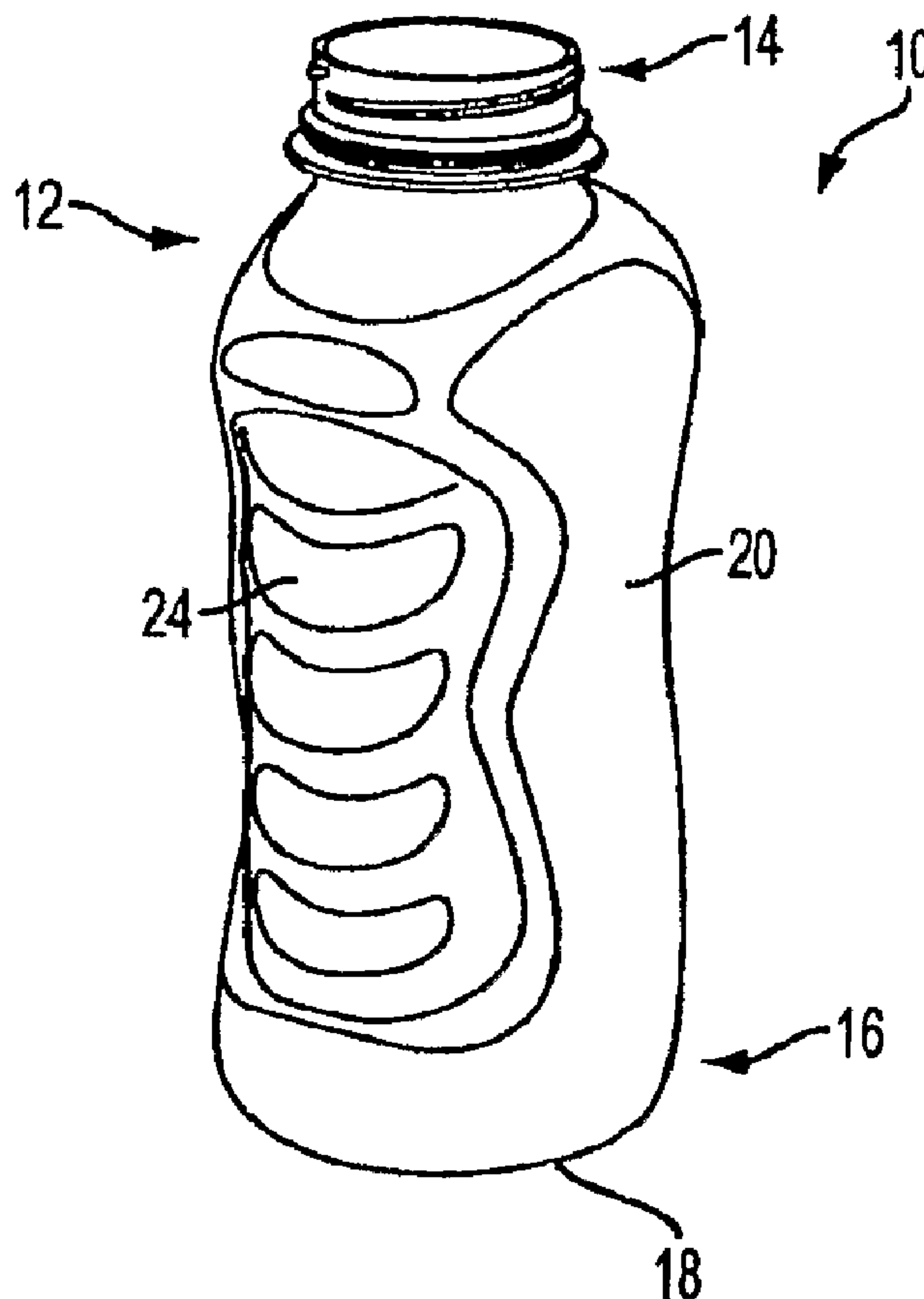




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(54) **Titre : RECIPIENT EN PLASTIQUE RENFORCE PAR PRESSION ET PROCEDE APPARENTE DE TRAITEMENT D'UN RECIPIENT EN PLASTIQUE**
 (54) **Title: PRESSURE REINFORCED PLASTIC CONTAINER AND RELATED METHOD OF PROCESSING A PLASTIC CONTAINER**



(57) **Abrégé/Abstract:**

A plastic container (10) comprises an upper portion (12) including a finish (14) adapted to receive a closure, a lower portion (16) including a base (18), and a sidewall (20) extending between the upper portion and the lower portion. The upper portion, the lower

(57) Abrégé(suite)/Abstract(continued):

portion, and the sidewall define an interior volume for storing liquid contents. The plastic container further comprises a pressure panel (22) located on the container and moveable between an initial position and an activated position. The pressure panel is located in the initial position prior to filling the container, and is moved to the activated position after filling and sealing the container. Moving the pressure panel from the initial position to the activated position reduces the internal volume of the container and creates a positive pressure inside the container. The positive pressure reinforces the sidewall. A method of processing a container is also disclosed.

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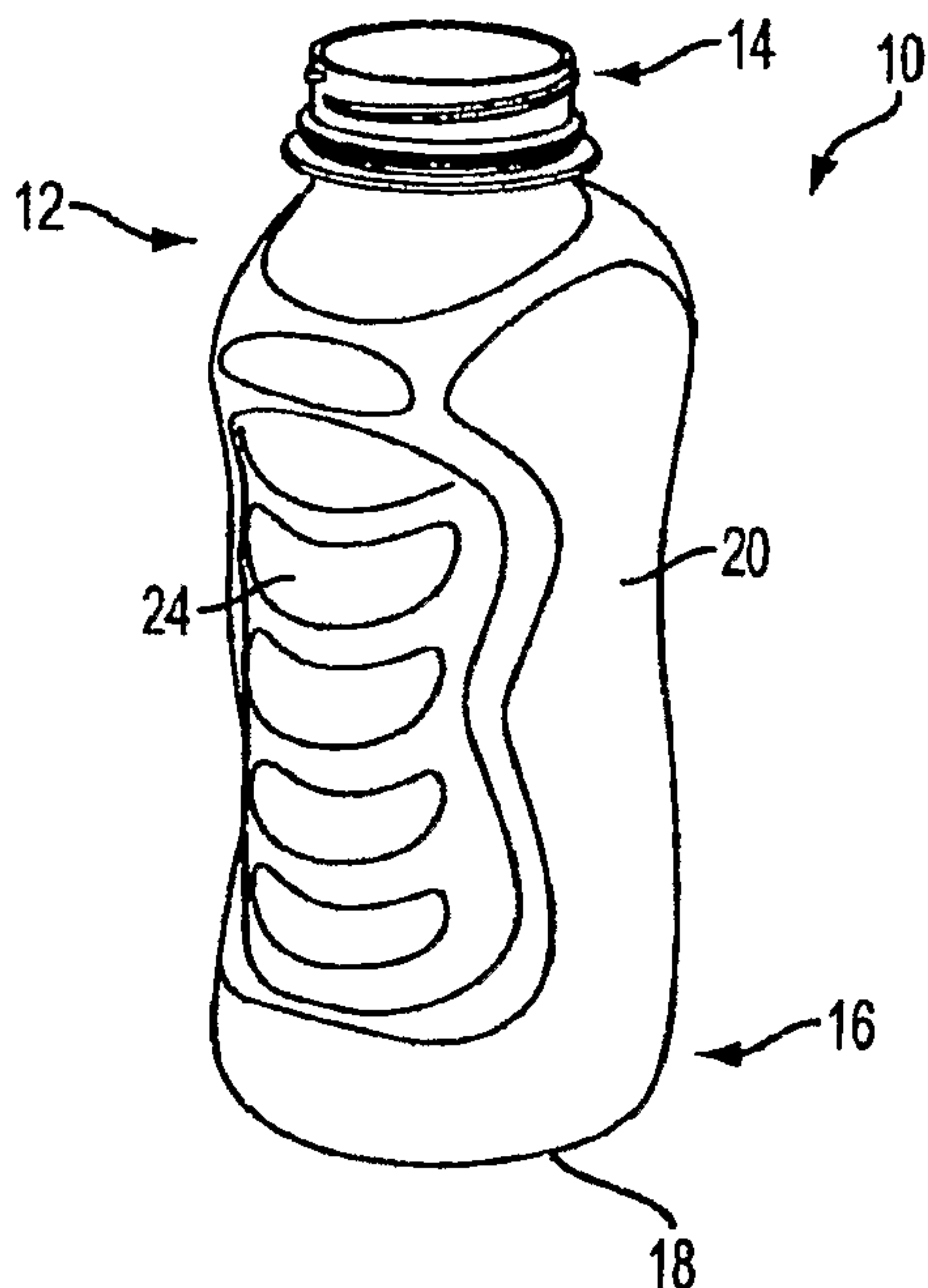
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(54) Title: PRESSURE REINFORCED PLASTIC CONTAINER AND RELATED METHOD OF PROCESSING A PLASTIC CONTAINER



(57) Abstract: A plastic container (10) comprises an upper portion (12) including a finish (14) adapted to receive a closure, a lower portion (16) including a base (18), and a sidewall (20) extending between the upper portion and the lower portion. The upper portion, the lower portion, and the sidewall define an interior volume for storing liquid contents. The plastic container further comprises a pressure panel (22) located on the container and moveable between an initial position and an activated position. The pressure panel is located in the initial position prior to filling the container, and is moved to the activated position after filling and sealing the container. Moving the pressure panel from the initial position to the activated position reduces the internal volume of the container and creates a positive pressure inside the container. The positive pressure reinforces the sidewall. A method of processing a container is also disclosed.

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**PRESSURE REINFORCED PLASTIC CONTAINER AND RELATED
METHOD OF PROCESSING A PLASTIC CONTAINER**

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates generally to plastic containers, and more specifically, to plastic containers in which the contents are pressurized
5 to reinforce the walls of the containers.

Related Art

[0002] In order to achieve the strength characteristics of a glass bottle, conventional lightweight plastic containers are typically provided with rib structures, recessed waists, or other structures that reinforce the sidewall of the
10 container. While known reinforcing structures usually provide the necessary strength, they tend to clutter the sidewall of the container and detract from the desired smooth, sleek appearance of a glass container. In addition, the known reinforcing structures often limit the number of shapes and configurations that are available to bottle designers.

15 [0003] Thus, there remains a need in the art for a relatively lightweight plastic container that has the strength characteristics of a glass container as well as the smooth, sleek appearance of a glass container, and offers increased design opportunities.

BRIEF SUMMARY OF THE INVENTION

[0004] In summary, the present invention is directed to a plastic container having a structure that reduces the internal volume of the container in order to create a positive pressure inside the container. The positive pressure inside the container serves to reinforce the container, thereby reducing the need for reinforcing structures such as ribs in the sidewall. This allows the plastic container to have the approximate strength characteristics of a glass container and at the same time maintain the smooth, sleek appearance of a glass container.

[0005] In one exemplary embodiment, the present invention provides a plastic container comprising an upper portion including a finish adapted to receive a closure, a lower portion including a base, a sidewall extending between the upper portion and the lower portion, wherein the upper portion, the lower portion, and the sidewall define an interior volume for storing liquid contents. A pressure panel is located on the container and is moveable between an initial position and an activated position, wherein the pressure panel is located in the initial position prior to filling the container and is moved to the activated position after filling and sealing the container. Moving the pressure panel from the initial position to the activated position reduces the internal volume of the container and creates a positive pressure inside the container. The positive pressure reinforces the sidewall.

[0006] According to another exemplary embodiment, the present invention provides a plastic container comprising an upper portion having a finish adapted to receive a closure, a lower portion including a base, and a sidewall extending between the upper portion and the lower portion, a substantial portion of the sidewall being free of structural reinforcement elements, and a pressure panel located on the container and moveable between an initial position and an activated position. After the container is filled and sealed, the sidewall is relatively flexible when the pressure panel is in the initial position, and the sidewall becomes relatively stiffer after the pressure panel is moved to the activated position.

[0007] According to yet another exemplary embodiment, the present invention provides a method of processing a container comprising providing a container comprising a sidewall and a pressure panel, the container defining an internal volume, filling the container with a liquid contents, capping the container to

seal the liquid contents inside the container, and moving the pressure panel from an initial position to an activated position in which the pressure panel reduces the internal volume of the container, thereby creating a positive pressure inside the container that reinforces the sidewall.

5 **[0008]** Further objectives and advantages, as well as the structure and function of preferred embodiments, will become apparent from a consideration of the description, drawings, and examples.

