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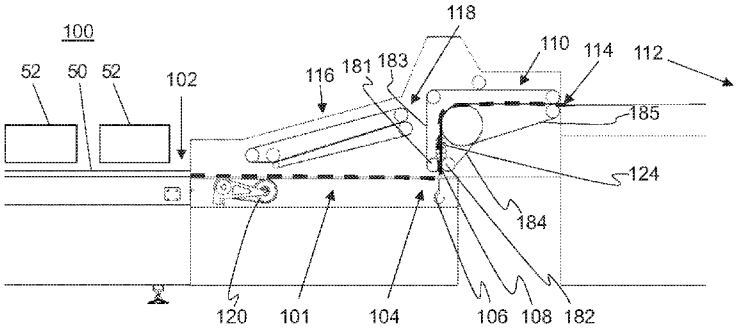

FIG 2A

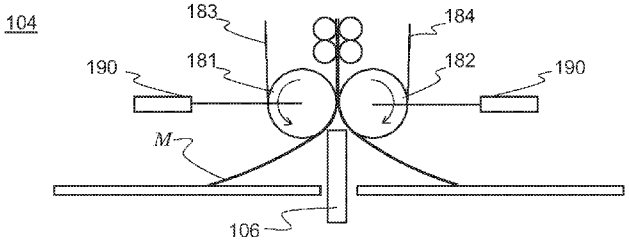

FIG 3C

(57) Abstract: Method of folding a mail item (M) comprising: • - transporting the mail item from a starting position (102) to a folding station (104) by a first transport section (101), the mail item having a leading edge (Ml) and a trailing edge (M2); • - at the folding station, folding the mail item over a folding member (106) by moving the folding member towards an entry location (108) of a second transport section (110), such that the mail item is moved into second transport section with a section of the mail item between the leading edge and the trailing edge first, thereby folding the mail item at a cross folding line on said section; and • - transporting the mail item through the second transport section.

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Title: Method and arrangement for folding a mail item

TECHNICAL FIELD

The aspects and the embodiments thereof relate to the field of methods and arrangements for folding a mail item.

BACKGROUND

For some mail items, it preferred that the mail item is folded, for example to reduce a length of the mail items. Because manually folding mail items is time consuming and expensive, it has been proposed to automate the process of folding mail items.

Devices for providing folds in documents are known from US20110277418A1 and WO2022012881A1.

US20110277418A1 relates to sheet processing system including an insertion device that inserts recording media sheets in envelopes. In fact, it relates to a copying machine including a folding device. In the folding device, a stack of sheets is collected in a center folding tray and remains stationary in that tray. While being stationary, a folding plate moves reciprocally between a home position outside the storage area of the center-folding tray and a position inside the storage area of the center-folding tray to push the bundle of sheets into a nip between two folding rollers (see [0067]). The position of the bundle of sheets in the center-folding tray may be adjusted in dependence of the size of the bundle of sheets front of a folding knife. The position is determined by a back fence of which the position may be set in accordance to the sheet size (see [0079] to [0083] of US'418).

Also in WO2022012881A1, the products to be folded are transport until a leading edge thereof abuts against a stop 32 (see page 17, lines 18-22 of WO'881). The stop 32 defines the position of the product to be folded relative to the folding knife 16 and the fold cylinders 10, 12.

In other words, both in US'418 and WO'881 the folding knife or folding member is operated while the product to be folded is stationary. The transport of the product to be folded is therefore an intermittent transport as opposed to a continuous transport.

SUMMARY

The object of the present invention is a method and an arrangement for folding a mail item wherein the transport movement of the mail item to be folded is continuous as opposed to intermittently. Additionally, it is an object of the present invention to provide a method and an arrangement for folding mail items of which the thickness and/or the length may vary between subsequently supplied mail items.

In fact, upstream of the folding arrangement, a mail item collecting arrangement will be positioned. The mail item collecting arrangement comprises a conveying track and a number of document feeders which are configured to discharge documents on the conveying track, thus forming stacks of documents. The content of each stack of documents may depend on the addressee for the respective stack. Some addressees may receive more or different documents than others. The subsequently produced stacks form the mail items which are supplied to the arrangement for folding the mail items. This supply is performed with a continuous transport speed as opposed to an intermittent transport. An example of such a mail item collecting arrangement is disclosed in EP0832837A1.

In a first aspect, the present disclosure provides a method of folding a mail item. The method comprises:

- creating a continuously moving stream of subsequent mail items on a conveying track along which one or more document feeders are arranged by feeding one or more printed documents on subsequently arranged collecting positions of the conveying track which collecting positions continuously move in a transport direction along the document feeders,

wherein each mail item comprises a single printed document, e.g. a single sheet, a folded sheet, a brochure, or a magazine, or a stack of printed documents, e.g. a stack of sheets, folded sheets, brochures, or magazines, each mail item having a leading edge and a trailing edge and having length defined by the distance between the leading edge and the trailing edge, as well as having a thickness;

- continuously transporting the subsequent mail items from a starting position at the end of the conveying track to a folding station by a first transport section;
- at the folding station, without interrupting the continuous transport of the mail item, folding the mail item over a folding member by moving the folding member towards an entry location of a second transport section, such that the mail item is moved into the entry location of the second transport section with a section of the mail item between the leading edge and the trailing edge first, thereby folding the mail item at a cross folding line on said section of the mail item; and
- continuously transporting each folded mail item through the second transport section.

In general, any mail item referred to herein may comprises a single printed document, e.g. a single sheet, a plurality of sheets, the sheet(s) being folded or unfolded, a magazine, or a stack of printed documents, e.g. a stack of magazines. Any mail item may be a paper mail item, other conceivable can comprise any other material. Optionally, a banderole can be wrapped around the mail item.

Furthermore in general, the mail item, prior to arriving at the folding station, the mail item can have a length between the trailing edge and the leading edge which is larger than a width of the mail item perpendicular to the length. After having been folded, the length of the mail item between the trailing edge and the leading edge can be smaller than, equal to, or remain larger than the width of the mail item perpendicular to the length.

Also in general, thus applicable to any mail item, any arrangement and any method disclosed herein, the length between the trailing edge and the leading edge of the mail item may be reduced between the starting position and an end of the second transport section by virtue of folding the mail item.

With the method according to the invention, a high speed processing of mail items including folding of the mail items can be achieved. This is due to the fact that the folding member engages a moving mail item. This is contrary to the prior art mentioned in the background section in which the mail items move intermittently and the folding is performed on stationary document sheets. Thus, a method is provided with which a high throughput or capacity per hour can be processed.

In an embodiment, the timing of the movement of the folding member may controlled such that the position of the fold is not only dependent on the length of the mail item and the desired position of fold relative to that length but also dependent on the thickness of the mail item.

The folding member pushes the mail item, which is continuously moving perpendicularly to the movement of the folding member, with a folding section thereof in the entry location of the second transport section. When the mail item is thick, the entry location of the second transport section engages the mail item at an earlier moment than when the mail item is thin. Thus, the thickness of the mail item has an influence on the longitudinal position of the fold line relative to the leading and the trailing edge of the mail item. Indeed, when the mail item is thick, the folding line will be closer to the leading edge than when the mail item is thin. This embodiment compensates for the varying thickness of the mail item so as to ensure that the folding line is always at the desired position between the leading edge and the trailing edge of the respective mail item.

In an embodiment, the entry location may be formed by a nip region between two pulleys of the second transport section, wherein the pulleys also function as pressing rollers.

In an embodiment, a distance between the rotation axes of the two pulleys may be automatically adjustable on the fly for each mail item to be folded in dependence of the thickness of that mail item.

By virtue of the fact that the distance between the rotation axes of the two pulleys is adjustable in dependence of the thickness of the mail item to be folded, mail items having a larger range of various thickness may be processed by the system according to this embodiment.

In an embodiment, the length of the mail item may be reduced by the folding to a predetermined standard length. This has the advantage that in the subsequent mail item processing system, e.g. a packaging line, the size of the mail item to be packaged has the predetermined standard length for the subsequently supplied mail items to be packaged. By virtue thereof, the subsequent mail item processing system can be kept more simple, because it does not have to deal with subsequently supplied mail items of differing lengths.

In another embodiment, the length of the mail item may be reduced by approximately by a fixed percentage, e.g. 50% in case the mail item is folded in half.

In an embodiment, the method may comprise:

- using an electronic controller to make a decision on whether the mail item has to be folded, and based on the decision, either:
- folding the mail item using a method according to the first aspect; or alternatively one of:
- transporting the mail item from a starting position to a position downstream of a folding station without folding the mail item; or
- transporting the mail item to a discard position.

By virtue of this method, an automated or semi-automated method is provided for performing different operations, such as folding, not folding, and/or discarding, on one or more mail item to be processed.

