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(54) **LOW MAINTENANCE SYSTEM FOR PRODUCING ARTICLES FORMED OF WEB MATERIAL COMPONENTS**

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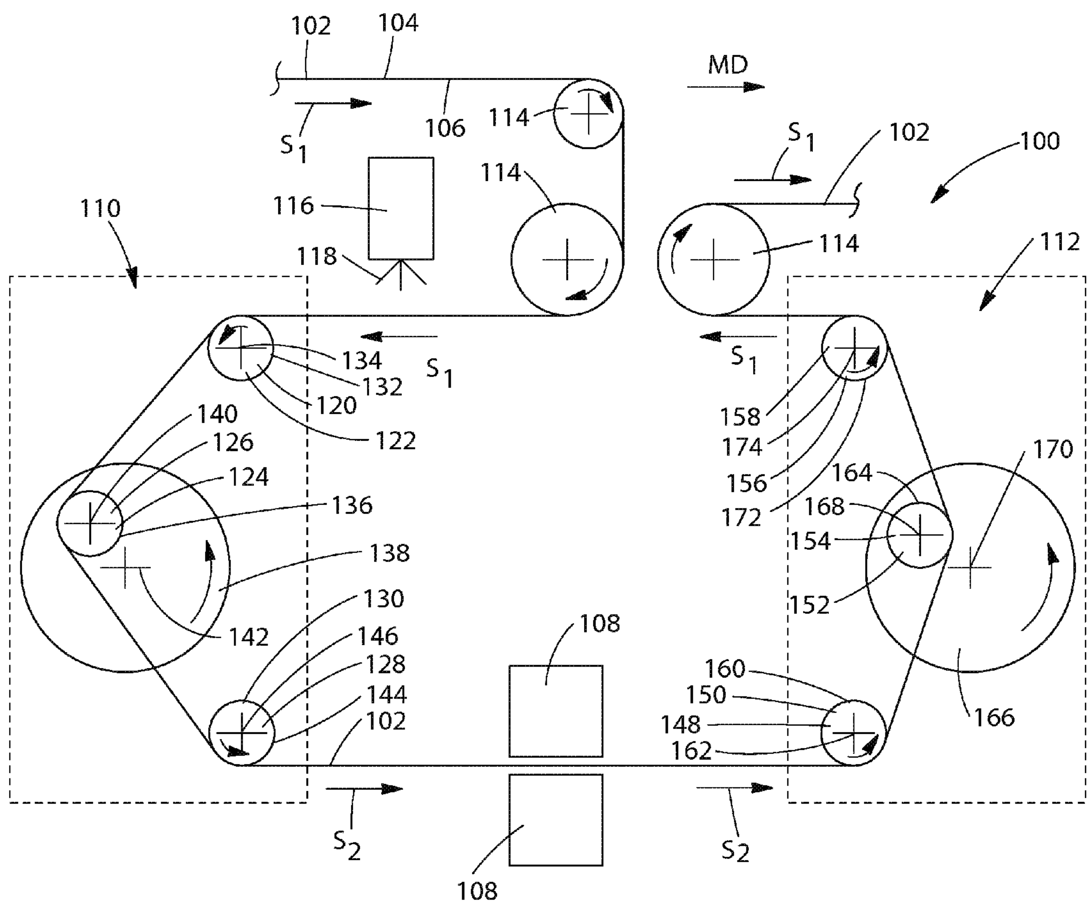
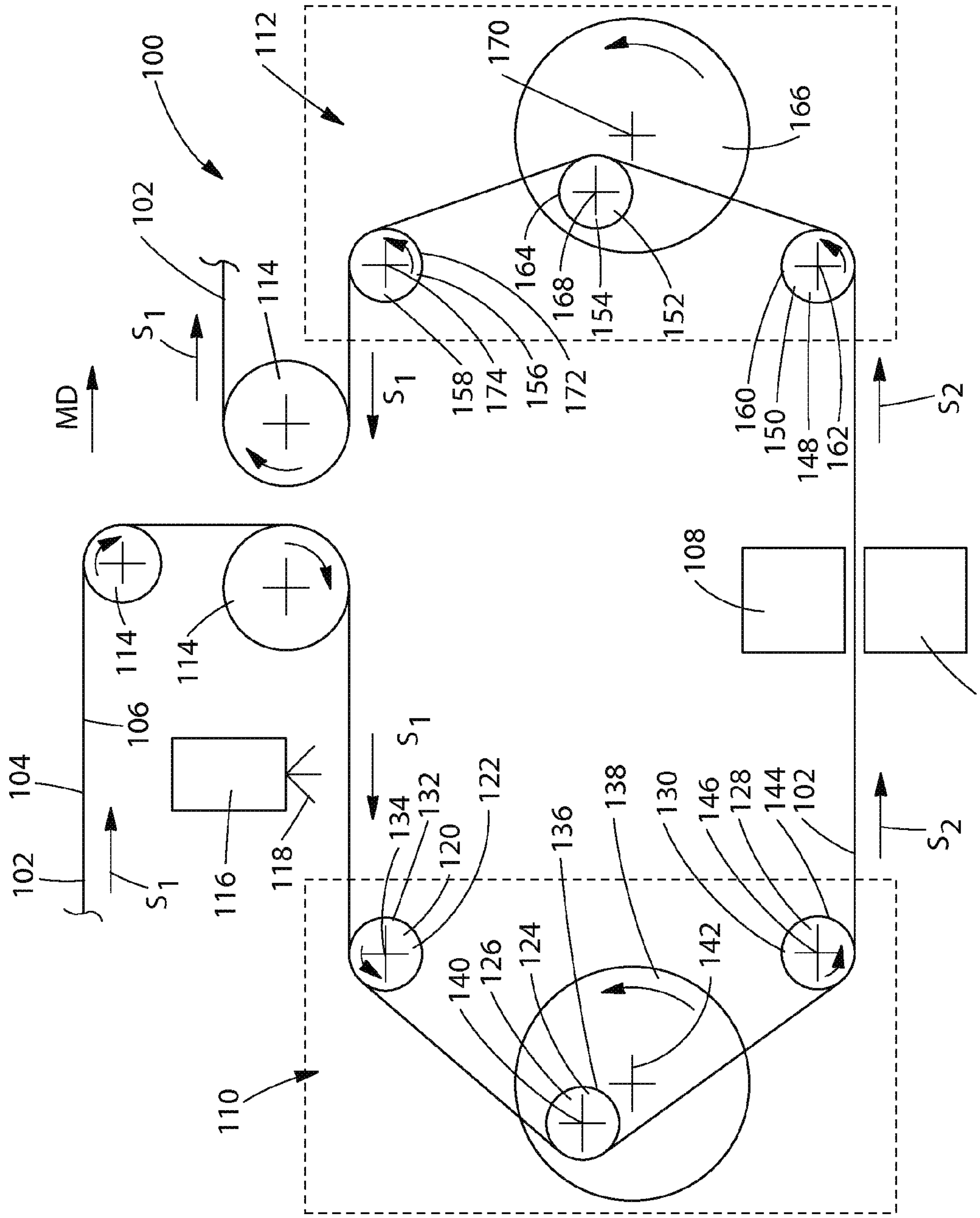
USPC **226/191**; 226/195

(57) **ABSTRACT**

A low-maintenance system for producing articles formed of web components is disclosed. The system may include a continuous supply of a web material; a conveyor system operative to move the web material along a machine direction, and a component having a contact surface with which the web material engages in sliding contact as the material travels along the machine direction, wherein the component via the sliding contact supports the web material, guides the web, or alters the path of the web material, the contact surface comprising aluminum magnesium boride.

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144
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148
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162
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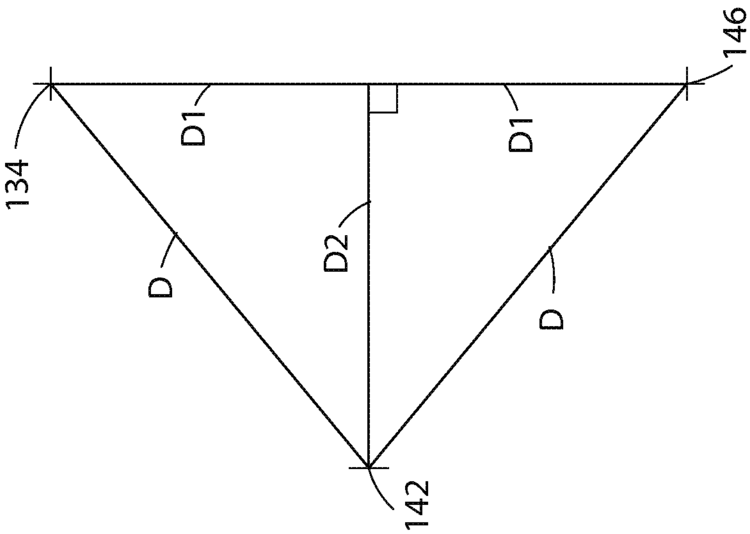
166
168
170
172
174
MD
S_1
S_2

Fig. 1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146
142
D1
D1
D2
D
D

Fig. 2B

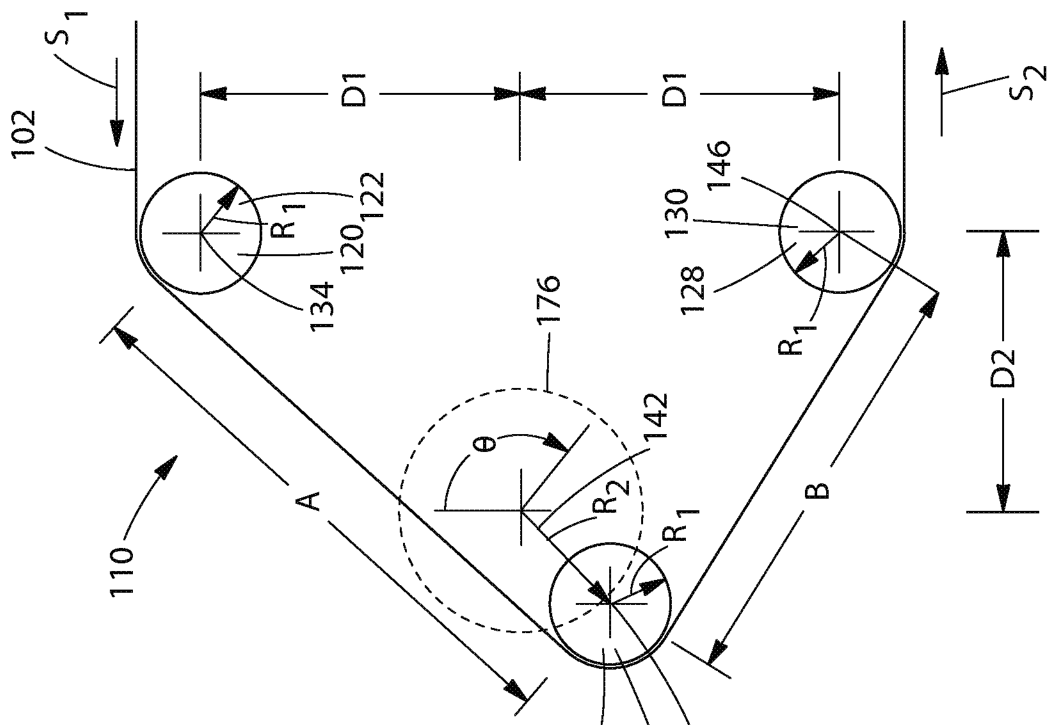
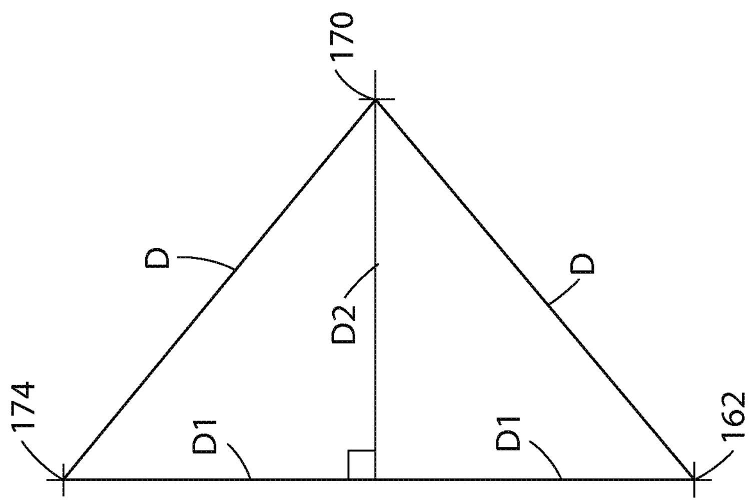

