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(54) **TRANSPORT DEVICE FOR A SCANNING INKJET PRINTER**

(57) 1. A method of transporting print media (M) past a printing assembly (7), the method comprising the steps of:

- feeding a print medium (M) onto an endless, air permeable transport belt (4) at an input side roller (3A), the input side roller (3A) being positioned on an opposite side of suction assembly (5) with respect to an output side roller (3C);
- the print medium (M) moving over a first suction device (20) of the suction assembly (5) adjacent the input side roller (3A), wherein the first suction device (20) applies a first negative pressure to a portion of the print medium

(M);

- the print medium (M) moving from over the first suction device (20) to over a second suction device (26), which second suction device (26) applies a second negative pressure to the print medium (M), the second negative pressure being smaller than the first negative pressure;
- the print medium (M) moving from over the second suction device (26) to over a third suction device (32) adjacent the output side roller (3C), which third suction device (32) applies a third negative pressure to the print medium (M), the third negative pressure being substantially similar to the first negative pressure.

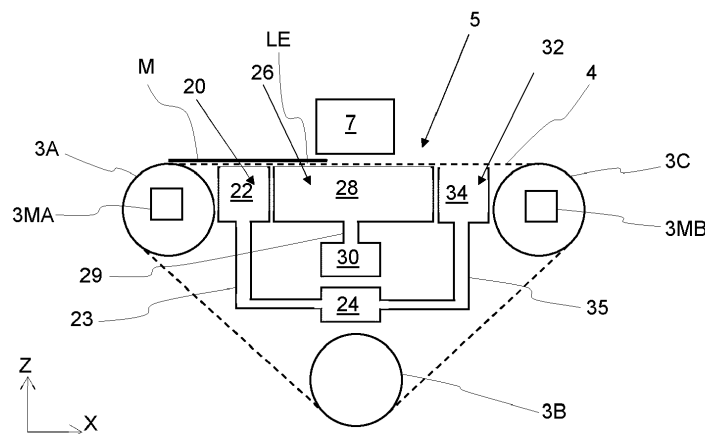


Fig. 5

Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The invention relates to a method of transporting a print medium and to a printer.

2. Description of Background Art

[0002] So-called 'hybrid' printers comprise a transport device configured for selectively transporting web-based print media and individual print substrates past a printing assembly. Such a transport device may comprise an endless, air permeable transport belt supported on a plurality of rollers and extending over a suction assembly. The suction assembly comprises a suction source to generate a negative pressure in a suction chamber adjacent the transport belt. The negative pressure is applied to hold the print medium in position on the transport belt as well to flatten the print medium against the transport belt.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide a low costs and reliable manner for transporting print media through a printer.

[0004] In accordance with the present invention, a method of transporting print media past a printing assembly according to claim 1 and a printer according to claim 8 are provided. The method comprises the steps of:

- feeding a print medium onto an endless, air permeable transport belt at an input side roller, the input side roller being positioned on an opposite side of a suction assembly with respect to an output side roller;
- the print medium moving over a first suction device of the suction assembly, preferably adjacent the input side roller, wherein the first suction device applies a first negative pressure to a portion of the print medium;
- the print medium moving from over the first suction device to over a second suction device of the suction assembly, which second suction device applies a second negative pressure to the print medium, the second negative pressure being smaller than the first negative pressure;
- the print medium moving from over the second suction device to over a third suction device of the suction assembly, preferably adjacent the output side roller, which third suction device applies a third negative pressure to the print medium, the third negative pressure being larger than the second negative pressure, preferably wherein the third negative pressure is substantially similar to the first negative pressure.

[0005] It is the insight of the inventors that greater negative pressures are required at the input and output side rollers, while at the printing assembly higher airflows per unit area are preferred, as these were found to provide an improved flattening of the print medium. It is the further insight of the inventors that by dividing the suction assembly into three suction devices, different pressures may be set as such with a small number of suction sources, thereby achieving a low-costs printer. The greater negative pressures in the first and third suction chambers that are needed for reliably gripping the print medium during feeding and unloading may be achieved by a type first suction source (e.g. a static pressure or high pressure suction source), while the smaller negative pressure in the second suction chamber may be achieved by a different type of suction source more suited to flattening the print medium (e.g. a high airflow suction source). These latter types of suction sources are relatively cheap as compared to suction sources configured to provide both higher pressures and higher airflows. The greater negative pressures in the first and third suction chamber ensure reliable transport when feeding and unloading of the print medium, while the smaller negative pressure in the second suction chamber allows for the application of a suction source that ensures flattening of the print medium. By splitting the suction assembly in this manner, lower costs components can be used. Thereby the object of the present invention has been achieved.

[0006] More specific optional features of the invention are indicated in the dependent claims.

[0007] In an embodiment, the printing assembly extends over the second suction device, specifically over a second suction chamber of the second suction device. The second suction chamber faces the printing assembly. Preferably, the printing assembly comprises inkjet printheads, which are positioned in close proximity to the transport belt to form a narrow print gap through which the print medium may pass in an undeformed state. Deformations in the print medium may cause it to locally contact the printheads, resulting in print artifacts or malfunctioning of the printheads.

[0008] In an embodiment, the second suction device generates a substantially greater airflow per unit area through a support surface of the transport belt than the first or third suction devices. The second suction device may comprise a high airflow suction source. Such high airflow suction sources are generally configured to achieve high flow rates (expressed e.g. in terms of velocity or transported volume per unit time in e.g. m³/s or m/s), but are less suited for achieving great negative pressures. It was found that high flow rates, or the capacity therefor, contribute to flattening the print medium against the transport belt. Preferably, during operation, the relatively greater airflow of the second suction device flattens the print media against the transport belt. It is noted that the high/static pressure suction sources applied for e.g. the first and/or third suction chambers generally are unable to generate such high airflow rates. It

is preferred that the negative pressure in the second suction chamber is preferable no greater than half or a quarter of the negative pressure in the first and/or third suction chambers (relative to atmospheric pressure), while the airflow per unit area through the transport belt over the second suction chamber is at least double that over first and/or third suction chambers. This preferably also applies to a state of the transport belt when not covered by print media. It is noted that the air flows are preferably through the sections of the transport belt currently over the suction chambers.

