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(72) Inventeurs/Inventors:
MAST, LUKE A., US;
STEIH, RICHARD, US;
MAKI, KIRK EDWARD, US;
DOLE, OMKAR, US;
WOLOSZYK, MARK, US;
DOWNING, DAVID, US

(73) Propriétaire/Owner:
AMCOR RIGID PLASTICS USA, LLC, US

(74) Agent: GOWLING WLG (CANADA) LLP

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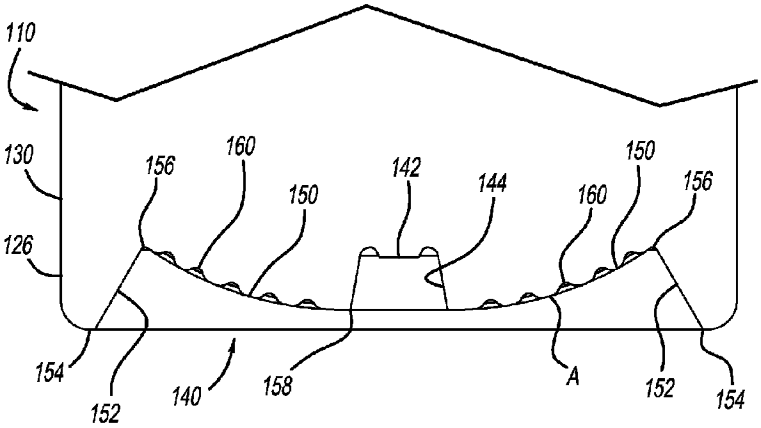

(57) Abrégé/Abstract:
A blow-molded container including a finish and a base. The finish defines an opening at a first end of the container that provides access to an internal volume. The base includes a diaphragm and a standing surface. The diaphragm extends radially outward from a central push-up portion. The standing surface of the container is at a second end of the container. In response to an internal vacuum caused by hot-filling and closing the container, the diaphragm is configured to move passively from an as-blown first configuration to a second configuration in which the diaphragm is closer to the first end of the container as compared to the as-blown first configuration. The diaphragm is configured to move from the second configuration to an activated third configuration in which the diaphragm is closer to the first end of the container in response to the diaphragm being externally actuated by a tool.

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(71) **Applicant**: **AMCOR LIMITED** [AU/AU]; 109 Burwood Road, Hawthorne, Victoria 3122 (AU).

(72) **Inventors; and**
(71) **Applicants** *(for US only)*: **MAST, Luke A.** [US/US]; 11999 Swan View Drive, Brooklyn, Michigan 49230 (US). **STEIH, Richard** [US/US]; 7641 Napoleon Road, Jackson, Michigan 49201 (US). **MAKI, Kirk Edward** [US/US]; 115 N. Union Street, Tecumseh, Michigan 49286 (US). **DOLE, Omkar** [US/US]; 660 Hidden Valley Club Drive, Apt. 108, Ann Arbor, Michigan 48104 (US). **WOLOSZYK, Mark** [US/US]; 7929 Werkner Rd., Chelsea, Michigan 48118 (US). **DOWNING, David** [US/US]; 20478 Boetger Road, Manchester, Michigan 48152 (US).

(74) **Agents**: **SEITZ, Brent G.** et al.; Harness, Dickey & Pierce, P.L.C., P.O. Box 828, Bloomfield Hills, Michigan 48303 (US).

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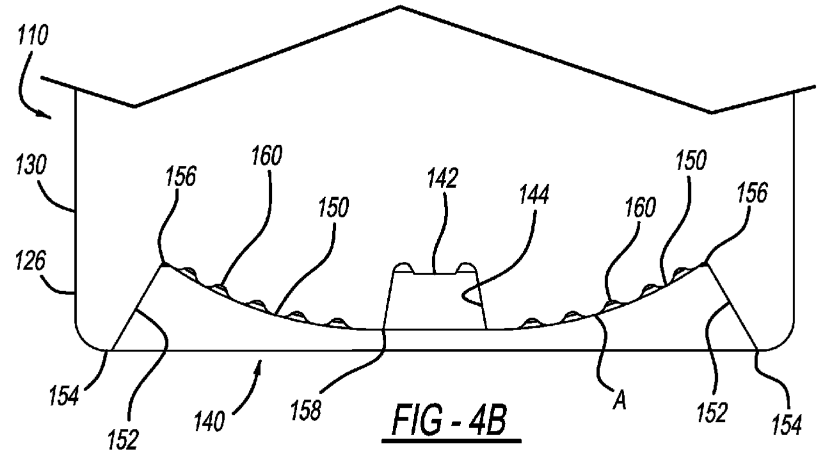


FIG - 4B

(57) **Abstract**: A blow-molded container including a finish and a base. The finish defines an opening at a first end of the container that provides access to an internal volume. The base includes a diaphragm and a standing surface. The diaphragm extends radially outward from a central push-up portion. The standing surface of the container is at a second end of the container. In response to an internal vacuum caused by hot-filling and closing the container, the diaphragm is configured to move passively from an as-blown first configuration to a second configuration in which the diaphragm is closer to the first end of the container as compared to the as-blown first configuration. The diaphragm is configured to move from the second configuration to an activated third configuration in which the diaphragm is closer to the first end of the container in response to the diaphragm being externally actuated by a tool.

WO 2016/029016 A1

TWO-STAGE CONTAINER BASE

[0001]

FIELD

[0002] The present disclosure relates to a two-stage container base.

BACKGROUND

[0003] This section provides background information related to the present disclosure, which is not necessarily prior art.

[0004] As a result of environmental and other concerns, plastic containers, more specifically polyester and even more specifically polyethylene terephthalate (PET) containers, are now being used more than ever to package numerous commodities previously supplied in glass containers. Manufacturers and fillers, as well as consumers, have recognized that PET containers are lightweight, inexpensive, recyclable and manufacturable in large quantities.

[0005] Blow-molded plastic containers have become commonplace in packaging numerous commodities. PET is a crystallizable polymer, meaning that it is available in an amorphous form or a semi-crystalline form. The ability of a PET container to maintain its material integrity relates to the percentage of the PET container in crystalline form, also known as the "crystallinity" of the PET container. The following equation defines the percentage of crystallinity as a volume fraction:

$$\%\ \text{Crystallinity} = \left(\frac{\rho - \rho_a}{\rho_c - \rho_a}\right) x100$$

where ρ is the density of the PET material; ρ_a is the density of pure amorphous PET material (1.333 g/cc); and ρ_c is the density of pure crystalline material (1.455 g/cc).

[0006] Container manufacturers use mechanical processing and thermal processing to increase the PET polymer crystallinity of a container. Mechanical processing involves orienting the amorphous material to achieve strain hardening. This processing commonly involves stretching an injection molded PET preform along a longitudinal axis and expanding the PET preform along a transverse or radial axis to form a PET container. The combination promotes what manufacturers define as biaxial orientation of the molecular structure in the container. Manufacturers of PET containers currently use mechanical processing to produce PET containers having approximately 20% crystallinity in the container's sidewall.

[0007] Thermal processing involves heating the material (either amorphous or semi-crystalline) to promote crystal growth. On amorphous material, thermal processing of PET material results in a spherulitic morphology that interferes with the transmission of light. In other words, the resulting crystalline material is opaque, and thus, generally undesirable. Used after mechanical processing, however, thermal processing results in higher crystallinity and excellent clarity for those portions of the container having biaxial molecular orientation. The thermal processing of an oriented PET container, which is known as heat setting, typically includes blow molding a PET preform against a mold heated to a temperature of approximately 250°F - 350°F (approximately 121°C - 177°C), and holding the blown container against the heated mold for approximately two (2) to five (5) seconds. Manufacturers of PET juice bottles, which must be hot-filled at approximately 185°F (85°C), currently use heat setting to produce PET bottles having an overall crystallinity in the range of approximately 25%-35%.

[0008] While current containers are suitable for their intended use, they are subject to improvement. For example, a reduced weight container that can immediately respond to internal vacuum created during filling in order to reduce the risk of the container being damaged on the fill line, and that can induce a positive pressure within the container to help fix and prevent denting of the container, would be desirable.

SUMMARY

[0009] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0010] The present teachings provide for a blow-molded container including a finish and a base portion. The finish defines an opening at a first end of the container that provides access to an internal volume defined by the container. The base portion includes a diaphragm and a standing surface. The diaphragm extends radially outward from a central push-up portion through which a longitudinal axis of the container extends. The standing surface of the container is at a second end of the container that is opposite to the first end. In response to an internal vacuum caused by hot-filling and closing the container, the diaphragm is configured to move passively from an as-blown first configuration to a second configuration in which the diaphragm is closer to the first end of the container as compared to the as-blown first configuration. The diaphragm is configured to move from the second configuration to an activated third configuration in which the diaphragm is closer to the first end of the container as compared to the second configuration in response to the diaphragm being actuated by an external tool.

[0011] The present teachings further provide for a blow-molded container including a finish and a base portion. The finish defines an opening at a first end of the container that provides access to an internal volume defined by the container. The base portion is at a second end of the container that is opposite to the first end. The base portion includes an external standing surface, an upstanding wall, a central push-up portion, a diaphragm, and a hinge. The external standing surface is at an outer diameter of the base portion. The upstanding wall extends from the external standing surface towards the first end of the container and is angled inward away from a sidewall of the container. The central push-up portion is at a center of the container. A longitudinal axis of the container extends through the central push-up portion. The diaphragm extends between the upstanding wall and the central push-up portion. The hinge is where the diaphragm mates with the upstanding wall. In the as-blown first configuration, the diaphragm is a first distance away from the external standing surface. Subsequent to the container being hot-filled, an internal vacuum within the container draws the diaphragm towards the first end of the container to a second configuration. In response to an external actuation force applied to the diaphragm when in the second configuration, the diaphragm moves from the second configuration to an activated third configuration. The diaphragm is closer to the first end of the container in the activated third configuration as compared to the first configuration.

[0012] The present teachings further provide for a method for filling a blow-molded container. The method includes hot-filling the container through an opening defining a finish at a first end of the container such that a base portion at a second end of the container passively moves from an as-blown first configuration to a second configuration in response to internal vacuum forces of the container. A diaphragm of the base portion is closer to the first end of the container in the second configuration than the as-blown first configuration. The diaphragm further includes applying external force to the base portion when the base portion is in the second configuration to move the base portion from the second configuration to an activated third configuration in which the base portion is closer to the first end of the container as compared to the second configuration.

