed on when passing the printing assembly. For every print substrate image data has been provided, which is scheduled to be printed on a respective print substrate, before said print substrates reach the printing assembly, for example during or prior to loading. If a print substrate has been determined to be skewed, mispositioned, and/or to have an incorrect dimension, i.e. deviates substantially from the reference, then the respective image data is not processed into printing instructions. In consequence, the corresponding image is not printed on the deviating print substrate. However, for properly oriented print substrates moving in parallel to a skewed print substrate, the respective image data is processed, resulting in the printing of images on the respective, correctly oriented, positioned, and/or dimensionsed print substrates. It will be appreciated that herein a conveyance speed of the conveyor is the same or similar as to when all print substrates on the conveyor are non-deviating. Thus, the conveyor may operate on a constant, average speed without interruption, which may include the conveyor moving stepwise. The image data for non-deviating substrates is printed uninterrupted as anydeviating substrate passes the printing assembly without printing thereon. Uninterrupted herein being defined as performing a regular print operation, which for a page-wide printhead array means that the substrate moves continuously with respect to the printhead array while for a scanning printer the transport may continuous or stepwise, while the printheads continue to scan across the substrate. In consequence, all image data is printed in an uninterrupted print process, so that print artifacts that may occur due to pausing or stopping and resuming the print process are avoided.

[0010] In an embodiment, the plurality of substrates are positioned besides one another in a lateral direction of a conveyor and the printing assembly defines a print region extending in the lateral direction, wherein the step of conveying comprises moving a plurality of substrates besides one another through the print region. The print substrates, including the deviating print substrates, overlap when viewed in the lateral direction, when one of the print substrates moves into the print region. As a result, a plurality of print substrates will be simultaneously positioned besides one another inside the print region. This allows the printing assembly to print on multiple print substrates in a single swath. A swath is preferably defined by an array of printheads extending in the lateral direction (in case of print comprising a page-wide array) or by the reciprocal trajectory of the printhead carriage (in case of a scanning printer).

[0011] In an embodiment, printing is only prevented for print substrates in the print region of which the detected orientation, dimension, and/or position deviates from the respective reference. Print substrates which were determined to be correctly oriented, positioned, and/or dimensioned, i.e. deviating from the reference by less than a predetermined threshold, are printed on as previously scheduled.

[0012] In an embodiment, the print substrates are distributed on the conveyor over a plurality of lanes, which lanes are posited besides one another in the lateral direction. Preferably, every lane is provided with aligning means for registering a print substrate in the respective lane with respect to the reference. The aligning means may comprise a aligning surface oriented with respect to the reference. For example, the aligning means may comprise a straight surface extending parallel to the transport direction, which is perpendicular to the lateral direction in which the printing assembly extends. In another embodiment, the respective reference is with respect to the transport direction and/or the lateral direction. Every lane is provided with aligning means, so that in each lane a print substrate can be easily and quickly registered, so that it conforms to the reference. The aligning means may be removable to accommodate large format media.

[0013] In an embodiment, the method further comprises the step of delaying the printing of an image initially assigned to a print substrate which was determined to deviate from the respective reference until a following, similar print substrate is conveyed to the printing assembly in an orientation and/or position and/or having a dimension conforming to the respective reference. When printing for a deviating print substrate is prevented, the corresponding image data is re-scheduled into a print queue, so that it is to printed at a later time. The actual printing of said image data is performed when it has been determined that a corresponding print substrate has been provided on the conveyor in the correct orientation, dimension, and/or position. This print substrate may be the original print substrate after reloading it onto the conveyor or a different print substrate with the same properties, such as dimensions and/or materials.

[0014] In an embodiment, the method further comprises the step of an user interface prompting that that a print substrate deviates from the respective reference. The user interface communicates deviating substrate information, so that an operator is informed which of the print substrates is in a skewed orientation, has an incorrect dimension, and/or is in the wrong position. This allows the operator to re-use the deviating print substrate. The user interface may further comprise additional information, such as a time schedule for the deviating print substrate to e.g. arrive at the output side of the conveyor, and/or instructions in which lane and when to reload the deviating print substrate on the conveyor.

[0015] The invention further relates to a printer comprising :

- a conveyor for conveying multiple print substrates in parallel lanes past a printing assembly in a transport direction;

[0016] The printer is characterized by:

- a detector assembly for determining an orientation, dimension, and/or position of each substrate with respect to the transport direction, and

a controller configured to compare a deviation of the detected orientations, dimensions, and/or positions of each substrate with respect to a respective reference and to prevent printing on a print substrate as it passes the printing assembly if the detected orientation, dimension, and/or position of said print substrate deviates from the respective reference.

[0017] The detector assembly is arranged to determine an orientation, dimension, and/or position of each individual print substrate on the conveyor with respect to the print assembly. The conveyor preferably has a lateral width of over 2 meters, more preferably over 2.5 meters, and very preferably over 3 meters, so that multiple normal or small format print substrates may fit lateral besides one another on the conveyor. The conveyor consist preferably of a single transport belt for holding all print substrates. The detector assembly, for example a camera or line scanner, determines position data for each print substrate, which is transmitted to the controller. The controller compares the position data to the reference to determine whether a respective substrate is deviates or not with respect to the printing assembly or its predefined size. The controller controls the printing assembly so that no ink is printed on deviating substrates in contrast to npn-deviating print substrates provided parallel to a deviating print substrate on the conveyor.

[0018] In an embodiment, the printing assembly defines a print region extending in a lateral direction of the conveyor perpendicular to the transport direction, wherein the controller stores a plurality of image data assigned to be printed on different print substrates positioned on the conveyor besides one another in the lateral direction, and wherein the controller is configured to prevent printing of respective image data when the detector assembly determines that the respective print substrate assigned to said image data deviates from the respective reference. If the controller determines that a print substrate is deviating with respect to the printing assembly, it prevents the respective image data for said deviating print substrate from being printed. The substrate may deviate in position, orientation, and/or dimensions. However, image data for other images, which are to printed on other print substrates overlapping with the deviating print substrate in the lateral direction are printed. For printing in multiple parallel lanes, a print queue corresponds to a two dimensional matrix of images, wherein images are provided besides one another in both the transport and lateral direction. Multiple images move together into the laterally extending print region, so that these may be printed together in a single swath.

[0019] In an embodiment, the controller is configured to store the image data assigned to a print substrate deviating from the respective reference, without printing it, while printing the respective image data on print substrates conforming to the respective reference positioned besides the deviating print substrate. The image data for a deviating print substrate is not printed, as the print substrate passes the printing assembly in a incorrect orientation, dimension, and/or position. The respective image data is stored on a memory, such that it is printed when an available, suitable print substrate passes the printing assembly.

[0020] The invention further relates to a computer-readable medium comprising instructions which, when executed by a printer according to the prevent invention, cause the printer to carry out the steps of the method according to the present invention.

[0021] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the present invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 is a schematic perspective view of a printing system according to the present invention in a first printing mode;

Fig. 2 is a schematic perspective view of a printing system in Fig. 1 in a second printing mode;

Fig. 3 is a schematic diagram of a controller of a reprographic system according to Fig. 1 or 2;

Figs. 4 to 7 illustrates different steps of processing multiple print substrates including a skewed print substrate in the method according to the present invention when performed on the printer in Figs. 1 and 2;

Figs. 8 to 11 illustrates different steps of image processing in the method according to the present invention when performed on the printer in Figs. 1 and 2;

Figs. 12 to 15 illustrates different steps of processing multiple print substrates including a mispositioned print substrate in the method according to the present invention when performed on the printer in Figs. 1 and 2; and

Figs. 16 to 19 illustrates different steps of processing multiple print substrates including a incorrectly dimensionsed print substrate in the method according to the present invention when performed on the printer in Figs. 1 and 2.

Printing system

[0023] Fig. 1 shows a wide format inkjet printer 1. The wide-format printer 1 comprises an inkjet printing assembly 7 for printing on a print medium 15. The print medium 15 in Fig. 1 is a relatively rigid substrate, such as a panel. The print medium 15 is supplied from a media input unit 14, which may be configured for storing a plurality of such print media 15 and supplying these to the printer 1. The printer 1 comprises a conveyor for receiving and transporting the print medium 15 along the inkjet printing assembly 7. In Fig. 1, the conveyor comprise an endless transport belt 4 supported on a plurality of support rollers 3A, 3B, 3C. At least one of the support rollers 3A, 3B, 3C is provided with driving means for moving the belt 4. Additionally, one or more one of the support rollers 3A, 3B, 3C may be configured to be moved and/or tilted to adjust and control the lateral position of the belt 4. The inkjet printing assembly 7 may be provided with a sensor assembly 8, such as an area camera or line scanner, to determine the relative position and/or orientation of the belt 4 and/or the print medium 15 with respect to the printing assembly 7. The sensor assembly 8 may also be configured to determine one or more dimensions of the print medium 15, such as its width, length, and/or thickness/height. Data from said sensor assembly 8 may be applied to control the position of the belt 4 and/or the print medium 15. Specifically, the sensor assembly 8 may be arranged to determine the position, a dimension, and/or orientation of print media 15 on the belt 4, relatively e.g. to the transport direction X and/or their lateral position in the Y direction. The sensor assembly 8 may comprise a camera or scanner coupled to a data processor to determine a length, a position, and/or orientation of at least one edge of each substrate. The sensor assembly 8 is arranged to simultaneously detect multiple, parallel substrates on the belt 4. The belt 4 is further provided with through-holes and a suction box 5 in connection with a suction source (not shown), such that an underpressure may be applied to the print medium 15 via the through-holes in the belt 4. The underpressure adheres the print medium 15 flatly to the belt 4 and prevents displacement of the print medium 15 with respect to the belt 4. Due to this holding the belt 4 is able to transport the print medium 15. It will be appreciated that other suitable conveyors, such as rollers, steppers, etc, may alternatively be applied. The print medium 15 may be transported stepwise and/or in continuous movement.