[0009] In an embodiment, the method further comprises the step of driving the input side roller and/or the output side roller, wherein respectively the relatively greater first and/or third negative pressure hold the print medium onto the transport belt over respectively the first and/or third suction device, such that the print medium moves synchronously with the transport belt. Preferably, the input side roller and/or the output side roller are driven intermittently, such that the transport belt moves stepwise. Print media are loaded at the input side roller and unloaded at the output side roller. During loading, the transport belt should reliably grip the print medium being loaded, even when the print media is only partially over the transport belt, so that it is fed to the printing assembly in the predetermined orientation and/or position. Similarly, the printed print media should be reliably transported to the output location.

[0010] In an embodiment, the first and third suction devices are connected to a common suction source. A single suction source, preferably a static pressure suction source or high pressure suction source, is in fluid connection to both the first and third suction chambers. Using a single suction source for both suction chambers reduces the number of components in the printer and thus the costs.

[0011] A further aspect of the present invention relates to a printer comprising a transport device configured for selectively transporting web-based print media and individual print substrates past a printing assembly,

- wherein the transport device comprises an endless, air permeable transport belt supported on a plurality of rollers and extending over a suction assembly,
- wherein the suction assembly comprises, preferably adjacent the transport belt, a second suction device positioned between a first and a third suction device, as seen in a transport direction of the transport belt, and
- wherein the first and third suction device configured to apply a relatively high negative pressure to a print medium on the transport belt, and wherein the second suction device is configured to apply relatively low negative pressure to a print medium on the transport belt, while generating a relatively high airflow in and/or through at least uncovered areas of the transport belt, such that a portion of the print medium over the second suction device is thereby flattened onto

the transport belt.

[0012] The printer is preferably a 'hybrid' printer. Preferably, the first and third suction device are each positioned adjacent one of the rollers. The higher negative pressures at the input side and output side rollers ensure reliable gripping of the print medium, even when the print medium is only partially positioned over the transport belt. At the second suction device, which is preferably positioned at the printing assembly, most print substrates will be entirely or for their majority be positioned over the transport belt, which allows for reliable gripping with a smaller negative pressure. Since the negative pressure is allowed to be smaller at the second suction device, a high airflow suction source may be applied for generating said negative pressure. The high airflow suction source is capable of generating higher airflows per unit area of the transport belt, which result in a flattening of the print medium by the second suction device. This allows for relatively simple and low-costs yet reliable transport device for a printer.

[0013] In an embodiment, the printing assembly extends over the second suction device.

[0014] In an embodiment, the first and third suction device are each configured to generate respective first and second airflow rates through their respective sections of the transport belt, which first and second airflow rates are smaller than a second airflow rate generated by the second suction device through its respective section of the transport belt during operation, preferably with the transport belt being free of print media. The airflow rate, e.g. a volume of displaced airflow per unit area per unit time, which the second suction device sucks through the transport belt is substantially greater than those of the first and third suction devices, also preferably when print media are present on the transport belt. The first and third suction device are arranged to first maintaining their relatively greater negative pressure, while the second suction device prioritizes greater airflow to flatten the print medium against the transport belt.

[0015] In an embodiment, the printing assembly comprises a scanning printhead carriage reciprocally movable in a scanning direction perpendicular to the transport direction, and wherein the transport device is configured to stepwise transport the print medium in between passes of the printhead carriage. Preferably, the printhead carriage comprises inkjet printheads.

[0016] In an embodiment, the first and third suction device are configured to generate a larger normal force per unit area on respective portions of the print medium as compared to the second suction device, whereas the second suction device is configured to generate a larger airflow underneath respective portions of the print medium, thereby generating a dynamic negative pressure which flattens the respective portions of the print medium to the transport belt.

[0017] In an embodiment, each suction device comprises a respective suction chamber adjacent the trans-

port belt, and wherein the first and third suction chambers of respectively the first and third transport device are in fluid connection to the same suction source. This suction source is preferably a high pressure suction source, specifically a high pressure fan or pressure static fan, also known as a pressure optimized fan. Such fans are arranged to achieve a relatively great negative pressure, though their ability for displacing air (i.e. their flow rates) are relatively low. In contrast, the second suction chamber is preferably connected to a high airflow fan, which is arranged to displace large volumes of air per unit time. The high airflow fan however is less suited to achieve great negative pressures. In another embodiment, the first and third suction devices comprise a (high) pressure static fan and the second suction device comprises a high airflow fan.

[0018] In an embodiment, the suction chambers are arranged to apply their respective negative pressures over substantially a full width of a support surface of the transport belt in a scanning direction. It will be appreciated that each suction chamber may comprise walls or valves that allow compartmentalization to reduce the width of the print area to conform to width dimensions of different print media.

[0019] In an embodiment, the second suction chamber is positioned adjoining and/or neighbouring the first and third suction chamber in the transport direction. The suction chambers form a single unit, wherein the second suction chamber is neighbouring the first and third suction chambers on opposite sides in the transport direction.

[0020] 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

[0021] 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 perspective, schematic of a printer according to the present invention in a substrate printing mode;

Fig. 2 is a perspective, schematic of a printer according to the present invention in a web printing mode; Figs. 3 to 7 are cross-sectional, schematic views the printer in Fig. 1 during different stages of transporting a print medium;

Fig. 8 is a schematic close-up of a print medium on

a transport belt of the printer in Fig. 1; and Fig. 9 is a graph illustrating the different pressures and airflows in the printer in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The present invention will now be described with reference to the accompanying drawings, wherein the same reference numerals have been used to identify the same or similar elements throughout the several views.

