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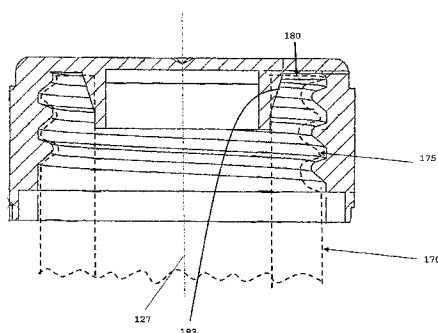
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(54) Title: CAP FOR VIAL THAT HOLDS SPECIMENS



(57) Abstract: A cap for sealing a vial, comprising: a top wall having an inner surface and an outer surface; a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with a counterpart connection mechanism formed on the vial; characterized in that: an inner seal is provided on the underside of the cap, wherein the inner seal comprises a generally tubular structure which extends inwardly from the inner surface of the top wall, coaxial with, but radially spaced from, the side wall of the cap, wherein the inner seal comprises an inner surface and an outer surface, and further wherein when the cap is seated on the vial, (i) the top rim of the vial will make a secure seal against the inner surface of the top wall of the cap, and (ii) the top inside

rim of the vial will make a secure seal with the outer surface of the inner seal. A cap for sealing a vial, comprising: a top wall having an inner surface and an outer surface; a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with a counterpart connection mechanism formed on the vial; characterized in that: a projection is formed on the inner surface of the top wall, coaxial with, but spaced from, the side wall of the cap, and further wherein when the cap is seated on the vial, the top rim of the vial will make a secure seal against the projection and the inner surface of the top wall. A cap for sealing a vial of the sort comprising a tubular top end defining a cylindrical outer surface with a connection mechanism thereon, a top annular rim and a cylindrical inner surface, the cap comprising: a top wall having an inner surface and an outer surface; a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with the connection mechanism formed on the vial/ characterized in that: the cap comprises an inner seal comprising a tubular structure extending coaxially with, but radially spaced from, the cylindrical side wall of the cap, wherein the inner seal comprises an inner surface and an outer surface, and wherein when the cap is seated on the vial, (i) the top rim of the vial will make a secure seal against the inner surface of the wherein the inner seal comprises an inner surface and an outer surface, and further wherein when the cap is seated on the vial, (i) the top rim of the vial will make a secure seal against the inner surface of the top wall of the cap, and (ii) the top inside rim of the vial will make a secure seal with the outer surface of the inner seal. A container assembly comprising: a vial; and a cap for sealing the vial, comprising: a top wall having an inner surface and an outer surface; a cylindrical side wall connected to

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CAP FOR VIAL THAT HOLDS SPECIMENSReference To Pending Prior Patent Application

This patent application claims benefit of pending prior U.S. Provisional Patent Application Serial No. 60/688,746, filed 06/08/2005 by James Bruno for SEPTUMLESS, DOUBLE SEALING, THREADED CAPS AND CLOSURES FOR VIALS, BOTTLES AND OTHER CONTAINERS THAT HOLD MEDIA, LIQUIDS AND SAMPLES (Attorney's Docket No. BRUNO-1 PROV).

The aforementioned provisional patent application is hereby incorporated herein by reference.

Field Of The Invention

This invention relates to caps for vials, and more particularly to caps of the type which permit access to the interior of the vial without removal of the cap.

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Background Of The Invention

Today, laboratory personnel face applications that are increasingly more challenging. Due to the highly sensitive nature of the laboratory work, it is important that the laboratory personnel use the best possible equipment, including the best vials and caps, in order to ensure that a specimen is accurately analyzed. Use of a vial and cap which fail to properly seal can result in contamination of the specimen or, in the case of volatile specimens, loss of the specimen through evaporation. Furthermore, the vial and cap must be inert vis-a-vis the specimen in order to avoid having the vial and/or cap themselves contaminate the specimen.

Accordingly, it will be appreciated that the vials and their caps: (i) must not contaminate the specimen; and (ii) must maintain an effective seal so as to prevent contamination and/or loss of the specimen.

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In many situations, the vial cap should also permit access to the interior of the vial without necessitating removal of the cap.

Typically, the caps used to seal a vial have a central opening which is closed off by a special liner or "septum". The septum is configured so that it may be penetrated by a sharp sampling instrument (i.e., a needle), whereby to permit access to the interior of the vial without removing the cap. As noted above, the cap, including its septum component, must be constructed so that: (i) it does not itself contaminate the specimen, and (ii) it is able to maintain an effective seal with the vial prior to penetration by a needle.

In order to meet these requirements, the septum is typically formed with two layers, a silicone outer layer and a polytetrafluoroethylene (PTFE) inner layer. The silicone outer layer serves as the sealing agent since the softness of the silicone allows it to "squeeze" against the top of the vial, thereby forming a reliable seal. However, silicone is reactive with

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many materials, which could result in contamination of the specimen if the silicone were to come into contact with the specimen, either directly or via the needle during the sampling process. As a result, the silicone outer layer is typically lined with an inert inner layer, i.e., the PTFE inner layer. To manufacture the complete septum, the silicone layer and the PTFE layer are typically bonded together and then "rolled" out into a single, thin, composite layer. See, for example, Figs. 1 and 2, where there is shown a typical prior art cap 5 having a central opening 10 closed off by a septum 15, wherein septum 15 comprises a composite structure formed by a silicone outer layer 20 and a PTFE inner layer 25. Due to the nature of septum 15, it is possible to pass a sharp sampling needle through the septum, whereby to access the interior of the vial without necessitating the removal of the cap from the vial.

Thus it will be seen that the foregoing prior art cap construction provides a closure which can both seal the vial, and yet selectively permit access to

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extend inwardly from outer surface 120. Score lines 140 preferably intersect at an apex 145. Score lines 140 provide a weakened zone in top wall 110 so as to facilitate penetration of top wall 110 by a sampling needle, as will hereinafter be discussed. Cylindrical side wall 125 includes screw threads 150 formed on inner surface 130. Screw threads 150 mate with counterpart screw threads formed on the top of a vial.

In accordance with the present invention, an inner seal 155 is provided on the underside of cap 105. More particularly, inner seal 155 comprises a generally tubular (cylindrical and tapered) structure which extends inwardly from inner surface 115, coaxial with, but radially spaced from, side wall 125. In one preferred form of the invention, inner seal 155 comprises a cylindrical inner surface 160 which extends substantially coaxial with the longitudinal axis of the cap and an outer surface 165 which is inclined, in a frustoconical manner, relative to the longitudinal axis of the cap.

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In view of the foregoing construction, and looking now at Fig. 14, it will be appreciated that cap 105 may be secured to a vial 170 by screwing cap 105 onto the top of vial 170, with the cap's screw threads 150 engaging the vial's counterpart screw threads 175, and with (i) the top rim 180 of vial 170 making a secure seal with inner surface 115 of cap 105, and (ii) top inside rim 183 of vial 170 making a secure seal with the inclined outer surface 165 of inner seal 155. Due to the geometries selected for cap 105, a reliable seal may be achieved between cap 105 and vial 170 even where cap 105 is formed out of a single, easily moldable material which is non-reactive with the contents of the vial, e.g., an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK, nylon, etc. Among other things, the combination of (i) the seal against the underside of the cap, and (ii) the seal against the inner seal 155 of the cap, provides a double sealing design, which will effectively seal in even volatile solutions, which are the most difficult to contain.

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Looking now at Fig. 15, when it is desired to access the contents of the vial, a sharp sampling needle 185 is driven through the cap's top wall 110 at the weakened apex 145. By utilizing the weakened apex design described above, fast and easy penetration on top wall 110 is achieved. More particularly, when the sampling needle applies pressure on the weakened apex 145, the score lines 140 allow the needle to penetrate the top wall of the cap with much less force than would be required if no weakened apex were provided.

Second Embodiment

Looking now at Figs. 16-29, there is shown a cap 205 which generally comprises a top wall 210 having an inner surface 215 and an outer surface 220, and a cylindrical side wall 225 extending substantially coaxial with the cap's longitudinal axis 227 and having an inner surface 230 and an outer surface 235. Top wall 210 preferably includes score lines 240 which extend inwardly from outer surface 220. Score lines 240 preferably intersect at an apex 245. Score lines

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240 provide a weakened zone in top wall 210 so as to facilitate penetration of top wall 210 by a sampling needle, as will hereinafter be discussed. Cylindrical side wall 225 includes screw threads 250 formed on inner surface 230. Screw threads 250 mate with counterpart screw threads formed on the top of a vial.

In accordance with the present invention, an inner seal 255 is provided on the underside of cap 205. More particularly, inner seal 255 comprises a generally tubular (cylindrical and tapered) structure which extends inwardly from inner surface 215, coaxial with, but radially spaced from, side wall 225. In one preferred form of the invention, inner seal 255 comprises a cylindrical inner surface 260 which extends substantially coaxial with the longitudinal axis of the cap and an outer surface 265 which is inclined, in a frustoconical manner, relative to the longitudinal axis of the cap.

Also in accordance with the present invention, in this form of the invention, at least the central portion 290 of top wall 210 is domed upward so as to

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provide additional column strength against the force of a penetrating needle.

In view of the foregoing construction, and looking now at Fig. 18, it will be appreciated that cap 205 may be secured to a vial 270 by screwing cap 205 onto the top of vial 270, with the cap's screw threads 250 engaging counterpart screw threads formed on the upper end of vial 270, and with (i) the top rim of vial 270 making a secure seal with inner surface 215 of cap 205, and (ii) the top inside rim of vial 270 making a secure seal with the inclined outer surface 265 of inner seal 255. Again, due to the geometries selected for cap 205, a reliable seal may be achieved between cap 205 and vial 270 even where cap 205 is formed out of a single, easily moldable material which is non-reactive with the contents of the vial, e.g., an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK, nylon, etc. Among other things, the combination of (i) the seal against the underside of the cap, and (ii) the seal against the inner seal 255 of the cap, provides a

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double sealing design, which will effectively seal in even volatile solutions, which are the most difficult to contain.

