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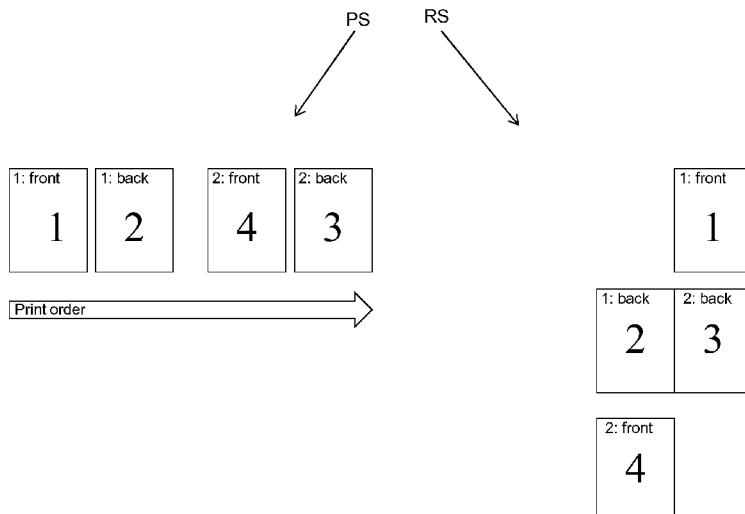
Fig. 5

(57) **Abstract**: The invention relates to a method for printing a digital document on a plurality of cut sheets arranged in a cut sheet printing sequence order resulting in at least one reader spread in an end product, each cut sheet having a first side and a second side, the at least one reader spread consisting of two neighboring sides, each neighboring side of which is of a different cut sheet of the plurality of cut sheets and is intended to be printed upon by a digital page image of the digital document, wherein the method comprises the step of for each reader spread in an end product printing each digital page image corresponding to the reader spread on the first side of the corresponding cut sheet or printing each digital page image corresponding to the reader spread on the second side of the corresponding cut sheet. The invention also relates to a cut sheet printing system configured to apply the method.

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Method for application in a cut sheet printing system

5   Field of the invention

The invention relates to a method for printing a digital document by a cut sheet printing system on a plurality of cut sheets resulting in an end product having a reader spread formed by two opposing sheets of the plurality of sheets, each cut sheet of the plurality of sheets having a first side and a second side, the first side having a first print

10   characteristic and the second side having a second print characteristic different from the first print characteristic. As is well known a reader spread comprises at least a part of each of two neighboring sides and each of the neighboring sides is a side of a different sheet of the plurality of sheets.

The invention further relates to a cut sheet printing system configured to perform the

15   method according to the invention.

Background of the invention

Printing systems for digital cut sheet printing are nowadays also used for printing books and other documents having both sides of the sheets printed upon with images. Such a

20   printing system may comprise a tandem construction of two print engines or two print heads, each print engine or print head printing on one predetermined side of the cut sheets. The cut sheets are separated from a media input holder with one predetermined side upwards. On the other hand such a printing system may comprise a turning-over unit for turning over a cut sheet between a first printing action of printing on one side of

25   the cut sheet and a second printing action of printing on the other side of the cut sheet. The first printing action and the second printing action may be done by a same print head or print engine or by different print heads or print engines. The cut sheets are printed in a cut sheet printing sequence order. If for example a book is printed the pages 1 and 2 may be printed on sides of a first cut sheet, the pages 3 and 4 may be printed

30   on sides of a second cut sheet after printing of the pages 1 and 2, etc. If for example a booklet or a signature is printed comprising an even number n of pages, the pages 1 and n may be printed on a first side of a cut sheet, the pages 2 and n-1 may be printed on a second side of the same cut sheet, and the cut sheet may be folded in half later on after printing on the cut sheet has finished.

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Fig. 4 shows an example of a print sequence of cut sheets for duplex printing and a corresponding reader spread in the end product according to the prior art. Fig. 7 shows an example of a diagram of a prior art method for duplex printing of cut sheets.

Fig. 4 shows a print sequence PS of sides of cut sheets numbered 1 and 2 for duplex printing on both sides of the cut sheets 1, 2. The cut sheet numbered 1 has a front side indicated by the text "1: front" and a back side indicated by the text "1: back" and provided with the number "2". The cut sheet numbered 2 has a front side indicated by the text "2: front" and a back side indicated by the text "2: back". The plurality of images to be printed in an end product on subsequent pages on both sides of the cut sheets 1 and 2 are the images provided with large numbers "1", "2", "3" and "4". The print order of the plurality of images will now be explained in combination with a flow diagram of a method according to the prior art as shown in Fig. 7. A starting point A leads to a first step S1.

According to the first step S1 the cut sheet numbered 1 is separated from the input holder of a cut sheet printing system and transported to the print engine.

According to a second step S2 a bitmap representing the large number "1" is printed upon the front side of the cut sheet numbered 1.

According to a third step S3 the cut sheet numbered 1 is transported to a known duplex print loop module and is turned by the duplex print loop module.

According to a fourth step S4 the cut sheet numbered 1 is transported again to the print engine and a bitmap representing the large number "2" is printed upon the back side of the cut sheet numbered 1.

According to a fifth step S5 the cut sheet numbered 1 is deposited in an output holder of the cut sheet printing system.

According to the sixth step S6 the cut sheet numbered 2 is separated from the input holder of the cut sheet printing system and transported to the print engine.

According to a seventh step S7 a bitmap representing the large number "3" is printed upon the front side of the cut sheet numbered 2.

According to an eighth step S8 the cut sheet numbered 2 is transported to the duplex print loop module again and is turned by the duplex print loop module.

According to a ninth step S9 the cut sheet numbered 2 is transported again to the print engine and a bitmap representing the large number "4" is printed upon the back side of the cut sheet numbered 2.

According to an tenth step S10 the cut sheet numbered 2 is deposited in the output holder of the cut sheet printing system. The method ends in an end point B.

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The steps S1 – S5 may be executed in parallel or interleaved with the steps S6 – S10.

The resulting reader spread RS (See Fig. 4) shows that the two subsequent pages having the prints of the bitmaps representing the numbers "2" and "3" form a reader

5   spread. The first page of this reader spread with the number "2" is printed on the back side of the cut sheet numbered 1, while the second page of this reader spread with the number "3" is printed on the front side of the cut sheet numbered 2. The reader spread is printed on sides of different print characteristics.

10   After printing of all the cut sheets, the printed cut sheets may be gathered into a printed document. The printed document comprises two-page spreads in which the left part of the spread is printed on the first side of a cut sheet, while the right part of the spread is printed on the second side of another cut sheet. A reader spread may usually be printed on cut sheets which are subsequent in the cut sheet printing sequence order.

15   Since the first side of a cut sheet has a different print characteristic than the second side of a cut sheet, a print quality consistency difference, like a color consistency difference, may appear in the printed document, especially in a reader spread.

It is an objective of the invention to provide a method for reaching a print quality

20   consistency in a reader spread within a document to be printed on a cut sheet printing system.

Summary of the invention
According to the present invention the object is achieved by a method according to the

25   preamble, wherein the method comprises printing each digital image of the digital document intended to be printed on the reader spread in the end product on the side of the corresponding cut sheet of the reader spread, which side has the first print characteristic, or printing each digital image of the digital document intended to be printed in the reader spread in the end product on the side of the corresponding cut

30   sheet of the reader spread, which side has the second print characteristic.

By doing so, a consistent print quality in a two-page spread of a document is achieved, since the print characteristics of the sides in the reader spread are the same.
According to an embodiment a first digital image of the digital document is assigned to

35   be printed on the first side of a cut sheet of the plurality of cut sheets and a second

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digital image of the digital document is assigned to be printed on the second side of the cut sheet, and the plurality of cut sheets is arranged in a cut sheet printing sequence order, the method comprising the steps of printing the first digital image and the second digital image respectively on either side of the cut sheet, wherein the step of printing on

5   the cut sheet comprises the steps of, if the cut sheet is of a first mathematical parity in the cut sheet printing sequence order, printing the first digital image on the first side of the cut sheet, and printing the second digital image on the second side of the cut sheet, and, if the cut sheet of a second mathematical parity in the cut sheet printing sequence order, the second mathematical parity other than the first mathematical parity, printing

10   the second digital image on the first side of the cut sheet, and printing the first digital image on the second side of the cut sheet.

