A flexible plastic cap for drinking water containers has a flat circular top formed integrally with a generally cylindrical skirt.

An expansion ring encircles the central part of the top. The expansion ring serves as a hinge and provides the expansion required for the flexure and elongation produced by pressing the cap into sealing position over the two vertically spaced external beads on the container neck.

The skirt incorporates a tension ring which engages the top bead with a high unit pressure and retains the cap on the container neck. Vertical external ribs connect the lower edge portion of the skirt with the tension ring and couple expansion of the skirt to the tension ring while permitting the skirt itself to be formed of quite thin wall section.

A removal tab is combined with two adjacent ribs and reduced thickness wall sections immediately adjacent those two ribs. This combination produces vertical separation of the tab from the skirt and removal of the cap from the container neck with the ribs acting as fulcrums for the tab.
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CLOSURE FOR WATER BOTTLE

BACKGROUND OF THE INVENTION

This invention relates to a plastic cap closure for containers and particularly to a removable cap for contain-
ers of the kind used for drinking water.

Cost of manufacture, effective sealing action, ease of installation and removal, and sanitation are all major factors in the construction and use of the caps to which this invention relates.

The containers hold a relatively large amount of water (usually 5 gallons) and are often turned upside down at least once before being placed in a dispenser. The cap therefore must grip the neck of the container tightly enough to perform its primary function of preventing leakage.

The cap must also prevent the entry of foreign matter into the container or onto the surfaces of the neck which engage the dispenser. For maximum sanitation the cap should be removable in a way that does not re-

quire handling of the neck area covered by the cap.

The cap should also be easy and quick to remove in a single motion since the containers are sometimes picked up and held partially inverted over the dispenser before the cap is removed.

The caps usually are molded from a plastic material.

The cap construction should permit the use of a low cost material. The construction should also permit the material to flow readily to all parts of the mold cavity. For maximum economy of production the material should set up quickly. This indicates thin wall section wherever possible in the cap. To minimize rejects the molded cap should be capable of being easily removed from the mold without damage to the cap.

It is a primary object of the present invention to con-

struct a cap which fulfills all of the requirements and the desired qualities noted above.

SUMMARY OF THE INVENTION

A flexible plastic cap constructed in accordance with the present invention comprises a generally flat circular top and a generally cylindrical skirt connected to and extending downwardly from the top. The top and the skirt form a one piece, imperforate cap.

The cap is molded from a low density polyethylene material and has thin wall sections in the major portion of the cap. The top is joined with the skirt in a curved transition area of reduced wall thickness. The transition area elongates in length and effects an additional seal on the outer curved surface at the end of the neck and top of the first bead when the cap is pressed into sealing position.

The central part of the top is a disc shaped diaphragm which closes off the end of the container neck. This di-

aphragm has a thicker wall section than the adjacent transition area.

The central diaphragm is connected to the transition area by an inwardly curved expansion ring. The expan-
sion ring serves two functions. The expansion ring acts as a hinge to permit the flexing required to press the skirt over the top and bottom beads of the container neck. The expansion ring also permits the expansion required during the elongation of the curved transition area as described above. The inner surface of the ex-

pansion ring also projects below the lower surface of the central diaphragm and engages the end of the con-
tainer neck in tangential contact to provide an addi-
tional seal.

A tension ring is molded into the skirt at a location corre-

sponding to the undersurface of the upper bead. This tension ring has a substantially increased wall thickness extending circumferentially in the skirt and causes this part of the skirt surface to engage the lower surface of the upper bead with a high unit pressure both to provide a fluid seal and to retain the cap on the con-
tainer neck.

The lower edge portion of the skirt has a diameter re-

lated to the diameter of the lower bead which causes the lower edge portion of the skirt to expand and to en-

gage the lower bead in sealing contact when the cap is installed.

A plurality of vertically extending and circumferen-
tially spaced ribs are formed on the outside of the skirt and connect the lower edge portion of the skirt with the tension ring. These ribs couple the expansion of the lower edge portion of the skirt to the tension ring. The ribs effectively transmit the expansion forces through the vertical wall of the skirt while permitting the skirt itself to be formed of quite thin wall section.

A removal tab extends downwardly from between two adjacent ribs. Wall sections of reduced thickness are located immediately adjacent to and on the out-

sides of the two ribs to facilitate removal of the cap from the container neck by pulling the tab straight up. Pulling the tab straight up causes the ribs to act as ful-

crums for the tab in separating the tab from the adjoining skirt. This causes the cap to pull off the neck of the container without pressing down on the opposite side of the cap.

Cap constructions effective to function in the ways described above constitute further, specific objects of the present invention.

