



(51) International Patent Classification:

B65B 1/22 (2006.01) *B65B 51/30* (2006.01)
B65B 9/207 (2012.01) *B65B 65/02* (2006.01)
B65B 31/00 (2006.01)

(21) International Application Number:

PCT/US2018/038979

(22) International Filing Date:

22 June 2018 (22.06.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

15/630,580 22 June 2017 (22.06.2017) US

(71) Applicant: FRITO-LAY NORTH AMERICA, INC.
[US/US]; 7701 Legacy Drive, Plano, TX 75024 (US).

(72) Inventors: EDWARDS, Eduard; 8901 Sunrise Court, White Settlement, TX 76108 (US). HUEBNER, Chad, Arthur; 45 Linderhof Cir, Bedford, TX 76022 (US).

(74) Agent: GOURLEY, James R.; Carstens & Cahoon, LLP, P.O. Box 802334, Dallas, TX 75380 (US).

(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, JO, 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).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

(54) Title: METHOD AND APPARATUS FOR A PRODUCT SETTLER

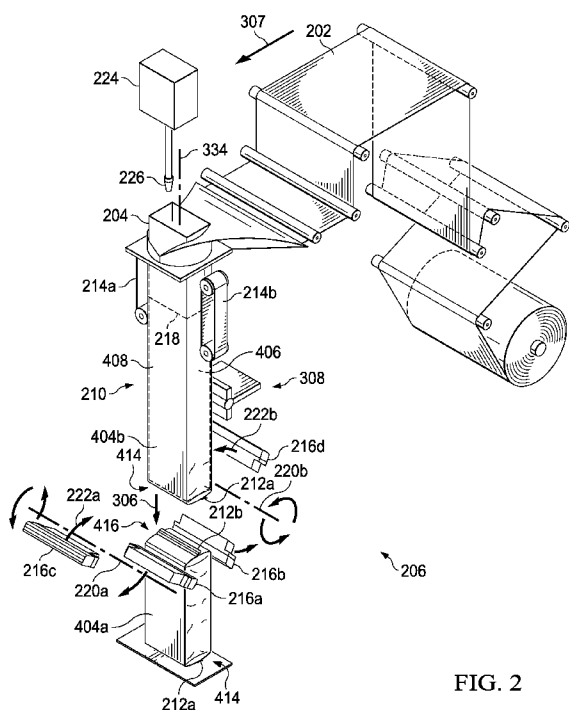


FIG. 2

(57) Abstract: A method and apparatus for settling a product in a package made on a form, fill and seal machine. In one aspect the invention comprises the steps: providing a package material on a product conduit of a form, fill and seal machine; forming a first end seal on the package material to form a partially formed package; filling the partially formed package with product; and settling the product in the partially formed package while continuously conveying the package material along the product conduit. In a second aspect, the invention comprises a product settler comprising a first object positioned to cause an impact against a package material. The impact agitates the package material and settles a product from an unsettled height to a settled height while the package material is continuously conveyed.

Published:

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

METHOD AND APPARATUS FOR A PRODUCT SETTLER

BACKGROUND OF THE INVENTION

Cross-Reference to Related Applications

[0001] The present application is a continuation-in-part of and claims priority to U.S. Nonprovisional Patent Application No. 14/581,013, entitled “Method and Apparatus for a Product Settler,” filed December 23, 2014, and published as US 2016/0176548 A1 on June 23, 2016, and U.S. Nonprovisional Patent Application No. 14/581,110, entitled “Method and Apparatus for a Product Settler,” filed December 23, 2014, and published as US 2016/0176549 A1 on June 23, 2016, all of which are hereby incorporated by reference in their entirety as examples.

Technical Field

[0002] The present invention relates to an apparatus and method for settling products in a package.

Background

[0003] Many foodstuffs, such as potato chips, are packaged in pillow pouch packages that are made using a form, fill and seal (“FFS”) machine. Typically, a form, fill and seal machine forms the film into a tube, seals the bottom of the tube, fills the partially sealed tube with product, and then seals the top of the tube to form a packaged product. Often, a form, fill and seal machine is oriented so that film travels in a direction that is generally vertical as the film is formed into a tube, filled with product and sealed. Such a machine is an example of a vertical form, fill and seal (“VFFS”) machine.

[0004] When the product being packaged is an irregularly shaped product such as potato chips, there can be large void spaces between each piece. The void space takes up volume in the package and requires the package to be larger than required for the product

alone. This requires more resources, which is less environmentally friendly. It is also more expensive for producers and ultimately consumers.

[0005] To avoid these and other problems posed by void space, some form, fill and seal machines are fitted with product settlers. These settlers typically shake the product to make it settle into a more compact configuration and thereby reduce void space.

[0006] In addition to reducing void space in a product, it is desirable to package product more quickly. One way to increase the speed with which product is packaged is to increase the speed with which film is fed to the form, fill and seal machines. Other things being equal, continuously feeding film to a machine is faster than intermittently feeding film.

[0007] To take advantage of this principle, some machines, called continuous motion machines, are capable of running in a continuous mode in which film is continuously being advanced, as opposed to being paused intermittently. However, running a machine in continuous mode is incompatible with conventional settlers that grab or pinch the film. This is because grabbing or pinching will damage the film unless the film is paused.

[0008] Examples of conventional settlers that require a film to be paused include settlers with beater bars that grab and shake the film. Another conventional settler that requires film to be paused uses two swinging panels. The two panels are positioned below the product conduit and can rotate together like doors. When the panels come together, they pinch and seal off the film below the product conduit. After product falls on the closed panels, seal jaws come together to form an end seal on the film. This forms the bottom of a partially formed package. Then, the panels rotate open, which releases the film and allows the product to fall to the bottom of the partially formed package. This process of repeatedly dropping and catching the product causes the product to be settled. However, it can also damage the product by causing breakage, for example, of chips.

[0009] As these examples illustrate, when using conventional settlers, form, fill and seal machines must run in an intermittent mode in which the film is stopped when the settlers

grab the film, and the film advances when the settlers release the film. As a result, many continuous motion machines do not even come with a settler. Other machines come with a settler that can be installed by a user, but the machine must then be run in an intermittent mode. Running machines in intermittent mode is inefficient and results in additional wear and tear on the machines and film. Thus, using a conventional settler with a continuous motion form, fill and seal machine can be undesirable.

[0010] Accordingly, it would be advantageous to have a settler that is compatible with a form, fill and seal machine running in continuous mode. For example, it is desirable to have a settler that does not grab film and can be used with a machine that continuously conveys the film. Such a settler would not require the film to be paused during production of packages. This could, in turn, avoid wear and tear on the machine and film caused by large transient forces that occur when starting and stopping the machine.

[0011] It would also be advantageous if an inventive settler could be used to produce product-filled packages more quickly than conventional settlers that require packaging film to be paused intermittently.

[0012] In addition, it would be desirable if the inventive settler reduced the volume that product occupies in a package. For example, it would be desirable if the settler reduced the volume occupied by a product at least as much as a conventional settler.

[0013] Furthermore, it would be desirable if an inventive settler could increase the head space in a package of a given size. For example, increased head space can help prevent product inside the package from being too close to, or caught in, the end seal of the package. This helps to ensure that the package is properly sealed. Increased head space can also help prevent other manufacturing defects, for example, unintended pleats and unintended tucks. It would be even more desirable if the inventive settler could increase head space and/or reduce manufacturing defects when compared to conventional settlers.

[0014] Likewise, it would be beneficial if the inventive settler did not break a substantial amount of product by impacting the product. For example, it would be beneficial if the settler were positioned so that it did not impact a substantial amount of the product through the packaging film. It would also be advantageous if the inventive settler could optionally be mounted somewhere besides the seal jaw carriage of a form, fill and seal machine. As another example, it would be beneficial if the inventive settler could operate intermittently or continuously. For example, it would be beneficial if the inventive settler could stop settling while the product is in a position to be damaged by the settler. However, after the product is no longer in such a position, the inventive settler would begin settling again.

[0015] Similarly, it would be desirable if the inventive settler decreased the amount of film required to package a given amount of product. This could help reduce waste, increase the environmental friendliness of a process, reduce manufacturing costs, and further increase the speed of a manufacturing process. For example, using a settler that can be used with a continuous motion form, fill and seal machine can increase the speed of a manufacturing process. Also, if the inventive settler could decrease the amount of film necessary to package a product, less film would need to be conveyed for a unit of product. This could further reduce the amount of time required to produce each unit.

[0016] In addition, it would be advantageous if the inventive settler did not interfere with the continuous motion of a package film when the inventive settler stopped. For example, it would be advantageous if the inventive settler had a low torque motor so that if the settler stopped running or even failed while the settler was in contact with a package film, the film could push the settler out of the path of the film, and the film could continue to be advanced. It would also be advantageous if the inventive settler could be stopped in a position where it does not impede the continuous conveyance of packaging film.

[0017] It would be another benefit if the inventive settler were simple compared to conventional settlers. For example, it would be beneficial if the inventive settler had fewer moving parts than conventional settlers, had a less complicated operating mechanism, and were easier to maintain, repair and/or replace. It would also be beneficial if the inventive settler required minimal training of or input from maintenance personnel.

[0018] Furthermore, it would be useful if the inventive settler were small compared to conventional settlers. For example, conventional settlers can have components that take up a large amount of space and it would be advantageous to avoid these components.

[0019] Additionally, it would be desirable if the inventive settler could be easily installed on existing form, fill and seal machines. For example, it would be desirable if the inventive settler were modular and could be easily added to existing continuous motion vertical form, fill and seal machines. It would also be useful if a modular form of the inventive settler were easier to maintain, repair, and/or replace than conventional settlers. For example, it would be desirable if an inventive settler needing maintenance could be easily removed from a continuous motion form, fill and seal machine and replaced with a recently serviced settler. It would also be desirable if the inventive settler were designed so that the form, fill and seal machine could run without needing to be substantially reconfigured if the inventive settler were removed and were not replaced. For example, the machine could be instructed to create bigger packages due to a lack of settling, but the machine would not require other reconfiguration. This could increase the versatility of a product manufacturing line and increase its resilience in the face of maintenance issues.

[0020] Similarly, it would be advantageous if a form, fill and seal machine were easier to maintain and repair when the inventive settler is used with the machine instead of a conventional settler. It would also be advantageous if the small size and location of the inventive settler made it easier to access and service the machine compared to conventional settlers. For example, the size and location of conventional settlers can block or substantially

impede access to the seal jaw carriage of a form, fill and seal machine. In contrast, it would be advantageous if the inventive settler could be installed on one side of a machine making it easy to access the seal jaw carriage even when the inventive settler is installed. It would also be advantageous if the inventive settler could easily be removed in comparison to a conventional settler, for example, if the inventive settler were modular, as this would also increase the ease of servicing of form, fill and seal machine.

SUMMARY OF THE INVENTION

[0021] The present invention is a method and apparatus for settling products. For example, the inventors have developed a new type of settler that can be used in conjunction with a form, fill and seal machine even when the machine is running in continuous mode.

[0022] In a first aspect, the invention provides a method for settling a product in a package made on a form, fill and seal machine. The method comprises the steps: providing a package material on a product conduit of a form, fill and seal machine; forming a first end seal on the package material to form a partially formed package; filling the partially formed package with product; and settling the product in the partially formed package while continuously conveying the package material along the product conduit.

[0023] In a second aspect, the invention provides an apparatus comprising an improved continuous motion form, fill and seal machine. The machine comprises a product conduit, a conveyor, and seal jaws. The conveyor is positioned to convey a package material that is wrapped around the product conduit, and the conveyor moves the package material along the product conduit. The seal jaws are positioned adjacent to opposite portions of the package material to form a first end seal on the package material, thereby forming a partially formed package. The product conduit is positioned so that a product passing through the product conduit will enter the partially formed package after exiting the product conduit, and the product conduit is positioned above the seal jaws. The improvement comprises a product settler comprising a first object positioned to cause an impact against the package material. The impact agitates the package material and settles the product from an unsettled height to a settled height while the machine continuously conveys the package material along the product conduit.

[0024] In a third aspect, the invention provides a method for settling a product in a partially formed package. The method comprises the steps: providing a partially formed package; filling the partially formed package with a product; and settling the product in the

partially formed package. The settling step comprises rotating a paddle wheel comprising at least one paddle against the partially formed package.

[0025] In a fourth aspect, the invention provides an apparatus comprising an improved product settler for settling product in a partially formed package. The improved product settler comprises a paddle wheel. The paddle wheel comprises at least one paddle that is positioned to cause an impact against the partially formed package. The impact agitates the partially formed package and thereby settles the product.

[0026] The invention described herein provides many advantages in its various embodiments. In one aspect, the invention provides a settler that is compatible with a form, fill and seal machine running in continuous mode. For example, it provides a settler that does not grab film and can be used with a machine that continuously conveys the film. Such a settler does not require the film to be paused during the production of packages. This, in turn, avoids large transient forces that occur when starting and stopping the machine and avoids associated wear and tear on the machine. In one embodiment, the inventive settler comprises a rotating paddle wheel with a paddle that impacts the film in substantially the same direction that the film is conveyed. Accordingly, in one embodiment, the inventive settler comprises paddles that intermittently contact the film and scrub the film in the film's direction of conveyance.

[0027] The inventive settler also can be used to produce product-filled packages more quickly than conventional settlers, which require packaging film to be paused intermittently.

[0028] In addition, the inventive settler can reduce the volume that product occupies in a package. For example, the settler reduces the volume occupied by a product at least as much as a conventional settler.

[0029] Furthermore, the inventive settler increases the head space in a package of a given size. For example, increased head space can help prevent product inside the package from being too close to, or caught in, the end seal of the package. This helps to ensure that

the package is properly sealed. Increased head space can also help prevent other manufacturing defects, for example, unintended pleats and unintended tucks. Additionally, the inventive settler can increase head space and/or reduce manufacturing defects when compared to conventional settlers.

[0030] As another advantage, the inventive settler does not break a substantial amount of product by impacting the product. In one embodiment, the inventive settler causes little or no breakage of product. For example, the settler can be positioned so that the settler does not impact a substantial amount of the product through the packaging film when the settler is in operation. In one embodiment, the inventive settler can be mounted somewhere besides the seal jaw carriage of a form, fill and seal machine. For example, the settler can be positioned just below the product conduit of a form, fill and seal machine so that the settler does not impact a substantial amount of product as the product falls from the product conduit and into the packaging film. The inventive settler can also operate intermittently or continuously. For example, the inventive settler can stop settling while the product is in a position to be damaged by the settler. However, after the product is no longer in such a position, the inventive settler can begin settling again.

[0031] The inventive settler can also decrease the amount of film required to package a given amount of product. This helps reduce waste, increase the environmental friendliness of the process, reduce manufacturing costs, and further increase the speed of a manufacturing process. For example, the inventive settler can be used with a continuous motion form, fill and seal machine which increases the speed of a manufacturing process relative to using an intermittent machine. Also, although conventional settlers cannot be used with continuous motion machines, the inventive settler can. Accordingly, the inventive settler can decrease the amount of film necessary to package a product on a continuous motion machine. Since less film needs to be conveyed for a unit of product, this further reduces the amount of time required to produce each unit.

[0032] In addition, the inventive settler does not interfere with the continuous motion of a package film when the inventive settler stops. For example, the inventive settler has a low torque motor so that if the settler stops running or even fails while the settler is in contact with a package film, the film can push the settler out of the path of the film, and the film can continue to be advanced. As another example, the inventive settler can be stopped in a position where it does not impede the continuous conveyance of packaging film.

[0033] The inventive settler is also simple compared to conventional settlers. For example, compared to conventional settlers, the inventive settler has fewer moving parts, has a less complicated operating mechanism, is easier to maintain, is easier to repair and/or is easier to replace. The inventive settler also requires minimal training of and input from maintenance personnel.

[0034] Furthermore, the inventive settler is small compared to conventional settlers. For example, conventional settlers can have components that take up a large amount of space and the inventive settler advantageously avoids this.

[0035] Additionally, the inventive settler can be easily installed on existing form, fill and seal machines. For example, in one embodiment, the inventive settler is modular and can be easily added to existing continuous motion vertical form, fill and seal machines. Also, the inventive settler is easier to maintain, repair, and/or replace than conventional settlers. For example, a modular form of the inventive settler can be installed, uninstalled, and serviced with ease. As another example, the inventive settler can be easily removed from a continuous motion form, fill and seal machine and replaced with another inventive settler. Also, the inventive settler is designed so that the form, fill and seal machine can run without needing to be substantially reconfigured if the inventive settler is removed and is not replaced. For example, the machine can be instructed to create bigger packages due to a lack of settling, but the machine does not require other reconfiguration to continue producing product.

Accordingly, the inventive settler increases the versatility of a product manufacturing line and increases its resilience in the face of maintenance issues.

[0036] Similarly, a form, fill and seal machine is easier to maintain and repair when the inventive settler is used with the machine instead of a conventional settler. In one embodiment, the small size and location of the inventive settler during operation make the machine easier to access and service when compared to machines using conventional settlers. For example, the size and location of conventional settlers can block or substantially impede access to the seal jaw carriage of a form, fill and seal machine. In contrast, the inventive settler can be installed on one side of a machine, rather than, for example, having components that are adjacent to opposite sides of the machine. For example, the inventive settler can comprise a paddle wheel that is positioned adjacent to one side of a product conduit of a form, fill and seal machine. Accordingly, when the inventive settler, as opposed to a conventional settler, is installed on a machine, it is easier to access the components (e.g., seal jaw carriage) of the machine. Furthermore, the inventive settler can easily be removed in comparison to a conventional settler. When the inventive settler is modular, this further increases the ease of servicing a form, fill and seal machine when compared to servicing a machine using a conventional settler.

[0037] Another benefit of the inventive settler is that it can be used to settle many different kinds of products. For example, the inventive settler is especially useful for settling larger or irregularly shaped products such as tortilla chips or potato chips. The settler is also useful for settling smaller or regularly shaped products such as Cheetos® cheese puffs. Although, when compared to larger or irregularly shaped products, smaller or regularly shaped products may experience less settling.

[0038] Other aspects, embodiments and features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings. The accompanying figures are schematic and

are not intended to be drawn to scale. In the figures, each identical or substantially similar component that is illustrated in various figures is represented by a single numeral or notation. For purposes of clarity, not every component is labeled in every figure. Nor is every component of each embodiment of the invention shown where illustration is not necessary to allow those of ordinary skill in the art to understand the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will be best understood by reference to the following detailed description of illustrative embodiments when read in conjunction with the accompanying drawings, wherein:

[0040] Figure 1 is a flow chart depicting one embodiment of a process according to the invention;

[0041] Figure 2 is a schematic view of one embodiment of the invention for use with a vertical, form, fill, and seal machine;

[0042] Figures 3A-3C are a progression of schematic views of one embodiment of the invention depicting a product settler being used to settle product;

[0043] Figures 4A-4B are schematic depictions of a package for product that can be settled by one embodiment of the invention;

[0044] Figure 5A is a schematic top view of one embodiment of the invention;

[0045] Figure 5B is a schematic side view of the embodiment shown in Figure 5A;

[0046] Figure 5C is a schematic front view of the embodiment shown in Figure 5A;

[0047] Figures 6A-6C are schematic perspective views depicting one embodiment of a product settler;

[0048] Figure 7 is a schematic view of one embodiment of the invention for use with a vertical, form, fill, and seal machine;

[0049] Figure 8 is a schematic side view depicting, from left to right, a progression of scenes illustrating how an embodiment of a product settler impacts a partially formed package to settle product within the partially formed package;

[0050] Figure 9 is a schematic illustration useful for characterizing the flexibility or rigidity of a paddle of a product settler and depicting how any bend that occurs in the paddle

during use can be measured, for example, with the aid of a camera or other imaging device, and limited to a specified bend tolerance;

[0051] Figures 10-11 are schematic perspective views depicting one embodiment of a product settler in which a rotor for a motor of the product settler also acts as an axle for a paddle wheel of the product settler;

[0052] Figure 12 is a schematic view of one embodiment of a product settler for use with a vertical, form, fill, and seal machine and illustrating a product settler with concentric axes of rotation for a rotor and a paddle wheel;

[0053] Figure 13 is a schematic view of one embodiment of a product settler depicting a reference motor cylinder provided with the smallest radius that enables the reference motor cylinder to contain a motor of the product settler and depicting a reference paddle wheel cylinder provided with the smallest radius that enables the reference paddle wheel cylinder to contain a paddle wheel of the product settler;

[0054] Figure 14 is a schematic view of a product settler with a paddle wheel in which adjacent paddles are mutually oriented at a paddle spacing angle and illustrating how the paddle spacing angle can vary among the pairs of adjacent paddles.

DETAILED DESCRIPTION

[0055] Several embodiments of Applicant's invention will now be described with reference to the drawings. Unless otherwise noted, like elements will be identified by identical numbers throughout all figures.

[0056] One embodiment of the invention will now be described with respect to **Figures 1, 2, 3A-3C, and 4A-4B**. The embodiment is a method for settling a product in a package **404** made on a form, fill and seal machine. The method comprises the following steps. First, in a providing step **102**, a film **202** is provided on a product conduit **204** of a form, fill and seal machine **206** (e.g. a vertical form, fill and seal machine).

[0057] Second, in a longitudinal sealing step **104**, the film **202** is sealed to form a longitudinal seal **402** (e.g. back seal) on a package **404**. **Figures 4A-4B** depict a package **404** with a first face (e.g., first end **414** or a bottom **414**), a second face (e.g., a second end **416** or a top **416**), a third face **408** (e.g., a front face), a fourth face **406** (e.g., a back face), a fifth face **410** (e.g., a right face), and a sixth face **412** (e.g., a left face). An example of a longitudinal seal **402** (e.g., a back seal) can be seen on the fourth face **406** (e.g., back side) of the package **404**. The longitudinal seal **402** can be useful to form a tube **210** from a film **202** that has been wrapped around a product conduit **204** (e.g., a hollow former). As shown, the tube **210** has a continuous circumference **218**. Although a longitudinal seal **402** is provided in some embodiments, in other embodiments, a longitudinal seal is not provided. Accordingly, the longitudinal sealing step **104** is optional. When a longitudinal sealing step **104** is not used to provide a tube-shaped film **210**, the tube-shaped film can be provided in other ways, for example, by using a process to produce a blown film, which can have a continuous circumference **218** without using a longitudinal sealing step **104**.

