(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 388 378 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.10.2018 Bulletin 2018/42

(21) Application number: **18165823.8**

(22) Date of filing: **05.04.2018**

(51) Int Cl.:
B65H 85/00 *(2006.01)* ***B65H 29/58*** *(2006.01)*
B41J 3/60 *(2006.01)* ***B41J 13/00*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **11.04.2017 EP 17165997**

(71) Applicant: **OCE Holding B.V.**
5914 CA Venlo (NL)

(72) Inventor: **DINNISSEN, Johannes H.A.**
5914 CA VENLO (NL)

(74) Representative: **OCE IP Department**
St. Urbanusweg 43
5914 CA Venlo (NL)

(54) PRINTING SYSTEM, TRANSPORT SWITCH, AND METHOD FOR DUPLEX PRINTING OF TABBED SHEETS

(57) The present invention provides a printing system (1) for duplex printing of tabbed sheets (TS), comprising a transport mechanism, a sheet flipping device (21) for flipping tabbed sheets, and a transport switch (30) for selectively directing sheets between different transport paths (P1, P2). The transport switch comprises a plurality of longitudinal transport fingers (32, 132), each having a top support surface (33, 133) and a side face (34, 36, 134, 136) positioned below the medium support plane (MSP). In the prior art duplex printing of tabbed sheets is avoided, as duplex printing of tabbed sheet led to the tabbed sheets becoming jammed at the transport switch. In the present invention this is prevented, as the side face of the transport finger comprises a longitudinal upward tab deflection face (35, 37, 135, 137) laterally inclined with respect to the medium support plane, such that a tab coming into contact with the upward tab deflection face is guided onto the medium support plane of the transport finger.

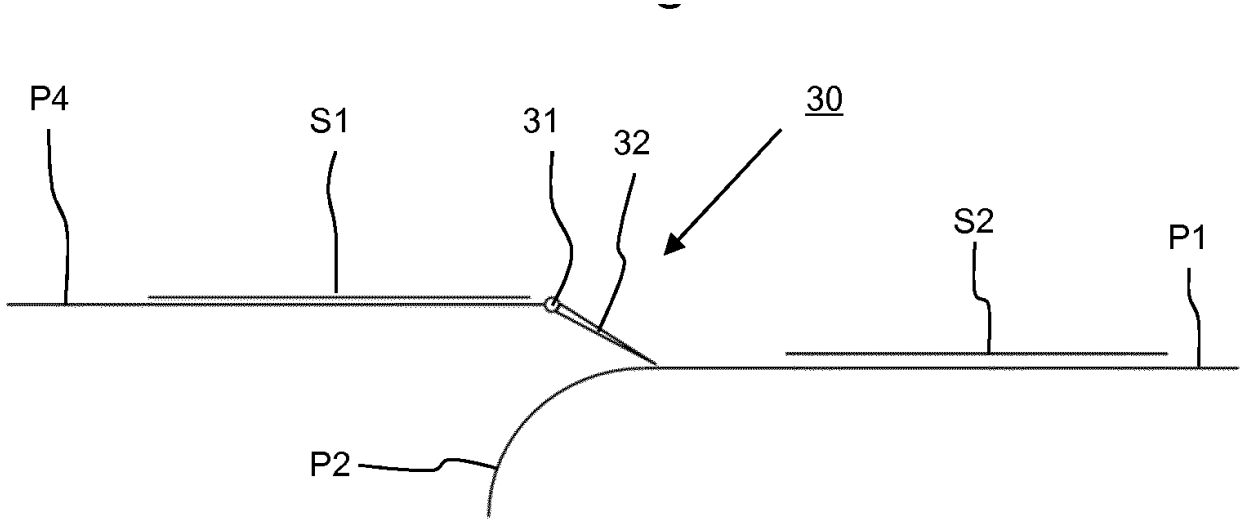

Fig. 3A

EP 3 388 378 A1

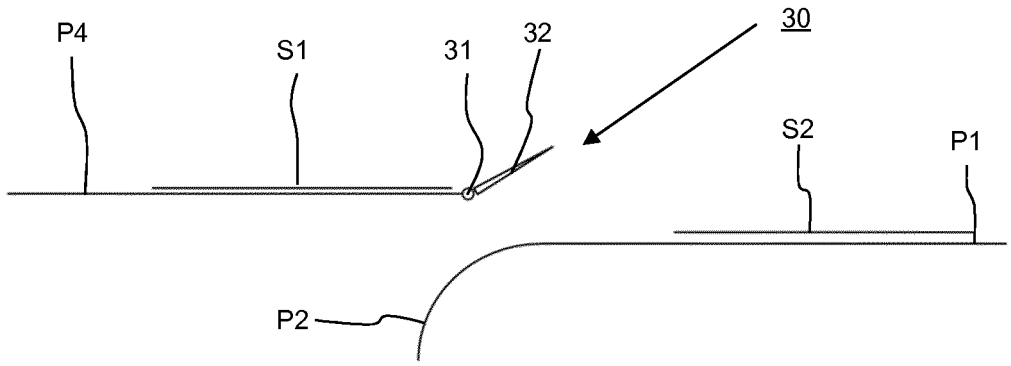

Fig. 3B

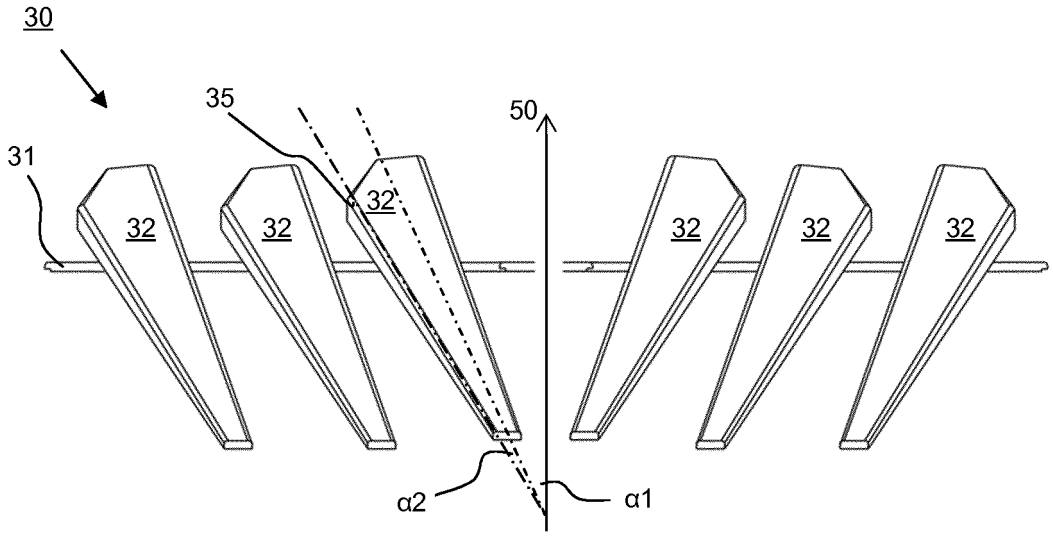

Fig. 7

Description

FIELD OF THE INVENTION

[0001] The present invention generally pertains to a printing system for printing tabbed sheets, a transport switch for use in such a printing system, and a method for printing tabbed sheets.

BACKGROUND ART

[0002] Duplex printing of plain sheets is commonly known. A sheet is printed on a first side, flipped, and then printed on its second side. A disadvantage of the known printing systems is that these systems are unsuited for the duplex printing of tabbed sheets. In the prior art tabbed sheets are transported with their tabs on the trailing edge, as tabs on the leading edge result in the tabbed sheet becoming jammed in the printing system. For duplex printing the plain tab-free sheets are flipped by a flipping device, while the tabbed sheets bypass the flipping device such that the tabbed sheets remain their original orientation on their duplex pass. A first drawback is that the stream of sheets of a print job then needs to be split upstream of the sheet flipping again and re-integrated afterwards, which affects the production speed and increases the complexity of the printing system. As the tabbed sheets are not flipped, their unprinted sides face away from the image forming unit, preventing an image to be printed on said side. Thus, the prior art systems are unable to fulfill the long-felt need for duplex printing on tabbed sheets.

SUMMARY OF THE INVENTION

[0003] It is thus an object of the present invention to provide a printing system for double sided printing of tabbed sheets.

[0004] In a first aspect of the present invention, a printing system according to claim 1 is provided. The printing system according to the present invention is configured for double sided (or duplex) printing of tabbed sheets and comprises:

- a transport mechanism comprising a first transport path extending along an image forming unit and a second transport path downstream of the image forming unit, which second transport path connects to the first transport path, such that a printed sheet is returned to the image forming unit;
- a sheet flipping device for flipping sheets positioned along the second transport path, such that a sheet which has been printed on a first side on a first pass over the first transport path is oriented with its second side to the image forming unit on a second pass over the first transport path;
- a transport switch for selectively directing sheets from the first transport path to the second transport path or from the first transport path to an output path, wherein the transport switch comprises:
- a plurality of longitudinal transport fingers, wherein each transport finger comprises:
    - a top support surface extending between an upstream and a downstream end of the transport finger, wherein the top surfaces of the transport fingers are aligned to define a medium support plane;
    - a side face positioned below the medium support plane, wherein the side face is connected to the top support surface and extends between the upstream and downstream ends of the transport finger,

wherein the side face of the transport finger comprises a longitudinal upward tab deflection face laterally inclined with respect to the medium support plane, such that a tab of a tabbed sheet coming into contact with the upward tab deflection face is guided onto the medium support plane of the transport finger.