BRIEF DESCRIPTION OF THE DRAWINGS

10 **[0009]** The foregoing and other features and advantages of the invention will be apparent from the following, more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings wherein like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

15 **[00010]** FIG. 1 is a perspective view of an exemplary embodiment of a plastic container according to the present invention;

[00011] FIG. 2 is a side view of the plastic container of FIG. 1;

[00012] FIG. 3 is a front view of the plastic container of FIG. 1;

[00013] FIG. 4 is a rear view of the plastic container of FIG. 1;

[00014] FIG. 5 is a bottom view of the plastic container of FIG. 1;

20 **[00015]** FIG. 6 is a cross-sectional view of the plastic container of FIG. 1 taken along line A-A of FIG. 3, shown with a pressure panel in an initial position;

25 **[00016]** FIG. 7 is a cross-sectional view of the plastic container of FIG. 1 taken along line A-A of FIG. 3, shown with the pressure panel in an activated position;

[00017] FIGS. 8A-8C schematically represent the steps of an exemplary method of processing a container according to the present invention;

[00018] FIG. 9 is a pressure verses time graph for a container undergoing a method of processing a container according to the present invention;

30 **[00019]** FIG. 10 is a side view of an alternative embodiment of a plastic container according to the present invention;

[00020] FIG. 11 is a side view of another alternative embodiment of a plastic container according to the present invention;

[00021] FIG. 12 is a side view of another alternative embodiment of a plastic container according to the present invention;

5 [00022] FIG. 13 is a side view of yet another alternative embodiment of a plastic container according to the present invention;

[00023] FIG. 14A is a cross-sectional view of the plastic container of FIG. 13, taken along line B-B of FIG. 13, prior to filling and capping the container; and

10 [00024] FIG. 14B is a cross-sectional view of the plastic container of FIG. 13, taken along line B-B of FIG. 13, after filling, capping, and activating the container.

DETAILED DESCRIPTION OF THE INVENTION

15 [00025] Embodiments of the invention are discussed in detail below. In describing embodiments, specific terminology is employed for the sake of clarity. However, the invention is not intended to be limited to the specific terminology so selected. While specific exemplary embodiments are discussed, it should be understood that this is done for illustration purposes only. A person skilled in the relevant art will recognize that other components and configurations can be used without departing from the spirit and scope of the invention. All references cited herein are incorporated by reference as if each had been individually incorporated.

20 [00026] The present invention relates to a plastic container having one or more structures that allow the internal volume of the container to be reduced after the container has been filled and sealed. Reducing the internal volume of the container may result in an increase in pressure inside the container, for example, by compressing the headspace of the filled container. The pressure increase inside the container can have the effect of strengthening the container, for example, increasing the container's top-load capacity or hoop strength. The pressure increase can also help ward off deformation of the container that may occur over time, for example, as the container loses pressure due to vapor loss. In addition, the reduction in internal volume can be adjusted to compensate for the internal vacuum that often develops in

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hot-filled containers as a result of the cooling of the liquid contents after filling and capping. As a result, plastic containers according to the present invention can be designed with relatively less structural reinforcing elements than prior art containers. For example, plastic containers according to the present invention may have fewer reinforcing elements in the sidewall as compared to prior art designs.

5 [00027] Referring to FIGS. 1-4, an exemplary container embodying the principles of the present invention is shown. Container 10 generally includes an upper portion 12 including a finish 14 adapted to receive a closure, such as a cap or a spout. Container 10 also includes a lower portion 16 including a base 18,
10 which may be adapted to support container 10, for example, in an upright position on a generally smooth surface. A sidewall 20 extends between the upper portion 12 and the lower portion 16. The upper portion 12, lower portion 16, and sidewall 20 generally define an interior volume of container 10, which can store liquid contents, such as juices or other beverages. According to one exemplary
15 embodiment of the invention, the liquid contents can be hot filled, as will be described in more detail below. Container 10 is typically blow molded from a plastic material, such as a thermoplastic polyester resin, for example, PET (polyethylene terephthalate), or polyolefins, such as PP and PE, although other materials and methods of manufacture are possible.

20 [00028] Referring to FIG. 5, base 18, or some other portion of container 10, can include a pressure panel 22. Pressure panel 22 can be activated to reduce the internal volume of the container 10 once it is filled and sealed, thereby creating a positive pressure inside container 10. For example, activating pressure panel 22 can serve to compress the headspace of the container (*i.e.*, the portion of the
25 container that is not occupied by liquid contents). Based on the configuration of the pressure panel 22, the shape of container 10, and/or the thickness of sidewall 20, the positive pressure inside container 10 can be sufficiently large to reinforce container 10, and more specifically, sidewall 20. As a result, and as shown in FIGS. 1-4, sidewall 20 can remain relatively thin and still have at least a
30 substantial portion that is free of known structural reinforcement elements (such as ribs) that were previously considered necessary to strengthen containers, and which can detract from the sleek appearance of containers.

[00029] Referring to FIGS. 1-4, sidewall 20 can have a generally circular cross-section, although other known cross-sections are possible. The portions of the sidewall 20 that are free of structural reinforcement elements may have ornamental features, such as dimples, textures, or etchings. Additionally or alternatively, sidewall 20 can include one or more grip panels, for example, first grip panel 24 and second grip panel 26. It is known in the prior art for grip panels to serve as reinforcement elements, however, this may not be necessary with grip panels 24, 26 if the pressure panel 22 is configured to provide sufficient pressure inside container 10. Accordingly, simplified grip panels (*e.g.*, without stiff rib structures) may be provided that do not serve as reinforcement elements, or that do so to a lesser extent than with prior art containers.

[00030] Referring to FIGS. 5-7, base 18 can include a standing ring 28. Pressure panel 22 can be in the form of an invertible panel that extends from the standing ring 28 to the approximate center of the base 18. In the exemplary embodiment shown, pressure panel 22 is faceted and includes a push-up 30 proximate its center, although other configurations of pressure panel 22 are possible. Standing ring 28 can be used to support container 10, for example on a relatively flat surface, after the pressure panel 22 is activated.

[00031] Pressure panel 22 can be activated by moving it from an initial position (shown in FIG. 6) in which the pressure panel 22 extends outward from container 10, to an activated position (shown in FIG. 7) in which the pressure panel 22 extends inward into the interior volume of the container 10. In the exemplary embodiment shown in FIGS. 5-7, moving pressure panel 22 from the initial position to the activated position effectively reduces the internal volume of container 10. This movement can be performed by an external force applied to container 10, for example, by pneumatic or mechanical means.

[00032] Container 10 can be filled with the pressure panel 22 in the initial position, and then the pressure panel 22 can be moved to the activated position after container 10 is filled and sealed, causing a reduction in internal volume in container 10. This reduction in the internal volume can create a positive pressure inside container 10. For example, the reduction in internal volume can compress the headspace in the container, which in turn will exert

pressure back on the liquid contents and the container walls. It has been found that this positive pressure reinforces container 10, and in particular, stiffens sidewall 20 as compared to before the pressure panel 22 is activated. Thus, the positive pressure created as a result of pressure panel 22 allows plastic container 10 to have a relatively thin sidewall yet have substantial portions that are free of structural reinforcements as compared to prior art containers. One of ordinary skill in the art will appreciate that pressure panel 22 may be located on other areas of container 10 besides base 18, such as sidewall 20. In addition, one of ordinary skill in the art will appreciate that the container can have more than one pressure panel 22, for example, in instances where the container is large and/or where a relatively large positive pressure is required inside the container.

[00033] The size and shape of pressure panel 22 can depend on several factors. For example, it may be determined for a specific container that a certain level of positive pressure is required to provide the desired strength characteristics (e.g., hoop strength and top load capacity). The pressure panel 22 can thus be shaped and configured to reduce the internal volume of the container 10 by an amount that creates the predetermined pressure level. For containers that are filled at ambient temperature, the predetermined amount of pressure (and/or the amount of volume reduction by pressure panel 22) can depend at least on the strength/flexibility of the sidewall, the shape and/or size of the container, the density of the liquid contents, the expected shelf life of the container, and/or the amount of headspace in the container. Another factor to consider may be the amount of pressure loss inside the container that results from vapor loss during storage of the container. Yet another factor may be volume reduction of the liquid contents due to refrigeration during storage. For containers that are "hot filled" (i.e., filled at an elevated temperature), additional factors may need to be considered to compensate for the reduction in volume of the liquid contents that often occurs when the contents cool to ambient temperature (and the accompanying vacuum that may form in the container). These additional factors can include at least the coefficient of thermal expansion of the liquid contents, the magnitude of the temperature changes that the contents undergo, and/or water vapor transmission. By considering all or some of the above factors, the size and

shape of pressure panel 22 can be calculated to achieve predictable and repeatable results. It should be noted that the positive pressure inside the container 10 is not a temporary condition, but rather, should last for at least 60 days after the pressure panel is activated, and preferably, until the container 10 is opened.

5 [00034] Referring to FIGS. 8A-8C, an exemplary method of processing a container according to the present invention is shown. The method can include providing a container 10 (such as described above) having the pressure panel 22 in the initial position, as shown in FIG. 8A. The container 10 can be provided, for example, on an automated conveyor 40 having a depressed region 42 configured
10 to support container 10 when the pressure panel 22 is in the initial, outward position. A dispenser 44 is inserted into the opening in the upper portion 12 of the container 10, and fills the container 10 with liquid contents. For certain liquid contents (*e.g.*, juices), it may be desirable to fill the container 10 with the contents at an elevated temperature (*i.e.*, above ambient temperature). Once the liquid
15 contents reach a desired fill level inside container 10, the dispenser 44 is turned off and removed from container 10. As shown in FIG. 8B, a closure, such as a cap 46, can then be attached to the container's finish 14, for example, by moving the cap 46 into position and screwing it onto the finish 14 with a robotic arm 48. One of ordinary skill in the art will appreciate that various other techniques for filling
20 and sealing the container 10 can alternatively be used.

 [00035] Once the container 10 is filled and sealed, the pressure panel 22 can be activated by moving it to the activated position. For example, as shown in FIG. 8C, a cover 50, arm, or other stationary object may contact cap 46 or other portion of container 10 to immobilize container 10 in the vertical direction. An
25 activation rod 52 can engage pressure panel 22, preferably proximate the push-up 30 (shown in FIG. 7) and move the pressure panel 22 to the activated position (shown in FIG. 7). The displacement of pressure panel 22 by activation rod 52 can be controlled to provide a predetermined amount of positive pressure, which, as discussed above, can depend on various factors such as the strength/flexibility
30 of the sidewall 20, the shape and/or size of the container, etc.

 [00036] In the exemplary embodiment shown in FIG. 8C, the activation rod 52 extends through an aperture 54 in conveyor 40, although other

configurations are possible. In the case where the liquid contents are filled at an elevated temperature, the step of moving the pressure panel 22 to the inverted position can occur after the liquid contents have cooled to room temperature.

5 [00037] As discussed above, moving the pressure panel 22 to the activated position reduces the internal volume of container 10 and creates a positive pressure therein that reinforces the sidewall 20. As also discussed above, the positive pressure inside container 10 can permit at least a substantial portion of sidewall 20 to be free of structural reinforcements, as compared to prior art containers.

10 [00038] FIG. 9 is a graph of the internal pressures experienced by a container undergoing an exemplary hot-fill process according to the present invention, such as a process similar to the one described above in connection with FIGS. 8A-C. When the container is initially hot filled and capped, at time t_0 , a positive pressure exists within the sealed container, as shown on the left side of
15 FIG. 9. After the container has been hot filled and capped, it can be left to cool, for example, to room temperature, at time t_1 . This cooling of the liquid contents usually causes the liquid contents to undergo volume reduction, which can create a vacuum (negative pressure) within the sealed container, as represented by the central portion of FIG 9. This vacuum can cause the container to distort
20 undesirably. As discussed previously, the pressure panel can be configured and dimensioned to reduce the internal volume of the container by an amount sufficient to eliminate the vacuum within the container, and moreover, to produce a predetermined amount of positive pressure inside the container. Thus, as shown on the right side of the graph in FIG. 9, when the pressure panel is activated, at
25 time t_2 , the internal pressure sharply increases until it reaches the predetermined pressure level. From this point on, the pressure preferably remains at or near the predetermined level until the container is opened.

[00039] Referring to FIGS. 10-13, additional containers according to the present invention are shown in side view. Similar to container 10 of FIGS. 1-7,
30 containers 110, 210, and 310 generally include an upper portion 112, 212, 312, 412 including a finish 114, 214, 314, 414 adapted to receive a closure. The containers 110, 210, 310, 410 also include a lower portion 116, 216, 316, 416

including a base 118, 218, 318, 418, and a sidewall 120, 220, 320, 420 extending between the upper portion and lower portion. The upper portion, lower portion, and sidewall generally define an interior volume of the container. Similar to container 10 of FIGS. 1-7, containers 110, 210, 310, and 410 can each include a pressure panel (see pressure panel 422 shown in FIG. 13; the pressure panel is not visible in FIGS. 10-12) that can be activated to reduce the internal volume of the container, as described above.

