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(54) Title: LIGHTWEIGHT PREFORM HAVING A DECREASED WEIGHT SUPPORT RING

(57) Abstract: A lightweight polyester preform is disclosed for the production of light weight polyester containers by blow molding. The preforms and the resulting blown containers have threads on an exterior surface adjacent an upper end. Adjacent to and located below the threads is a support ring. The support ring is used in handling and conveying a preform from injection molding to a blow mold and in blow molding the container from the preform. It also is used in handling and conveying the preform from storage to the blow mold. To lightweight the preform, and subsequent container, the support ring is designed to have a minimum weight, but a sufficient strength for the handling of the preform in the production of the blow molded container. The support ring is reduced in weight by about 10% to about 70% from a conventional preform support ring. In addition, the lightweight support ring can be removed from the blow molded container during a subsequent filling and capping of the container to further reduce the container weight.

# LIGHTWEIGHT PREFORM HAVING A DECREASED WEIGHT SUPPORT RING

## Cross-Reference to Related Applications

This application claims priority to U.S. Application 61/689,790 filed June 12, 2012, the contents of which are incorporated by reference herein.

## Field of the Invention

The present invention is directed to lightweight preforms for the production of blow molded containers. More particularly, the invention is directed primarily to polyester container preforms where a part of the lightweight structure is a preform support ring of a decreased weight and a polyester material. The preform support rings have a structure which is solely sufficient to support the preform through handling and the blow molding of the preform to the container and subsequently handling the container through the use of a minimum amount of polyester material.

## Background

There is an interest in producing containers with as low a weight as reasonably possible. An economic reason is to save on the amount of structural material in a container. This lowers the cost of the container and the overall cost of the product in the container. There additionally is a companion interest in using lightweight closures. In many countries there also is an ecological advantage in that an ecological tax is levied on the material content of a container and closure. Consequently, there is considerable attention given to the issue of container weight and the associated closure. They are designed to minimize weight and thus cost. The extra weight in a blow molded container will usually be in the base and in the neck finish. The base must be sufficiently strong to support the filled container throughout filling, shipping and use. This includes the stacking of the containers whether within stacked cartons or stacked as individual containers. This is more so the case for containers for carbonated beverages. The neck finish must be sufficiently strong to withstand the filling and capping operations as well as subsequent shipping and use. This issue of decreasing the weight of blow molded containers has been approached in various ways.

In U.S. Patent 7,976,767 the preform is lightweighted through the use of thinned neck finish areas that are molded into the preform at the time of injection molding the preform. The thicker areas will be sufficiently strong to provide a sufficient strength to the overall neck finish. This will compensate for a lack of strength in the thinned areas. U.S. Patent 7,708,159 is directed to making containers with a lower center of gravity. This is accomplished by reducing the weight of the neck portion by decreasing its height and by making the tamper evident bead discontinuous. The primary objective is to lightweight the container. In U.S. 7,279,207 the container is light weighted by the container not having a neck finish to be sealed with a threaded closure, but rather by a flat seal, such as a foil seal. This significantly decreases the height of the neck finish and thus the weight of the container. However, such a container could not be used for carbonated beverages and in other uses where a substantial closure is needed. In US 2010/0116771 the increased lightweight technique is to decrease the dimension of the neck sufficient to attach a closure using the support ring as a part of the tamper evident closure structure. This requires strengthening the support ring but may lower material content of the neck/spout. This will add weight to the support ring. In US 2011/0100946 a polyester container is light weighted by utilizing internal threads in order to decrease the linear dimension of the neck. There is a support ring that is used for the conventional purpose of handling the preform through the container blow molding process and the use of the support ring as a part of the container closure. When used as a part of the container closure the support ring in whole or in part secures the closure onto the container neck. This requires that the support ring have an added strength in order to provide for the two functions. It must be sufficient to support the preform through the blow molding process and when it is being removed from the mold as well as assist in sealing the container. Additionally, closures threaded onto the exterior of the neck finish cannot be used. This includes the containers commonly used in the carbonated beverage industry.

Summary

The present invention is directed to reducing the amount of material in the support ring of the preform and thus of the resulting container. The support ring is engineered to dimensions and strength to handle the preform through the blow molding process, but is not of dimensions and strength for other purposes such as to additionally be used as a part of the

technique to close the container. That would require different dimensions and additional material. In the present invention the material of the support ring is reduced about 10% to about 70% from the support rings on various prior art containers. The total savings for the preform will depend on other parts of the preform. This will include the thickness of the base portion and other parts of the finished container. Thus the only clear way to look at additional weight savings is through the weight savings of the preform ring alone.

In addition to the light weighting of the support ring the resulting container can be further lightweighted by the removal of the support ring after it is no longer is need in the support or handling of the container. It has been found that a convenient time to remove the support ring is during the container filling and capping operation. As a cap is being applied to the container a knife edge can rotate with the cap and remove the remaining support ring for recycling.

The invention comprises a lightweight thermoplastic preform for the production of lightweight thermoplastic containers comprising an elongated thermoplastic body having an open end and a closed end, the open end having an opening defined by a sidewall of the thermoplastic body, threads on an exterior surface of the sidewall adjacent the open end, a support surface located below the threads, the support surface extending a distance from the sidewall, the support surface having defined dimensions whereby the weight of the preform can be reduced about 10% to about 70% utilizing the defined dimensions.

The defined dimensions of the support surface for the lightweight thermoplastic container can include a varied thickness of the support surface, a varied width of the support surface, a discontinuity of the support surface and void regions in the support surface. There also can be a combined utilization of one or more of a varied thickness, a varied width, discontinuity and void regions. This will reduce the material content and thus the weight of the support surface.

When the defined dimensions include a support surface with a varied thickness there can be reinforcing segments on a lower surface of the support surface, on the upper surface of the support surface, or on both the lower and the upper surfaces of the support surface. In addition the reinforcing segments can comprise information such as a logo, product name or information as to the opening of the associated container or as to use of the product.

The lightweight thermoplastic preform can have an elongated thermoplastic body that is generally cylindrical having a circular cross-section or a polygonal cross-section of three or more sides. The threads are for the attachment of a closure to a container formed from the preform.

The lightweight thermoplastic preform preferably is comprised of a polyester, a preferred polyester being a polyethylene terephthalate.

The resulting container from the lightweight preform can be further reduced in weight by the removal of the support ring during a subsequent operation, such as during the filling and capping of the container.

Brief Description of the Drawings

Figure 1 is a perspective view of a preform with a lower elongated body, an open upper end, threads adjacent the open upper end and a support surface below the threads, the support surface containing voids.

Figure 2 is a side elevation view of the preform of Figure 1.

Figure 3 is a vertical cross-section of the preform of Figure 1.

Figure 4 is a top plan view of the preform of Figure 1.

Figure 5 is a bottom plan view of the preform of Figure 1.

Figure 6 is a cross-section view of the preform of Figure 2 along line 6-6 of Figure 2.

Figure 7 is a first alternate embodiment of the preform of Figure 1 where there is a plurality of support surface reinforcements on an upper surface of the support surface.

Figure 8 is a bottom plan view of the preform of Figure 7.

Figure 9 is a top plane view of the preform of Figure 7.

Figure 10 is a second alternate embodiment of the preform of Figure 1 where there is a plurality of support surface reinforcements on a lower surface of the support surface.

Figure 11 is a bottom plan view of the preform of Figure 10.

Figure 12 is a top plan view of the preform of Figure 10.

Figure 13 is a third alternate embodiment of the preform of Figure 1 where there is a plurality of support surface reinforcements on a lower surface of the support surface.

Figure 11 is a bottom plan view of the preform of Figure 10.

Figure 12 is a top plane view of the preform of Figure 10.

Figure 13 is a fourth alternate embodiment of the preform of Figure 1 where the support surface is of a decreased width.

Figure 14 is a bottom plan view of the preform of Figure 13.

Figure 15 is a top plane view of the preform of Figure 13.

Figure 16 is a fifth alternate embodiment of the preform of Figure 1 where the support surface is comprised of a plurality of reinforced segments.

Figure 17 is a bottom plan view of the preform of Figure 16.

Figure 18 is a top plane view of the preform of Figure 16.

Figure 19 is a sixth alternate embodiment of the preform of Figure 1 where the support surface is reinforced with an embossed message.

Figure 20 is a bottom plan view of the preform of Figure 19.

Figure 21 is a top plane view of the preform of Figure 19.

