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• **SCHOOT UITERKAMP, Andreus Johannes Maria**
3584 CT Utrecht (NL)

• **FERRANDIZ MARTINEZ, Rafael**
3584 CT Utrecht (NL)

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(74) Representative: **Nederlandsch Octrooibureau**

P.O. Box 29720
2502 LS The Hague (NL)

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(73) Proprietor: **N.V. Nutricia**

2712 HM Zoetermeer (NL)

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(72) Inventors:

• **PIETTE, Benoît Marie François**
3584 CT Utrecht (NL)

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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] The present invention relates to packages for the packaging and dispensing of products, in particular powdered products such as infant nutrition or milk formula. The invention relates in particular to constructions and methods for separating different parts of such packages especially for the purpose of recycling.

2. Description of the related art

[0002] Powdered material, such as infant milk formula, has been sold in various forms of package for many years. Metal cans were initially the preferred container as they were relatively easy and cheap to produce and could be sealed for long term storage. The seal comprised an aluminium foil across the mouth of the container that was removed on first use. As a single container would be used for an extended period, the containers were provided with re-closable plastic lids which gripped over the outer rim of the can. A measuring scoop was frequently included with the container, either packaged separately or within the can itself. Such cans are however relatively heavy and expensive to produce.

[0003] More recently, alternative packaging forms have become available which improve on the existing cans, including the Cekacan™ range from Å&R Carton Lund AB. These are based on plastic and foil laminate tubular container bodies and often include closures in the form of hinged lid assemblies having a facility to receive and retain a measuring scoop. One such package is described in WO 2010/123361. The container part may consist of a laminate of carton, metal foil and plastic material, while the lid assembly may consist of plastic.

[0004] While these materials allow the container to be produced relatively cheaply, the use of these materials may be disadvantageous for recycling of the containers. WO 2016/074104 A1 Z, which accords with the preamble of claim 1, teaches a composite container which can be disassembled and the components thereof recycled. The container comprises a body, a collar, and a liner wherein peripheral regions of the collar are of weakened strength so that the collar and the liner can be separated from the base.

[0005] In light of the above, it would be desirable to provide an improved package that at least partially overcomes some of the inconveniences of the prior art.

SUMMARY OF THE INVENTION

[0006] According to the invention there is provided a package for a powdered nutritional product having the features of claim 1, comprising: a container for receiving the product, the container having a base and a peripheral

wall extending to an open top surrounded by a peripheral edge wherein at least the peripheral wall comprises a carton material; a seal for closing the container prior to use, the seal being connected to the peripheral wall at a distance below the peripheral edge and being at least partially removable to gain access to the product; a closure, made of plastic material, including a circumferential rim connected to an upper part of the peripheral wall and defining an access opening and a lid, pivotably attached to the rim, for selectively closing the access opening; and a separation region for facilitating the separation of the container and the closure after use, the separation region being located above the seal and comprising a point or line of weakness where separation can be initiated and/or facilitated by a user.

[0007] The invention described in this document relates to improved separation of the different materials and particularly to the separation between the container and the closure after use. After use is thus intended to mean after final use when the package is empty and needs to be disposed of. The closure is made of plastic material and can very well be recycled to fabricate new products. Therefore, clean separation, in which virtually no non-plastic components are attached to the closure, is advantageous. It would also be advantageous for recycling purposes to end up with a container part without any remainders of the closure.

[0008] As the packages are often used for milk powder for babies and infants, it is very important that the packages are sealed and remain sealed before first use. For reasons of durability, safety, insect-tightness and convenient transportation, the closure may thus be very tightly adhered to the container, preferably using an adhesive. In present designs, the adhesive and mechanical connection have been optimised with these reasons in mind. As a consequence, recycling of the different components is complicated because, due to the effectiveness of the connection, they cannot easily be separated by hand. In fact existing packages are so well constructed that it is almost impossible to separate the closure and container without some form of tool. The present invention provides a solution to this problem, in the form of packages which include a separation region. The separation region facilitates the separation of the closure and the container, as will be further explained below and is defined as the region in which the point or line of weakness is located at which separation of the closure from the container occurs. Depending upon the choice of location for the point or line of weakness, the separation region may be part of the closure, the peripheral wall adjacent to and below the closure or may comprise part of both the closure and the container. Similarly, the line of weakness may be formed in the circumferential rim of the plastic closure and/or the peripheral wall of the container located above the seal. The peripheral edge is defined as the uppermost limit of the peripheral wall, surrounding the open top.

[0009] The separation region is thus arranged and constructed to initiate and/or facilitate separation of the plas-

tic closure from the carton comprising container. In this context, reference to carton is intended to denote paper or pulp based materials, sometimes referred to as cardboard, paperboard or fibreboard, for which a different recycling process is intended and/or desired than that for the plastic closure.

[0010] As the separation region comprises the point or line of weakness, it is important that this region is located above the seal that closes the container prior to use. This is of relevance since it should be ensured that the container contents remain sealed and unspoiled in a gas-tight manner. This is of particular interest where infant formula is concerned, as infants are vulnerable and, when breast feeding is not possible, may depend solely on intake of infant formula. By placing the separation region above the seal, the contents of the sealed container are not jeopardized, even in case of unintended puncture or rupture of the point or line of weakness.

[0011] In the present context, the seal is intended to denote a gas-tight seal, for hermetically closing the container prior to use. The contents of the package, namely the powdered nutritional product, may be packaged under a modified atmosphere e.g. with a high level of inert gas/depleted oxygen. The seal is then intended to ensure the contents are kept under the modified atmosphere until the user breaks the seal, such as is the case with any infant formula. The seal is connected to the inside of the peripheral wall, and must be at least partially removable to gain access to the product. In a preferred embodiment, the seal is located below the separation region and connected to the inside of the peripheral wall at a distance below the peripheral edge, such as between 15 and 50 mm or between 20 mm and 40 mm or between 25 and 35 mm. The seal may be located at a distance below the peripheral edge to allow accommodation of an infant formula dosing scoop in the void space between the closure and the seal.

[0012] The seal could be connected to the inside of the peripheral wall by heat-sealing or induction-sealing. Preferably, the seal is partially removable in the sense that it comprises a tearstrip configured to be torn along a tear-path and to leave a part of the seal attached to the inside of the peripheral wall. With this opening mechanism, a part of the seal is left in the container when the tear strip is torn, and the seal is therefore not completely removed when opened but only a central panel thereof to gain access to the product. For the avoidance of doubt, the opening mechanism and tear path of the seal is distinct from the separation region and point/line of weakness by which the closure and container are separated.

[0013] Thus, according to the invention, the seal is located at a distance below the peripheral edge to allow accommodation of an infant formula dosing scoop in the void or head space between the closure and the seal. Infant formula dosing scoops are well known in the art and included in packages containing infant formula because the exact dosing thereof is dependent on the nutritional value of a particular infant formula. It will be un-

derstood that said accommodation is intended to mean that on the one hand the scoop will not be so tightly fitted that it may puncture the seal whereas on the other hand the package further contains the infant formula below the seal imposing a space limitation on the head space.

[0014] Preferably an adhesive is applied between the upper part of the peripheral wall and the circumferential rim of the closure. This is to ensure adequate sealing of the container/closure interface is achieved and/or maintained to provide a barrier to keep insects out of the container and away from the nutritional contents. Preferably substantially the full interface of the peripheral wall and the circumferential rim of the closure is sealed using an adhesive. The adhesive is preferably applied as an uninterrupted region completely surrounding the upper part of the peripheral wall, such that wall and rim are properly sealed together and insects cannot pass through. As an example, for keeping certain minute insects living in tropical regions out of the container, gaps of greater than 70 microns are preferably not tolerated.