[0024] The inkjet printing assembly 7 is configured to translate along a first guide beam 6 in a scanning direction. The scanning direction is perpendicular to the direction in which the print medium is transported by the belt 4. The inkjet printing assembly 7 holds a plurality of print heads (not shown), which are configured to jet a plurality of different marking materials (different colors of ink, primers, coatings, etc.) on the print medium 15. Each marking material for use in the printing assembly 7 is stored in one of a plurality of containers arranged in fluid connection with the respective print heads for supplying marking material to said print heads to print an image on the print medium 15.

[0025] The ejection of the marking material from the print heads is performed in accordance with data provided in the respective print job. The timing by which the droplets of marking material are released from the print heads determines their position on the print medium 15. The timing may be adjusted based on the position of the inkjet printing assembly 7 along the first guide beam 6. The above mentioned sensor assembly 8 may therein be applied to determine the relative position and/or velocity of the inkjet printing assembly 7 with respect to the print medium 15. Based upon data from the sensor assembly 8, the release timing of the marking material may be adjusted.

[0026] Upon ejection of the marking material, some marking material may be spilled and stay on a nozzle surface of the print heads. The marking material present on the nozzle surface, may negatively influence the ejection of droplets and the placement of these droplets on the print medium 15. Therefore, it may be advantageous to remove excess of marking material from the nozzle surface. The excess of marking material may be removed for example by wiping with a wiper and/or by application of a suitable anti-wetting property of the surface, e.g. provided by a coating.

[0027] The marking materials may require treatment to properly fixate them on the print medium. Thereto, a fixation unit 10 is provided downstream of the inkjet printing assembly 7. The fixation unit 10 may emit heat and/or radiation to facilitate the marking material fixation process. In the example of Fig. 1, the fixation unit 10 is a radiation emitter, which emits light of certain frequencies, which interacts with the marking materials, for example UV light in case of UV-curable inks. The fixation unit 10 in Fig. 1 is translatable along a second guide beam 9. Other fixation units 10, such as page-wide curing or drying stations may also be applied. Further, the inkjet printing assembly 7 may be provided with a further fixation unit on the same carriage which holds the print heads. This further fixation unit can be used to (partially) cure and/or harden the marking materials, independent of or interaction with the fixation unit 10.

[0028] After printing, and optionally fixation, the print medium 15 is transported to a receiving unit (not shown). The receiving unit may comprise a take-up roller for winding up the print medium 15, a receiving tray for supporting sheets of print medium 15, or a rigid media handler, similar to the media input unit 14. Optionally, the receiving unit may comprise processing means for processing the medium 8, 9 after printing, e.g. a posttreatment device such as a coater, a folder, a cutter, or a puncher.

[0029] The wide-format printer 1 furthermore comprises a user interface 11 for receiving print jobs and optionally for manipulating print jobs. The local user interface unit 11 is integrated to the print engine and may comprise a display unit and a control panel. Alternatively, the con-

trol panel may be integrated in the display unit, for example in the form of a touch-screen control panel. The local user interface unit 11 is connected to a controller 12 connected to the printer 1. The controller 12, for example a computer, comprises a processor adapted to issue commands to the printer 1, for example for controlling the print process. The printer 1 may optionally be connected to a network. The connection to the network can be via cable or wireless. The printer 1 may receive printing jobs via the network. Further, optionally, the controller 12 of the printer 1 may be provided with an input port, such as a USB port, so printing jobs may be sent to the printer 1 via this input port.

Hybrid printing system

[0030] The printer 1 in Fig. 1 is a so-called hybrid printer, capable of handling both flexible media and rigid substrates. In Fig. 1, the printer 1 operates in a first print mode, wherein the printer 1 is configured for transporting rigid substrates, such as the print medium 15. Such rigid print media 15 may be panels for doors, walls, etc, corrugated media, plates formed of plastic or metal, etc. To handle these rigid print media 15, the printer 1 in Fig. 1 is configured with a substantially linear transport path: from the media input device 14, the print medium 15 moves forward along the inkjet printing assembly 7 at a at substantially constant height. The media input unit 14 and the receiving unit are positioned at the level of the medium support surface of the belt 4. In Fig. 2, a flexible web medium 16 is supplied to the printer 1, which web medium 16 may be composed of e.g. paper, label stock, coated paper, plastic or textile. The web medium 16 is supplied from the input roller 2A and extends across the belt 4 to the take-up roller 2B, where the web medium 16 is re-wound. The printer 1 is configured to swiftly and efficiently switch between print modes.

Control

[0031] An embodiment of the controller 12 is in more detail presented in Fig. 3. As shown in Fig. 3, the controller 12 comprises a Central Processing Unit (CPU) 31, a Graphical Processor Unit (GPU) 32, a Random Access Memory (RAM) 33, a Read Only Memory (ROM) 34, a network unit 36, an interface unit 37, a hard disk (HD) 35 and an image processing unit 39 such as a Raster Image Processor (RIP). The aforementioned units 31 - 37 are interconnected through a bus system 38. However, the controller 12 may also be a distributed controller.

[0032] The CPU 31 controls the printing system 1 in accordance with control programs stored in the ROM 34 or on the HD 35 and the local user interface panel 5. The CPU 31 also controls the image processing unit 34 and the GPU 32. The ROM 34 stores programs and data such as boot program, set-up program, various set-up data or the like, which are to be read out and executed by the CPU 31. The hard disk 35 is an example of a non-volatile storage unit for storing and saving programs and data which make the CPU 31 execute a print process to be described later. The hard disk 35 also comprises an area for saving the data of externally submitted print jobs. The programs and data on the HD 35 are read out onto the RAM 33 by the CPU 31 as needed. The RAM 33 has an area for temporarily storing the programs and data read out from the ROM 34 and HD 35 by the CPU 31, and a work area which is used by the CPU 31 to execute various processes. The interface unit 37 connects the controller 12 to the client devices 21 - 24 and to the printing system 1. The network unit 36 connects the controller 12 to the network N and is designed to provide communication with the workstations 22 - 24, and with other devices 21 reachable via the network N. The image processing unit 39 may be implemented as a software component running on an operation system of the controller 12 or as a firmware program, for example embodied in a field-programmable gate array (FPGA) or an application-specific integrated circuit (ASIC). The image processing unit 39 has functions for reading, interpreting and rasterizing the print job data. Said print job data contains image data to be printed (i.e. fonts and graphics that describe the content of the document to be printed, described in a Page Description Language or the like), image processing attributes and print settings.

Handling of skewed media

[0033] Fig. 4 illustrates in top-down view the printer in Figs. 1 and 2 in an initial stage, where print substrates M1-M4 are loaded onto the belt 4 of the conveyor. The belt 4 has sufficient width, such that the print substrates M1-M4 can be positioned laterally besides one another, so that these move together on the belt 4 past the printing assembly 7. The conveyor preferably defines a plurality of parallel lanes L1-L5 extending in the transport direction X. Each lane L1-L5 is preferably provided with registering means for aligning a print substrate in said lane L1-L5 to the transport direction X. As illustrated for the larger print substrate M4, a print substrate M1-M4 may be wider than the lateral width of a single lane L1-L5. Parallel printing of print media M1-M4 in parallel L1-L5 provides a productive and flexible printing method. Aligning means (not shown) may be provided for each lane L1-L5 to assist in aligning the print substrates M1-M4 with respect to the printing assembly 7. Aligning means may comprise pins or a plate defining an aligning surface parallel to the transport direction X, against which print substrates M1-M4 can be slid to align these.

[0034] After loading, the print media M1-M4 are adhered to the belt 4 by the negative pressure applied to the suction chamber 5. In consequence, all print media M1-M4 move synchronously with the belt 4, and thus with one another. The print media M1-M4 are conveyed towards the print region defined by the printing assembly 7, as shown in Fig. 5. When viewed in the lateral direction Y, the print substrates M1-M4 overlap with one another,

so that one or more of them have a point with the same position in the transport direction X. The printing assembly 7 comprise a scanning printhead carriage as in Fig. 1 and 2 or alternatively comprise a during printing stationary printhead array spanning substantially the width of the belt 4 parallel to the lateral direction Y.

[0035] The active scanning region of the sensor assembly 8 is provided upstream of the print region, so that the positions and orientations of the individual print media M1-M4 can be determined before these reach the printing assembly 7. The sensor assembly 8 preferably comprises a scanner arranged to detect the position of each print media M1-M4 in the transport and/or lateral direction Y, as well an orientation, dimension, and/or position of each print medium M1-M4 with respect to the lateral direction Y, extending perpendicular to the transport direction X. An area camera may be applied to determine the dimensions, positions, and orientations in a single scan using e.g. image recognition methods. In another example, the sensor assembly 9 comprises a line scanner, which determines the dimensions, positions, and orientations by multiple measurements as the print media M1-M4 pass the line scanner.

[0036] Print substrates M1, M3-M4 in Fig. 5 are only printed on if the controller 12 determines that these are oriented correctly with respect to the transport direction X. For most squarely shaped print substrates M1-M4, this requires the leading edge to be parallel to the lateral direction Y and/or side edge to be parallel to the transport direction X, which is the direction of the print region defined by the printing assembly.

[0037] In Fig. 5, the controller 12 has determined, based on data received from the sensor assembly, 8 that the print substrate M2 in the second lane L2 is skewed with respect to the transport direction X and/or the lateral direction Y. Digitally correcting the to be printed image data to align with the skewed substrate M2 would require pausing printing on all print media M1-M4 until, the image data has been corrected for the respective skew angle. In the shown example however, the controller 12 prevents printing on print substrates M1-M, which have been determined to be skewed with respect to the transport direction X. Printing continues on any print substrate M1-M4 that was determined to be aligned with the transport direction X and/or the lateral direction Y. It will be appreciated that any other suitable reference other than the directions X, Y may be applied as well.

