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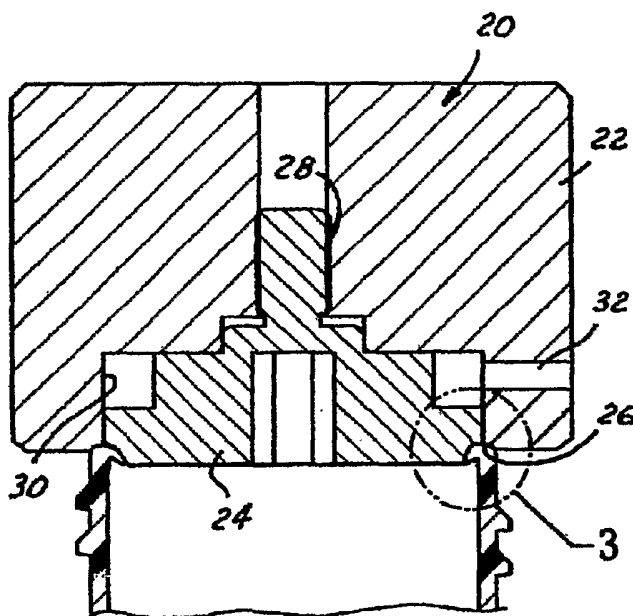
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(54) Title: METHODS AND APPARATUSES FOR REFORMING AN UPPER PORTION OF A BLOW MOLDED PLASTIC CONTAINER



(57) Abstract: The present invention relates to a method of reforming the end portion and sealing surface of a blow molded plastic container. The method includes the steps of directing energy from a non-contact heater onto an annular end portion of a container neck finish so as to heat the end portion to its softening temperature while leaving the remainder of the neck finish relatively unheated, and then engaging the annular end portion with an unheated forming tool so as to reform and cool the end sealing surface of the neck finish. Plastic containers, as well as apparatuses for reforming a blow molded plastic container, are also disclosed.

METHODS AND APPARATUSES FOR REFORMING AN UPPER PORTION OF A BLOW MOLDED PLASTIC CONTAINER

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates generally to plastic containers. More specifically, the present invention relates to methods and apparatuses for reforming the upper
5 portion of a plastic container, and particularly, a blow molded plastic container.

Related Art

[0002] Capping processes for plastic containers typically require the upper portion of the container, such as the neck finish, to meet exacting dimensional tolerances. One common method of forming plastic containers is extrusion blow molding. Extrusion blow molding typically requires
10 trimming the end of the container neck finish after molding. This trimming operation can involve removal of a dome or moil from the neck finish. In another type of extrusion blow molding operation, the trimming operation can involve separation of two containers that are molded end-to-end. In either event, the trimming operation can leave an uneven end surface that is unsatisfactory for later sealing engagement with a container closure. Furthermore, the end surface of the container
15 neck finish may have mold parting line seams that can deleteriously affect sealing engagement with a container closure. It typically is necessary to induction weld a liner disk to the container end surface after filling the container to obtain a satisfactory container seal.

[0003] It is known in the art to reform the end surface of the neck finish by contacting the neck finish end surface with a heated forming tool. This tool simultaneously heats the end
20 portion of the neck finish to the softening temperature of the plastic material, and modifies the end surface in an effort to eliminate mold parting line seams, trim scars, and other post-molding scars. However, the container neck finish tends to stick to the hot forming tool. It is also difficult to control the temperature of the forming tool so as to obtain a desired temperature at the forming surface of the tool. In some embodiments, the forming tool or container may need to rotate, which
25 can cause frictional heat that adds further inconsistency to the forming tool's temperature. Furthermore, the combination of the tendency of the container to stick to the forming tool and the difficulty of controlling the forming surface temperature of the tool makes the tool/container contact time process window very narrow and difficult to control. The dwell time, during which the

forming tool is in contact with the end portion of the neck finish, should be minimized to achieve desired production speeds.

[0004] According to another method of making containers, the upper portion is produced using an injection molding process, for example, injection blow molding. Injection blow molding can provide the necessary tolerances for the neck finish, however, injection blow molding is at a significant output-to-cavity disadvantage when compared to other types of blow molding, such as extrusion blow molding, described above. In addition, injection blow molding often requires expensive injection manifolds and involves sensitive injection processes.

[0005] According to yet another method of making containers, a preform with a pre-configured upper portion (*e.g.*, neck finish) is made by injection molding. Subsequently, a container is blow molded from the lower portion of the preform. However, the upper portion can become distorted during blow molding due to the heat applied to the preform. This can cause the pre-configured upper portion to fall out of tolerance.

[0006] Therefore, there remains a need in the art for improved methods, apparatuses, and containers that overcome the shortcomings of conventional solutions.

BRIEF SUMMARY OF THE INVENTION

[0007] According to one exemplary embodiment of the present invention, a method of reforming the end portion and sealing surface of a blow molded plastic container includes directing energy from a non-contact heater onto the annular end portion of the container neck finish so as to heat the end surface to its softening temperature while leaving the remainder of the neck finish relatively unheated. The heated annular end portion of the neck finish is then engaged by an unheated forming tool so as to reform and cool the end sealing surface of the neck finish. Heating and reforming the neck finish end portion in separate steps allows the heating step to be controlled by the intensity of the heat source and/or the dwell time of the container adjacent to the heater. Employing an unheated forming tool reduces the tendency of the container neck finish to stick to the tool. The container neck finish can be heated with additional or more powerful non-contact heaters while not affecting the dwell time in contact with the forming tool, thereby giving a greater level of process control.

[0008] According to another exemplary embodiment, an apparatus for reforming an end portion and sealing surface of a blow molded plastic container includes a non-contact heater for focusing radiant heat energy onto a container neck finish end portion to heat at least an end surface

of the end portion to the softening temperature of the plastic material while leaving the remainder of the neck finish relatively unheated. An unheated forming tool is provided to contact, reform and cool the end portion of the container finish after heating by the heater. The unheated forming tool preferably has a surface for engagement with the heated end portion of the container neck finish. In two exemplary embodiments of the invention, the unheated forming tool has a portion for opposed abutment with a shoulder on the unheated portion of the container neck finish or with tooling that engages the container neck finish to limit engagement of the reforming tool with the neck finish.

[0009] According to another exemplary embodiment, a plastic container has a blow molded and trimmed neck finish with an axially facing end surface that is free of mold parting line seams, trim scars and other post-mold scars. According to this embodiment, the blow molded and trimmed neck finish has a radially inwardly extending end flange, with the end flange having an external surface forming the axially facing end surface of the neck finish. The neck finish can have an end surface, preferably planar, and a flange, preferably circumferentially continuous, that extend radially inwardly and axially downwardly from the neck finish end surface.

[00010] According to another exemplary embodiment, a method of reforming an upper portion of a blow molded plastic container comprises the steps of directing energy from a non-contact heater onto the upper portion to soften the upper portion, and compressing the upper portion between at least a first forming tool and a second forming tool to reform the upper portion.

[00011] According to another exemplary embodiment, the present invention relates to a blow molded plastic container having a upper portion with a flange reformed in accordance with the aforementioned method.

[00012] According to yet another exemplary embodiment, an apparatus for reforming an upper portion of a blow molded plastic container comprises a non-contact heat source adapted to heat the upper portion of the plastic container, and first and second reforming tools spaced apart from the heat source. The first and second reforming tools are adapted to compress the heated upper portion between the first and second reforming tools to reform the upper portion.

[00013] 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

[00014] 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.

