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(72) Inventor: **Ioannides, Andrew, Gregory**
Oxford, Oxfordshire OX5 1RR (GB)

(74) Representative: **Ratliff, Ismay Hilary**
CarnaudMetalbox Technology plc,
Downsview Road
Wantage,
Oxon OX12 9BP (GB)

(71) Applicant: **Crown Packaging Technology, Inc**
Alsip, IL 60803-2599 (US)

(54) **Container with clamped seal**

(57) A container comprising a metal can body (1) and a diaphragm (40) closing the body end. The diaphragm (40) is clamped between opposing sur-

faces of a collapsed annular beard (15b) to close the body.

A method and apparatus for making the container are disclosed.

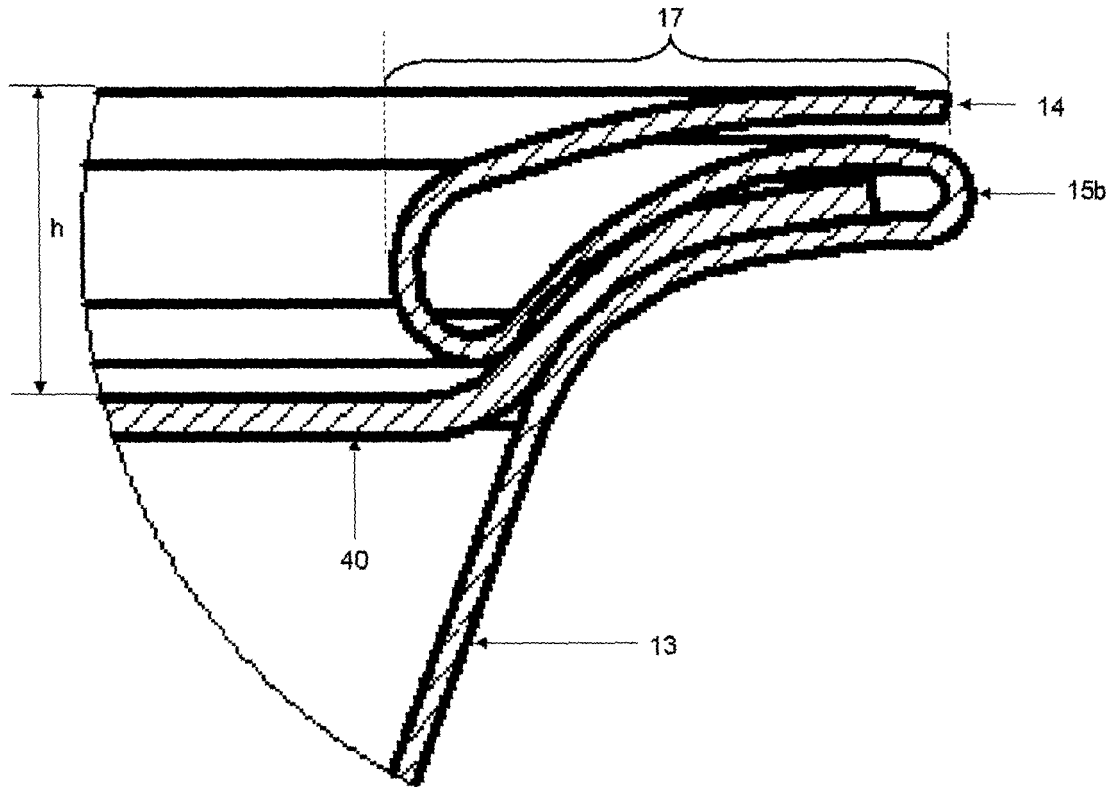


Fig. 4b

Description

Technical Field

[0001] This invention relates to a container in the form of a metal can body having an access opening closed with a flexible diaphragm, the container provided with an improved means of securing the diaphragm to the can body.

Background Art

[0002] In the field of food packaging, metal containers are known having a can body provided with an access opening which is sealed by a flexible diaphragm in the form of lightweight peelable foil lidding. The diaphragm typically includes a metal substrate to perform the functions of providing strength, forming a barrier to mitigate loss of moisture and flavours from the filled can, and preventing contamination. Heat sealing or adhesive are commonly used to provide a peelable bond between the diaphragm and the can body. The diaphragm is typically bonded to an intermediate ring component, which is then seamed to the sidewall of the can body. GB 2237259 A (CMB FOODCAN PLC) 01.05.1991 discloses a typical example of such a known metal container, with the diaphragm peelably bonded to an intermediate metal ring.

[0003] A problem common to such known containers having a peelable flexible diaphragm is that positive pressure within the container will act to cause the diaphragm to progressively peel itself away from the surface to which it is bonded. This progressive peeling initiates and propagates from inside the container and is therefore invisible to the can manufacturer, the filler and end-consumer. For this reason, when considering the case of containers for food products requiring sterilisation, such containers must either:

- be processed in an overpressure retort which includes pressure balancing to compensate for pressure changes within the container caused by the heat generated during processing; or
- have the diaphragm bonded to an inclined sealing surface of the container body (as disclosed in EP 0683110 A (CARNAUD METALBOX) 22.11.1995), the inclined sealing surface ensuring that the bond between diaphragm and container remains predominantly loaded in shear (rather than peel) when subject to "in-can" pressure.

[0004] A problem specific to the use of an intermediate ring component is that its manufacture results in material wastage because the ring is cut from a sheet of metal, with the central cut-out portion being thrown away.

