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(71) Applicant: **HELIOSONIC GMBH** [DE/DE]; Abelstraße 43, 46483 Wesel (DE).

(72) Inventor: **LEHMANN, Udo**; ALTANA Management Services GmbH IP Department, 46483 Wesel (DE).

(74) Agent: **ALTANA IP DEPARTMENT**; ALTANA Management Services GmbH Abelstraße 45, 46483 Wesel (DE).

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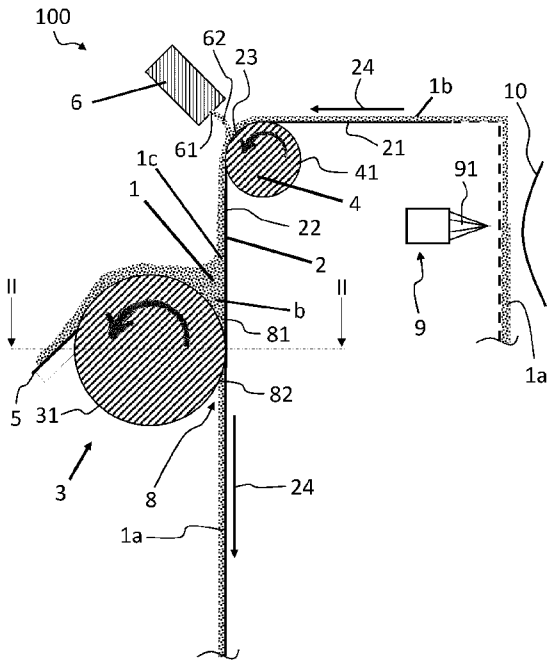

Fig. 1

(57) Abstract: A printing device (100, 100') and a print method are provided. The printing device (100, 100') comprises: a colorant carrier (2); a delivery device (9) arranged to deliver at least part of a colorant (1a) from the colorant carrier (2) to a substrate (10) or a transmission means; a transfer device (6, 46) arranged to transfer fresh colorant (62) from a reservoir to the colorant carrier (2) in order to form, on the colorant carrier (2), an excess printing substance (1c) including fresh colorant (62) and at least part of the colorant (1b) not delivered by the delivery device (9); and a thickness adjuster (3) arranged to adjust a thickness of the excess printing substance (1c) on the colorant carrier (2) so as to provide a defined printing substance (1a) having a defined thickness.

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Printing Device

Technical Field

The invention relates to a printing device and a print method.

Background

Printing devices and print methods require an effective colouring. Such an effective colouring is in particular required to achieve a printing result with good quality.

US 2021/276354 A1 discloses such a printing device comprising a colorant carrier and a delivery device to deliver colorant from the carrier to a substrate.

DE 37 02 643 A1 discloses an inkjet printing device comprising an ink film that is coloured by way of a roller system. The roller system comprises a colour roller arranged in a container that contains water-soluble ink or colorant. The container is arranged close to a guide roller around which the ink film is guided. The so coloured ink film is then moved to be arranged to a light source unit where a laser beam is emitted on a backside of the ink film. Thereby, the colorant is punctually heated and thus, a detachment process of the colorant is initiated. The so detached colorant is delivered to an oppositely arranged substrate to form a print image thereon. To achieve a good printing quality, a colorant film of high quality on the ink film is required.

However, by the colouring device being a roller system, the resulting quality of the colorant film is inferior. In particular, the quality is inferior due to so-called colour separation processes. By such colour separation processes, the surface of the colorant film becomes rough, structured, and qualitatively inferior. Further, the refreshing process is not sufficient, because the colour exchange is not well defined.

EP 2 155 499 B1 discloses a further colouring system. This colouring system solves the objective of the colouring better. According to this colouring system, a colorant

film is defined by two opposing rollers; the rollers comprise a dipping roller and a rubber roller, which comprise two surfaces, respectively, moving in opposite directions. Thereby, there is no colour separation process; rather, the colorant film is defined by shearing. Accordingly, the colorant film surface has a relatively good and homogenously smooth quality. Subsequently, the so defined smooth colorant film is transferred as a whole to a continuous band by touching the rubber roller. By the rubber roller and the band moving in opposite directions in a region at which they are closest, the colorant film is completely exchanged.

A disadvantage of this variant is that both rollers are not precisely supported. Each of these rollers has a bearing play of about 3 µm. This play is required to ensure a proper operation, or run, of the rollers. A further reduction of this tolerance results in the danger that the rollers undesirably clamp, e.g. due to thermal expansion. Further, since both rollers have a play in such an extent, the total play, and thus the precision error, can accumulate to up to 6 µm in total. For a resulting colorant film of about 20-30 µm, such an error or deviation is clearly visible as a striped pattern effected by deviations of the colorant layer thickness.

Further, the colorant exchange is ensured by a process completely exchanging the colorant. Such a complete exchange is effected by the transfer (rubber) roller touching the band moving in counter directions. This wears out (abrades, etc.) the band so that after a relatively short period of time the quality of the band is already worsened, in particular when using an abrasive colorant.

In addition, the overall design of the above-described devices and systems is complex, laborious, and costly.

Accordingly, there is a need to provide a printing device and a print method, which overcome the above-mentioned disadvantages. In particular, there is a need to achieve a colorant layer of high quality in an easy manner.

These and other objects, which become apparent upon reading the following description, are solved by the subject-matter of the independent claims. The dependent claims refer to preferred embodiments of the invention.

Summary of the invention

According to a first aspect of the invention, a printing device is provided. The printing device comprises: a colorant carrier; a delivery device arranged to deliver at least part of a colorant from the colorant carrier to a substrate or a transmission means; a transfer device arranged to transfer fresh colorant from a reservoir onto the colorant carrier in order to form, on the colorant carrier, an excess printing substance including fresh colorant and at least part of the colorant not delivered by the delivery device; and a thickness adjuster arranged to adjust a thickness of the excess printing substance on the colorant carrier so as to provide a defined printing substance having a defined thickness.

The printing device particularly provides the advantage that the defined printing substance has a well-defined structure, e.g. comprising a smooth surface and/or a homogenous thickness along the moving direction of the colorant carrier. The thickness adjuster may have only the function of defining (smoothening, thickness homogenization, etc.) the excess printing substance to provide the defined printing substance. The adjusting provided by the thickness adjuster in particular includes a thickness reduction from an (undefined) thickness of the excess printing substance to the defined thickness of the defined printing substance. Once the defined printing substance is obtained, the delivery device can deliver at least part of the colorant provided by the defined printing substance from the colorant carrier to the substrate or the transmission means. Hence, the resulting printing quality is, in particular due to the defined printing substance having the improved quality, improved.

The transfer device may be a nozzle.

The transfer device may be a transfer device roller. The transfer device roller is not limited to a particularly type of roller but is to be understood as encompassing any

roller or roller arrangement capable of transferring fresh colorant from a reservoir onto the colorant carrier. For example, the transfer device roller is a pan roller. The transfer device roller may be arranged to be at least partly immersed in the reservoir.

The transfer device, such as the nozzle, may be designed to transfer the fresh colorant from the reservoir onto the colorant carrier in the form of a stream of fresh colorant. By using transfer device, such as the nozzle, a complete exchange or replacement of the colorant film consisting of colorant not delivered, in a preceding delivery step, by the delivering device is not necessary. Rather, the colouring or renewal of the colorant film (or layer) on the colorant carrier is performed at least by a refilling. In other words, the void areas (or void spaces) effected by the delivery device delivering part of the colorant from the colorant carrier to the substrate or the transmission means are provided with, or refilled by, the fresh colorant. The other parts of the colorant film, i.e. those parts of the film not delivered by the delivery device, interact with the fresh colorant delivered (dispensed, etc.) by the transfer device, such as the nozzle. Thereby, the colorant not delivered by the delivery device (i.e., “old” or “non-fresh” colorant) is refreshed. This refreshing is particularly effected by uncontrolled exchange, mixing and/or diffusion processes during the transfer of the fresh colorant onto the colorant carrier in order to form the excess printing substance.

