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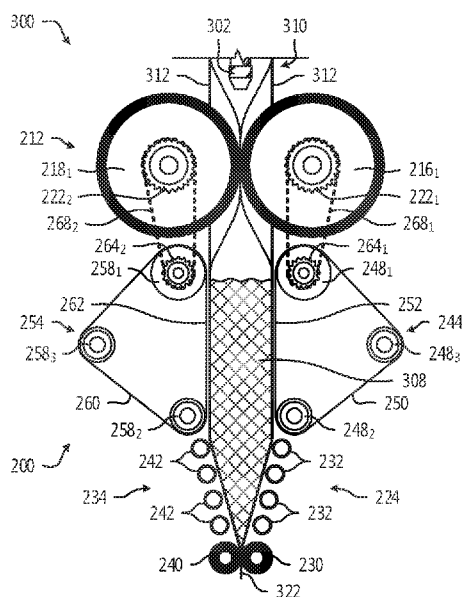


Fig. 4B

(57) Abstract: A vertical form-fill-seal (VFFS) system includes a dispenser, a drive system, a void-forming mechanism, and a film support system. The dispenser is configured to dispense a product into a tube of film. The drive system is configured to selectively advance the tube of film in a downstream direction. The void-forming mechanism is configured to periodically close on the tube of film to void or clean an area of the tube of film. The film support system is configured to provide lateral support to the tube of film. The film support system is positioned upstream of the void-forming mechanism. A method of packaging a product using the VFFS system includes the dispenser dispensing the product into the tube of film, the drive system advancing the tube of film in the downstream direction, and the void-forming mechanism closing on the tube of film to in the area of the tube of film.

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FILM SUPPORT IN VERTICAL FORM-FILL-SEAL SYSTEMS

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SPECIFICATION

BACKGROUND

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[0001] The present disclosure is in the technical field of vertical form-fill-seal (VFFS) systems. More particularly, the present disclosure is directed to embodiments of VFFS systems with film support systems that provide lateral support for film tubes while product is dispensed into the tube.

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[0002] Vertical form-fill-seal (VFFS) packaging systems have proven to be very useful in packaging a wide variety of food and non-food pumpable and/or flowable products. Many vertical form-fill-seal systems are commercially available from manufacturers or suppliers such as Hayssen, Illipak, Kartridge Pak, DuPont and Fresco.

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[0003] One example of such systems is the ONPACK™ family of flowable food packaging systems marketed by Cryovac/Sealed Air Corporation. The VFFS process is known to those of skill in the art, and described for example in U.S. Patent Nos. 4,506,494 (Shimoyama et al.), 4,589,247 (Tsuruta et al), 4,656,818 (Shimoyama et al.), 4,768,411 (Su), 4,808,010 (Vogan), and 5,467,581 (Everette), all incorporated herein by reference in their entirety. Typically, in such a process, lay-flat thermoplastic film is advanced over a forming device to form a tube, a longitudinal (vertical) fin or lap seal is made, and a bottom end seal is made by transversely sealing across the tube with heated seal bars. A liquid, flowable, and/or pumpable product, such as a liquid, semiliquid, or paste, with or without particulates therein, is introduced through a central, vertical fill tube to the formed tubular film. Squeeze rollers spaced apart and above the

bottom end seal squeeze the filled tube and pinch the walls of the flattened tube together. When a length of tubing of the desired height of the bag has been fed through the squeeze rollers, a heat seal is made transversely across the flattened tubing by heat seal bars which clamp and seal the film of the tube therebetween. After the seal bars have been withdrawn the film moves downwardly to be contacted by cooled clamping and severing bars which clamp the film therebetween and are provided with a cutting knife to sever the sealed film at about the midpoint of the seal so that approximately half of the seal will be on the upper part of a tube and the other half on the lower. When the sealing and severing operation is complete, the squeeze rollers are separated to allow a new charge of product to enter the flattened tube after which the aforementioned described process is repeated thus continuously producing vertical form-fill-seal pouches which have a bottom end and top end heat seal closure.

[0004] The process can be a two-stage process where the creation of a transverse heat seal occurs at one stage in the process, and then, downstream of the first stage, a separate pair of cooling/clamping means contact the just-formed transverse heat seal to cool and thus strengthen the seal. In some VFFS processes, an upper transverse seal of a first pouch, and the lower transverse seal of a following pouch, are made, and the pouches cut and thereby separated between two portions of the transverse seals, without the need for a separate step to clamp, cool, and cut the seals. A commercial example of an apparatus embodying this more simplified process is the ONPACK™ 3002 VFFS packaging machine marketed by Cryovac/Sealed Air Corporation. In either type of VFFS process, variations in the volume of product filling the individual pouches is undesirable. Thus, it would be desirable to provide more precise product volume control in these conventional systems.

SUMMARY

[0005] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not

intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

5 [0006] In a first embodiment, a vertical form-fill-seal (VFFS) system includes a dispenser, a drive system, a void-forming system, and a film support system. The dispenser is configured to dispense a product into a tube of film. The drive system configured to selectively advance the tube of film in a downstream direction. The void-forming mechanism is configured to periodically close on the tube of film to void or clean an area of the tube of film. The film support system configured to provide lateral support to the tube of film. The film support system is positioned upstream of the void-forming mechanism.

10 [0007] In a second embodiment, the film support system of the first embodiment comprises a first film support system having a first belt configured to provide lateral support to the tube of film and a second film support system having a second belt configured to provide lateral support to the tube of film. The first and second belts are capable of counterrotating with the tube of film located therebetween.

15 [0008] In a third embodiment, the VFFS system of the second embodiment is configured such that the first belt includes a substantially-vertical portion, the second belt includes a substantially-vertical portion, and the first and second film support systems are arranged such that the substantially-vertical portion of the first belt and the substantially-vertical portion of the second belt are substantially parallel to each other.

20 [0009] In a fourth embodiment, the VFFS system of any one of the second or third embodiments is configured such that respective positions of the first and second film support systems can be varied to accommodate different sizes of tubes of film.

[0010] In a fifth embodiment, the drive system of any of the second through the fourth embodiments includes a first drive wheel and a second drive wheel. The first and second drive wheels are configured to counterrotate to advance the tube of film.

5 [0011] In a sixth embodiment, the VFFS system of the fifth embodiment is configured such that the first drive wheel is coupled to a first belt roller around which the first belt is looped such that rotation of the first drive wheel causes rotation of the first belt roller and the first belt. The second drive wheel is coupled to a second belt roller around which the second belt is looped such that rotation of the second drive wheel causes rotation of the second belt roller and the second belt.

10 [0012] In a seventh embodiment, the VFFS system of the sixth embodiment is configured such that the coupling of the first drive wheel to the first belt roller and the coupling of the second drive wheel to the second belt roller are configured to cause the first and second belts and the tube of film to move at substantially similar speeds in response to the drive system advancing the tube of film.

15 [0013] In an eighth embodiment, the film support system of any of the second to the seventh embodiments comprises a third film support system having a third belt configured to provide lateral support to the tube of film and a fourth film support system having a fourth belt configured to provide lateral support to the tube of film. The first, second, third, and fourth film support systems are arranged such that substantially-
20 vertical portions of the first, second, third, and fourth belts form a rectangular shape through which the tube of film is capable of passing.

[0014] In a ninth embodiment, the void-forming mechanism of any of the preceding embodiments comprises a first squeeze roller positioned on a first void-forming structure and a second squeeze roller positioned on a first void-forming structure.

[0015] In a tenth embodiment, the VFFS system of the ninth embodiment further comprises a support structure configured to which the film support system is movably secured. The first void-forming structure is rotatably coupled to the support structure and the second void-forming structure is rotatably coupled to the support structure.

5 [0016] In an eleventh embodiment, the VFFS system of any of the ninth and tenth embodiments is configured such that the first void-forming structure further includes a plurality of first support rollers located upstream of the first squeeze roller, each of the plurality of first rollers has an axis that is substantially parallel to an axis of the first squeeze roller, the second void-forming structure further includes a plurality of second support rollers located upstream of the second squeeze roller, and each of the plurality of second rollers has an axis that is substantially parallel to an axis of the second squeeze roller.

10 [0017] In a twelfth embodiment, the VFFS system of any of the preceding embodiments further comprises a transverse seal mechanism configured to selectively form two transverse seals in the area of the tube of film.

15 [0018] In a thirteenth embodiment, the VFFS system of the twelfth embodiment further comprises a cutting element configured to sever a product-filled pouch from the tube of film by transversely cutting the tube of film between the two transverse seals formed in the tube of film by the transverse seal mechanism.

20 [0019] In a fourteenth embodiment, the product of any of the preceding embodiments is a food product having a viscosity at or above at least one of 0.5 Pa·s, 1 Pa·s, 2 Pa·s, 3 Pa·s, 5 Pa·s, or 10 Pa·s.

[0020] In a fifteenth embodiment, the product of any of the preceding embodiments is a non-Newtonian fluid.

[0021] In a sixteenth embodiment, the product of any of the preceding embodiments has a temperature that is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C.

5 [0022] In a seventeenth embodiment, a method can be performed to package a product using a vertical form-fill-seal (VFFS) system. The VFFS system comprises a dispenser, a drive system, a void-forming mechanism, and a film support system. The method comprises dispensing, from the dispenser of the VFFS system, the product into a tube of film; advancing, by the drive system of the VFFS system, the tube of film in a downstream direction; and closing, by the void-forming mechanism of the VFFS system, 10 on the tube of film to void or clean an area of the tube of film. The film support system is configured to provide lateral support to the tube of film during the dispensing. The film support system is positioned upstream of the void-forming mechanism.

15 [0023] In an eighteenth embodiment, the method of the seventeenth embodiment further comprises forming, by a transverse seal mechanism of the VFFS system, two transverse seals in the area of the tube of film.

[0024] In a nineteenth embodiment, the method of the eighteenth embodiment further comprises cutting, by a cutting element of the VFFS system, the tube of film between the two transverse seals in the area of the tube of film to sever a product-filled pouch from the tube of film.

20 [0025] In a twentieth embodiment, the film support system in the method of any of the seventeenth to the nineteenth embodiments comprises a first film support system having a first belt configured to provide lateral support to the tube of film and a second film support system having a second belt configured to provide lateral support to the tube of film. The first and second belts are capable of counterrotating with the tube of 25 film located therebetween.

5 [0026] In a twenty first embodiment, the film support system in the method of twentieth embodiment is configured such that the first belt includes a substantially-vertical portion, the second belt includes a substantially-vertical portion, and the first and second film support systems are arranged such that the substantially-vertical portion of the first belt and the substantially-vertical portion of the second belt are substantially parallel to each other.

[0027] In a twenty second embodiment, the method of any of the twentieth or the twenty first embodiments further comprises varying respective positions of the first and second film support systems to accommodate different sizes of tubes of film.

10 [0028] In a twenty third embodiment, the product of any of the seventeenth to the twenty second embodiments is a food product having a viscosity at or above at least one of 0.5 Pa·s, 1 Pa·s, 2 Pa·s, 3 Pa·s, 5 Pa·s, or 10 Pa·s.

[0029] In a twenty fourth embodiment, the product of any of the seventeenth to the twenty third embodiments is a non-Newtonian fluid.

15 [0030] In a twenty fifth embodiment, the product of any of the seventeenth to the twenty fourth embodiments has a temperature that is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C.

BRIEF DESCRIPTION OF THE DRAWING

20 [0031] The foregoing aspects and many of the attendant advantages of the disclosed subject matter will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0032] Figs. 1A to 1F depict a series of instances of an embodiment of a VFFS system in the process of making product-filled pouches, in accordance with the embodiments described herein;

5 [0033] Figs. 2A and 2B depict perspective and exploded perspective views, respectively, of an embodiment of a VFFS system, in accordance with the embodiments described herein;

[0034] Figs. 3A and 3B depict perspective cutaway views of the VFFS system shown in Figs. 2A and 2B with film support systems positioned at different locations, in accordance with the embodiments described herein;

10 [0035] Figs. 4A to 4F depict a series of instances of an embodiment of a system that includes the VFFS system shown in Figs. 2A and 2B in the process of making product-filled pouches, in accordance with the embodiments described herein;

15 [0036] Figs. 5A and 5B depict instances of the system shown in Figs. 4A to 4F in the process of making product-filled pouches using a tube of film that is smaller than the tube of film shown in Figs. 4A to 4F, in accordance with the embodiments described herein; and

20 [0037] Figs. 6A and 6B depict instances of an embodiment of a system that is a variation of the system shown in Figs. 5A to 5F in which film support systems are primary support mechanisms upstream of the void-forming mechanisms, in accordance with the embodiments described herein.