[0005] There is therefore a need to provide an alternative container which has the benefits of using lightweight lidding material, whilst also being more suitable for use in positive (and negative) pressure applications

than conventional peelable lidding/closures.

Disclosure of Invention

[0006] Accordingly, for a first aspect of the invention there is provided a container comprising a tubular metal can body and a diaphragm, the sidewall of the can body comprising a circumferential radially-expanded region located at one or both ends of the can body, wherein an outwardly-directed collapsed annular bead is provided in the expanded region, **characterised in that** the diaphragm is clamped between opposing surfaces of the collapsed bead to close the end of the container.

[0007] The use of the metal of the can body - via the opposing surfaces of the collapsed annular bead - to secure the diaphragm by clamping overcomes the tendency of peelable lidding to progressively peel away from the container when subject to positive pressures. The clamping mechanism used by the invention to close the container ensures that the diaphragm can sustain both negative and positive pressures in a better manner than conventional peelable lidding. Therefore, considering the case of containers for food products requiring sterilisation, the container of the invention may be processed within a larger range of retorts with a reduced need for pressure balancing.

[0008] The use of clamping to secure the diaphragm also avoids the use of adhesive, heat sealing or other sealing compounds, and therefore simplifies the manufacturing route for the container of the invention compared to containers provided with conventional peelable lidding. However, whilst the invention can deliver good seal integrity without the use of sealing compound, improved sealability is provided when using a sealing compound at the interface between the diaphragm and the opposing surfaces of the collapsed bead.

[0009] Additionally, the invention does not require the use of the intermediate ring component commonly used in the manufacture of containers closed with peelable lidding (see GB 2237259 A), and therefore results in material cost savings and a simplified manufacturing route.

[0010] The metal can body is conveniently made of aluminium or steel; however, other metals may also be used. The diaphragm is conveniently made from foil sheet metal, thereby providing flexibility and reduced weight relative to conventional generally rigid sheet metal can ends that are seamed onto can bodies. The diaphragm may also include one or more polymer coatings/films on either or both faces of a metal substrate. The use of such polymer coatings/films may provide a suitable surface for printing of text/graphics and protect the metal substrate from corrosion. Further, the polymer coating/film material would act like a gasket when clamped between the opposing surfaces of the collapsed bead, with its resilience enabling it to deform and adapt to the profile of the opposing bead surfaces, thereby helping to develop and maintain a hermetic seal between the diaphragm and can body. The diaphragm may also be

made from:

- A barrier plastic material. This is where the diaphragm is made wholly from plastics. It includes either a single homogeneous layer or a laminate composed of different plastics layers; or
- A composite. For example, good seal integrity has been achieved using a composite of cardboard, metal foil, and polymer coatings (such as the material used on Tetra Pak® cartons).

[0011] To reduce the risk of cuts to an individual, a portion of the sidewall of the can body extending between the collapsed bead and a free edge of the can body is flattened to lie against the exterior surface of the collapsed bead to provide protection against cuts from the free edge. This flattening results in the diaphragm being, in effect, recessed beneath a double thickness of the material of the can body sidewall. This feature provides advantages in terms of:

- increased container rigidity; and
- increased protection for the diaphragm (due to the recessed construction) during handling and transportation of the sealed containers.

[0012] Alternatively, the portion may incorporate one or more folds (for example, in a concertina-like manner) which are flattened to lie against the exterior surface of the collapsed bead. This would further enhance container rigidity and protection for the diaphragm.

[0013] In a preferred embodiment which would further enhance protection against cuts to an individual, a portion of the sidewall of the can body extending between the collapsed bead and a free edge of the can body, wherein the portion is wrapped around and under the periphery of the exterior surface of the collapsed bead so that the free edge is directed radially inwardly to oppose the exterior surface of the can body sidewall. The protection from cuts is improved because the free edge is tucked safely out of the way underneath the collapsed annular bead and is directed radially inwards towards the exterior surface of the can body sidewall.

[0014] For ease of opening, it is preferred that the diaphragm comprises a score line defining an opening area, and a tab for severing the score line.

[0015] According to a second aspect of the invention, there is provided a method of forming a container, the method comprising the following steps:

- i. radially expanding the sidewall of a tubular can body at one or both ends of the can body to define a circumferential radially-expanded region in the sidewall;
- ii. applying a first axial load to the can body whilst using means adapted to limit radial growth of a free edge of the can body, so that the circumferential radially-expanded region partially axially collapses to

form an outwardly-directed open annular bead;

iii. locating a diaphragm relative to the can body so that the diaphragm locates between opposing surfaces of the open annular bead; and

iv. applying a second axial load to the can body to fully axially collapse the bead to thereby clamp the diaphragm between the opposing surfaces of the bead and close the end of the container.

[0016] The invention takes advantage of the fact that on application of a sufficient axial load to the can body, the sidewall of the can body will buckle (or collapse). Formation of the circumferential radially-expanded region in the sidewall provides a region that is highly susceptible to buckling or collapse on application of sufficient axial load. Therefore, the expanded region serves the function of preferentially controlling where buckling or collapse of the sidewall will occur.

[0017] By "axial load" is meant a load applied generally parallel to the longitudinal axis of the can body.