The excess printing substance is understood as a layer that has an undefined geometrical shape such as a shape with a non-smooth surface and/or with a varying thickness. The excess printing substance may have a variable thickness exceeding the defined thickness of the defined printing substance.

The defined printing substance preferably has a defined (geometrical) shape in a cross-section; the cross-section may be a lateral cross-section and/or a cross-section with a section plane perpendicular to the moving direction of the colorant carrier. For example, the defined printing substance may have a constant thickness relative to the extension and/or moving direction of the colorant carrier. The exposed and visible surface of the defined printing substance may be smooth and/or may have no (irregular) elevations (protrusions, etc.) or recesses (grooves,

flutes, etc.). The defined printing substance is in particular more defined than the excess printing substance. For example, the excess printing substance may comprise a non-periodic shape in a cross-section, wherein this shape is adjusted, by the thickness adjuster, to be smoother or to be a periodic shape.

The defined thickness may be in a range from 10 to 50 µm, preferably in a range from 15 to 40 µm, more preferably in a range from 20 to 30 µm.

The colorant may be a liquid colorant (aniline dye, etc.) and/or a solid colorant. The colorant may have a viscosity of less than 10000 mPas, preferably less than 1000 mPas.

Using the nozzle to transfer fresh colorant from the reservoir onto the colorant carrier also provides the advantage that a roller for such a transfer is avoided. In other words, fresh colorant may be transferred from the reservoir onto the colorant carrier by not using a roller. Accordingly, disadvantages using a roller as the transfer device are avoided or at least significantly reduced. For example, using the nozzle avoids the disadvantage of the tolerances involved by using a roller. That is, using the nozzle as the transfer device does not require a consideration of tolerances (play, etc.) relative to the colorant carrier in order to properly transfer fresh colorant onto the colorant carrier. Rather, the nozzle can be arranged without much precision relative to the colorant carrier in order to transfer fresh colorant thereto. This makes the printing device less complex.

The thickness adjuster may be arranged to define a gap between the colorant carrier and at least part of the thickness adjuster so that the gap adjusts the thickness of the excess printing substance. By the gap, the defined printing substance having the defined thickness can be provided in a very easy manner. The gap may comprise an inlet and an outlet. With respect to the moving direction of the colorant carrier, the excess printing substance may be arranged upstream of the inlet and the defined printing substance may be arranged downstream of the outlet of the gap. The gap may have a gap width that corresponds to the defined thickness. For example, the gap has the gap width in a region between the inlet and

the outlet. The gap may be defined by a surface of the colorant carrier, wherein this surface carries the colorant, and a surface of the thickness adjuster, wherein this surface is arranged to contact the colorant on the colorant carrier.

The thickness adjuster may comprise a recess for adjusting the thickness of the excess printing substance on the colouring carrier. The recess may comprise a bottom and/or a side wall. The side wall may extend from the bottom. The side wall may be arranged to avoid that excess printing substance is driven or pushed away from the colorant carrier, such as along a direction across the moving direction of the colorant carrier.

The gap, which is defined between the colorant carrier and at least part of the thickness adjuster, may be delimited by at least part of the recess, such as by the bottom and/or the side wall of the recess. Thereby, the colorant carrier can touch or contact the thickness adjuster, while at the same time the gap is defined between the colorant carrier and at least part of the thickness adjuster, such as the bottom of the recess. For example, the colorant carrier may touch at least the side wall of the recess. The gap may be delimited on the one hand by the bottom of the recess and on the other hand by the colorant carrier, such as by the surface on which the colorant carrier carries the colorant.

By the colorant carrier touching or contacting the thickness adjuster, the colorant carrier and the thickness adjuster can be arranged easily. For example, it is not required to take into account play and tolerances between the colorant carrier and the thickness adjuster in order to define the gap in a precise manner. Rather, the colorant carrier and the thickness adjuster may merely require an arrangement to contact each other in order to define the gap.

The thickness adjuster may be spaced apart from the colorant carrier, e.g. in order to form said gap. Thereby, the thickness adjuster can be designed simply, e.g. in such a way that the thickness adjuster does not comprise any recess for forming and/or delimiting the gap. Further, the thickness adjuster may be arranged so as not to contact the colorant carrier. By spacing apart the thickness adjuster from the

colorant carrier, wear of the colorant carrier and/or of the thickness adjuster can be reduced. Alternatively, thickness adjuster may contact the colorant carrier.

The colorant carrier and the thickness adjuster may be arranged to delimit a space in which excess printing substance can accumulate. This in particular provides the advantage that voids or gaps in the colorant film can be refilled in an effective manner, and that the colorant not delivered by the delivery device interacts with the fresh colorant in an effective manner, i.e. is effectively refreshed. Hence, a closed colorant film for a subsequent delivering by the delivery device to the substrate or the transmission means can be provided in an easy manner.

The space may taper towards a region (or area) of closest distance between the colorant carrier and the thickness adjuster, such as towards a region where the colorant carrier and the thickness adjuster contact each other. For example, the space forms a tapering shape such as funnel shape, wherein the outlet of this tapering shape preferably comprises, or is, the inlet of the gap. By the space tapering towards said region, the excess printing substance can accumulate in a very good manner. Thus, voids or gaps in the colorant film can be effectively refilled and at least part of the colorant not delivered by the delivery device effectively refreshed. This provides the advantage that the defined printing substance has a particularly good quality.

The printing device may further comprise a counter support, such as a roller or a rigid support, arranged to support the colorant carrier relative to the thickness adjuster. Hence, a tolerance range between the colorant carrier and the thickness adjuster can be reduced, in particular such that the tolerance range is defined by the thickness adjuster only. Accordingly, the defined printing substance can be formed with an improved quality, in particular without a striped pattern. The rigid support may comprise, or may be, a protrusion contacting the colorant carrier, such as a backside of the colorant carrier; the backside faces away from the surface carrying the colorant. The protrusion may protrude and/or taper towards the colorant carrier and/or the thickness adjuster. The protrusion may have a blade form. The colorant carrier may be arranged to slide on the counter support, such as the roller

or the rigid support. Due to the rigid support being rigid, the sliding of the colorant carrier on the support does not move or drive the support. The support rather remains stationary. The gap for adjusting the thickness of the excess printing substance may at least partly extend between the thickness adjuster and the counter support, such as the roller or the rigid support.

The thickness adjuster may comprise, or may be, a roller. Said roller may be an anilox roller. The anilox roller is a roller that comprises one or more recesses receding from its surface. The above-mentioned recess for adjusting the thickness of the excess printing substance may be a recess of these one or more recesses of the anilox roller. The one or more recesses of the anilox roller may be obtained by engraving the anilox roller's surface.

Alternatively, the roller may be a plain roller. This preferably means that the roller does not comprise any recess receding from its surface. Rather, the surface of the plain roller is preferably smooth. Accordingly, the thickness adjuster may be provided in a very easy and cost effective manner.

The thickness adjuster may be configured to remove part of the excess printing substance to effect the defined thickness of the defined printing substance. In other words, the thickness adjuster may be configured to allow the passage of only a part of the excess printing substance in order to provide the defined printing substance. The defined printing substance may consist of the part of the excess printing substance passing the thickness adjuster, such as of the part of the excess printing substance not removed by the thickness adjuster. For example, the thickness adjuster may be arranged to withhold a part of the excess printing substance in order to smoothen the excess printing substance and thereby effect the defined thickness of the defined printing substance.

Additionally or alternatively, the thickness adjuster may be configured to transport a part, such as the (above-mentioned) part, of the excess printing substance away from the colorant carrier and, optionally, to a reservoir such as the reservoir of the transfer device, such as of the nozzle, and/or a further reservoir which may be

connected to the reservoir of the transfer device, such as of the nozzle. Thereby, the efficiency of the printing device is increased. An unintended or undesired accumulation of excess printing substance and the so involved disadvantages (degradation of excess printing substance, provision of much space to contain excess printing substance, etc.) can be avoided. In particular, the thickness adjuster may be configured to transport the part of the excess printing substance away from the colorant carrier such that upstream of the thickness adjuster, such as in the space in which the excess printing substance can accumulate, a stationary amount of excess printing substance is provided.