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 transport means for receiving and transporting the print medium 15 along the inkjet printing assembly 7. In

[0024] Fig. 1, the transport means 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 8, such as a CCD camera, to determine the relative position of belt 4 and/or the print medium 15. Data from said sensor 8 may be applied to control the position of the belt 4 and/or the print medium 15. The belt 4 is further provided with through-holes and a suction assembly 5 in connection with a suction source (not shown), such that a negative pressure may be applied to the print medium 15 via the through-holes in the belt 4. The negative pressure 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 transport means, such as rollers, steppers, etc., may alternatively be applied. The print medium 15 may be transported stepwise and/or in continuous movement.

[0025] 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.

[0026] 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 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 8, the release timing of the marking material may be adjusted.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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 control unit 12 connected to the printer 1. The control unit 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 control unit 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.

15 Hybrid printing system

[0031] 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 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.

40 Transport device

[0032] Fig. 3 shows a cross-sectional side view of the printer 1 in Figs. 1 and 2. The input side roller 3A is provided with a drive 3MA, preferably a step motor, for rotating the input side roller 3A. Another drive 3MB may be provided at the output side roller 3C as well, though it will be clear to the skilled person that a single drive 3MA, 3MB will also suffice for rotating the transport belt 4.

[0033] The suction assembly 5 comprises three suction devices 20, 26, 32. Each suction device 20, 26, 32 comprises a respective suction chamber 22, 28, 34. The suction device 26 (the suction chamber 28) is provided so as to face the printing assembly 7. The suction chambers 22, 28, 34 are positioned besides one another in between the input side roller 3A and the output side roller 3C. The suction chambers 22, 28, 34 comprise an open side which faces the transport belt 4. Preferably, support structures for supporting the transport belt 4 have been incorporated into the suction chambers 22, 28, 34 at their

open sides for supporting the transport belt 4 and maintaining it in a substantially planar state between the input side roller 3A and the output side roller 3C. In this manner, a support surface for print media is defined. The support structures may comprise support beams or a perforated plate to support the transport belt 4, while allowing air to pass into the respective suction chambers 22, 28, 34.

[0034] The first suction chamber 22 is positioned adjacent the input side roller 3A, preferably directly downstream of the input side roller 3A. Similarly, the third suction chamber 34 is positioned near or at the output side roller 3C. In between the first and third suction chambers 22, 34, the second suction chamber 28 is positioned opposite the printing assembly 7. Preferably, the second suction chamber 28 is directly adjacent the first or third suction chambers 22, 34 on each of its sides in the transport direction X. The second suction chamber 28 substantially extends from the first suction chamber 22 to the third suction chamber 34, filling the entire or at least a substantial majority of the space between the first and third suction chambers 22, 34. A length of the second suction chamber 28 measured in the transport direction X is greater than that of the first and/or third suction chambers 22, 34, preferably at least 20%, more preferably at least 50%, very preferably at least twice greater, and even more preferably thrice as long.

[0035] The first and third suction chambers 22, 34 are in fluid connected to the static pressure suction source 24 via their respective lines 23, 35. The static pressure suction source 24 is configured to achieve a relatively great negative pressure as compared to that in the second suction chamber 28. The static pressure suction source 24 is for example a static pressure fan. In consequence, when the first or third suction chamber 22, 34 is covered by a print medium M, the relatively great negative pressure results in a relatively large normal force per unit area on the print medium M. Thereby, the print medium M is held firmly against the transport belt 4, resulting in sufficiently high frictional forces between the transport belt 4 and the print medium M. This prevents the print medium M from shifting with respect to the transport belt 4, so that it can be accurately transported past the printing assembly 7. At the input and output side rollers 3A, 3C, the print medium M is fed onto or unloaded from the transport belt 4. Reliable holding of the print medium M by the transport belt 4 in those regions is required to ensure that the print medium M does not slip over the transport belt 4 and becomes displaced and/or misaligned. Errors in position and/or orientation may result in images being printed out-of-place on the print medium M. Unreliable gripping when feeding the print medium M onto the transport belt 4 may also introduce deformations, such as wrinkles, in the print medium M.

[0036] In contrast, the high airflow suction source 30 connected to the second suction chamber 28 is configured to generate a high airflow per unit area through the transport belt 4 in the region over the second suction chamber 28. As a consequence of this configuration, the

high airflow suction source 30 achieves a smaller negative pressure in the second suction chamber 28. However, the ability to rapidly generate a relatively greater airflow per unit area was found to provide an flattening effect that helps maintain the print medium M flat against the transport belt 4. Thereby, the chance of the print medium M colliding with the printing assembly 7 is reduced. Additionally, the relatively small negative pressure in the second suction chamber 28 results in a relatively small normal force on the transport belt 4 over the second suction chamber 28, thereby reducing the friction between the transport belt 4 and its support structure. This allows for improved control of the transport belt 4 and/or the implementation of less powerful drives 3MA, 3MB, thereby reducing the total costs of the printer 1.

[0037] The third suction chamber 34 is positioned at the output side roller 3C and acts similar to the first suction chamber 22 to apply a relatively great negative pressure to the print medium M when its over the third suction chamber 34. The third suction chamber 34 is connected to the same high pressure suction source 24 as the first suction chamber 22, thereby reducing the number of suction sources 24, 30 required for the printer 1.

