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Jemmett

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[45] **May 13, 1975**

[54] **GASKETS FOR CONTAINER CLOSURES**

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[73] Assignee: **W. R. Grace & Co.,** Cambridge, Mass.

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[21] Appl. No.: **457,690**

[30] **Foreign Application Priority Data**

Apr. 12, 1973 United Kingdom 17646/73

[52] **U.S. Cl.** **215/341**
[51] **Int. Cl.** **B65d 53/00**
[58] **Field of Search** 215/341, 349

[56] **References Cited**

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Attorney, Agent, or Firm—C. E. Parker; Armand McMillian

[57] **ABSTRACT**

The invention relates to gaskets for container closures, e.g. bottle caps.

The gaskets of the invention are seated in closures which are threaded or in which a thread can be formed when the closure is fitted onto the neck of the container. The gaskets are characterised by having a substantially flat central portion and an adjoining peripheral portion which at all points is of greater thickness than the central panel. The thickness of the peripheral portion increases continuously, stepwise or part-continuously and part-stepwise radially outwards to the skirt of the closure. The radial length (x) between the centre of the closure and the beginning of the peripheral portion is 0.25 to 0.45 times the diameter of the closure.

11 Claims, 17 Drawing Figures

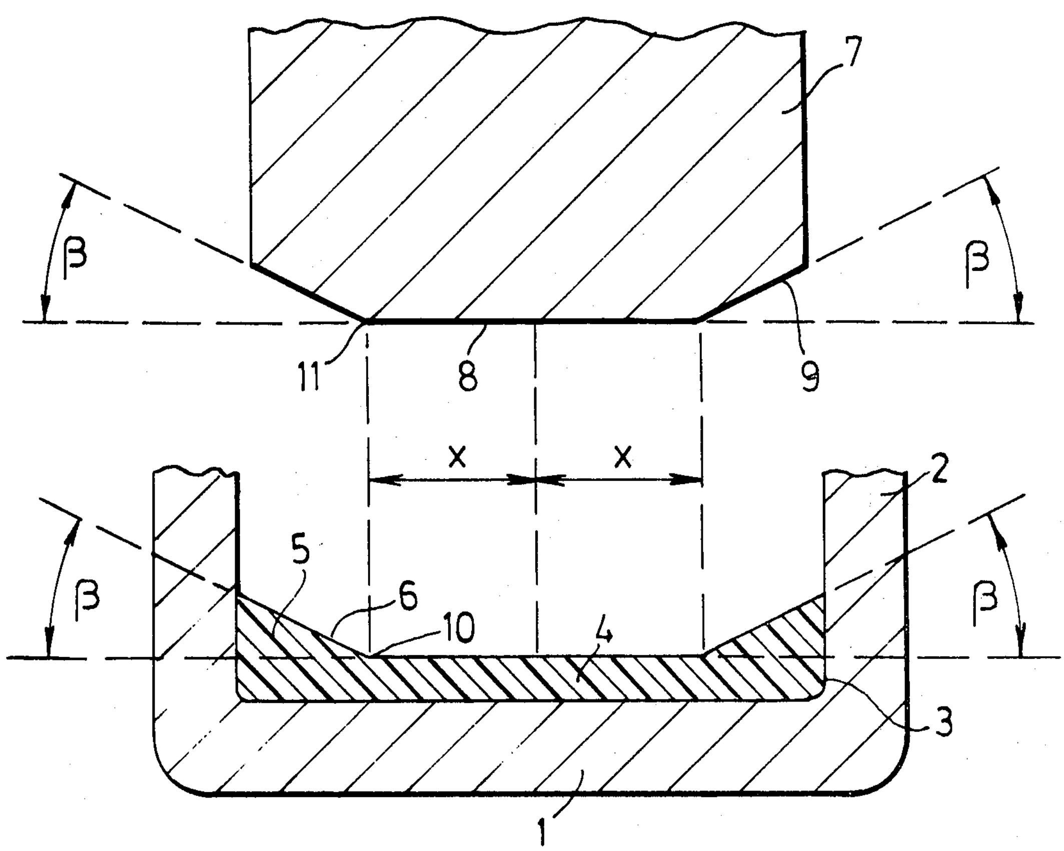


FIG. 1.