[0058] Third, in a first end-sealing step **106**, a first end seal **212a** is formed on the film **202** to form a partially formed package (e.g., partially formed second package **404b** in **Figure 2**). The first end seal **212a** is located on a first face (e.g., first end **414**) of the

partially formed package. As can be seen in **Figure 2**, a first package **404a** has already been formed and a second package **404b** is a partially formed package. However, before the first package **404a** was formed, it was also a partially formed package (e.g., partially formed second package **404b**).

[0059] Fourth, in a filling step **108**, the partially formed package (e.g., partially formed package **404b**) is filled with a product **302**. An example of how a package **404b** can be filled with product is illustrated in **Figures 3A-3B**. The product **302** enters the package **404b** through the product conduit **204**. As the product enters the package, it moves in a fill direction **304**, and the product **302** falls under the force of gravity. Accordingly, as shown, the fill direction **304** is downward, although other fill directions are also possible.

[0060] Fifth, in a settling step **110**, the product **302** in the package (see, e.g., partially formed second package **404b** in **Figures 3A-3B**) is settled while the film **202** is continuously conveyed along the product conduit **204** in a direction of conveyance **306**. In one embodiment, the package material is continuously conveyed at a location where the package material is formed into a package (or partially formed package). Additionally, as shown in **Figure 2**, the film is continuously conveyed in a direction of conveyance **306** at the product conduit **204**, but the film can also be conveyed in a different direction of conveyance **307** at another location.

[0061] **Figures 3A-3C** illustrate how product **302** is settled in a partially formed package **404b**. In one embodiment, the inventive settler includes a paddle wheel that rotates and contacts (e.g., scrubs) a package film in the direction of the film's conveyance. The contact between the paddle wheel and the film causes the film to shake and thereby settles product inside the film.

[0062] **Figure 3A** shows a package **404b** being filled with the product **302** under the force of gravity. **Figure 3B** illustrates how the product **302** has accumulated at the first end **414** of the partially formed package **404b**. A product settler **308** is actuated to cause the

product **302** to settle into a more compact configuration as shown in **Figure 3C**. As shown in **Figure 3B** the product settler settles the product so that it requires less longitudinal space in the partially formed package **404b**. For example, in one embodiment, before settling, the first end of a package is at a first-end product line **310** and the product is longitudinally distributed (e.g., in a longitudinal direction along central axis **334**) in the package from the first-end product line **310** to an unsettled second-end product line **314** (e.g., unsettled level or height of the product). However, after settling, the product **302** settles to a settled second-end product line **312** (e.g., settled level or height of the product). Accordingly, the unsettled package film length **316** required for the unsettled product **302** is greater than the settled package film length **318** required for the settled product **302**. For example, as shown in **Figures 3A** and **3B**, the unsettled package film length **316** is the distance from the first-end product line **310** to the unsettled second-end product line **314** of the product **302**. Similarly, the settled package film length **318** is the distance from the first-end product line **310** to the settled second-end product line **312** of the product **302**. Although the settled and unsettled package film lengths indicate the length of film required for a column of product, the overall package length can be greater, for example, to accommodate folds, gussets, seals, and any desired head space.

[0063] In some embodiments, the settled package film length **318** required for settled product is about 0.5 to about 1.0 inches shorter than the unsettled package film length **316** required for unsettled product. Accordingly, in some embodiment, the settler can reduce overall package lengths for a product by about 0.5 to about 1.0 inches.

[0064] In some embodiments, the settler **308** settles product **302** while the product is falling. In other embodiments, the settler **308** settles product **302** after the product has fallen. In some embodiments, the settler **308** settles product **302** while the product is falling and after the product has fallen. In some embodiments, the settler **308** comprises a paddle (e.g., one of a plurality of paddles **320a,b**) that rotates in a rotational direction **322** so that when the paddle

contacts the film **202**, the paddle pushes the film generally in the direction of conveyance **306** of the film.

[0065] Sixth, in a second end-sealing step **112**, a second end seal **212b** is formed on the partially formed package **404b** to form a package **404a**. The second end seal **212b** is located on a second face of the package (e.g., second end **416** of the first package **404a**). This can be seen, for example, in **Figure 2**.

[0066] In the illustration shown in **Figures 4A-4B**, the first end seal **212a** is approximately perpendicular to the longitudinal seal **402** (e.g., a back seal).

[0067] In one embodiment, the settling step **110** comprises the step of intermittently contacting the package (e.g., the partially formed second package **404b** in **Figure 2**) to move the package, thereby moving the product **302** in the package and causing the product to settle.

[0068] In one embodiment, the settling step further comprises the step of intermittently applying a force to the film (e.g., by impacting or contacting the film) that does not pause the conveyance of the film. For example, the component of the force that is opposed to the conveyance of the film is not sufficient to pause the conveyance of the film.

[0069] In one embodiment, the settling step **110** further comprises the steps of continuously or intermittently rotating a paddle wheel **326** that comprises a paddle (e.g., paddle **320a** or paddle **320b**). The paddle is rotated into contact with the package (e.g., second package **404b** in **Figure 3A**), thereby moving the product **302** inside the package. In addition to using a paddle wheel to intermittently contact the package film, other objects and mechanisms (e.g., a single bar that moves into and out of contact with the film) can also be used to intermittently contact the film.

[0070] In one embodiment, gas is directed into the partially formed package **404b**. For example, some form, fill and seal machines **206** use pressurized gas to maintain positive pressure inside the package **404b**. Such a machine can also be used in conjunction with the inventive settler. For example, when pressured gas is used, it can be directed in the fall

direction **304** shown in **Figure 3A**. The gas pressurizes the inside of the package **404b**. This pressure provides some structural rigidity to the package **404b** and provides resistance to the paddle (e.g., one of a plurality of paddles **320a,b**) when the paddle impacts the film **202** of the package **404b**. Upon impact, the paddle pushes the film **202** inward. However, after the impact, there is a period of time before the paddle again impacts the film. During the period of time between impacts, the pressure of the gas inside the package **404b** provides a force (e.g., force **324** in **Figure 3B**) to push the film **202** out before it is again impacted by a paddle **320a,b**. The cycle of film being pushed in by impact from the paddle and the film being pushed out by the pressure from the gas causes the film to vibrate (e.g., shake or oscillate), which in turn, causes the product **302** inside the partially formed package **404b** to settle (e.g., in a longitudinal direction along central axis **334**). This cycle is shown with reference to the partially formed package **404b** in **Figures 3B-3C**. Although, this cycle has been described in the context of using a pressurized gas to return the film to an original position after the film is deformed by impact, in other embodiments, the film may be sufficiently elastic to return to an original position even without using the pressurized gas.

[0071] In one embodiment, gas is directed (e.g., in the fill direction **304**) into the package (e.g., partially filled second package **404b** in **Figure 3A**) in the form of a first jet of gas (e.g., air). In one embodiment, the first jet is directed into the package **404b** intermittently. For example, in one embodiment, the first jet is activated 520 milliseconds after a first end seal is formed on the package. The first jet is active for 1465 milliseconds and then becomes inactive. Additionally, in one embodiment, a plurality of jets are directed into the package. For example, a second jet of gas (e.g., air) can be directed (e.g., in the fill direction **304**) into the package **404b**. In some embodiments, the second jet is directed into the package **404b** intermittently. For example, in one embodiment, the second jet is activated 120 milliseconds after the first jet becomes inactive. The second jet is active for 1465 milliseconds and then becomes inactive.

[0072] In one embodiment, the paddle wheel **326** rotates continuously. In another embodiment, the paddle wheel **326** rotates intermittently. When the paddle wheel **326** rotates intermittently, the paddle (e.g. paddle **320a** or paddle **320b**) also rotates intermittently. In one embodiment, a paddle rotates intermittently in the sense that an actuator (e.g., motor **616** in **Figures 6B-6C**) continuously rotates the paddle for a first period of time (e.g., 1500 milliseconds and then the actuator is inactive for a second period of time (e.g., 750 milliseconds). In one embodiment, after the actuator **616** rotates the paddle, the actuator stops the paddle in a desired position (e.g., so that the paddle is not in contact with the film). In one embodiment, the actuator **616** actively accelerates the paddle to increase or decrease its angular velocity. In another embodiment, the actuator only actively accelerates the paddle to increase its angular velocity and the paddle is allowed to decelerate passively (e.g., due to frictional forces). In some embodiments, the paddle wheel rotates at about 600 to 700 revolutions per minute (rpm), at about 660 rpm, or at about 600 rpm.

[0073] One embodiment of the invention will now be described with reference to **Figures 2, 3A-3C, 5A-5C, 6A-6C, and 7**. For example, **Figure 2** depicts an apparatus comprising an improved product settler **308** for use with a continuous motion form, fill, and seal machine **206**. The form, fill, and seal machine comprising a product conduit **204**, a conveyor (e.g., pull belts **214a,b**), and seal jaws **216a-d**. The continuous motion form, fill and seal machine is continuous in the sense that a package film **202** is continuously conveyed along a product conduit **204**. For example, the conveyor **214a,b** is positioned to convey (e.g., positioned to contact) the package film **202** that is wrapped around the product conduit **204**. The conveyor **214a,b** continuously moves the package film **202** along the product conduit **204**. The seal jaws **216a-d** are positioned adjacent to opposite portions (e.g., faces **408, 406** in **Figures 4A-4B**) of the package film **202** to form a first end seal **212a** on the package film when the seal jaws **216a-d** move together and the package film is pressed between the seal jaws. This forms a first end seal **212a** on a first face **414** of a package (e.g., partially formed

second package **404b**). The product conduit **204** is positioned so that a product (e.g., product **302** in **Figures 3A-3C**) passing through the product conduit will enter the package (e.g., second package **404b**) after exiting the product conduit. The product conduit **204** is positioned higher than (e.g., above) the seal jaws **216a-d**.

[0074] As seen in **Figure 2** and **Figure 7**, a first seal jaw **216a** rotates around a first axis of rotation **220a**, and a second seal jaw **216b** rotates around a second axis of rotation **220b**. Additionally, a third seal jaw **216c** rotates around the first axis of rotation **220a**, and a fourth seal jaw **216d** rotates around the second axis of rotation **220b**. As the first and second seal jaws **216a,b** rotate, they come together to seal and cut the package film **202** (e.g., to form a first end seal **212a** on the package film). As shown in figure 7, as the seal jaws rotate a sealing face **217** of each seal jaw **216a-d** faces the package film **202** and the package film is pressed between seal jaws **216a-d** to form a seal. Likewise, as the second and third seal jaws **216c,d** rotate, they come together to seal and cut the package film **202** (e.g., to form a second end seal **212b** on the package film). In some embodiments, for example, as shown in **Figure 2**, a second end seal **212b** for a first package **404a** is formed simultaneously with a first end seal **212a** for a second package **404b**.

[0075] As shown in the embodiment of **Figure 7**, the first seal jaw **216a** and third seal jaw **216c** are fixed to a first rotating seal jaw carriage **220a**. Similarly, the second seal jaw **216b** and fourth seal jaw **216d** are fixed to a second rotating seal jaw carriage **220b**. As shown in **Figure 2**, the seal jaws **216a-d** rotate in a direction **222a,b** so that when the seal jaws **216a-d** contact the package film **202**, the seal jaws have a translational velocity that is generally parallel to a direction of conveyance **306** of the package film. This is advantageous as it permits the package film **202** to continuously move in the direction of conveyance while the seal jaws **216a-d** seal and cut the package film **202** to form packages (e.g., package **404a**). This is an example of a continuous form, fill and seal machine **206**. In one embodiment, a form, fill and seal machine produces at least about 25 packages (e.g. package

404 or package **404a**) per minute. In one embodiment, a form, fill and seal machine produces at least about 40 packages per minute.

[0076] Generally speaking, because the inventive settler does not pause a package film, the number of packages per minute that a machine produces with the inventive settler is greater than the number of packages per minute that a machine produces when using a conventional settler. For example, the speed at which packages of product are produced can depend on the speed at which a film is conveyed for forming a package, the speed at which the package is filled with product, and any pause in conveying the film that is required to settle a product. If a package can be filled with product faster than the film can be conveyed into position to form a package, the limiting factor for producing a package of product is the speed at which the film is conveyed. Furthermore, if film speed is the limiting factor for the rate at which packages of a product can be manufactured, pausing the film during the activation of a conventional settler will further reduce the number packages per minute produced. Thus, when film speed is the limiting factor for a machine's rate of package production and settling is desired, settling with the inventive settler will result in an increased rate of package production when compared to settling with a conventional settler.

[0077] Accordingly, the product settler **308** is especially useful in conjunction with continuous, form, fill and seal machines because the product settler does not require the package film **202** to stop in order to settle product **302** in the package film. Although the product settler **308** has been described with reference to a continuous form, fill and seal machine, the product settler can also be used with machines that intermittently advance the package film **202**. An example is any form, fill and seal machine that that stops or pauses the film **202** of a package **404a** while the package **404a** is being formed. Although a partially formed package has been described with reference to a package that has been made on a form, fill and seal machine, this is only an illustrative example.

[0078] As another example, the product settler can be used to settle product in a package that is open. For example, a partially formed package can be an open package and the formed package can be the closed package. Although using a product settler on a package that is open, but otherwise formed, may not result in savings related to package materials (e.g., film or paper), it can still provide other benefits. For example, it can decrease the size of the package and reduce costs associated with shipping, including secondary packaging costs for items such as shipping crates.

[0079] With reference to **Figures 3A-3C**, a product settler **308** is positioned to agitate a product **302** in the package film **202**. The product settler **308** comprises a first object (e.g., paddle **320a,b**) positioned to cause an impact against the film **202**. The impact agitates the film **202** and settles the product **302** from an unsettled height **314** to a settled height **312** while a form, fill and seal machine **206** continuously conveys the film along the product conduit **204**. The impact against the film can be caused directly or indirectly by the first object.

[0080] An example of an object directly impacting the film is shown in **Figures 3A-3C**. As shown, the product settler **308** comprises a rotatable paddle wheel **326** and the paddle wheel comprises a paddle (e.g., one of a plurality of paddles **320a,b**). The paddle is positioned so that, as the paddle wheel **326** rotates, the paddle causes agitation of the product **302** and thereby settles the product. In the example shown in **Figures 3A-3C**, the paddle intermittently contacts the package film **202** thereby causing agitation of the product **302**.

[0081] In some embodiments, a first object (e.g., paddle **320a**) is positioned to intermittently and directly contact the package film **202** and the first object thereby agitates the product **302**. In other embodiments, the first object (e.g., paddle **320a**) is positioned to intermittently and directly contact a second object (e.g., the product conduit **204**), and the second object contacts the product film **202** and thereby agitates the product **302**.

[0082] As shown in **Figures 3B-3C**, the product settler **308** can be positioned adjacent to a tube of film **202**, below the product conduit **204**, and above the unsettled second-end product line **314**. For example, this can provide settling of a product without resulting in breakage of the product. The risk of breakage can be further reduced by running the product settler intermittently. For example, the product settler can be paused while product is falling and actuated after the product has fallen past the product settler.

[0083] In one embodiment, the package film **202** comprises an impact face (e.g., back side **406** in **Figure 4B**). The impact face **406** is adjacent to the product settler **308**, as shown, for example, in **Figures 3A-3C**. When the impact face **406** of the package film **202** hangs under the force of gravity (which as shown in **Figures 3A-3C** is the same as the direction of conveyance **306**), the impact face defines a first position of the impact face (e.g., as shown in **Figure 3A**). The settler **308** is positioned so that as the paddle (e.g., paddle **320a**) rotates, a first tip **328** of the paddle will reach past the first position by a first distance **330**. In one embodiment, as the paddle (e.g., paddle **320a**) rotates, the first distance **330** reaches a maximum of about 1 inch. In one embodiment, the first distance **330** reaches a maximum of about 0.5 inch. In one embodiment, the ratio of the first distance to the diameter of the product conduit (e.g., former) is a maximum of about 0.041. In one embodiment, the ratio of the first distance to the diameter of the product conduit (e.g., former) is a maximum of about 0.143. In one embodiment, the settler **308** is positioned so that, as the paddle (e.g., paddle **320a**) rotates, the paddle will first contact the package film **202** at a first point that is a second distance **332** below the product conduit **204**. In some embodiments the second distance **332** is about 0.5 inch to about 3.6 inches.

[0084] In one embodiment, the settler **308** is used with a form, fill and seal machine that further comprises a source of pressurized gas (e.g., compressor **224**). In one embodiment, the source of pressurized gas **224** comprises a nozzle **226** to direct the

pressurized gas into the package film **202**. In one embodiment, the source of pressurized gas **224** is selected from the group consisting of a fan, a blower, or a centrifugal compressor.

[0085] In one embodiment, pressurized gas is used to provide pressure on the inside of the package film **202**. This can be useful when a package film is not resilient enough on its own to move out of a deformed position (e.g., the deformed position illustrated in **Figure 3B**) that results when the settler **308** impacts the package film **202**. When pressurized gas is used and the impact face **406** of the film **202** is not in a deformed position caused by the settler **308**, the position of the impact face will be different from the position of the impact face when the inside of the package film is not under pressure. In other words, rather than being in a first position as illustrated in **Figure 3A**, the impact face **406** will be in a second position that can be similar to the position illustrated in **Figure 3A**, but can also be further from a central axis **334** of a package (e.g., package **404b**).

[0086] As another example, in one embodiment, the package film **202** comprises an impact face **406** that is adjacent to the product settler **308**. When the package film **202** is filled with the pressurized gas and hangs under the force of gravity, the impact face **406** defines a second position of the impact face. This position can be substantially similar to the first position of the impact face **406** described with reference to **Figure 3A**. However, when the impact face **406** is in the second position, the package film **202** is filled with a pressurized gas, and the pressure from the gas can push the surface of the package film, including the impact face **406**, outward. Accordingly, the second position of the impact face **406** can be located further away from a central axis **334** of a package (e.g., the second package **404b**) than the first position of the impact face. In one embodiment, the settler **308** is positioned so that as the paddle (e.g., paddle **320a**) rotates, a first tip **328** of the paddle will reach past the second position of the impact face **406** by a third distance. The third distance can be substantially the same as the first distance **330** shown in **Figure 3B**. However, the third distance can also be greater than the first distance **330** when the second position of the impact

face **406** is further from the central axis **334** than the first position of the impact face **406**. In one embodiment, as the paddle (e.g., paddle **320a**) rotates, the third distance reaches a maximum of about 0.5 to 4, 1 to 3, 1 to 2, 2 to 3 or about 2.5 inches. In one embodiment, the ratio of the third distance to the diameter of the product conduit (e.g., former) is a maximum of about 0.041. In one embodiment, the ratio of the third distance to the diameter of the product conduit (e.g., former) is a maximum of about 0.208.

[0087] For example, in one embodiment, the distance from the first tip **328** of a paddle **320a** to the axle **602** of a paddle wheel **326** is about 2.5 inches and the axle of the paddle wheel is positioned about 0.5 inches from the impact face **406** of a package **202**. Accordingly, when the paddle **320a** rotates, the first tip **328** reaches past the original position of the impact face **406** by about 2.0 inches and the third distance is about 2.0 inches.

[0088] In one embodiment of an apparatus according to the invention, a package film **202** is wrapped around the product conduit **204**. The apparatus can comprise a plurality of conveyors **214a,b** positioned to convey the package film **202** along the product conduit **204** at substantially a single speed along a perimeter **218** of the packaging film. The product conduit **204** is selected, for example, from the group consisting of a tube, a chute, a duct, and a pipe.

[0089] In one embodiment illustrated in **Figure 5A** the apparatus is a form, fill and seal machine that comprises a positional sensor **614** to determine the position of the paddle wheel **326**. For example, in one embodiment, the machine comprises a product settler **308** and the product settler comprises the positional sensor **614**.

[0090] The positional sensor **614** can be, for example, a camera or electromagnetic device. The positional sensor **614** can also be a proximity switch. For example, in one embodiment, the positional sensor **614** senses the presence or absence of a sensor target **622** (e.g., a magnet) within a given range of the positional sensor. In another embodiment, the positional sensor **614** senses a distance from the positional sensor **614** to the sensor target

622. For example, the sensor target **622** can move (e.g. rotate) with the paddle wheel **326** so that the position of the sensor target indicates the position of the paddle wheel. In another example, the position of a portion **624** (e.g., a magnet or discontinuity) of the sensor target indicates the position of the paddle wheel **326**.

[0091] In one embodiment, the positional sensor **614** is used to position the paddle wheel **326** or a paddle (e.g., paddle **320a**). For example, when the paddle wheel **326** is stopped, the paddle wheel can be stopped outside the path of a package film **202**. This can be desirable because if the paddle wheel **326** is stopped in the path of the package film **202**, the paddle wheel **326** will increase the resistance that must be overcome to convey the package film.

[0092] One embodiment of the invention will now be described with reference to **Figures 6A-6B**. A settler **308** comprises a paddle wheel **326**. The paddle wheel **326** comprises a plurality of paddles (e.g., paddles **320a,b**). The paddles **320a,b** rotate around an axle **602**. As shown in **Figures 6A** and **6B** the paddles **320a,b** are fixed to the axle **602**, although in other embodiments the paddles **320a,b** are not fixed to the axle directly, but are instead fixed to another component that rotates around the axle.