[0015] The point or line of weakness defines where separation of the closure from the container can be initiated and/or facilitated by a user. In an example, the point of weakness is located in the container peripheral wall and has the shape of a triangle, a square, a semi-circle or an ellipse. In an embodiment, the line of weakness is located in the container peripheral wall or the circumferential rim of the closure. The line of weakness can be partially circumferential or completely circumferential. Tearing or breaking the line of weakness can be commenced by a user by grasping a grip tab which indicates the point where the line of weakness can be accessed or grasped.

[0016] In an example, the container comprises a circumferential line of weakness extending from the point of weakness. The point of weakness may partially coincide with the peripheral edge, or may alternatively be positioned just below the peripheral edge, such that the point of weakness can be pressed into the container without interfering with the rim. After pressing the point of weakness into the container, the circumferential line of weakness may tear when a user pulls the closure from the container, so as to facilitate separation.

[0017] The container may be of any suitable shape as defined by the peripheral wall, which forms a tube having a given cross-sectional shape. In an embodiment, a cross-section of the peripheral wall, parallel to the base, has the shape of a rounded rectangle or rounded square. In other words, the peripheral wall can be in the form of a tube of quasi-rectangular cross section. In this case, the point of weakness may be arranged in a corner of the peripheral wall. The corner is an advantageous place to initiate the pulling force, since it is easier to separate a corner of the rim than a part located in the middle between the corners. Alternatively, the point of weakness may be located on one of the sides, e.g. centrally on one of the shorter sides of the rectangle. For display purposes, it is more advantageous that the container has the

shape of a rounded rectangle as this provides more display surface to communicate with the consumer.

[0018] In an embodiment, the package further comprises a gripping region for improving a user's grip on the closure and/or on the container. When the user's grip on the closure and/or the container is improved, it will be easier for the user to apply a force onto the package in order to separate the closure from the container. The gripping region may also encourage a user to place their hands at the correct location, for instance by visual and/or tactile instructions, and in the correct orientation to cause separation to correctly initiate. The gripping region may be within or partially coincide with the separation region or may be located elsewhere on the package.

[0019] In an example, the gripping region is located in the peripheral wall, adjacent to the rim and created after the user presses the point of weakness into the container thereby enabling the user to grip beneath the rim. Thus in this case, the point of weakness corresponds to and/or creates the gripping region. The user may use her/his thumb to press the point of weakness into the container, thus allowing to grip beneath the rim and pull the rim off the container. The point of weakness may be sufficiently large to enable a user to accommodate not only a finger (e.g. a thumb) of one hand, but also a finger of the other and. In this way, the user has a good grip on the closure and also on the container. This allows for effective application of force to separate the two components. Additionally or alternatively, the container may have more points of weakness which can accommodate a user's fingers in order to provide for better grip on the container.

[0020] In an embodiment, the gripping region or the closure may comprise a pull-tab connected to the rim, preferably moulded with the rim, whereby a user can exert a pulling force on the rim to facilitate separation. The pull-tab may have the shape of a ring connected to the rim, with an opening in the middle of the pull-tab large enough to accommodate a finger. The pull-tab may be initially positioned flush with respect to the peripheral wall, extending downwards from the rim, such that the stacking of the container is unaffected. After use, the pull-tab may be bent or hinged outwards and/or upwards, such that a finger can fit through and the user can apply a force in the longitudinal direction of the container. By bending or hinging the pull-tab, the rim may be locally deformed at the position where the pull-tab is connected to the rim. This deformation may initiate breaking or loosening of the rim so as to facilitate separation from the container. By pulling the pull-tab, the closure and the container may be separated from each other. It will be understood that the pull tab should be adequately strong to achieve the desired separation force. It will also be understood that in this embodiment, the separation region may be the interface between the container and the closure, which may be separated by breaking of the adhesive bond. This may be facilitated by, in relation to the presently marketed container as described in WO 2010/123361, reducing the strength of the adhesive or

by using less adhesive or by having locally less adhesive adjacent to the pull-tab. In a preferred embodiment, the force to remove or separate the closure from the container by use of the pull-tab lies in the range of 25 N to 150 N, preferably between 35 N and 100 N, more preferably between 40 and 75 N as mentioned below.

[0021] In an embodiment which does not form part of the invention, a line of weakness is arranged in the rim of the closure, e.g. extending from the outer edge of the rim towards the access opening, and adapted to break open the rim, to facilitate separating the rim from the container. Preferably, the line of weakness is formed by a local thinning of the rim, by frangible connections and/or by a partial cut. The line of weakness may be combined with a pull-tab as described above, wherein the pull-tab is connected to the rim adjacent to the line of weakness. In this way, the pull-tab provides a good grip on the rim at the position of the line of weakness to initiate tearing at the line of weakness. In this case, the line of weakness may be located at a location on the rim having a minimum dimension. It will be understood that the rim should remain strong enough to not break during transportation.

[0022] According to the invention, the line of weakness is arranged in the carton material comprised by the container peripheral wall. In this case, the line of weakness may be formed by a partial cut of the carton material, a line of partial perforations (i.e. a line of recesses in the wall or rim) or a plastic strip enclosed in the carton material from which a grip tab visibly protrudes from the carton.

[0023] In an embodiment, the separation region comprises a tear band substantially surrounding the peripheral wall and/or the rim. The tear band may surround the peripheral wall and/or the rim completely or partially. When it surrounds the peripheral wall and/or the rim partially, the remaining part of the circumference may be sufficiently small such that the closure and the container can easily be manually separated when the tear band has been removed. Preferably, the tear band surrounds the peripheral wall and/or the rim for at least 70% of the circumference, more preferably at least 85% of the circumference or surrounds it completely.

[0024] In an embodiment, the tear band is arranged in the peripheral wall or the rim by means of at least one circumferential line of weakness. The line of weakness may be formed by a line of partial perforations (i.e. a line of recesses in the wall or rim) or by partially cutting the peripheral wall or rim, to a depth of between 20 and 80% of its local thickness, preferably between 40 and 60%. When only a single line of weakness is used, the tear band is formed between the line of weakness and the edge of the wall or rim. When multiple lines of weakness are used, preferably when the carton material contains two lines of weakness, the tear band is formed between the different lines of weakness. As has been indicated above, the fact that the separation region and the line of weakness are located above the seal assures that the sealing of the package cannot be compromised due to

the line of weakness. Nevertheless, during use of the package after initial opening, it is important that the line of weakness does not compromise the ability to reseal the package.

[0025] In an embodiment, the tear band is provided with a grip tab to facilitate gripping the tear band. The grip tab may have any shape as long as it achieves the mentioned objective of facilitating gripping and pulling the tear band. Preferably, the grip tab is made of the same material as the tear band in order to avoid creating weak points between the grip tab and the tear band. The grip tab may be formed by an enlarged end portion of the tear band. Alternatively, the grip tab may be a separate component that is glued, moulded or otherwise attached to the tear band. The grip tab may preferably be provided at the outside of the package, or, alternatively, at the inside of the package, above the seal.

[0026] In an embodiment, the rim has an inverted U-shaped channel engaging the peripheral edge and the adhesive is provided on one side of the U-shaped channel only, and preferably wherein said one side forms the tear band. In this way the adhesive is removed or broken when a user pulls the tear band. As the tear band is removed preferentially by pulling in the radial direction, the adhesive is broken more easily compared to pulling in the longitudinal direction along the height of the package. The one side is preferably the outer side of the U-shaped channel, but may alternatively be the inner side of the U-shaped channel, allowing for pulling the tear band inside. As an alternative to breaking the adhesive, the material of the peripheral wall may delaminate at the place where the adhesive is applied, such that the connection between the rim and the container is broken.

[0027] The present invention is intended to be applicable to packages that are assembled or connected by any appropriate means. The closure may be attached to the peripheral wall by mechanical connection, by adhesive, by welding or the like. In a preferred embodiment, the rim is adhered to the peripheral wall using an adhesive, in particular, a hot-melt adhesive. Using an adhesive, the closure and the container may be tightly connected such that they cannot fall apart during transport and use. Furthermore, the adhesive is applied to maintain adequate sealing, meaning the complete container/closure interface is sealed by the adhesive.