[0013] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0014] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0015] Figure 1 is a side view of a container according to the present teachings;

[0016] Figure 2 is a plan view of a base portion of the container of Figure 2;

[0017] Figure 3A is a cross-sectional view of the base portion of the container of Figure 1 in an as-blown configuration;

[0018] Figure 3B is a cross-sectional view of the base portion of the container of Figure 1 under internal vacuum force;

[0019] Figure 3C is a cross-sectional view of the base portion of the container of Figure 1 at a mid-point of activation, and Figure 3C illustrates external actuation tooling configured to move the base inward to a full positive displacement position (activated position);

[0020] Figure 3D is a cross-sectional view of the base portion of the container of Figure 1 in the full positive displacement position (activated position);

[0021] Figure 4A is a plan view of a base portion of another container according to the present teachings;

[0022] Figure 4B is a cross-sectional view of the base portion of the container of Figure 4A;

[0023] Figure 5A is a plan view of a base portion of an additional container according to the present teachings;

[0024] Figure 5B is a cross-sectional view of the base portion of the container of Figure 5A;

[0025] Figure 6A is a plan view of a base portion of yet another container according to the present teachings;

[0026] Figure 6B is a cross-sectional view of the base portion of the container of Figure 6A;

[0027] Figure 7A is a plan view of a base portion of a further container according to the present teachings;

[0028] Figure 7B is a cross-sectional view of the base portion of the container of Figure 7A;

[0029] Figure 8A is a plan view of a base portion of yet an additional container according to the present teachings;

[0030] Figure 8B is a cross-sectional view of the base portion of the container of Figure 8A;

[0031] Figure 9A is a plan view of a base portion of still another container according to the present teachings;

[0032] Figure 9B is a perspective view of the base portion of the container of Figure 9A;

[0033] Figure 9C is a cross-sectional view of the base portion of the container of Figures 9A and 9B;

[0034] Figure 10A is a cross-sectional view of the base portion of the container of Figures 9A-9C showing the container in an as-blown configuration (phantom) and under internal vacuum force (solid lines);

[0035] Figure 10B is a cross-sectional view of the base portion of the container of Figures 9A-9C showing the container in an as-blown configuration (phantom) and a full positive displacement position (activated position); and

[0036] Figure 11 is a chart of exemplary diaphragm diameter (DD) to base inversion height (h) ratios for different containers according to the present teachings.

[0037] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

[0038] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0039] Illustrated throughout the Figures are exemplary blow-molded containers 10, 110, 210, 310, 410, 510, and 610 according to the present teachings. The containers can be any suitable shape and size, such as 20 ounces for example. The containers can be made of any suitable material, such as any suitable blow-molded thermoplastic or bio-resin, including polyethylene terephthalate (PET), high density or low density polyethylene (HDPE, LDPE), polypropylene (PP), polyethylene naphthalate (PEN), a PET/PEN blend or copolymer, and the like, for example. The containers can be formed in any suitable manner, such as by stretch blow-molding.

[0040] The containers each include a lightweight container base portion 40, 140, 240, 340, 440, 540, and 640 for use with hot-fill product applications, such as juice, teas, enhanced water, and the like. As described herein, each of the base portions 40, 140, 240, 340, 440, 540, and 640 use at least two modes of operation to control vacuum and pressure within the filled container. A first mode provides for passive movement of the base under the forces of internal vacuum caused by the hot-fill process and subsequent cooling. A second mode is an active mode that includes application of external force to permanently form a base geometry into the container displacing internal volume to reduce or completely eliminate residual vacuum. Positive pressure in the container may also be achieved to help prevent and fix denting.

[0041] With initial reference to Figures 1 and 2, the present teachings provide for a container 10 including a first end 12 and a second end 14, which is opposite to the first end 12. At the first end 12 is a finish 16 defining an aperture 18, which provides access to an internal volume 22 of the container 10. The internal volume 22 of the container 10 is at least partially defined by a shoulder portion 24 and a body portion 26. One or more ribs 28A and 28B can be defined by a sidewall 30 of the container 10.

[0042] With continued reference to Figures 1 and 2, and additional reference to Figures 3A and 3B, at the second end 14 is a base portion 40. The base portion 40 includes a central push-up portion (also referred to as a center isolation post) 42, which can be at an axial center of the base portion 40. A longitudinal axis L of the container 10 can extend through a center of the push-up portion 42. The base portion 40 can be formed using a counter-stretch rod that is of a standard length or shorter, and over-stroke can be used to advantageously reduce weight of the base portion 40.

[0043] With particular reference to Figures 3A and 3B, the push-up portion 42 includes an angled portion (also referred to as an interfacial angled portion) 44, which extends to a diaphragm (also referred to as an inversion ring/radius) 50 of the base portion 40. The diaphragm 50 extends from the central push-up portion 42 to an upstanding wall (also referred to as a primary hemisphere wall) 52. The upstanding wall 52 extends from the diaphragm 50 to a standing surface 54 of the container 10. The base portion 40 generally provides a hinge (also referred to as a transitional radius) 56 where the upstanding wall 52 and the diaphragm 50 meet. An isolation radius 58 is where the diaphragm 50 and the angled portion 44 meet.

[0044] Figure 3A illustrates the base portion 40 in an as-blown first configuration A. In this first configuration A the diaphragm 50 is curved and is generally convex relative to an exterior of the container 10, such as convex relative to the external standing surface 54 of the container 10. The upstanding wall 52 is angled away from the sidewall 30 towards the longitudinal axis L. The upstanding wall 52 can be at any suitable angle, such as about 30°. For example, the upstanding wall 52 can be angled towards the longitudinal axis L from about 15° to about 45°. Thus, the upstanding wall 52 can be angled greater than 20° relative to the longitudinal axis L. The upstanding wall 52 is also less than about 0.34 inches tall as measured from the standing surface 54.

[0045] After the container 10 is hot-filled and allowed to cool, an internal vacuum within the container 10 will passively draw the base portion 40 inward towards the first end 12 and to the second configuration B illustrated in Figure 3B. Specifically, the central push-up portion 42 is drawn along the longitudinal axis L towards the first end 12. The diaphragm 50 also moves towards the first end 12. The diaphragm 50 moves most at the portion thereof proximate to the push-up portion 42. At the hinge portion 56, the diaphragm 50 moves the least, or not at all. A curve radius of the diaphragm 50 is reduced or becomes smaller, and an angle between the upstanding wall 52 and the sidewall 30 generally remains constant as the diaphragm 50 moves from the as-blown first configuration A to the second configuration B. This passive movement of the base portion 40 from the first configuration A of Figure 3A to the second configuration B of Figure 3B allows the base portion 40 to respond to the internal vacuum immediately after filling, capping, and cooling (typically in a water spray cooling tunnel), thereby reducing risk of damage to the container 10 as it contacts other containers and tooling on the fill line conveyor.

[0046] With reference to Figure 3C, external force is applied to the base portion 40 to move the base portion 40 from the second configuration B to the activated third configuration C. This can be done at any time after filling and capping, or after the container 10 has cooled. The external force can be applied in any suitable manner. For example, a tool 80A including a curved surface 82 that generally matches curvature of the diaphragm 50 in the activated third configuration C can be used. A tool 80B can also be used, which is sized and shaped to be received within the central push-up portion 42 in order to apply the external force at the central push-up portion 42.

[0047] As the base portion 40 is forced from the second configuration B to the third configuration C, the central push-up portion 42 and the diaphragm 50 are pushed further towards the first end 12. The diaphragm 50 pivots at the hinge portion 56. The curve radius of the diaphragm 50 may be reduced and the diaphragm 50 may temporarily distort or straighten, as illustrated in Figure 3C, as the radius of the diaphragm 50 reverses from positive to negative. The change in the curve radius of diaphragm 50 may be either uniform or variable about the circumference of the diaphragm. The upstanding wall 52 is forced towards the sidewall 30 to decrease the angle between the upstanding wall 52 and the sidewall 30.

[0048] As additional force is applied to the diaphragm 50, its position is reversed such that, as illustrated in Figure 3D, the diaphragm 50 is concave relative to external standing surface 54 of the container 10, and more particularly to a plane extending across the standing surface 54. Furthermore, the upstanding wall 52 will pivot back towards the longitudinal axis L and the angle between the upstanding wall 52 and the sidewall 30 will increase back to, or about to, the original angle between the upstanding wall 52 and the sidewall 30 of the first configuration A. Force of the angle of the upstanding wall 52 acts upon the inverted diaphragm 50 to hold the diaphragm 50 in the position of the activated third configuration C and prevent the diaphragm 50 from returning to the second configuration B or the first configuration A. In addition to or in place of the concave and convex configuration of the diaphragm 50 described above, the diaphragm 50 can be provided with a generally straight or “S-shaped” cross-section.

[0049] By forcing the base portion 40 to the activated third configuration C and into the internal volume 22 of the container 10, any remaining internal vacuum will be eliminated or nearly eliminated. Positive pressure may also be induced into the container 10 to help prevent and fix denting of the container 10. Such a positive pressure state in the container 10 allows for a lighter weight and thinner sidewall 30 that performs as good as, or better than, heavier containers with residual internal vacuum. The base portion

40 is formed using over-stroke, which leads to a base portion 40 with a lighter weight as compared to prior containers, uniform material distribution, and a reduced thickness of the sidewall 30. A clearance is provided between the standing surface 54 and the rest of the base portion 40 to prevent roll-out past the standing surface 54.

[0050] Figure 4A and 4B illustrate another container according to the present teachings at reference numeral 110 in the as-blown first configuration A. The container 110 is substantially the same as the container 10. Therefore, features in common between the container 110 and the container 10 are illustrated using the same reference numbers, but increased by 100. The description the container 10 also applies to the container 110, at least with respect to the common features. Unlike the container 10, the container 110 includes dimples 112 formed in the diaphragm 150, such as to provide the diaphragm 150 with additional strength. Although the dimples 112 are illustrated as round recesses within the diaphragm 150, the dimples 160 can have any other suitable size, configuration, and shape.

[0051] Figures 5A and 5B illustrate an additional container according to the present teachings at reference numeral 210 in the as-blown first configuration A. The container 210 is substantially the same as the container 10. Therefore, features in common between the container 210 and the container 10 are illustrated using the same reference numbers, but increased by 200. The description the container 10 also applies to the container 210, at least with respect to the common features. Unlike the container 10, the container 210 includes a diaphragm 250 that is at least substantially straight or linear between the hinge 256 and the central push-up portion 242. Thus, from the central push-up portion 242 the diaphragm 250 extends linearly upward to the hinge 256 and generally away from the standing surface 254.