The thickness adjuster may comprise a first surface and the colorant carrier may comprise a second surface. The first surface may be, or may comprise, the bottom of the recess or part of the (e.g. smooth) surface of the plain roller. The second surface may be the surface on which the excess printing substance and the defined printing substance are arranged on the colorant carrier. The thickness adjuster and the colorant carrier may be configured such that the surfaces (i.e. the first and second surfaces) move in opposite directions in a region where the surfaces come closest to one another. The region may be a contact region between the colorant carrier and the thickness adjuster. In an embodiment, the gap between the colorant carrier and at least part of the thickness adjuster may be delimited by surfaces moving in opposite direction, such as the first and the second surfaces.

This particularly achieves the advantage that the defined printing substance is provided in a very easy manner and good quality. In the region where the surfaces come closest to one another, the thickness adjuster can move a part of the excess printing substance opposite the moving direction of the colorant carrier, i.e. of the second surface. Thereby, this part of the excess printing substance may be transported (e.g. by so effected shearing processes or shearing forces) away from the colorant carrier in order to provide a very smooth defined printing substance. In other words, the first surface may move a first part of the excess printing substance relative to a second part of the excess printing substance, wherein the second part remains on the colorant carrier, such as on the second surface of the colorant carrier. The first part may be transferred away from the second part, e.g. so as to be made

available for being again used in the printing device. Further, by the surfaces moving in opposite directions, colorant separation processes in the colorant film on the colorant carrier can be avoided. Such colorant separation process often happen when corresponding surfaces move in the same direction.

The thickness adjuster may be arranged to spread the excess printing substance on the colorant carrier so that the so spread excess printing substance corresponds to the defined printing substance.

The first surface of the thickness adjuster and the second surface of the colorant carrier may move with different velocity values (i.e. different amounts of the velocities). For example, the velocity value of the second surface is greater than the velocity value of the first surface. Thus, the defined printing substance can be provided in a particularly good quality. The velocity value of the second surface may be at least twice the velocity value of the first surface. Preferably, the velocity value of the second surface is at least three times, in particular at least four times (e.g. at least five times), the velocity value of the first surface. For example, the velocity value of the first surface may be about 1000mm/s or less, wherein the velocity value of the second surface may be about 5000mm/s or less. The relative velocity between the first surface and the second surface may be 6000mm/s or less, e.g. in the range from 4000 to 6000mm/s. A control unit may be configured to move the thickness adjuster and the colorant carrier with the different velocity values.

The delivery device may comprise a device configured to generate an energy beam. The device may be a laser. The delivery device may be arranged to emit the energy beam indirectly (e.g. via the colorant carrier) or directly into the colorant on the colorant carrier, such as into the defined printing substance. The energy beam effects that a position and/or a volume of at least part of the colorant arranged on, or carried by, the colorant carrier is modified, thereby delivering this part (e.g. as a drop) to the substrate or the transmission means. By the delivery device, a plurality of regions (in the form of dots, drops, etc.) may be removed from the colorant film, such as the defined printing substance, in order to accumulate on the substrate or

the transmission means, e.g. to provide a printed image. The delivery device may be configured to emit an addressable energy beam or shot.

The colorant carrier may be a belt such as an endless belt or a continuous belt.

The printing device may be a printing unit or an inking unit. The printing device may be configured as a device (or unit or module) for a printer or printing machine. For example, a printer (or a printing machine) comprises the printing device so that, for example, the printing device is a printing unit or an inking unit of the printing device.

According to a second aspect of the invention, a print method is provided. The print method comprises the steps of: delivering, by a delivery device, in particular by an energy beam generated by the delivery device, such as a laser beam, at least part of a colorant from a colorant carrier to a substrate or a transmission means; transferring, by a transfer device, fresh colorant from a reservoir onto the colorant carrier in order to form, on the colorant carrier, an excess printing substance including fresh colorant and at least part of the colorant not delivered by the delivery device; and adjusting, by a thickness adjuster, a thickness of the excess printing substance on the colorant carrier so as to provide a defined printing substance having a defined thickness. The thickness adjuster may comprise, or may be, a roller.

The transfer device may be a nozzle.

The transfer device may be a transfer device roller. The transfer device roller is not limited to a particularly type of roller but is to be understood as encompassing any roller or roller arrangement capable of transferring fresh colorant from a reservoir onto the colorant carrier. For example, the transfer device roller is a pan roller. The transfer device roller may be arranged to be at least partly immersed in the reservoir.

The thickness adjuster may comprise a first surface and the colorant carrier may comprise a second surface, wherein the surfaces (i.e. the first and second surfaces) move in opposite directions in a region where the surfaces come closest to one another.

The print method may comprise the step of removing, by the thickness adjuster, a part of the excess printing substance for effecting the defined thickness of the defined printing substance.

The print method may comprise the step of transporting, by the thickness adjuster, the part of the excess printing substance away from the colorant carrier, e.g. to a reservoir such as the reservoir of the transfer device, such as of the nozzle.

The print method may further comprise the step of further delivering, by the delivery device, at least part of the defined printing substance on the colorant carrier to the substrate or the transmission means. In other words, after the step of adjusting in order to provide the defined printing substance, the defined printing substance may be transported, by the colorant carrier, to the delivery device, where the delivery device delivers, in the step of further delivering, at least part of the defined printing substance from the colorant carrier to the substrate or the transmission means.

Brief description of the drawings

Exemplary embodiments of the invention are now further explained with respect to the drawings by way of example only, and not for limitation. In the drawings:

FIG. 1 shows a schematic side view of a first embodiment of the printing device according to the invention;

FIG. 2 shows a schematic cross-sectional view of a detail of the thickness adjuster of the embodiment shown in FIG. 1 along the line II-II;

FIG. 3 shows a schematic side view of a second embodiment of the printing device according to the invention;

FIG. 4 shows a schematic cross-sectional view of a detail of the thickness adjuster of the embodiment shown in FIG. 3 along the line IV-IV; and

FIG. 5 shows a schematic side view of a further embodiment of the printing device according to the invention.

Detailed description of the preferred embodiments

FIG. 1 shows a first embodiment of a printing device 100. The printing device 100 comprises a colorant carrier 2. The colorant carrier 2 may be a belt (film, band, etc.), such as an endless belt or a continuous belt. In other embodiments, the colorant carrier 2 may be provided differently, e.g. in the form of one or more rollers. The colorant carrier 2 may comprise at least a first section 21 and a second section 22. The second section 22 may extend transversely, such as perpendicularly, to the first section 21. The first and second sections 21, 22 may be connected to one another via a connecting section 23. The connecting section 23 may be curved, e.g. in the form of a circle segment.

The printing device 100 may comprise a guide element 4 for guiding the colorant carrier 2, in particular such that the sections 21, 22 are provided. The guide element 4 may comprise, or may be, a roller 41. The colorant carrier 2 is configured to move along a moving direction 24. The moving direction 24 is parallel to the extension of the colorant carrier 2. The guide element 4 may be driven, e.g. by a rotating movement as indicated by the arrow in the figure, in order to move the colorant carrier 2 along the moving direction 24. The roller 41 may be driven by a (not shown) engine or unit in order to rotate, whereby the colorant carrier 2 is driven to move along the direction 24. The printing device 100 may comprise one or more (further) guide elements, such as in the form of one or more further rollers, for guiding the colorant carrier 2. The (further) rollers may be driven or not driven, i.e. passive rollers. The (further) rollers may rotate simultaneously to the roller 41.

The colorant carrier 2 may be made of a polymer (polyamide, etc.) and/or may be heat resistant (e.g. up to at least 110 °C or up to at least 180 °C or more), and/or may be transparent. The thickness of the continuous (or endless) belt may be about 50 µm.