5 [00015] FIG. 1 is a schematic representation of the step of non-contact heating the end portion of a container neck finish in accordance with an exemplary embodiment of the present invention;

[00016] FIG. 2 is a schematic representation of the step of contacting the heated container neck finish end portion with a forming tool in accordance with an exemplary embodiment of the present invention;

10 [00017] FIG. 3 is an enlarged fragmentary view of the portion of FIG. 2 within the area 3;

[00018] FIG. 4 is a partial schematic diagram that illustrates a container neck finish end portion and forming tool in accordance with an exemplary embodiment of the present invention;

15 [00019] FIG. 5 is a partial, enlarged, cross-sectional view of the portion of FIG. 4 within the area 5;

[00020] FIGS. 6 and 7 are sequential schematic diagrams similar to that of FIG. 5 but showing sequential steps of an exemplary method of the present invention;

20 [00021] FIG. 8 is a schematic representation of another exemplary embodiment of the present invention;

[00022] FIG. 9 is a partial, enlarged view of the portion of FIG. 8 within the area 9;

[00023] FIG. 10 is a partial, cross-sectional view of a container neck finish reformed in accordance with an exemplary embodiment of the present invention;

25 [00024] FIGS. 11 and 12 are partial, cross-sectional views of another exemplary embodiment of the forming head in accordance with the present invention;

[00025] FIG. 13 is a schematic representation of the step of heating an upper portion of a container according to another exemplary embodiment of the present invention;

[00026] FIG. 14 is a schematic representation of the step of compressing the upper portion of the container between two forming tools according to an exemplary embodiment of the present invention;

[00027] FIG. 15 is an enlarged fragmentary view of the portion of FIG. 14 within the area A, prior to completion of the compressing step;

[00028] FIG. 16 is an enlarged fragmentary view of the portion of FIG. 14 within the area A, upon completion of the compressing step; and

[00029] FIG. 17 is side view of a plastic container according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[00030] 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.

[00031] FIGS. 1-3 illustrate a method and apparatus for reforming the end sealing surface of a plastic container neck finish in accordance with an exemplary embodiment of the present invention. Referring to FIG. 1, a plastic container 10 can have a neck finish 12 with an end portion 14 that includes a radially inwardly and axially upwardly extending flange 16. (Directional words such as “upwardly” and “downwardly” are employed by way of description and not limitation with respect to the orientation of the apparatus and the containers illustrated in the drawings. Directional words such as “axial” and “radial” are employed by way of description and not limitation with respect to the axis of the container finish or the reforming tool, as appropriate.) Flange 16 typically is formed by a trimming operation after extrusion blow molding, for example, in which container 10 is severed from a moil or the like. Flange 16 as initially formed can have a radially outwardly and axially upwardly facing surface that typically forms the end sealing surface of the neck finish.

[00032] Neck finish 12 of container 10 is positioned adjacent to a non-contact heater 18 to soften the neck finish. By “non-contact” is meant that the heating energy is transferred to neck finish 12 by radiation, convection, or other methods that don’t involve physical contact with the

neck finish. Heater 18 can comprise an infrared heater, a radiant heater, a quartz lamp, focused light energy, a heated forming tool, or the like. One of ordinary skill in the art will know and appreciate that other “non-contact” techniques are available for softening neck finish 12. For example, energy from a laser or other focused light may be used to soften neck finish 12. Heater 18 may be adapted and configured to focus the heating energy onto the neck finish end portion 14, for example, to heat at least the end surface of flange 16 to its softening temperature, while leaving the remainder of neck finish 12 substantially unheated. For example, the end portion of the neck finish, comprising at least the end surface, can be heated to its softening temperature, while the remainder of the neck finish (and the remainder of the container) is substantially unheated by heater 18.

10 **[00033]** After heating neck finish end portion 14, a forming tool head 20 is brought into contact with the end portion of the container neck finish, as shown in FIGS. 2 and 3. Forming tool head 20, which is unheated, can include a shell 22 having a central plug 24 removably received therein. Adjacent end portions of shell 22 and plug 24 can form an annular channel 26 for opposed facing engagement with finish end portion 14. For example, after heating finish end portion 14 to its softening temperature, unheated forming tool head 22 is brought into contact with the container neck finish so that heated end portion 14 is engaged under pressure by the opposing surface of channel 26. The neck finish end portion thereby is reformed, cooled and solidified by the opposing surface of channel 26 so as to form a smooth neck finish end surface for sealing engagement with a closure or the like. Plug 24 is threadably received within shell 22 in the exemplary embodiment shown, so that the adjacent portions of channel 26 can be brought into alignment without having a shoulder or step in the channel surface between the plug and shell. This threaded engagement is illustrated at 28 in FIG. 2. Plug 24 and shell 22 can be such that a small radial gap 31 extends from channel 26 to pocket 30. This gap 31 can be annular and of substantially uniform radial width, such as on the order of 0.001 inch. Gap 31 allows air to vent from the contact area of channel 26. Gap 31 also functions as a thermal barrier between plug 24 and shell 22. Pocket 30 can be connected to the external atmosphere by one or more passages 32 to minimize heating of plug 24 and shell 22 due to contact with the container neck finishes during reforming, and to vent the air from gap 31.

25 **[00034]** FIGS. 1 and 4-7 illustrate a reforming apparatus and process in accordance with a second exemplary embodiment of the present invention. In FIGS. 4-7, the forming tool head 34 includes a shell 36 and a plug 38. Shell 36 and plug 38 have opposed channel segments that together form an annular channel 40 for engaging and reforming the container neck finish end

portion, as in the previous embodiment. Plug 38 again is positionable within shell 36 in this embodiment to bring the adjacent channel segments into smooth alignment, and air channels and passages 42, 44, 46, 48 are provided in plug 38 and shell 36 to minimize heating of the surfaces that form forming channel 40. An air vent gap 31, preferably annular, circumferentially continuous and of substantially uniform radial dimension, can be formed between the outer periphery of plug 38 and the opposing surface of shell 36, both of which can be cylindrical.

[00035] The container 50 illustrated in FIGS. 4-7 has a neck finish 52 with an end portion 54 and a flange 56 in accordance with another exemplary embodiment of the invention. As best seen in FIG. 5, flange 56 has an external groove 58 that extends circumferentially around the flange, at about the mid portion of the flange, in a plane perpendicular to the axis of the neck finish. The purpose of groove 58 is to localize bending of flange 56 during the reforming operation to the end portion of the flange, as shown in FIG. 7. Neck finish end portion 54 also has an axially facing shoulder 60 in the embodiment of FIGS. 4-7. This axially facing external shoulder 60 cooperates with an opposed axially facing shoulder 62 on shell 36 to limit axial motion of tool head 34 and container neck finish 52 with respect to each other, as shown in FIG. 7, and thereby to limit and control bending of flange 56 and to maintain dimensional tolerance stability during the reforming operation. Neck finish shoulder 60 can be spaced sufficiently from flange 56 so as not to be heated substantially by the focused energy from heater 18 (FIG. 1), so that contact by tool shoulder 62 does not reform shoulder 60.

[00036] FIGS. 8 and 9 illustrate a reforming tool head 70 in accordance with another exemplary embodiment of the invention. Head 70 includes a shell 72 and a plug 74 that are mounted to a holder 76 by a screw 78. An air vent gap 31 again is formed between the outer periphery of plug 74 and the opposing surface of shell 72. A collar 80 is adjustably threadably received on holder 76. Collar 80 preferably is adjusted on holder 76 to abut a pair of clamp arms 82, 84 that hold container 50 in position beneath head 70. Thus, collar 80 cooperates with clamp arms 82, 84 to limit and control the bending of flange 56, but without contacting a shoulder on container finish 52 as in the embodiment of FIGS. 4-7. FIG. 8 also illustrates cooling of head 70 by means of a pump 86 that circulates a coolant, such as a water/glycol mixture, through a chiller 88. Chiller 88 can have an associated control 90 for setting a desired coolant temperature.