[0005] The surface of upward tab deflection face has a positive slope in the lateral direction towards the center of the transport finger. Basically, from the outside to the middle of the transport finger, the upward tab deflection face provides an upward sloping plane. When a tab is urged in between two neighboring transport fingers, the tab first comes into contact with the upward tab deflection face. The movement of the tabbed sheet in the transport direction urges the tab against the upward tab deflection face. The positive slope of the upward tab deflection face re-directs the force on the tab in the upward direction. The tab thus is urged onto the top support surface, bringing the tab back onto the medium support plane. In this manner further bending of the tab and jamming of the tabbed sheet is prevented.

[0006] It is the insight of the inventor that in the prior art systems, tabbed sheets become jammed due to the tab being forced downward in between neighboring transport fingers of a transport switch. It is the further insight of the inventor that the jamming is prevented by providing a laterally extending and upwardly inclining tab deflection face on the transport fingers. Thereby, the tabbed sheets may be flipped in the same manner as plain sheets, allowing the tabbed sheets to be printed on both sides. Thereby, the object of the present invention has been achieved.

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

[0008] In an embodiment, the transport fingers are mounted on a pivot axis for pivoting the transport fingers between an output position wherein the medium support plane connects the first transport path to the output path; and a duplex position wherein the medium support plane connects the first transport path to the second transport path. The printing system is preferably a high speed printing system processing sheets at rates of 300-600 sheets

per minute. The transport switch comprises an actuator arranged for controlled switching of the transport switch at a similar rate. Thereto, the transport switch is provided with sufficient rigidity to perform reliable switching at such switching rates.

[0009] In another embodiment, the longitudinal upward tab deflection face, when viewed along a lateral direction towards a central longitudinal axis of the transport finger, inclines upwards. Moving from the outside to the inside or middle of the transport finger, the upward tab deflection face slopes upwards towards the top support surface. Preferably, the upward tab deflection face is smooth and slopes upwards continuously to avoid irregularities which may catch or trap the tab. In said laterally inward direction, the slope is thus always positive providing a smooth upward tab deflection ramp for the tab. The longitudinal upward tab deflection face extends along the lateral side face of the transport finger from the upstream to the downstream end of the transport finger, preferably over substantially the full length of the transport finger or the top support surface.

[0010] In an easy to produce embodiment, the longitudinal upward tab deflection face is formed by a longitudinal chamfered top side edge of the transport finger. The upward tab deflection face smoothly curves upwards, thereby forming a rounded longitudinal side edge. In a cross-sectional view, one or both upper corners of the cross-section would then be rounded, though a straight or flat inclined upward tab deflection face may also be applied within the scope of the present invention. The transport finger according to the present invention may be easily produced, e.g. by molding or by milling the top corners of an existing transport switch.

[0011] In an embodiment, a radius of curvature of the longitudinal upward tab deflection face, specifically of the chamfered top side edge, is at least 1 mm, preferably at least 2 mm, and very preferably at least 3 mm. The radius of curvature is sufficiently large to ensure the tab contacts the longitudinal upward tab deflection face. So the longitudinal upward tab deflection face is sufficiently large to accommodate tabbed of different media types, as these may show different degrees of downward bending due differences is stiffness. By selecting an appropriately large radius of curvature, it is prevented that the tab bends below the longitudinal upward tab deflection face, as well as that the curvature guides the tab onto the top support surface.

[0012] In an embodiment, the transport finger may comprise a longitudinal upward tab deflection face on opposite lateral sides of the transport finger. In another embodiment, each transport finger comprises a longitudinal chamfered top side edge at both laterally opposing sides of the top support surface. This improves the versatility of the present invention, making it proof against variations in the position of the tab or the position of the deformations along the sheet edge.

[0013] In a further embodiment, the longitudinal upward tab deflection face extends at a non-zero angle with respect to a transport direction of the first transport path, when viewed in a height direction substantially perpendicular to the medium support plane. The transport finger tapers in the upstream transport direction, thereby positioning the longitudinal upward tab deflection face skewed with respect to the transport direction. As the tab then moves downstream in the transport direction, the longitudinal upward tab deflection face moves laterally with respect to the tab. Thereby the tab is guided onto the top sheet support surface due to the relative lateral motion. Due to the tapered form of the transport fingers, the lateral spacing between neighboring transport fingers is greater at the upstream end of the transport switch than at the downstream end. The skewed orientation of the longitudinal upward tab deflection face improves the upward urging of the tab onto the top support surface. In another embodiment, at least one of the longitudinal fingers extends at angle with respect to a transport direction of the first transport path. Alternatively or additionally, skewed orientation of the longitudinal upward tab deflection face may be achieved by skewing the transport finger with respect to the transport direction.

[0014] In an embodiment, at least one of the longitudinal transport fingers is tapered in an upstream direction. The transport finger may taper in its width and/or height. The tapering allows a further reduction of the rotational inertia of the transport finger, whilst still providing sufficient rigidity. The tapered transport fingers thus comprise a greater width and/or height at their downstream ends than at their upstream ends.

[0015] In another embodiment, the transport switch is positioned between the image forming unit and the sheet flipping device. The sheet flipping device is positioned downstream of the image forming unit for flipping tabbed sheets with their unprinted side towards the image forming unit.

[0016] In a further embodiment, the printing system further comprises:

- a sheet input module with a supply unit for holding tabbed sheets; and
- a controller for, in accordance with a print job, controlling:
  - the sheet input module to supply a tabbed sheet to the image forming unit;
  - the image forming unit to provide a first image on a first side of the tabbed sheet;
  - the sheet flipping device to flip the tabbed sheet;
  - the transport mechanism to transport the flipped tabbed sheet over the transport switch;
  - the image forming unit to provide a second image on a second side of the flipped tabbed sheet.

The tabbed sheets are supplied from a sheet input module comprising a first sheet supply for plain sheets and a second sheet supply for tabbed sheets. The controller instructs the sheet input module to supply the sheets in

an order defined by the print job. In accordance with the print job, tabbed sheets are supplied in between plain sheets. The sheet stream for the print job then comprises a sequence of plain sheets as well as one or more tabbed sheets. The advantage of the present invention is that the sheet order in the sheet stream is maintained. All duplex sheets, including tabbed duplex sheets, are transported via the same transport path, reducing the complexity of the transport path, as no alterations to the sheet order during transport are required.

[0017] In an embodiment, the printing system according to the present invention further comprises a sheet edge detection system for determining the position and/or orientation of an edge of a sheet to align the sheet and the image forming unit with respect to another, wherein the sheet edge detection system comprises:

- a pair of laterally spaced apart sheet edge detection sensors; and
- a controller configured for:
    - identifying whether a sheet comprises a tab;
    - identifying whether the tab of the tabbed sheet is trailing or leading as the tabbed sheet is transported over the sheet edge detection sensors;
    - if the tab of the tabbed sheet is trailing, determine from the sheet edge detection sensors a position of a tab-free leading edge of the identified tabbed sheet; and
    - if the tab of the tabbed sheet is leading, determine from the sheet edge detection sensors a position of a tab-free trailing edge of the identified tabbed sheet. When the tab is on the leading edge, there is the risk of erroneously determining the orientation of the sheet edge, when the tab moves over one of the pair of sheet edge detectors. During duplex printing, the tabbed sheet is flipped, so that the tabbed edge is leading during either the simplex or the duplex pass of the tabbed sheet. The controller is configured to track the progress of a tabbed sheet through the printing system. The controller is then adapted to determine whether a tabbed sheet is moving on the first transport path with the tab on its leading edge or on its trailing edge. When the tab is leading, the controller controls the pair of sheet edge detection sensors to detect the position of the trailing edge at two laterally spaced apart positions on said trailing edge. The controller from said positions derives the orientation of the tabbed sheet with respect to the transport direction (or the image forming unit). Similarly, when the tab is trailing, the controller controls the pair of sheet edge detection sensors to detect the position of the leading edge at two laterally spaced apart positions on said trailing edge. In the latter case, the controller derives the orientation of the tabbed sheet from the leading edge. The determined orientation, which for example is the form of a skew angle with respect to the transport direction, is transmitted to a registering device between the pair of sheet edge detection sensors and the image forming unit. If required, the registering device then rotates the tabbed sheet into alignment with image forming unit, reducing the skew angle to zero. Thereby, the front and back images on the tabbed sheets are properly registered.

[0018] In a further aspect, the present invention provides a transport switch according to claim 13. The transport switch is arranged for selectively directing sheets from the first transport path to the second transport path or from the first transport path to an output path of a printing system for double sided printing of tabbed sheets, the transport switch comprising:

- a plurality of longitudinal transport fingers, wherein each transport finger comprises:
    - a top support surface extending between an upstream and a downstream end of the transport finger, wherein the top surfaces of the transport fingers are aligned to define a medium support plane;
    - a side face positioned below the medium support plane, wherein the side face is connected to the top support surface and extends between the upstream and downstream ends of the transport finger,

wherein the side face of the transport finger comprises a longitudinal upward tab deflection face laterally inclined with respect to the medium support plane, such that a tab of a tabbed sheet coming into contact with the upward tab deflection face is guided onto the medium support plane of the transport finger.