[0018] Preferably, steps i & ii are performed substantially simultaneously. For example, the invention may be enabled by steps i and ii comprising inserting a flared die within one or both ends of the can body to apply both radial and axial loads to the can body, the flared die terminating in a generally radially extending end face, a limit ring situated adjacent the end face, the limit ring having a generally axially extending wall to thereby limit radial growth of the free edge of the can body. It is anticipated that the method would work as follows:

- Either or both of the flared die and the can body would be driven towards each other so that the flared die enters an end of the can body.
- As the flared die enters the end of the can body, the walls of the die would act against the sidewall of the can body to thereby apply both radial and axial loads to the can body sidewall, and progressively radially expand the sidewall.
- When the die has sufficiently entered the can body, the free edge of the can body would contact the radially-extending end face of the die, with further insertion of the die then leading to radial growth of the free edge along the end face until it contacts the axially extending wall of the limit ring.
- The limit ring acts as a constraint to further radial growth of the free edge. Consequently, further axial movement of the flared die within the end of the can body would result in the partial axial collapse (or buckling) of the sidewall in the radially expanded region, resulting in formation of the outwardly-directed open annular bead.
- The die would then be removed and the diaphragm inserted.
- Once the diaphragm has been inserted, a flat plate (or equivalent mechanical means) may be used to apply the second axial load to thereby fully collapse the bead and securely clamp the diaphragm in po-

sition.

[0019] To enable formation of a container with increased rigidity and cut edge protection, the method may be modified so that during step ii the circumferential radially-expanded region is formed to leave a portion of the sidewall of the can body extending between the partly collapsed outwardly-directed open annular bead and the free edge, wherein simultaneously with or subsequent to step iv the portion is flattened to lie against the exterior surface of the collapsed bead. This flattening may be achieved by using a flat plate as referred to above (or equivalent mechanical means).

[0020] To further increase container rigidity, the portion may be folded back and forth in a succession of folds (for example, in a concertina-like manner), these folds then flattened against the exterior surface of the collapsed bead.

[0021] In a further variation to the method of the invention which would enhance protection against cuts to an individual, it is preferred that during step ii the circumferential radially-expanded region is formed to leave a portion of the sidewall of the can body extending between the partly collapsed outwardly-directed open annular bead and the free edge, wherein simultaneously with or subsequent to step iv the portion is folded around and under the periphery of the exterior surface of the collapsed bead so that the free edge is directed radially inwardly to oppose the exterior surface of the can body sidewall.

[0022] According to a third aspect of the invention, there is provided an apparatus for forming a container, the apparatus having:

- i. means for radially expanding the sidewall at one or both ends of a tubular metal can body to define a circumferential radially-expanded region in the sidewall;
- ii. means for applying a first axial load to the can body, plus means adapted to limit radial growth of a free edge of the can body such that during application of the first axial load the circumferential radially-expanded region partially axially collapses to form an outwardly-directed open annular bead;
- iii. means for locating a diaphragm formed of flexible lidding material relative to the can body so that the diaphragm locates between opposing surfaces of the open annular bead;
- iv. means for applying a second axial load to the can body to fully axially collapse the bead to thereby clamp the flexible diaphragm between the opposing surfaces of the bead and close the end of the container.

[0023] Preferably, a common entity is used to simultaneously both radially expand the sidewall (see i) and apply the first axial load (see ii). Conveniently, the common entity is a flared die, the flared die terminating in a gen-

erally radially extending end face, wherein the means to limit radial growth is a limit ring situated adjacent the end face, the limit ring having a generally axially extending wall to thereby limit radial growth of the free edge of the can body.

[0024] The flared die and limit ring may be separate components; however, it has been found preferable to combine the flared die and the limit ring into an integrally formed single component.

Brief Description of Figures in the Drawings

[0025] Two embodiments of the present invention at various stages in manufacture are described below and is illustrated in the following drawings:

[0026] FIGURE 1a relates to a first embodiment of the invention and shows a cross-section through a can body of uniform diameter and a flared die before any deformation of the can body.

[0027] FIGURE 1b is a detail view of figure 1a, more clearly showing the profile of the flared die.

[0028] FIGURE 2a shows a cross-section through the can body and the flared die after the die has been driven within one end of the can body to define an outwardly-directed open annular bead.

[0029] FIGURE 2b is a detail view of figure 2a, more clearly showing the profile of the outwardly-directed open annular bead.

[0030] FIGURE 3 is a detail view of the can body prior to full collapse of the annular bead by a flat plate, with the diaphragm located in position between the opposing surfaces of the open annular bead.

[0031] FIGURE 4a shows a cross-section through the can body in its final form, with the bead in its fully collapsed state to clamp the diaphragm in position between opposing surfaces of the bead.

[0032] FIGURE 4b is a detail view corresponding to figure 4a, but inverted relative to figure 4a.

[0033] FIGURE 5 shows a perspective view of the can body after the process steps shown in the earlier figures.

[0034] FIGURE 6 relates to a second embodiment of the invention and corresponds to figure 4b, but adapted to provide enhanced rigidity and protection against cuts from the free edge than the first embodiment of the invention.

Mode(s) for Carrying Out the Invention

[0035] As shown in figures 1a & 1b, a cylindrical metal can body 1 of uniform diameter is initially located with one end co-axial with a flared die 2 and limit ring 3. The flared die 2 terminates in a generally radially extending end face 21 (see figure 1 b) which is curved in profile. The flared die 2 locates within a recess provided in the limit ring 3, the recess defined by a generally axially extending wall 31 extending upwardly from base 32 of the limit ring (see figures 1 a & 1 b). The periphery of the end face 21 has a diameter corresponding in size to that of

the axial wall 31 (see figure 1 b). Therefore, there is little or no gap between the periphery of the end face 21 and the axially extending wall 31. In an alternative embodiment not shown in the figures, the flared die and the limit ring would be integrally formed.