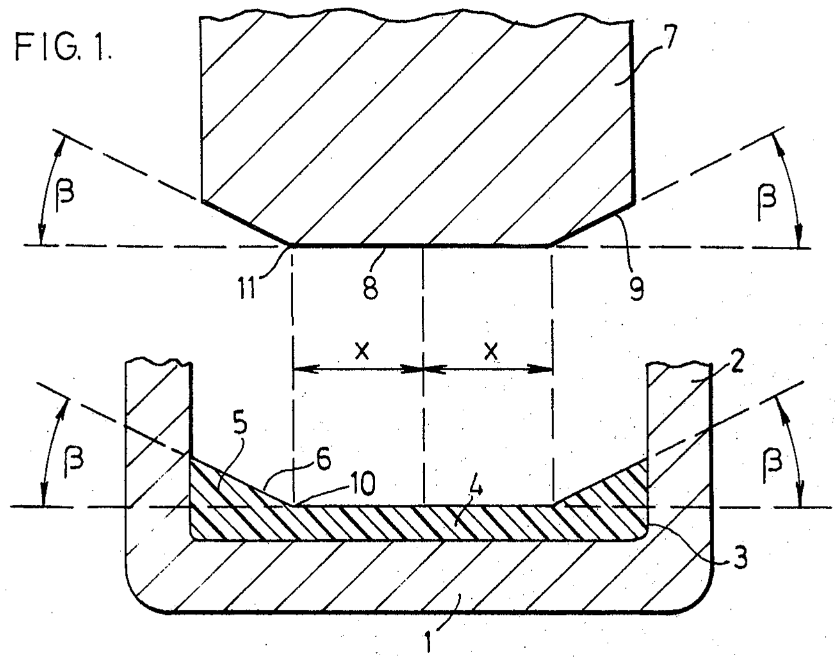


FIG. 2.

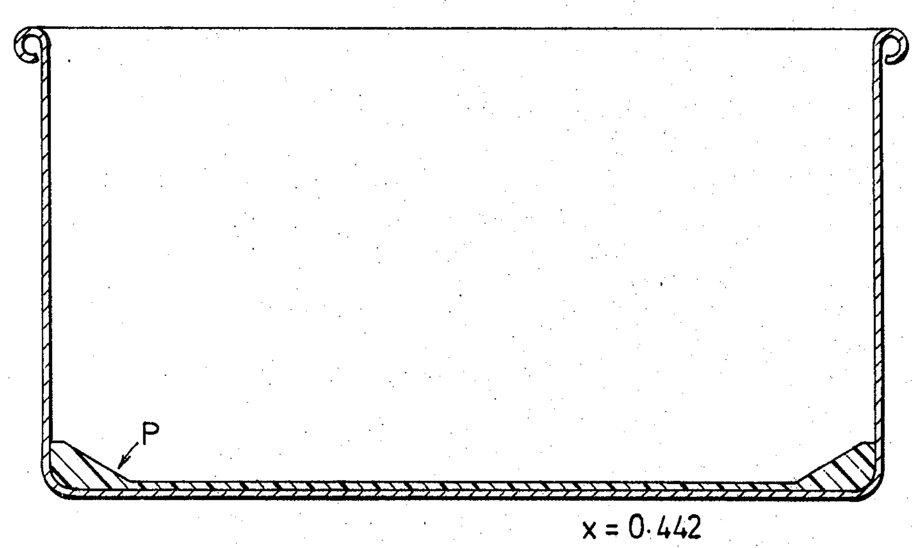


FIG. 3.