The printing device 100 further comprises a delivery device 9. The delivery device 9 as such is known. For example, the delivery device 9 may be designed and arranged, in particular relative to the colorant carrier 2, as described in DE 37 02 643 A1 or WO 01/72518 A1. The delivery device 9 is arranged to deliver at least part of a colorant, which is arranged on, or carried by, the colorant carrier 2, from the colorant carrier 2 to a substrate 10 such as a paper. Alternatively, the at least part of the colorant may be delivered to a transmission means (or a transfer means; not shown). By the transmission means, the delivered colorant may be delivered indirectly from the colorant carrier 2 to the substrate 10. The delivery device 9 may comprise a device configured to generate an energy beam 91. For example, the device is a laser. In this case, the energy beam 91 is a laser beam. By the energy beam 91, said part of the colorant can be delivered from the colorant carrier 2 to the substrate 10. More specifically, the energy beam 91 introduces locally energy into the colorant arranged on the colorant carrier 2, whereby a part of the colorant will be removed and delivered onto the substrate 10. For example, this part of the colorant is heated, by the energy beam 91, whereby a solvent of the colorant suddenly evaporates and the colorant is moved away from the colorant carrier 2.

The delivery device 9 can deliver colorant from the colorant carrier 2 to the substrate 10 along a row that extends transversely, in particular perpendicularly, to the moving direction 24 of the colorant carrier 2. For example, the energy beam 91 may be moved along the row and may be selectively activated or deactivated, thereby transferring any arrangement of printing dots from the colorant carrier 2 to the substrate 10 line by line.

By the delivery device 9 delivering part of the colorant from the colorant carrier 2 to the substrate 10, a colorant film 1b remains on the colorant carrier 2. The colorant film 1b may be arranged on at least the first section 21 of the colorant carrier 2. On

the one hand, the colorant film 1b comprises areas that comprise colorant not delivered by the delivery device 9. In other words, these areas are unchanged compared to a state before passing the delivery device 9. On the other hand, the colorant film 1b comprises void areas that were filled by colorant before passing the delivery device 9. The delivery device 9 thus forms, by delivering part of the colorant from the colorant carrier 2 to the substrate 10, the void areas in the colorant film 1b. The colorant film 1b thus has an inhomogeneous thickness.

The printing device 100 further comprises a nozzle 6. The nozzle 6 is arranged to transfer (dispense, spray, etc.) fresh colorant from a reservoir (not shown) onto the colorant carrier 2, in particular onto the colorant film 1b arranged on the colorant carrier 2 and/or onto a surface 25 of the colorant carrier 2, on which surface 25 at least the colorant film 1b is arranged. The nozzle 6 may be connected to, and/or may comprise, a pumping device arranged to draw the fresh colorant from the reservoir and subsequently dispense the so drawn fresh colorant onto the colorant carrier 2. The nozzle 6 may comprise a discharge opening 61. The discharge opening 61 may be in the form of a slit or in any other form (oval, circle, etc.). The nozzle 6 may be configured to generate a stream 62 comprising, or consisting of, the fresh colorant. With respect to the moving direction 24, the nozzle 6 may be arranged to transfer the fresh colorant onto the colorant carrier 2 at a position downstream of the delivery device 9. As shown in FIG. 1, the nozzle 6 may be arranged to deliver the fresh colorant onto the connecting part 23 of the colorant carrier 2. Additionally or alternatively, the nozzle 6 may be arranged to deliver the fresh colorant onto the first part 21 and/or the second part 22 of the colorant carrier 2. The nozzle 6 may be arranged such that the stream 62, or at least part of the stream 62, extends along a direction across at least part of the colorant carrier 2, such as across, e.g. perpendicular to, the connecting part 23.

By the nozzle 6 transferring fresh colorant onto the colorant carrier 2, an excess printing substance 1c is formed on the colorant carrier 2, such as at least on the section 22 of the colorant carrier 2. On the one hand, the excess printing substance 1c includes fresh colorant dispensed by the nozzle 6. The fresh colorant is dispensed, by the nozzle 6, to fill up the void areas of the colorant film 1b and to be

provided onto at least part of the colorant not delivered by the delivery device 9. Accordingly, at least part of the fresh colorant contacts at least part of the colorant not delivered by the delivery device 9 (i.e. “old” or “not-delivered” colorant). On the other hand, the excess printing substance 1c includes at least part of the colorant not delivered by the delivery device 9. In the excess printing substance 1c, mixing and/or diffusion processes involving the fresh colorant and at least part of the not-delivered colorant 1b may take place. Thus, by forming the excess printing substance 1c on the colorant carrier 2, the colorant of the colorant film 1b is refreshed. In other words, by the nozzle 6 dispensing fresh colorant onto the colorant film 1b (which means both into the void areas and onto the areas having not-delivered colorant), the latter is, in particular by uncontrolled exchange, mixing, and/or diffusion processes by means of the fresh colorant supply carried out by the nozzle 6, transformed to have such a quality that is comparable, or equal, to the quality of the fresh colorant supplied by the nozzle 6.

By transferring the fresh colorant by the nozzle 6 such that not only the void areas of the colorant film 1b are refilled, the excess printing substance 1c is provided in an undefined manner. For example, the excess printing substance 1c has, in a cross-sectional view (e.g. taken along a section plane perpendicular to the moving direction 24 or extension of the colorant carrier 2), an undefined shape. In particular, the excess printing substance 1c may have no smooth surface, but rather an undefined wavy surface and/or a surface comprising undefined elevations. The excess printing substance 1c may have an inhomogeneous thickness, e.g. along the moving direction 24, and/or parts or areas that have a thickness exceeding the thickness of the areas of the colorant film 1b comprising colorant not delivered by the delivery device 9.

To define the excess printing substance 1c, the printing device 100 comprises a thickness adjuster 3. Thus, once the excess printing substance 1c is formed on the colorant carrier 2, such as on the section 22, the colorant carrier 2 transports the excess printing substance 1c towards the thickness adjuster 3. As shown in FIG. 1, the corresponding transporting direction may be along or parallel to the direction 24. The thickness adjuster 3 is arranged to adjust (in particular reduce) a thickness of

the excess printing substance 1c on the colorant carrier 2 to provide a defined printing substance 1a having a defined thickness, such as a defined height measured from the surface 25 of the colorant carrier 2. The surface 25 is arranged to carry the defined printing substance 1a. The measurement of the defined height may be along a direction perpendicular to the surface 25. The defined thickness may depend on the design of the thickness adjuster 3, such as on a passing degree (e.g. defined by a pick-up volume of the thickness adjuster 3) for allowing the passage of only a part of the excess printing substance 1c past the thickness adjuster 3.

According to the embodiment shown in FIG. 1, the thickness adjuster 3 comprises, or is, a roller 31 such as an anilox roller. As shown in FIG. 2 in more detail, the roller 31 may comprises at least one recess 311 for adjusting the thickness of the excess printing substance 1c on the colorant carrier 2. The recess 311 recedes from a surface of the roller 31. The recess 311 may comprise a bottom 312 and/or one or more side walls 313, which may extend from the bottom 312. The recess 311 may extend linearly (e.g. along a line such as a straight line) and/or along a peripheral direction. The recess 311 may be of the “Haschur”- type. This means that the roller 31 may be a so-called “Haschur” roller. To provide the recess 311 or a plurality of the recesses 311, it is in particular preferred to provide the roller 31 as an anilox roller. The recesses, which are inherent in the anilox roller, may comprise the recess 311.

The thickness adjuster 3 may be arranged such that a gap 8 is defined, or formed, between the colorant carrier 2 and a part of the thickness adjuster 3. For example, the gap 8 may be delimited by the colorant carrying surface 25 of the colorant carrier 2 and the bottom 312 of the recess 311 comprised by the roller 31. The gap 8 may be further delimited by the one or more side walls 313 of the recess 311. The colorant carrier 2 may contact, or touch, the roller 31. For example, the colorant carrier 2 may contact, e.g. by the surface 25, at least the one or more side walls 313, such as a distal end thereof.

