(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 June 2017 (15.06.2017)

(10) International Publication Number
WO 2017/100490 A1

(51) International Patent Classification:
*A61F 13/15* (2006.01) *B29C 65/00* (2006.01)

(21) International Application Number:
PCT/US2016/065693

(22) International Filing Date:
9 December 2016 (09.12.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/265,445 10 December 2015 (10.12.2015) US
62/300,115 26 February 2016 (26.02.2016) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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# (54) Title: APPARATUSES AND METHODS FOR TRANSFERRING AND BONDING SUBSTRATES

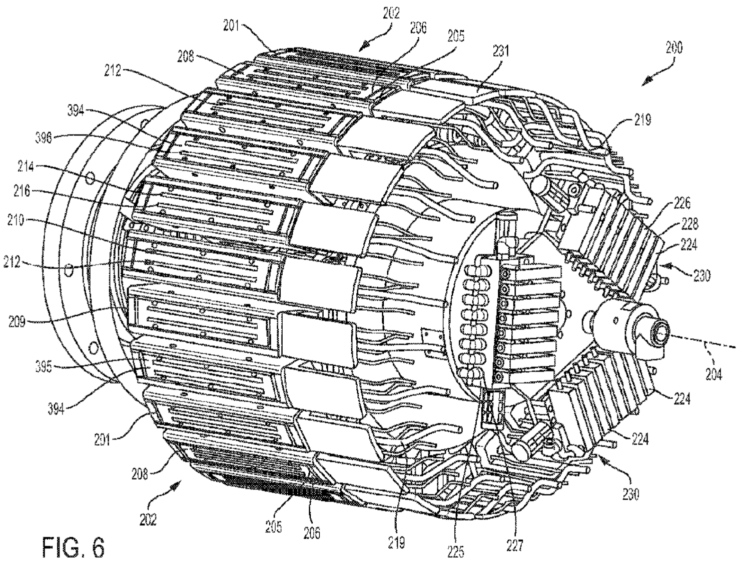



FIG. 6

**(57) Abstract**: A method and apparatus for mechanically deforming a substrate assembly. The substrate assembly may advance toward a bonder apparatus. The bonder apparatus may rotate about an axis of rotation and is configured to radially traverse based on the process product pitch of the substrate assembly. The bonder apparatus may include a plurality of manifolds positioned about the axis of rotation. The substrate assembly may be advanced onto the bonder apparatus such that the substrate assembly is disposed on the plurality of manifolds. The manifolds may heat fluid and release the same onto the trailing edge portion and the leading edge portion of the substrate assembly. The heated portion of the substrate assembly may then be bonded forming a seam.

WO 2017/100490 A1

**Published**:

— *with international search report (Art. 21(3))*

# APPARATUSES AND METHODS FOR TRANSFERRING AND BONDING SUBSTRATES

## TECHNICAL FIELD

The present disclosure relates to methods for manufacturing absorbent articles, and more particularly, to apparatuses and methods for bonding two or more partially meltable materials.

## BACKGROUND

Disposable absorbent articles, in particular, disposable diapers, are designed to be worn by people experiencing incontinence, including infants and invalids. Such diapers are worn about the lower torso of the wearer and are intended to absorb and contain urine and other bodily discharges, thus preventing the soiling, wetting, or similar contamination of articles that may come into contact with a diaper during use (e.g., clothing, bedding, other people, etc.). Disposable diapers are available in the form of pull-on diapers, also referred to as training pants, having fixed sides, or taped diapers having unfixed sides.

Along an assembly line, various types of articles, such as diapers and other absorbent articles, may be assembled by adding components to and/or otherwise modifying an advancing, continuous web of material. In some processes, advancing webs of material are combined with other advancing webs of material. In other processes, individual components created from advancing webs of material are combined with advancing webs of material, which in turn, are then combined with other advancing webs of material. In some cases, individual components created from advancing web or webs are combined with other individual components created from other advancing web or webs. Webs of material and component parts used to manufacture diapers may include: backsheets, topsheets, leg cuffs, waist bands, absorbent core components, front and/or back ears, fastening components, and various types of elastic webs and components such as leg elastics, barrier leg cuff elastics, stretch side panels, and waist elastics. Once the desired component parts are assembled, the advancing web(s) and component parts are subjected to a final knife cut to separate the web(s) into discrete diapers or other absorbent articles.

In some converting configurations, discrete chassis spaced apart from each other are advanced in a machine direction and are arranged with a longitudinal axis parallel with the cross direction. Opposing waist regions of discrete chassis are then connected with continuous lengths of elastically extendable front and back belt webs advancing in the machine direction. While connected with the chassis, the front and back belt webs are maintained in a fully stretched condition along the machine direction, forming a continuous length of absorbent articles. The continuous length of absorbent articles may then be folded in a cross direction. During the folding process in some converting configurations, one of the front and back belt webs is folded into a facing relationship with the opposing belt. The front and back belts may then be bonded together to create the side seams on diapers.

Absorbent articles, such as diapers which may be worn by infants and adults, come in a variety of sizes. Thus, one absorbent article may include a larger chassis and a larger belt as compared to another absorbent article which may include a smaller chassis and a smaller belt. The manufacturing process for these absorbent articles is desired to be such that the absorbent article including the larger chassis and the larger belt can be manufactured on the same equipment or similar equipment as the absorbent article including the smaller chassis and the smaller belt. Having to switch out equipment or to make large modifications to the equipment for manufacturing different sized articles is costly and time consuming for manufacturers.

Thus, it would be beneficial to provide an apparatus and a method for transferring and bonding absorbent articles of different sizes.

## SUMMARY

Aspects of the present disclosure involve apparatuses and methods for manufacturing absorbent articles, and more particularly, methods for mechanically deforming substrates during the manufacture of disposable absorbent articles. Particular embodiments of methods of manufacture disclosed herein provide for forming side seams in various types of diaper configurations. It is to be appreciated that the methods and apparatuses disclosed herein can also be applied to other mechanical deformation used on diapers as well as other types of absorbent articles.

In one embodiment, an apparatus for bonding one or more substrates includes a plurality of manifolds disposed about a central longitudinal axis and configured to rotate about the central longitudinal axis. Each of the plurality of manifolds includes a first end portion and a second end portion opposite the first end portion. Further, each of the plurality of manifolds may include a nozzle plate including a first surface, a second surface opposite the first surface, and a plurality of apertures extending from the first surface to the second surface. The first surface of the nozzle plate may be positioned adjacent to the internal surface of the support plate. Each manifold may also include a fluid chamber adjacent the second surface of the nozzle plate and configured to supply a fluid to the plurality of apertures. The fluid chamber includes a first fluid inlet, a first fluid outlet, and a first fluid pathway between the first fluid inlet and the first fluid outlet. The first fluid outlet may be fluidly connected to the plurality of apertures of the nozzle plate. The bonder apparatus may also include a plurality of heat members adjacent the plurality of manifolds and configured to rotate about the central longitudinal axis. The heat member may be configured to heat the fluid. A plurality of valves may be fluidly connected to each fluid inlet. Each of the plurality of valves may be configured to be in a first open position such that the fluid enters through the fluid inlet or a

second closed position such that the fluid is prevented from entering the fluid inlet. The fluid may enter the fluid inlet at a first entrance temperature and the fluid may exit the fluid outlet at a first exit temperature. The first entrance temperature may be less than or equal to the first exit temperature. Further, the bonder apparatus may be configured to move from an initial radius to a second radius.

In another embodiment, a method for forming a bond may include the steps of: rotating a bonder apparatus about an axis of rotation, wherein the bonder apparatus comprises a plurality of manifolds disposed about a central longitudinal axis; advancing a first substrate assembly in a machine direction, wherein the first substrate assembly comprises a first process product pitch, wherein the first product pitch is defined by a first leading portion and a first trailing portion, and a first central portion between the first leading portion and the first trailing portion, and wherein the first substrate assembly comprises a first surface and a second surface opposite the first surface; radially expanding the bonder apparatus from an initial radius to a second radius, wherein the second radius is greater than the initial radius; advancing the first substrate assembly onto the bonder apparatus such that the first surface of the first substrate assembly is in facing relationship with the plurality of manifolds; receiving the first leading portion of the first substrate assembly on a first manifold of the plurality of manifolds; receiving the first trailing portion of the first substrate assembly on a second manifold of the plurality of manifolds, wherein the first manifold and the second manifold are separated by a product arc length, wherein the first central portion of the first substrate assembly is disposed on one or more manifolds between the first manifold and the second manifold; passing a fluid to the first manifold and the second manifold, wherein the fluid is at a first temperature; heating the fluid to a second temperature within each of the first manifold and the second manifold to form a heated fluid; releasing the heated fluid through a first plurality of apertures of the first manifold such that the heated fluid engages the first leading portion; releasing the heated fluid through a second plurality of apertures of the second manifold such that the heated fluid engages the first trailing portion; and bonding at least a portion of the first leading portion and the first trailing portion of the first substrate assembly.

In another embodiment, a method for forming a bond may include the steps of: rotating a bonder apparatus about an axis of rotation, wherein the bonder apparatus comprises a plurality of manifolds disposed about a central longitudinal axis; advancing a first substrate assembly in a machine direction, wherein the first substrate assembly comprises a first process product pitch, wherein the first product pitch is defined by a first leading portion and a first trailing portion, and a first central portion between the first leading portion and the first trailing portion, and wherein the first substrate assembly comprises a first surface and a second surface opposite the first surface; radially traversing the bonder apparatus; advancing the first substrate assembly onto the bonder apparatus such that the first surface of the first substrate assembly is in facing relationship with the plurality of manifolds; receiving the first leading portion of the first substrate assembly on a first manifold of the plurality of manifolds; receiving the first trailing portion of the first substrate assembly on a second manifold of the plurality of manifolds, wherein the first manifold and the second manifold are separated by a product arc length, wherein the first central portion of the first substrate assembly is disposed on one or more manifolds between the first manifold and the second manifold; passing a fluid to the first manifold and the second manifold, wherein the fluid is at a first temperature; heating the fluid to a second temperature within each of the first manifold and the second manifold to form a heated fluid; releasing the heated fluid through a first plurality of apertures of the first manifold such that the heated fluid engages the first leading portion; releasing the heated fluid through a second plurality of apertures of the second manifold such that the heated fluid engages the first trailing portion; and bonding at least a portion of the first leading portion and the first trailing portion of the first substrate assembly.

These and additional features provided by the embodiments described herein will be more fully understood in view of the following detailed description, in conjunction with the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments set forth in the drawings are illustrative and exemplary in nature and not intended to limit the subject matter defined by the claims. The following detailed description of the illustrative embodiments can be understood when read in conjunction with the following drawings, where like structure is indicated with like reference numerals and in which:

Figure 1 is a perspective view of a diaper pant;

Figure 2 is a partially cut away plan view of the diaper pant shown in Figure 1;

Figure 3A is a cross-sectional view of the diaper pant of Figure 2 taken along line 3A-3A of Figure 2;

Figure 3B is a cross-sectional view of the diaper pant of Figure 2 taken along line 3B-3B of Figure 2;

Figure 4 is a schematic representation of a converting apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 5A is a top view of a chassis assembly taken along line 5A-5A of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5B1 is a top view of a discrete chassis taken along line 5B1-5B1 of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5B2 is a top view of a discrete chassis taken along line 5B2-5B2 of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5C is a top view of elastic belt substrates taken along line 5C-5C of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5D is a top view of multiple discrete chassis attached to a first elastic belt substrate and a second elastic belt substrate taken along line 5D-5D of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5E is a top view of multiple discrete chassis attached to a substrate assembly taken along line 5E-5E of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 5F is a top view of two discrete absorbent articles taken along line 5F-5F of Figure 4 in accordance with one non-limiting embodiment of the present disclosure;

Figure 6 is a perspective view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 6A is a partial, perspective view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 7A is a side view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 7B is a perspective view of a plurality of valves attached to a fluid block in accordance with one non-limiting embodiment of the present disclosure;

Figure 7C is a perspective view of a support bracket in accordance with one non-limiting embodiment of the present disclosure;

Figure 8 is a partial, perspective view of a portion of the bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 8A is a top view of a manifold in accordance with one non-limiting embodiment of the present disclosure;

Figure 8B is a top view of a manifold in accordance with one non-limiting embodiment of the present disclosure;

Figure 9 is a side view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 10A is a top view of multiple discrete chassis attached to a first elastic belt substrate and a second elastic belt substrate in accordance with one non-limiting embodiment of the present disclosure;

Figure 10B is a top view of multiple discrete chassis attached to a first elastic belt substrate and a second elastic belt substrate in accordance with one non-limiting embodiment of the present disclosure;

Figure 10C is a top view of a portion of multiple discrete chassis attached to a first elastic belt substrate and a second elastic belt substrate disposed on a portion of the bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 10D is a top view of a portion of multiple discrete chassis attached to a first elastic belt substrate and a second elastic belt substrate disposed on a portion of the bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 11 is a side view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 11A is a side view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 11B is a side view of a bonder apparatus in accordance with one non-limiting embodiment of the present disclosure;

Figure 12 is a perspective view of a manifold in accordance with one non-limiting embodiment of the present disclosure;

Figure 13 is a perspective view of a manifold taken along line 13-13 of Figure 12 in accordance with one non-limiting embodiment of the present disclosure;

Figure 14A is a schematic representation of the communication of a controller in accordance with one non-limiting embodiment of the present disclosure;

Figure 14B is a schematic representation of the communication of a controller in accordance with one non-limiting embodiment of the present disclosure; and

Figure 14C is a schematic representation of the communication of a controller in accordance with one non-limiting embodiment of the present disclosure.

## DETAILED DESCRIPTION

The methods and apparatuses described herein relate to transferring and bonding substrates. In general, portions of substrates may be overlapped and a jet of heated fluid is delivered from an aperture to at least partially melt the overlapping substrate portions. More particularly, the jet of heated fluid penetrates the substrate portions and at least partially melts the overlapping substrate portions where the substrate portions interface at an overlap area. The location of the substrate portions relative to the heated fluid may be controlled such that the substrate portions are held a predetermined distance away from the heating operation. Pressure may then be applied at the overlap area thereby joining the substrate portions together. In all the embodiments described herein, the fluid may include ambient air or other gases.

The term “machine direction” (MD) is used herein to refer to the direction of material flow through a process. In addition, relative placement and movement of material can be described as flowing in the machine direction through a process from upstream in the process to downstream in the process.

The term “cross direction” (CD) is used herein to refer to a direction that is generally perpendicular to the machine direction.

As used herein, the term “joining” describes a configuration whereby a first element is directly secured to another element by affixing the first element directly to the other element.

As used herein, the term “substrate” 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 substrates include a substrate, layer or layers or fibrous materials, nonwovens, films and foils such as polymeric films or metallic foils. These materials may be used alone or may comprise two or more layers laminated together. As such, a web is a substrate.

The term “elongatable,” “extensible,” or “stretchable” are used interchangeably and refer to a material that, upon application of a biasing force, can stretch to an elongated length of at least 130% of its relaxed, original length (i.e. can stretch to 30% more than its original length), without complete rupture or breakage as measured by EDANA method 20.2-89. In the event such an elongatable material recovers at least 40% of its elongation upon release of the applied force, the elongatable material will be considered to be “elastic” or “elastomeric.” For example, an elastic material that has an initial length of 100 mm can extend to 150 mm, and upon removal of the force retracts to a length of at least 130 mm (i.e., exhibiting a 40% recovery).

As used herein, the term “pull-on diaper” refers to a garment that is generally worn by infants and sufferers of incontinence, which is pulled on like pants. It should be understood, however, that the present disclosure is also applicable to other absorbent articles, such as taped diapers, incontinence briefs, feminine hygiene garments, and the like, including absorbent articles intended for use by infants, children, and adults.

As used herein, the term “at least partially melted” refers to materials at least a portion of which have reached at least a softening point temperature, but have not reached a melt point temperature. “Melted” also refers, in its ordinary sense, to materials which have exceeded their melt point temperatures over at least a portion of the material. “Meltable” refers to materials that at least soften when heated or when some other energy is applied or generated.

The present disclosure relates to methods and apparatuses for bonding substrates together. Generally, the bonder apparatus is rotated about an axis of rotation and a substrate assembly may be advanced in a machine direction and received on the bonder apparatus. The bonder apparatus may include a plurality of manifolds positioned about the axis of rotation. A fluid may be supplied to one or more manifolds such that a portion of the substrate assembly is heated and, subsequently, the one or more layers of the substrate assembly may be bonded. Further, in some embodiments, the substrate assembly may be compressed.

As discussed below, the bonder apparatus may be configured to partially melt and/or compress the substrates while traveling on the bonder apparatus. More specifically, the bonder apparatus may include a plurality of manifolds positioned about the axis of rotation. Further, as previously discussed, absorbent articles may be produced in a number of different sizes. Thus, the belt of the absorbent article may be bonded at any number of positions based on the intended size of the absorbent article. The plurality of manifolds allow for a number of different sized absorbent articles to be processed, such as by joining one or more substrates. For example, a substrate assembly having a first size is advanced onto the bonder apparatus. Based on the desired size, the substrate assembly will need to be joined at a first location and a second location. These locations coincide with certain manifolds. More specifically, the first location of the substrate assembly may be disposed on a first manifold and the second location of the substrate assembly may be disposed on the second manifold. A fluid is heated to a temperature sufficient to at least partially melt the portions of the substrate assembly corresponding to the first and second locations. As the bonder apparatus rotates, the fluid is supplied to the first manifold and the second manifold and is heated by the first and second manifold to form a heated fluid. The heated fluid is released through the apertures defined by the first and second manifolds. The potions of the substrate assembly disposed on the first and second manifolds may be partially melted. It is to be appreciated that the manifolds located between the first and second manifolds may not release heated fluid. Only those manifolds that have portions of the substrate assembly disposed thereon that are intended to be partially melted are activated by releasing fluid. It is also to be appreciated that each manifold may be individually controlled such that any combination of manifolds may be activated, release heated fluid, at any given time. The partially melted area may then be compressed, creating a discrete bond region or seam. The bonder apparatus continues to rotate and the substrate assembly may be removed from the bonder apparatus and advanced to subsequent processes. It is to be appreciated that the partially melted area may be compressed while disposed on the bonder apparatus or after being removed from the bonder apparatus.

As described in greater detail below, a seam may be formed between at least two substrate layers, each substrate layer comprising one or more meltable components. A seam may also be formed between portions of the same substrate that is, for example, folded along a fold line formed between two substrate portions. The substrate portions to be bonded may be positioned adjacent one another.

It is to be appreciated that although the transfer and bonding methods and apparatuses herein may be configured to bond various types of substrates, the methods and apparatuses herein are discussed below in the context of manufacturing absorbent articles. In particular, the methods and apparatuses are discussed in the context of bonding substrates, such as belts, together to form side seams of advancing, continuous lengths of absorbent articles during production. As discussed below, an advancing continuous length of absorbent articles may include a plurality of chassis connected with a continuous first substrate and a continuous second substrate.

Prior to the bonder apparatus, continuous first and second substrates may be separated from each other along a cross direction while advancing along a machine direction MD. Each chassis may extend in the cross direction CD and may include opposing first and second end regions separated by a central region, wherein the first end regions are connected with the first substrate and the second end regions are connected with the second substrate. The chassis may also be spaced from each other along the machine direction MD. A folding apparatus operates to fold the chassis around the folding axis along the central regions and to bring the second substrate and second end region of the chassis into a facing relationship with the first substrate and first end region of the chassis. The first substrate and the second substrate positioned in a facing relationship to form a substrate assembly. The substrate assembly and the folded chassis advance in the machine direction onto the bonder apparatus such as described above.

The methods and apparatuses discussed herein may be used to bond various types of substrate configurations, some of which may be used in the manufacture of different types of absorbent articles. To help provide additional context to the subsequent discussion of the process embodiments, the following provides a general description of absorbent articles in the form of diapers that include components that may be bonded in accordance with the methods and apparatuses disclosed herein.

Figures 1 and 2 show an example of a diaper pant 100 that may be transferred and/or bonded with the apparatuses and methods disclosed herein. In particular, Figure 1 shows a perspective view of a diaper pant 100 in a pre-fastened configuration, and Figure 2 shows a plan view of the diaper pant 100 with the portion of the diaper that faces away from a wearer oriented towards the viewer. The diaper pant 100 shown in Figures 1 and 2 includes a chassis 102 and a ring-like elastic belt 104. As discussed below in more detail, a first elastic belt 106 and a second elastic belt 108 are connected together to form the ring-like elastic belt 104.

With continued reference to Figure 2, the chassis 102 includes a first waist region 116, a second waist region 118, and a crotch region 119 disposed intermediate the first and second waist regions. The first waist region 116 may be configured as a front waist region, and the second waist region 118 may be configured as back waist region. In some embodiments, the length of each of the front waist region, back waist region, and crotch region 120 may be 1/3 of the length of the absorbent article 100. The diaper 100 may also include a laterally extending front waist edge 121 in the front waist region 116 and a longitudinally opposing and laterally extending back waist edge 122 in the back waist region 118. To provide a frame of reference for the present discussion, the diaper 100 and chassis 102 of Figure 2 is shown with a longitudinal axis 124 and a lateral axis 126. In some embodiments, the longitudinal axis 124 may extend through the front waist edge 121 and through the back waist edge 122. And the lateral axis 126 may extend through a first longitudinal or right side edge 128 and through a midpoint of a second longitudinal or left side edge 130 of the chassis 102.

As shown in Figures 1 and 2, the diaper pant 100 may include an inner, body facing surface 132, and an outer, garment facing surface 134. The chassis 102 may include a backsheet 136 and a topsheet 138. The chassis 102 may also include an absorbent assembly 140 including an absorbent core 142 that may be disposed between a portion of the topsheet 138 and the backsheet 136. As discussed in more detail below, the diaper 100 may also include other features, such as leg elastics and/or leg cuffs to enhance the fit around the legs of the wearer.

As shown in Figure 2, the periphery of the chassis 102 may be defined by the first longitudinal side edge 128, a second longitudinal side edge 130; a first laterally extending end edge 144 disposed in the first waist region 116; and a second laterally extending end edge 146 disposed in the second waist region 118. Both side edges 128 and 130 extend longitudinally between the first end edge 144 and the second end edge 146. As shown in Figure 2, the laterally extending end edges 144 and 146 are located longitudinally inward from the laterally extending front waist edge 121 in the front waist region 116 and the laterally extending back waist edge 122 in the back waist region 118. When the diaper pant 100 is worn on the lower torso of a wearer, the front waist edge 121 and the back waist edge 122 of the chassis 102 may encircle a portion of the waist of the wearer. At the same time, the chassis side edges 128 and 130 may encircle at least a portion of the legs of the wearer. And the crotch region 120 may be generally positioned between the legs of the wearer with the absorbent core 142 extending from the front waist region 116 through the crotch region 120 to the back waist region 118.

It is also to be appreciated that a portion or the whole of the diaper 100 may also be made laterally extensible. The additional extensibility may help allow the diaper 100 to conform to the body of a wearer during movement by the wearer. The additional extensibility may also help, for example, allow the user of the diaper 100 including a chassis 102 having a particular size before extension to extend the front waist region 116, the back waist region 118, or both waist regions of the diaper 100 and/or chassis 102 to provide additional body coverage for wearers of differing size, i.e., to tailor the diaper to an individual wearer. Such extension of the waist region or regions may give the absorbent article a generally hourglass shape, so long as the crotch region is extended to a relatively lesser degree than the waist region or regions, and may impart a tailored appearance to the article when it is worn.