Figure 22 is a seventh alternate embodiment of the preform of Figure 1 where the support surface contains a plurality of voids.

Figure 23 is a bottom plan view of the preform of Figure 22.

Figure 24 is a top plane view of the preform of Figure 22.

Figure 25 is an eight alternate embodiment of the preform of Figure 1 where the support surface has a varied width.

Figure 26 is a bottom plan view of the preform of Figure 25.

Figure 27 is a top plan view of the preform of Figure 25.

Figure 28 is a ninth alternate embodiment of the preform of Figure 1 where the support surface has an L-shape.

Figure 29 is a bottom plan view of the preform of Figure 28.

Figure 30 is a top plan view of the preform of Figure 28.

Figure 30A is a cross-section of the support ring of Figure 28.

Figure 31 is a tenth alternate embodiment of the preform of Figure 1 where the support surface has support segments.

Figure 32 is a bottom plan view of the preform of Figure 31.

Figure 33 is a top plan view of the preform of Figure 31.

Figure 34 is a tenth alternative embodiment of the preform of Figure 1 where Figure 34 is a perspective view of this embodiment.

Figure 35 is an elevation view of the preform of Figure 34.

Figure 36 is a bottom plan view of the preform of Figure 34.

Detailed Description of the Invention

The invention will now be described in more detail in its preferred embodiments with reference to the attached drawings. The described invention is susceptible to modifications with regard to specific uses, but all such modifications will be obvious and will be considered to be within the concepts of the presently described embodiments.

Figures 1 to 6 show the first embodiment of the light weight preform. Figure 1 is a perspective view of the preform 10, Figure 2 a side elevation view of the preform 10 and Figure 3 a longitudinal cross-section of the preform 10. The preform 10 is comprised of a body 12, a shoulder 14 and an upper portion neck 20 with threads 24 for attaching a closure when the preform is blown into a container. The preform neck 20 has a top rim 22 and an interior surface 21. The neck finish includes the threads 24. Below the threads 24 are a sealing ring 26 and a support ring 16. The sealing ring can provide for a seal between the closure for the resulting container. The support ring has the purpose of supporting the preform after being formed usually by injection molding and during removal from the injection molding process and during subsequent conveying and handling while being transported to and inserted into a blow mold. In the blow mold the preform is heated and a high pressure gas is blown into the preform to stretch it to the internal shape of the mold portion of the blow mold. The preform support ring 16 is shown having void spaces 18 to reduce the weight of the support ring, but yet maintain sufficient strength in handling the preform in the blow molding of the preform to the container.

Figures 4 to 6 show primarily the upper part of the preform 10 of Figure 1 in more detail. This primarily is the neck 24. Figure 4 is a top plan view, which in addition to the showing the body 12, shows the support ring 16 with void spaces 18 to thus light weight the support ring. The void spaces 18 will decrease the weight of the support rings by up to about 42%. Also shown are threads 24 and portions of seal ring 26 in spaces between the threads. Figure 5 is a bottom plan view which shows the body 12, support ring 16 with void spaces 18 and the seal ring 26. Figure 6 is a perspective view of the upper portion 20 of the preform 10

showing the interior surface 21, upper edge 22, threads 24, the seal ring 26 and the support ring 16 with void spaces 18.

Figures 7 to 9 disclose a first alternate embodiment of the preform 10. The body of the preform 10 is the same as in Figures 1 to 3. Figure 7 shows a top plan view of the first alternate embodiment, Figure 8 a bottom plan view, and Figure 9 a perspective view of the upper portion 20 of the preform 10. In these views there is shown the upper portion neck which remains part 20, the threads 24, the seal ring 26, the upper edge 22 and the inner surface 21. The support ring is 36 with upper supports 30, 32, 34, and 38. The support ring has a weight of up to about 55% less than a usual support ring. Also shown in this view is the upper portion 20 of body 12 and the shoulder 14 of the preform 10.

Figures 10 to 12 disclose a second alternate embodiment of the preform 10. The body 12 of the preform 10 is the same as in Figures 1 to 3. Figure 10 shows a top plan view of the second alternate embodiment, Figure 11 a bottom plan view, and Figure 12 a perspective view of the upper portion 20 of the preform 10 of the second alternate embodiment. In these views there is shown the neck upper portion 20, the threads 24, the seal ring 26, the upper neck edge 22 and the inner surface 21 of the neck. The support ring is 46 with a plurality of lower supports 48. Although there is shown a large number of supports 48 these can range from about four to the number shown in Figures 10 to 12. This support ring 46 has a weight of up to about 45% less than a usual support ring. Also shown in this view is the upper part of body 12 and the shoulder 14 of the preform 10.

Figures 13 to 15 disclose a third alternate embodiment of the preform 10. The body of the preform 10 is the same as in Figures 1 to 3. Figure 13 shows a top plan view of the third alternate embodiment, Figure 14 a bottom plan view, and Figure 15 a perspective view of the upper portion 20 of the preform 10. In these views there is shown the neck upper portion 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring 56 is comprised of two disc sections attached at given points. These are sections 56a and 56b attached at connectors 57. The support ring 56a/56b can have a weight of up to about 43% of that of a usual support ring. Also shown in the Fig. 15 view is the upper part of body 12 and the shoulder 14 of the third alternate embodiment of preform 10.

Figures 16 to 18 disclose a fourth alternate embodiment of the preform 10. The body of the preform 10 is the same as in Figures 1 to 3. Figure 16 shows a top plan view of the

fourth alternate embodiment, Figure 17 a bottom plan view, and Figure 18 a perspective view of the neck upper portion 20 of the fourth alternate embodiment of preform 10. In these views there is shown the upper portion of the preform 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring 66 is comprised of a disc supported by a plurality of lower supports 64. Although there is shown seven supports these can be fewer than seven supports and more than seven supports. This support ring structure has a weight of up to about 64% less than a usual support ring. Also shown in Figure 18 is the upper part of body 12 and the shoulder 14 of the fourth alternate embodiment preform 10.

Figures 19 to 21 disclose a fifth alternate embodiment of the preform 10. The body of this fifth alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 19 shows a top plan view of the fifth alternate embodiment, Figure 20 a bottom plan view, and Figure 21 a perspective view of the upper portion 20 of the fifth alternate embodiment of preform 10. In these views there is shown the upper portion which remains part 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring is 76 with a plurality of reinforcing letters 78 on a lower surface. The reinforcing letters 78 are molded into the support ring 76 at the time of forming the preform. The letters also can be embossed into the support ring. In addition the letters can be on the upper surface of the support ring 76. The lettering can be a brand name or some form of advertising. The support ring 76 has a weight of up to about 11% less than a usual support ring. Also shown in Figure 21 is the upper part of body 12 and the shoulder 14 of the fifth alternate embodiment of preform 10.

Figures 22 to 24 disclose a sixth alternate embodiment of the preform 10. The body of the sixth alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 22 shows a top plan view of the sixth alternate embodiment, Figure 23 a bottom plan view, and Figure 24 a perspective view of the upper portion 20 of the sixth alternate embodiment of preform 10. In these views there is shown the neck upper portion 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring is 86 has a plurality of circular voids 82 and elongated voids 80. This mix of voids serves to strengthen the support ring. Although there is shown a large number of voids 80 and 82 these voids can range from about four to the number shown in Figures 22 to 24 or more. The support ring has a weight reduction of up to about 42% less than a usual support ring. This is related to

the weight reduction of the embodiment of Figures 1 to 6. Also shown in Figure 24 is the upper part of body 12 and the shoulder 14 of the preform 10.

Figures 25 to 27 disclose a seventh alternate embodiment of the preform 10. The body of this seventh alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 25 shows a top plan view of the seventh alternate embodiment, Figure 26 a bottom plan view, and Figure 27 a perspective view of the neck upper portion 20 of the seventh alternate embodiment of preform 10. In these views there is shown the upper portion which remains part 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring 96 has a plurality of narrow width portions 97. The varied width provides for the integrity of the support ring 96 to functionally support the perform 10 during subsequent processing to blow mold a container. Although there are shown five wide portions and five portions 97 of decreased width, these portions can range from about three wide and decreased width portions up to ten or more of each. Also there need not be the same number of wide and decreased width portions. As the number of wide and decreased width portions increase the support ring 96 will approach a circle. The support ring 96 has a weight of about 36% less than a usual support ring. Also shown in Figure 27 is the upper part of body 12 and the shoulder 14 of the preform 10.