In a document with subsequent reader spreads like a 1-up document, 2-up document, a booklet or a signature, two pages of the document determines one side of a reader

15   spread and the other side of a reader spread. The two pages may be subsequent in case of a 1-up document, or complementary with respect to the number of pages in case of a 2-up document or a signature. By applying the method the digital images corresponding to a reader spread are printed on the first side of each of the two sheets in the reader spread in case the cut sheet is of a first mathematical parity in the cut

20   sheet printing sequence order or on the second side of each of the two sheets in the reader spread in case the cut sheet is of a second mathematical parity in the cut sheet printing sequence order. This means that, in a first example, the digital images corresponding to a reader spread are printed on the first side of each of the two sheets in the reader spread in case of an even cut sheet in the cut sheet printing sequence

25   order or on the second side of each of the two sheets in the reader spread in case of an odd cut sheet in the cut sheet printing sequence order. This means that, in a second example, the digital images corresponding to a reader spread are printed on the first side of each of the two sheets in the reader spread in case of an odd cut sheet in the cut sheet printing sequence order or on the second side of each of the two sheets in the

30   reader spread in case of an even cut sheet in the cut sheet printing sequence order.

According to an embodiment the method comprises the steps of for a cut sheet of the first mathematical parity swapping the first and second digital image of the cut sheet before printing the cut sheet and turning the cut sheet with respect to the first side and

35   the second side after printing on the first and second side of the cut sheet. The

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swapping step of the first and second digital image intended to be printed on the cut sheet of the first mathematical parity may be achieved in several ways. If a control unit of the cut sheet printing system receives a digital document in a PDL language which is sent to a RIP rasterizer, the ripped image is stored in a set memory, and the stored

5   ripped image is sent to the print head or marking print engine, two scenarios may be followed to print a page 2 on the first side of cut sheet and a page 1 on the second side of a cut sheet. According to a first scenario the RIP rasterizer processes the PDL document in a normal order to the set memory resulting in a first bitmap for page 1 and a second bitmap for page 2 in the set memory. The print head or marking print engine

10   read first the second bitmap from set memory for printing and then the first bitmap from set memory for printing. According to a second scenario the RIP rasterizer first processes page 2 and then page 1 as indicated by the control unit of the cut sheet printing system. Page 2 is stored in set memory for printing on the first side of the cut sheet and page 1 is stored in set memory for printing on the second side of the cut

15   sheet.
The turning step is turning the cut sheet along an axis in the cut sheet plane. The axis may be a line through mid points of opposing edges of the cut sheet. The turning step is done in order to deposit the cut sheets of the first mathematical parity in a correct order in an output station with respect to the right reader sequence of the printed document.

20   The swapping of the corresponding bitmaps is controlled by a control unit of the cut sheet printing system.

According to an embodiment the method comprises the steps of for a cut sheet of the first mathematical parity turning the cut sheet with respect to the first side and the

25   second side before printing on the first and second side of the cut sheet. This is advantageous if swapping of bitmaps as in the previous embodiment is to be avoided. The turning step is turning the cut sheet along an axis in the cut sheet plane. The axis may be a line through mid points of opposing edges of the cut sheet.

30   According to an embodiment the turning of the cut sheet is achieved by a duplex loop module. For duplex printing, i.e. printing on both sides of a cut sheet, a skilled person may use a duplex loop module. The duplex loop module is configured to turn the cut sheet after one side of the cut sheet has been printed upon and before the second side of the cut sheet is printed upon. The duplex loop module is part of a paper path for the

35   cut sheets through the cut sheet printing system. The duplex loop module may also be

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used for the additional turning of the cut sheet for applying the method of the invention.

According to an embodiment the first print characteristic and the second print characteristic are determined by a media characteristic of the cut sheet. Such a media characteristic is a print characteristic determined a priori to printing. A cut sheet may have a first (physical front) side and a second (physical back) side which are different for the resulting prints on the first and second side of the cut sheet. Since most cut sheets are positioned in a package of sheets, such a media characteristic may be due to the position in the package, for example an upside of each sheet in the package has the first print characteristic while a downside of each sheet in the package has the second print characteristic. A media characteristic may be an adhesiveness for recording material like an ink or toner to the cut sheet medium, which is different for a physical front side and a physical back side of the cut sheet. The print characteristic of a cut sheet which is determined by the media characteristic is already determined before any image has been printed on the cut sheet.

According to an embodiment the first print characteristic and the second print characteristic are determined by a difference in the print process and print interaction between printing on the first side of the cut sheet and printing on the second side of the cut sheet. Such a print characteristic is a print characteristic determined a posteriori to printing. Such a print characteristic may be established after tests of printing cut sheets by the cut sheet printing system. The print process may be such that the first side of a cut sheet is printed by a first print unit, like a print engine or a print head, and the second side of the cut sheet is printed by a second print unit, like a print engine or a print head. By the fact that the first side and the second side are printed by different print units, the print quality of the first side of a cut sheet and a second side of a cut sheet may differ. In a reader spread of a document printed according to the method of the invention, such a difference is eliminated since both sides of the reader spread are printed by the first print unit or both sides of the reader spread are printed by the second print unit. For a cut sheet the printing on the first side of the cut sheet is done by the first print unit and the printing on the second side of the cut sheet is done by the second print unit other than the first print unit.

According to an embodiment the first print characteristic and the second print characteristic are determined by the sequence order in which the first side and the

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second side of the cut sheet are printed upon. If for example, the cut sheet is printed upon one side by a print unit at a certain temperature or at a certain humidity, the printing of the other side of the cut sheet may be done at a different temperature or humidity respectively at the same print unit, which may lead the a print quality difference

5   between the one side and the other side. In another further embodiment for a cut sheet of the plurality of cut sheets the printing on the first side of the cut sheet is done by a first print unit and the printing on the second side of the cut sheet is done by a second print unit other than the first print unit.

10   According to an embodiment of the method the digital document is a 2-up booklet or a signature. The method according to the invention may also be applied to a 2-up booklet or a signature. When the cut sheets of the 2-up booklet or a signature are folded after printing a reader spread is still of the same side of cut sheet. The digital images of the 2-up booklet or signature intended to be printed on the reader spread in the end product

15   comprise the digital images for at least two pages of the 2-up booklet or the signature.

The invention also relates to a cut sheet printing system for printing a digital document on a plurality of cut sheets resulting in an end product having a reader spread formed by two opposing sheets of the plurality of sheets, each cut sheet of the plurality of sheets

20   having a first side and a second side, the first side having a first print characteristic and the second side having a second print characteristic different from the first print characteristic, the cut sheet printing system comprising at least one print unit for printing digital images of the digital document on the plurality of cut sheets, a control unit comprising a determining means for determining at least one digital image intended to

25   be printed on the reader spread in the end product, and a scheduling means configured to schedule each digital image of the digital document intended to be printed in the reader spread in the end product to be printed on the side of the corresponding cut sheet of the reader spread, which side has the first print characteristic, or to schedule each digital image of the digital document intended to be printed in the reader spread in

30   the end product to be printed on the side of the corresponding cut sheet of the reader spread, which side has the second print characteristic.

According to an embodiment of the cut sheet printing system the plurality of cut sheets are arranged in a predetermined cut sheet printing sequence order, and to a cut sheet

35   of the plurality of cut sheets a first digital image of the digital document is assigned to be

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printed on the first side of the cut sheet and a second digital image of the digital document is assigned to be printed on the second side of the cut sheet, the printing system comprising a print engine for printing a digital image on a side of a cut sheet of the plurality of cut sheets, a schedule module configured to schedule the plurality of digital images of the document into the predetermined cut sheet printing sequence order, wherein the printing system further comprises a turning module configured to turn a cut sheet of a first mathematical parity in the cut sheet printing sequence order with respect to the first side and the second side of the cut sheet after printing on the cut sheet, and the schedule module is configured to swap the first and second digital image assigned to a cut sheet of the first mathematical parity before turning the cut sheet.

According to an embodiment of the cut sheet printing system the plurality of cut sheets are arranged in a predetermined cut sheet printing sequence order, and to a cut sheet of the plurality of cut sheets a first digital image of the digital document is assigned to be printed on the first side of the cut sheet and a second digital image of the digital document is assigned to be printed on the second side of the cut sheet, the printing system comprising a print engine for printing a digital image on a side of a cut sheet, a schedule module configured to schedule the plurality of digital images of the document into the predetermined cut sheet printing sequence order, wherein the printing system further comprises a turning module configured to turn a cut sheet of a first mathematical parity in the cut sheet printing sequence order with respect to the first side and the second side of the cut sheet before printing on the cut sheet.

According to an embodiment the cut sheet printing system comprises a duplex loop module for enabling duplex printing of a cut sheet and the duplex loop module comprises the turning module.

The invention further relates to a recording medium comprising computer executable program code configured to instruct at least one computer to perform the method according to the invention.
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

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this detailed description.

Brief description of the drawings

Fig. 1 - 3 show schematic configurations of cut sheet printing systems according to the
invention.

Fig. 4 shows a print sequence of cut sheets for duplex printing and a corresponding
reader spread in the end product according to the prior art.