[0019] In another aspect, the present invention provides a method for duplex printing of tabbed sheets according to claim 14. The method comprises the steps of:

- supplying a tabbed sheet;
- printing a first image on a first side of the tabbed sheet;
- transporting the tabbed sheet over a transport switch for selectively directing sheets from a first transport path to a second transport path or from the first transport path to an output path, wherein the transport switch comprises:
    - a plurality of longitudinal transport fingers, wherein each transport finger comprises:
    - a top support surface extending between an upstream and a downstream end of the transport finger, wherein the top surfaces of the transport fingers are aligned to define a medium support

plane;

- a side face positioned below the medium support plane, wherein the side face is connected to the top support surface and extends between the upstream and downstream ends of the transport finger,

wherein the side face of the transport finger comprises a longitudinal upward tab deflection face laterally inclined with respect to the medium support plane, such that a tab of a tabbed sheet coming into contact with the upward tab deflection face is guided onto the medium support plane of the transport finger;

- flipping the tabbed sheet; and
- printing a second image on a second side of the flipped tabbed sheet.

[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 embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the 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 hereinbelow and the accompanying schematical drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 shows a schematic representation of an inkjet printing system according to the present invention;
Fig. 2 shows a schematic representation of a transport path of the inkjet printing system in Fig. 1;
Fig. 3A shows a schematic representation of a transport switch of the inkjet printing system in Fig. 1 in an output position;
Fig. 3B shows a schematic representation of a transport switch of the inkjet printing system in Fig. 1 in a duplex position;
Fig. 4 illustrates in schematic perspective view a tabbed sheet becoming jammed in a transport switch of a prior art printing system;
Fig. 5 illustrates in schematic perspective view a transport finger according to the present invention;
Fig. 6A illustrates a cross-sectional view of the transport finger in Fig. 5 in the plane YZ;
Fig. 6B illustrates a cross-sectional view of the transport finger in Fig. 5 in the plane XZ;
Fig. 7 illustrates in schematic perspective view a transport switch according to the present invention;
Fig. 8 illustrates in schematic perspective view a further transport finger according to the present invention; and
Fig. 9 shows in schematic top down view a sheet edge detection device according to the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[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 process

[0023] A printing process in which the inks according to the present invention may be suitably used is described with reference to the appended drawings shown in Fig. 1. Fig. 1 shows a schematic representation of an inkjet printing system.

[0024] Fig. 1 shows that a sheet of a receiving medium, in particular a machine coated medium, P, is transported in a direction for conveyance as indicated by arrows 50 and 51 and with the aid of transportation mechanism 12. Transportation mechanism 12 may be a driven belt system comprising one (as shown in Fig. 1) or more belts. Alternatively, one or more of these belts may be exchanged for one or more drums. A transportation mechanism may be suitably configured depending on the requirements (e.g. sheet registration accuracy) of the sheet transportation in each step of the printing process and may hence comprise one or more driven belts and/or one or more drums. For a proper conveyance of the sheets of receiving medium, the sheets need to be fixed to the transportation mechanism. The way of fixation is not particularly limited and may be selected from electrostatic fixation, mechanical fixation (e.g. clamping) and vacuum fixation. Of these vacuum fixation is preferred.

[0025] The printing process as described below comprises of the following steps: media pre-treatment, image formation, drying and fixing and optionally post treatment.

Media pre-treatment

[0026] To improve the spreading and pinning (i.e. fixation of pigments and water-dispersed polymer particles) of the ink on the receiving medium, in particular on slow absorbing media, such as machine coated media, the receiving medium may be pretreated, i.e. treated prior to printing an image on the medium. The pre-treatment step may comprise one or more of the following:

- preheating of the receiving medium to enhance spreading of the used ink on the receiving medium and/or to enhance absorption of the used ink into the receiving medium;
- primer pre-treatment for increasing the surface ten-

sion of receiving medium in order to improve the wettability of the receiving medium by the used ink and to control the stability of the dispersed solid fraction of the ink composition (i.e. pigments and dispersed polymer particles). Primer pre-treatment may be performed in the gas phase, e.g. with gaseous acids such as hydrochloric acid, sulfuric acid, acetic acid, phosphoric acid and lactic acid, or in the liquid phase by coating the receiving medium with a pre-treatment liquid. The pre-treatment liquid may comprise water as a solvent, one or more cosolvents, additives such as surfactants and at least one compound selected from a polyvalent metal salt, an acid and a cationic resin;

- corona or plasma treatment.

Image formation

[0027] Image formation is performed in such a manner that, employing an inkjet printer loaded with inkjet inks, ink droplets are ejected from the inkjet heads based on the digital signals onto a print medium. Although both single pass inkjet printing and multi pass (i.e. scanning) inkjet printing may be used for image formation, single pass inkjet printing is preferably used since it is effective to perform high-speed printing. Single pass inkjet printing is an inkjet recording method with which ink droplets are deposited onto the receiving medium to form all pixels of the image by a single passage of a receiving medium underneath an inkjet marking module.

[0028] Subsequently and while printing, the receiving medium P is conveyed to the down stream part of the inkjet marking module 11.

Drying and fixing

[0029] After an image has been formed on the receiving medium, the prints have to be dried and the image has to be fixed onto the receiving medium. Drying comprises the evaporation of solvents, in particular those solvents that have poor absorption characteristics with respect to the selected receiving medium. Fig. 1 schematically shows a drying and fixing unit 20, which may comprise a heater, for example a radiation heater. After an image has been formed, the print is conveyed to and passed through the drying and fixing unit 20. The print is heated such that solvents present in the printed image, to a large extent water, evaporate. As described above, the transportation mechanism 12 in the fixing and drying unit 20 may be separated from the transportation mechanism of the pre-treatment and printing section of the printing apparatus and may comprise a belt or a drum.

Post treatment

[0030] To increase the print robustness or other properties of a print, such as gloss level, the print may be post treated, which is an optional step in the printing process. In an embodiment, the prints may be post treated by laminating the prints.

Sheet transport

[0031] Fig. 2 schematically illustrates the sheet transport in a printing system 1 according to the present invention. Sheets S1, S2 are supplied from a sheet input module 40, which comprises a plurality of media supply units 41, 42 for storing sheets S1, S2 of different media types. The media input module 40 supplies a sheet S1, S2 onto the supply main path P3 towards the sheet detection device 18. The sheet detection device 18 comprises one or more sensors for detecting the position and orientation of the sheet S1, S2 on the transport path P3. The sheet detection device 18 may further comprise a registering device to adjust the position and orientation of the sheet S1, S2 to align the sheet S1, S2 with respect to the image forming unit 11. The image forming unit 11 then deposits an image on the sheet S1, S2 on the first or simplex transport path P1.

[0032] After printing, the sheet S1, S2 is transported to the transport switch 30. Dependent upon instructions from the controller 60, the transport switch 30 directs the sheet S1, S2 from the first transport path P1 to one of an output transport path P4 and a second transport path P2. The output transport path P4 extends further to a stacker or finisher for processing sheets S1, S2 which have completed printing. Sheets S1, S2 selected by the controller 60 for duplex printing are directed onto the second or duplex transport path P2. The duplex transport path P2 comprises a sheet flipping device 21 for flipping the sheets S1, S2. The top and bottom sides of the sheets S1, S2 are inverted by the sheet flipping device 21, such that on unprinted side or face of the sheets S1, S2 faces up (meaning facing towards to the image forming unit 11 on the first transport path P1). The sheet flipping device 21 may alternatively be positioned between the image forming unit 11 and the transport switch 30.

[0033] Fig. 3A shows the transport switch in an output position for directing sheets S1, S2 to the output transport path P4. The transport switch comprises a plurality of transport fingers 32 which are aligned to define or form a medium support plane. The transport fingers 32 are secured to the pivot axis 31, such that the transport fingers 32 are pivotable from the output position to a duplex position, shown in Fig. 3B, and vice versa.

[0034] In Fig. 3B, the transport switch is in its duplex position, such that printed sheets S1, S2 are returned from the first transport path P1 via the second transport path P2 to the first transport path P1 for printing on a second side of the sheets S1, S2. The sheet flipping device 21 orients the unprinted side of the sheets S1, S2 towards the image forming unit 11. The sheet flipping device 21 may be any manner of flipping device known in the art, such as a flipping wheel or inversion rollers.

Transport of duplex sheets

[0035] Fig. 4 schematically illustrates the issues with the sheet transport of tabbed sheets TS in a printing system according to the prior art. The transport switch 530 as known in the prior art comprises a plurality of transport fingers 532 aligned to form a medium support plane, which can be pivoted to be connected to one of two transport paths downstream of the transport switch 530. The top support surface 533 of the transport fingers 532 is flat, while the side faces 534 of the transport fingers 532 extend perpendicularly downward from the top support surface 533.

[0036] The tab of a tabbed sheet, when said tab is not supported, tends to curve downwards in the direction of gravity, thereby positioning the tab below the plane of the rest of the sheet. The inventor found that this downward hanging of the tab causes paper jams. This downward deviation of the tab may in practice be even further aggravated, as the tabbed sheets TS are not perfectly flat and comprise local deformations, such as the dog-ear DE, shown on the upper left corner of the tabbed sheet TS in Fig. 4. Such deformations DE locally raise a section of the tabbed sheet TS above the medium support plane, while an upstream part of the tab T is thereby driven below the medium support plane defined by the top surfaces 533. The dog-ear basically tilts the sheet TS.