Again, when it is desired to access the contents of the vial, a sharp sampling needle is driven through the cap's top wall 210 at the weakened apex 245. By utilizing the weakened apex design described above, fast and easy penetration of top wall 210 is achieved. More particularly, when the sampling needle applies pressure on the weakened apex 245, the score lines 240 allow the needle to penetrate the top wall of the cap with much less force than would be required if no weakened apex were provided.

Third Embodiment

Looking now at Fig. 30, there is shown a cap 305 which generally comprises a top wall 310 having an inner surface 315 and an outer surface 320, and a cylindrical side wall 325 extending substantially coaxial with the cap's longitudinal axis 327 and having an inner surface 330 and an outer surface 335.

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Top wall 310 preferably includes score lines 340 which extend inwardly from outer surface 320. Score lines 340 preferably intersect at an apex 345. Score lines 340 provide a weakened zone in top wall 310 so as to facilitate penetration of top wall 310 by a sampling needle, as will hereinafter be discussed. Cylindrical side wall 325 includes screw threads 350 formed on inner surface 330. Screw threads 350 mate with counterpart screw threads formed on the top of a vial.

In accordance with the present invention, an inner seal 355 is provided on the underside of cap 305. More particularly, inner seal 355 comprises a generally tubular (cylindrical and tapered) structure which extends inwardly from inner surface 315, coaxial with, but radially spaced from, side wall 325. In one preferred form of the invention, inner seal 355 comprises a cylindrical inner surface 360 which extends substantially coaxial with the longitudinal axis of the cap and an outer surface 365 which is inclined, in a frustoconical manner, relative to the longitudinal axis of the cap.

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Also in accordance with the present invention, in this form of the invention, at least the central portion 390 of top wall 310 is domed upward so as to provide additional column strength against the force of a penetrating needle.

And in further accordance with the present invention, in this form of the invention, a projection 395 is formed on inner surface 315 of cap 305, in the region between side wall 325 and inner seal 355. Projection 395 preferably is in the form of an annular ring having a hemispherical cross-section, whereby to form the equivalent of an O-ring underseal for engagement with the top rim of the vial.

In view of the foregoing construction, it will be appreciated that cap 305 may be secured to a vial by screwing cap 305 onto the top of the vial, with the cap's screw threads 350 engaging counterpart screw threads formed on the upper end of the vial and with (i) the top rim of the vial making a secure seal with projection 395 and with inner surface 315 of cap 305, and (ii) the top inside rim of the vial making a

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secure seal with the inclined outer surface 365 of inner seal 355. Again, due to the geometries selected for cap 305, a reliable seal may be achieved between cap 305 and the vial even where cap 305 is formed out of a single, easily moldable material which is non-reactive with the contents of the vial, e.g., an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK, nylon, etc. Among other things, the combination of (i) a seal against the underside of the cap, and (ii) the seal against the inner seal 355 of the cap, provides a double sealing design, which will effectively seal in even volatile solutions, which are the most difficult to contain.

Again, when it is desired to access the contents of the vial, a sharp sampling needle is driven through the cap's top wall 310 at the weakened apex 345. By utilizing the weakened apex design described above, fast and easy penetration of top wall 310 is achieved. More particularly, when the sampling needle applies pressure on the weakened apex 345, the score lines 340

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allow the needle to penetrate the top wall of the cap with much less force than would be required if no weakened apex were provided.

Fourth Embodiment

Looking now at Figs. 31-45, there is shown a cap 405 which generally comprises a top wall 410 having an inner surface 415 and an outer surface 420, and a cylindrical side wall 425 extending substantially coaxial with the cap's longitudinal axis 427 and having an inner surface 430 and an outer surface 435. Top wall 410 preferably includes score lines 440 which extend inwardly from outer surface 420. Score lines 440 preferably intersect at an apex 445. Score lines 440 provide a weakened zone in top wall 410 so as to facilitate penetration of top wall 410 by a sampling needle, as will hereinafter be discussed. Cylindrical side wall 425 includes screw threads 450 formed on inner surface 430. Screw threads 450 mate with counterpart screw threads formed on the top of a vial.

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Also in accordance with the present invention, in this form of the invention, at least the central portion 490 of top wall 410 is domed upward so as to provide additional column strength against the force of a penetrating needle.

And in further accordance with the present invention, in this form of the invention, a projection 495 is formed on inner surface 415 of cap 405, coaxial with, but spaced from, side wall 425. Projection 495 preferably is in the form of an annular ring having a hemispherical cross-section, whereby to form the equivalent of an O-ring underseal for engagement with the top rim of the vial.

In view of the foregoing construction, it will be appreciated that cap 405 may be secured to vial 470 by screwing cap 405 onto the top of vial 470, with the cap's screw threads 450 engaging counterpart screw threads formed on the upper end of vial 470, and with the top rim of the vial making a secure seal with projection 495 and with inner surface 415 of cap 405. Again, due to the geometries selected for cap 405, a

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reliable seal may be achieved between cap 405 and vial 470 even where cap 405 is formed out of a single, easily moldable material which is non-reactive with the contents of the vial, e.g., an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK, nylon, etc. Among other things, the seal against the underside of the cap provides a reliable seal which will effectively seal in even volatile solutions, which are the most difficult to contain.

Again, when it is desired to access the contents of the vial, a sharp sampling needle is driven through the cap's top wall 410 at the weakened apex 445. By utilizing the weakened apex design described above, fast and easy penetration of top wall 410 is achieved. More particularly, when the sampling needle applies pressure on the weakened apex 445, the score lines 440 allow the needle to penetrate the top wall of the cap with much less force than would be required if no weakened apex were provided.

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Vial Size

The present invention is typically used with a 9 mm vial, however, it is important to note that the cap of the present invention can be used for vials and other containers of various sizes.

Other Types of Cap/Vial Connections

In the foregoing discussions, the novel cap is described as mounting to the vial with a screw-on connection. However, it should be appreciated that the novel cap may be mounted to the vial with another type of connection, e.g., a snap-on mount, a bayonet-type mount, etc.

Modifications

It is to be understood that the present invention is by no means limited to the particular constructions herein disclosed and/or shown in the drawings, but also comprises any modifications or equivalents within the scope of the invention.

What Is Claimed Is:

1. A cap for sealing a vial, comprising:

a top wall having an inner surface and an outer surface;

a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with a counterpart connection mechanism formed on the vial;

characterized in that:

an inner seal is provided on the underside of the cap, wherein the inner seal comprises a generally tubular structure which extends inwardly from the inner surface of the top wall, coaxial with, but radially spaced from, the side wall of the cap, wherein the inner seal comprises an inner surface and an outer surface, and further wherein when the cap is seated on the vial, (i) the top rim of the vial will

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make a secure seal against the inner surface of the top wall of the cap, and (ii) the top inside rim of the vial will make a secure seal with the outer surface of the inner seal.

2. A cap according to claim 1 wherein the outer surface of the inner seal is inclined.

3. A cap according to claim 2 wherein the outer surface of the inner seal is inclined in a frustoconical manner.

4. A cap according to claim 1 wherein the inside surface of the inner seal is cylindrical.

5. A cap according to claim 1 wherein the inside surface of the inner seal is cylindrical and the outside surface of the inner seal is tapered.

6. A cap according to claim 1 wherein the cap is formed out of a single material which is selected

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from the group consisting of: an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK and nylon.

7. A cap according to claim 1 wherein the top wall includes at least one score line which extends inwardly from the outer surface of the top wall.

8. A cap according to claim 7 wherein the top wall comprises a plurality of score lines which intersect at an apex.

9. A cap according to claim 1 wherein the top wall comprises a dome configuration.

10. A cap according to claim 1 wherein a projection is formed on the inner surface of the top wall, in the region between the side wall of the cap and the inner seal.

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11. A cap according to claim 10 wherein the projection is in the form of an annular ring having a hemispherical cross-section.

12. A cap according to claim 1 wherein the connection mechanism comprises a screw thread.

13. A cap according to claim 1 wherein the connection mechanism comprises a snap mount.

14. A cap according to claim 1 wherein the connection mechanism comprises a bayonet mount.

15. A cap for sealing a vial, comprising:
a top wall having an inner surface and an outer surface;
a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being

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configured to mate with a counterpart connection mechanism formed on the vial;

characterized in that:

a projection is formed on the inner surface of the top wall, coaxial with, but spaced from, the side wall of the cap, and further wherein when the cap is seated on the vial, the top rim of the vial will make a secure seal against the projection and the inner surface of the top wall.

16. A cap according to claim 15 wherein the projection is in the form of an annular ring having a hemispherical cross-section.

17. A cap according to claim 15 wherein the cap is formed out of a single material which is selected from the group consisting of: an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK and nylon.

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18. A cap according to claim 15 wherein the top wall includes at least one score line which extends inwardly from the outer surface of the top wall.

19. A cap according to claim 18 wherein the top wall comprises a plurality of score lines which intersect at an apex.

20. A cap according to claim 15 wherein the top wall comprises a dome configuration.

21. A cap according to claim 15 wherein the connection mechanism comprises a screw thread.

22. A cap according to claim 15 wherein the connection mechanism comprises a snap mount.

23. A cap according to claim 15 wherein the connection mechanism comprises a bayonet mount.

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24. A cap for sealing a vial of the sort comprising a tubular top end defining a cylindrical outer surface with a connection mechanism thereon, a top annular rim and a cylindrical inner surface, the cap comprising:

a top wall having an inner surface and an outer surface;

a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with the connection mechanism formed on the vial;

characterized in that:

the cap comprises an inner seal comprising a tubular structure extending coaxially with, but radially spaced from, the cylindrical side wall of the cap, wherein the inner seal comprises an inner surface and an outer surface, and wherein when the cap is seated on the vial, (i) the top rim of the vial will

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make a secure seal against the inner surface of the top wall of the cap, and (ii) the cylindrical inner surface of the vial will make a secure seal with the outer surface of the tubular structure.

25. A cap according to claim 24 wherein the outer surface of the inner seal is inclined.

26. A cap according to claim 25 wherein the outer surface of the inner seal is inclined in a frustoconical manner.

27. A cap according to claim 24 wherein the inside surface of the inner seal is cylindrical.

28. A cap according to claim 24 wherein the inside surface of the inner seal is cylindrical and the outside surface of the inner seal is tapered.