[0036] As indicated in figure 1a, the flared die 2 and can body 1 are driven towards each other along the longitudinal axis 11 of the can body (indicated by arrows A and A), so that the die enters one end of the can body. In alternative embodiments, only one of the die 2 and the can body 1 are moved, the other entity remaining stationary. In the embodiment shown in the figures, a forming operation is performed on the opposite end of the can body 1 (by means not shown), to provide a flare 12 (as indicated in figure 2a). The flare 12 enables a conventional sheet metal can end to be seamed to that opposite end of the can body 1.

[0037] As shown in figures 2a & 2b, as the flared die 2 gradually enters the end of the can body 1, the flared walls 22 (see figure 2b) of the die act against the sidewall 13 of the can body, thereby progressively radially-expanding the sidewall adjacent the end of the can body. By the nature of its flared profile, the die 2 is able to simultaneously apply both axial and radial loads to the can body 1. When the die 2 has sufficiently entered the end of the can body 1, the free edge 14 of the can body contacts the end face 21 of the die, with further insertion of the die leading to radial growth of the free edge until constrained by the axially extending wall 31 of the limit ring 3. Further insertion of the die 2 causes the radially-expanded region of the sidewall 13 to partially axially collapse or buckle, resulting in formation of an outwardly-directed open annular bead 15a (as shown in figures 2a & 2b). A portion 16 of the sidewall 13 extends generally axially between the open annular bead 15a and the free edge 14.

[0038] At this point, the flared die 2 is then removed to allow insertion of a diaphragm 40 between the opposing surfaces of the outwardly-directed open annular bead 15a (see figure 3). The diaphragm 40 is formed from sheet metal, such as aluminium.

[0039] Once the diaphragm 40 is located in position, a second axial load is applied to the end of the can body 1 by means of a flat plate 50 (indicated in figure 3). In the embodiment shown, the plate 50 and the can body 1 are moved towards each other (indicated by arrows B in figure 3). However, in alternative embodiments just one of the plate 50 and can body 1 is moved. Sufficient axial load is applied via the plate 50 to fully axially collapse (or buckle) the outwardly-directed open annular bead 15a. The bead in its final fully collapsed state 15b is shown in figures 4a & 4b. In this state, the periphery of the diaphragm 40 is clamped between the opposing surfaces of the fully collapsed bead 15b to seal the end of the can body 1. The force exerted by the plate 50 also results in the portion 16 of the sidewall being flattened 17 to lie against the exterior surface of the collapsed bead 15b (see figure 4b). This ensures that the free edge 14 does

not protrude and cause a cut hazard to individuals. The flattening of the portion 16 against the exterior surface of the collapsed bead 15b also results in the clamped diaphragm 40 being recessed a distance 'h' beneath the uppermost plane of the can end (see figure 4b). Furthermore, the flattening also results in a triple thickness of can body sidewall material at that end of the can body 1, with consequent benefits to container rigidity.

[0040] The container that results from the above process steps is shown in figure 5, showing the can body 1 with the diaphragm 40 clamped in position to close one end of the can body. As can be seen from figure 5, the diaphragm is formed with a score line 41 to define a prearranged opening area for dispensing of the container's contents, with a tab 42 for opening of the prearranged opening area by severing of the score line. The tab shown in figure 5 is adhered to the diaphragm by an adhesive. However, in an alternative embodiment, the tab may be riveted to the diaphragm.

[0041] In an alternative embodiment shown in figure 6, the portion 16 is greater in length than that of the embodiment of figures 1 to 5. This additional length is necessary to enable the portion 16 to be flattened 17 and wrapped around and under 18 the periphery of the exterior surface of the collapsed bead 15b (as shown in figure 6), so that the free edge 14 is directed radially inwardly to oppose the exterior surface of the can body sidewall, thereby providing enhanced rigidity and protection against cuts from the free edge.

Claims

1. A container comprising a tubular metal can body (1) and a diaphragm (40), the sidewall (13) of the can body comprising a circumferential radially-expanded region located at one or both ends of the can body, wherein an outwardly-directed collapsed annular bead (15b) is provided in the expanded region, **characterised in that** the diaphragm is clamped between opposing surfaces of the collapsed bead to close the end of the container.
2. A container as claimed in claim 1, a portion (16) of the sidewall (13) of the can body (1) extending between the collapsed bead (15b) and a free edge (14) of the can body, the portion flattened (17) to lie against the exterior surface of the collapsed bead to provide protection against cuts from the free edge.
3. A container as claimed in claim 1, a portion (16) of the sidewall (13) of the can body (1) extending between the collapsed bead (15b) and a free edge (14) of the can body, wherein the portion is wrapped around and under (18) the periphery of the exterior surface of the collapsed bead so that the free edge is directed radially inwardly to oppose the exterior surface of the can body sidewall, thereby providing

enhanced rigidity and protection against cuts from the free edge.