Fig. 5 - 6 show print sequences of cut sheets for duplex printing and corresponding
reader spreads in the end product according to the method of the invention.

Fig. 7 shows a diagram of a prior art method for duplex printing of cut sheets.

Fig. 8 - 9 show diagrams of embodiments of the method according to the invention.

Detailed description of the embodiments

A number of embodiments will now be described in conjunction with the drawings, in
which same reference numerals refer to like elements.

Fig. 1 is a first schematic configuration of a cut sheet printing system 10 according to
the invention. The cut sheet printing system 10 comprises an input holder 4 for holding a
plurality of cut sheets and an output holder 5 for holding printed cut sheets. A cut sheet
Sh1, Sh2, Sh3, Sh4 is transported along a medium path in a medium transport direction
A by means of a transport belt 6 from the input holder 4 to the output holder 5. A
finishing module (not shown) may be coupled to the output holder 5 or directly to the
transport belt 6 instead of the output holder 5 in order to finish the printed cut sheets into
an end product comprising the plurality of reader spreads such as a book. The cut sheet
printing system 10 further comprises a turning module 3 for turning a cut sheet
according to the method of the invention and a print engine 1 for printing an image on a
side of the cut sheet. The turning module 3 may be configured to turn a cut sheet along
an axis through mid points of opposing edges of the cut sheet. The turning module 3
and the print engine 1 are connected to a control unit 2 for controlling the turning
process and the print process respectively. In Fig. 1 the turning module 3 is positioned
along the medium path before the print engine 1 which is also positioned along the
medium path. This means that a cut sheet first arrives at the turning module 3 and
thereafter at the print engine 1. The print engine 1 is configured to printing an image on
at least one side of a cut sheet Sh1, Sh2, Sh3, Sh4. The print engine 1 may be a
tandem print engine which is able to simultaneously print images on both sides of the

cut sheet. The print engine 1 may also comprise a print unit and a duplex loop module. The print engine 1 is then configured to print an image on one side of the cut sheet by means of the print unit, to turn the cut sheet by means of the duplex loop modules and offering the cut sheet which is printed upon on one side again to the print unit for

5   printing an image on the other side of the cut sheet. The process of twice printing and once turning by means of the print engine 1 is a known process which is controlled by the control unit 2 which controls the print engine 1.

The process of the additional turning of the cut sheet by the turning module 3 according to the method of the invention is also controlled by the control unit 2. Besides printing a

10   double sided document the print engine 1 may also be used to print a single sided document.

In an alternative embodiment of the cut sheet printing system, the turning module 3 is positioned between the input holder 4 and the print engine 1 and an additional input holder is positioned between the turning module 3 and the print engine 1. After a cut

15   sheet has been turned by the turning module 3 the cut sheet is transported to the additional input holder for buffering a stack of cut sheets. Each odd cut sheet is transported from the input holder 4 to the additional input holder without turning the odd cut sheet – bypassing the turning module - and each even cut sheet is transported from the input holder 4 to the additional input holder via the turning module which turns the

20   even cut sheet. In this way the stack of cut sheets which has arrived in the additional input holder is suitable for printing of the end product with reader spreads according to the method of the invention.

Fig. 2 is a second schematic configuration of a cut sheet printing system 20 according to

25   the invention. The cut sheet printing system 20 comprises an input holder 14 for holding a plurality of cut sheets and an output holder 15 for holding printed cut sheets. A cut sheet Sh11, Sh13, Sh14, Sh15 is transported along a medium path in a medium transport direction A by means of a transport belt 16 from the input holder 14 to the output holder 15. A finishing module (not shown) may be coupled to the output holder

30   15 or directly to the transport belt 16 instead of the output holder 15 in order to finish the printed cut sheets into an end product comprising the plurality of reader spreads such as a book. The cut sheet printing system 20 further comprises a turning module 13 for turning a cut sheet according to the method of the invention and a print engine 11 for printing an image on a side of the cut sheet. The turning module 13 and the print engine

35   11 are connected to a control unit 12 for controlling the turning process and the print

process respectively. Contrary to Fig. 1, in Fig. 2 the turning module 13 is positioned
along the medium path after the print engine 11 which is also positioned along the
medium path. This means that a cut sheet first arrives at the printing engine 11 and
thereafter at the turning module 13. The print engine 11 is configured to printing an

5   image on at least one side of a cut sheet Sh11, Sh13, Sh14, Sh15. The print engine 11
may be a tandem print engine which is able to simultaneously print on both sides of the
cut sheet. The print engine 11 may also comprise a print unit and a duplex loop module.
The print engine 11 is then configured to print an image on one side of the cut sheet by
means of the print unit, to turn the cut sheet by means of the duplex loop module and

10   offering the cut sheet which is printed upon on one side again to the print unit for
printing an image on the other side of the cut sheet. The process of twice printing and
once turning by means of the print engine 11 is a known process which is controlled by
the control unit 12 which controls the print engine 11.
The process of the additional turning of the cut sheet by the turning module 13

15   according to the method of the invention is also controlled by the control unit 12.
Besides printing a double sided document the print engine 11 may also be used to print
a single sided document.

Fig. 3 is a third schematic configuration of a cut sheet printing system 30 according to

20   the invention. The cut sheet printing system 30 comprises an input holder 34 for holding
a plurality of cut sheets and an output holder 35 for holding printed cut sheets. A cut
sheet Sh31, Sh32, Sh33, Sh34, Sh35, Sh36 is transported along a medium path in a
medium transport direction A by means of a transport belt 36 from the input holder 34 to
the output holder 35. A finishing module (not shown) may be coupled to the output

25   holder 35 or directly to the transport belt 36 instead of the output holder 35 in order to
finish the printed cut sheets into an end product comprising the plurality of reader
spreads such as a book. The cut sheet printing system 30 further comprises a print unit
37. The print unit 37 comprises a turning module 33 for turning a cut sheet when duplex
printing on the cut sheet is intended and for turning the cut sheet according to the

30   method of the invention and a print engine 31 for printing an image on a side of the cut
sheet. The turning module 33 and the print engine 31 are connected to a control unit 32
for controlling the turning process and the print process respectively. The turning of the
cut sheet according to the method of the invention is integrated in the print unit 37. The
turning module 33 is used as duplex loop module for turning the cut sheet in case of

35   duplex printing on both sides of the cut sheet as well as for turning the cut sheet

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according to the method of the invention. The double sided arrow 38 between the turning module 33 and the print engine 31 indicates that a cut sheet may be transported from the print engine 31 to the turning module 33 and vice versa when printing on at least one side of the cut sheet. This means that the method according to the invention

5   can also be applied to a print job which at least partly consists of cut sheets which are intended to be printed upon on a single side of a cut sheet. Contrary to Fig. 3, in an alternative embodiment the print engine 31 is positioned along the medium path after the turning module 33 which is also positioned along the medium path. This means that a cut sheet first arrives at the turning module 33 and thereafter at the print engine 31.

10   The print engine 31 is configured to printing an image on at least one side of a cut sheet Sh31, Sh32, Sh33, Sh34, Sh35, Sh36. The print engine 31 may be a tandem print engine which is able to simultaneously print on both sides of the cut sheet. The print unit 37 uses the turning module 33 as a duplex loop module. The print engine 31 is then configured to print an image on one side of the cut sheet by means of the print unit, to

15   turn the cut sheet by means of the duplex loop module 33 and offering the cut sheet which is printed upon on one side again to the print unit for printing an image on the other side of the cut sheet. The process of twice printing and once turning by means of the print engine 31 and the turning module 33 is a known process and controlled by the control unit 12 which controls the print unit 37.

20   The process of the additional turning of a cut sheet according to the method of the invention is also controlled by the control unit 12. Besides printing a double sided document the print unit 37 may also be used to print a single sided document.

The print engine 1, 11, 31 in Fig. 1, Fig. 2 and Fig. 3 respectively, may be an inkjet print

25   engine using ink material to be ejected on a cut sheet medium, an inkjet print engine using ink material to be ejected on an intermediate which transports the ink material along a cut sheet medium or an electro-photographical print engine using toner material to adhere to the cut sheet medium.
The print engines 1, 11, 31 may be suitable for printing black-and-white images or

30   colour images. The medium of the cut sheet may be paper, plastic, or any other suitable receiving medium. In case of an inkjet print engine the used ink material may be a hot melt ink, a UV curable ink, a water-based ink and/or a latex ink.

Fig. 5 shows a print sequence PS of sides of cut sheets small numbered 1 and 2 for

35   duplex printing on both sides of the cut sheets small numbered 1, 2. For showing the

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principle of the method of the invention the number of presented cut sheets is equal to 2, but within the scope of the invention a larger plurality of cut sheets may be envisioned. The cut sheet small numbered 1 has a front side indicated by the text "1: front" and a back side indicated by the text "1: back" and provided with the number "2".