[00037] FIGS. 11-12 illustrate a reforming tool head 100 in accordance with a further exemplary embodiment of the invention. A shell 102 has a pocket 104 within which a plug 106 in

mounted by a screw 108. Plug 106 has a conical surface 110 and a peripheral flat surface 112 that faces the neck finish of the container. When head 100 is brought into engagement with the container neck finish (FIG. 12), the flange 56 is engaged by the conical surface 110 to reform the flange axially inwardly. The end surface 92 is engaged by the flat surface 112.

5 **[00038]** In the exemplary embodiments of FIGS. 1-12, the neck finish end portion is first subjected to focused non-contact heating so as to heat at least the end surface of the neck finish end portion to its softening temperature while leaving the remainder of the neck finish substantially unheated. The neck finish end portion is then engaged by an unheated forming tool so as to reform the heated and softened end portion of the neck finish. As noted above, the heating operation can be
10 accomplished using various techniques, including an infrared lamp, radiant heater, quartz lamp, focused light energy, a heated forming tool, etc. The unheated forming tool may be at room temperature (ignoring the heating effects due to contact with the heated neck finish end portion), or may be cooled by circulation of a coolant fluid such as air or another media. The pressure applied by the forming tool and the reforming tool contact time may be adjusted empirically to obtain the
15 desired end surface reformation at the container neck finish end portion. The neck finish end portion takes the shape of the opposing surface(s) of the forming tool, which leaves the neck finish end surface free of features that can deleteriously affect the ability to seal against the neck finish end surface, such as mold parting line mismatch seams, nicks and other features created in the production and trimming process. The neck finish 52 in the exemplary embodiment of FIG. 10 has
20 an end surface that is planar, and a flange 56 (or 16 in FIGS. 1-3) that extend radially inwardly and axially downwardly from the end surface. Flange 56 can be circumferentially continuous.

[00039] FIGS. 13-16 depict another exemplary method and apparatus for reforming a container flange according to the present invention. Referring to FIG. 13, plastic container 200 includes an upper portion 202. In the exemplary embodiment shown, plastic container 200 is in
25 the shape of a bowl, for example, a soup bowl, and the upper portion 202 includes a substantially annular, outwardly-extending flange 204. Flange 204 can be adapted and configured to receive a closure, such as a metal lid, a layer of film (*e.g.*, thermo-sealed or glued film), a snap-on lid, or a double-seam metal lid, although other configurations are possible. One of ordinary skill in the art will know and appreciate that plastic container 200 and/or upper
30 portion 202 can take other forms. For example, plastic container 200 may alternatively be a

beverage container, and upper portion 202 may alternatively include a threaded neck finish, or feature other geometries for sealing applications.

[00040] The upper portion 202 is typically formed during the blow molding of container 200, for example, during extrusion blow molding. The upper portion 202 may additionally or alternatively be formed, or modified, during a trimming or other operation that takes place, for example, after the container is blow molded. Alternatively, the upper portion 202 may be formed in connection with an injection or compression molding process, for example, on containers made using a reheat blow molding process or an injection/extrusion/blow molding process. Alternatively, the upper portion 202 may be formed in connection with an injection molded preform, in which the upper portion 202 is preconfigured during injection molding of the preform.

[00041] The present invention provides a method and apparatus that reforms the upper portion 202, for example, to provide the shape and dimensional tolerances required for the capping and/or sealing process. The method includes softening the upper portion 202, for example, by heating it with a non-contact heater 206. By “non-contact” is meant that the energy from non-contact heater is transferred to the upper portion 202 by radiation, convection, or other methods that don’t involve physical contact with the upper portion 202. Heater 206 can comprise an infrared heater, a radiant heater, a quartz lamp, focused light energy, or a heated forming tool. One of ordinary skill in the art will know and appreciate that other “non-contact” techniques are available for softening upper portion 202. For example, energy from a laser or other focused light may be used to soften upper portion 202. Heater 206 may be adapted and configured to focus the heating energy onto the upper portion 202, for example, to heat flange 204 to its softening temperature, while leaving the remainder of container 200 relatively unheated.

[00042] Once the upper portion 202 of container 200 is softened, two or more forming tools can be used to reform the upper portion 202. Referring to the exemplary embodiment of FIG. 14, a first forming tool 207 and a second forming tool 208 can be used to reform the upper portion 202, and more specifically, the flange 204. According to one exemplary embodiment, the first and second forming tools 207, 208 are constructed of metal, such as bronze, stainless steel, or aluminum, although other materials can alternatively be used.

[00043] In the exemplary embodiment shown in FIG. 14, the forming tools 207, 208 are substantially opposed to one another, and can be moved from the position shown in FIGS. 14 and 15 to the position shown in FIG. 16, thereby compressing and reforming the upper portion 202. When in the position shown in FIG. 16 (*i.e.*, the “closed position”), the first forming tool 207 and the second forming tool 208 mate to define a cavity 210 in which the upper portion 202 (*e.g.*, the flange 204) is reformed to the desired shape and size. The first and second forming tools 207, 208 can include cooperating surfaces that engage one another (when the forming tools are in the closed position) to orient the forming tools 207, 208 with respect to one another and to maintain the cavity 210 at the intended shape and size. For example, first forming tool 207 can include a first engagement surface 212 and second forming tool 208 can include a corresponding second engagement surface 214. The amount of pressure applied by the first and/or second forming tools 207, 208 to move them to the closed position shown in FIG. 16, and the amount of time the forming tools 207, 208 are held in the closed position, can be adjusted empirically to obtain the desired geometrical, dimensional, and surface finish characteristics for the upper portion 202. A spring and cam system can be used to control the movement and pressure of the first and second forming tools 207, 208. Alternatively, hydraulic or pneumatic means can be used to control the forming tools.

[00044] Still referring to FIGS. 14-16, the first forming tool 207 can extend around the periphery of the upper portion 202. For example, first forming tool 207 can comprise a ring-shaped portion having an aperture corresponding in shape and size (*e.g.*, diameter) to the upper portion 202 of container 200, allowing the container 200 to extend therethrough. According to an alternative embodiment, first forming tool 207 can have a recess or depression that corresponds in shape and size of the entire container 200. As shown in FIGS. 14-16, the second forming tool 208 can approach the container 200 from above, and compress the upper portion 202 downward and against the first forming tool 207, although other configurations of the first and second forming tools 207, 208 are possible.

[00045] While the exemplary embodiment of FIGS. 14-16 shows two forming tools, one of ordinary skill in the art will know and appreciate that in some situations, it may be preferable to use more than two forming tools, for example, depending on the shape, size, and configuration of the container 200 and/or upper portion 202.