[0038] Fig. 4 in combination with Fig. 9 illustrates the operation of the first suction device 20, when a print medium M is fed onto the transport belt 4. The printer medium M is fed over the input side transport roller 3A until its leading edge LE is over the first suction chamber 22. A relatively great negative pressure has been established in the first suction chamber 22 by the static pressure suction source 24. As the static pressure suction source 24 is not suited for generating large airflows, the static pressure suction source 24 is preferably activated well before feeding the print medium M, allowing the high pressure suction source 24 sufficient time to establish the greater negative pressure in the first suction chamber 22, as indicated by the graph S1 in Fig. 9. As the leading edge LE of the print medium M moves over the first suction chamber 22, the negative pressure in the first suction chamber 22 results in a normal force Fn1 on the portion of the print medium M over the first suction chamber:

$$F_{n1} = P_1 \times A_1,$$

wherein P1 is the negative pressure in the first suction chamber 22 and A1 the surface area of the portion of the print medium M currently over the first suction chamber 22. The normal force Fn1 results in a friction force between the print medium M and the transport belt 4:

$$F_{f1} = \mu \times F_{n1},$$

wherein μ is the coefficient of friction of the transport belt 4, specifically with respect to the print medium M. The friction force Ff1 should be sufficiently great to prevent slipping between the print medium M and the transport

belt 4, so that the print medium M is accurately transported by the transport belt 4. Especially, since the transport belt 4 is preferably moved stepwise, the friction force Ff1 should be great enough to ensure that the print medium M moves synchronously with the transport belt 4. To that end, the negative pressure P1 in the first suction chamber 22 is selected to be sufficiently great to achieve a friction force Ff1 that ensures that the transport belt 4 securely grips the print medium M, at least before the leading edge LE of the print medium M reaches the downstream end of the first suction chamber 22.

[0039] Fig. 5 in combination with Fig. 9 illustrates the print medium M progressing over the second suction chamber 28. The relatively great negative pressure P1 in the first suction chamber 22 ensures that the print medium M is gripped securely by the transport belt 4, which allows the leading edge LE of the print medium M to progress over the second suction chamber 28. In the second suction chamber 28, the negative pressure P2 is significantly smaller (i.e. closer to atmospheric pressure) than the pressure P1 in the first suction chamber 22, as it is connected to the high airflow suction source 30. In consequence, the airflow per unit area through uncovered area(s) of the transport belt 4 and/or porous areas of the print medium M is much larger than at the first suction chamber 22, as indicated by the graph S2 in Fig. 9. This increased airflow capacity contributes to flattening the print medium M, as illustrated in Fig. 8.

[0040] Fig. 8 shows a portion of the print medium M over the second suction chamber 28. In Fig. 9 the leading edge LE is momentarily released from the transport belt 4. The high airflow suction source 30 is the able to swiftly generate a relatively large airflow AF that passes underneath the released leading edge LE into the second suction chamber 28. Thereby, the airflow AF causes the velocity of the air underneath the leading edge LA to be momentarily increased. That increase in velocity changes the dynamic pressure under the leading edge LE and results in a momentary decrease of the static pressure underneath the leading edge LE, as a consequence of Bernoulli's principle as commonly known in Fluid Dynamics textbooks. The decreased static pressure causes a downward force which pulls the leading edge LE back against the transport belt 4. Similar mechanics apply to maintain other areas of the print medium M flat against the transport belt 4.

[0041] It is further noted that the area A2 of the second suction chamber 28 is greater than that of the first and/or third suction chambers 22, 34. The larger area of the second suction chamber 28 allows for a larger area A2 of the print medium M to be exposed to the negative pressure P2 in the second suction chamber 28. The friction force Ff2 between the print medium M and the transport belt 4 over the second suction chamber 28 is:

$$Ff2 = \mu \times P2 \times A2.$$

[0042] Since the negative pressure P2 is smaller, the normal force Fn2 on the print medium M:

$$Fn2 = P2 \times A2,$$

will preferably also be smaller, at least per unit area. This is advantageous as the normal force also presses the print belt 4 against its support structures, causing friction between the transport belt 4 and the support structures. By maintaining a smaller negative pressure P2 in the second suction chamber 28, the friction between the transport belt 4 and its support structures may be kept small, despite the relatively large area of the second suction chamber 28.

[0043] Fig. 7 in combination with Fig. 9 illustrates the print medium M moving over the third suction chamber 34. The third suction chamber 34 is connected to the high pressure suction source 24 and in consequence operates similar to the first suction chamber 22, but for the output side roller 3C. The same negative pressure P1 is applied to the third suction chamber 34, though in different embodiments the pressure in the third suction chamber 34 may differ from that in the first suction chamber 22. The relatively high negative pressure in the third pressure chamber 34 ensures that the print medium M is reliably transported by the transport belt 4 until it is handed over to a further transport device or handled by an operator, even when the print medium M extends only partially over the transport belt 4.

[0044] 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.

[0045] 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 under-

stood 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.

[0046] 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 transporting print media (M) past a printing assembly (7), the method comprising the steps of:

- feeding a print medium (M) onto an endless, air permeable transport belt (4) at an input side roller (3A), the input side roller (3A) being positioned on an opposite side of suction assembly (5) with respect to an output side roller (3C);
- the print medium (M) moving over a first suction device (20) of the suction assembly (5), wherein the first suction device (20) applies a first negative pressure to a portion of the print medium (M);
- the print medium (M) moving from over the first suction device (20) to over a second suction device (26), which second suction device (26) applies a second negative pressure to the print medium (M), the second negative pressure being smaller than the first negative pressure;
- the print medium (M) moving from over the second suction device (26) to over a third suction device (32), which third suction device (32) applies a third negative pressure to the print medium (M), the third negative pressure being larger than the second negative pressure.