Figures 28 to 30 disclose an eighth alternate embodiment of the preform 10. The body of this eighth alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 28 shows a top plan view of the eight alternate embodiment, Figure 29 a bottom plan view, and Figure 30 a perspective view of the upper portion 20 of the eighth alternate embodiment of preform 10. In these views there is shown the upper portion which remains part 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring is 116 has an L-shape as shown in a partial cross-section in Figure 30A. The L-shape has a top surface of 117 and a side surface of 118. The support ring 116 has a weight of up to about 36% less than a usual support ring. Also shown in Figure 29 is the upper part of body 12 and the shoulder 14 of the eighth alternate embodiment of preform 10.

Figures 31 to 33 disclose a ninth alternate embodiment of the preform 10. The body of the ninth alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 31 shows a top plan view of the ninth alternate embodiment, Figure 32 a bottom plan view, and Figure 33 a perspective view of the upper portion 20 of the ninth alternate embodiment of

preform 10. In these views there is shown the neck upper portion 20, the threads 24, the seal ring 26, the neck upper edge 22 and the neck inner surface 21. The support ring is 126 has a plurality of support nodes 128. This mix of nodes 128 serves to strengthen the support ring. Although there is shown a large number of nodes these nodes can range from about three to the number shown in Figures 31 to 33 or more. The support ring has a weight reduction of up to about 25% less than a usual support ring. This is related to the weight reduction of the embodiment of Figures 1 to 6. Also shown in Figure 33 is the upper part of body 12 and the shoulder 14 of the preform 10.

Figures 34 to 36 discloses a tenth alternative embodiment of the perform 10. The body of the tenth alternate embodiment of preform 10 is the same as in Figures 1 to 3. Figure 34 shows a perspective view of the tenth alternate embodiment, Figure 35 an elevation view of this embodiment, and Figure 36 a bottom plan view of this tenth alternate embodiment of preform 10. Figure 34 is also illustrative of the lower body portion 12 of all of the embodiments. In these views there is shown the neck upper portion 20, the threads 24, the neck upper edge 22 and the neck inner surface 21. The support ring has a plurality of elongated support sections 136 having apertures 137 and nodes 138. Nodes 138 separate the elongated support sections 136. This mix of nodes 138 serves to strengthen the overall support ring. Although there is shown in Figure 36 the same number of elongated sections 137 and nodes 138 the number of elongated sections and nodes can vary and need not be of equal number. The support ring has a significant weight reduction depending on the number of elongated sections and the size and number of the apertures 137. This is related to the weight reduction of the embodiment of Figures 1 to 6.

As noted above the preforms preferably are polyester preforms. Useful polyesters include polyethylene terephthalate and polyethylene naphthanate. Other blow moldable resins also can be used but the polyester resins usually have a lower cost and blow molding equipment is readily available for processing polyester performs to containers.

As noted above, one of the reasons for light weighting the preform and the subsequent container is to use less plastic. This is a “green” objective. It saves the cost of materials and in some countries a “green” tax savings. The resulting container can be further lightweighted and made ‘greener” by the removal of the support ring after it is no longer needed in the transport or handling of the blown container. The support ring can be removed,

and the plastic recycled at any time after the blow molding of the preform to the container. One of the preferred times to remove the support ring is during the container filling and capping operation. The containers usually are filled and capped on high speed lines with the containers moving along a track. The cap in many instances, such as for filled beverage containers, is screwed onto the container neck promptly after filling. During this capping operation a knife edge can extend from the capping structure to the support ring and be rotated along with the cap. The knife edge then removes the support ring with the remnants of the support rings collected and recycled. The removal of the support ring during the capping is a convenient way to further lightweight the container and recycle the plastic of the support ring. It is important that the support ring be essentially fully removed so there are no jagged edges remaining on the container in the area of the removed support ring to cause any injuries to a person using the contents of the container.

I Claim:

1. A lightweight thermoplastic preform for the production of thermoplastic containers comprising an elongated thermoplastic body having an open end and a closed end, the open end having an opening defined by a sidewall of the thermoplastic body, threads on an exterior surface of the sidewall adjacent the open end, a support surface located below the threads, the support surface extending a distance from the sidewall, the support surface having defined dimensions whereby the weight of the preform can be reduced about 10% to about 70% utilizing the defined dimensions.

2. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the support surface has a varied thickness.

3. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 2 wherein the support surface is discontinuous.

4. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 3 wherein the support surface has void regions.

5. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the support surface is discontinuous.

6. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 2 wherein the support surface has void regions.

7. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the support surface has reinforcing segments on a lower surface.

8. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 7 wherein the reinforcing segments comprise information.

9. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the support surface has reinforcing segments on an upper surface.

10. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 9 wherein the reinforcing segments comprise information.

11. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the support surface extends varying distances from the sidewall.

12. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the elongated thermoplastic body is cylindrical.

13. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 12 the thermoplastic body has a circular cross-section.

14. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the threads are for the attachment of a closure to a container formed from the preform.

15. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 1 wherein the thermoplastic preform is comprised of a polyester.

16. A lightweight thermoplastic preform for the production of thermoplastic containers as in claim 15 wherein the polyester is a polyethylene terephthalate.