[00046] According to an exemplary embodiment of the invention, one or both of the forming tools 207, 208 can be substantially unheated. For example, the forming tools 207, 208 may be kept at room temperature (ignoring the heating effects due to contact with the upper portion 202). Accordingly, when the heated upper portion 202 contacts the forming tools 207, 208, the relatively cool forming tools 207, 208 cause the upper portion 202 to cool and solidify. Thus, compressing the softened upper portion 202 with the relatively cool forming tools 207, 208 reforms, cools, and solidifies the upper portion 202 (*e.g.*, the flange 204), resulting in a reformed upper portion 202 having a smooth surface finish, as well as high geometrical and dimensional tolerances. Air vents, channels, or similar cooling structures can be provided in one or both of the forming tools 207, 208 to help maintain the forming tools 207, 208 at or near room temperature. Additionally or alternatively, coolant can be pumped through channels in one or both of the forming tools 207, 208 to actively cool the forming tools 207, 208 to desired temperature. For example, one of ordinary skill in the art will know and appreciate that a pump can be used to circulate a coolant, such as a water/glycol mixture, through a cooling system and into channels in the forming tools 207, 208, although other configurations are possible and contemplated.

[00047] The container of the present invention can be made of monolayer plastic construction, or alternatively, of multilayer plastic construction. In the case of a container of multilayer plastic construction, intermediate layers may or may not extend into the upper portion/neck finish of the container. For polypropylene, it has been found that the softening temperature is in the range of about 220 to 320° F, preferably about 275 to 315° F, and more preferably about 300° F. According to one exemplary embodiment, the unheated surfaces of the forming tools that contact the container are maintained at a temperature of less than about 100° F. According to exemplary embodiments of the invention, such as the embodiment shown in FIGS. 8-9, a chiller 88 can be controlled to maintain a temperature of about 60° F at reforming head 70. According to one exemplary embodiment, the heated neck finish/upper portion of the container is preferably engaged by the reforming tool about three seconds or less after heating.

[00048] Referring to FIG. 17, a plastic container 200 having an upper portion 202 reformed in accordance with the present invention is shown. As shown in FIG. 17, the upper portion 202 exhibits high geometrical and dimensional tolerances, such as the thickness T, width W, and outer diameter D of the flange 204. The reforming method of the present

invention can facilitate use of high-output blow molding processes (*e.g.*, continuous extrusion blow molding) to produce the container, while obtaining the high geometrical and dimensional tolerances for the upper portion 202 typical of lower output processes such as injection blow molding. The reforming method can also facilitate the production of multi-layer containers, due to the robust layer formation associated with the continuous extrusion blow molding process.

[00049] 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. For example, although embodiments of the invention have been disclosed in conjunction with reforming the upper portion/neck finish of an extrusion blow molded container, the invention in its broadest aspects can be applied to other types of containers. For example, the invention in its broadest aspects can be implemented in conjunction with injection or compression molded upper portions/neck finishes on containers made in a reheat blow molding operation or an injection/extrusion/blow molding operation. 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 method of reforming the end portion and sealing surface of a blow molded plastic container, which includes the steps of:

5 (a) directing energy from a non-contact heater onto an annular end portion of a container neck finish so as to heat said end portion to its softening temperature while leaving the remainder of said neck finish relatively unheated, and then

(b) engaging said annular end portion with an unheated forming tool so as to reform and cool the end sealing surface of the neck finish.

10 2. The method set forth in claim 1 wherein said step (b) includes the step of:
(c) limiting engagement of said forming tool with said annular portion of said neck finish.

3. The method set forth in claim 2 wherein said step (b) includes engaging the
15 container neck finish with tooling to hold said neck finish in position with respect to said forming tool, and wherein said step (c) is carried out by engaging a portion of said forming tool against said tooling.

4. The method set forth in claim 2 wherein said neck finish has an annular shoulder at
20 a position spaced from said end portion, wherein said unheated forming tool has a shoulder in opposition to said shoulder on said neck finish, and wherein said step (c) is carried out by moving said unheated forming tool against said end portion until said shoulder on said forming tool engages said shoulder on said neck finish.

5. The method set forth in claim 1 wherein said end portion of said neck finish includes a radially inwardly extending flange, said step (a) includes heating an outer surface portion of said flange to its softening temperature, and said step (b) includes bending said flange radially and axially inwardly by engagement with said forming tool.

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6. The method set forth in claim 5 wherein said flange has an external groove to localize bending of said flange during said step (b) to an end portion of said flange.

7. A blow molded plastic container having a neck finish and an end portion reformed in accordance with the method set forth in claim 1.

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8. A plastic container having a blow molded and trimmed neck finish with an axially facing end surface that is free of mold parting line seams and trim scars.

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9. The container set forth in claim 8 wherein said blow molded and trimmed neck finish has a radially inwardly extending end flange, said end flange having an external surface forming said axially facing end surface.

10. The container set forth in claim 9 wherein said flange has an external groove extending circumferentially around said flange in a plane perpendicular to an axis of said neck finish.

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11. Apparatus for reforming an end portion and sealing surface of a blow molded

plastic container, which includes:

a non-contact heater for focusing radiant heat energy onto a container neck finish end portion to heat at least an end surface of the container neck finish end portion to its softening temperature while leaving the remainder of the neck finish relatively unheated, and

5 an unheated forming tool separate from said heater to contact, reform and cool the end portion of the container neck finish after heating by said heater.

12. The apparatus set forth in claim 11 wherein said forming tool includes a shell having a pocket and a plug received in said pocket.

10

13. The apparatus set forth in claim 12 wherein adjacent portions of said plug and said shell form a surface for engagement with the end portion of the container neck finish.

14. The apparatus set forth in claim 13 wherein said forming tool includes an air gap between said plug and said shell, said air gap extending from said forming surface to said pocket to vent air from between said forming surface and the end portion of the neck finish.

15

15. The apparatus set forth in claim 11 wherein said forming tool includes a head having a forming surface for engagement with the container neck finish.

20

16. The apparatus set forth in claim 15 wherein said head includes at least one air vent passage extending from said forming surface to vent air from between said forming surface and the end portion of the container neck finish.

17. The apparatus set forth in claim 15 including a cooler coupled to said head for cooling said head.

18. The apparatus set forth in claim 17 wherein said cooler includes means for
5 circulating liquid coolant through said head.

19. The apparatus set forth in claim 15 wherein said head has an annular channel for receipt over the heated end portion of the container neck finish.

10 20. The apparatus set forth in claim 15 wherein said head includes means for limiting engagement with the end portion of the container neck finish.

21. The apparatus set forth in claim 20 wherein said means includes a collar that is adjustably positionable on said head for abutment with tooling for holding the container in position
15 with respect to said head.

22. The apparatus set forth in claim 20 wherein said means includes a shoulder for opposed abutment with a shoulder on the container neck finish to limit engagement of said forming tool with the neck finish end portion.

20

23. A container having a neck finish of molded plastic construction, said neck finish having an end surface and a flange extending radially inwardly and axially downwardly from said end surface.

24. The container set forth in claim 23 wherein said end surface is planar, and said flange is circumferentially continuous.

5 25. A method of reforming an upper portion of a blow molded plastic container, the method comprising the steps of:

(a) directing energy from a non-contact heater onto the upper portion to soften the upper portion; and

10 (b) compressing the upper portion between at least a first forming tool and a second forming tool to reform the upper portion.

26. The method of claim 25, wherein said step (a) comprises heating the upper portion to about its softening temperature.

15 27. The method of claim 25, wherein said step (a) comprises leaving remaining portions of the plastic container relatively unheated compared to the upper portion.

28. The method of claim 25, wherein at least one of the first forming tool or the second forming tool is unheated, and said step (c) comprises cooling the upper portion by contacting the upper portion with at least one of the first forming tool or the second forming tool.

29. The method of claim 25, wherein the first forming tool is substantially opposed to the second forming tool.

25 30. The method of claim 25, wherein the first forming tool and the second forming tool mate to define a cavity in which the upper portion is reformed.