[0093] As shown, for example, in **Figure 6C**, the product settler **308** comprises a first adjustable mount **604** to adjust the position of the product settler in a first direction **606**. The product settler **308** comprises a second adjustable mount **608** to adjust the position of the product settler in a second direction **610**. As shown in **Figure 6B**, the product settler **308** also comprises a third adjustable mount **512** to adjust the position of the product settler in a third direction **620**. As can be seen, the three directions **606**, **610** and **620** are represented by vectors having the same origin, and the three vectors can be mutually perpendicular. Additionally or alternatively, each vector can have the same origin and be non-parallel to the other two vectors. With reference to **Figure 10**, a single mount (e.g., mount **604/512**) can effectively provide the function of a plurality of adjustable amounts, if the mount (e.g., mount

604/512) enables the adjustment of the position of the product settler **308** in a plurality of directions (e.g., directions **606**, **620**).

[0094] With reference to **Figure 6B**, the product settler **308** comprises a controller **612** to set the number of impacts against the package film that the product settler causes. For example, the number of impacts per minute can be calculated by multiplying the number of paddle wheels by the number of rotations or revolutions per minute that the paddle wheel **326** performs. Although, if another object is used to impact the package film, for example, a rod that oscillates into and out of contact with the package film, the number of impacts per minute will need to be calculated differently. For example, one end of the rod can be fixed to a rotating sphere and the other end of the rod can follow an orbital pattern into or out of contact with the package. As another example, the rod can move linearly back and forth between two positions, for example, a first position in contact with the package film and a second position remote from the package film. Regardless of the mechanism used to cause an impact, in some embodiments the number of impacts against a package or package material is greater than about 180 impacts per minute, about 240 impacts per minute, about 300 impacts per minute, about 360 impacts per minute, about 420 impacts per minute, about 480 impacts per minute, about 540 impacts per minute, about 600 impacts per minute, or about 660 impacts per minute. In some embodiments, the number of impacts per minute is about 300 impacts per minute to about 900 impacts per minute. In some embodiments, the number of impacts is about 540 impacts per minute to about 720 impacts per minute. In some embodiments, the number of impacts is about 600 impacts per minute to about 660 impacts per minute.

[0095] Turning back to **Figure 6B**, the illustrated product settler also comprises a positional sensor **614** (e.g., proximity switch) to determine the position of the paddle (e.g., paddle **320a**). In one embodiment, the controller **612** uses information from the positional

sensor **614** to instruct the actuator **616** to stop the paddle (e.g., paddle **320a**) when the paddle is in a desired position.

[0096] As can be seen in **Figure 6C**, the product settler **308** comprises a motor **616** with sufficiently low torque that if the motor turns off while the paddle (e.g., paddle **320a**) is contacting the package film **202**, as the package film is conveyed, the package film will push the paddle out of the path of the package film. Although the benefits of using a low torque motor have been described with respect to turning off the motor, the similar benefits will be realized if the product settler fails or loses power. In one embodiment, the settler is powered by a small AC/DC drive motor that will rotate the paddle wheel. For example, in one embodiment the actuator (e.g., motor) for the inventive settler requires a maximum of 96 Watts to settle product.

[0097] As shown in **Figures 6A-6C** and **Figures 5A-5C**, the product settler **308** comprises a frame **618** that fixes the position of the product settler **308** in relation to the path of the package film **202**. For example, as shown in **Figure 5A**, the product settler **308** is adjacent to a package **404b**. The package **404b** extends on both sides of a center plane **531** that is oriented parallel to a central axis (e.g., central axis **334** in **Figures 2** and **3A-3C**) of the package **404b**. In some embodiments the frame **618** comprises adjustable mounts (e.g., the first adjustable mount **604**, the second adjustable mount **608**, and/or the third adjustable mount **512**) to facilitate changing the position of the product settler **308** relative to the form, fill and seal machine **206**. For example, in one embodiment, the adjustable mounts **604**, **608**, **512** can be used to move adjust the position of the product settler **308** in one, two, or three directions. For example, the first adjustable mount **604**, second adjustable mount **608**, and third adjustable mount **512** can be used to move or adjust the position of the product settler **308** in a first direction **606**, second direction **610**, or third direction **620**, respectively. In one embodiment, the adjustable mounts **604**, **608**, **512** can be used to move or adjust the position of the product settler **308** in a plurality of mutually perpendicular directions (e.g., two or

three). In other embodiments, the frame **618** does not comprise the adjustable mounts **604**, **608**, **512** and the frame is positioned in a desired location when it is installed on a form, fill and seal machine **206**.

[0098] As shown in **Figures 5A-5C**, the first adjustable mount **604** comprises a first mechanism (e.g., bolts **528a,b**) to fix the product settler **308** in a desired vertical position relative to the form, fill, and seal machine **206**. The second adjustable mount **608** comprises a second mechanism (e.g., bolt **530**) to fix the product settler **308** at a desired proximity to the form, fill, and seal machine **206**. The third adjustable mount **512** comprises a third mechanism (e.g., bolts **532a,b**) to fix the product settler **308** in a desired horizontal position relative to the form, fill, and seal machine **206**.

[0099] One embodiment of the invention will now be described with reference to **Figures 5A-5C** and **Figure 8**. As shown, the product settler **308** is modular. For example, besides connecting the product settler **308** to a form, fill, and seal machine, no assembly is required for the product settler. Accordingly, in one embodiment, the product settler **308** is operable after being electronically connected to a power source and placed in a desired position relative to the form, fill and seal machine **206**. In one embodiment, this is accomplished by mounting a module in the form of a product settler **308** on the form, fill and seal machine **206** using a machine mount **502**. For example, the machine mount **502** can connect the frame **618** of the product settler **308** (see, e.g., **Figures 5A-5C**) to the frame **702a,b** of the form, fill and seal machine **206** (see, e.g., **Figure 7**). In one embodiment, the machine mount **502** is fixed to controller **612** using a mechanism **534** such as screws or bolts (see, e.g., **Figures 5A-5C**). The same mechanism **534** or an additional mechanism can also be used to fix the machine mount **502** to the form, fill and seal machine **206**.

[00100] In one embodiment shown in **Figures 5A-5C**, a modular product settler **308** is linked to a form, fill, and seal machine through a line of communication (e.g., one of a plurality of lines of communication **504a,b**). The line of communication can be

electronic, pneumatic, or some other manner of conveying power and/or information. For example, a line of communication (e.g., **504a,b**) can provide an electronic line of communication between the product settler **308** and the form, fill and seal machine **206**. In turn, the form, fill and seal machine **206** can provide a power source **508** for the product settler **308**. Although, the product settler **308** can also be connected to a power source **508** (e.g., power outlet or battery) that is separate from the form, fill and seal machine **206**. Similarly, a line of communication (e.g., **504a,b**) can connect the product settler **308** to a controller **612** for the product settler. In turn, the controller **612** can be used to control the position of the paddle wheel **326** in conjunction with a positional sensor **614**. Furthermore, the controller **612** can be used to control the angular velocity or rotational speed of the paddle wheel **326**. In some embodiments, a plug **506** is provided to facilitate connecting and disconnecting a line of communication between the product settler **308** and a component (e.g., the controller **612**) or the form, fill and seal machine **206**. In some embodiments, the line of communication between the product settler **308** and the form, fill and seal machine **206** goes through the controller **612**. In some embodiments, the controller **612** for the product settler **308** is in communication with the form, fill and seal machine **206** through an auxiliary port **510** of the form, fill and seal machine **206**. Accordingly, in some embodiments a line of communication (e.g., **504a,b**) exists between the form, fill and seal machine **206** and the product settler **308** so that a control system of the form, fill and seal machine **206** can be used to control the controller **612** of the product settler **308**, and thereby control the product settler **308**.

[00101] The product settler **308**, shown in **Figures 5A-5C** also comprises a timing belt **514** which is used to actuate the product settler **308**. The timing belt **514** is wrapped around a rotor **516** and an axle **602**. When that the rotor **516** is rotated by motor **616**, it causes the timing belt **514** to travel around the axle **602**. This, in turn, causes the axle **602** to rotate, which rotates the paddle wheel **326**.

[00102] In the embodiment shown in **Figures 5A-5C**, the product settler **308** comprises a timing belt guard **518**. The timing belt guard protects the timing belt from being caught on an object, for example, product **302** or film **202**. Similarly, as shown in **Figures 6A-6C**, the frame **618** of the product settler **308** can comprise a paddle guard that protects the paddle (e.g., on one side or a plurality of sides) from being obstructed by objects other than the package film **202**.

[00103] As can be seen in Figure 7, the product settler **308** is unobtrusive. The product settler is fairly small, lightweight, and located to one side of the seal jaw carriage **704a,b** so it does not obstruct access to the carriage for repair or maintenance. For example, as shown in **Figures 5B-5C**, one embodiment of the product settler has a length **522** of about 24 inches, a width **524** of about 16, and a height **526** of about 8 inches. In some embodiments, the product settler has a length **522** of about 6 to about 30 inches, a width **524** of about 6 to about 30 inches, and a height **526** of about 4 to about 12 inches. In one embodiment, the product settler, excluding the machine mount **502** and third adjustable mount **512**, weighs a maximum of about 12 lbs. In comparison, conventional product settlers, excluding mounting plates, typically weight about 50 lbs.

[00104] Additionally, the product settler can be easily installed or uninstalled. For example, with reference to the embodiment shown in **Figures 5A-5C**, a portion of the product settler can be uninstalled by removing a plug **506** and detaching the portion from the machine mount **502**, which can be left attached to a form, fill, and seal machine **206**. Alternatively, the machine mount **502** can be detached from the form, fill and seal machine **206**. This can be done without (or in addition to) removing the plug **506** and detaching a portion of the product settler **308** from the machine mount **502**.

[00105] Although the inventive product settler has been described by reference to use of a package made from film. The package material can be made from a film or some other form of material. For example, the inventive settler can be used with packages made

from package materials of varying thicknesses. Furthermore, the package material can be, for example, paper, metal, metal oxides, polymer, or some combination thereof.

[00106] **Examples**

[00107] Illustrative examples of the inventive settler and experiments involving the inventive settler will now be described.

[00108] Example 1

[00109] An experiment was conducted to measure certain benefits of using the inventive product settler **308** described herein. A continuous motion vertical form, fill and seal machine **206** was fitted with the inventive settler **308**. Then, the machine **206** was used to produce 13.0 oz packages **202** containing TOSTITOS® Restaurant Style Tortilla Chips. The machine **206** ran at a speed of about 26 packages per minute. The packages **202** were produced on a product conduit **204** (e.g., former) with a circular cross-section. The cross-section of the product conduit **204** had a diameter of about 10.5 inches, and accordingly the packages **202** had a diameter of about 10.5 inches while wrapped around the product conduit. The packages **202** had a length of about 15.75" from the tip of a first end seal **212a** to the opposite tip of a second end seal **212b**. Each end seal **212a,b** was approximately 3/8 inches long providing a total usable package length of about 15 inches. In other words, the length of the package **202** that could be filled with product was approximately 15 inches.

[00110] A first set of five packages **202** were produced on a machine **206** without using the inventive settler **308**. The average package head space was about 1.3 inches and the average unsettled height **314** of the product was about 13.7 inches. A second set of five packages **202** were produced on the machine **206** with the inventive settler **308** activated. Using this set up, the average package head space was about 2.9 inches and the average settled height **312** of the product was about 12.1 inches. As can be seen, the inventive settler resulted in an average settling of about 1.6 inches, which is a settling fraction of at least about 0.116 relative to the unsettled height **314** of the product.

[00111] Additionally, the inventive settler reduced the average length of film required to package each unit of product by about 1.6 inches. For example, rather than increasing the head space in a package, the product settler could also have been used to maintain a given head space while decreasing the length of film required for the package. In this example, the length of film required to package each unsettled unit of product was 15.75 inches. Since the product settler resulted in settling of about 1.6 inches, the product settler could have reduced the length of film required by 1.6 inches. This is a film reduction fraction of at least 0.101 relative to the length of film required if no settler is used.

[00112] Breakage of product occurring with and without the inventive settler activated was substantially the same. The use of the inventive settler did not result in any statistically significant increase in the ratio of broken product to non-broken product in a package. In other words, any increase in breakage was within the margin of error for the experiment.

[00113] Table 1

[00114] Table 1 provides speeds in packages per minute at which an illustrative form, fill and seal machine can produce packages with a clamp on. All information in the table corresponds to a seal time of 70 milliseconds. In other words, the seal jaws press against the film for approximately 70 milliseconds to form package end seals. The table shows how package production speeds vary with bag length. As can be seen, increased package lengths result in lower package production speeds. This is because, given a fixed speed for conveying packages, longer packages require more time to be convey.

[00115] **Table 1**

Package length (inches)	Production Speed (packages / minute)
27.99	19
27.5	19
27	19
26.5	19
26	20
25.5	20

25	21
24.5	21
24	22
23.5	22
23	23
22.5	23
22	24
21.5	24
21	25
20.5	25
20	26
19.5	27
19	27
18.5	28
18	29
17.5	30
17	31
16.5	32
16	33
15.5	34
15	35

[00116] Example 2.

[00117] A method for settling a product **302** in a package **404** made on a form, fill and seal machine **206** will now be described with reference, for example, to Figure 2. It should be understood that the elements described in this method are not mutually exclusive with any other illustrative method or apparatus described herein. Rather, the elements described can be added to or substituted for elements described in any other illustrative method or apparatus herein.

[00118] Turning to Figure 2, in one illustrative embodiment, the method comprises the steps:

- a. providing a package material (e.g., package film **202**) on a product conduit **204** of a form, fill and seal machine **206**;
- c. forming a first end seal **212a** on the package material **202** to form a partially formed package (e.g., second package **404b** in Figure 2);
- d. filling the partially formed package **404b** with the product **302**; and
- e. settling the product **302** in the partially formed package **404b** while continuously conveying the package material **202** along the product conduit **204**.

[00119] It is contemplated that filling the partially formed package **404b** with the product **302** can comprise filling the partially formed package **404b** with a desired amount of product **302** or with an amount of product that provides the package **404** with a desired amount of headspace. Additionally, it is contemplated that the first end seal **212a** can be formed approximately perpendicularly to a longitudinal seal **402** or the first end seal **212a** can be formed within 30, 25, 20, 15, 10, or 5 degrees of perpendicular to the longitudinal seal **402**.

[00120] In some embodiments, the method comprises at least one step selected from the group consisting of:

- b. sealing the package material **202** to form a longitudinal seal **402**;
 - f. forming a second end seal **212b** on the partially formed package **404b** to form a package **404** from the partially formed package **404b**; and
- a combination thereof.

[00121] In some embodiments, the settling step comprises the steps:

(i) pressurizing an interior of the partially formed package **404b** to provide resistance; and

(ii) intermittently contacting the partially formed package **404b** to move the partially formed package **404b**, thereby moving the product **302**.

[00122] In some embodiments, the settling step comprises the steps:

(i) rotating a paddle wheel **326** comprising a paddle **320a** (or plurality of paddles **320a,b**); and

(ii) intermittently rotating the paddle **320a** into contact with the partially formed package **404b**, thereby moving the product **302** while the product **302** is inside the partially formed package **404b**.

[00123] In some embodiments, an actuator **616** oscillates or rotates the paddle **320a** and stops the paddle **320a** in a desired position. This can be useful, for example, to

avoid the paddle stopping in contact with a package material **202** or in the path of a package material, which could among other things, damage the packaging material or damage the actuator **616** if the film pushes the paddle, depending on the type of actuator used.

[00124] In some embodiments, the actuator **616** is characterized by a feature selected from the following group of features:

- (i) the actuator **616** is a motor **616**;
- (ii) the actuator **616** is a stepper motor **616**;
- (iii) the actuator **616** is programmable to change (e.g., increase or decrease) an oscillatory or rotational speed of the paddle **320a** at a desired rate;
- (iv) the actuator **616** is programmable to control acceleration (e.g., increasing or decreasing rotational speed) of the paddle wheel **326**;
- (v) the actuator **616** is programmable to select the position of the paddle **320a** when the paddle **320a** stops; and
- (vi) a combination thereof.

[00125] In some embodiments, the method comprises a step selected from the group consisting of:

- (i) using the actuator **616** to change (e.g., increase or decrease) an oscillatory or rotational speed of the paddle **320a** at a first desired rate by changing an oscillatory or rotational speed of a component of the actuator **616** (e.g., rotor **516**, drive shaft, piston, etc.), wherein the component of the actuator is linked to the paddle, and optionally using the actuator **616** to change the oscillatory or rotational speed of the paddle **320a** at a second desired rate by changing the oscillatory or rotational speed of the component of the actuator **616**;
- (ii) using the actuator **616** to control acceleration (e.g., increasing or decreasing rotational or oscillatory speed) of the paddle **320a**, the plurality of paddles **320a,b**, the paddle wheel **326**, or a combination thereof;

(iii) using the actuator **616** to stop the paddle **320a** (or each of the plurality of paddles **320a,b**) in a desired position (e.g., out of a path of the package material **202** or out of contact with the package material **202**); and

(iv) a combination thereof.

[00126] Several illustrative features of a product settler **308** will now be described with reference to Figure 8, which illustrates the use of the product settler through several scenes that progress in time from left to right. Starting with the leftmost scene, an impact face **406** of a package material **202** is illustrated in a first position **804**. As illustrated, the package material **202** hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor **224**)). Additionally, the product settler **308** is inactive and out of contact with the package material **202**.

[00127] Next, as time progresses, the product settler **308** has moved into contact with the impact face **406** to displace the package material **202** by a first distance **330** in the horizontal direction. Accordingly, the impact face **406** of the package material **202** is in a second position **806**.

[00128] Then, as time progresses, the product settler **308** has moved out of contact with the package material **202**. However, a flow **812** of air created by the movement of the product settler **308** results in a force on the package material **202** that keeps the impact face **406** from returning to the first position **804**. Rather, the impact face **406** of the package material **202** has moved to a third position **808**. As can be seen, a horizontal displacement of the impact face **406** from the second position **806** to the third position **808** provides an amplitude **802** of vibration for the impact face **406** of the package material **202**. As a result of the flow **812** of air created by the movement of the product settler **308**, the amplitude **802** of vibration is less than it could be if the impact face **406** returned to the first position **804**.

[00129] As time continues to progress, the product settler **308** has moved again into contact with the impact face **406** of the package material **202**. Accordingly, the impact

face **406** of the package material **202** is in a fourth position **810**, which is similar to the second position **806**, although it could be different if the paddles **320a,b** of the product settler **308** were to have different lengths. Also, while not illustrated, the cycling of the impact face **406** between a position similar to the third position **808** and a position similar to the fourth position **810** can continue until the settling movement of the product settler **308** is stopped.

[00130] As explained with respect to the third position **808**, as a result of the flow **812** of air created by the movement of the product settler **308**, the amplitude **802** of vibration can be less than an amplitude **802** of vibration that would occur if the impact face **406** returned to the first position **804**, or at least a position closer to the first position **804**. Accordingly, in some embodiments, it is desirable to configure the product settler **308** so that it produces no more than a limited, specified flow **812** of air. This can be accomplished, for example, by including at least one aperture **536** in the product settler **308**. In some embodiments, the at least one aperture is positioned in a rotating paddle **320a** or plurality of paddles **320a,b** that make up a paddle wheel **326**. As a skilled person would understand after reading this disclosure, by reducing the flow **812** of air created by the movement of the product settler **308**, the impact face **406** of the package material **202** can cycle between a position similar to the first position **806** and a position similar to the second position **806** rather than a position similar to the third position **808** and the fourth position **810**. Advantageously, this results in a relatively larger amplitude **802** of vibration of the impact face **406** and can help to better settle product **302**.

[00131] With reference again to Figure 8, in some embodiments, the settling step of a method described herein comprises using a product settler **308** to provide the package material **202** with an amplitude **802** of vibration equal to at least 3, 2.5, 2, 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, or 0.1 inches, no more than 3, 2.5, 2, 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, or 0.1 inches, or a combination thereof. As illustrations of the amplitude **802** of vibration, in some embodiments, the amplitude **802** of vibration can be equal to the first

distance **330** illustrated and described, for example, with reference to Figure 3B. In some embodiments, the amplitude **802** of vibration can be greater than the first distance **330**, for example, if the package material **202** is pushed beyond the first tip **328** of the paddle and/or the package material moves beyond a position of the impact face **406** when the impact face **406** is hanging under gravity and any internal pressure. Additionally, as illustrated in Figure 8, in some embodiments the amplitude **802** of vibration can be less than the first distance **330**, for example, if the flow **812** of air from the paddle prevents the impact face **406** from returning to a position **804** of the impact face **406** when the impact face **406** is hanging under gravity and any internal pressure.

[00132] In some embodiments, a method described herein is characterized by one or more of the following features. First, with reference, for example, to Figure 6A, in some embodiments, the paddle **320a** (or each of a plurality of paddles **320a,b**) comprises at least one aperture **536**.

[00133] Second, with reference to Figures 3A-3C, in some embodiments, a paddle **320a** contacts the package **404** once per rotation of the paddle **320a**.

[00134] Third, with reference to Figure 8, in some embodiments the package material **202** is pushed by a flow **812** of air created by the rotation of the paddle **320a**, for example, rather than contact with the paddle **320a**. However, in some embodiments, it can be useful to limit the force of the flow **812** of air on the package material **202**, for example, to help maintain a desired amplitude of vibration. Accordingly, in some embodiments, the flow **812** of air pushes the package material by no more than and/or at least 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 or 0.1 inches from a hanging reference position. With reference to Figure 8, in some embodiments, the hanging reference position is a position of the package material **202** when the package material **202** hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor **224**) and when the product

settler **308** is inactive and out of contact with the package material **202**. An example of a hanging reference position is illustrated by first position **804** in Figure 8.

[00135] Fourth, with reference again to Figure 8, in some embodiments, after impact by a paddle **320a** (or each of a plurality of paddles **320a,b**) the package material **202** returns to a hanging reference position as described herein.