102
110
S1
S2
D1
D1
D2
A
B
R1
R2
θ
120
122
124
126
128
130
134
140
142
146
176

Fig. 2A


170
D
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D2
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D1
D1
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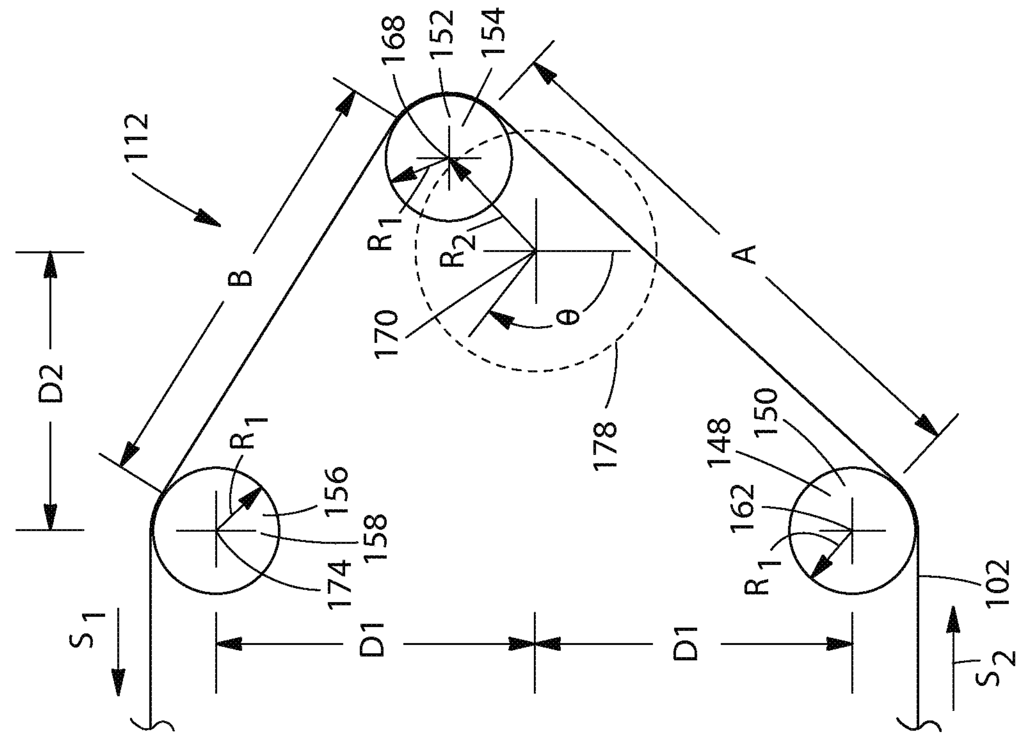
Fig. 2D


112
B
A
D2
168
152
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R_1
R_2
170
θ
178
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158
174
R_1
S_1
S_2
D1
D1

Fig. 2C

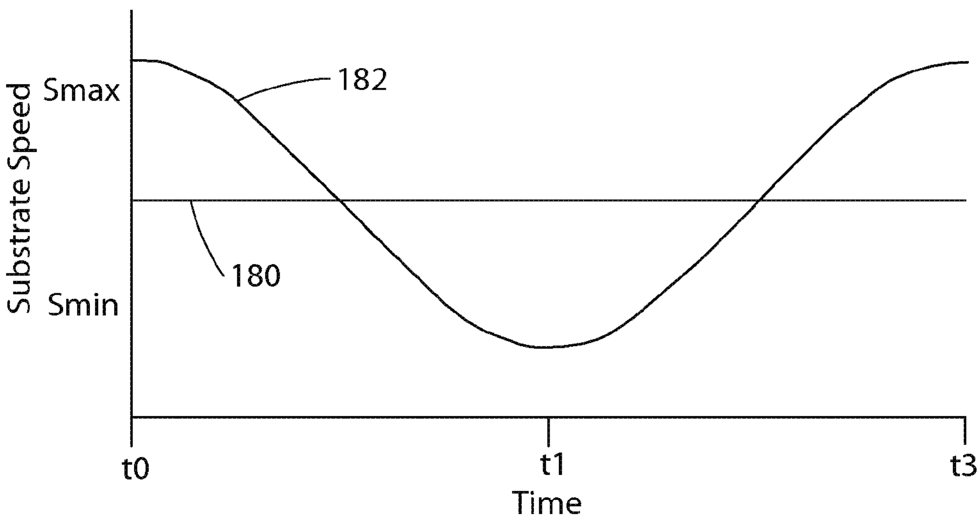
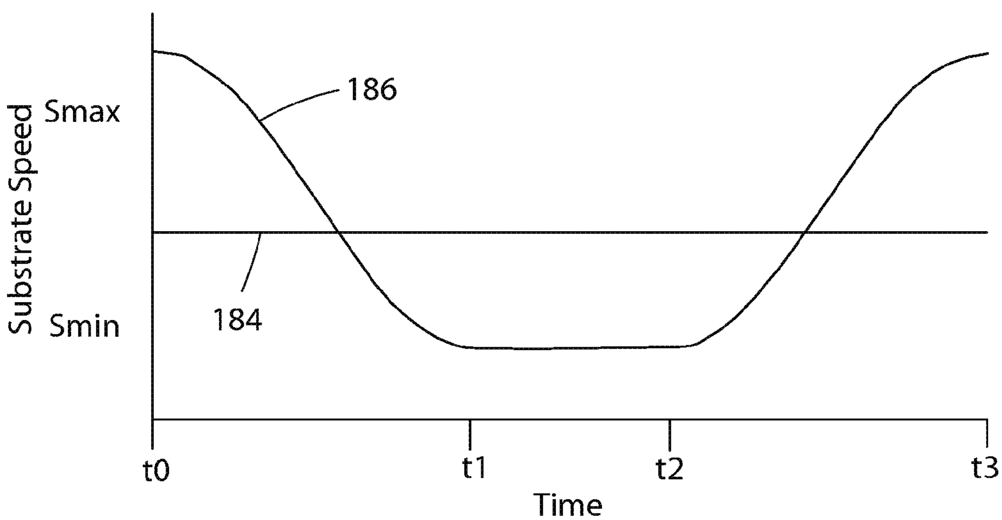

Substrate Speed
Smax
Smin
182
180
t0
t1
t3
Time

Fig. 3A


Substrate Speed
Smax
Smin
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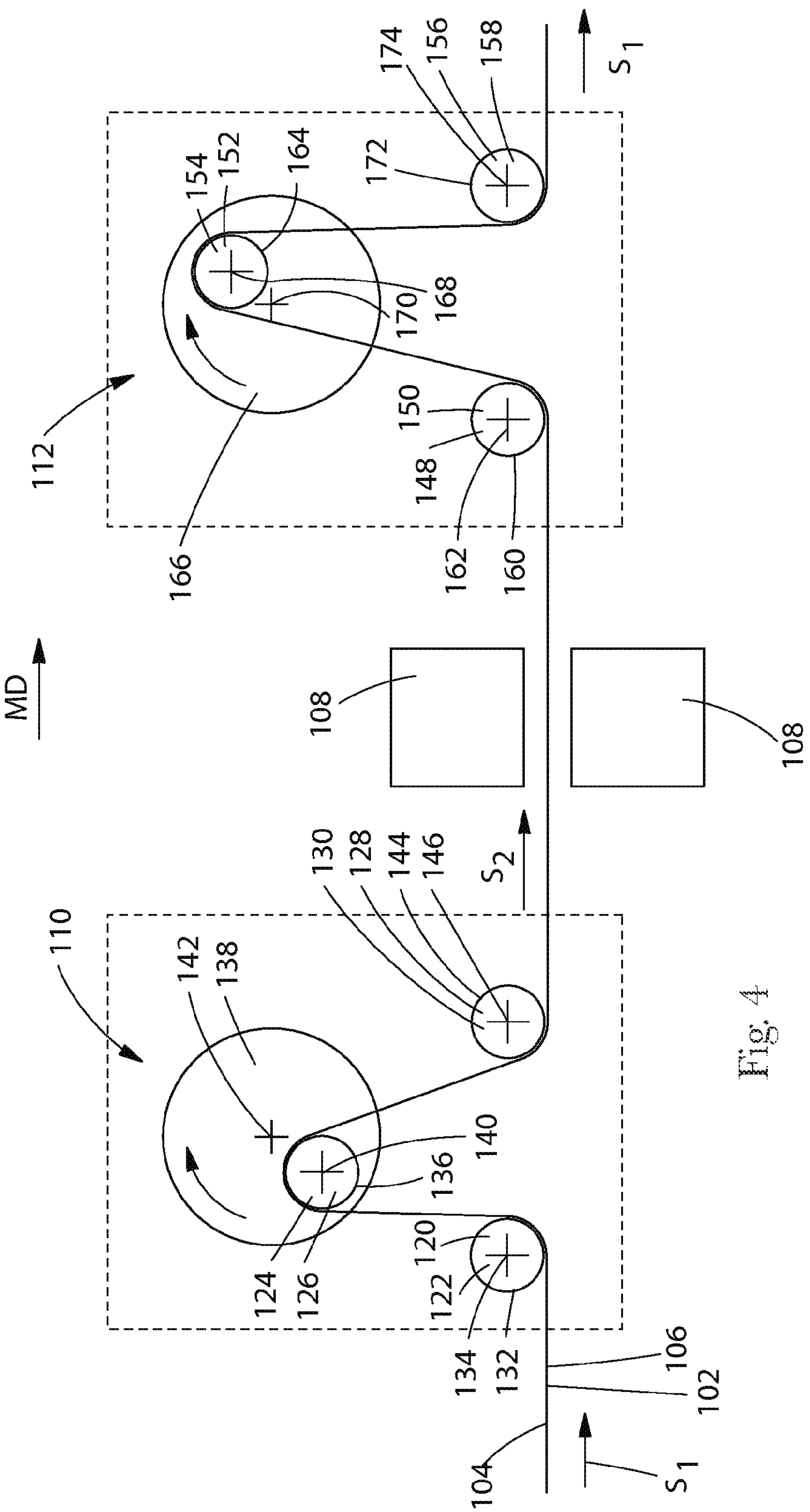
t0
t1
t2
t3
Time