In a second aspect, the present disclosure provides an arrangement for folding a mail item. The arrangement comprises:

- a conveying track along which one or more document feeders are arranged for feeding one or more printed documents on subsequently arranged collecting positions of the conveying track which collecting positions continuously move in a transport direction along the document feeders, wherein the conveying track with the one or more document feeders is configured to create a continuously moving stream of subsequent mail items, wherein each which mail item comprises a single printed document, e.g. a magazine, or a stack of printed documents, e.g. a stack of magazines, each mail item having a leading edge and a trailing edge and having length defined by the distance between the leading edge and the trailing edge, as well as having a thickness;
- a folding station;
- a first transport section for continuously transporting the subsequent mail items from a starting position at the end of the conveying track to the folding station; and
- a second transport section configured for continuously transporting each folded mail item from an entry location of the second transport section to an exit location of the second transport section;

wherein the folding station comprises a folding member and an actuator for moving the folding member towards the entry location of the second transport section, wherein the folding member is actuated to engage and fold, without interrupting the continuous transport of the mail item and move the mail item into the entry location of the second transport section with a section of the mail item between the leading edge and the trailing edge first,

thereby folding the mail item at a cross folding line on said section of the mail item.

The arrangement according to the invention has the same advantages as mentioned in relation to the method according to the invention, namely a high number of mail items per hour can be processed. In fact, a processing capacity in the range of 10.000 to 30.000 mail items per hour is feasible.

In general, any transport section disclosed herein may comprise one or more transport device for moving one or more mail items, for example using one or more rollers, one or more belts, one or more moving platforms, one or more lug chains, any other mover, or any combination thereof. The supply of mail items to the arrangement and delivery from mail items by the arrangement is continuous as opposed to intermittent. Continuous does not imply constant speed although that is not excluded. The meaning of continuous supply and delivery of mail items and continuous transport within the arrangement herein is intended to differentiate from arrangements in which the transport of the mail items is intermittent, in the sense that each mail item intermittently comes to a standstill when being supplied, moving through the arrangement and being delivered to a subsequent mail item processing system. . It will be appreciated that any of these optional features may be applied to any transport section disclosed herein. Any single mover may form part of multiple transport sections.

In general, any arrangement disclosed herein may be used to perform one, multiple, or all steps of any method disclosed herein. As such, features disclosed in conjunction with a method may be applied to any arrangement to make the arrangement suitable for performing said feature.

In an embodiment, the arrangement may comprise an electronic controller configured to time the movement of the folding member, wherein the timing of the movement of the folding member is controlled such that the

position of the fold is not only dependent on the length of the mail item and the desired position of fold relative to that length but also dependent on the thickness of the mail item.

As explained in relation to the corresponding embodiment of the method, this embodiment of the arrangement compensates for the varying thickness of the mail item so as to ensure that the folding line is always at the desired position between the leading edge and the trailing edge of the respective mail item irrespective of the thickness of the mail item.

In an embodiment, the entry location may be formed by a nip region between two pulleys of the second transport section. Such a nip region is very suitable for engaging a mail item in a folding section thereof which is between the leading edge and the trailing edge.

In an embodiment, a distance between the rotation axes of the two pulleys is adjustable in dependence of the thickness of the mail item to be folded. Thus, mail items having a larger range of varying thickness may be processed.

BRIEF DESCRIPTION OF THE FIGURES

In the figures,

Fig. 1 shows the principle of applying a cross fold in a mail item moving in a transport direction;

Figs. 2A-2C schematically show a first embodiment of a device for folding a mail item;

Figs. 3A-3C schematically show a first embodiment of a folding station;

Figs. 4A-4C schematically show a second embodiment of a device for folding a mail item;

Figs. 5A-5C schematically show a second embodiment of a folding station; .and

Fig. 6 schematically shows a third embodiment of a device for folding a mail item;

The embodiments depicted in the figures should not be construed as limiting the general scope of the present disclosure. Instead, the embodiments represent examples of how the technology of the present disclosure may be embodied.

DETAILED DESCRIPTION

Fig.1 shows a schematic example of applying a cross fold C in a mail item M. The transport direction is indicated with the arrow T. The mail item M in the left bottom part of the figure has not yet been folded. The mail item M has a leading edge M1 and a trailing edge M2 and two opposite longitudinal edges L1 and L2. The mail item M has a length in the longitudinal direction of D1. With the folding method and the folding arrangement a cross fold C is applied as will be explained below reducing the length of the mail item to D2. It is clear that the cross fold C extends substantially perpendicular to the longitudinal edges L1, L2. It should be noted that the transport direction T is not a linear movement. As shown in e.g. Figs. 3A-3C and 5A-5C as well as Figs. 2A-2C and 4A-4C it is clear that the transport direction of the mail item M changes before, during and after the folding action but is always substantially perpendicular to the direction in which the longitudinal edges L1 and L2 extend. In that sense, the cross fold is applied in a direction which is substantially perpendicular to the transport direction. After applying the cross folding line C, the mail item M leaves the arrangement for folding the mail item and may be transported to a packaging arrangement, for example, for applying a paper wrap. An example of a possible wrapping arrangement for wrapping the mail items is subject of the European patent application EP 4 173 977 A2 of which the contents are incorporated herein by reference.

Figs. 2A-2C show a first embodiment of an arrangement 100 for folding a mail item. The arrangement 100 comprises a conveying track 50 along which one or more document feeders 52 are arranged for feeding one or more printed documents on subsequently arranged collecting positions of the conveying track 50. The collecting positions continuously move in a transport direction along the document feeders 52. The conveying track 50 with the one or more document feeders 52 is configured to create a continuously moving stream of subsequent mail items. The arrangement further comprises a folding station 104, and a first transport section 101 for continuously transporting the subsequent mail items from a starting position 102 at the end of the conveying track 50 to the folding station 104. The arrangement 100 further comprises a second transport section 110 configured for continuously transporting each folded mail item from an entry location 108 of the second transport section 110 to an exit location 114 of the second transport section 110. The mail item can be transferred from the first transport section 101 to the second transport section 110 at or near the folding station 104.

The folding station 104 comprises a folding member 106 and an actuator for moving the folding member towards the entry location 108 of the second transport section 110. The folding member 106 is actuated to engage and fold, without interrupting the continuous transport of the mail item M, and move the mail item M into the entry location 108 of the second transport section 110 with a section of the mail item M between the leading edge and the trailing edge first, thereby folding the mail item M at a cross folding line on said section of the mail item M. For any folding station disclosed herein, the actuator may be a pneumatic or hydraulic actuator. Alternatively, an electric actuator can be used. For any actuator, a translating actuator can be used, or a rotating actuator for example in combination with a straight-guide or quasi-straight-guide for guiding a movement of the folding member 106 towards the entry location 108 of the second transport section 110.

The assembly may comprise an electronic controller configured to time the movement of the folding member 106. The timing of the movement of the folding member 106 is preferably controlled such that the position of the fold is not only dependent on the length of the mail M item and the desired position of fold relative to that length but also dependent on the thickness of the mail item M. If the mail item is thick, the engagement by the entry location 108 of the second transport section 110 would be earlier and as a consequence, the fold line would be closer to the leading edge than in the case that the mail item M is thin. This embodiment compensates for that.

In an embodiment, the entry location 108 is formed by a nip region between two pulleys 181, 182 of the second transport section 110, wherein the pulleys 181, 182 also function as pressing rollers. Such pressing roller 181, 182 provide a nice folding line in the mail item M when the mail item M passes between the pressing rollers 181, 182 which may also guide endless belts 183, 184.

In order to increase the range of thickness variation of the various products that may be processed by the arrangement, an embodiment of the arrangement may comprise that a distance between the rotation axes of the two pulleys 181, 182 is automatically adjustable on the fly for each mail item to be folded in dependence of the thickness of that mail item M. To that end, each pulley 181, 182 may be connected to an actuator 190, e.g. an electric, pneumatic or hydraulic actuator 190. The actuators 190 may be controlled by an electronic controller which has information about the thickness of each mail item M to be folded. This information may be based on a thickness measurement of the mail item M by means of a sensor. Alternatively, the thickness may have been determined by the electronic controller on the basis of knowledge about the thickness of the various components of the mail item which together form the mail item M. Thus, subsequently supplied mail items M with different thicknesses may be processed, simply by adjusting on the fly

the distance between the rotation axes of the pulleys 181, 182 for each mail item M to be folded, at least when necessary.

As an option depicted in Fig. 2A but applicable to any arrangement of the present disclosure, the mail item is moved into the second transport section 110 with a top surface first, by virtue of a generally upward movement of the folding member 106. Alternatively, a generally sideward or downward movement of the folding member 106 may be used, for example depending on the position of the folding member 106 relative to the entry location 108 of the second transport section 110.

It will be understood that any actuator may also be arranged for moving the folding member 106 away from the entry location 108 and/or the folding member may be biased away from the entry location of the second transport section 110.