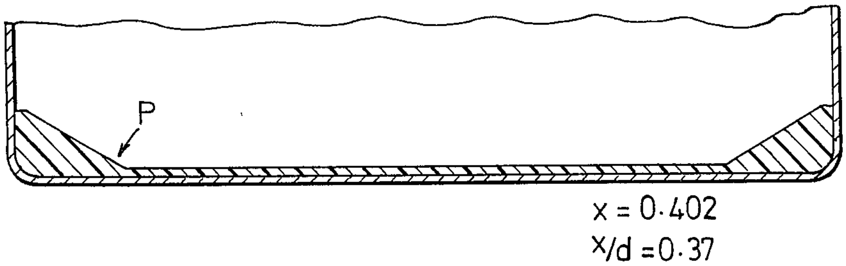
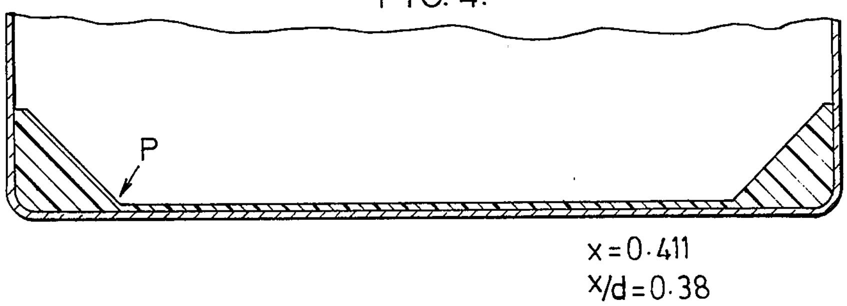


FIG. 4.



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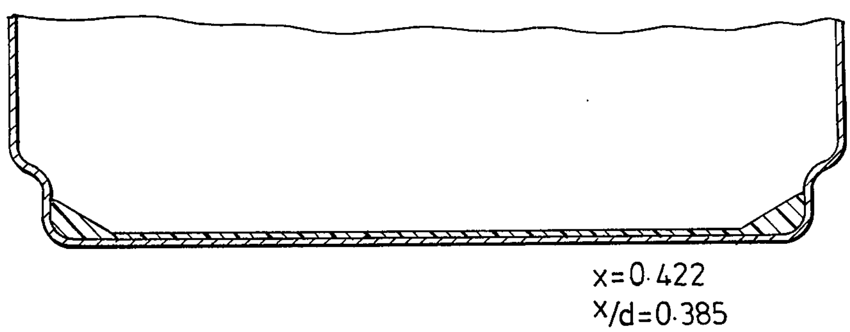

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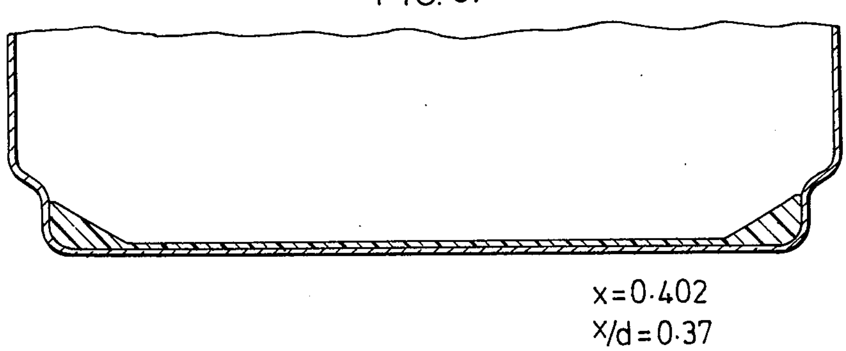
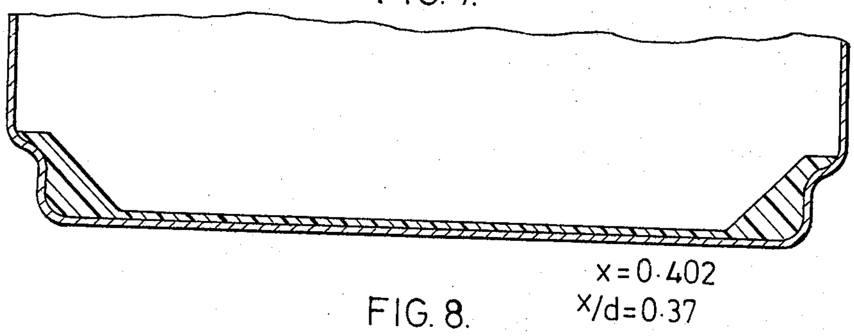


FIG. 7.