29. A cap according to claim 24 wherein the cap is formed out of a single material which is selected

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from the group consisting of: an olefin, high density polyethylene, low density polyethylene, polypropylene, PEEK and nylon.

30. A cap according to claim 24 wherein the top wall includes at least one score line which extends inwardly from the outer surface of the top wall.

31. A cap according to claim 30 wherein the top wall comprises a plurality of score lines which intersect at an apex.

32. A cap according to claim 24 wherein the top wall comprises a dome configuration.

33. A cap according to claim 24 wherein a projection is formed on the inner surface of the top wall, in the region between the side wall of the cap and the inner seal.

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34. A cap according to claim 33 wherein the projection is in the form of an annular ring having a hemispherical cross-section.

35. A cap according to claim 24 wherein the cap's connection mechanism comprises a screw thread.

36. A cap according to claim 24 wherein the cap's connection mechanism comprises a snap mount.

37. A cap according to claim 24 wherein the cap's connection mechanism comprises a bayonet mount.

38. A container assembly comprising:

a vial; and

a cap for sealing the vial, comprising:

a top wall having an inner surface and an outer surface;

a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a

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connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with a counterpart connection mechanism formed on the vial;

characterized in that:

an inner seal is provided on the underside of the cap, wherein the inner seal comprises a generally tubular structure which extends inwardly from the inner surface of the top wall, coaxial with, but radially spaced from, the side wall of the cap, wherein the inner seal comprises an inner surface and an outer surface, and further wherein when the cap is seated on the vial, (i) the top rim of the vial will make a secure seal against the inner surface of the top wall of the cap, and (ii) the top inside rim of the vial will make a secure seal with the outer surface of the inner seal.

39. A container assembly comprising:

a vial; and

a cap for sealing the vial, comprising:

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a top wall having an inner surface and an outer surface;

a cylindrical side wall connected to the top wall and having an inner surface and an outer surface, wherein the cylindrical side wall includes a connection mechanism formed on the inner surface of the side wall, with the connection mechanism being configured to mate with a counterpart connection mechanism formed on the vial;

characterized in that:

a projection is formed on the inner surface of the top wall, coaxial with, but spaced from, the side wall of the cap, and further wherein when the cap is seated on the vial, the top rim of the vial will make a secure seal against the projection and the inner surface of the top wall.