17. A lightweight container formed by blow molding the preform of claim 1.

18. A lightweight container as in claim 17 wherein the support ring has been removed.

19. A lightweight container as in claim 18 wherein the container has been filled and capped.

20. A lightweight container as in claim 17 wherein the container is comprised of polyethylene terephthalate.

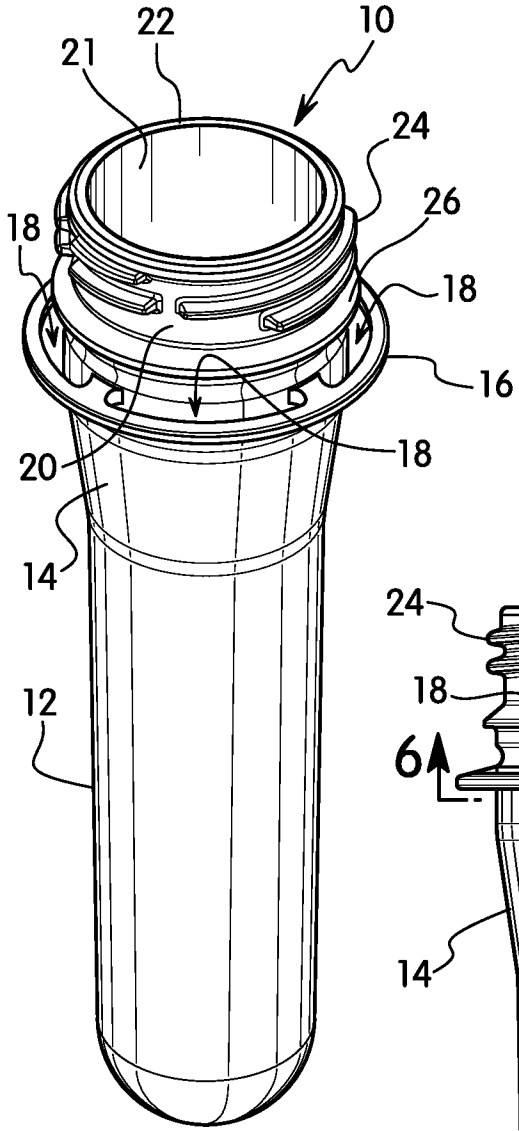


FIG. 1

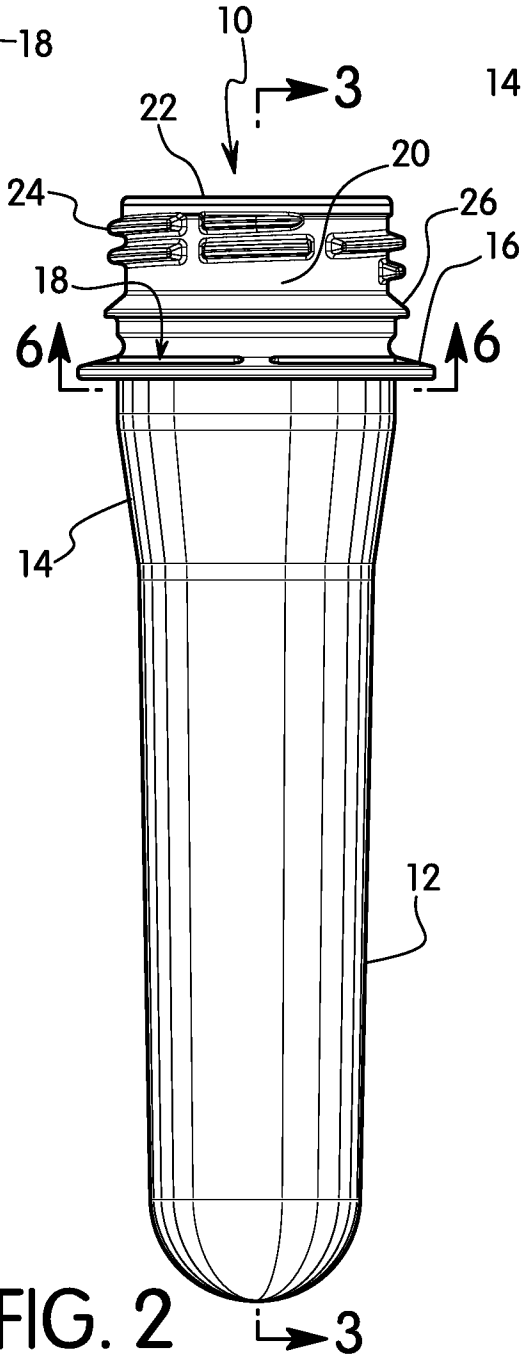