5   The cut sheet small numbered 2 has a front side indicated by the text "2: front" and a back side indicated by the text "2: back". The plurality of images to be printed in an end product on subsequent pages on both sides of the cut sheets 1 and 2 are the images provided with large numbers "1", "2", "3" and "4", although any other images may be envisioned.

10

The print order of the plurality of images will now be explained in combination with a flow diagram of a method according to the invention as shown in Fig. 8. A starting point A leads to a first step T1.

According to the first step T1 the cut sheet small numbered 1 is separated from the

15   input holder of the cut sheet printing system and transported to the print engine.

According to a second step T2 a bitmap representing the large number "1" is printed upon the front side of the cut sheet small numbered 1.

According to a third step T3 the cut sheet small numbered 1 is transported to the turning module and is turned by the turning module.

20   According to a fourth step T4 the cut sheet small numbered 1 is transported again to the print engine and a bitmap representing the large number "2" is printed upon the back side of the cut sheet small numbered 1.

According to a fifth step T5 the cut sheet small numbered 1 is deposited in the output holder of the cut sheet printing system.

25   Steps T1 – T5 are equal to the steps S1 – S5 in Fig. 7 according to the prior art.

According to the sixth step T6 the cut sheet small numbered 2 is separated from the input holder of the cut sheet printing system and transported to the print engine.

According to a seventh step T7 a bitmap representing the large number "4" is printed

30   upon the front side of the cut sheet small numbered 2.

According to an eighth step T8 the cut sheet small numbered 2 is transported to the turning module and is turned by the turning module.

According to a ninth step T9 the cut sheet small numbered 2 is transported again to the print engine and a bitmap representing the large number "3" is printed upon the back

35   side of the cut sheet small numbered 2.

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According to a tenth step T10 the cut sheet small numbered 2 is transported to the turning module again and is turned by the turning module.

According to an eleventh step T11 the cut sheet small numbered 2 is deposited in the output holder of the cut sheet printing system. The method ends in an end point B.

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The turning steps T3 and T8 resemble the turning steps of a usual duplex printing by means of a duplex loop module. The turning step T10 is additional and is necessary since printing steps T7 and T9 of the bitmaps representing the numbers "4" and "3" are swapped in comparison with the normal print steps S7 and S9 in the known print order

10   in the prior art case in Fig. 4. The separation step T6 of cut sheet small numbered 2 may be planned before the printing and turning steps S2 – S4 of the cut sheet small numbered 1.

The resulting reader spread RS (See Fig. 5) shows that the two subsequent pages

15   having the prints of the bitmaps representing the numbers "2" and "3" form a reader spread. The two pages of this reader spread are both printed on the back sides of the cut sheets numbered 1 and 2. In this way the print quality issue due to printing on different sides of a cut sheet has been avoided. The page order of the pages in the resulting document is still conform the page order as specified in the document

20   specifications, namely a sequence order of "1", "2", "3" and at last "4".
The method according to the invention also works for 2-up booklets and signatures.

In case of a larger plurality of cut sheets to be printed the steps T1 – T11 may be repeated accordingly. Parallel processing of cut sheets of the plurality may be

25   envisioned. The cut sheet printing systems 20 and 30 in Fig. 2 and Fig. 3 respectively, are configured to execute the steps T1 – T11 of the first embodiment of the method according to Fig. 8. The control units 12 and 32 in Fig. 2 and Fig. 3 respectively are programmed to execute the steps T1 – T11 according to Fig. 8.

30   Fig. 6 shows a print sequence PS of sides of cut sheets numbered 1 and 2 for duplex printing on both sides of the cut sheets 1, 2. For showing the principle of the method of the invention the number of presented cut sheets is equal to 2, but within the scope of the invention a larger plurality of cut sheets may be envisioned. The cut sheet numbered 1 has a front side indicated by the text "1: front" and a back side indicated by the text "1:

35   back" and provided with the number "2". The cut sheet numbered 2 has a front side

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indicated by the text "2: front" and a back side indicated by the text "2: back". The plurality of images to be printed in an end product on subsequent pages on both sides of the cut sheets 1 and 2 are the images provided with large numbers "1", "2", "3" and "4", although any other images may be envisioned. The print order of the plurality of

5   images will now be explained in combination with a flow diagram of a method according to the invention as shown in Fig. 9. A starting point A leads to a first step V1.

According to the first step V1 the cut sheet numbered 1 is separated from the input holder of the cut sheet printing system and transported to the print engine.

10   According to a second step V2 a bitmap representing the large number "1" is printed upon the front side of the cut sheet numbered 1.

According to a third step V3 the cut sheet numbered 1 is transported to the turning module and is turned by the turning module.

According to a fourth step V4 the cut sheet numbered 1 is transported again to the print

15   engine and a bitmap representing the large number "2" is printed upon the back side of the cut sheet numbered 1.

According to a fifth step V5 the cut sheet numbered 1 is deposited in the output holder of the cut sheet printing system.

Steps V1 – V5 are equal to the steps T1 – T5 in Fig. 8.

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According to the sixth step V6 the cut sheet numbered 2 is separated from the input holder of the cut sheet printing system and transported to the print engine.

According to an seventh step V7 the cut sheet numbered 2 is transported to the turning module and is turned by the turning module.

25   According to a eighth step V8 a bitmap representing the large number "3" is printed upon the back side of the cut sheet numbered 2.

According to a ninth step V9 the cut sheet numbered 2 is transported to the turning module again and is turned by the turning module.

According to a tenth step V10 the cut sheet numbered 2 is transported again to the print

30   engine and a bitmap representing the large number "4" is printed upon the front side of the cut sheet numbered 2.

According to an eleventh step V11 the cut sheet numbered 2 is deposited in the output holder of the cut sheet printing system. The method ends in an end point B.

35   The turning steps V3 and V9 resemble the turning steps of a usual duplex printing by

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means of a duplex loop module. The turning step V7 is additional and is necessary since printing steps V8 and V10 of the bitmaps representing the numbers "3" and "4" are as in the same printing sequence order in comparison with the normal print steps S7 and S9 in the known printing sequence order in the prior art case in Fig. 4.

The resulting reader spread RS (See Fig. 6) shows that the two subsequent pages having the prints of the bitmaps representing the numbers "2" and "3" form a reader spread. The two pages of this reader spread are both printed on the back sides of the cut sheets numbered 1 and 2. In this way the print quality issue due to printing on different sides of a cut sheet has been avoided. The page order of the pages in the resulting document is still conform the page order as specified in the document specifications, namely a sequence order of "1", "2", "3" and at last "4".

In case of a larger plurality of cut sheets to be printed the steps V1 – V11 may be repeated accordingly. Parallel processing of cut sheets from the plurality may be envisioned. The cut sheet printing systems 10 and 30 in Fig. 1 and Fig. 3 respectively, are configured to execute the steps V1 – V11 of the second embodiment of the method according to Fig. 9. The control units 2 and 32 in Fig. 1 and Fig. 3 respectively are programmed to execute the steps V1 – V11 according to Fig. 9.

The skilled person will recognise that other embodiments are possible within the scope of the appended claims.

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CLAIMS

1. Method for printing a digital document by a cut sheet printing system on a plurality of
    cut sheets resulting in an end product having a reader spread formed by two
    opposing sheets of the plurality of sheets, each cut sheet of the plurality of sheets
    having a first side and a second side, the first side having a first print characteristic
    and the second side having a second print characteristic different from the first print
    characteristic,
    wherein
    the method comprises the step of
    printing each digital image of the digital document intended to be printed on the
    reader spread in the end product on the side of the corresponding cut sheet of the
    reader spread, which side has the first print characteristic, or
    printing each digital image of the digital document intended to be printed in the
    reader spread in the end product on the side of the corresponding cut sheet of the
    reader spread, which side has the second print characteristic.

2. Method according to claim 1, wherein a first digital image of the digital document is
    assigned to be printed on the first side of a cut sheet of the plurality of cut sheets
    and a second digital image of the digital document is assigned to be printed on the
    second side of the cut sheet, and the plurality of cut sheets is arranged in a cut
    sheet printing sequence order, the method comprising the steps of
    for the cut sheet printing the first digital image and the second digital image
    respectively on either side of the cut sheet,
    wherein the step of printing on the cut sheet comprises the steps of
    if the cut sheet is of a first mathematical parity in the cut sheet printing sequence
    order
    (a) printing the first digital image on the first side of the cut sheet, and
    (b) printing the second digital image on the second side of the cut sheet,
    and
    if the cut sheet of a second mathematical parity in the cut sheet printing sequence
    order, the second mathematical parity other than the first mathematical parity,
    (c) printing the second digital image on the first side of the cut sheet, and
    (d) printing the first digital image on the second side of the cut sheet.