30 31. The method of claim 30, wherein a portion of the first forming tool contacts a portion of the second forming tool to orient the first and second forming tools with respect to one another.

32. The method of claim 30, wherein the cavity is adapted and configured to reform the upper portion of the plastic container into an outwardly-extending flange.

5 33. The method of claim 25, wherein the first reforming tool extends around the upper portion of the plastic container.

34. The method of claim 33, wherein the second reforming tool presses the upper portion against the first reforming tool.

10

35. The method of claim 25, wherein the upper portion is substantially annular.

36. A blow molded plastic container having a upper portion with a flange reformed in accordance with the method set forth in claim 25.

15

37. An apparatus for reforming an upper portion of a blow molded plastic container, comprising:

a non-contact heat source adapted to heat the upper portion of the plastic container; and

20 first and second reforming tools spaced apart from the heat source, the first and second reforming tools adapted to compress the heated upper portion between the first and second reforming tools to reform the upper portion.

38. The apparatus of claim 37, wherein the first and second reforming tools are unheated.

25

39. The apparatus of claim 37, wherein the first and second reforming tools are substantially opposed to one another.

40. The apparatus of claim 37, wherein the first forming tool and the second forming tool mate to define a cavity in which the upper portion is reformed.

30

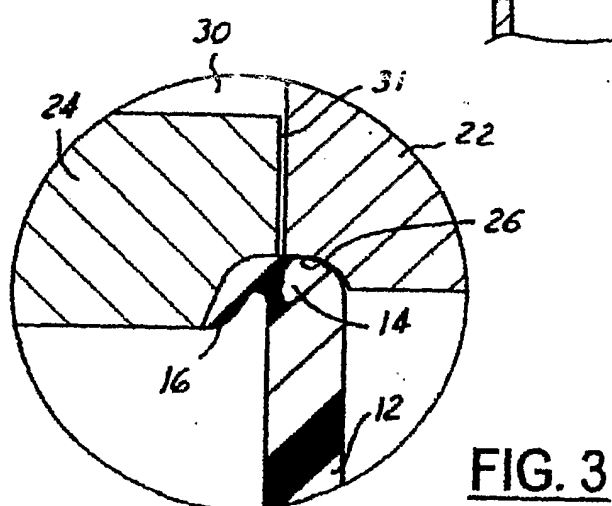
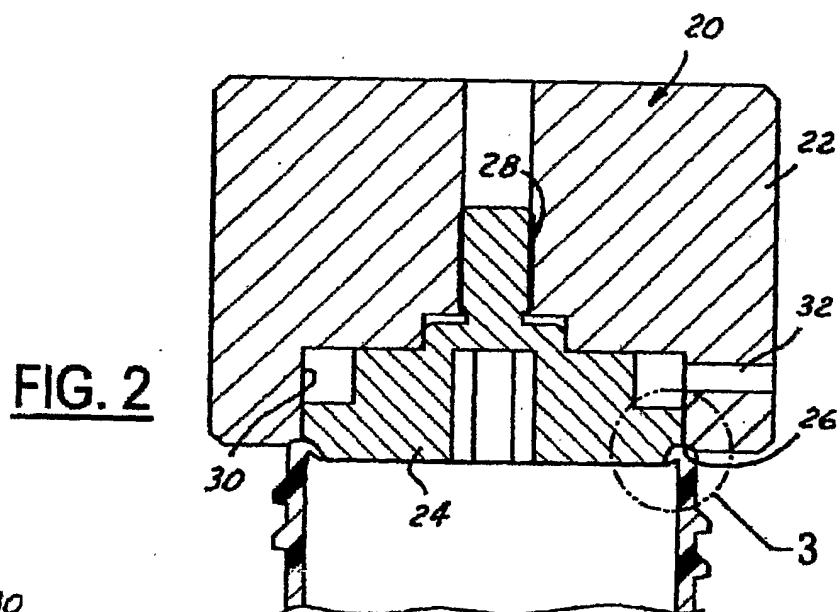
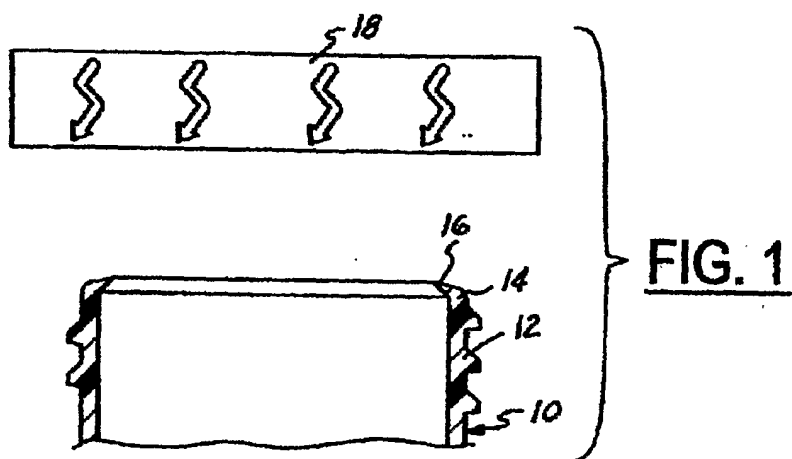
41. The apparatus of claim 40, wherein a portion of the first forming tool contacts a portion of the second forming tool to orient the first and second forming tools with respect to one another.

5 42. The apparatus of claim 40, wherein the cavity is adapted and configured to reform the upper portion of the plastic container into an outwardly-extending flange.

43. The apparatus of claim 40, wherein the first reforming tool is adapted to surround the upper portion of the plastic container.

10

44. The apparatus of claim 43, wherein the second reforming tool is adapted to press the upper portion against the first reforming tool.