[0038] Fig. 5 further indicates that the user interface comprises an indicator 17B that prompts or informs an operator of a print medium M1-M4 have been determined to be skewed. In Fig. 5, the indicator 17B comprises a light positioned at the respective lane L2, which lights up as a print medium M2 in said lane L2 was found to be skewed. In another example, the indicator may be prompted on a screen of the user interface, for example on a mobile device or computer. This allows the operator to retrieve the unprinted substrate M2 and re-use it in another print process. Additionally, the controller 12 stores the image data that was assigned to the skewed print substrate M2 into its memory 33, 34. Preferably, the controller 12 re-schedules the printing of the respective image data into the print queue, so that it can be printed when the print substrate M2 passes by the printing assembly 7 for a second time. The respective image data may also be re-scheduled to be printed on a different print substrate M1-M4 with similar properties (size or material) as the skewed print substrate M2.

[0039] In consequence, as shown in Fig. 6, all aligned print substrates M1, M3, M4 are printed on by the printing assembly 7, while the skewed print substrate M2 remains blank or unprinted. This allows the skewed print substrate M2 to be re-loaded on the input side of the belt 4 in an aligned orientation, as shown in Fig. 7. Upon determining that the intended type of print substrate M2 is available, the respective image is printed on the print substrate M2 on its second pass. No material is wasted and the overall productivity of the printed is maintained.

[0040] Fig. 8 schematically illustrates the image queue to be printed on the print substrates M1-M4 in Fig. 4. Image date I1 to I4 have been input to the controller 12 and are assigned to be printed in their respective lanes L1-L5. Via the user interface 11, the controller 12 instructs the operator which print substrates M1-M4 are to be loaded in which lane L1-L5. Loading may take place as the belt 4 moves, so that the leading edges of the print substrates M1-M4 do not have the same position in the transport direction X. The sensor assembly 8 determines for each print substrate the relative position in the transport direction X, the lateral position Y, and the orientation (corresponding to e.g. the angle of the leading edge with respect to the lateral direction Y or the transport direction X). Dependent on the determined positions in X, Y directions, the image data I1-I4 in the image queue is adjusted, so that the image data I1-I4 are shifted in the print queue relatively to one another, so that the printing of each image data I1-I4 would coincide with the respective substrate M1-M4 arriving at the printing assembly 7. The relative shifting of image data I1-I4 is illustrated in Fig. 9. The image data I5-I8 for upstream print substrates M5-M8 are preferably already scheduled in the print queue at a predetermined spacing from their respective leading image data I1-I4, NP. After the positions and orientations of the upstream print substrates M5-M8 have been detected, the upstream image data I5-I8 is shifted accordingly.

[0041] In case the orientation exceeding a predetermined threshold with respect to the reference, e.g. the leading edge deviating more than a predetermined number of degrees from the lateral direction Y, the image would be printed visibly skewed with respect to the edges of the respective print medium M1-M4. A corresponding rotational correction generally requires re-processing the image data via the image processing unit 39, which would require a substantial amount of time in which the belt 4 would have to be stopped, thereby halting print production. Instead, the conveyor is controlled to continue mov-

ing the belt 4 and thereby all print media M1-M4 on it, while preventing printing on any print substrate M2 that was determined to be skewed. This allows the printing on non-skewed substrate M1, M3, M4 to continue without interruption. This is illustrated in Fig. 9 wherein the image data I2 for the skewed print medium M2 has been temporarily removed from the print queue. At the determined position for the skewed print medium M2 blank or non-printing image data NP is positioned, so that the printheads are prevented from jetting on the skewed print medium M2.

[0042] The image data I2 for the skewed print substrate M2 is temporarily stored on the controller's memory 34, in this example the ROM. The controller 12 further control the user interface 11, 17B to prompt the operator that a print medium M2 is scheduled to pass the printing assembly 7 without printing. Preferably, the controller 12 further identifies the respective skewed print substrate M2, for example by indicating the respective lane L2 of the print substrate M2, and/or an estimated time for outputting the skewed print substrate M2 at the output side of the belt 4. The controller 12 may further analyze the remaining image data I5-I8 in the print queue to determine an optimal time window for a second attempt of printing the image data I2.

[0043] As indicated in Fig. 10, the controller 12 may utilize the user interface 11, 17B to indicate a loading position LP, where the previously skewed print substrate M2 may be re-inserted. In the shown example, the previously skewed print substrate M2 is inserted in the second lane L2. Upon determining that a suitable print substrate M2 for the image I2 is available on the belt 2, the controller 12 re-schedules the image data I2 from its memory into the print queue at the corresponding position LP, as illustrated in Fig. 11. Since the respective print substrate M2 has now been correctly aligned, the image data I2 will be printed on said print substrate M2. It will be appreciated that other scheduling tactics may be applied when re-inserting the image data I2 from the memory into the print queue. For example, the image data I2 could in another example have been assigned to be printed on the print substrate M9 (which has similar dimensions and/or materials as the previously skewed print substrate M2). The image data I9 originally scheduled for print substrate M9 would then be re-assigned to the re-inserted print substrate M2. This would aid in conserve the original order in which images were scheduled to be printed.

[0044] Fig. 12 illustrates an example wherein an unprinted substrate M2 has been positioned offset with respect to its reference position RP on the belt 4. The controller 12 defines a reference position RP for each substrate M1-M4 on the belt 4. Via the user interface 11 the operator is instructed to load the substrates M1-M4 on the belt 4 aligned with their respect reference positions RP. In this example, the substrate M2 is not skewed and its reference position RP is defined in the in-plane directions X, Y. Due to a loading error, the substrate M2 has been offset with respect to its reference position RP in the transport and/or lateral directions X, Y. The sensor assembly 8 is arranged to detect the position of each substrate M1-M4, for example by determining the position of one or more edges of the substrates M1-M4. The detected position for each susbstrate M1-M4 is compared to its respective reference position RP by the controller 12. Substrates M1, M3, M4 are determined by the controller 12 to be aligned with their reference positions within a predetermined margin. Substrate M2 however deviates from its reference position RP in both the transport and lateral directions X, Y by more than a predetermined threshold value. Consequently, the controller 12 prevents printing on the mispositioned substrate M2, while the respective image data on the parallel substrates M1, M3, M4 are printed, as all substrates M1-M4 move past the printing assembly 7. Movement of the substrates M1-M4 may be stepwise or continuous. The print jobs for printing the image data on the aligned substrates M1, M3, M4 are printed as a single uninterrupted print process, as shown ion Fig. 13. Uninterrupted herein may include swathwise printing wherein the printheads move reciprocally over the substrates M1-M4. The image data for mispositioned substrate M2 is stored on memory for later use and non-printing or blank image data is inserted into the image data set, where said image data was originally scheduled.

[0045] In Fig. 14 the printing of the aligned substrates M1, M3, M4 has been completed. Each image on the substrates M1, M3, M4 was printed in a regular print process, wherein each swath was positioned with the same or similar timing with respect to the previous swath. However, in the respective section of each swath which overlapped with the mispositioned substrate M2 no marking material was deposited, so that the mispositioned substrate M2 remained unprinted. The controller 12 defines a new reference position RP for the unprinted substrate M2, which is communicated to the operator via the user interface 11. In Fig. 15, the operator positions the unprinted substrate M2 at the reference position RP. Upon determining that the unprinted substrate M2 is positioned correctly at the reference position RP, the controller 12 retrieves the image data for the substrate M2 from memory and schedules this image data, so that it is to printed on the substrate M2, as it passes the printing assembly a second time. During its second pass, the substrate M2 is positioned in between a new batch of substrates M9-13 on the belt 4.

[0046] Fig. 16 illustrates the controller 12 comparing a detected dimension of each substrate M1-M4 to a reference dimension RD. In this example, all substrates M1-M4 have already been determined to be non-skewed as well as being positioned at their reference positions RP. In contrast to the substrates M1, M3, M4, the substrate M2 was found to deviate from its predetermined reference dimension RD. In this example, the reference dimension RD is a size, length, and/or width preferably defined in the transport and/or lateral directions X, Y.

[0047] Upon determining that the substrate M2 deviates from its reference dimension RD, the controller 12 prevents printing on the deviating substrate M2, while still allowing the substrate M2 to move in parallel with the other substrates M1, M3, M4. All substrates M1-M4 move stepwise past the printing assembly 7 which in an uninterrupted process prints the respective images on all substrates M1, M3, M4 except for the deviating substrate M2, which is kept blank or unprinted, as shown in Fig. 17. The print process for the printed images in not stopped or paused, so that all swaths of the printed images are printed in a substantially homogenous process. In Fig. 18, the controller 12 defines a reference dimension for a new substrate M14, which is to input at the position indicated on the user interface 11, as shown in Fig. 19.

[0048] It will be appreciated that the controller 12 may prevent on any substrate M1-M14 which deviates from its respective reference, wherein the reference comprises one or more of a reference orientation, a reference positions, and a reference dimensions, in any order or combination.

[0049] Although specific embodiments of the invention are illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are examples only and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0050] It will also be appreciated that in this document the terms "comprise", "comprising", "include", "including", "contain", "containing", "have", "having", and any variations thereof, are intended to be understood in an inclusive (i.e. non-exclusive) sense, such that the process, method, device, apparatus or system described herein is not limited to those features or parts or elements or steps recited but may include other elements, features, parts or steps not expressly listed or inherent to such process, method, article, or apparatus. Furthermore, the terms "a" and "an" used herein are intended to be understood as meaning one or more unless explicitly stated otherwise. Moreover, the terms "first", "second", "third", etc. are used merely as labels, and are not intended to impose numerical requirements on or to establish a certain ranking of importance of their objects.

[0051] The present 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 spirit and scope of the present 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, the method comprising the steps of:

   - conveying a plurality of print substrates (M1-M14) in parallel past a printing assembly (7) in a transport direction (X),

   characterized by the steps of:

   - determining an orientation, dimension, and/or position of each substrate (M1-M14) with respect to a respective reference,
   - preventing printing on those (M2) of the parallel print substrates (M1-M14) of which the orientation, dimension, and/or position has been determined to substantially deviate from the respective reference as they pass the printing assembly (7).