3. Method according to claim 2, wherein the method comprises the steps of for a cut sheet of the first mathematical parity swapping the first and second digital image of the cut sheet before printing the cut sheet and turning the cut sheet with respect to the first side and the second side after printing on the first and second side of the cut sheet.

4. Method according to claim 2, wherein the method comprises the steps of for a cut sheet of the first mathematical parity turning the cut sheet with respect to the first side and the second side before printing on the first and second side of the cut sheet.

5. Method according to claim 3 or 4, wherein the turning of the cut sheet is achieved by a duplex loop module.

6. Method according to claim 1, wherein the first print characteristic and the second print characteristic are determined by a media characteristic of the cut sheet.

7. Method according to claim 1, wherein the first print characteristic and the second print characteristic are determined by a difference in the print process between printing on the first side of the cut sheet and printing on the second side of the cut sheet.

8. Method according to claim 7, wherein for a cut sheet of the plurality of cut sheets the printing on the first side of the cut sheet is done by a first print unit and the printing on the second side of the cut sheet is done by a second print unit other than the first print unit.

9. Method according to claim 1, wherein the first print characteristic and the second print characteristic are determined by the sequence order in which the first and second side of the cut sheet are printed upon.

10. Method according to claim 1, wherein the digital document is a 2-up booklet or a signature.

11. Cut sheet printing system for printing a digital document on a plurality of cut sheets

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resulting in an end product having a reader spread formed by two opposing sheets of the plurality of sheets, each cut sheet of the plurality of sheets having a first side and a second side, the first side having a first print characteristic and the second side having a second print characteristic different from the first print characteristic, the cut sheet printing system comprising at least one print unit for printing digital images of the digital document on the plurality of cut sheets, a control unit comprising a determining means for determining at least one digital image intended to be printed on the reader spread in the end product, and a scheduling means configured to schedule each digital image of the digital document intended to be printed in the reader spread in the end product to be printed on the side of the corresponding cut sheet of the reader spread, which side has the first print characteristic, or to schedule each digital image of the digital document intended to be printed in the reader spread in the end product to be printed on the side of the corresponding cut sheet of the reader spread, which side has the second print characteristic.

12. Cut sheet printing system according to claim 11, wherein the plurality of cut sheets are arranged in a predetermined cut sheet printing sequence order, and to a cut sheet of the plurality of cut sheets a first digital image of the digital document is assigned to be printed on the first side of the cut sheet and a second digital image of the digital document is assigned to be printed on the second side of the cut sheet, the printing system comprising a print engine for printing a digital image on a side of a cut sheet of the plurality of cut sheets, a schedule module configured to schedule the plurality of digital images of the document into the predetermined cut sheet printing sequence order, wherein the printing system further comprises a turning module configured to turn a cut sheet of a first mathematical parity in the cut sheet printing sequence order with respect to the first side and the second side of the cut sheet after printing on the cut sheet, and the schedule module is configured to swap the first and second digital image assigned to a cut sheet of the first mathematical parity before turning the cut sheet.

13. Cut sheet printing system according to claim 12, wherein the plurality of cut sheets are arranged in a predetermined cut sheet printing sequence order, and to a cut sheet of the plurality of cut sheets a first digital image of the digital document is assigned to be printed on the first side of the cut sheet and a second digital image of

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the digital document is assigned to be printed on the second side of the cut sheet, the printing system comprising a print engine for printing a digital image on a side of a cut sheet, a schedule module configured to schedule the plurality of digital images of the document into the predetermined cut sheet printing sequence order, wherein the printing system further comprises a turning module configured to turn a cut sheet of a first mathematical parity in the cut sheet printing sequence order with respect to the first side and the second side of the cut sheet before printing on the cut sheet.

14. Cut sheet printing system according to claim 12 or 13, wherein the cut sheet printing system comprises a duplex loop module for enabling duplex printing of a cut sheet and the duplex loop module comprises the turning module.

15. Recording medium comprising computer executable program code configured to instruct at least one computer to perform the method according to claim 1.

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Fig. 1

Fig. 2

Fig. 3

Fig. 4 (Prior Art)

PS

RS

1: front	1: back	2: front	2: back
1	2	4	3

Print order →

1: front	2: back
1	3

1: back	2: front
2	4

Fig. 5

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Fig. 6

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S6	Separate sheet 2
S7	Print bitmap 3
S8	Turn sheet 2
S9	Print bitmap 4
S10	Deposit sheet 2

S1	Separate sheet 1
S2	Print bitmap 1
S3	Turn sheet 1
S4	Print bitmap 2
S5	Deposit sheet 1