[0028] If an adhesive is used, the adhesive may be adapted for better enabling separation of the closure and the container. The separation force may be defined as the linear force (applied in the longitudinal direction along the wall) needed to totally separate the closure from the container (i.e. breaking the adhesive), when applying a distributed force around the outer edge of the rim. This may be measured by providing a rigid frame having an opening corresponding in size to the peripheral wall, whereby the closure cannot pass the opening. With the container hanging in the frame, a distributed force can be applied all around the rim by exerting a force onto the base of the container through the access opening. The

force is increased until separation occurs and the separation force is the maximum force prior to separation.

[0029] With existing adhesives and the known packages as sold, in particular as described in WO 2010/123361, the separation force is at least more than 200 N which is considered too high for manual separation by the consumer. On the other hand, the separation force should not be so low that the closure comes off when lifting a full package with infant formula, such as a package with a weight of about 1 kilogram.

[0030] Thus, in an embodiment, the force to remove or separate the closure from the container lies in the range of 25 N to 150 N, preferably between 35 N and 100 N, more preferably between 40 N and 75 N. It is considered to lie within the capabilities of the average skilled person to design a package that shows the separation force as indicated. In any case, for convenience of a user, the force that they may find acceptable to exert by hand will generally be as low as possible and to lie within the indicated range. Values at the lower end of the range are considered sufficiently high to withstand the normal logistics and handling of the packages of the invention from the production site to the domestic environment where package are first used. The indicated separation force is especially preferred in combination with the embodiments wherein the gripping region or the closure comprises a pull-tab connected to the rim and/or wherein the gripping region is located in the peripheral wall, adjacent to the rim and created after the user presses the point of weakness into the container thereby enabling the user to grip beneath the rim.

[0031] Removal of a tear strip or rupture of a line of weakness may require a force of 3 N to 10 N and thereafter the closure and container may separate without a further separation force.

[0032] In an embodiment, the adhesive is water-soluble or adapted to weaken or melt upon heating. This has the advantage that separation may be made easier by heating the rim, e.g. by bringing it in contact with hot water. The adhesive may have a viscosity of between 500 and 3000 mPa.s at 160 degrees C, preferably between 1000 and 2000 mPa.s at 160 degrees C. Alternatively, the adhesive may have a viscosity of between 500 and 3000 mPa.s at 190 degrees C, preferably between 1000 and 2000 mPa.s at 190 degrees C.

[0033] In an embodiment, the rim contacts the peripheral wall defining a contact area, and the adhesive is applied at between 1% and 100% of the contact area, preferably between 10% and 60% or 20% and 40%. The contact area is the surface area on which adhesive can be applied for adhering the rim to the peripheral wall, which is thus located in between the rim and the peripheral wall. At the contact area, the rim does not necessarily contact the peripheral wall at all locations; however, at the contact area, the distance between rim and peripheral wall is sufficiently small such that a normal layer of adhesive will stick the two surfaces together. The rim may contact the peripheral wall at either the inside or the out-

side surface of the peripheral wall. For a laminated carton container of carton, metal foil and plastic it will be understood that there is a difference if the rim is adhered to the outer carton surface or to the inner plastic surface. For a U-shaped rim as discussed above, the rim may contact the peripheral wall at both the inner and the outer surfaces and also along the peripheral edge.

[0034] The contact area may be defined by the area of contact of the rim per mm of circumference of the peripheral edge or in other words the length of contact as viewed at any given cross section. Preferably, the contact area is between 5 and 25 mm² per mm of circumference, more preferably between 10 and 15 mm² per mm of circumference. The actual adhesive coverage is preferably between 0.5 and 5 mm² per mm of circumference, more preferably between 1 and 3 mm² per mm of circumference. By adjusting the area over which the adhesive is applied, the strength of the bond between the closure and the container can be adjusted as well. In particular, the smaller the adhered area, the easier will separation of the closure and the container be. An optimum adhered area which balances good sealing properties and convenient separation is preferred. The adhesive strength can be tuned by adjusting the amount and position of the adhesive.

[0035] In an embodiment, the separation region allows for separating the package into a first part and a second part, wherein the first part comprises the closure, and the second part comprises at least 80 wt% or preferably 95 wt % of the container or even 100 wt%. This has the advantage that the second part comprises no parts of the closure, resulting in a waste product consisting of only the container's material, which may be a laminate of carton, metal foil and plastic.

[0036] In an embodiment, the separation region allows for separating the package into a first part and a second part, wherein the first part comprises at least 80 wt% or preferably 95 wt% of the closure, and the second part comprises the container. This has the advantage that the first part comprises no parts of the container, resulting in a waste product consisting of only plastic.

[0037] In an embodiment, the separation region allows for separating the package into a first part and a second part, wherein the first part comprises the closure, and the second part comprises the container. Such perfect separation may be achieved when the entire closure (i.e. all injection-moulded plastic) is separated as a first part from a second part which includes the entire container (i.e. all carton/metal/plastic laminate).

[0038] In an aspect of the invention, there is provided a method of disposing of a package as defined by appended claim 13. The method may be applicable to the containers described above and hereinafter. In an embodiment, said force is less than 70 N or less than 50 N or less than 30 N or even less than 10 N. The force may be applied to a removable tear band or grip tab.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] The features and advantages of the invention will be further appreciated upon reference to the following drawings of a number of exemplary embodiments, in which:

Figure 1 shows a perspective view of a package with a point of weakness;

Figure 2 shows a perspective view of a package with pull-tab;

Figure 3A shows a rear perspective view of a package with a tear band on the container;

Figure 3B shows a front perspective view of the package of Figure 3A, during removal of the tear band;

Figure 3C shows a cross-sectional view of a detail of the package of Figure 3A.

Figure 4A shows a rear perspective view of a package with a tear band in the rim, not falling under the scope of the claims;

Figure 4B shows a front perspective view of the package of Figure 4A, during removal of the tear band;

Figure 4C shows a cross-sectional view of a detail of the package of Figure 4A;

Figure 5 shows a perspective view of a package not falling under the scope of the claims, with line of weakness in the rim and pull-tab attached to rim.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0040] Figure 1 shows a first embodiment of a package 1 for powdered infant nutrition according to the present invention, comprising a closure 2 and a container 3. The package 1 substantially corresponds to the commercially available Easypack package in which Nutrilon™ infant formula is marketed by Groupe Danone.

[0041] The closure 2 comprises a circumferential rim 20, a hinge 10 and a lid 21 and is shown with opened lid 21. Lid 21 is thus pivotably connected to rim 20. The rim 20 defines an access opening 27. In this embodiment, a first flange 11 bounds the access opening 27. Lid 4 is provided with a lid flange 12 which fits on the first flange 11 to close off access opening 27 and to hermetically seal the package 1. In this embodiment, the access opening 27 is almost elliptic. The access opening 27 can also be round. Alternatively, it can be rectangular with rounded corners. Important in all embodiments, however, is that the lid flange 12 fits around the flange 11 to hermetically seal the access opening 27.

[0042] In order to provide a closure 2 with a lid 21 which can be opened easily, the hinge 10 has a connection part connecting to the lower end of lid flange 12. Thus, the entire lid 21 can remain accessible for engaging it for opening lid 21. Furthermore lid 21 is provided with a lip 13 for opening the lid 21 easily. In this embodiment, the lip 13 is also provided at the lower end of lid flange 12. Here, it is provided opposite the hinge 10. Thus, a user can engage the lip 13 to open lid 21 easily. The lip 13

further provides an end rim which can be covered or shielded with a tamper evident band 14.

[0043] Rim 20 further comprises a wall 15 which is provided with said access opening 27. On the wall 15, cam elements 16 are provided. The use of such cams 16 is further explained in WO2007/142522 of the current applicant. These cams 16 provide part of stacking means for stacking lid parts in production. Furthermore, these cams 16 provide part of stacking means for stacking complete packages for instance in stores.