FIG. 2

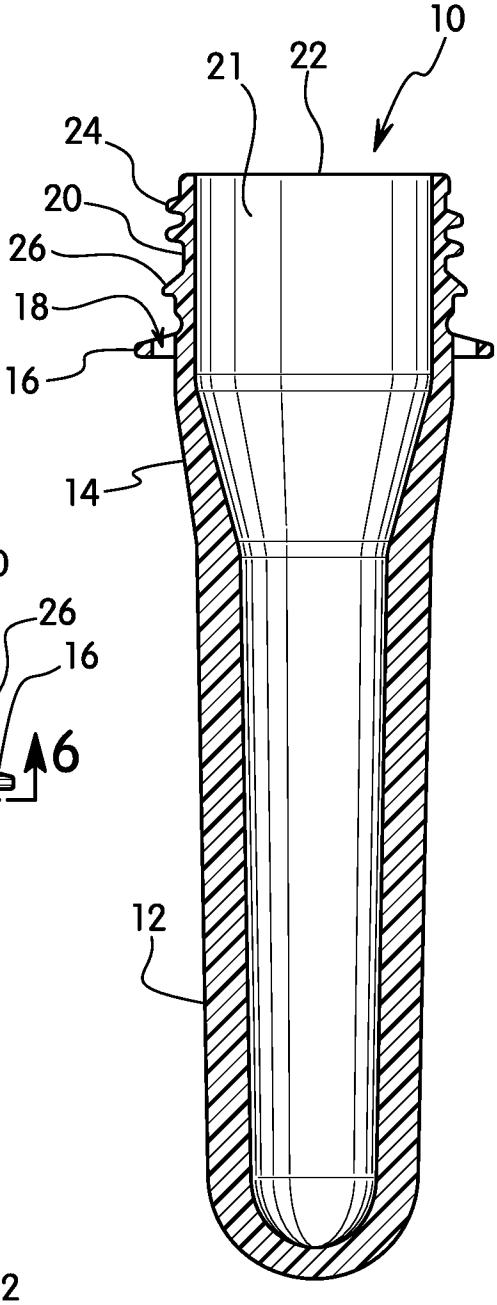


FIG. 3

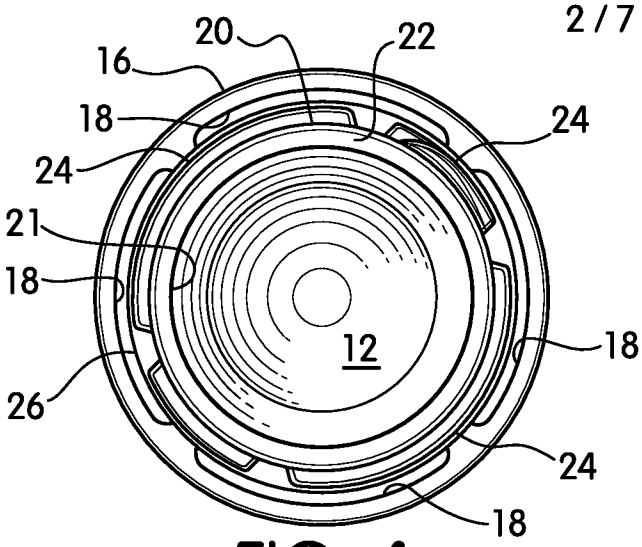


FIG. 4

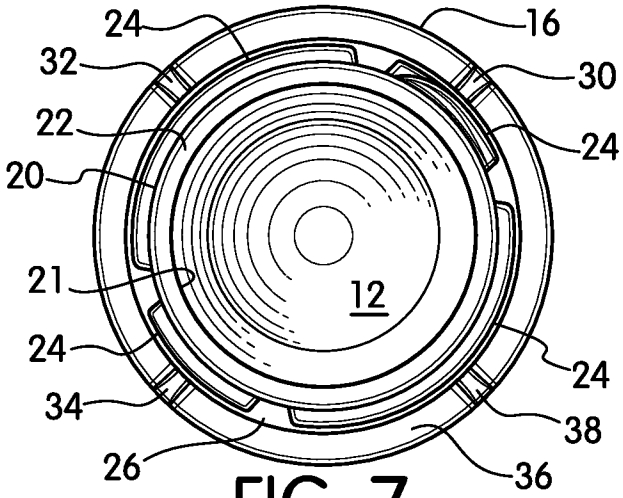


FIG. 7

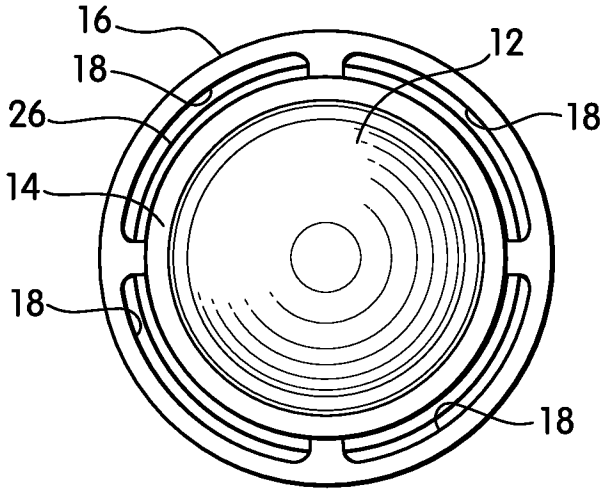


FIG. 5

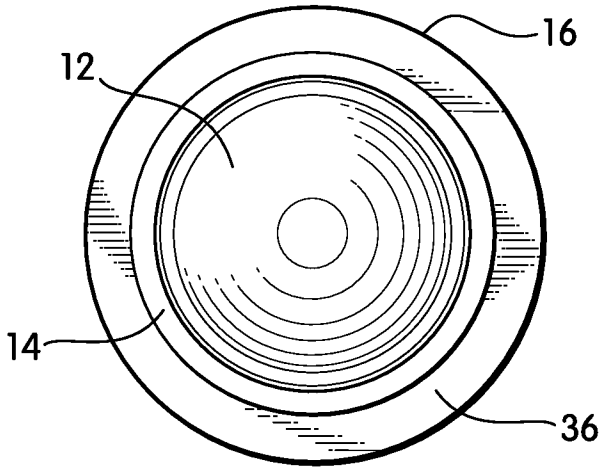


FIG. 8

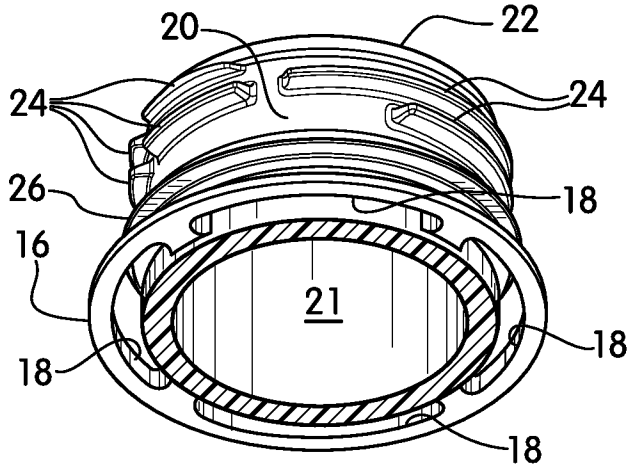


FIG. 6

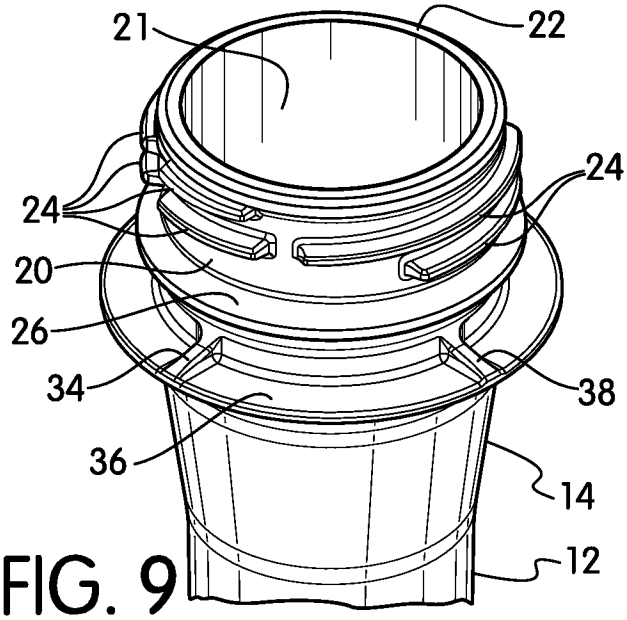


FIG. 9

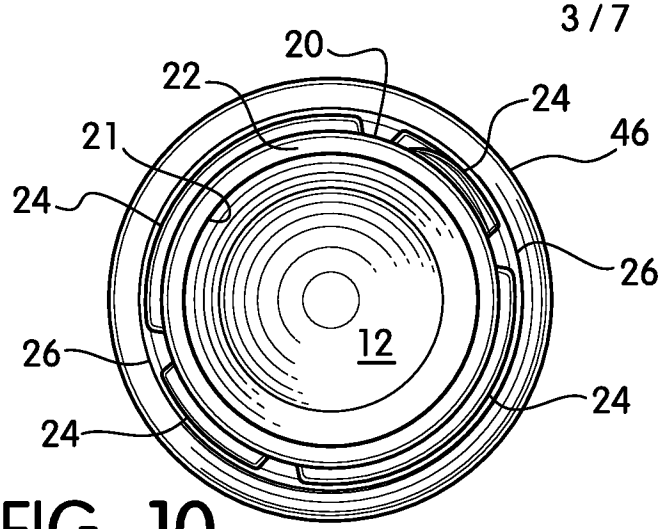


FIG. 10

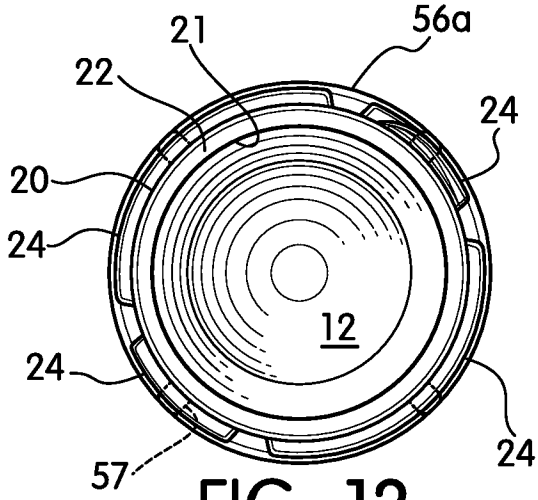