Fig. 3B


MD
S1
S2
S1
110
112
108
108
102
104
106
120
122
124
126
128
130
132
134
136
138
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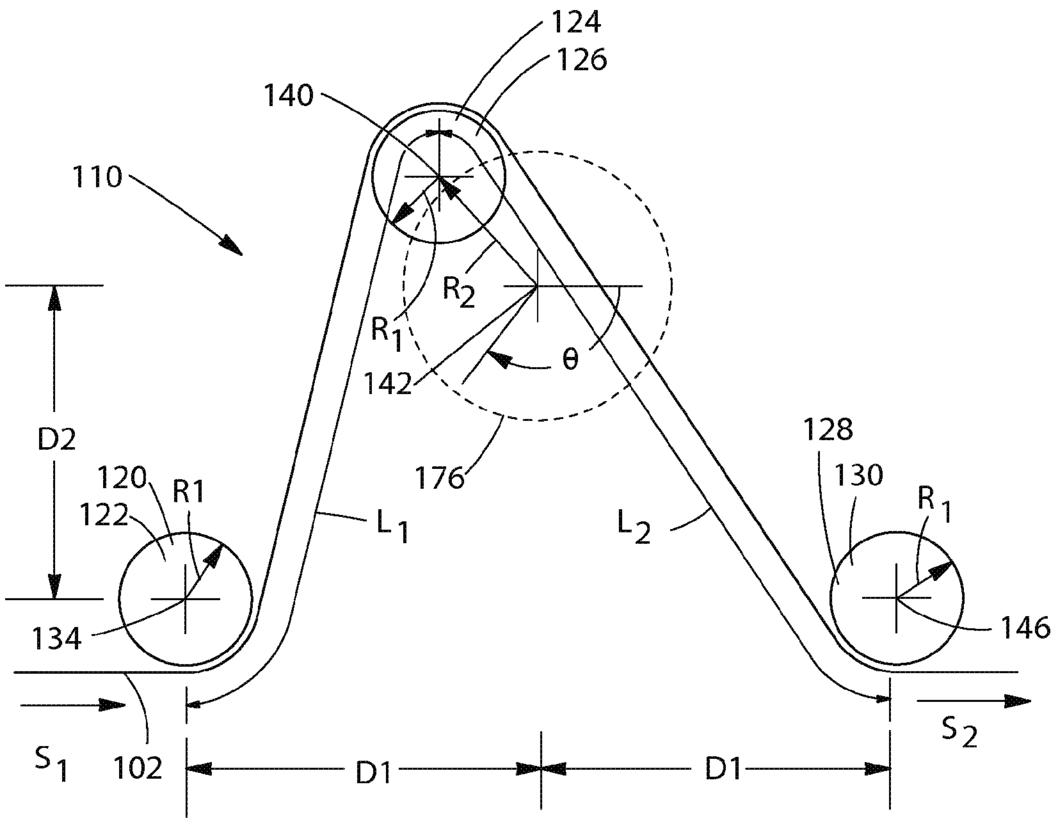
174

Fig. 4


124
126
140
110
R2
R1
142
θ
176
D2
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R1
122
L1
L2
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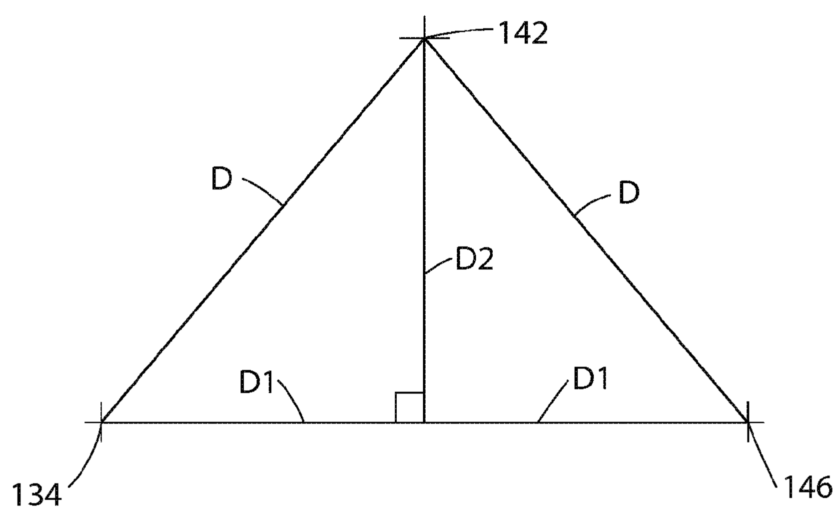
130
R1
134
146
S1
102
D1
D1
S2

Fig. 5A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D2
D1
D1
134
146

Fig. 5B

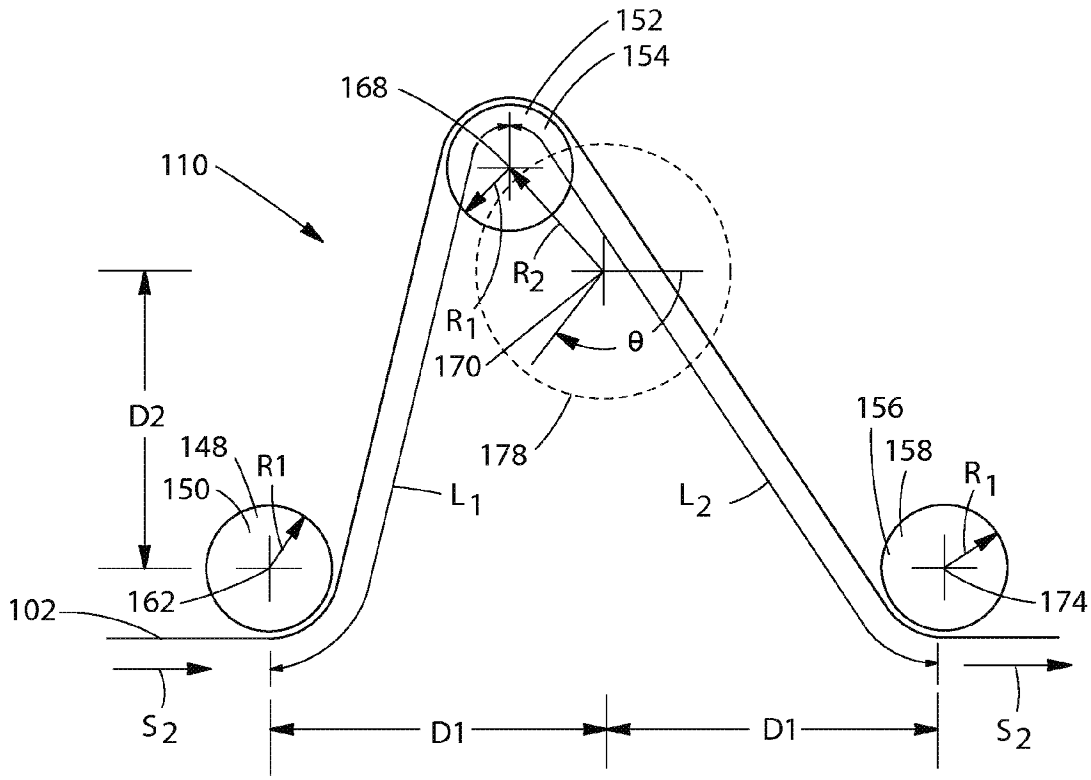
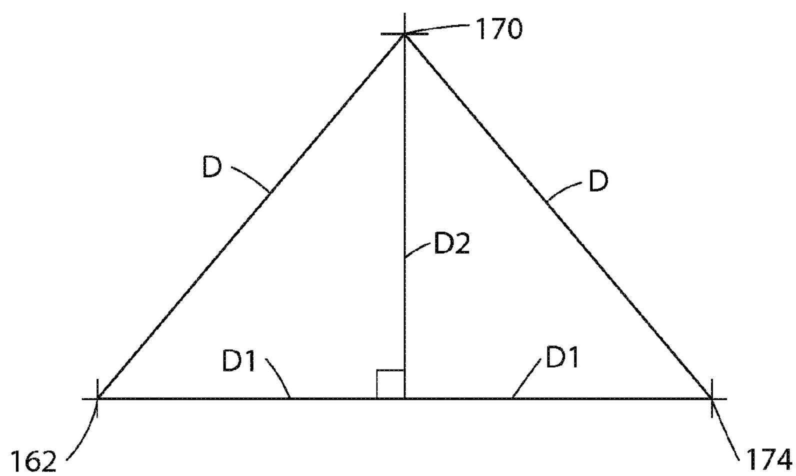

152
154
168
110
R2
R1
170
θ
D2
178
156
158
148
R1
150
L1
L2
R1
162
174
102
S2
D1
D1
S2

Fig. 5C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D
D
D2
D1
D1
162
174

Fig. 5D

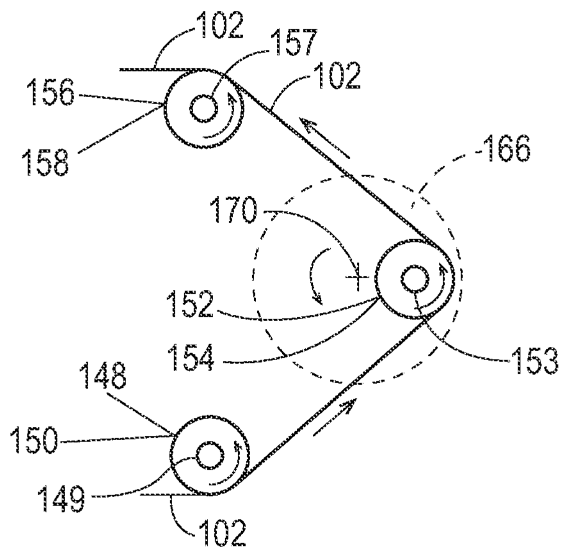
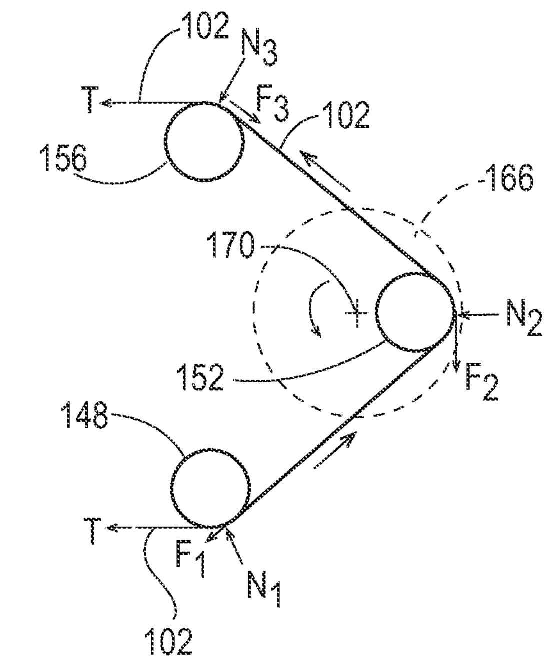