2. The method according to claim 1, wherein substrates (M1-M14) being transported in parallel to the deviating print substrate (M2) and conforming to the respective reference are printed when passing the printing assembly (7).

3. The method according to claim 1, wherein the plurality of substrates (M1-M14) are positioned besides one another in a lateral direction (Y) of a conveyor and the printing assembly (7) defines a print region extending in the lateral direction (Y), wherein the step of conveying comprises moving a plurality of substrates (M1-M14) besides one another through the print region.

4. The method according to claim 3, wherein printing is only prevented for print substrates (M1-M14) in the print region of which the detected orientation, dimension, and/or position deviates from the respective reference.

5. The method according to claim 3 or 4, wherein the print substrates (M1-M14) are distributed on the conveyor over a plurality of lanes (L1-L5), which lanes (L1-L5) are posited besides one another in the lateral direction (Y).

6. The method according to any of the preceding claims, wherein the respective reference is with respect to the transport direction (X) and/or the lateral direction (Y).

7. The method according to any of the preceding of the preceding claims, further comprising the step of delaying the printing of an image initially assigned to a print substrate (M1-M14) which was determined to deviate from the respective reference until a following, similar print substrate (M1-M14) is conveyed to the printing assembly (7) in an orientation conforming to the respective reference.

8. The method according to any of the previous claims, further comprising the step of an user interface (11, 17B) prompting that that a print substrate (M1-M14) deviates from the respective reference.

9. A printer (1) comprising :

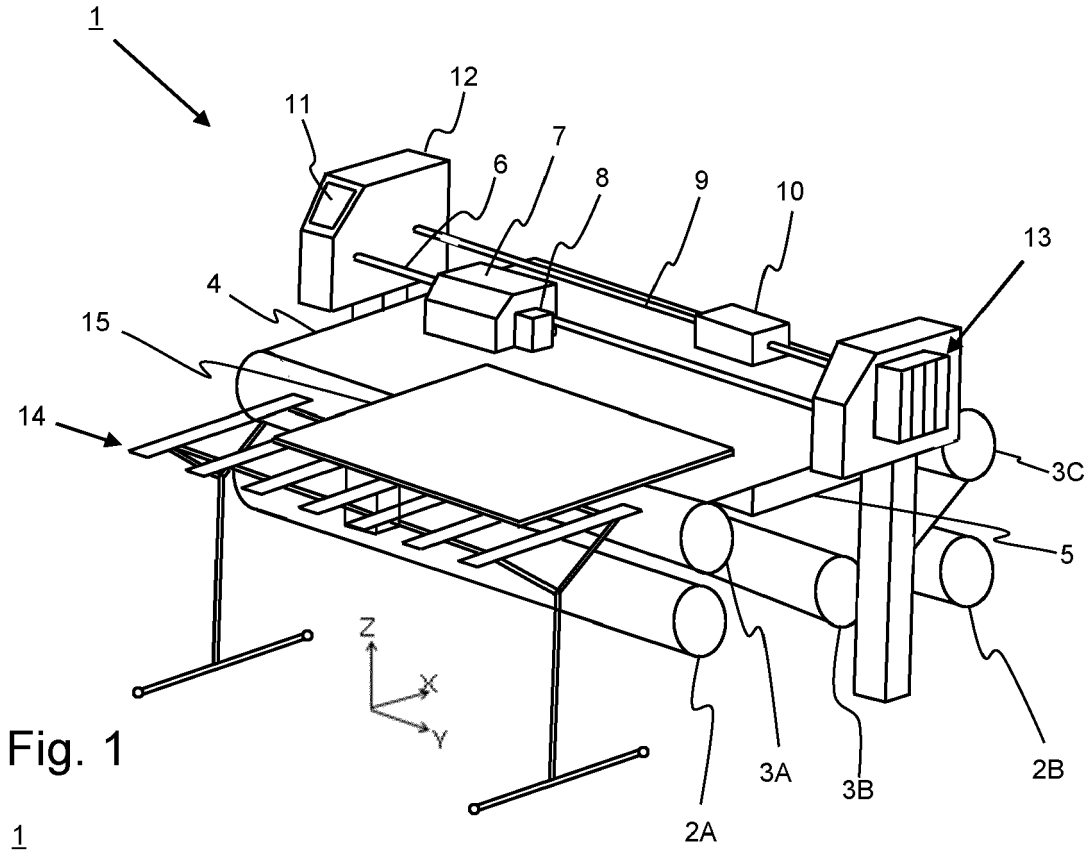
- a conveyor for conveying multiple print substrates (M1-M113) in parallel lanes (L1-L5) past a printing assembly (7) in a transport direction (X);
- a detector assembly (8) for determining an orientation, dimension, and/or position of each substrate (M1-M5) with respect to the transport direction (X);

characterized by a controller (12) configured to compare a deviation of the detected orientations of each substrate (M1-M14) with respect to a respective reference and to prevent printing on a print substrate (M1-M14) as it passes the printing assembly (7) if the detected orientation, dimension, and/or position of said print substrate (M2) deviates from the respective reference.

10. The printer (1) according to claim 9, wherein the printing assembly (7) defines a print region extending in a lateral direction (Y) of the conveyor perpendicular to the transport direction (X), wherein the controller (12) stores a plurality of image data (I1-I13) assigned to be printed on different print substrates (M1-M14) positioned on the conveyor besides one another in the lateral direction (Y), and wherein the controller (12) is configured to prevent printing of respective image data (I1-I13) when the detector assembly (8) determines that the respective print substrate (M2) assigned to said image data (I2) deviates from the respective reference.

11. The printer (1) according to claim 10, wherein the controller (12) is configured to store the image data (I2) assigned to a print substrate (M2) deviating from the respective reference, while printing the respective image data (I1, I3-I13) on print substrates (M1, M3-M13) conforming to the respective reference positioned besides the deviating print substrate (M2).

12. A computer-readable medium comprising instructions which, when executed by a printer (1) according to any of the claims 9 to 11, cause the printer (1) to carry out the steps of the method according to any of the claims 1 to 8.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12
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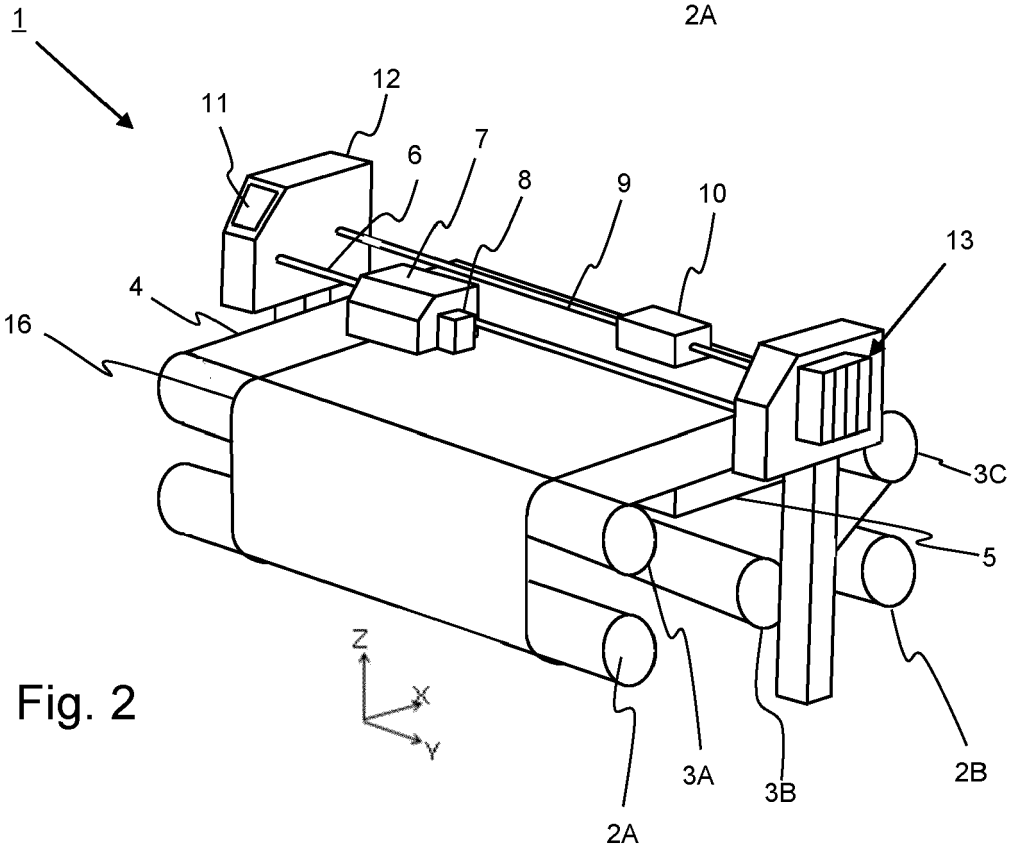
15
14
3C
5
Z
X
Y
3A
3B
2B
2A