FIG. 13

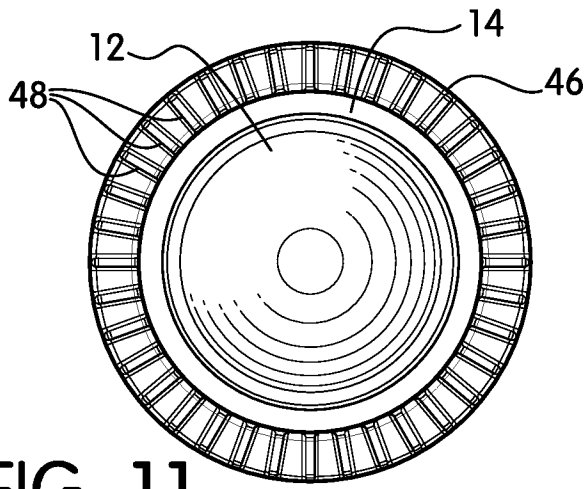


FIG. 11

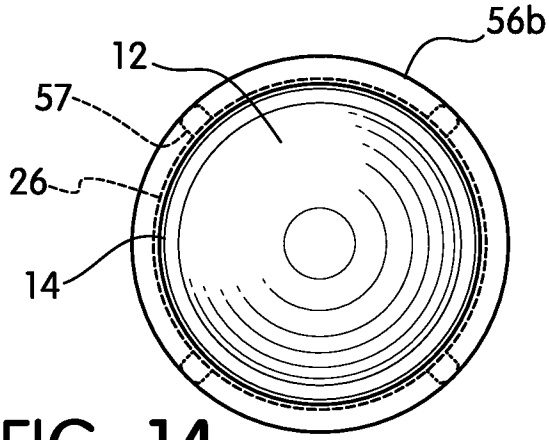


FIG. 14

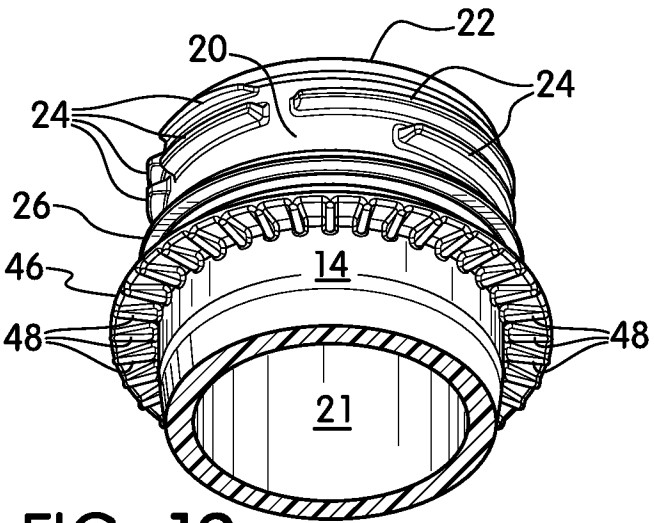


FIG. 12

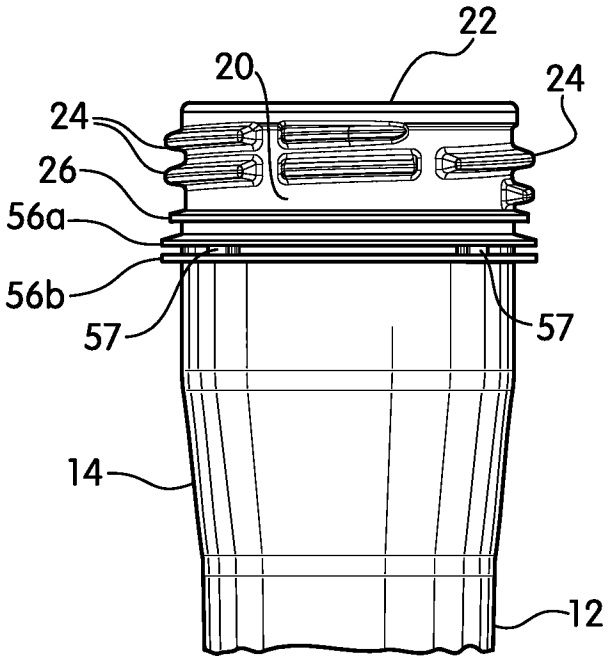


FIG. 15

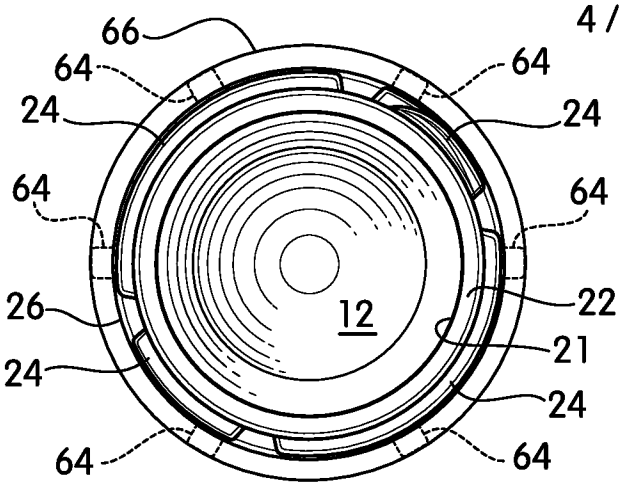


FIG. 16

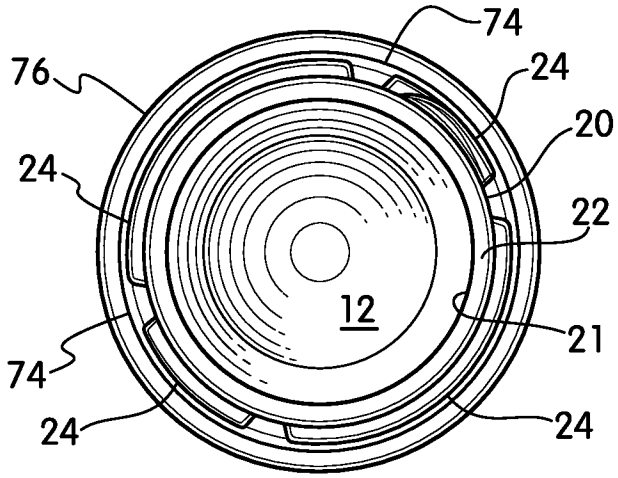


FIG. 19

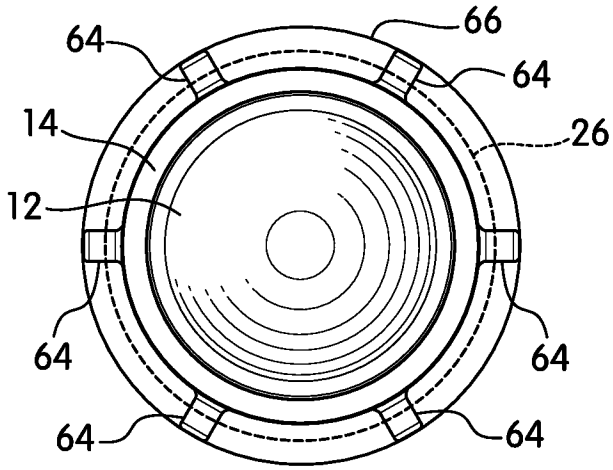


FIG. 17

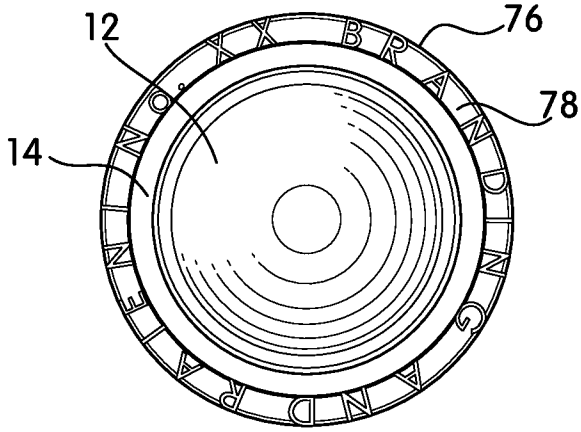


FIG. 20

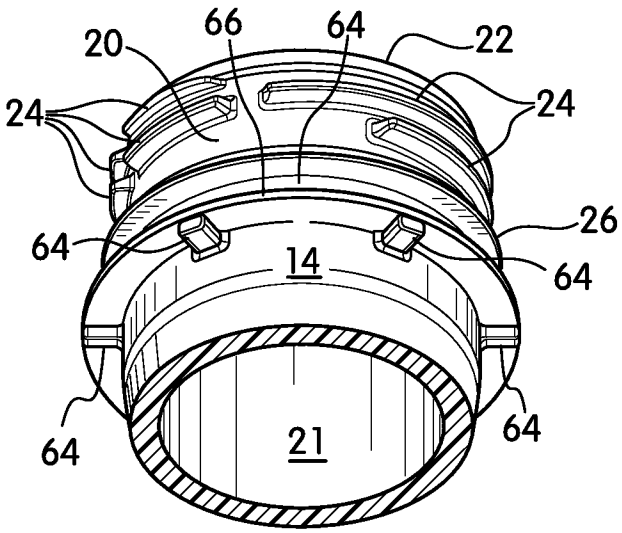