[00040] Containers according to the present invention may have sidewall profiles that are optimized to compensate for the pressurization imparted by the pressure panel. For example, containers 10, 110, 210, 310, and 410, and particularly the sidewalls 20, 120, 220, 320, 420, may be adapted to expand radially outwardly in order to absorb some of the pressurization. This expansion can increase the amount of pressurization that the container can withstand. This can be advantageous, because the more the container is pressurized, the longer it will take for pressure loss (*e.g.*, due to vapor transmission through the sidewall) to reduce the strengthening effects of the pressurization. The increased pressurization also increases the stacking strength of the container.

[00041] Referring to FIGS. 10-12, it has been found that containers including a vertical sidewall profile that is teardrop shaped or pendant shaped (at least in some vertical cross-sections) are well suited for the above-described radial-outward expansion. Referring to FIG. 4, other vertical sidewall profiles including a S-shaped or exaggerated S-shaped bend may be particularly suited for radial-outward expansion as well, although other configurations are possible.

[00042] Referring to FIGS. 13-14, it has also been found that containers having a sidewall that is fluted (at least prior to filling, capping, and activating the pressure panel) are well suited for the above-described radial-outward expansion. For example, the sidewall 420 shown in FIG. 13 can include a plurality of flutes 460 adapted to expand radially-outwardly under the pressure imparted by the pressure panel 422. In the exemplary embodiment shown, the flutes 460 extend substantially vertically (*i.e.*, substantially parallel to the container's longitudinal axis A), however other orientations of the flutes 460 are possible. The exemplary

embodiment shown includes ten flutes 460 (visible in the cross-sectional view of FIG. 14A), however, other numbers of flutes 460 are possible.

[00043] FIG. 14A is a cross-sectional view of the sidewall 420 prior to activating the pressure panel 422. As previously described, activating the pressure panel 422 creates a positive pressure within the container. This positive pressure can cause the sidewall 420 to expand radially-outwardly in response to the positive pressure, for example, by reducing or eliminating the redundant circumferential length contained in the flutes 460. FIG. 14B is a cross-sectional view of the sidewall 420 after the pressure panel has been activated. As can be seen, the redundant circumferential length previously contained in the flutes 460 has been substantially eliminated, and the sidewall 420 has bulged outward to assume a substantially circular cross-section.

[00044] One of ordinary skill in the art will know that the above-described sidewall shapes (*e.g.*, teardrop, pendant, S-shaped, fluted) are not the only sidewall configurations that can be adapted to expand radially outwardly in order to absorb some of the pressurization created by the pressure panel. Rather, one of ordinary skill in the art will know from the present application that other shapes and configurations can alternatively be used, such as concertina and/or faceted configurations.

[00045] The embodiments illustrated and discussed in this specification are intended only to teach those skilled in the art the best way known to the inventors to make and use the invention. Nothing in this specification should be considered as limiting the scope of the present invention. All examples presented are representative and non-limiting. The above-described embodiments of the invention may be modified or varied, without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the claims and their equivalents, the invention may be practiced otherwise than as specifically described.

WHAT IS CLAIMED IS:

1. A pressure reinforced plastic container having a longitudinal axis, comprising:
 - an upper portion including a finish adapted to receive a closure;
 - a lower portion including a base, the base comprising an outer annular edge and a central cavity;
 - a sidewall extending between the upper portion and the lower portion, wherein the upper portion, the lower portion, and the sidewall define an interior volume for storing liquid contents; and
 - a flexible annular pressure panel located on the container extending between the outer annular edge and the central cavity, and moveable between an initial convex exterior position and an activated concave exterior position, wherein the pressure panel includes a first portion inclined outwardly when the pressure panel is in the initial position, wherein the pressure panel is located in the initial position prior to filling the container and is moved to the activated position after filling and sealing the container;
 - wherein the pressure panel is adapted to receive an external force to move the pressure panel from the initial position to the activated position, to reduce the internal volume of the container and create an increased pressure inside the container, and the increased pressure reinforces the sidewall.
2. The plastic container of claim 1, wherein a headspace exists in the container after filling and sealing, and moving the pressure panel from the initial position to the activated position compresses the headspace.
3. The plastic container of claim 1 wherein the sidewall is adapted to expand radially outwardly due to the increased pressure.
4. The plastic container of claim 3, wherein the sidewall defines a vertical profile that is approximately teardrop shaped or approximately pendant shaped.
5. The plastic container of claim 3, wherein the sidewall comprises a plurality of flutes adapted to expand radially outwardly due to the positive pressure.

6. The plastic container of claim 5, wherein the plastic container defines a longitudinal axis, and the plurality of flutes extend substantially parallel to the longitudinal axis.
7. The plastic container of claim 1, wherein a substantial portion of the sidewall is free of structural reinforcement elements, and the increased pressure is sufficient to support the sidewall.
8. The plastic container of claim 1, wherein the sidewall defines a generally circular cross-section.
9. The plastic container of claim 1, wherein the sidewall includes a grip portion.
10. The plastic container of claim 1, wherein the pressure panel is adapted to reduce a predetermined amount of volume inside the container when in the activated position.
11. The plastic container of claim 10, wherein the predetermined amount of volume reduction is calculated based at least partially on strength characteristics of the sidewall.
12. The plastic container of claim 10, wherein the predetermined amount of volume reduction is calculated based at least partially on coefficient of thermal expansion characteristics of the liquid contents.
13. The plastic container of claim 10, wherein the predetermined amount of volume reduction is calculated based at least partially on the rate of vapor transmission through the sidewall.
14. The plastic container of claim 1, wherein increased pressure inside the container is maintained for at least 60 days after the pressure panel is moved to the activated position.
15. The plastic container of claim 1, wherein the pressure panel extends outward from the container when in the initial position, and the pressure panel extends inward into the interior volume of the container when in the activated position.

16. The plastic container of claim 1, wherein the liquid contents are hot filled.
17. The plastic container of claim 1 wherein the increased pressure is a positive pressure relative to the pressure inside the container prior to sealing.
18. A method of processing a container, comprising:
 - providing a container comprising a sidewall, a base comprising an outer annular edge and a central cavity, and a flexible annular pressure panel located on the container extending between the outer annular edge and the central cavity, the container defining an internal volume;
 - filling the container with a liquid contents;
 - capping the container to seal the liquid contents inside the container; and
 - using an external force to move the pressure panel from an initial convex exterior position to an activated concave exterior position in which the pressure panel reduces the internal volume of the container, thereby creating an increased pressure inside the container that reinforces the sidewall.
19. The method of claim 18, wherein a headspace exists in the container after capping, and the step of moving the pressure panel from the initial position to the activated position compresses the headspace.
20. The method of claim 18, wherein the step of moving the pressure panel from the initial position to the activated position causes the sidewall to expand radially outwardly.
21. The method of claim 18, wherein a substantial portion of the sidewall is free of structural reinforcement elements, and the step of moving the pressure panel to the activated position creates sufficient increased pressure inside the container to support the sidewall.
22. The method of claim 18, wherein the liquid contents are filled at an elevated temperature, and the step of moving the pressure panel to the activated position occurs after the liquid contents have cooled to room temperature.
23. The method of claim 18, wherein the step of moving the pressure panel to the activated position reduces a predetermined amount of volume inside the container.

24. The method of claim 23, wherein the predetermined amount of volume reduction is calculated based at least partially on strength characteristics of the sidewall.
25. The method of claim 23, wherein the predetermined amount of volume reduction is calculated based at least partially on coefficient of thermal expansion characteristics of the liquid contents.
26. The method of claim 23, wherein the predetermined amount of volume reduction is calculated based at least partially on the rate of vapor transmission through the sidewall.
27. The method of claim 23, wherein increased pressure inside the container is maintained for at least 60 days after the pressure panel is moved to the activated position.
28. A plastic container, comprising:
an upper portion having a finish adapted to receive a closure;
a lower portion including a base; and
a sidewall extending between the upper portion and the lower portion, a substantial portion of the sidewall being free of structural reinforcement elements;
and
a pressure panel located on the container and moveable between an initial position and an activated position, wherein after the container is filled and sealed, the sidewall is relatively flexible when the pressure panel is in the initial position, and the sidewall becomes relatively stiffer after the pressure panel is moved to the activated position; wherein the pressure panel is moved to the activated position by an external force applied to the container.
29. The plastic container of claim 28, wherein the container defines an internal volume, and the pressure panel is adapted to reduce a predetermined amount of internal volume when in the activated position, thereby creating an increased pressure inside the container.
30. The plastic container of claim 29, wherein the predetermined amount of volume reduction is calculated based at least partially on the relative flexibility of the sidewall when the pressure panel is in the initial position.

31. The plastic container of claim 29, wherein the container is adapted to store liquid contents, and the predetermined amount of volume reduction is calculated based at least partially on coefficient of thermal expansion characteristics of the liquid contents.
32. The plastic container of claim 29, wherein the predetermined amount of volume reduction is calculated based at least partially on the rate of vapor transmission through the sidewall.
33. The plastic container of claim 29, wherein increased pressure inside the container is maintained for at least 60 days after the pressure panel is moved to the activated position.
34. The plastic container of claim 28, wherein the sidewall defines a generally circular cross-section.
35. The plastic container of claim 28, wherein the sidewall includes a grip portion.
36. The plastic container of claim 28, wherein the pressure panel extends outward from the container when in the initial position, and the pressure panel extends inward into container when in the activated position.
37. The plastic container of claim 28, wherein the container is adapted to store liquid contents, and the liquid contents are hot filled.
38. The plastic container of claim 28, wherein the sidewall is adapted to expand radially outwardly due to the increased pressure.
39. The plastic container of claim 38, wherein the sidewall defines a vertical profile that is approximately teardrop shaped or approximately pendant shaped.
40. The plastic container of claim 38, wherein the sidewall comprises a plurality of flutes adapted to expand radially outwardly due to the increased pressure.
41. The plastic container of claim 40, wherein the plastic container defines a longitudinal axis, and the plurality of flutes extend substantially parallel to the longitudinal axis.

42. The plastic container of claim 28, wherein the pressure panel is located in the base.

43. A system for processing a pre-formed plastic container filled with a hot product, the container having a longitudinal axis, the system comprising:

hot filling means for filling a rigid container body of the pre-formed plastic container with the hot product in a production line, the rigid container body having a surface surrounding an interior of the rigid container body and having a closed base comprising a standing surface and a centrally located push-up portion configured to receive a mechanical device, the base also having a pressure panel that is invertible from an outwardly inclined position to an inwardly inclined position, the pressure panel extending between the standing surface and the push-up, and wherein the pressure panel includes a portion inclined outwardly at an angle of greater than 10 degrees relative to a plane orthogonal to the longitudinal axis when in the outwardly inclined position,

means for capping a neck of the filled rigid container body with a cap in the next operation of the production line;

means for conveying through the production line the pre-formed plastic container having the pressure panel in the outward position;

means for cooling the rigid container body of the pre-formed plastic container filled with the hot product; and

means for pushing the pressure panel from the outwardly inclined position of the cooled rigid container body into the inwardly inclined position within the interior of the rigid container.

44. The system for processing a pre-formed plastic container according to claim 43, wherein, when the rigid container body is cooled by said means for cooling, the cooling produces a vacuum within the rigid container body, and substantially all of the vacuum is taken up by the pushing of the pressure panel.

45. The system for processing a pre-formed plastic container according to claim 43, further comprising means for blow-molding a parison to form the rigid container body, when the rigid container body has the neck, a shoulder area, the base, and a side surface surrounding the interior of the rigid container body, and the base includes an instep connected by a hinge structure to the outwardly inclined pressure panel before the filling begins.