[0037] The tab T then collides with the side face 534 and is driven even further below the top support surface as the tabbed sheet TS moves further into the transport direction 50. This result in damage to the tabbed sheet TS and eventually a paper jam, leading to downtime of the printing system in the prior art. It will be appreciated that the dog-ear is here is used exemplary for illustrating the downward bending of the tab. The inventor found this effect to be generally present in tabbed sheets, deformed or not.

[0038] The downward urging of the tab is particularly disadvantageous in combination with a dog-ear deformation as drawn in Fig. 4. The dog-ear DE comprises a fold at a corner of the tabbed sheet TS. In Fig. 4 the dog-ear DE is folded downwards in the direction DOWN. As the tabbed sheet TS moves up the transport finger 532, the dog-ear locally raises the upper left corner of the tabbed sheet TS in the direction UP away from the medium support plane. In consequence, the leading edge of the tabbed sheet TS, slightly folds in the downward direction DOWN, where the tabbed sheets TS is not supported by the transport fingers 532. The tab T then drops below the medium support plane in between the transport fingers 532. As the tabbed sheet TS moves further in the transport direction 50, the tab comes into contact with a side face 534 of a transport finger 532. The side faces 534 extend at angle with respect to the transport direction due to the fact that the transport fingers 532 are tapered in the transport direction 50. Contact with the side face 534 forces the tab T even further downwards. The tab T is then folded further in the downward direction DOWN. Since the remainder of the tabbed sheet TS cannot follow the tab T down in between the transport fingers 532, the tabbed sheet TS jams or even tears. Production is then temporarily halted upon. For the above reasons, tabbed sheets are generally supplied with the tab trailing the sheet and the controller is configured to prevent flipping of tabbed sheets. As stated previously, this jamming of tabbed sheets occurs even when without dog-ear deformations in the tabbed sheet. In consequence, duplex printing of tabbed sheets is not available in known prior art systems.

Transport switch

[0039] Fig. 5 illustrates a transport finger 32 of a switch transport switch 30 according to the present invention. By providing transport fingers 32, the inertia of the switch 30 is reduced, enabling fast switching which allows for fast transport and high productivity. As such, sheets S1, S2 may be printed at rates of 300 to 600 or more sheets S1, S2 per minute in a printing system 1 according to the present invention.

[0040] In Fig. 5, the longitudinal direction X is defined with respect to a central longitudinal axis (shown in Figs. 6A and 7) extending through the transport finger 32. The longitudinal direction X may be aligned with the transport direction 50, though non-aligned transport fingers 32 may be applied within the scope of the present invention. The lateral direction Y is perpendicular both the top support surface 33 and the longitudinal direction X. The lateral direction Y may be parallel to the lateral direction of the transport path P. The height direction Z is then perpendicular the both the longitudinal and lateral directions X, Y and extends substantially perpendicular to the sheet support surface 33 and/or the plane of the transport path P.

[0041] The transport finger 32 comprises a longitudinal body 32. The transport finger 32 is tapered in its longitudinal direction X in both the width direction Y and the height direction Z. The upstream end 38 of the transport finger 32 is thus narrower and thinner than its downstream 39 end. The transport finger 32 comprises a top support surface 33 for supporting a sheet S1, S2 as it travels over the transport switch 30. The top support surface 33 is preferably planar, flat or even. The transport finger 32 is mounted onto the pivot axis 31, such that its top support surface is aligned with the top support surfaces 33 of the other transport fingers 32 of the transport switch 30. Thereby, the top support surfaces 33 define a substantially flat medium support plane. When viewed in a lateral direction Y, the medium support plane comprises alternating sections of top support surfaces 33 and voids in between transport fingers 32.

[0042] On either lateral side of the transport finger 32, a side face 35, 36 extends away from the top support surface 33. The side face 35, 36 extends downwards from the medium support plane in the height direction Z. The side face 35, 36, when viewed in the lateral direction

away from the top support surface 33, extends downwards to a bottom or lower portion 32B of the transport finger 32.

[0043] A more detailed illustration of the side faces 35, 36 is shown in the cross-sectional view in Fig. 6A, which shows a cross-section of the transport finger 32 through the plane YZ. Fig. 6A clearly shows the side face 35, 36 inclining upwards to the medium support plane MSP, when viewed laterally towards the center of the transport finger 32. In consequence, the upper part of the cross-section in Fig. 6A is tapered in the height direction Z, such that, when viewed in the height direction Z, top support surface 33 is laterally enclosed by the side faces 35, 36.

[0044] In Fig. 6A, the side face comprises a lower section 34A, 36A connected to the bottom portion 32B of the transport finger 32. The lower section 34A, 36A extends vertically perpendicular to the medium support plane MSP in the height direction Z. The upper end of the lower portion 34A, 36A is connected to the upward tab deflection face 35, 37, which forms the inclined part of the side face 34, 35. The upward tab deflection face 35, 37 in Fig. 6A is shown as curve, but may comprise any inclined shape, such as a quarter circle, spline, or a straight inclined line.

[0045] In the laterally inward direction Y, the upward tab deflection face 35, 37 has a positive slope in the height direction Z. This upwards slope deflects any tab T coming into contact with the upward tab deflection face 35, 37 onto the top support surface 33. Thereby, the tab T is aligned with the remainder of the tabbed sheet TS in the medium support plane MSP.

[0046] The upward tab deflection face 35, 37 may be relatively simple to implement in the form of a rounded of chamfered edge 35, 37 of the transport finger 32. One or both lateral longitudinal edges of the transport finger 32 are then rounded, e.g. by milling, to have a radius of curvature of preferably at least 1 mm, very preferably at least 2 mm, even more preferably at least 3 mm, extremely preferably at least 4 mm, or optionally at least 5 mm. Preferably, the upward tab deflection face 35, 37 is integrally formed with the transport finger 32, for example by molding. The transport finger 32 may be formed of plastics, such as polyethylene.

[0047] Fig. 6B shows a cross-section of the transport finger 32 through the plane XZ. Fig. 6B illustrates the transport finger 32 being tapered along the longitudinal direction X, such that the upstream end 38 has a smaller height than the downstream end 39. Further, as shown in Fig. 5 the width of the transport finger 32 is tapered along the longitudinal direction X, such that the upstream end 38 has a narrower lateral width than the downstream end 39. The width and height tapering may be applied independently of one another and aid in further reducing the inertia of the transport switch 30 without significantly affecting its rigidity. This allows for fast switching without the risk of vibrations disrupting the orientation of the transport switch 30.

[0048] Fig. 7 schematically shows a transport switch 30 according to the present invention. The transport switch 30 comprises a plurality of transport fingers 32 secured onto the pivot axis 31. The pivot axis 31 extends laterally with respect to the transport path P1. One or more transport fingers 32 may be provided at a first angle $\alpha 1$ with respect to the transport direction 50. The first angle $\alpha 1$ is preferably non-zero, e.g. between 0 to 30 or 45°. with Note that the top support surfaces 33 of the transport fingers 32 are aligned in the medium support plane MSP, which plane MSP is parallel to the transport direction 50 for a sheet S1, S2 passing over the transport switch 30. It will be appreciated that the first angle $\alpha 1$ may also be zero. The transport fingers 32 may further be formed symmetrically with respect to a mirror plane extending through the middle of a respective transport finger 32 and parallel to the transport direction 50.

[0049] A side face 34, 36 of the transport finger 32 extends at a second $\alpha 2$ with respect to the transport direction 50. The second angle $\alpha 2$ is illustrated as a non-zero angle $\alpha 2$, for example between 0 and 45°, preferably between 0 and 30°, even more preferably between 5 and °, very preferably between 5 or 10 and 30°. Either or both the orientation of the transport finger 32 by the angle $\alpha 1$ and the tapering of the lateral width of the transport finger 32 determine the value of the second angle $\alpha 2$. As explained in Fig. 4, the second angle $\alpha 2$ causes the tab to tab T to be urged against a side face 34, 36. By providing the upward tab deflection face 35, 27 of a transport finger 32 at the second angle $\alpha 2$ with respect to the transport direction 50, any tab T bending below the medium support plane MSP is forced back up onto the top support surface 33 of said transport finger 32. As the tab T is urged against, the upward tab deflection face 35, 27 positioned at the non-zero second angle $\alpha 2$, the positive slope SL of the upward tab deflection face 35, 27 forces the tab T in the upward height direction Z. Thereby, tabbed sheets TS may be transported through the printing system 1 with the tabbed edge as the leading edge.

[0050] Fig. 8 illustrates a further embodiment of a transport finger 132 according to the present invention. With respect the transport finger 32, the transport finger 132 differs in that the entire side face 134, 136 forms the inclined upward tab deflection face 135, 137. From the bottom 132B, upward tab deflection face 135, 137 slopes upwards, when viewed in the lateral direction Y towards the center of the transport finger 132. The upward tab deflection face 135, 137 thus has a positive slope SL, meaning that the slope angle between a tangential vector on the upward tab deflection face 135, 137 and the lateral direction Y (or the top support surface 33) is between 0 and 90°. The slope angle therein faces towards the middle of the transport finger 132.