Fig. 2A shows the arrangement 100 in a folding state. Fig. 2B shows the same arrangement 100, in a bypass state. Fig. 2C shows the same arrangement, in a discard state. The different states will be elaborated below. It will be appreciated that arrangements are also envisioned which do not allow for a bypass state and/or discard state, in any combination thereof. In Figs. 2A-2C, a typical path a mail item will follow is highlighted by a thicker dashed line.

In the folding state, the arrangement 100 may be used to perform one or more or all steps in a method of folding a mail item. In the bypass state, the mail item is not folded at the folding station, but is however transported to the same location downstream of the folding station as it would have in the folding state of the arrangement. In the discard state, the mail item is transported to another location without being folded

Now referring to Fig. 2A with the arrangement 100 in the folding state, the thickened dashed line depicts a path a mail item may travel through the arrangement 100 in order to be folded. The mail item is transported from the starting position 102 to the folding station 104, using

the first transport section 101. For example, the first transport section may comprise a transport surface on which the mail item rests, and one or more lugs to push the mail item along the transport surface. Alternatively, the first transport section may disclose any other mover as disclosed herein. When the mail item is at the starting position 102, it may be unfolded, or already folded in a previous folding method.

At the folding station 104, the mail item can be folded over the folding member 106 by moving the folding member 106 towards the entry location 108 of the second transport section 110. The entry location 108 of the second transport section 110 may be bound by two pulleys 181, 182, respectively associated with two transport belts 183, 184. When the first transport belt 183 moves in a generally counter-clockwise direction, and the second transport belt 184 moves in a generally clockwise direction, the mail item can be caught between the two transport belts 183, 184. When the mail item is caught between the two transport belts 183, 184 with a section of the mail item between the leading edge and the trailing edge first, the mail item is folded at a cross folding line on said section, and subsequently transported through the second transport section 110 to the exit location 114 of the second transport section 110.

In the embodiment depicted in Fig. 2A, as an optional feature, also applicable to any other arrangement disclosed herein, the second transport section 110 comprises a third transport belt 185 downstream of the second transport belt 184. The first transport belt 183 can as such be partially aligned with the second transport belt 184, and partially with the third transport belt 185, such that the mail item is transported first between the first transport belt 183 and the second transport belt 184, and subsequently between the first transport belt 183 and the third transport belt 185. In the embodiment of Fig. 2A, the exit location 114 of the second transport section 110 is defined between the first and third transport belts 183, 185. However, it is also envisioned for the second transport section 110 to comprise any

number of additional movers downstream of the first and/or third transport belts.

As indicated in Fig. 2A, as an option for any arrangement disclosed herein, a set of rollers 124 is comprised by the arrangement 100, which set of rollers is positioned generally downstream of the entry location 108 of the second transport section 110, preferably near this entry location 108. The set of rollers 124, which may comprise two, four, six, or any other number of rollers, are arranged in two subsets, such that the mail item can pass between rollers of the two subsets. The rollers 124 may aid in forming a sharper fold in the mail item, for example because a stiffness of the rollers 124 against being pushed outward away from the mail item may be higher than a similar stiffness of the transport belt or belts of the second transport section 110.

In an embodiment, at least an upstream positioned set of rollers of the rollers 124 may be placed at a distance from one another so as to better facilitate entering of the folding member 106 and the partially folded mail item in between the upstream set of the sets of rollers 124. Optionally, the distance between the rollers of the upstream set of rollers may be settable and adjustable. In an embodiment, the adjustment of the distance between the rollers of the upstream set may be automated and be effected by an actuator, optionally even on the fly for each individual mail item which has to be folded and thus has to pass the rollers 124. Thus, a mixed stream of mail items of varying thicknesses may be processed.

Reference is now made to Fig. 2B, where the arrangement 110 is shown in the bypass state. Compared to the folding state of Fig. 2A, in the bypass state, the mail item does not reach the folding station 104, as depicted by the thickened dashed line depicting the intended travel path for the mail item through the arrangement 100 of Fig. 2B. However, the mail item does reach the same exit location 114 of the second transport section 110 as in the folding state of Fig. 2A, albeit without being folded at the folding station 104.

The arrangement 110, as indicated in Fig. 2B, may comprise a guiding member 120 which is generally positioned upstream of the folding station 104. Between the states of Fig. 2A and Fig. 2B, the guiding member 120 has been moved from an inactive state (Fig. 2A) to a bypass state (Fig. 2B), for example by pivoting the guiding member 120 upwards. In general, the guiding member 120 may comprises a transport belt and/or any other mover disclosed herein.

In the bypass state of Fig. 2B, the mail item is moved from the starting position 102 via the guiding member 120 to a third transport section 116. The third transport section 116 is generally arranged for transporting the mail item to the entry location of the second transport section. The third transport section 116 is in the first embodiment positioned generally in parallel with at least part of the first transport section 101. Parallel here does not necessarily refer to the orientation between the first and third transport section, but rather to the concept that the mail item either moves through at least part of the first transport section and not through the entire third transport section (Figs. 2A, 2C), or the mail item moves through at least part of the third transport section and not through the entire first transport section (Fig. 1B).

Between the states depicted in Fig. 2A and 2B, the entry location 108 of the second transport section 110 has been moved to a third transport section position in which the entry location 108 of the second transport section 110 is aligned with an exit 118 of the third transport section 116. In Fig. 2A, the entry location 108 of the second transport section 110 is in a folding station position in which the entry location of the second transport section is aligned with the folding station 104.

To move the entry location 108 of the second transport section 110, the first pulley 181, the second pulley 182, and a third pulley 186 are in the embodiment of Figs. 2B and 2C moved, e.g. pivoted around a pivot axis, for example using an actuator 117 for moving the entry location – schematically

indicated in Fig. 2B. The actuator 117, as with any actuator disclosed herein, may be a pneumatic or hydraulic actuator. Alternatively, an electric actuator can be used. The third pulley 186 may be a tensioning pulley which is spring loaded to keep the transport belt or transport chain 183 of the second transport section 110 tensioned.

As can be seen in Fig. 2B, when the second transport section 110 has been moved to the third transport section position, the optional set of rollers 124 may be moved further apart, such that a spacing between the first subset of rollers 124' and the second subset of rollers 124" is increased, preferably such that this spacing is at least equal or larger than a height of the mail item.

When the entry location 108 of the second transport section 110 is defined by the first and second pulleys, 181, 182, these pulleys can be moved by generally the same movement into the third transport section position when the arrangement 100 transitions from the folding state to the bypass state. One or more further actuators may be comprised by the arrangement 100 for moving the first and second pulleys 181, 182.

In the third transport section position, the entry location 108 of the second transport section 110 is aligned with an exit 118 of the third transport section 116. As such, as depicted by the thickened dashed line in Fig. 2B, the mail item can be transported from the start position 102, via the guiding member 120, through the third transport section 116, and subsequently through second transport section to the exit 114 of the second transport section 114, for example to be subsequently transported to a packaging location 112 downstream or comprised by the arrangement 100 (not depicted further in the figures) – without having been folded by the folding station 104.

In a discard state of the arrangement 100 of which an example is shown in Fig. 2C, the mail item can be transported from the starting position 102 to a discard position 122 in which the mail item can generally leave the arrangement 100, or move to another section of the arrangement 100 not

associated with the second transport section 110. The first transport section 101 can for example be used to the transport the mail item from the starting position 102 to the discard position 122, as generally depicted by the thickened dashed line in Fig. 2C. While being moved to the discard position 122, the mail item may be moved past the folding station 104, and the discard position 122 may thus be located downstream of the folding station 104. Alternatively, the discard position 122 may be upstream of the folding station 104.

As shown in Fig. 2C, in the discard state, the guiding member 120 can be in a bypass state to prevent the mail item from being guided into the third transport section 116 by the guiding member 120. Similarly, also in the folding state of Fig. 2A, the guiding member 120 can be in the bypass state. Whenever an arrangement 100 comprises a guiding member 120, the arrangement may comprise an actuator for moving the guiding member 120 to the bypass state of Fig. 2B and/or to the folding state of Fig. 2A. Optionally, the guiding member 120 may be biased into the bypass state or to the folding state.

It should be noted that the discard state can also be assumed on the basis of the situation shown in Fig. 2A, i.e. with the first and second pulleys 181, 182 being moved close to the folding station 104. In order to transport a mail item from the starting position 102 to the discard position 122, the only thing needed to transport the mail item to the discard position 122 is refrain from operating the folding member 106 of the folding station 104.

Figs. 3A-3C schematically show a folding station 104, which may be comprised by the arrangement 100 depicted in Figs. 2A-2C. At the folding station 104, in subsequent steps, the mail item M is folded at a cross folding line F between a leading edge and trailing edge of the mail item M. It will be understood that Figs. 3A-3C show only parts of an arrangement 100 detailing

the folding station, and parts of the arrangement 100 are cut off from the figures to increase clarity and legibility of the figures.