46. The system for processing a pre-formed plastic container according to claim 45, wherein the instep is inwardly recessed from the standing surface to such an extent that the entire pressure panel is contained above the standing surface.
47. The system for processing a pre-formed plastic container according to claim 43, wherein the rigid container body with the pressure panel in the outwardly inclined position is conveyed by its neck during the filling and capping.
48. The system for processing a pre-formed plastic container according to claim 43, wherein the means for pushing the pressure panel from the outwardly inclined position to the inwardly inclined position within the cooled rigid container body is configured to position a mechanical rod or punch like device underneath a container.
49. The system for processing a pre-formed plastic container according to claim 43, wherein the rigid container body has a grip portion.
50. The system for processing a pre-formed plastic container according to claim 43, further comprising at least a portion of a sidewall of the container being configured to respond to vacuum pressure prior to the pushing of the pressure panel from the outwardly inclined position to the inwardly inclined position.
51. The system for processing a pre-formed plastic container according to claim 50, wherein the portion of the sidewall configured to respond to vacuum pressure is a vacuum panel.
52. The system for processing a pre-formed plastic container according to claim 51, wherein the vacuum panel takes up a first portion of vacuum pressure during the cooling of the hot product.
53. The system for processing a pre-formed plastic container according to claim 52, wherein the pushing of the pressure panel from the outwardly inclined position to the inwardly inclined position takes up at least a portion of a resultant vacuum caused by the cooling, and the vacuum panel takes up the remainder of the vacuum.
54. The system for processing a pre-formed plastic container according to claim 46, wherein the conveyor means supports the standing surface of the rigid container body.

55. The system for processing a pre-formed plastic container according to claim 50, wherein the portion of the sidewall configured to respond to the vacuum pressure is a grip portion.

56. The system for processing a pre-formed plastic container according to claim 43, wherein the centrally located push-up is recessed inwardly into the container.

57. The system for processing a pre-formed plastic container according to claim 43, wherein:

the means for conveying is configured to convey a plurality of said filled and capped containers;

the system further comprising:

an in-feed apparatus, which includes at least one feed in assembly, and which receives the filled and capped containers from said means for conveying;

and

a rotary apparatus configured to receive the plurality of filled and capped containers after said in feed apparatus, wherein said in feed apparatus is configured to create space between adjacent ones of the filled and capped containers, with said in feed apparatus acting on the plurality of filled and capped containers to create the respective spaces, wherein the space created between adjacent ones of the filled and capped containers is for receipt by said rotary apparatus.

58. The system for processing a pre-formed plastic container according to claim 57, wherein said in feed apparatus further indicates an in feed wheel to receive the filled and capped containers from said feed in assembly and to feed the filled and capped containers to said rotary apparatus.

59. The system for processing a pre-formed plastic container according to claim 57, further comprising an in feed wheel, wherein said in feed apparatus is configured to feed the plurality of filled and capped containers having spaces therebetween to said in feed wheel, and wherein said in feed wheel is configured to feed the filled and capped containers having spaces therebetween to said rotary apparatus.

60. The system of claim 57, wherein said rotary apparatus includes said means for pushing being an actuator apparatus that moves the pressure panel positioned in a lower portion of

each of the filled and capped containers from the outwardly inclined position to the inwardly inclined position, the pressure panel being at or entirely above the standing surface of the filled and capped container when in the outwardly inclined position and being above said standing surface when in the inwardly inclined position, said pressure panel being a vacuum panel.

61. The system of claim 60, further comprising an out-feed wheel, wherein the out feed wheel is configured to receive the plurality of filled and capped containers having vacuum panels in the inwardly inclined position.