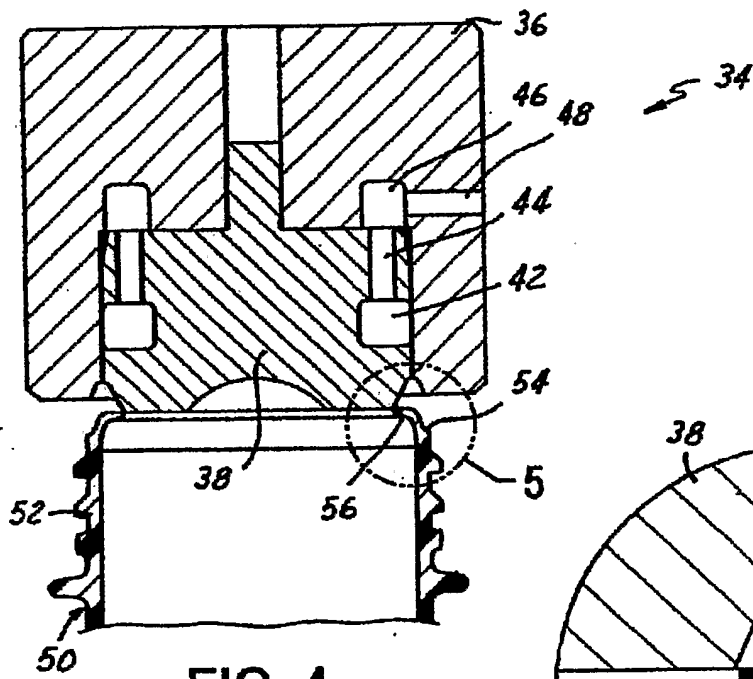


FIG. 4

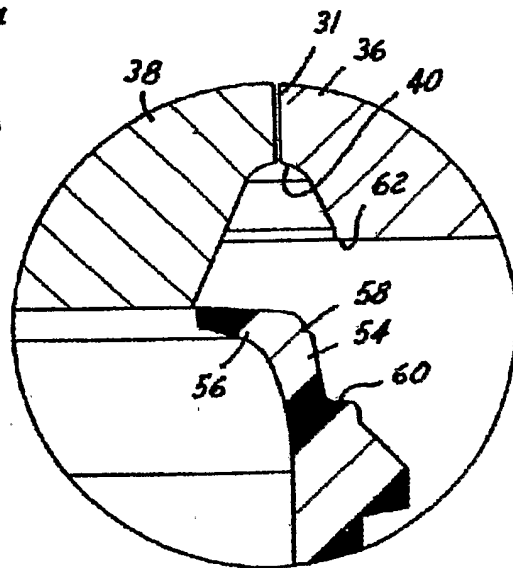


FIG. 5

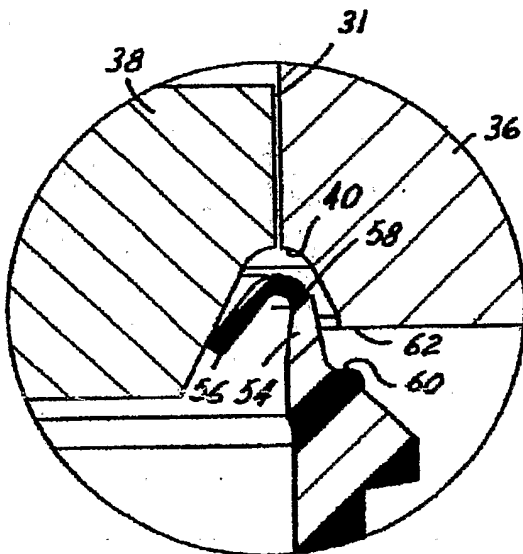


FIG. 6

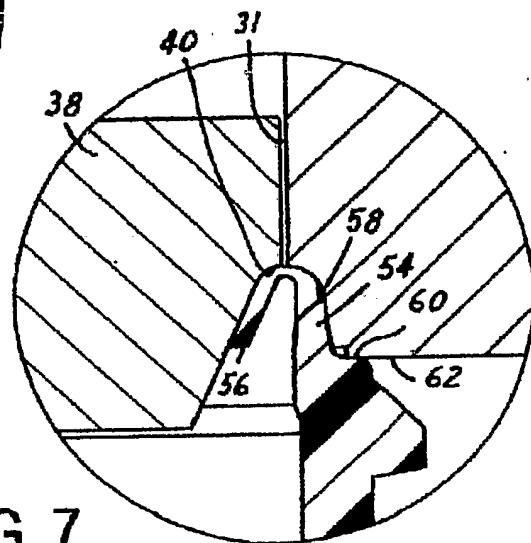
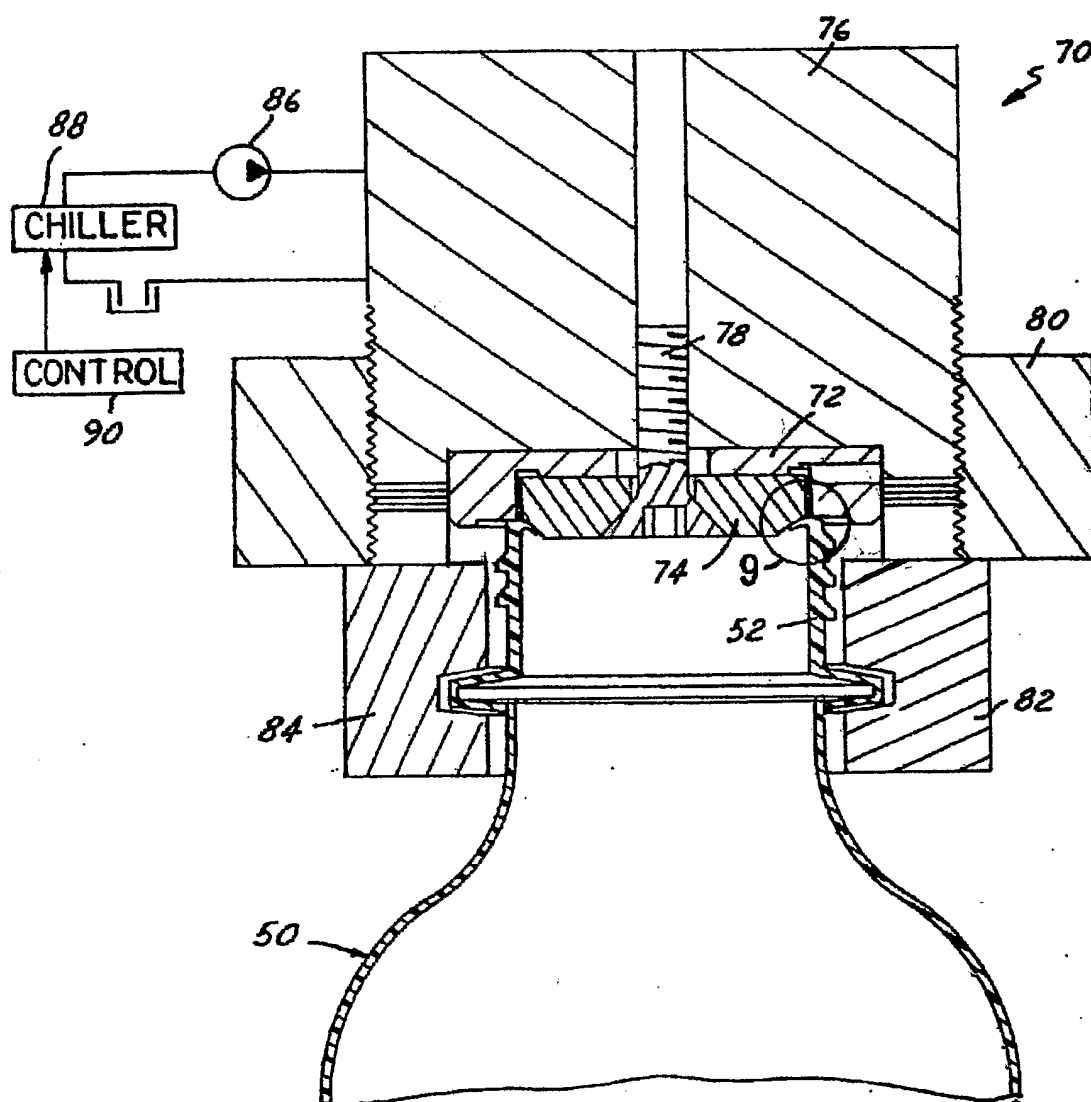
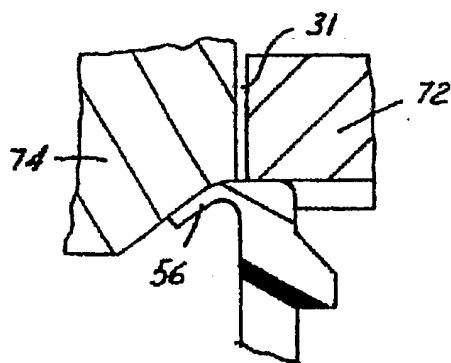