As previously mentioned, the diaper pant 100 may include a backsheet 136. The backsheet 136 may also define the outer surface 134 of the chassis 102. The backsheet 136 may be impervious to fluids (e.g., menses, urine, and/or runny feces) and may be manufactured from a thin plastic film, although other flexible liquid impervious materials may also be used. The backsheet 136 may prevent the exudates absorbed and contained in the absorbent core from wetting articles which contact the diaper 100, such as bedsheets, pajamas, and undergarments. The backsheet 136 may also comprise a woven or nonwoven material, polymeric films such as thermoplastic films of polyethylene or polypropylene, and/or a multi-layer or composite materials comprising a film and a nonwoven material (e.g., having an inner film layer and an outer nonwoven layer). The backsheet may also comprise an elastomeric film. An example backsheet 136 may be a polyethylene film having a thickness of from about 0.012 mm (0.5 mils) to about 0.051 mm (2.0 mils). Exemplary polyethylene films are manufactured by Clopay Corporation of Cincinnati, Ohio, under the designation BR-120 and BR-121 and by Tredegar Film Products of Terre Haute, Ind., under the designation XP-39385. The backsheet 136 may also be embossed and/or matte finished to provide a more clothlike appearance. Further, the backsheet 136 may permit vapors to escape from the absorbent core (i.e., the backsheet is breathable) while still preventing exudates from passing through the backsheet 136. The size of the backsheet 136 may be dictated by the size of the absorbent core 142 and/or particular configuration or size of the diaper 100.

Also described above, the diaper pant 100 may include a topsheet 138. The topsheet 138 may also define all or part of the inner surface 132 of the chassis 102. The topsheet 138 may be compliant, soft feeling, and non-irritating to the wearer's skin. It may be elastically stretchable in one or two directions. Further, the topsheet 138 may be liquid pervious, permitting liquids (e.g., menses, urine, and/or runny feces) to penetrate through its thickness. A topsheet 138 may be manufactured from a wide range of materials such as woven and nonwoven materials; apertured or hydroformed thermoplastic films; apertured nonwovens, porous foams; reticulated foams; reticulated thermoplastic films; and thermoplastic scrims. Woven and nonwoven materials may comprise natural fibers such as wood or cotton fibers; synthetic fibers such as polyester, polypropylene, or polyethylene fibers; or combinations thereof. If the topsheet 138 includes fibers, the fibers may be spunbond, carded, wet-laid, meltblown, hydroentangled, or otherwise processed as is known in the art.

Topsheets 138 may be selected from high loft nonwoven topsheets, apertured film topsheets and apertured nonwoven topsheets. Apertured film topsheets may be pervious to bodily exudates, yet substantially non-absorbent, and have a reduced tendency to allow fluids to pass back through and rewet the wearer’s skin. Exemplary apertured films may include those described in U.S. Patent Nos. 5,628,097; 5,916,661; 6,545,197; and 6,107,539.

As mentioned above, the diaper pant 100 may also include an absorbent assembly 140 that is joined to the chassis 102. As shown in Figure 2, the absorbent assembly 140 may have a laterally extending front edge 148 in the front waist region 116 and may have a longitudinally opposing and laterally extending back edge 150 in the back waist region 118. The absorbent assembly may have a longitudinally extending right side edge 152 and may have a laterally opposing and longitudinally extending left side edge 154, both absorbent assembly side edges 152 and 154 may extend longitudinally between the front edge 148 and the back edge 150. The absorbent assembly 140 may additionally include one or more absorbent cores 142 or absorbent core layers. The absorbent core 142 may be at least partially disposed between the topsheet 138 and the backsheet 136 and may be formed in various sizes and shapes that are compatible with the diaper. Exemplary absorbent structures for use as the absorbent core of the present disclosure are described in U.S. Patent Nos. 4,610,678; 4,673,402; 4,888,231; and 4,834,735.

Some absorbent core embodiments may comprise fluid storage cores that contain reduced amounts of cellulosic airfelt material. For instance, such cores may comprise less than about 40%, 30%, 20%, 10%, 5%, or even 1% of cellulosic airfelt material. Such a core may comprises primarily absorbent gelling material in amounts of at least about 60%, 70%, 80%, 85%, 90%, 95%, or even about 100%, where the remainder of the core comprises a microfiber glue (if applicable). Such cores, microfiber glues, and absorbent gelling materials are described in U.S. Patent Nos. 5,599,335; 5,562,646; 5,669,894; and 6,790,798 as well as U.S. Patent Publication Nos. 2004/0158212 and 2004/0097895.

As previously mentioned, the diaper 100 may also include elasticized leg cuffs 156. It is to be appreciated that the leg cuffs 156 can be and are sometimes also referred to as leg bands, side flaps, barrier cuffs, elastic cuffs or gasketing cuffs. The elasticized leg cuffs 156 may be configured in various ways to help reduce the leakage of body exudates in the leg regions. Example leg cuffs 156 may include those described in U.S. Patent Nos. 3,860,003; 4,909,803; 4,695,278; 4,795,454; 4,704,115; 4,909,803; U.S. Patent Publication No. 2009/0312730 A1; and U.S. Patent Publication No. 2013/0255865 A1.

As mentioned above, diaper pants may be manufactured with a ring-like elastic belt 104 and provided to consumers in a configuration wherein the front waist region 116 and the back waist region 118 are connected to each other as packaged, prior to being applied to the wearer. As such, diaper pants may have a continuous perimeter waist opening 110 and continuous perimeter leg openings 112 such as shown in Figure 1. As previously mentioned, the ring-like elastic belt 104 is defined by a first elastic belt 106 connected with a second elastic belt 108. As shown in Figure 2, the first elastic belt 106 defines first and second opposing end regions 106a, 106b and a central region

106c, and the second elastic 108 belt defines first and second opposing end regions 108a, 108b and a central region 108c.

The central region 106c of the first elastic belt is connected with the first waist region 116 of the chassis 102, and the central region 108c of the second elastic belt 108 is connected with the second waist region 118 of the chassis 102. As shown in Figure 1, the first end region 106a of the first elastic belt 106 is connected with the first end region 108a of the second elastic belt 108 at first side seam 178, and the second end region 106b of the first elastic belt 106 is connected with the second end region 108b of the second elastic belt 108 at second side seam 180 to define the ring-like elastic belt 104 as well as the waist opening 110 and leg openings 112.

As shown in Figures 2, 3A, and 3B, the first elastic belt 106 also defines an outer lateral edge 107a and an inner lateral edge 107b, and the second elastic belt 108 defines an outer lateral edge 109a and an inner lateral edge 109b. The outer lateral edges 107a, 109a may also define the front waist edge 121 and the laterally extending back waist edge 122. The first elastic belt and the second elastic belt may also each include an outer, garment facing layer 162 and an inner, wearer facing layer 164. It is to be appreciated that the first elastic belt 106 and the second elastic belt 108 may comprise the same materials and/or may have the same structure. In some embodiments, the first elastic belt 106 and the second elastic belt may comprise different materials and/or may have different structures. It should also be appreciated that the first elastic belt 106 and the second elastic belt 108 may be constructed from various materials. For example, the first and second belts may be manufactured from materials such as plastic films; apertured plastic films; woven or nonwoven webs of natural materials (e.g., wood or cotton fibers), synthetic fibers (e.g., polyolefins, polyamides, polyester, polyethylene, or polypropylene fibers) or a combination of natural and/or synthetic fibers; or coated woven or nonwoven webs. In some embodiments, the first and second elastic belts may include a nonwoven web of synthetic fibers, and may include a stretchable nonwoven. In other embodiments, the first and second elastic belts may include an inner hydrophobic, non-stretchable nonwoven material and an outer hydrophobic, non-stretchable nonwoven material.

The first and second elastic belts 106, 108 may also each include belt elastic material interposed between the outer layer 162 and the inner layer 164. The belt elastic material may include one or more elastic elements such as strands, ribbons, or panels extending along the lengths of the elastic belts. As shown in Figures 2, 3A, and 3B, the belt elastic material may include a plurality of elastic strands 168 that may be referred to herein as outer, waist elastics 170 and inner, waist elastics 172.

As shown in Figure 2, the outer, waist elastics 170 extend continuously laterally between the first and second opposing end regions 106a, 106b and across the central region 106c of the first elastic belt 106 and between the first and second opposing end regions 108a, 108b and across the central region 108c of the second elastic belt 108. In some embodiments, some elastic strands 168 may be configured with discontinuities in areas. For example, as shown in Figure 2, the inner, waist elastics 172 extend intermittently along the first and second elastic belts 106, 108. More particularly, the inner, waist elastics 172 extend along the first and second opposing end regions 106a, 106b and partially across the central region 106c of the first elastic belt 106. The inner, waist elastics 172 also extend along the first and second opposing end regions 108a, 108b and partially across the central region 108c of the second elastic belt 108. As such, the inner, waist elastics 172 do not extend across the entirety of the central regions 106c, 108c of the first and second elastic belts 106, 108. Thus, some elastic strands 168 may not extend continuously through regions of the first and second elastic belts 106, 108 where the first and second elastic belts 106, 108 overlap the absorbent assembly 140. In some embodiments, some elastic strands 168 may partially extend into regions of the first and second elastic belts 106, 108 where the first and second elastic belts 106, 108 overlap the absorbent assembly 140. In some embodiments, some elastic strands 168 may not extend into any region of the first and second elastic belts 106, 108 where the first and second elastic belts 106, 108 overlap the absorbent assembly 140. It is to be appreciated that the first and/or second elastic belts 106, 108 may be configured with various configurations of discontinuities in the outer, waist elastics 170 and/or the inner, waist elastic elastics 172.

In some embodiments, the elastic strands 168 may be disposed at a constant interval in the longitudinal direction. In other embodiments, the elastic strands 168 may be disposed at different intervals in the longitudinal direction. As discussed in more detail below, the belt elastic strands 168, in a stretched condition, may be interposed and joined between the uncontracted outer layer and the uncontracted inner layer. When the belt elastic material is relaxed, the belt elastic material returns to an unstretched condition and contracts the outer layer and the inner layer. The belt elastic material may provide a desired variation of contraction force in the area of the ring-like elastic belt. It is to be appreciated that the chassis 102 and elastic belts 106, 108 may be configured in different ways other than as depicted in Figure 2.

As previously mentioned, the apparatuses and methods according to the present disclosure may be utilized to transfer and/or bond discrete absorbent articles 100 and/or various components of absorbent articles 100, such as for example, chassis 102, elastic belts 106, 108, and/or leg cuffs 156. Although the following methods may be provided in the context of the diaper 100 shown in Figures 1 and 2, it is to be appreciated that the methods and apparatuses herein may be used with various process configurations and/or absorbent articles, such as for example, disclosed in U.S. Patent No. 7,569,039; U.S. Patent Publication Nos. 2005/0107764 A1, 2012/0061016 A1, and 2012/0061015 A1; 2013/0255861 A1; 2013/0255862 A1; 2013/0255863 A1; 2013/0255864 A1; and 2013/0255865 A1.

As previously mentioned, the apparatuses and methods according to the present disclosure may be utilized to assemble various components of absorbent articles 100. For example, Figure 4 shows a schematic view of a converting apparatus 300 adapted to manufacture absorbent articles 100. The method of operation of the converting apparatus 300 may be described with reference to the various components of absorbent articles 100, such as described above and shown in Figures 1 and 2. Although the following methods are provided in the context of the absorbent article 100 shown in Figures 1 and 2, it is to be appreciated that various embodiments of diaper pants can be manufactured according to the methods disclosed herein, such as for example, the absorbent articles disclosed in U.S. Patent No. 7,569,039 and U.S. Patent Publication Nos. 2005/0107764 A1; 2012/0061016 A1; and 2012/0061015 A1.

As described in more detail below, the converting apparatus 300 shown in Figure 4 operates to advance discrete chassis 102 along a machine direction MD such that the lateral axis of each chassis 102 is parallel with the machine direction, and wherein the chassis 102 are spaced apart from each other along the machine direction. Opposing waist regions 116, 118 of the spaced apart chassis 102 are then connected with continuous lengths of advancing first and second substrates 406, 408, as illustrated in Figures 5B1 and 5C. The chassis 102 are then folded along the lateral axis to bring the first and second substrates 406, 408 into a facing relationship, as illustrated in Figure 5D, and the first and second substrates are connected together along regions 336 intermittently spaced along the machine direction MD, wherein each region 336 may include one or more discrete bond sites 336a, as illustrated in Figure 5E. And the substrates 406, 408 are cut along the regions 336 to form a discrete belt and creating discrete absorbent articles 100, such as shown in Figure 1.

As shown in Figures 4 and 5A, a continuous length of chassis assemblies 302 are advanced in a machine direction MD to a carrier apparatus 308 and cut into discrete chassis 102 with knife roll 306. The continuous length of chassis assemblies 302 may include absorbent assemblies 140 sandwiched between topsheet material 138 and backsheet material 136, leg elastics, barrier leg cuffs and the like.

After the discrete absorbent chassis 102 are cut by the knife roll 306, the carrier apparatus 308 rotates and advances the discrete chassis 102 in the machine direction MD in the orientation shown in Figure 5B1, wherein the longitudinal axis 124 of the chassis 102 is generally parallel with the machine direction MD. While the chassis 102 shown in Figure 5B1 is shown with the second laterally extending end edge 146 as a leading edge and the first laterally extending end edge 144 as the trailing edge, it is to be appreciated that in other embodiments, the chassis 102 may be advanced in other orientations. For example, the chassis may be oriented such that the second laterally extending end edge 146 is a trailing edge and the first laterally extending end edge 144 is a leading edge. The carrier apparatus 308 also rotates while at the same time changing the orientation of the advancing chassis 102. The carrier apparatus 308 may also change the speed at which the chassis 102 advances in the machine direction MD. It is to be appreciated that various forms of carrier apparatuses may be used with the methods herein, such as for example, the carrier apparatuses disclosed in U.S. Patent No. 7,587,966. Figure 5B2 shows the orientation of the chassis 102 on the carrier apparatus 308 while advancing in the machine direction. More particularly, Figure 5B2 shows the chassis 102 with the lateral axis 126 of the chassis 102 generally parallel with the machine direction MD, and wherein the second longitudinal side edge 130 is the leading edge and the first longitudinal side edge 128 is the trailing edge.

As discussed below with reference to Figures 3, 5C, 5D, 5E, and 5F, the chassis 102 are transferred from the carrier apparatus 308 and combined with advancing, continuous lengths of substrates 406, 408, which may be referred to herein as belts, belt substrates, or elastic belt substrates. The substrates 406, 408 may be elastically extensible or inelastic. These substrates 406, 408 may be subsequently cut to form first and second belts 106, 108 on diapers 100, as illustrated in Figure 1.

As illustrated in Figure 4, the chassis 102 are transferred from the carrier apparatus 308 to a nip 316 between the carrier apparatus 308 and a roll 318 where the chassis 102 is combined with continuous lengths of advancing first substrate 406 and second substrate 408. The first substrate material 406 and the second substrate material 408 each define a wearer facing surface 312 and an opposing garment facing surface 314, as illustrated in Figure 5C. The wearer facing surface 312 of the first substrate 406 may be combined with the garment facing surface 134 of the chassis 102 along the first waist region 116, and the wearer facing surface 312 of the second substrate 408 may be combined with the garment facing surface 134 of the chassis 102 along the second waist region 118. As shown in Figure 4, adhesive 320 may be intermittently applied to the wearer facing surface 312 of the first and second substrates 406, 408 before combining with the discrete chassis 102 at the nip 316 between roll 318 and the carrier apparatus 308.

With reference to Figures 4 and 5D, a continuous length of absorbent articles 400 are defined by multiple discrete chassis 102 spaced from each other along the machine direction MD and connected with each other by the substrate assembly 190 which includes the second substrate 408 and the first substrate 406. As shown in Figure 4, the continuous length of absorbent articles 400 advances from the nip 316 to a folding apparatus 500. At the folding apparatus 500, each chassis 102 is folded in the cross direction CD along a lateral axis 126 to place the first waist region 116, and specifically, the inner, body facing surface 132 into a facing, surface to surface orientation with the inner, body surface 132 of the second waist region 118. The folding of the chassis also positions the wearer facing surface 312 of the second substrate 408 extending between each chassis 102 in a facing relationship with the wearer facing surface 312 of the first substrate 406 extending between each chassis 102. As shown in FIGS. 4, 5D, and 5E, the folded discrete chassis 102 connected with the first and second substrates 406, 408 are advanced from the folding apparatus 500 to a bonder apparatus 200. The bonder apparatus 200 operates to bond, at least a portion of the region 336, which may include an overlap area 362, of the substrate assembly 190 thus creating discrete bond sites 336a. An overlap area 362 includes a portion of the second substrate 408 extending between each chassis 102 and a portion of the first substrate 406 extending between each chassis 102. As shown in Figures 4 and 5F, a continuous length of absorbent articles are advanced from the bonder apparatus 200 to a knife roll 338 where the regions 336 are cut into along the cross direction to create a first side seam 178 and a second side seam 180 on an absorbent article 100. It is to be appreciated that the regions 336 may be cut while the first and second substrates 406, 408 are disposed on the bonder apparatus 200. Thus, the first and second substrates 406, 408 may be joined and cut while being rotated by the bonder apparatus 200.

Although the absorbent article is described as having a substrate assembly that includes first and second substrates, it is to be appreciated that the absorbent article may have only one substrate or, alternatively, one or more substrates. For example, the substrate assembly may include a first substrate, a second substrate, a third substrate, and a fourth substrate. Further, it is to be appreciated that the chassis and substrate of the absorbent article may be one continuous substrate such that the overlap area is formed from the same substrate. As such, the bonder apparatus may operate to bond a continuous substrate at an overlap area to form one or more discrete bond sites.

As previously discussed, the converting apparatus 300 may include a bonder apparatus 200. Figure 6 illustrates a perspective view of an embodiment of a bonder apparatus 200 that may be used with the methods and apparatuses herein. As shown in Figure 6, the bonder apparatus 200 may include a plurality of manifolds 202 rotatable about a central longitudinal axis of rotation 204. Each of the plurality of manifolds 202 may be disposed about the central longitudinal axis 204, such that the plurality of manifolds 202 substantially surround the central longitudinal axis 204 and form an outer circumferential surface 201. The bonder apparatus 200 may include at least four manifolds, or at least ten manifolds, or at least twenty manifolds, or at least 40 manifolds, or at least 50 manifolds. Each of the plurality of manifolds may be placed about the central longitudinal axis 204 such that adjacent manifolds are in abutting relationship or adjacent one another. Stated another way, there may be a gap between adjacent manifolds or the manifolds may abut one another.

Each of the plurality of manifolds 202 includes a first end portion 206 and a second end portion 208, opposite the first end portion 206. Each of the plurality of manifolds may also include a support plate 394 that extends from the first end portion 206 to the second end portion 208 of the manifold 202, in a direction substantially parallel to the central longitudinal axis 204. The support plate 394 may include an external support surface 395 and an internal support surface 397, opposite the external support surface 395, as illustrated in Figure 13. The external support surface 395 of each of the support plates 394 form at least a portion of the outer circumferential surface 201. The external support surface 395 of the support plate 394 may be configured to receive a portion of the substrate assembly 190. Further, the support plate 394 may define one or more slots 396 that extend vertically from the external support surface 395 to the internal support surface 397. The one or more slots 396 may extend horizontally in a direction parallel to the central longitudinal axis 204. The internal support surface 397 may be in facing relationship with a nozzle plate 210.

The nozzle plate 210 may define a plurality of apertures 212. The plurality of apertures 212 may extend in a direction substantially parallel to the central longitudinal axis 204 along the nozzle plate 210. In some embodiments, the plurality of apertures 212 may extend from the first end portion 206 to the second end portion 208 of the nozzle plate 210. However, it is to be appreciated that the plurality of apertures 212 may be any length and positioned in any configuration that is sufficient to heat the portion of the substrate assembly to be joined. As illustrated in Figure 6, for example, the nozzle plate 210 may defines a first group of apertures 214 and a second group of apertures 216. The first group of apertures 214 may be adjacent the second group of apertures 216. The plurality of apertures 210 may be substantially surrounded by the one or more slots 396 defined by the support plate 394.

The bonder apparatus 200 may also include a plurality of support arms 231. Each support arm 231 may be joined to the first end portion 206 or the second end portion 208 of the manifold 202. The support arm 231 may be removably attached to the manifold 202. The support arm 231 may be used to extend the length of the outer circumferential surface 201 such that larger articles may be processed on a single bonder apparatus 200. The support arm 231 may be a substantially rigid member. The support arm 231 may also be used to protect the absorbent article from interfering with additional components of the bonder apparatus 200, such as the fluid inlets, the temperature gauge, and the fluid supply, which will be discussed in detail herein.

Referring to Figures 6 and 6A, each of the plurality of manifolds 202 may include a first end surface 205 and a second end surface 209 opposite the first end surface 205. The first end surface 205 may include a fluid inlet portion 218. The fluid inlet portion 218 may include one or more fluid inlets 220. For example, as illustrated in Figure 6A, the fluid inlet portion 218 of each of the plurality of manifolds 202 may include a first fluid inlet 220 and a second fluid inlet 222. Fluid, such as air, may be supplied through one or more fluid supply lines 219, as illustrated in Figure 6, to each fluid inlet included in the fluid inlet portion 218. Each fluid inlet may be configured to connect to a single fluid supply line.

Further, the supply of fluid may be controlled such that fluid may be passed through the fluid inlet 220 to specific, predetermined manifolds 202. The plurality of fluid inlets 220 may be operatively connected to a plurality of valves 230. More specifically, the fluid supply line 219 may connect the fluid inlet 220 to a fluid outlet 227 defined by a fluid block 225. The fluid outlet 227 may be controlled by a valve 230. The valve 230 may be any device that can be configured to be in an open position or a closed position based on input from a controller. A valve 230 may be configured to control one fluid outlet or more than one fluid outlet. Thus, a valve 230 may control whether fluid is supplied to a single fluid inlet or more than one fluid inlet.

For example, each fluid inlet, such as the first fluid inlet 220 and the second fluid inlet 222, may be operatively connected to a valve 224. More specifically, the first fluid inlet 220 may be operatively connected to a first valve 226 and the second fluid inlet 222 may be operatively connected to a second valve 228. When the first valve 226 is configured to be in the open position, a fluid may be supplied to the first fluid inlet 220. Similarly, when the second valve 228 is configured to be in an open position, a fluid may be supplied to the second fluid inlet 222. When the first and second valves 226, 228 are configured to be in the closed position, no fluid is supplied to the first and second fluid inlets 220, 222, respectively. Thus, each fluid inlet may be controlled by an individual valve. However, it is also to be appreciated that the first and second fluid inlets 220, 222 may be controlled by the same valve or a single valve. Any number of fluid inlets may be controlled by a single valve. The number of valves may be based on the number of manifolds, the number of fluid inlets in each manifold, and how those fluid inlets are chosen to be controlled, individually or in groups of two or more.

A controller, not illustrated, may be operatively connected to each of the plurality of valves 230. The controller is configured to pass instructions to the plurality of valves, such that certain valves 224 change from an open position to a closed position or vice versa.

The bonder apparatus 200 may be driven by a motor. The motor may be any device that transmits rotational energy to the bonder apparatus. The motor may be operatively linked or operatively engaged with the bonder apparatus using any technique known to those skilled in the art such as, for example, a gear to gear connection, transmission belting and pulleys, gearboxes, direct couplings, and the like or any combination thereof.