DETAILED DESCRIPTION

[0038] The present disclosure describes embodiments of vertical form-fill-seal (VFFS) systems with film support systems that provide lateral support for film tubes while product is dispensed into the tube. In some embodiments, the film support systems are

located upstream of a void-forming mechanism configured to form voids in the film tube. In some embodiments, the VFFS systems include a plurality of film support systems, each of which has a belt with a substantially-vertical portion configured to provide lateral support to the tube. Where the VFFS systems include belts, the belts may be
5 configured to move at substantially the same speed as the tube of film when the tube of film is advanced. In some embodiments, positions of the film support systems are configured to be changed in order to accommodate different sizes of film tubes.

[0039] For purposes of this disclosure, and following long-standing patent law convention, the terms “a”, “an”, and “the” refer to “one or more” when used in the
10 subject application, including the claims. Thus, for example, reference to “a film” includes a plurality of such films, and so forth.

[0040] As used herein, the term “film” can be used in a generic sense to include a thermoplastic film, laminate, sheet, or web, either multilayer or monolayer, and of any suitable thickness that may be used in connection with the embodiments disclosed
15 herein.

[0041] The term “filled” as used herein refers to an item (such as a pouch) that has been occupied with a product in a manner consistent with a commercial filling operation. Thus, a pouch may or may not be 100% filled.

[0042] The term “flexible” is used herein to refer to materials that are pliable and easily deform in the presence of external forces. In some embodiments, suitable flexible
20 materials can be characterized by a modulus of less than about 50,000 PSI and in some embodiments less than 40,000 PSI (ASTM D-872-81).

[0043] As used herein, the term “pouch” refers to any of the wide variety of containers known in the art, including (but not limited to) bags, packets, packages, and the like.

[0044] As used herein, the term “seal” refers to any seal of a first region of an outer film surface to a second region of an outer film surface, including heat or any type of adhesive material, thermal or otherwise. In some embodiments, the seal can be formed by heating the regions to at least their respective seal initiation temperatures. The sealing can be performed by any one or more of a wide variety of methods, including (but not limited to) using a heat seal technique (e.g., melt-bead sealing, thermal sealing, impulse sealing, dielectric sealing, radio frequency sealing, ultrasonic sealing, hot air, hot wire, infrared radiation).

[0045] Although the majority of the above definitions are substantially as understood by those of skill in the art, one or more of the above definitions can be defined hereinabove in a manner differing from the meaning as ordinarily understood by those of skill in the art, due to the particular description herein of the presently disclosed subject matter.

[0046] VFFS systems can be used in the process of making product-filled pouches. Depicted in Figs. 1A to 1F are a series of instances of an embodiment of a VFFS system 100 in the process of making product-filled pouches. The VFFS system 100 includes a dispenser 102, void-forming mechanism 104, and a transverse seal mechanism 106. In the depicted embodiment, the void-forming mechanism 104 includes squeeze rollers. In the depicted embodiment, the transverse seal mechanism 106 includes retractable jaws. Variations of the VFFS system 100 and other embodiments of VFFS systems are generally well known to those of skill in the art, and described, for example, in U.S. Patent Nos. 4,589,247 (Tsuruta et al), 4,656,818 (Shimoyama et al.), 4,768,411 (Su), 4,808,010 (Vogan), 5,467,581 (Everette), and 6,244,747 (Caudle), all of which are hereby incorporated herein by reference in their entirety.

[0047] In the depicted embodiment, the dispenser 102 is configured to dispense product 108 into a tube 110 of film 112. Although not shown in Figs. 1A to 1F, the VFFS system 100 may include an apparatus that converts the film 112 from a lay-flat configuration

into the tube 110. The VFFS system 100 is configured to create flexible containers (or “pouches”) that are filled with the product 108. While the VFFS system 100 includes the dispenser 102 configured to mechanically dispense the product 108 into the tube 110, it will be apparent that the product 108 can be dispensed in any other manner, such as manually dispensing the product 108 into the tube 110. The product 108 can be any food or non-food product, can be a liquid, semi-liquid, paste, or semi-solid product, or any other flowable or pumpable product. For example, the product 108 may be any high acid or low acid foods, such as tomato products, milk or dairy products, medical products, or the like.

[0048] The VFFS system 100 is capable of forming pouches filled with the product 108 at the bottom of the VFFS system 100. The film 112 from which the pouches are formed can be advanced from a feed roller (not shown) and over a forming tube (not shown, which is sometimes known as a “sailor’s collar” or “forming collar.” As the film 112 passes over the forming tube, opposite longitudinal sides of the film 112 are brought together and subsequently joined with a longitudinal seal that can be formed by a longitudinal heat sealing device. Once the longitudinal seal is formed, the film 112 takes the shape of a vertically-oriented tube 110 of the film 112. In general, the film 112 will travel vertically downward from the forming tube towards the portion of the VFFS system 100 depicted in Figs. 1A to 1F. A film feed mechanism (not shown) can be powered and directed by rollers, a belt, another suitable motive device, or any combination thereof, to advance the tube 110 of the film 112 downward. In the depicted embodiment, the film 112 is a single-ply film and the tube 110 is a single-wall tube. In other embodiments, the film 112 can include two or more separate layers of film. In some multi-layer film embodiments, a longitudinal seal can be made to form a multi-wall tube and/or multiple tubes.

[0049] In the instance depicted in Fig. 1A, a pouch 120 has been formed below the void-forming mechanism 104. The portion of the film 112 that forms the pouch 120 is still coupled to the tube 110 of the film 112. A bottom seal 122 has been formed

transversely across the bottom of the pouch 120 to prevent the product 108 in the pouch 120 from falling out of the bottom of the pouch 120. The squeeze rollers of the void-forming mechanism 104 are configured to periodically close on the film 112 as it moves in order to void and/or clean the area 114 of the product 108 where a transverse seal and cut are to be applied. The dispenser 102 is also dispensing product 108 into a volume in the tube 110 above the void-forming mechanism 104. In the depicted embodiment, no product is in the tube 110 above the void-forming mechanism 104 when the dispenser 102 begins dispensing the product 108 into the tube 110; in other embodiment, some product may already be in the tube 110 above the void-forming mechanism 104 when the dispenser 102 begins dispensing the product 108 into the tube 110.

[0050] The dispenser 102 may be supplied with the product 108 by a pump. The pump may be any suitable device that moves the product 108 by mechanical action and can include any of a variety of pump types, such as positive displacement pumps (e.g. peristaltic pumps, screw pumps, etc.), velocity pumps, centrifugal pumps, or gravity pumps. In some embodiments, the VFFS system 100 includes a controller configured to control the one or more of the flow rate of the product 108, the timing of the flow of the product 108, the pressure of the product 108, or any other characteristic, in order to cause the dispenser 102 to dispense the product 108 in a desired manner. The product 108 can be dispensed until an amount of the product 108 for a subsequent pouch has been dispensed into the tube, as shown in Fig. 1B.

[0051] From the instance shown in Fig. 1B to the instance shown in Fig. 1C, the squeeze rollers of the void-forming mechanism 104 remain in contact with the tube 110. The retractable jaws of the transverse seal mechanism 106 have been brought in to contact with opposite sides of the tube 110 at the area 114 of the void formed by the void-forming mechanism 104. The retractable jaws of the transverse seal mechanism 106 are configured to close and seal the film 112 transverses across tube 110. As can be seen in Fig. 1D, the transverse seal mechanism 106 forms a top seal 124 in the

pouch 120 to close the pouch 120. The transverse seal mechanism 106 also forms a bottom seal 132 in the tube 110 as the VFFS system 100 forms a pouch 130, which is the subsequent pouch after the pouch 120.

5 [0052] In some embodiments, the transverse seal mechanism 106 is configured to cut the film 112 to sever the pouch 120 from the tube 110 at the time shown in Fig. 1C when the jaws of the transverse seal mechanism 106 are in contact with the film 112 on either side of the tube 110. In some embodiments, the transverse seal mechanism 106 includes three heating wires that extend transversely across the transverse seal mechanism 106, including two sealing wires configured to seal the film 112 and one
10 cutting wire located between the two sealing wires and configured to heat the film 112 until the film 112 is cut between the two seals formed by the two sealing wires. In other embodiments, the transverse seal mechanism 106 is configured to form two seals in the film 112 but does not cut the film 112. In those embodiments, the VFFS system 100 may include a separate cutting device, such as a knife or a blade, configured to cut the
15 film 112 between the seals to sever the pouch 120 from the tube 110.

[0053] From the instance shown in Fig. 1D to the instance shown in Fig. 1E, the tube 110 has been advanced downward and the pouch 120 has been moved away from the area depicted in Fig. 1E. The void-forming mechanism 104 has also reengaged the film 112 near the top of the product 108 in the pouch 130. In the depicted embodiment, no
20 product is left in the tube 110 above the void-forming mechanism 104 in Fig. 1E. In other embodiments, it may be advantageous for the void-forming mechanism 104 to close with a portion of the product 108 located above the void-forming mechanism 104. The void-forming mechanism 104 is configured to close on the film 112 as the tube 110 moves in order to void and/or clean an area 116 of the product 108 where a transverse seal and cut are to be applied. In some embodiments, the void-forming mechanism 104
25 includes two squeeze rollers that are driven to counterrotate so that the portions of the squeeze rollers in contact with the tube 110 move at a speed substantially similar to the speed at which the tube 110 moves. While the void-forming mechanism 104 is closed,

the tube 110 can be further advances to the instance shown in Fig. 1F where the area 116 has been formed between the pouch 130 and the tube 110. From the instance shown in Fig. 1F, the process shown in Figs. 1A to 1F can be performed repetitively so that the VFFS system 100 creates pouches consecutively.

5 [0054] It will be understood that the process shown in Figs. 1A to 1F is one embodiment of a VFFS process and that many other embodiments and variations thereof can be used by a VFFS system. For example, in the embodiment depicted in Figs. 1A to 1F, the dispensing of the product 108 by the dispenser 102 occurs intermittently. There are times during the process shown in Figs. 1A to 1F when the product 108 is being
10 dispensed from the dispenser 102 and there are times during the same process when the product 108 is not being dispensed from the dispenser 102. In other embodiments, the process shown in Figs. 1A to 1F can be varied so that the product 108 is continuously dispensed from the dispenser 102. Such continuous dispensing can decrease the amount of time to produce each of the pouches, thereby increasing
15 throughput of the VFFS system 100. Any number of other examples of varying the process shown in Figs. 1A to 1F.

[0055] One problem with the use of VFFS systems to fill and form pouches with non-solid products is the shape that the pouches take. More specifically, the non-solid products inside of pouches allows the pouches to change shape, especially when
20 pouches are made of flexible materials, such as film. However, customers and others typically prefer products to have a more uniform shape from an aesthetic perspective, to have a shape appropriate for stacking or packaging (e.g., packaging multiple pouches in a box), or any other reason for the pouches having a more uniform shape. Additionally, any printed material on the pouch can be distorted by the changing shape of the
25 pouches. Past efforts to address the shape of pouches include providing shaping elements that hold the shape of the pouches for a time after the pouches are formed. In one example, Great Britain Patent No. 1,531,023 ("the GB '023 patent") shows a system with void-forming mechanisms 23/24, 23'/24' that form pouches of liquid food product

and a pair of counterrotating conveyor belts 3, 3' have half molds 4, 4' that interact to maintain the shape of the pouches. In another example, Great Britain Patent No. 1,366,768 ("the GB '768 patent") shows a system with void-forming mechanisms 9 that form pouches of foodstuffs 1 and a pair of counterrotating conveyor belts 24 have molding frames 12 that interact to maintain the shape of the pouches. In both the GB '023 patent and the GB '768 patent, the shape-maintaining mechanisms are located downstream of the void-forming mechanisms in order to maintain the shape of the pouches after they are formed.

