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(54) **STACKER UNIT FOR FORMING A STACK OF ARTICLES, AND CORRESPONDING METHOD FOR CONTINUOUSLY CONTROLLING HEIGHT AND SHAPE OF STACKS OF FLAT ARTICLES**

(57) The present invention is an apparatus and its operation for reliably forming stacks of compressible articles, such as absorbent articles comprising fibrous

materials. These stacks may then be packaged. The articles are often flat and relatively thin compared to their width and length and stacked onto their flat sides.

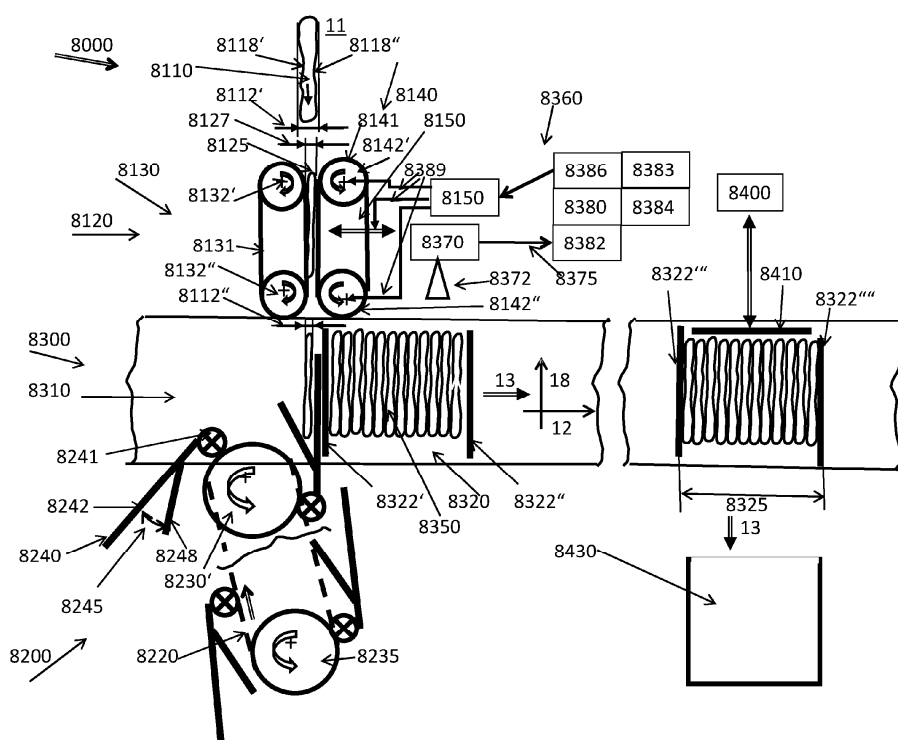
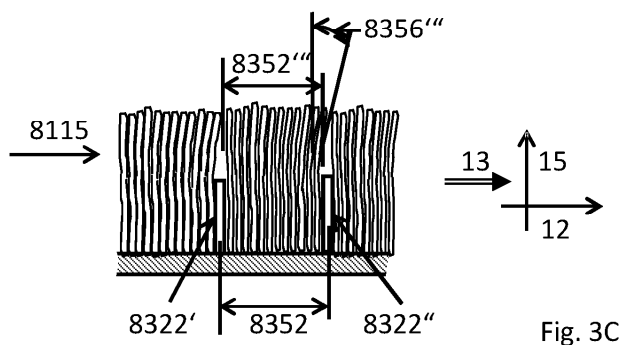
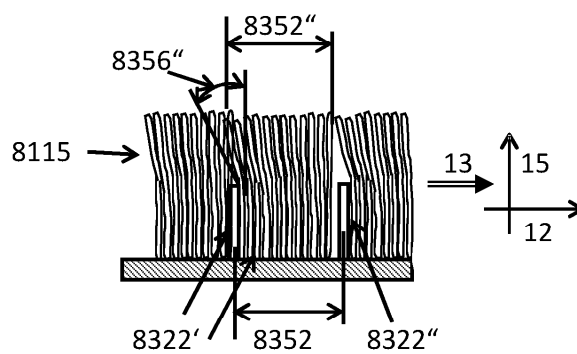
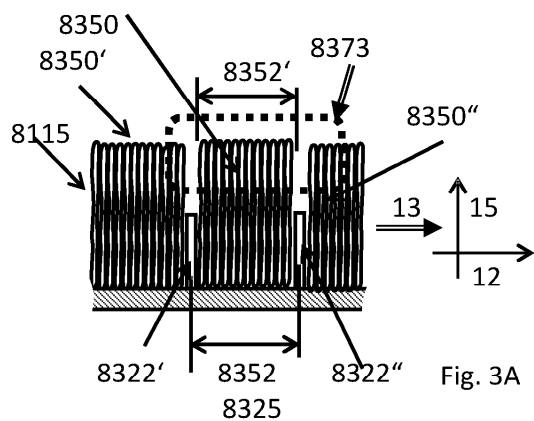