[0044] In this embodiment, the cams 16 are provided on the rim 20. An advantage of this is that the lid 21 is not loaded. Thus, the quality of closure is not compromised. Yet, the height of the lid 21 in closed position is equal or substantially equal to the height of the cams 16. Thus, when packages are stacked, the load of the containers will keep the lids pressed closed, while preventing loads from other directions. Especially with a lid 21 which fits clampingly on the flange 11, the cams 16 further secure the closing of the lid 21.

[0045] It was already discussed that hinge 10 has a connection part connecting to the lower end of lid flange 12. In fact, in order not to compromise the sealing property of the lid 21, the connection part of hinge 10 connects below the circumferential lower end of lid flange 12. This, however, also required a lowered part 17 in wall 15. Thus, the sealing properties of lid 21 on rim 20 are not compromised at all. This sealing can be improved even further by connecting opening lip 13 also below the circumferential lower end of lid flange 12, thus also not impeding stacking of packages together. The container 3 comprises a base 38 and a peripheral wall 36 extending to an open top 30 surrounded by a peripheral edge 31. The peripheral wall 36 is in the form of a quasi-rectangular tube i.e. a rectangular cross-section tube with bowed sides and rounded corners. Inside the container 3, there is provided a seal 4 which separates the content of the container 3, in this case milk formula, from the outside.

[0046] The rim 20 is typically in the form of a U-shape having a groove (see below in Fig 3C), and closely fits over the peripheral edge 31, and the two are glued together using an adhesive provided in the groove. The container 3 further comprises a point of weakness 32 in the peripheral wall 36 adjacent to the peripheral edge 31. The point of weakness 32 is provided in what may be referred to as the headspace of the container 3 between the seal 4 and the peripheral edge 31.

[0047] The point of weakness 32 is formed by a part of the container which is weakened by means of a line of weakness 37, e.g. a pre-folded line or a line of partial perforations. The point of weakness can be pressed towards the inside of the container by a user, either by means of folding or by means of breaking.

[0048] The point of weakness 32 also provides a gripping region by which a user can grip beneath the closure 2 in order to break the tight connection between the closure 2 and the container 3. The point of weakness 32 is provided in a corner of the peripheral wall 36 just below

the rim 20, such that it can conveniently be pressed inwards to allow placement of a thumb. Subsequently, the closure 2 can be torn from the container 1 in order to allow separated recycling after use. It will be understood that such a point of weakness and gripping region may be provided at other locations around the rim 20 e.g. on one of the sides. Preferably it will not be positioned at a location where a user may accidentally cause the container to fold or puncture during normal gripping in use.

[0049] The base 38 and peripheral wall 36 of the container 3 are made up of a laminate. From outside to inside the laminate consists of an ink/varnish, a layer of board/paper, a relatively thin aluminium foil and, arranged inside this, a layer of a plastic material that can be joined to the seal 4 by induction or heat sealing and to the base 38. The carton is included to provide mechanical strength to the pack, the aluminium provides the required barrier properties for the container to be suited to contain infant formula. In the described embodiment, the plastic is a polyethylene although it will be understood that other alternatives may be provided. The thickness of the peripheral wall 36 is about 700 micron and the carton has a density of between 250 g/m² and 500 g/m².

[0050] Lid 21 and rim 20 consist of plastic material and are produced in a single piece by injection moulding. In the disclosed embodiment they are moulded of (substantially) phthalate free polypropylene but alternative materials may also be applicable. It may be designed to be insect-tight and the tamper-evident band 14 can be integrated in the design. This has to be removed from the closure 2 by breaking three frangible ligaments to be able to open the lid 21 for the first time. The closure 2 has a weight of about 30 grams.

[0051] The illustrated package 1 is designed to contain 800 grams of powdered infant formula. It will be understood that such packages may alternatively contain between 100 and 2000 grams, preferably between 300 and 1200 grams, most preferably either about 450 grams or about 900 grams.

[0052] The peripheral wall 36 of the container 3 is provided with information leading the user to use the point of weakness 32 properly for separation of the closure 2 and the container 3.

[0053] Figure 2 shows a second embodiment of a package 201 similar to the first embodiment but without a point of weakness of the type shown in Figure 1. Instead, the package 201 comprises a pull-tab 225 which is connected to and integrally formed with the rim 220. The pull-tab 225 can be grasped by a user to supply grip for tearing the closure 202 and the container 203 apart. It is moulded together with the rim 220, such that the connecting force between the rim 220 and the pull-tab 225 is larger than the connecting force between the rim 220 and the container 203. After use, the user can separate the closure 202 and the container 203 in order to recycle them separately.

[0054] In this embodiment, a separation region between the closure 202 and the container 203 corresponds

to the adhesive connection between the rim 220 and the upper part of the peripheral wall just below the peripheral edge 231. By location of the pull-tab 225 at a specific location on the rim 220, a locally increased force can be created at this location causing the adhesive to commence separation at this point. In order to facilitate separation, the adhesive may be reduced in quantity and strength compared to the first embodiment, in particular adjacent to the pull-tab 225, thereby creating a point of weakness at this location.

[0055] Figures 3A and 3B show a third embodiment of a package 301 from rear and front sides respectively. The package 301 comprises a closure 302 and a container 303. The peripheral wall 336 of the container 303 comprises a tear band 333, extending all around the peripheral wall 336. The tear band 333 is defined by two circumferential lines of weakness 335, 337 formed by lines of partial perforations in the peripheral wall 336 of the container 303. After emptying the package 301, when it is desired to dispose thereof, a user 306 can grasp the tear band 333 by means of a grip tab 334, and remove the tear band 333.

[0056] The part of the container 303 lower than the tear band 333 is not connected to the closure 302, such that removal of the tear band 333 allows for the falling apart of the container 303 and the closure 302. In this way, separated recycling of the package 301 is possible. Although not shown, it is noted that the package 301 is sealed before use with a seal corresponding to seal 4 of the first embodiment, with the seal being located below the tear band 333 and below the line of weakness 335. The hermetic closure of the package 301 prior to first use is thus not compromised.

[0057] Figure 3C shows a cross-sectional view of the package 301 of Fig 3A viewed in the direction III C -III C, showing part of the container 303, the rim 320 and the lid 321. The rim 320 is fitted over the peripheral edge 331, forming a U-shaped channel with the edge 331 in between the legs of the U. The peripheral wall 336 is glued to the rim 320 by means of adhesive 305, which is applied on the inside of the peripheral wall 336, such that the inner leg of the U-shaped channel of the rim 320 is glued. The tear band 333 is formed in between two circumferential lines of weakness 335, 337. The lines of weakness 335, 337 are formed in the peripheral wall 336 of the container 303 by means of partial perforations. When a user grips the tear band 333 (e.g. by means of the grip tab 334 which is not visible in this figure), the lines of weakness 335, 337 tear and the closure 302 and container 303 are separated. A small part of the peripheral wall 336, in particular the part above the highest line of weakness 337, has been glued to the rim 320 and remains as such. Consequently, the closure 302 can be recycled together with the small part of the peripheral wall 336. The container 303 is, after separation, not connected to any part of the closure 302. The cross-sectional view of Fig 3C also shows a seal 304 for sealing the product 307 from the outside. The distance r from the

seal 304 to the peripheral edge 331 of the container 303 is preferably between 20 and 50 mm and more in particular about 40 mm. This distance r allows for placement of a scoop under the lid 321 and for a tear band 333 just below the peripheral edge 331. The tear band 333 is thus located above the seal 304 since the lines of weakness 335, 337 form weak points in the container 303, to which the product 307 should not be exposed.