[0056] While locating shape-maintaining mechanisms downstream of the void-forming mechanisms may maintain the shape of the pouches after the pouches are formed, such shape-maintaining mechanisms may not prevent all types of misshapen pouches. For example, past attempts at maintaining the shape of pouches do not recognize that misshaping of the pouches can occur upstream of void-forming mechanisms. For example, in Fig. 1A, as the product 108 is dispensed into the tube 110, the dispensing of the product 108 can damage the film 112 or a seal in the film 112. Such damage is more likely to occur if the product 108 is dispensed at higher pressure. Dispensing the product 108 at high pressures may be required when the product 108 is a high viscosity product, such as ground beef, mashed potatoes, refried beans, and the like, and/or a non-Newtonian fluid, such as caramel, ketchup, mayonnaise, and the like. In some embodiments, high viscosity products have a viscosity at or above at least one of 0.5 Pa·s, 1 Pa·s, 2 Pa·s, 3 Pa·s, 5 Pa·s, or 10 Pa·s. In addition, when the product 108 dispensed is at high temperatures, the temperature of the product 108 may weaken the film 112 of the tube 100, leading to a greater likelihood of failure due to forces from the product 108 being dispensed (whether the product 108 is dispensed at high or low pressures). In embodiments disclosed herein, a product may be considered to be dispensed at high temperature if the temperature of the product is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C. Dispensing the product 108 at high pressures and/or at high temperatures upstream of the void-forming mechanism 104 may cause the film 112 in the tube 110 to plastically deform and bulge outward, may

cause the high forces to be applied to seals in the film 112 resulting in rips and/or rib failures, may cause stretching in the film 112 in variable amounts resulting in poor control of weigh and/or volume of the product 108 in the tube 110, and/or may cause the film 112 to form into a shape (e.g., a substantially spherical shape) that cannot be corrected downstream of the void-forming mechanism 104.

[0057] Described herein are embodiments of VFFS systems that include support mechanism for tubes of film upstream of void-forming mechanisms. Depicted in Figs. 2A and 2B are perspective and exploded perspective views, respectively, of an embodiment of a VFFS system 200. The VFFS system 200 includes a support structure 202 configured to support various components of the VFFS system 200. In the depicted embodiment, the support structure 202 includes a first side support 204₁, a second side support 204₂, and a transverse support 206 that spans between the first and second side supports 204₁ and 204₂. The first side support 204₁ includes a first slot 208₁ and a second slot 210₁ and the second side support 204₂ includes a first slot 208₂ and a second slot 210₂. The functions of the first slots 208₁ and 208₂ and the second slots 210₁ and 210₂ are described below.

[0058] The VFFS system 200 also includes a drive system 212. The drive system includes a first shaft 214₁ and a second shaft 214₂. Each of the first and second shafts 214₁ and 214₂ spans between the first and second side supports 204₁ and 204₂ and is rotatably coupled to each of the first and second side supports 204₁ and 204₂. In some embodiments, bearings are positioned between the first and second shafts 214₁ and 214₂ and the first and second side supports 204₁ and 204₂ to improve rotatability of the first and second shafts 214₁ and 214₂ with respect to the first and second side supports 204₁ and 204₂.

[0059] The first shaft 214₁ has mounted thereon a first drive wheel 216₁ and a second drive wheel 216₂. The second shaft 214₂ has mounted thereon a first drive wheel 218₁ and a second drive wheel 218₂. In the depicted embodiment, the first and second drive

wheels 216₁, 216₂, 218₁, and 218₂ are positioned on the first and second shafts 214₁ and 214₂ between the first and second side supports 204₁ and 204₂. In some embodiments, the first and second drive wheels 216₁, 216₂, 218₁, and 218₂ are configured to advance a drive a tube of film. In the depicted embodiment, the first wheel 216₁ and the first wheel 218₁ are arranged to form a nip therebetween such that the film roll can pass through the nip to be driven by the first wheel 216₁ and the first wheel 218₁. Similarly, the second wheel 216₂ and the second wheel 218₂ are arranged to form a nip therebetween such that the film roll can pass through the nip to be driven by the second wheel 216₂ and the second wheel 218₂. In some embodiments, the first and second drive wheels 216₁ and 216₂ are keyed to the first shaft 214₁ and the first and second drive wheels 218₁ and 218₂ are keyed to the second shaft 214₂. This keying ensures rotation of the first and second drive wheels 216₁ and 216₂ in response to rotation of the first shaft 214₁ and rotation of the first and second drive wheels 218₁ and 218₂ in response to rotation of the second shaft 214₂.

[0060] The first shaft 214₁ has mounted thereon a first driven wheel 220₁. The second shaft 214₂ has mounted thereon a second driven wheel 220₂. In the depicted embodiment, the first and second driven wheels 220₁ and 220₂ are gears with teeth located on a circumferential edge of the first and second driven wheels 220₁ and 220₂. The first and second driven wheels 220₁ and 220₂ are configured to be rotated by a driving force, such as a motor coupled to the first and second driven wheels 220₁ and 220₂ via one or more of another gear, a drive shaft, a jack screw, or other motion transmission device. In the depicted embodiment, the first driven wheel 220₁ is keyed to the first shaft 214₁ so that the driving of the driven wheel 220₁ causes rotation of the first shaft 214₁ and the first and second drive wheels 216₁ and 216₂. Similarly, the second driven wheel 220₂ is keyed to the second shaft 214₂ so that the driving of the driven wheel 220₂ causes rotation of the second shaft 214₂ and the first and second drive wheels 218₁ and 218₂. In the depicted embodiment, the first and second driven wheels 220₁ and 220₂ are located on the first and second shafts 214₁ and 214₂, respectively, on an opposite side of the first side support 204₁ from the first driving

wheels 216₁ and 218₁. In other embodiments, the first and second driven wheels 220₁ and 220₂ can be located on any other portion of the first and second shafts 214₁ and 214₂, respectively.

5 [0061] In the depicted embodiment, the first shaft 214₁ has mounted thereon a first rotational coupling mechanism 222₁ configured to couple the first shaft 214₁ to another shaft such that rotation of the first shaft 214₁ causes rotation of the other shaft. Similarly, the second shaft 214₂ has mounted thereon a second rotational coupling mechanism 222₂ configured to couple the second shaft 214₂ to another shaft such that rotation of the second shaft 214₂ causes rotation of the other shaft. In the depicted
10 embodiment, the first and second rotational coupling mechanisms 222₁ and 222₂ are sprockets configured to engage a roller chain. In other embodiments, the first and second rotational coupling mechanisms 222₁ and 222₂ may be any rotary device configured to engage a roller chain, a toothed belt, or any other rotational motion transference device.

15 [0062] The VFFS system 200 further includes a first void-forming structure 224. The first void-forming structure 224 includes a first side support 226₁ and a second side support 226₂. In the depicted embodiment, each of the first and second side supports 226₁ and 226₂ is rotatably coupled to the support structure 202. More specifically, the first side support 226₁ is rotatably coupled to the first side support 204₁ and the second
20 side support 226₂ is rotatably coupled to the second side support 204₂. A transverse support 228 spans between the first and second side supports 226₁ and 226₂. In the depicted embodiment, the transverse support 228 is coupled to the first and second side supports 226₁ and 226₂ so that the first and second side supports 226₁ and 226₂ rotate together.

25 [0063] The first void-forming structure 224 further includes a first void-forming mechanism 230. In the depicted embodiment, the first void-forming mechanism 230 is in the form of a squeeze roller that spans between and is rotatably coupled to the first

and second side supports 226₁ and 226₂. In the depicted embodiment, the first void-forming structure 224 further includes first support rollers 232. The first support rollers 232 span between and are rotatably coupled to the first and second side supports 226₁ and 226₂. The first support rollers 232 are located upstream of the first void-forming mechanism 230 and have axes that are substantially parallel to the squeeze roller of the first void-forming mechanism 230. In the depicted example, the first support rollers 232 include four rollers; in other embodiment, the first support rollers 232 may include any number of rollers. Examples of the functions of the first void-forming mechanism 230 and the first support rollers 232 are discussed in greater detail below.

[0064] The VFFS system 200 further includes a second void-forming structure 234. The second void-forming structure 234 includes a first side support 236₁ and a second side support 236₂. In the depicted embodiment, each of the first and second side supports 236₁ and 236₂ is rotatably coupled to the support structure 202. More specifically, the first side support 236₁ is rotatably coupled to the first side support 204₁ and the second side support 236₂ is rotatably coupled to the second side support 204₂. A transverse support 238 spans between the first and second side supports 236₁ and 236₂. In the depicted embodiment, the transverse support 238 is coupled to the first and second side supports 236₁ and 236₂ so that the first and second side supports 236₁ and 236₂ rotate together.

[0065] The second void-forming structure 234 further includes a second void-forming mechanism 240. In the depicted embodiment, the second void-forming mechanism 240 is in the form of a squeeze roller that spans between and is rotatably coupled to the first and second side supports 236₁ and 236₂. In the depicted embodiment, the first void-forming structure 234 further includes second support rollers 242. The second support rollers 242 span between and are rotatably coupled to the first and second side supports 236₁ and 236₂. The second support rollers 242 are located upstream of the second void-forming mechanism 240 and have axes that are substantially parallel to the squeeze roller of the second void-forming mechanism 240. In the depicted example,

the second support rollers 242 include four rollers; in other embodiment, the second support rollers 242 may include any number of rollers. Examples of the functions of the second void-forming mechanism 240 and the second support rollers 242 are discussed in greater detail below.

5 [0066] The VFFS system 200 further includes a first film support system 244. The first film support system 244 includes a first side support 246₁ and a second side support 246₂. The first film support system 244 further includes belt rollers 248₁, 248₂, and 248₃ (collectively, belt rollers 248). The belt rollers 248 span between and are rotatably coupled to the first and second side supports 246₁ and 246₂. While the number of the
10 belt rollers 248 in the depicted embodiment is three, other embodiments of film support systems can have any number of belt rollers, such as any plurality of belt rollers. The first film support system 244 further includes a belt 250 that is looped around the belt rollers 248. In some embodiments, the belt 250 is formed from steel, polyester, nylon, cotton, aramid, rubber, polyvinyl chloride, and other suitable material, or any
15 combination thereof. In some embodiments, the belt 250 can be a solid belt, a meshed belt, a chain belt, or any other suitable type of belt. The belt 250 is configured to interact with the belt rollers 248 so that rotation of one or more of the belt rollers 248 causes movement of the belt 250 around the belt rollers 248. Belt rollers 248 are positioned so that a substantially-vertical portion 252 of the belt 250 is substantially
20 planar within the VFFS system 200.

[0067] The VFFS system 200 further includes a first film support system 254. The first film support system 254 includes a first side support 256₁ and a second side support 256₂. The first film support system 254 further includes belt rollers 258₁, 258₂, and 258₃ (collectively, belt rollers 258). The belt rollers 258 span between and are rotatably
25 coupled to the first and second side supports 256₁ and 256₂. While the number of the belt rollers 258 in the depicted embodiment is three, other embodiments of film support systems can have any number of belt rollers, such as any plurality of belt rollers. The first film support system 254 further includes a belt 260 that is looped around the belt

rollers 258. In some embodiments, the belt 260 is formed from steel, polyester, nylon, cotton, aramid, rubber, polyvinyl chloride, and other suitable material, or any combination thereof. In some embodiments, the belt 260 can be a solid belt, a meshed belt, a chain belt, or any other suitable type of belt. The belt 260 is configured to interact with the belt rollers 258 so that rotation of one or more of the belt rollers 258 causes movement of the belt 260 around the belt rollers 258. Belt rollers 258 are positioned so that a substantially-vertical portion 262 of the belt 260 is substantially planar within the VFFS system 200.

[0068] In some embodiments, at least one of the belt rollers 248 is configured to be driven by the drive system 212 and at least one of the belt rollers 258 is configured to be driven by the drive system 212. In the depicted embodiment, the first film support system 244 includes a rotational coupling mechanism 264₁ coupled to the belt roller 248₁ and the second film support system 254 includes a rotational coupling mechanism 264₂ coupled to the belt roller 258₁. In the depicted embodiment, the rotational coupling mechanisms 264₁ and 264₂ are sprockets configured to engage a roller chain. In other embodiments, the rotational coupling mechanisms 264₁ and 264₂ may be any rotary device configured to engage a roller chain, a toothed belt, a set of gears, or any other rotational motion transference device. In the depicted embodiment, a roller chain can be looped around the rotational coupling mechanism 264₁ and the first rotational coupling mechanism 222₁ so that rotation of the first rotational coupling mechanism 222₁ causes the roller chain to rotate the rotational coupling mechanism 264₁ and the belt 250 causes the remainder of the belt rollers 248 to rotate in response to the movement of the belt 250. In this way, rotation of the first shaft 214₁ results in rotation of the belt rollers 248 and movement of the belt 250. In the depicted embodiment, a roller chain can be looped around the rotational coupling mechanism 264₂ and the second rotational coupling mechanism 222₂ so that rotation of the second rotational coupling mechanism 222₂ causes the roller chain to rotate the rotational coupling mechanism 264₂ and the belt 260 causes the remainder of the belt rollers 258 to rotate

in response to the movement of the belt 260. In this way, rotation of the second shaft 214₂ results in rotation of the belt rollers 258 and movement of the belt 260.