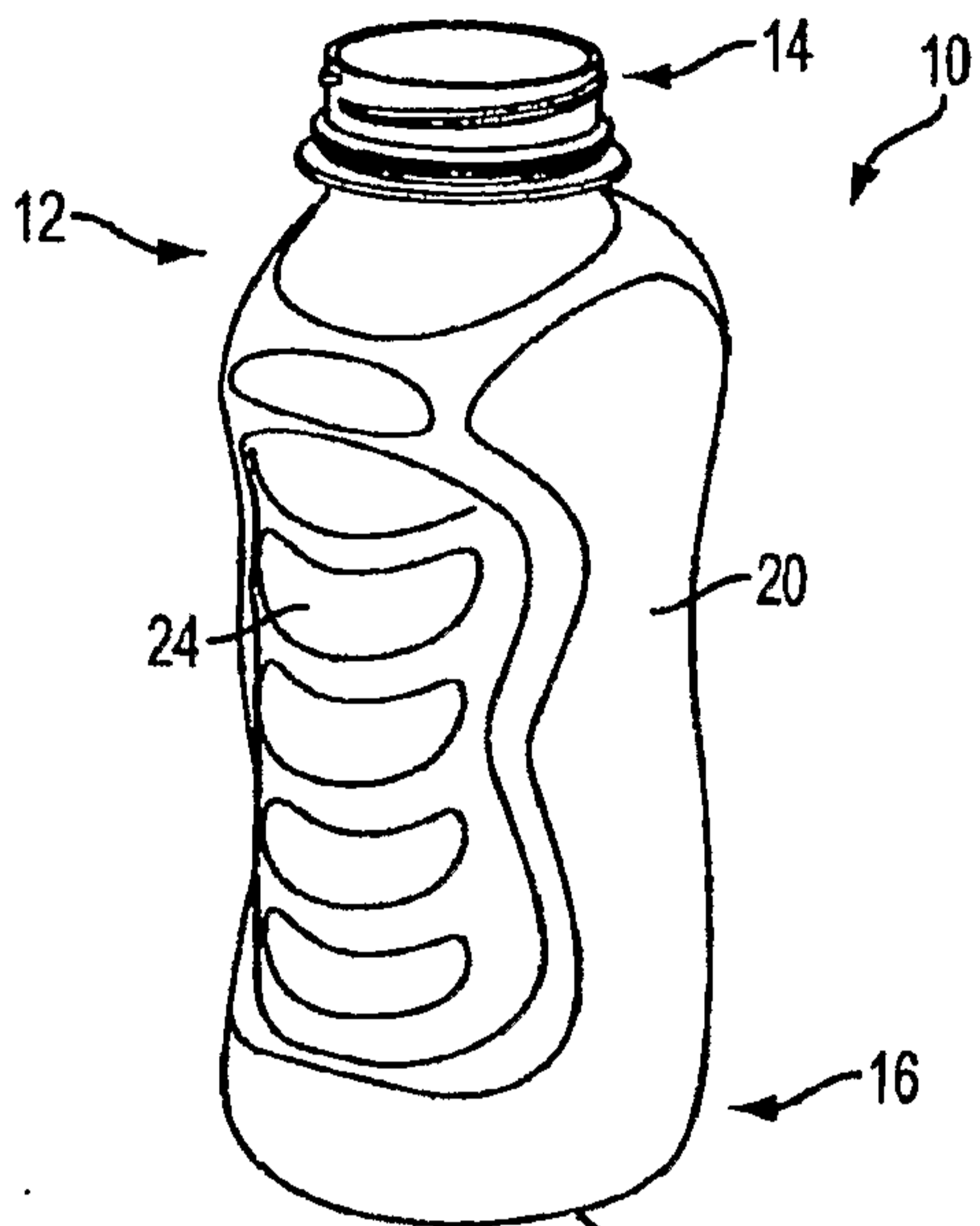


FIG. 1 18

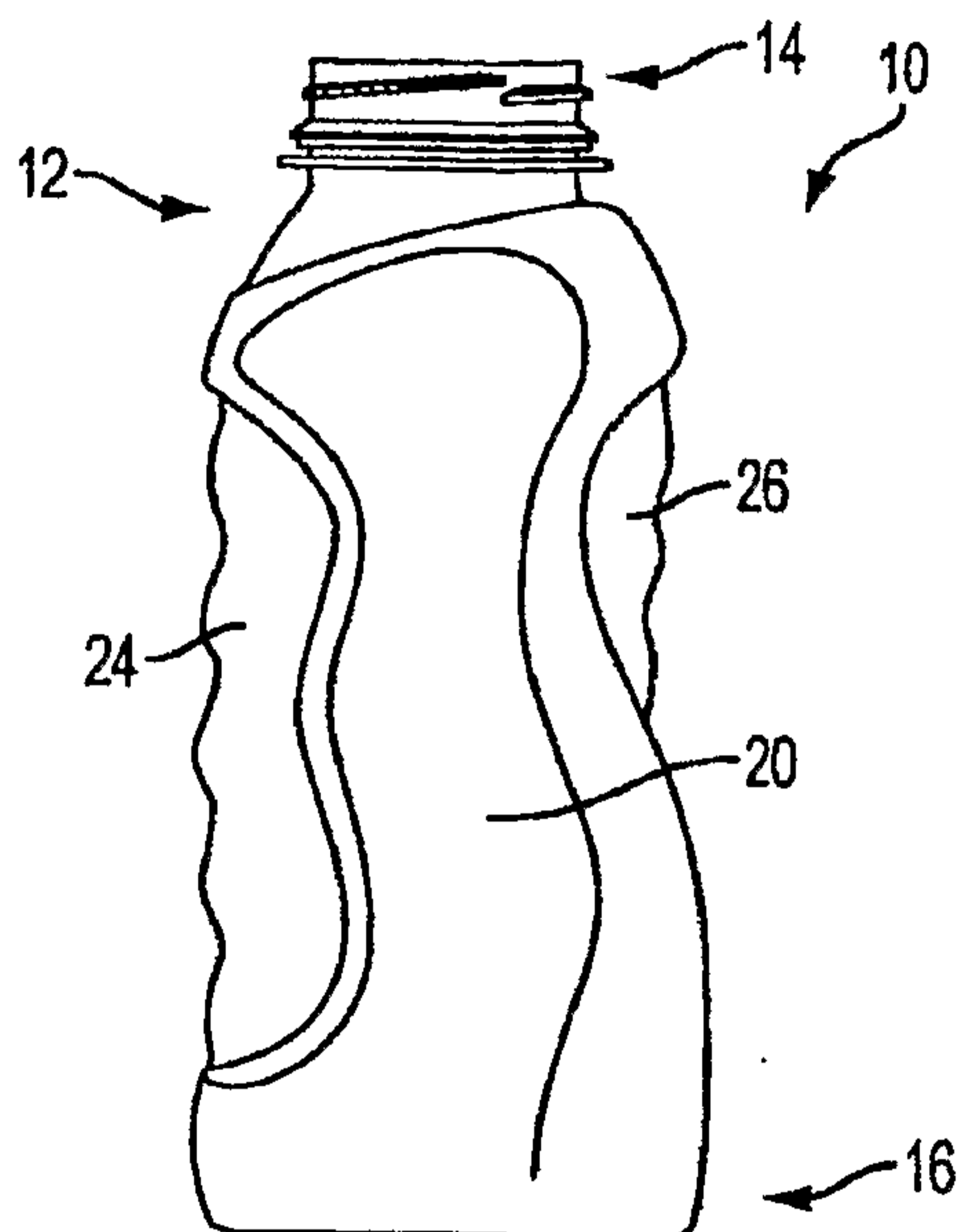


FIG. 2 18

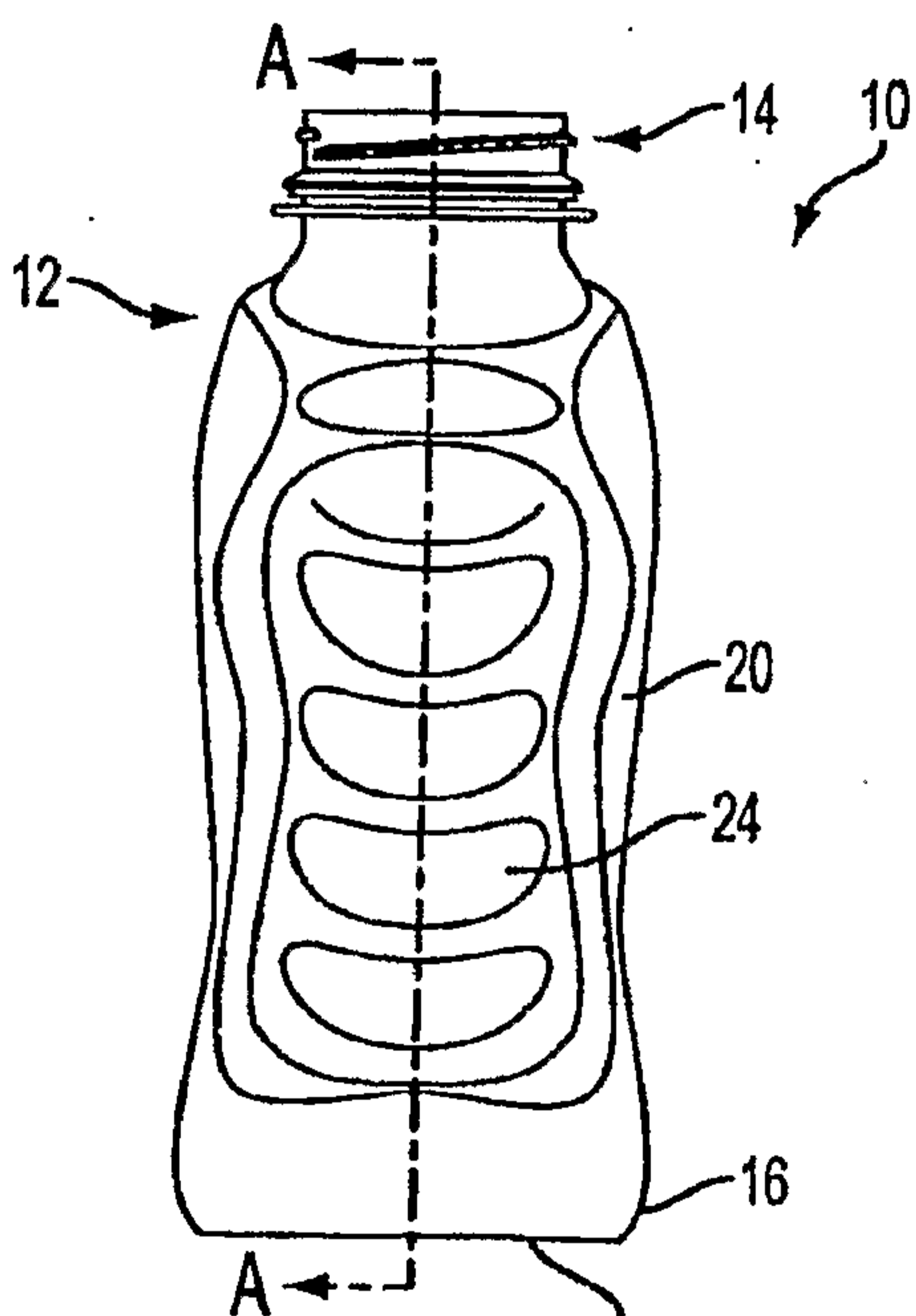


FIG. 3 18

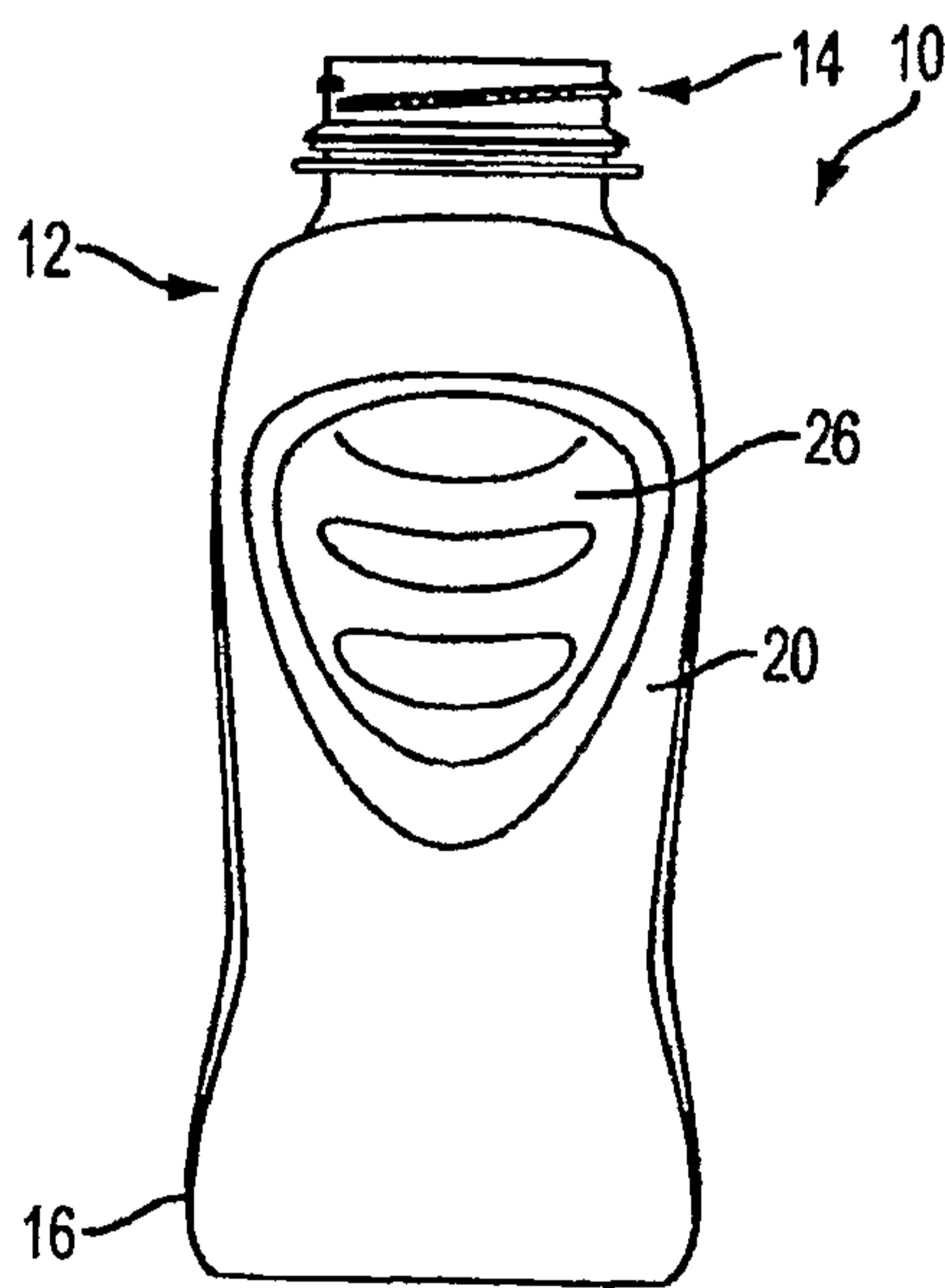


FIG. 4 18

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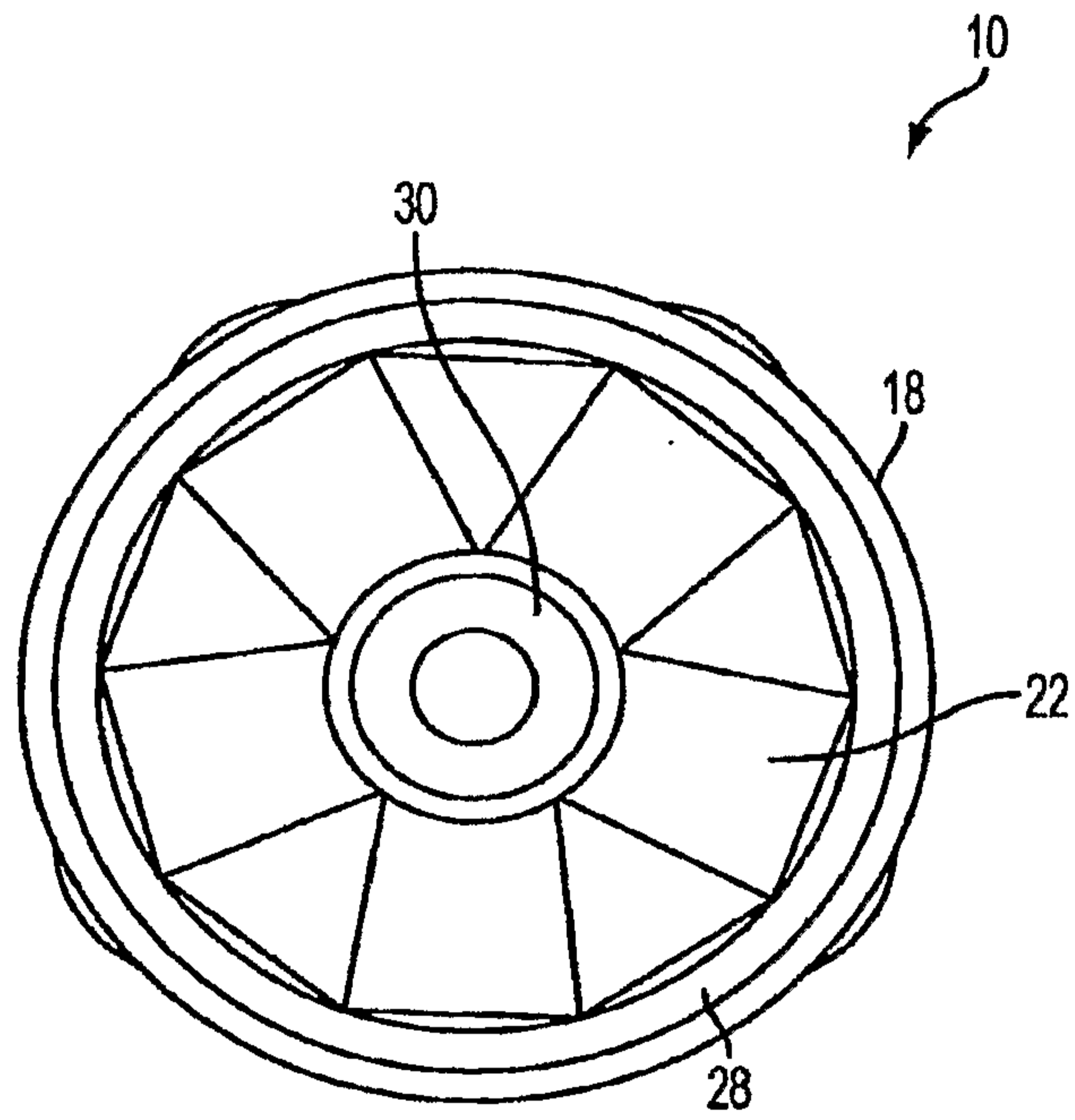