[00136] Several illustrative features of a product settler **308** will now be described with reference to Figure 9, which illustrates a paddle **320a** impacting a package material **202**. As will be better understood with reference to Figure 9, it can be desirable for a paddle **320a** to be relatively rigid, depending on the application. In some embodiments, the paddle **320a** does not bend by more than a specified bend tolerance **902** during use, for example, as a result of contact with the package material **202**. As illustrated in Figure 9, the specified bend tolerance **902** is an angle measured in a plane that is perpendicular to the axis of rotation **626** of the paddle wheel **326**, for example, in the plane of Figure 9. In some embodiments, the specified bend tolerance is no more than 30, 20, 15, 10, 5, 4, 3, 2, or 1 degrees. As illustrated in Figure 9, the specified bend tolerance **902** is measured for a leading surface **912** of the paddle **320a**. Additionally, the specified bend tolerance **902** is measured from a proximal reference line **904** to a distal reference line **906**, wherein the proximal reference line **904** is parallel to a proximal end **908** of the paddle **320a** and the distal reference line **906** is parallel to a distal end **910** of the paddle **320a**. With reference to Figure 9, the proximal end **908** is the end closer to an axis of rotation **626** of the paddle wheel **326**. The distal end **910** is the end further from an axis of rotation **626** of the paddle wheel **326**.

[00137] Example 3

[00138] An improved continuous motion form, fill and seal machine **206**, will now be described with reference, for example, to Figure 2. It should be understood that the elements described in this apparatus are not mutually exclusive with any other illustrative

apparatus or method described herein. Rather, the elements described can be added to or substituted for elements described in any other illustrative method or apparatus herein.

[00139] As illustrated in Figure 2, the improved continuous motion form, fill and seal machine **206** comprises a product conduit **204**, a conveyor (e.g., conveyor **214a,b**), and seal jaws (e.g., a cooperative pair of seal jaws **216a-d**). The conveyor **214a,b** is positioned to convey a package material (e.g., package film **202**) that is wrapped around the product conduit **204**. For example, as illustrated, the conveyor **214a,b** moves the package material **202** along the product conduit **204**.

[00140] With reference again to Figure 2, the seal jaws **216a-d** are positioned adjacent to opposite portions of the package material **202** to form a first end seal **212a** on the package material **202**, thereby forming a partially formed package (e.g., second package **404b** in Figure 2).

[00141] The product conduit **204** of the machine **206** is positioned so that a product **302** passing through the product conduit **204** will enter the partially formed package **404b** after exiting the product conduit **204**. Additionally, the product conduit **204** is positioned above the seal jaws **216a-d**.

[00142] With reference to Figure 2, the improvement to the continuous motion form, fill and seal machine comprises a product settler **308**. As illustrated, the product settler **308** comprises a first object (e.g., paddle **320a,b**) positioned to cause an impact against the package material **202**. The impact agitates the package material **202** and settles the product **302** from an unsettled height **314** to a settled height **312** while the machine **206** continuously conveys the package material **202** along the product conduit **204**.

[00143] With further reference to Figure 2, in some embodiments, the machine **206** comprises a source of pressurized gas (e.g., compressor **224**), and conduit (e.g., a nozzle **226**) to direct the pressurized gas into the package material **202**.

[00144] With reference to Figure 3B, in some embodiments, the impact occurs on one and only one face (e.g., impact face **406**) of the partially formed package.

[00145] With reference to Figure 3B and Figure 3C, in some embodiments, the impact against the package material **202** occurs below the product conduit **204** and above the unsettled height **314**.

[00146] With reference to Figure 3B, Figure 6c, Figure 6d, Figure 10 and Figure 11, in some embodiments, the product settler **308** comprises a motor **616** with sufficiently low torque so that if the motor **616** stops (e.g., turns off) while the first object is in contact with the package material **202**, as the package material **202** is conveyed, the package material **202** will push the first object out of a path of the package material **202**.

[00147] With reference to Figure 3A, Figure 3B and Figure 3C, in some embodiments the first object positioned to cause an impact against the package material **202** is a rotatable paddle wheel **326**. As illustrated, the paddle wheel **326** comprises a paddle **320a**, and the paddle **320a** is positioned so that, as the paddle wheel **326** rotates, the paddle **320a** causes agitation of the package material **202** and thereby settles the product **302**.

[00148] With reference to Figure 3A, Figure 3B, Figure 3C, and Figure 8, in some embodiments, the package material **202** comprises an impact face **406**, and the impact face **406** is adjacent to the product settler **308**. As illustrated, when the impact face **406** of the package material **202** hangs under a force of gravity, the impact face **406** defines a first position **804**. As illustrated, for example, in Figure 8, the product settler **308** is positioned so that as the paddle wheel **326** rotates, a first tip **328** of the paddle **320a** will reach past (e.g., horizontally past) the first position **804** by a first distance **330**. In some embodiments, the first distance **330** reaches at least and/or no more than about 0.25, 0.5, 1, 1.5, 2, 2.5 or 3 inches while the paddle wheel **326** rotates.

[00149] For purposes of illustration, several features of a product settler **308** will now be described with reference to Figure 10 and Figure 11. As a skilled person would

understand upon reading this disclosure, many of the elements of Figures 10 and 11 have already been described with respect to Figure 6B and Figure 6C, respectively. Accordingly, these elements are not be addressed again. However, for purposes of comparison, it is evident that Figure 10 and Figure 11 illustrate a motor **616** comprising a rotor **516**, which also serves as an axle **602** for a paddle wheel **326**. As can be seen, the rotor **516** and the axle **602** have concentric axes of rotation. In contrast, Figure 6B and Figure 6C illustrate an embodiment in which a rotor **516** (not illustrated) for the motor **616** and an axle **602** for the paddle wheel **326** have different axes of rotation.

[00150] Figure 12 illustrates how a product settler with concentric axes (e.g., axis **1302** and axis **626**) of rotation for a rotor **516** and a paddle wheel **326** can be used to settle product in conjunction with a vertical, form, fill, and seal machine. Most of the components of Figure 12 have already been described, for example, with reference to Figure 7, and need not be further discussed.

[00151] Figure 13 illustrates how it can be advantageous to provide a product settler or its components with a desirable size and geometry, for example, to facilitate installation, maintenance or proper operation. As an illustration, in some embodiment it can be advantageous if the product settler, its motor, or its paddle wheel fit within a specified volume or a specified cross-sectional area. With reference to Figure 13, if the rotor **516** for a motor **616** and the axis of rotation paddle wheel **326** have concentric axes of rotation, and both the motor **616** and paddle wheel **326** are adjacent to a package material **202**, then it can be useful for the paddle wheel **326** to have a cross-sectional radius (corresponding to radius **1310** of imaginary cylinder **1304** as illustrated in Figure 13) that is larger than the cross-sectional radius (corresponding to radius **516** of imaginary cylinder **1306** in Figure 13) of the motor **616**. For example, this will enable the paddle wheel **326** to reach the package material **202**. Alternatively, such a configuration may be less advantageous if only the paddle wheel

326 is adjacent to the package material **202** and the motor **616** is not in a position to block the package material **202** from coming into contact with the paddle wheel **326**.

[00152] With reference again to Figure 10, Figure 11, Figure 12 and Figure 13, in some embodiments, the product settler **308** comprises a motor **616**, and the motor comprises a rotor **516**. As illustrated, the motor **616** causes the rotor **516** to rotate. As shown, for example, in Figure 13, the rotor **516** can also be an axle **602** for the paddle wheel **326**, and/or the axis **1302** of rotation for the rotor **516** and the axis **626** of rotation for the paddle wheel **326** can be concentric.

[00153] As a skilled person would understand after reading this disclosure, some embodiments described herein include one or more of the following features. First, with reference to Figure 13, in some embodiments, the rotor **516** is straight from the motor **616** and along the portion of the rotor **516** that acts as the axle **602** for the paddle wheel **326**.

[00154] Second, in some embodiments, no force transfer components (e.g., gears, belt, etc.) apart from the rotor **516** are used between the motor **616** and the paddle wheel **326**.

[00155] Third, in some embodiments, the product settler **308** occupies less space than a reference product settler **308** that comprises the force transfer components.

[00156] Fourth, with reference to Figure 10, in some embodiments, the motor **616**, the rotor **516**, and the paddle wheel **326** fit within a reference cylinder **1002**. For example, the reference cylinder can circumscribe these components. As illustrated, the reference cylinder has a reference cylinder radius **1004** of no more than and/or at least 8, 7, 6, 5, 4, 3, 2, 1.5, 1 or 0.5 inches. The reference cylinder has a reference cylinder height **1006** of no more than and/or at least 24, 20, 18, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, or 2 inches. As a skilled person would understand upon reading this disclosure, many of the elements of Figures 10 and 11 have already been described with respect to Figure 6B and Figure 6C, respectively. Accordingly, these elements are not be addressed again. However,

for purposes of comparison, it is evident that Figure 10 and Figure 11 illustrate a motor **616** comprising a rotor **516**, which also serves as an axle **602** for a paddle wheel **326**. As can be seen, the rotor **516** and the axle **602** have concentric axes of rotation. In contrast, Figure 6B and Figure 6C illustrate an embodiment in which a rotor **516** (not illustrated) for the motor **616** and an axle **602** for the paddle wheel **326** have different axes of rotation.

[00157] Fifth, with reference to Figure 13, in some embodiments, an axis **1302** of rotation for the rotor **516** of the motor **616** and an axis **626** of rotation for the paddle wheel **326** are concentric. Additionally, as viewed from a side during use, the motor **616** can use more area than the paddle wheel **326**, the motor **616** can use less area than the paddle wheel **326**, or both the motor **616** and the paddle wheel **326** can use equal amounts of area. In order to characterize the amount of volume and/or area that the motor **616** or the paddle wheel **326** uses, it is useful to define an imaginary reference motor cylinder **1304** and an imaginary reference paddle wheel cylinder **1306**, which can circumscribe the motor and paddle wheel, respectively. As illustrated in Figure 13, the reference motor cylinder **1304** has a central axis that is concentric with the axis **1302** of rotation for the rotor **516**, and the radius **1308** of the reference motor cylinder **1304** is the minimum radius that results in the reference motor cylinder **1304** being large enough to fully contain the motor (e.g., with no portion of the motor **616** protruding outside the reference motor cylinder **1304**). Similarly, the reference paddle wheel cylinder **1306** has a central axis that is concentric with the axis **1302** of rotation for the rotor **516**, and the radius **1310** of the reference paddle wheel cylinder **1306** is the minimum radius that results in the reference paddle wheel cylinder **1306** being large enough to fully contain the paddle wheel **326** (e.g., with no portion of the paddle wheel **326** protruding outside the reference paddle wheel cylinder **1306**). With these definitions in mind, in some embodiments, the reference paddle wheel cylinder **1306** is at least as large or larger than the reference motor cylinder **1304**. Meanwhile, in some embodiments, the

reference motor cylinder **1304** is at least as large or larger than the reference paddle wheel cylinder **1306**.

[00158] Sixth, in some embodiments, the motor, the rotor **516**, the paddle wheel **326** or a combination thereof fit within a volume equal to no more than and/or at least 2, 1.9, 1.8, 1.7, 1.6, 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.8, 0.7, 0.6, 0.6, 0.4, 0.3, 0.2, 0.1, 0.5, 0.1, 0.05, 0.04 cubic feet.

[00159] In some embodiments described herein, the motor **616** is characterized by a feature selected from the following group of features:

- (i) the motor **616** is a stepper motor **616**;
- (ii) the motor **616** can be programmed to change (e.g., increase or decrease) oscillatory or rotational speed of the first object at a desired rate;
- (iii) the motor **616** can be programmed to provide more control over acceleration (e.g., increasing or decreasing rotational or oscillatory speed) of the at least one object (e.g., paddle **320a**) or paddle wheel **326**, to enable selecting the position of the at least one object when it stops; and
- (iv) a combination thereof.

[00160] For purposes of illustration, some features of a product settler **308** will now be described with reference to Figure 14, which depicts a product settler comprising a paddle wheel **326**. As illustrated, the paddle wheel **326** comprises paddles **320a-d** and adjacent paddles are mutually oriented at a paddle spacing angle **1402a-d**. As can be seen, the paddle spacing angle **1402a-d** can vary from one pair of adjacent paddles to another pair of adjacent paddles.

[00161] Figure 14 is useful to illustrate several features of some embodiments of a product settler **308**. For example, in some embodiments, a paddle wheel **326** of the product settler **326** comprises a plurality of paddles **320a-d** (e.g., no more than and/or at least four, three, or two paddles). Nonetheless, it is also contemplated that in some embodiments,

using relatively fewer paddles **320** is advantageous. For example, this can help to facilitate the stopping of each paddle (as applicable) in a position in which the paddle is not in contact with package material **202** and not in a path of the package material **202**. In some cases, depending on the geometry (e.g., arrangement, size, shape, etc.) of a plurality of paddles and/or a paddle wheel, it may be impossible or difficult to avoid stopping at least one of the plurality of paddles in a position that such that the at least one paddle is in contact with the package material **202** or in a path of the package material **202**. As a skilled person would understand after reading this disclosure, it can be desirable to avoid such a geometry for the plurality of paddles and/or paddle wheel.

[00162] In some embodiments, the plurality of paddles **320a-d** are spaced around a paddle wheel **326** to provide a paddle spacing angle **1402a-d** between each set of two adjacent paddles in the plurality of paddles **320a-d**. Additionally, in some embodiments, the paddle spacing angle **1402a-d** differs from a common angle **1404** by no more than a specified tolerance **1406a,b**. As used in this context, the common angle is defined to equal 360 degrees divided by the number of paddles in the plurality of paddles **320a-d**. With reference again to Figure 14, in some embodiments, the specified tolerance **1406a,b** has a magnitude of no more than 45, 30, 25, 20, 15, 10, 5, 4, 3, 2 or 1 degrees.

[00163] In some embodiments, it can be useful for all of the paddle spacing angles to be approximately equal because, for example, this can help to provide a vibration of a package material **202** that is relatively constant in terms of the time between impacts of a paddle **320a** (or other object) with the package material **202**. Although, by way of comparison, it is also possible to create a vibration of a package material **202** that is less constant in terms of the time between impacts of a paddle **320a** (or other object) with the package material, or in terms of the amplitude of the vibration caused by subsequent impacts. For example, this can be accomplished using a paddle wheel **326** with different paddle

spacing angles, adjacent paddles with different lengths, or adjacent paddles configured to displace the package material **202** by different distances **330**.

[00164] With reference, for example, to Figure 6A and Figure 8, in some embodiments, the first object (e.g., paddle **320a,b**) positioned to cause an impact against the package material comprises at least one aperture **536**. For example, this can enable passage of air through the first object. This can also help to avoid a fan-like effect in which the first object causes air to move into contact with the package material **202** and push the package material **202** away from the first object.

[00165] With reference again to Figure 6A and Figure 8, in some embodiments, the first object, paddle **320a**, or each of a plurality of paddles **320a,b**, comprises at least one aperture **536**. With reference to Figure 8, the at least one aperture **536** can be configured to provide one or more of the following characteristics. First, the aperture **536** can be configured to avoid creating a flow **812** of air that pushes the package material **202** away from the paddle **320a**.

[00166] Second, the at least one aperture **536** can be configured to avoid creating a flow **812** of air that pushes the package material **202** sufficiently far away from the paddle **320a** during a rotation of the paddle **320a** that the paddle **320a** does not contact the package material **202** during the rotation.

[00167] Third, the at least one aperture **536** can be configured to avoid creating a flow **812** of air that pushes the package material **202** by more than 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 or 0.1 inches from a hanging reference position (e.g., a first position **804**) in which the package material **202** hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor **224**)),

[00168] Fourth, the at least one aperture **536** can be configured to avoid creating a flow **812** of air that prevents the package material **202** from returning to a hanging

reference position (e.g., a first position **804**) under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor **224**)),

[00169] Fifth, the at least one aperture **536** can be configured so that the at least one aperture **536** (e.g., the aperture or the plurality of apertures) has a total aperture surface area equal to at least and/or no more than 30, 40, 50, 60, 70, 80, 85, 90, 95, 96, 97, 98, or 99% of a surface area of a leading surface **912** of the paddle **320a**.

[00170] In some embodiments, the first object (e.g., paddle **320a**) is rigid.

[00171] With reference to Figure 9, in some embodiments, the first object does not bend by more than a specified bend tolerance **902** during use, for example, as a result of contact with the package material **202**. In some embodiments, the specified bend tolerance **902** is at least and/or no more than 30, 20, 15, 10, 5, 4, 3, 2, or 1 degrees. As illustrated in Figure 9, the specified bend tolerance **902** is measured from a proximal reference line **904** to a distal reference line **906** and measured in a plane perpendicular to the axis **626** of rotation of the paddle wheel **326** (e.g., plane of Figure 9). Additionally, the proximal reference line **904** is parallel to a proximal end **908** of the first object and the distal reference line **906** is parallel to a distal end **910** of the first object. As used herein, the proximal end **908** of the first object is the end closer to an axis **626** of rotation of the paddle wheel **326**. Similarly, the distal end **910** of the first object is the end further from an axis **626** of rotation of the paddle wheel **326**.

[00172] In some embodiments, the first object (e.g., paddle **320a,b**) is made from a material selected from the group consisting of metal, alloy, steel, polymer, plastic, resin, rubber, and wood.

[00173] With reference, for example, to Figure 3B and Figure 8, in some embodiments, the length of a paddle **320a** from the axis **626** of rotation of the paddle wheel **326** to a distal end **910** of the paddle **320a** (as measured radially outward from the axis of rotation of the paddle wheel) is long enough to enable the paddle **320a** to reach the

package material **202** and past the package material **202** by a first distance **330** equal to at least and/or no more than 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2 or 3 inches. In some embodiments, the length of the paddle **320a** from the axis **626** of rotation of the paddle wheel **326** to a distal end **910** of the paddle **320a** (as measured radially outward from the axis of rotation of the paddle wheel) is equal to at least and/or no more than 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2, 3 or 4 inches.

[00174] Although the inventive settler is described herein as being installed on specific embodiments of vertical form, fill, and seal machines, the inventive settler is not limited to being used with these machines. Rather, the inventive settler can be used, for example, with essentially any process where a product can be settled in a package. Although, the inventive settler is especially useful with processes where a film is being continuously advanced to form a package that is filled with product and then sealed. When used with such a process, the inventive settler can settle product within the film while the film is being continuously advanced. This is a substantial improvement over conventional settlers that require a film to pause intermittently for settling.

[00175] Additionally, while the product settler has generally be described in the form of a paddle wheel, some embodiments of the product settler for use with a form, fill and seal machine are also possible. For example, the product settler can be in the form of an object such as a rod that is positioned and actuated to intermittently impact a partially formed package and thereby settle product in the package. In some embodiments, the object can provide settling by contacting the partially formed package on one and only one face. In some embodiments, the object impacts the partially formed package more than 300 times per minute. In some embodiments, the object impacts the partially formed package more than 600 times per minute.

[00176] Furthermore, while the steps for particular embodiments of the invention have been described herein, a person skilled in the art would understand from the

disclosure that the steps can be modified. For example, as appropriate, steps can occur at different times, steps can occur simultaneously or sequentially, the order of steps can be swapped or varied, certain steps can overlap even if they start at different times, and steps can be added or removed.

[00177] While this invention is particularly shown and described herein with reference to preferred embodiments, it will be understood by those skilled in the art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend the invention to be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the elements described herein, in all possible variations thereof, is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context. For example, various advantages of the invention can still be realized if additional elements are added to provide additional advantages or if certain elements are omitted because a particular feature is unnecessary or undesirable for a given application.

ADDITIONAL DISCLOSURE

[00178] The following clauses are offered as further description of the disclosed invention.

1. A method for settling a product in a package made on a form, fill and seal machine, the method comprising the steps:
 - a. providing a package material on a product conduit of a form, fill and seal machine;
 - c. forming a first end seal on the package material to form a partially formed package;
 - d. filling the partially formed package with the product (e.g., with a desired amount of product or with an amount of product provides the package with a desired amount of headspace); and
 - e. settling the product in the partially formed package while continuously conveying the package material along the product conduit.
2. The method of any preceding clause further comprising the step:
 - f. forming a second end seal on the partially formed package to form a package from the partially formed package.
3. The method of any preceding clause further comprising the step:
 - b. sealing the package material to form a longitudinal seal.
4. The method of clause 3, wherein the first end seal is approximately perpendicular to the longitudinal seal, or wherein the first end seal is within 30, 25, 20, 15, 10, 5 degrees of perpendicular to the longitudinal seal.
5. The method of any preceding clause, further comprising the step:
 - directing a gas into the partially formed package.
6. The method of clause 5, wherein the gas is directed into the partially formed package as a first jet of gas.

7. The method of clause 5 or 6, wherein the gas pressurizes an interior of the partially formed package.

8. The method of any preceding clause, wherein the settling step further comprises the steps:

pressurizing an interior of the partially formed package to provide resistance; and
intermittently contacting the partially formed package to move the partially formed package, thereby moving the product.

9. The method of any preceding clause, wherein the settling step further comprises the steps:

rotating a paddle wheel comprising a paddle; and
intermittently rotating the paddle into contact with the partially formed package,
thereby moving the product while the product is inside the partially formed package.

10. The method of clause 9,
wherein the method is characterized by a feature selected from the group consisting of:

wherein the paddle (or each of a plurality of paddles) comprises at least one aperture (e.g., slot or hole);

wherein the paddle contacts the package once per rotation of the paddle;

wherein a flow of air created by the rotation of the paddle (as opposed to contact with the paddle) pushes the package material by no more than 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 or 0.1 inches from a hanging reference position (e.g., a first position) wherein the hanging reference position is a position of the package material when the package material hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor)) and when the product settler is inactive and out of contact with the package material;

wherein after impact by a paddle (or each of a plurality of paddles) the package material returns to a hanging reference position, wherein the hanging reference position is a position of the package material when the package material hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas (e.g., compressor)) and when the product settler is inactive and out of contact with the package material; and a combination thereof.

11. The method of clause 9 or 10, wherein an actuator rotates the paddle and stops the paddle in a desired position.

12. The method of clause 11, wherein the actuator is characterized by a feature selected from the following group of features:

the actuator is a motor;

the actuator is a stepper motor;

the actuator is programmable to change (e.g., increase or decrease) oscillatory or rotational speed of the paddle at a desired rate;

the actuator is programmable to control acceleration (e.g., increasing or decreasing rotational speed) of the paddle wheel;

the actuator is programmable to select the position of the paddle when the paddle stops; and

a combination thereof.