[0069] In some embodiments, the relative positions of the first and second film support systems 244 and 254 can be varied. In some embodiments, the first film support system 244 is couplable to the support structure 202 via fasteners 266₁ and the second film support system 254 is couplable to the support structure 202 via fasteners 266₂. In the depicted embodiment, the fasteners 266₁ pass through the first slot 208₁ of the first side support 204₁ and other fasteners can pass through the second slot 210₁ of the second side support 204₂. Before securing the first film support system 244 to the support structure 202, the fasteners 266₁ and the other fasteners can be positioned at different locations within the first and second slots 208₁ and 210₁ to position the first film support system 244 at a desired location. In the depicted embodiment, the fasteners 266₂ pass through the second slot 208₂ of the first side support 204₁ and other fasteners can pass through the second slot 210₂ of the second side support 204₂. Before securing the second film support system 254 to the support structure 202, the fasteners 266₂ and the other fasteners can be positioned at different locations within the first and second slots 208₂ and 210₂ to position the second film support system 254 at a desired location.

[0070] The ability to selectively position the first and second film support systems 244 and 254 can allow the VFFS system 200 to be used with film tubes of multiple widths and/or used to form pouches of different sizes. Depicted in Figs. 3A and 3B are perspective cutaway views of the VFFS system 200 with the film support systems 244 and 254 positioned at different locations. In Figs. 3A and 3B, a number of the elements of the VFFS system 200—including the first side support 204₁, the first and second driven wheels 220₁ and 220₂, the first side support 226₁, and the first side support 236₁—have been removed so that other components of the VFFS system 200 are more clearly visible.

[0071] The first and second film support systems 244 and 254 have been positioned in Fig. 3A at locations that are farther apart than the first and second film support systems 244 and 254 have been positioned in Fig. 3B. In Fig. 3A, the substantially-vertical portion 252 of the belt 250 and the substantially-vertical portion 262 of the belt 260 are located a distance d_1 apart from each other. In Fig. 3B, the substantially-vertical portion 252 of the belt 250 and the substantially-vertical portion 262 of the belt 260 are located a distance d_2 apart from each other. In the depicted embodiments, the distance d_1 is greater than the distance d_2 . In some embodiments, the substantially-vertical portions 252 and 262 remain substantially parallel to each other regardless of the respective locations of the first and second film support systems 244 and 254. In some embodiments, the respective positions of the first and second film support systems 244 and 254 are selected so that a tube of film of a particular size can pass between the substantially-vertical portions 252 and 262 of the belts 250 and 260 and/or so that the VFFS system 200 is capable of forming pouches of a particular size.

[0072] The VFFS system 200 can be used in the process of making product-filled pouches. Depicted in Figs. 4A to 4F are a series of instances of an embodiment of a system 300 that includes the VFFS system 200 in the process of making product-filled pouches. The system 300 includes a dispenser 302 configured to dispense product 308. In the depicted embodiment, the dispenser 302 is configured to dispense product the 308 into a tube 310 of film 312. Although not shown in Figs. 4A to 4F, the system 300 may include an apparatus that converts the film 312 from a lay-flat configuration into the tube 310. The system 300 is configured to create flexible containers (or "pouches") that are filled with the product 308. While the system 300 includes the dispenser 302 configured to mechanically dispense the product 308 into the tube 310, it will be apparent that the product 308 can be dispensed in any other manner, such as manually dispensing the product 308 into the tube 310. The product 308 can be any food or non-food product, can be a liquid, semi-liquid, paste, or semi-solid product, or any other flowable or pumpable product. For example, the product 308 may be any

high acid or low acid foods, such as tomato products, milk or dairy products, medical products, or the like.

[0073] In the instance depicted in Fig. 4A, the tube 310 of the film 312 has been fed downward past the dispenser 302, past the first and second driving wheels 216₁, 216₂, 218₁, and 218₂, past the first and second film support systems 244 and 254, past the first and second support rollers 232 and 242, and past the first and second void-forming mechanisms 230 and 240. A bottom seal 322 has been formed transversely across the bottom of the tube 310 to prevent the product 308 from falling out of the bottom of the tube 310. The squeeze rollers of the first and second void-forming mechanisms 230 and 240 are configured to periodically close on the film 312 as it moves in order to void and/or clean the area of the product where a transverse seal and cut are to be applied. In the depicted embodiment, no pouch is connected to the bottom of the tube 310; however, in other embodiments, a pouch may be connected to the bottom of the tube 310 so that the first and second void-forming mechanisms 230 and 240 are forming a void between the tube 310 and the connected pouch.

[0074] At the instance shown in Fig. 4A, the dispenser 302 is dispensing the product 308 into a volume in the tube 310 above the first and second void-forming mechanisms 230 and 240. The dispenser 302 may be supplied with the product 308 by a pump (not shown). In some embodiments, the system 300 includes a controller configured to control the one or more of the flow rate of the product 308, the timing of the flow of the product 308, the pressure of the product 308, or any other characteristic, in order to cause the dispenser 302 to dispense the product 308 in a desired manner. The product 308 can be dispensed until an amount of the product 308 for a pouch has been dispensed into the tube 310, as shown in Fig. 4B. In Figs. 4A and 4B, the dispenser 302 is depicted above the level of the product 308 in the tube 310 when the product 308 is dispensed from the dispenser 302. In other embodiments, the dispenser 302 is at or below the level of the product 308 in the tube when the product is dispensed from the dispenser 302.

[0075] During the dispensing of the product 308 between the instances shown in Figs. 4A and 4B, the pressure from the dispensing of the product 308 can cause product 308 to exert forces on the film 312 as the product 308 fills a portion of the tube 310. Dispensing the product 308 at high pressures may be required when the product 308 is a high viscosity product, such as ground beef, mashed potatoes, refried beans, and the like, and/or a non-Newtonian fluid, such as ketchup, mayonnaise, and the like. During the dispensing of the product 308 between the instances shown in Figs. 4A and 4B, the temperature of the product 308 may be at a high temperature that increases the likelihood of failure of the film 312 during dispensing. In some embodiments, the product 308 is considered to be dispensed at high temperature if the temperature of the product 308 is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C. The film 312 of the tube is positioned near the substantially-vertical portions 252 and 262 of the belts 250 and 260. In this arrangement, the substantially-vertical portions 252 and 262 of the belts 250 and 260 are positioned to provide lateral support to the film 312. This support to the film 312 by the substantially-vertical portions 252 and 262 can deter or prevent physical deformation of the film 312 as the product 308 is dispensed. The support to the film 312 by the substantially-vertical portions 252 and 262 can also help to maintain a shape of the tube 310 so that a pouch formed from that portion of the tube 310 can have a particular shape. The first and second void-forming mechanisms 230 and 240 and the first and second support rollers 232 and 242 can also provide support to the film 312 to prevent and/or deter physical deformation and misshaping of the tube 310.

[0076] From the instance shown in Fig. 4B to the instance shown in Fig. 4C, the squeeze rollers of the first and second void-forming mechanisms 230 and 240 have been retracted from the tube 310 so that the tube 310 can be advanced downward. In the instance shown at Fig. 4C, the first and second drive wheels 216₁ and 218₁ have begun to be driven in counter-rotating directions. The first and second drive wheels 216₁ and 218₁ can be rotated by driving the first and second driven wheels 220₁ and 220₂. The rotation of the first and second drive wheels 216₁ and 218₁ causes

corresponding respective rotation of the first and second rotational coupling mechanisms 222₁ and 222₂. A roller chain 268₁ is looped around the first rotational coupling mechanism 222₁ and the rotational coupling mechanism 264₁ such that rotation of the first rotational coupling mechanism 222₁ causes rotation of the rotational coupling mechanism 264₁. A roller chain 268₂ is looped around the second rotational coupling mechanism 222₂ and the rotational coupling mechanism 264₂ such that rotation of the second rotational coupling mechanism 222₂ causes rotation of the rotational coupling mechanism 264₂. The counterrotation of the rotational coupling mechanisms 264₁ and 264₂ causes counterrotation of the belts 250 and 260.

[0077] In some embodiments, characteristics of the first and second rotational coupling mechanisms 222₁ and 222₂ and characteristics of the rotational coupling mechanisms 264₁ and 264₂ to produce respective movements of the tube 310 and the belts 250 and 260. For example, one or more of a gear ratio between the first rotational coupling mechanism 222₁ and the rotational coupling mechanism 264₁, a gear ratio between the second rotational coupling mechanism 222₂ and the rotational coupling mechanism 264₂, a diameter of one or more of the first and second rotational coupling mechanisms 222₁ and 222₂ and the rotational coupling mechanisms 264₁ and 264₂, or any other characteristic can be selected. In some embodiments, the respective movements of the tube 310 and the belts 250 and 260 include movement of the tube 310 and movement of the belts 250 and 260 through the substantially-vertical portions 252 and 262 at substantially similar speeds. Moving the tube 310 and the belts 250 and 260 through the substantially-vertical portions 252 and 262 at substantially similar speeds can prevent damage that may occur to the film 312 if the tube 310 moved at a different speed than the belts 250 and 260 move through the substantially-vertical portions 252 and 262. In other embodiments, the respective movements of the tube 310 and the belts 250 and 260 include movement of the tube 310 at a speed that is lower than the movement of the belts 250 and 260 through the substantially-vertical portions 252 and 262 in order to induce tension in film 312 that forms the tube 310 above the belts 250 and 260.

[0078] From the instance shown in Fig. 4C, the first and second void-forming mechanisms 230 and 240 can continue to be withdrawn and the tube 310 can be advanced downward by the drive system 212 until the instance shown in Fig. 4D. As can be seen in Fig 4D, the first and second void-forming mechanisms 230 and 240 can be withdrawn sufficiently to allow the tube 310 with the product inside to pass by the first and second void-forming mechanisms 230 and 240. The portion of the tube 310 with the product 308 inside will become a pouch 320 that is filled with the product 308.

[0079] At the instance shown in Fig. 4E, the tube 310 continues to be advanced downward. The first and second void-forming mechanisms 230 and 240 also begin to extend into the film 312 of the tube 310 near the top of the product 308 inside the tube 310. The tube 310 can continue being advanced and the first and second void-forming mechanisms 230 and 240 can continue being extended into the film 312 of the tube 310 until the instance shown in Fig. 4F. In Fig. 4F, the first and second void-forming mechanisms 230 and 240 are forming an area 316 where a transverse seal and cut are to be applied. In the depicted embodiment, no product is left in the tube 310 above the first and second void-forming mechanisms 230 and 240 in Fig. 4F. In other embodiments, it may be advantageous for the first and second void-forming mechanisms 230 and 240 to close with a portion of the product 308 located above the first and second void-forming mechanisms 230 and 240, such as to prevent an air pocket from being left inside the top of the pouch 320. In some embodiments, the system 300 includes a transverse seal mechanism (not shown) configured to form two seals—a top seal of the pouch 320 and a bottom seal in the tube 310—in the area 316 where a void has been formed by the first and second void-forming mechanisms 230 and 240. In some embodiments, the system 300 includes a cutting mechanism (not shown) configured to sever the pouch 320 from the tube 310 by cutting the film transversely between the seals formed by the transverse seal mechanism.

[0080] In Fig. 4F, the dispenser 302 beings to dispense the product 308 into the tube 310 above the area 316. The product 308 dispensed into the tube 310 after the first

and second void-forming mechanisms 230 and 240 form the area 316 will be include in a pouch subsequent to the pouch 320. The subsequent pouch can be created by repeating the process shown in Figs. 4A to 4F. It is noted that the embodiment of the process shown in Figs. 4A to 4F includes intermittent dispensing of the product 308 into the tube 310. In other embodiments, the process shown in Figs. 4A to 4F can be varied to including continuous dispensing of the product 308 into the tube 310.

[0081] As noted above, the relative positions of the first and second film support systems 244 and 254 can be varied to accommodate different sizes of film tubes. Depicted in Figs. 5A and 5B are instances of the system 300 that includes the VFFS system 200 in the process of making product-filled pouches using a tube 330 of film 332 that is smaller than the tube 310 of film 312.

[0082] In the instance depicted in Fig. 5A, the tube 330 of the film 332 has been fed downward past the dispenser 302, past the first and second driving wheels 216₁, 216₂, 218₁, and 218₂, past the first and second film support systems 244 and 254, past the first and second support rollers 232 and 242, and past the first and second void-forming mechanisms 230 and 240. The tube 330 of film 332 is narrower than the tube 310 of film 312. The first and second film support systems 244 and 254 have been repositioned from their position shown in Figs. 4A to 4F to a position where the substantially-vertical portions 252 and 262 of the belts 250 and 260 are closer together in Figs. 5A and 5B.