FIG. 18

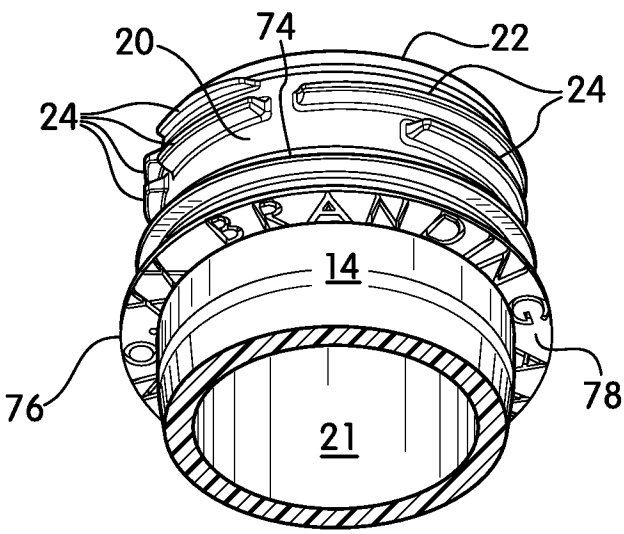


FIG. 21

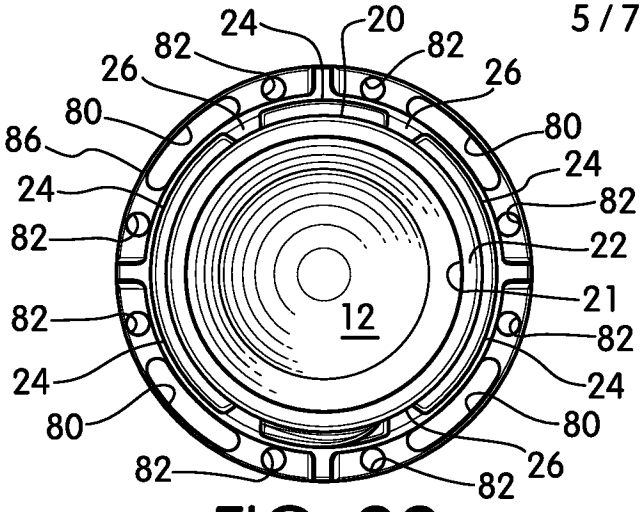


FIG. 22

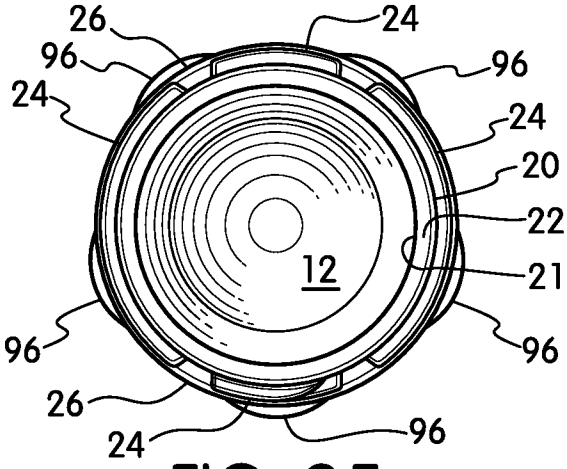


FIG. 25

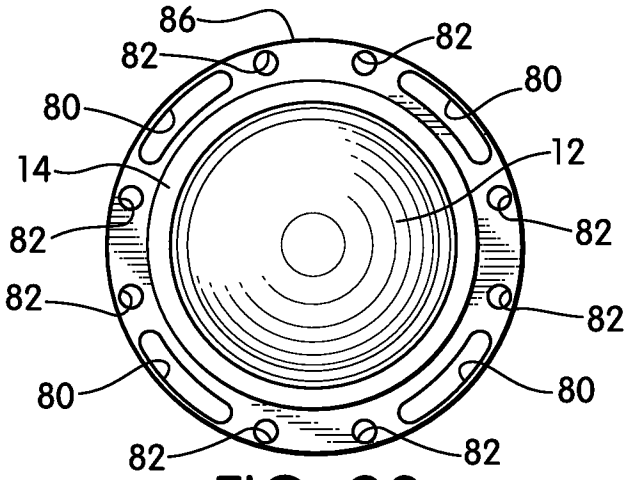


FIG. 23

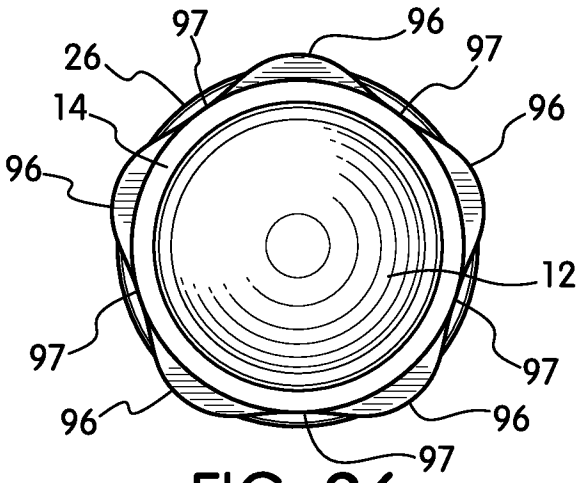


FIG. 26

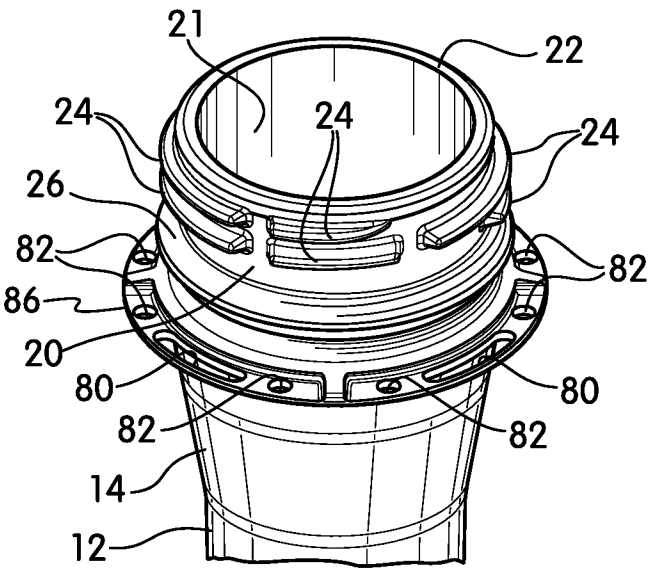


FIG. 24

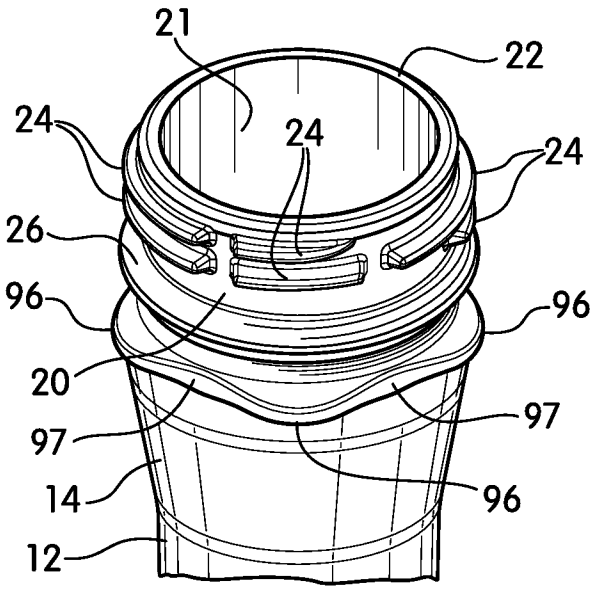


FIG. 27

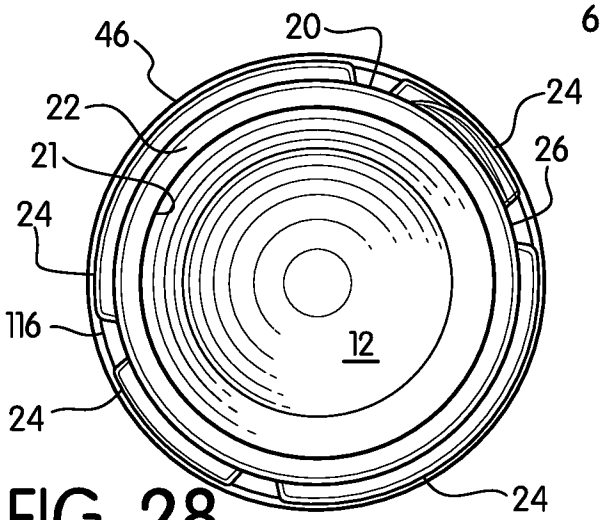


FIG. 28