13. The method of claim 11 or 12, wherein the method further comprises a step selected from the group consisting of:

using the actuator to change (e.g., increase or decrease) an oscillatory or rotational speed of the paddle at a first desired rate by changing an oscillatory or rotational speed of a component of the actuator (e.g., rotor, drive shaft, piston, etc.), optionally wherein the component of the actuator is linked (e.g., mechanically, electromagnetically, or a combination thereof) with the paddle, and optionally using the actuator to change the

oscillatory or rotational speed of the paddle at a second desired rate by changing the oscillatory or rotational speed of the component of the actuator oscillates or rotates;

using the actuator to control acceleration (e.g., increasing or decreasing rotational or oscillatory speed) of the paddle, the plurality of paddles, the paddle wheel, or a combination thereof;

using the actuator to stop the paddle (or each of the plurality of paddles) in a desired position (e.g., out of a path of the package material or out of contact with the package material); and

a combination thereof.

14. The method of any preceding clause, wherein the settling step further comprises:

using the product settler to provide the package material with an amplitude of vibration equal to at least and/or no more than 3, 2.5, 2, 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1 inches.

15. The method of any of clauses 9-14, wherein the paddle does not bend by more than a specified bend tolerance during use (e.g., as a result of contact with the package material), wherein the specified bend tolerance is an angle measured in a plane that is perpendicular to the axis of rotation of the paddle wheel, wherein the specified bend tolerance is no more than 30, 20, 15, 10, 5, 4, 3, 2, or 1 degrees, and wherein the specified bend tolerance is measured for a leading surface of the paddle and from a proximal reference line to a distal reference line, wherein the proximal reference line is parallel to a proximal end of the paddle (e.g., end closer to an axis of rotation of the paddle wheel) and the distal reference line is parallel to a distal end of the paddle (e.g., end further from an axis of rotation of the paddle wheel).

16. The method of any preceding clause wherein the package material is a film.

17. An improved continuous motion form, fill and seal machine, said machine comprising a product conduit, a conveyor, and seal jaws; wherein the conveyor is positioned to convey a package material that is wrapped around the product conduit; wherein the conveyor moves

the package material along the product conduit; wherein the seal jaws are positioned adjacent to opposite portions of the package material to form a first end seal on the package material, thereby forming a partially formed package; wherein the product conduit is positioned so that a product passing through the product conduit will enter the partially formed package after exiting the product conduit; and wherein the product conduit is positioned above the seal jaws; wherein the improvement comprises:

a product settler comprising a first object positioned to cause an impact against the package material;

wherein the impact agitates the package material and settles the product from an unsettled height to a settled height while the machine continuously conveys the package material along the product conduit.

18. The machine of any preceding clause, wherein the machine comprises a source of pressurized gas.
19. The machine of clause 18, wherein the machine comprises a nozzle and/or conduit to direct the pressurized gas into the package material.
20. The machine of any preceding clause, wherein the product settler comprises a controller to set a number of impacts per minute that the first object causes on the package material.
21. The machine of any preceding clause, wherein the product settler comprises a positional sensor to determine a position of the first object.
22. The machine of any preceding clause, wherein the impact occurs on one and only one face of the partially formed package.
23. The machine of any preceding clause, wherein the first object directly contacts the package material to cause the impact.
24. The machine of any preceding clause, wherein the impact against the package material occurs below the product conduit and above the unsettled height.

25. The machine of any preceding clause, wherein the product settler comprises a motor with sufficiently low torque that if the motor is deactivated (e.g., stopped, turned off, disengaged) while the first object is in contact with the package material, as the package material is conveyed, the package material will push the first object out of a path of the package material.
26. The machine of any preceding clause, wherein the product settler is modular.
27. The machine of any preceding clause, wherein the product settler comprises a frame that spatially fixes the product settler in relation to a path of the package material.
28. The machine of any preceding clause, wherein the product settler comprises a first adjustable mount to move the product settler in a first direction.
29. The machine of any preceding clause, wherein the settler is positioned so that, as the first object moves into contact with the package material, the first object will first contact the package material at a first point that is a second distance below the product conduit.
30. The machine of any preceding clause, wherein the product settler is positioned adjacent to the package material so that, as the first object moves into contact with the package material, the first object will contact the package material below the product conduit and above the unsettled height of the product.
31. The machine of any preceding clause:
- wherein the seal jaws comprise a first seal jaw and a second seal jaw;
 - wherein the first seal jaw rotates around a first axis of rotation;
 - wherein the second seal jaw rotates around a second axis of rotation;
 - wherein the first seal jaw, the first axis of rotation, the second seal jaw and the second axis of rotation are positioned so that, as the first seal jaw and the second seal jaw rotate, the first seal jaw and the second seal jaw come together to form the first end seal.
32. The machine of any preceding clause:

wherein the seal jaws comprise a third seal jaw and a fourth seal jaw;

wherein the third seal jaw rotates around a first axis of rotation;

wherein the fourth seal jaw rotates around a second axis of rotation;

wherein the third seal jaw, the first axis of rotation, the fourth seal jaw and the second axis of rotation are positioned so that, as the third seal jaw and the fourth seal jaw rotate, the third seal and the fourth seal jaw come together to form a second end seal on the package material thereby forming a package.

33. The machine of any preceding clause, wherein the package material is a film.

34. The machine of any preceding clause, wherein the machine is a vertical form, fill and seal machine.

35. The machine of any preceding clause:

wherein the first object is a rotatable paddle wheel;

wherein the paddle wheel comprises a paddle; and

wherein the paddle is positioned so that, as the paddle wheel rotates, the paddle causes agitation of the package material and thereby settles the product.

36. The machine of clause 35, wherein the length of the paddle (as measured radially outward from an axis of rotation of the paddle wheel to a distal end of the paddle wheel) is (i) long enough to enable the paddle to reach the package material and past the package material by at least and/or no more than 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1, 1.5, or 2 inches, or (ii) is at least and/or no more than 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1, 1.5, 2, 3 or 4 inches, or (iii) a combination thereof.

37. The machine of clause 35 or 36, wherein the product settler comprises:

a motor comprising a rotor, wherein the motor causes the rotor to rotate, optionally, wherein the rotor is or is not an axle for the paddle wheel, and optionally wherein an axis of rotation for the rotor and an axis of rotation for the paddle wheel are or are not concentric.

38. The machine of clause 37,

optionally, wherein the rotor is straight from the motor and along the portion of the rotor that acts as the axle for the paddle wheel;

optionally, wherein no force transfer components (e.g., gears, belt, etc.) apart from the rotor are used between the motor and the paddle wheel;

optionally wherein the product settler occupies less space than a reference product settler that comprises the force transfer components;

optionally, wherein the motor, the rotor, the paddle wheel or a combination thereof fit (e.g., during operation) within a reference cylinder, wherein the reference cylinder has a reference cylinder radius of no more than and/or at least 8, 7, 6, 5, 4, 3, 2, 1.5, 1 or 0.5 inches, and wherein the reference cylinder has a reference cylinder height of no more than and/or at least 24, 20, 18, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, or 2 inches;

optionally, wherein an axis of rotation for the rotor of the motor and an axis of rotation for the paddle wheel are concentric, and wherein a reference motor cylinder has a central axis that is concentric with the axis of rotation for the rotor and wherein the radius of the reference motor cylinder is the minimum radius that results in the reference motor cylinder being large enough to fully contain the motor (e.g., with no portion of the motor protruding outside the reference motor cylinder), and wherein a reference paddle wheel cylinder has a central axis that is concentric with the axis of rotation for the rotor and wherein the radius of the reference paddle wheel cylinder is the minimum radius that results in the reference paddle wheel cylinder being large enough to fully contain the paddle wheel (e.g., with no portion of the paddle wheel protruding outside the reference paddle wheel cylinder), and optionally wherein the reference paddle wheel cylinder is at least as large or larger than the reference motor cylinder or alternatively, or optionally wherein the reference motor cylinder is at least as large or larger than the reference paddle wheel cylinder;

optionally wherein the motor, the rotor, the paddle wheel or a combination thereof fit (e.g., during operation) within a volume equal to no more than and/or at least 2, 1.9, 1.8, 1.7,

1.6, 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.8, 0.7, 0.6, 0.6, 0.4, 0.3, 0.2, 0.1, 0.5, 0.1, 0.05, 0.04

cubic feet; or

a combination thereof.

39. The machine of any of clauses 37-38, wherein the motor is characterized by a feature selected from the following group of features:

the motor is a stepper motor;

the motor can be programmed to change (e.g., increase or decrease) oscillatory or rotational speed of the first object at a desired rate;

the motor can be programmed to provide more control over acceleration (e.g., increasing or decreasing rotational or oscillatory speed) of the at least one object (e.g., paddle) or paddle wheel, to enable selecting the position of the at least one object when it stops; and

a combination thereof.

40. The machine of any one of clauses 35-39, wherein the paddle wheel comprises a plurality of paddles (e.g., no more than and/or at least four, three, or two paddles);

optionally, wherein the plurality of paddles are spaced around a paddle wheel to provide a paddle spacing angle between each set of two adjacent paddles in the plurality of paddles;

optionally, wherein the paddle spacing angle differs from a common angle by no more than a specified tolerance, wherein the common angle is defined to equal 360 degrees divided by the number of paddles in the plurality of paddles, wherein the specified tolerance has a magnitude of no more than 45, 30, 25, 20, 15, 10, 5, 4, 3, 2 or 1 degrees.

41. The machine of any one of clauses 35-40, wherein the paddle (or each of a plurality of paddles) comprises at least one aperture;

optionally, wherein the at least one aperture is configured:

to avoid creating a flow of air that pushes the package material away from the paddle,

to avoid creating a flow of air that pushes the package material sufficiently far away from the paddle during a rotation of the paddle that the paddle does not contact the package material during the rotation,

to avoid creating a flow of air that pushes the package material by more than 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2 or 0.1 inches from a hanging reference position in which the package material hangs under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas),

to avoid creating a flow of air that prevents the package material from returning to a hanging reference position under the force of gravity and any force of internal pressure (e.g., from a source of pressurized gas),

so that the at least one aperture (e.g., the aperture or the plurality of apertures) has a total aperture surface area equal to at least 30, 40, 50, 60, 70, 80, 85, 90, 95, 96, 97, 98, or 99% of the surface area of a leading surface of the paddle **320a**; or

a combination thereof.

42. The machine of any one of clauses 35-41:

wherein the package material comprises an impact face;

wherein the impact face is adjacent to the product settler;

wherein, when the impact face of the package material hangs under a force of gravity, the impact face defines a first position;

wherein the settler is positioned so that as the paddle wheel rotates, a first tip of the paddle will reach past (e.g., horizontally) the first position by a first distance; and

wherein the first distance reaches a maximum of at least and/or no more than 0.25, 0.5, 1, 1.5, 2, 2.5 or 3 inches while the paddle wheel rotates.

43. The machine of any one of clauses 35-42, wherein the paddle wheel comprises a plurality of paddles.

44. The machine of any preceding clause, wherein the first object is characterized by at least one of the following features:

the first object (e.g., paddle) is rigid;

the first object does not bend by more than a specified bend tolerance during use (e.g., as a result of contact with the package material), wherein the specified bend tolerance is no more than 30, 20, 15, 10, 5, 4, 3, 2, or 1 degrees, wherein the specified bend tolerance is measured from a proximal reference line to a distal reference line and measured in a plane perpendicular to the axis of rotation of the paddle wheel, wherein the proximal reference line is parallel to a proximal end of the first object (e.g., end closer to an axis of rotation of the paddle wheel), and wherein the distal reference line is parallel to a distal end of the first object (e.g., end further from an axis of rotation of the paddle wheel); and

a combination thereof.

45. The machine of any preceding clause, wherein the first object comprises at least one aperture (e.g., to enable passage of air through the first object, to avoid a fan-like effect in which the first object causes air to move into contact with the package material and push the package material away from the first object).

46. The machine of any preceding clause, wherein the first object is made from a material selected from the group consisting of metal, alloy, steel, polymer, plastic, resin, rubber and wood.

47. A method for settling a product in a partially formed package, the method comprising the steps:

- a. providing a partially formed package;
- b. filling the partially formed package with a product; and
- c. settling the product in the partially formed package;

wherein the settling step comprises:

rotating a paddle wheel comprising at least one paddle against the partially formed package.

48. The method of any preceding clause, further comprising the step:
 - g. closing the partially formed package to form a package.
49. The method of any preceding clause, further comprising the step:
 - h. directing a pressurized gas into the partially formed package.
50. The method of any preceding clause, wherein the paddle wheel rotates intermittently.
51. The method of any preceding clause, wherein the paddle wheel rotates continuously.
52. The method of any preceding clause, wherein the at least one paddle intermittently contacts the partially formed package.
53. The method of any preceding clause, wherein the partially formed package is provided on a form, fill and seal machine that intermittently conveys a package material along a product conduit.
54. The method of any preceding clause, wherein the partially formed package is provided on a form, fill and seal machine that continuously conveys a package material along a product conduit.
55. The method of any preceding clause, wherein the providing step further comprises the steps:
 - i. providing a package material on a product conduit of a form, fill and seal machine;
 - iii. forming a first end seal on the package material to form the partially formed package.
56. The method of clause 55, wherein the providing step further comprises the step:
 - ii. sealing the package material to form a longitudinal seal.
57. The method of clause 55 or 56, further comprising the step:

f. forming a second end seal on the partially formed package to form a package from the partially formed package.

58. The method of any preceding clause, further comprising the step:

e. settling the product in the partially formed package while continuously conveying a package material along a product conduit.

59. The method of clause 56, 57 or 58:

wherein the first end seal is approximately perpendicular to the longitudinal seal.

60. An apparatus comprising an improved product settler for settling product in a partially formed package; wherein the improved product settler comprises:

a paddle wheel;

wherein the paddle wheel comprises at least one paddle that is positioned to cause an impact against the partially formed package;

wherein the impact agitates the partially formed package and thereby settles the product.

61. The apparatus of any preceding clause, wherein the apparatus further comprises a source of pressurized gas.

62. The apparatus of clause 61, wherein the apparatus comprises a conduit (e.g., nozzle) to direct the pressurized gas into the partially formed package.

63. The apparatus of any preceding clause, wherein the product settler comprises a controller to set a number of impacts per minute that the paddle wheel causes on the partially formed package.

64. The apparatus of any preceding clause, wherein the product settler comprises a positional sensor to determine the position of the paddle wheel.

65. The apparatus of any preceding clause, wherein the apparatus comprises a positional sensor to determine the position of the paddle wheel.

66. The apparatus of any preceding clause, wherein the impact occurs on one and only one face of the partially formed package.
67. The apparatus of any preceding clause, wherein the paddle wheel directly contacts the partially formed package to cause the impact.
68. The apparatus of any preceding clause, wherein the product settler comprises a motor with sufficiently low torque that if the motor turns off while the paddle wheel is in contact with the partially formed package, as the partially formed package is conveyed, the partially formed package will push the paddle wheel out of a path of the partially formed package.
69. The apparatus of any preceding clause, wherein the product settler is modular.
70. The apparatus of any preceding clause, wherein the product settler comprises a frame that spatially fixes the product settler in relation to a path of the partially formed package.
71. The apparatus of any preceding clause, wherein the product settler comprises a first adjustable mount to move the product settler in a first direction.
72. The apparatus of any preceding clause, wherein the paddle wheel comprises a plurality of paddles.
73. The apparatus of any preceding clause, wherein the apparatus comprises a form, fill and seal machine.
74. The apparatus of any preceding clause, wherein the apparatus comprises a form, fill and seal machine that advances film continuously along a product conduit.
75. An apparatus comprising at least one element selected from any of the preceding apparatus clauses, machine clauses, or a combination thereof.
76. A method comprising at least one element selected from any of the preceding method clauses, apparatus clauses, machine clauses or a combination thereof.
77. A method comprising elements selected from any of the preceding method clauses or a combination thereof, optionally, wherein the method comprises the apparatus of any of the

preceding clauses, the machine of any of the preceding clauses, or a combination thereof, optionally, wherein the method is a method of using an apparatus or machine.

CLAIMS

What is claimed:

1. A method for settling a product in a package made on a form, fill and seal machine, the method comprising the steps:
 - a. providing a package material on a product conduit of a form, fill and seal machine;
 - 5 c. forming a first end seal on the package material to form a partially formed package;
 - d. filling the partially formed package with the product; and
 - e. settling the product in the partially formed package while continuously conveying the package material along the product conduit.
2. The method of claim 1 further comprising a step selected from the group consisting of:
 - b. sealing the package material to form a longitudinal seal;
 - f. forming a second end seal on the partially formed package to form a
5 package from the partially formed package; and
 - a combination thereof.
3. The method of claim 1, wherein the settling step further comprises the steps:
 - pressurizing an interior of the partially formed package to provide resistance;
 - and
 - intermittently contacting the partially formed package to move the partially
5 formed package, thereby moving the product.

4. The method of claim 1, wherein the settling step further comprises the steps:
- rotating a paddle wheel comprising a paddle;
- intermittently rotating the paddle into contact with the partially formed package, thereby moving the product while the product is inside the partially formed package.
- 5
5. The method of claim 4, wherein an actuator rotates the paddle and stops the paddle in a desired position.
6. The method of claim 5, wherein the method further comprises:
- using the actuator to change a rotational speed of the paddle at a first desired rate by changing a rotational speed of a component of the actuator, wherein the component of the actuator is linked to the paddle.
7. The method of claim 1, wherein the settling step further comprises:
- using a product settler to provide the package material with an amplitude of vibration of 0.1 to 3 inches.
8. The method of claim 4, wherein the paddle contacts the package once per rotation of the paddle.

9. The method of claim 4, wherein the paddle does not bend by more than a specified bend tolerance during use, wherein the specified bend tolerance is an angle measured in a plane that is perpendicular to the axis of rotation of the paddle wheel, wherein the specified bend tolerance is no more than 30 degrees, and wherein the specified bend tolerance is
- 5 measured on a leading surface of the paddle and from a proximal reference line to a distal reference line, wherein the proximal reference line is parallel to a proximal end of the paddle, and wherein the distal reference line is parallel to a distal end of the paddle.

10. An improved continuous motion form, fill and seal machine, said machine comprising a product conduit, a conveyor, and seal jaws; wherein the conveyor is positioned to convey a package material that is wrapped around the product conduit; wherein the conveyor moves the package material along the product conduit; wherein the seal jaws are positioned adjacent
5 to opposite portions of the package material to form a first end seal on the package material, thereby forming a partially formed package; wherein the product conduit is positioned so that a product passing through the product conduit will enter the partially formed package after exiting the product conduit; and wherein the product conduit is positioned above the seal jaws; wherein the improvement comprises:

10 a product settler comprising a first object positioned to cause an impact against the package material;

wherein the impact agitates the package material and settles the product from an unsettled height to a settled height while the machine continuously conveys the package material along the product conduit.

11. The machine of claim 10, wherein the machine comprises a source of pressurized gas, and a conduit to direct the pressurized gas into the package material.

12. The machine of claim 10, wherein the impact occurs on one and only one face of the partially formed package.

13. The machine of claim 10, wherein the impact against the package material occurs below the product conduit and above the unsettled height.

14. The machine of claim 10, wherein the product settler comprises a motor with sufficiently low torque so that if the motor is deactivated while the first object is in contact with the package material, as the package material is conveyed, the package material will push the first object out of a path of the package material.
15. The machine of claim 10:
wherein the first object is a rotatable paddle wheel;
wherein the paddle wheel comprises a paddle; and
wherein the paddle is positioned so that, as the paddle wheel rotates, the
5 paddle causes agitation of the package material and thereby settles the product.
16. The machine of claim 15:
wherein the package material comprises an impact face;
wherein the impact face is adjacent to the product settler;
wherein, when the impact face of the package material hangs under a force of
5 gravity, the impact face defines a first position;
wherein the product settler is positioned so that as the paddle wheel rotates, a first tip of the paddle will reach past the first position by a first distance; and
wherein the first distance reaches a maximum of 0.25 to 3 inches while the paddle wheel rotates.
17. The machine of claim 15, wherein the product settler comprises:
a motor comprising a rotor;
wherein the motor causes the rotor to rotate; and

wherein an axis of rotation for the rotor and an axis of rotation for the paddle wheel
5 are concentric.

18. The machine of claim 17,

wherein, in use, the motor, the rotor, and the paddle wheel fit within a reference
cylinder, wherein the reference cylinder has a reference cylinder radius of no more than 8
inches and a reference cylinder height of no more than 24 inches.

19. The machine of claim 17, wherein the motor is a stepper motor.

20. The machine of claim 15, wherein the paddle wheel comprises a plurality of paddles;
wherein the plurality of paddles are spaced around a paddle wheel to provide a paddle
spacing angle between each set of two adjacent paddles in the plurality of paddles;
wherein the paddle spacing angle differs from a common angle by no more than a
5 specified tolerance;

wherein the common angle is defined to equal 360 degrees divided by the number of
paddles in the plurality of paddles; and

wherein the specified tolerance has a magnitude of no more than 45 degrees.

21. The machine of claim 15, wherein the paddle comprises at least one aperture; and

wherein the at least one aperture is configured so that the at least one aperture has a
total aperture surface area equal to at least 30% of the surface area of a leading surface of the
paddle.

22. The machine of claim 10, wherein the first object does not bend by more than a specified bend tolerance during use;
- wherein the specified bend tolerance is no more than 30 degrees;
- wherein the specified bend tolerance is measured from a proximal reference line to a distal reference line and measured in a plane perpendicular to the axis of rotation of the paddle wheel;
- wherein the proximal reference line is parallel to a proximal end of the first object;
- and
- wherein the distal reference line is parallel to a distal end of the first object.
23. The machine of claim 10, wherein the first object is made from a material selected from the group consisting of metal, alloy, steel, polymer, plastic, resin, rubber and wood.
24. The machine of claim 15, wherein the length of the paddle, as measured radially outward from an axis of rotation of the paddle wheel to a distal end of the paddle: (i) is long enough to enable the paddle to reach the package material and past the package material by at least 0.5 inches, or (ii) is at least 0.5 inches.