[0051] Fig. 9 illustrates in top view the first transport path P1 running along the image forming unit 11. Upstream of the image forming unit 11, a sheet edge detection system 18 has been provided. The sheet edge detection system 18 comprises an upstream pair of op-

tical sensors 18C, 18D configured to detect a sheet edge. The optical sensors 18C, 18D may comprise an emitter and detector positioned on opposite sides of the first transport path P1, for example a photo-emitter, LED, laser, and a photo detector, such as a photo-diode, camera etc. The controller 60 determines the position of two points on the edge of the sheet S1, S2, from which the sheet's orientation with respect to the first transport path P1 and/or the image forming unit 11 is determined.

[0052] When the controller 60 determines that the determined sheet orientation differs from the desired reference orientation, i.e. when the sheet S1, S2 is not aligned with the image forming unit 11, the controller 60 controls the registering device 18A, 18B to adjust the position and/or orientation of the sheet S1, S2. The registering device 18A, 18B in Fig. 9 comprises a pair of independently driveable registering wheels 18A, 18B. By applying different angular velocities to the register wheels 18A, 18B, the sheet S1, S2 may be rotated into alignment with the image forming unit 11. The registering wheels 18A, 18B may further be rotatable around an axis perpendicular to the plane of the first transport path P1. Such a rotation allows the sheet S1, S2 to be moved laterally.

[0053] Fig. 9 shows a tabbed sheet TS on its first or simplex pass over the first transport path P1 (the upper sheet TS in Fig. 9). The tab-free edge of the tabbed sheet TS is leading, which can be determined by the controller 60 from e.g. the print job or a signal from the sheet input module 40. The pair of sheet edge detectors 18C, 18D then measures the leading edge's position at two points along said edge. The controller 60 derives from said measurements the sheet edge orientation and instructs the registering device 18A, 18B to adjust the sheet's orientation and/or position accordingly.

[0054] The tabbed sheet TS is then via the transport switch 30 transported to the flipping device 21 which flips the tabbed sheet TS. The tabbed edge then becomes the leading edge, a shown for the bottom sheet TS in Fig. 9. As the tab T covers one of the sheet edge detection sensors 18C, 18D, any measurement along the leading edge will result in an incorrect orientation of the sheet's orientation. In consequence, the printed image will be printed askew on the tabbed sheet TS.

[0055] The controller 60 is configured to identify tabbed sheet TS within a stream of sheets S1, S2 passing through the printing system 1. Thereto the controller 60 may use information provided in the printing job or by the sheet input module 40. The controller 60 further identifies whether the tabbed sheet TS is being transported with a tab T on its leading edge or trailing edge. In case the tab T is on the trailing edge, the controller 60 may apply the usual control scheme for non-tabbed sheets S1, S2, which comprises detecting the orientation of the leading edge of the sheet S1, S2, TS and, if required, registering the sheet S1, S2, TS in accordance with orientation.

[0056] When the controller 60 determines that an indentified tabbed sheet TS is being transported with a tab T on its leading edge, the controller 60 instructs the sheet edge detection device 18 to sense the position of the tab-free trailing edge. The determined trailing edge orientation is then applied to instruct the registering device 18A, 18B to rotate the tabbed sheet TS into alignment with the image forming unit 11. In this manner, the images printed on the front and back side of the tabbed sheet TS will be properly aligned. The sheet edge detection 18 system according to the present has the advantage that it is relatively cheap and easy to implement with few components, specifically with only a few (two or four) optical sensors 18C-18F. Further, any existing printing system may be easily upgraded to comprise a sheet edge detection device 18 according to the present invention. Note that within the present invention the order wherein tabbed sheets TS are supplied may be reversed with respect to the above explained embodiment.

[0057] For the sake of illustration, Fig. 9 comprises an upstream and a downstream pair of sheet edge detection sensors 18C-18F, but only a single pair 18E, 18F may be applied with the scope of the present invention, given that said pair 18E, 18F is positioned sufficiently upstream of the registering device 18A, 18B and/or the image forming unit 11. The embodiment in Fig. 9 is especially advantageous when upgrading an existing printing system.

[0058] Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. In particular, features presented and described in separate dependent claims may be applied in combination and any advantageous combination of such claims are herewith disclosed.

Further, it is contemplated that structural elements may be generated by application of three-dimensional (3D) printing techniques. Therefore, any reference to a structural element is intended to encompass any computer executable instructions that instruct a computer to generate such a structural element by three-dimensional printing techniques or similar computer controlled manufacturing techniques. Furthermore, such a reference to a structural element encompasses a computer readable medium carrying such computer executable instructions. Further, the terms and phrases used herein are not intended to be limiting; but rather, to provide an understandable description of the invention. The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language). The term coupled, as used herein, is defined as connected, although not necessarily directly.

The 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 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. Printing system (1) for double sided printing of tabbed sheets (TS), comprising:

    - a transport mechanism comprising a first transport path (P1) extending along an image forming unit (11) and a second transport path (P2) downstream of the image forming unit (11), which second transport path (P2) connects to the first transport path (P1), such that a printed sheet (S1, S2, TS) is returned to the image forming unit (11);
    - a sheet flipping device (21) for flipping sheets (S1, S2, TS) positioned along the second transport path (P2), such that a sheet (S1, S2, TS) which has been printed on a first side on a first pass over the first transport path (P1) is oriented with its second side to the image forming unit (11) on a second pass over the first transport path (P1);
    - a transport switch (30) for selectively directing sheets (S1, S2, TS) from the first transport path (P1) to the second transport path (P2) or from the first transport path (P1) to an output path (P4), wherein the transport switch (30) comprises:
    - a plurality of longitudinal transport fingers (32, 132), wherein each transport finger (32, 132) comprises:

        - a top support surface (33, 133) extending between an upstream end (38, 138) and a downstream end (39, 139) of the transport finger (32, 132), wherein the top support surfaces (33, 133) of the transport fingers (32, 132) are aligned to define a medium support plane (MSP);
        - a side face (34, 36, 134, 136) positioned below the medium support plane (MSP), wherein the side face (34, 36, 134, 136) is connected to the top support surface (33, 133) and extends between the upstream end (38, 138) and the downstream end (39, 139) of the transport finger (32, 132),

    characterized in that
    the side face (34, 36, 134, 136) of the transport finger (32, 132) comprises a longitudinal upward tab deflection face (35, 37, 135, 137) laterally inclined with respect to the medium support plane (MSP), such that a tab (T) of a tabbed sheet (TS) coming into contact with the upward tab deflection face (35, 37, 135, 137) is guided onto the medium support plane (MSP) of the transport finger (32, 132).

2. Printing system (1) according to claim 1, wherein the transport fingers (32, 132) are mounted on a pivot axis (31) for pivoting the transport fingers (32, 132) between:

    - an output position wherein the medium support plane MSP) connects the first transport path (P1) to the output path (P4); and
    - a duplex position wherein the medium support plane (MSP) connects the first transport path (P1) to the second transport path (P2).

3. Printing system (1) according to any of the previous claims, wherein the longitudinal upward tab deflection face (35, 37, 135, 137), when viewed along a lateral direction (Y) towards a central longitudinal axis of the transport finger, inclines upwards.

4. Printing system (1) according to any of the previous claims, wherein the longitudinal upward tab deflection face (35, 37, 135, 137) is formed by a longitudinal chamfered top side edge of the transport finger (32, 132).

5. Printing system (1) according to claim 4, wherein a radius of curvature of the chamfered top side edge (35, 37, 135, 137) is at least 1 mm, preferably at least 2 mm, and very preferably at least 3 mm.

6. Printing system (1) according to any of the previous claims, wherein the transport finger (32, 132) may comprise a longitudinal upward tab deflection face (35, 37, 135, 137) on opposite lateral sides (34, 36, 134, 136) of the transport finger (32, 132).

7. Printing system (1) according to any of the previous claims, wherein at least one of the longitudinal transport fingers (32, 132) extends at angle (α1) with respect to a transport direction (50) of the first transport path (P1).

8. Printing system (1) according to any of the previous claims, wherein, when viewed in a height direction (Z) perpendicular to the medium support plane (MSP), the longitudinal upward tab deflection face (35, 37, 135, 137) extends at an angle (α2) with respect to a transport direction (50) of the first transport path (P1).

9. Printing system (1) according to any of the previous claims, wherein at least one of the longitudinal transport fingers (32, 132) is tapered in an upstream di-

rection (X).

10. Printing system (1) according to any of the previous claims, wherein the transport switch (30) is positioned between the image forming unit (11) and the sheet flipping device (21).

11. Printing system (1) according to any of the previous claims, further comprising:

- a sheet input module (40) with a supply unit for holding tabbed sheets (TS); and
- a controller (60) for, in accordance with a print job, controlling:
  - the sheet input module (40) to supply a tabbed sheet (TS) to the image forming unit (11);
  - the image forming unit (11) to provide a first image on a first side of the tabbed sheet (TS);
  - the sheet flipping device (21) to flip the tabbed sheet (TS);
  - the image forming unit (11) to provide a second image on a second side of the flipped tabbed sheet (TS).