4. A container as claimed in any preceding claim, wherein the diaphragm (40) comprises a score line (41) defining an opening area, and a tab (42) for severing the score line. 5
5. A method of forming a container, the method comprising the following steps: 10
 - i. radially expanding (2) the sidewall (13) of a tubular can body (1) at one or both ends of the can body to define a circumferential radially-expanded region in the sidewall; 15
 - ii. applying a first axial load (2, A) to the can body whilst using means (3, 31) adapted to limit radial growth of a free edge of the can body, so that the circumferential radially-expanded region partially axially collapses to form an outwardly-directed open annular bead (15a); 20
 - iii. locating a diaphragm (40) relative to the can body so that the diaphragm locates between opposing surfaces of the open annular bead; and
 - iv. applying a second axial load (50, B) to the can body to fully axially collapse the bead (15b) to thereby clamp the diaphragm between the opposing surfaces of the bead and close the end of the container. 25
6. A method as claimed in claim 5, wherein steps i & ii are performed substantially simultaneously. 30
7. A method as claimed in claim 6, wherein steps i and ii comprise inserting a flared die (2, 22) within one or both ends of the can body (1) to apply both radial and axial loads to the can body, the flared die terminating in a generally radially extending end face (21), a limit ring (3) situated adjacent the end face, the limit ring having a generally axially extending wall (31) to thereby limit radial growth of the free edge of the can body. 35
8. A method as claimed in any one of claims 5 to 7, wherein during step ii the circumferential radially-expanded region is formed to leave a portion (16) of the sidewall of the can body extending between the partly collapsed outwardly-directed open annular bead (15a) and the free edge (14), wherein simultaneously with or subsequent to step iv the portion is flattened (17) to lie against the exterior surface of the collapsed bead to provide protection against cuts from the free edge. 40
9. A method as claimed in any one of claims 5 to 7, wherein during step ii the circumferential radially-expanded region is formed to leave a portion (16) of the sidewall of the can body extending between the 45

partly collapsed outwardly-directed open annular bead (15a) and the free edge (14), wherein simultaneously with or subsequent to step iv the portion is folded around and under (18) the periphery of the exterior surface of the collapsed bead so that the free edge is directed radially inwardly to oppose the exterior surface of the can body sidewall, thereby providing enhanced rigidity and protection against cuts from the free edge.

10. An apparatus for forming a container, the apparatus having: 50

- i. means for radially expanding (2) the sidewall (13) at one or both ends of a tubular metal can body (1) to define a circumferential radially-expanded region in the sidewall;
- ii. means for applying a first axial load (2) to the can body, plus means adapted to limit radial growth (3, 31) of a free edge of the can body such that during application of the first axial load the circumferential radially-expanded region partially axially collapses to form an outwardly-directed open annular bead (15a);
- iii. means for locating a diaphragm (40) formed of flexible lidding material relative to the can body so that the diaphragm locates between opposing surfaces of the open annular bead;
- iv. means (50) for applying a second axial load to the can body to fully axially collapse the bead (15b) to thereby clamp the flexible diaphragm between the opposing surfaces of the bead and close the end of the container. 55

11. An apparatus as claimed in claim 10, wherein a common entity (2) is used to simultaneously both radially expand the sidewall (in step i) and apply the first axial load (in step ii). 35
12. An apparatus as claimed in claim 10, wherein the common entity comprises a flared die (2), the flared die terminating in a generally radially extending end face (21), wherein the means to limit radial growth is a limit ring (3) situated adjacent the end face, the limit ring having a generally axially extending wall (31) to thereby limit radial growth of the free edge of the can body. 40
13. An apparatus as claimed in claim 12, wherein the flared die and the limit ring are integrally formed. 50