[0083] A bottom seal 342 has been formed transversely across the bottom of the tube 330 to prevent the product 308 from falling out of the bottom of the tube 330. The squeeze rollers of the first and second void-forming mechanisms 230 and 240 are configured to periodically close on the film 332 as it moves in order to void and/or clean the area of the product 308 where a transverse seal and cut are to be applied. In the depicted embodiment, no pouch is connected to the bottom of the tube 330; however, in other embodiments, a pouch may be connected to the bottom of the tube 330 so that

the first and second void-forming mechanisms 230 and 240 are forming a void between the tube 330 and the connected pouch.

[0084] At the instance shown in Fig. 4A, the dispenser 302 is dispensing the product 308 into a volume in the tube 330 above the first and second void-forming mechanisms 230 and 240. The dispenser 302 may be supplied with the product 308 by a pump (not shown). In some embodiments, the system 300 includes a controller configured to control the one or more of the flow rate of the product 308, the timing of the flow of the product 308, the pressure of the product 308, or any other characteristic, in order to cause the dispenser 302 to dispense the product 308 in a desired manner. The product 308 can be dispensed until an amount of the product 308 for a pouch has been dispensed into the tube 330, as shown in Fig. 5B.

[0085] During the dispensing of the product 308 between the instances shown in Figs. 5A and 5B, the pressure from the dispensing of the product 308 can cause product 308 to exert forces on the film 332 as the product 308 fills a portion of the tube 330. Dispensing the product 308 at high pressures may be required when the product 308 is a high viscosity product, such as ground beef, mashed potatoes, refried beans, and the like, and/or a non-Newtonian fluid, such as ketchup, mayonnaise, and the like. The film 332 of the tube is positioned near the substantially-vertical portions 252 and 262 of the belts 250 and 260. In this arrangement, the substantially-vertical portions 252 and 262 of the belts 250 and 260 are positioned to provide lateral support to the film 332. This support to the film 332 by the substantially-vertical portions 252 and 262 can deter or prevent physical deformation of the film 332 as the product 308 is dispensed. The support to the film 332 by the substantially-vertical portions 252 and 262 can also help to maintain a shape of the tube 330 so that a pouch formed from that portion of the tube 330 can have a particular shape. The first and second void-forming mechanisms 230 and 240 and the first and second support rollers 232 and 242 can also provide support to the film 332 to prevent and/or deter physical deformation and misshaping of the tube 330.

[0086] Figs. 6A and 6B depict instances of an embodiment of a system 300' that is a variation of the system 300 shown in Figs. 5A to 5F. The system 300' includes a VFFS system 200' that is similar to the VFFS system 200, where the same reference number depicted in the VFFS systems 200 and 200' indicates that the item referenced is the same or similar in both systems. The VFFS system 200' includes first and second void-forming structures 224' and 234'. The first and second void-forming structures 224' and 234' differ from the first and second void-forming structures 224 and 234 in that the first and second void-forming structures 224' and 234' do not include first and second support rollers 232 and 242. The VFFS system 200' also includes film support systems 244' and 254' that have the same components as the film support systems 244 and 254, except that the film support systems 244' and 254' have different dimensions. The

[0087] In the system 300', the film support systems 244' and 254' are initial film support systems upstream of the void-forming mechanisms 230 and 240, respectively. As used herein, an initial film support system upstream of a void-forming mechanism refers to the first film support system upstream of a void-forming mechanism. In other words, no other film support systems are located between the void-forming mechanism and the initial film support system upstream of a void-forming mechanism. In the depicted embodiment, no film support systems are located between the void-forming mechanisms 230 and 240 and the film support systems 244' and 254', respectively. In the depicted embodiment, the first and second void-forming structures 224 and 234 do not include first and second support rollers 232 and 242 so that no film support systems are located between the void-forming mechanisms 230 and 240 and the film support systems 244' and 254', respectively. In addition, the dimensions of the film support systems 244' and 254' has been modified from the film support systems 244 and 254 so that the substantially-vertical portions 252 and 262 of the belts 250 and 260 extend closer to the void-forming mechanisms 230 and 240 than they do in the VFFS system 300. Under certain circumstances, the an initial film support system upstream of a void-forming mechanism is able to provide a level of lateral support for a tube of film that would not be possible with other support elements, such as the first and second support

rollers 232 and 242, between the void-forming mechanism and the initial film support system.

[0088] In the embodiments depicted herein, the film support systems upstream of the void-forming mechanism includes two counter-rotating conveyor belts with parallel substantially-vertical portion on opposite sides of the two belts. In any of these embodiments, the film support systems could be supplemented with two additional counter-rotating conveyor belts. Each of the two additional counter-rotating conveyor belts can include a substantially-vertical portion that is substantially perpendicular to the substantially-vertical portions of the original two counter-rotating conveyor belts. In this way, the two original counter-rotating conveyor belts and the two additional counter-rotating conveyor belts form a rectangular shape (e.g., a square shape) through which the tube passes. In any of the embodiments disclosed herein, the two counter-rotating conveyor belts can be replaced with other forms of film support systems. In one example, the film support systems in a VFFS system can include a series of driven support rollers that are located on opposite sides of the tube of film upstream of the void-forming mechanism. The driven support rollers can be driven so that the portions of the driven support rollers that contact the tube of film move at a speed substantially similar to the speed of the film. In another example, the film support systems in a VFFS system can include two or more volume plates located on opposite sides of a tube of film. The two or more volume plates can be moved in the same direction and at similar speeds when the film is moved.

[0089] It will be apparent that, while the embodiments of product described herein have been described in terms of liquid or semi-liquid products, the VFFS systems described herein can be used when filling pouches with non-liquid products. For example, dry products, such as breakfast cereals, nuts and nut mixtures, cookies, crackers, granular foodstuffs (e.g., sugar), grains (e.g., rice), dry pet foods, and the like, can be packaged using the VFFS systems described herein to maintain proper shapes of the pouches created. In addition, the products described herein are not limited to food products, but

can be any other type of product dispensed, such as soils, mulches, pebbles, dry cement mixes, and the like.

5 [0090] For purposes of this disclosure, terminology such as “upper,” “lower,” “vertical,” “horizontal,” “inwardly,” “outwardly,” “inner,” “outer,” “front,” “rear,” and the like, should be construed as descriptive and not limiting the scope of the claimed subject matter. Further, the use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless limited otherwise, the terms “connected,” “coupled,” and “mounted” and variations thereof herein are used broadly and encompass direct and
10 indirect connections, couplings, and mountings. Unless stated otherwise, the terms “substantially,” “approximately,” and the like are used to mean within 5% of a target value.

15 [0091] The principles, representative embodiments, and modes of operation of the present disclosure have been described in the foregoing description. However, aspects of the present disclosure which are intended to be protected are not to be construed as limited to the particular embodiments disclosed. Further, the embodiments described herein are to be regarded as illustrative rather than restrictive. It will be appreciated that variations and changes may be made by others, and equivalents employed, without departing from the spirit of the present disclosure. Accordingly, it is expressly intended
20 that all such variations, changes, and equivalents fall within the spirit and scope of the present disclosure, as claimed.

CLAIMS

What is claimed is:

1. A vertical form-fill-seal (VFFS) system, comprising:
 - a dispenser configured to dispense a product into a tube of film;
 - 5 a drive system configured to selectively advance the tube of film in a downstream direction;
 - a void-forming mechanism configured to periodically close on the tube of film to void or clean an area of the tube of film; and
 - a film support system configured to provide lateral support to the tube of film,
 - 10 wherein the film support system is positioned upstream of the void-forming mechanism.
2. The VFFS system of claim 1, wherein the film support system comprises:
 - a first film support system having a first belt configured to provide lateral support to the tube of film; and
 - a second film support system having a second belt configured to provide lateral
 - 15 support to the tube of film;
 - wherein the first and second belts are capable of counterrotating with the tube of film located therebetween.
3. The VFFS system of claim 2, wherein:
 - the first belt includes a substantially-vertical portion;
 - 20 the second belt includes a substantially-vertical portion; and
 - the first and second film support systems are arranged such that the substantially-vertical portion of the first belt and the substantially-vertical portion of the second belt are substantially parallel to each other.
4. The VFFS system of claim 2, wherein respective positions of the first and second
- 25 film support systems can be varied to accommodate different sizes of tubes of film.

5. The VFFS system of claim 2, wherein the drive system includes a first drive wheel and a second drive wheel, and wherein the first and second drive wheels are configured to counterrotate to advance the tube of film.

6. The VFFS system of claim 5, wherein:

5 the first drive wheel is coupled to a first belt roller around which the first belt is looped such that rotation of the first drive wheel causes rotation of the first belt roller and the first belt; and

10 the second drive wheel is coupled to a second belt roller around which the second belt is looped such that rotation of the second drive wheel causes rotation of the second belt roller and the second belt.

7. The VFFS system of claim 6, wherein the coupling of the first drive wheel to the first belt roller and the coupling of the second drive wheel to the second belt roller are configured to cause the first and second belts and the tube of film to move at substantially similar speeds in response to the drive system advancing the tube of film.

15 8. The VFFS system of claim 2, wherein the film support system comprises:

a third film support system having a third belt configured to provide lateral support to the tube of film; and

a fourth film support system having a fourth belt configured to provide lateral support to the tube of film;

20 wherein the first, second, third, and fourth film support systems are arranged such that substantially-vertical portions of the first, second, third, and fourth belts form a rectangular shape through which the tube of film is capable of passing.

9. The VFFS system of claim 1, wherein the void-forming mechanism comprises:

a first squeeze roller positioned on a first void-forming structure; and

25 a second squeeze roller positioned on a first void-forming structure.

10. The VFFS system of claim 9, further comprising:

a support structure configured to which the film support system is movably secured;

wherein the first void-forming structure is rotatably coupled to the support structure; and

wherein the second void-forming structure is rotatably coupled to the support structure.

11. The VFFS system of claim 9, wherein:

the first void-forming structure further includes a plurality of first support rollers located upstream of the first squeeze roller;

each of the plurality of first rollers has an axis that is substantially parallel to an axis of the first squeeze roller;

the second void-forming structure further includes a plurality of second support rollers located upstream of the second squeeze roller; and

each of the plurality of second rollers has an axis that is substantially parallel to an axis of the second squeeze roller.

12. The VFFS system of claim 1, further comprising:

a transverse seal mechanism configured to selectively form two transverse seals in the area of the tube of film.

13. The VFFS system of claim 12, further comprising:

a cutting element configured to sever a product-filled pouch from the tube of film by transversely cutting the tube of film between the two transverse seals formed in the tube of film by the transverse seal mechanism.

14. The VFFS system of claim 1, wherein the product is a food product having a

viscosity at or above at least one of 0.5 Pa·s, 1 Pa·s, 2 Pa·s, 3 Pa·s, 5 Pa·s, or 10 Pa·s.

15. The VFFS system of claim 1, wherein the product is a non-Newtonian fluid.

16. The VFFS system of claim 1, wherein the product has a temperature that is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C.

17. A method of packaging a product using a vertical form-fill-seal (VFFS) system,
5 wherein the VFFS system comprises a dispenser, a drive system, a void-forming mechanism, and a film support system, the method comprising:

dispensing, from the dispenser of the VFFS system, the product into a tube of film;

10 advancing, by the drive system of the VFFS system, the tube of film in a downstream direction; and

closing, by the void-forming mechanism of the VFFS system, on the tube of film to void or clean an area of the tube of film;

wherein the film support system is configured to provide lateral support to the tube of film during the dispensing; and

15 wherein the film support system is positioned upstream of the void-forming mechanism.

18. The method of claim 17, further comprising:

forming, by a transverse seal mechanism of the VFFS system, two transverse seals in the area of the tube of film.

20 19. The method of claim 18, further comprising:

cutting, by a cutting element of the VFFS system, the tube of film between the two transverse seals in the area of the tube of film to sever a product-filled pouch from the tube of film.

20. The method of claim 17, wherein the film support system comprises:

a first film support system having a first belt configured to provide lateral support to the tube of film; and

a second film support system having a second belt configured to provide lateral support to the tube of film;

wherein the first and second belts are capable of counterrotating with the tube of film located therebetween.

21. The method of claim 20, wherein:

the first belt includes a substantially-vertical portion;

the second belt includes a substantially-vertical portion; and

the first and second film support systems are arranged such that the substantially-vertical portion of the first belt and the substantially-vertical portion of the second belt are substantially parallel to each other.

22. The method of claim 20, further comprising:

varying respective positions of the first and second film support systems to accommodate different sizes of tubes of film.

23. The method of claim 17, wherein the product is a food product having a viscosity at or above at least one of 0.5 Pa·s, 1 Pa·s, 2 Pa·s, 3 Pa·s, 5 Pa·s, or 10 Pa·s.