12. Printing system according to any of the previous claims, further comprising a sheet edge detection system (18) for determining the position and orientation of an edge of a sheet (S1, S2, TS) to align the sheet (S1, S2, TS) and the image forming unit (11) with respect to another, wherein the sheet edge detection system (18) comprises:

- a pair of laterally spaced apart sheet edge detection sensors (18C-18F);
- a controller (60) configured for:
  - identifying whether a sheet (S1, S2, TS) comprises a tab (T);
  - identifying whether the tab (T) of the tabbed sheet (TS) is trailing or leading as the tabbed sheet (TS) is transported over the sheet edge detection sensors (18C-18F);
  - if the tab (T) of the tabbed sheet (TS) is trailing, determine from the sheet edge detection sensors (18C-F) a position of a tab-free leading edge of the identified tabbed sheet (TS); and
  - if the tab (T) of the tabbed sheet (TS) is leading, determine from the sheet edge detection sensors (18C-18F) a position of a tab-free trailing edge of the identified tabbed sheet (TS).

13. Transport switch (30) for selectively directing tabbed sheets (TS) from a first transport path (P1) to a second transport path (P2) or from the first transport path (P1) to an output path (P4) of a printing system (1) for double sided printing of tabbed sheets TS), the transport switch (30) comprising:

- a plurality of longitudinal transport fingers (32, 132), wherein each transport finger (32, 132) comprises:
  - a top support surface (33, 133) extending between an upstream end (38, 138) and a downstream end (39, 139) of the transport finger (32, 132), wherein the top support surfaces (33, 133) of the transport fingers (32, 132) are aligned to define a medium support plane (MSP);
  - a side face (34, 36, 134, 136) positioned below the medium support plane (MSP), wherein the side face (34, 36, 134, 136) is connected to the top support surface (33, 133) and extends between the upstream end (38, 138) and the downstream end (39, 139) of the transport finger (32, 132),

characterized in that
the side face (34, 36, 134, 136) of the transport finger (32, 132) comprises a longitudinal upward tab deflection face (35, 37, 135, 137) laterally inclined with respect to the medium support plane (MSP), such that a tab (T) of a tabbed sheet (TS) coming into contact with the upward tab deflection face (35, 37, 135, 137) is guided onto the medium support plane (MSP) of the transport finger (32, 132).

14. Method for duplex printing of tabbed sheets (TS), comprising the steps of:

- supplying a tabbed sheet (TS);
- printing a first image on a first side of the tabbed sheet (TS);
- transport the tabbed sheet (TS) over a transport switch (30) for selectively directing tabbed sheets (TS) from a first transport path (1) to a second transport path (P2) or from the first transport path (P1) to an output path (P4), wherein the transport switch comprises (30):
- a plurality of longitudinal transport fingers (32, 132), wherein each transport finger (32, 132) comprises:
  - a top support surface (33, 133) extending between an upstream end (38, 138) and a downstream end (39, 139) of the transport finger (32, 132), wherein the top support surfaces (33, 133) of the transport fingers (32, 132) are aligned to define a medium support plane (MSP);

- a side face (34, 36, 134, 136) positioned below the medium support plane (MSP), wherein the side face (34, 36, 134, 136) is connected to the top support surface (33, 133) and extends between the upstream end (38, 138) and the downstream end (39, 139) of the transport finger (32, 132),

characterized in that
the side face (34, 36, 134, 136) of the transport finger (32, 132) comprises a longitudinal upward tab deflection face (35, 37, 135, 137) laterally inclined with respect to the medium support plane (MSP), such that a tab (T) of a tabbed sheet (TS) coming into contact with the upward tab deflection face (35, 37, 135, 137) is guided onto the medium support plane (MSP) of the transport finger (32, 132).

- flipping the tabbed sheet (TS); and
- printing a second image on a second side of the flipped tabbed sheet (TS).