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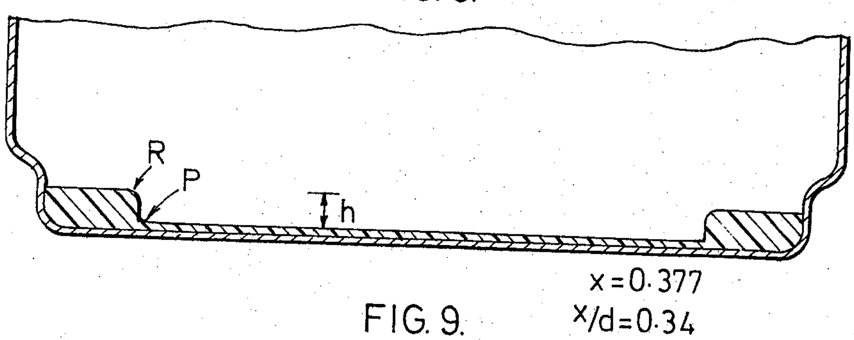


FIG. 9.

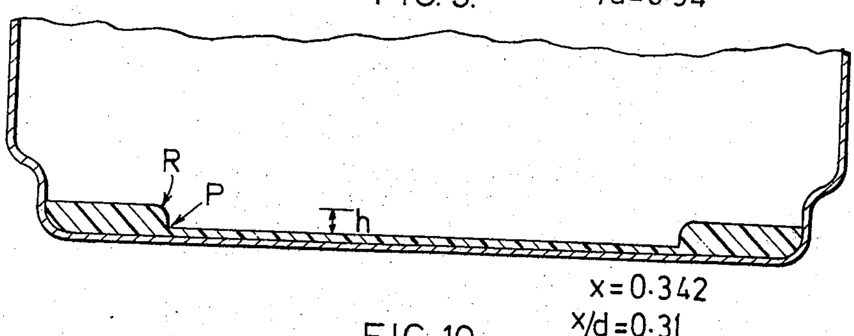


FIG. 10.

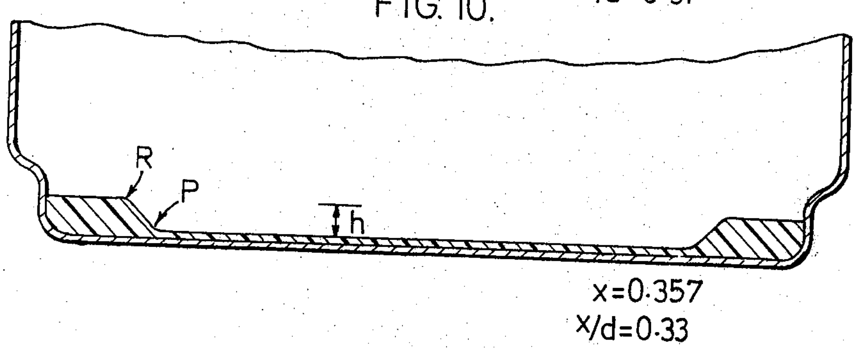
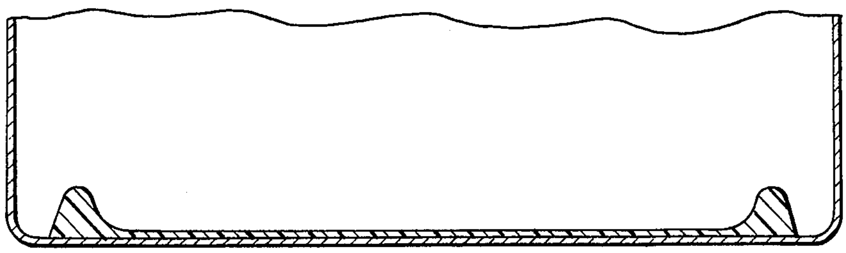
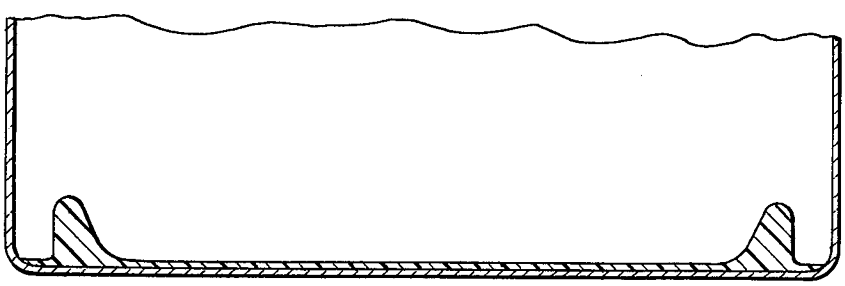