By the gap 8, the thickness of the excess printing substance 1c can be adjusted (e.g. reduced) such that the defined printing substance 1a has the defined thickness. The gap 8 may comprise an inlet 81 and an outlet 82. Upstream of the inlet 81, the excess printing substance 1c may be provided. Downstream of the outlet 82, the defined printing substance 1a may be provided. “Upstream” and “downstream” refer to the moving direction 24 of the colorant carrier 2. The gap 8 may comprise a gap width, e.g. in an area or a region between the inlet 81 and the outlet 82 of the gap 8. The defined thickness of the defined printing substance 1a thus corresponds to the gap width of the gap 8. The gap width may extend between the bottom 312 and the surface 25.

The arrangement of the roller 31 to form the gap 8 is provided for smoothening and defining the film of the excess printing substance 1c, thereby providing the defined printing substance 1a with the defined thickness. In other words, the roller 31 is not arranged to remove colorant, which is not delivered by the delivery device 9, from the colorant carrier 2 in order to expose the colorant carrier 2 such as the surface 25. The renewal of the colorant film is effected in a region of the excess printing substance 1c (i.e. in a region upstream of the roller 31, when seen relative to the moving direction 24), wherein the roller 31 only has the function of smoothening and defining the layer of the so renewed colorant film, i.e. to provide the defined printing substance 1a having the defined thickness.

The colorant carrier 2 and the thickness adjuster 3 may be arranged to delimit a space 1 in which excess printing substance 1c can accumulate. Accordingly, an accumulation b may be formed in the space 1. The accumulation b may have the form of a small lake or a swamp. As shown in FIG. 1, the space 1 may be delimited by two lateral surfaces, which may be comprised by the colorant carrier 2 and the roller 31, respectively. The one of the two lateral surfaces may be curved, preferably curved according to the shape of the roller 31. The other of the two lateral surfaces, which the colorant carrier 2 may comprise, may be straight. Thereby, the space 1 may be formed to have a tapering shape such as a funnel shape. To form the tapering shape of the space 1, the two lateral surfaces may also extend differently, such as along straight directions being across to each other. The tapering shape of

the space 1 may taper along the direction of movement 24. Additionally or alternatively, the space 1 may taper towards an area or a region of closest distance between the colorant carrier 2 and the thickness adjuster 3, which means in the embodiment according to FIG. 1 towards the area of contact between the colorant carrier 2 and the thickness adjuster 3. The space 1 may join the gap 8. For example, the space 1 has an outlet that corresponds to the inlet 81 of the gap 8.

In an area or a region where the surface 312 (first surface) and the surface 25 (second surface) come closest to one another, the surfaces 312, 25 may move in opposite directions. For example, the parts of the surfaces 312, 25 delimiting the gap 8 may move in opposite directions. Hence, a smoothening of the upper surface of the defined printing substance 1a can be effected in a very effective manner. The colorant carrier 2, which is preferably a belt such as an endless or continuous belt, may surround or delimit a space, wherein the roller 31 is arranged outside this space; for example, the extension of the belt providing the colorant carrier 2 may surround the space. On the other hand, the roller 41 may be arranged inside this space. In particular, the roller 31 and the roller 41 and/or any other roller, which is/are arranged to drive or move the colorant carrier 2 to move along the direction 24, may be arranged to rotate in the same direction (e.g., counter clockwise or clockwise). The roller 31 is preferably a driven roller, e.g. by being connected to a drive unit or an engine.

The thickness adjuster 3 may be configured to remove part of the excess printing substance 1c to effect the defined thickness of the defined printing substance 1a. For example, the shearing forces acting between the roller 31 and the colorant carrier 2, such as inside of the gap 8, may be such that they drive the part of the excess printing substance 1c exceeding the defined thickness of the defined printing substance 1a in a direction away from the defined printing substance 1a, preferably along a direction corresponding to,or conforming, the moving direction of the roller 31.

Additionally, or alternatively, the roller 31 may be configured to transport a part of the excess printing substance 1c (such as the part of the excess printing substance

1c removed to provide the defined printing substance 1a) away from the colorant carrier 2. The printing device 100 may comprise a line 5 (such as a rail, a tube, or a pipe) which is arranged such that the roller 31 can drive at least some of the part being transported away from the colorant carrier 2 into the line 5. Preferably, the roller 31 is configured to transport this part of the excess printing substance 1c, directly or indirectly, to a reservoir such as a reservoir of the nozzle 6. For example, the line 5 is connected to the reservoir of the nozzle 6, i.e. the reservoir from which the nozzle 6 draws fresh colorant. Accordingly, the printing substance transported, by the roller 31, away from the colorant carrier 2 may form at least part of the fresh colorant from which the nozzle 6 draws fresh colorant for a subsequent transfer onto the colorant carrier 2, such as onto the colorant film 1b and/or the surface 25. The line 5 may comprise a remover (such as a scraper) that is in contact with the roller 31. The remover may aid in removing printing substance from the roller 31 for being subsequently driven into, or downstream, the line 5.

The defined printing substance 1a obtained by using the roller 31 is then in a state ready for being delivered by the delivery device 9. The colorant carrier 2 may transport the defined printing substance 1a into the position in which the delivery device 9 can deliver at least part of the defined printing substance 1a from the colorant carrier 2 to the substrate 10 or the transmission means. In other words, the defined printing substance 1a forms a (film of) colorant, wherein the delivery device 9 can deliver at least part of this colorant from the colorant carrier 2 to the substrate 10 or the transmission means. The delivery device 9 delivers at least part of the defined printing substance 1a from the colorant carrier 2 to the substrate 10 or the transmission means and thereafter, the colorant carrier 2 transports the so processed defined printing substance as the colorant film 1b away from the delivery device 9.

Subsequently, the following process steps may be again carried out: a) transferring, by the nozzle 6, fresh colorant onto the film 1b and/or onto the colorant carrier 2 in order to form, on the colorant carrier 2, an excess printing substance 1c including fresh colorant and at least part of the colorant (i.e. of the (first) defined printing substance 1a) not delivered by the delivery device 9; and b) adjusting, by the

thickness adjuster 3, a thickness of this excess printing substance 1c on the colorant carrier 2 to provide a (further or second) defined printing substance 1a having the defined thickness. This (further) defined printing substance 1a having the defined thickness can then be supplied to the delivery device 9.

FIG. 3 shows a printing device 100' according to a second embodiment of the invention. The printing device 100' according to this embodiment differs from the printing device 100 according to the first embodiment in that the thickness adjuster 3 is designed and arranged differently. More specifically, the thickness adjuster 3 comprises a roller 31' and is spaced apart (as a whole) from the colorant carrier 2. In other words, the roller 31' does not contact the colorant carrier 2, such as the surface 25. The gap 8 is thus formed by spacing apart the roller 31' from the colorant carrier 2, e.g. from the surface 25.

As shown in FIG. 4, the roller 31' may be a plain roller comprising a surface 312'. The surface 312' is preferably a smooth surface void of any protrusions, recesses, or the same. Accordingly, the gap 8 may be delimited by the surface 312' of the roller 31' and the surface 25 of the colorant carrier 2. The description with respect to the surface or bottom 312 applies analogously to the surface 312'.

The printing device 100' may comprise a counter support arranged to support the colorant carrier 2 relative to the thickness adjuster 3, such as the roller 31'. Thus, the support may be arranged to define a position of at least a part of the colorant carrier 2 relative to the thickness adjuster 3.

The counter support may be the guide element 4, wherein the guide element 4 may be rigid.

The counter support may comprise, or may be, a roller, like the roller 41 or another roller (not shown). Such a counter support represents in particular in applications with a thick colorant film, where thickness variations do not play an important role, a good, in particular cost-saving solution. The roller of the counter support may be

arranged to guide the colorant carrier, e.g. as the guide element 4, such as the roller 41, or as an additional guide element.