Other objects, advantages and features of our inven-
tion will become apparent from the following detailed description of one preferred embodiment taken with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a top of a water con-
tainer having a cap constructed in accordance with one embodiment of the present invention;

FIG. 2 is an isometric view of the cap shown in FIG. 1. FIG. 2 shows the cap configuration as molded and prior to pressing the cap on the container neck;

FIG. 3 is an enlarged side elevation view in cross section taken along the line and in the direction indicated by the arrows 3-3 in FIG. 1;

FIG. 4 is an enlarged plan view of the cap shown in FIG. 2;

FIG. 5 is an elevation view in cross section taken along the line and in the direction indicated by the arrows 5-5 in FIG. 4;

FIG. 6 is an enlarged fragmentary plan view in cross section of the portion of the skirt shown encircled by the arrows 6-6 in FIG. 4;

FIG. 7 is an enlarged elevation view of the portion of the structure in FIG. 5 shown encircled by the arrows 7-7; and

FIG. 8 is an enlarged fragmentary plan view in cross section of a portion of the skirt sidewall shown encircled by the arrows 8-8 in FIG. 4.
DESCRIPTION OF ONE PREFERRED EMBODIMENT

A cap constructed in accordance with one embodiment of this invention is indicated generally by the reference numeral 20 in FIG. 1. In FIG. 1 the cap 20 is shown in sealing position on the neck 22 of a water container or bottle 24.

As best illustrated in FIG. 3, the neck 22 has an annular surface or finish 26 at the end of the neck. The surface 26 curves inwardly to merge with the inner sidewall 28 of the hollow neck and merges on its outer edge with a first or upper bead 30.

A second or lower bead 32 is spaced from the upper bead 30 by a reduced diameter portion 34. The cap 20 comprises a generally flat, circular top 36 and a generally cylindrical skirt 38.

The top 36 and skirt 38 form a one-piece imperforate cap, and the cap is made by molding a low density polyethylene material.

In a specific embodiment of the present invention a polyethylene material having a melt index of 50 and a density index of 925 was molded for 6 seconds at a temperature range of 380°F to 425°F. under a pressure of around 2,000 pounds per square inch.

As will become more apparent from the description to follow, the cap 20 of the present invention has a number of structural features which make it easy to mold. These features include straight walls with no back taper. It requires little force to strip. The cap has quite thin wall sections and is easy to cool. The molded product therefore sets up quickly and can be produced at a high rate. Because a low density polyethylene density is used, the present cap requires only about one-half of the amount of material required for prior art caps. Outside vertical ribs on the cap provide runners to get the material to the lower end of the die. This is important in providing the capability to mold a thin walled cap without rejects.

The cap 20 also has the advantage that it can be used by existing capping machines.

Continuing with the description of the structural features of the cap itself, the cap 20 must flex and expand when pressed over the beads 30 and 32. These beads are of somewhat larger diameter than the internal diameter of the skirt 38 in the cap as molded. Thus, the lower edge portion or diameter A (see FIG. 5) of the skirt must expand initially as it passes over the bead 30. This lower edge portion of the skirt 38 must expand a second time as it passes over and around the bead 32 to the sealing position 39 illustrated in FIG. 3. As will be described in greater detail below, the expansion of this diameter A of the skirt is coupled to a tension ring 50 through vertical outside ribs 52.

The diameter B indicated in FIG. 5 is the first engagement of the tension ring seal on the top bead 30 as the cap is pressed down on the neck.

The required flexure and expansion are provided by the combination of an expansion ring 40 and a thin wall curved transition area 42 which connect the top 36 and the skirt 38.

The transition area 42 elongates in length and effects a seal on the outer edge of the curved surface 26. This transition area has a quite thin wall thickness to permit the elongation and the conformation to the underlying surface 26 of the container neck.

The expansion ring 40 permits the expansion required during the elongation of the curved transition area 42. The expansion ring 40 also acts as a hinge to permit the flexing required to press the skirt 38 over the top and bottom beads 30 and 32.

As best illustrated in FIG. 7, the inner surface 44 of the expansion ring 40 is a convexly curved surface, as viewed from the inside of the cap, and projects downwardly below the immediately adjacent part of the transition area 42. This surface 44 engages the upper, flat part of the surface 26 in tangential contact to provide an additional seal as illustrated in FIG. 3.

The central part of the top 36 is a disc shaped diaphragm 46 having greater thickness than the transition area 42. This diaphragm closes off the inner diameter 28 of the neck 22 to block flow out of the container.

A tension ring 50 of substantially increased wall thickness (see FIG. 5) extends circumferentially in the upper part of the skirt 38 and is located to engage the lower surface of the upper bead 30 with a high unit pressure. The tension ring 50 provides a fluid seal and retains the cap on the container neck.