FIG. 11.



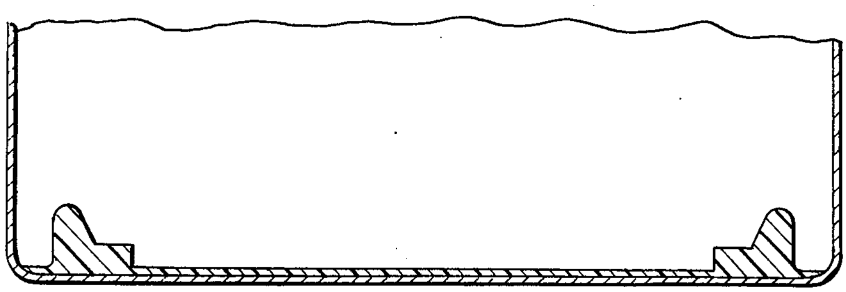
x = 0.392
x/d = 0.36

FIG. 12.



x = 0.352
x/d = 0.32

FIG. 13.



x = 0.391
x/d = 0.36

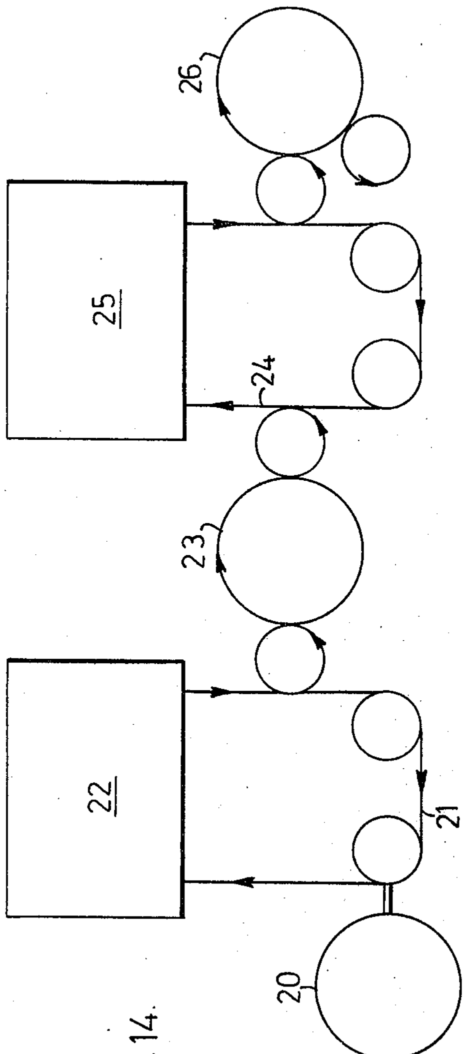


FIG.14.