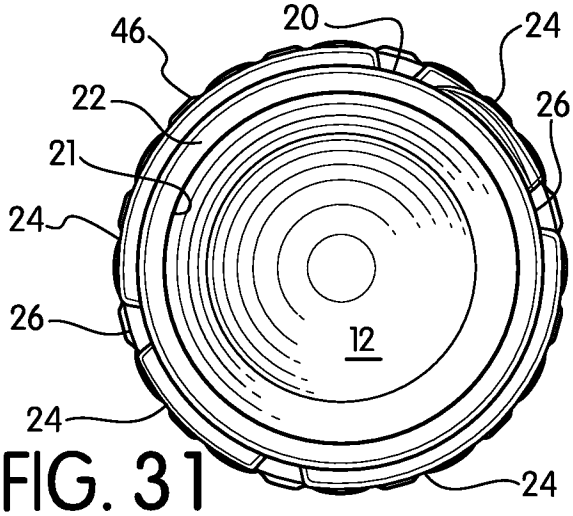


FIG. 31

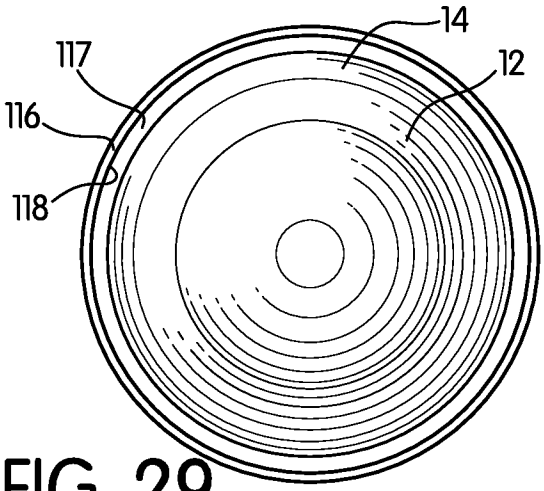


FIG. 29

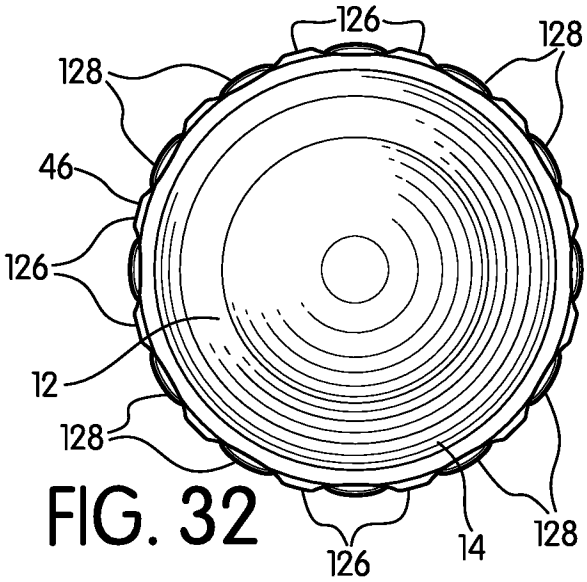


FIG. 32

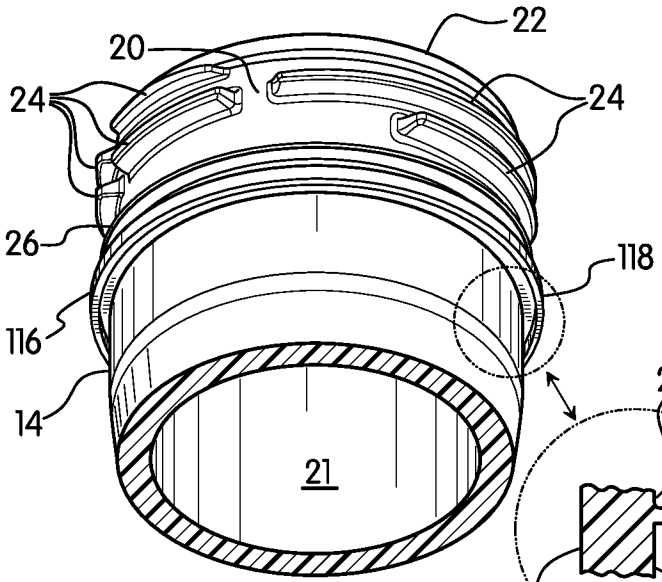


FIG. 30

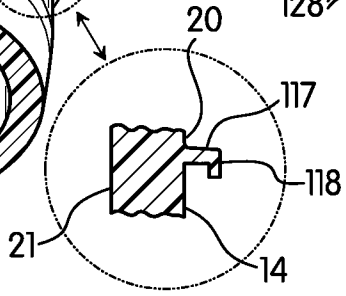


FIG. 30A

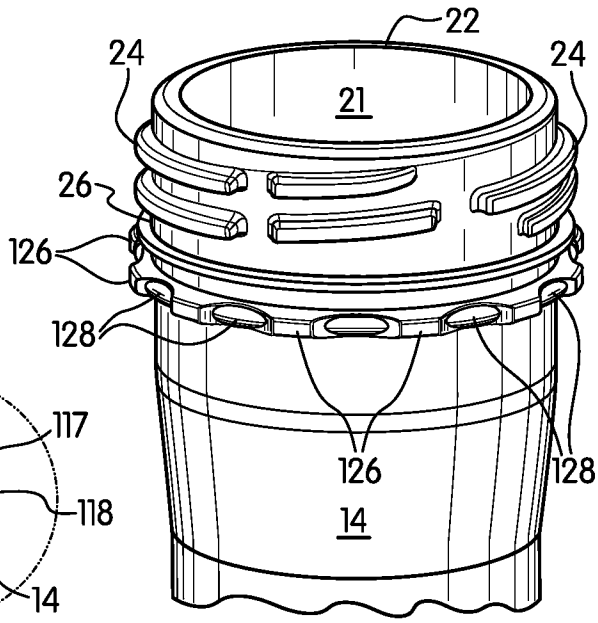


FIG. 33

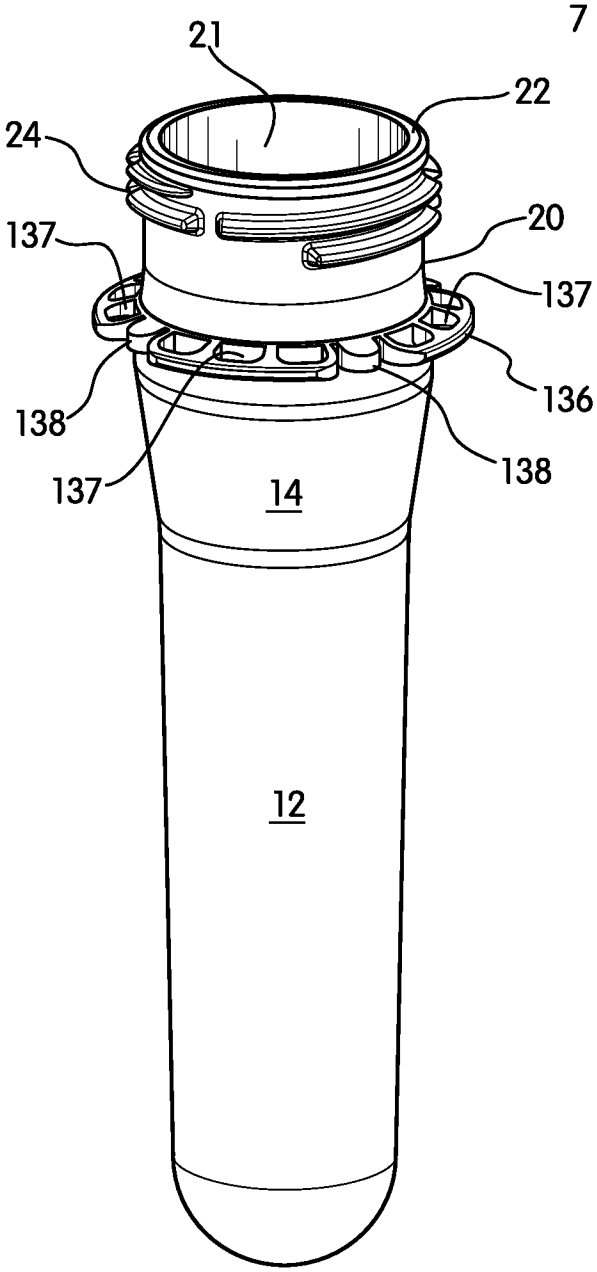


FIG. 34

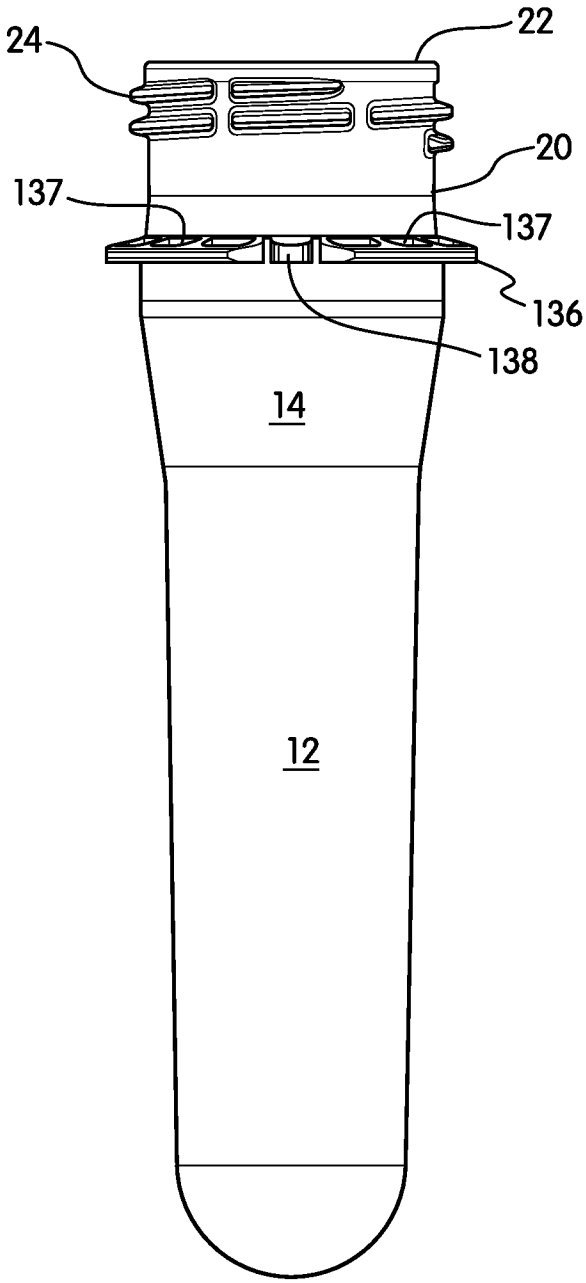


FIG. 35

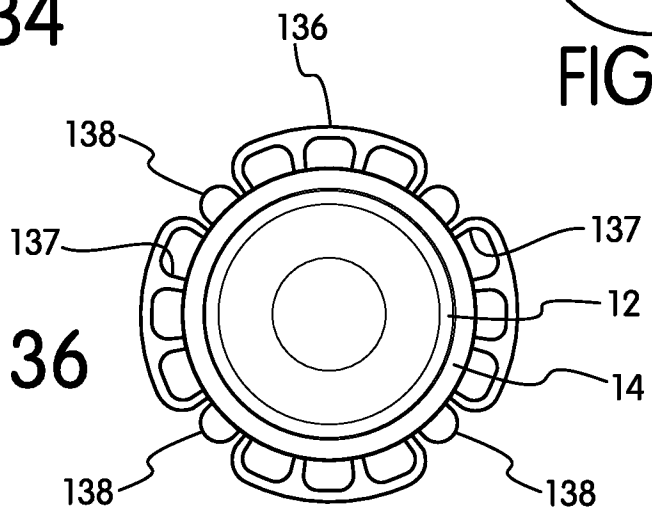


FIG. 36