FIG. 5

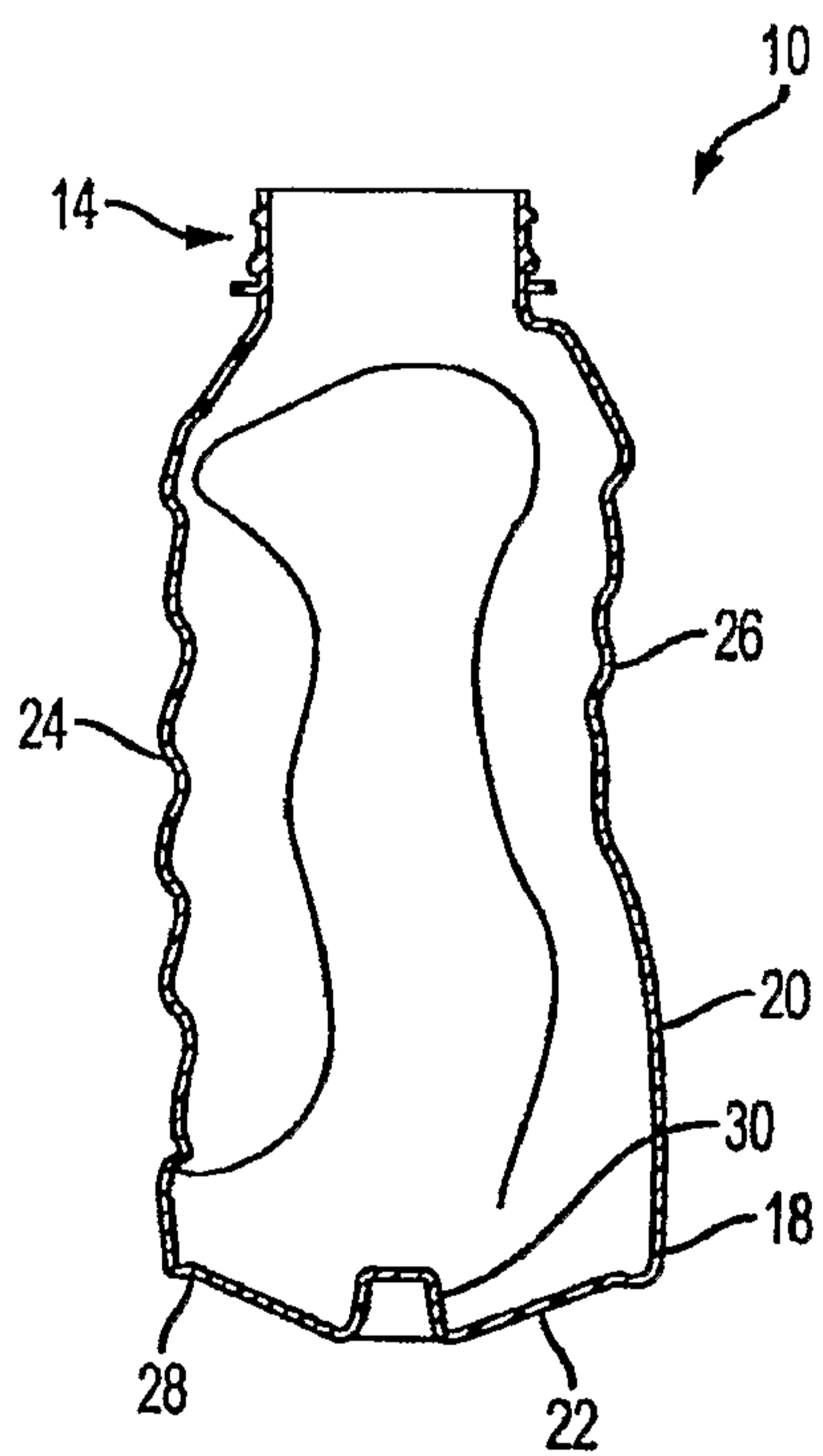


FIG. 6

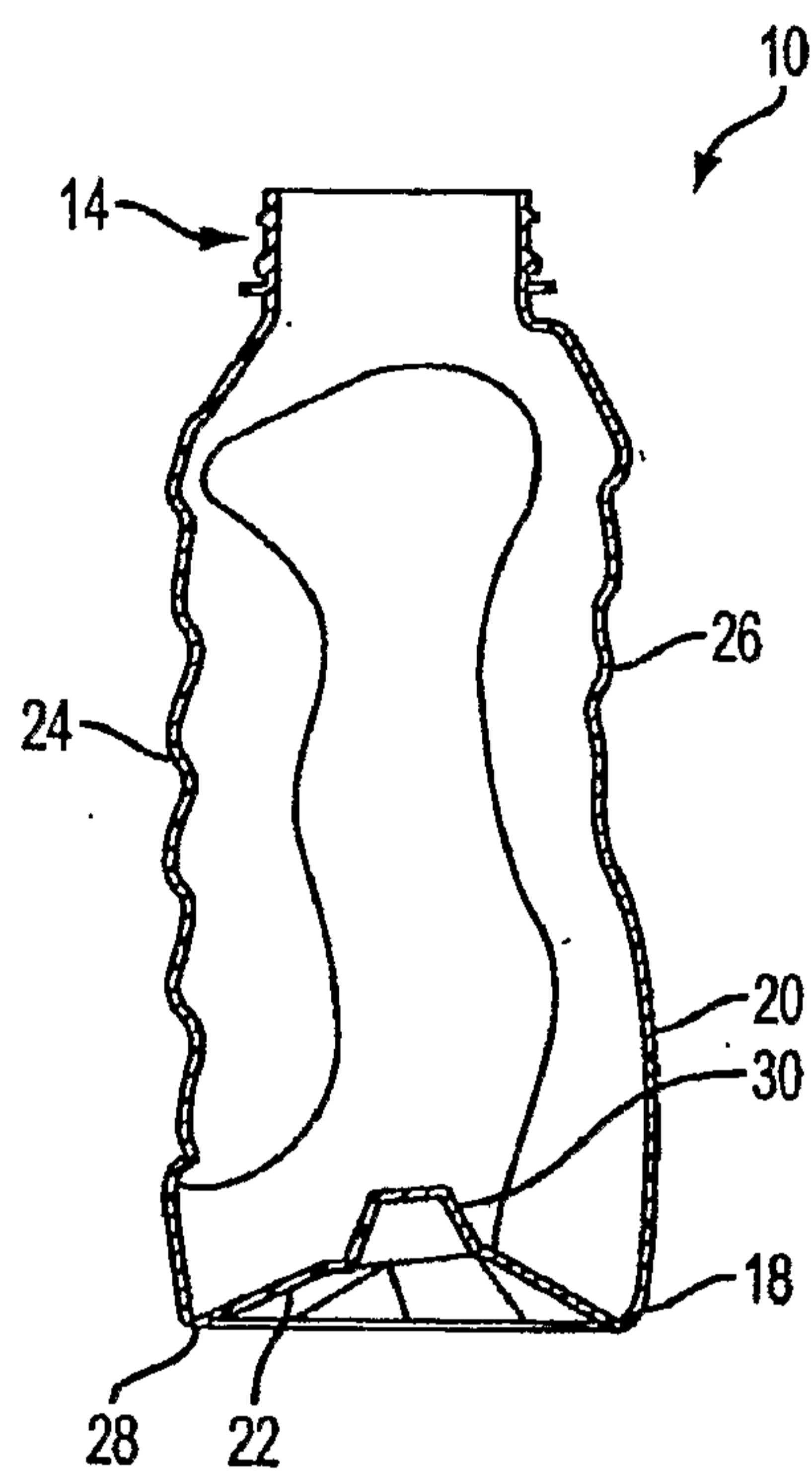


FIG. 7

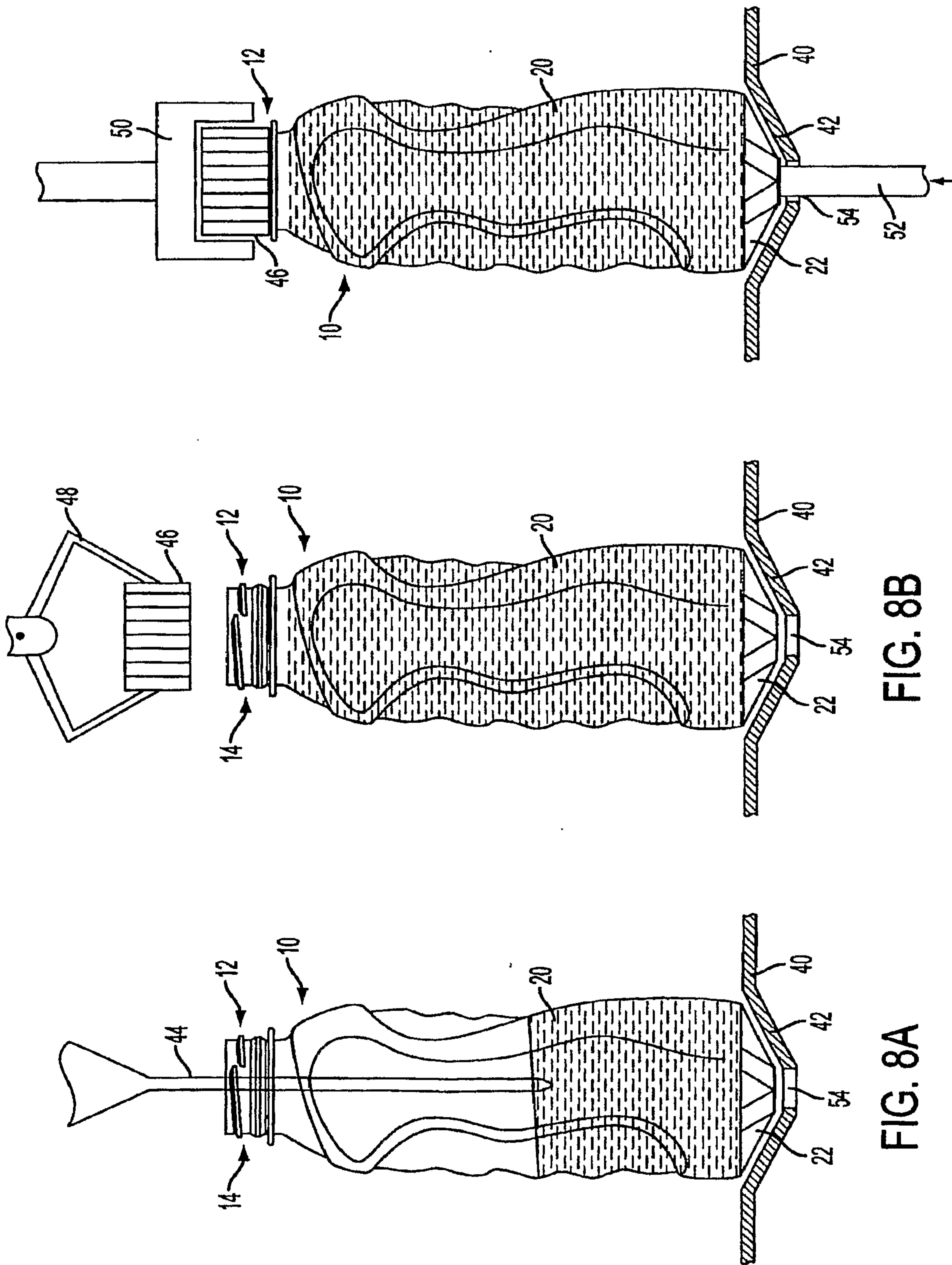


FIG. 8C

FIG. 8B

FIG. 8A

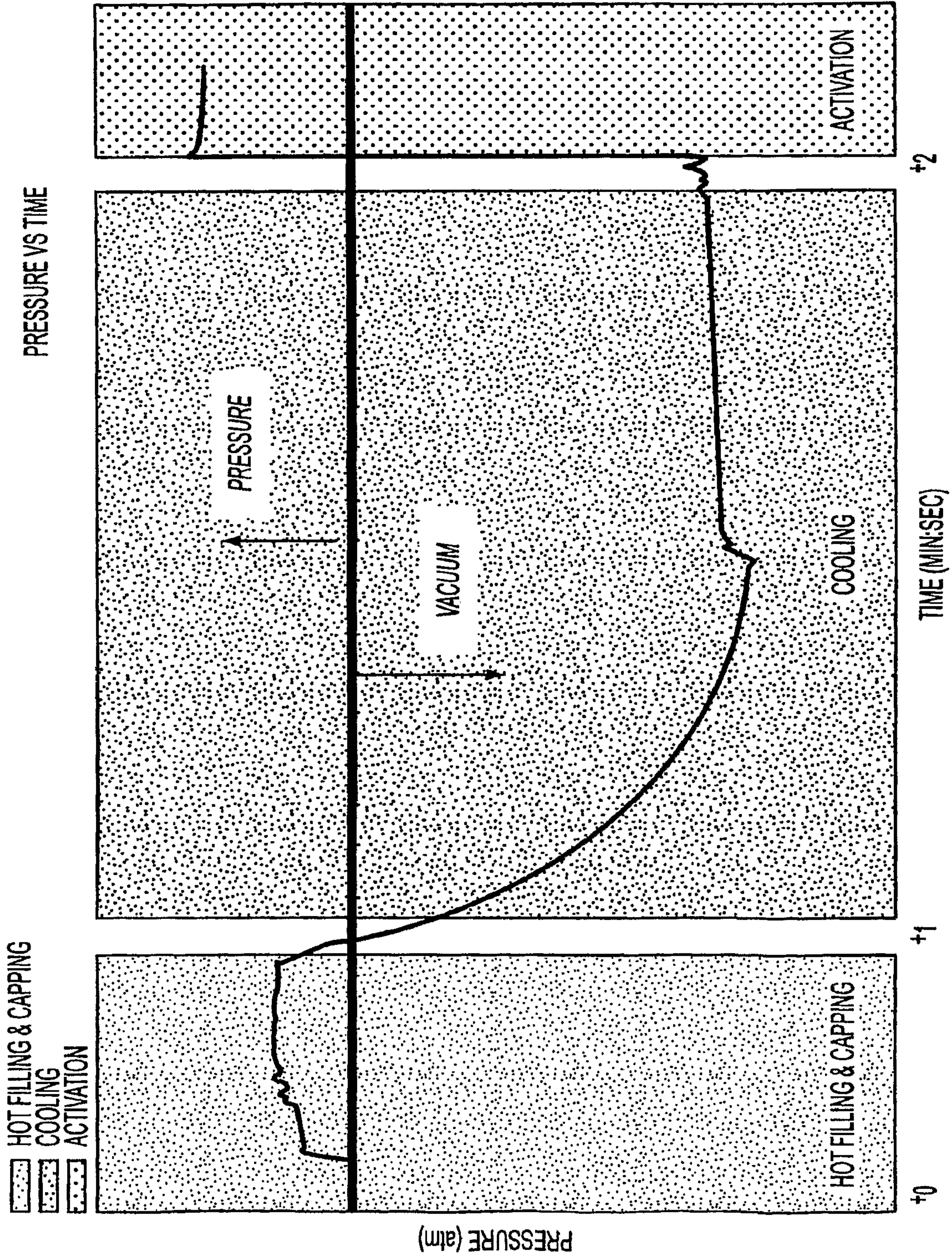


FIG. 9