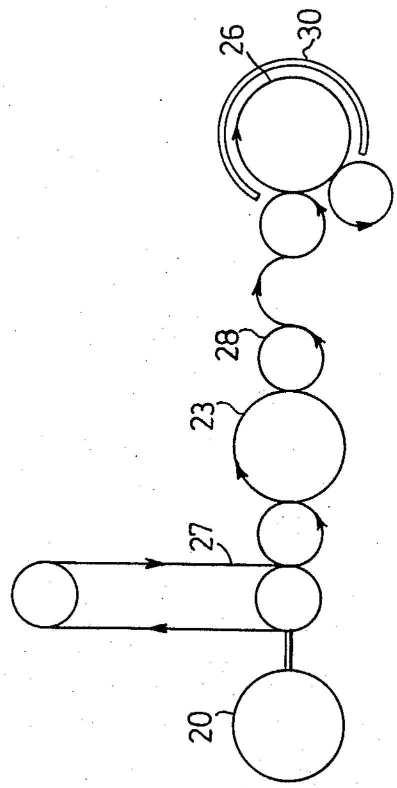
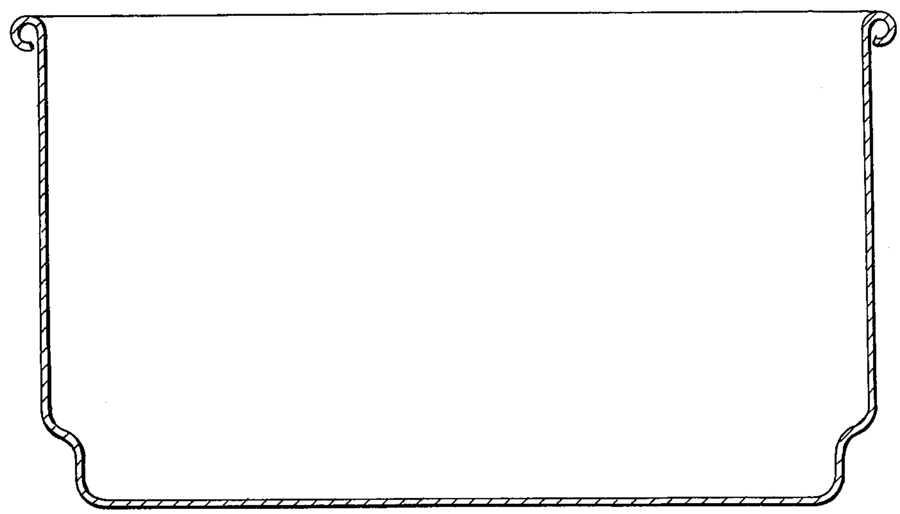


FIG.15.

FIG. 16.



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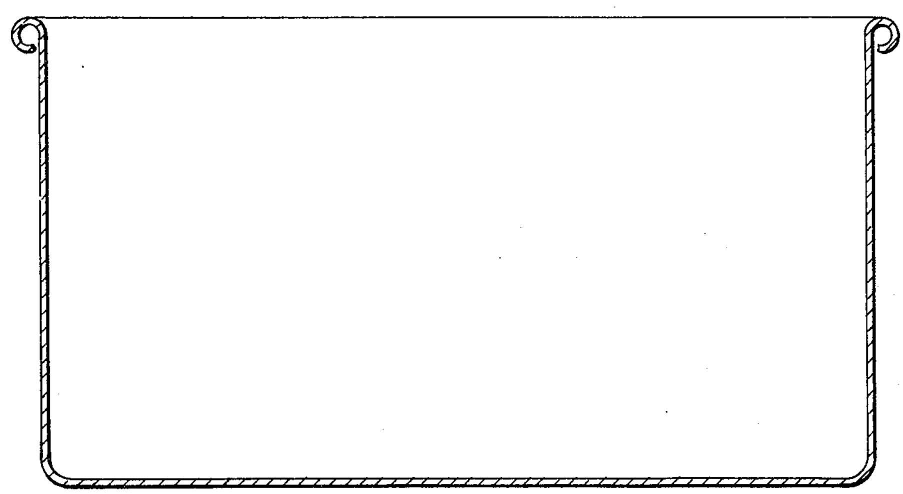

GASKETS FOR CONTAINER CLOSURES

This invention relates to gaskets for container closures, especially threaded closures.