Fig. 1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X
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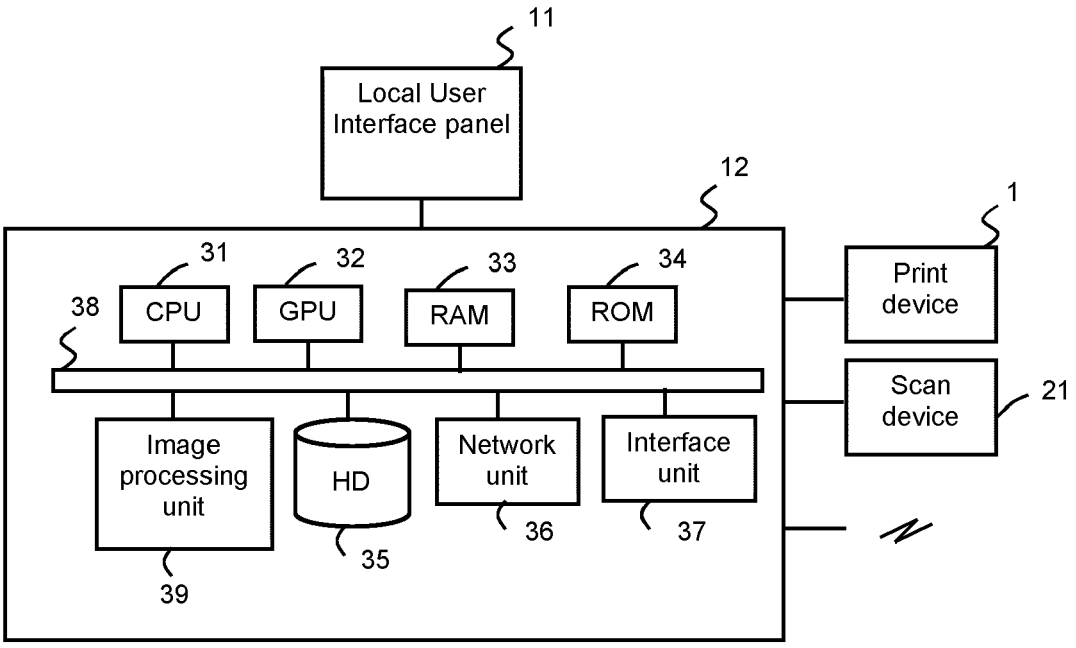
3A
3B
2B
2A

Fig. 2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1
31
32
33
34
38
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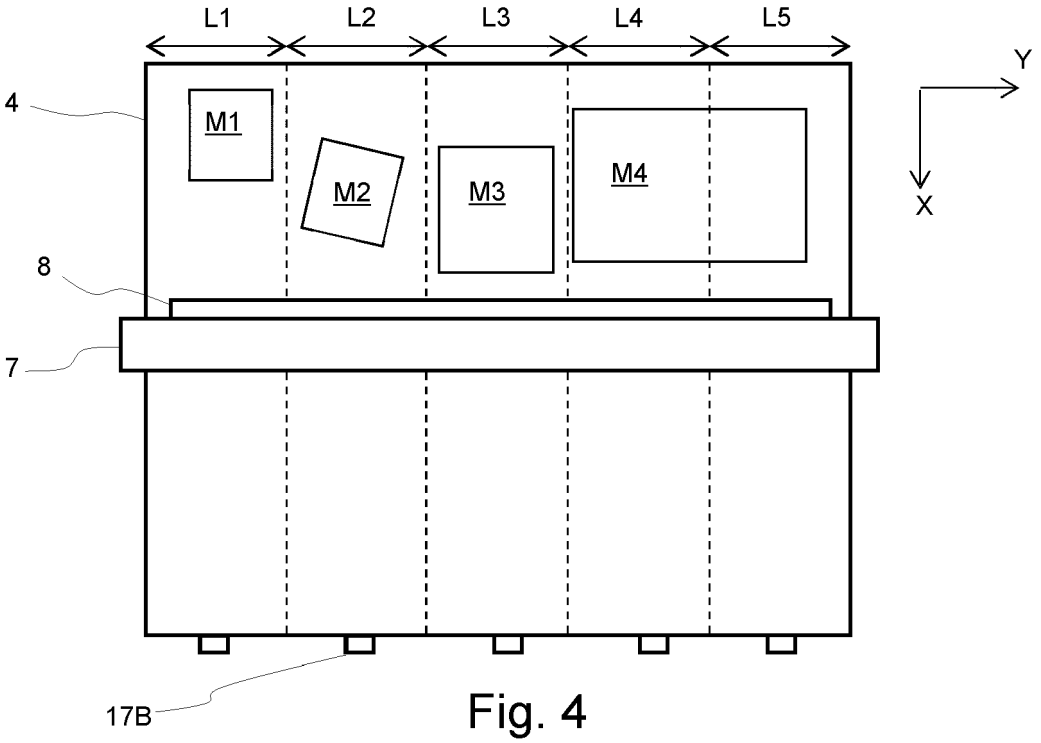
GPU
RAM
ROM
Print device
Scan device
21
Image processing unit
HD
Network unit
Interface unit
39
35
36
37

Fig. 3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L4
L5
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X
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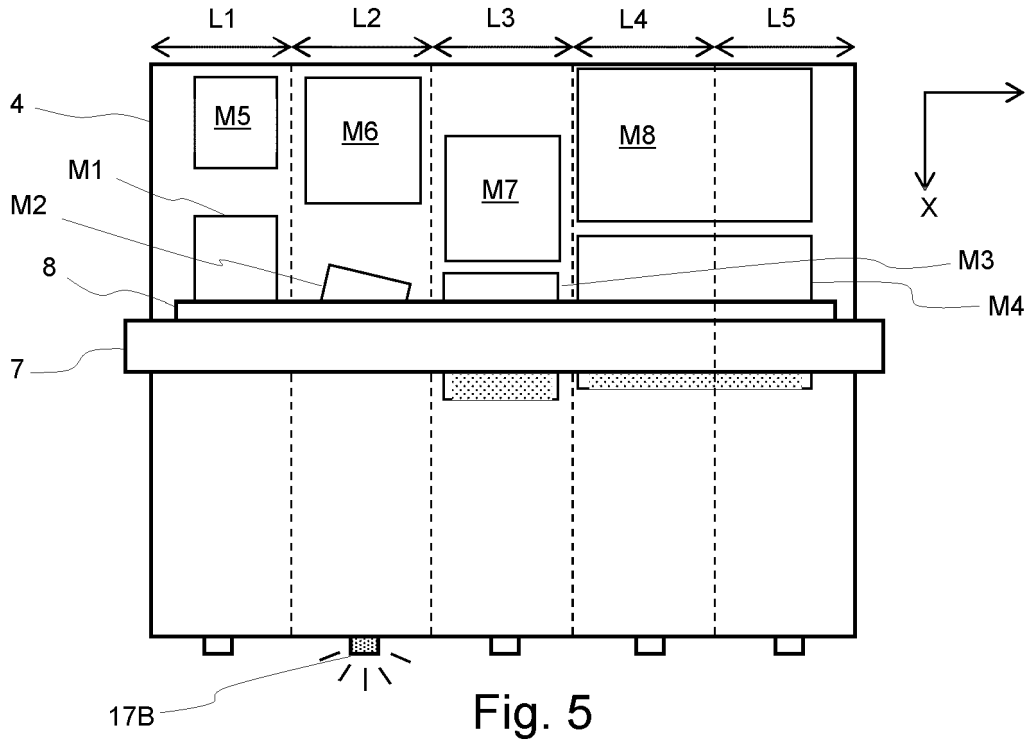
M1
M2
M3
M4
8
7
17B

Fig. 4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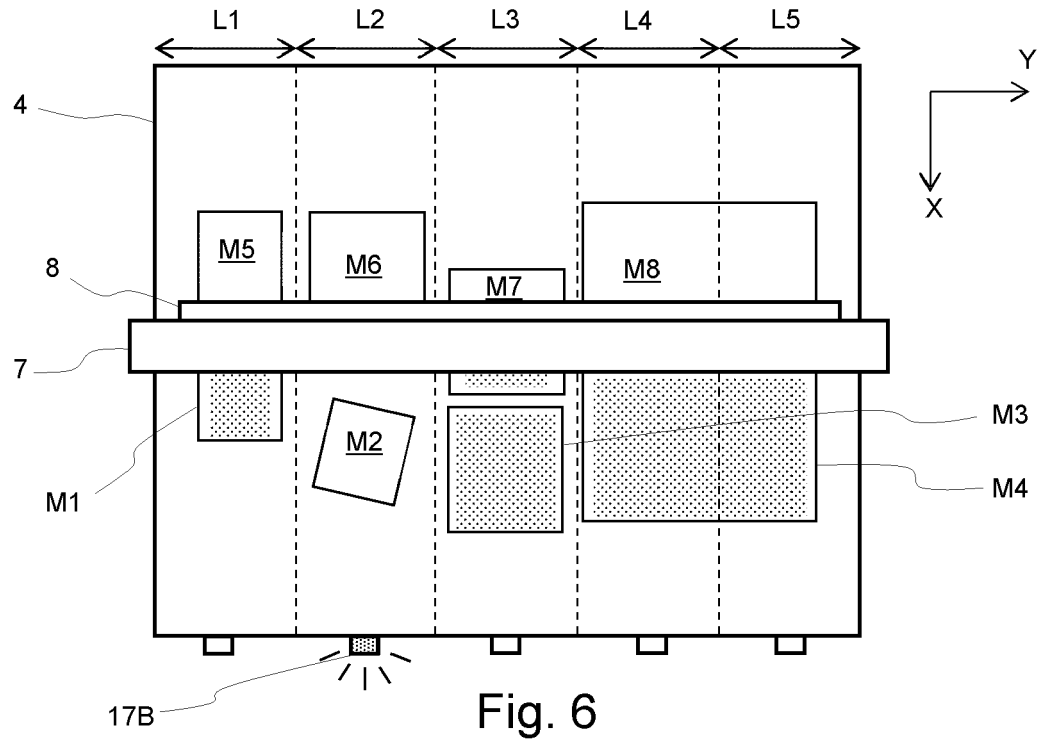
17B