24. The method of claim 17, wherein the product is a non-Newtonian fluid.

25. The method of claim 17, wherein the product has a temperature that is at or above one or more of 70°C, 75°C, 80°C, 85°C, 90°C, or 95°C.

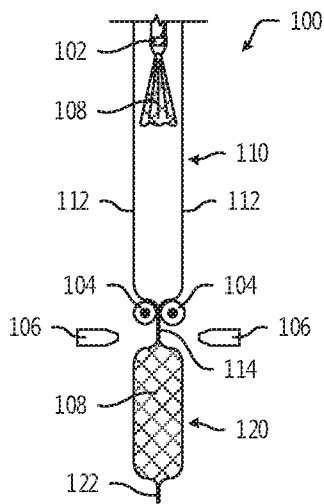


Fig. 1A

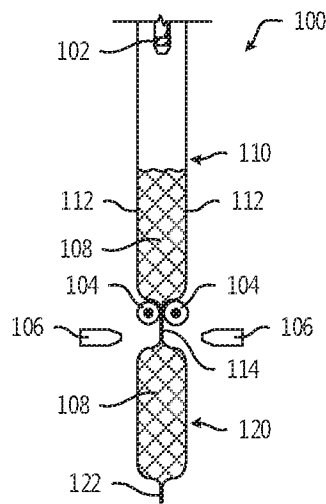


Fig. 1B

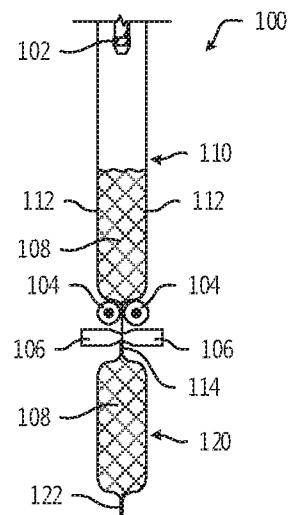


Fig. 1C

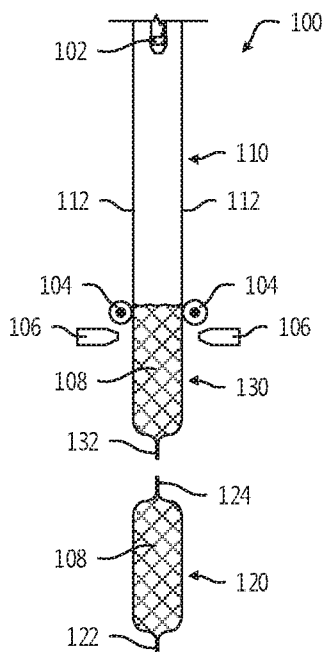


Fig. 1D

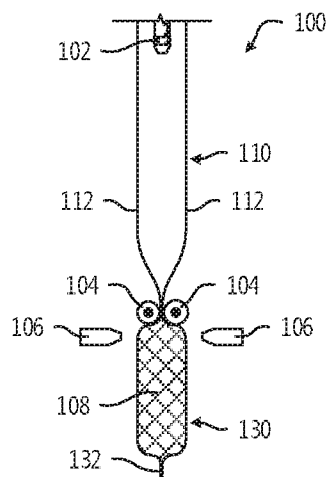


Fig. 1E

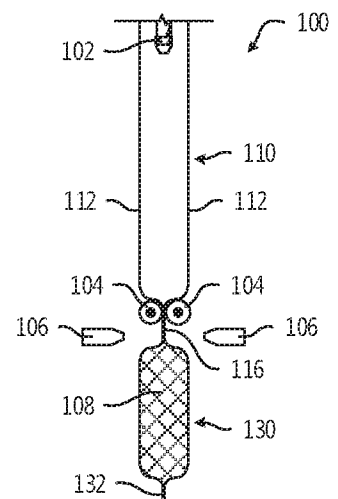


Fig. 1F

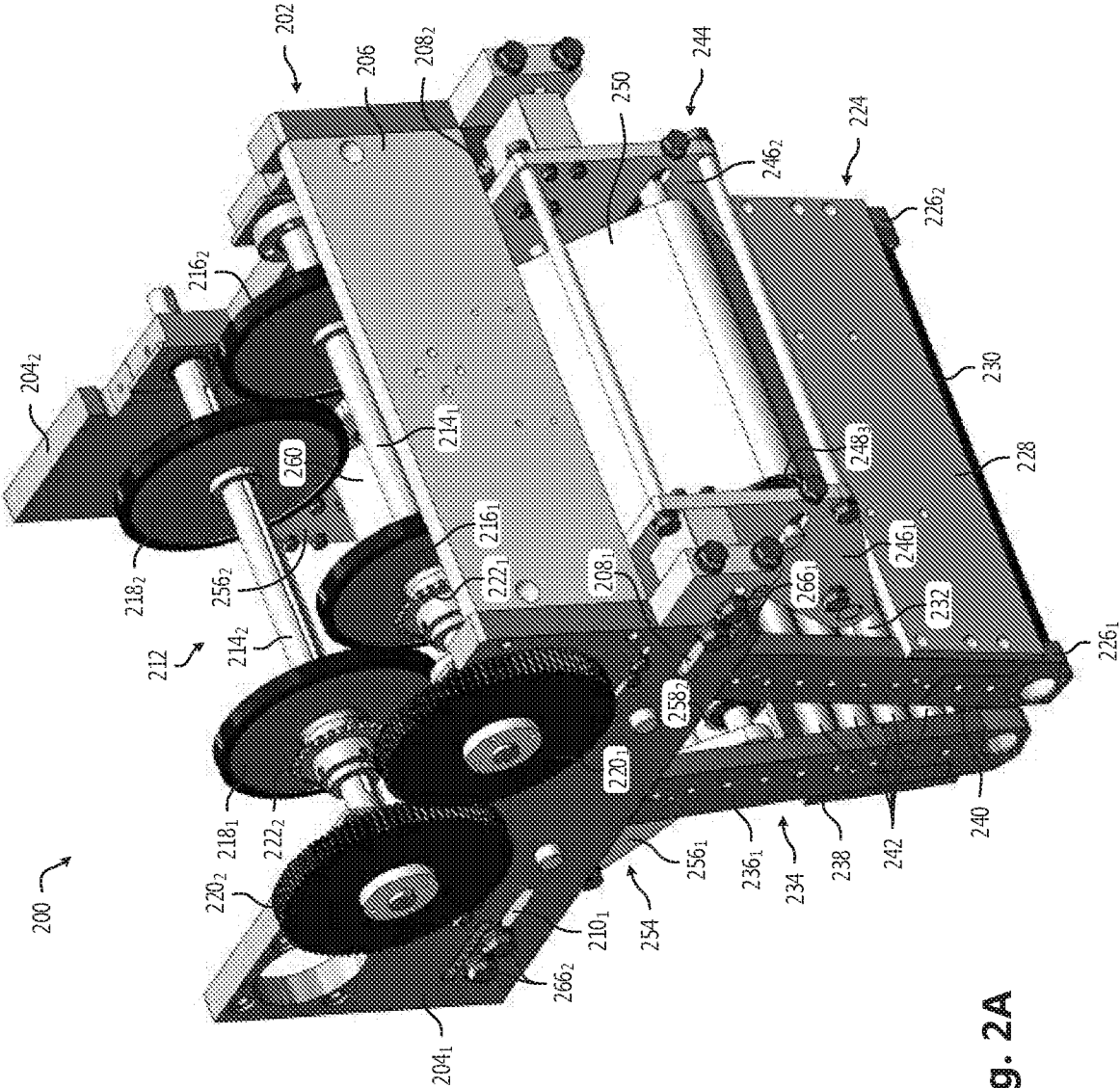


Fig. 2A

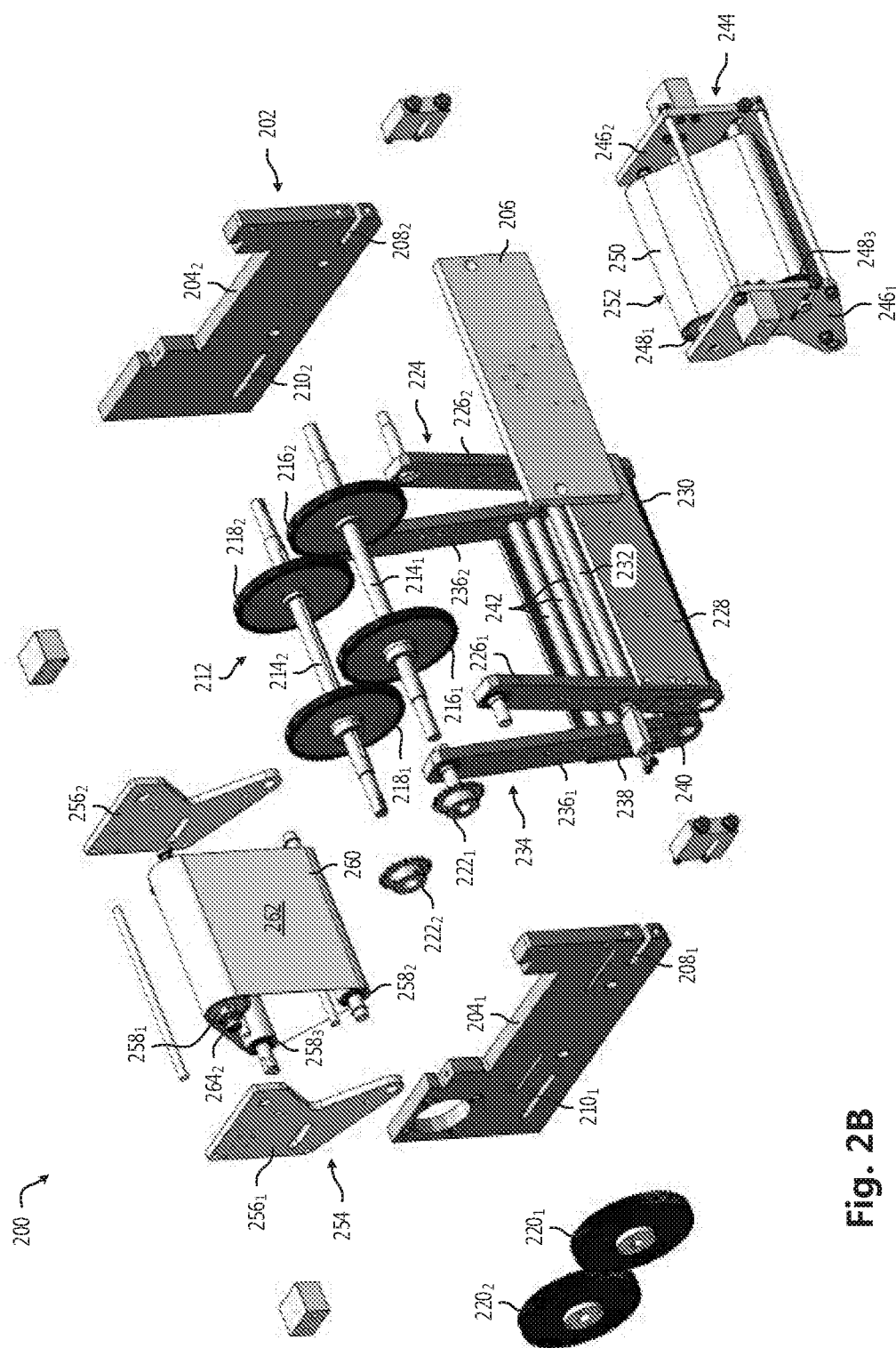
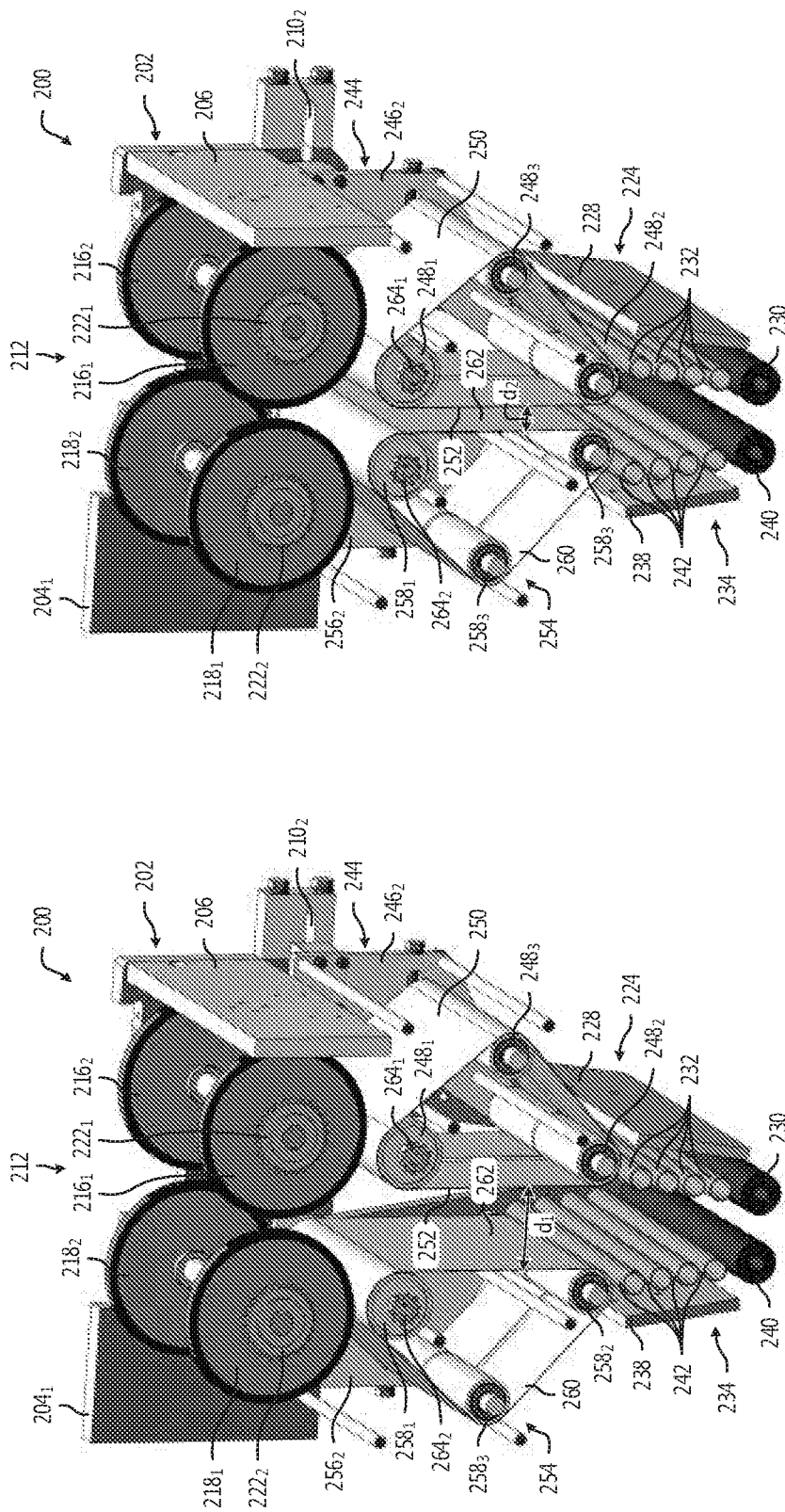
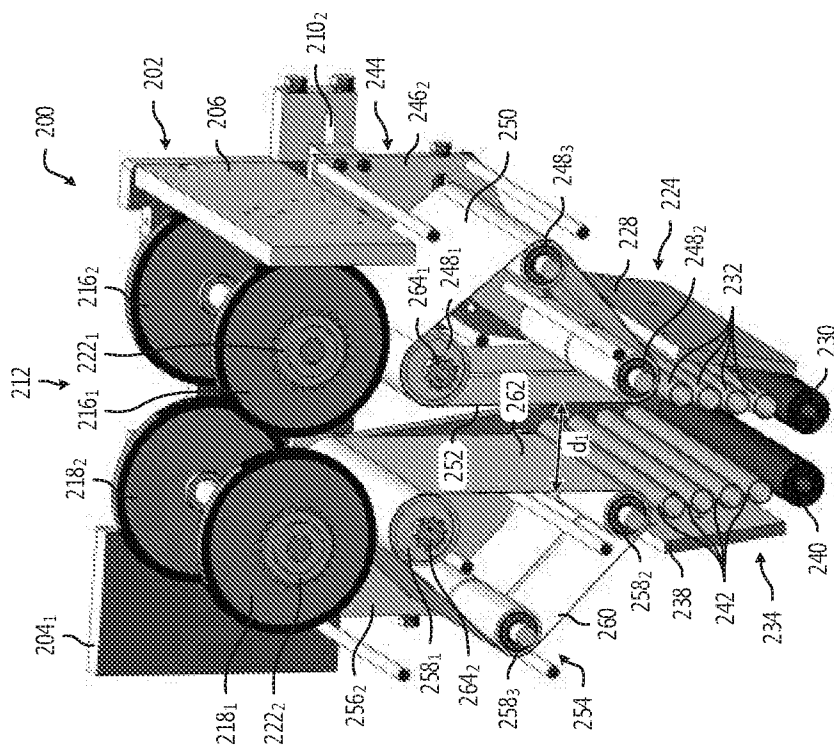