A plurality of vertically extending and circumferentially spaced ribs 52 are formed on the outside of the skirt 38. These ribs connect the lower edge portion of the skirt, that portion of diameter A having the surface 39 engaged with the bead 32, with the tension ring 50. The ribs therefore effectively transmit the expansion forces through the vertical wall of the skirt while permitting the skirt itself to be formed with a quite thin wall section. The ribs also facilitate gripping of the outside of the cap. As indicated above, the ribs 52 also provide runners for conveying the material from one end of the mold to the other during the molding operation and thus permit extended thin wall sections to be formed with a minimum of rejects.

A removal tab 70 extends downwardly from between two adjacent ribs 52. The tab 70 continues upwardly between the ribs as an increased wall thickness section (see FIG. 6).

As illustrated in FIG. 6 relieved areas or sharps 72 are formed in the outer surface of the skirt just outside the two ribs 52 adjacent to the removal tab 70. These relieved areas 72 produce decreased wall thickness which facilitates separation of the removal tab 70 from the remainder of the skirt when the lower end of the tab 70 is pulled straight up. The location of these relieved areas 72 close to the ribs 52 causes the ribs to act as fulcrums for the tab in separating the tab from the adjoining skirt. This in turn causes the cap to pull off the neck of the container without pressing down on the outside of the cap.

In summary, as the cap 20 is pressed down on the neck 22, the diameter A engages the top of the bottle neck and starts the initial expansion of the tension ring closure 50. The diameter A forms a secondary seal 39 at the bottle neck as a second engagement of the bottle neck, that is, the engagement with the lower bead 32.

The diameter B is the first engagement of the tension ring seal at the top of the bottle neck.

The tension ring 50 effects the sealing of the cap by the tension field created in the cap by expanding the skirt area diameters A and B thereby creating a higher unit pressure area within the tension ring area.

The reduced wall thickness of the transition area 42 above the tension ring 50 permits this part of the cap to elongate in length and to effect a seal on the curved
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outer part of the surface 26. This is the resultant of the radical expansion of the two related diameters A and B and the engagement of the tension ring 50 with the major diameter of the top bead 30. The transition area 42 elongates, through its flexibility, and adjusts to the varying diameters of the top bead induced by the manufacturing process of the bottle.

The expansion ring 40 provides the hinge and expansion action necessary to permit the material in the wall of the transition area 42 to move, to elongate and to conform to the area of the top bead 30 of the bottle. This configuration provides the radial flexibility and circumferential elongation to promote the controlled flow of material throughout the reduced material thickness of the transition area 42.

The tangential seal on the surface 44 is the result of the action and reactions of the combined forces described above.

The diaphragm 46 is held in place by its couple through expansion ring 40. This circumferential connection to the transition area 42 produces a radial tension attitude that, through the transfer of radial and circumferential tension fields, seals the opening 28.

The ribs 52 are vertical stiffeners. These ribs are the vertical, structural connection coupling diameters A and B to the circumferential tension ring 50. Through this couple the forces are connected and transmitted throughout the vertical wall area of the cap to effect the seals at the tangential contacts of the container and the cap. The increased wall thickness in the ribs 52 control the expansion of the skirt area permitting the use of a thinner wall section and permitting material in the molding cycle to flow to the thinner wall sections. The exterior surface area of the skirt produced by the undulations of the rib to the circumferential flat area of the skirt provides a non-slip texture for hand or mechanical grip areas.

The areas 72 of reduced material thickness have contours which create fault areas of reduced structural integrity to permit a controlled rupture or tear in a directed manner to break the intentionally directed circumferential tension field of the skirt and land areas of the cup. This condition, for the specific purpose of ease of cap removal from the sealed areas of the container, must be in an upward direction, that is, from an area of the lower portion of the skirt to the upper sealing area. The initial rupture or tear occurs when force at the tear tab 70 is applied in a curling upward attitude thereby creating a high stress concentration in the areas 72. This high stress results in a failure of the material in the areas 72 resulting in a complete separation of the two adjacent wall areas separated by the areas 72. That results in a tear of the vertical section of the skirt. The result is a release or normalizing of the originally created tension fields and the relaxing of pressures of the cap that were originally exerted upon the tangential contact areas of the container. The area of tear must be the radial area between the vertical rib sections 52. The variation of material thickness in this area promotes the tear. The areas designated as the recesses 72 initiate the tear or rupture and the rib walls 52 act as fulcrums.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

We claim:

1. A cap for a container of the kind having a hollow neck, an annular finish at the end of the neck, an upper external first bead on the neck, a lower external second bead on the neck and a reduced diameter portion between the beads, said cap comprising, a generally flat circular top and a generally cylindrical skirt connected to and extending downwardly from the top, both the top and the skirt being formed from a plastic material as a unitary imperforate cap having sufficient flexibility to be pressed over the beads to a fluid sealing position, and wherein the skirt includes a tension ring means for engaging an area of the skirt with an annular part of the lower surface of the first bead under a high unit pressure to provide a fluid seal and to retain the cap on the container neck, and wherein the tension ring means include a substantially increased wall thickness in a ring extending circumferentially in the skirt and including a downwardly curved transition area between the top and the skirt and wherein said transition area is a reduced wall thickness section which elongates in length and effects an additional seal on the container neck finish at the end of the neck and beginning of the first bead when the cap is pressed into sealing position on the container neck and wherein the top has a central disc shaped diaphragm for closing the hollow interior of the bottle neck and including expansion ring means between the diaphragm and the transition area for providing a hinge between the diaphragm and the transition area and skirt and for permitting the expansion required during said elongation of the curved transition area.