Container closures are provided with gaskets primarily in order to prevent air from entering the container and/or loss of contents of the container to the outside. They are especially important in closures for containers which hold food or drink since contamination of the food or drink within a container by the entry of air before consumption can be a serious health hazard. A major area of use of gasketted closures is for the closing of bottles.

In order to enable a customer to re-close the container after it has been opened it is desirable to provide a threaded closure which can be removed by unscrewing. One general type of threaded closure which has found widespread commercial acceptance is the in situ-threaded type: threads are formed during the operation of closing the closure onto the container. A closure which is initially unthreaded is applied to the neck of a threaded container and pressure is applied to impart threads to the closure while it is on the container, the threads formed in the closure corresponding to those on the neck of the container. For example the threads may be formed with the aid of a roller. One well known kind of closure of this type is the "Roll-on" bottle cap. Various sub-types of roller-threaded caps have been employed, including the "Flavorlok" (Metal closures Ltd., British Patent Specification No. 975,739) and the "Coronet" (The Metal Box Company Ltd., British Patent Specification No. 1,054,295). The disclosures of these patent specifications are herein incorporated by reference. The in situ-threaded type of closure will herein be termed generally as I.S. threadable closures.

Gaskets for threaded closures have frequently been produced by the so-called spin-line process. In the spin-line process a pre-determined quantity of a plastisol of polyvinyl chloride is metered into a closure, the closure is spun rapidly about an axis through the centre of its main panel so as to distribute the plastisol by the action of centrifugal force, and the plastisol in the closure is then fluxed. The plastisol is a viscous dispersion of polyvinyl chloride in a plasticiser. It is fluxed by heating it to a temperature at which the plasticizer is absorbed by the polyvinyl chloride to form a homogeneous mass, which upon cooling gives a rubbery solid.

The spin-line process, although commercially successful, has limitations. One limitation is that the shape of gasket cannot be greatly varied. Because the shaping is effected by centrifugal force the gaskets produced will inevitably gradually increase in thickness from the centre of the main panel to its periphery. Since in general different shapes of gasket are optimum for different types of closure or container it is a serious limitation of the spin-line process that other shapes cannot be produced by it. Another problem of the spin-line process is that in large production runs it is difficult to introduce the gasket-forming material symmetrically into the region of the centre of the closure, with the result that when the closure is spun the sealing portion is not formed consistently in the shape desired.

The present invention relates to certain new configurations of gasket suitable for use in various threaded closures, and to conditions under which it is possible to mould gaskets in closures from a solid pellet of vinyl chloride polymer resin.

In one aspect the invention provides threaded container closures and I.S. threadable closures, having therein a gasket which considered in its undeformed configuration, i.e. before the closure is closed onto the container, comprises a substantially flat central panel and an adjoining peripheral portion, the thickness of which is at all points greater than the thickness of the central panel and increases continuously and/or stepwise radially outwards to the skirt of the closure.

Considering the closure in its inverted position, meaning the opposite way up to which it is seen when closed onto a bottle, the peripheral portion of the gasket extends to a point on the skirt which is overall upwards from the central panel. Considered in the direction of increasing radius from the centre of the closure (the radially outward direction), the height of the peripheral portion above the central panel starts by increasing and thereafter either continues to increase or remains the same or increases over part of the radial distance and is the same over the rest. Another way of expressing this feature is by reference to the gradient of the peripheral portion. Considered in the radially outward direction the peripheral portion has a gradient which is initially positive and thereafter is zero or positive.

The peripheral portion of the gasket may include a stepped skirt portion extending a substantial distance up the skirt roughly parallel thereto.

In one embodiment the thickness of the peripheral portion increases continuously, preferably with the same gradient, radially outwards to the skirt of the closure or to the beginning of a step which constitutes a skirt portion of the gasket.

In another embodiment the peripheral portion is a step which extends radially outwards either to the skirt of the closure or to the beginning of a second step which constitutes a skirt portion of the gasket.