In Fig. 3A, the mail item M is depicted after having been transported to the folding station 104, using the first transport section 101. As an option, applicable to any arrangement 100 disclosed herein, the transport section is depicted as comprising a pushing lug 130 and a track surface 132 on which the mail item M is positioned. By virtue of the pushing lug 130, the mail item M is moved in a transport direction T.

When the mail item M is folded over the folding member 106 by moving the folding member towards the entry location 108 of the second transport section 110, the mail item M is moved into the second transport section while folding the mail item at cross folding line F, as depicted in Figs. 3B and 3C.

Although in figures 3A-3C the second transport section 110 is depicted with the same pulleys 181, 182 and belts 183, 184 as in Fig. 2A, it will be appreciated that this is merely one of many envisioned embodiments for the second transport section 110. The arrows in Figs. 3B-3C indicate a typical rotational direction for the pulleys 181, 182. The belts 183 and 184 are not depicted entirely.

Figs. 4A-4C schematically shows a second embodiment of an arrangement 100 for folding a mail item. The arrangement 100 comprises a a conveying track 50 along which one or more document feeders 52 are arranged for feeding one or more printed documents on subsequently arranged collecting positions of the conveying track 50 which collecting positions continuously move in a transport direction along the document feeders 52. The conveying track 50 with the one or more document feeders 52 is configured to create a continuously moving stream of subsequent mail items M. The arrangement 100 further comprises a folding station 104, and a first transport section 101 for continuously transporting the subsequent mail items from a starting position 102 to the folding station 104. The arrangement

100 further comprises a second transport section 110 configured for continuously transporting each folded mail item from an entry location 108 of the second transport section 110 to an exit location 114 of the second transport section 110. The mail item can be transferred from the first transport section 101 to the second transport section 110 at or near the folding station 104. The folding station 104 comprises a folding member 106 and an actuator for moving the folding member 106 towards the entry location 108 of the second transport section 110. The folding member 106 is actuated to engage and fold, without interrupting the continuous transport of the mail item M, and move the mail item M into the entry location 108 of the second transport section 110 with a section of the mail item M between the leading edge and the trailing edge first, thereby folding the mail item M at a cross folding line on said section of the mail item M.

Fig. 4A depicts the arrangement 100 in a folding state, in which a mail item can be transported from the starting position 102 to the folding station 104 by the first transport section 101. At the folding station 104, the mail item can be folded over a folding member 106 by moving the folding member 106 towards the entry location 108 of the second transport section 110.

According to the second embodiment, the mail item is moved into the second transport section with a bottom surface first – as also depicted in conjunction with Figs. 5A-5C showing a folding station 104 which can be used in the arrangement 100 of Fig. 4A. As a further optional feature for any arrangement disclosed herein, and explicitly comprised by the second embodiment of the arrangement 100, the third transport section 116 is positioned in series with the first transport section 101. As such, the mail item can move first through the first transport section, and subsequently through the third transport section 116. More in particular, the second transport section 110 can be positioned in parallel with the third transport

section 116, such that the mail item passes either through the second transport section 110 (Fig. 4A) or to the third transport section 116 (Fig. 4B).

Fig. 4A shows the arrangement 100 in a folding state, Fig. 4B shows the arrangement 100 in a bypass state, and Fig. 4C shows the arrangement 100 in a discard state. In general, the discard state may be a state in which the mail item is discarded from the arrangement 100, but not discarded in general, thus not meaning that the mail item is necessarily trashed.

As depicted in Fig. 4A, the arrangement 100 may comprise an optional guiding member 120 arranged to guide the mail item from the starting position 102 to the folding station 104 via the first transport section 101. Fig. 4A shows the guiding member 120 in a folding state, and Fig. 4C shows the guiding member 120 in a discard state in which the guiding member 120 does not guide the mail item to the first transport section 101, but to the discard position 122 instead – as depicted by the thickened dashed line in Fig. 4C. An actuator may be comprised by the arrangement 100 to control the state of the guiding member 120. The guiding member 120 may be biased in the discard state or the folding state. The state of the guiding member 120 depicted in Fig. 4B may be referred to as a bypass state, which for this embodiment of the arrangement corresponds to the folding state in that the guiding member 120 can guide a mail item to the folding station 104. As for any arrangement disclosed herein, the guiding member 120 may be considered as forming part of the first transport section 101, for example together with a first transport belt 133.

The arrangement 100 depicted in Figs. 4A-4C as an example comprises a second transport belt 134, a third transport belt 135, and a fourth transport belt 136. In the folding state of Fig. 4A, the third transport belt 135 and the fourth transport belt 136 together form the second transport section 110. In the bypass state of Fig. 4B, the second transport belt 134 and the third transport belt 135 together form the third transport section 116. It will thus

be appreciated that depending on the state of the arrangement 100, any mover may from part of multiple transport sections.

Fig. 4B shows the second embodiment of the arrangement 100 in a bypass state in which the mail item can be transported from the starting position to the position downstream of the folding station without folding the mail item comprises moving the mail item past the folding member 106, and wherein the third transport section 116 is positioned downstream of the folding member.

For example to prevent the mail item from being transported into the third transport section 116 in the folding state of Fig. 4A – as also indicated in Fig. 5A – the second transport belt 134 can be moved away from the third transport belt 135 in the folding state, and towards the third transport belt 135 in the bypass state – as can be seen by comparing Fig. 4A and 4B, and Fig. 5A and 5B. . As explained before, instead of transport belts, lug chains or combinations of belts and lug chains are feasible for transporting the mail items. For example, the second transport belt 134 may very well be embodied as a lug chain and this may also be the case for the first transport belt 133.

Fig. 5A shows an example wherein the mail item M passes past the folding actuator 106 without the folding actuator 106 moving towards the entry location 108 of the second transport section 110. As such, Fig. 5A resembles a bypass state of the arrangement in which the mail item M is not folded in the folding station but is transported to the exit location 114 of the second transport section 110.

Figs. 5B and 5C show the folding station 104 of Fig. 5A, with the mail item M being folded over a folding member 106 by moving the folding member towards the entry location 108 of the second transport section 110 formed by the third transport belt 135 and the fourth transport belt 136.

Also in this embodiment, an electronic controller of the arrangement may be configured to time the movement of the folding member

106, wherein the timing of the movement of the folding member 106 is controlled such that the position of the fold is not only dependent on the length of the mail M item and the desired position of fold relative to that length but also dependent on the thickness of the mail item M. Thus, the fact that thicker mail items M are engaged earlier by the entry location 108 of the second transport section than thinner mail items may be compensated for by the timing of the folding member 106 in dependence of the thickness.

As in the example of Figs 2A, 2B, 2C, 3A, 3B, 3C here again, the distance between the rotation axes of the pulleys 181, 182 which function as pressing rollers but also guide third transport belt 135 and fourth transport belt 136, may optionally be automatically adjusted on the fly for each mail item M to be folded in dependence of the thickness of the mail item to be folded. To that end each pulley 181, 182 may be connected to an actuator 190 which may be of the same types as described above with reference to the example shown in Figs. 2A, 2B, 2C, 3A, 3B, 3C. The actuators 190 may be controlled by an electronic controller which has information about the thickness of each mail item to be folded as described above.

Although not indicated in the figures, any arrangement discussed herein may comprise an electronic controller, which controller may be used to control one, more, or all of the actuators and transport sections of the arrangement, in any combination thereof. The electronic controller may be programmed to decide whether the mail item has to be folded, bypassed, or discarded. Based on the deciding, the state of the arrangement 100 can be changed to respectively a folding state, bypass state, or discard state, by operating one or more actuators accordingly, as elaborated on above.

To provide data to base the decision of the electronic controller on, the electronic controller may be provided with one or more sensors, for example on or more visual sensors arranged to obtain and process graphical data of the mail item, for example on a barcode or other machine-readable code such as a QR-code on the mail item. Alternatively or additionally,

sensors may be provided to determine the length and/or thickness of a mail item M or to determine whether the position of the mail item M is correct. For example, an oblique position of the mail item M may cause problems in the folding station 104 or in a subsequent packaging module. With one or more sensors measuring the position of each mail item M, it can be determined whether it is correctly positioned and can be transported to the end 114 of the second transport section 116 or, if not, to the discharge position 122. The electronic controller may be configured to determine whether and if yes, at which moment in time the folding member 106 is actuated so to provide the cross fold at the desired position in the mail item M thereby taking account of the length and optionally the thickness of the mail item M to be folded.