The bonder apparatus 200 may include a support drum. The support drum may substantially surround the central longitudinal axis 204. The support drum includes an internal drum surface and an external drum surface, which is opposite the internal drum surface. The external drum surface supports a portion of each of the plurality of manifolds 202. The plurality of manifolds 202 are disposed about the external drum surface and are positioned radially about the external drum surface such that the plurality of manifolds 202 substantially surround the central longitudinal axis 204. The support drum is configured to rotate about the central longitudinal axis 204. The plurality of manifolds 202 and the support drum are configured to rotate together about the central longitudinal axis 204. In some embodiments, the bonder apparatus 200 may include greater than about 4 manifolds or greater than about 10 manifolds or greater than about 25 manifolds or greater than about 50 manifolds positioned radially about the central longitudinal axis 204.

The support drum also includes a distal end portion and a proximal end portion, which is opposite the distal end portion. The plurality of valves 230 may be supported on one or more support brackets 242, as illustrated in Figures 7A and 7C, positioned adjacent at least one of the distal end potion and the proximal end portion of the support drum. Each support bracket 242 may support a number of valves 224 and a fluid block 225, as illustrated in Figures 7A, 7B, and 7C. For example, as illustrated in Figure 7A, a support bracket 242 may support three fluid blocks 225 that each support eight valves 224. The fluid block 225 may be operatively connected to one or more valves and may be used to supply fluid to the one or more fluid outlets 227, which the valves 224 control. Thus, the fluid may be supplied through tubing or another suitable supply device positioned adjacent the support bracket 242 and connected to the fluid outlet 227 of the fluid block 225. The support bracket 242 may be a rigid member having any shape such that the valves and support block are adequately supported as the bonder apparatus 200 traverses about the central longitudinal axis 204. The support bracket 242 including the plurality of valves 230 and the fluid block 225 may be configured to rotate about the central longitudinal axis 204. It is to be appreciated, the support brackets 242 may include one or more internal cavities through which fluid may be supplied to the valves 224. Thus, the support bracket 242 may serve the purpose of the fluid block 225. It is also to be appreciated that the support bracket 242 may be a singular, rigid member, or two or more rigid members that are connected to form the support bracket 242

As previously discussed, the nozzle plate 210 may include a plurality of apertures 212. The plurality of apertures 212 may be arranged into a first group of apertures 214 and a second group of apertures 216. The first and second group of apertures 214, 216 may extend from the first end portion 206 to the second end portion 208 of a first manifold 202, 266. In some embodiments, the plurality of apertures 212 may also include a third group of apertures 244 and a fourth group of apertures 246, as illustrated in Figure 8. The third and fourth group of apertures 244, 246 may also extend from the first end portion 206 to the second end portion 208 of the first manifold 202, 266. Further each of the groups of apertures may be substantially parallel to one another. It is to be appreciated that the plurality of apertures may be arranged in any configuration which corresponds to the area of the substrate assembly to be at least partially melted. For example, one or more rows of apertures may be used or a random arrangement of apertures may be used.

Referring to Figures 8 and 8A, the first group of apertures 214 and the second group of apertures 216 may be separated by a first aperture distance 1AD. The first aperture distance 1AD may be from about 1 mm to about 15 mm and/or from about 2 mm to about 8 mm and/or from about

2.5 mm to about 5 mm, including all 0.1 mm between the recited ranges. Similarly, the third group of apertures 244 and the fourth group of apertures 246 may be separated by a second aperture distance 2AD. The second aperture distance 2AD may be greater than, less than, or equal to the first aperture distance 1AD. The second aperture distance 2AD may be from about 1 mm to about 20 mm, including all 0.1 mm between the recited range. Further, the second group of apertures 216 may be separated from the third group of apertures 244 by an intermediate aperture distance IAD. The intermediate aperture distance IAD may be long enough such that additional processes may be performed on the substrate, such as cutting. The intermediate aperture distance IAD may be from about 5 mm to about 20 mm and/or from about 4 mm to about 40 mm, including all 0.1 mm between the recited ranges.

Further still, the fourth group of apertures 246, as illustrated in Figure 8 and 8A, or the group of apertures closest to the adjacent manifold may be separated by the first group of apertures 214a disposed on an adjacent or a second manifold 202, 268 by an adjacent aperture distance AAD. The adjacent aperture distance AAD may be from about 5 mm to about 40 mm and/or from about 15 mm to about 80 mm and/or from about 20 mm to about 200 mm, including all 0.1 mm between the recited ranges. The adjacent aperture distance AAD is a dynamic distance, which means the adjacent aperture distance ADD changes as the apparatus radially traverses. The adjacent aperture distance AAD may change based on the circumference of the bonder apparatus 200. As will be discussed in detail herein, the outer circumference of the bonder apparatus 200 may increase and decrease by changing the distance between adjacent manifolds. Thus, as the distance between adjacent manifold changes the adjacent aperture distance AAD also changes. The aforementioned distances between each of the groups of apertures may be measured along the outer circumferential surface 201 in a direction parallel to the machine direction MD of the bonder apparatus 200. Further, the distances are measured from the center of the aperture. It is to be appreciated that each manifold may be configured to have the same pattern of apertures. Thus, the distance between groups of apertures on a given manifold may be about the same as the distance between the groups of apertures on another manifold.

Referring to Figure 8B, the bonder apparatus 200 may include a plurality of support plates 394. A support plate 394 may be disposed on each of the plurality of nozzle plates 210 and may be used to separate the substrate assembly from the nozzle plate by a predetermined distance, as will be discussed herein. Each of the support plates 294 may define one or more slots 396. The slots 396 may be positioned to substantially surround the plurality of apertures 212. For example, as illustrated in Figure 8B, the support plate 294 includes two slots 396. A first slot 396 surrounds the first group of apertures 214 and a second slot 396 surrounds the second group of apertures 216. It is to be appreciated that a single slot may surround more than one group of apertures, or more than one slot may surround a group of apertures. Similar to the above, the first group of apertures 214 may be separated from the second group of apertures 216 by an intermediate aperture distance IAD. Further, the second group of apertures 216 of the first manifold 202, 266 may be separated from a first group of apertures 214a on the adjacent or second manifold 202, 268 by an adjacent aperture distance AAD, which is a dynamic distance as discussed above. Further still, as will be discussed herein, the slots 396 defined by the support plate 394 disposed on the first manifold 202, 266 may be separated by a radial slot distance RSD and a cross direction slot distance CSD. It is to be appreciated that the support plate 294 may define more than one slot 396. These slots 396 may be separated from adjacent slots in both the machine direction MD and the cross direction CD, as illustrated in Figure 8B. It is to be appreciated that the slots may be any shape and any size such that a group of apertures is substantially surrounded and the substrate assembly is adequately supported.

As previously discussed, fluid may be released through the plurality of apertures 212. The release of fluid through the plurality of apertures 212 may be controlled by the plurality of valves 230, as illustrated in Figure 6 and 7A. More specifically, one or more of the plurality of valves may be controlled such that any combination of the groups of apertures may release the fluid. For example, one or more values may configured to be positioned in an open position such that fluid is released through the first group of apertures 216 and the third group of apertures 244 and no fluid is released through the second group of apertures 216 and the fourth group of apertures 246, as illustrated in Figures 8, 8A, and 8B. In another example, the first and second group of apertures 214, 216 may be configured to release fluid and the third and fourth group of apertures 244, 246 may not release fluid. In yet another example, the second group of apertures 216 and the fourth group of apertures 246 may be configured to release fluid and the first and third group of apertures 214, 244 may not release fluid. In yet another example, the first, second, third, and fourth groups of apertures 214, 216, 244, and 246 may be configured to release the fluid. The dimensions and characteristics of the substrate assembly to be at least partially melted may be used to determine which one of the groups of the plurality of apertures releases fluid. Thus, the configuration of which of the plurality of apertures release fluid may change with each revolution of the bonder apparatus 200.

Referring to Figures 9, 10A, and 10B, the substrate assembly 190, which may include the folded chassis 102, may advance in the machine direction MD to the bonder apparatus 200. As previously discussed, a substrate assembly 190 may include a first substrate and a second substrate in a facing relationship. It is to be appreciated that a substrate assembly 190 may include any number of substrates in any partially overlapping configuration. As previously described, the first substrate and the second substrate may be used to form a first belt and a second belt of the absorbent article. The first substrate and the second substrate may be elastically extensible in at least one of the machine direction MD and the cross direction CD. The first and second substrates may include regions 336 intermittently spaced along the machine direction MD, wherein each region 336 may include a leading portion 332 and a trailing portion 334. For example, as illustrated in Figure 10A, a first region 352 may include a first leading portion 342 and a subsequent or adjacent region in the machine direction MD, such as a second region 354, may include a first trailing portion 344 and a second leading portion 346 and yet another subsequent or adjacent region in the machine direction MD, such as a third region 356, may include a second trailing portion 348.

Each leading portion and trailing portion may define a process product pitch 340, 340a. More specifically, for example, a process product pitch 340, 340a refers to the distance measured parallel to the machine direction MD between the area at which a leading edge portion and a trailing edge portion meet in a first region to the area at which a leading edge portion and a trailing edge portion in a subsequent, adjacent region meet, as illustrated in Figures 10A and 10B. The length of the process product pitch may change based on the size of the absorbent article, the amount of elasticity of the substrate assembly, and the process tension placed on the substrate assembly as the substrate assembly is advanced in the machine direction MD. It is to be appreciated that the process product pitch includes the process tension placed on the substrate during processing.

As previously stated, absorbent articles come in a variety of sizes. For example, one absorbent article may include a larger chassis and a larger belt as compared to another absorbent article that may include a smaller chassis and a smaller belt, as illustrated in Figures 10B and 10A, respectively. Thus, the plurality of manifolds 202 may be used such that the absorbent article including the larger chassis and the larger belt can be manufactured on the same equipment as the absorbent article including the smaller chassis and the smaller belt. This prevents manufacturers from having to switch out equipment or to make large modifications to the equipment for manufacturing different sized articles, which is both costly and time consuming.

For example, the same bonder apparatus 200 may be used to process the substrate assembly illustrated in 10A and the substrate assembly illustrated in Figure 10B. As shown, the substrate assembly of Figure 10A has a shorter process product pitch 340 than the process product pitch 340a of the substrate assembly of Figure 10B. Due to the number of manifolds and the spacing of the groups of apertures, a number of different sized absorbent articles may be manufactured on a single bonder apparatus 200. However, the bonder apparatus 200 may be designed for a minimum product pitch based on the diameter of the bonder apparatus 200, the number of manifolds 202, and the distance between apertures 212.

As illustrated in Figure 9, the substrate assembly 190 may advance in the machine direction MD toward the bonder apparatus 200 at a first velocity $V_1$. Further, the substrate assembly 190 may be held at a process tension as the substrate assembly is advanced toward the bonder apparatus 200. A guide roll 248 configured to rotate about a first axis of rotation 250 and including a first outer circumferential surface 252 may be used to transfer the substrate assembly 190 onto the bonder apparatus 200. The substrate assembly 190 may be disposed on a portion of the outer circumferential surface 252 of the guide roll 232 as the substrate assembly is transferred to the bonder apparatus 200.

The bonder apparatus 200 includes a plurality of manifolds 202 that may be configured to rotate about an axis of rotation 204 in a direction indicated by arrow 254. Each of the plurality of manifolds 202 includes a support plate 394. The support plate 394 may include an external support surface 395. The external support surface 395 of the support plate 394 may be configured to receive the substrate assembly 190 and/or the folded chassis 102. More specifically, as the substrate assembly 190 advances onto the bonder apparatus 200, the substrate assembly 190 is received by the support plate 394 of each manifold 202, which forms the outer circumferential surface 201 of the bonder apparatus 200.

As illustrated in Figures 10C and 10D, the substrate assembly 190 may be positioned on the first, external surface 256 of the nozzle plate 210 such that the areas of the substrate assembly to be bonded are disposed on a portion of the group of apertures 214, 216. For example, as illustrated in Figure 10C, the second region 354 of the substrate assembly 190 may be disposed on a first support plate 402, which is disposed on a first nozzle plate 258. More specifically, the first trialing portion 344 may be disposed on a portion of a first group of apertures 214 defined by the first nozzle plate 258 and the second leading portion 346 may be disposed on a portion of a second group of apertures 216 defined by the first nozzle plate 258. The central portion 330 of the substrate assembly 190 between the second leading portion 346 and the subsequent second trailing portion 348, extending in a direction parallel to the machine direction MD, may extend across intermediate manifolds 260 or portions thereof. The chassis 102 may also be disposed on the intermediate manifolds 260. Following the central portion 330 of the substrate assembly 190 disposed on the intermediate manifolds 260, the second trailing portion 348 may be disposed on a portion of a second support plate 404. The second support plate 404 is disposed on a second nozzle plate 262. Further, the third leading portion 250 may be disposed on a third support plate 405. The third support plate 405 may be disposed on a third nozzle plate 264. More specifically, the second trailing portion 348 may be disposed on a second group of apertures 216 of the second nozzle plate 262 and a third leading portion 350 may be disposed on a portion of a first group of apertures 214 of the third nozzle plate 264. The substrate assembly 190 is positioned such that the leading portion and the trailing portion are each disposed on an adjacent group of apertures. It is to be appreciated that adjacent groups of apertures do not have to be defined by the same nozzle plate. As will be discussed in more detail herein, fluid is released through the groups of apertures on which the leading edge portion and the trailing edge portion of the substrate assembly are disposed.

In another example, as illustrated in Figure 10D, when the substrate assembly 190 is disposed on the outer circumferential surface 201 of the bonder apparatus, the second region 354 of the substrate assembly 190 may be disposed on a first support plate 402, which is disposed on a first nozzle plate 258. More specifically, the first trailing portion 344 may be disposed on a portion of a first group of apertures 214 of the first nozzle plate 258 and the second leading portion 346 may be disposed on a portion of a second group of apertures 216 of the first nozzle plate 258. The central portion 330 of the substrate assembly 190 between the second leading portion 346 and the subsequent second trailing portion 346, extending in a direction parallel to the machine direction MD, may extend across intermediate manifolds 260 or portions thereof. The chassis 102 may also be disposed on one or more of the intermediate manifolds 260. Following the central portion 330 of the substrate assembly 190 disposed on the intermediate manifolds 260, a region 336 of the substrate assembly 190 may be disposed on a second support plate 402, which is disposed on a second nozzle plate 262. The second trailing portion 348 may be disposed on a portion of a first group of apertures 214 defined by the second nozzle plate 262 and a third leading portion 350 may be disposed on a portion of a second group of apertures 216 defined by the second nozzle plate 262. As illustrated in Figures 10C and 10D, the process tension, the process product pitch 340, 340a, and the distance between the groups of apertures are all factors in aligning the leading edge portion and the trailing edge portion of the substrate assembly with the apertures defined by the nozzle plates.

As illustrated in Figure 9, the substrate assembly 190 rotates with the plurality of manifolds 202 about the central longitudinal axis 204 of rotation. The substrate assembly 190 may have the same process product pitch or different process product pitches along the length of the substrate assembly 190, which is parallel with the machine direction MD. As illustrated in Figure 9, for example, the substrate assembly 190 may include a portion such that a first process product pitch 340 is adjacent a second process product pitch 340a. The first process product pitch 340 may be greater than or less than the second process product pitch 340a. In another example, the substrate assembly 190 may include a process product pitch 340 that is the same along the length of the substrate assembly. State another way, a first portion of the substrate assembly 190 having a first product pitch 340 may be adjacent to a second portion of the substrate assembly 190 having a second product pitch 340, and the first product pitch is substantially the same as the second product pitch.

As the substrate assembly 190 traverses about the central longitudinal axis 204, heated fluid may be released through the apertures defined by the nozzle plate. As previously discussed, the heated fluid is released through those apertures in the nozzle plate on which a leading edge portion or a tailing edge portion is disposed. For example, a heated fluid may be supplied to a first manifold 266 on which a leading edge portion and a trailing edge portion of the substrate assembly is disposed. Further, a heated fluid may be supplied to a second manifold 268 on which an adjacent, subsequent leading edge portion and trailing edge portion is disposed. However, the heated fluid may not be supplied to the intermediate manifolds 260, which are those manifolds that are located between the first manifold 266 and the second manifold 268. The first and second manifolds 266, 268 may be controlled such that the release of heated fluid occurs when the manifold reaches some radial position about the central longitudinal axis 204. The release of heated fluid may also be timed based on other processes such as in relation to the process of compressing the substrate assembly 190.

For example, the leading edge portion and the trailing edge portion of the substrate assembly 190 may be at least partially melted while traversing about the central longitudinal axis 204. The substrate assembly 190 may then be advanced to an anvil roll 368. The anvil roll 368 may operatively engage at least a portion of the substrate assembly 190. Thus, the anvil roll 368 may be positioned adjacent the support plate 394 and/or the nozzle plate 210. The anvil roll 368 includes an anvil roll outer circumferential surface 370 and may be adapted to rotate about an anvil roll axis of rotation 372. The operative engagement of the anvil roll 368 and the external surface 256 of the nozzle plate 210 joins the at least partially melted portion of the one or more overlapping substrates of the substrate assembly 190 forming one or more bonds, as illustrated in Figure 5E.

It is also to be appreciated that the outer circumferential surface 370 of the anvil roll 368 may rotate at a circumferential velocity. The circumferential velocity may be constant or may be varied as the anvil roll 368 rotates about its axis of rotation 372. The circumferential velocity may be changed according to the size of the substrate assembly so that the anvil roll 368 engages that substrate assembly at the desired location, which may correspond to the intended size of the finished absorbent article or other consumer product. Further, during each rotation of the anvil roll 368, the circumferential velocity may vary. For example, in a single rotation, the rotational velocity may increase and decrease one or more times to position the anvil roll 368 in the desired location to bond the substrate assembly. The anvil roll 368 may be operatively connected to a servo motor (not shown). The servo motor may operate to change the circumferential velocity of the anvil roll 368.

It is to be appreciated that the anvil roll may alternatively be an anvil block, which traverses linearly to compress at least a portion of the region 336, which includes the leading edge portion and the trailing edge portion, of the substrate assembly 190.

The bonder apparatus 200 may continue to rotate about the central longitudinal axis 204 such that the substrate assembly 190 is advanced to a second guide roll 270. The second guide roll 270 may include a second outer circumferential surface 272 and may be configured to rotate about a second axis of rotation 274. As the second guide roll 270 rotates about the second axis of rotation 274 the substrate assembly 190, which may include a chassis 102, may be transferred from the bonder apparatus 200 to the second outer circumferential surface 272 of the second guide roll 270. The substrate assembly 190 may then be advanced to additional downstream processes.

Referring to Figure 11, as the substrate assembly 190 traverses about the central longitudinal axis 204, a position control apparatus 410 may be used to maintain the position of the substrate assembly 190 and/or the chassis 102. In some embodiments, the position control apparatus 410 may include a belt 412, such as a conveyor belt, and two or more rollers 414. The belt 412 may be positioned about a portion of the rollers such that the belt may move in a direction indicated by arrow 416. The position control apparatus 410 may be positioned adjacent the bonder apparatus 200 and may take the shape of at least a portion of the outer circumferential surface 201 of the bonder apparatus 200. The position control apparatus may hold the substrate assembly 190 and/or the chassis 102 in the range of 0 millimeters to about 10 millimeters from the outer circumferential surface 201, or between about 0.5 millimeters to about 5 millimeters from the outer circumferential surface 201. It is to be appreciated that the position control apparatus may be a mechanical apparatus such as clamps or another type of fastener that holds the region 336 of the substrate assembly 190 and/or the chassis 102 in place during the bonding process. Further, a vacuum force, generated by the movement of fluid toward the central longitudinal axis 204, may be used in addition to the mechanical device, or each of the vacuum force and the mechanical device may be applied independently to secure the substrate assembly 109 and/or the chassis 201 against the outer circumferential surface 201 of the bonder apparatus 200. The vacuum force may be generated by pulling air through the plurality of apertures 212 in a direction from the outer circumferential surface 201 toward the central longitudinal axis 204. Alternatively or in addition to the vacuum force generated by the plurality of apertures 212 an external device may direct air toward the outer circumferential surface 201 and/or against the substrate assembly disposed on the outer circumferential surface 201 of the bonder apparatus 200.

A process member 276 may also be placed adjacent the bonder apparatus 200. The process member 276 may be a device that is used to mechanically deform the substrate assembly 190 and/or the chassis 102 in some manner. For example, the process member 276 may be a device that bonds, cuts, scores, or performs some other mechanical deformation on the substrate assembly 190 and/or the chassis 102. Thus, as the substrate assembly 190 and/or the chassis 102 rotate about the central longitudinal axis 254, one or more additional processes may be performed by one or more process members 276. It is to be appreciated that more than one process member 276 may be positioned adjacent to the bonder apparatus 200.

Still referring to Figure 11, as previously discussed, the leading edge portion and the trailing edge portion of the substrate assembly 190 may be at least partially melted by heated fluid that is released by the groups of apertures corresponding to the position of the leading edge portion and the trailing edge portion of the substrate assembly 190. After the leading edge portion and the trailing edge portion of the substrate assembly 190 have undergone at least a partial melting, the substrate assembly 190 may be transferred from or removed from the outer circumferential surface 201 of the bonder apparatus 200. Upon being removed from the outer circumferential surface 201, the substrate assembly 190 may traverse onto an anvil roll 368. The anvil roll 368 may include an outer circumferential surface 370 and be configured to rotate about an axis of rotation 372. The substrate assembly 190 may advance onto the outer circumferential surface 370 of the anvil roll 368. The anvil roll 368 may be positioned adjacent a bond roll 376 forming a nip 374 therebetween. The anvil roll 368 may be configured to operatively engage at least a portion of the bond roll 376. The bond roll 376 may be configured to rotate about an axis of rotation 380 and may include an outer circumferential surface 378. The bonding roll 376 may rotate such that the outer circumferential surface rotates at variable speeds to account for the changes in the substrate assembly 190. Further, one or more pressure applying members 382 may extend radially outward from the outer circumferential surface 378 of the bond roll 376. The substrate assembly 190 may advance through the nip 374 between the bond roll 376 and the anvil roll 368. The pressure applying members 382 of the bond roll 376 may engage the outer circumferential surface 370 of the anvil roll 368 causing a portion of the substrate assembly 190 to compress and forming a bond between one or more layers of the substrate assembly 190. The bond roll 376 may be configured such that the pressure applying members 382 are appropriately spaced to engage the leading edge portion and the trailing edge portion that have been at least partially melted by the heated fluid.

More specifically, the outer circumferential surface 378 of the bond roll 376 may rotate at a circumferential velocity. The circumferential velocity may be constant or may be varied as the bond roll 376 rotates about its axis of rotation 380. The circumferential velocity may be changed according to the size of the substrate assembly so that the bond roll 376 engages that substrate assembly at the desired location, which may correspond to the intended size of the finished absorbent article or other consumer product. Further, during each rotation of the bond roll 376, the circumferential velocity may vary. For example, in a single rotation, the rotational velocity may increase and decrease one or more times to position the bond roll 376 in the desired location to bond the substrate assembly. The bond roll 376 may be operatively connected to a servo motor (not shown). The servo motor may operate to change the circumferential velocity of the bond roll 376. The anvil roll 368 may rotate at a constant circumferential velocity and may be configured to operatively engage the bond roll 376.

It is to be appreciated that the substrate assembly is compressed by the one or more pressure applying member while the meltable components of the substrate assembly are at least partially melted, and/or in a tacky state. The temperature of the pressure applying members may be at least below the melting point of the region 336. However, the pressure applying member may be heated. The tackiness property of the meltable components permits the joining of substrate layers, which may include a first substrate 406 and a second substrate 408 or an overlap portion of a single substrate. The pressure applying members may be designed according to aesthetic criteria, for example, to provide discrete, shaped bonds where substrate layers are joined, as illustrated in Figure 5E. Discrete bonds may also make the seam easier to open, if desired. The discrete bonds may generally take the shape and spacing of the pressure applying surfaces. As one example, the pressure applying members may be generally oval, or may have any other geometric or decorative shape consistent with the desired removal force. The pressure applying members may be regularly or irregularly spaced, and may be oriented in various directions. After being compressed, the substrate assembly 190 may exit the nip 374, as illustrated in Figure 11, and continue to additional downstream processes.