[0058] Figures 4A and 4B, which do not fall under the scope of the claims, show a fourth embodiment of a package 401 from rear and front sides respectively, comprising a closure 402 and a container 403. The closure 402 comprises a lid 421 and a rim 420 which is glued to the upper part of the peripheral wall 436 of the container 403.

[0059] The rim 420 comprises a tear band 422, extending all around circumferential rim 420. The tear band 422 is defined by a circumferential line of weakness 423 in the rim 420, formed by a locally thinner circumferential line. The line of weakness 423 allows for tearing of the tear band 422 from the rim 420.

[0060] Figure 4C shows a cross-sectional view of the non-claimed embodiment of the package 401 of Fig 4A viewed in the direction IV C -IV C, showing part of the container 403, the rim 420, the lid 421 and the seal 404. The rim 420 is fitted over the peripheral edge 431, forming a circumferential U-shaped channel with the peripheral edge 431 in between the legs of the U. The peripheral wall 436 is glued to the rim 420 by means of adhesive 405, which is applied on the outside of the peripheral wall 436, such that the outer leg of the U-shaped channel of the rim 420 is glued. The tear band 422 and circumferential line of weakness 423 can also be seen in cross-section.

[0061] In use, a user 406 can grasp the tear band 422 by means of a grip tab 424. Before tearing, the tear band 422 is the only part of the closure 402 which is glued to the peripheral wall 436 just below the peripheral edge 431 of the container 403. It can thus be seen that when a user pulls the tear band 422, the line of weakness 423 induces a tearing of the rim 420. The pulling of the tear band 422 results in a radial force, which allows for peeling away of the adhesive 405. The peel force required will be understood to be much less than the shear force that would be required when pulling in the longitudinal direction along the height of the container 403. When the tear band 422 is removed, the adhesive 405 no longer connects the rim 422 and the container 403 together, such that they can be easily separated and recycled. It will be understood that removing the tear band may not remove all of the adhesive and that some adhesive may remain between the rim 422 and the upper part of the peripheral wall 436. Nevertheless, the connection will be adequately weakened to allow easy separation and separate recycling.

[0062] Figure 5 shows a perspective view of a non-claimed example, which does not form part of the invention, of package 501, including a closure 502 and a container 503 which has been sealed with a seal 504. The

rim 520 of the closure 502 is fixed to the peripheral edge (not shown) of the container 503. The rim 520 comprises a line of weakness 523 extending from the access opening 527 to the lower edge 528 of the rim 520.

[0063] Adjacent to the line of weakness 523, a pull-tab 525 is attached to the rim 520. The pull-tab is normally flat, positioned against the peripheral wall 536. After use, the pull-tab 525 can be bent or hinged upward over 90 to 180 degrees, towards the access opening 527. A user pulls the pull-tab 525 such that the line of weakness 523 breaks and the rim 520 is released from the peripheral edge of the container 503. The pull-tab 525 provides a good grip on the weakest part of the rim 520.

[0064] The invention has been described by reference to certain embodiments discussed above. It will be recognized that these embodiments are susceptible to various modifications and alternative forms well known to those of skill in the art. In particular, both the hinges and the container may be distinct from the schematically illustrated design.

[0065] Accordingly, although specific embodiments have been described, these are examples only and are not limiting upon the scope of the invention, which is defined by the appended claims.

Claims

1. A package (1) for a powdered nutritional product comprising:

a container (3) for receiving the product, the container having a base (38) and a peripheral wall (36) extending to an open top (30) surrounded by a peripheral edge (31) wherein at least the peripheral wall comprises a carton material;
a seal (4) for closing the container prior to use, the seal being connected to the peripheral wall at a distance below the peripheral edge and being at least partially removable to gain access to the product;
a closure (2), made of plastic material, including a circumferential rim (20) connected to an upper part of the peripheral wall and defining an access opening (27) and a lid (21), pivotably attached to the rim, for selectively closing the access opening; and **characterized by** a separation region for facilitating the separation of the container and the closure after use, the separation region being located above the seal and comprising a point (32) or line (37) of weakness in the peripheral wall where separation can be initiated or facilitated by a user.

2. The package according to claim 1, wherein an adhesive is applied between the upper part of the peripheral wall and the rim, and optionally, wherein the adhesive is water-soluble or adapted to weaken or

melt upon heating.

3. The package according to claim 1 or 2, further comprising a gripping region for improving a user's grip on the closure and/or on the container.
4. The package according to any of the preceding claims, further comprising a pull-tab (225) connected to the rim, preferably moulded with the rim, whereby a user can exert a pulling force on the rim to facilitate separation.
5. The package according to claim 1, 2 or 3, wherein the separation region comprises a point of weakness in the peripheral wall adjacent to the rim and the point of weakness is adapted to be pressed into the container, enabling a user to grip beneath the rim.
6. The package according to any one of the preceding claims, wherein a cross-section of the peripheral wall, parallel to the base, has a shape of a rounded rectangle and the point of weakness is arranged in a corner of the peripheral wall and/or wherein the separation region comprises a line of weakness, substantially surrounding the peripheral wall.
7. The package according to any one of the preceding claims, wherein the separation region comprises a tear band (333) substantially surrounding the peripheral wall, and optionally, wherein the tear band is arranged in the peripheral wall by means of one or two circumferential line(s) of weakness.
8. The package according to claim 7, wherein the tear band is provided with a grip tab to facilitate gripping the tear band.
9. The package according to any one of the preceding claims, wherein the rim has an inverted U-shaped channel engaging the peripheral edge and an adhesive is provided on one side of the U-shaped channel only.
10. The package according to any one of the preceding claims, wherein the rim contacts the peripheral edge defining a contact area, and wherein the adhesive is applied at between 1% and 100% of the contact area, preferably between 10% and 60% or between 20% and 40%.
11. The package according to any one of the preceding claims, wherein the separation region allows for separating the package into a first part and a second part, wherein the first part comprises the closure, and the second part comprises at least 80 wt% of the container, preferably at least 95 wt% of the container.

12. The package according to any one of the preceding claims, wherein the distance at which the seal is located below the peripheral edge is between 15 mm and 50 mm or the distance at which the seal is located below the peripheral edge is sufficient to allow accommodation of an infant formula dosing scoop in the head space between the lid and the seal.

13. A method for disposing of a package (1), the package comprising

a container (3) for receiving a product, the container having a base (38) and a peripheral wall (36) extending to an open top (30) surrounded by a peripheral edge (31) wherein at least the peripheral wall comprises a carton material; and a closure (2), made of plastic material, including a circumferential rim (20) connected to the peripheral edge and defining an access opening (27) and a lid (21), pivotably attached to the rim for selectively closing the access opening; and a separation region for facilitating the separation of the container and the closure after use, the separation region comprising a point (32) or line (37) of weakness in the peripheral wall where separation can be initiated or facilitated by a user, the method comprising the steps of:

- engaging the package at a gripping region; and
- applying a force of less than 100 N to separate the container and the closure.

14. The method according to claim 13, wherein the package is a package according to any of claims 1 to 12.

15. The method according to claim 13 or 14, wherein the force is less than 70 N or less than 50 N or less than 30 N or even less than 10 N, and/or, wherein the force is applied to a removable tear band or grip tab.

Patentansprüche

1. Verpackung (1) für ein pulverförmiges Nahrungsmittelprodukt, die aufweist:

einen Behälter (3) zum Aufnehmen des Produkts, wobei der Behälter eine Basis (38) und eine Umfangswand (36) aufweist, die sich zu einem offenen oberen Teil (30) erstreckt, der von einem Umfangsrand (31) umgeben ist, wobei zumindest die Umfangswand ein Pappmaterial aufweist; eine Dichtung (4) zum Verschließen des Behälters vor Gebrauch, wobei die Dichtung in einem Abstand unterhalb des Umfangsrandes mit der

Umfangswand verbunden ist und zumindest teilweise abnehmbar ist, um Zugriff auf das Produkt zu bieten;

einen Verschluss (2) aus einem Kunststoffmaterial, der eine Umfangseinfassung (20), die mit einem oberen Teil der Umfangswand verbunden ist und eine Zugangsöffnung (27) definiert, und einen schwenkbar an der Einfassung angebrachten Deckel (21) zum selektiven Verschließen der Zugangsöffnung umfasst; und

gekennzeichnet durch

eine Trennregion zum Vereinfachen der Trennung des Behälters und des Verschlusses nach Gebrauch, wobei sich die Trennregion über der Dichtung befindet und einen Schwächungspunkt (32) oder eine Schwächungslinie (37) in der Umfangswand aufweist, an dem/der eine Trennung durch einen Benutzer initiiert oder vereinfacht werden kann.