Fig. 6 shows the embodiment of Figs. 4A-4B with a fifth transport device 137 which may be embodied as a transport belt or a lug chain. The electronic controller may determine from each mail item M the length. When one of the mail items has a length which is sufficiently short to be processed in a subsequent packaging machine, it does not have to be folded and may bypass the folding station 104. An example of such a mail item is indicated with reference number 138 showing a mail item 138 that is transported by the second transport belt or lug chain 134 and the fifth transport device 137 at a speed that is reduced relative to the transport speed of the third transport belt 135 and the fourth transport belt 136. As is clearly visible in Fig. 6, there is an empty space 139 between the subsequent mail items M which are transported by the third and fourth transport belts 135, 136. Because the transport path of the mail items between the third and the fourth transport belts 135, 136 is longer than the transport path of the mail item 138 that is transported by the second transport belt or lug chain 134 and the fifth transport device 137, at the end of the second transport section 116, the mail item 138 following the bypass route will be placed in the empty space 139 created between the folded mail items M. In other words, the fifth transport device 137 enables a controlled transport of a mail item that follows the

bypass route so that it can be positioned when the non-folded mail item 138 is joined again in the stream of folded mail items. Thus, mail items M which have to be cross folded and mail items 138 which do not have to be cross folded can be processed interchangeably.

Instead of reducing the speed of second transport belt or lug chain 134 and the fifth transport device 137 relative to the speed of the third and the fourth transport belts 135, 136, which is necessary to be able to merge the bypassed product 138 correctly in the empty space 139 of the stream of products which have been folded, it is alternatively possible to design the second transport belt or lug chain 134 and the fifth transport device 137 such that the transport path length thereof is the same as the transport length of the products which are folded and following a transport path defined by the third and the fourth transport belts 135, 136. In that configuration, due to the equal transport length, the speeds of the third and fourth transport belts 135, 136 can be substantially the same as the speed of the second transport belt or lug chain 134 and the fifth transport device 137.

Claims

1. A method of folding a mail item (M), the method comprising:

- creating a continuously moving stream of subsequent mail items (M) on a conveying track (50) along which one or more document feeders (52) are arranged by feeding one or more printed documents on subsequently arranged collecting positions of the conveying track (50) which collecting positions continuously move in a transport direction along the document feeders (52), wherein each mail item comprises a single printed document, e.g. a magazine, or a stack of printed documents, e.g. a stack of magazines, each mail item (M) having a leading edge and a trailing edge and having length defined by the distance between the leading edge and the trailing edge, as well as having a thickness;
- continuously transporting the subsequent mail items from a starting position (102) at the end of the conveying track (50) to a folding station (104) by a first transport section (101);
- at the folding station (104), without interrupting the continuous transport of the mail item, folding the mail item over a folding member (106) by moving the folding member towards an entry location (108) of a second transport section (110), such that the mail item is moved into the entry location (108) of the second transport section (110) with a section of the mail item between the leading edge and the trailing edge first, thereby folding the mail item at a cross folding line on said section of the mail item (M); and
- continuously transporting each folded mail item through the second transport section (110).

2. Method according to claim 1, wherein the timing of the movement of the folding member is controlled such that the position of the fold is not only dependent on the length of the mail item and the desired position of fold relative to that length but also dependent on the thickness of the mail item.

3. Method according to claim 1 or 2, wherein the entry location (108) is formed by a nip region between two pulleys (181, 182) of the second transport section (110), wherein the pulleys (181, 182) also function as pressing rollers.

4. Method according to claim 3, wherein a distance between the rotation axes of the two pulleys (181, 182) is automatically adjustable on the fly for each mail item to be folded in dependence of the thickness of that mail item.

5. Method according to any one of claims 1 to 4, wherein the mail item is transported towards a packaging location (112) by the second transport section (110).

6. Method according to any of the preceding claims, wherein the mail item is moved into the second transport section (110) with a top surface first.

7. Method according to any of the claims 1-5, wherein the mail item is moved into the second transport section (110) with a bottom surface first.

8. Method according to any one of the preceding claims, wherein the length of the mail item is reduced by the folding so as to reduce the length of the mail item to a predetermined standard length.

9. Method according to any one of the preceding claims, wherein the length of the mail item is reduced by fixed percentage, preferably by 50%.

10. Method according to any one of the preceding claims, the method comprising:

- using an electronic controller to make a decision on whether the mail item has to be folded, and based on the decision, either:

- folding the mail item using a method according to any of the preceding claims; or alternatively one of:
- transporting the mail item from a starting position (102) to a position downstream (114) of a folding station (104) without folding the mail item; or
- transporting the mail item to a discard position (122).

11. Method according to claim 10, wherein transporting the mail item from the starting position (102) to the position (114) downstream of the folding station (104) without folding the mail item comprises transporting the mail item with a third transport section (116).

12. Method according to claim 11, further comprising moving the entry location (108) of the second transport section (110) to a third transport section position in which the entry location (108) of the second transport section (110) is aligned with an exit (118) of the third transport section (116).

13. Method according to any of the claims 10-12, further comprising moving a guiding member (120) to a bypass state such that the mail item is guided from the starting position (102) to the third transport section (116) and the mail item does not reach the folding station (104).

14. Method according to any one of claims 10-13, wherein transporting the mail item to the discard position (122) comprises moving the mail item past the folding station (104) to the discard position (122), which discard position (122) is positioned downstream of the folding station (104).

15. Method according to claim 11, wherein transporting the mail item from the starting position (102) to the position (114) downstream of the folding station (104) without folding the mail item comprises moving the mail

item past the folding member (106), and wherein the third transport section (116) is positioned downstream of the folding member (106).

16. Arrangement (100) for folding a mail item (M), the arrangement (100) comprising:

- a conveying track (50) along which one or more document feeders (52) are arranged for feeding one or more printed documents on subsequently arranged collecting positions of the conveying track (50) which collecting positions continuously move in a transport direction along the document feeders (52), wherein the conveying track (50) with the one or more document feeders (52) is configured to create a continuously moving stream of subsequent mail items (M), wherein each which mail item comprises a single printed document, e.g. a magazine, or a stack of printed documents, e.g. a stack of magazines, each mail item (M) having a leading edge and a trailing edge and having length defined by the distance between the leading edge and the trailing edge, as well as having a thickness;
- a folding station (104);
- a first transport section (101) for continuously transporting the subsequent mail items from a starting position (102) at the end of the conveying track to the folding station (104); and
- a second transport section (110) configured for continuously transporting each folded mail item from an entry location (108) of the second transport section (110) to an exit location (114) of the second transport section (110);

wherein the folding station (104) comprises a folding member (106) and an actuator for moving the folding member (106) towards the entry location (108) of the second transport section (110), wherein the folding member (106) is actuated to engage and fold, without interrupting the continuous transport of the mail item (M), and move the mail item (M) into the entry location of the second transport section (110) with a section of the mail item (M) between the leading edge and the trailing edge first, thereby

folding the mail item at a cross folding line on said section of the mail item (M).

17. Arrangement according to claim 16, comprising an electronic controller configured to time the movement of the folding member (106), wherein the timing of the movement of the folding member (106) is controlled such that the position of the fold is not only dependent on the length of the mail (M) item and the desired position of fold relative to that length but also dependent on the thickness of the mail item (M).

18. Arrangement according to claim 16 or 17, wherein the entry location (108) is formed by a nip region between two pulleys (181, 182) of the second transport section (110), wherein the pulleys (181, 182) also function as pressing rollers.

19. Arrangement according to claim 18, wherein a distance between the rotation axes of the two pulleys (181, 182) is automatically adjustable on the fly for each mail item to be folded in dependence of the thickness of that mail item (M).

20. Arrangement according to any one of claims 16-19 , further comprising a third transport section (116) for transporting the mail item to the entry location of the second transport section (110), and an actuator (117) for moving the entry location (108) of the second transport section (110) between:

- a folding station position in which the entry location (108) of the second transport section (110) is aligned with the folding station (104); and
- a third transport section position in which the entry location (108) of the second transport section (110) is aligned with an exit (118) of the third transport section (116).

21. Arrangement according to claim 20, further comprising a guiding member (120) which is moveable between:
- a folding state in which the guiding member (120) allows a mail item to be transported from the starting position (102) upstream of the guiding member to the folding station (104), which folding station (104) is positioned downstream of the guiding member (120); and
- a bypass state in which the guiding member (120) is arranged to guide a mail item to move from the starting position (102) to the third transport section (116).

22. Arrangement according to any of the claims 20-21, wherein the third transport section (116) is positioned in parallel with at least part of the first transport section (101).

23. Arrangement according to any of the claims 20-21, wherein the third transport section (116) is positioned in series with the first transport section (101).

24. Arrangement according to any of the claims 20-21, wherein the third transport section (116) is positioned in parallel with at least part of the second transport section (110).

25. Arrangement according to any of the claims 16-24, comprising:
- an electronic controller which is configured to determine for each mail item which is processed by the arrangement whether the mail item has to be folded, does not have to be folded, or has to be discarded, and based thereon either:
- control the arrangement to bring it in a folding state and fold the mail item; or

- control the arrangement to bring it in a bypass state so as to transport the respective mail item from the starting position (102) to the downstream position (114) without folding the mail item (M); or
- control the arrangement to transport the mail item (M) to a discard position (122).