(A) (B)
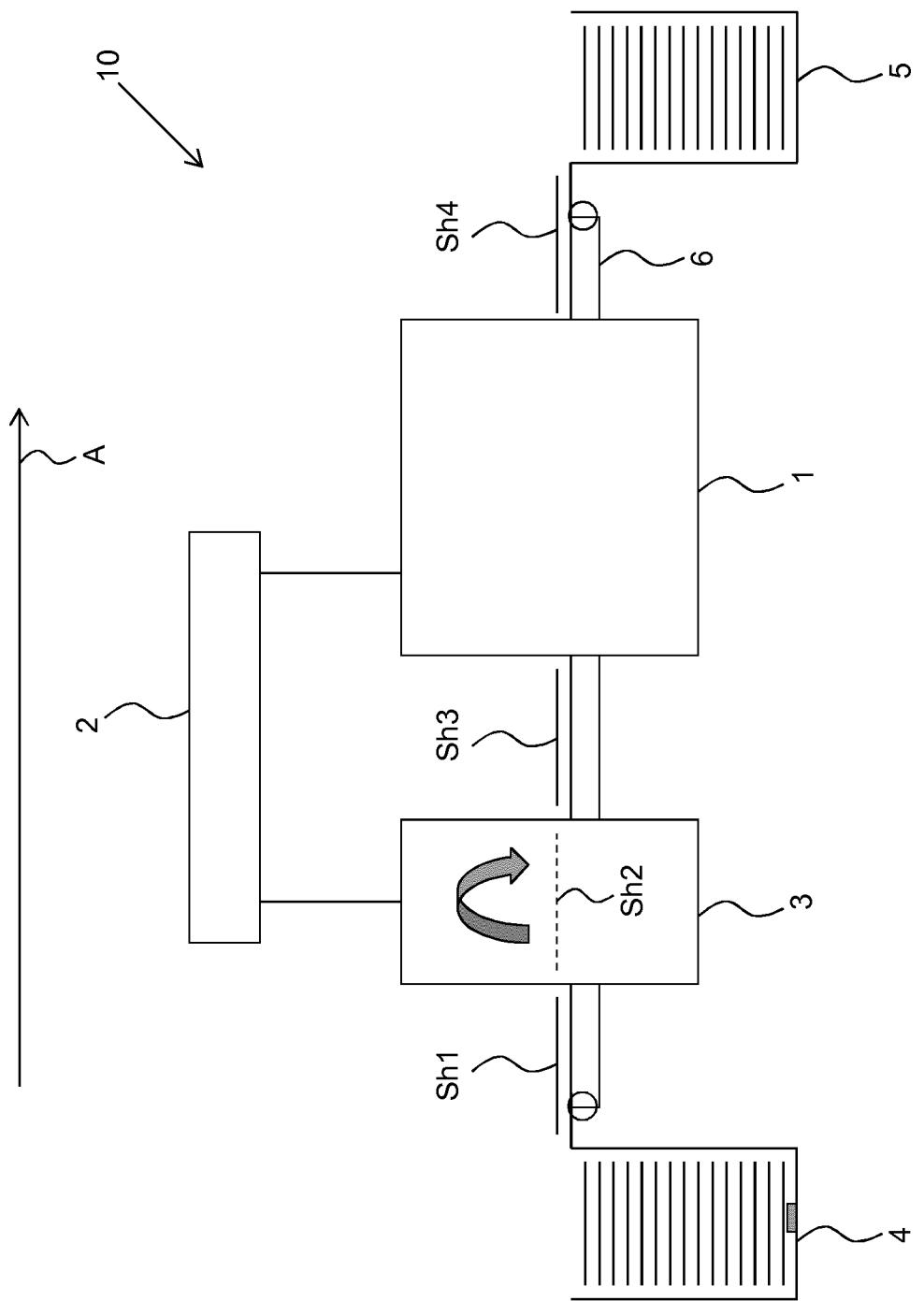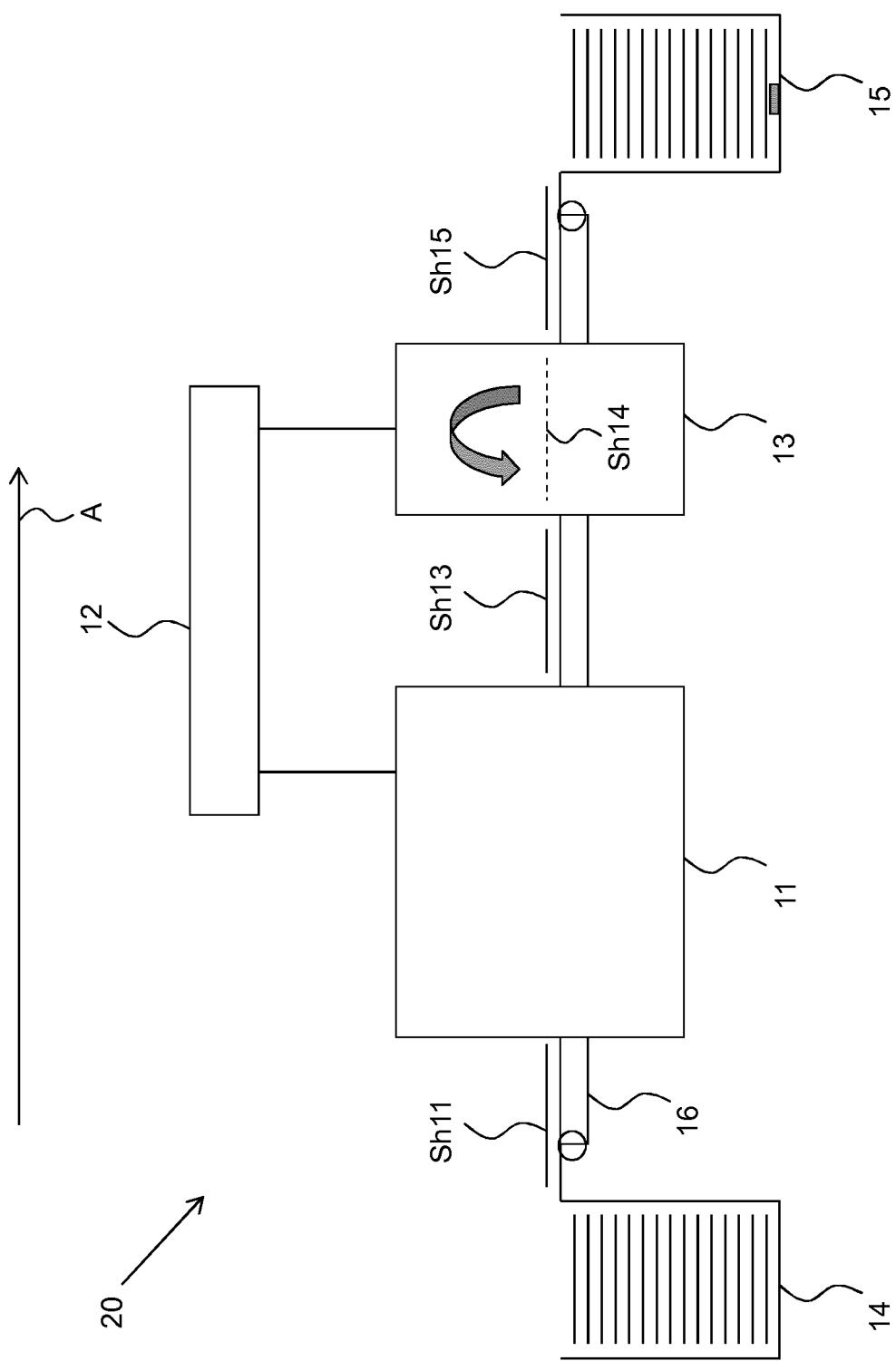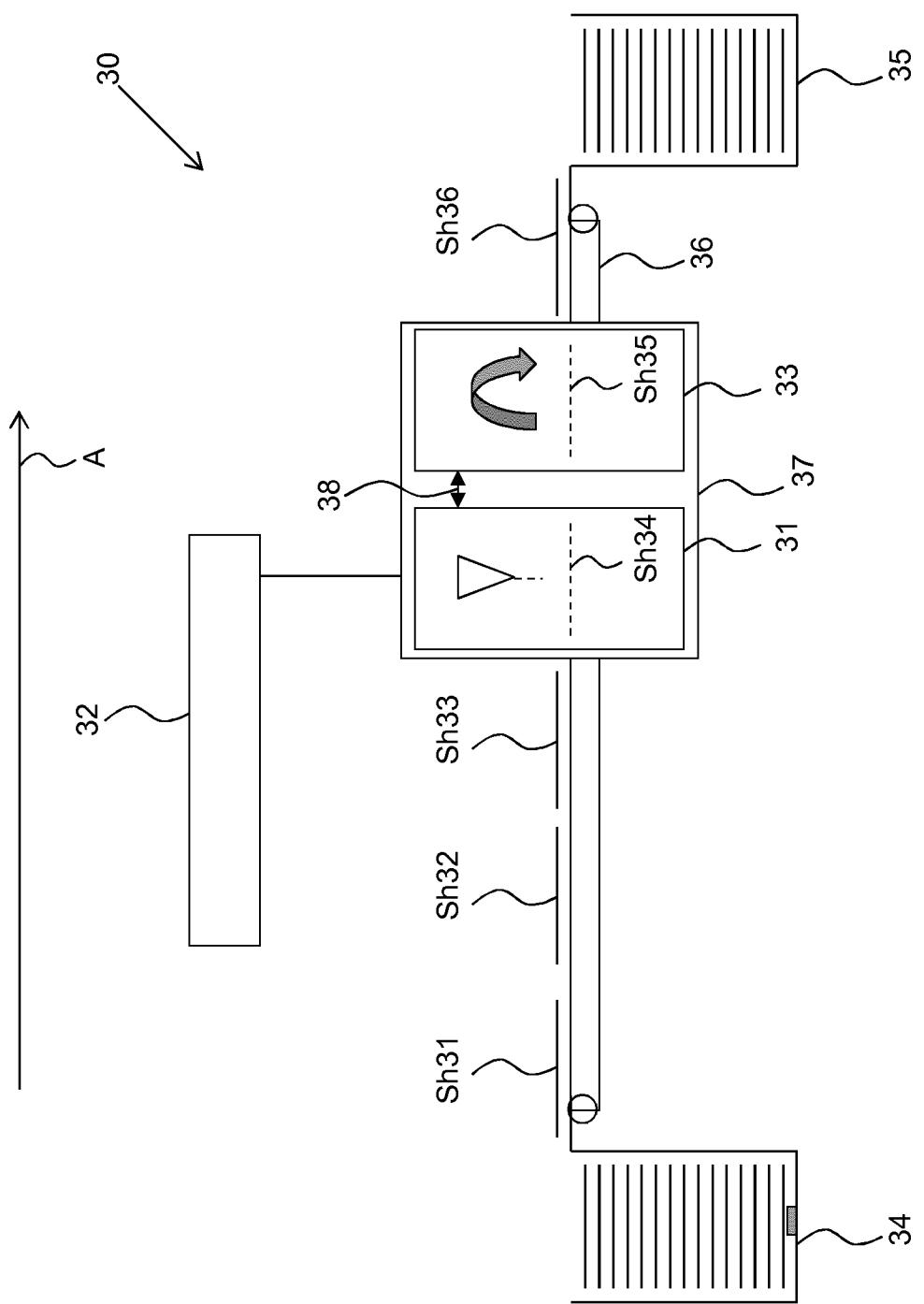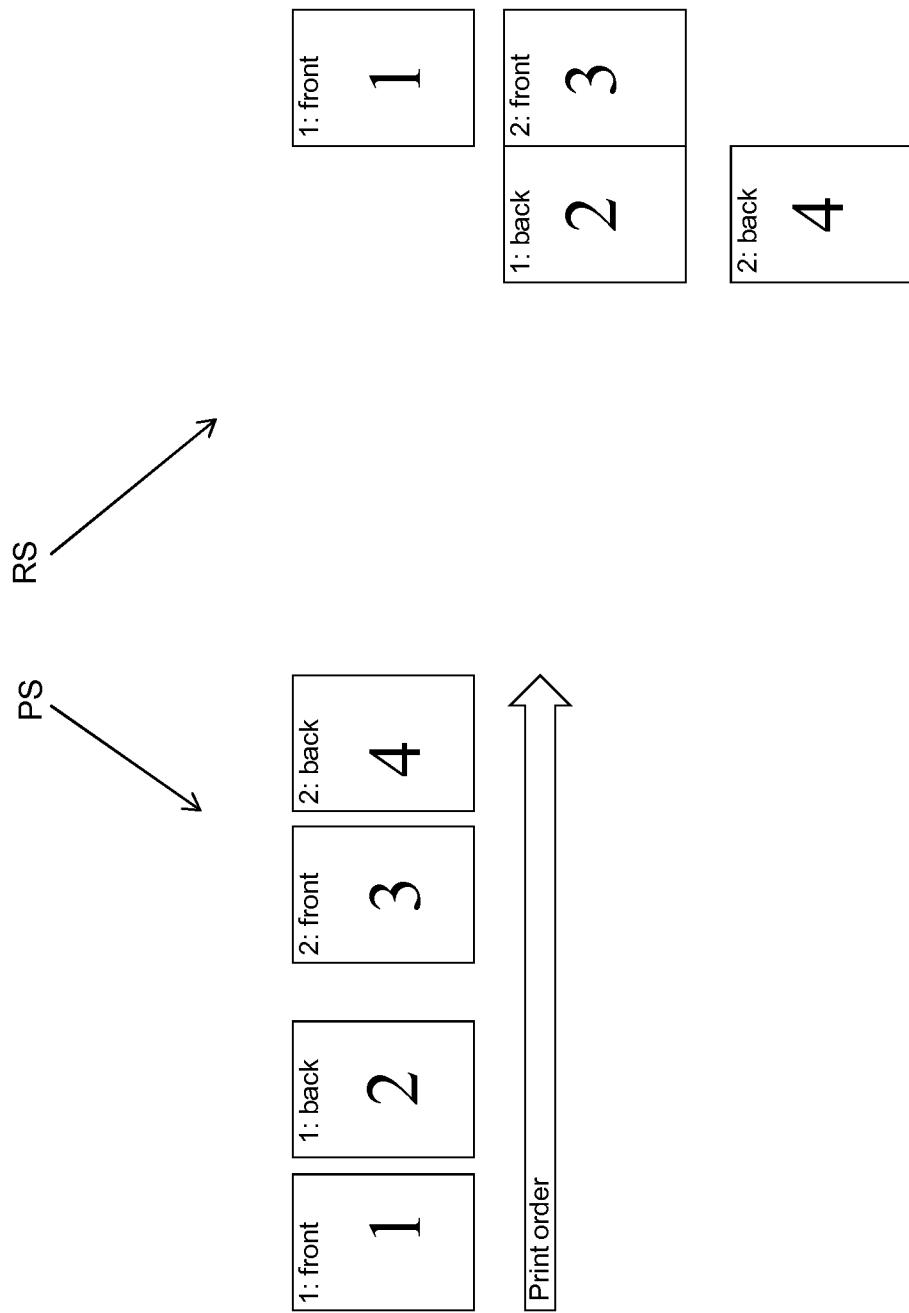