Fig. 5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L4
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7
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M3
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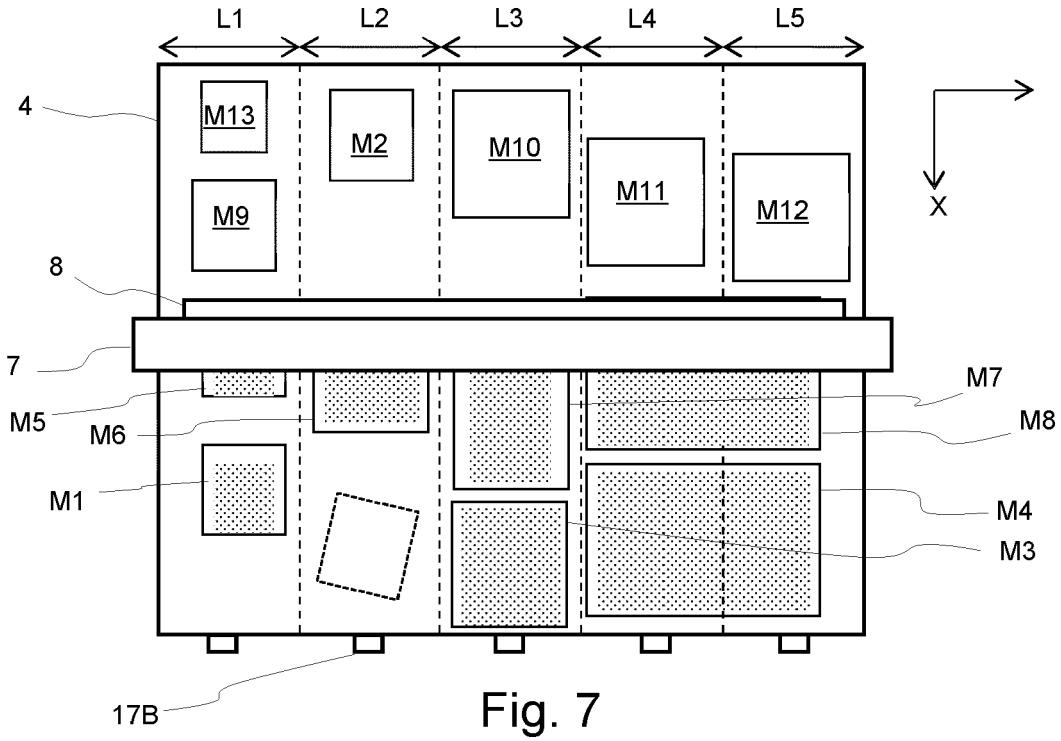
M7
M8
17B

Fig. 6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L3
L4
L5
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7
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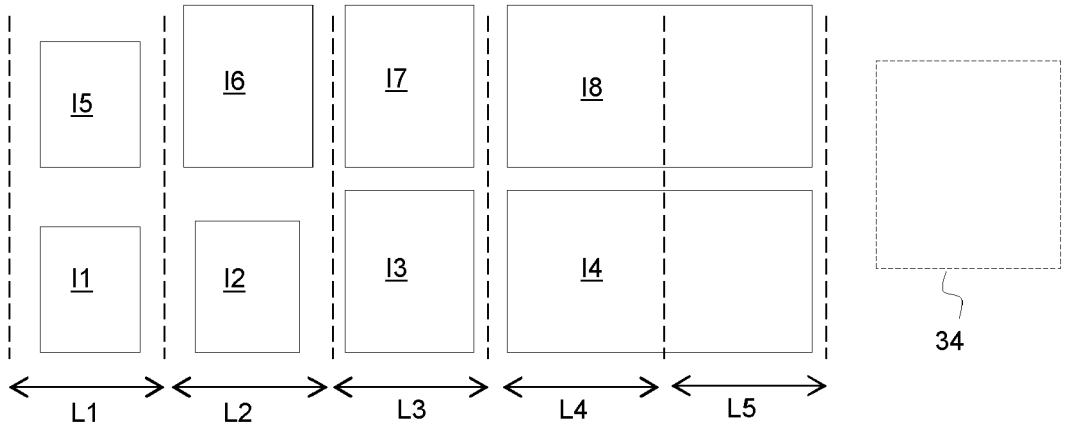
M8
M9
M10
M11
M12
M13
17B

Fig. 7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I8
I1
I2
I3
I4
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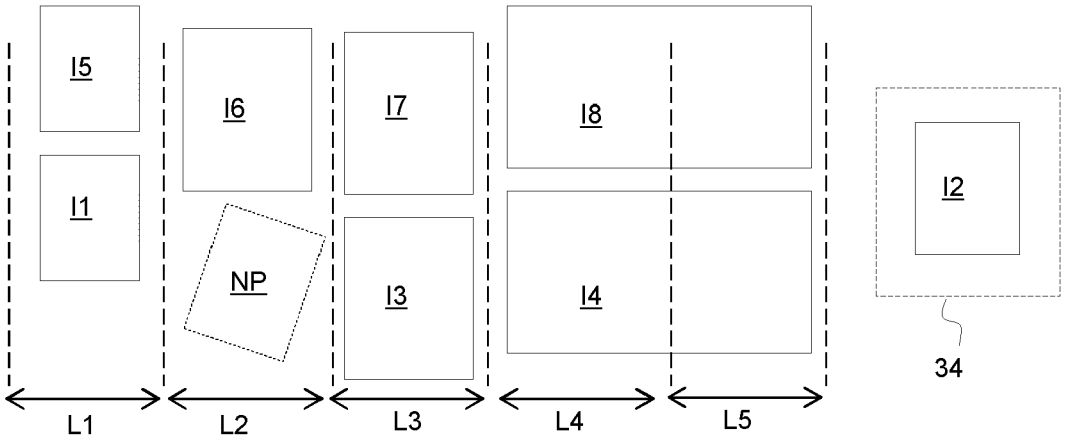
L1
L2
L3
L4
L5

Fig. 8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I2
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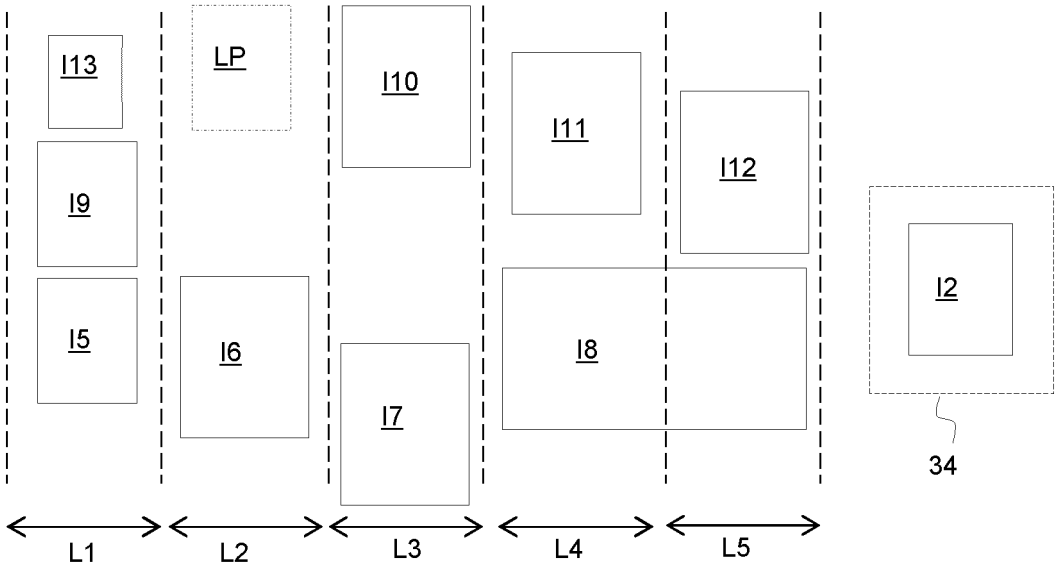
L1
L2
L3
L4
L5

Fig. 9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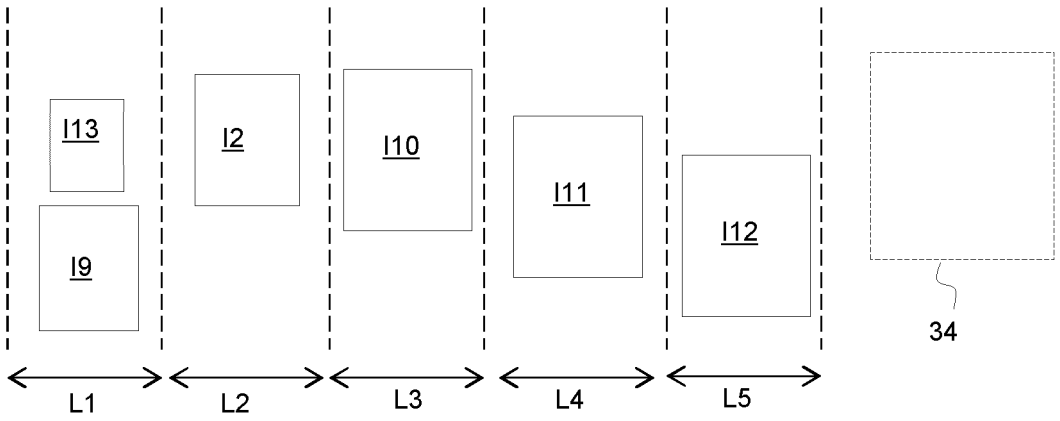
L1
L2
L3
L4
L5

Fig. 10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I9
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L2
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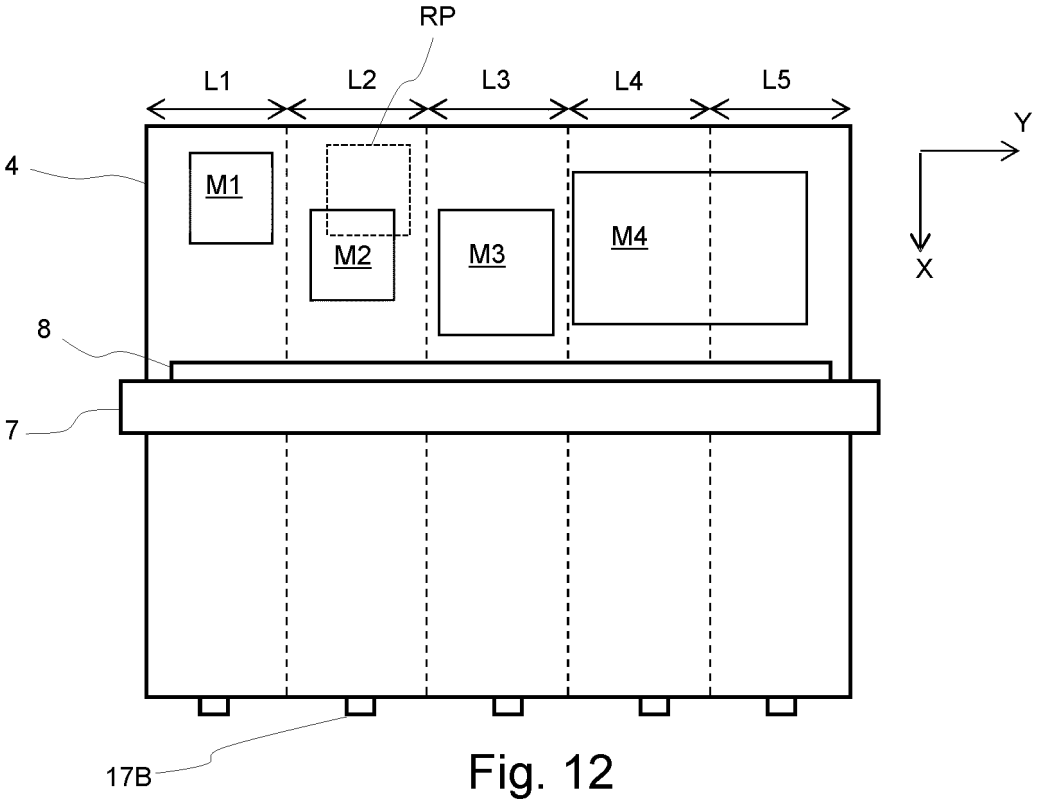
L4
L5