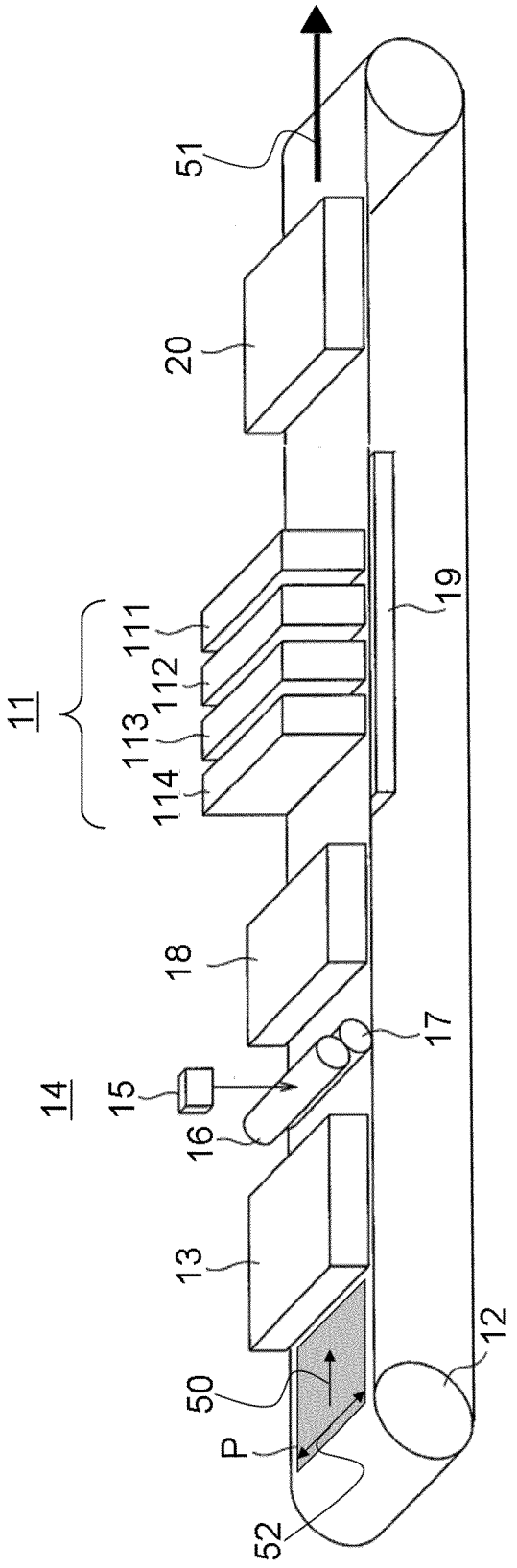

Fig. 1

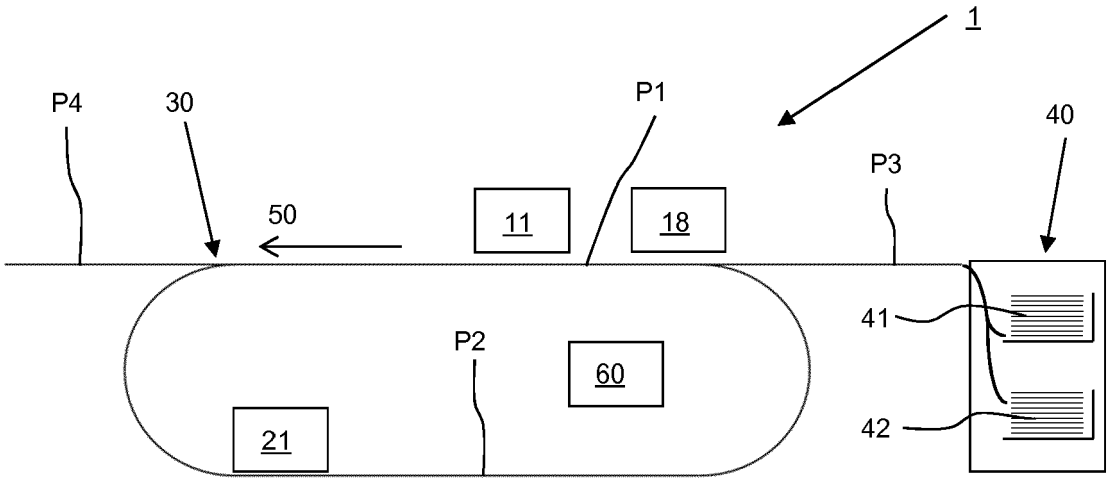

Fig. 2

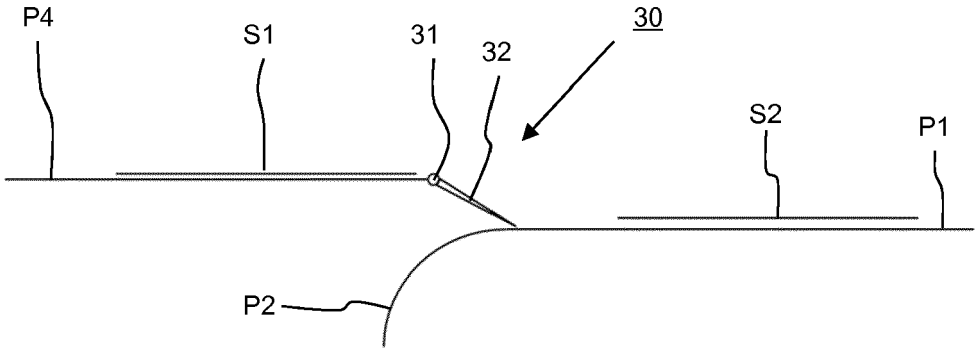

Fig. 3A

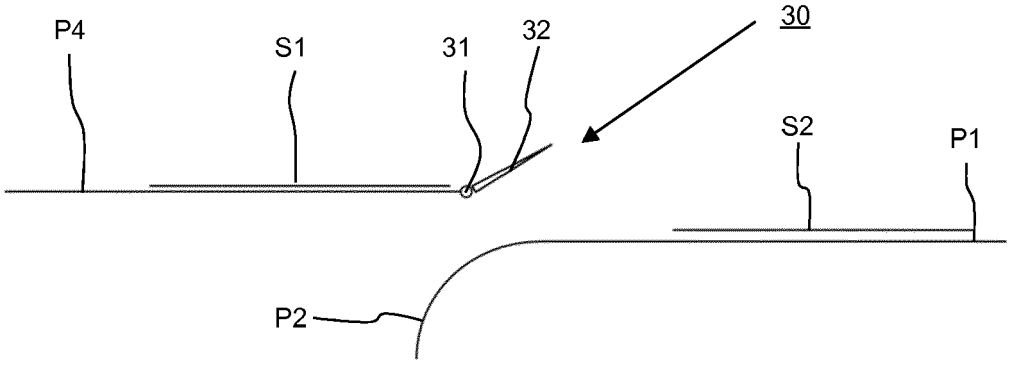

Fig. 3B

PRIOR ART

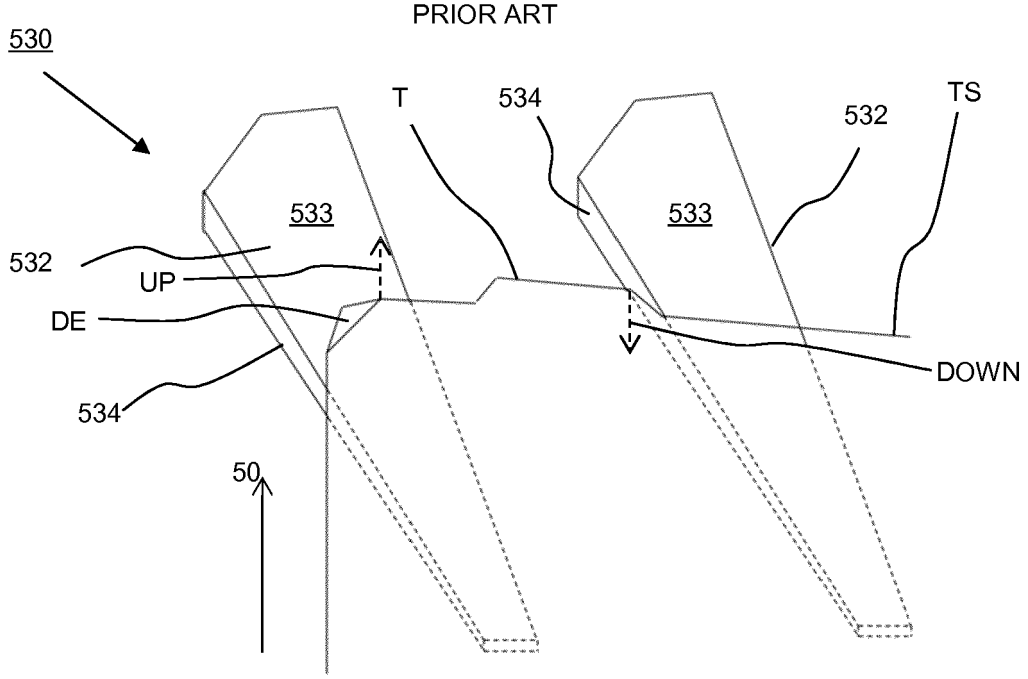

Fig. 4

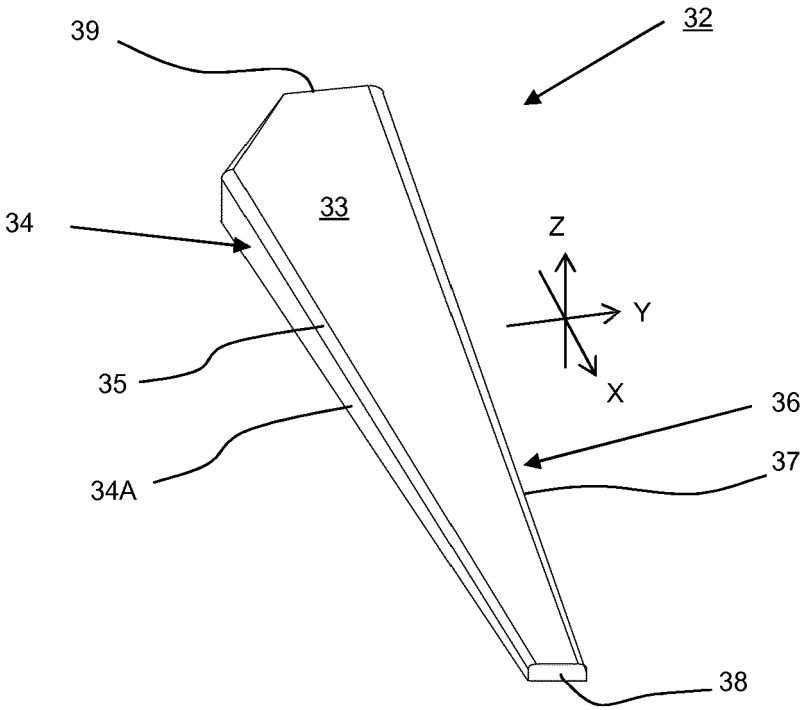

Fig. 5

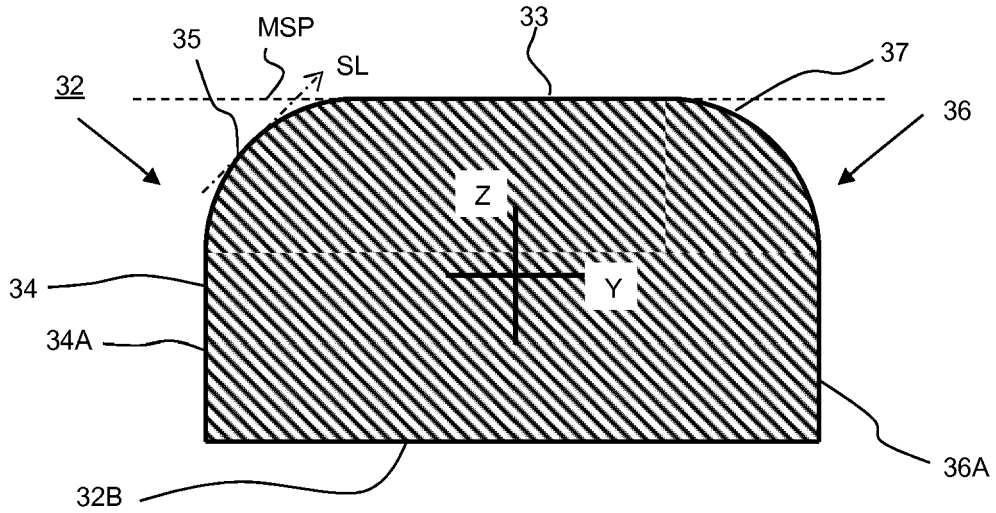

Fig. 6A

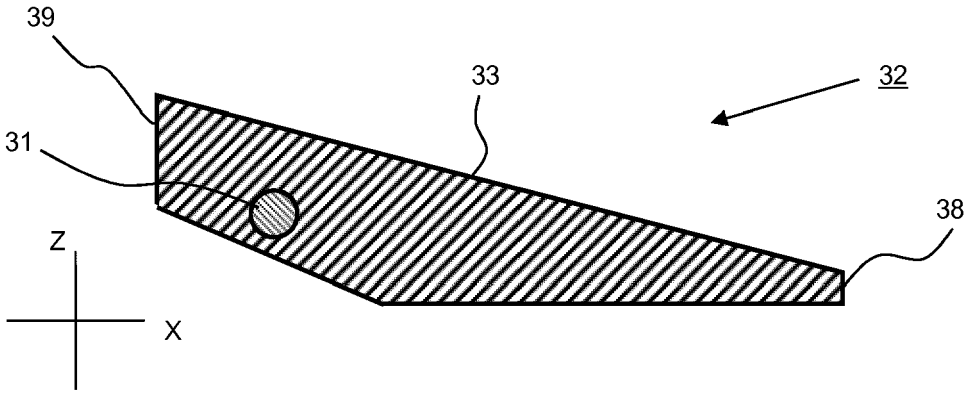

Fig. 6B

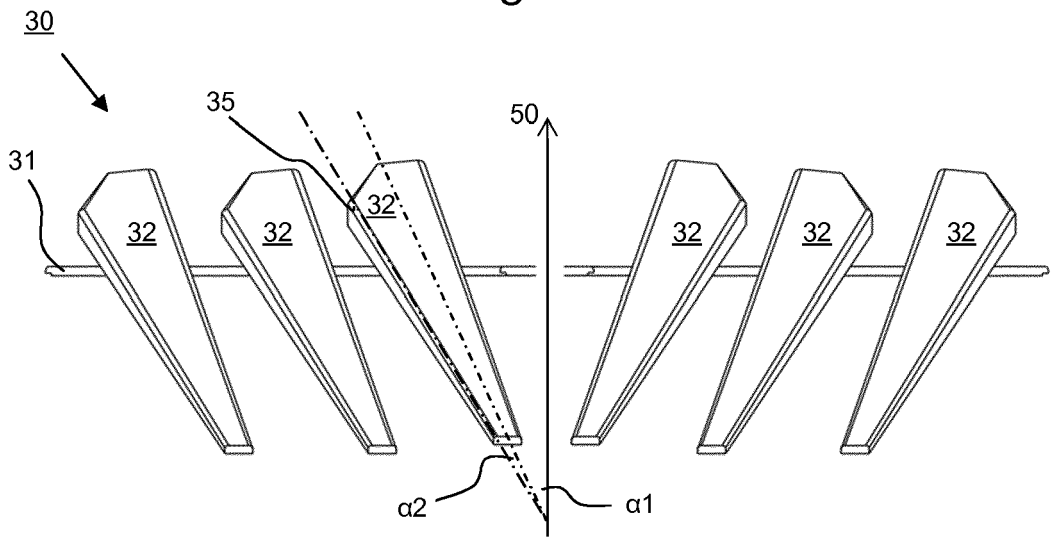

Fig. 7

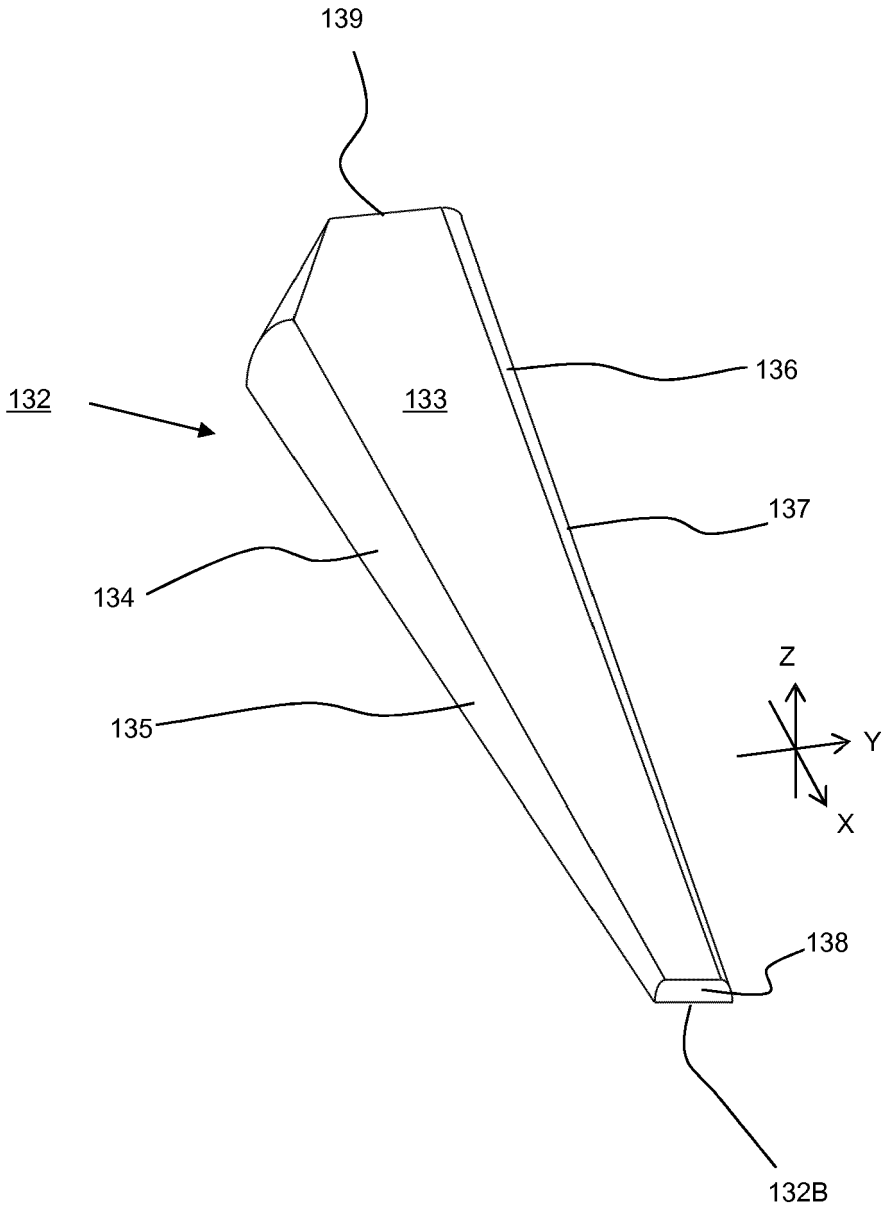

Fig. 8

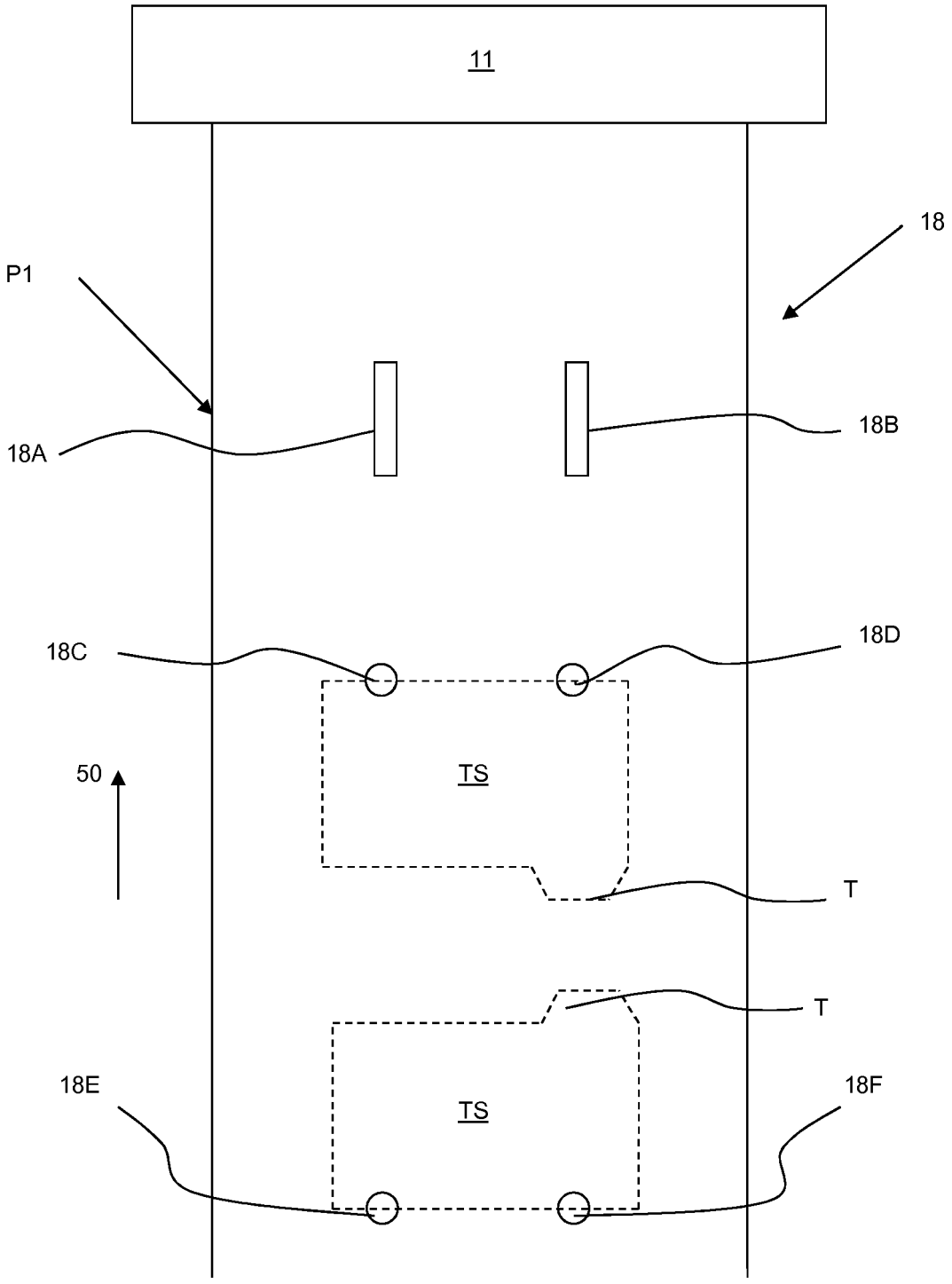

Fig. 9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 16 5823

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2016/145063 A1 (SEGERS JOHANNES T H [NL] ET AL) 26 May 2016 (2016-05-26) * the whole document * -----	1-3,5, 7-9, 11-13	INV. B65H85/00 B65H29/58 B41J3/60 B41J13/00
A	US 2016/280496 A1 (MASUDA TAKEHIRO [JP] ET AL) 29 September 2016 (2016-09-29) * the whole document * -----	4,6	
A	JP 2005 263423 A (SHARP KK) 29 September 2005 (2005-09-29) * the whole document * -----	10,13,14	

TECHNICAL FIELDS SEARCHED (IPC)

B65H
B41J
G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 June 2018	Ureta, Rolando

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 16 5823

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-06-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016145063 A1	26-05-2016	EP 3023375 A1	25-05-2016
		US 2016145063 A1	26-05-2016
US 2016280496 A1	29-09-2016	CN 106019878 A	12-10-2016
		JP 2016184010 A	20-10-2016
		US 2016280496 A1	29-09-2016
JP 2005263423 A	29-09-2005	JP 4139790 B2	27-08-2008
		JP 2005263423 A	29-09-2005

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82