[0052] Figures 6A and 6B illustrate an additional container according to the present teachings at reference numeral 310 in the as-blown first configuration A. The container 310 is substantially the same as the container 10. Therefore, features in common between the container 310 and the container 10 are illustrated using the same reference numbers, but increased by 300. The description the container 10 also applies to the container 310, at least with respect to the common features. Unlike the container 10, the container 310 includes a diaphragm 350 that is at least substantially straight or linear between the hinge 356 and the central push-up portion 342. Thus, from the central push-up portion 342 the diaphragm 350 extends linearly upward to the hinge 356 and generally away from the standing surface 354. The container 310 is therefore substantially similar to the container 210, but includes dimples 360 formed in diaphragm 350, such as to provide the diaphragm 350 with additional strength. Although the dimples 360 are illustrated as round recesses within the diaphragm 350, the dimples 360 can have any other suitable size, configuration, and shape.

[0053] Figures 7A and 7B illustrate an additional container according to the present teachings at reference numeral 410 in the as-blown first configuration A. The container 410 is substantially the same as the container 10. Therefore, features in common between the container 410 and the container 10 are illustrated using the same reference numbers, but increased by 400. The description the container 10 also applies to the container 410, at least with respect to the common features. Unlike the container 10, the container 410 includes a central push-up portion 442 with a radius that is enlarged as compared to the radius of the central push-up portion 42. Furthermore, the container 410 includes a diaphragm 450 that is at least substantially straight or linear between the hinge 456 and the central push-up portion 442. Thus, from the central push-up portion 442 the diaphragm 450 extends linearly upward to the hinge 456 and generally away from the standing surface 454. Figures 8A and 8B illustrate container 510 in the as-blown first configuration A, which is substantially the same as the container 410, but includes dimples 560 formed in diaphragm 550, such as to provide the diaphragm 550 with additional strength. Although the dimples 560 are illustrated as round recesses within the diaphragm 550, the dimples 560 can have any other suitable size, configuration, and shape.

[0054] With reference to Figures 9A-9B, another container according to the present teachings is illustrated at reference numeral 610 in the as-blown first configuration A. The container 610 is substantially similar to the container 10. Therefore, features in common between the container 610 and the 10 are illustrated using the same reference numbers, but increased by 600. The description of the container 10 also applies to the container 610, at least with respect to the common features. Unlike the container 10, the container 610 includes a diaphragm or inversion ring/radius 650 that is concave relative to the standing surface 654 and an exterior of the base portion 40 when the base portion 40 is in the as-blown position A of Figures 9B, 9C, and 10A (in phantom), for example. The diaphragm or inversion ring/radius 650 is thus without any flat portions or convex portions, which advantageously provides the base portion 640 with a greater ability to absorb internal vacuum prior to the base portion 640 being mechanically inverted to position C of Figure 10B by any suitable inversion tool, such as tools 80A or 80B of Figure 3C. Furthermore, unlike the container 10, the primary hemisphere wall 652 of the container 610 has a radius, and is not a linear upstanding wall.

[0055] The base portion 640 further includes an isolation rib 670. The isolation rib 670 is located at the isolation radius 658 and circumscribes the central push-up portion 42. The isolation rib 670 protrudes outward and allows the geometry of the base portion 640 to flex and absorb internal vacuum prior to the base portion 640 being mechanically inverted to the activated position C of Figure 10B. As illustrated in Figure 10B, the as-blown concave diaphragm or inversion ring/radius 650 at position A transitions to being at least partially convex in activated position C between the transitional radius hinge 656 and the isolation rib 670. This convex configuration in the activated position C helps to prevent the base portion 640 from reverting to position B or position A.

[0056] The base portion 640 includes an inversion height “h” (Figure 9C) between the standing surface 654 and a peak of the inversion radius/ring 650 (such as at the transitional radius hinge 656). The inversion height h controls the amount of vacuum absorbed by the base portion 640. The inversion height h of the base portion 640 is relatively lower than inversion heights of other containers, such as the containers 10, 110, 210, 310, 410, and 510. The relatively short inversion height h of the base portion 640 allows the base portion 640 to absorb more vacuum when moving from position A to position B, and prior to the base portion 640 being mechanically inverted to position C of Figure 10B by any suitable inversion tool, such as tools 80A or 80B.

[0057] The inversion height h can be any suitable height, and can depend on the diameter DD (see Figures 9C and 10A for example) of the diaphragm 650 and the overall size of the container 610. For example, if the container 610 is a 20oz container and the diameter DD of the diaphragm 650 is 64mm, the height h can be 9mm, and thus the ratio of the diaphragm diameter DD to the height h can be 7.11mm. If the container 610 is a 20oz container and the diameter DD of the diaphragm 650 is 67.22mm, the height h can range from 8mm to 11.79mm, and thus the ratio of the diaphragm diameter DD to the height h can be from 5.7mm to 8.4mm. If the container 610 is a 20oz container and the diameter DD of the diaphragm 650 is 66.67mm, the height h can be 14.42mm and the ratio of the diaphragm diameter DD to the height h can be 4.623mm. If the container 610 is a 28oz or 32oz container and the diameter DD of the diaphragm 650 is 80.5mm, the height h can be 12.39mm or 13.62mm, resulting in a ratio of the diaphragm diameter DD to the height h being 6.49mm and 5.91mm respectively. If the container 610 is a 12oz container and the diameter DD of the diaphragm 650 is 52.68mm, the ratio of the diaphragm diameter DD to the height h can be 6.175mm. As the diaphragm diameter (DD)/height (h) ratio is increased, the vacuum absorption capability of the base 640 is advantageously increased. An exemplary diaphragm diameter (DD)/height (h) ratio is greater than about 6mm. Figure 11 illustrates exemplary diaphragm diameter (DD)/height (h) ratios for various containers according to the present teachings.

[0058] The vacuum absorption of the base 640 (or any other suitable base) is the ease in which the diaphragm 650 is able to move to absorb initial vacuum as the diaphragm 650 moves from the first configuration A to the second configuration B, and thus prior to being subject to mechanical activation to move the diaphragm to the third configuration C. As the height h increases, the radius of the transitional radius hinge 656 typically decreases. The smaller the radius at 656, the more force (vacuum) that is required to move the base 640 from the first configuration A to the second configuration B, as compared to if the radius at 656 is larger. Therefore, as the height "h" increases, the base 640 will absorb less vacuum initially. As the "h" decreases the radius at 656 increases and the base 640 will move at lower vacuum forces absorbing more vacuum initially. In the second configuration B, when the base 640 is mechanically activated, the smaller height "h" will have a smaller vacuum absorbing capacity overall. For example, at a height h of 11.79mm, the base 640 can absorb approximately 20.5ml of volume. At a height h of 9.6mm, the base 640 can absorb approximately 15.7ml of volume. The larger the volume that the base 640 ultimately displaces, the lower the final residual vacuum in the container 610. But the initial force required to move the base 640 with the height h of 9.6mm to relieve the vacuum prior to mechanical activation (mechanically moving the base 640 to configuration C) will be substantially less than the base 640 with the height h of 11.79mm. Wall thickness of the container base 640 may change based on container size. As wall thickness decreases, the capacity to absorb vacuum increases.

[0059] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS

What is claimed is:

1. A blow-molded container comprising:

a finish (16) defining an opening at a first end (12) of the container (10, 110, 210, 310, 410, 510, 610) that provides access to an internal volume (22) defined by the container (10); and

a base portion (40, 640) at a second end (14) of the container (10, 110, 210, 310, 410, 510, 610) opposite to the first end (12), the base portion (40, 640) including:

an external standing surface (54, 254, 354, 454, 654) of the container (10, 110, 210, 310, 410, 510, 610) at an outer diameter of the base portion (40, 640);

a central push-up portion (42, 242, 342, 442) at a center of the base portion (40, 640), a longitudinal axis of the container (10, 110, 210, 310, 410, 510, 610) extending through the central push-up portion (42, 242, 342, 442);

an upstanding wall (52) extending from the external standing surface (54, 254, 354, 454, 654) towards the first end (12) of the container (10, 110, 210, 310, 410, 510, 610) and angled inward away from a sidewall (30) of the container (10, 110, 210, 310, 410, 510, 610) and towards the central push-up portion (42, 242, 342, 442);

a diaphragm (50, 150, 250, 350, 450, 550, 650) extending between the upstanding wall (52) and the central push-up portion (42, 242, 342, 442); and

a hinge (56, 256, 356, 456, 656) where the diaphragm (50, 150, 250, 350, 450, 550, 650) mates with the upstanding wall (52);

wherein:

the diaphragm (50, 150, 250, 350, 450, 550, 650) is configured for being drawn from an as-blown first configuration towards the first end (12) of the container (10, 110, 210, 310, 410, 510, 610) to a second configuration, in response to an internal vacuum within the container (10, 110, 210, 310, 410, 510, 610) caused by hot-filling the container (10, 110, 210, 310, 410, 510, 610); and the diaphragm (50, 150, 250, 350, 450, 550, 650) is configured for moving from the second configuration to an activated third configuration in response to an external actuation force applied to the diaphragm (50, 150, 250, 350, 450, 550, 650) when being in the second configuration, the diaphragm (50, 150, 250, 350, 450, 550, 650) being closer to the first end (12) of the container (10, 110, 210, 310, 410, 510, 610) in the activated third configuration as compared to the second configuration;

characterized in that at least a portion of the upstanding wall (52) is arranged movably towards the sidewall (30) and subsequently away from the sidewall (30) as the base portion (40, 640) moves from the second configuration to the third configuration.

2. The blow-molded container of Claim 1, wherein the diaphragm is concave relative to the external standing surface (54, 254, 354, 456, 656) of the container (10, 110, 210, 310, 410, 510, 610) in the as-blown first configuration, and the diaphragm (50, 150, 250, 350, 450, 550, 650) is at least partially convex relative to the external standing surface (54, 254, 354, 454, 654) of the container (10, 110, 210, 310, 410, 510, 610) in the activated third configuration.

3. The blow-molded container of Claim 1, wherein he diaphragm (50, 150, 250, 350, 450, 550, 650) is convex relative to the external standing surface (54, 254, 354, 454, 654) of the container (10, 110, 210, 310, 410, 510, 610) in the as-blown first configuration, and the diaphragm (50, 150, 250, 350, 450, 550, 650) is concave relative to the external standing surface (54, 254, 354, 454, 654) of the container (10, 110, 210, 310, 410, 510, 610) in the activated third configuration.

4. The blow-molded container of Claim 1, further comprising an isolation rib (670) circumscribing the central push-up portion (42, 242, 342, 442) and protruding outward from the base portion (40, 640) away from the first end of the container (10, 110, 210, 310, 410, 510, 610).

5. The blow-molded container of Claim 1, wherein the hinge is stationary as the central push-up portion (42, 242, 342, 442) and the diaphragm (50, 150, 250, 350, 450, 550, 650) move towards the first end of the container (10, 110, 210, 310, 410, 510, 610).