1/16

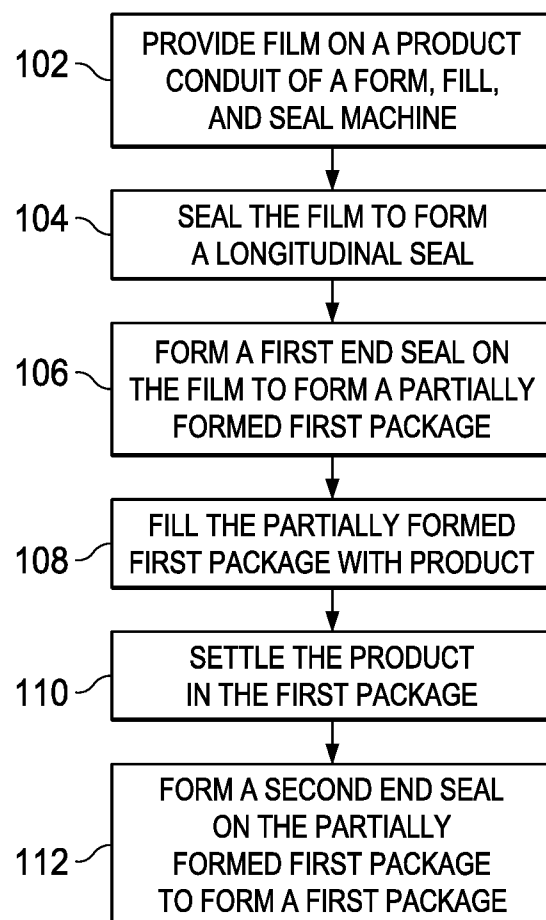


FIG. 1

2/16

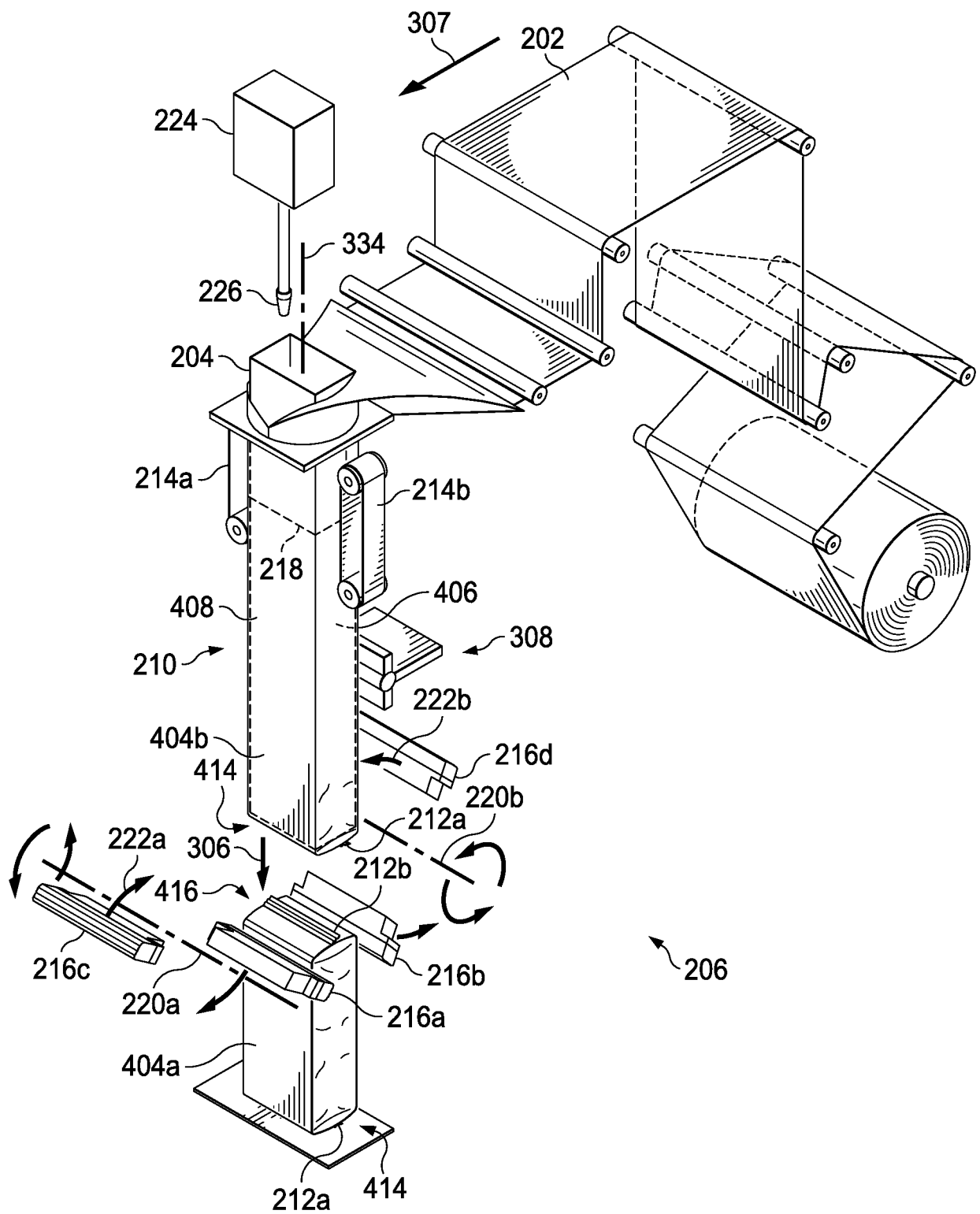


FIG. 2

3/16

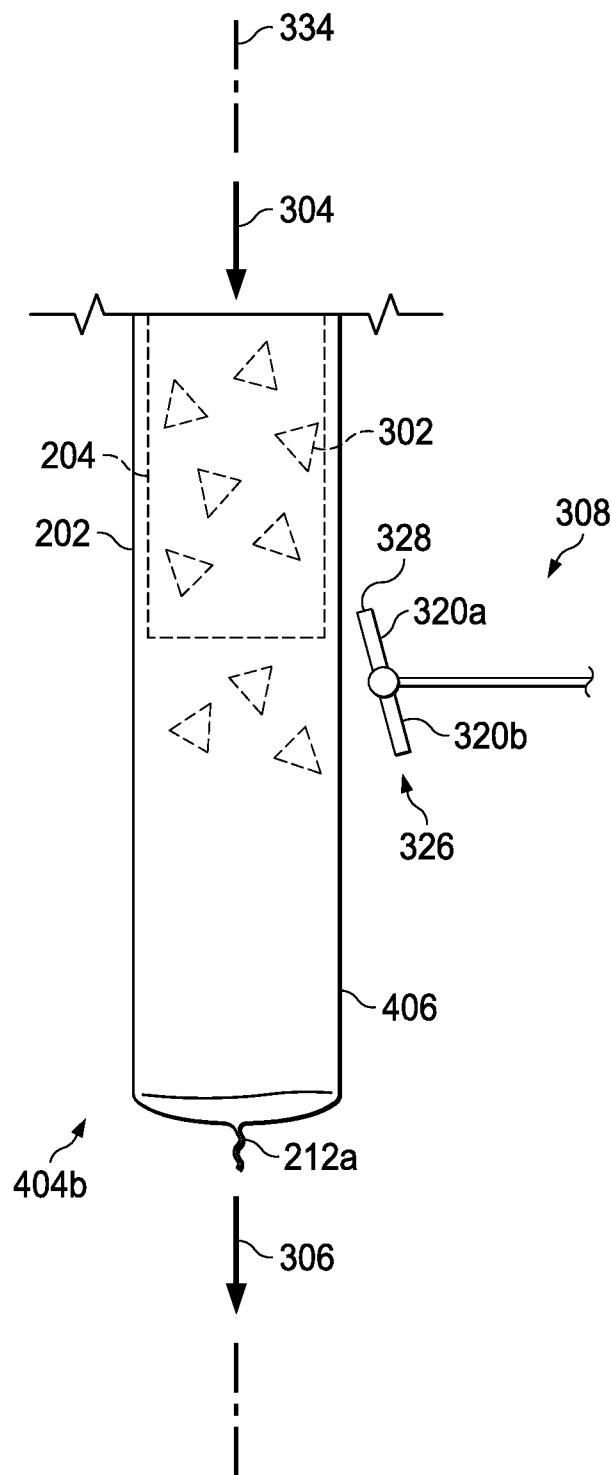


FIG. 3A

4/16

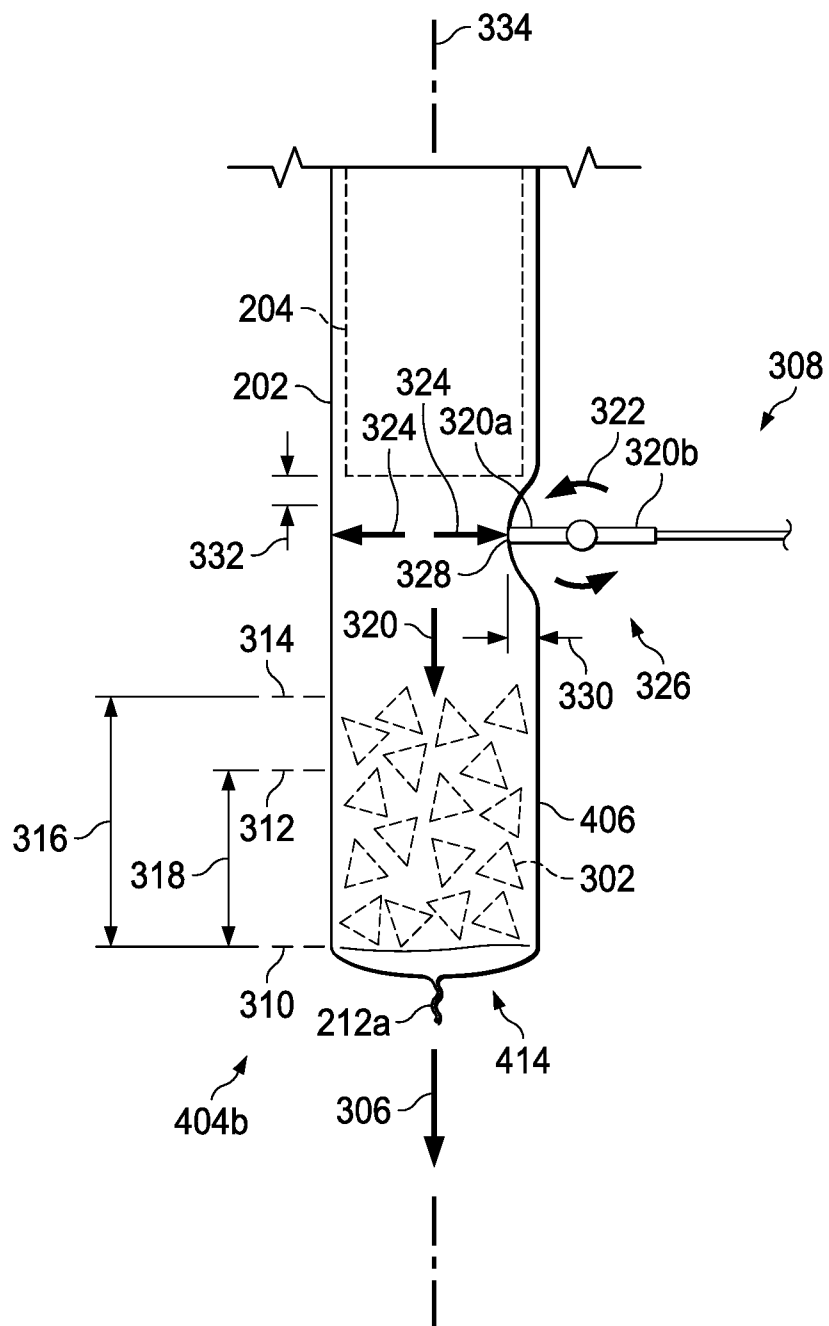


FIG. 3B

5/16

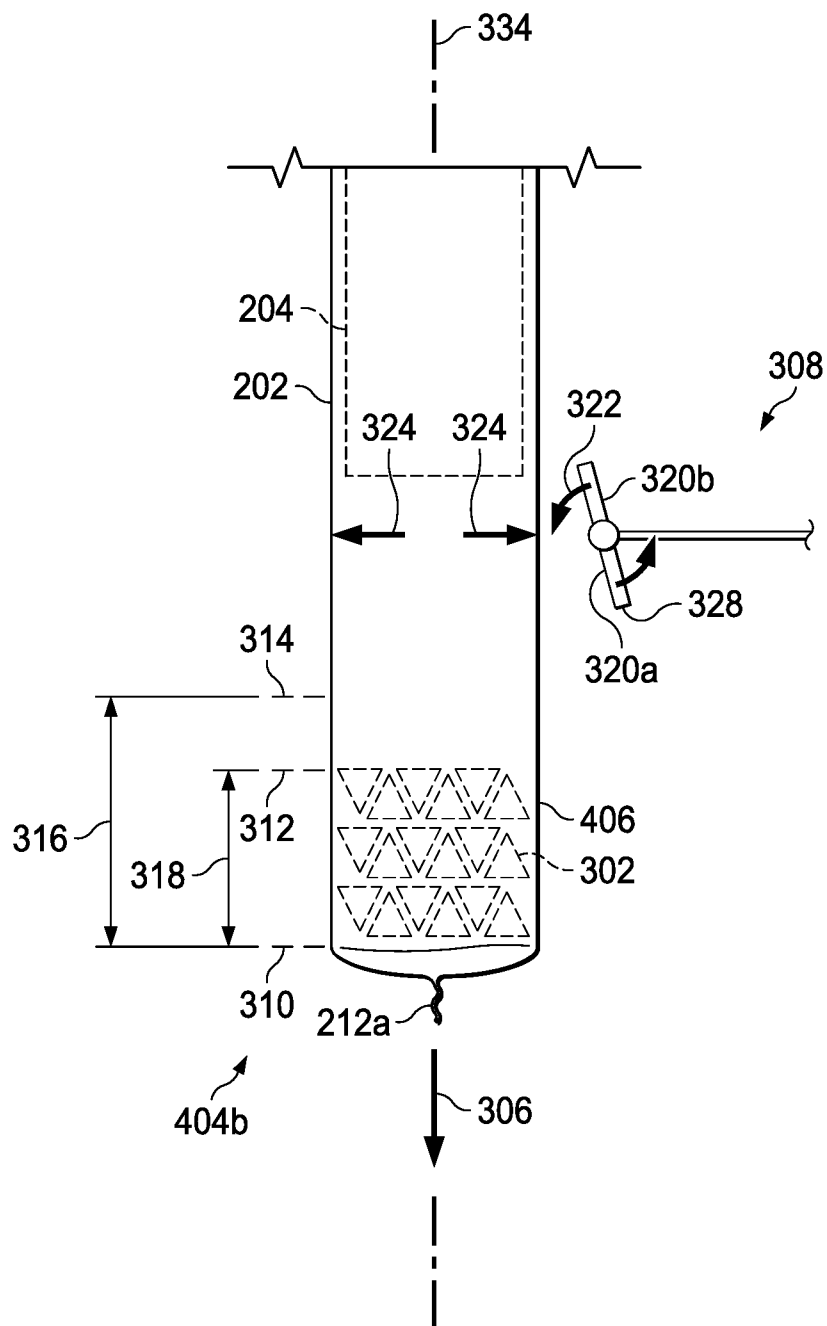
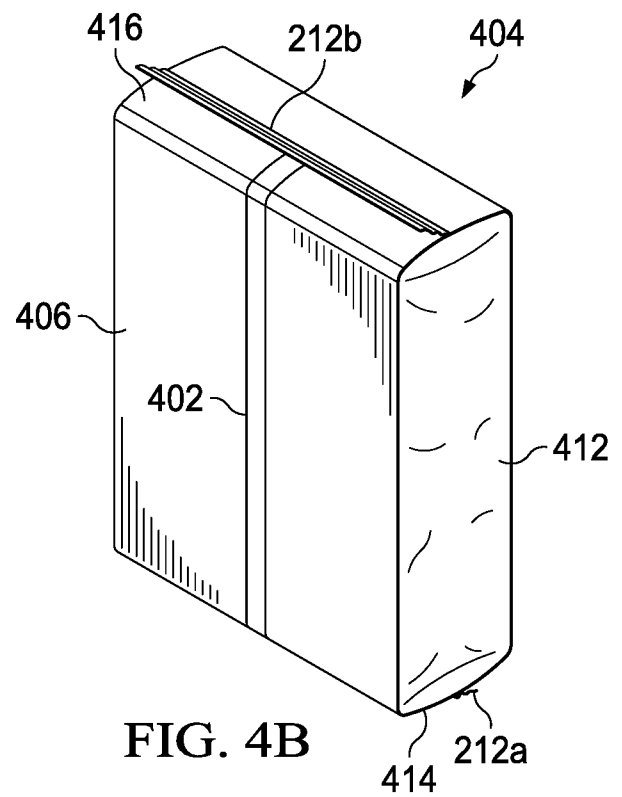
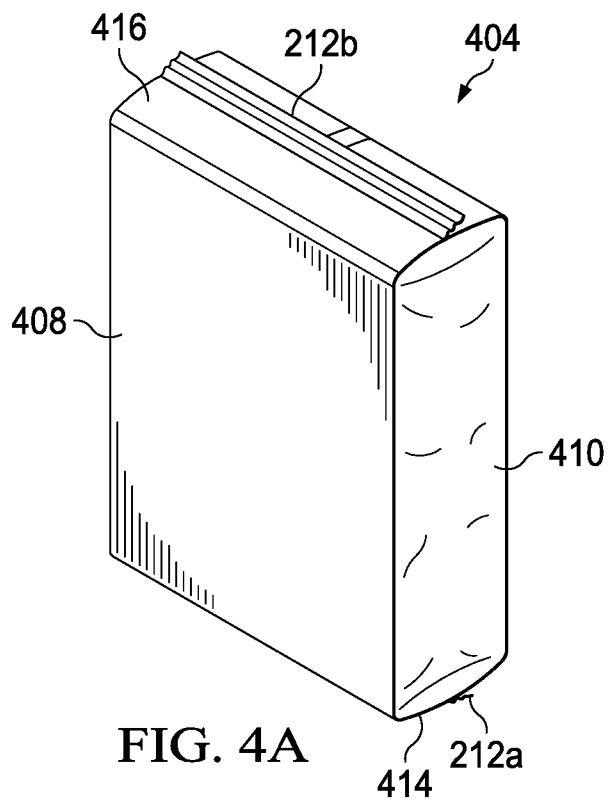