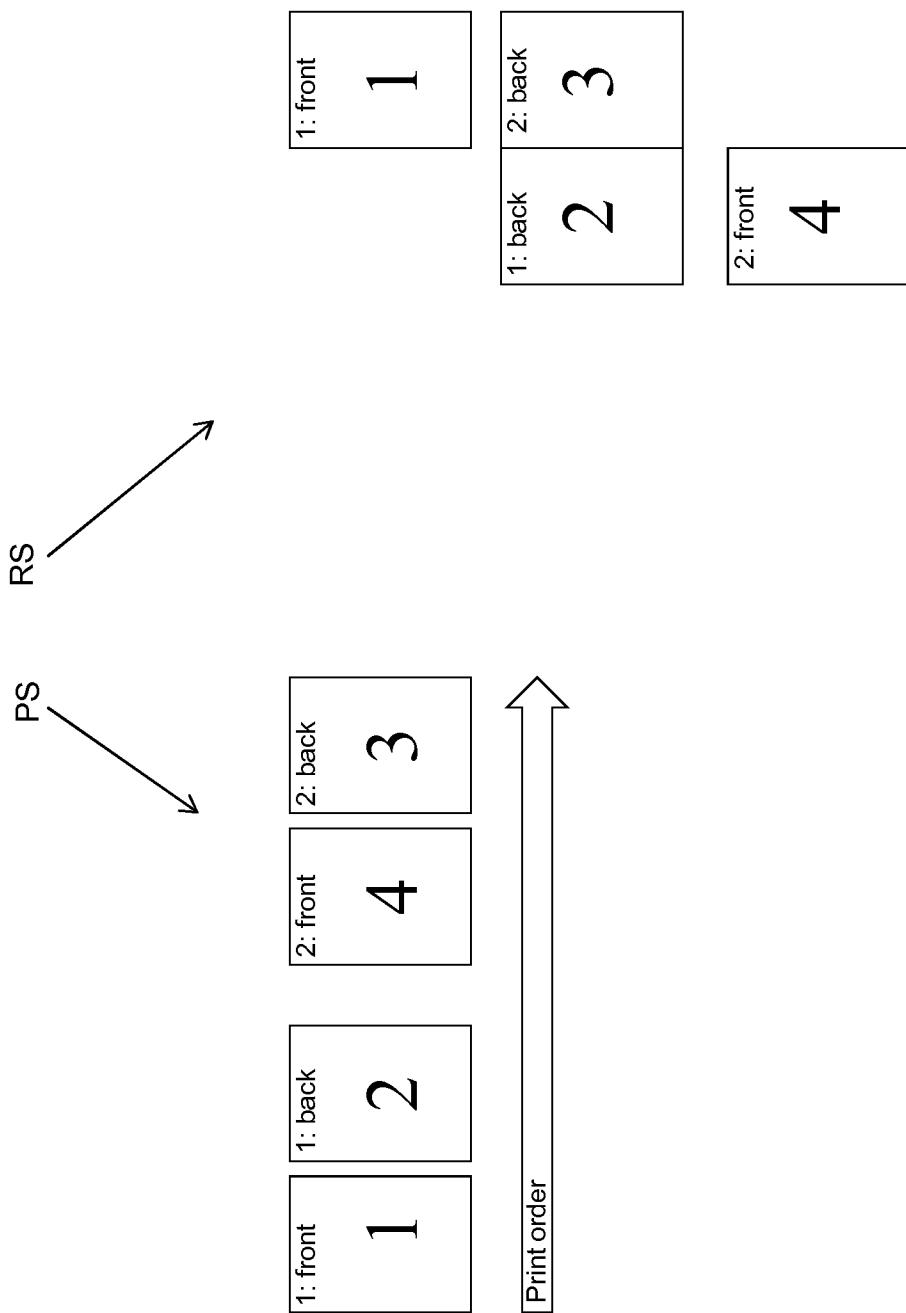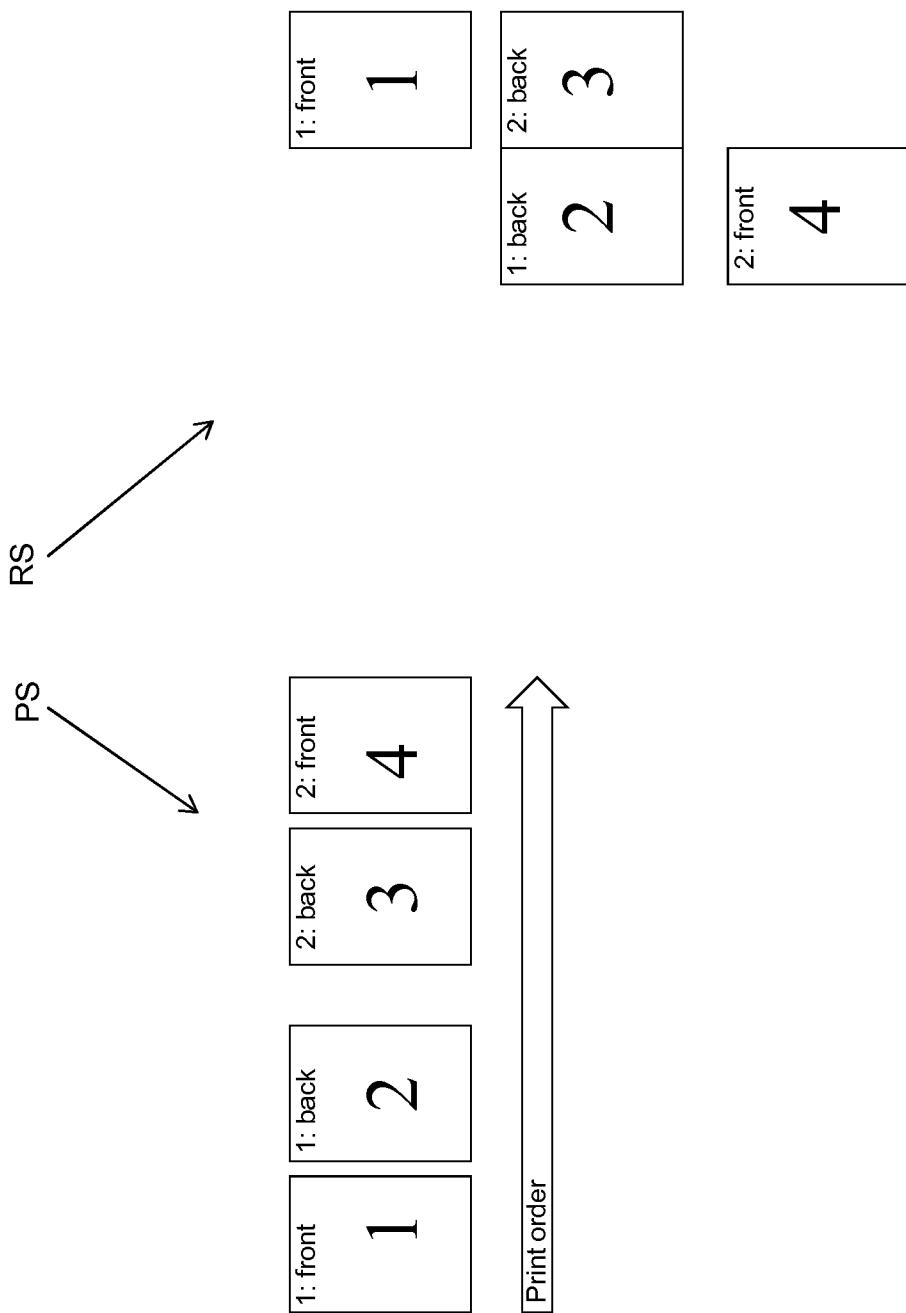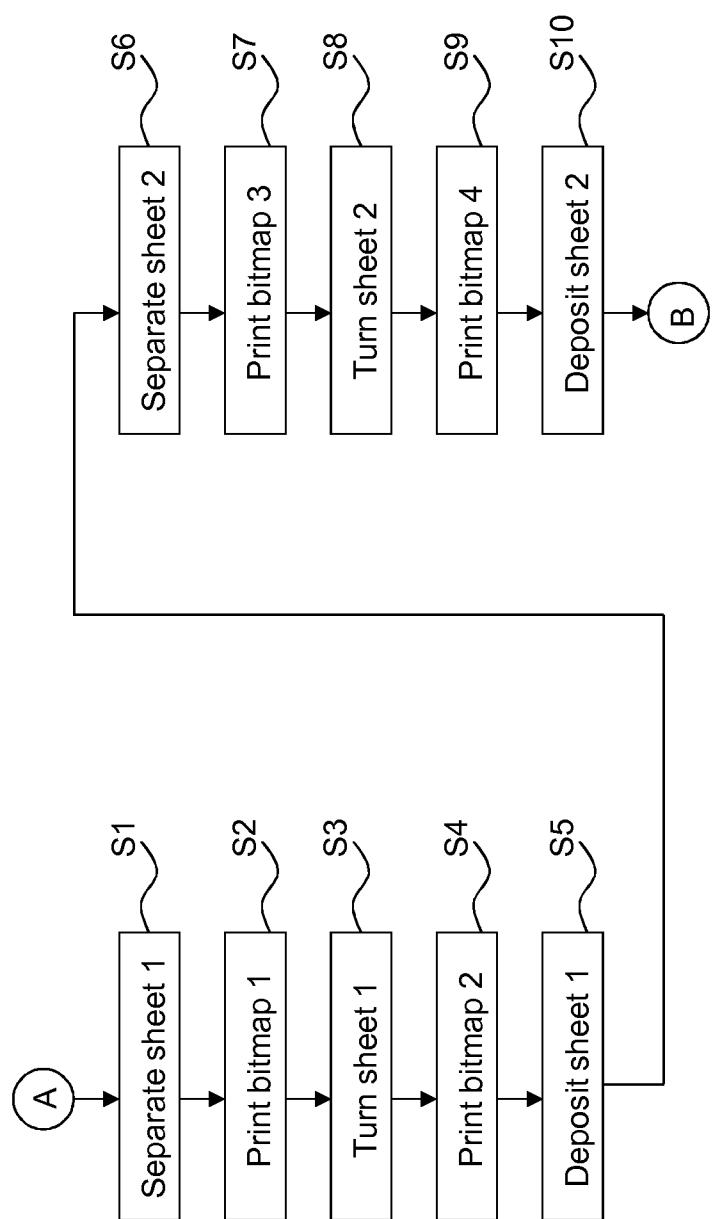
Fig. 7 (Prior Art)