6. The blow-molded container of Claim 1, wherein the hinge and the upstanding wall (52) are concave relative to the second end of the container (10, 110, 210, 310, 410, 510, 610) in the as-blown first configuration.

7. The blow-molded container of Claim 1, wherein the diaphragm (50, 150, 250, 350, 450, 550, 650) changes shape as the diaphragm (50, 150, 250, 350, 450, 550, 650) moves towards the first end of the container (10, 110, 210, 310, 410, 510, 610).

8. The blow-molded container of Claim 1, wherein the upstanding wall (52), in the as-blown first configuration, is angled greater than about 20° away from the sidewall (30) of the container (10, 110, 210, 310, 410, 510, 610) towards the central push-up portion (42, 242, 342, 442).

9. The blow-molded container of Claim 1, wherein the container has a ratio of diaphragm diameter to inversion height (h) of the base portion (40, 640) defined between the external standing surface (54, 254, 354, 454, 654) and a peak of the diaphragm (50, 150, 250, 350, 450, 550, 650) in the as-blown first configuration of greater than about 6:1.

10. The blow-molded container of Claim 1, wherein the diaphragm (150, 350, 550) includes dimples (160, 360, 560) recessed therein relative to the second end of the container (10, 110, 210, 310, 410, 510, 610).

11. he blow-molded container of Claim 1, wherein the diaphragm (50, 150, 250, 350, 450, 550, 650) continuously curves outward away from the longitudinal axis and the central push-up portion (42, 242, 342, 442) in the as-blown first configuration.

12. The blow-molded container of Claim 1, wherein the diaphragm (50, 150, 250, 350, 450, 550, 650) extends linearly outward away from the longitudinal axis and the central pushup portion (42, 242, 342, 442) in the as-blown first configuration.