Alternatively, the printing device 100' may comprise a rigid support 7, as the counter support, arranged to support the colorant carrier 2 relative to the thickness adjuster 3, such as the roller 31'. Thus, the support 7 may be arranged to define a position of at least a part of the colorant carrier 2 relative to the thickness adjuster 3. Thereby, the gap 8 between the thickness adjuster 3 (roller 31') and the colorant carrier 2 (surface 25) can be provided with a significantly reduced tolerance range. This is because the support 7 does not represent a roller or any other rotatably supported component including a play for effecting the corresponding rotational movement. In other words, the tolerance range between the thickness adjuster 3 (e.g. in the form of the roller 31') and the colorant carrier 2 (e.g. the surface 25) is substantially defined by a play of the thickness adjuster 3, such as by the bearing play of the roller 31', only. The rigid support 7 does not require a bearing such as the bearing for supporting the roller 31'. Rather, the support 7 can be rigidly arranged with no or almost no play. For example, the support 7 may be rigidly fixed to a fixed or stationary part of the printing device 100' by using a fastening element (such as a form and/or frictional fit (bolt, nut, snap fit, etc.), and/or by using substance-to-substance bond, e.g. welding) and/or by using one or more alignment means (a protrusion, a pin, a hole, etc.).

The support 7 may be arranged such that at least part of the gap 8 extends between the roller 31' and the support 7. The support 7 may be arranged opposite the roller 31' so that the colorant carrier 2 extends between the roller 31' and the support 7, e.g. when seen parallel to the rotational axis of the roller 31'. The support 7 may be arranged such that at least part of the colorant carrier 2 is supported by the support 7 so as not to move away from the roller 31'. The support 7 may be arranged to define the gap 8 between the roller 31' and the colorant carrier 2. The support 7 may be a protrusion, e.g. a protrusion protruding towards the colorant carrier 2 and the roller 31'. Thus, when seen along a direction along which the support 7 protrudes, the roller 31' may be arranged behind the support 7. The support 7 may be arranged to contact (e.g. directly) the colorant carrier 2, such as a backside 26

of the colorant carrier 2. Accordingly, the surface 25 may form the front side of the colorant carrier 2, i.e. may face away from the backside 26. The support 7 may comprise rounded edges on which the colorant carrier 2 is guided. The support 7 may be arranged such that the colorant carrier 2 slides, e.g. via the backside 26, over the support 7. By the colorant carrier 2 sliding over the support 7, the support 7 is, due to being rigid, not driven or moved. Rather, the support 7 remains stationary.

The printing device 100' particularly provides the advantage that wear can be significantly reduced, because there is no contact between the roller 31' and the colorant carrier 2. In addition, the gap 8 may be provided easily and without involving a broad tolerance range that could have a negative effect on the quality of the defined printing substance.

In an embodiment, the printing device 100, 100' comprises in addition to one or more rollers for driving the colorant carrier 2 and/or one or more rollers for guiding the colorant carrier 2 (such as to provide at least the sections 21-23), only one further roller, namely the roller 31 in the printing device 100 and the roller 31' in the printing device 100', respectively.

The nozzle 6 described in the above-mentioned embodiments is one example for the transfer device for transferring fresh colorant 62 from the reservoir onto the colorant carrier 2. Instead of the nozzle 6, another transfer device may be used in another embodiment. One example for such another transfer device is shown in FIG. 5. As shown in FIG. 5, the transfer device may be a roller 46 (i.e. a "transfer device roller"). Thus, other embodiments may correspond to the first and second embodiments described above, respectively, with the difference that instead of the nozzle 6 another transfer device is used, such as the roller 46. The roller 46 is arranged to transfer fresh colorant 62 from a reservoir 47 onto the colorant carrier 2 in order to form, on the colorant carrier 2, the excess printing substance 1c including fresh colorant 62 and at least part of the colorant 1b not delivered by the delivery device 9.

The roller 46 may comprise a (third) surface 461 that is adapted to receive and carry fresh colorant. The roller 26 and the colorant carrier 2 may be configured such that the surfaces 461, 25 move in the same direction in a region where the surfaces 461, 25 come closest to one another.

Between the roller 46 and the colorant carrier 2, a gap 462 may be provided. The gap 462 may be delimited by the surfaces 461, 25. With respect to the moving direction of the colorant carrier 2 (in FIG. 5: downwards), upstream of the gap 462 colorant 1b not delivered by the delivery device 9 may be arranged on the colorant carrier 2, whereas downstream of the gap 462 the excess printing substance 1c may be arranged on the colorant carrier 2.

At least part of the roller 46 may be arranged in the reservoir 47 and, thus, immersed in the fresh colorant contained in the reservoir 47. In other embodiments, fresh colorant may be transferred onto the roller 46 by means different from the roller 46 being immersed in the fresh colorant contained in the reservoir 47, e.g. by delivering (such as spraying) a stream of fresh colorant onto the roller 46.

Claims

1. A printing device (100, 100‘), comprising:
   - a colorant carrier (2);
   - a delivery device (9) arranged to deliver at least part of a colorant (1a) from the colorant carrier (2) to a substrate (10) or a transmission means;
   - a transfer device (6, 46) arranged to transfer fresh colorant (62) from a reservoir onto the colorant carrier (2) in order to form, on the colorant carrier (2), an excess printing substance (1c) including fresh colorant (62) and at least part of the colorant (1b) not delivered by the delivery device (9); and
   - a thickness adjuster (3) arranged to adjust a thickness of the excess printing substance (1c) on the colorant carrier (2) so as to provide a defined printing substance (1a) having a defined thickness,

   wherein the thickness adjuster (3) comprises, or is, a roller (31, 31’).

2. The printing device (100, 100‘) according to claim 1, wherein the transfer device is a nozzle (6).

3. The printing device (100, 100‘) according to claim 1, wherein the transfer device is a transfer device roller such as a pan roller (46).

4. The printing device (100, 100‘) according to any one of the preceding claims, wherein the thickness adjuster (3) is arranged to define a gap (8) between the colorant carrier (2) and at least part of the thickness adjuster (3) so that the gap (8) adjusts the thickness of the excess printing substance (1c).

5. The printing device (100) according to any one of the preceding claims, wherein the thickness adjuster comprises (3) a recess (311) for adjusting the

thickness of the excess printing substance (1c) on the colorant carrier (2), wherein, optionally, the gap (8) is delimited by at least a part of the recess (311), such as by a bottom (312) and/or a side wall (313) of the recess (311).

6. The printing device (100, 100') according to any one of the preceding claims, wherein the thickness adjuster (3) contacts the colorant carrier (2) or is spaced apart from the colorant carrier (2), e.g. in order to form said gap (8).

7. The printing device (100, 100') according to any one of the preceding claims, wherein the colorant carrier (2) and the thickness adjuster (3) are arranged to delimit a space (1) in which excess printing substance (1c) can accumulate, wherein the space (1) preferably tapers towards a region of closest distance between the colorant carrier (2) and the thickness adjuster (3).

8. The printing device (100') according to any one of the preceding claims, further comprising a counter support, in particular a roller or a rigid support (7) such as a protrusion, wherein the counter support, such as the roller or the rigid support (7), is arranged to support the colorant carrier (2) relative to the thickness adjuster (3), and wherein, preferably, at least part of the gap (8) extends between the counter support, such as the roller or the rigid support (7), and the thickness adjuster (3).

9. The printing device (100, 100') according to any one of the preceding claims, wherein the roller (31, 31') is provided as an anilox roller (31) or as a plain roller (31').

10. The printing device (100, 100') according to any one of the preceding claims, wherein the thickness adjuster (3) is configured to
    - remove part of the excess printing substance (1c) to effect the defined thickness of the defined printing substance (1a), and/or to
    - transport a part, such as the part, of the excess printing substance (1c) away from the colorant carrier (2) and, optionally, to a reservoir such as the reservoir of the transfer device, such as of the nozzle (6).

11. The printing device (100, 100‘) according to any one of the preceding claims, wherein the thickness adjuster (3) comprises a first surface (312, 312’) and the colorant carrier (2) comprises a second surface (25), wherein the thickness adjuster (3) and the colorant carrier (2) are configured such that the surfaces (312, 25; 312’, 25) move in opposite directions in a region where the surfaces (312, 25; 312’, 25) come closest to one another, wherein, preferably, the gap (8) is delimited by the surfaces (312, 25; 312’, 25) moving in opposite directions.