2. The invention defined in claim 1 wherein the expansion ring means include a downwardly curved annular section having a lower convexly curved surface which projects below the lower surface of the diaphragm and the immediately adjacent lower surface of the transition area for engaging the annular finish at the end of the neck in tangential sealing contact.

3. The invention defined in claim 1 wherein the disc shaped diaphragm has substantially greater thickness than the adjacent expansion ring and transition area.

4. The invention defined in claim 1 wherein the lower edge portion of the skirt has a diameter related to the diameter of the second bead which causes the lower edge portion of the skirt to expand and to engage the second bead in sealing contact when the cap is installed.

5. A cap for a container of the kind having a hollow neck, an annular finish at the end of the neck, an upper external first bead on the neck, a lower external second bead on the neck and a reduced diameter portion between the beads, said cap comprising, a generally flat circular top and a generally cylindrical skirt connected to and extending downwardly from the top, both the top and the skirt being formed from a plastic material as a unitary imperforate cap having sufficient flexibility to be pressed over the beads to a fluid sealing position, and wherein the skirt includes tension ring means for engaging an area of the skirt with an annular part of the lower surface of the first bead under a high unit pressure to provide a fluid seal and to retain the cap on the container neck, and wherein the lower edge portion of the skirt has a diameter related to the diameter of the second bead which causes the lower edge portion of the skirt to expand and to engage the second bead in seal-
ing contact when the cap is installed, and including a plurality of vertically extending and circumferentially spaced ribs on the outside of the skirt and connecting the lower edge portion of the skirt with the tension ring means to couple the expansion of the lower edge portion of the skirt to the tension ring means and to effectively transmit the expansion forces through the vertical wall of the cap with an overall thin wall skirt.

6. A cap for a container of the kind having a hollow neck, an annular finish at the end of the neck, an upper external first bead on the neck, a lower external second bead on the neck and a reduced diameter portion between the beads, said cap comprising, a generally flat circular top and a generally cylindrical skirt connected to and extending downwardly from the top, both the top and the skirt being formed from a plastic material as a unitary perforate cap having sufficient flexibility to be pressed over the beads to a fluid sealing position, and wherein the skirt includes tension ring means for engaging an area of the skirt with an annular part of the lower surface of the first bead under a high unit pressure to provide a fluid seal and to retain the cap on the container neck, and wherein the lower edge portion of the skirt has a diameter related to the diameter of the second bead which causes the lower edge portion of the skirt to expand and to engage the second bead in sealing contact when the cap is installed, and including a plurality of vertically extending and circumferentially spaced ribs on the outside of the skirt and connecting the lower edge portion of the skirt with the tension ring means to couple the expansion of the lower edge portion of the skirt to the tension ring means and to effectively transmit the expansion forces through the vertical wall of the cap with an overall thin wall skirt, and including a tab extending downwardly from between two adjacent ribs and including reduced thickness wall sections immediately adjacent said two ribs to facilitate tearing of the skirt vertically alongside said two ribs when the tab is pulled straight up.

7. The invention defined in claim 6 wherein the reduced wall thickness areas are formed by depressions on the outer surface of the skirt and are located just to the outside of the ribs.

8. The invention defined in claim 7 wherein the tab includes an increased thickness section which extends the full vertical distance between the lower edge of the skirt and the tension ring.

9. A cap for a container of the kind having a hollow neck, an annular finish at the end of the neck, an upper external first bead on the neck, a lower external second bead on the neck and a reduced diameter portion between the beads, said cap comprising, a generally flat circular top and a generally cylindrical skirt connected to and extending downwardly from the top, both the top and skirt being formed from a plastic material as a unitary perforate cap, a downwardly curved transition area between the top and the skirt having a reduced wall thickness section which elongates in length and effects an additional seal on the curved finish at the end of the neck and beginning of the first bead when the cap is pressed into sealing position on the container neck, and including expansion ring means between the top and the transition area for providing a hinge between the top and the transition area and for permitting the elongation in the transition area immediately adjacent the expansion ring which is required to press the skirt over the beads to a fluid sealing position on the container neck.