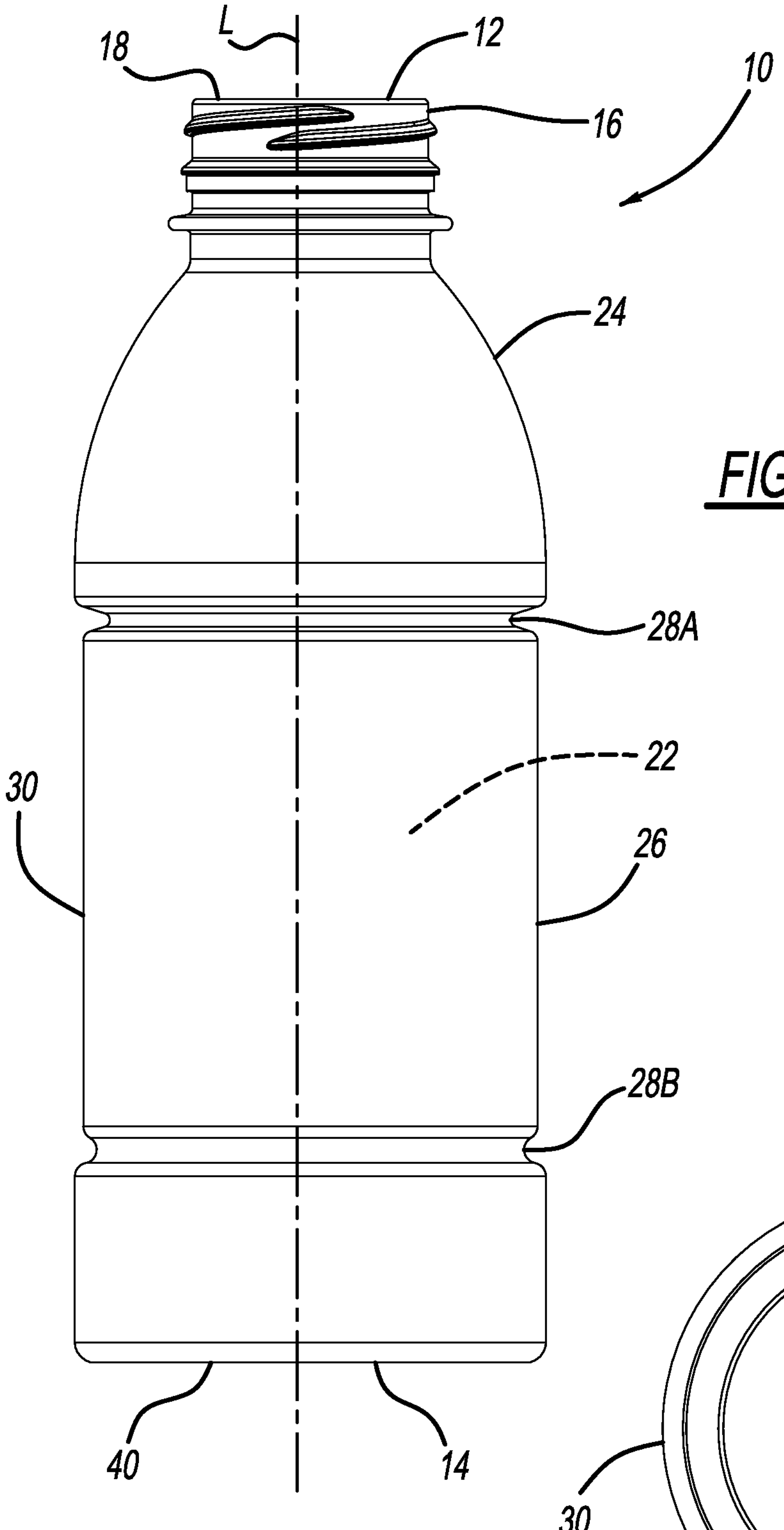


FIG - 1

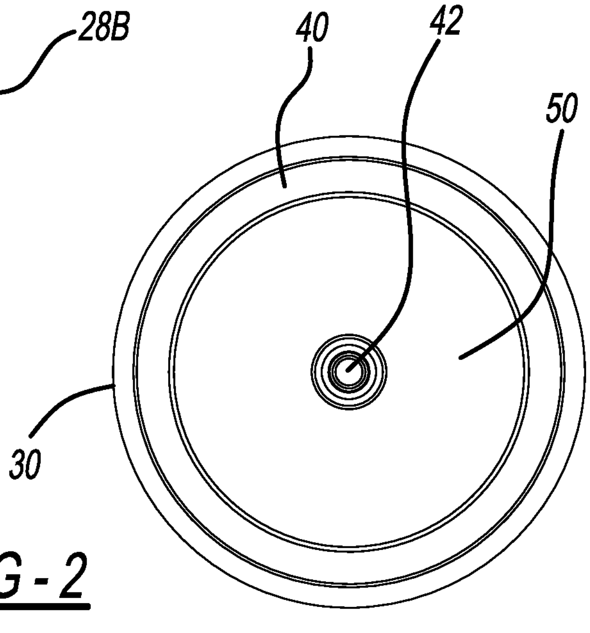


FIG - 2

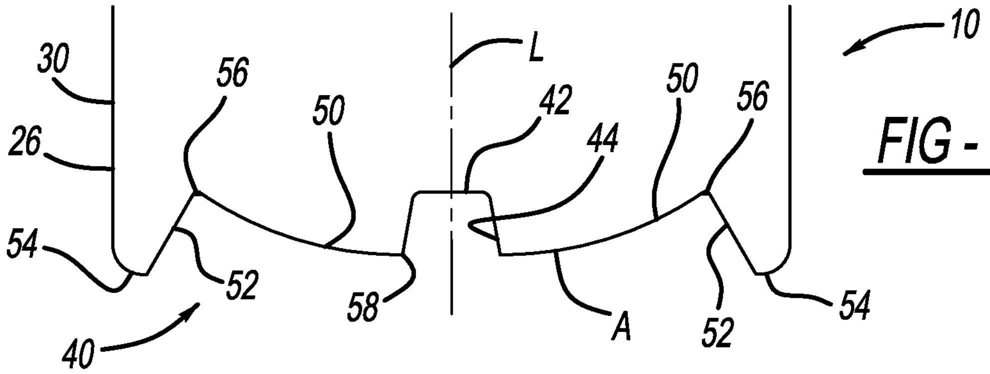


FIG - 3A

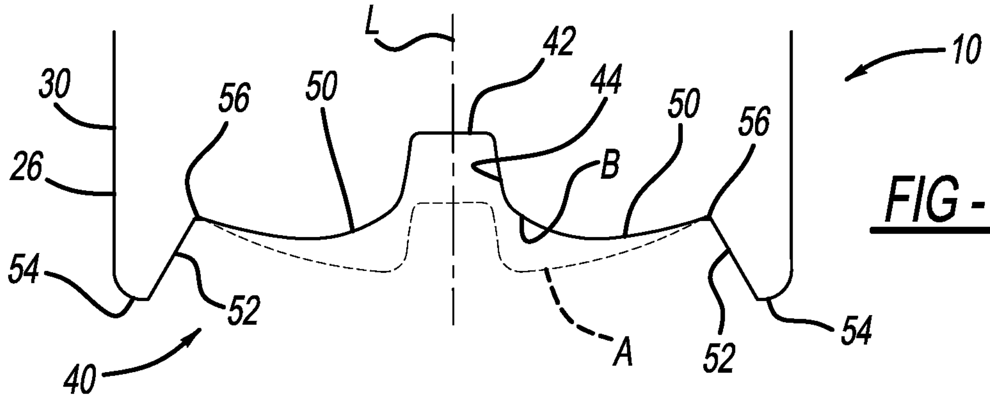


FIG - 3B

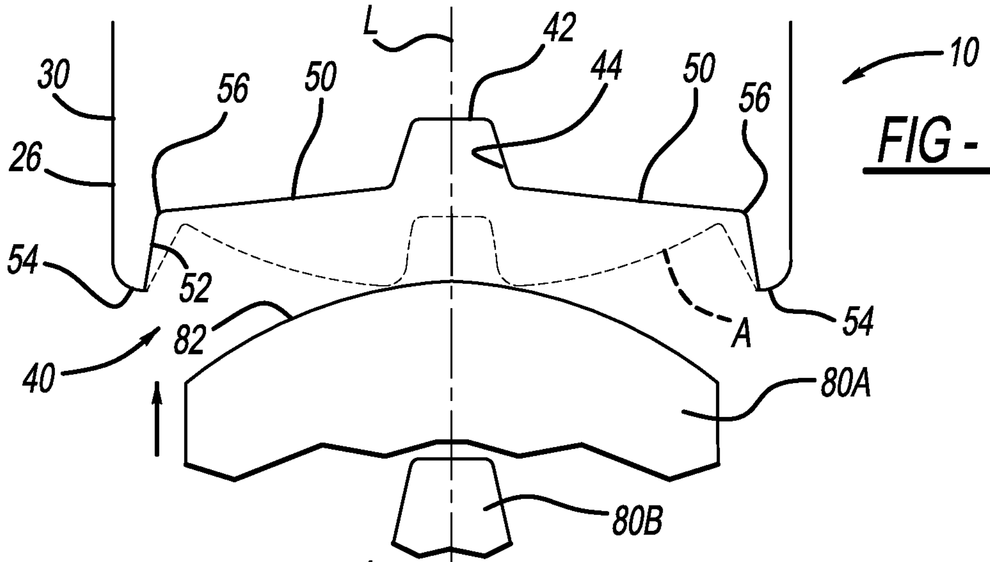


FIG - 3C

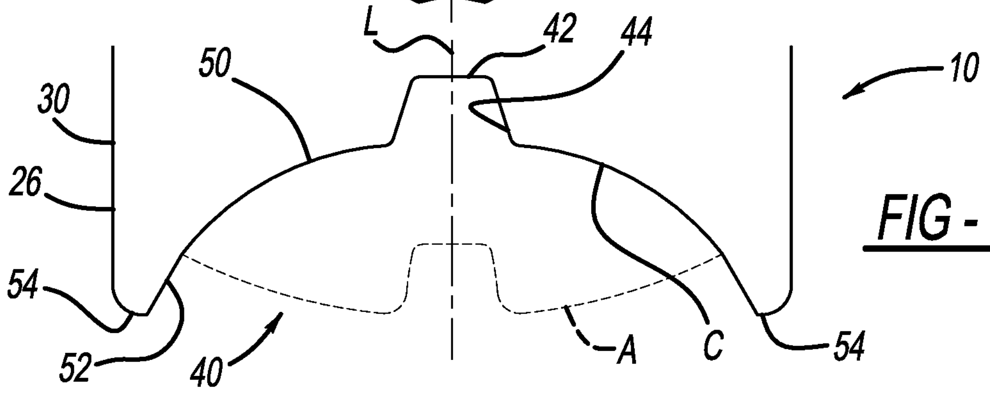
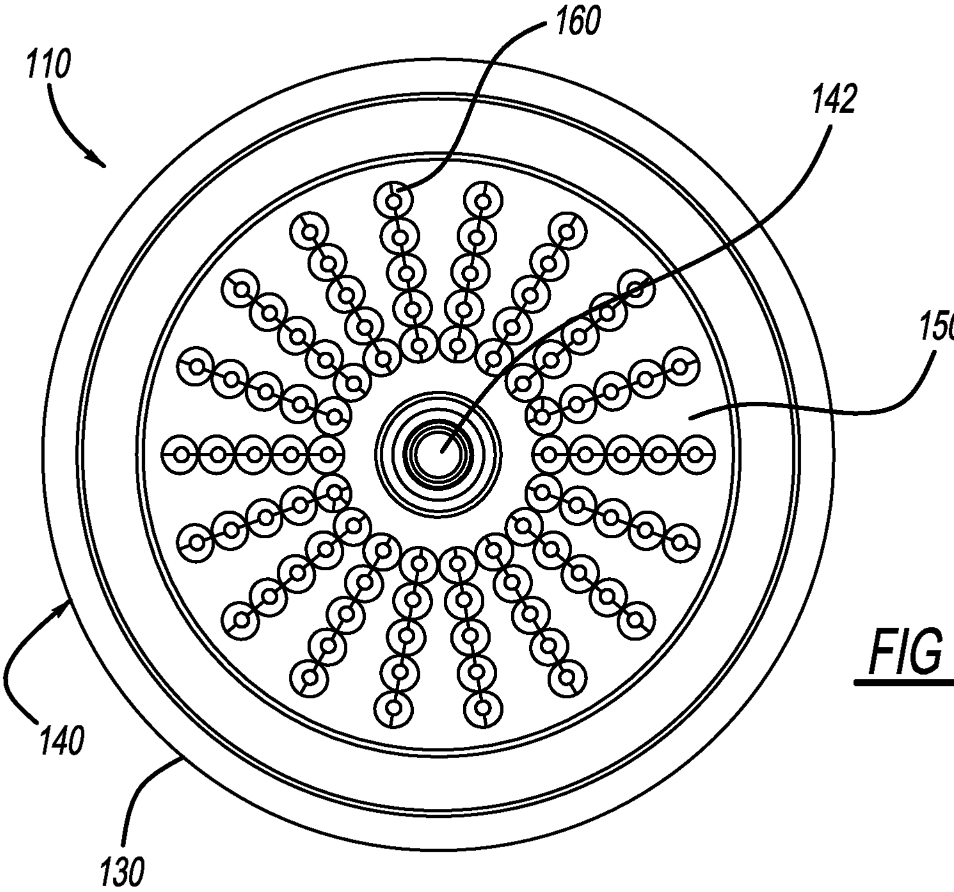


FIG - 3D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110
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130

FIG - 4A

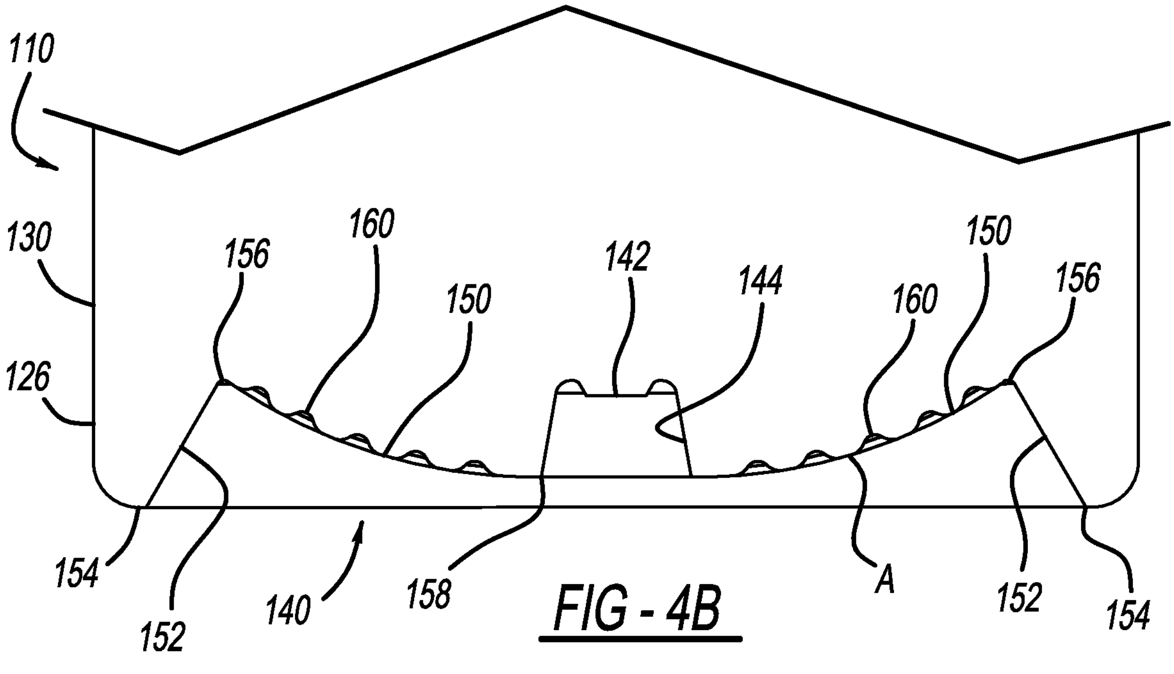
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FIG - 4B

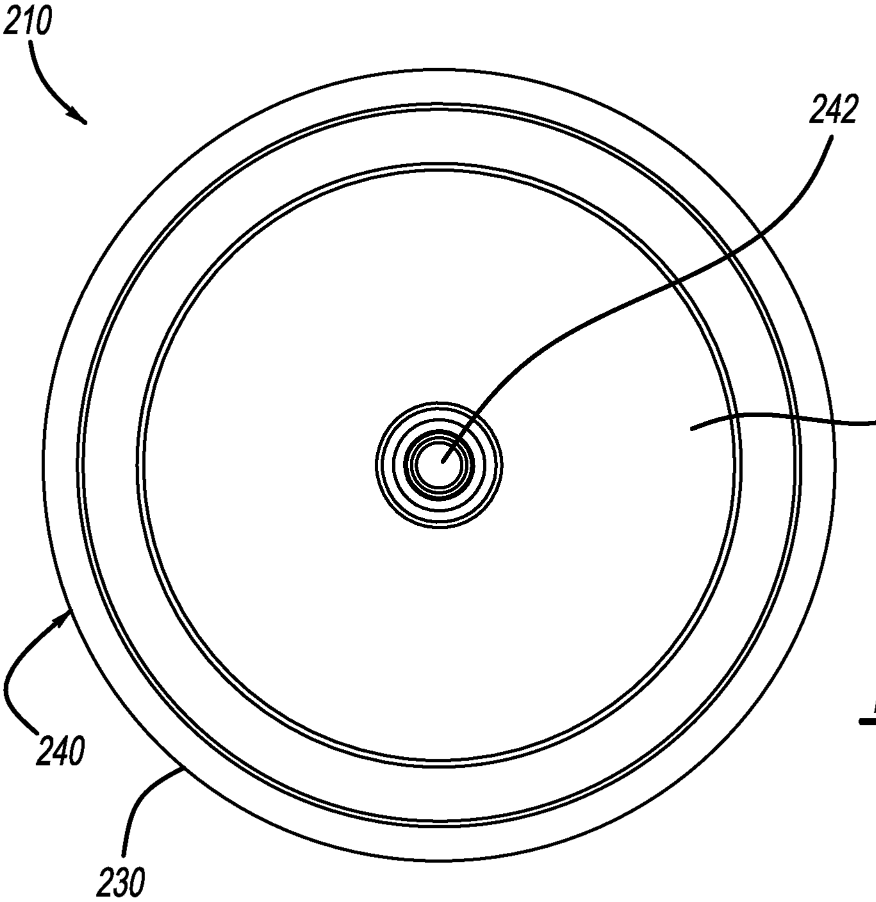
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FIG - 5A