FIG. 3C

6/16



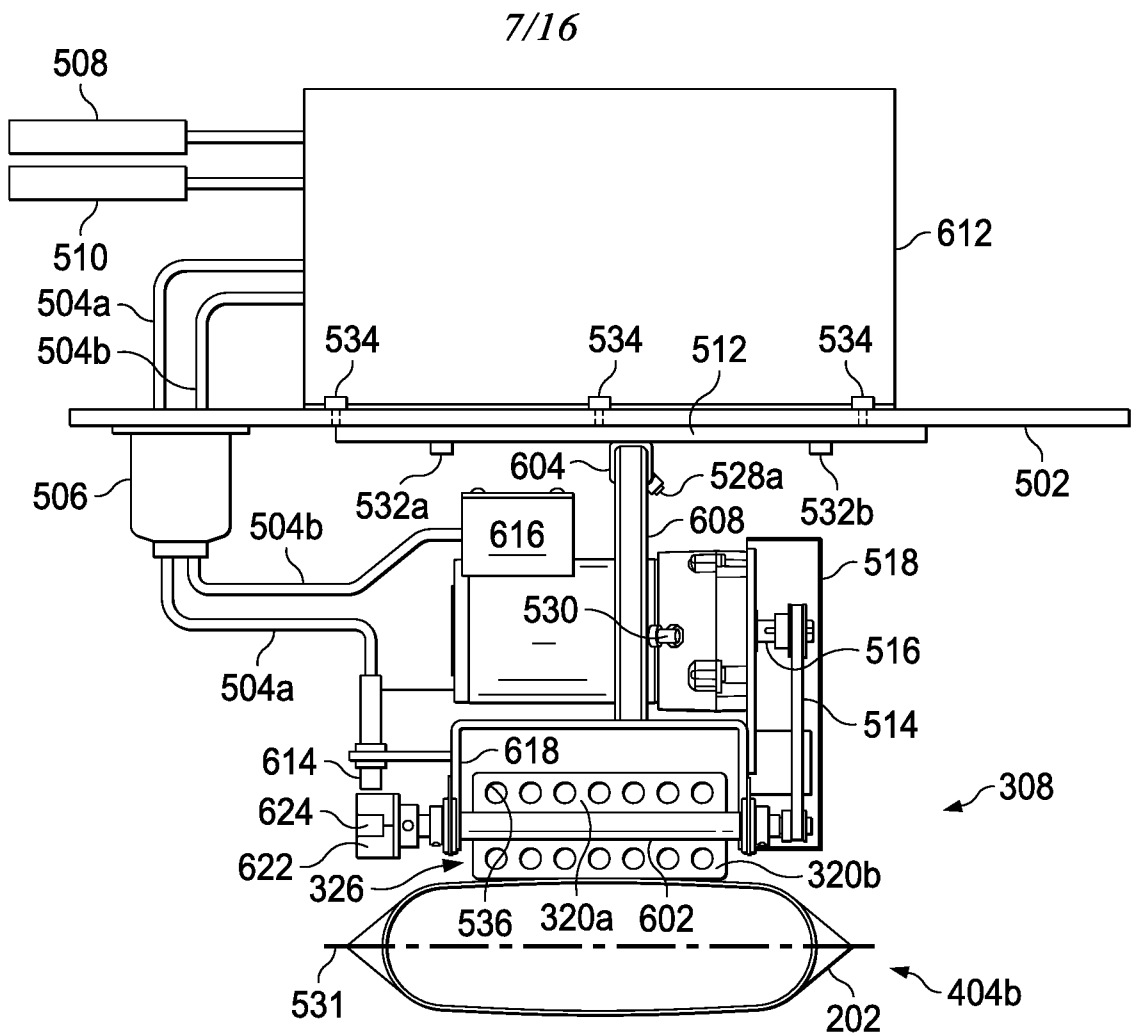


FIG. 5A

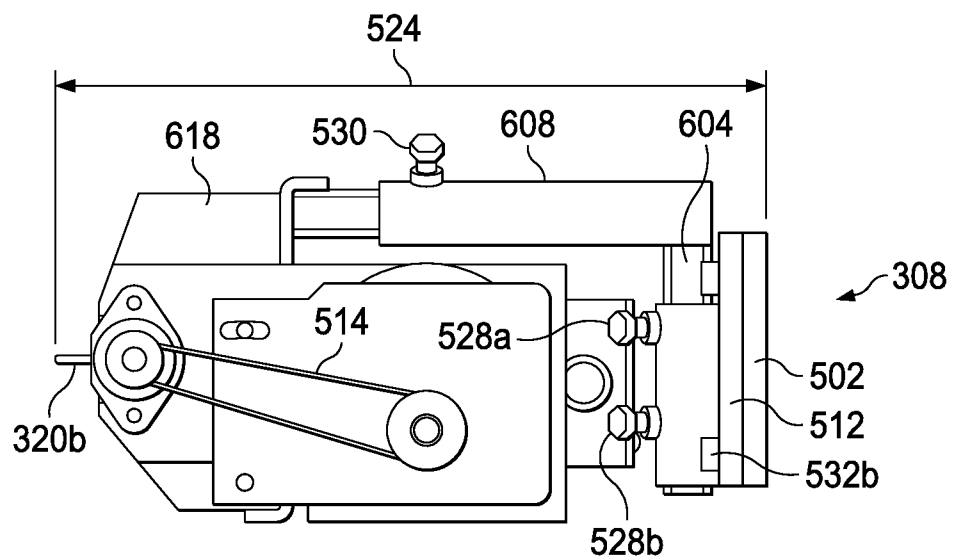


FIG. 5B

8/16

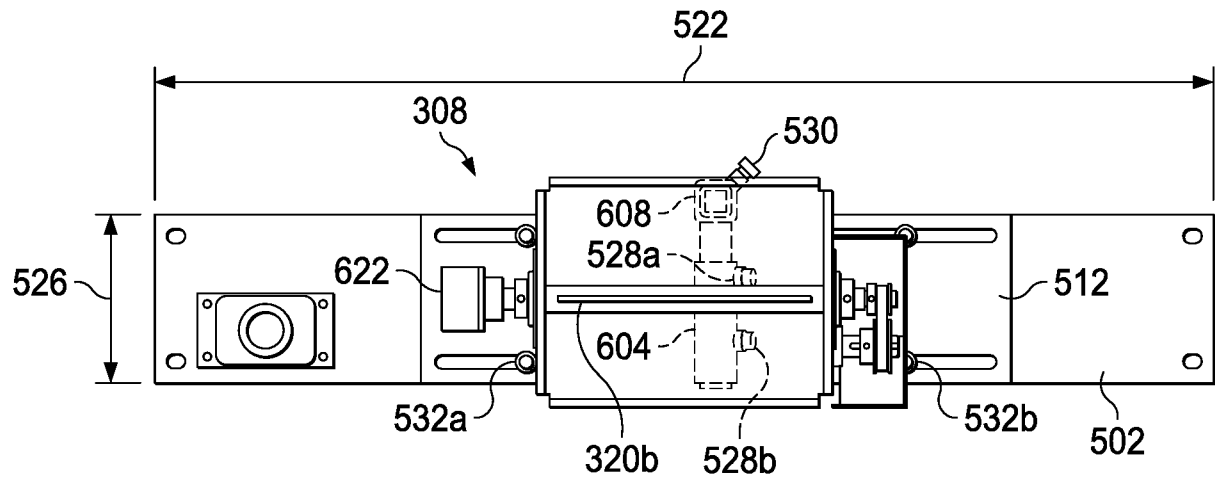


FIG. 5C

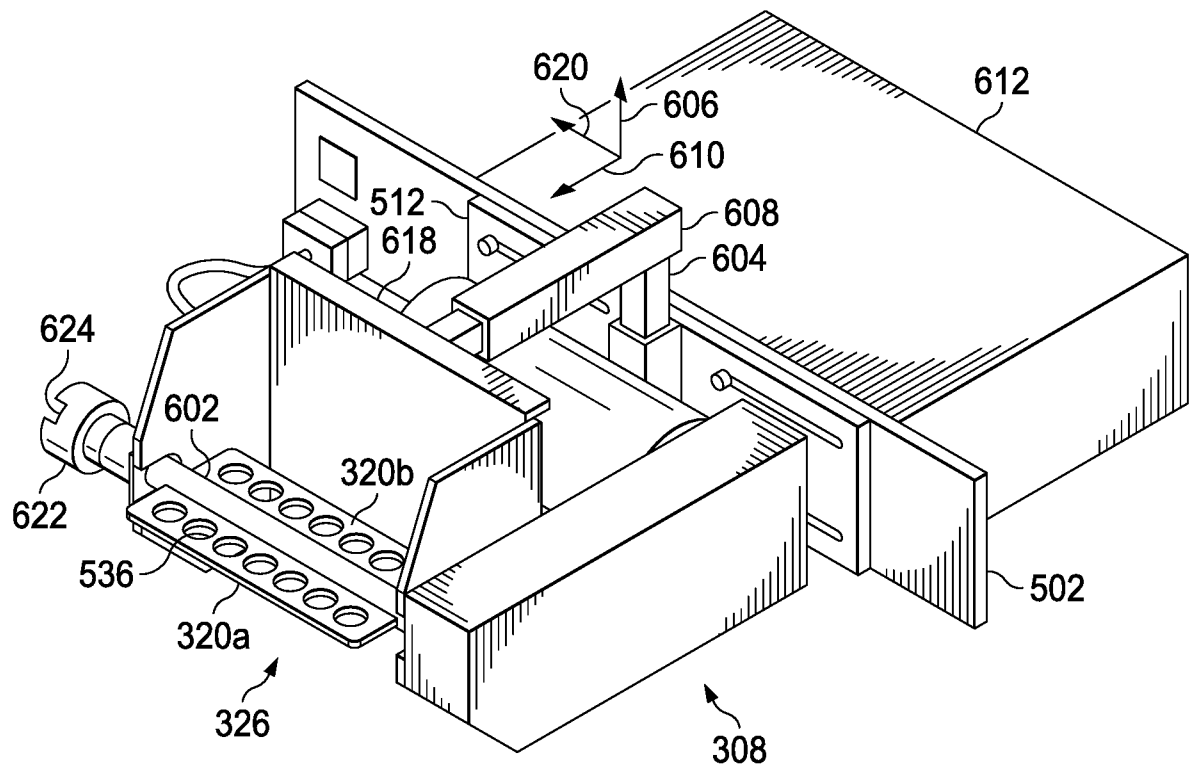
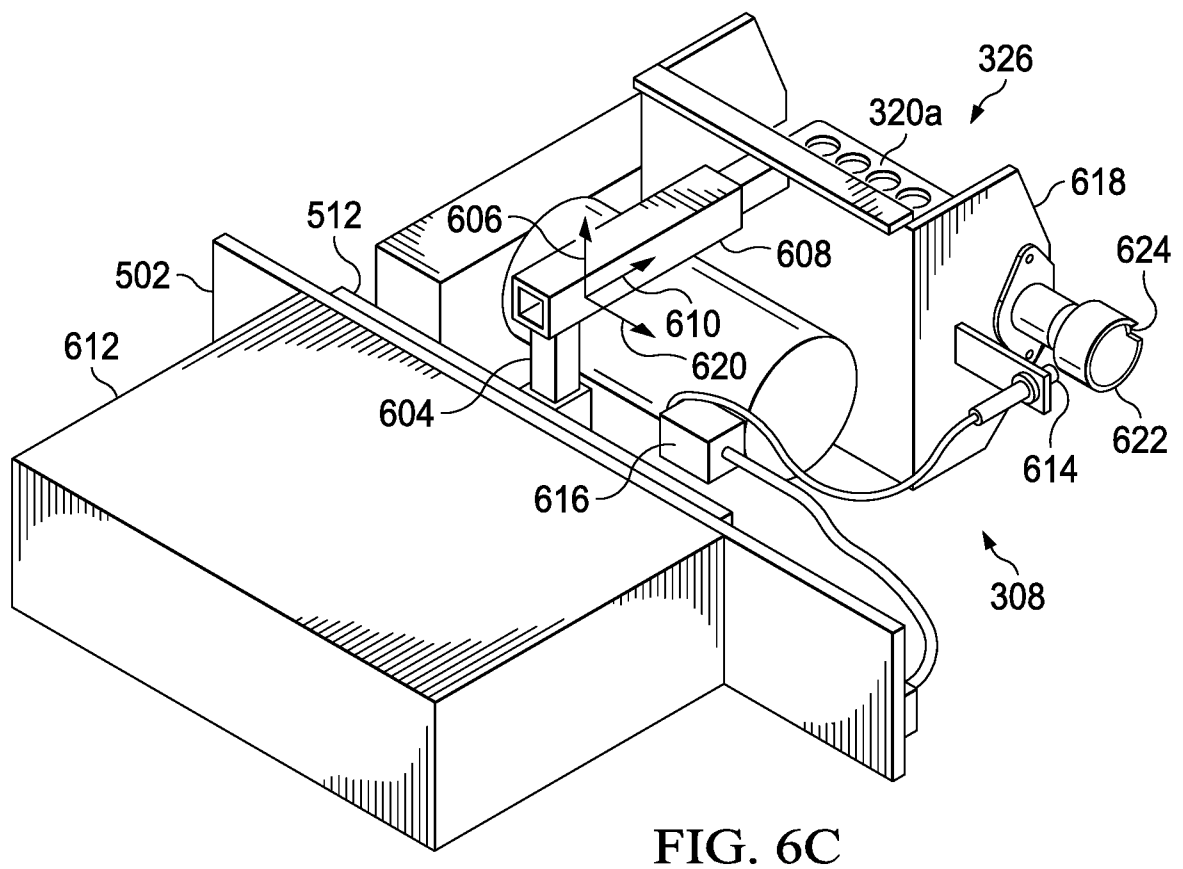
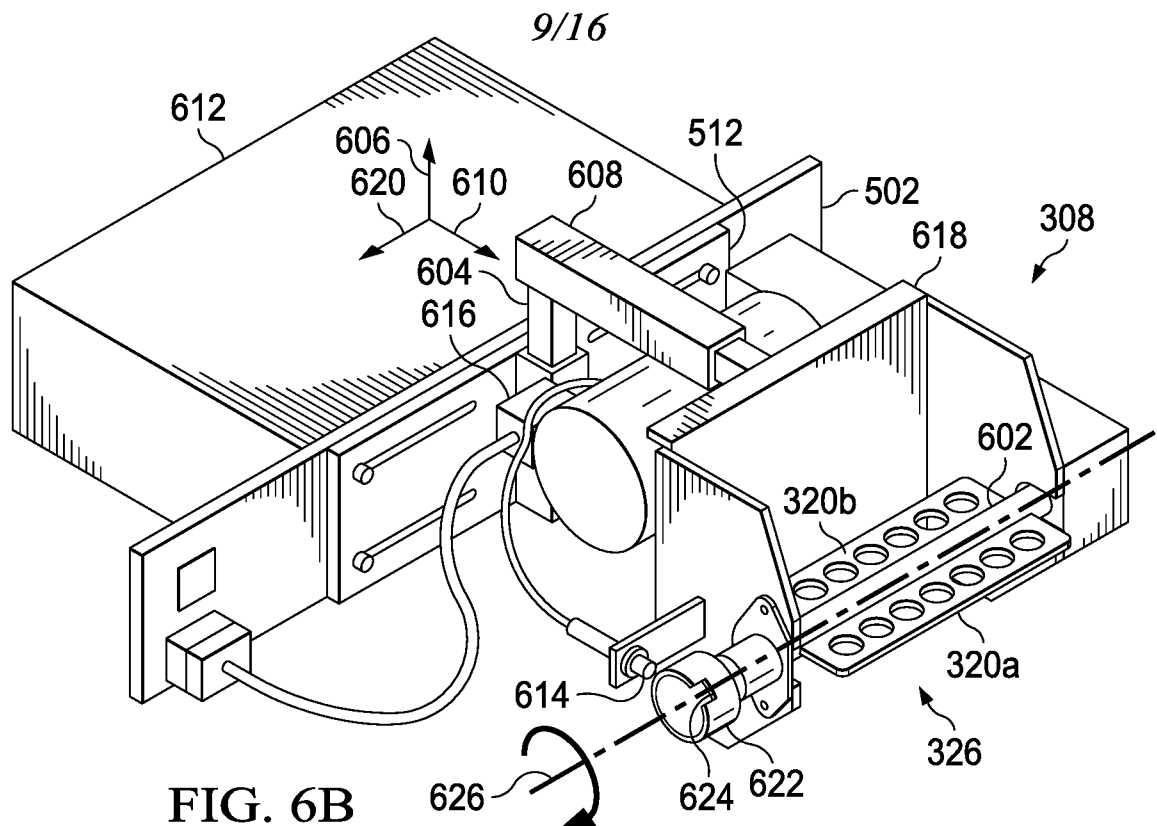
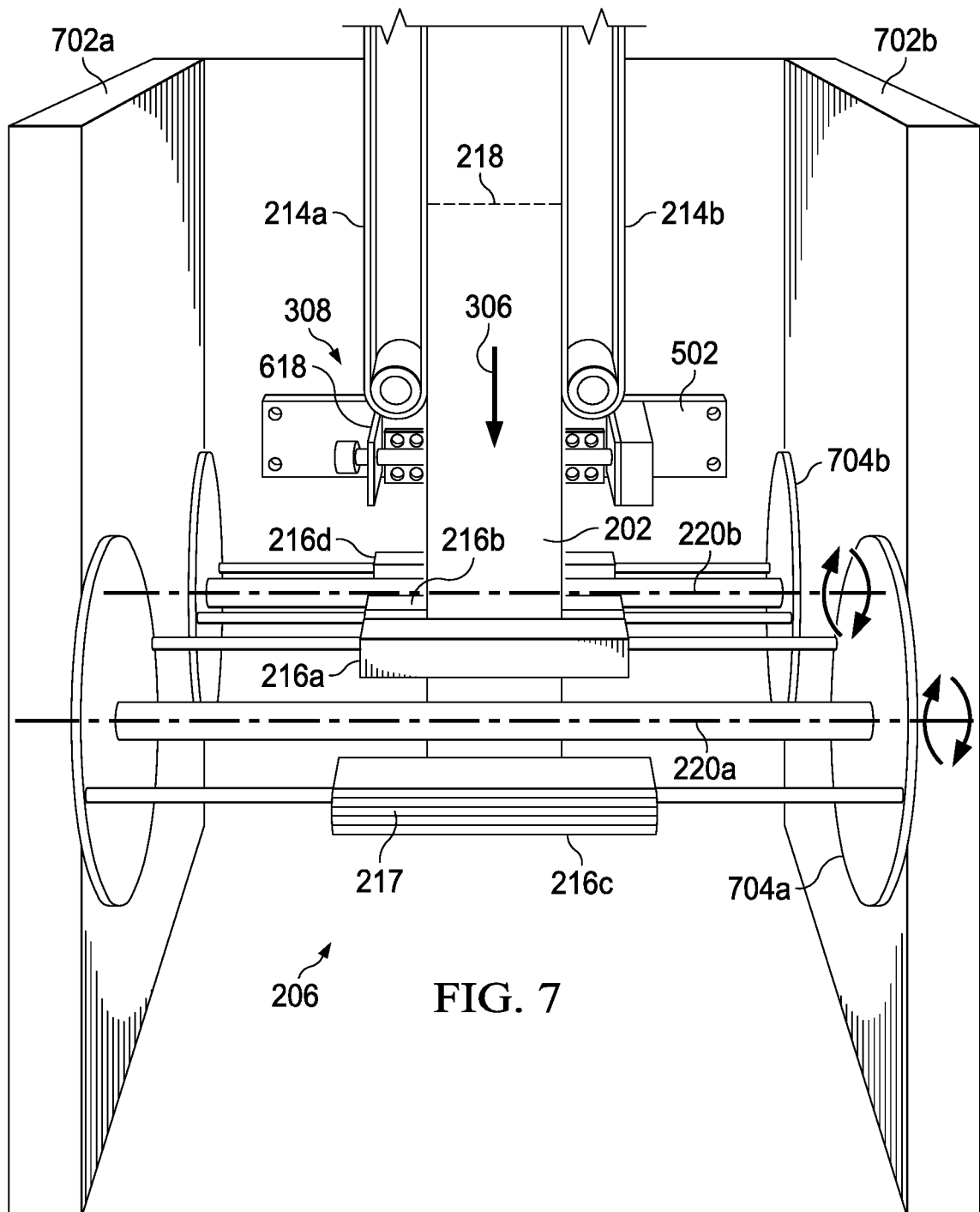
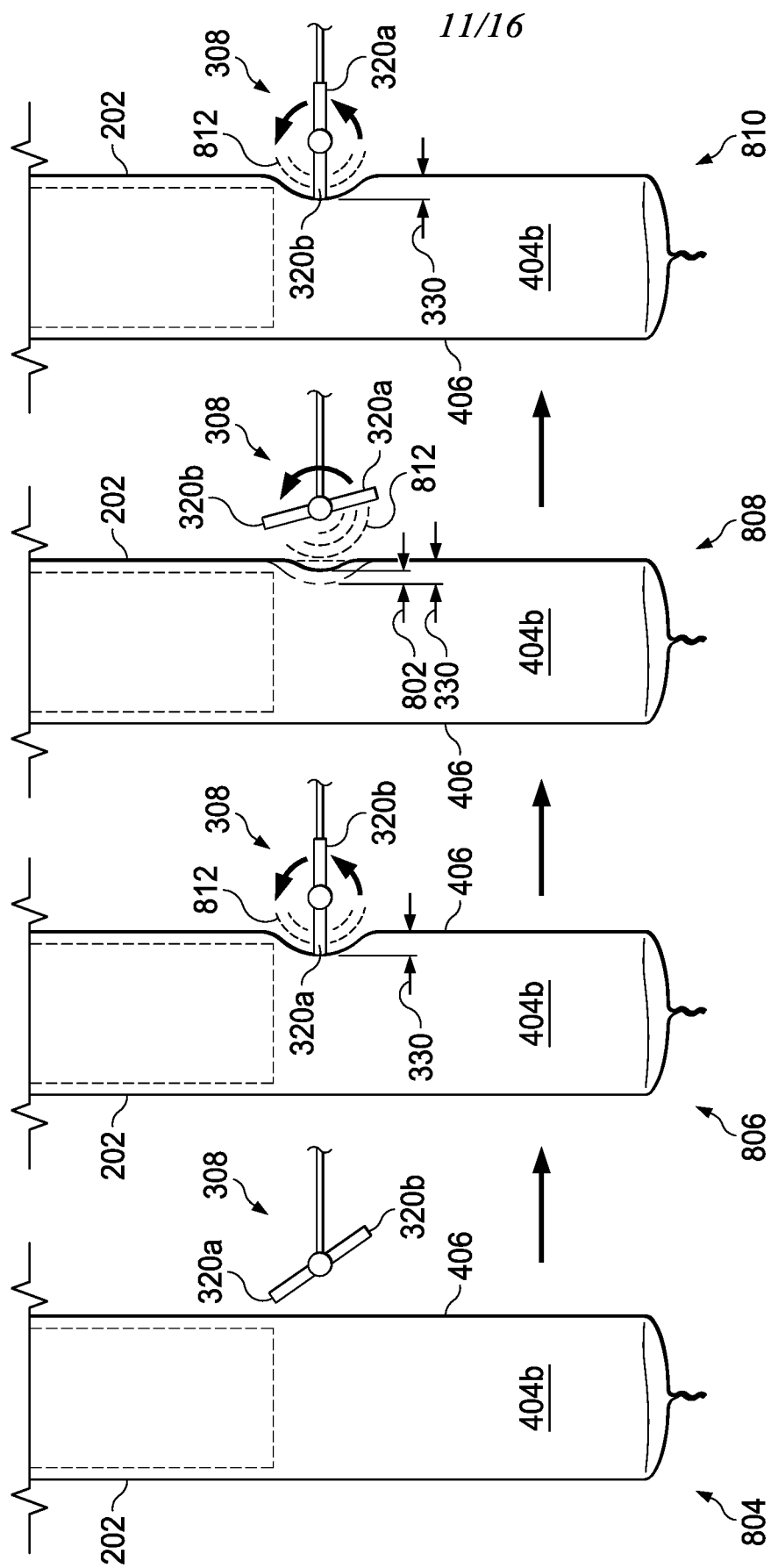