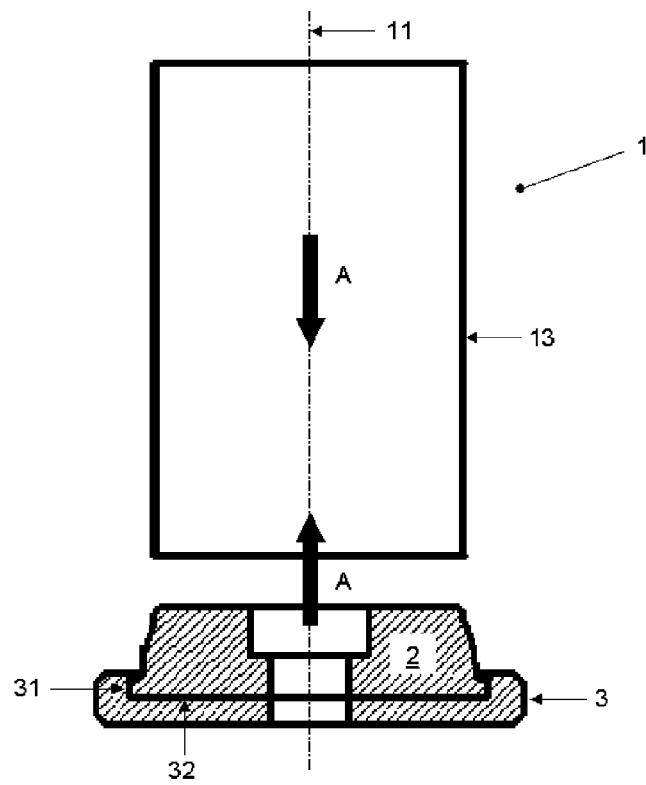


Fig. 1a

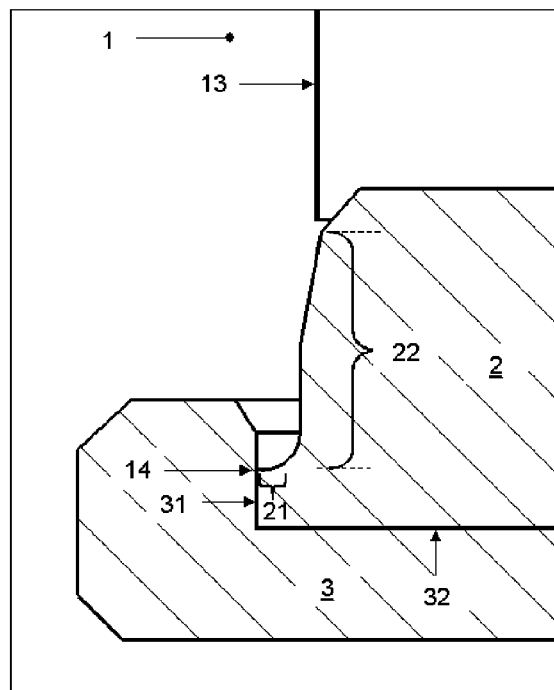


Fig. 1b

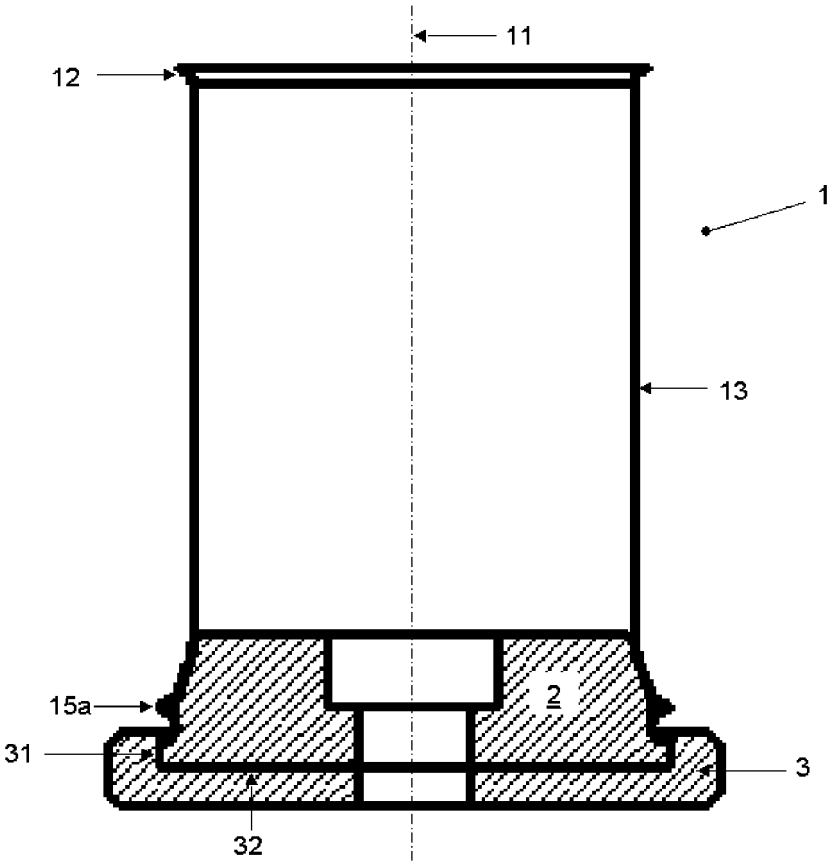


Fig. 2a

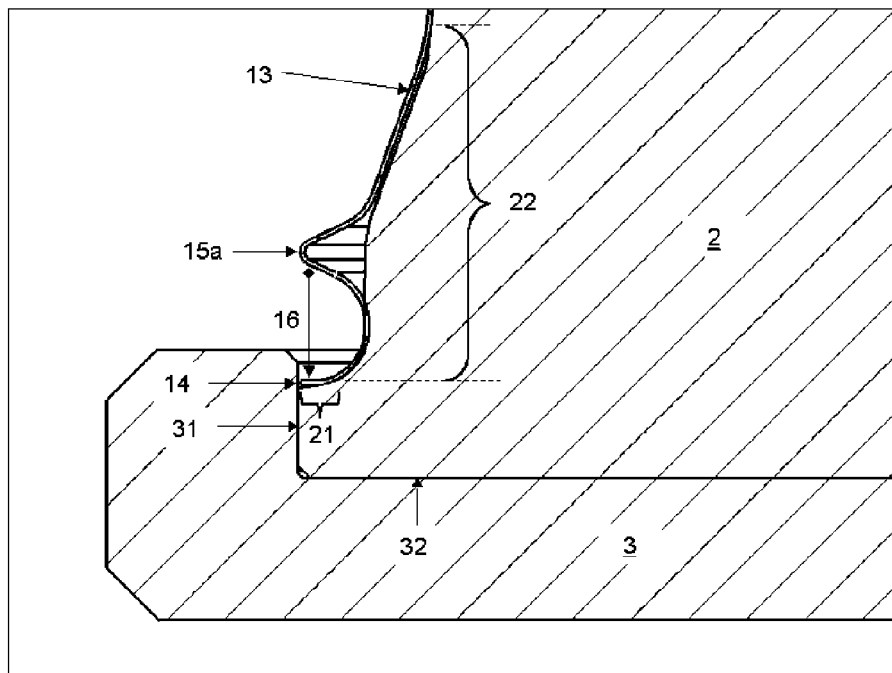


Fig. 2b

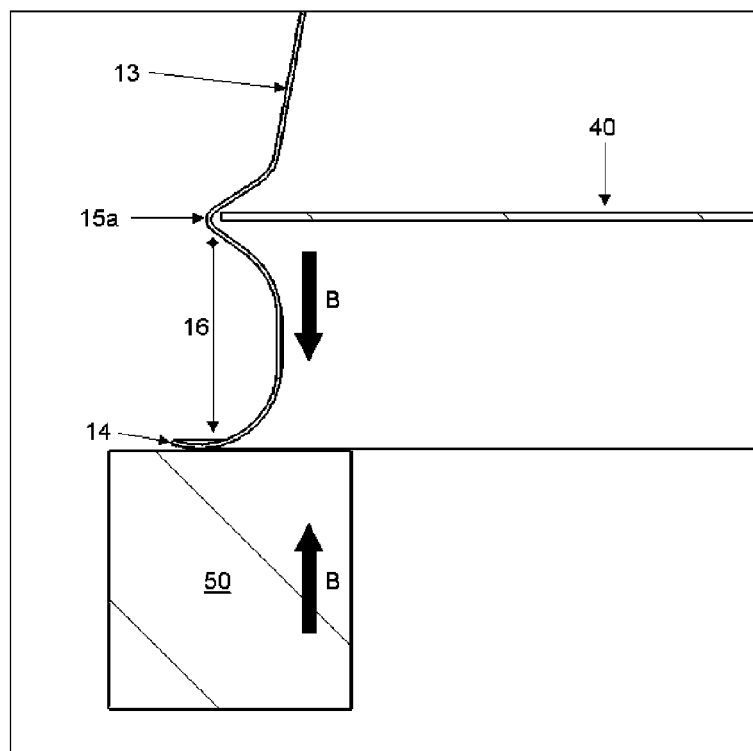


Fig. 3

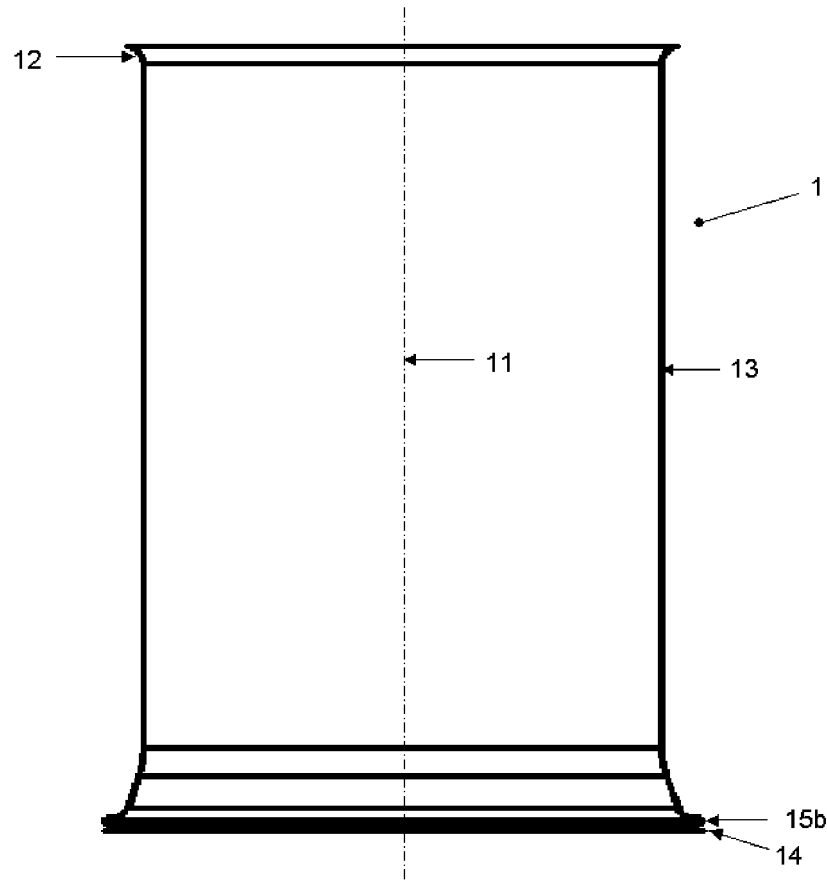


Fig. 4a