102
157
156
102
158
166
170
152
154
153
148
150
149
102

Fig. 6A


102
N_3
T
F_3
102
156
166
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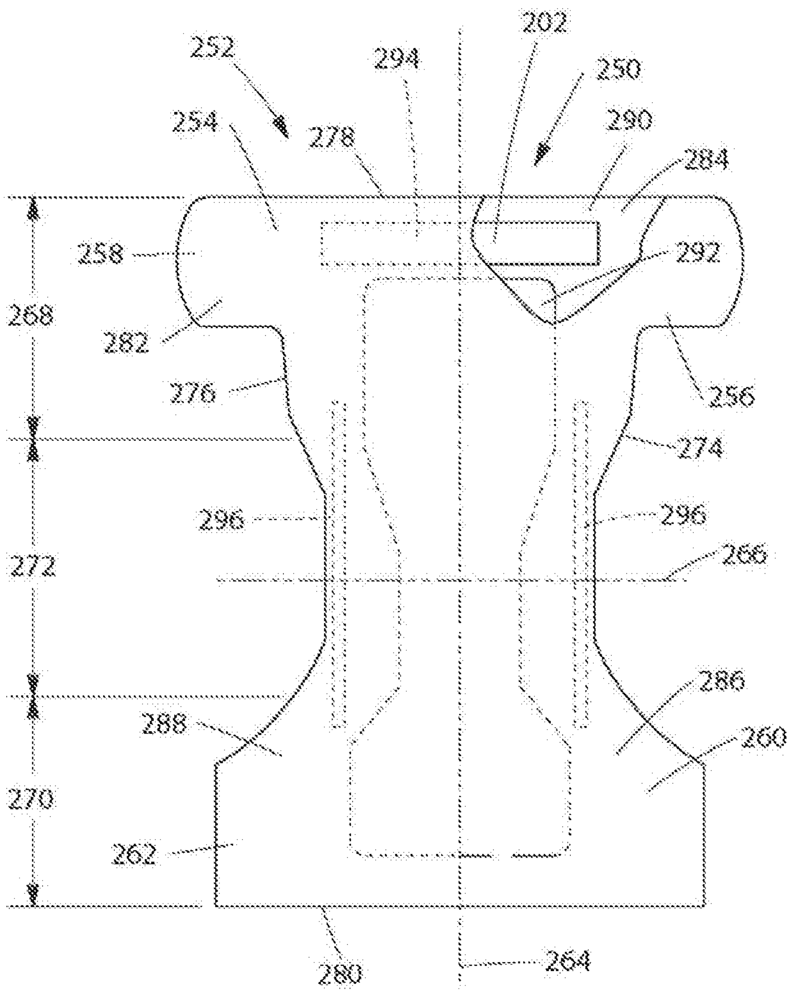
N_2
152
F_2
148
T
F_1
N_1
102

Fig. 6B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278
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282
256
276
274
296
296
272
266
286
288
260
270
262
280
264

Fig. 7

LOW MAINTENANCE SYSTEM FOR PRODUCING ARTICLES FORMED OF WEB MATERIAL COMPONENTS

BACKGROUND OF THE INVENTION

[0001] Currently, absorbent articles such as disposable diapers, disposable training pants, disposable adult incontinence garments, feminine hygiene pads and the like are constructed of various types of web materials. These materials may include nonwoven webs formed of synthetic polymer and/or natural fibers ("nonwovens"), polymeric films, elastomeric films or strips, or assemblies or laminates of these materials. In a typical absorbent article, nonwoven webs, films and/or laminate webs of various types form at least one component of an outward- and/or garment-facing layer ("backsheet"), an inner body-facing layer ("topsheet") and also may form various internal layers, cuffs, envelopes or other features, depending upon the particular features of the product. The component web materials are usually supplied in the form of large continuous rolls, or alternatively, boxes of continuous longitudinal sheet material gathered and folded transversely in accordion fashion.

[0002] Along a manufacturing line, various types of articles, such as for example, diapers and other absorbent articles, may be assembled by adding components to and otherwise modifying an advancing, continuous web material. For example, in some processes, advancing web materials are combined with other advancing web materials. In other examples, individual components created from advancing web materials are combined with advancing web materials, which in turn, are then combined with other advancing web materials. Webs of material and component parts used to manufacture diapers may include backsheets, topsheets, absorbent cores, front and/or back ears, fastener components, and various types of elastic webs and components such as leg elastics, barrier leg cuff elastics, and waist elastics. Once the desired component parts are assembled, the advancing web materials and component parts are subjected to a final knife cut to separate the web(s) into discrete diapers or other absorbent articles. The discrete diapers or absorbent articles may also then be folded and packaged.

[0003] Various methods and apparatuses may be used for attaching different components to the advancing web material. Some production operations are configured to advance substrates in a machine direction at a constant speed. However, when advancing web materials have components added thereto or are otherwise subjected to processing operations during production, it may be necessary to slow or stop the advancing web material. For example, it may be necessary to slow or stop an advancing web material passing through a processing station configured to perform such operations as, for example, gluing, welding, and adding discrete components. In an attempt to avoid having to vary the speed of the entire length of a web material passing through an assembly line, some devices can be used to vary the speed of a portion of the web material without affecting the overall speed of the web material through the line. However, such devices may only be configured to slow or stop the portion of the advancing web material passing through a processing station for an instant or a very short duration of time. In turn, the processing stations may not be able to complete their respective functions during the relatively short time period while the web material is slowed or stopped. In addition, some speed varying devices are configured to engage both sides an advancing web material, which may have a negative impact on other process steps.

[0004] More generally, a web material is moved through the manufacturing line by one or move conveyor systems that grip the web material (e.g., between pairs of relatively high friction rollers) and continuously draw it from the supply and through the various processing stations that perform the operations that convert the web material into an incorporated component of the finished product. As the material is drawn through the line, it is typically necessary to guide it, alter its path direction, decelerate it (in some circumstances, to zero velocity), accelerate it, or perform other actions affecting the speed and path direction of the web material through the line as various operations are performed. Some of the components that are used to perform these actions may include idler rollers over which the web material rolls along its machine direction path. Some of the components that are used to perform these actions may include stationary rollers, guides, tables, chutes or other structures which guide the web material along its machine direction path.

[0005] Generally, for purposes of improving efficiency, competitiveness and profitability, increasing the production rate is an ever-present objective. Increasing the production rate requires increasing the overall machine direction speed of web material components through the line. As machine direction speed is increased, the performance limits of many types of moving components in the line can be reached and often become limiting factors. Additionally, fixed or stationary components that contact web material components may become sources of excessive friction, and the resulting heat energy generated may be detrimental. Thus, such components also may become limiting factors with respect to the objective of increasing machine direction speed of web materials.

[0006] With respect to components such as, for example, rollers and guides, various designs and materials have been used to reduce inertia, mass, momentum and friction generated by or at these components so as to enable increases in machine direction speed of web materials. In one approach, which may be applied to, for example, fixed rollers and guides, the surfaces that are exposed to sliding contact with the web material may be formed of a relatively hard, highly polished material (such as highly polished stainless steel) to minimize friction. In another approach, such surfaces may be coated with a material such as polytetrafluoroethylene (PTFE) (e.g., TEFLON). These approaches, however, may be less than satisfactory because coefficients of friction may still be too high, and become limiting factors, as web material machine direction speeds are increased. This is particularly true when the web material wraps about contact surfaces of a component along its path and/or normal forces between the web material and the contact surfaces become substantial (as when there is a combination of machine direction tension in the web material and alteration of the path of the web material effected by the component).

[0007] Further, all production lines require shutdowns from time to time for cleaning, maintenance, component replacement and repair. Generally, moving components and components exposed to friction and wear are components that create the need for shutdowns. As greater numbers of such components are included in a line, generally, the frequency of needed shutdowns may be multiplied. Shutdowns are generally counterproductive to the goals of improving efficiency, competitiveness and profitability.

[0008] For the foregoing reasons, it would advantageous if improvements were developed that provide a relatively simple and controllable way of locally accelerating and decelerating machine direction velocity of a web material, while not altering its machine direction velocity through the line overall. It would further be advantageous if improvement were available that enable an increase of machine direction speed of web materials through a production line, beyond limits inherent in existing technology, a reduction of cost and space and motion constraints, and a reduction of necessary frequency of shutdowns.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a cross direction, schematic view of an example of an apparatus according to the present disclosure.

[0010] FIG. **2**A shows the relative positions of components in a first web material guide of FIG. **1**.

[0011] FIG. **2**B shows a geometrical representation of the relative positions of the components shown in FIG. **2**A.

[0012] FIG. **2**C shows the relative positions of components in a second web material guide of FIG. **1**.

[0013] FIG. **2**D shows a geometrical representation of the relative positions of the components shown in FIG. **2**C.

[0014] FIG. **3**A shows a first example of a web material speed profile.

[0015] FIG. **3**B shows a second example of a web material speed profile.

[0016] FIG. **4** is a side view of second embodiment of the apparatus according to the present disclosure.

[0017] FIG. **5**A shows the relative positions of components in a first web material guide of FIG. **4**.

[0018] FIG. **5**B shows a geometrical representation of the relative positions of the components shown in FIG. **5**A.

[0019] FIG. **5**C shows the relative positions of components in a second web material guide of FIG. **4**.

[0020] FIG. **5**D shows a geometrical representation of the relative positions of the components shown in FIG. **5**C.

[0021] FIG. **6**A is a cross direction, schematic view of a portion of an example of an apparatus according to the present disclosure.

[0022] FIG. **6**B is a cross direction, schematic view of a portion of an example of an apparatus according to the present disclosure, in an alternative embodiment.

[0023] FIG. **7** is a top plan view of a disposable absorbent article.

DETAILED DESCRIPTION OF EXAMPLES

[0024] The following term explanations may be useful in understanding the present disclosure:

[0025] "Absorbent article" is used herein to refer to consumer products whose primary function is to absorb and retain soils and wastes.

[0026] "Diaper" is used herein to refer to an absorbent article generally worn by infants and incontinent persons about the lower torso.

[0027] The term "disposable" is used herein to describe absorbent articles which generally are not intended to be laundered or otherwise restored or reused as an absorbent article (e.g., they are intended to be discarded after a single use and may also be configured to be recycled, composted or otherwise disposed of in an environmentally compatible manner).

[0028] The term "disposed" is used herein to mean that an element(s) is formed (joined and positioned) in a particular place or position as a macro-unitary structure with other elements or as a separate element joined to another element.

[0029] As used herein, the term "joined" encompasses configurations whereby an element is directly secured to another element by affixing the element directly to the other element, and configurations whereby an element is indirectly secured to another element by affixing the element to intermediate member(s) which in turn are affixed to the other element.

[0030] The term "web material" is used herein to describe a material which is primarily two-dimensional (i.e. in an XY plane) and whose thickness (in a Z direction) is relatively small (i.e. 1/10 or less) in comparison to its length (in an X direction) and width (in a Y direction). Non-limiting examples of web materials include a layer or layers or nonwovens, polymeric and/or elastomeric films and foils such as plastic films or metallic foils that may be used alone or laminated to one or more web, layer, film and/or foil.

[0031] The term "nonwoven" refers herein to a material made from continuous (long) filaments (fibers) and/or discontinuous (short) filaments (fibers) by processes such as spunbonding, meltblowing, and the like. Nonwovens do not have a woven or knitted filament pattern.

[0032] The term "machine direction" (MD) is used herein to refer to the direction of material flow through a manufacturing line or portion thereof. In addition, relative placement and movement of material can be described as moving in the machine direction through a process from upstream in the process to downstream in the process. For a continuous web material supplied to a manufacturing line, the "machine direction" is usually substantially parallel to the greater length of the web material.

[0033] The term "cross direction" (CD) is used herein to refer to a direction that is generally perpendicular to the machine direction.

[0034] The terms "elastic" and "elastomeric" as used herein refer to any material that upon application of a biasing force, can stretch to an elongated length of at least about 110% of its relaxed, original length (i.e. can stretch to 10% more than its original length), without rupture or breakage, and upon release of the applied force, recovers at least about 40% of its elongation. For example, a material that has an initial length of 100 mm can extend at least to 110 mm, and upon removal of the force would retract to a length of 106 mm (40% recovery). The term "inelastic" refers herein to any material that does not fall within the definition of "elastic" above.