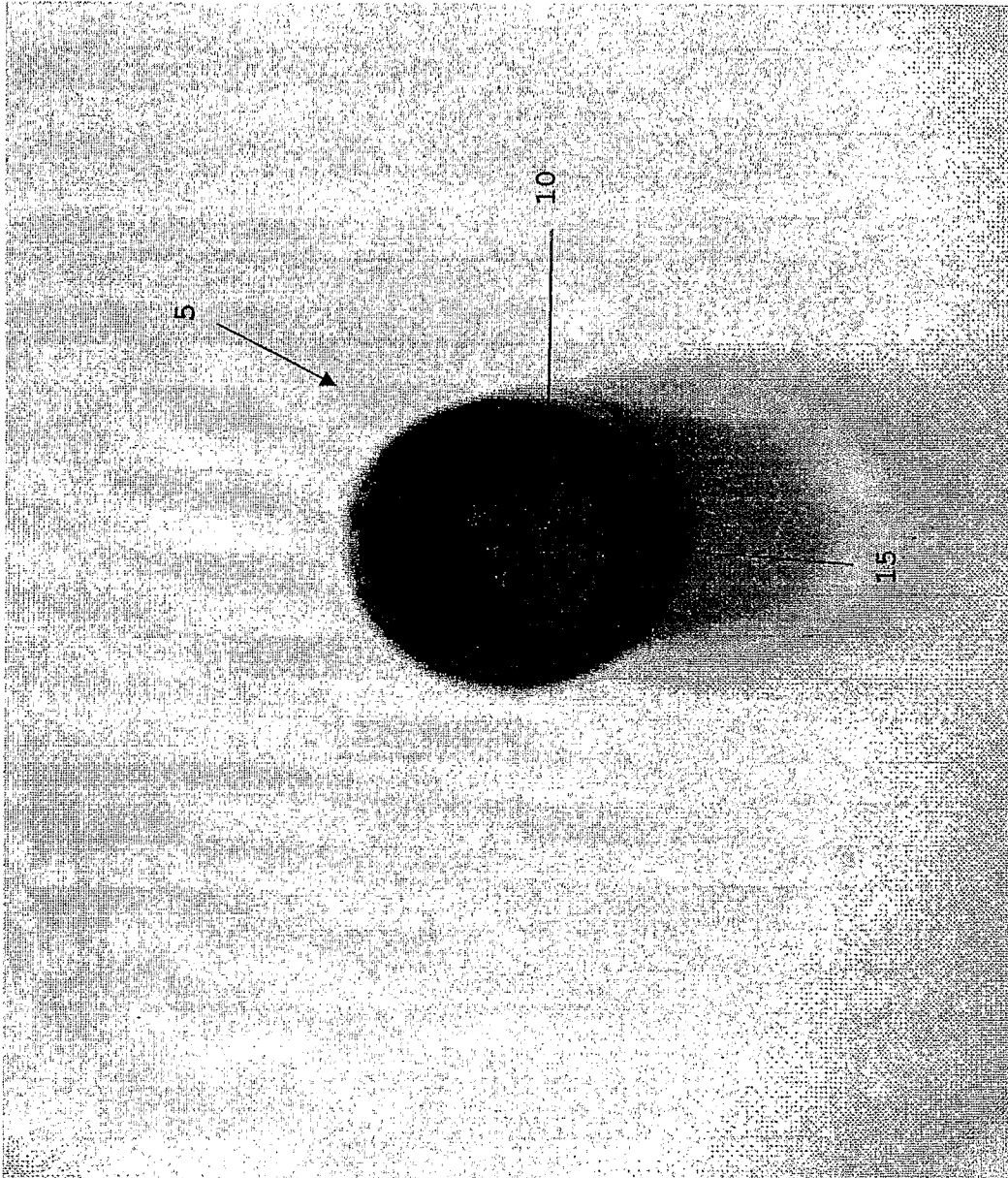


FIG. 1

Prior Art

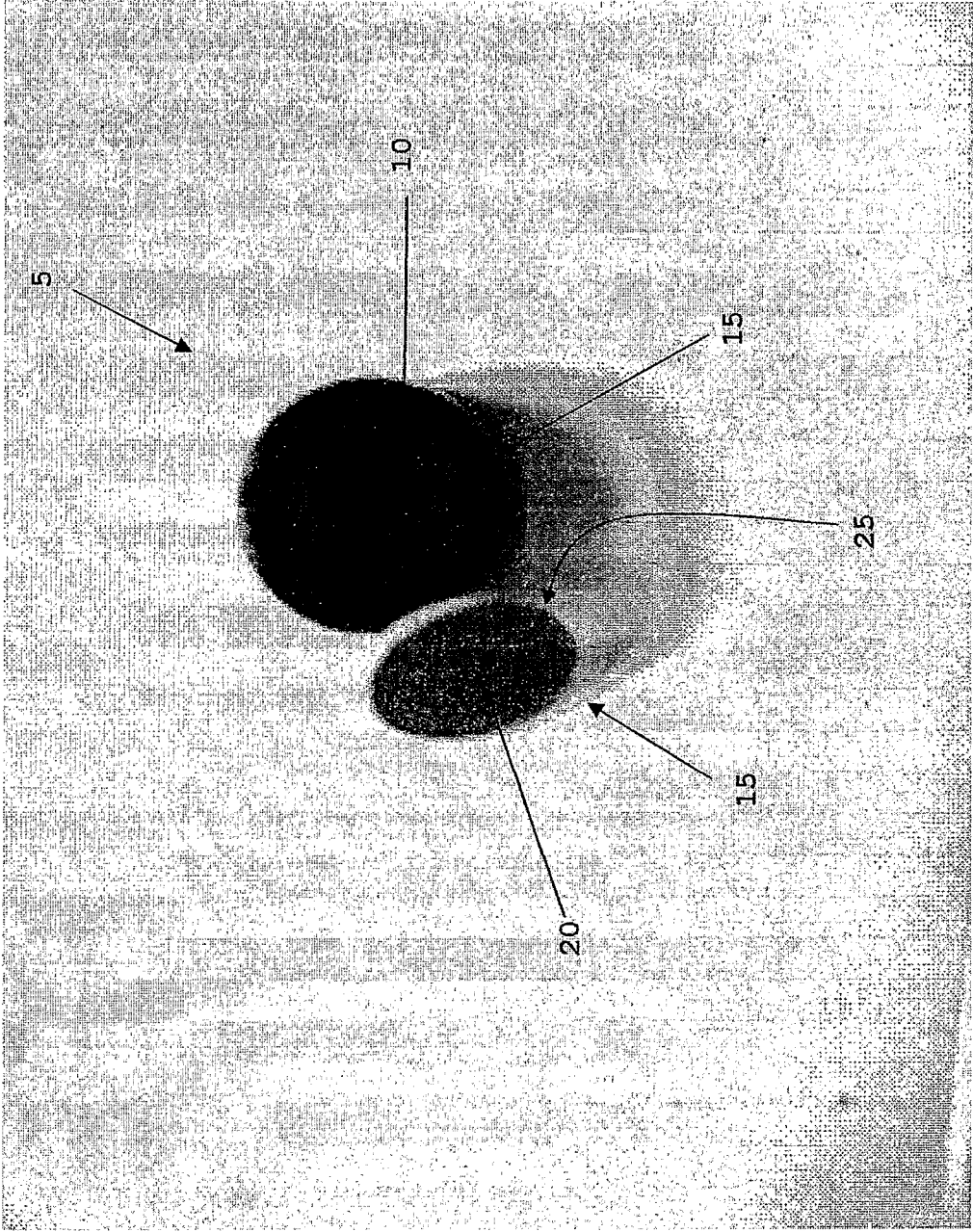


FIG. 2
Prior Art

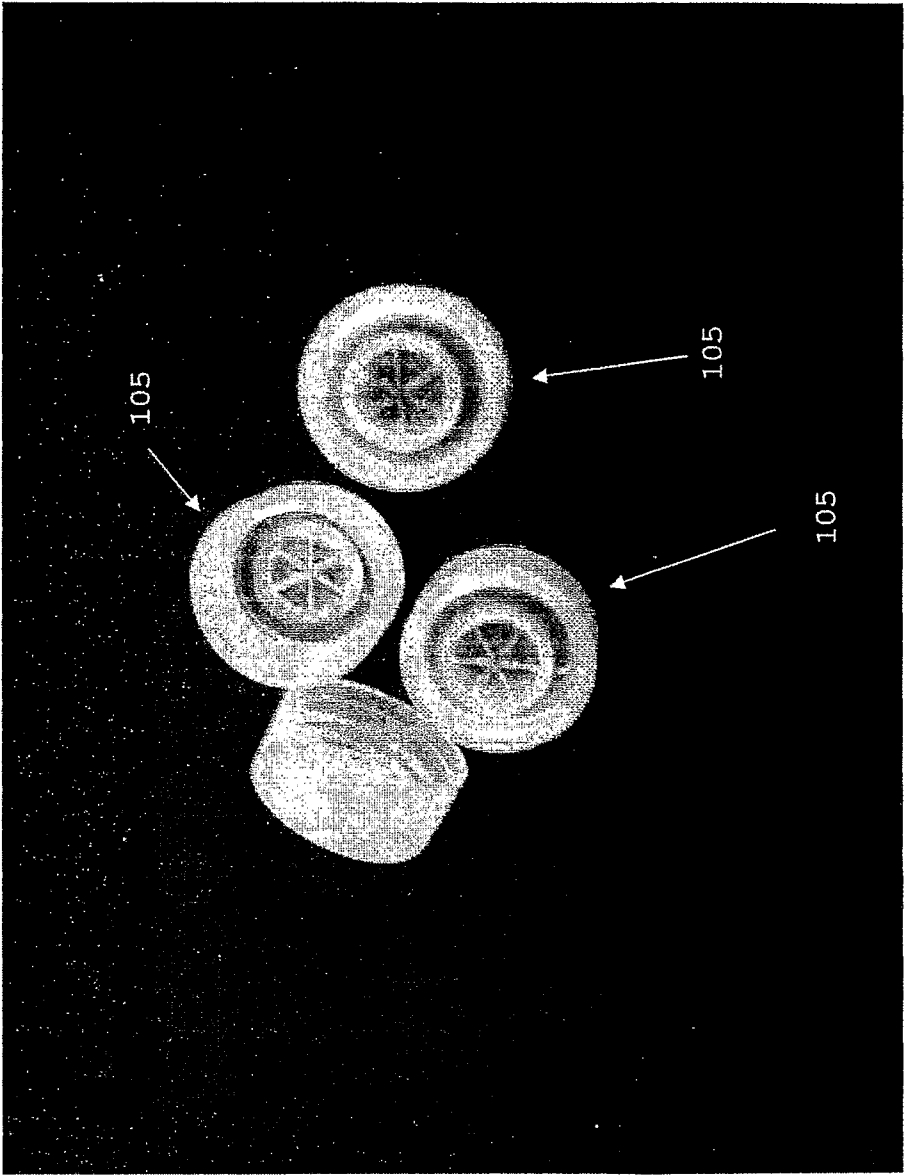


FIG. 3

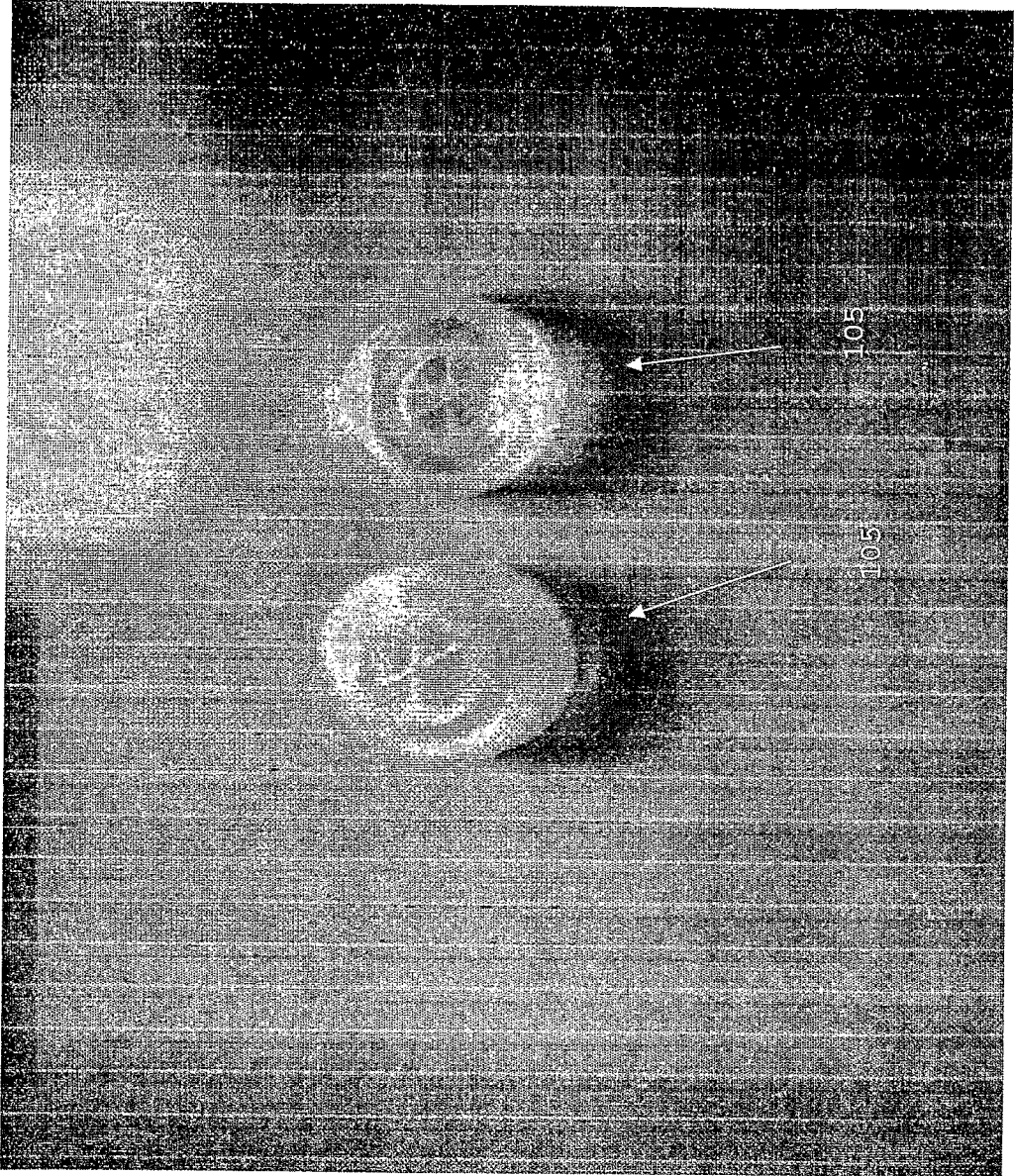


FIG. 4

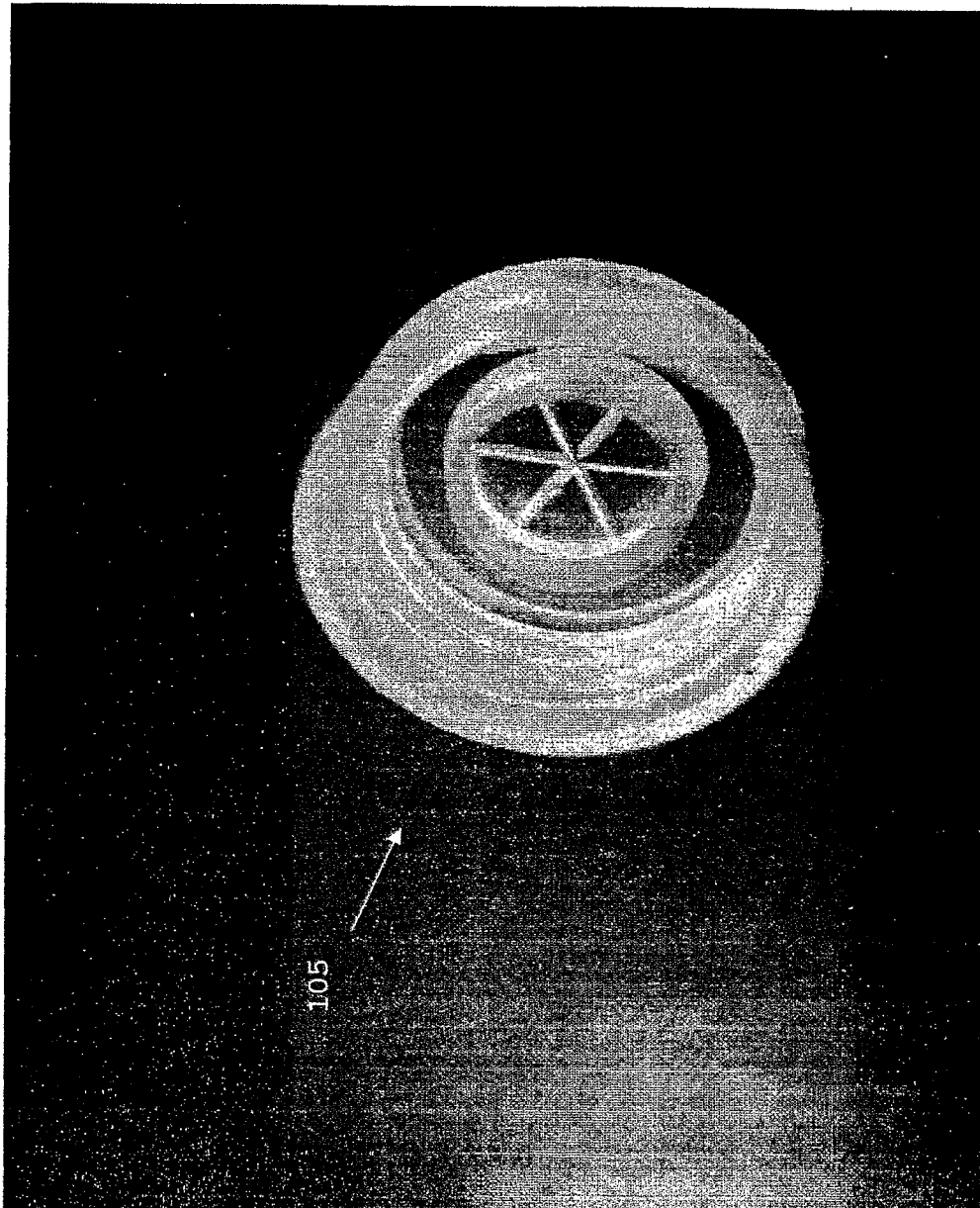


FIG. 5