2. The method according to claim 1, wherein the printing assembly (7) extends over the second suction device (20).
3. The method according to any of the preceding claims, wherein the second suction device (20) generates a substantially greater airflow per unit area through a support surface of the transport belt than the first or third suction devices (26, 32).
4. The method according to claim 2, wherein the relatively greater airflow of the second suction device (20) flattens the print medium (M) against the transport belt (4).

5. The method according to any of the preceding claims, further comprising the step of driving the input side roller (3A) and/or the output side roller (3C), wherein respectively the relatively greater first and/or second negative pressure holds the print medium (M) onto the transport belt (4) over respectively the first and/or third suction device (20, 32), such that the print medium (M) moves synchronously with the transport belt (4).

6. The method according to claim 5, wherein the input side roller (3A) and/or the output side roller (3C) are driven intermittently, such that the transport belt (4) moves stepwise.

7. The method according to any of the preceding claims, wherein the first and third suction devices (20, 32) are connected to a common suction source (24).

8. A printer (1) comprising a transport device configured for selectively transporting web-based print media and individual print substrates past a printing assembly (7),

- wherein the transport device comprises an endless, air permeable transport belt (4) supported on a plurality of rollers (3A-3C) and extending over a suction assembly (5),
- wherein the suction assembly (5) comprises, , a second suction device (26) positioned between a first and third suction device (20, 32), as seen in a transport direction (X) of the transport belt (4), and
- wherein the first and third suction device (20, 32) are configured to apply a relatively high negative pressure to a print medium (M) on the transport belt (4), and wherein the second suction device (26) is configured to apply relatively low negative pressure to the print medium (M) on the transport belt (4), while generating a relatively high airflow through at least uncovered areas of the transport belt (4), such that a portion of the print medium (M) over the second suction device (20) is thereby flattened onto the transport belt (4).

9. The printer (1) according to claim 8, wherein the first and third suction device (20, 32) are each configured to generate respective first and second airflow rates through their respective sections of the transport belt (4), which first and second airflow rates are smaller than a second airflow rate generated by the second suction device (20) through its respective section of the transport belt (4) during operation, preferably with the transport belt (4) being free of print media (M).
during operation an area of the second suction de-

vice (26) at the transport belt (4) is greater than the respective area of the first and/or third suction device (20, 32).

10. The printer (1) according to claim 8, wherein the printing assembly (7) comprises a scanning printhead carriage reciprocally movable in a scanning direction (Y) perpendicular to the transport direction (X), and wherein the transport device is configured to step-wise transport the print medium (M) in between passes of the printhead carriage. 5
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11. The printer (1) according to any of the claims 8 to 10, wherein the first and third suction device (20, 32) are configured to generate a larger normal force per unit area on respective portions of the print medium (M) as compared to the second suction device (26), whereas the second suction device (26) is configured to generate a larger airflow underneath respective portions of the print medium (M), thereby generating a dynamic negative pressure which flattens the respective portions of the print medium (M) to the transport belt (4). 15
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12. The printer (1) according to any of the claims 8 to 11, wherein each suction device (20, 26, 32) comprises a respective suction chamber (22, 28,, 34) adjacent the transport belt (4), and wherein the first and third suction chambers (22, 34) of respectively the first and third suction device (20, 32) are in fluid connection to the same suction source (24). 25
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13. The printer (1) according to claim 12, wherein the suction chambers (22, 28, 34) are arranged to apply their respective negative pressure over substantially a full width of a support surface of the transport belt (4) in a scanning direction. 35
14. The printer (1) according to claim 13, wherein the second suction chamber (28) is positioned neighbouring the first and third suction chamber (22, 34) in the transport direction (X). 40
15. The printer (1) according to any of the preceding claims, wherein the first and third suction devices (20, 32) comprise a pressure static pressure fan (24) and the second suction device (26) comprises a high airflow fan (30). 45

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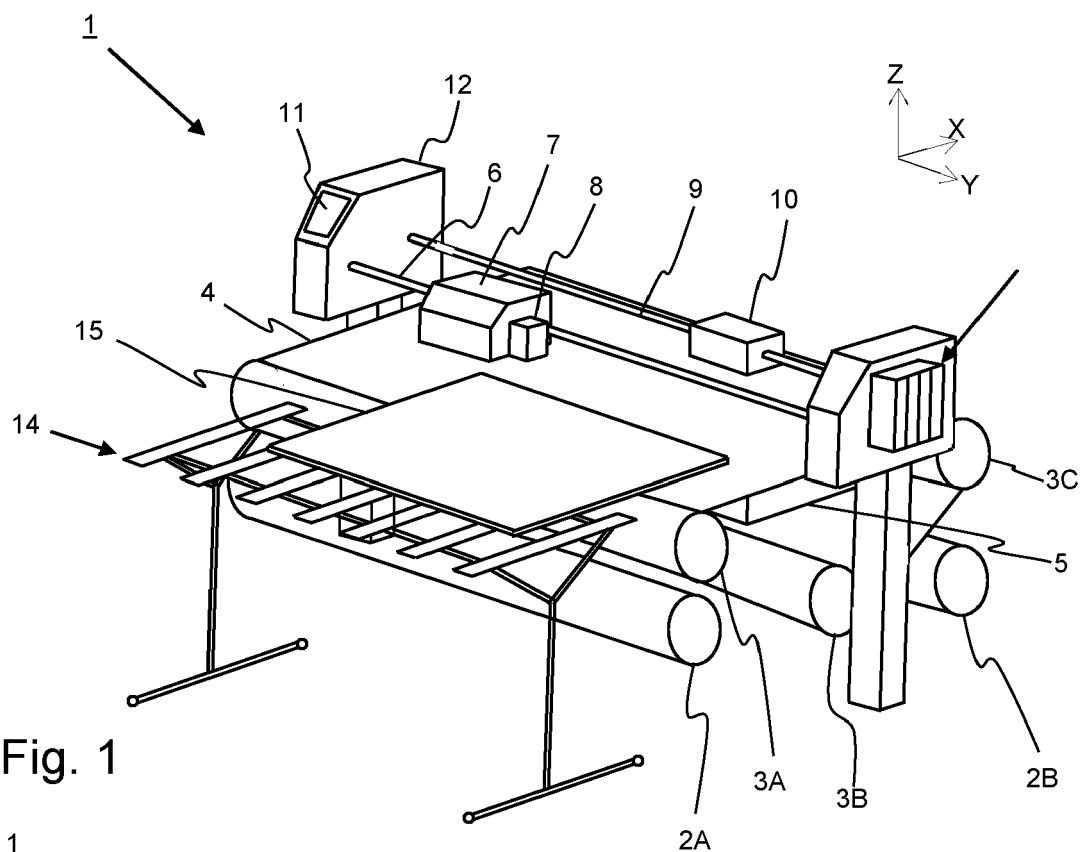