2. Verpackung nach Anspruch 1, bei der ein Kleber zwischen dem oberen Teil der Umfangswand und der Einfassung aufgebracht ist, wobei optional der Kleber wasserlöslich oder dazu vorgesehen ist, zu schwächen oder bei Erwärmung zu schmelzen.

3. Verpackung nach Anspruch 1 oder 2, die ferner eine Greifregion zum Verbessern des Greifens des Verschlusses und/oder des Behälters durch den Benutzer aufweist.

4. Verpackung nach einem der vorhergehenden Ansprüche, die ferner eine Zuglasche (225) aufweist, welche mit der Einfassung verbunden ist, vorzugsweise mit der Einfassung spritzgegossen ist, wodurch ein Benutzer eine Zugkraft auf die Einfassung aufbringen kann, um eine Trennung zu vereinfachen.

5. Verpackung nach Anspruch 1, 2 oder 3, bei der die Trennregion einen Schwächungspunkt in der Umfangswand angrenzend an die Einfassung aufweist und der Schwächungspunkt dazu vorgesehen ist, in den Behälter gedrückt zu werden, um einem Benutzer ein Greifen unterhalb der Einfassung zu ermöglichen.

6. Verpackung nach einem der vorhergehenden Ansprüche, bei der ein Querschnitt der Umfangswand parallel zu der Basis eine Form eines abgerundeten Rechtecks hat und der Schwächungspunkt in einer Ecke der Umfangswand angeordnet ist und/oder bei der die Trennregion eine Schwächungslinie aufweist, die die Umfangswand im Wesentlichen umgibt.

7. Verpackung nach einem der vorhergehenden Ansprüche, bei der die Trennregion ein Aufreißband

- (333) aufweist, das die Umfangswand im Wesentlichen umgibt, wobei das Aufreißband mittels einer oder zwei am Umfang vorhandener Schwächungslinie(n) in der Umfangswand angeordnet ist.
8. Verpackung nach Anspruch 7, bei der das Aufreißband mit einer Greifflasche zum Vereinfachen des Greifens des Aufreißbands versehen ist.
9. Verpackung nach einem der vorhergehenden Ansprüche, bei der die Einfassung einen Kanal in Form eines umgekehrten U aufweist, der mit dem Umfangsrand zusammengreift, und ein Kleber nur auf einer Seite des U-förmigen Kanals vorgesehen ist.
10. Verpackung nach einem der vorhergehenden Ansprüche, bei der die Einfassung mit dem Umfangsrand in Kontakt kommt und eine Kontaktfläche definiert und bei der der Kleber auf zwischen 1 % und 100 % der Kontaktfläche, vorzugsweise zwischen 10 % und 60 % oder zwischen 20 % und 40 % aufgebracht ist.
11. Verpackung nach einem der vorhergehenden Ansprüche, bei der die Trennregion ein Trennen der Verpackung in einen ersten Teil und einen zweiten Teil ermöglicht, wobei der erste Teil den Verschluss aufweist und der zweite Teil mindestens 80 Gew.-% des Behälters, vorzugsweise mindestens 95 Gew.-% des Behälters aufweist.
12. Verpackung nach einem der vorhergehenden Ansprüche, bei der der Abstand, in dem sich die Dichtung unterhalb des Umfangsrandes befindet, zwischen 15 mm und 50 mm beträgt oder der Abstand, in dem sich die Dichtung unterhalb des Umfangsrandes befindet, ausreicht, um ein Aufnehmen eines Säuglingsfertiernahrungs-Dosierlöffels in dem Kopfraum zwischen dem Deckel und der Dichtung zu ermöglichen.
13. Verfahren zum Entsorgen einer Verpackung (1), wobei die Verpackung aufweist
- einen Behälter (3) zum Aufnehmen eines Produkts, wobei der Behälter eine Basis (38) und eine Umfangswand (36) aufweist, die sich zu einem offenen oberen Teil (30) erstreckt, der von einem Umfangsrand (31) umgeben ist, wobei zumindest die Umfangswand ein Pappmaterial aufweist; und
- einen Verschluss (2) aus einem Kunststoffmaterial, der eine Umfangseinfassung (20), die mit einem oberen Teil der Umfangswand verbunden ist und eine Zugangsöffnung (27) definiert, und einen schwenkbar an der Einfassung angebrachten Deckel (21) zum selektiven Verschließen der Zugangsöffnung umfasst; und

eine Trennregion zum Vereinfachen der Trennung des Behälters und des Verschlusses nach Gebrauch, wobei die Trennregion einen Schwächungspunkt (32) oder eine Schwächungslinie (37) in der Umfangswand aufweist, an dem/der eine Trennung durch einen Benutzer initiiert oder vereinfacht werden kann, wobei das Verfahren die folgenden Schritte umfasst:

- Angreifen an der Packung in einer Greifregion; und
- Aufbringen einer Kraft von weniger als 100 N zum Trennen des Behälters und des Verschlusses.

14. Verfahren nach Anspruch 13, bei dem die Verpackung eine Verpackung nach einem der Ansprüche 1 bis 12 ist.

15. Verfahren nach Anspruch 13 oder 14, bei dem die Kraft kleiner als 70 N ist oder kleiner als 50 N ist oder kleiner als 30 N ist oder sogar kleiner als 10 N ist, und/oder bei dem die Kraft auf ein lösbares Aufreißband oder eine Greifflasche aufgebracht wird.

Revendications

1. Emballage (1) pour produit nutritionnel en poudre comprenant :

un récipient (3) pour recevoir le produit, le récipient ayant une base (38) et une paroi périphérique (36) s'étendant vers un dessus ouvert (30) entouré par un bord périphérique (31) dans lequel au moins la paroi périphérique comprend un matériau en carton ;

un joint (4) pour fermer le récipient avant utilisation, le joint étant relié à la paroi périphérique à une distance sous le bord périphérique et étant au moins partiellement amovible pour obtenir un accès au produit ;

une fermeture (2), constituée de matière plastique, comprenant un rebord circonférentiel (20) relié à une partie supérieure de la paroi périphérique et définissant une ouverture d'accès (27) et un couvercle (21), fixé de manière pivotante au rebord, pour fermer sélectivement l'ouverture d'accès ; et **caractérisé par**

une région de séparation pour faciliter la séparation du récipient et de la fermeture après utilisation, la région de séparation étant située au-dessus du joint et comprenant un point (32) ou une ligne (37) de faiblesse dans la paroi périphérique où une séparation peut être initiée ou facilitée par un utilisateur.