As previously discussed, the substrate assembly 190 may be positioned such that the leading edge portion and the trailing edge portion are disposed on one or more groups of apertures. The leading edge portion and the trailing edge portion are to be disposed on one or more groups of apertures such that these portions of the substrate assembly may be at least partially melted and joined. However, it is to be appreciated that the bonder apparatus 200 may be constrained as to the sizes of substrate assemblies that can be processed on the bonder apparatus 200. More specifically, the bonder apparatus 200 may comprise a certain number of manifolds and each of these manifolds may be configured with groups of apertures, these groups of apertures are spaced from one another at a certain distance. Thus, only substrate assemblies having a certain process product pitch may be acted upon using the bonder apparatus 200. Thus, to accommodate a larger range of substrate assemblies, the radius and, thus, the circumference of the outer circumferential surface 201 may be radially expand and radially contract based on the process product pitch of the substrate assembly 190.

Referring to Figures 9, 11 and 11A, the bonder apparatus 200 is configured to expand and contract radially. As illustrated in Figure 9, the bonder apparatus 200 includes an initial radius R1. The initial radius R1 is measured from the central longitudinal axis 204 to the outer circumferential surface 201. The outer circumferential surface 201 is the surface on which the substrate assembly 190 will be disposed and a portion thereof will be partially melted. Thus, the outer circumferential surface 201 may include the external support surface 395 of the support plate 394 or the external surface 256 of the nozzle plate 210 in embodiments wherein the bonder apparatus 200 does not include a support plate 394. The initial radius R1 is measured when the plurality of manifolds 202 are positioned such that adjacent manifolds abut one another or when the manifolds are positioned such that the outer circumferential surface of the manifold is as close as mechanically possible to the central longitudinal axis 204. Stated another way, the initial radius R1 may be measured when the plurality of manifolds 202 are positioned such that no gap is present between adjacent manifolds 202. The initial radius R1 may be from about 250 mm to about 1500 mm and/or from about 300 mm to about 900 mm and/or from about 350 mm to about 580 mm and/or from about 380 mm to about 450 mm, including all 0.1 mm increments therebetween. It is to be appreciated that the initial radius R1 may be determined by the size of the substrate assembly and/or the final absorbent article to be processed on the bonder apparatus 200. The bonder apparatus 200 may radially expand and contract as indicated by directional arrow 434 illustrated in Figure 11A.

As illustrated in Figure 11, the bonder apparatus 200 may be configured to radially expand. The plurality of manifolds 202 may be moved in a direction away from the central longitudinal axis 204. In the extended position, the bonder apparatus 200 may have a second radius R2, which is greater than the initial radius R1. The second radius R2 is measured from the central longitudinal axis 204 to the outer circumferential surface 201. The outer circumferential surface 201 is the surface on which the substrate assembly 190 will be disposed and a portion thereof will be partially melted. Thus, the outer circumferential surface 201 may include the external support surface 395 of the support plate 394 or the external surface 256 of the nozzle plate 210 in embodiments wherein the bonder apparatus 200 does not include a support plate 394.

Further, the bonder apparatus 200 may be configured to radially contract. The plurality of manifolds 202 may be moved in a direction toward the central longitudinal axis 204. The bonder apparatus 200 may radially contract from some maximum radius, such that the manifolds are extended to a position wherein the manifolds unable to be mechanically extend by any additional amount. It is to be appreciated that the bonder apparatus 200 may be radially extended or radially contracted to any position between the initial radius and the maximum radius.

As illustrated in Figure 11A, the bonder apparatus 200 may include a hub 436 and a plurality of linkage members 438. The hub 436 may substantially surrounds the central longitudinal axis 204 and may be configured to rotate about the central longitudinal axis 204. The hub 436 may operatively engage a motor that causes the hub 436 to rotate. Each of the plurality of linkage members 438 may include a proximal end portion 440 attached to a portion of the hub 436 and a distal end portion 442, which is opposite the proximal end portion 440, operatively engaged to a portion of the manifold 202. The proximal end portion 440 of the linkage member 438 may be configured to engage a guide opening 444. As the hub 436 rotates in a first direction indicated by expansion arrow 446, the proximal end portion of the linkage members 438 moves away from the central longitudinal axis 204 and the manifolds 202 operatively connected to the linkage member 438 move radially outward from the central longitudinal axis 204. Similarly, as the hub 436 rotates in a second direction indicated by expansion arrow 448, the proximal end portion of the linkage members

438 moves toward the central longitudinal axis 204 and the manifolds 202 operatively connected to the linkage member 438 move radially inward toward the central longitudinal axis 204. The hub 436 rotates in both a first direction and a second direction about a portion of the central longitudinal axis 204. For example, the hub 436 may be configured to rotate about 45 degrees in the first direction and about 45 degrees in the second direction. It is to be appreciated that each manifold may be supported by a track member 450 positioned adjacent a portion of the manifold and configured to direct the radial motion of the manifold as the manifold traverses radially inward and radially outward. The track member 450 may be attached to a support disk 437. The support disk 437 does not rotate with the hub 436, but rather, rotates with the other components of the bonder apparatus 200 about the central longitudinal axis 204. The rotation of the hub 436 with respect to the support disk 437 causes the linkage members 438 to move, which results in the manifolds moving radially inward and radially outward.

It is to be appreciated that the hub 436 may be driven by the same drive that causes rotation of the bonder apparatus 200. However, an intermediary device operatively connecting the hub 436 and the drive would need to be used such that the hub 436 would rotate only when the manifolds needed to be radially traversed. Intermediary devices may include a clamping or clutch system.

As illustrated in Figure 11B, a plate 454 comprising arcuate slots 456 operatively connected to a drive member may be used to radially adjust the bonder apparatus 200. A plurality of rigid members 462, each having a distal end portion 458 and a proximal end portion 459 opposite the distal end portion, may connect the plate 454 to the each of the plurality of manifolds 202. More specifically, the proximal end portion of each of the plurality of rigid members 462 may be attached directly or indirectly to each manifold 202. Thus, each manifold 202 may have a rigid member 462 extending therefrom in a direction substantially parallel to the central longitudinal axis 204. The distal end portion 458 may be slidably connected to the arcuate slot 456 of the plate 454. Each distal end portion 458 may engage a single arcuate slot. As the drive member operatively engages the plate 454, the plate 454 rotates causing the distal end portions of the rigid members 462 to slide along the arcuate slots. As the plate rotates in a first direction 446, the manifolds may radially expand. Similarly, as the plate rotates in a second direction 448, the manifolds may radially contract. The drive member may include a servo motor with a worm gear box.

Having the ability to adjust the radius of the bonder apparatus 200 changes the circumference about the outer circumferential surface 201 of the bonder apparatus 200. By changing the circumference, the position of the manifolds 202 may be changed with respect to the substrate assembly 190. The radial position of the manifolds 202 may be changed incrementally based on the process product pitch of the substrate assembly 190. This allows for a greater number of different sized substrate assemblies to be processes on a single bonder apparatus 200, which is a savings in manufacturing time and cost.

It is to be appreciated that the radius of the bonder apparatus 200 may be traversed prior to accepting the substrate assembly or after the substrate assembly is disposed on the bonder apparatus. It is also to be appreciated that in addition to changing the radius and, thus, the circumference of the bonder apparatus 200, the substrate assembly 190 may be condensed or expanded using various metering assemblies, as described in U.S. Case No. 14137P filed on December 10, 2015. The radial traversing bonder apparatus in combination with controlling the process product pitch and the velocity at which the bonder apparatus 200 rotates, allows for an even greater number of different sized substrate assemblies to be processed on a single bonder apparatus 200.

As previously discussed, a fluid is heated to a temperature sufficient to at least partially melt at least a portion of the region 336, which includes the leading edge portion and trailing edge portion, of the substrate assembly 190. The apertures 212 defined by the nozzle plate 210 direct a jet of the heated fluid onto at least a portion of the region 336 of the substrate assembly 190, which may include a first substrate 406 and a second substrate 408. The heated fluid partially melts at least a portion of the region 336. As the bonder apparatus 200 continues to rotate about the axis of rotation 204, an anvil roll may compress the partially melted overlap portion against the outer circumferential surface 201 of the bonder apparatus. Alternatively, the substrate assembly 190 may be transferred from the bonder apparatus 190 and advance through a compression assembly. The anvil roll and bond roll, which may include one or more press members, then compresses the partially melted overlap area creating one or more discrete bond sites 336a in the overlap area 362, as shown in Figure 5E, between the first and second substrates.

It is to be appreciated that by applying different amounts of force in different locations, it may be possible to bond through different numbers of substrate layers or materials along the region. By selectively compressing portions with more or less force, portions of the substrates with fewer layers or different materials will not be over compressed and portions of the substrates with more layers or different materials will not be under compressed. In some embodiments, the compression assembly may include different shaped projections, or may have different configurations of projections.

In some embodiments, the press member may compress the partially melted overlap area against the anvil roll outer circumferential surface at a pressure in the range of about $1x10^5$ Newtons per square meter to about $1x10^8$ Newtons per square meter. In some embodiments, the press member 366 may compress the first and second belt substrates for a time period ranging from about 1 millisecond to about 3 milliseconds or from about 3 milliseconds to about 10 milliseconds or from about 10 milliseconds to about 1000 milliseconds or greater. Shorter or longer time intervals may be used.

The bonder apparatus 200 includes a plurality of manifolds 202 that are disposed about a central longitudinal axis 204. The plurality of manifolds 202 are configured to release a heated fluid through a plurality of apertures 212 defined by the nozzle plate 210. More specifically, a plurality of valves 224 may be fluidly connected to the plurality of manifolds 202. One or more valves may be fluidly connected to each of the plurality of manifolds. Based on the process product pitch and the position of the leading edge portion and the trailing edge portion on the outer circumferential surface 201 of the bonder apparatus 200, the valves corresponding to those manifolds on which the leading edge portion and the trailing edge portion are disposed are configured to be in an open position such that fluid may be supplied to the manifold. The fluid supplied to the manifold 202 may enter through a fluid inlet 220. The fluid inlet 220 may be defined by a first end surface 205 of the manifold 202 and be positioned in a fluid inlet portion 218. The fluid supplied through the fluid inlet 220 may be heated within the manifold 202. Thus, the fluid may be supplied through the fluid inlet 220 at an entrance temperature and, after being heated, may exit the manifold at an exit temperature. The exit temperature may be greater than the entrance temperature.

It is to be appreciated, in some embodiments, a heat member may be positioned adjacent the plurality of manifolds 202. The heat member may also be located adjacent the first end surface 205 of the manifold 202 such that the heat member does not interfere with the fluid inlet 220. The heat member may be any device which increases in temperature, such as an electric heater, an induction heater, which heats an electronically conductible object by electromagnetic indication, laser heating, or ultrasonically heating. The heat member may be used to heat the manifold causing any fluid within the manifold to be heated. The fluid is heated to a temperature sufficient to at least partially melt at least a portion of the region 336 of the substrate assembly 190.

The heated fluid may include ambient air or other gases. It is to be appreciated that the fluid may be heated to various temperatures and pressurized to various pressures. For example, in some embodiments, the fluid may be heated up to an exit temperature ranging from the lower melting point of first and second substrates minus 30°C to the lower melting point of the first and second substrates plus 100°C. In some embodiments, the fluid pressure may range from $0.1 x 10^5$ Newtons per square meter to $1 x 10^6$ Newtons per square meter. In some embodiments, the heated fluid may be directed toward at least one of the first and second substrates for a time interval ranging from about 10 to about 1000 milliseconds or greater. Shorter or greater time intervals may be used.

Also, it is to be appreciated that the each aperture 212 may have an oval, square, or various other shapes. The apertures 212 may have a diameter sufficient to transfer enough heated fluid to at least partially melt at least a portion of the substrate assembly. For example, the apertures 212 may each have a diameter ranging from about 0.1 millimeters to about 6 millimeters, including all 0.1 mm therebetween.

The fluid may be sufficiently heated to enable at least a partial melting of at least a portion of the substrate assembly 190. A jet of the heated fluid may be directed toward the substrate assembly 190. The fluid may be allowed to penetrate the substrate assembly 190 such that at least a portion of each of the substrate layers is melted in the region, which may be an overlap area 362. The heated fluid, at a controlled temperature and pressure, may pass from the apertures, leading to the formation of controlled and concentrated jets of heated fluid, which are directed toward the region 336 of the substrate assembly 190 to be joined.

By controlled, it is meant that the temperature and pressure of the fluid are maintained within a specified range once the nominal set points are selected. For example, a set point may be selected and the temperature may then be maintained in a fixed range around the nominal set point, such as ±30°C, and the pressure may be maintained in a fixed range around the nominal set point, such as ±1 bar. The acceptable range will depend on the properties, such as softening point and/or melting temperature, of the materials to be joined and the nominal set point selected.

For example, a nominal set point above the melting temperature of one or more of the materials to be joined may require a tighter control range than a nominal set point well below the melting temperature of one or more materials to be joined. The control range may be asymmetrical about the nominal set point. By sufficiently heating, it is meant that the fluid is heated to a temperature that will enable at least partial melting, or at least softening, of the substrate or substrates. Sufficient heating may vary with the materials and equipment used. For example, if the heated fluid is applied to the substrate or substrates almost immediately, with little or no time to cool, the fluid may be heated to approximately the softening point or approximately the melting point of the substrate or substrates. If the heated fluid is directed to the substrate or substrates over some gap in time or distance, such that the heated fluid may cool somewhat before interacting with the substrate or substrates, it may be necessary to heat the fluid above, possibly significantly above, the softening point or melting point of the substrate or substrates.

The fluid may also be delivered with a pulsed application. The impact of the jet of heated fluid may be adjusted such that both the energy introduced by the jet plus the energy introduced by other means such as a heated anvil (if the anvil is heated), deformation of the substrate, and the internal friction of substrate layers are sufficient to at least partially melt the meltable components in the region 336 to create a certain tackiness, which will form a strong bond in the region 336, which may include an overlap area 362, upon compression. The melting of the meltable components may occur in a non-uniform manner throughout substrates in the region 336.

The duration of energy transfer in the process described herein may be a dynamic process, and may create a temperature gradient across the cross sections of the meltable components. That is, the core of the meltable components may remain solid while the exterior surface of the meltable components melt or come close to melting. Even below the melting temperature, the exterior surface may reach a softening point, such that plastic deformation of the material may occur at a much lower load than for the same material at ambient temperature. Thus, if one or more of the materials to be bonded have a softening point, the process may be adjusted to achieve a temperature in at least a portion of substrates between the softening point and the melting point. The use of a temperature at or above the softening point but below the melting point of one or more of the meltable components may allow for the creation of a strong bond between the substrate layers with reduced disruption to the structure of the meltable components e.g., attenuating or otherwise weakening the meltable components.

Figure 12 illustrates a perspective view of a manifold 202 and Figure 13 illustrates a perspective view of the manifold taken along line 13-13 of Figure 12. As previously discussed, the manifold 202 may include a first end surface 205 and a second end surface 209, opposite the first end surface 205. The first end surface 205 may include a fluid inlet portion 218 that defines at least one fluid inlet 220. The fluid inlet 220 may be connected to a fluid pathway 388 defined by a fluid chamber 386. The fluid pathway 388 connects the fluid inlet 220 with one or more fluid outlets. The fluid pathway 388 may include pathway segments including curved, angled, and/or linear portions that are configured to route the fluid through the fluid chamber 386 for a sufficient time for the fluid to be heated, as illustrated in Figure 13. An external heat member, not shown, and/or an internal heat member 304, as illustrated in Figure 13, heats the fluid chamber 386, which allows the fluid passing through the fluid pathway 388 to be heated to an exit temperature, which is the temperature at which the heated fluid at least partially melts the substrate assembly. The fluid may be released through the one or more fluid outlets. The fluid may move from the one or more fluid outlets into a fluid channel 392. The fluid channel 392 may be defined by a portion of the fluid chamber 386 and the nozzle plate 210. Thus, the nozzle plate 210 is positioned adjacent the fluid channel 392. The nozzle plate 210 may include a plurality of apertures 212, which may be formed into one or more groups or another pattern desirable for at least partially melting the substrate assembly. The fluid channel 392 may extend along the length and width of the portion of the nozzle plate 210 defining the plurality of apertures 212. The heated fluid may pass through the plurality of apertures 212 defined by the nozzle plate 210 and onto the substrate assembly 190 and/or through the substrate assembly 190.

The manifold 202 may include a support plate 394, as illustrated in Figures 12 and 13. The support plate 394 may be disposed on the external surface 256 of the nozzle plate 210. The support plate 394 may cover a portion of the nozzle plate 210. The support plate 394 may include one or more slots 396. Each of the slots 396 may substantially surround the plurality of apertures 212 or a portion of the plurality of apertures 212. Each slot may include one or more slot walls 398 that extend from the external surface 256 of the nozzle plate 210 to the external support surface 395 of the support plate 394 or the outer circumferential surface 201 and substantially surround a portion of one or more apertures 212. As illustrated in Figures 8B and 12, the one or more slots 396 may be separated by a radial slot distance RSD. The radial slot distance RSD is the distance measured along the outer circumferential surface 201 in the machine direction MD between a first plane taken parallel to the central longitudinal axis 204 and intersecting the point or portion of the first slot that is nearest to the adjacent slot in the machine direction and a second plane taken parallel to the central longitudinal axis 204 and intersecting the point or portion of the adjacent slot that is nearest to the first slot in the machine direction. The RSD may be from about 5 millimeters to about 80 millimeters and/or from about 15 millimeters to about 40 millimeters, including all 0.1 millimeters therebetween, such as 8.5 millimeters. It is to be appreciated that the radial slot distance RSD between slots placed on adjacent manifolds may be a dynamic distance. The radial slot distance RSD will change based on the radius of the bonder apparatus 200 and, more specifically, the radial movement of the plurality of manifolds 202. The radial slot distance RSD between slots on a single manifold may be static or fixed.

The one or more slots 396 may also be separated by a cross direction slot distance CSD, not shown. The cross direction slot distance CSD is the distance measured along the outer circumferential surface 201 in the cross direction CD, which is parallel to the central longitudinal axis 204, between a first plane taken perpendicular to the central longitudinal axis 204 and intersecting the point or portion of the first slot that is nearest to the adjacent slot in the cross direction CD and a second plane taken perpendicular to the central longitudinal axis 204 and intersecting the point or portion of the adjacent slot that is nearest to the first slot in the cross direction. The cross direction slot distance CSD may be from about 25 mm to about 500 mm and/or about 50 mm to about 300 mm and/or about 150 mm to about 250 mm, including all 0.1 mm therebetween.

The support plate 394 may include a thickness Y, as illustrated in Figure 13, of from about 0.5 millimeters to about 20 millimeters, including all 0.1 increments therebetween. The support plate 394 may be any thickness Y such that the substrate assembly 190 is a desired distance from the external surface 256 of the nozzle plate 210 and, thus, the plurality of apertures 212. For example, the thickness Y may be such that the such that the distance from the layer of the substrate assembly positioned closest to the fluid nozzles and the external surface 256 of the nozzle plate 210 may range from 0.5 millimeters to about 20 millimeters, or between about 0.5 millimeters and about 5 millimeters, or between about 0.5 millimeters and about 3 millimeters, including all 0.1 millimeter increments between the recited ranges. Control of the distance between the substrate assembly 190 and the apertures 212 may also result in a relatively more predictable fluid spray and melt pattern during the fluid application and heating/melting process. It is also to be appreciated that the manifold 202 may not include a support plate 394 and the substrate assembly 190 may be disposed on the external surface 256 of the nozzle plate 210. Thus, the substrate assembly 190 may abut the external surface 256 of the nozzle plate and the apertures of the nozzle plate. Thus, the distance between the substrate assembly 190 and the external surface 256 may be about zero millimeters.

Alternatively or in addition to the heat member positioned adjacent the first end surface 205 or the second end surface 209 of the manifold 202, each of the plurality of manifolds 202 may include a heat member 304, as illustrated in Figure 13. The heat member 304 may extend along a side surface 424 of the manifold from the first end portion 206 to the second end portion 208. The heat member 304 may include an external side surface 420 and an internal side surface 422. The internal side surface 422 of the heat member 304 may be in facing relationship with the fluid chamber 386. The external side surface 420 of the heat member 304 may be placed in facing relationship with the side surface 424 of the manifold 202, or the external side surface 420 of the heat member of an adjacent or second manifold 202. A heat member 304 may be placed on either or both sides of the manifold 202. Each heat member, placed on opposite sides of the manifold, may include an internal side surface and an external side surface, and each internal side surface may be in facing relationship with the fluid chamber 382 and each external side surface may be in facing relationship with an external side surface of the adjacent manifold or the side surface of the manifold. The heat member 304 may be configured to heat the fluid chamber 386 and, thus, the fluid contained within the fluid chamber 386. The heat member 304 may be any device that provides heat to the fluid chamber 386. For example, the heat member 304 may be an electric heater, an induction heater, which heats an electronically conductible object by electromagnetic indication, laser heating, or ultrasonically heating. The heat source 304 may be connected to a power supply 426.

Each of the heat sources 304 may have a temperature sensor 428 attached thereto. The temperature sensor 428 may be any device that detects the temperature of the heat source 304 and/or the fluid chamber and/or the heated fluid. The output of the temperature sensor may be transmitted back to a controller and the controller may increase, decrease, turn on, or turn off a given heat source. The temperature sensor 428 may extend through an aperture in the manifold. The temperature sensors allows an operator to monitor and change the temperature of the fluid chamber 386, the temperature of the fluid supplied to the plurality of apertures, and the heat member 304.

As previously discussed, the manifold 202 may include a first end surface 205 having a fluid inlet portion 218 defining one or more fluid inlets. For example, as illustrated in Figure 6A, the fluid inlet portion 218 may include a first fluid inlet 220 and a second fluid inlet 222, or the fluid inlet portion 218 may include a first fluid inlet 220, as illustrated in Figure 12. The first fluid inlet 220 may be connected with a first fluid pathway 388 and a second fluid pathway 389. However, in some embodiments, the first fluid inlet 220 may be connected with the first fluid pathway 388 and the second fluid inlet 222 may be connected with a second fluid pathway 389. The opposite end of the fluid pathways may be operatively connected to the plurality of apertures 212 such that fluid may be released through the plurality of apertures 212. Each of the first fluid pathway 388 and the second fluid pathway 389 may be defined by the fluid chamber 386. The first fluid pathway 388 and the second fluid pathway 389 may be configured such that the fluid passed through each of the first and second fluid pathways 388, 389 is supplied to all of the plurality of apertures 212 defined by the nozzle plate 210. The first fluid pathway 388 and the second fluid pathway 389 may also be configured such that the first fluid pathway 388 supplies fluid to the first group of apertures 214 and the second fluid pathway 389 supplies fluid to the second group of apertures 216. Thus, the fluid pathways may be configured to supply separate, independent apertures.

It is also to be appreciated that the first fluid pathway 388 may be configured to supply the fluid and the second fluid pathway 389 may be used to heat the fluid by passing a second heated fluid, such as oil or air. For example, the first fluid pathway 388 may receive fluid at an entrance temperature, which may be at an ambient temperature. The second fluid pathway 389 may receive a second fluid at a temperature above ambient. As the first fluid passes through the first fluid pathway 389 and the second fluid passes through the second fluid pathway, the temperature of the second fluid may heat the fluid chamber 386 causing the first fluid to be heated. The first fluid may be heated to an exit temperature, which is sufficient to at least partially melt the substrate assembly. The first fluid may be released through the plurality of apertures and the second fluid may exit through a fluid exit defined by the first end surface or the second end surface of the manifold.