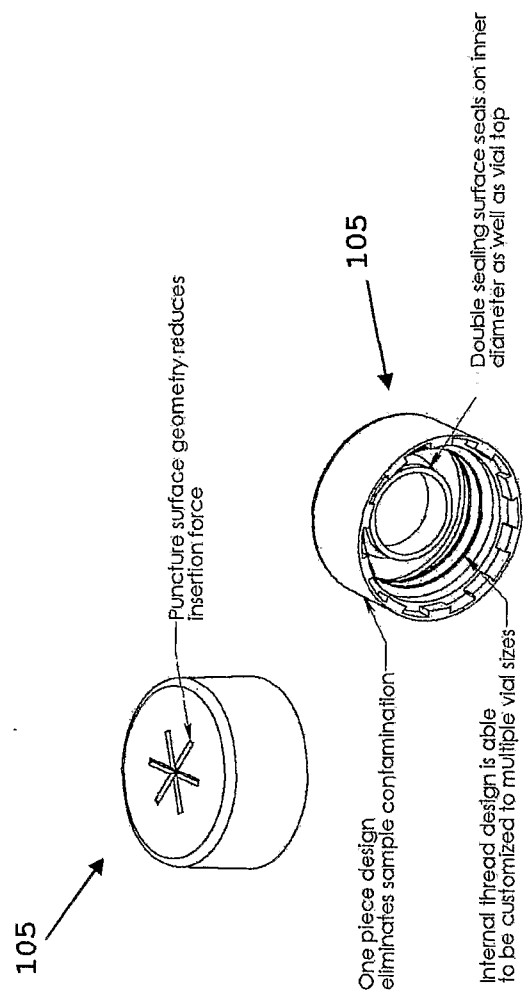


FIG. 6

FIG. 7

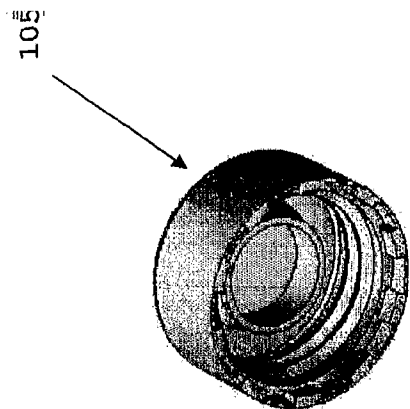


FIG. 9

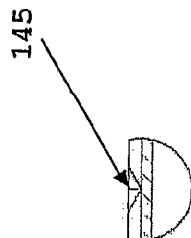


FIG. 13

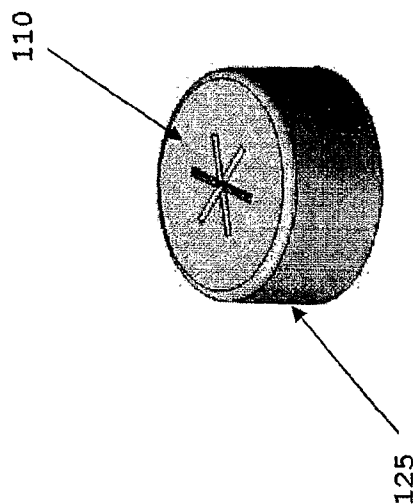


FIG. 8

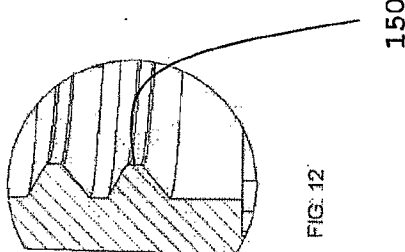


FIG. 12

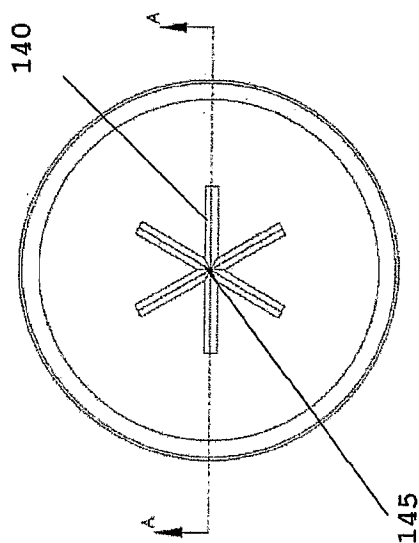