Fig. 1

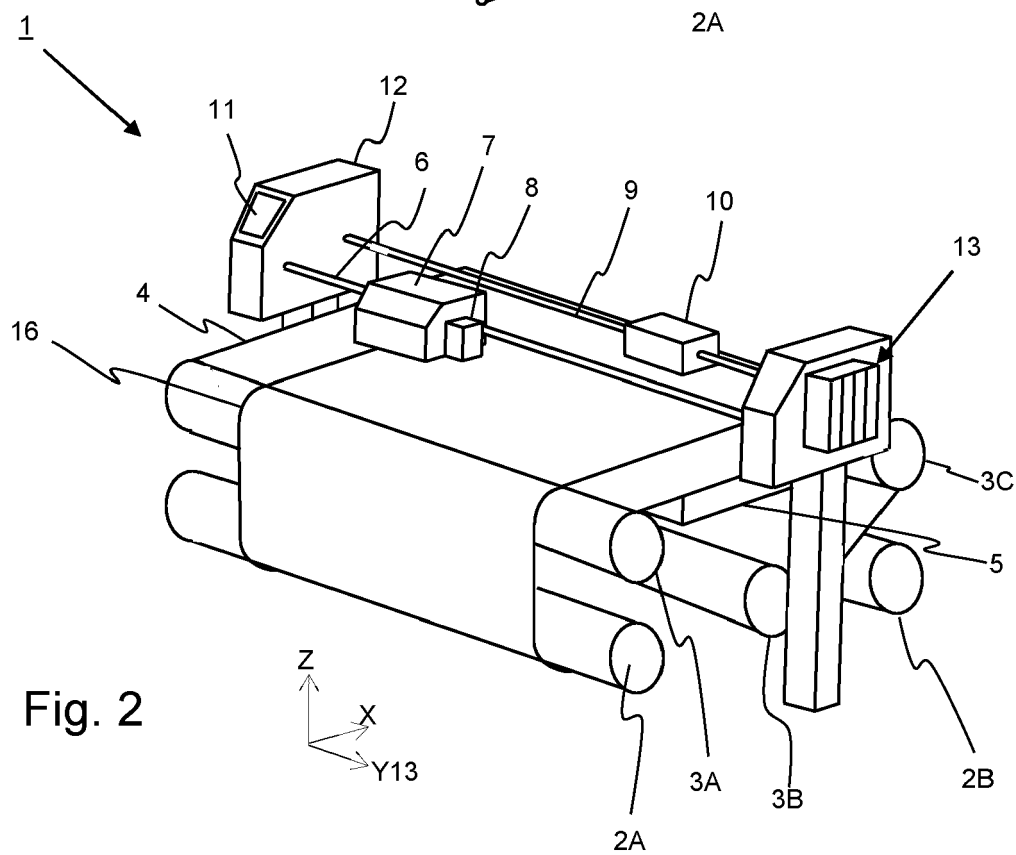


Fig. 2

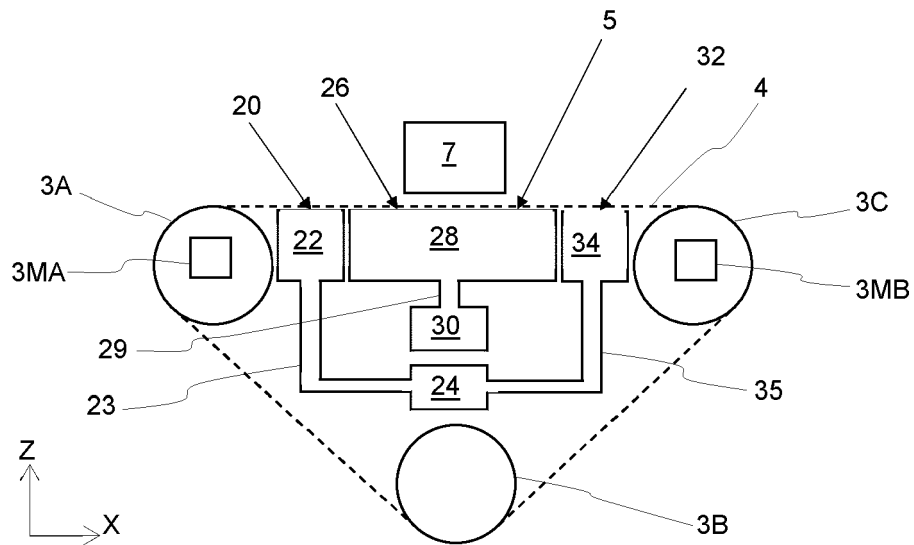


Fig. 3

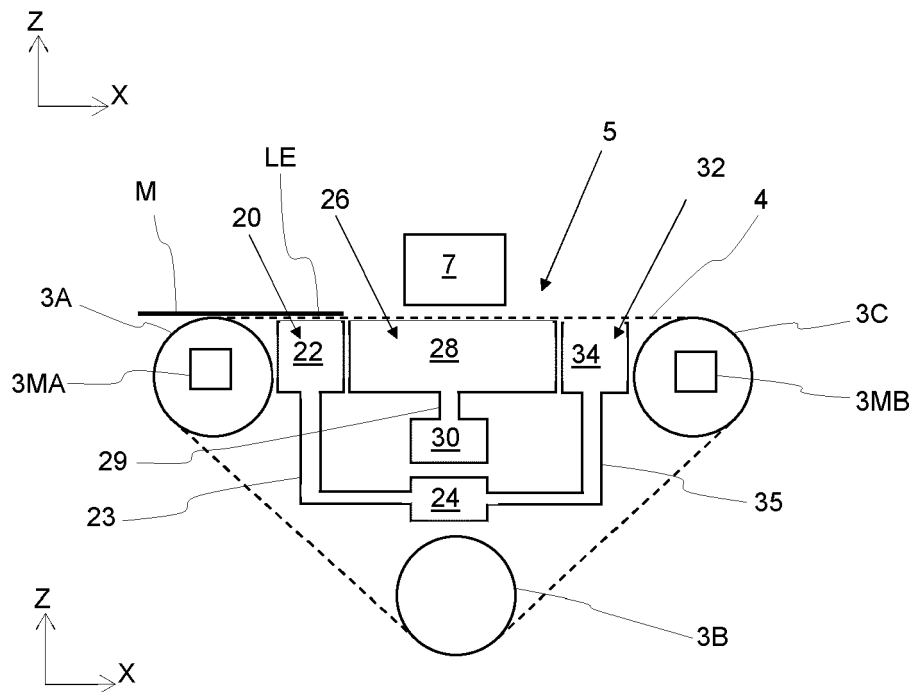


Fig. 4

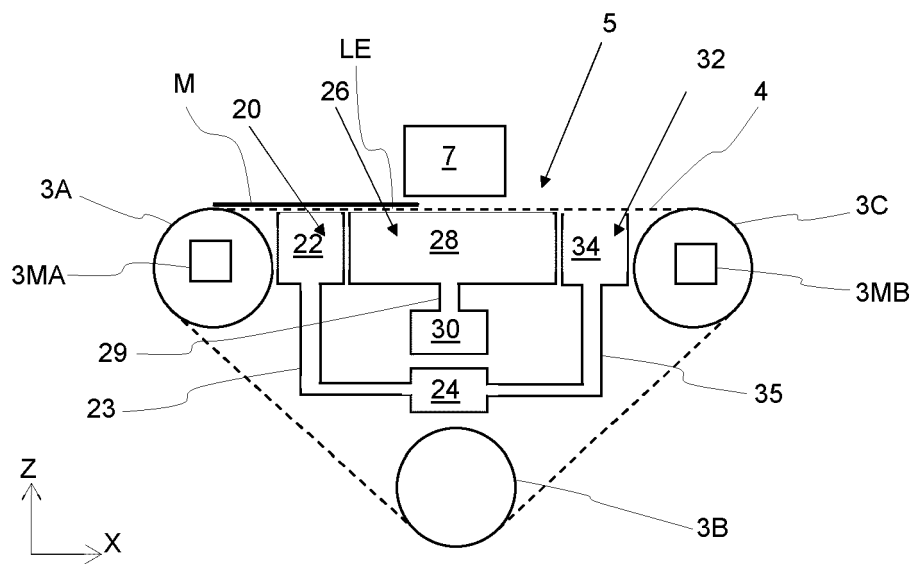


Fig. 5

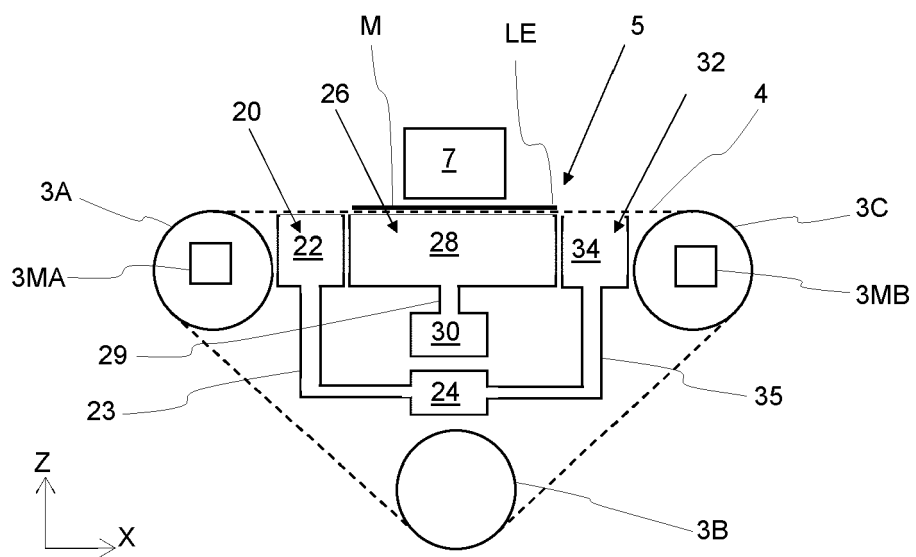


Fig. 6

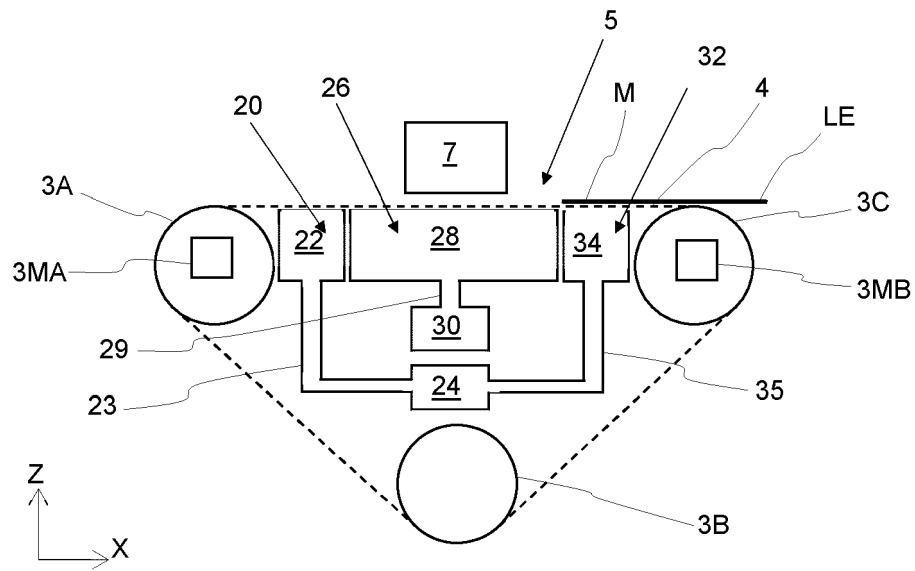


Fig. 7

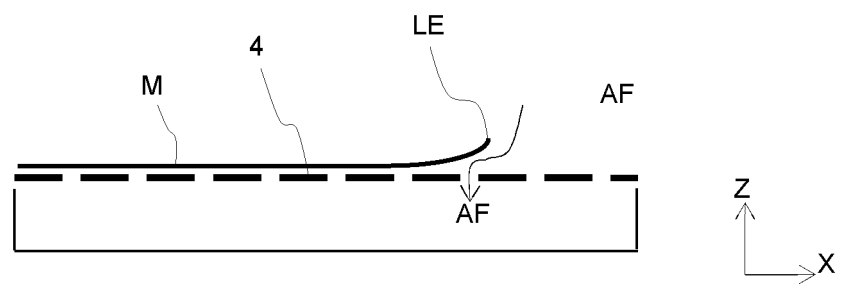


Fig. 8

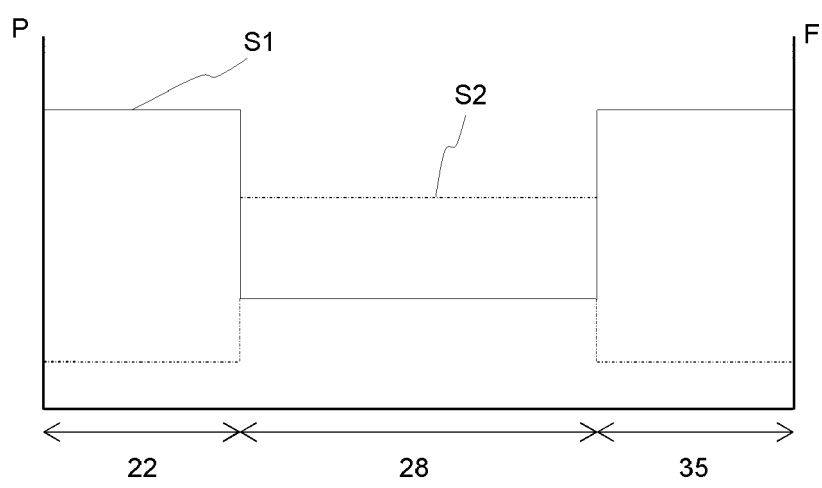


Fig. 9



EUROPEAN SEARCH REPORT

Application Number

EP 23 15 4215

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2020/009884 A1 (MUNENAKA TAIYA [JP]) 9 January 2020 (2020-01-09)	1, 3-15	INV. B41J11/00
Y	* paragraphs [0051], [0054], [0080]; figures 1, 3 *	2	