It is also to be appreciated that the fluid chamber 386 may include any number of fluid pathways. The number of pathways may depend, in part, on the groups of apertures and how these groups of apertures are controlled.

Each of the fluid inlets 220 may be operatively connected, such as by fluid supply lines 219, to a valve 224. The valve 224 may be positioned in an open configuration, which allows fluid to flow into the fluid inlet and through the fluid pathway, or a closed configuration, which prevents fluid from being supplied to the fluid inlet and the fluid pathway. A controller 430 may be any device that passes a signal that is used to control the position or configuration of the valve. An example of a controller 430 may include a programmable logic controller (PLC) or other control computer that may be a stand-alone system or part of an overall control system. Generally, the valve is controlled by providing an on signal to place the valve in an open configuration or an off signal to place the valve in a closed configuration. The controller may pass an on or off signal at an exact predetermined time. This allows for precise and accurate control of the valve. The controller may also account for performance speed of the valve, by varying the one and off signal timing to account for the actuation time of the valve. The controller 430 may control one or more valves 224, and the one or more valves may be operatively connected to one or more fluid inlets 220. The controller 430 may communicate either an open configuration or a close configuration to a valve 224, as illustrated in Figure 14A, for example. The open or closed configuration may depend on the placement of the substrate assembly 190 on the bonder apparatus 200, as previously discussed. The valve 224 may then be connected to a single, fluid inlet 220 which is defined by the first end surface 205 of a manifold 202. If the valve 224 is positioned in the open configuration, the fluid will pass through the plurality of apertures defined by the nozzle plate. If the valve is positioned in the closed configuration, no fluid will pass through the valve.

In another example, the controller 430 may control a valve operatively connected to a first fluid inlet 220 and a second fluid inlet 222, as illustrated in Figure 14B. Because a single valve controls both fluid inlets, when the valve is positioned in an open configuration, fluid may be supplied to both the first fluid inlet 220 and the second fluid inlet 222. Similar to the above, when the valve 224 is in a closed configuration, no fluid will pass through the first fluid inlet 220 and the second fluid inlet 222.

In yet another example, as illustrated in Figure 14C, the controller 430 may communicate with more than one valve. The controller 430 may configure the first valve 226 to be in either an open configuration, such that fluid passes to the first fluid inlet, or a closed configuration, such that no fluid passes to the first fluid inlet. Further, independent of the first valve 226, the controller 430 may configure the second valve 228 to be in an open configuration, such that fluid passes to the second fluid inlet, or a close configuration, such that no fluid passes to the second fluid inlet. Thus, a single manifold may include a first group of apertures fluidly connected to the first fluid inlet and a second group of apertures fluidly connected to the second fluid inlet. Depending on the control of the first valve and the second valve, fluid may exit through only the first group of apertures and not through the second group of apertures, or vice versa. It is also to be appreciated that the first and second valves may simultaneously be positioned in the open configuration such that fluid passes to both the first fluid inlet and the second fluid inlet. Similarly, both the first and the second valves may simultaneously be positioned in the closed position. It is to be appreciated that the manifold may include any number of fluid inlets and each of these fluid inlets may be operatively connected to a valve that is controlled by the controller. For example, the manifold may include a third and fourth fluid inlet that are fluidly connected to a third and fourth valve, respectively.

It is also to be appreciated that the valve 224 may be placed prior to the fluid entering the manifold 202, as previously discussed, or after the fluid has been at least partially heated within the manifold 202. More specifically, a valve many be placed after the fluid has traversed through the fluid pathway 388 but prior to the fluid being released into the fluid channel 392 or through the plurality of apertures 212. Thus, the valve 224 would control the release of fluid into the one or more fluid channels 392 and the controller 430 would control the position of the valve 224.

In summary, a method for forming a bond in a substrate assembly 190 may include the steps of rotating the bonder apparatus 200 about an axis of rotation 204. The bonder apparatus 200 includes a plurality of manifolds 202 disposed about a central longitudinal axis 204 and configured to rotate about the central longitudinal axis 204. The first substrate assembly 190 may be advanced in a machine direction. The first substrate assembly 190 may include a first process product pitch, wherein the first product pitch is defined by a first leading portion and a first trailing portion, and a first central portion between the first leading portion and the first trailing portion. Further, the first substrate assembly includes a first surface and a second surface opposite the first surface. The bonder apparatus 200 may be radially traversed prior to accepting the substrate assembly or after the substrate assembly has been disposed on the bonder apparatus. The bonder apparatus 200 may be radially traverse by either radially expanding the bonder apparatus such that the circumference of the outer circumferential surface becomes greater or radially contracting the bonder apparatus such that the circumference of the outer circumferential surface is reduced. The bonder apparatus 200 includes an initial radius or minimum radius. The substrate assembly 190 may be advanced onto the bonder apparatus such that the first surface of the first substrate assembly is in facing relationship with the plurality of manifolds 202. More specifically, the first leading portion of the first substrate assembly may be received on a first manifold of the plurality of manifolds. Further, the first trailing portion of the first substrate assembly may be received on a second manifold of the plurality of manifolds. The first manifold and the second manifold may be separated by a first product arc length. The first central portion of the first substrate assembly may be disposed on one or more manifolds between the first manifold and the second manifold. A fluid may be passed to or directed toward the first manifold and the second manifold. The fluid is at a first temperature while being moved to the first manifold and the second manifold. Once the fluid enters the first manifold and the second manifold, the fluid may be heated to a second temperature within each of the first manifold and the second manifold to form a heated fluid. The heated fluid may be released through a first plurality of apertures of the first manifold such that the heated fluid engages the first leading portion. The heated fluid may also be released through a second plurality of apertures of the second manifold such that the heated fluid engages the first trailing portion. At least a portion of the first leading portion and the first trailing portion of the first substrate assembly may be bonded while rotating on the bonder apparatus 200 or after being removed from the bonder apparatus 200.

The substrate assembly 190 may undergo one or more processes while being transferred by the bonder apparatus 200. For example, the substrate assembly 190 may undergo cutting, such as with a cutting mechanism. The cutting mechanism may be a laser, a knife, or an ultrasonic cutting device, such as an ultrasonic processes system as disclosed in European Patent Application No. 2796271A1. In some embodiments, the process assembly 220 may include a seaming station 548, such as disclosed in U.S. Patent No. 8,778,127 and U.S. Patent Publication Nos. 2014/0110053; 2014/0305593; and 2013/0218116.

It is also to be appreciated that the fluid may be heated prior to being supplied to the bonder apparatus 200, such as disclosed in U.S. Case No. 14138P filed on December 10, 2015. Thus, the fluid is heated external to the bonder apparatus and supplied to the bonder apparatus as a heated fluid.

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”.

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.

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.

## CLAIMS

What is claimed is:

1. An apparatus for bonding one or more substrates, the apparatus comprising:

a plurality of manifolds disposed about a central longitudinal axis and configured to rotate about the central longitudinal axis, and wherein each of the plurality of manifolds has a first end portion and a second end portion opposite the first end portion, and wherein each of the plurality of manifolds comprises:

a support plate;

a nozzle plate comprising a first surface, a second surface opposite the first surface, and a plurality of apertures extending from the first surface to the second surface, wherein the first surface of the nozzle plate is adjacent the internal surface of the support plate; and

a fluid chamber adjacent the second surface of the nozzle plate and configured to supply a fluid to the plurality of apertures, wherein the fluid chamber comprises a first fluid inlet, a first fluid outlet, and a first fluid pathway between the first fluid inlet and the first fluid outlet, wherein the first fluid outlet is fluidly connected to the plurality of apertures of the nozzle plate;

a plurality of heat members adjacent the plurality of manifolds and configured to rotate about the central longitudinal axis, wherein the plurality of heat members are configured to heat the fluid; and

a plurality of valves each of which being fluidly connected to a respective one of the fluid inlets, wherein each of the plurality of valves is configured to be in a first open position such that the fluid enters through the fluid inlet or a second closed position such that the fluid is prevented from entering the fluid inlet,

wherein the fluid enters the fluid inlet at a first entrance temperature and the fluid exits the fluid outlet at a first exit temperature, wherein the first entrance temperature is less than or equal to the first exit temperature, and

wherein the apparatus is configured to move from an initial radius to a second radius.

2. The apparatus of claim 1, wherein the fluid chamber comprises a second fluid inlet, a second fluid outlet, and a second fluid pathway between the second fluid inlet and the second fluid outlet, wherein a second fluid enters the second fluid inlet and exits the second fluid outlet defined by the second end surface of the fluid chamber, and wherein the second fluid enters the second fluid inlet at a second entrance temperature and the second fluid exits the second fluid outlet at a second exit temperature, wherein the second entrance temperature is greater than the second exit temperature.

3. The apparatus of claim 2, wherein the second fluid is oil.

4. The apparatus of any one of the preceding claims, wherein the fluid chamber comprises a second fluid inlet, a second fluid outlet, and a second fluid pathway between the second fluid inlet and the second fluid outlet, wherein the second fluid outlet is fluidly connected to the plurality of apertures, wherein a second fluid enters the second fluid inlet and exits the second fluid outlet, and wherein the second fluid enters the second fluid inlet at a second entrance temperature and the second fluid exits the second fluid outlet at a second exit temperature, wherein the second entrance temperature is less than the second exit temperature.

5. The apparatus of any one of the preceding claims, further comprising a support drum having an internal drum surface and an external drum surface opposite the internal drum surface, wherein the external drum surface supports the plurality of manifolds disposed radially about the external drum surface, and wherein the support drum is configured to rotate about the central longitudinal axis.

6. The apparatus of any one of the preceding claims, wherein the plurality of apertures comprise a first group of apertures, and wherein a first slot substantially surrounds the first group of apertures.

7. The apparatus of claim 6, wherein the plurality of apertures comprises a second group of apertures, and wherein the support plate comprises a second slot adjacent to the first slot, and wherein the second slot substantially surrounds the second group of apertures.

8. The apparatus of claim 7, wherein the first slot and the second slot are separated by a radial slot distance, wherein the radial slot distance is from about 7 mm to about 50 mm.

9. The apparatus of any one of the preceding claims, wherein each of the plurality of heat members comprises an external side surface and an internal side surface opposite the external side surface, wherein the external side surface and the internal side surface extend substantially parallel to the central longitudinal axis.

10. The apparatus of claim 9, wherein a first heat member of the plurality of heat members and a second heat member of the plurality of heat members are posited adjacent each other such that the external side surface of the first heat member is in facing relationship with the external side surface of the second heat member.

11. The apparatus of any one of the preceding claims, wherein each of the plurality of manifolds comprises a first end surface and a second end surface opposite the first end surface, wherein the first end surface and the second end surface are substantially perpendicular to the central longitudinal axis.

12. The apparatus of any one of the preceding claims, wherein the apparatus comprises at least four manifolds disposed about the central longitudinal axis.

13. The apparatus of any one of the preceding claims, further comprising a controller operatively connected to each of the plurality of valves, wherein the controller is configured to position a first

valve and a second valve of the plurality of valves in the first open position, wherein the first valve is operatively connected to a first manifold and the second valve is operatively connected to a second manifold, wherein the first manifold and the second manifold are separated by a first product pitch, and wherein the controller is configured to position a third valve and a fourth valve of the plurality of valves in the first open configuration, wherein the third valve is operatively connected to a third manifold and the fourth valve is operatively connected to a fourth manifold, wherein the third manifold and the fourth manifold are separated by a second product pitch.