FIG. 10

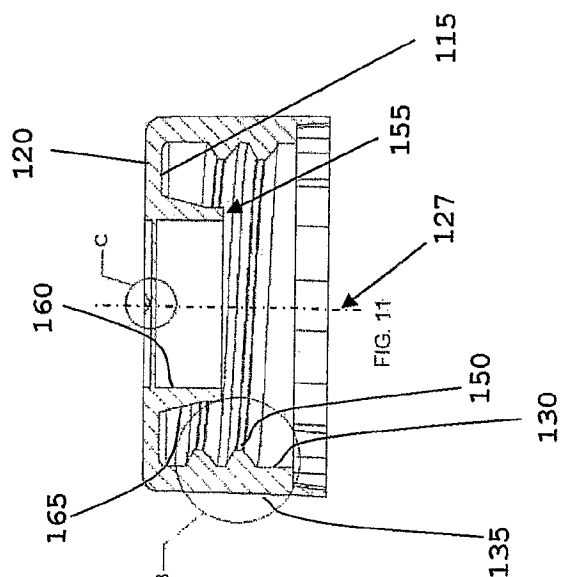


FIG. 11

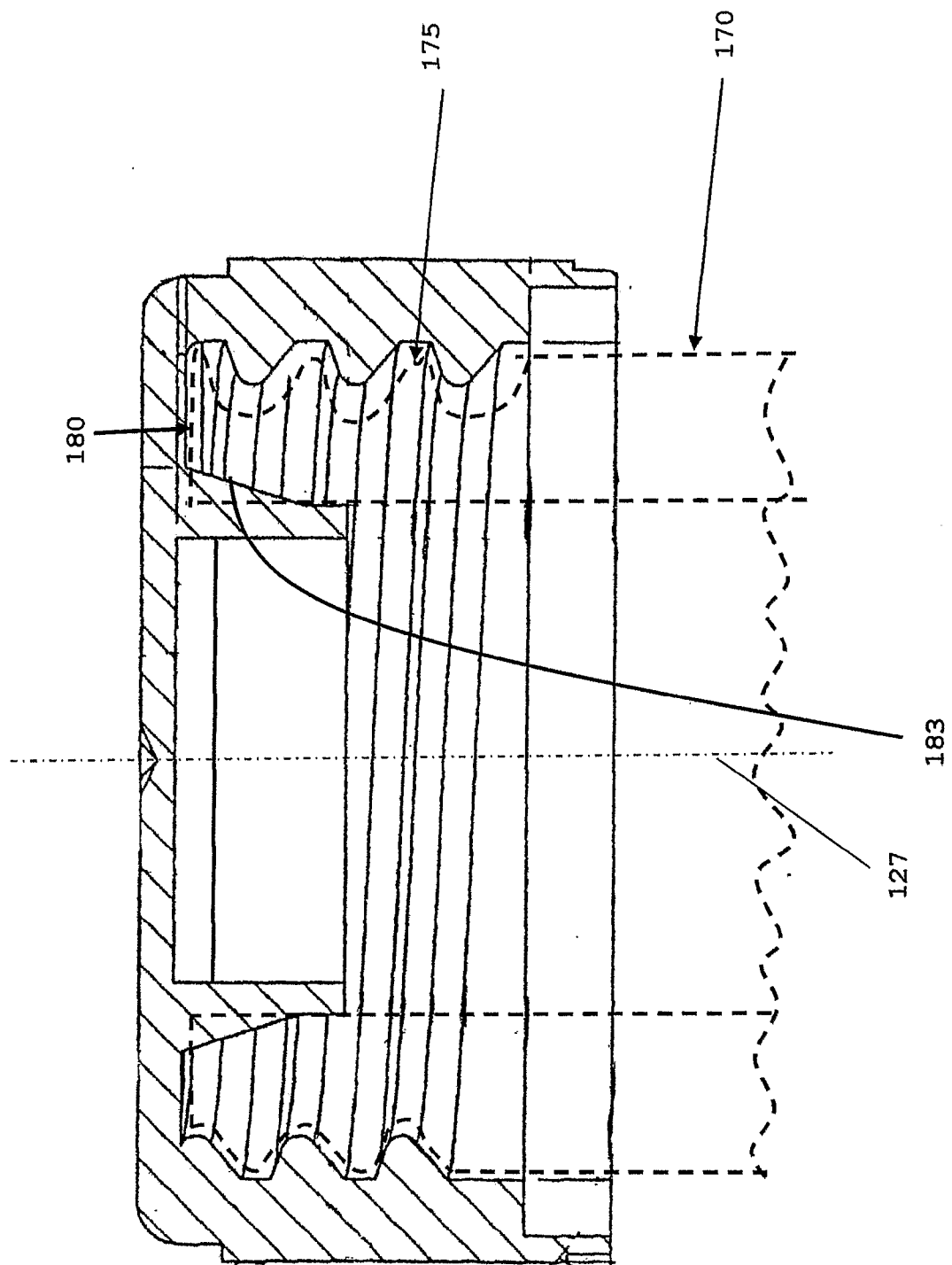


FIG. 14

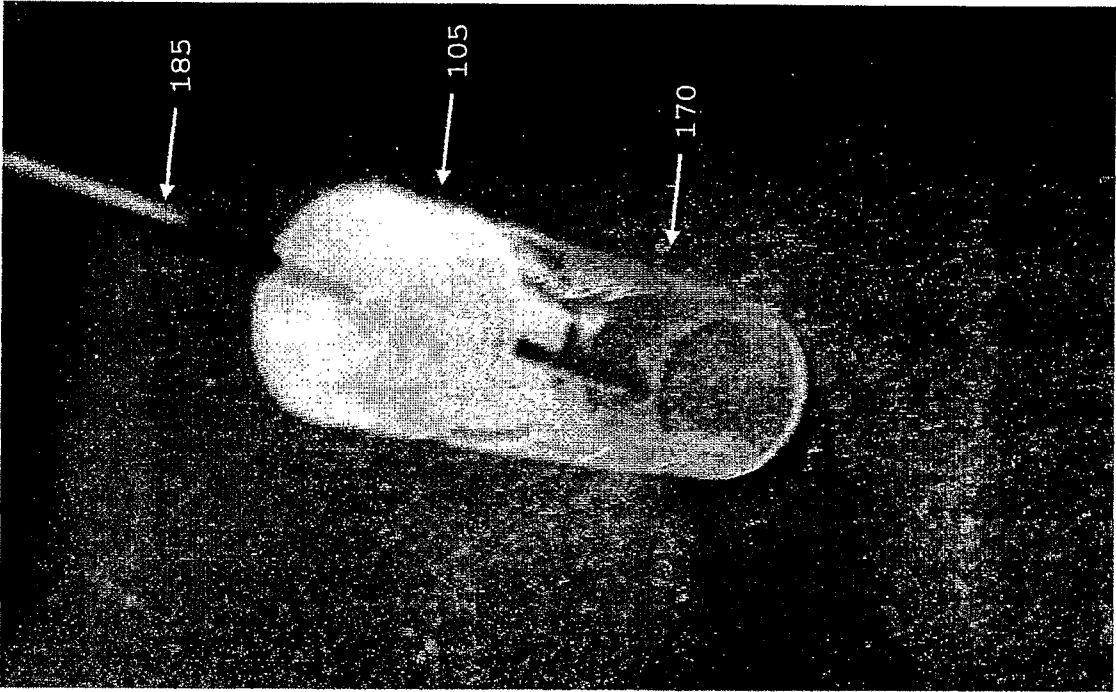
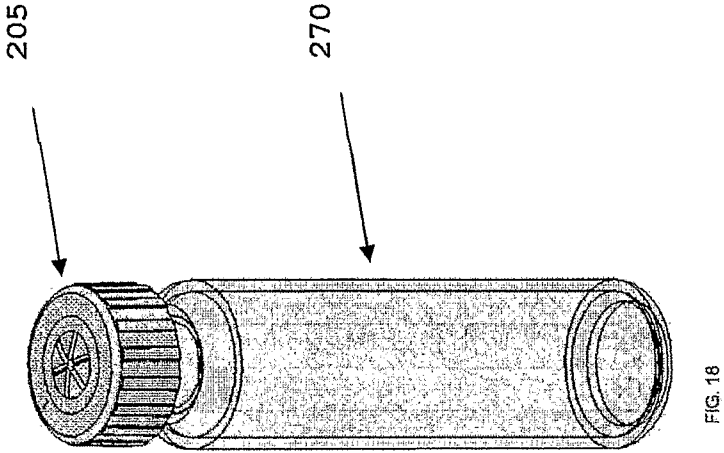
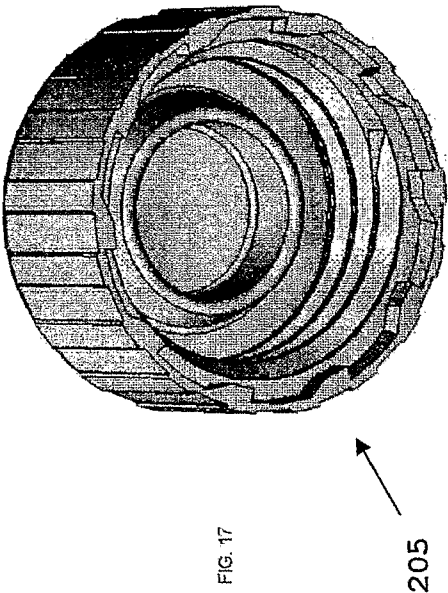
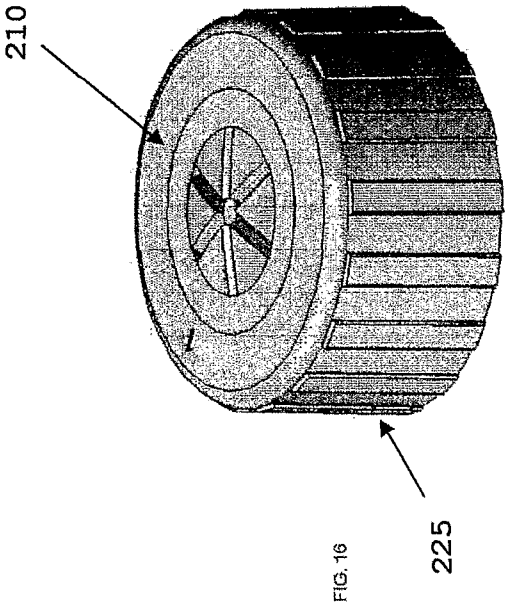