2. Emballage selon la revendication 1, dans lequel un adhésif est appliqué entre la partie supérieure de la paroi périphérique et le rebord, et facultativement, dans lequel l'adhésif est soluble dans l'eau ou adapté pour s'affaiblir ou fondre lors d'un chauffage. 5
3. Emballage selon la revendication 1 ou 2, comprenant en outre une région de préhension pour améliorer la préhension d'un utilisateur sur la fermeture et/ou sur le récipient. 10
4. Emballage selon l'une quelconque des revendications précédentes, comprenant en outre une tirette (225) reliée au rebord, de préférence moulée avec le rebord, à l'aide de laquelle un utilisateur peut exercer une force de traction sur le rebord pour faciliter une séparation. 15
5. Emballage selon la revendication 1, 2 ou 3, dans lequel la région de séparation comprend un point de faiblesse dans la paroi périphérique adjacente au rebord et le point de faiblesse est adapté pour être enfoncé dans le récipient, permettant à un utilisateur une préhension sous le rebord. 20 25
6. Emballage selon l'une quelconque des revendications précédentes, dans lequel une coupe transversale de la paroi périphérique, parallèle à la base, a une forme de rectangle arrondi et le point de faiblesse est agencé dans un coin de la paroi périphérique et/ou dans lequel la région de séparation comprend une ligne de faiblesse, entourant sensiblement la paroi périphérique. 30
7. Emballage selon l'une quelconque des revendications précédentes, dans lequel la région de séparation comprend une bande de déchirure (333) entourant sensiblement la paroi périphérique, et facultativement, dans lequel la bande de déchirure est agencée dans la paroi périphérique au moyen d'une ou deux ligne(s) circonférentielle(s) de faiblesse. 35 40
8. Emballage selon la revendication 7, dans lequel la bande de déchirure est munie d'une languette de préhension pour faciliter la préhension de la bande de déchirure. 45
9. Emballage selon l'une quelconque des revendications précédentes, dans lequel le rebord a un canal en forme de U inversé en prise avec le bord périphérique et un adhésif est prévu uniquement sur un côté du canal en forme de U. 50
10. Emballage selon l'une quelconque des revendications précédentes, dans lequel le rebord est en contact avec le bord périphérique définissant une zone de contact, et dans lequel l'adhésif est appliqué sur entre 1 % et 100 % de la zone de contact, de préférence entre 10 % et 60 % ou entre 20 % et 40 %. 55
11. Emballage selon l'une quelconque des revendications précédentes, dans lequel la région de séparation permet de séparer l'emballage en une première partie et une seconde partie, la première partie comprenant la fermeture, et la seconde partie comprenant au moins 80 % en poids du récipient, de préférence au moins 95 % en poids du récipient.
12. Emballage selon l'une quelconque des revendications précédentes, dans lequel la distance à laquelle le joint est situé sous le bord périphérique est comprise entre 15 mm et 50 mm ou la distance à laquelle le joint est situé sous le bord périphérique est suffisante pour permettre le logement d'une cuillère doseuse de lait maternisé dans l'espace de tête entre le couvercle et le joint.
13. Procédé de mise au rebut d'un emballage (1), l'emballage comprenant
- un récipient (3) pour recevoir un produit, le récipient ayant une base (38) et une paroi périphérique (36) s'étendant vers un dessus ouvert (30) entouré par un bord périphérique (31) dans lequel au moins la paroi périphérique comprend un matériau en carton ; et
- une fermeture (2), constituée de matière plastique, comprenant un rebord circonférentiel (20) relié au bord périphérique et définissant une ouverture d'accès (27) et un couvercle (21), fixé de manière pivotante au rebord pour fermer sélectivement l'ouverture d'accès ; et
- une région de séparation pour faciliter la séparation du récipient et de la fermeture après utilisation, la région de séparation comprenant un point (32) ou une ligne (37) de faiblesse dans la paroi périphérique où une séparation peut être initiée ou facilitée par un utilisateur,
- le procédé comprenant les étapes consistant à :
- mettre en prise l'emballage au niveau d'une région de préhension ; et
 - appliquer une force inférieure à 100 N pour séparer le récipient et la fermeture.
14. Procédé selon la revendication 13, dans lequel l'emballage est un emballage selon l'une quelconque des revendications 1 à 12.
15. Procédé selon la revendication 13 ou 14, dans lequel la force est inférieure à 70 N ou inférieure à 50 N ou inférieure à 30 N ou même inférieure à 10 N, et/ou, dans lequel la force est appliquée à une bande de déchirure amovible ou à une languette de préhension.