14. The apparatus of claim 13, wherein the first product pitch is different from the second product pitch.

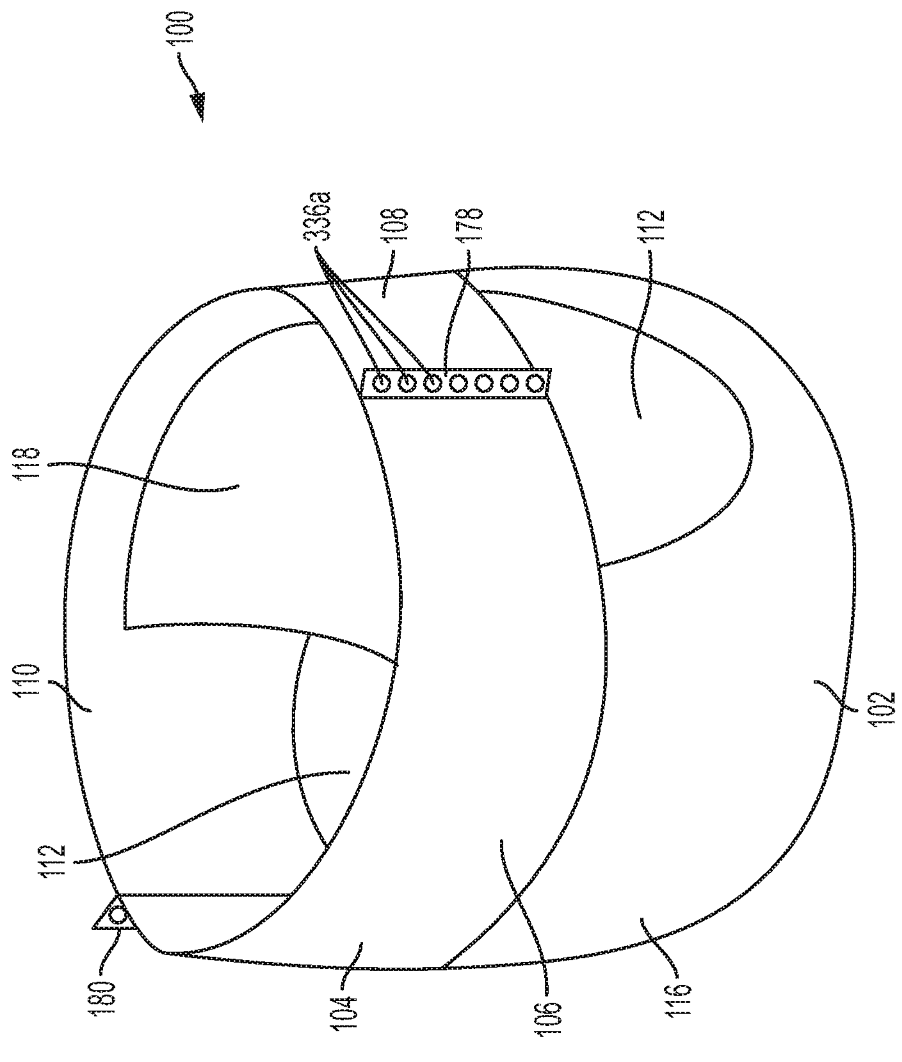



FIG. 1

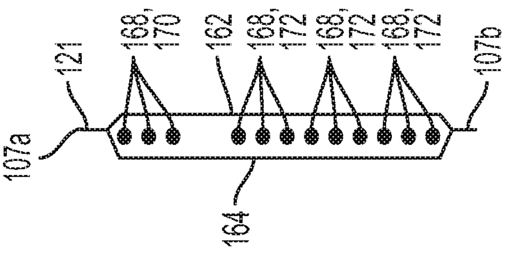



FIG. 3A

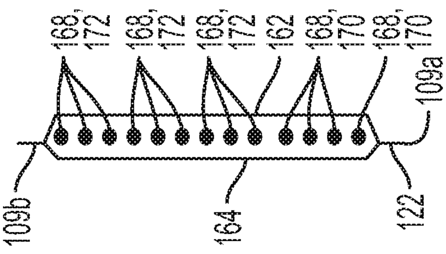



FIG. 3B

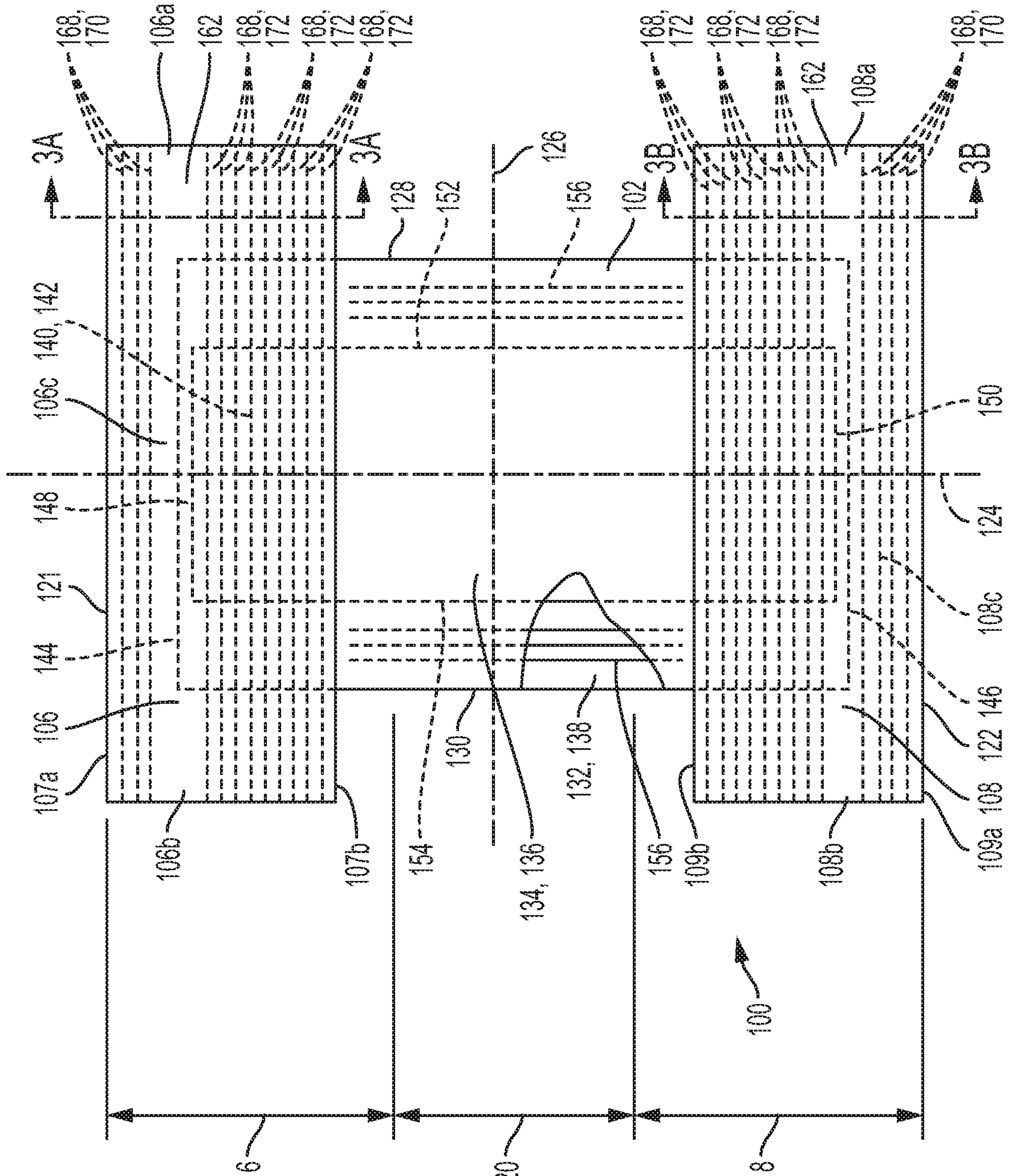



FIG. 2

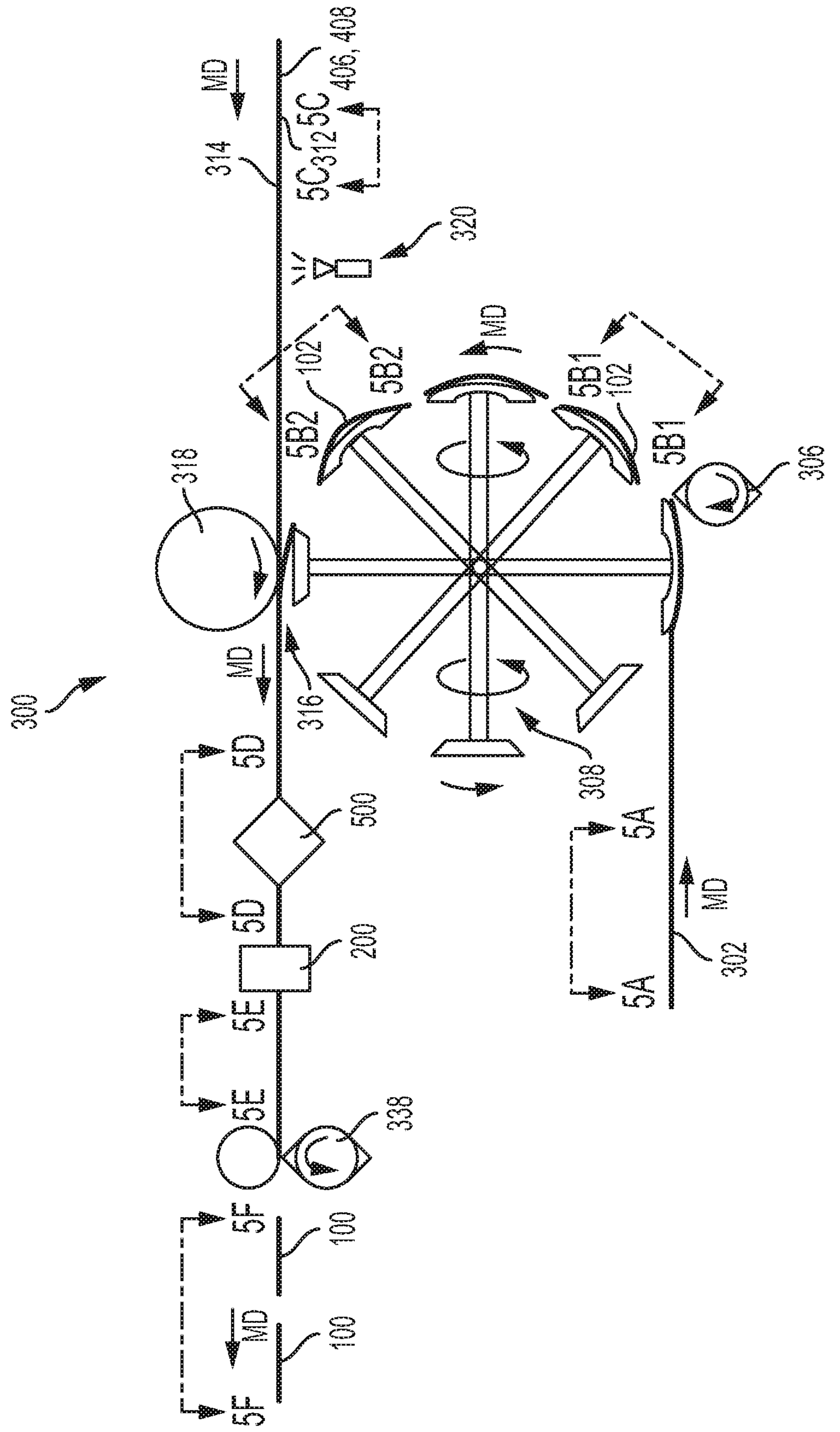

300
318
316
308
306
320
314
5C
312
406, 408
102
5B2
5B1
MD
5D
500
200
5E
338
5F
100
5A
302

FIG. 4

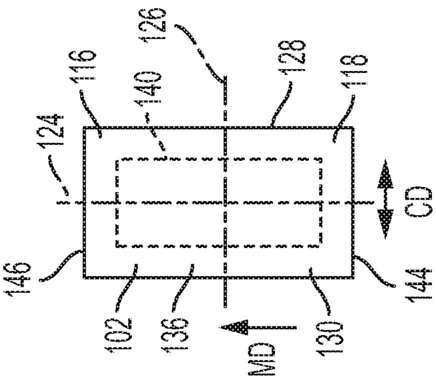



FIG. 5B1

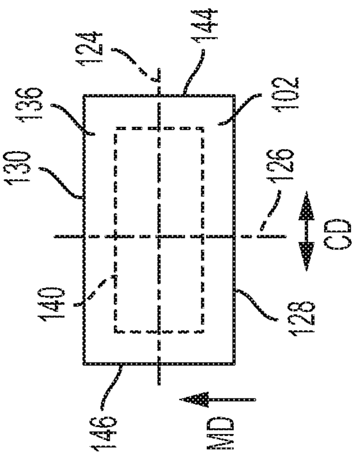



FIG. 5B2

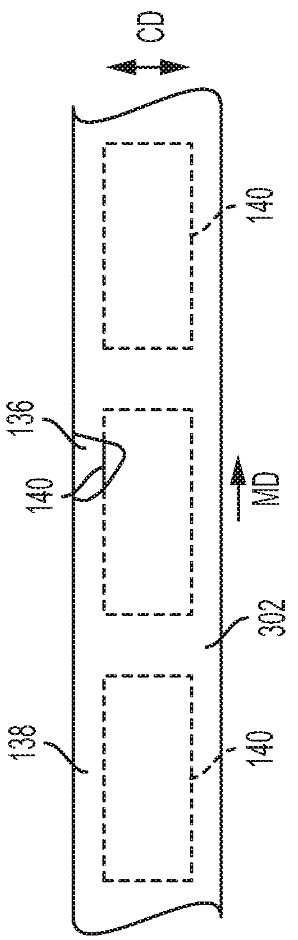



FIG. 5A

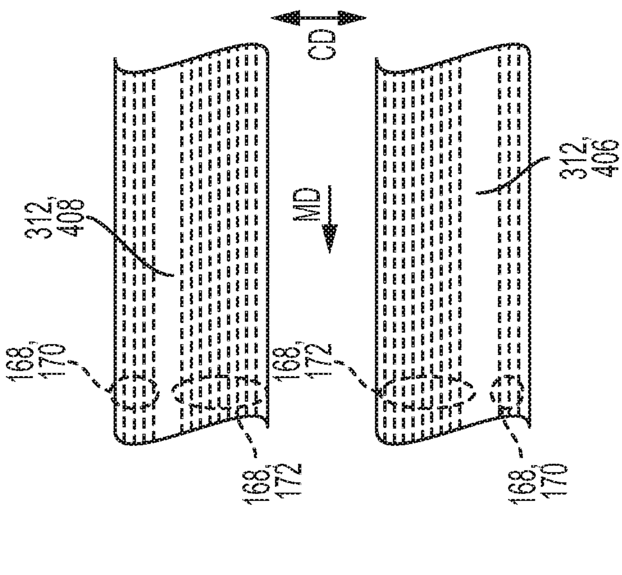



FIG. 5C

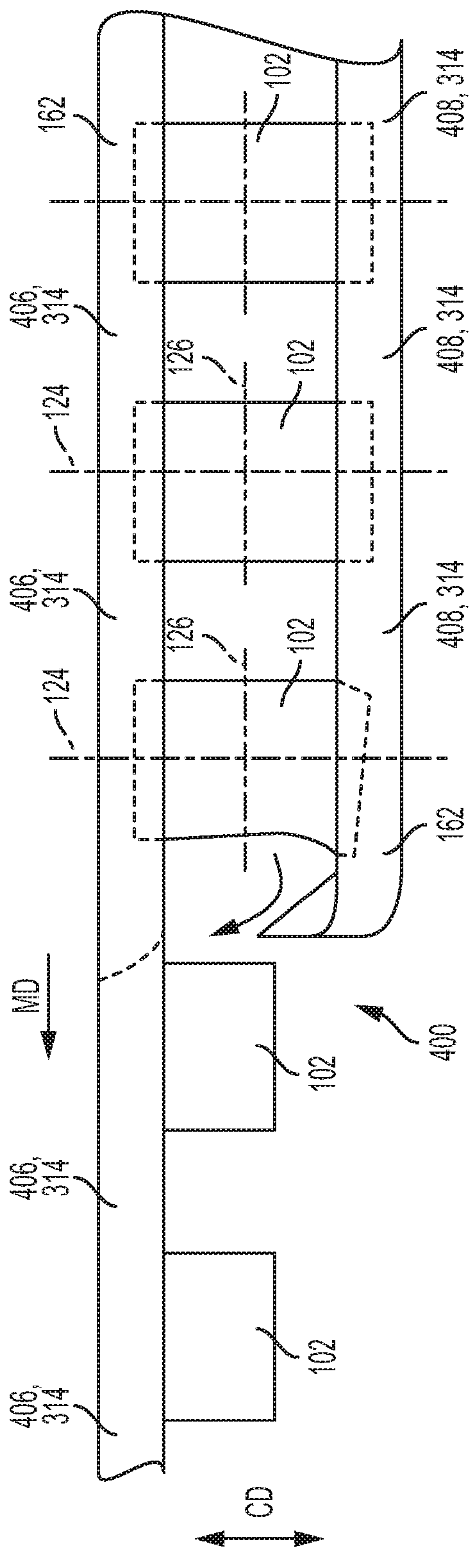



FIG. 5D

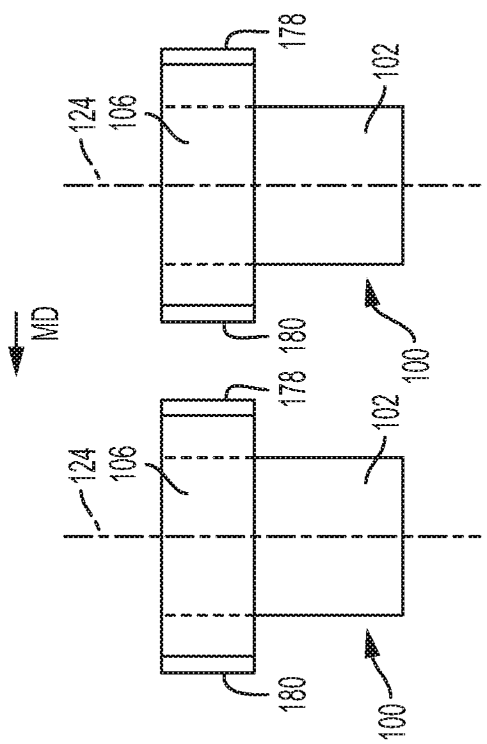



FIG. 5F

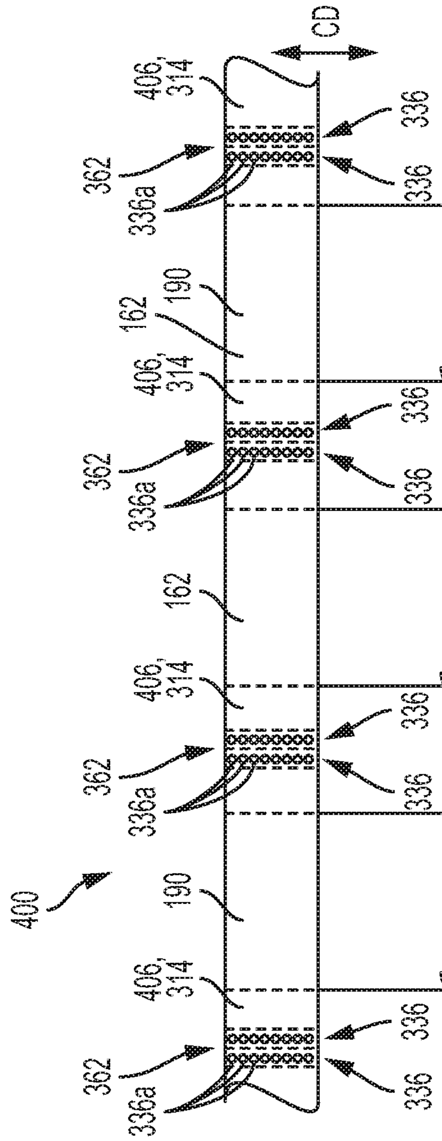



FIG. 5E

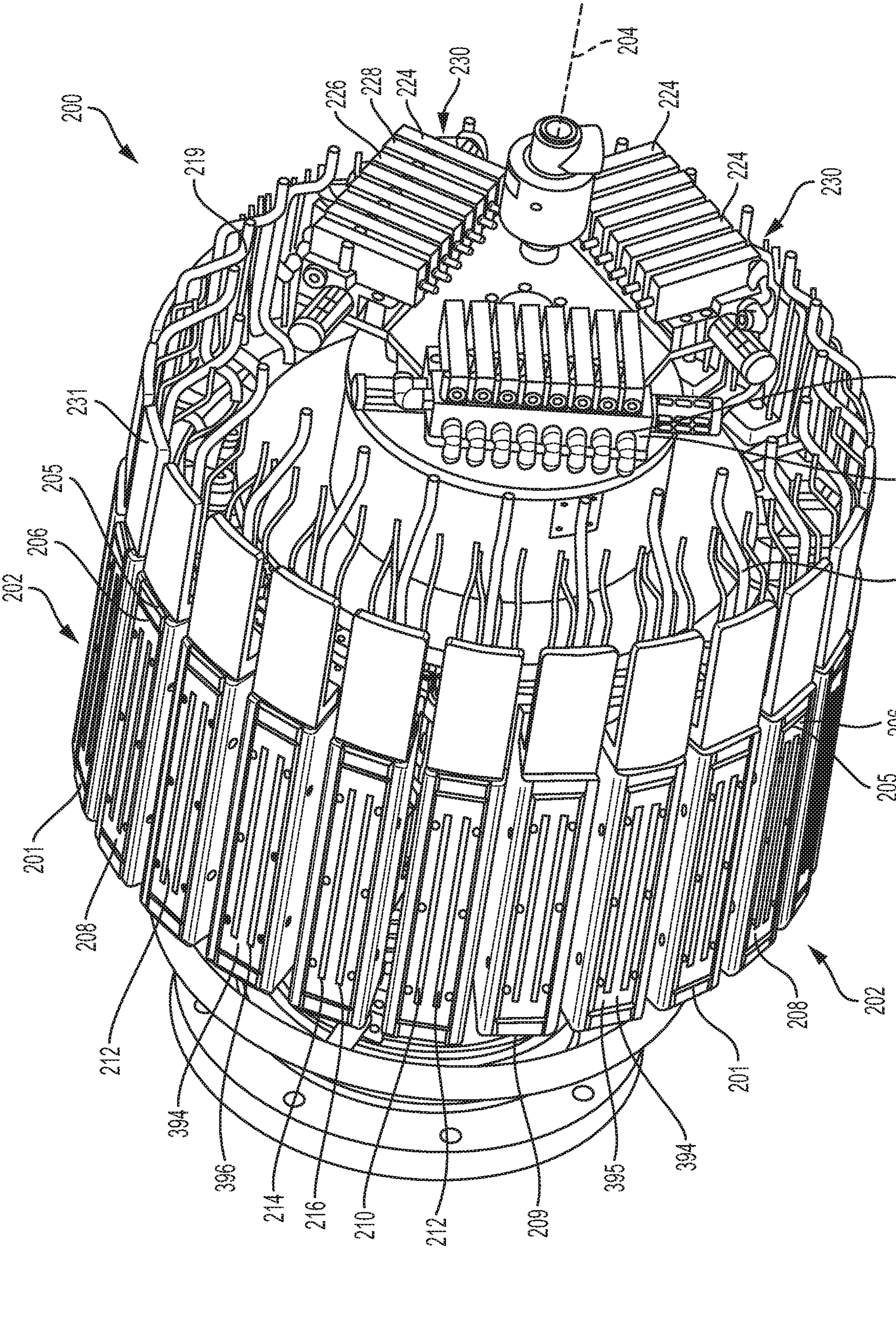

200
202
204
224
226
228
230
219
231
205
206
227
225
201
208
212
394
396
214
216
210
209
395