FIG. 15



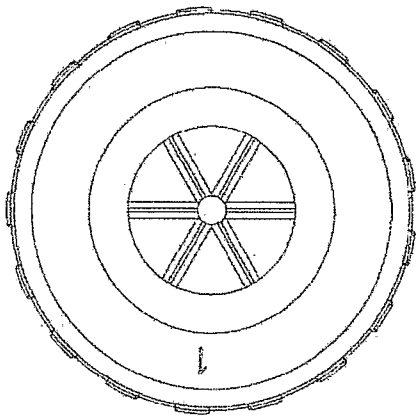


FIG. 19

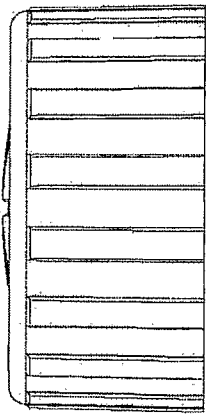


FIG. 20

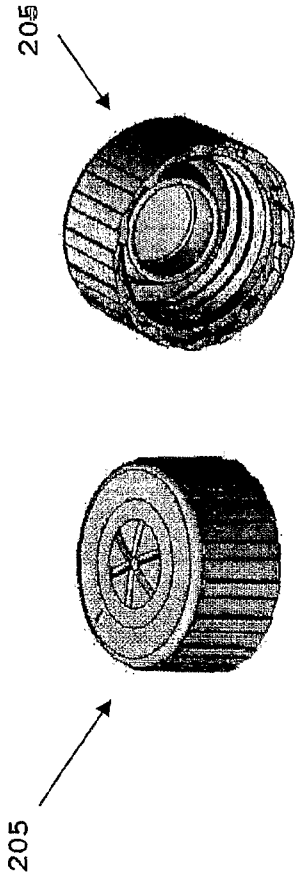


FIG. 22

FIG. 21

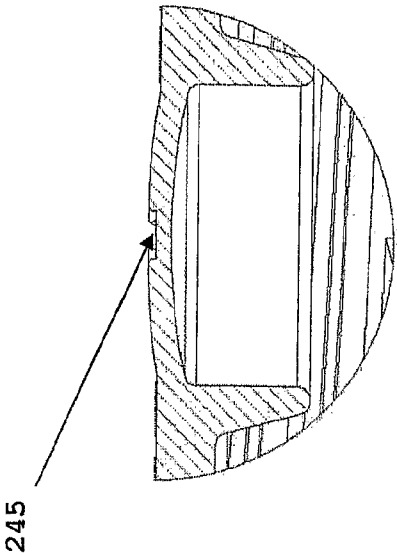


FIG. 25

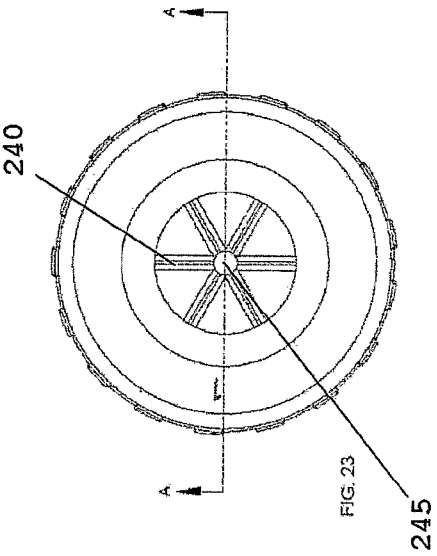
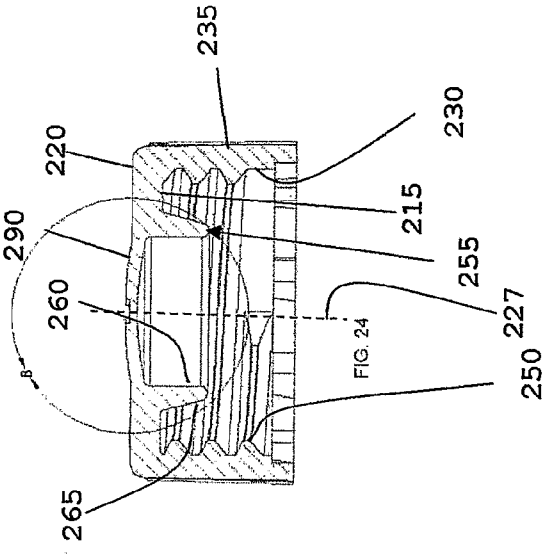
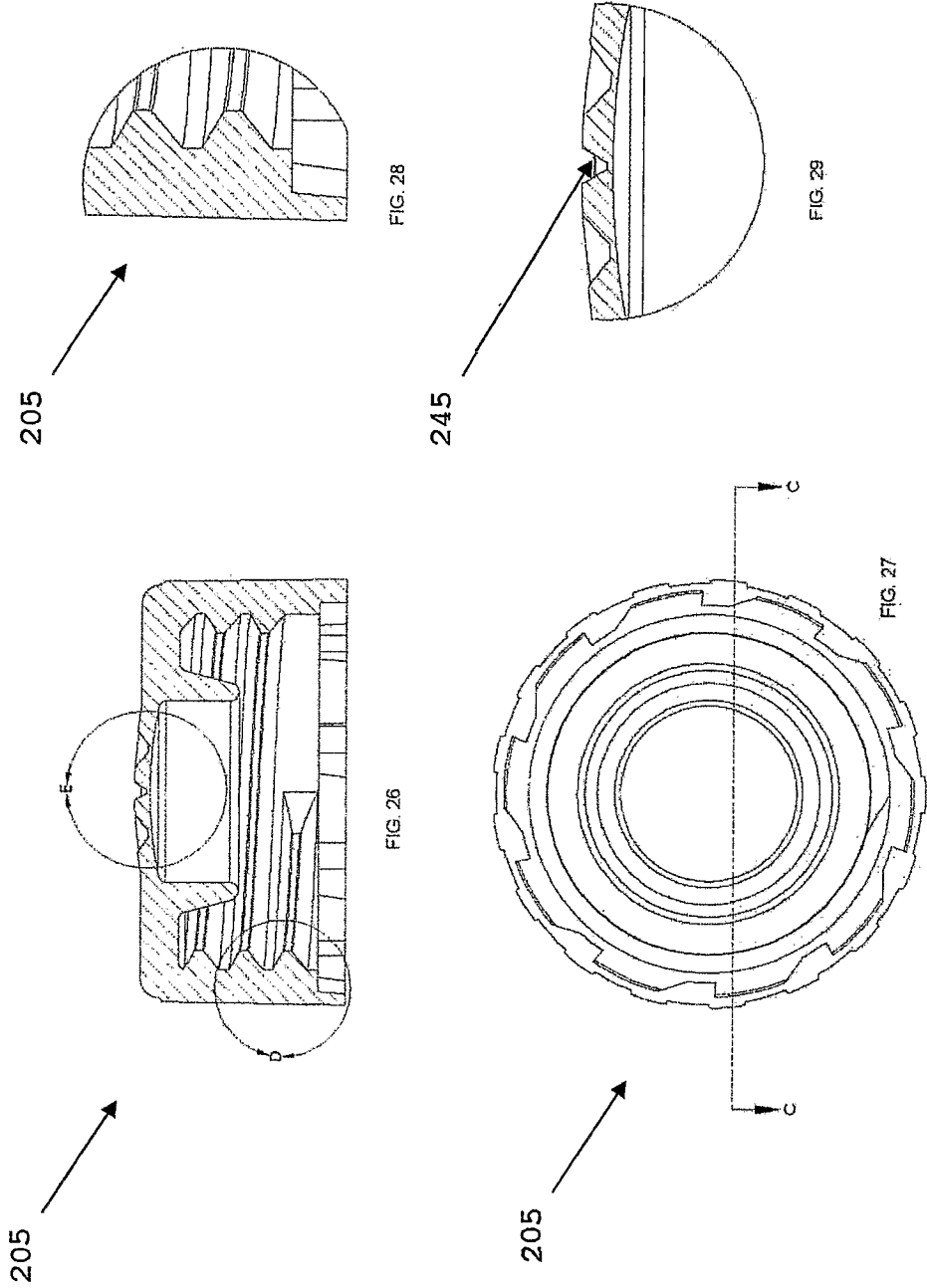


FIG. 23





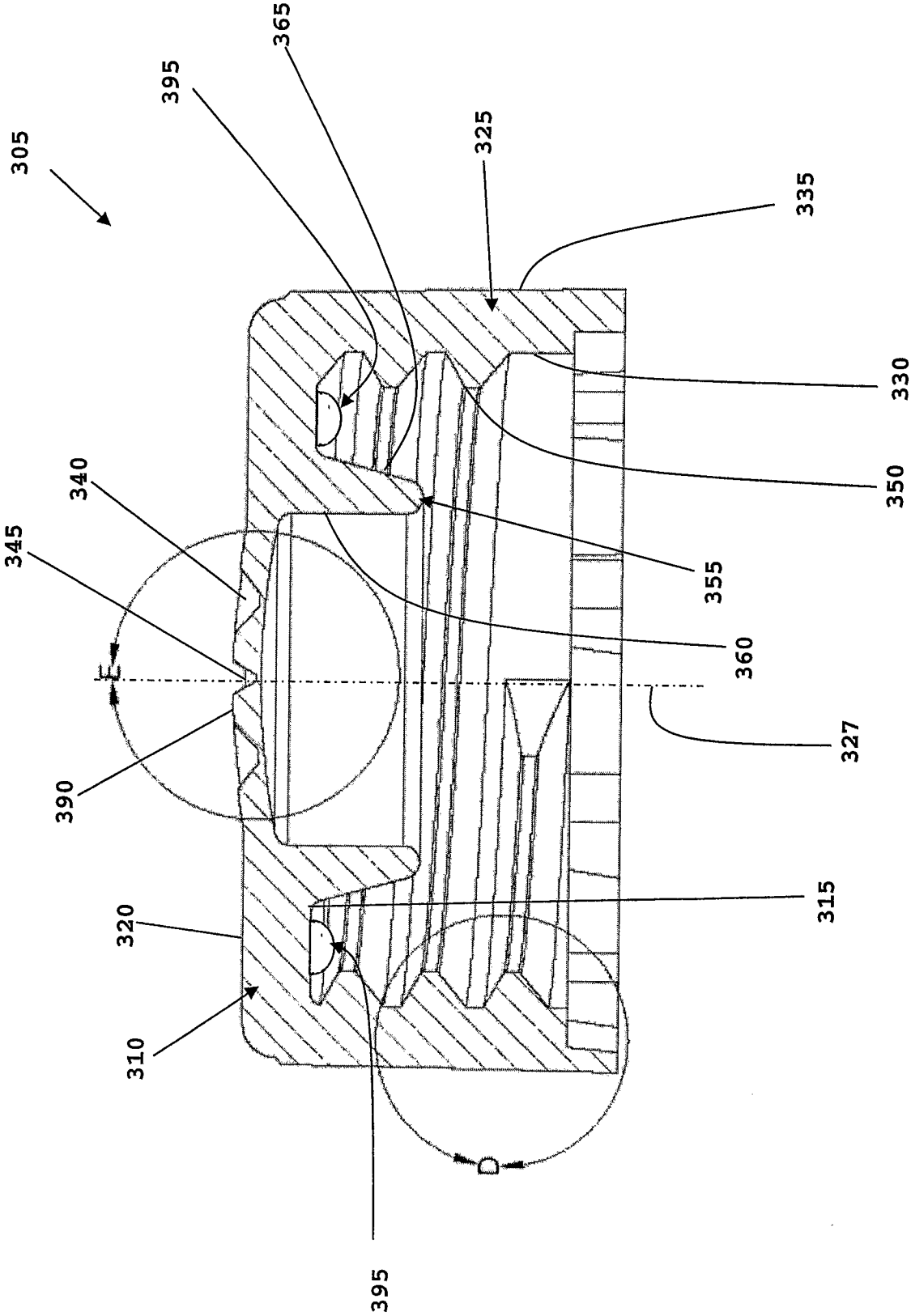
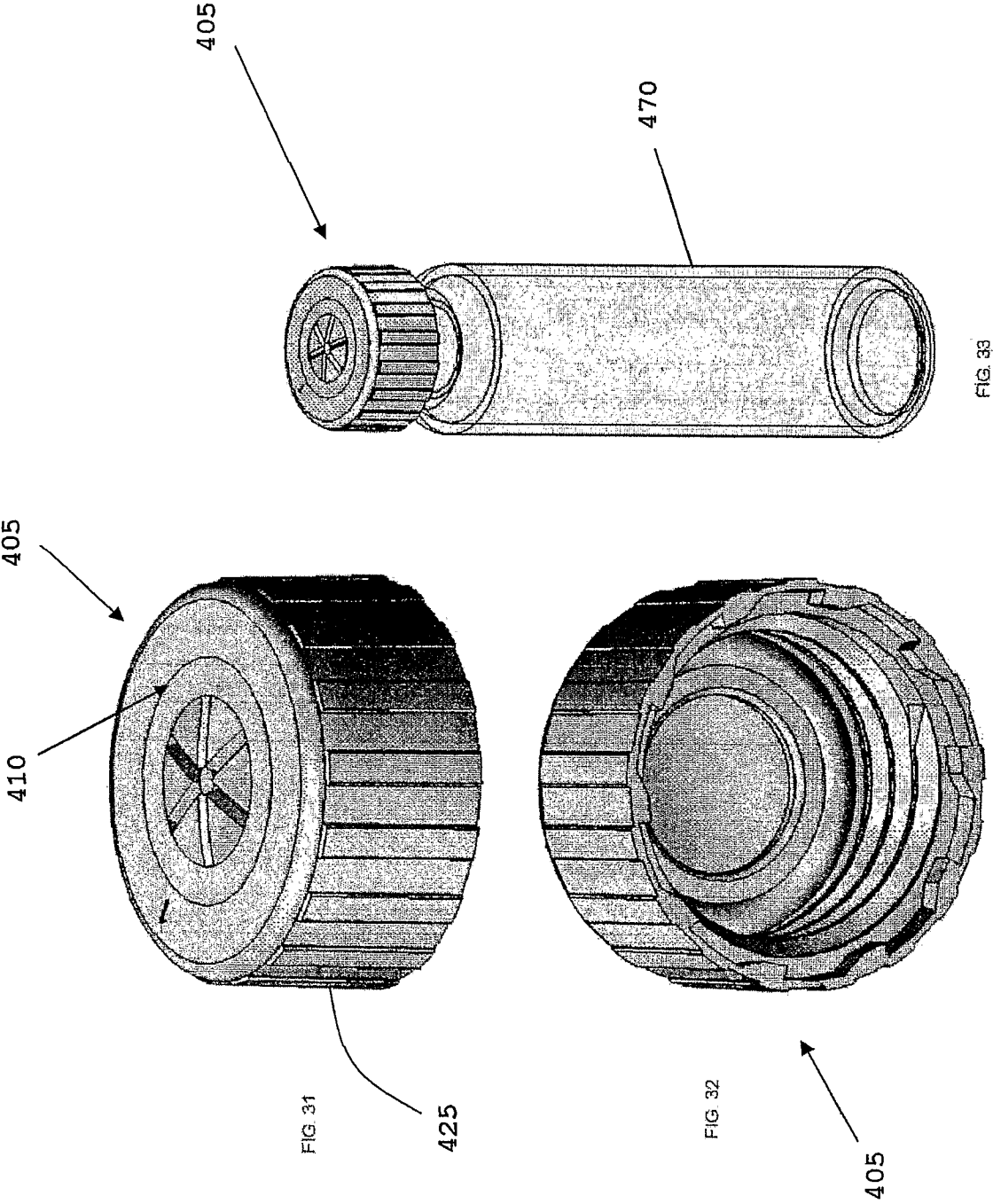
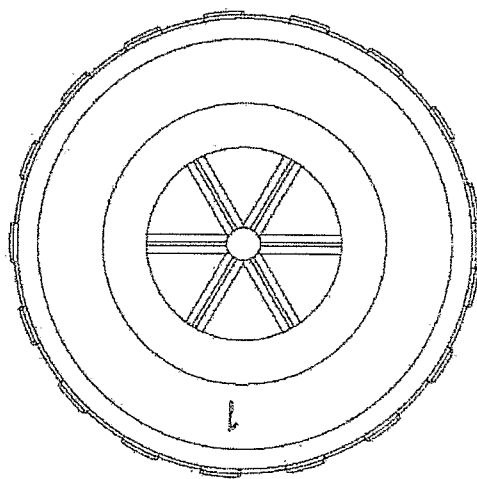