Fig. 2



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Description

Field of the invention

[0001] The invention relates to an apparatus and its operation for reliably forming stacks of compressible articles, such as absorbent articles comprising fibrous materials. These stacks may then be packaged. The articles are often flat and relatively thin compared to their width and length and stacked onto their flat sides. 5 10

Background

[0002] Stacker are well known in the art, see esp. EP1148014 (Optima), describing a machine for forming a stack of flat articles, which comprises a feeder. The feeder supplies the articles to be packaged, which are, for example, diapers, continuously in their own longitudinal direction one after another to a transfer device with receptacle into each of which one article is fed. They are then moved to Y-shaped receptacles of a transfer unit and released with their broad side outwards to form a stack in a receiving space with guide plates to separate subsequent stacks. From these receiving spaces, the stacks of articles are then pushed out into a package, such as a box or bag. 15 20 25

[0003] However, process variation during the manufacturing of the articles cause variation of the article thickness resulting in varying stack height outside of confining guide plates of the receiving space. When stacks with such varying shapes are further processed, such as being transferred into a bag or box, poor stack formation may result in reduced consumer acceptance or even jamming of stacker unit, as may further result in interruption of the complete article manufacturing line. The present inventions provide solutions to this issue by providing for measuring the stack formation, especially the stack deformation outside of guide plates, preferably optically such as by video camera. This is then compared to target settings corresponding to the product size and number per stack and the compression of the articles is then adjusted. In contrast to typical current machine set-up, this approach quite advantageously connects the stack forming process with the article forming process steps. 30 35 40 45

Summary

[0004] In a first aspect, the present invention is a stacker unit for forming a stack of a multiplicity of articles, which comprises: 50

- a compressing unit forming a compression gap, preferably counteracting compressing belts for compressing the articles therebetween, and a gap width adjustment tool; 55
- a transfer unit comprising

- a multiplicity of article receptacles, formed by a first and a second receptacle paddle positioned at a receptacle angle),
- the multiplicity of article receptacles being connected by article receptacle connectors to a continuous pulley operated by one or more pulley guides, at least one thereof being a pulley drive;

□ a stack former comprising a stack base belt and a multiplicity of stack guide plates forming a series of receiving spaces, adapted to receive articles from the compressing unit and forming a stack of a predetermined number of articles in a continuously moving series of the receiving spaces,

- thereby defining the machine direction MD of the stacker former,
- whereby the receiving spaces being separated by the guide plates extending cross-directionally CD and height-wise at a fixed MD distance,
- and each receiving space being adapted to receive a stack of articles from the transfer unit;

□ an article thickness control unit comprising

- a measurement unit creating a measuring signal, preferably a video camera, for determining
 - the MD extension of a stack of articles at a projecting portion of the articles which is not confined by the guide plates,
 - and the stack bulging angle of the projecting portions extending machine-directionally over the stack guide plates;
- a signal converting unit for creating a digital signal from the signal of the measurement unit;
- a target signal data storage unit comprising sets of target thicknesses of articles according to a predetermined article definition;
- a calculating unit adapted to
 - comparing the determined stack MD extension at the projecting portions of the articles of a stack and the stack bulging angle to a predetermined target data and creating a stack height and bulging angle deviation;
 - converting the stack height and bulging angle deviation into a signal for adjusting the compression gap width of the compression gap of the compression unit,
- an output signal converting unit for converting the deviation into a control signal for adjusting the compression gap width of the compressing unit;

□ one or more further processing unit(s), preferably a least a bagging unit.

[0005] In another aspect, the present invention is a method for controlling the stack height of a multiplicity of flat articles, which comprises the providing a series of articles (8110) and a stacker unit as described.

[0006] The articles exhibit a thickness between surfaces of the article, whereby the surfaces define the width and length of the article. Optionally, thickness results from folding a plurality of article layers in one or more folding steps.

[0007] The method comprises the steps of

- producing a series of flat, optionally folded, articles;
- feeding the articles into the compressing unit and adjusting the thickness of the articles;
- feeding the series of articles to the transfer unit and forming a stack of a predetermined number of articles in the receiving space, whereby a portion of the articles is protruding z-directionally from the guide plates;
- measuring the MD extension and bulge angle of the stack of articles at a protruding portion of the articles;
- comparing the measured MD extension and bulge angle of the stack of articles (8110) to predetermined targets and determining a stack height and bulge angle deviation;
- comparing the stack height and bulge angle deviation to a predetermined stack height and bulge angle deviation limit;
- if the stack height deviation is outside of the stack height deviation or bulge angle deviation limit, adjusting the compression of the compressing unit so as to reduce the stack height deviation. The articles may comprise fibrous material, preferably cellulosic fibers, and optionally particulate material.