26. Arrangement according to claim 25, wherein the arrangement comprises at least one sensor of which the output is connected to the electronic controller, wherein the electronic controller is configured to determine the length and/or the thickness of each mail item based on a sensor signal of the at least one sensor, and wherein the electronic controller is configured to determine whether and if yes, at which moment in time the folding member (106) is actuated so to provide the cross fold at the desired position in the mail item.

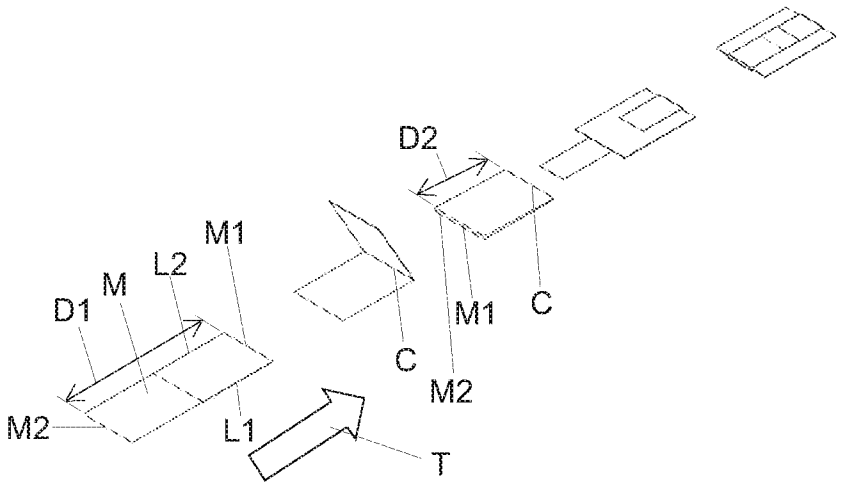

FIG 1

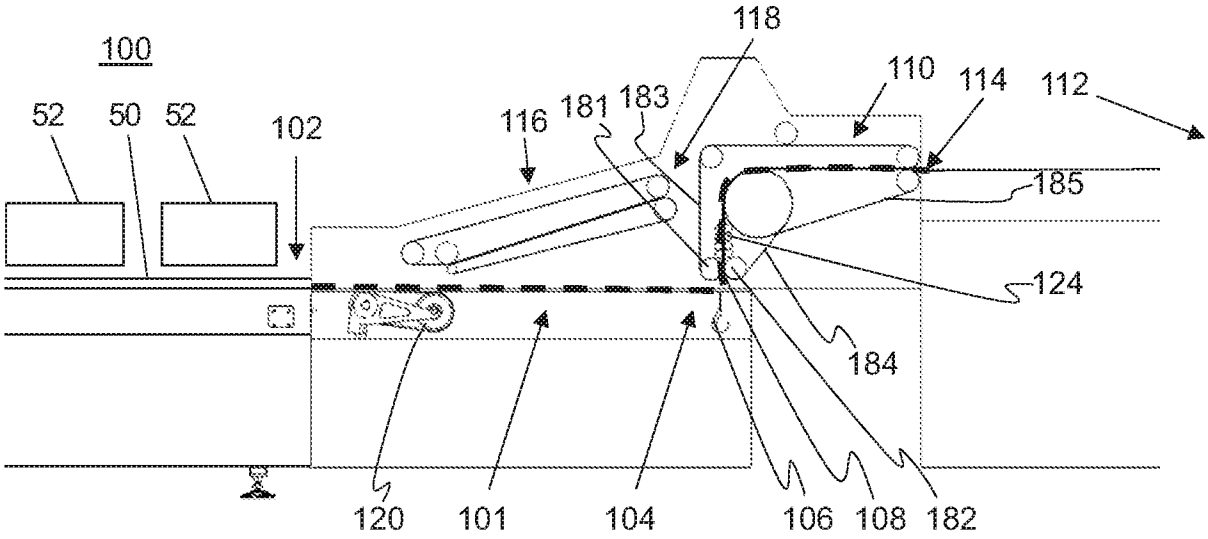

FIG 2A

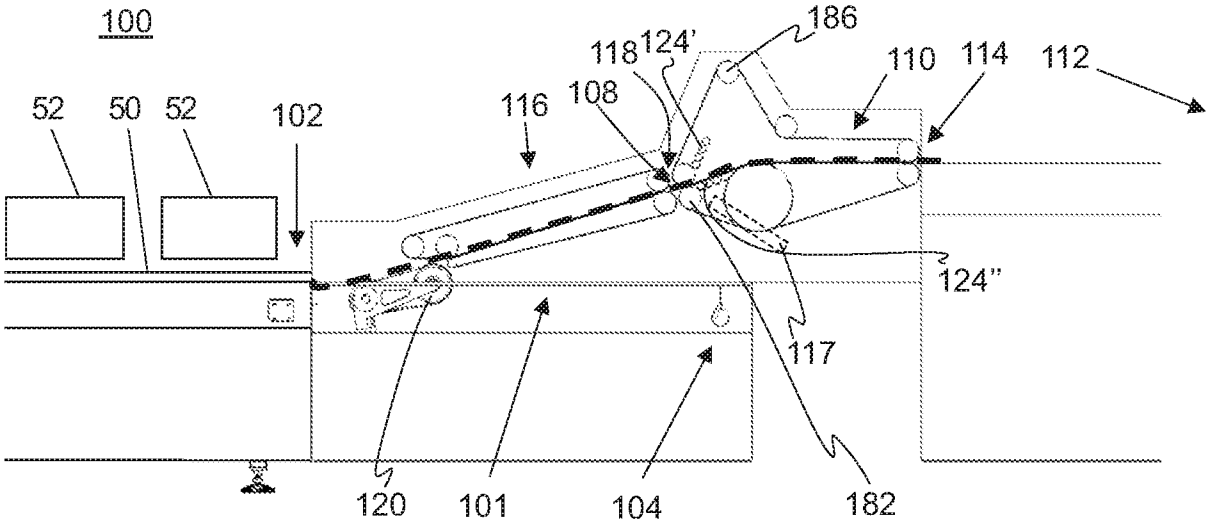

FIG 2B

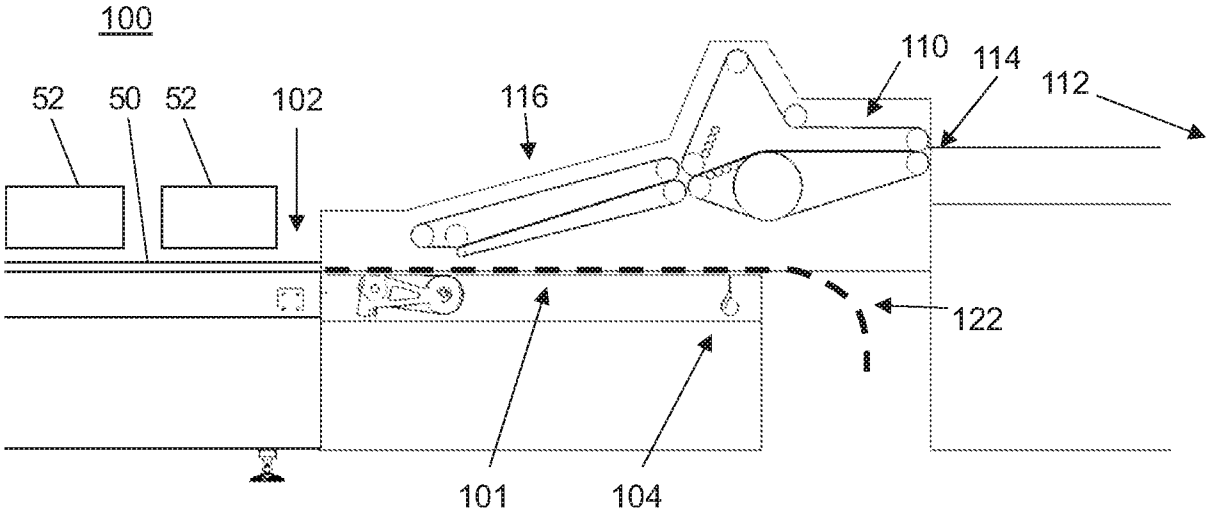

FIG 2C

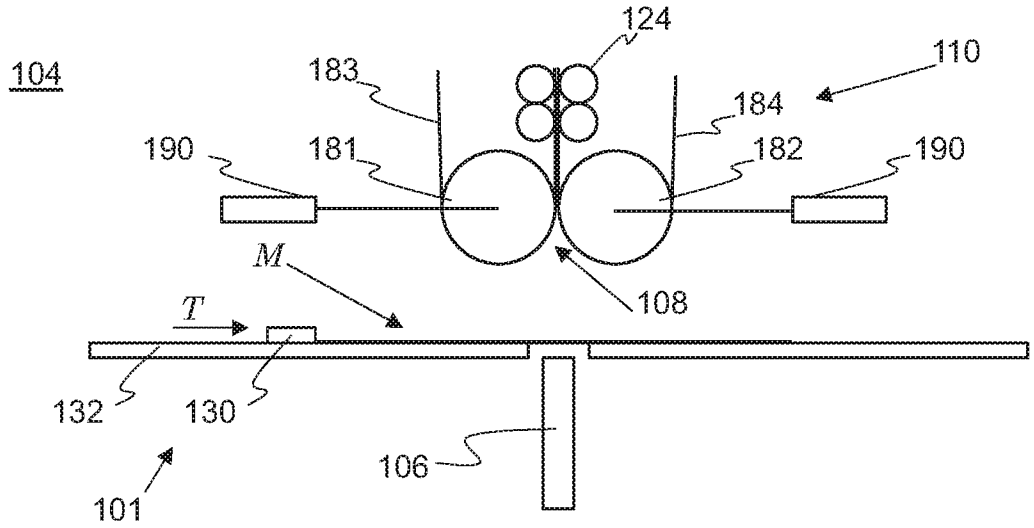

FIG 3A

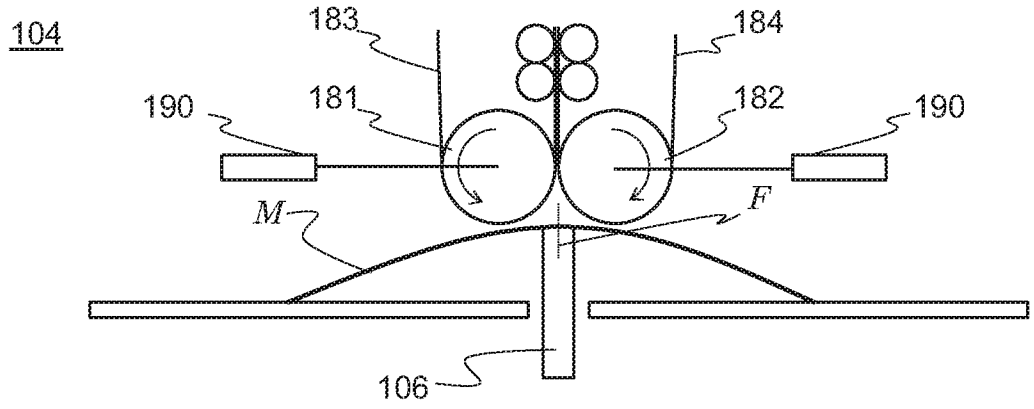

FIG 3B

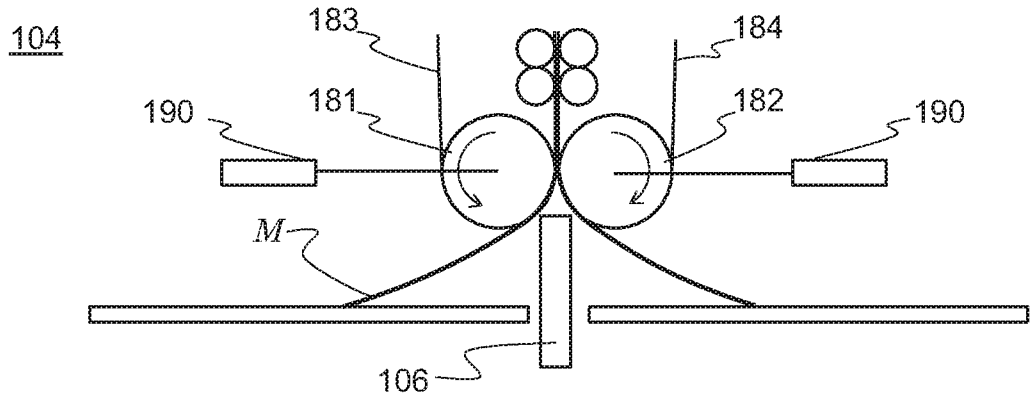