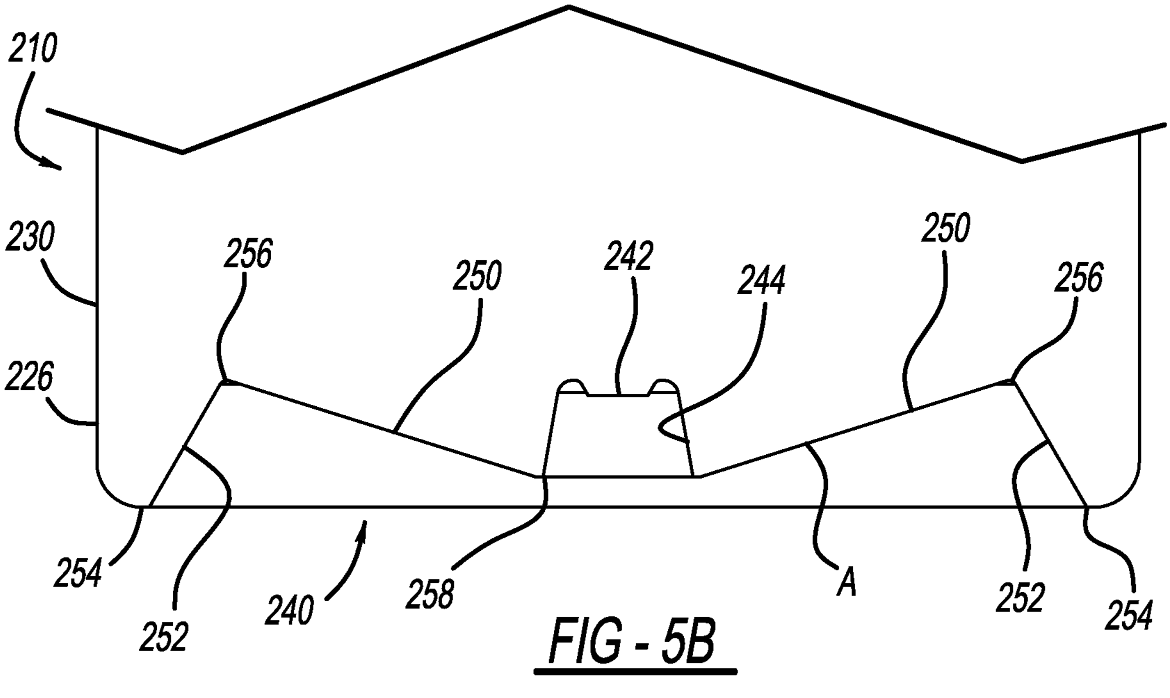
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FIG - 5B

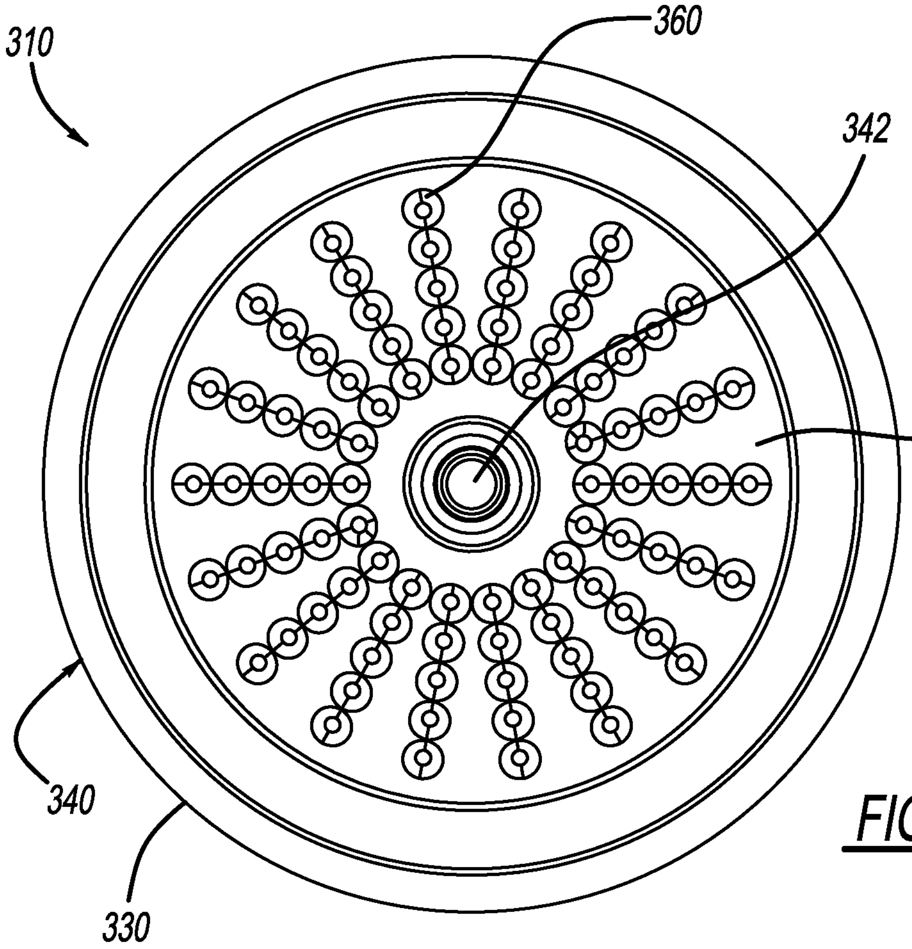
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FIG - 6A

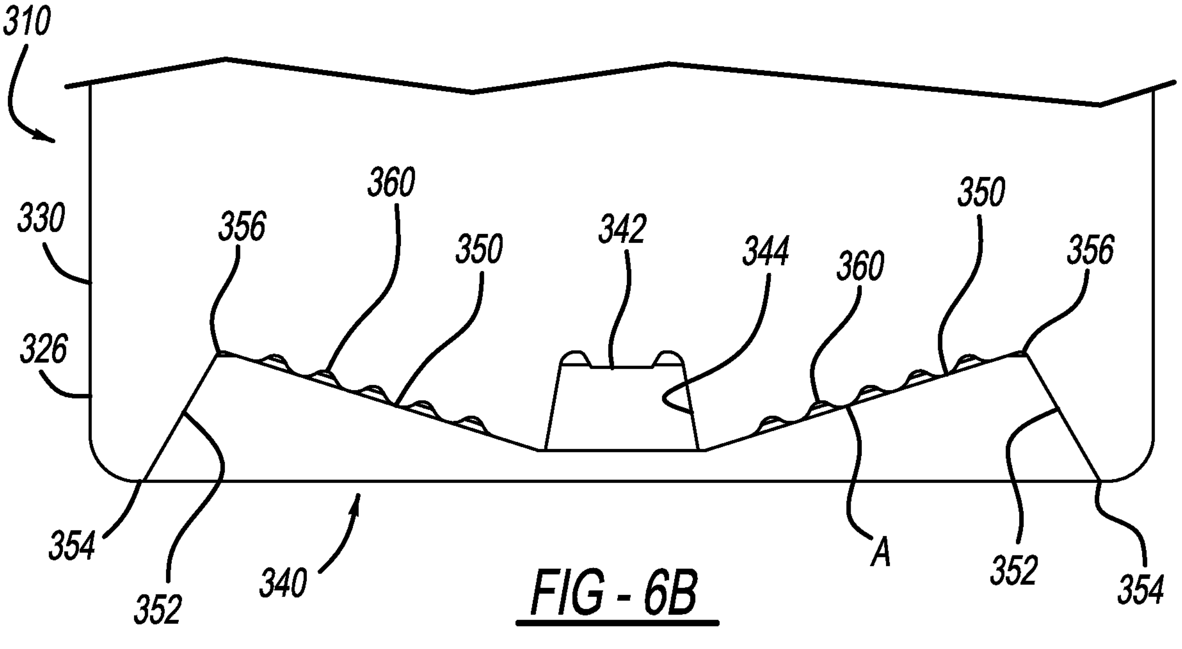
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FIG - 6B

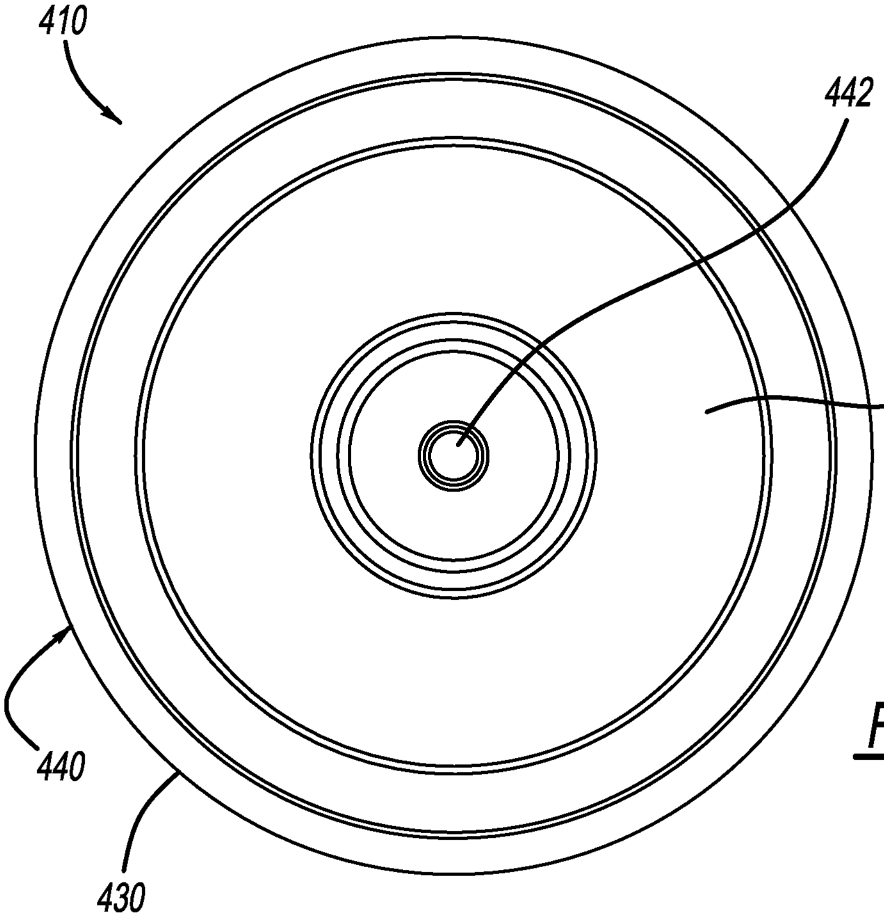
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FIG - 7A