12. The printing device (100, 100‘) according to any one of the preceding claims, wherein the delivery device (9) comprises a device configured to generate an energy beam (91), such as a laser.

13. The printing device (100, 100‘) according to any one of the preceding claims, wherein the colorant carrier (2) is a belt such as a continuous belt.

14. A print method, comprising the steps of:

- delivering, by a delivery device (9), in particular by an energy beam generated by the delivery device (9), such as by a laser beam, at least part of a colorant (1a) from a colorant carrier (2) to a substrate (10) or a transmission means;
- transferring, by a transfer device (6, 46), fresh colorant (62) from a reservoir onto the colorant carrier (2) in order to form, on the colorant carrier (2), an excess printing substance (1c) including fresh colorant (62) and at least part of the colorant (1b) not delivered by the delivery device (9); and
- adjusting, by a thickness adjuster (3), a thickness of the excess printing substance (1c) on the colorant carrier (2) so as to provide a defined printing substance (1a) having a defined thickness,

wherein the thickness adjuster (3) comprises, or is, a roller (31, 31’).

15. The print method according to claim 14, wherein the transfer device is a nozzle (6).

16. The print method according to claim 14, wherein the transfer device is a transfer device roller such as a pan roller (46).

17. The print method according to any one of claims 14 to 16, wherein the thickness adjuster (3) comprises a first surface (312, 312') and the colorant carrier (2) comprises a second surface (25), wherein the surfaces (312, 25; 312', 25) move in opposite directions in a region where the surfaces (312, 25; 312', 25) come closest to one another, wherein, optionally, the surfaces (312, 25; 312', 25) move with different velocity values.

18. The print method according to any one of claims 14 to 17, further comprising the steps of:
    - removing, by the thickness adjuster (3), a part of the excess printing substance (1c) for effecting the defined thickness of the defined printing substance (1a), and
    - transporting, by the thickness adjuster (3), the part of the excess printing substance (1c) away from the colorant carrier (2), e.g. to a reservoir such as the reservoir of the transfer device, such as of the nozzle (6, 46).

19. The print method according to any one of claims 14 to 18, further comprising the step of further delivering, by the delivery device (9), at least part of the defined printing substance (1a) from the colorant carrier (2) to the substrate (10) or the transmission means.

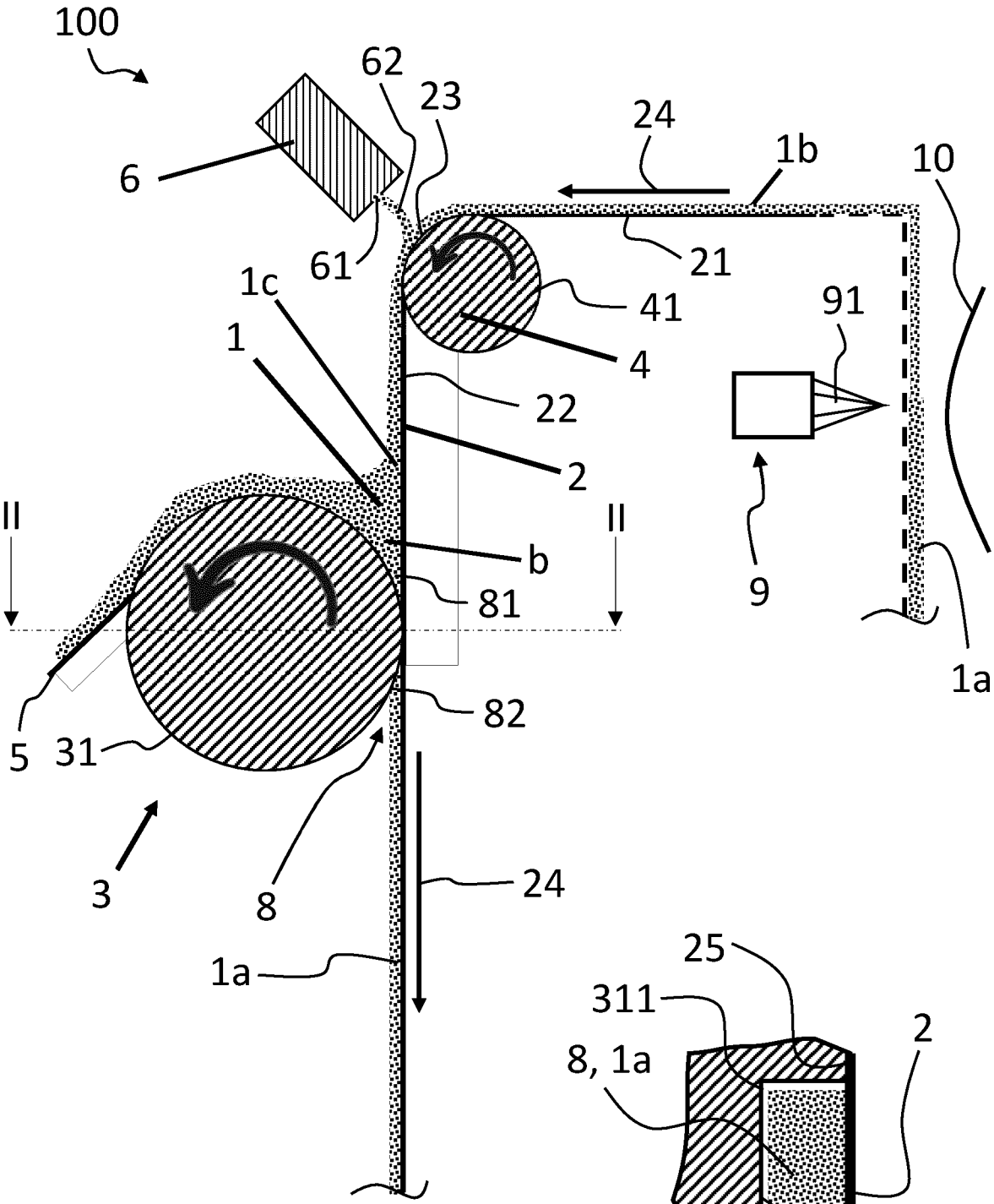
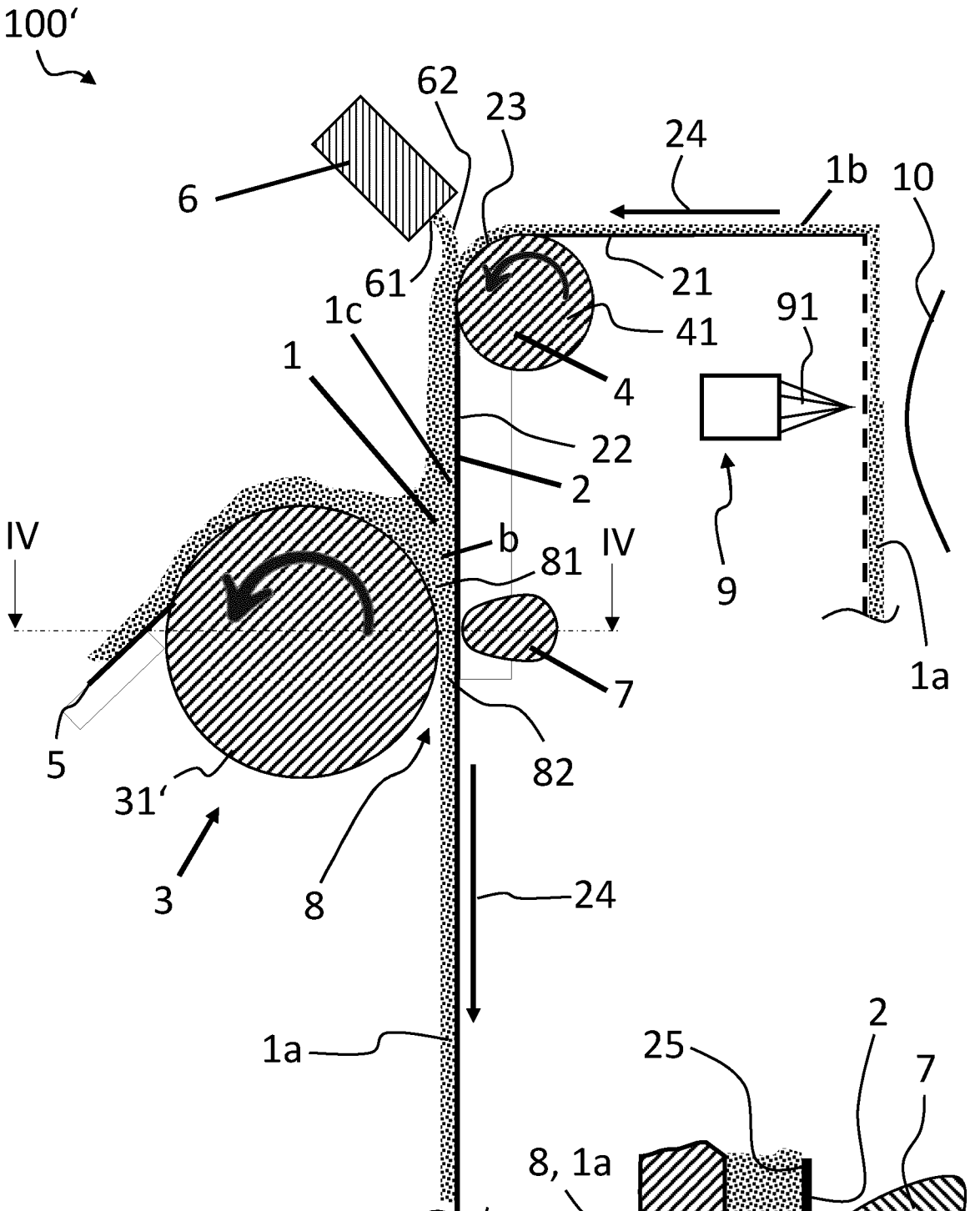