[0035] The term "extensible" as used herein refers to any material that upon application of a biasing force, can stretch to an elongated length of at least about 110% of its relaxed, original length (i.e. can stretch to 10%), without rupture or breakage, and upon release of the applied force, shows little recovery, less than about 40% of its elongation.

[0036] The terms "activating", "activation" or "mechanical activation" refer to the process of making a web material, or an elastomeric laminate more extensible than it was prior to the process.

[0037] "Live stretch" includes stretching elastic and bonding the stretched elastic to a web material. After bonding, the stretched elastic is released causing it to contract, resulting in a "corrugated" web material. The corrugated web material can extend as the corrugations are pulled to about the point that the web material reaches at least one original flat dimension. However, if the web material is also elastic, then the web material can stretch beyond the relaxed length of the web material prior to bonding with the elastic. The elastic is stretched at least 25% of its relaxed length when it is bonded to the web material.

[0038] Aspects of the present disclosure involve methods and apparatuses utilizing continuous web materials for manufacturing articles, and more particularly, methods and apparatuses for varying the speed of an advancing web material. Particular embodiments of the apparatuses and methods disclosed herein provide for localized speed changes of an advancing web material. As discussed below in more detail, embodiments of a localized speed varying apparatus may include first and second web material guides positioned upstream and downstream of a processing station, respectively. The web material guides utilize orbital motion of guide members to change the length of the web material path within the web material guides upstream and downstream of the processing station. The changes in web material path length within the web material guides result in localized speed changes of the web material between the web material guides. Coordination between the web material guides allows for localized speed changes of the web material passing through the processing station without affecting the speed of the web material upstream of the first web material guide and downstream of the second web material guide. As discussed in more detail below, the web material guides may be configured to engage and/or touch only one side or surface of the advancing web material. In addition, the web material guides may be configured with guide members having geometrically determinative relative positions to each other. In some configurations, the orbiting guide members may be adapted to move at a constant angular velocity, while in other configurations, the orbiting guide members may move at a varying angular velocity.

[0039] As mentioned above, apparatuses and methods of the present disclosure may be utilized to change the speeds of continuous web materials used in the manufacture of absorbent articles. Such web materials may be utilized in absorbent article components such as, for example: backsheets, topsheets, absorbent cores, front and/or back ears, fastener components, and various types of elastic webs and components such as leg elastics, barrier leg cuff elastics, and waist elastics. Exemplary descriptions of absorbent article components and web materials are provided below with reference to FIG. **7**. In addition, web materials may include continuous webs of material and component parts mounted on carrier web materials or may be in the form of a continuous web material. Although much of the present disclosure is provided in the context of manufacturing absorbent articles, it is to be appreciated that the apparatuses and methods disclosed herein may be applied to the manufacture of other types of articles and products manufactured from continuous web materials. Examples of other articles, products, and processes include packaging components, labels, and metal processing.

[0040] FIG. **1** shows an embodiment of an apparatus **100** for varying the speed of an advancing web material **102** including a first surface **104** and an oppositely disposed second surface **106**. The apparatus **100** may be utilized as part of a manufacturing or processing line wherein the web material advances at a first speed S_1 from an upstream position to a downstream position through a process in the machine direction (MD). As such, the apparatus may be configured to provide localized speed changes of the web material. For example, as shown in FIG. **1**, the apparatus **100** may provide localized speed changes of the web material **102** as the web material passes through a processing station **108**. In particular, the apparatus **100** includes a first web material guide **110** and a second web material guide **112**. As shown in FIG. **1**, the web material **102** advances in the machine direction (MD) around two idler rollers **114** and enters the first web material guide **110** at a first speed S_1. The web material **102** travels from the first web material guide **110** at a second speed S_2 through the processing station **108**. From the processing station **108**, the web material **102** enters the second web material guide **112**. The web material **102** then exits the second web material guide **112** at the first speed S_1. As discussed in more detail below, the first web material guide **110** and second web material guide **112** operate to change the lengths of the web material within the respective guides, and thus, vary the second speed S_2 of the web material traveling from the upstream, first web material guide **110** to the downstream, second web material guide **112**. At the same time, the speed of the web material entering the first web material guide and exiting the second web material guide is maintained at a constant first speed S_1. The idler rollers **114** in FIG. **1** show only one example of how the web material may be advanced to and from the apparatus **100**, and as such, it is to be appreciated that various other configurations and arrangements can be utilized.

[0041] As previously mentioned, the second speed S_2 of the web material **102** can be varied as the web material travels through the processing station **108**. As discussed in more detail below, the first and second web material guides **110**, **112** may be configured to periodically slow (e.g. second speed, S_2, is slower than the first speed, S_1) the movement of the web material **102** in the machine direction (MD) passing through the processing station **108**. In some configurations, the first and second web material guides **110**, **112** may be configured to periodically stop (e.g. second speed, S_2, is zero) the movement of the web material **102** in the machine direction (MD) passing through the processing station **108**. In yet other configurations, the first and second web material guides **110**, **112** may be configured to periodically reverse the movement of the web material (e.g. web material moves upstream relative to the machine direction (MD)) while passing through the processing station **108**. A generic representation of a processing station **108** is shown in FIG. **1**. As such, it is to be appreciated that the various different operations may be conducted by the processing station, for example, printing, web activation processes, ultrasonic bonding, glue application, attachment of other components and/or web materials, and press-type operations, such as stamp die cutting. In another example, the second web material speed S_2, may be varied to allow for the application of stretched waistbands at desired locations along the length of the web material, such as described in U.S. patent application Ser. No. 12/417,124, filed on Apr. 2, 2009 and U.S. Patent Application No. 61/056,131, filed on May 27, 2008.

[0042] As described in more detail below, the web material guides may be configured to touch only one side of the web material. For example, the first and second web material guides **110**, **112** may be configured to touch only the first surface **104** of the web material **102**, and do not touch the second surface **106** of the web material **102**. Such a configuration may be beneficial to reduce negative impacts on other operations performed on the web material. For example, FIG. **1** shows an example upstream operation **116** wherein glue **118** is applied to the second surface **106** of the web material **102** before the web material enters the first web material guide **110**. Because the first and second web material guides **110**, **112** touch only the first surface **104** of the web material **102**, risks of contaminating or otherwise affecting the glue **118** on the second surface **106** may be reduced. In another example, the processing station **108** of FIG. **1** may be configured to adhere or otherwise connect components to the web material. Because the second web material guide **112** touches only the first surface **104** of the web material **102**, risks of inadvertently removing, peeling off, otherwise damaging the components may be reduced.

[0043] As shown in FIG. **1**, the first web material guide **110** includes a first guide member **120** in the form of a first roller **122**, a second guide member **124** in the form of a second roller **126**, and a third guide member **128** in the form of a third roller **130**. As described below, the web material **102** travels in the machine direction (MD) at the first speed S_1 to the first roller **122**; from the first roller **122** to the second roller **126**; from the second roller **126** to the third roller **130**; and from the third roller **130** to the processing station **108** and/or the second web material guide **112** at the second speed S_2. As shown in FIG. **1**, the first roller **122** defines an outer radial surface **132** and rotates around a first center axis **134**. The second roller **126** defines an outer radial surface **136** and is rotatably connected with a support member **138** at a second roller axis **140**. The support member **138** is adapted to rotate around a second center axis **142**. As such, the second roller **126** orbits around the second center axis **142** as the support member **138** rotates. The third roller **130** defines an outer radial surface **144** and rotates around a third center axis **146**. As the web material **102** moves through the first web material guide **110**, only the first surface **104** of the web material **102** contacts the outer radial surfaces **132**, **136**, **144** of the first, second, and third rollers **122**, **126**, **130**.

[0044] Similar to the first web material guide **110**, the second web material guide **112** includes a first guide member **148** in the form of a first roller **150**, a second guide member **152** in the form of a second roller **154**, and a third guide member **156** in the form of a third roller **158**. As described below, the web material **102** travels in the machine direction at the second speed S_2 (from the first web material guide **110** and/or processing station **108**) to the first roller **150**; from the first roller **150** to the second roller **154**; from the second roller **154** to the third roller **158**; and from the third roller **158** to continue downstream at the first speed S_1. As shown in FIG. **1**, the first roller **150** defines an outer radial surface **160** and rotates around a first center axis **162**. The second roller **154** defines an outer radial surface **164** and is rotatably connected with a support member **166** at a second roller axis **168**. The support member **166** is adapted to rotate around a second center axis **170**. As such, the second roller **154** orbits around the second center axis **170** as the support member **166** rotates. The third roller **158** defines an outer radial surface **172** and rotates around a third center axis **174**. As the web material **102** advances through the second web material guide **112**, only the first surface **104** of the web material **102** contacts the outer radial surfaces **160**, **164**, **172** of the first, second, and third rollers **150**, **154**, **158**.

[0045] Although the guide members **120**, **124**, **128**, **148**, **152**, **156** of the first and second web material guides **110**, **112** are shown and described as rollers, it is to be appreciated that the guide members can be configured in other ways. For example, in some embodiments, the guide members may be configured as rollers, stationary pins, rods or bars, endless belts, spheres, and/or combinations thereof. In addition, although the support members **138**, **166** are shown in the form of wheels, it is to be appreciated that the support members may be configured in other ways, such as for example, an elongate member or rotating arm. Further, some or all of the rollers can be driven rollers, idler rollers, and/or combinations of each. For example, in some embodiments, all the rollers of the first and second web material guides may be driven by a common belt or chain. In addition, as discussed below, the support members can be rotated at constant or variable speeds. In some embodiments, the support members **138**, **166** may have separate and/or variable speed drives, such as for example, servo motors. In some embodiments, one of the support members is connected with a drive and the other support member is connected with the driven support member through a belt, chain, and/or gears.

[0046] As mentioned above, the first web material guide **110** and the second web material guide **112** utilize orbital motion of guide members to change the length of the web material **102** within the web material guides. In particular, rotation of the support members **138**, **166** causes the second rollers **124**, **152** to orbit around the second center axes **142**, **170**. In turn, the orbital motions of the second rollers **124**, **152** result in changes of the lengths of web material within the web material guides **110**, **112**. As such, the coordinated rotation of the support members **138**, **166** of the first and second web material guides **110**, **112** result in localized speed changes of the web material **102** passing through the processing station **108** (i.e. a variable second speed, S_2), while maintaining a constant first speed, S_1.

[0047] In each web material guide **110**, **112**, the geometrical arrangement of the guide members relative to each other within each web material guide may be used to configure to the desired drive profile of the web material guide. For example, FIG. **2**A illustrates an example of the first web material guide **110** such as shown in FIG. **1** labeled to show the relative positions of the guide members **120**, **124**, **128**. The orbital path **176** of the second guide member **124** as the support member **138** rotates around the second center axis **142** is represented by a dashed circle. FIG. **2**B shows an example of a triangle formed by drawing lines between the first center axis **134**, the second center axis **142**, and the third center axis **146** shown in FIG. **2**A. In FIG. **2**A, the first roller **122**, the second roller **126**, and the third roller **130** each define equal radii represented as R1. R2 is the distance between the second center axis **142** and the second roller axis **140**, and angle, θ, represents the angular position of the second roller axis **140** as the second roller **126** orbits around the second center axis **142**. Dimension, A, is the distance between the first center axis **134** and the second roller axis **140**, and dimension, B, is the distance between the second roller axis **140** and the third center axis **146**. With reference to FIG. **2**B, the distance between the second center axis **142** and first center axis **134** is distance, D, and the distance between the second center axis **142** and the third center axis **146** is also distance, D. With reference to FIGS. **2**A and **2**B, the distance between the first center axis **134** and the third center axis **146** is 2 times D1, and the distance from the second center axis **142** to a line extending between the first center axis **134** and the third center axis **146** is D2. It is to be appreciated that in some embodiments, D can be the same as or can be a different length than D2. The length of web material, L_{Web1}, in the first web material guide can be calculated as:

$$L_{Webi}=\lambda R_1+A+B \text{ where:} \quad \text{Equation 1}$$

$$A=\sqrt{(D_1+R_2\cos(\theta))^2+(D_2-R_2\sin(\theta))^2} \text{ and} \quad \text{Equation 2}$$

$$B=\sqrt{(D_1-R_2\cos(\theta))^2+(D_2-R_2\sin(\theta))^2} \quad \text{Equation 3}$$

[0048] With reference to FIGS. **1** and **2**A, as the support arm **138** in the first web material guide **110** rotates around the second center axis **142** (i.e. as θ changes) the length of web material **102** in the first web material guide **110**, L_{Web1}, will vary between a maximum value, $L_{Web1\text{-}Max}$, and a minimum value, $L_{Web1\text{-}Min}$. In turn, the variance of the length, L_{Web1}, causes the second speed S_2 of the web material **102** to change. As such, a specific profile for the second speed S_2 of the web material **102** can be created by varying θ in the above equations 1-3.