FIG. 6A



10/16





12/16

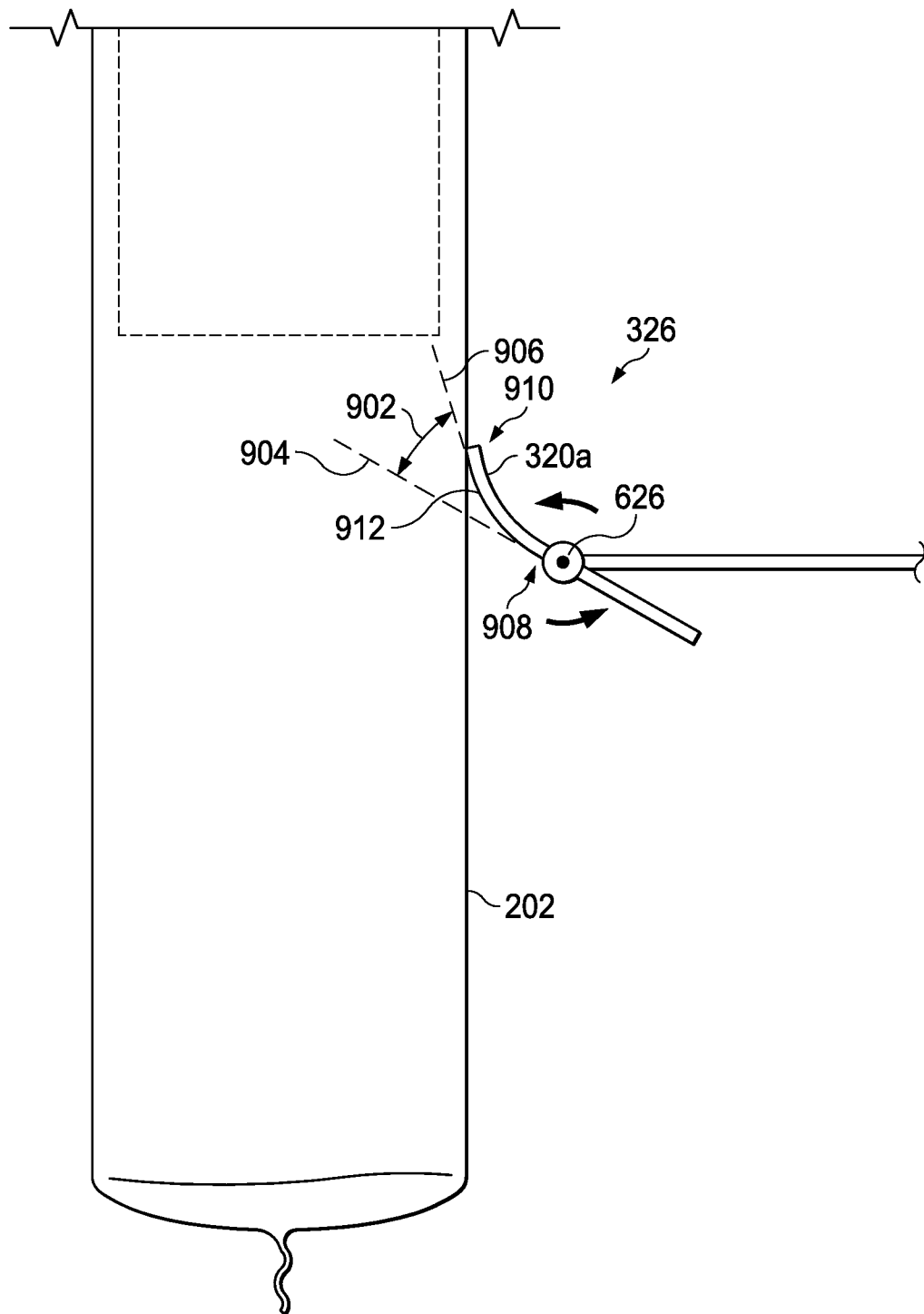
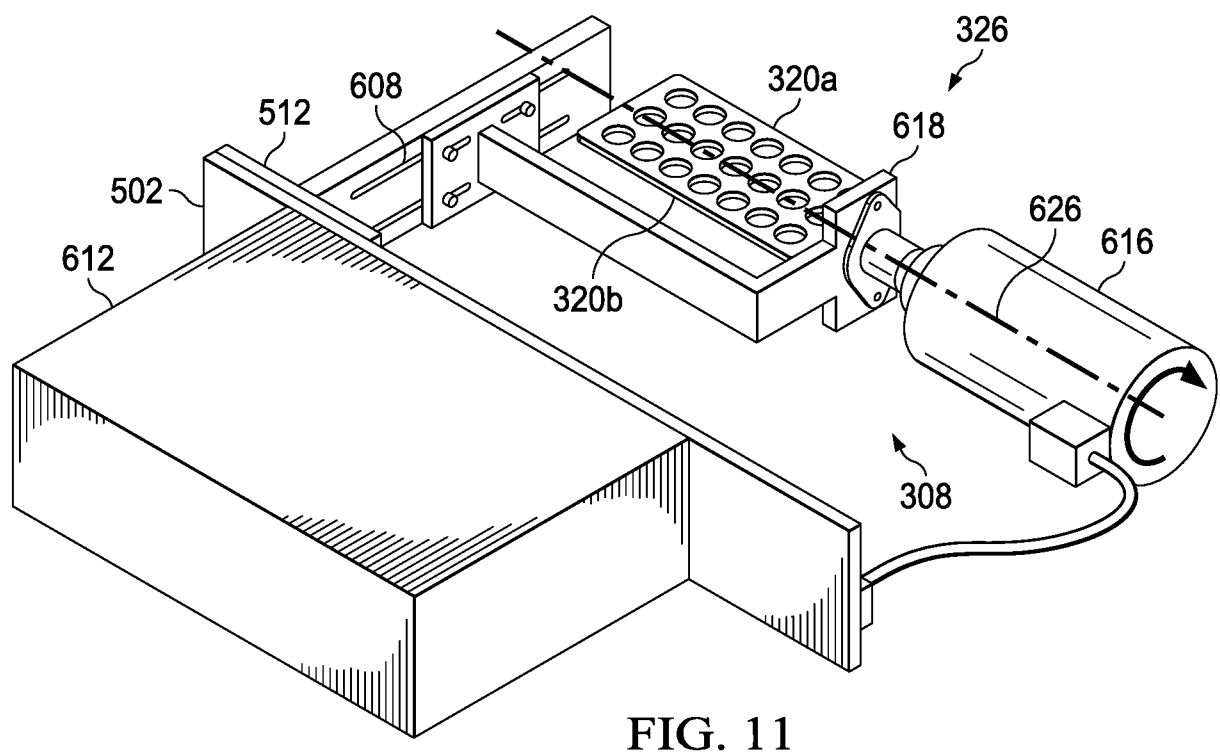
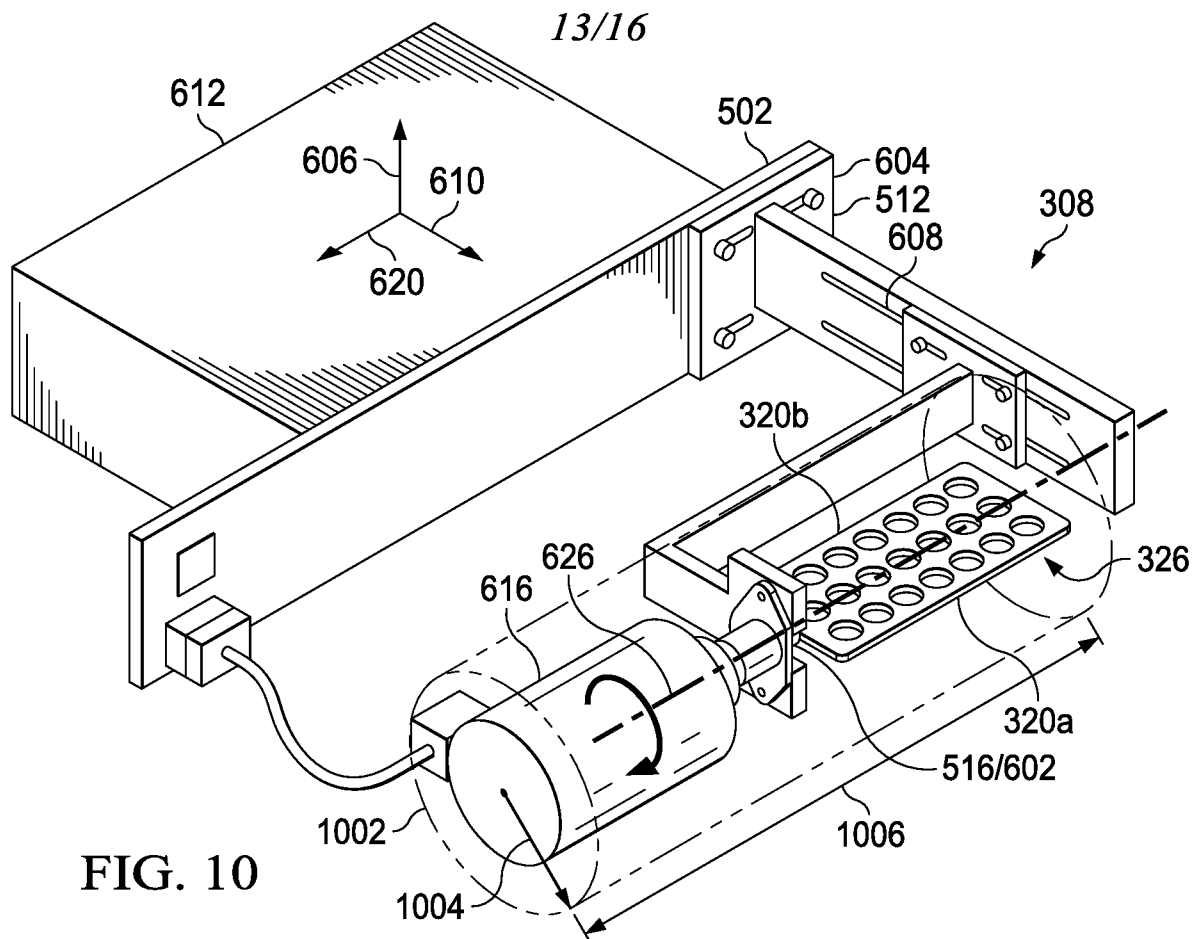
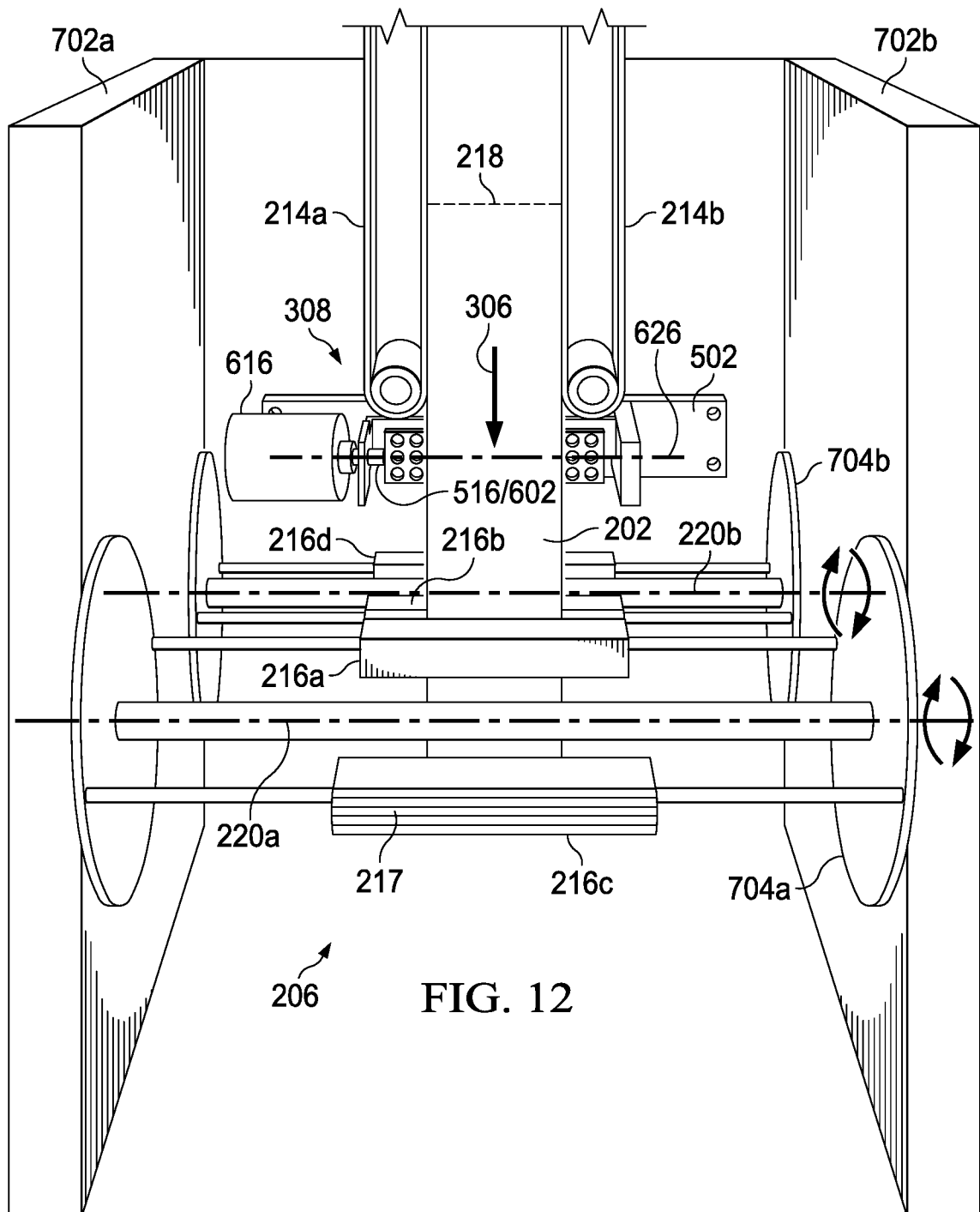


FIG. 9



14/16



15/16

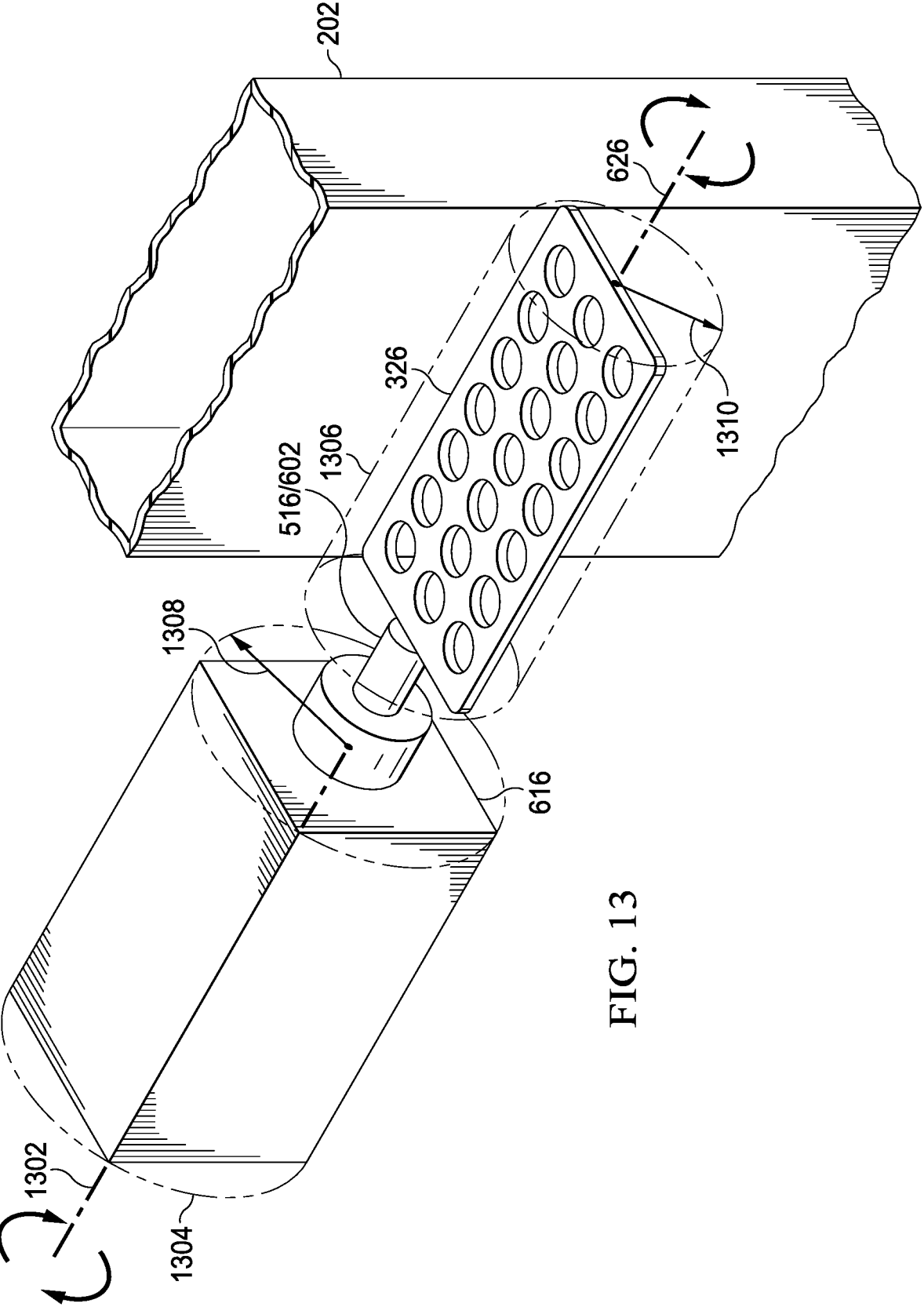


FIG. 13

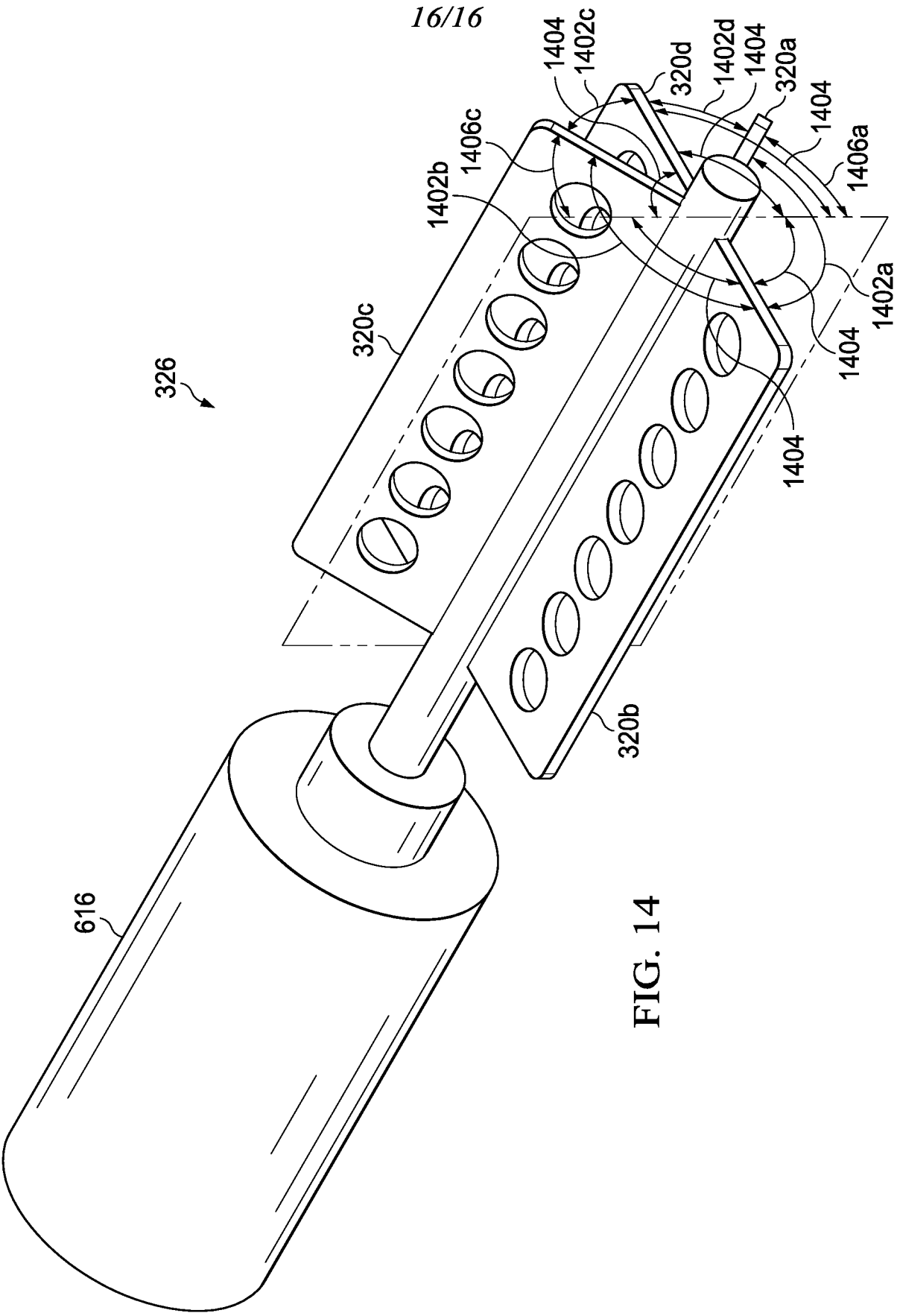


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US18/38979

A. CLASSIFICATION OF SUBJECT MATTER

IPC - B65B 1/22, 9/207, 31/00, 51/30, 65/02 (2018.01)

CPC - B65B 1/22, 1/24, 1/26, 9/2007, 9/2049, 9/207, 31/00, 51/30, 51/306, 65/02

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)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2016/0176548 A1 (FRITO-LAY NORTH AMERICA INC.) 23 June 2016; paragraphs [0082], [0095]-[0096], [0098]	1-6, 8-16, 20-22, 24 ----- 7, 17-19, 23
Y	US 2010/0330237 A1 (DEERING, C et al.) 30 December 2010; paragraph [0133]	7
Y	US 6,047,521 A (TERMINELLA, E et al.) 11 April 2000; column 6, lines 45-53; column 7, lines 4-6; column 13, lines 59-63	17-19
Y	GB 1,037,445 A (TAYLOR, W) 27 July 1966; page 2, lines 75-80	23

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

20 August 2018 (20.08.2018)

Date of mailing of the international search report

14 SEP 2018

Name and mailing address of the ISA/

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents

P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774