FIG. 7

FIG. 8FIG. 9

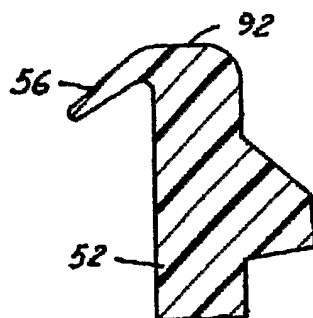


FIG. 10

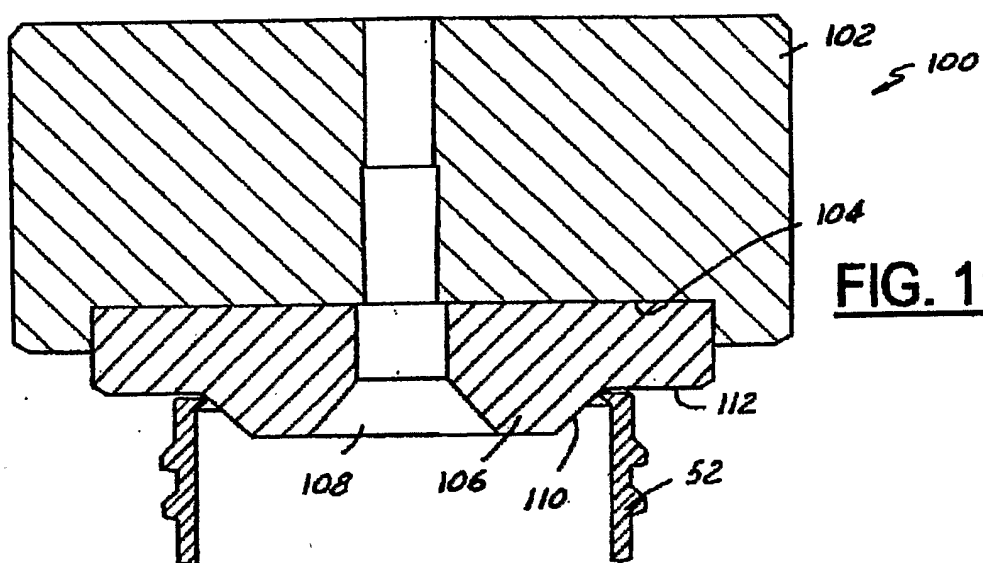


FIG. 11

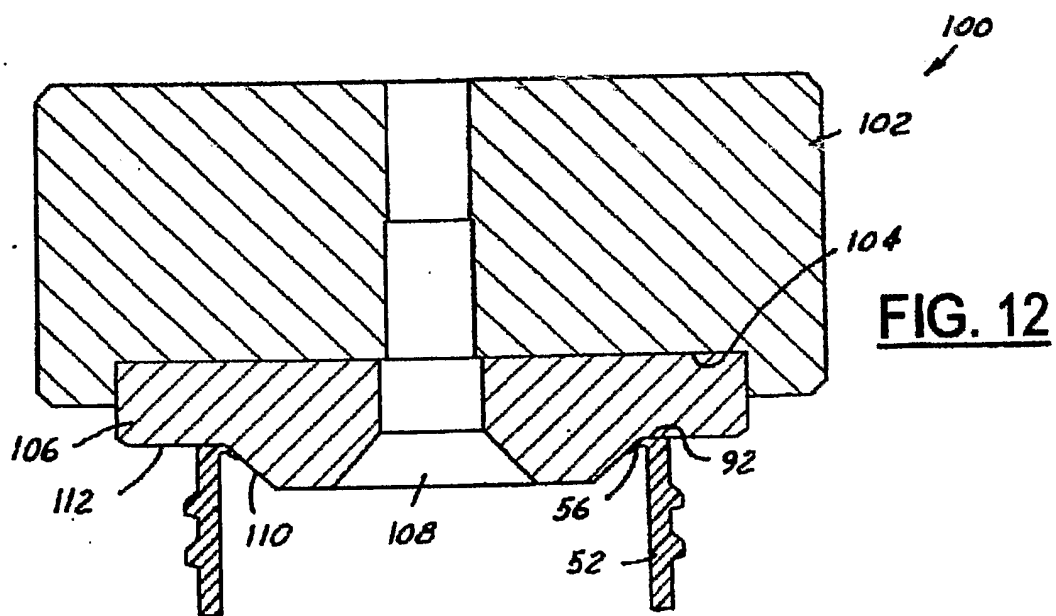


FIG. 12

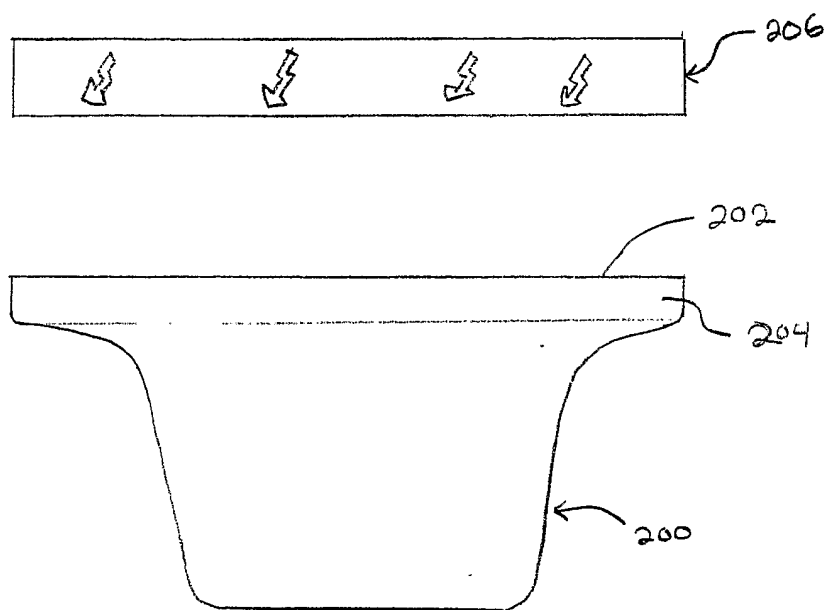