FIG. 6

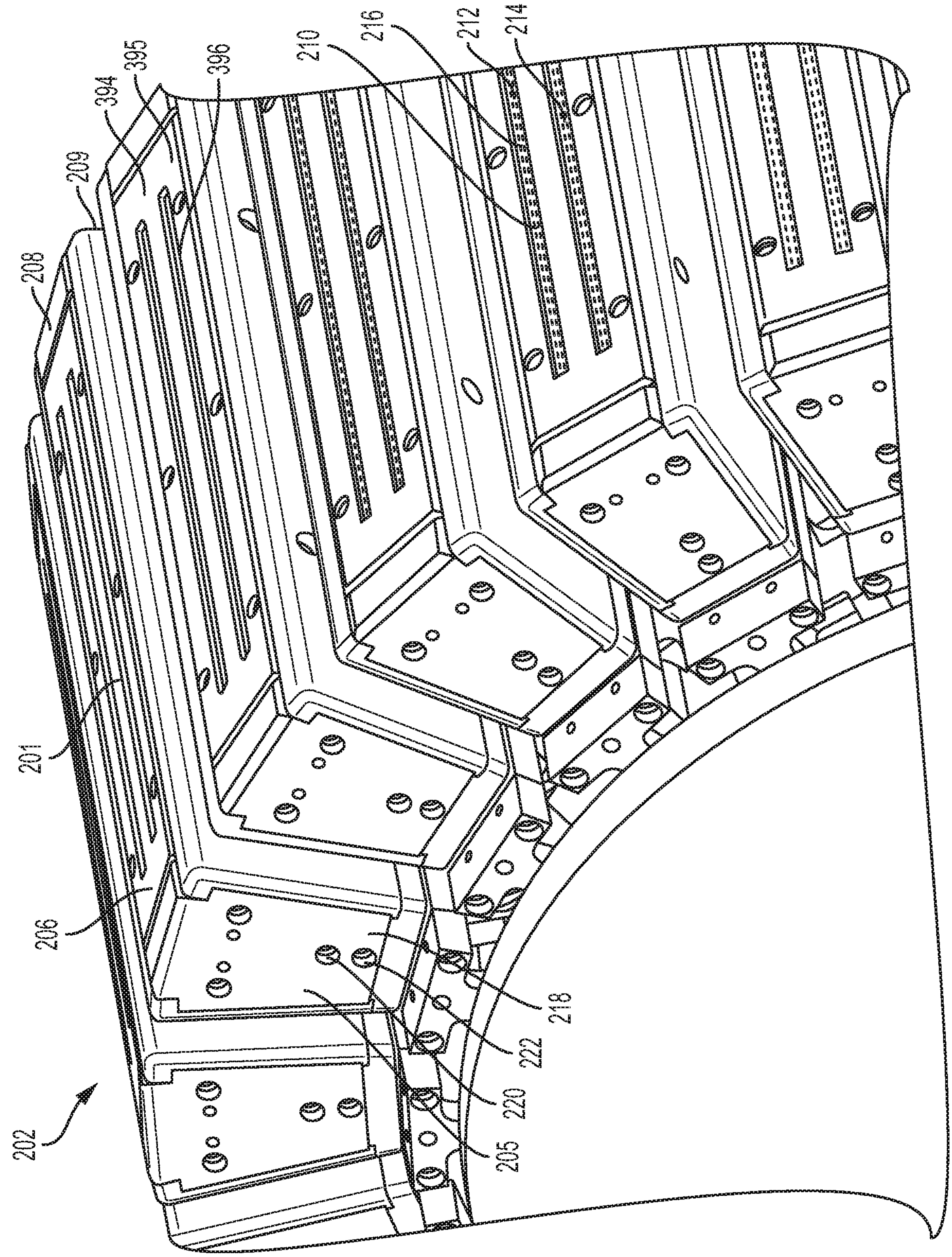



FIG. 6A

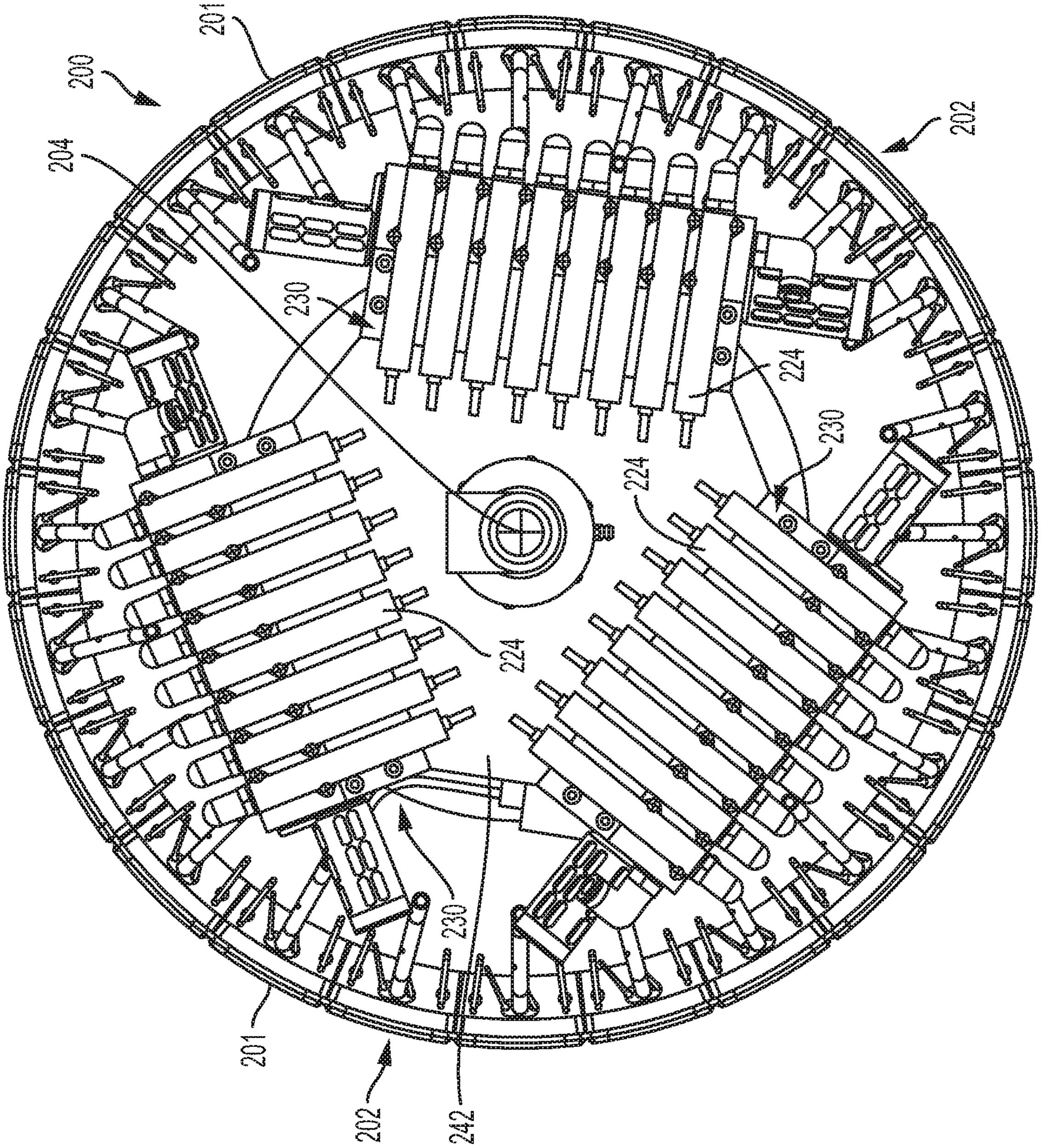



FIG. 7A

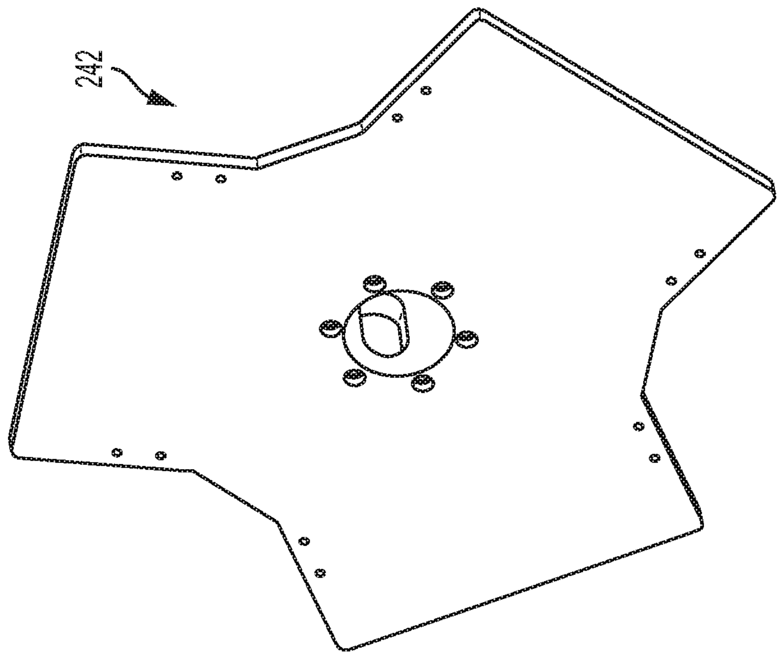



FIG. 7C

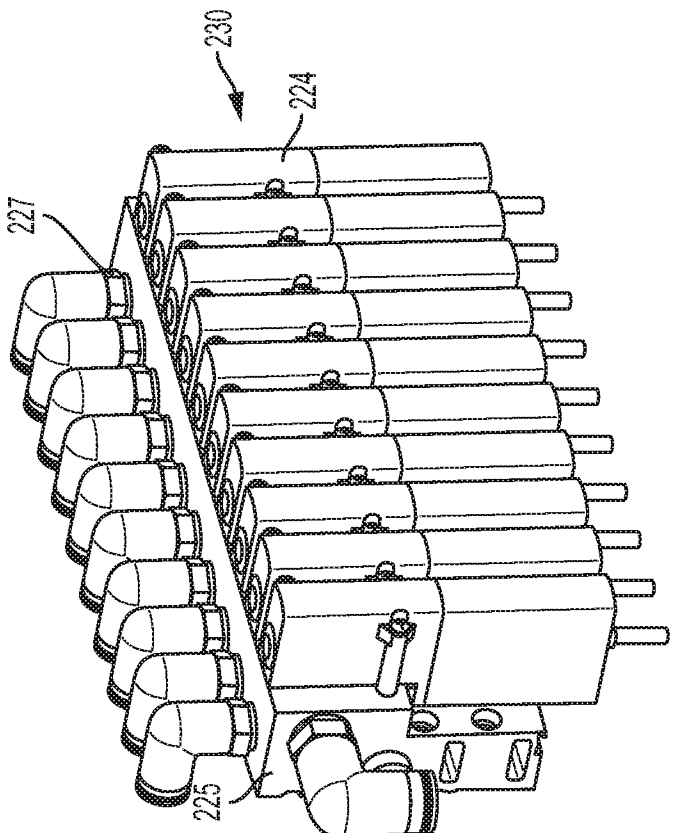



FIG. 7B

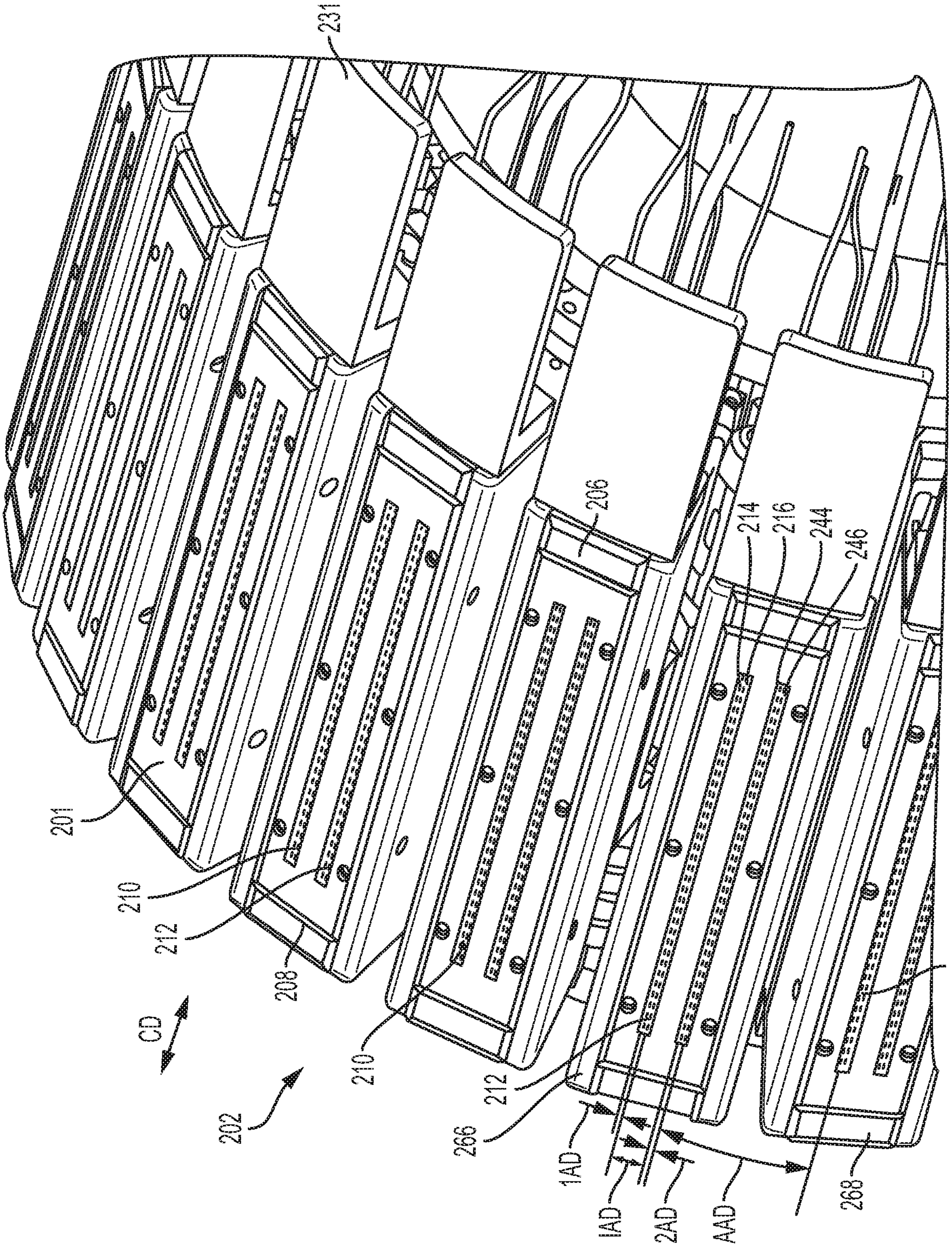
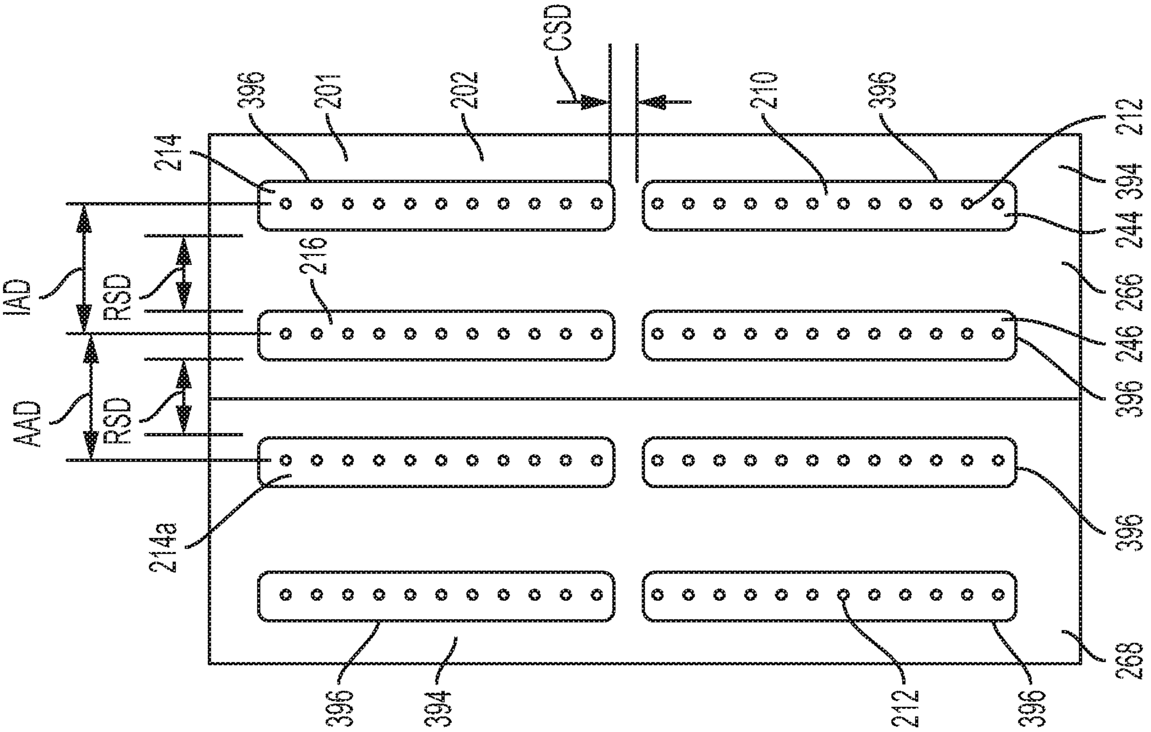

231
206
214
216
244
246
201
210
212
208
210
212
266
202
CD
1AD
IAD
2AD
AAD
268
214a

FIG. 8


CSD
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AAD
RSD
RSD
214
396
201
202
210
396
212
394
244
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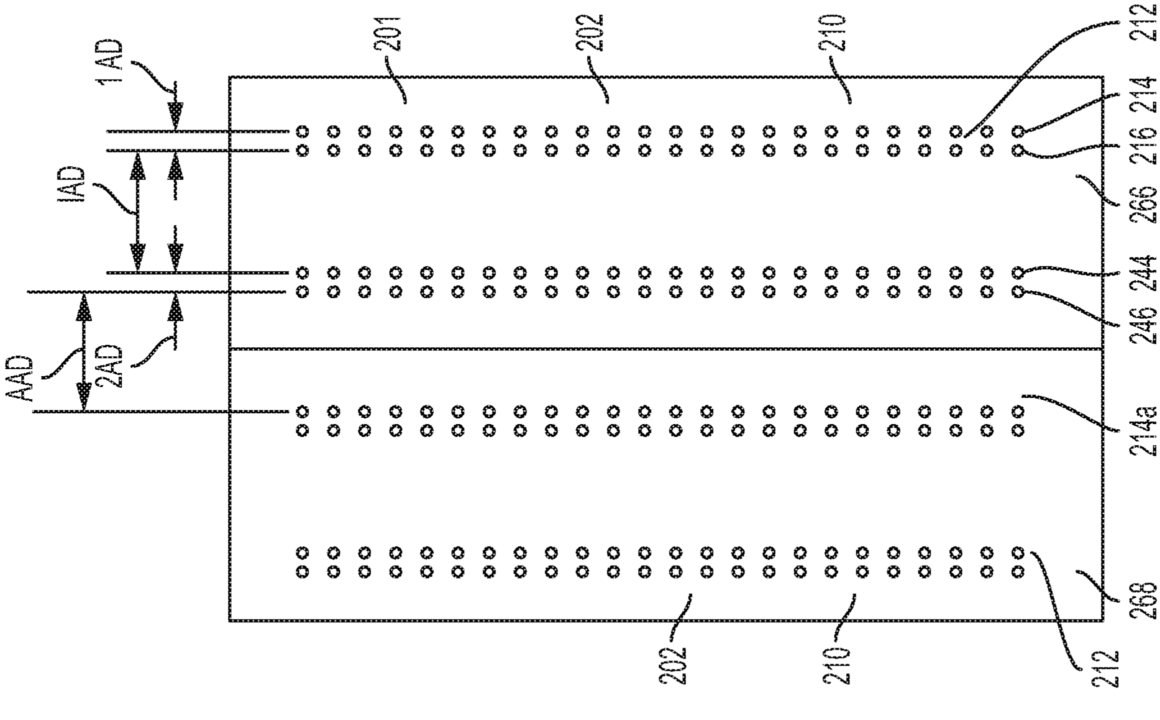
246
396
216
214a
396
268
396
394
212
396

FIG. 8B


1AD
IAD
AAD
2AD
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202
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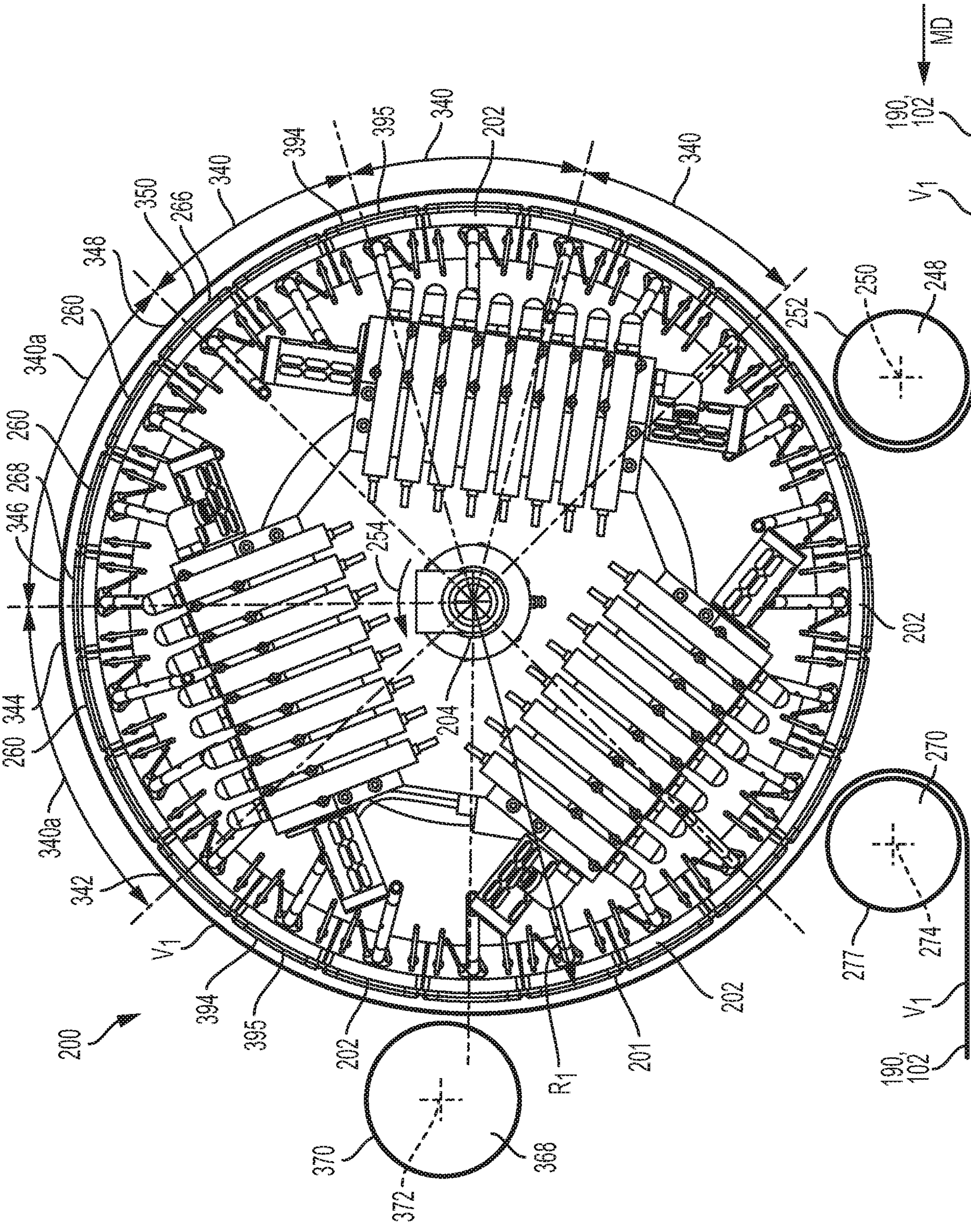
216
266
244
246
214a
268
202
210
212

FIG. 8A



MD
190, 102
V1
248
250
252
340
202
395
394
340
350
266
348
340a
260
260
268
346
254
204
202
344
260
340a
342
V1
394
395
202
200
R1
201
202
270
274
277
V1
190, 102
370
368
372


FIG. 9

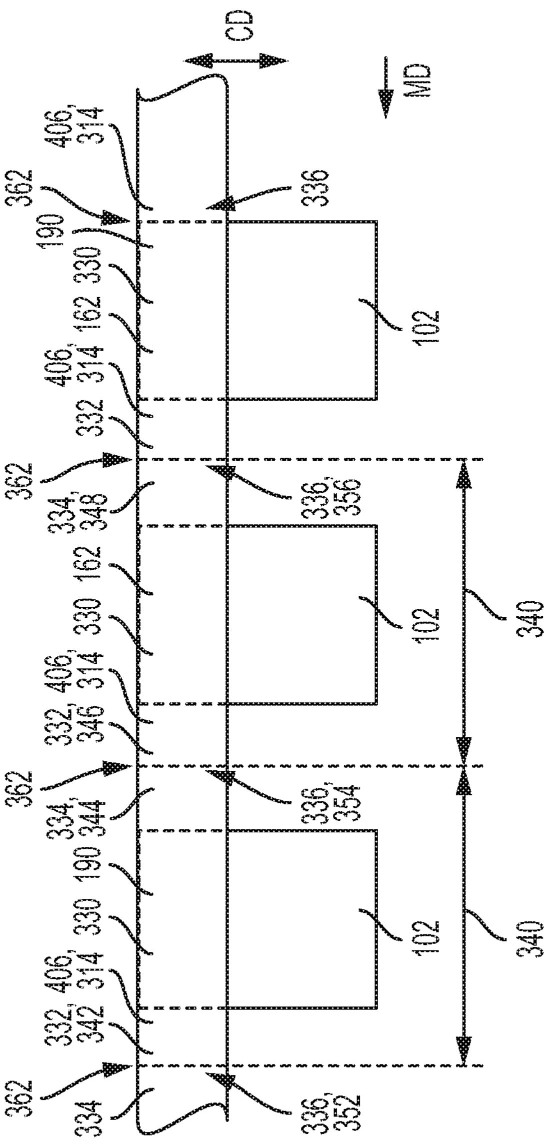



FIG. 10A

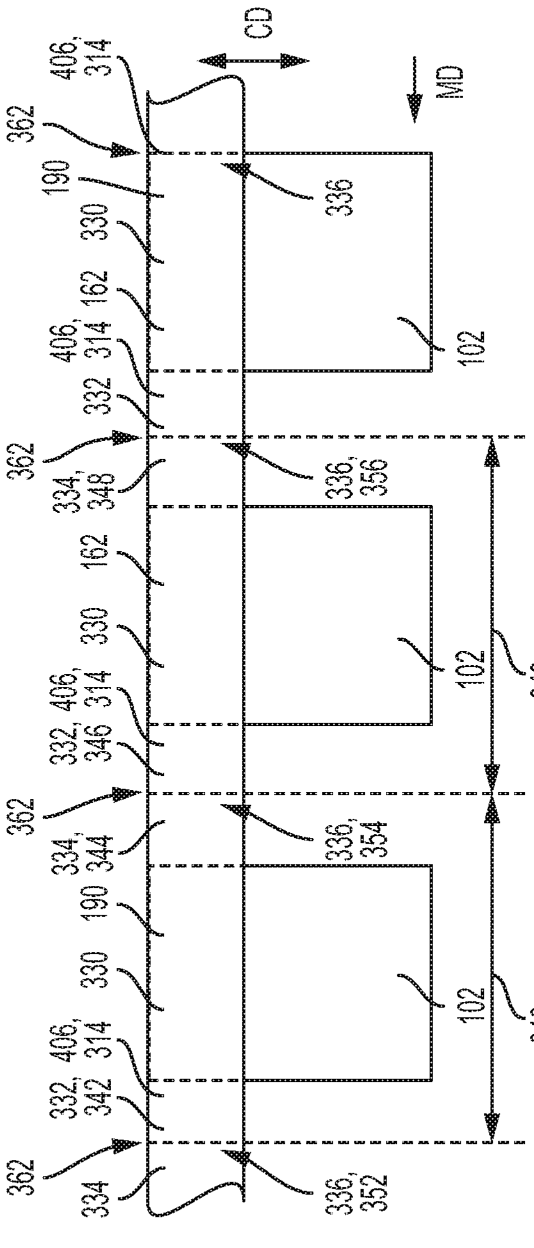
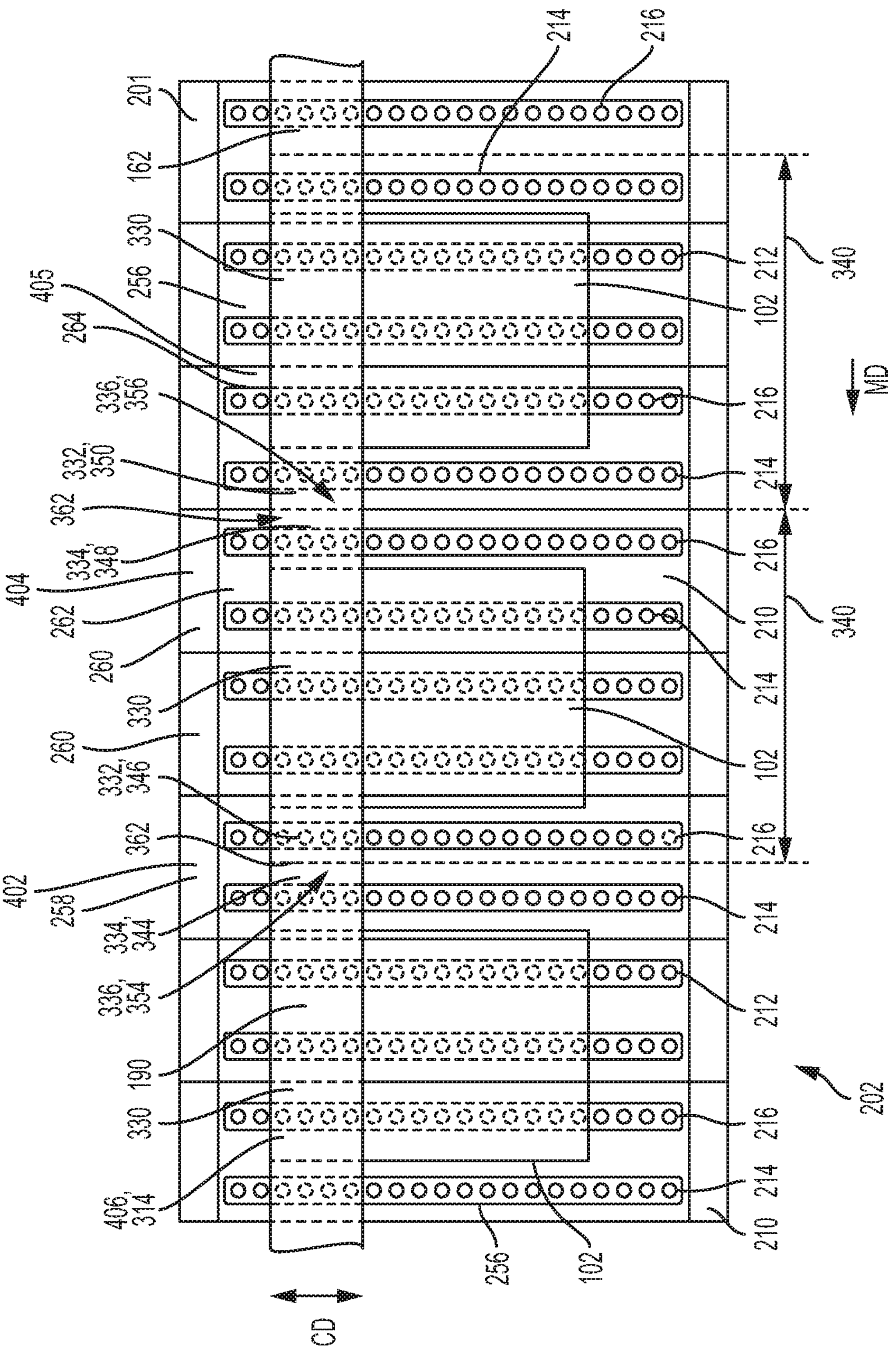



FIG. 10B


201
162
214
216
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256
405
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336,
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332,
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334,
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336,
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202
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FIG. 10C