FIG 3C

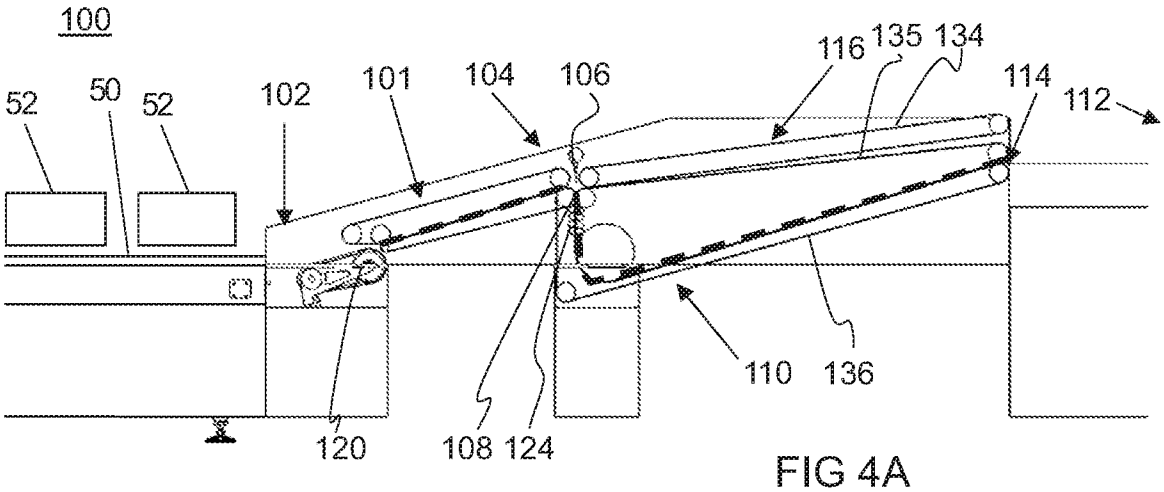

FIG 4A

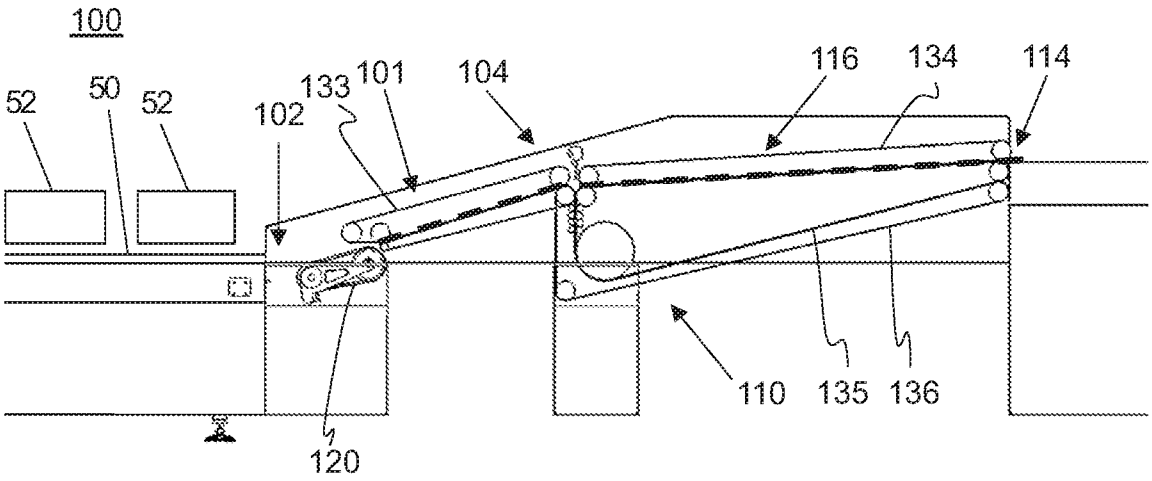

FIG 4B

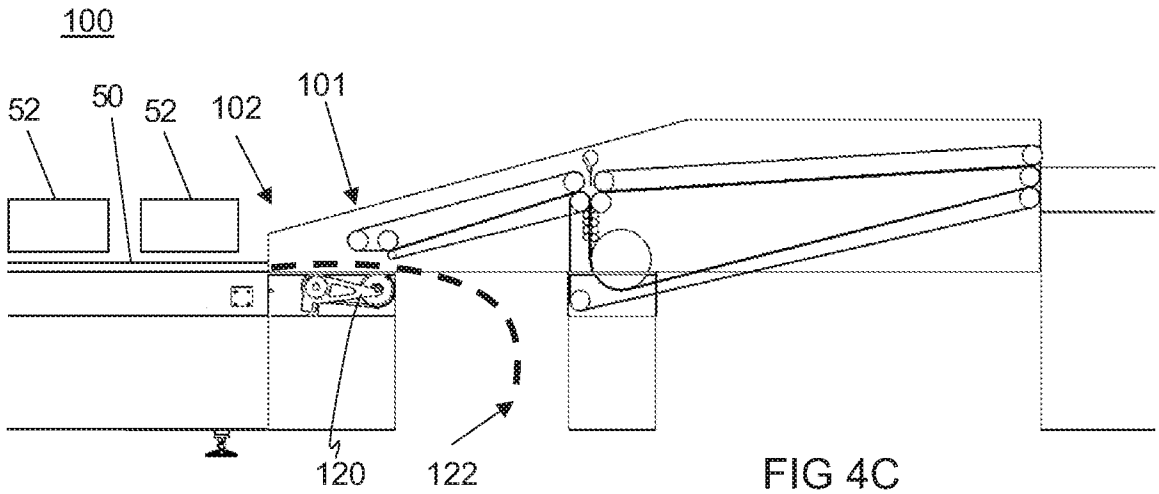

FIG 4C

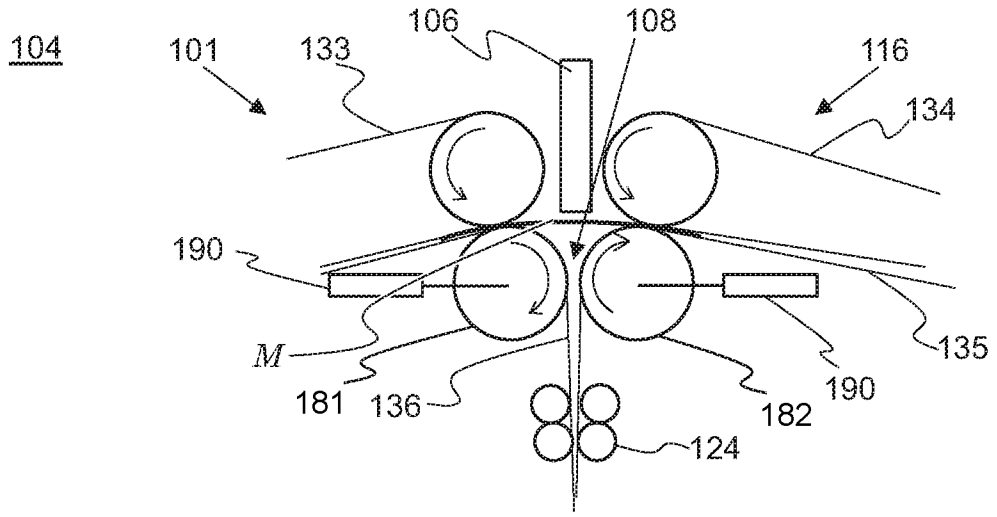

FIG 5A

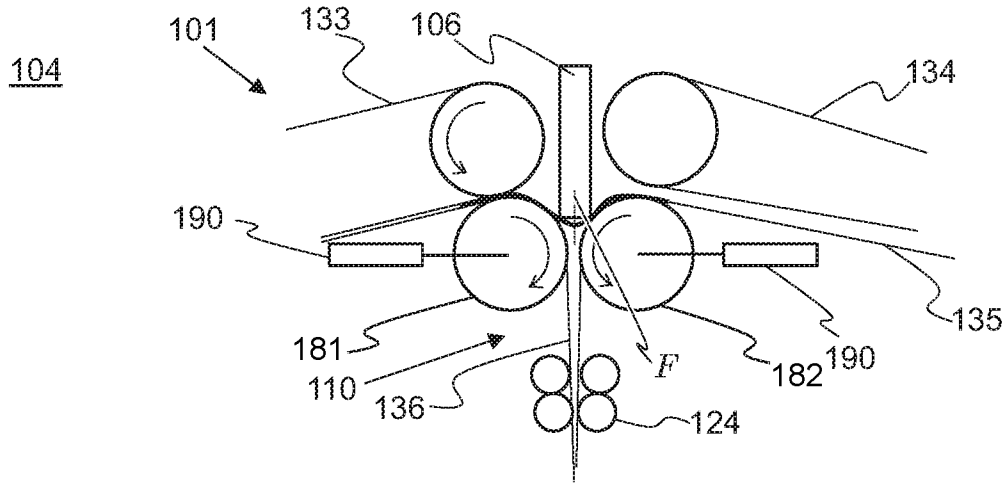

FIG 5B

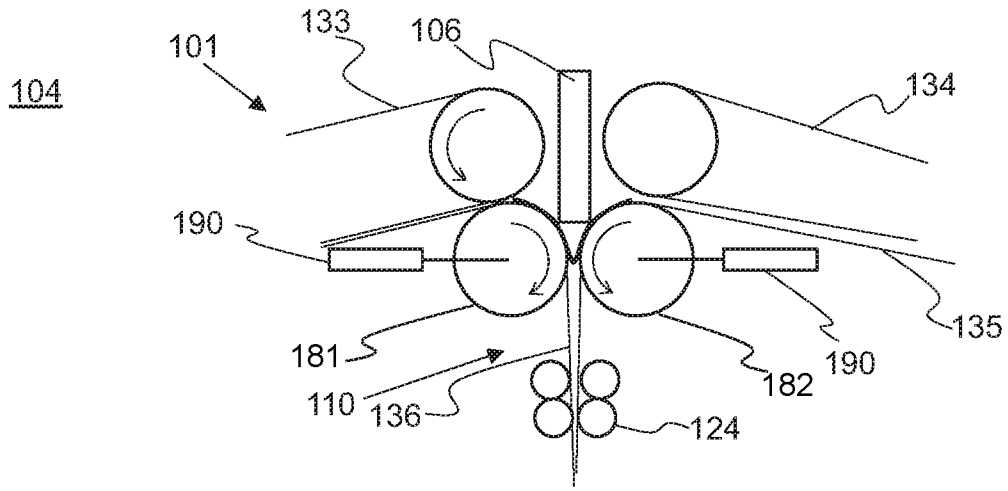

FIG 5C

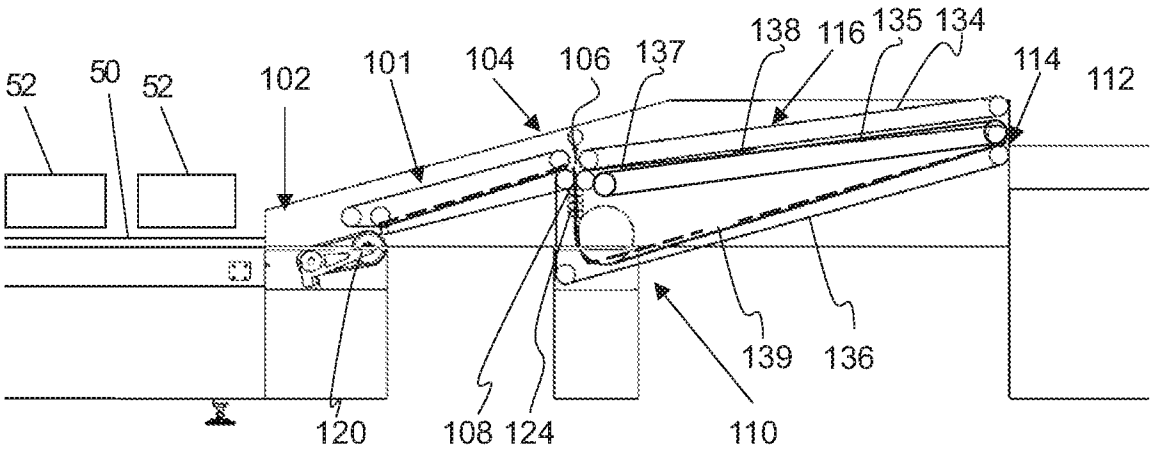
52
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FIG 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2024/050306

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65H45/18 B65H29/58 B65H39/055 B65H29/62 B65H31/30
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)
B65H

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 905 977 A (VIJUK ROBERT [US]) 6 March 1990 (1990-03-06) the whole document	1,2,8,9, 16,17
A	JP H07 237812 A (TOSHIBA MACHINE CO LTD) 12 September 1995 (1995-09-12) the whole document	3,4,18, 19
A	US 3 766 701 A (BESSERDICH O ET AL) 23 October 1973 (1973-10-23) the whole document	5
A	JP 2008 179431 A (DUPLO CORP) 7 August 2008 (2008-08-07) the whole document	6

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[x] Further documents are listed in the continuation of Box C.

[x] 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
3 September 2024	18/09/2024

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

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 593 118 A (WARD DAVIDSON WILLIAM) 15 April 1952 (1952-04-15) the whole document	7
A	US 2008/223537 A1 (WIEDMANN PETER [US]) 18 September 2008 (2008-09-18) the whole document	10,14, 25,26
A	JP H05 306054 A (MITSUBISHI HEAVY IND LTD) 19 November 1993 (1993-11-19) the whole document	11
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