Brief description of the Figures

[0008]

Fig. 1 depicts a prior art stacker device according to the teaching of EP1148014.

Fig. 2 depicts a stacker unit according to the present invention.

Fig. 3A to C show details of the stack of products with varying product thicknesses in a receiving space of the stacker unit according to the present invention.

[0009] The figures are schematic only, and not to scale. Same numerals refer to same or equivalent features or elements, single (') or multiple ('', ''', ...) apostrophes indicate duplicate features, such as a left and right or front and back, etc.. Omitting features in one figure does not imply that these cannot be combined with features of other figures.

Detailed description

[0010] In a first aspect, the present invention is a continuously operating a "stacker" unit, i.e., an apparatus for forming a stack of a multiplicity of articles, and in a second aspect a process for controlling stack properties as stack height and shape. A stacker converts a continuous series of articles into a series of stacks of articles each with a predetermined number of articles, which may then be fed into packages like boxes or bags.

[0011] The present invention is applicable to compressible articles that exhibit a flat shape, i.e. in a cartesian coordinate system the thickness is significantly smaller than the height or width. "Compressible" refers to articles which change their thickness upon application of pressure. Typical materials comprised in such articles are fibrous materials, especially cellulosic fibrous materials, or foams. Typically, such materials rebound upon release of the compressing forces, but the thickness is also depending on material properties, such as temperature, moisture, or compression at more "upstream" process steps, i.e., process steps that are applied to the articles before these arrive along a processing path at the stacker. Such articles may further comprise non-compressible materials, such as particulate material, and typically such articles comprise envelope webs. In a particular application, such articles can be absorbent articles, with a mixture of cellulose fibers and superabsorbent particles being enveloped between a topsheet and a backsheet. Often, though not necessarily, the articles exhibit large width and height dimensions and may be folded, optionally multiple times, to arrive at dimensions which are easier to handle. The number of articles in stack as well as the target thickness of the articles are constant throughout a production cycle, but may change from one production cycle, e.g., for a first product size, to another one, e.g., for a second product size. However, the actual thickness of the articles may change within a production cycle, be it due to varying process conditions, like temperature or humidity, or varying material properties, e.g., upon switching to a different lot of materials.

[0012] The principle of a conventional equipment and process suitable as a basis for the present invention is explained by referring to Fig. 1 (prior art) showing a stacker unit 8000 comprising most upstream (11) a feeder unit 8100 for feeding articles to a transfer unit 8200, and a stack former 8300 for delivering a stack of articles 8350 towards the most downstream (13) further processing unit 8430, such as a box or bag.

[0013] Articles 8110 are produced by further upstream (11) process steps and exhibit a pre-compression article thickness 8112' between two article surfaces 8118' and 8118" and fed into the feeder unit 8100 with two counter-acting compressing tools 8130, 8140, here shown as a first (8130) and second (8140) compressing tool, each with a compressing belt 8131, 8141 with respective belt drives 8132, 8142. A compression gap 8125 between the compressing tools exhibits a compression gap width

8127 smaller than the article thickness, such that the article exhibits a post-compression article thickness 8112", which is less than the pre-compression thickness 8122', but due to the rebound effect it is more than the compression gap width 8127.

[0014] Further along the process path, each of the articles 8110 is fed into an article receptacle 8240 of a transfer unit 8200. As shown, a multiplicity of receptacles 8240 are connected by receptacle connectors 8241 to a transfer pulley 8220 with guide (8230) and drive (8235) rolls. Such a receptacle comprises a first (8242) and a second (8248) receptacle paddle, arranged in an angled position with a receptacle angle 8245.

[0015] The stack former 8300 comprises a continuous stack base belt 8310 (guide and drive rolls not shown) and a multiplicity of guide plates 8322 moving along the machine direction 12 of the stack former. The guide plates 8322', 8322", ... are positioned equidistantly, forming a stack receiving space 8320 therebetween. The distance and hence the receiving space are held constant during a production cycle, but may be adjusted for different cycles with differing article numbers in a stack and/or article target thicknesses.