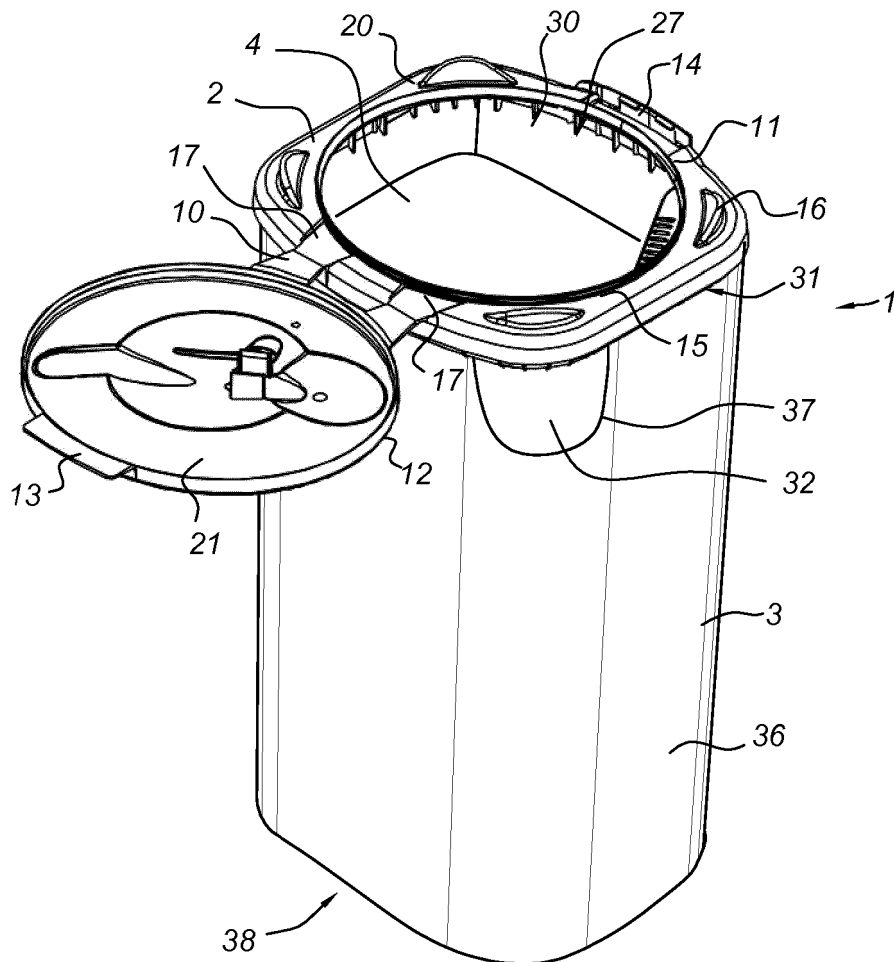


Fig. 1

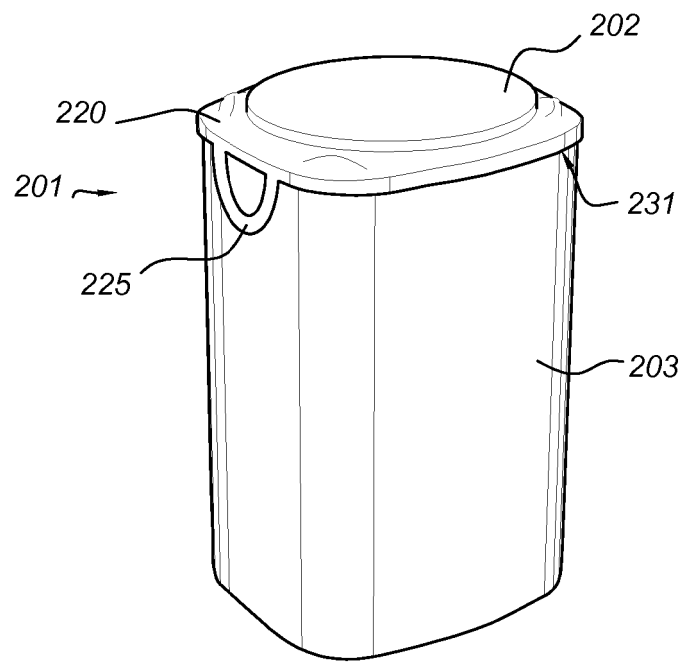


Fig. 2

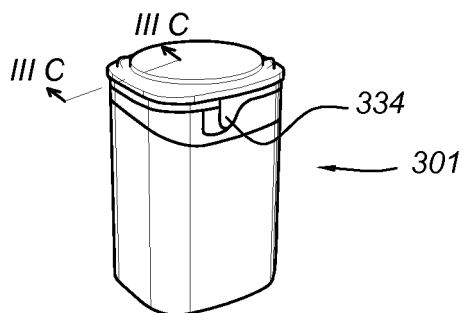


Fig. 3A

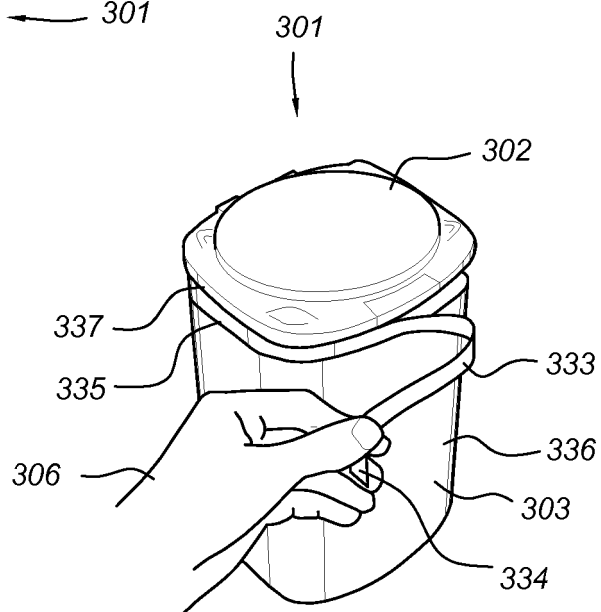


Fig. 3B

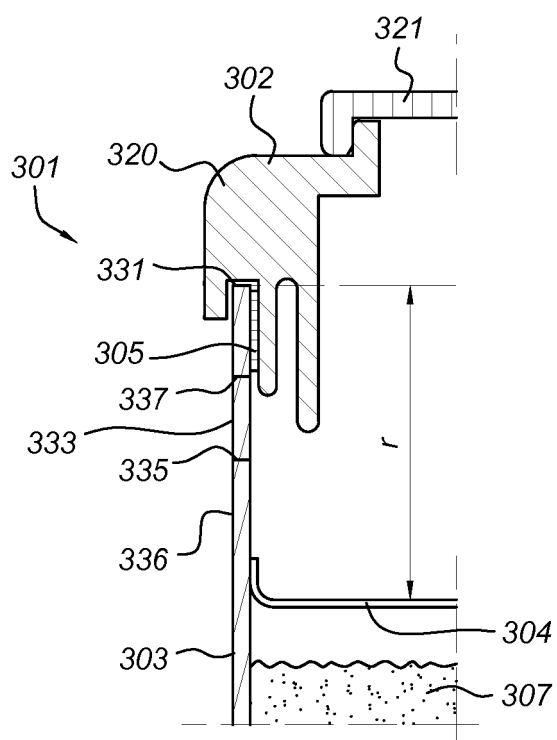


Fig. 3C

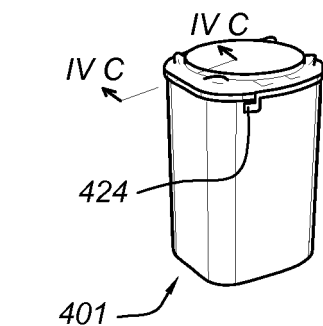


Fig. 4A

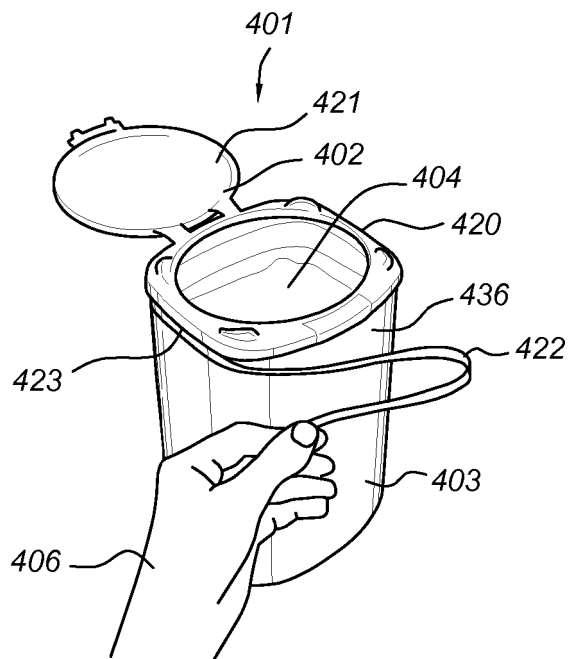


Fig. 4B

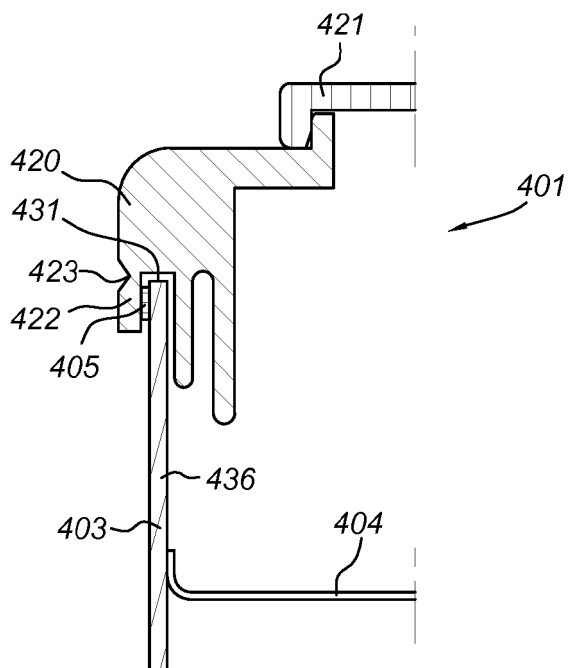


Fig. 4C

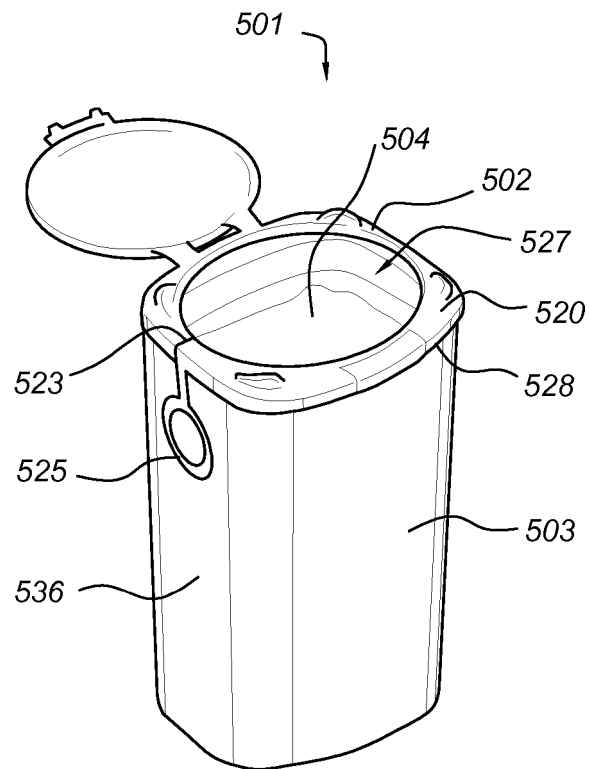


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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