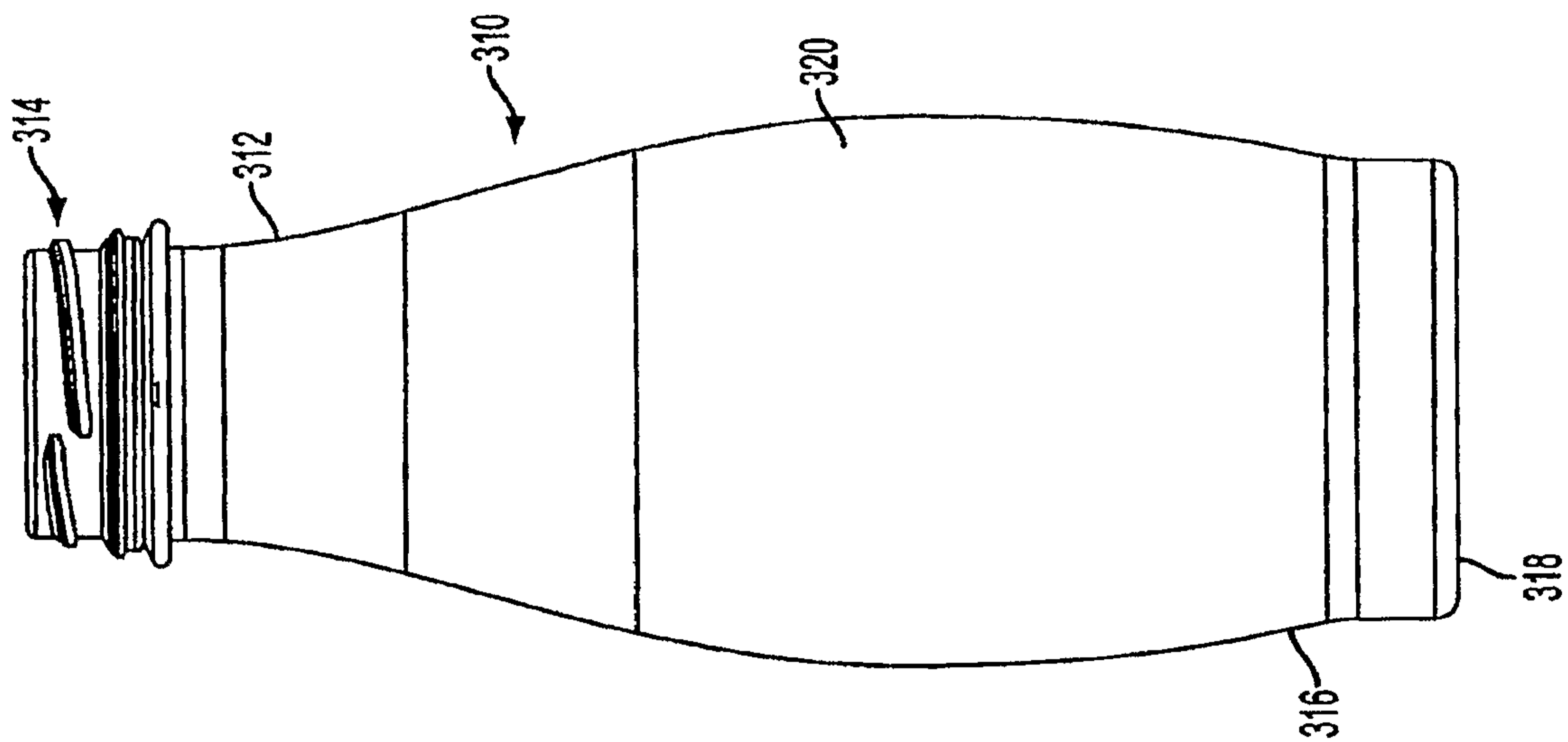


FIG. 12

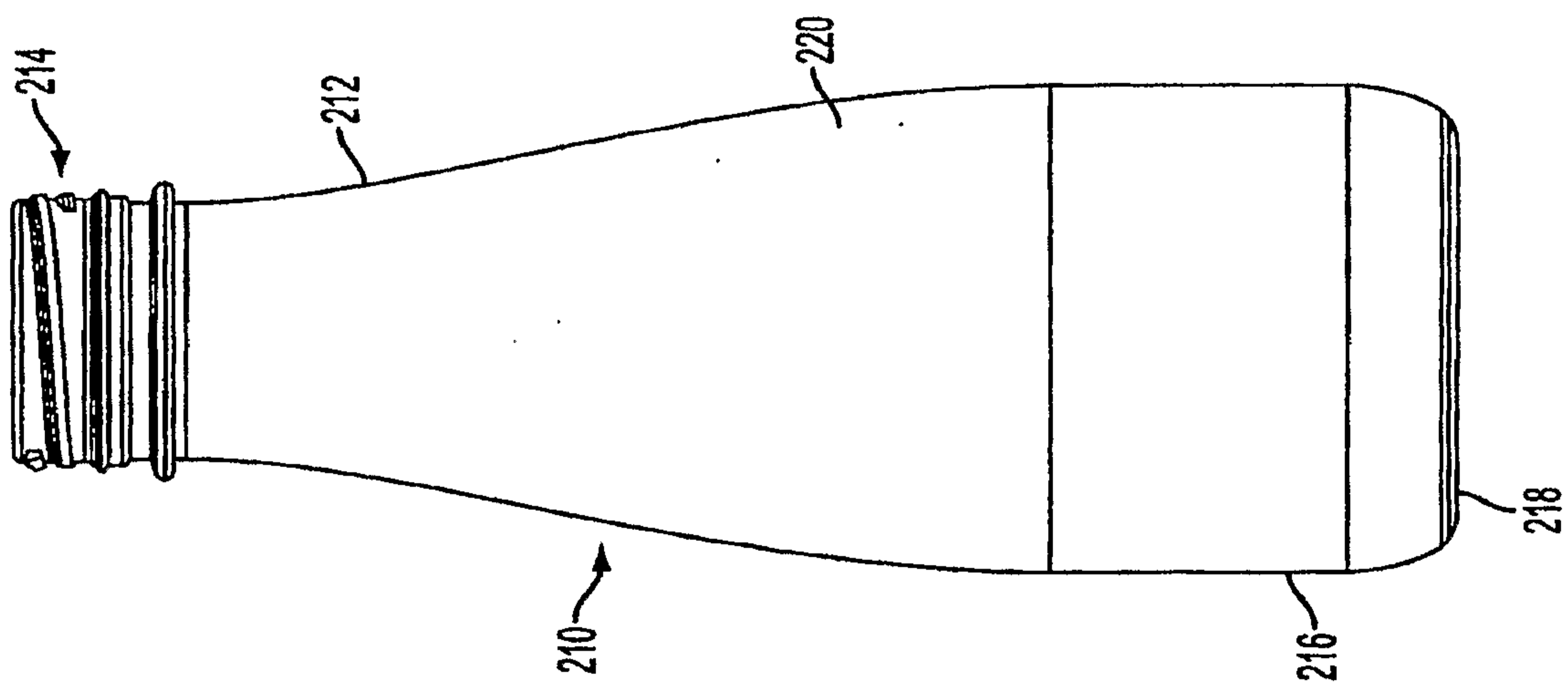


FIG. 11

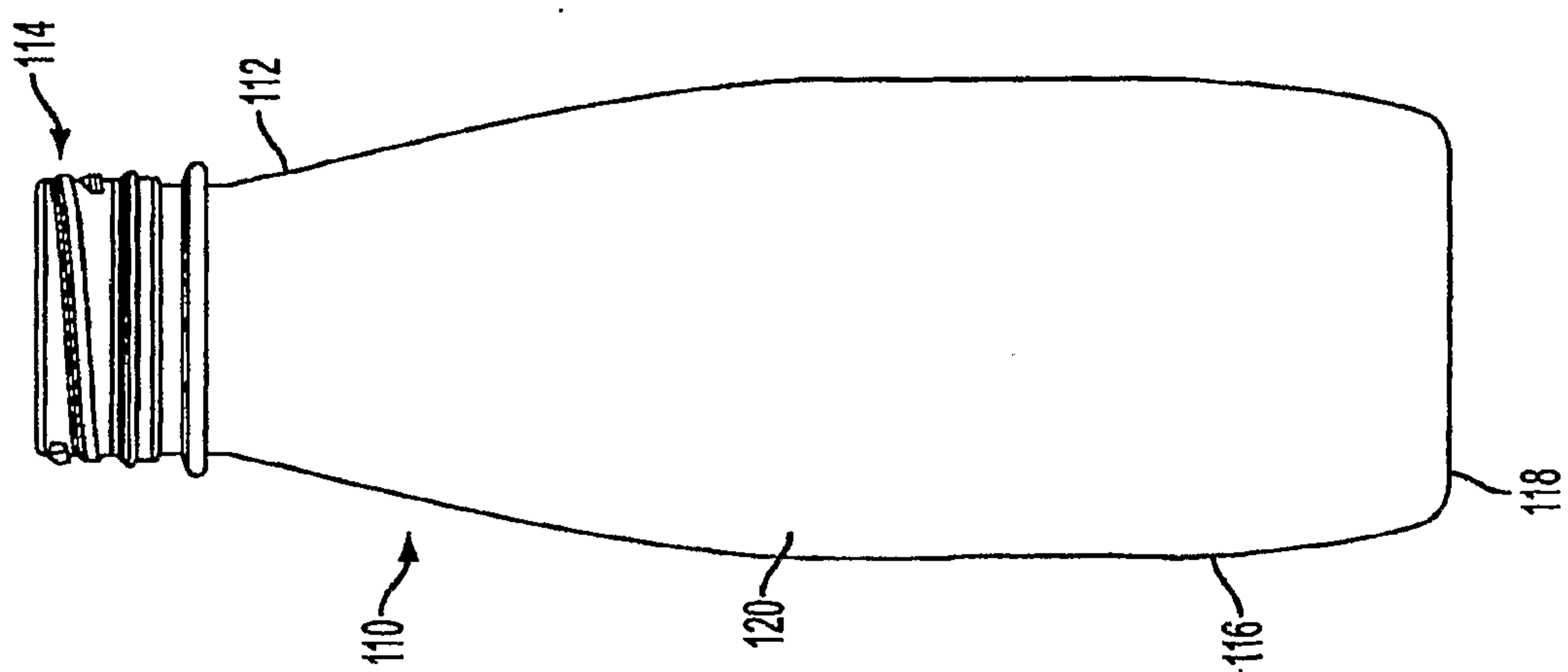


FIG. 10

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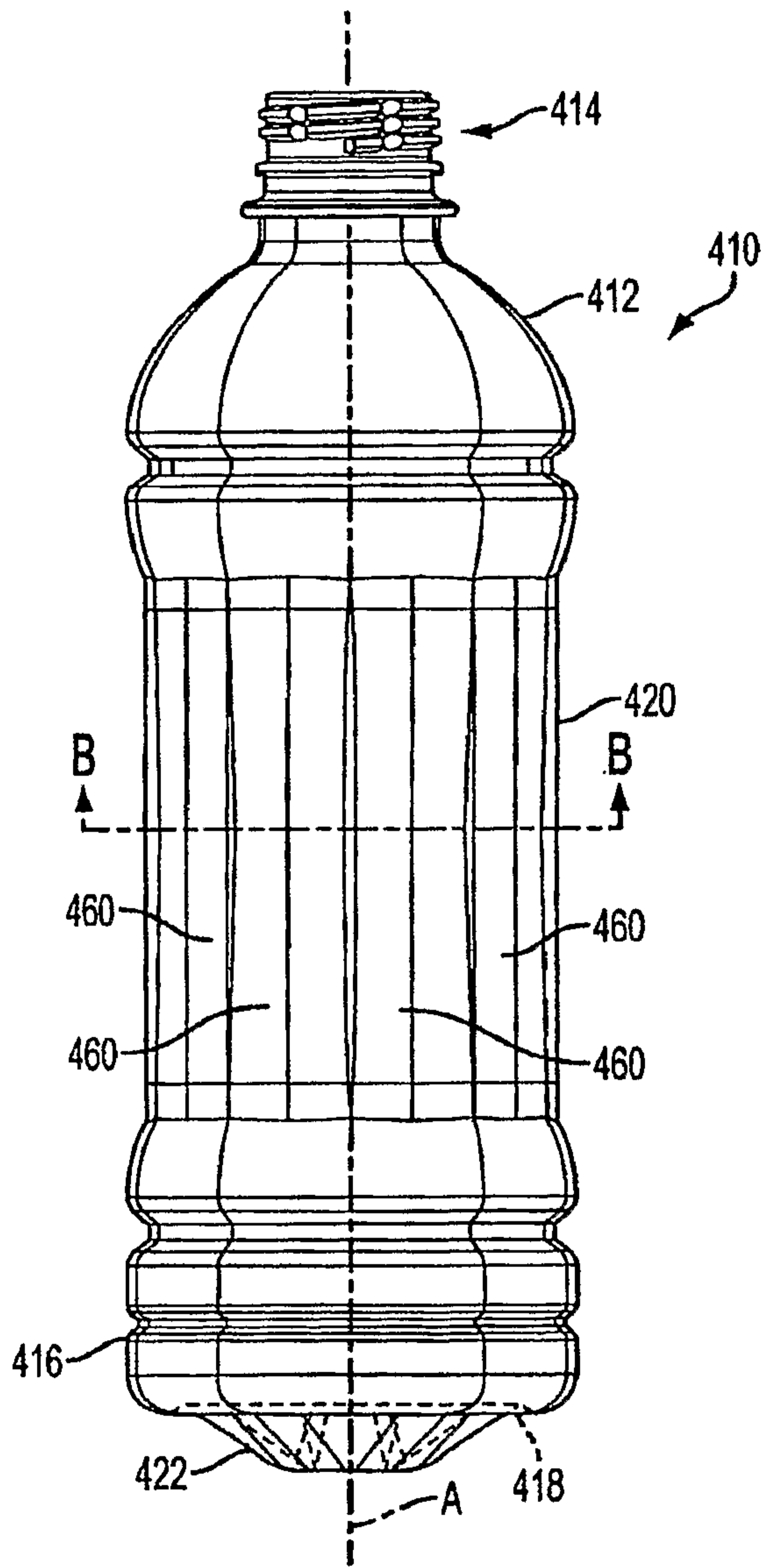