[0016] The speed of the transfer pulley 8220 for the receptacles 8240 and of the arriving articles 8110 are phased such that each one article is placed over the stack base belt 8310 into one properly positioned receptacle 8240, upon which the receptacle 8240 is pulled by the pulley 8220 cross-directionally (18) away, leaving the article 8110 in direct contact with the guide plate 8322 or a neighboring article, if already present. It should be noted that the guide plate 8322 is not covering the full surface of the article 8118, but that space must be allocated for the paddles 8242, 8248. Fig. 3A depicts a stack 8350 of articles, exemplarily shown with 12 articles, exhibiting an MD stack extension 8352, which may also be referred to as stack height, between two guide plate 8322', 8322", at a guide plate distance 8325. Thus, the article stack fills the space, and as in this depiction the article thickness is constant, i.e., also the portions 8115 projecting outwardly from the guide plates 8322 are positioned straight in the stack receiving space.

[0017] The stack 8350 of articles in the receiving space 8320 is moving along the stack base belt 8120 downstream and in the machine direction 12 of the stack former, until it is pushed cross-directionally by a pusher plate 8410 of a stack remover 8400, e.g., into a bag or box 8430, or a further processing step.

[0018] Whilst such an apparatus functions quite well under steady processing conditions, it occurs that the pre-compression article thickness and/or the post-compression article thickness changes over the operating time.

[0019] A first scenario of an increased thickness is explained by referring to Fig. 3B, showing that the articles remain confined between the stack guide plates 8322, but their thickness expands outside these guide plates 8322, increasing the article stack height 8352". Typically,

the upper part 8115 of the articles projecting over the guide plates 8322 bulges over the guide plates 8322 with article stack bulging angle 8356", in Fig. 3B exhibiting a negative value against the moving direction of the stack.

[0020] A second scenario of a reduced thickness is explained by referring to Fig. 3C, showing that the articles exhibit a slightly reduced stack height 8352'" but remain stable between the guide plates 8322. However, the upper part 8115 of the articles projecting over the guide plates 8322 tends to deform by reducing the stack height 8352'" and typically bulging at a positive bulging angle 8356'" along the moving direction or into the receiving space 8320 also a negative angle leaving a larger gap to adjacent stacks.

[0021] Both scenarios for a change in article thickness and resulting stack height and bulge are undesirable. In a less severe case, the stack can still be further processed, e.g., packed, but at a deteriorated appearance, if not performance. In more severe cases, jamming occurs at the stack remover, resulting in shut down of the stacker, but also of the complete upstream article production, requiring manual interaction and tedious resetting of the manufacturing line.

[0022] Thus, the present invention provides a solution for this problem by providing and operating a stack height control unit 8360, see Fig. 2 and 3.

[0023] The stack height control unit 8360 comprises stack height and shape measurement unit 8370. A preferred execution thereof is an optical or video camera 8372, positioned to have a field of view 8373 (see Fig. 3A) covering z-directionally (15) at least the upper portion 8115 of the articles protruding out of stack guide plates 8322 of a stack 8350 and machine-directionally (12) at least a stack of article 8350 and portions of upstream (8350') and downstream (8350") adjacent stacks. Without limiting the scope of the present invention, exemplary systems are available from e.g., Cognex Inc, Natick, MA, USA, or Mitsubishi Electric Europe B.V., Germany, under the trade designation Line Scan Bar.

[0024] The signal 8375 of the measuring unit 8370 is fed via a signal converter 8382 into a calculating unit 8380, comparing the determined stack MD extension 8352 at the projecting portions 8115 of the articles of a stack 8350 and said stack bulging angle 8356 to a predetermined target stack height from a target data storage unit 8384, whereby the set of target data can be selected by a human-machine-interface 8383 or by control signals from the article producing units (not shown). The comparison provides stack height and bulging angle deviation, which is further converted by an output signal converter 8386 into a signal 8389 for adjusting the compression gap width 8127 of the compression units 8140 and 8130 by a gap width adjustment tool 8150. Preferably, this control loop is continuous, or may be operated at predetermined intervals, e.g., corresponding to the time for completing a stack, such that the article thickness is permanently kept a target values and stack height and bulge angle deviations are minimized or eliminated.

[0025] In an exemplary process for the manufacturing of a bed pad, a web comprising cellulosic fibers and superabsorbent particles exhibits an on-target basis weight of about 45 g/m². Enveloped between a nonwoven web as a topsheet and a polyethylene film as backsheet, it exhibits a production on-target thickness of the single layer of about 0.7 mm. Consequently, upon multiple folding steps, first 5 times and further 3 times, the pre-compression thickness of the 15 folded layers is about 10.5 mm prior to the final compression step with a compression gap between two compression belts of about 5 mm. After the compression, the post-compression thickness re-bounds to the target folded product post-compression height of 10.5 mm. Thus, a stack of 30 articles exhibits a target stack height of 315 mm, and the stack receiving space between guide plates is adapted thereto to allow fitting into the proper package.