Fig. 2B



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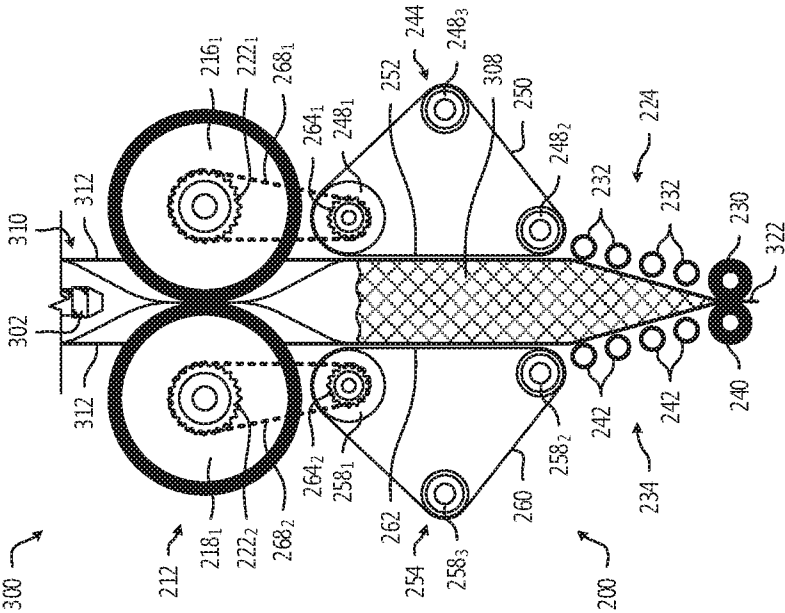