[0049] Although FIGS. **2**A and **2**B and the associated equations 1-3 are described with reference to the first web material guide, it is to be appreciated that the figures and equations can also be applied to calculate the length of web material, L_{Web2}, in the second web material guide. For example, similar to FIGS. **2**A and **2**B, FIGS. **2**C and **2**D show the relative positions of various components in the second web material guide **112**. In particular, FIG. **2**C illustrates an example of the second web material guide **112** such as shown in FIG. **1** labeled to show the relative positions of the guide members **148**, **152**, **156**. The orbital path **178** of the second guide member **152** as the support member **166** rotates around the second center axis **170** is represented by a dashed circle. FIG. **2**D shows an example of a triangle formed by drawing lines between the first center axis **162**, the second center axis **170**, and the third center axis **174** shown in FIG. **2**C. Applying the same analysis above to FIGS. **2**C and **2**D, the length of web material, L_{Web2}, in the second web material guide **112** can be calculated using Equations 1-3, wherein:

$$L_{Web2}=\pi R_1+A+B$$

[0050] Thus, as the support arm **166** in the second web material guide **112** rotates around the second center axis **170** (i.e. as θ changes) the length of web material **102** in the second web material guide, L_{Web2}, will vary from a maximum value, $L_{Web2\text{-}Max}$, and a minimum value, $L_{Web2\text{-}Min}$. In turn, the variance of length, L_{Web2}, can be configured to be the opposite of the variance of the length, L_{Web1}, so as to reduce strain and slack in the web material **102** as the web material travels from the first web material guide **110** to the second web material guide **112**. In other words, the first and second web material guides can be configured to provide a matched web material flow, wherein L_{Web1} increases at substantially the same rate as L_{Web2} decreases, and wherein L_{Web1} decreases at substantially the same rate as L_{Web2} increases. A matched web material flow can be achieved by defining certain geometric relationships of the guide members and support members in the first web material guide **110** and the second web material guide **112**. For example, a matched web material flow can be achieved by configuring the distances D1 and D2 (discussed above with reference to FIGS. **2**A-**2**D) to be equal or substantially equal to each other in the first web material guide **110** and in the second web material guide **112**, as well as having distances D1 and D2 in the first web material guide **110** equal or substantially equal to distances D1 and D2 in the second web material guide **112**.

[0051] As mentioned above, the first and second web material guides **110**, **112** can be configured to provide various different profiles defining the varying second speed S_2 of the web material **102** between the first and second web material guides **110**, **112**. In one example, the apparatus **100** can be configured such that the support arms **138**, **166** rotate at the same constant angular velocity. In particular, FIG. **3**A shows an example of a first speed profile **180** for the first speed S_1 and a second speed profile **182** for the second speed S_2 of the web material **102** that may be created by rotating the support arms **138**, **166** at a constant angular velocity. In particular, the first speed profile **180** represents a constant first web material speed S_1 versus time, and the second speed profile **182** represents a varying second web material speed S_2 versus time. As shown in FIG. **3**A, the second speed profile **182** is a near harmonic speed profile and may be created wherein a maximum second web material speed, Smax, and a minimum second web material speed, Smin, are achieved for an instant in time. In some configurations, the minimum second web material speed. Smin, may be a value greater than zero wherein the web material may be slowed for an instant in time. In other configurations, the minimum second web material speed, Smin, may be zero wherein the web material may be stopped for an instant in time. As such, the processing station **108** may be synchronized to perform an operation when the web material **102** is at the minimum web material speed, Smin, wherein the web material is slowed or stopped for an instant in time. It should also be appreciated that in some embodiments, the processing station may be configured to perform an operation when the web material **102** is at the maximum second web material speed, Smax, or at any other desired speed within the speed profile.

[0052] In some embodiments, the process station **108** may require more than an instant in time to perform an operation (i.e. not instantaneous). If the operation performed by the process station **108** is sufficiently fast enough and/or robust enough, it may be possible to have the processing station perform the operation during a period of time where the second speed S_2 of the web material **102** is near to a desired speed, such as Smin or Smax. For example, if it is desirable to stop the web material **102** at the processing station **108** in order to perform an operation that requires a processing time that is more than an instant in time to complete, there may be a window of time around the instantaneous zero second speed where the second speed S_2 is close enough to zero such that it is still possible to operate the process within the required processing time.

[0053] In some configurations, a processing station may require more than an instant in time to perform an operation at a desired speed and/or may not be robust enough to adequately operate in a speed range near an instantaneous speed. As such, the apparatus **100** may be configured with one or more variable speed servo motors adapted to rotate the support arms **138**, **166** at variable angular velocities. Thus, it is possible to define a web material speed profile that includes a dwell time at a desired speed that is greater than an instant in time. FIG. **3**B shows an example speed profile created with the utilization of variable speed drives. In particular, FIG. **3**B shows an example of a first speed profile **184** for the first speed S_1 and a second speed profile **186** for the second speed S_2 of the web material **102** that may be created by rotating the support arms **138**, **166** at variable angular velocities. In particular, the first speed profile **184** represents a constant first web material speed S_1 versus time, and the second speed profile **186** represents a varying second web material speed S_2 versus time. As shown in FIG. 3B, the second speed profile **186** is defined by a second web material speed S_2 that varies between a maximum second web material speed, Smax, and a minimum second web material speed, Smin. And the second web material speed is maintained at or dwells at a constant minimum speed Smin for a period of time between t1 and t2. In some configurations, the minimum second web material speed, Smin, may be a value greater than zero wherein the web material may be slowed for a period of time. In other configurations, the minimum second web material speed, Smin, may be zero wherein the web material may be stopped for a period of time. As such, the processing station **108** may be synchronized to perform an operation when the web material **102** is at the minimum web material speed, Smin, wherein the web material is slowed or stopped for a period of time. It should also be appreciated that in some embodiments, the processing station may be configured to perform an operation when the web material **102** is at the maximum second web material speed, Smax.

[0054] Although the above discussion relating to second web material speed profiles provides examples wherein the web material may be slowed, stopped, and/or sped up, it is to be appreciated that the web material guides may be configured to operate such that the web material temporarily moves backwards or upstream of the machine direction MD (S_{min} is less than zero). For example, the web material guides **110**, **112** may be configured to operate to slow and stop the web material **102** advancing from the first web material guide **110** to the second web material guide **112**, and temporarily reverse direction. As such, the web material **102** temporarily advances from the second web material guide **112** to the first web material guide **110**.

[0055] It is to be appreciated that the first and second web material guides **110**, **112** can be configured in different ways while still providing desired speed profiles as discussed above. For example, FIG. **4** shows a second embodiment of the apparatus **100** for varying the speed of an advancing web material **102** including a first surface **104** and an oppositely disposed second surface **106**. The apparatus shown in FIG. **4** includes a first web material guide **110** and a second web material guide **112**. The web material advances in the machine direction (MD) at a first speed S_1 and enters the first web material guide **110**. The web material **102** travels from the first web material guide **110** at a second speed S_2 through the processing station **108**. From the processing station **108**, the web material enters the second web material guide **112**. The web material **102** then exits the second web material guide **112** at the first speed S_1. As discussed above with the apparatus of FIG. **1**, the first web material guide **110** and second web material guide **112** operate to change the lengths of the web material within the respective web material guides, and thus, vary the second speed S_2 of the web material traveling from the upstream, first web material guide **110** to the downstream, second web material guide **112**. At the same time, the speed of the web material **102** entering the first web material guide **110** and exiting the second web material guide **112** is maintained at a constant first speed S_1.

[0056] Unlike the apparatus of FIG. **1**, the first and second web material guides **110**, **112** shown in FIG. **4** touch both the first and second surfaces **104**, **106** of the web material **102**. As shown in FIG. **4**, the first web material guide **110** includes a first guide member **120** in the form of a first roller **122**, a second guide member **124** in the form of a second roller **126**, and a third guide member **128** in the form of a third roller **130**. As described below, the web material **102** travels in the machine direction (MD) at the first speed S_1 to the first roller **122**; from the first roller **122** to the second roller **124**; from the second roller **124** to the third roller **126**; and from the third roller **126** to the processing station **108** and/or the second web material guide **112** at the second speed S_2. As shown in FIG. **4**, the first roller **122** defines an outer radial surface **132** and rotates around a first center axis **134**. The second roller **126** defines an outer radial surface **136** and is rotatably connected with a support member **138** at a second roller axis **140**. The support member **138** is adapted to rotate around a second center axis **142**. As such, the second roller **126** orbits around the second center axis **142** as the support member rotates. The third roller **130** defines an outer radial surface **144** and rotates around a third center axis **146**. As the web material **102** advances through the first web material guide **110**, the first surface **104** of the web material engages the outer radial surfaces **132**, **144** of the first and third rollers **122**, **130**, and the second surface **106** of the web material **102** engages the outer radial surface **136** of the second roller **126**.

[0057] Similar to the first web material guide **110**, the second web material guide **112** includes a first guide member **148** in the form of a first roller **150**, a second guide member **152** in the form of a second roller **154**, and a third guide member **156** in the form of a third roller **158**. As described below, the web material **102** travels in the machine direction (MD) at the second speed S_2 (from the first web material guide **110** and/or processing station **108**) to the first roller **150**; from the first roller **150** to the second roller **154**; from the second roller **154** to the third roller **158**; and from the third roller **158** to continue downstream at the first speed S_1. As shown in FIG. **4**, the first roller **150** defines an outer radial surface **160** and rotates around a first center axis **162**. The second roller **154** defines an outer radial surface **164** and is rotatably connected with a support member **166** at a second roller axis **168**. The support member **166** is adapted to rotate around a second center axis **170**. As such, the second roller **154** orbits around the second center axis **170** as the support member **166** rotates. The third roller **158** defines an outer radial surface **172** and rotates around a third center axis **174**. As the web material **102** advances through the second web material guide **112**, the first surface **104** of the web material **102** engages the outer radial surfaces **160**, **172** of the first and third rollers **150**, **158**, and the second surface **106** of the web material **102** engages the outer radial surface **164** of the second roller **154**.

[0058] It is to be appreciated that the guide members **120**, **124**, **128**, **148**, **152**, **156** of FIG. **4** can also be configured in other ways as discussed above. In addition, some or all the rollers can be driven rollers, idler rollers, and/or combinations of each, and the support members **138**, **166** can be rotated at constant or variable speeds and can be configured in various ways as discussed above.