[0026] However, during production, the fiber properties and/or the production conditions change and the thickness of a single layer increases to 0.75 mm, or the folded pre-compression folded thickness increases to 11.55 mm. When the compaction through the 5 mm compression gap is continued, the product thickness rebounds to about 11 mm, thus exhibiting an unconfined stack height of about 330 mm. However, as the stack is confined by the guide plates, the stack height between the guide plates remains at 315 mm, but where the products are protruding from the guide plates, the stack expands to 330 mm, providing a bulge angle of about 5°, which can cause product deformation in the package, or even jamming at the packaging operation.

[0027] With the automatic stack height control unit, the increase in the stack height is continuously monitored and the compression gap width is adjusted, here reduced to about 4.5 mm so as to maintain the folded article thickness at the target of about 10.5 mm, ensuring stable stacking and packaging conditions without significant bulging.

Claims

1. A stacker unit (8000) for forming a stack of a multiplicity of articles (8110), said stacker unit (8000) comprising

□ a compressing unit (8120) forming a compression gap (8125), preferably counteracting compressing belts (8131, 8141) for compressing said articles (8110) therebetween, and a gap width adjustment tool (8150);

□ a transfer unit (8200) comprising

- a multiplicity of article receptacles (8240), formed by a first (8242) and a second (8248) receptacle paddle positioned at a receptacle angle (8245),
- said multiplicity of article receptacles

(8240) being connected by article receptacle connectors (8241) to a continuous pulley (8220) operated by one or more pulley guides (8230), at least one thereof being a pulley drive (8235);

□ a stack former (8300) comprising a stack base belt (8310) and a multiplicity of stack guide plates (8322) forming a series of receiving spaces (8320), adapted to receive articles (8110) from said compressing unit (8120) and forming a stack (8350) of a predetermined number of articles (8110) in a continuously moving series of said receiving spaces (8320),

- thereby defining the machine direction MD (12) of said stacker former (8300),
- whereby said receiving spaces (8320) being separated by said guide plates (8322) extending cross-directionally CD (18) and height (15) wise at a fixed MD distance (8325),
- and each receiving space (8320) being adapted to receive a stack (8350) of articles (8110) from said transfer unit (8200);

□ an article thickness control unit (8360) comprising

- a measurement unit (8370) creating a measuring signal (8375), preferably a video camera (8372), for determining

- the MD extension (8352) of a stack (8350) of articles (8110) at a projecting portion (8115) of said articles (8110) which is not confined by said guide plates (8322),
- and the stack bulging angle (8356) of the projecting portions (8115) extending machine-directionally over said stack guide plates (8322);

- a signal converting unit (8382) for creating a digital signal from said signal (8375) of said measurement unit (8370);
- a target signal data storage unit (8384) comprising sets of target thicknesses of articles according to a predetermined article definition;
- a calculating unit (8380) adapted to

- comparing said determined stack MD extension (8352) at the projecting portions (8115) of said articles of a stack (8350) and said stack bulging angle (8356) to a predetermined target data

and creating a stack height and bulging angle deviation;

◦ converting said stack height and bulging angle deviation into a signal for adjusting the compression gap width (8127) of said compression gap (8125) of said compression unit (8120),

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• an output signal converting unit (8386) for converting said deviation into a control signal (8389) for adjusting said compression gap width (8127) of said compressing unit (8120);

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☐ one or more further processing unit(s) (8430), preferably a least a bagging unit.

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2. A method for controlling the stack height (8352) of a multiplicity of flat articles (8110), said method comprising

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- providing

◦ a series of articles (8110)

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▪ exhibiting a thickness between surfaces (8118', 8118") of said article (8110), said surfaces defining the width and length of said article,

▪ said thickness optionally being the thickness of a plurality of article layers upon one or more folding steps,

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◦ a stacker unit (8000) according to claim 1;

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- producing a series of flat, optionally folded, articles (8110);

- feeding said articles (8110) into said compressing unit (8120) and adjusting the thickness (8112) of said articles (8110);

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- feeding said series of articles (8110) to said transfer unit (8200) and forming a stack (8350) of a predetermined number of articles (8110) in said receiving space (8320),

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◦ whereby a portion (8115) of said articles (8110) is protruding z-directionally from said guide plates (8322);

- measuring the MD extension (8352) and bulge angle (8356) of said stack (8350) of articles (8110) at a protruding portion (8115) of said articles (8110);

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- comparing said measured MD extension (8352) and bulge angle (8356) of said stack (8350) of articles (8110) to predetermined targets and determining a stack height and bulge angle deviation;

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- comparing said stack height and bulge angle deviation to a predetermined stack height and bulge angle deviation limit;

- if said stack height deviation is outside of said stack height deviation or bulge angle deviation limit, adjusting the compression of said compressing unit (8120) so as to reduce said stack height deviation.

3. A method according to claim 2, wherein said articles comprise fibrous material, preferably cellulosic fibers, and optionally particulate material.