Fig. 4B

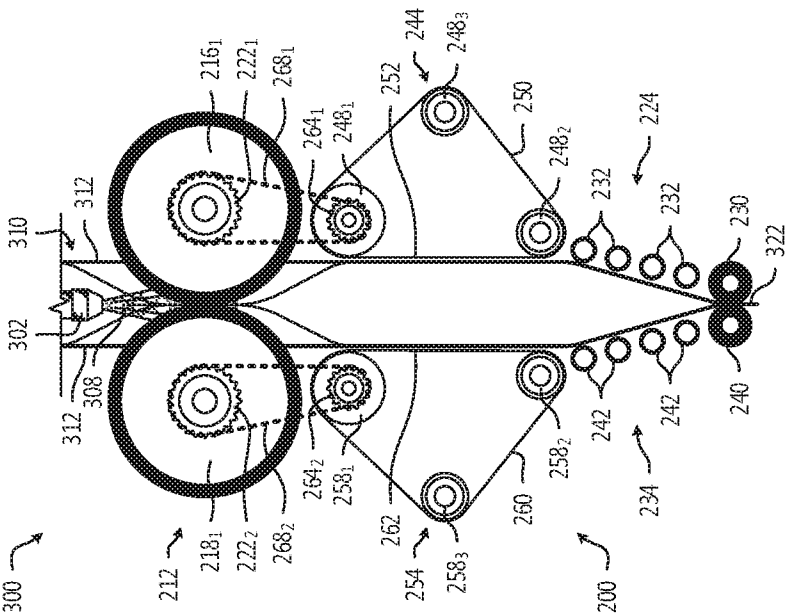


Fig. 4A

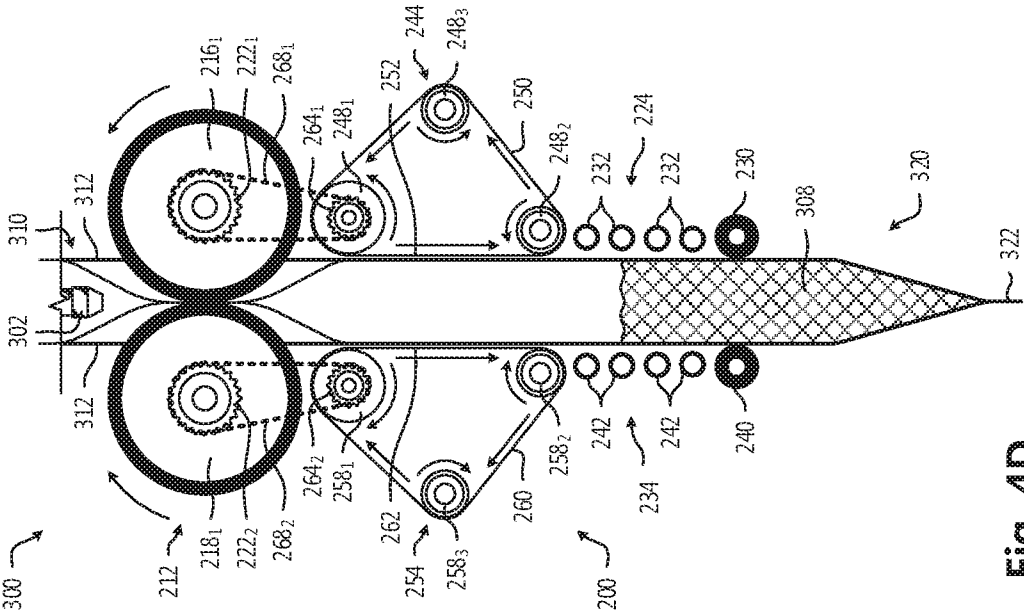


Fig. 4D

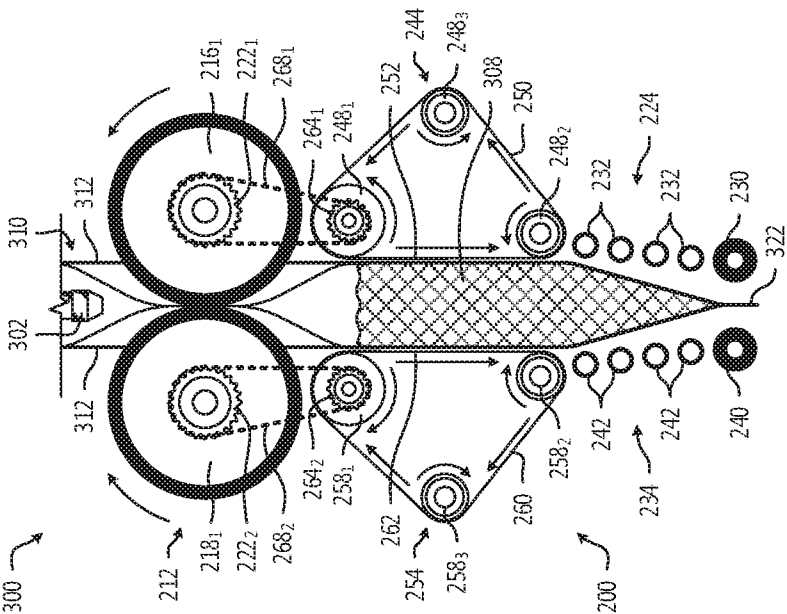


Fig. 4C

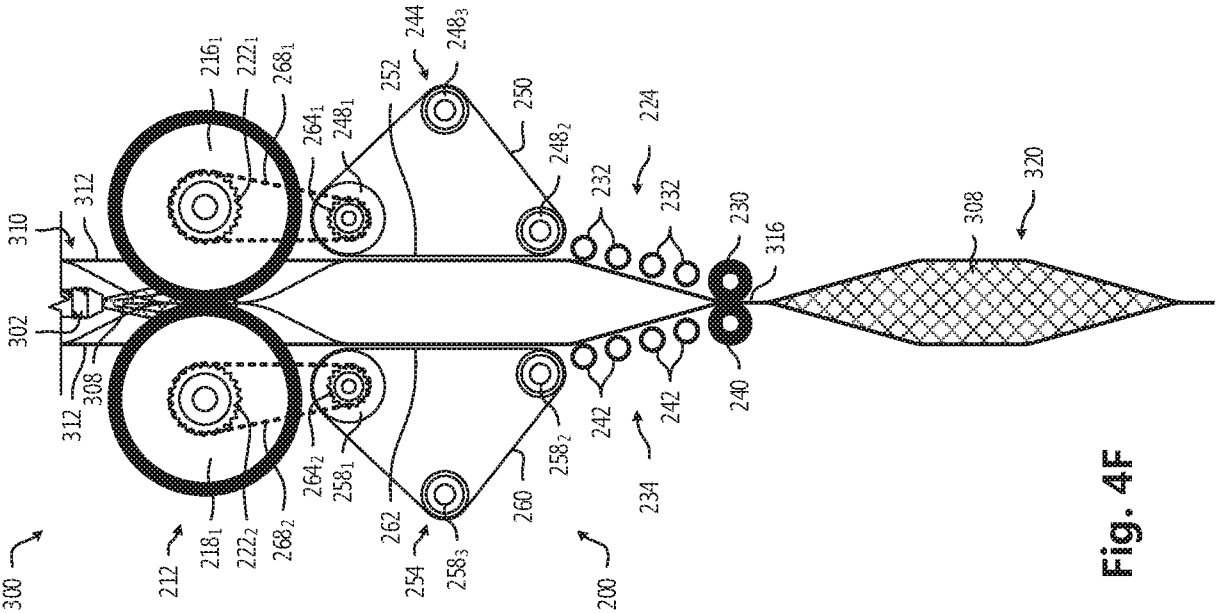


Fig. 4E

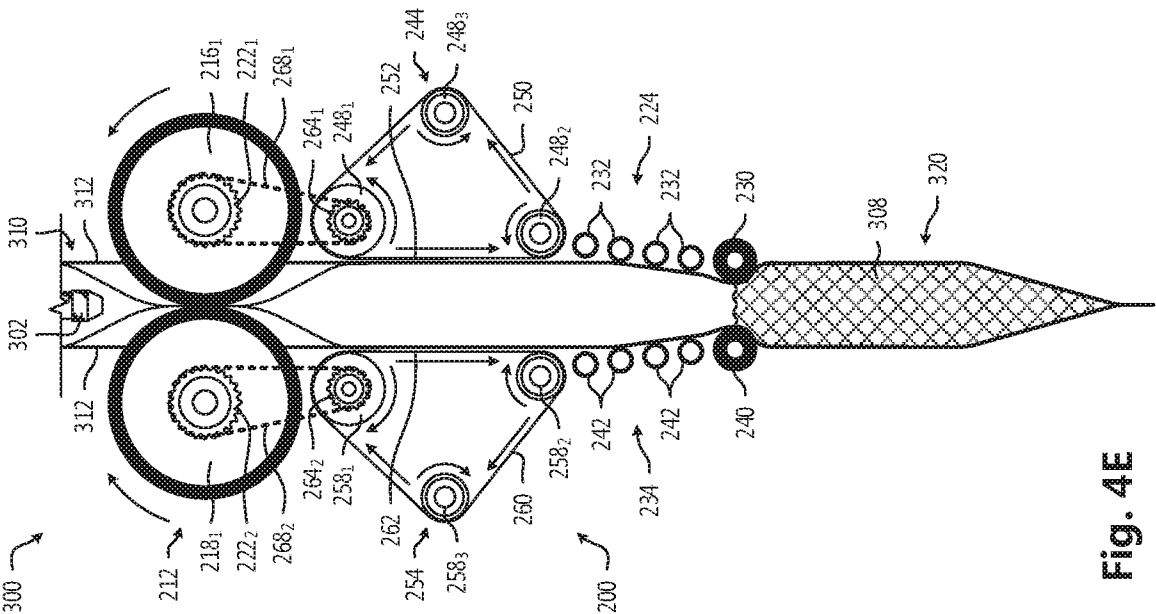


Fig. 4F

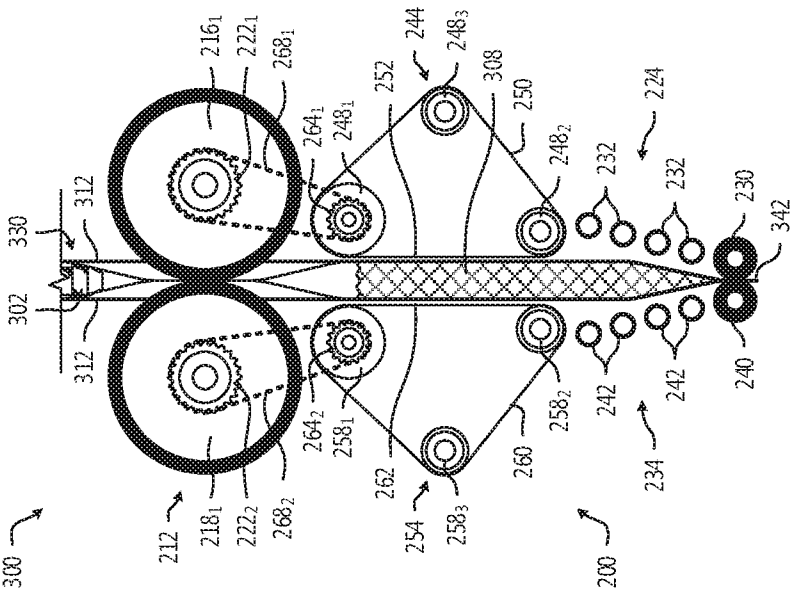


Fig. 5B

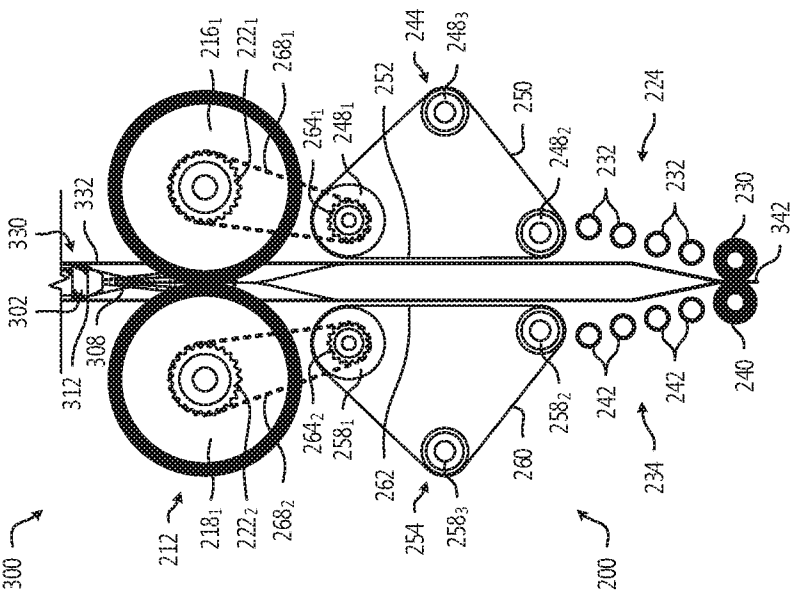


Fig. 5A

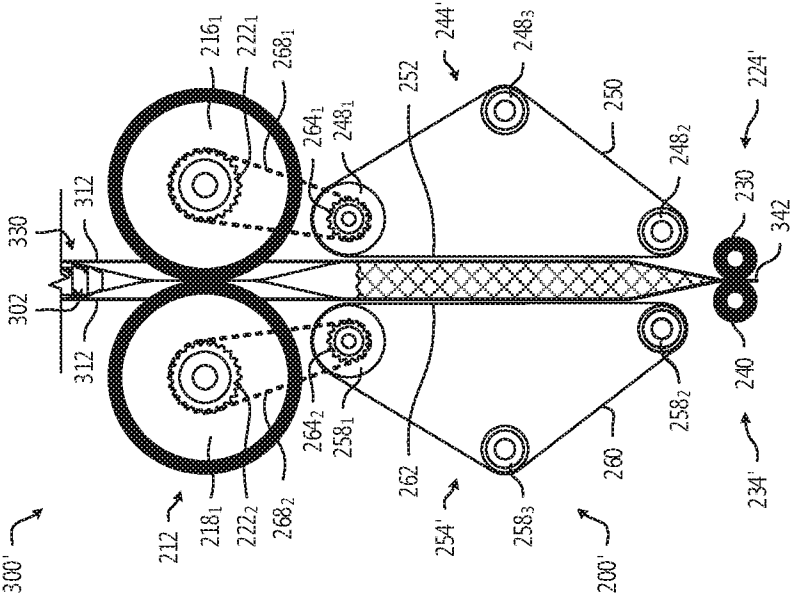


Fig. 6A

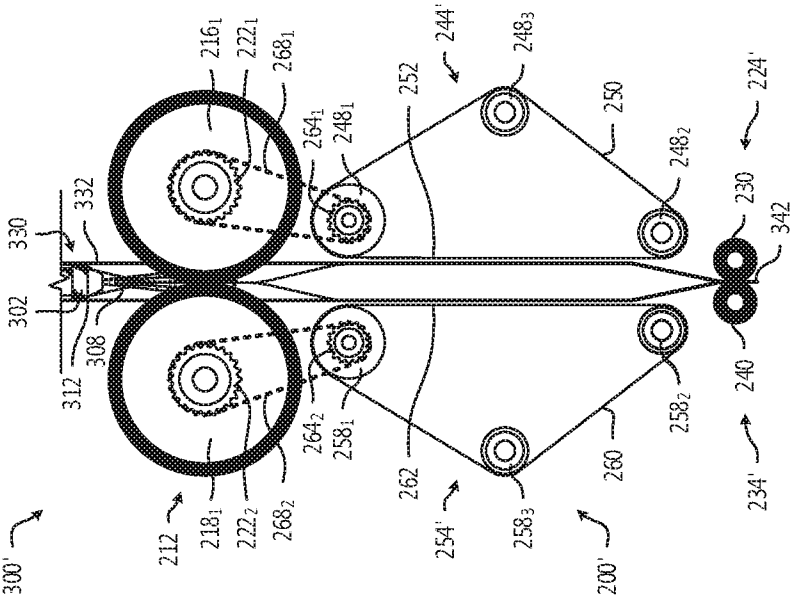


Fig. 6B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2020/023097

A. CLASSIFICATION OF SUBJECT MATTER INV. B65B9/20 B65B9/207 B65B9/213 B65B51/30 B65B51/32 B65B63/08 B65B59/00 B65B9/12 ADD. According to International Patent Classification (IPC) or to both national classification and IPC														
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B65B 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 <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category*</th> <th style="width: 70%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width: 20%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top;">X Y</td> <td style="vertical-align: top;"> US 3 849 965 A (DOMINICI A) 26 November 1974 (1974-11-26) figures 1-9 column 2, lines 4-14, 27-41, 60-66 column 3, lines 1-30, 61-63 ----- </td> <td style="vertical-align: top;"> 1-8,12, 13,17-22 2-11, 14-16, 22-25 </td> </tr> <tr> <td style="vertical-align: top;">X Y</td> <td style="vertical-align: top;"> WO 2018/066029 A1 (ORIHIRO ENG CO LTD [JP]) 12 April 2018 (2018-04-12) figures 4, 7, 13 paragraphs [0054] - [0065], [0073] - [0082] ----- </td> <td style="vertical-align: top;"> 1-7,12, 13,17-21 8-11, 14-16, 22-25 </td> </tr> <tr> <td style="vertical-align: top;">X Y A</td> <td style="vertical-align: top;"> US 2018/265231 A1 (CAUDLE TIMOTHY GRAY [US] ET AL) 20 September 2018 (2018-09-20) figures 1, 9, 11 paragraphs [0006], [0007], [0009], [0046], [0084] - [0088] paragraphs [0053] - [0057], [0060], [0067], [0068], [0096] ----- </td> <td style="vertical-align: top;"> 1,9,10, 12-25 2-8 11 </td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X Y	US 3 849 965 A (DOMINICI A) 26 November 1974 (1974-11-26) figures 1-9 column 2, lines 4-14, 27-41, 60-66 column 3, lines 1-30, 61-63 -----	1-8,12, 13,17-22 2-11, 14-16, 22-25	X Y	WO 2018/066029 A1 (ORIHIRO ENG CO LTD [JP]) 12 April 2018 (2018-04-12) figures 4, 7, 13 paragraphs [0054] - [0065], [0073] - [0082] -----	1-7,12, 13,17-21 8-11, 14-16, 22-25	X Y A	US 2018/265231 A1 (CAUDLE TIMOTHY GRAY [US] ET AL) 20 September 2018 (2018-09-20) figures 1, 9, 11 paragraphs [0006], [0007], [0009], [0046], [0084] - [0088] paragraphs [0053] - [0057], [0060], [0067], [0068], [0096] -----	1,9,10, 12-25 2-8 11
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Date of the actual completion of the international search 30 May 2020		Date of mailing of the international search report 09/06/2020												
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Schmitt, Michel												

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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