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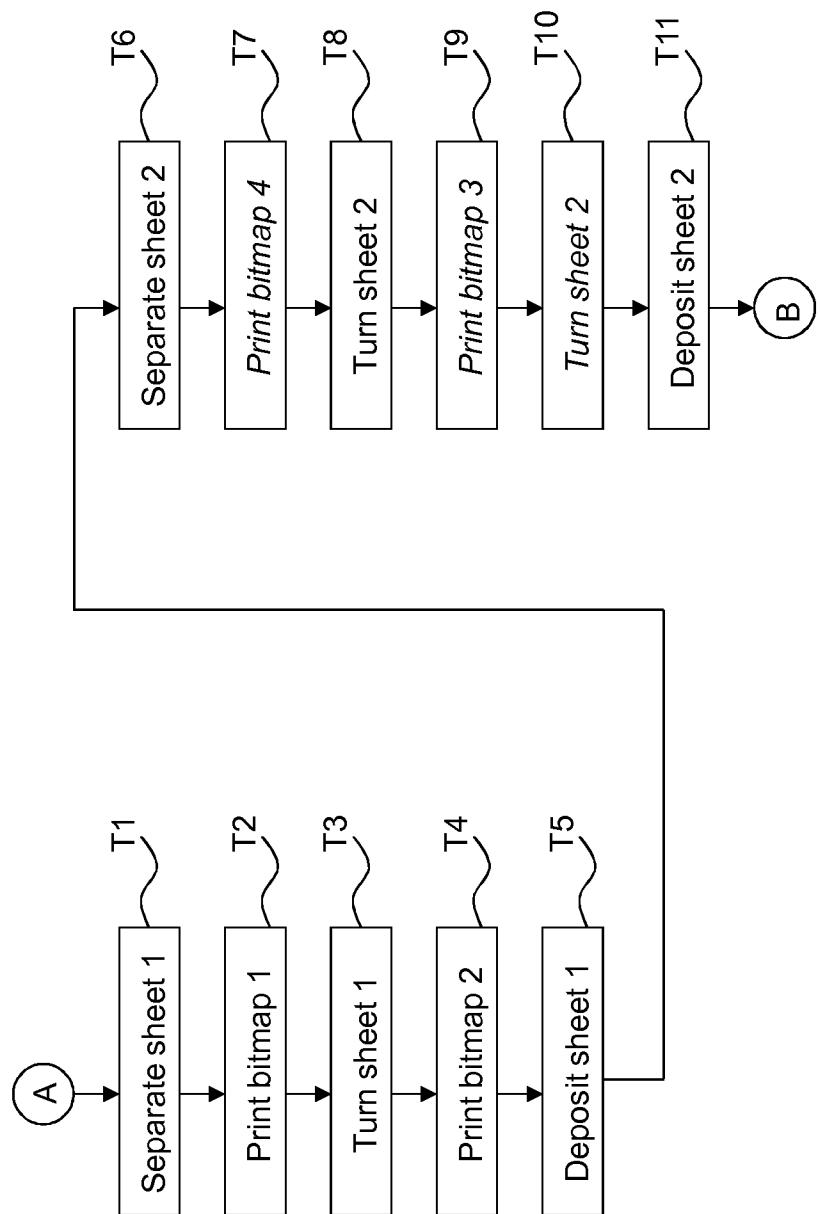
Fig. 8

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Fig. 9

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/12
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)
G06F H04N G06K G03G

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.
X	JP 2001 127947 A (CANON KK) 11 May 2001 (2001-05-11) the whole document -----	1-15
X	WO 2011/065172 A1 (CANON KK [JP]; IGARASHI HIROYA [JP]) 3 June 2011 (2011-06-03) paragraph [0029] - paragraph [0060] figures 1-9 -----	1,2,4,6, 9,11,13, 15
A	JP 2007 084223 A (CANON KK) 5 April 2007 (2007-04-05) the whole document -----	1-7,9, 11-15

☐ 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
28 April 2015	07/05/2015

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	Simigliani, V

Form PCT/ISA/210 (second sheet) (April 2005)

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