FIG. 13

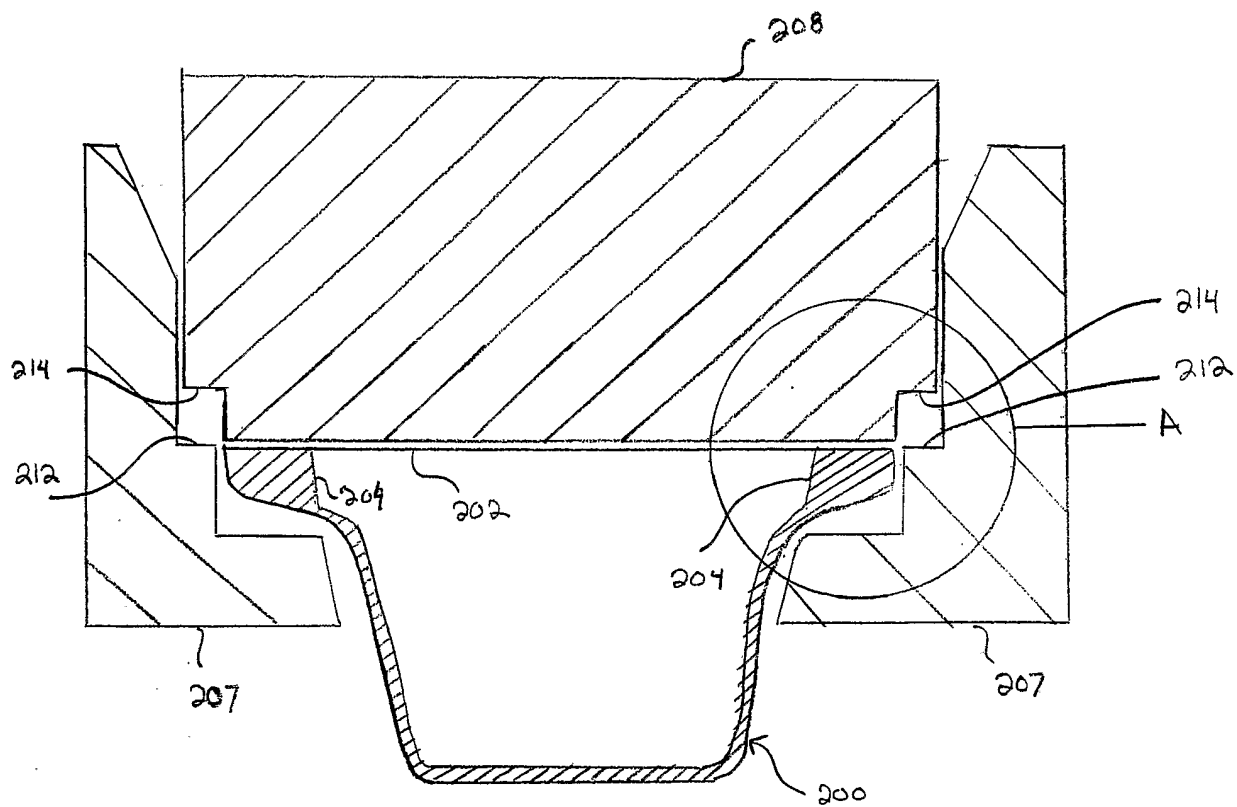


FIG. 14

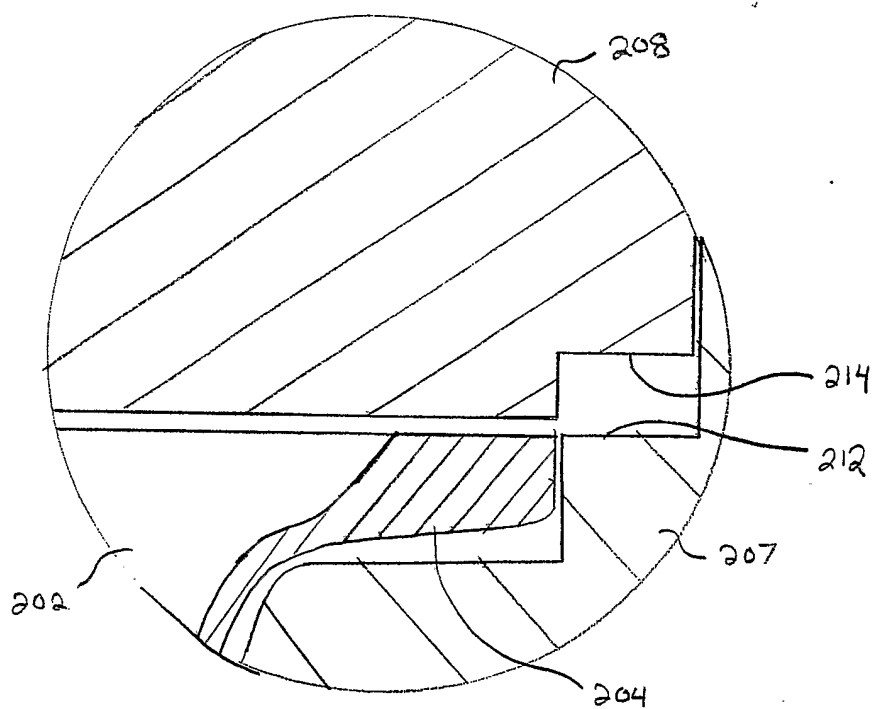


FIG. 15

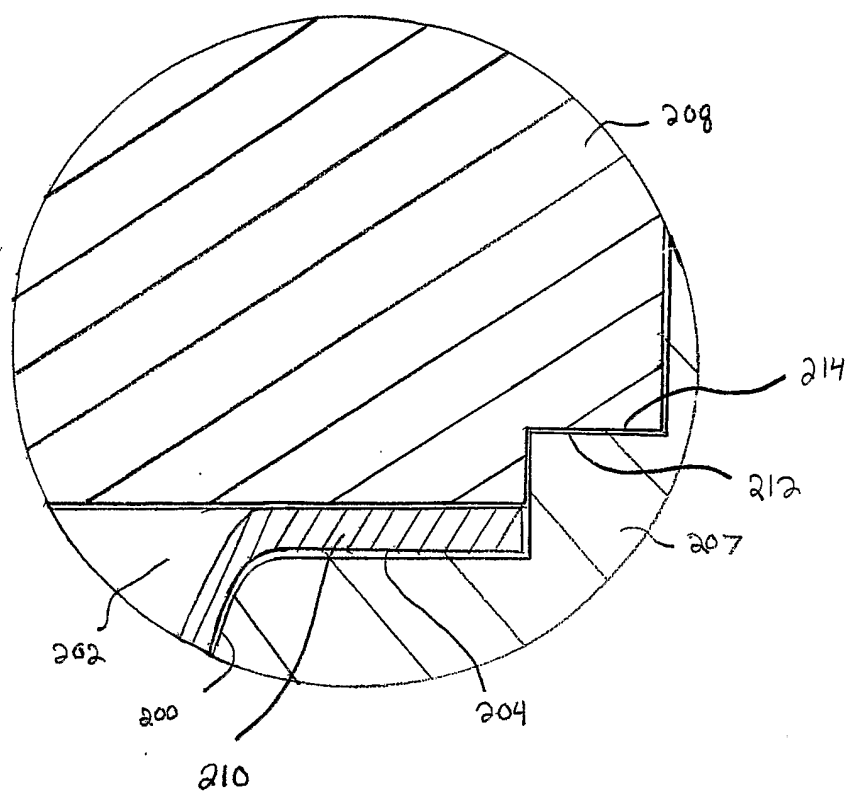


FIG. 16

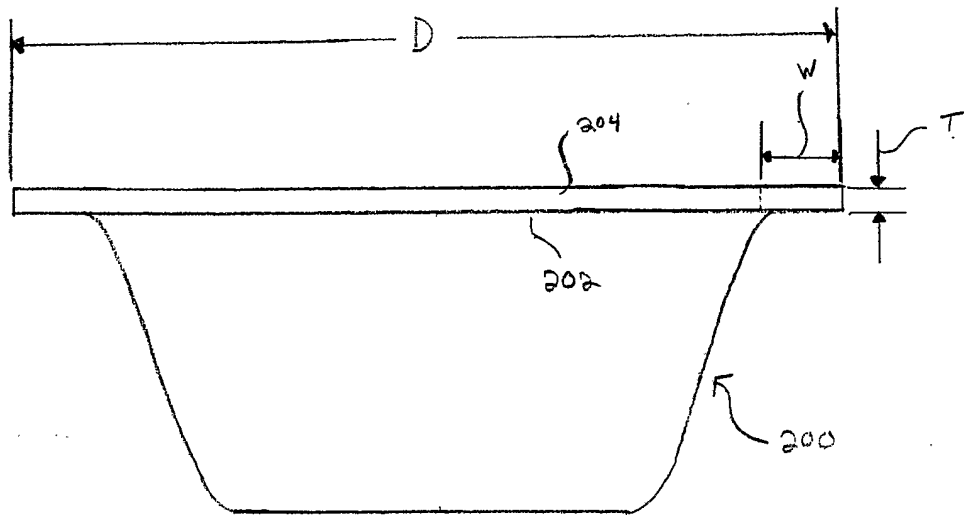


FIG. 17