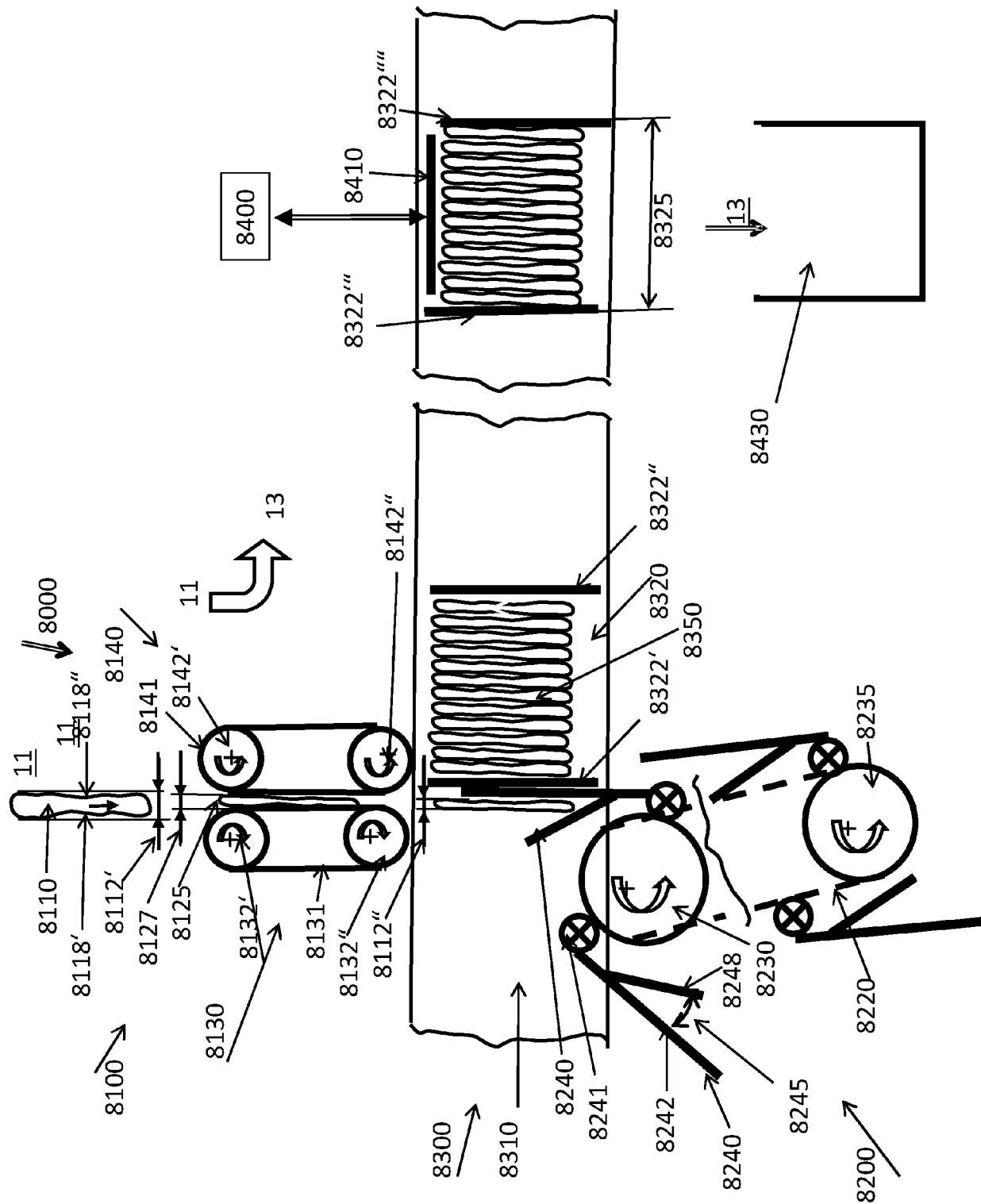


Fig. 1
Prior Art

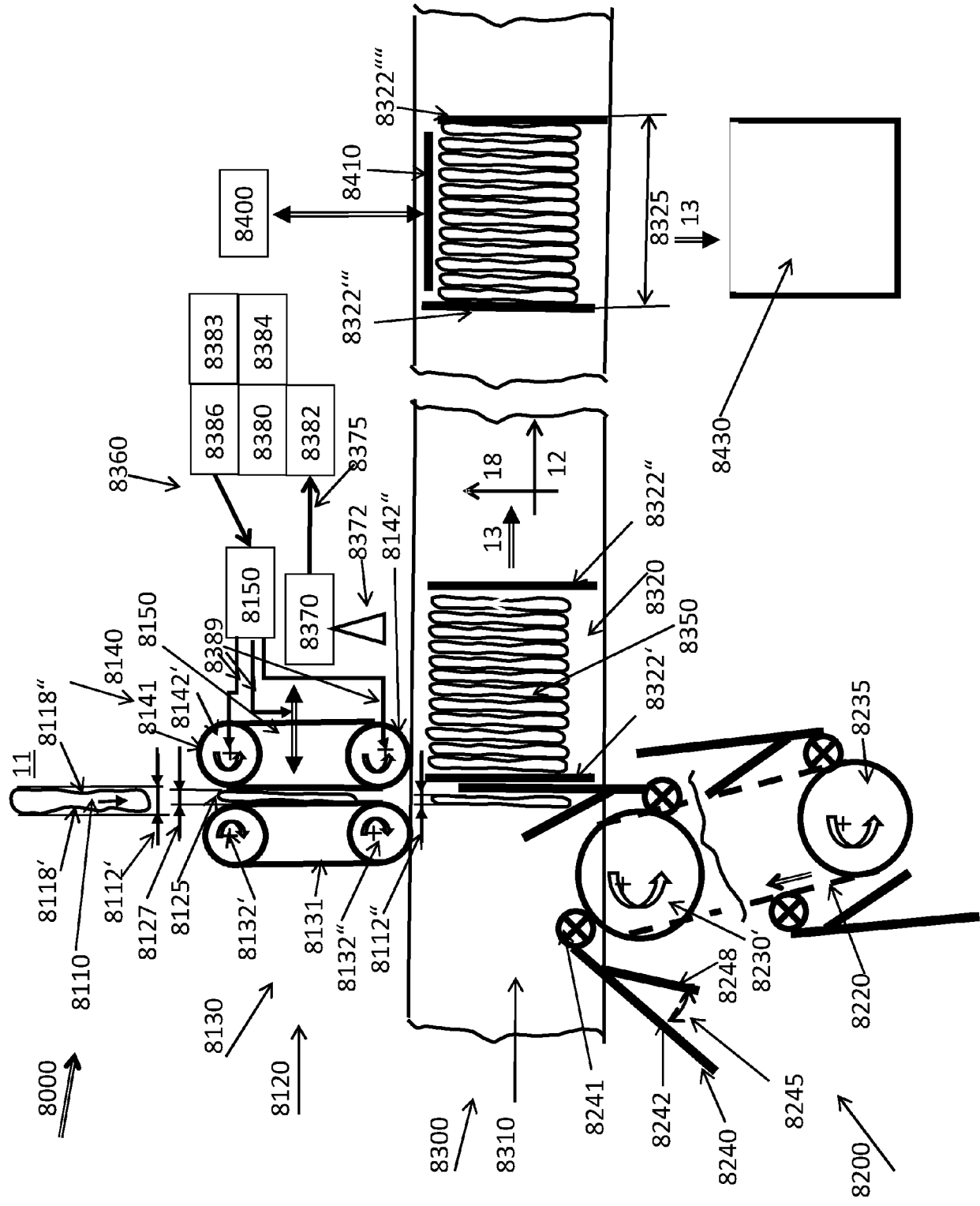
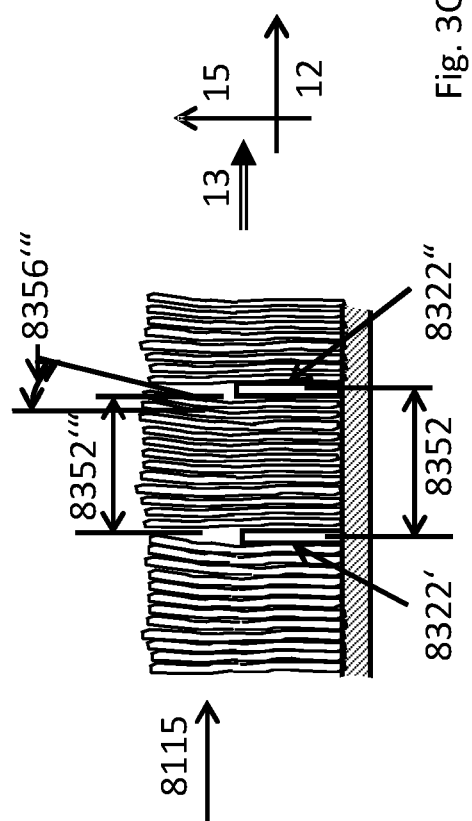
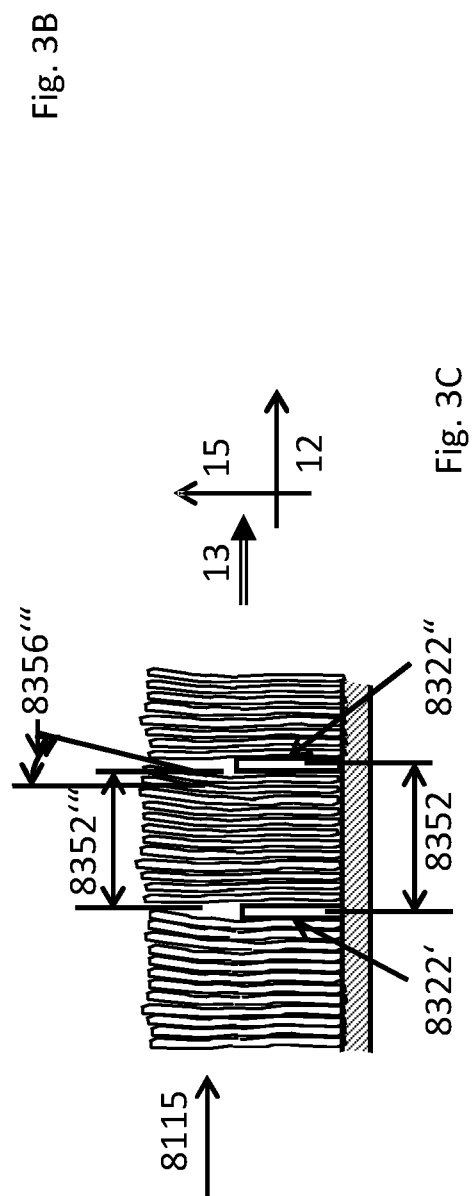
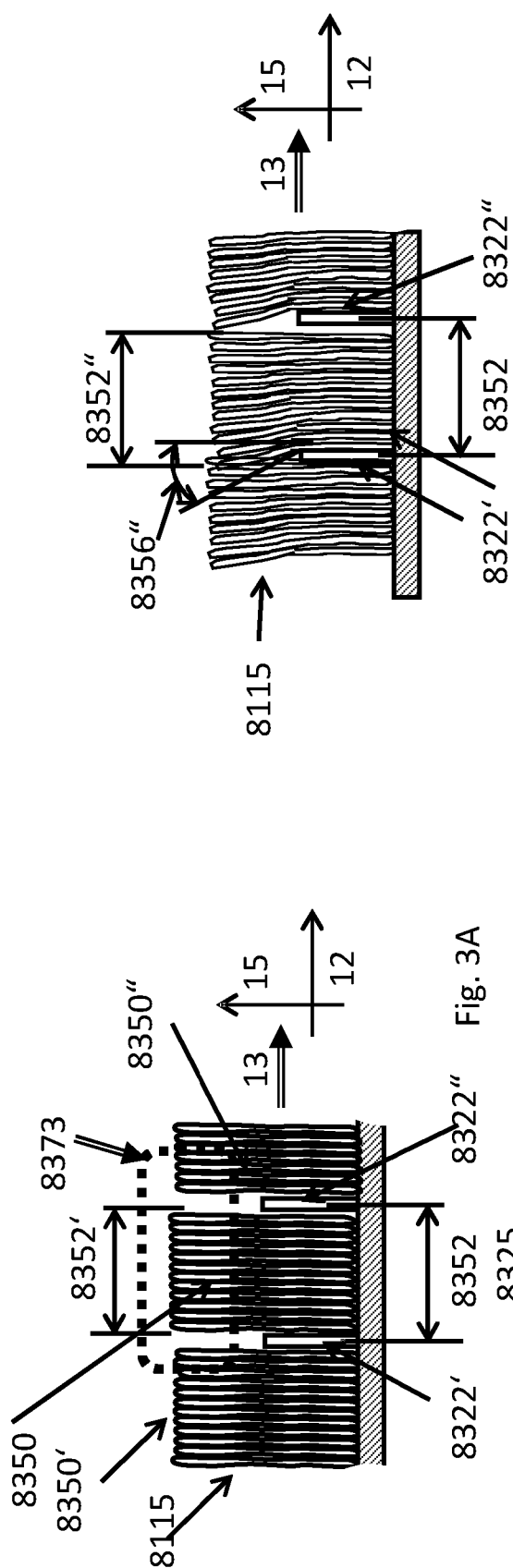


Fig. 2





EUROPEAN SEARCH REPORT

Application Number

EP 25 16 7420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 1 148 014 A2 (OPTIMA FILLING & PACKAGING [DE]) 24 October 2001 (2001-10-24) * the whole document *	1-3	INV. B65H29/14 B65H29/40 B65H31/06 B65H31/30 B65H43/04 B65H43/08
			TECHNICAL FIELDS SEARCHED (IPC)
			B65H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		12 September 2025	Ureta, Rolando
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T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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12-09-2025

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