X	US 2009/244242 A1 (SAWADA KEISHI [JP]) 1 October 2009 (2009-10-01) * figure 4 *	1, 2, 5-8, 11	
X	US 2022/041390 A1 (HAENEN MARCEL J H M [NL] ET AL) 10 February 2022 (2022-02-10) * paragraphs [0035], [0036]; figure 1 *	1, 8	
Y	US 2020/156365 A1 (BERNARD ANDREAS [DE] ET AL) 21 May 2020 (2020-05-21) * figure 19c *	2	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B41J
Place of search			Examiner
The Hague			Loi, Alberto
Date of completion of the search			
23 June 2023			
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EPO FORM 1503 03.82 (P04C01)

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ON EUROPEAN PATENT APPLICATION NO.**

EP 23 15 4215

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020009884 A1	09-01-2020	JP WO2018163590 A1	26-12-2019
		US 2020009884 A1	09-01-2020
		WO 2018163590 A1	13-09-2018
US 2009244242 A1	01-10-2009	CN 101544111 A	30-09-2009
		JP 5125678 B2	23-01-2013
		JP 2009234017 A	15-10-2009
		US 2009244242 A1	01-10-2009
US 2022041390 A1	10-02-2022	EP 3962845 A1	09-03-2022
		JP 2022530954 A	05-07-2022
		US 2022041390 A1	10-02-2022
		WO 2020225164 A1	12-11-2020
US 2020156365 A1	21-05-2020	CN 111372780 A	03-07-2020
		DE 102017212987 A1	31-01-2019
		EP 3658378 A1	03-06-2020
		IL 270968 A	30-01-2020
		JP 6844040 B2	17-03-2021
		JP 2020524120 A	13-08-2020
		US 2020156365 A1	21-05-2020
		WO 2019020434 A1	31-01-2019