Fig. 11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4
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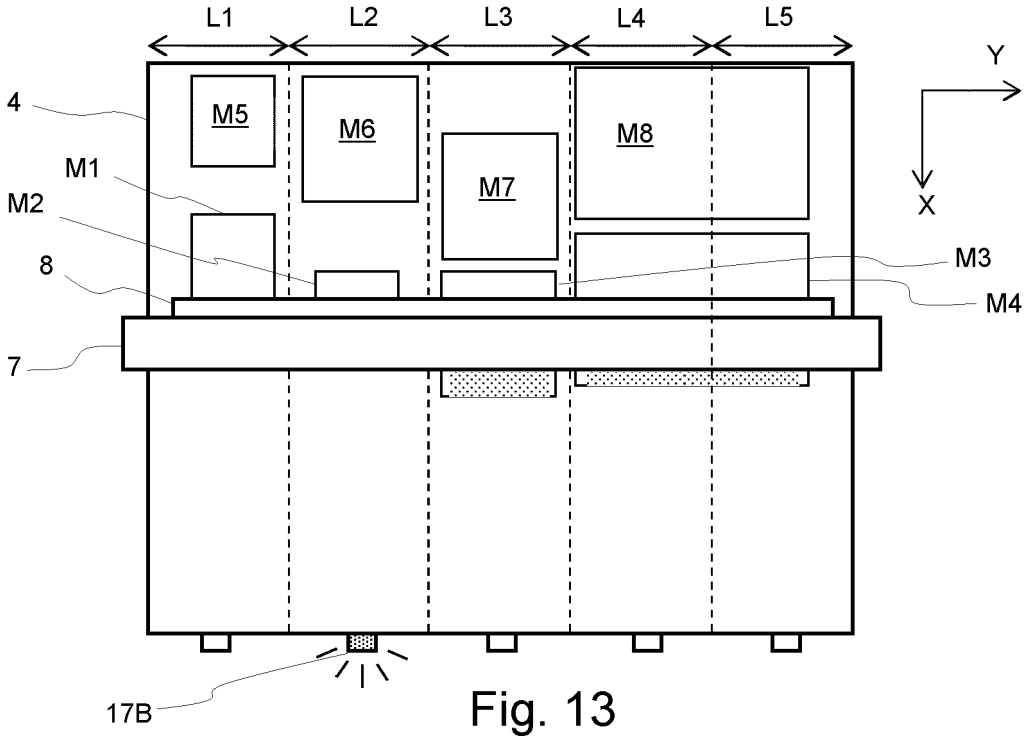
M2
M3
M4
8
7
17B

Fig. 12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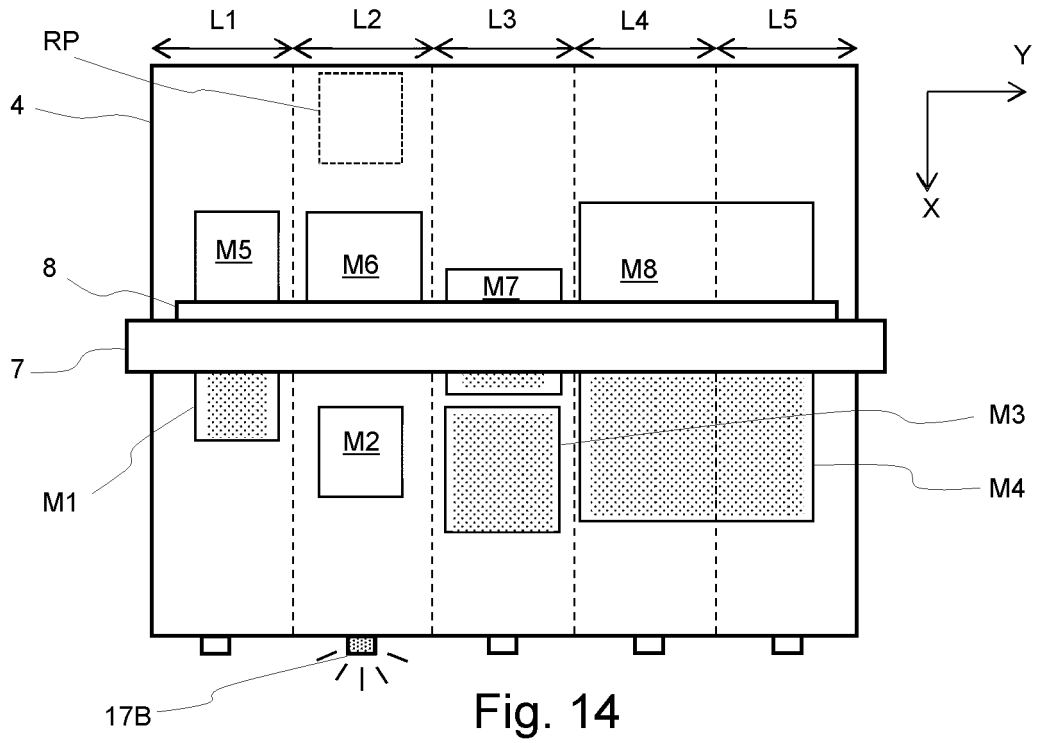
17B

Fig. 13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L4
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M4
17B