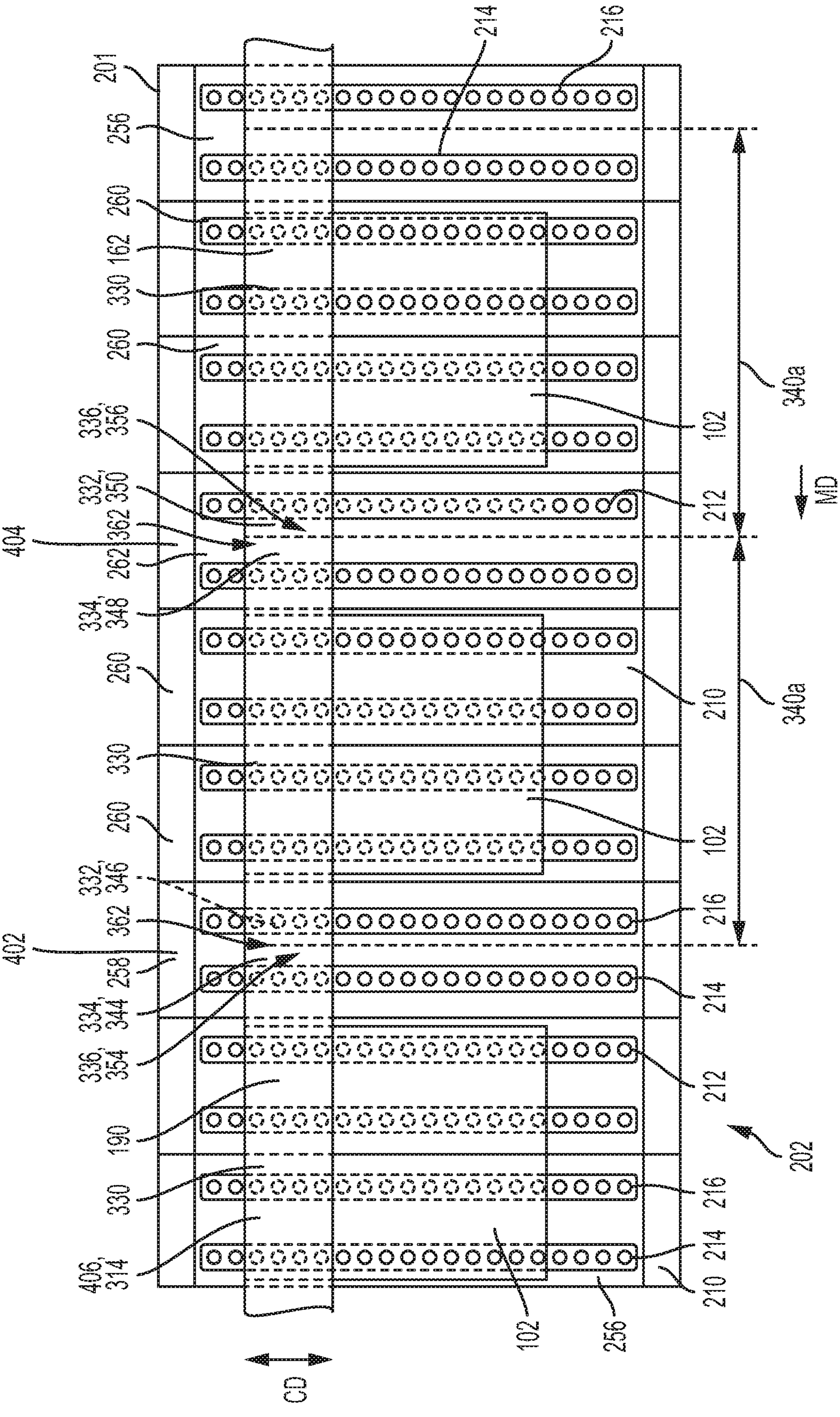

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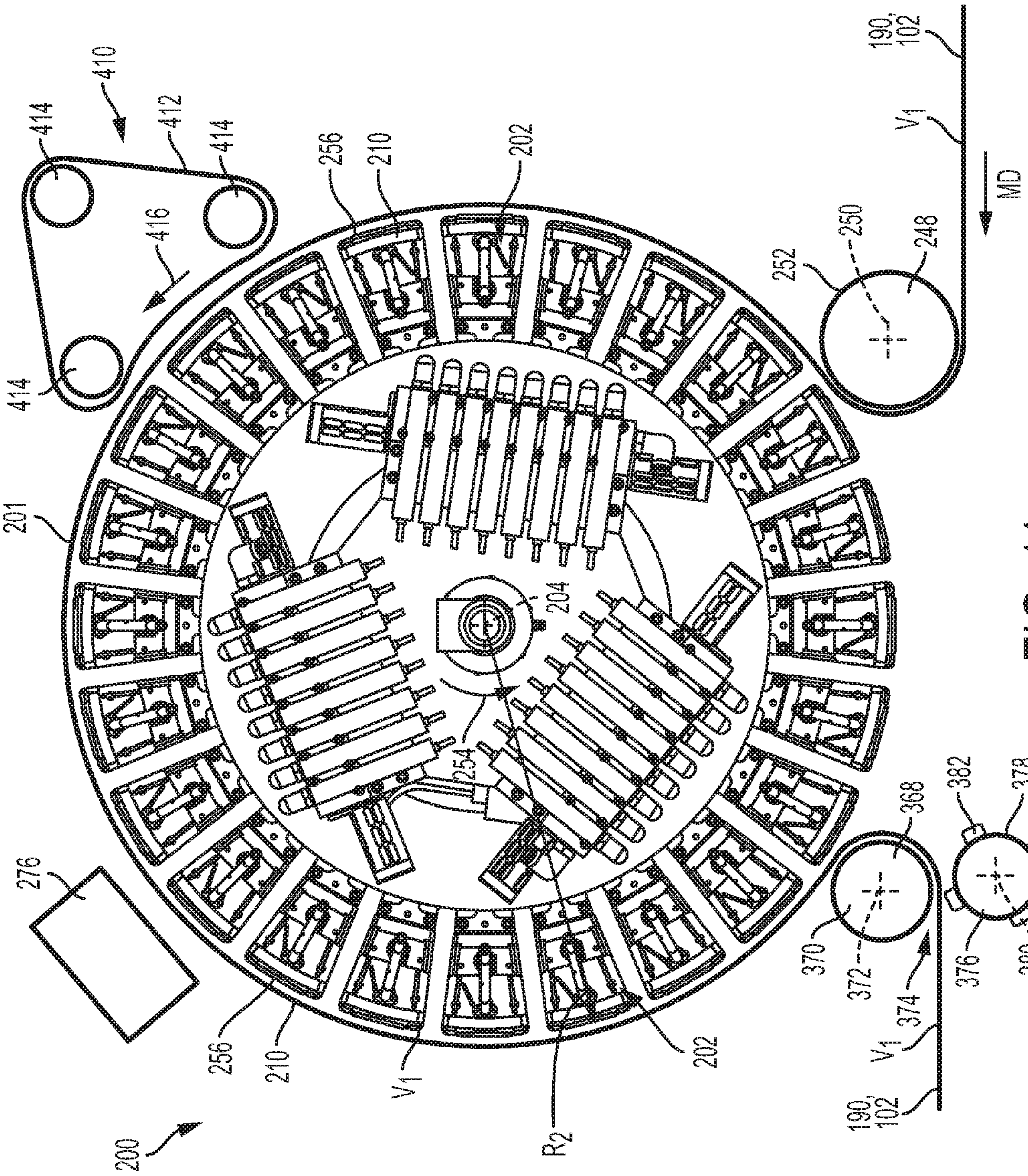
FIG. 10D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190, 102
V1

FIG. 11

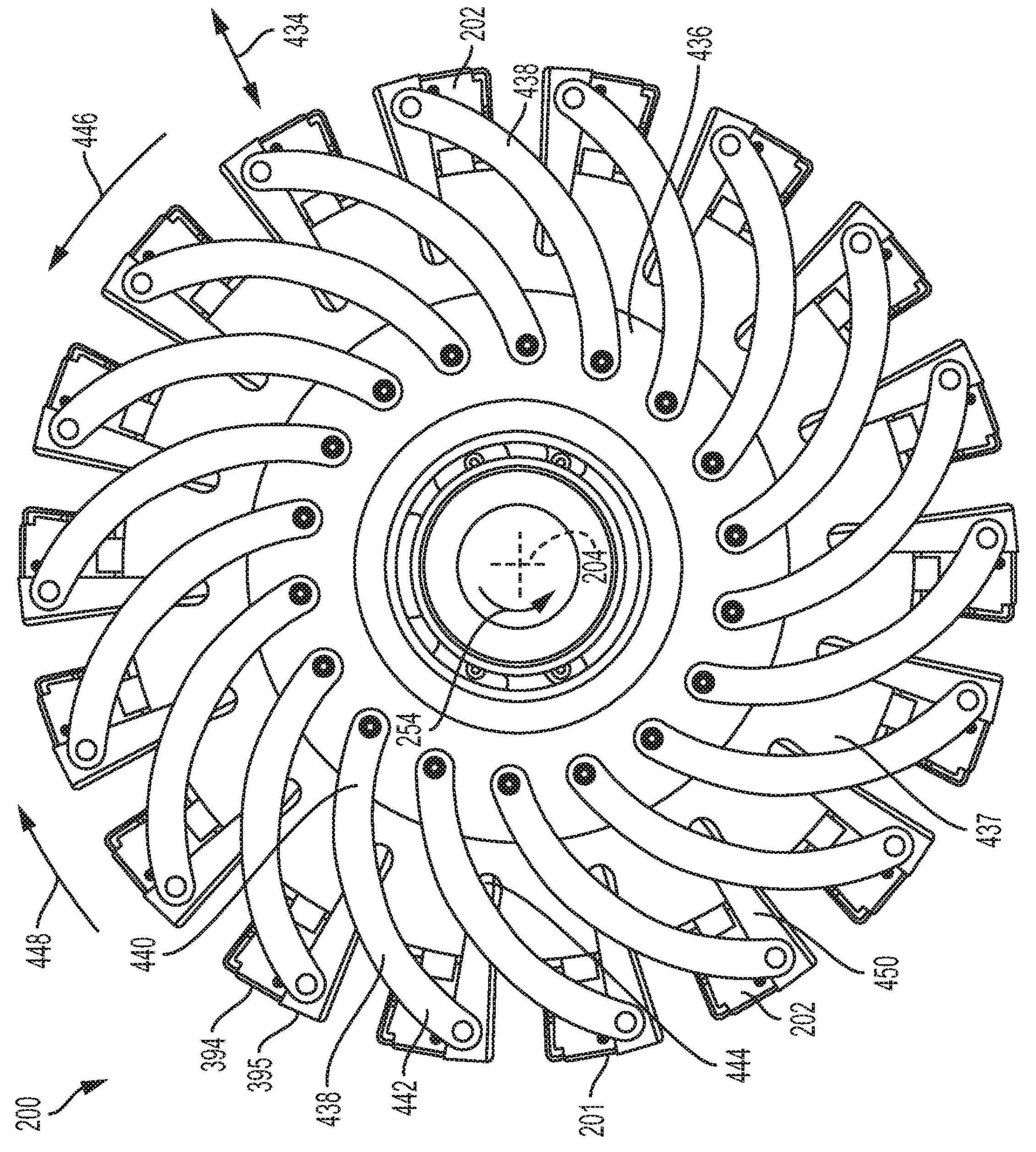
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FIG. 11A

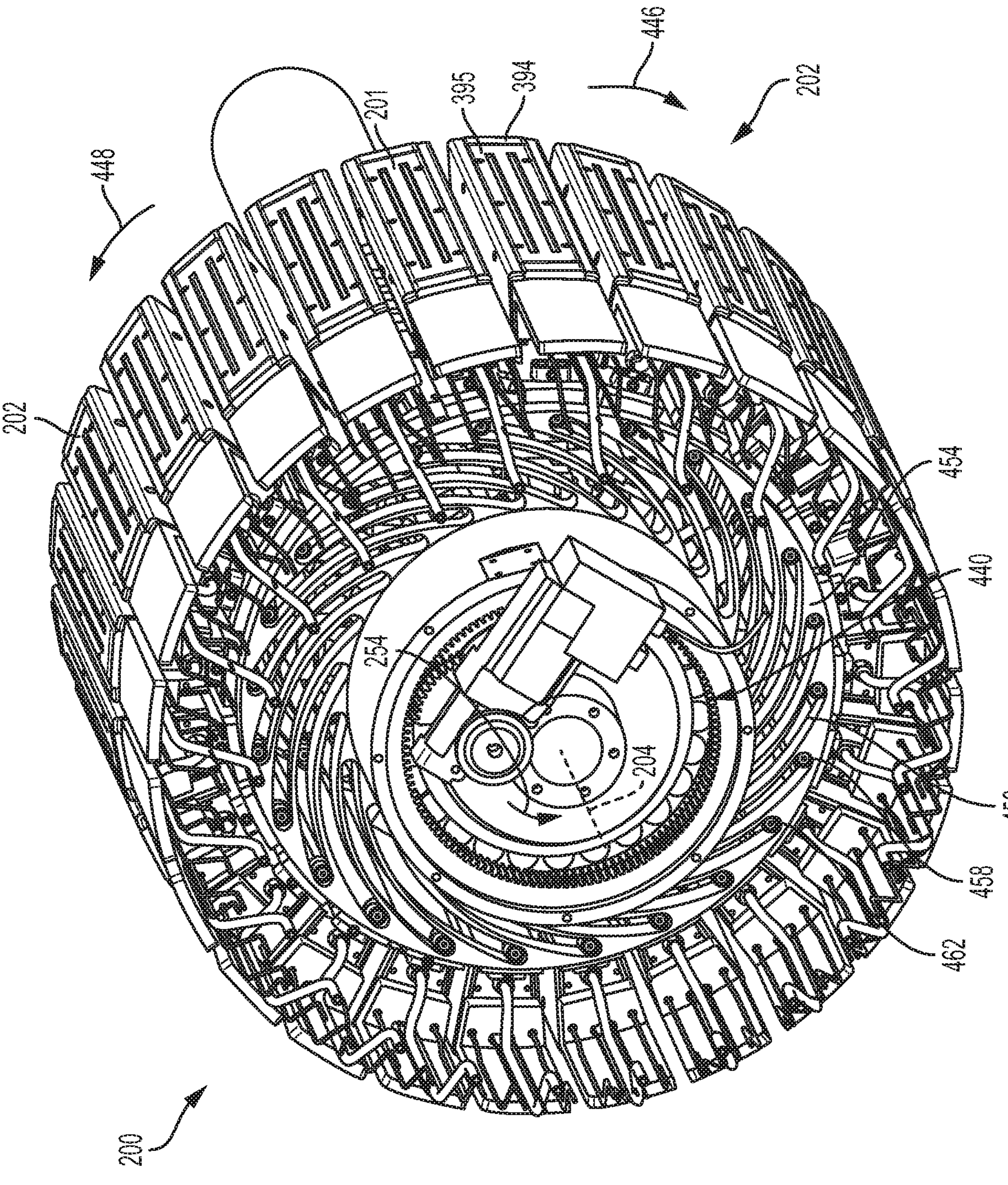
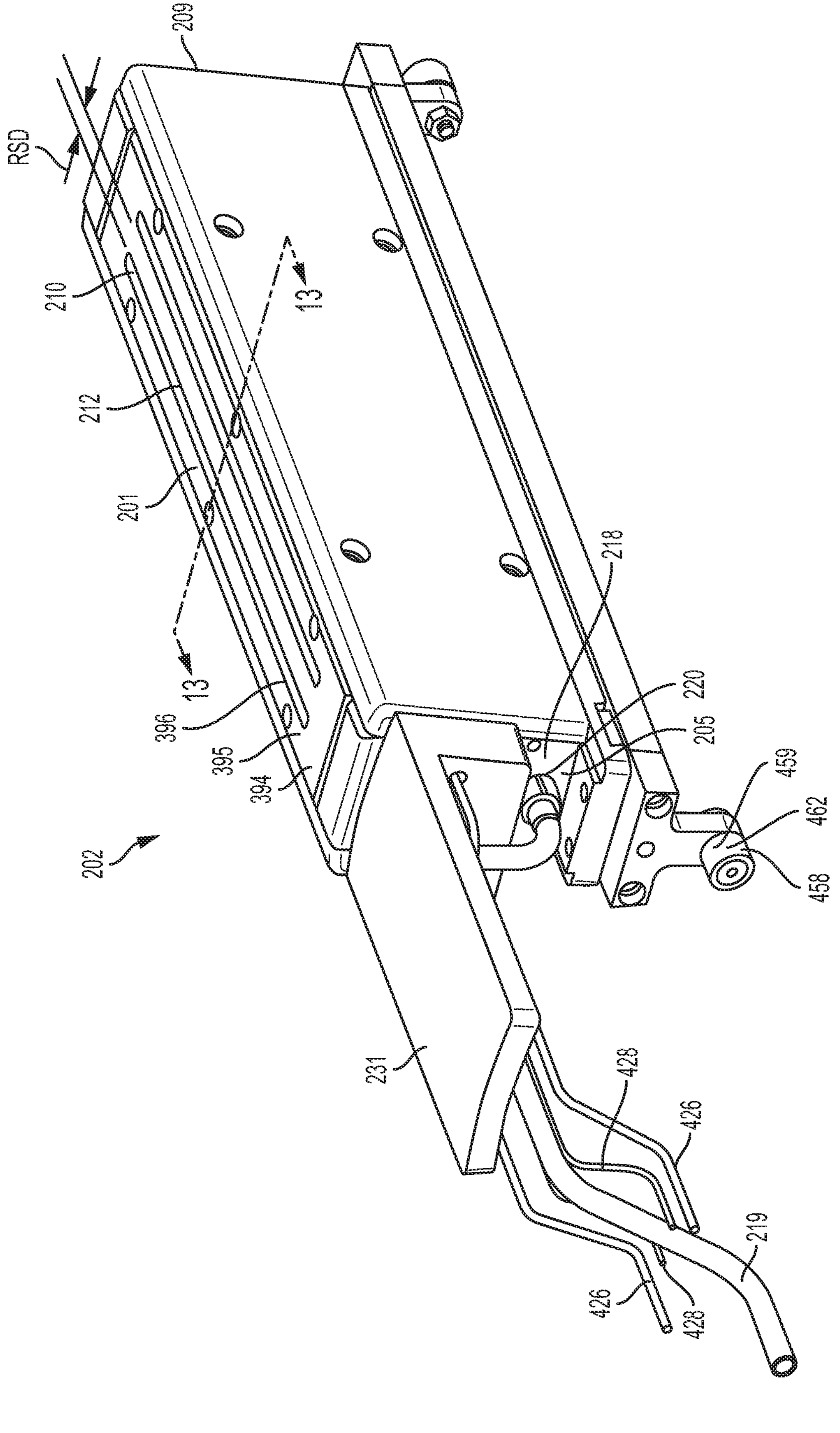



FIG. 11B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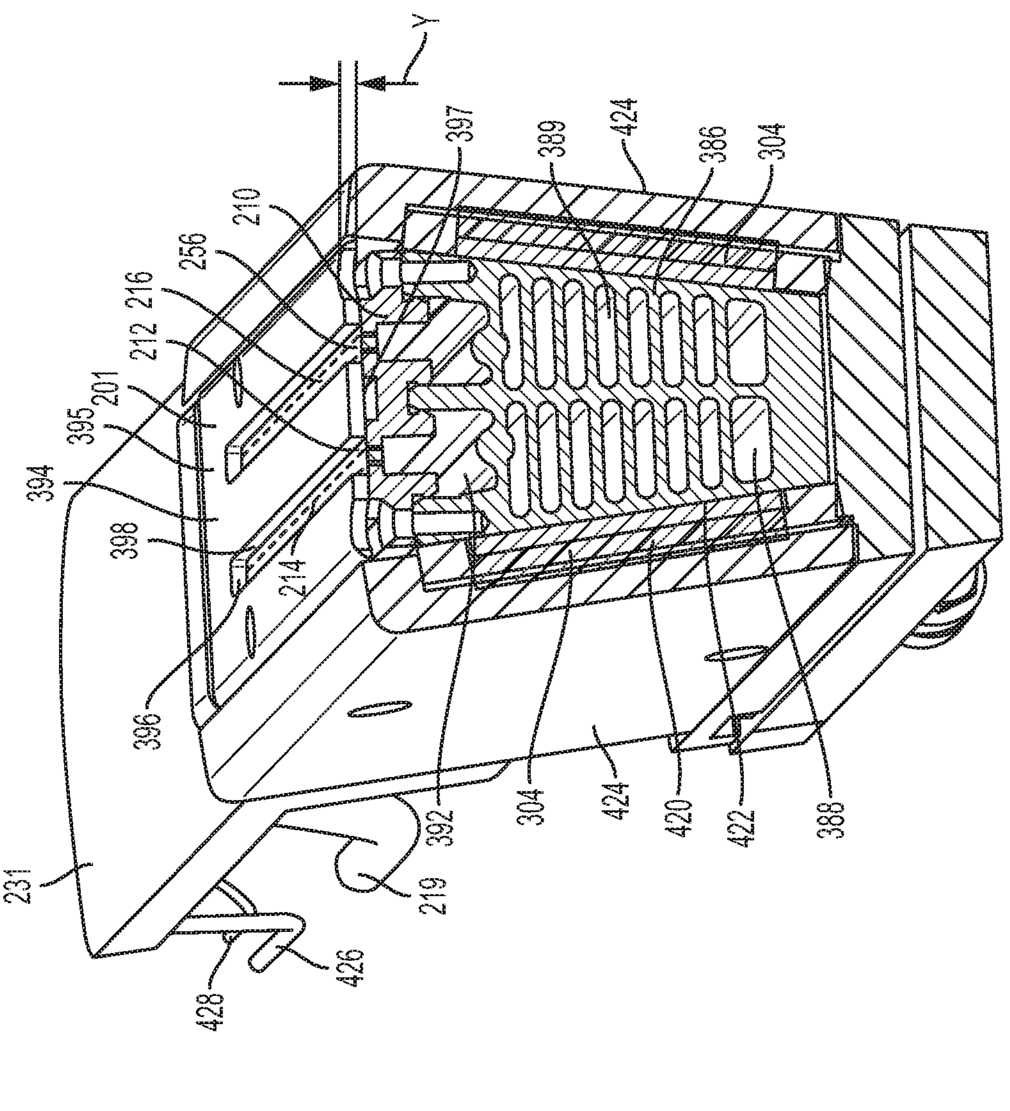
426
428

FIG. 12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219
426
428

FIG. 13

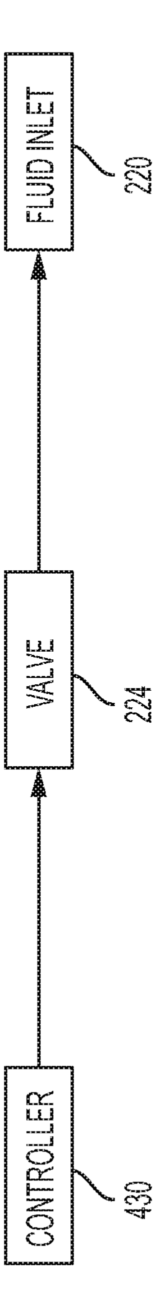


FIG. 14A

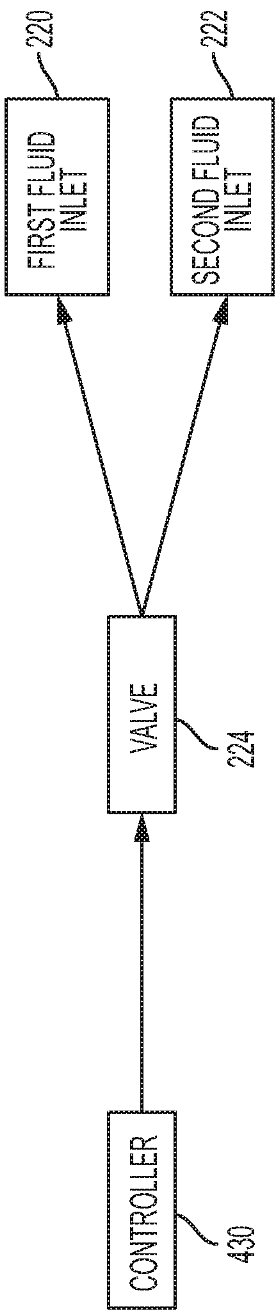


FIG. 14B

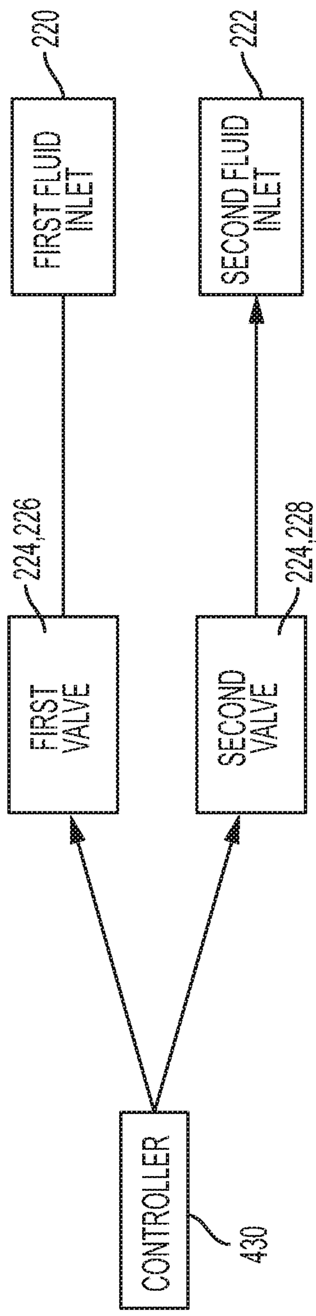


FIG. 14C

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/065693

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. A61F13/15 B29C65/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
A61F B29C

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 24 February 2017 | 09/03/2017 |

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

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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