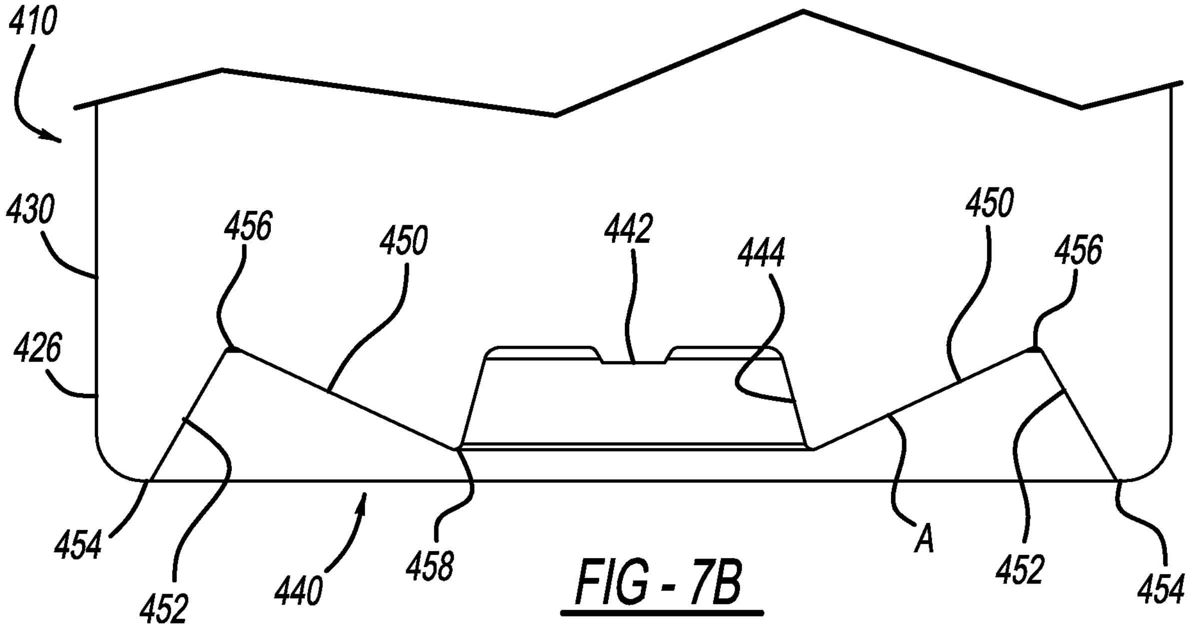
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FIG - 7B

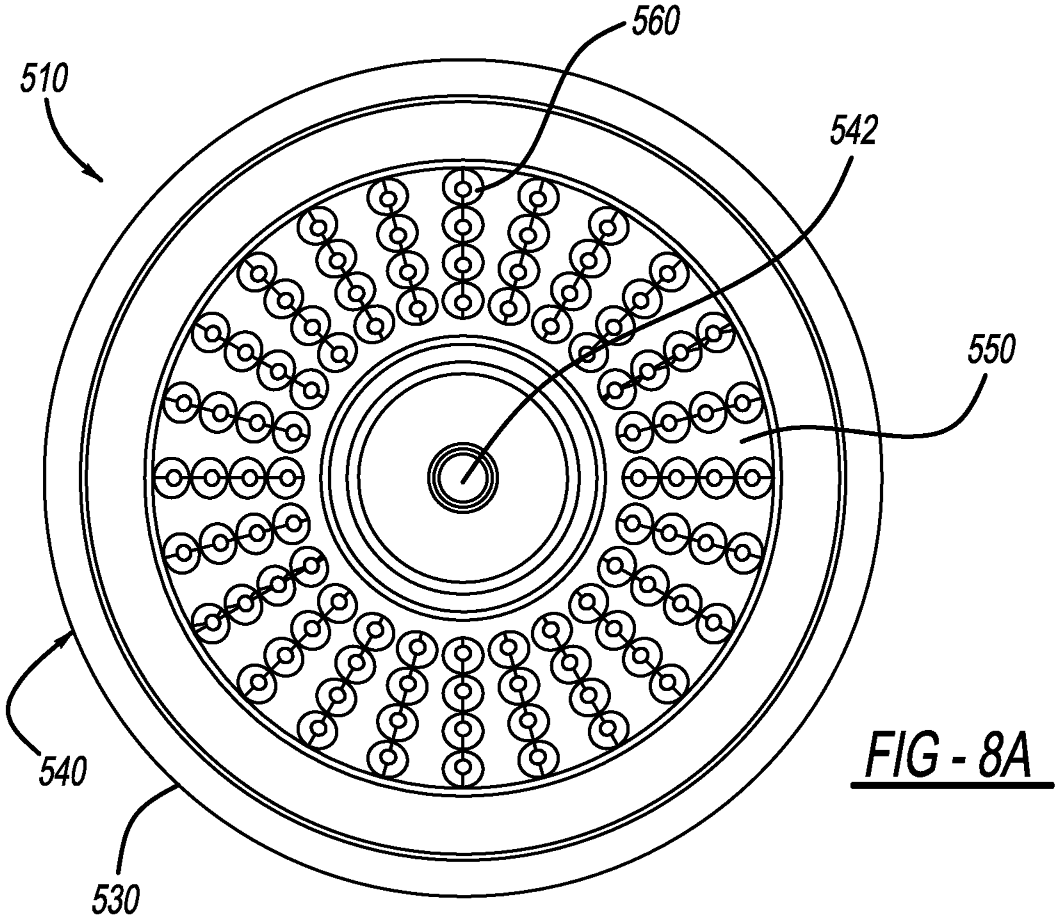
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FIG - 8A

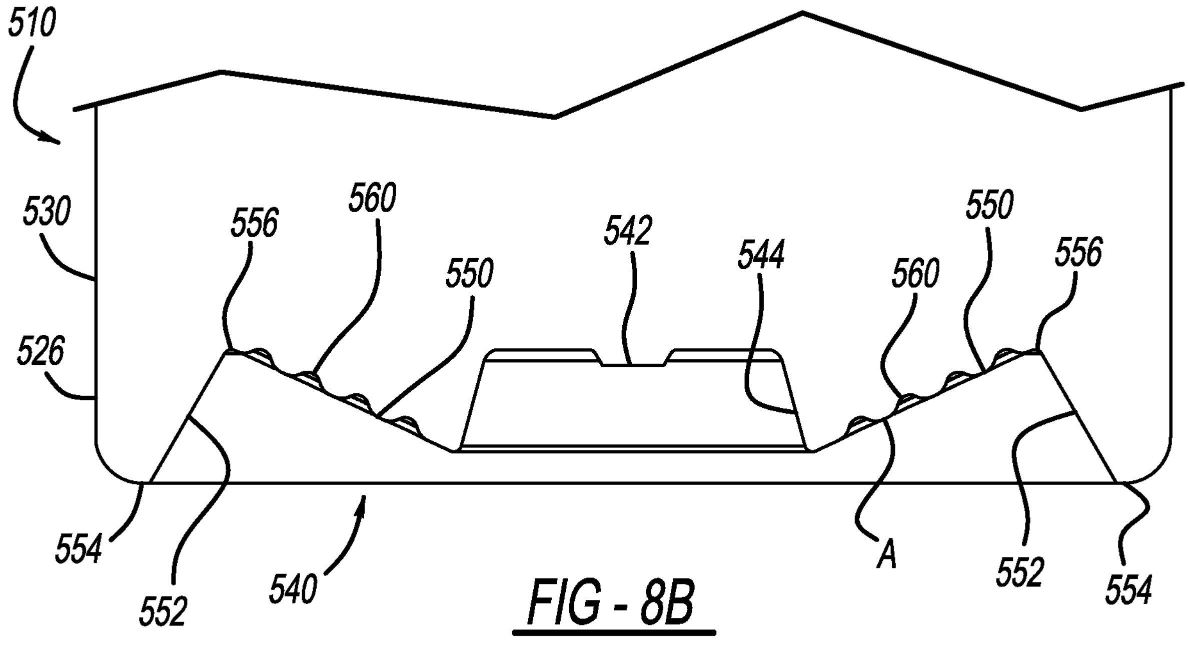
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FIG - 8B