Fig. 14

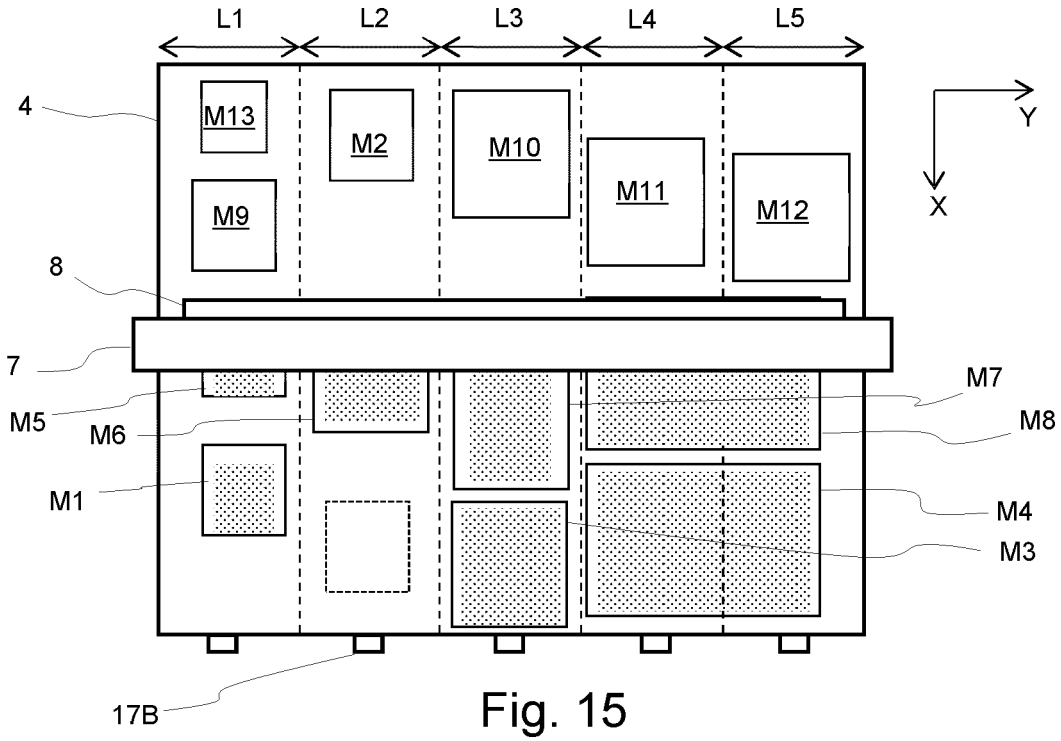
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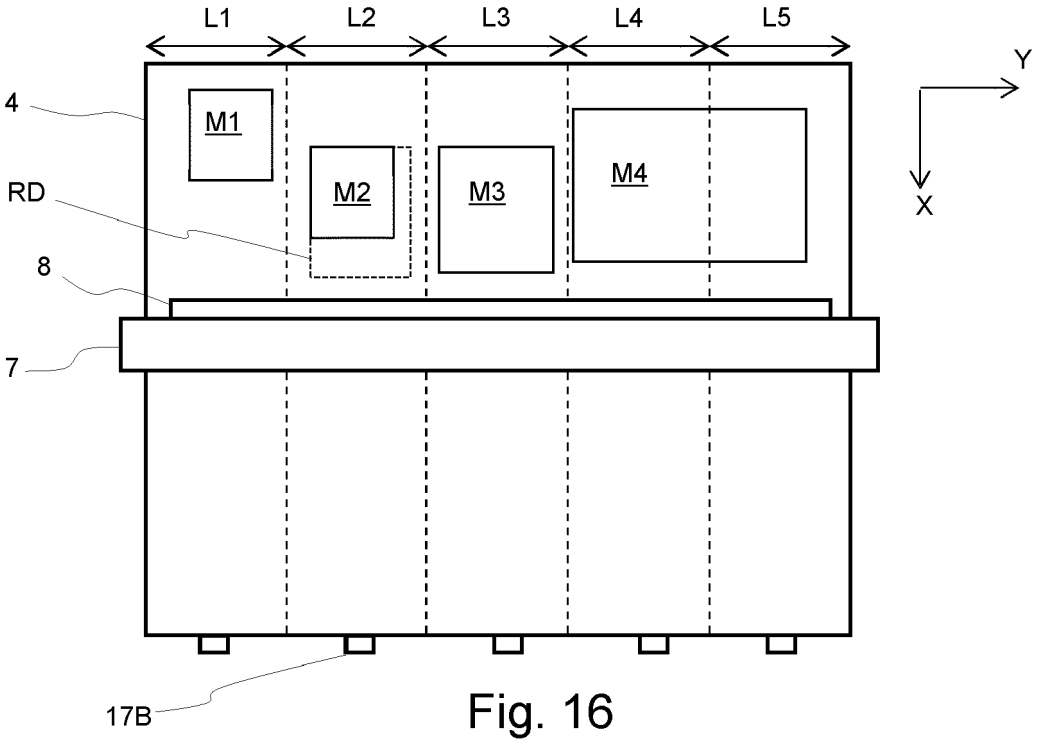
Fig. 15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M1
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M3
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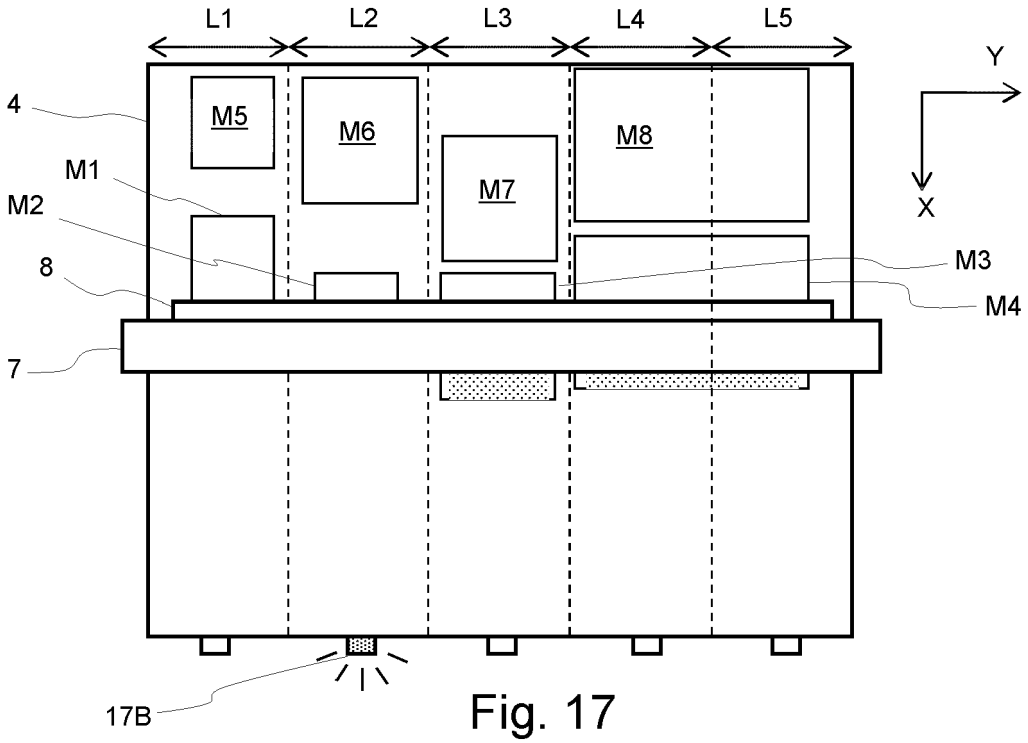
RD
8
7
17B

Fig. 16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17B

Fig. 17

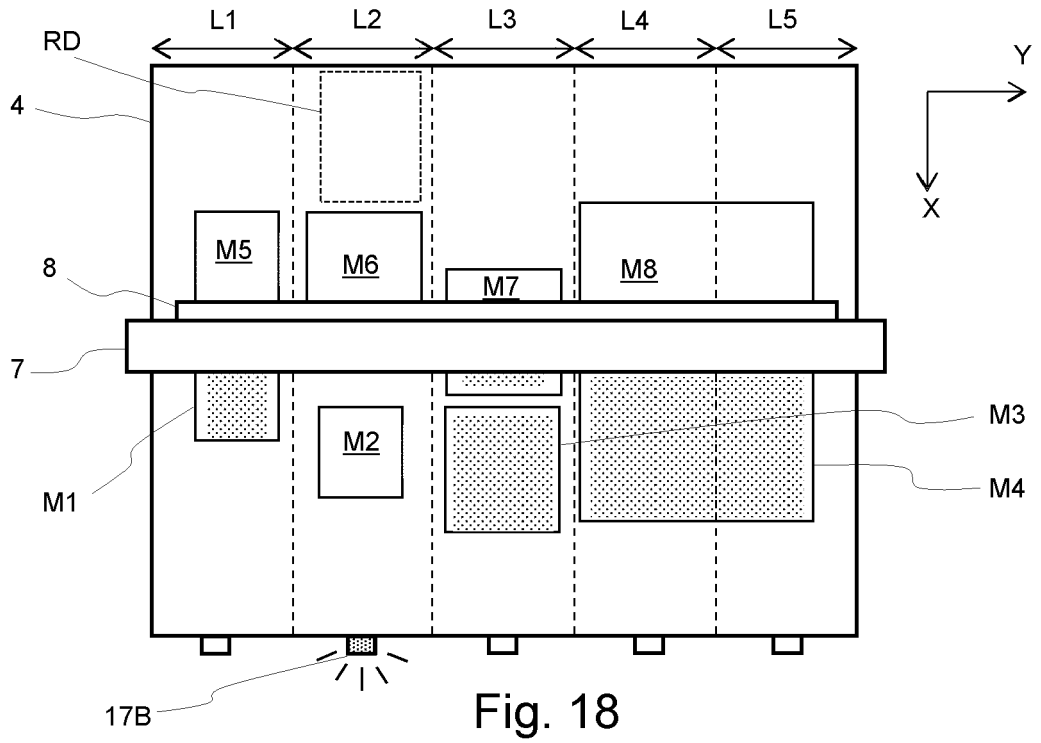
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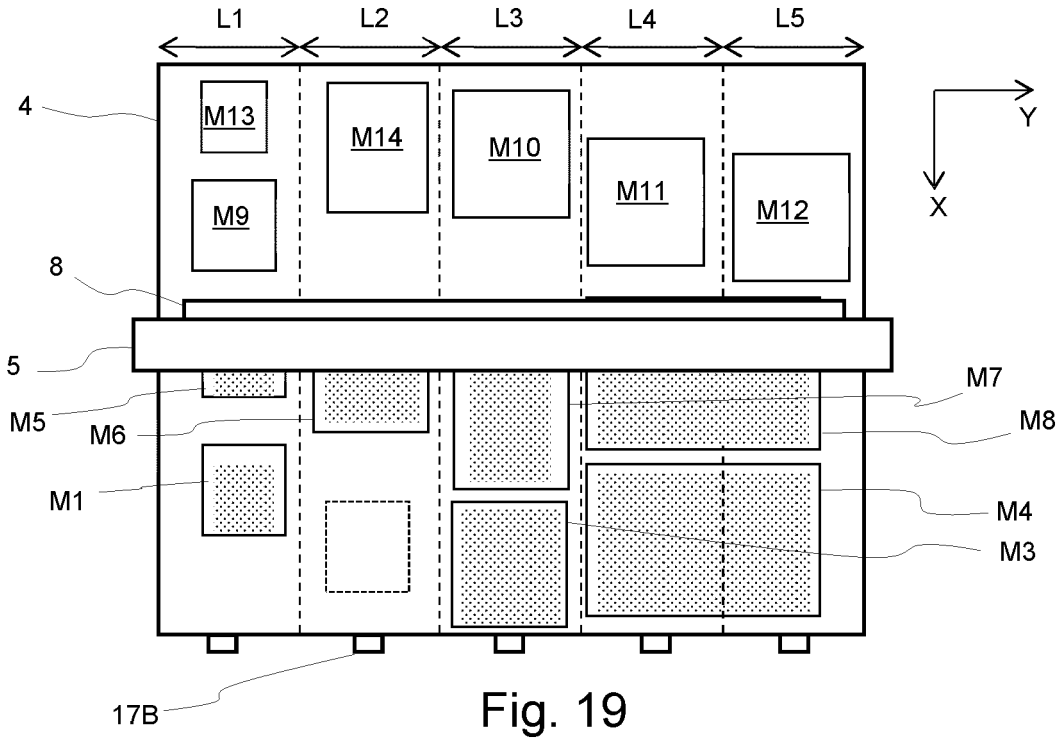
Fig. 18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M6
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M1
M4
M3
17B

Fig. 19

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 5484

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2017/217167 A1 (RABIN NOAM [US] ET AL) 3 August 2017 (2017-08-03) * paragraph [0043]; figure 2 *	1-12	INV. B41J3/62 B41J11/00 B41J13/00 B41J13/08
A	US 2009/007811 A1 (WEINGARTNER PETER [AT]) 8 January 2009 (2009-01-08) * paragraph [0045]; figure 2 *	1-12	
A	US 2017/259595 A1 (AOYAGI HITOSHI [JP] ET AL) 14 September 2017 (2017-09-14) * paragraph [0041] - paragraph [0050]; figures 1-18 *	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	30 August 2023	Loi, Alberto

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30-08-2023

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