[0059] As discussed above, the first web material guide **110** and the second web material guide **112** shown in FIG. **4** utilize orbital motion of guide members **124**, **152** to change the length of the web material **102** within the web material guides. In particular, rotation of the support members **138**, **166** causes the second rollers **124**, **152** to orbit around the second center axes **142**, **170**. In turn, the orbital motions of the second rollers **124**, **152** in the first and second web material guides **110**, **112** result in changes of the lengths of web material within the web material guides. As such, the coordinated rotation of the support members **138**, **166** of the first and second web material guides result in localized speed changes of the web material passing through the processing station **108** (i.e. variable second speed S_2) while maintaining a constant first speed S_1.

[0060] In each web material guide **110**, **112**, the geometrical arrangement of the guide members relative to each other within each web material guide may be used to configure to the desired drive profile of the web material guide. For example, FIG. **5**A illustrates an example of the first web material guide **110** such as shown in FIG. **4** labeled to show the relative positions of the guide members **120**, **124**, **128**. The orbital path **176** of the second guide member **124** as the support member **138** rotates around the second center axis **142** is represented by a dashed circle. FIG. **5**B shows an example of triangle formed by drawing lines between the first center axis **134**, the second center axis **142**, and the third center axis **146** shown in FIG. **5**A. In FIG. **5**A, the first roller **122**, the second roller **126**, and third roller **130** each define equal radii represented as R1. R2 is the distance between the second center axis **142** and the second roller axis **140**, and angle, θ, represents the angular position of the second roller axis **140** as the second roller **126** orbits around the second center axis **142**. With reference to the equations below, dimension, A, is the distance between the first center axis **134** and the second roller axis **140**, and dimension, B, is the distance between the second roller axis **140** and the third center axis **146**. With reference to FIG. **5**B, the distance between the second center axis **142** and first center axis **134** is distance, D, and the distance between the second center axis **142** and the third center axis **146** is also distance, D. With reference to FIGS. **5**A and **5**B, the distance between the first center axis **134** and the third center axis **146** is 2 times D1, and the distance from the second center axis **142** and a line extending between the first and third center axes **134**, **146** is D2. It is to be appreciated that in some embodiments, D1 can be the same as or can be a different length than D2. In light of the above discussion, the length of web material, L_{Web1}, in the first web material guide can be calculated as:

$$L_{Web1}=L_1+L_2 \text{ where:} \quad \text{Equation 4}$$

$$A=\sqrt{(D_1+R_2\cos(\theta))^2+(D_2-R_2\sin(\theta))^2} \quad \text{Equation 5}$$

$$L_1=2R_1[(\pi/2)-\arccos(2R_1/A)+\arcsin((D_2-R_2\sin\theta)/A)]+\sqrt{A^2-4R_1^2} \quad \text{Equation 6}$$

$$B=\sqrt{(D_1-R_2\cos(\theta))^2+(D_2-R_2\sin(\theta))^2} \text{ and} \quad \text{Equation 7}$$

$$L_2=2R_1[(\pi/2)-\arccos(2R_1/B)+\arcsin((D_2-R_2\sin\theta)/B)]+\sqrt{B^2-4R_1^2} \quad \text{Equation 8}$$

[0061] With reference to FIGS. **4** and **5**A, as the support arm **138** in the first web material guide **110** rotates around the second center axis **142** (i.e. as θ changes) the length of web material **102** in the first web material guide **110**, L_{Web1}, will vary between a maximum value, $L_{Web1\text{-}Max}$, and a minimum value, $L_{Web1\text{-}Min}$. In turn, the variance of the length, L_{Web1}, causes the second speed S_2 of the web material **102** to change. As such, a specific profile for the second speed S_2 of the web material can be created by varying θ in the above equations 4-8.

[0062] Although FIGS. **5**A and **5**B and the associated equations 4-8 are described with reference to the first web material guide, it is to be appreciated that the figures and equations can also be applied to calculate the length of web material, L_{Web2}, in the second web material guide. For example, similar to FIGS. **5**A and **5**B, FIGS. **5**C and **5**D show the relative positions of various components in the second web material guide **112**. In particular, FIG. **5**C illustrates an example of the second web material guide **112** such as shown in FIG. **4** labeled to show the relative positions of the guide members **148**, **152**, **156**. The orbital path **178** of the second guide member **148** as the support member **166** rotates around the second center axis **170** is represented by a dashed circle. FIG. **5**D shows an example of a triangle formed by drawing lines between the first center axis **162**, the second center axis **170**, and the third center axis **174** shown in FIG. **5**C. Applying the same analysis above to FIGS. **5**C and **5**D, the length of web material, L_{Web2}, in the second web material guide **112** can be calculated using Equations 4-8, wherein:

$$L_{Web2}=L_1+L_2$$

[0063] Thus, as the support arm **166** in the second web material guide **112** rotates around the second center axis **170** (i.e. as θ changes) the length of web material **102** in the second web material guide, L_{Web2}, will vary from a maximum value, $L_{Web2\text{-}Max}$, and a minimum value, $L_{Web2\text{-}Min}$. In turn, the variance of length, L_{Web2}, can be configured to be the opposite of the variance of the length, L_{Web1}, so as to reduce strain and slack in the web material **102** as the web material travels from the first web material guide **110** to the second web material guide **112**. In other words, the first and second web material guides can be configured to provide a matched web material flow, wherein L_{Web1} increases at substantially the same rate as L_{Web2} decreases, and wherein L_{Web1} decreases at substantially the same rate as L_{Web2} increases. As discussed above, a matched web material flow can be achieved by defining certain geometric relationships of the guide members and support members in the first web material guide **110** and the second web material guide **112**. For example, a matched web material flow can be achieved by configuring the distances D1 and D2 (discussed above with reference to FIGS. **5**A-**5**D) to be equal or substantially equal to each other in the first web material guide **110** and in the second web material guide **112**, as well as having distances D1 and D2 in the first web material guide **110** equal or substantially equal to distances D1 and D2 in the second web material guide **112**.

[0064] Referring again to FIG. **1**, as noted above, any or all of the guide members **120**, **124**, **128**, **148**, **152** and **156** may be configured as rollers, stationary pins, rods or bars of any shape, endless belts, spheres and/or combinations thereof. In order minimize friction in the system so as to regulate and/or promote uniform distribution of machine and cross direction tensile force in the web material **102** as it travels through the mechanism, it may be desired in some circumstances that some or all of the guide members be rollers or have rolling elements.

[0065] To reduce the chances that such rollers introduce friction drag against advancement of the web material, any of such rollers may be controllably driven via, e.g., a system of one or more servo motors, such that their angular velocity corresponds to the desired linear speed of the web material as it moves over the rollers, and there is no relative movement between the rollers and the web material that is a source machine direction frictional forces. However, it may be appreciated that such a system for driving the rollers adds cost, complexity, mass and rotating inertia to the system, and may also create constraints on movement and space within the system. The addition of mass may be particularly undesirable with respect to guide members **124** and **152**, since mass may become a limiting factor with respect to the angular velocity and angular acceleration/deceleration of support members **138**, **166**, and thus, a limiting factor on the machine direction speed at which the web material is conveyed through the system.

[0066] In another alternative, some or all of guide members **120**, **124**, **128**, **148**, **152** and **156** may be configured as idler rollers. In any case it may be desirable that such idler rollers ride on relatively low friction bearings or low friction surfaces, so as to create as little frictional resistance to machine direction velocity, acceleration or deceleration of the web as possible. Further, as will be appreciated from the description above, by coordinated rotation of support members **138** and **166**, the system as described can enable rapid acceleration and deceleration of the web material as it travels along its machine direction path from guide member **120** to guide member **156**. Thus, the system may cause speed S_2 to vary rapidly between a minimum and a maximum. In order to minimize the potential effects of friction, inertia and momentum to enable relatively high overall machine direction speed of the web material, it may be desired that guide members **124**, **128**, **148** and **152** be idler rollers engineered to have relatively low mass, and ride on relatively low friction bearings or low friction surfaces. Referring to FIG. **6**A for example, in one approach, any or all of guide members/rollers **148/150**, **152/154**, and **156/158** may include low-mass cylindrical roller sleeves that ride respectively on axles **149**, **153**, **157** with close tolerances therebetween. Any or all of axles **149**, **153** or **157** may be provided with an air bearing system (not shown), in which the axle is provided with an air inlet, central air passageway, and connecting air ports (not shown) exiting at its outer cylindrical surface (not shown). A source of compressed air is connected to the air inlet, such that compressed air exits the ports and provides a low-friction air bearing within the space between the roller sleeve and axle, about which the roller sleeve rotates. It will be appreciated, however, that such an air bearing system, like a driven roller system, adds cost and complexity, may add constraints on space and movement, and may also add mass which may be an undesirable speed limiting factor for guide **152**.

[0067] In still another approach, referring to FIGS. **1** and **6**B, guide members **124**, **152** may be configured to be fixed and stationary with respect to, respectively, support members **138**, **166**. In such a configuration, guide members **124**, **152** will move integrally with support members **138**, **166**. This configuration may provide advantages of eliminating complexity and moving parts, and thus, reducing costs of building and operating the system. This configuration may provide the further advantage of enabling a reduction of mass, and therefore, of associated inertia and momentum, of the guide members **138**, **166**, and thus, reduction the inertia and momentum associated with the rotation and operation of support members **138**, **166**. This may reduce the constraints on speed of operation/rotation of support members **138**, **166** resulting from inertia and momentum, and thus enable faster operation of the system, i.e., greater overall machine-direction speed of the web material through the system. As noted, guide members **124**, **152** may be configured as bars or rods, which may be cylindrical or elliptical in shape with axes parallel with the cross direction.

[0068] Other guide members in the system, such as guide members **120**, **128**, **148** and **156** may also be non-rotating, i.e., fixed with respect to the equipment to which they are mounted, thereby providing advantages described above.

[0069] It will be appreciated, however, that if any of guide members **120**, **124**, **128**, **148**, **152** and **156** are fixed members such as bars or rods, the web material **102** will be engaged in machine-direction sliding contact therewith. Comparing FIG. **1** with FIG. **6**B, it can be appreciated that such sliding contact will shift and rotate about the guide members **124**, **152** as support members **138**, **166** rotate, while such sliding contact will remain in a substantially consistent location on stationary guide members. Sliding contact between any particular web material **102** and the material forming the contact surface of a fixed guide member will have a coefficient of friction (CoF), that relates to the amount of friction drag resulting from the sliding contact. Additionally, web materials may have abrasive attributes. For example, some web materials may include quantities of materials such as calcium carbonate or titanium dioxide added to the resins used to form the web materials, for example, for opacifying, coloring, pore-forming, or other purposes. Such added materials may be abrasive.

[0070] Thus, it may be desired that the contact surfaces of such fixed guide members be formed of or coated with a relatively low friction material, so that such sliding contact does not result in an unacceptable level of friction drag on the web material **102**, tending to result in an unacceptable distribution of machine-direction tension in the web material, or create another unacceptable constraint upon machine-direction speed of the web material, or generate an unacceptable level of heat at the contact surfaces. It may also be desired that the contact surfaces be formed of relatively hard, durable and/or long-wearing material exhibiting low coefficients of friction with the polymers typically used to manufacture fiber constituents of nonwovens for disposable absorbent articles, which may include, but are not limited to, polyolefins, polypropylene, polyethylene, polyester (e.g., polyethylene terephthalate), polyether, polyamide, polyesteramide, polyvinylalcohol, polyhydroxyalkanoate, polysaccharide and combinations thereof.