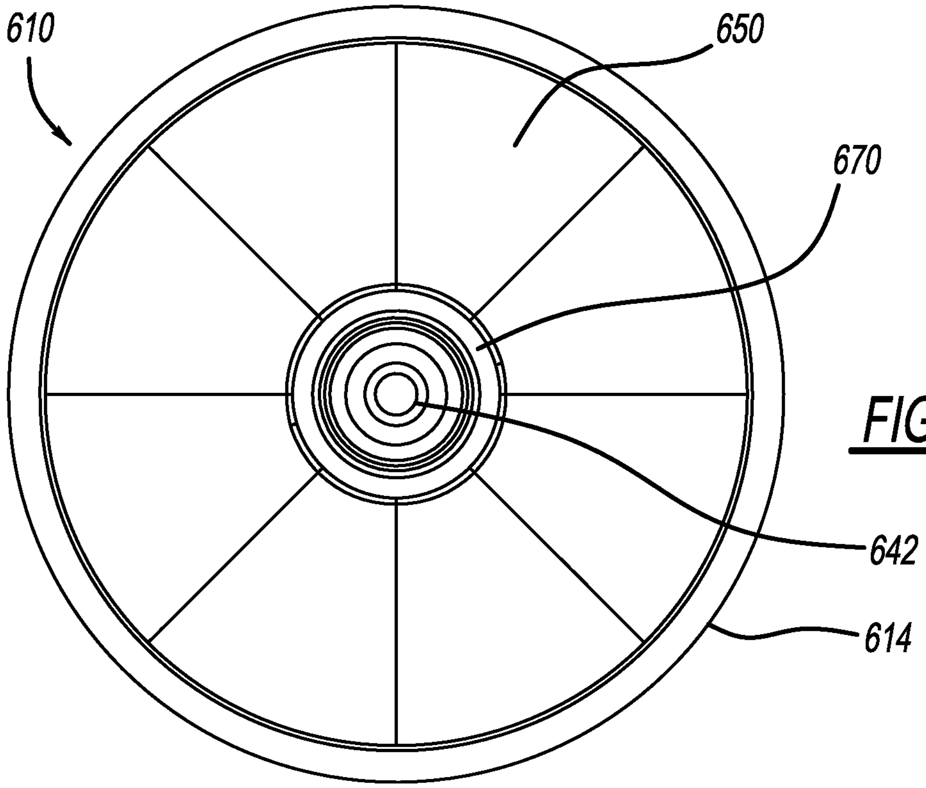


FIG - 9A

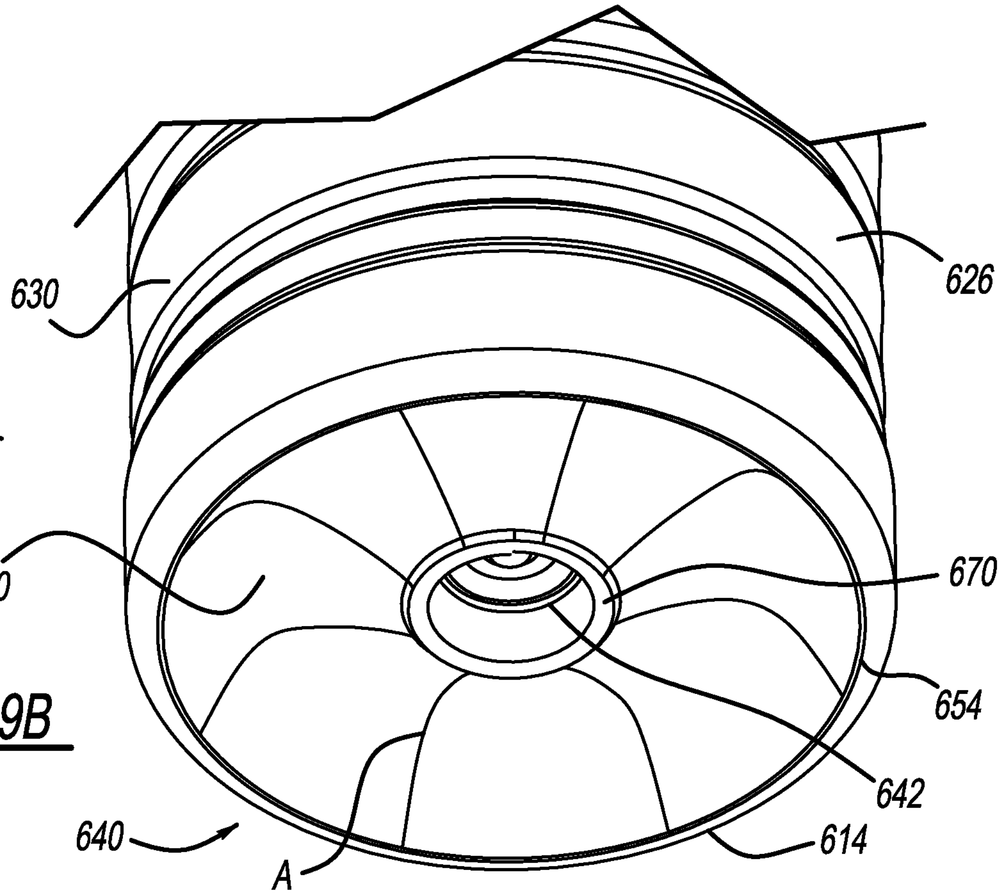


FIG - 9B

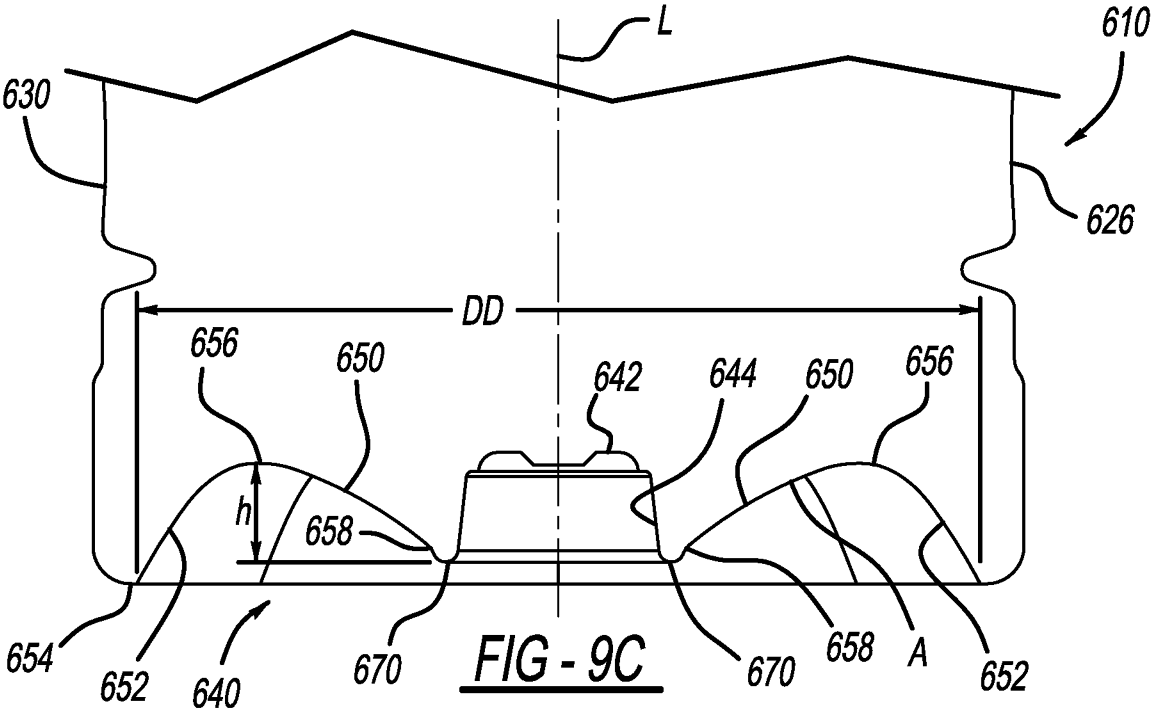


FIG - 9C

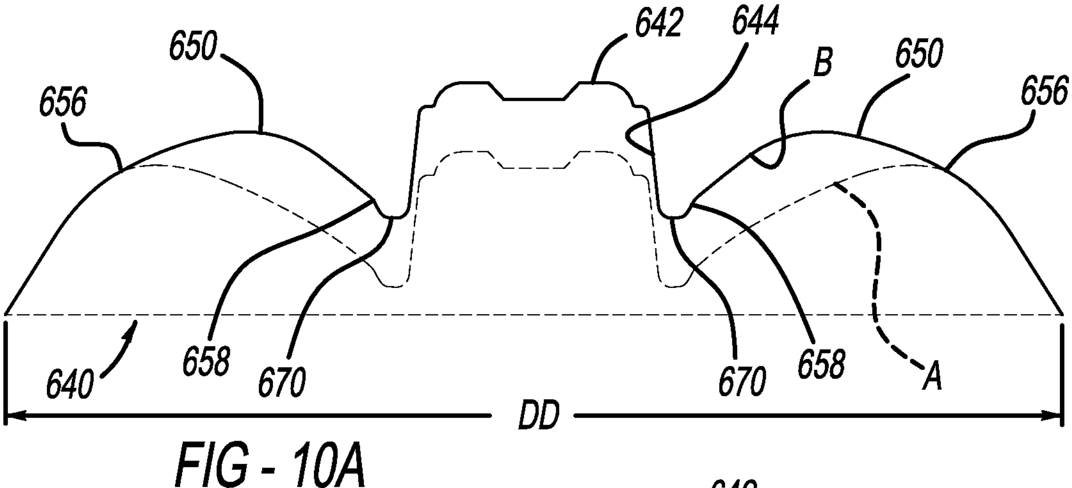


FIG - 10A

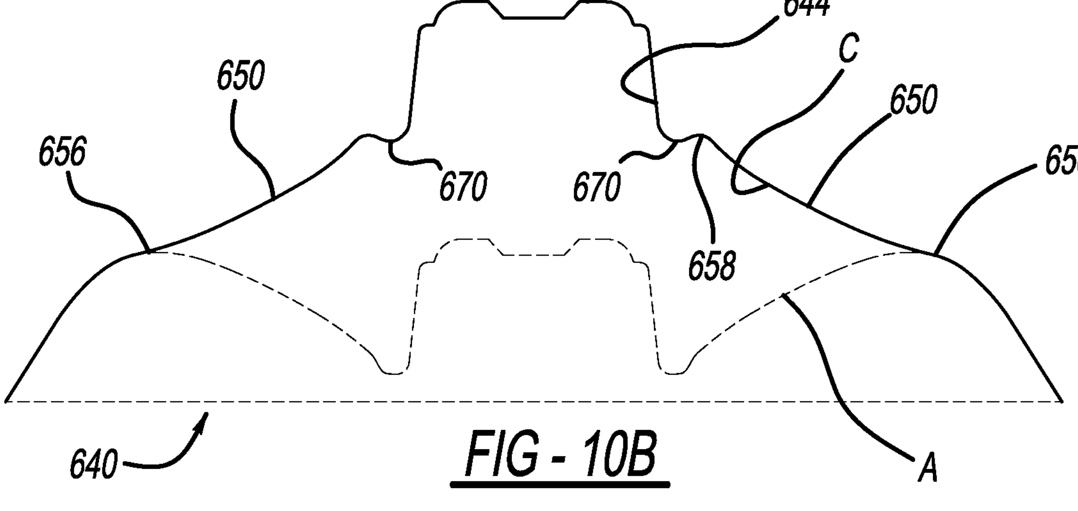
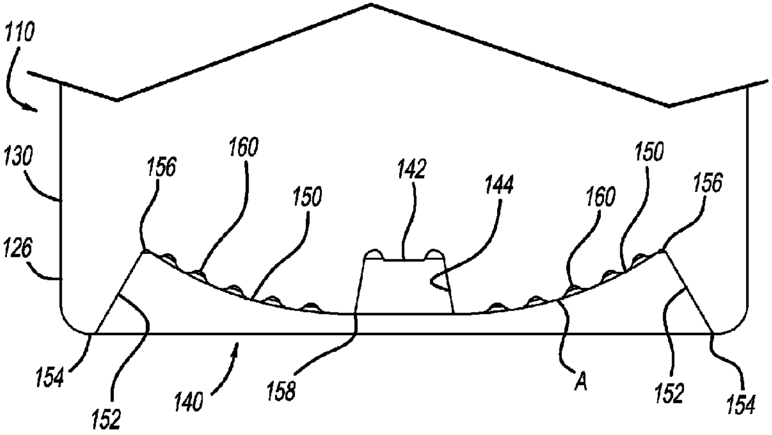


FIG - 10B

Size	h	Diaphragm Dia	DD/h	Optimum Ratio Range for Stage 1 Vacuum Absorbtion
20 FL OZ	14.42	66.67	4.62	
20 FL OZ	11.79	67.22	5.70	
28/32 FL OZ	13.62	80.50	5.91	
12 FL OZ	8.53	52.68	6.18	
20 FL OZ	10.80	67.22	6.22	
20 FL OZ	10.60	67.22	6.34	
20 FL OZ	10.59	67.22	6.35	
20 FL OZ	10.59	67.22	6.35	
20 FL OZ	10.59	67.22	6.35	
20 FL OZ	10.59	67.22	6.35	
20 FL OZ	10.58	67.22	6.35	
20 FL OZ	10.48	67.22	6.41	
28/32 FL OZ	12.39	80.50	6.50	
20 FL OZ	10.20	67.22	6.59	
20 FL OZ	9.81	67.22	6.85	
20 FL OZ	9.60	67.22	7.00	
20 FL OZ	9.60	67.22	7.00	
20 FL OZ	9.60	67.22	7.00	
20 FL OZ	9.60	67.22	7.00	
20 FL OZ	9.00	64.00	7.11	
20 FL OZ	9.00	64.00	7.11	
20 FL OZ	9.00	64.00	7.11	
20 FL OZ	8.00	67.22	8.40	

FIG - 11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