100
62
23
24
1b
10
6
61
21
1c
41
91
1
4
22
2
II
II
b
81
9
1a
5
31
82
3
8
24
1a

Fig. 1

25
311
2
8, 1a
312
313

Fig. 2


100‘
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23
24
1b
10
6
61
21
91
1c
41
1
4
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b
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9
7
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5
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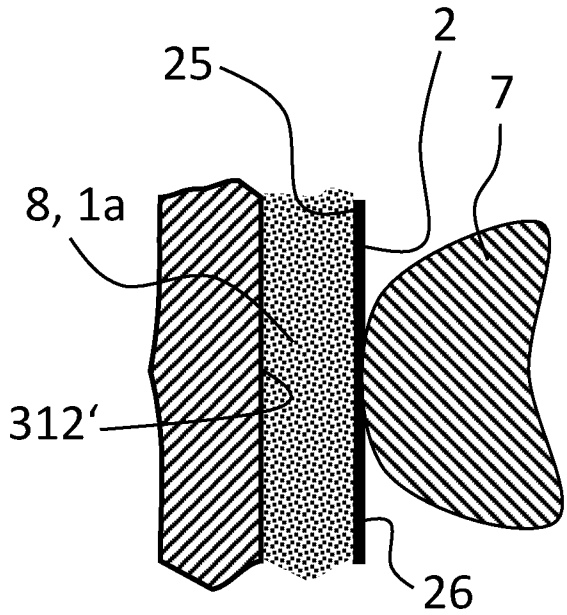
31‘
3
8
24
1a

Fig. 3


2
25
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8, 1a
312‘
26

Fig. 4

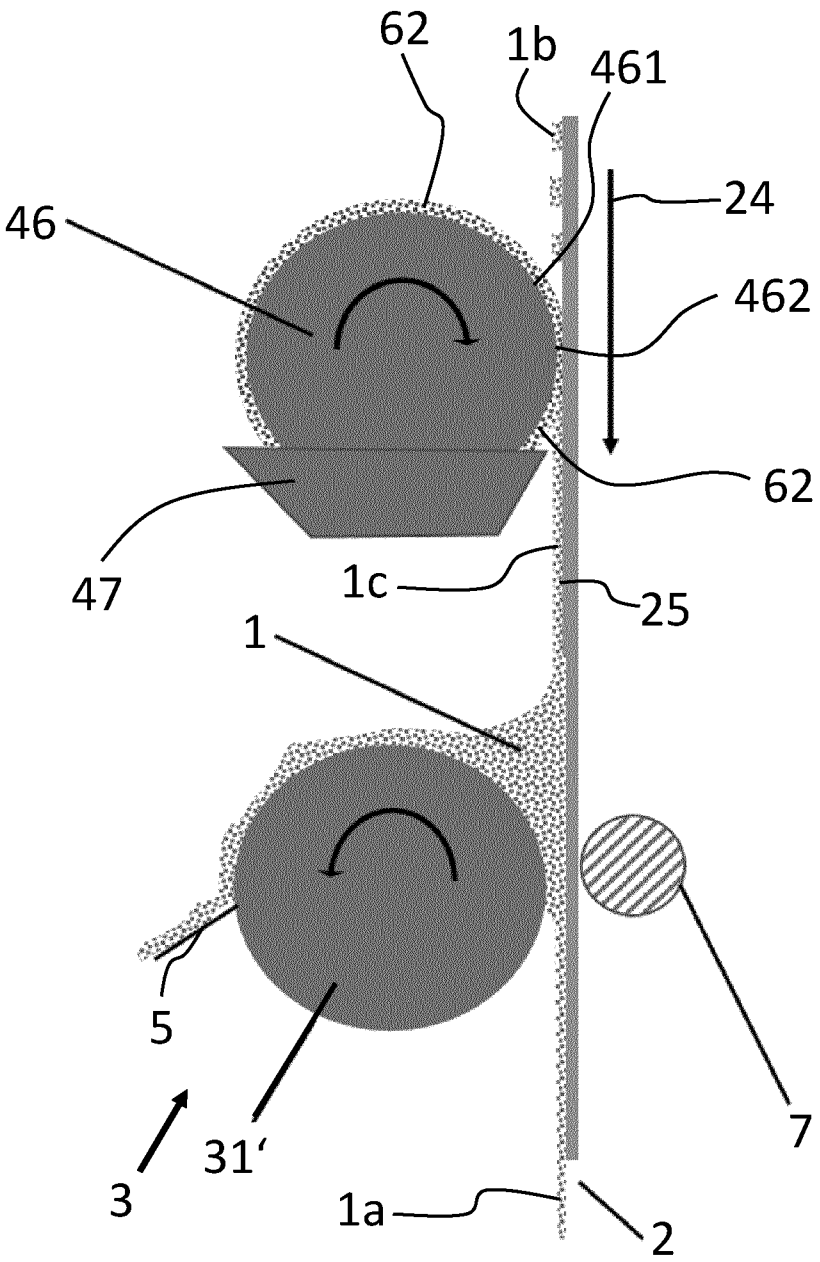

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/085359

A. CLASSIFICATION OF SUBJECT MATTER
INV. B41J2/005
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2021/276354 A1 (BENJAMIN ANN [US] ET AL) 9 September 2021 (2021-09-09) figures 1b,2b,2d	1-19
A	JP S56 21874 A (TOKYO SHIBAURA ELECTRIC CO) 28 February 1981 (1981-02-28) figure 4	1-19
A	US 5 865 115 A (FASSLER WERNER [US] ET AL) 2 February 1999 (1999-02-02) figures	1-19
A	US 11 396 190 B2 (LANDA CORP LTD [IL]) 26 July 2022 (2022-07-26) figures 4a, 5	1-19

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 February 2024	16/02/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bardet, Maude

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2023/085359

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2021276354 A1	09-09-2021	CN 110087890 A	02-08-2019
		CN 110087891 A	02-08-2019
		CN 110121425 A	13-08-2019
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