FIG. 30



405



405

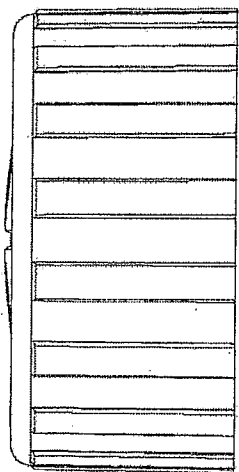
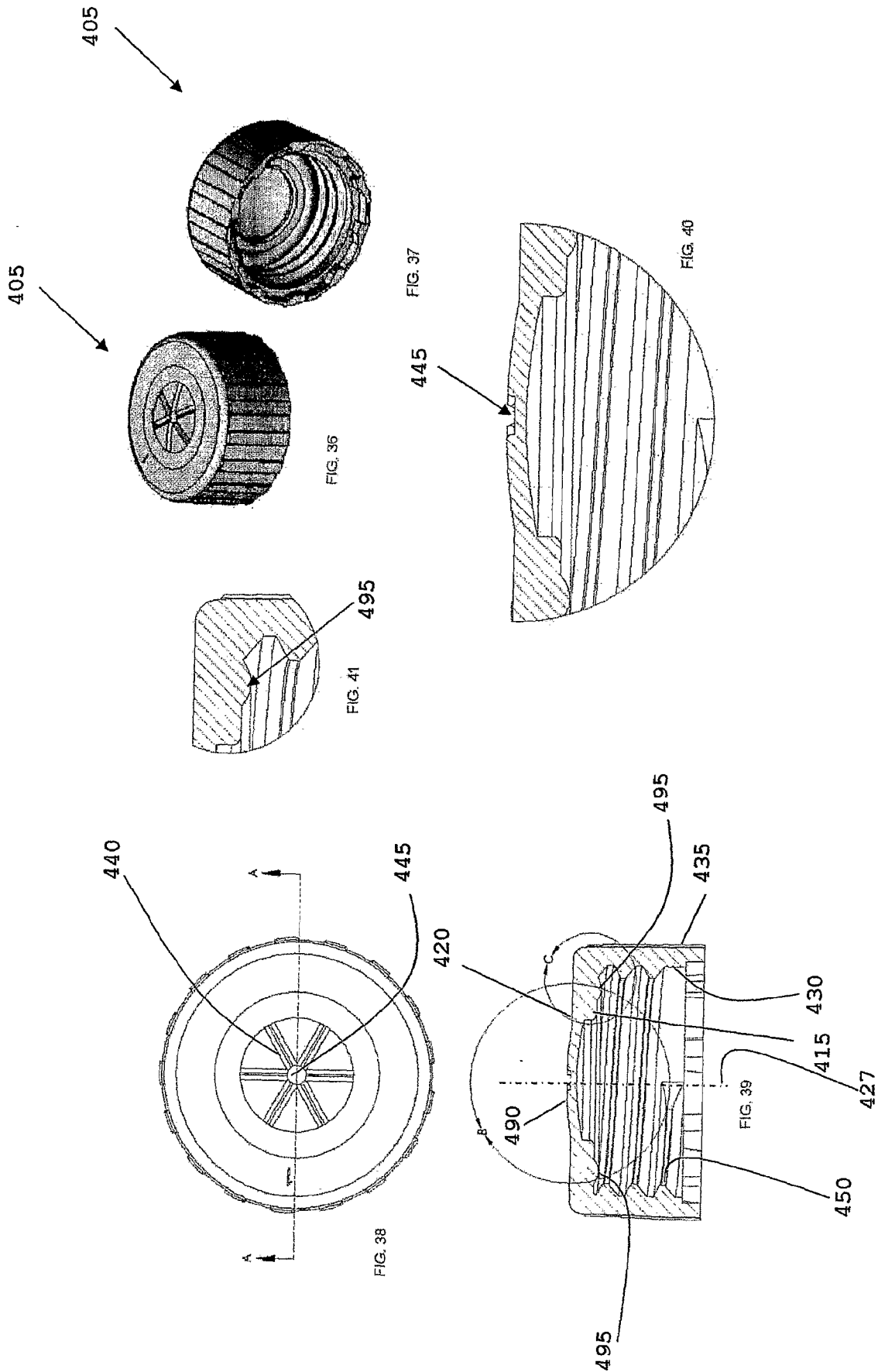


FIG. 34

FIG. 35



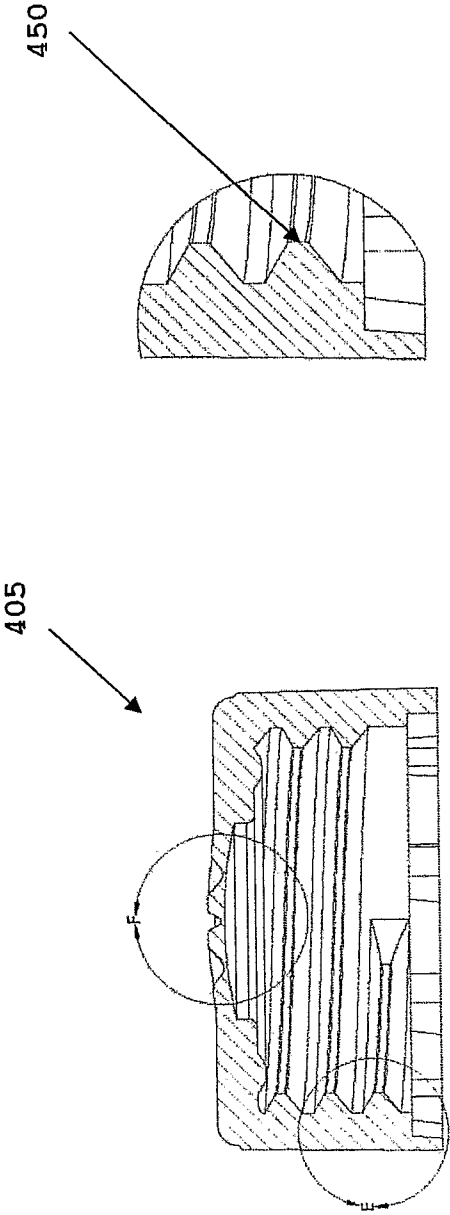


FIG. 42

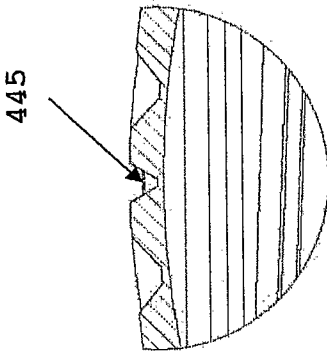


FIG. 44

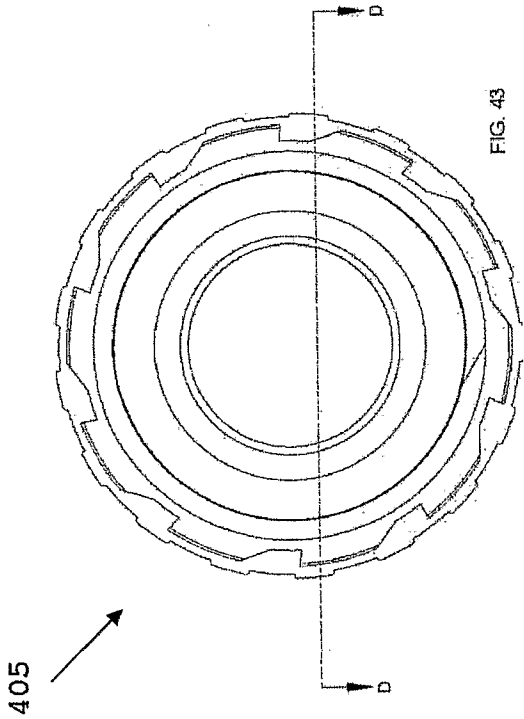


FIG. 43

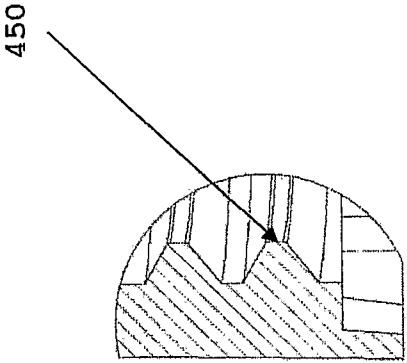


FIG. 45