FIG. 13

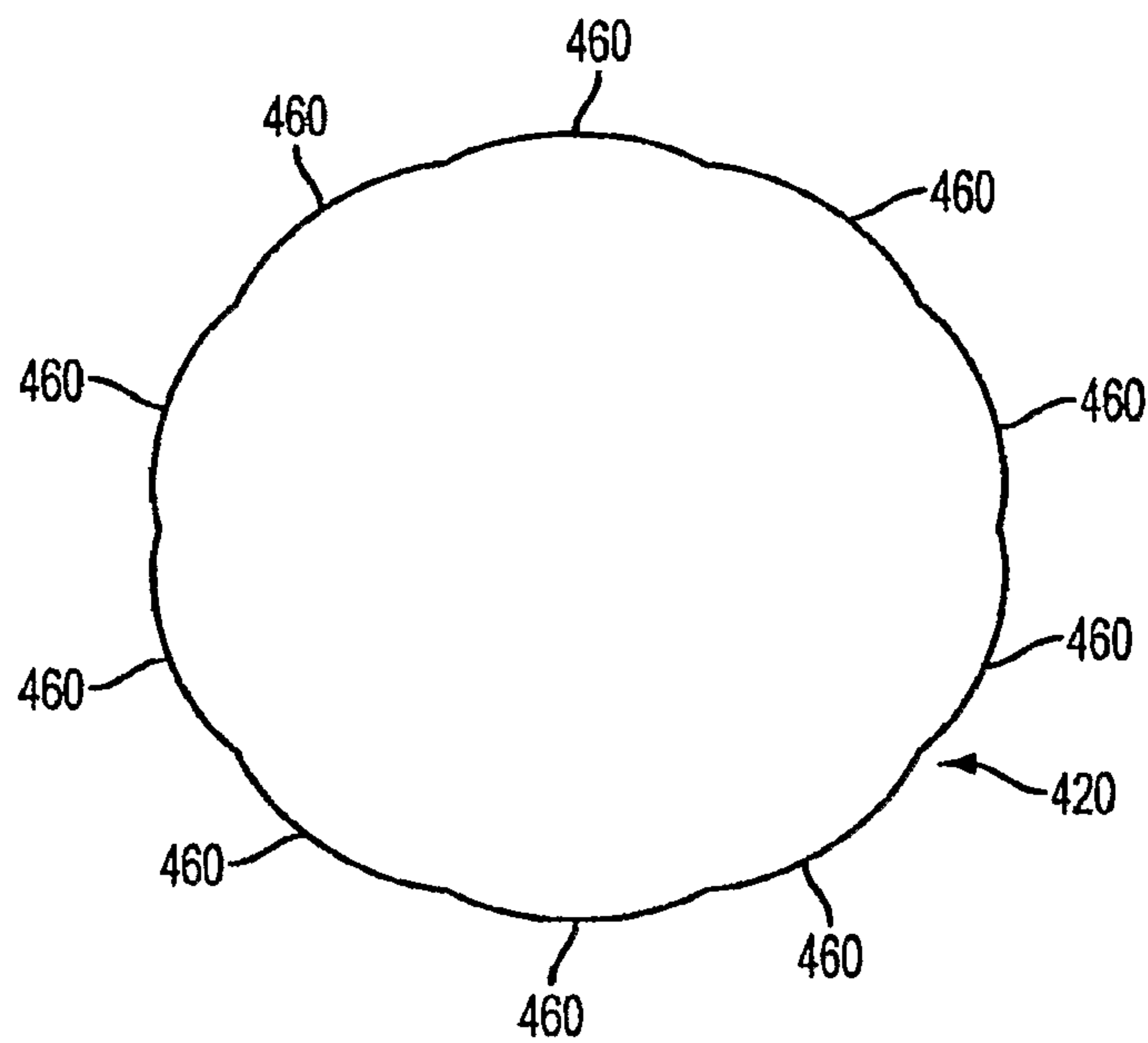


FIG. 14A

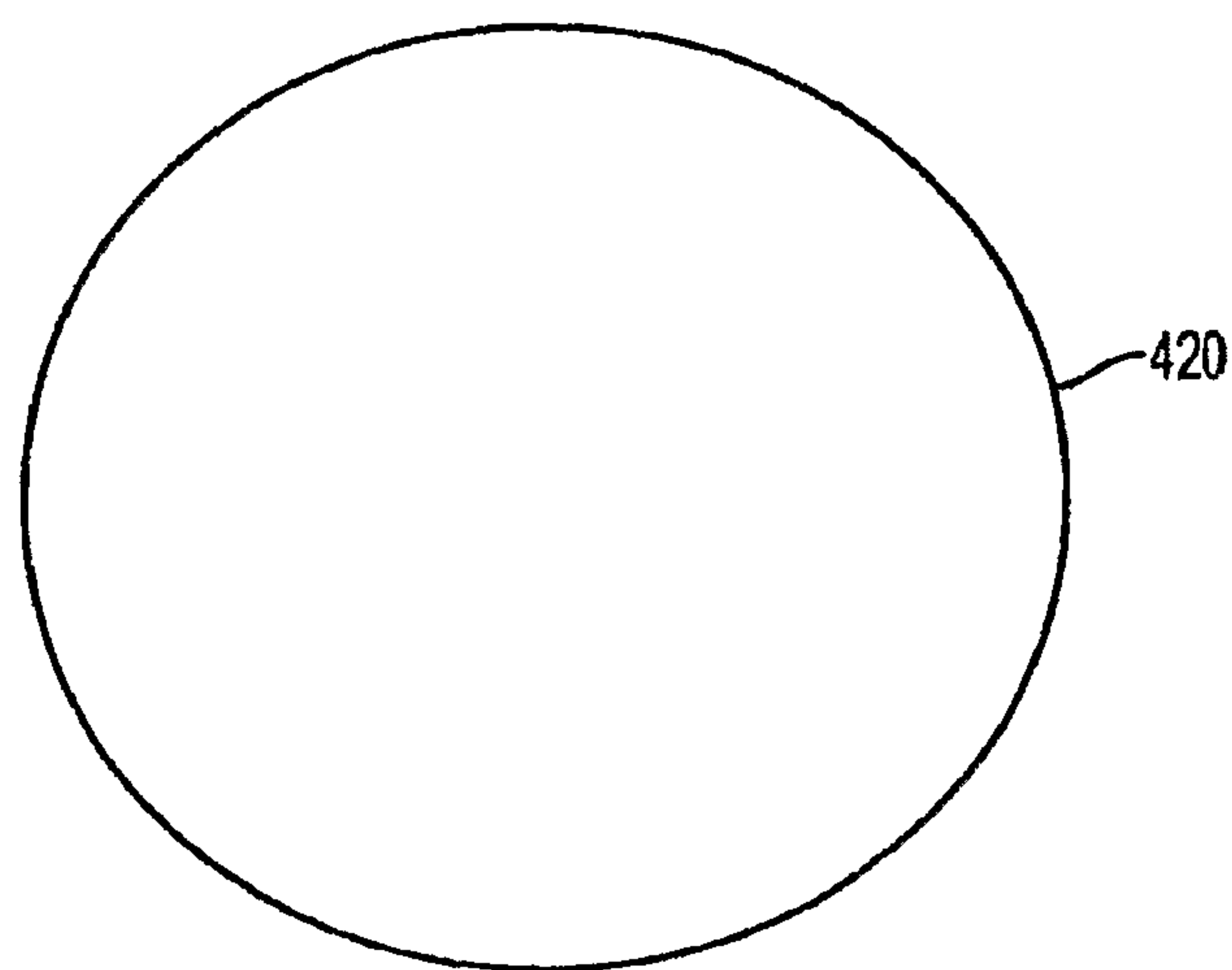
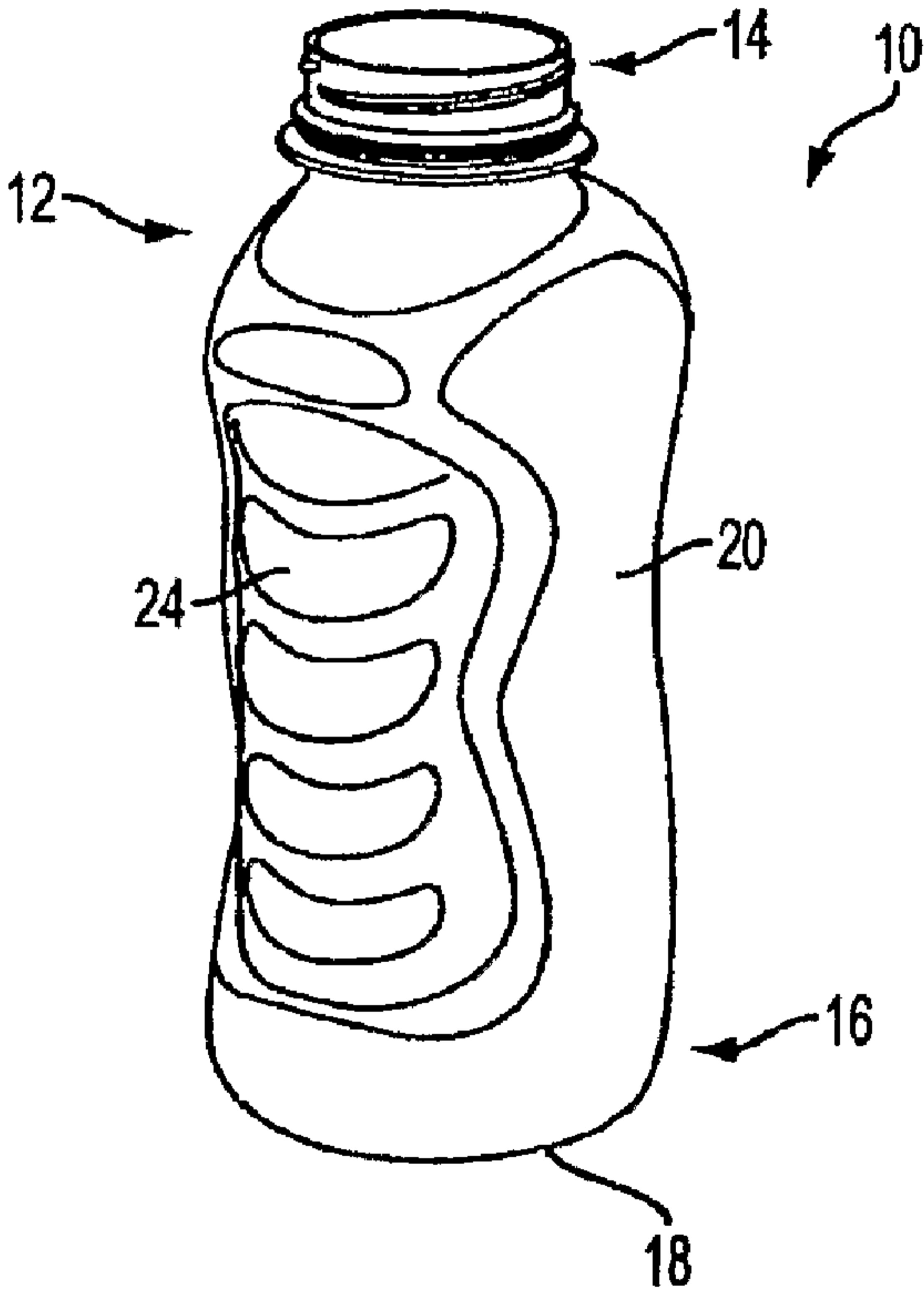


FIG. 14B



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