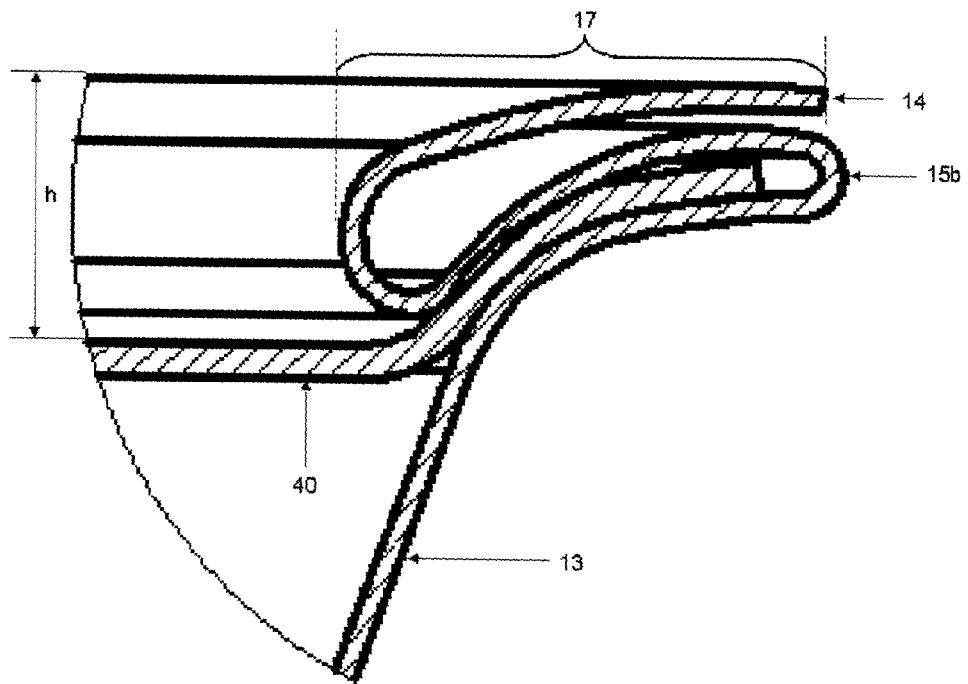


Fig. 4b

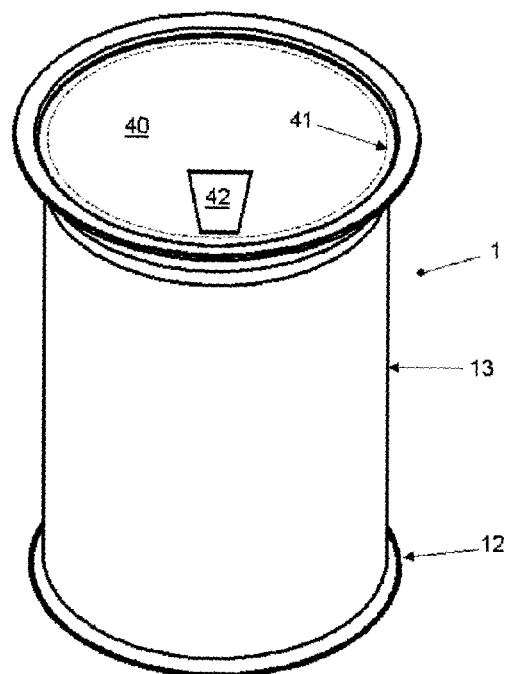


Fig. 5

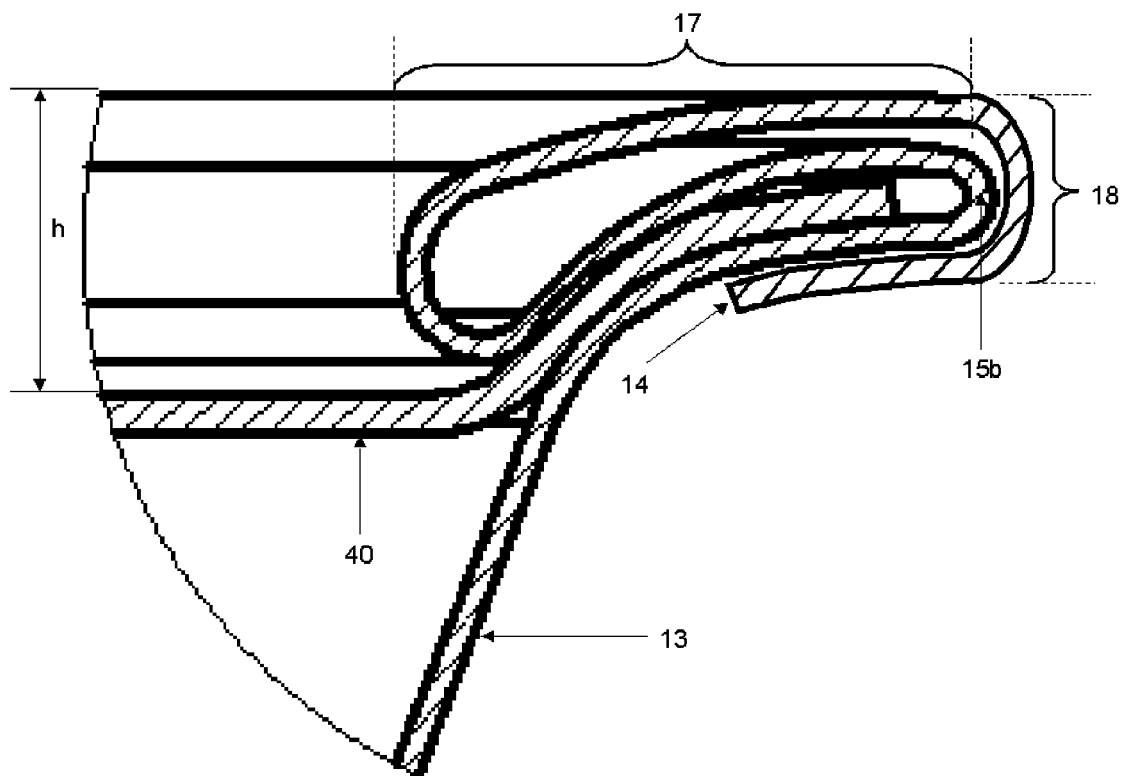


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 09 15 9611

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* page 3, paragraph 37 *	4	B65D17/28
A	* page 4, paragraph 42 - paragraph 45 * * page 5, paragraph 58 - paragraph 59; figures 7,8 *	2,3,5,10	B21D51/34 B29C57/12
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 16 July 2009	Examiner Newell, Philip
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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