[0071] Referring to the example depicted in FIG. **6**B, it can be appreciated that friction drag forces F_1, F_2 and F_3 will be functions of the CoFs at the contact surfaces of the guide members, the areas of the contact surfaces, and the distributed normal forces N_1, N_2 and N_3 exerted by the web material **102** against the contact surfaces. The distributed normal forces will be functions of the machine-direction tension T in the web material. Thus, reducing the CoFs of the contact surfaces will be effective to reduce the friction drag forces F_1, F_2 and F_3.

[0072] One approach has been, and may be, to form fixed guide members of a relatively hard material such as stainless steel, which has been highly polished to minimize the CoF. However, stainless steel is a relatively dense material, which may impart a speed-constraining quantity of mass to moving components such as guide members **124**, **152** and support members **138**, **166**. Further, stainless steel may not enable a CoF that is sufficiently low when relatively high web material speeds are sought.

[0073] Another approach has been, and may be, to form fixed guide members of a lighter material such as aluminum or aluminum alloy, coated with a polytetrafluoroethylene (PTFE) (e.g., TEFLON) or similar material. However, PTFE may not be acceptably durable/long wearing, and also may not enable a CoF that is sufficiently low when relatively high web material speeds are sought.

[0074] A third approach may be to form fixed guide members of a lighter metal or metal structure such as a thin steel or stainless shell structure, aluminum or aluminum alloy, or other relatively light material, bearing a coating or combination or layers of coatings that include aluminum magnesium boride, or $AlMgB_{14}$ ("BAM") at the contact surface. BAM is a ceramic alloy that has been proposed for use in other contexts for a number of years. See, e.g., U.S. Pat. Pub. No. US 2003/0219605; U.S. Pat. No. 7,238,429; Higdon III, Clifton B., "Nanocoatings for High-Efficiency Industrial Hydraulic and Tooling Systems," FINAL TECHNICAL REPORT, work supported by U.S. Department of Energy, Energy Efficiency and Renewable Energy, Industrial Technologies Program, Materials for Energy Efficient Industrial Processing under Award No. DE-FG36-06GO16054 (Eaton Corporation 2010); Britson, Jason Curtis, "Pulsed Laser Deposition of $ALMgB_{14}$ Thin Films" (2008), Graduate Theses and Dissertations, Paper 10882 (http://lib.dr.iastate.edu/etd/10882), which disclose BAM and methods for coating BAM onto substrates, and which are incorporated herein by reference. CoFs and/or durability associated with BAM coating materials may be enhanced by combining or alloying them with titanium boride, or TiB_2, and so a BAM coating including $AlMgB_{14}$ and TiB_2 may be particularly advantageous. It is believed that BAM coating technology has not previously been applied in the field of web material handling, or more particularly, to devices of the types described herein, despite a long-felt and continuing need for hard, durable, low-friction surfaces that create possibilities for elimination of various types of bearings and moving parts, elimination of mass from components, and/or longer wearing components and potential reduction of frequency and/or length of manufacturing line shutdowns.

[0075] In yet another approach, a BAM coating as described above might be applied to bearing surfaces of a fixed axle such as that depicted in FIG. 6A (axles **149**, **153**, **157**), so as to provide a low friction bearing that reduces friction between the axle and an outer, rotating roller sleeve.

[0076] It will also be appreciated that a BAM coating as described above might be applied to the contact surface of any other component in a manufacturing line that engages in sliding contact with the web material as it is conveyed along the machine direction through the line. Any component that contacts the web material for purposes or functions of guiding the material, altering its path direction, or performing other actions affecting the speed and path direction of the web material through the line as various operations are performed, might be improved in wear resistance/durability and have its friction drag effects reduced, by imparting the contact surfaces thereof with a BAM coating. Such components might include idler rollers, stationary rollers or rolls, guides, tables, chutes or other structures over which the web material rides along its machine direction path. Any rotating roller that contacts a material web for purposes of guiding it or altering its path, and where low friction is desired, might be improved by having its contact surfaces coated with BAM. Alternatively, any such rotating roller might be replaced by a fixed component with a BAM-coated sliding contact surface. Particular non-limiting examples may include the strip guide disclosed in U.S. Pat. No. 8,171,972; the guide members disclosed in U.S. Pat. App. Pub. No. 2010/0252603; and the rollers of the strain regulation system disclosed in U.S. Pat. App. Ser. No. 61/666,087, and the rollers and guiding members of the system disclosed in U.S. Pat. App. Ser. No. 61/665,930. It will be appreciated, from these patent applications, that a BAM coating might serve as a bearing or low-friction coating for an axle about which a rotating member turns. The rotating member might also have its bore, sleeve or inner surfaces that contact the axle coated with BAM.

[0077] It will be appreciated from the description above that BAM coating technology and BAM coatings may be used in a material web handling system at any bearing location, and on any component that engages in moving contact including moving contact with the material web, in a way that may reduce the complexity of the equipment, reduce friction generated by sliding contact, reduce mass and enable increased speed of operation of the equipment and associated machine-direction speed of the material web, reduce power consumption, increase wear resistance and durability and reduce the need for shutdowns and equipment maintenance and repairs.

[0078] As previously mentioned, the apparatuses and methods herein may be used to provide for localized speed changes of web materials and components during the manufacture of various different products. For the purposes of a specific illustration, FIG. **7** shows one example of a disposable absorbent article **250**, such as described in U.S. Patent Publication No. US2008/0132865 A1, in the form of a diaper **252** that may be constructed from such web materials and components manipulated during manufacture according to the apparatuses and methods disclosed herein. In particular, FIG. **7** is a plan view of one embodiment of a diaper **252** including a chassis **254** shown in a flat, unfolded condition, with the portion of the diaper **252** that faces a wearer oriented towards the viewer. A portion of the chassis structure is cut-away in FIG. **7** to more clearly show the construction of and various features that may be included in embodiments of the diaper.

[0079] As shown in FIG. **7**, the diaper **252** includes a chassis **254** having a first ear **256**, a second ear **258**, a third ear **260**, and a fourth ear **262**. To provide a frame of reference for the present discussion, the chassis is shown with a longitudinal axis **264** and a lateral axis **266**. The chassis **254** is shown as having a first waist region **268**, a second waist region **270**, and a crotch region **272** disposed intermediate the first and second waist regions. The periphery of the diaper is defined by a pair of longitudinally extending side edges **274**, **276**; a first outer edge **278** extending laterally adjacent the first waist region **268**; and a second outer edge **280** extending laterally adjacent the second waist region **270**. As shown in FIG. **7**, the chassis **254** includes an inner, body-facing surface **282**, and an outer, garment-facing surface **284**. A portion of the chassis structure is cut-away in FIG. **7** to more clearly show the construction of and various features that may be included in the diaper. As shown in FIG. **7**, the chassis **254** of the diaper **252** may include an outer covering layer **286** including a topsheet **288** and a backsheet **290**. An absorbent core **292** may be disposed between a portion of the topsheet **288** and the backsheet **290**. As discussed in more detail below, any one or more of the regions may be stretchable and may include an elastomeric material or laminate as described herein. As such, the diaper **252** may be configured to adapt to a specific wearer's anatomy upon application and to maintain coordination with the wearer's anatomy during wear.

[0080] The absorbent article may also include an elastic waist feature **202** shown in FIG. **7** in the form of a waist band **294** and may provide improved fit and waste containment.

The elastic waist feature **202** may be configured to elastically expand and contract to dynamically fit the wearer's waist. The elastic waist feature **202** can be incorporated into the diaper in accordance with the methods discussed herein and may extend at least longitudinally outwardly from the absorbent core **292** and generally form at least a portion of the first and/or second outer edges **278**, **280** of the diaper **252**. In addition, the elastic waist feature may extend laterally to include the ears. While the elastic waist feature **202** or any constituent elements thereof may comprise one or more separate elements affixed to the diaper, the elastic waist feature may be constructed as an extension of other elements of the diaper, such as the backsheet **290**, the topsheet **288**, or both the backsheet and the topsheet. In addition, the elastic waist feature **202** may be disposed on the outer, garment-facing surface **284** of the chassis **240**; the inner, body-facing surface **282**; or between the inner and outer facing surfaces. The elastic waist feature **202** may be constructed in a number of different configurations including those described in U.S. patent application Ser. No. 11/303,686, filed on Dec. 16, 2005; U.S. patent application Ser. No. 11/303,306, filed on Dec. 16, 2005; and U.S. patent application Ser. No. 11/599,862, filed on Nov. 15, 2006; all of which are hereby incorporated by reference herein.

[0081] As shown in FIG. **7**, the diaper **252** may include leg cuffs **296** that may provide improved containment of liquids and other body exudates. In particular, elastic gasketing leg cuffs can provide a sealing effect around the wearer's thighs to prevent leakage. It is to be appreciated that when the diaper is worn, the leg cuffs may be placed in contact with the wearer's thighs, and the extent of that contact and contact pressure may be determined in part by the orientation of diaper on the body of the wearer. The leg cuffs **296** may be disposed in various ways on the diaper **202**.

[0082] The diaper **252** may be provided in the form of a pant-type diaper or may alternatively be provided with a re-closable fastening system, which may include fastener elements in various locations to help secure the diaper in position on the wearer. For example, fastener elements may be located on the first and second ears and may be adapted to releasably connect with one or more corresponding fastening elements located in the second waist region. It is to be appreciated that various types of fastening elements may be used with the diaper.

[0083] The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as "40 mm" is intended to mean "about 40 mm."

[0084] Every document cited herein, including any cross referenced or related patent or application, is hereby incorporated herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

[0085] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

We claim:

1. A low-maintenance system for producing articles formed at least in part of web material components, comprising:

- a continuous supply of a web material having a cross-direction width;
- a conveyor system operable to move the web material through the system along a machine direction;
- a first component having a first contact surface with which the web material engages in sliding contact as it travels along the machine direction, wherein the first component via the sliding contact supports the web material, guides the web material, or alters the path of the web material, the first contact surface comprising aluminum magnesium boride.

2. The system of claim **1** wherein the web material is a woven or knitted web, nonwoven web, or a polymeric film.

3. The system of claim **1** wherein the first component is disposed on a second component comprised by the system and the second component moves to effect alteration of the path of the web material.

4. The system of claim **3** wherein the first component is a cylindrical roll and the first contact surface is a cylindrical surface of the roll.

5. The system of claim wherein the second component rotates about an axis and thereby causes the first component to move along a circular path or arc about the axis.

6. The system of claim **5** wherein the movement of the first component along the circular path or arc effects the alteration of the path of the web material.

7. The system of claim **1** wherein the first component is stationary.

8. The system of claim **1** wherein the first contact surface has a profile that is uniform across at least the cross-direction width of the web material.

9. The system of claim **8** wherein the profile is planar.

10. The system of claim **8** wherein the profile is curved along the machine direction.

11. The system of claim **8** wherein the profile is at least partially cylindrical and has a uniform radius across at least the cross-direction width of the web material.

12. The system of claim **1** comprising a second component disposed opposite the first component with respect to the material web, the web material passing between the first component and the second component, the second component having a second contact surface with which the web material engages in sliding contact as it travels along the machine direction, wherein the second component via the sliding contact supports the web material, guides the web material, alters the path of the web material, or reduces or increases the machine direction speed of the web material, the second contact surface comprising aluminum magnesium boride.

13. The system of claim **1** wherein the contact surface, first contact surface or second contact comprises a combination of aluminum magnesium boride and titanium boride.

14. The system of claim **1** wherein the first component is formed of aluminum or aluminum alloy which comprises a coating of aluminum magnesium boride which forms the contact surface.

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