More specific embodiments of the invention will now be described in more detail with reference to the accompanying drawings, in which:

FIG. 1 is a cross-sectional view along a diameter of a gasketted closure of the invention and of a moulding member which may be used to form it;

FIGS. 2–7 show cross-sectional views along a diameter of gasketted closures of the invention.

FIGS. 8–10 show cross-sectional views along a diameter of closures having therein gaskets of the invention of a different configuration;

FIGS. 11–13 show cross-sectional views along a diameter of gasketted closures having a different type of configuration from that described above;

FIGS. 14 and 15 are schematic diagrams of apparatus for moulding the gaskets, and

FIGS. 16 and 17 are cross-sectional views of the Coronet and Flavorlok bottle caps respectively

In FIGS. 3–13, 16 and 17, the gasket-retaining portion only of the closure has been shown (to save space). The heights of the closures are the same as in FIG. 2.

FIG. 1 of the drawings shows a bottle cap in the inverted position, and before it is closed onto a bottle. It consists of a main panel 1 and skirt 2 (only part shown). A gasket indicated by 3 comprises a substantially flat central panel 4 and a peripheral portion 5 which has a slope 6 upwards and radially outwards. The slope 6 is shown as planar, i.e. linear in cross-section, but it could alternatively be concavely or convexly curved. The radial length between the centre of the closure and the beginning of the raised peripheral portion of the gasket is denoted by reference character x and the angle made between the slope **6** and the flat panel **4** or **1** by β. Broken lines in the figure denote lines of geometrical construction. FIG. **1** also shows part of a complementary moulding member **7**, the moulding surface of which has a flat central portion **8** of dimensions corresponding to that of central panel **4** of the gasket and chamfered peripheral portions **9** of slope and dimensions complementary to the peripheral portion **5** of the gasket. The corner portion **10** of the gasket and the corresponding corner portion **11** of the face of the moulding member are preferably slightly curved to provide a more gradual change of profile between panel **4** and peripheral portion **5**.

The angle β may be from 20° to 80°; we have found an angle of about 30° to be especially suitable for the Flavorlok caps. These values of the angle beta apply to gaskets in which the peripheral portion has a constant gradient extending from the edge of the central panel to the skirt and to those in which the peripheral portion includes a single step adjoining the skirt of the closure, and has a constant gradient extending from the edge of the central panel to the beginning of the step. The step is desirably of a length equal to 0.1 to 50% of the radial length of the peripheral portion, preferably 5 to 20%.

The distance x will generally be from $0.25d$ to $0.45d$ where d is the maximum internal diameter of the closure. A good sealing performance of Flavorlok closures has been attained from gaskets in which x is $0.37d$ to $0.42d$. A particularly preferred class of gaskets according to the invention is those wherein the increase of thickness has a constant gradient extending from the edge of the central panel to the skirt of the closure or to the beginning of a flat or plateau portion adjoining the skirt, wherein β is 20° to 80°, most preferably 25° to 50°, x is $0.25d$ to $0.45d$, most preferably 0.37 to $0.42d$, and wherein if there is a flat or plateau portion adjoining the skirt, its radial length is 0.1 to 50%, most preferablyb 5 to 20%, of the radial length of the peripheral portion.

In general the moulding member will be slightly smaller than the internal diameter of the closure so as to allow clearance for it to enter the closure during moulding. FIGS. **2–13** illustrate gasketted closures. FIGS. **2–4** illustrate the configurations of gaskets for a Flavorlok cap 1.092 inch (2.67 cm.) in internal diameter while FIGS. **5–10** illustrate them for a Coronet cap also 1.092 inch (2.67 cm.) in maximum internal diameter. The gaskets of FIGS. **2–7** are of the sloping type, having the following values of β and x:

Figure No.	2	3	4	5	6	7
Angle β:	30	30	45	30	30	45
Distance x:	$0.40d$	$0.37d$	$0.38d$	$0.385d$	$0.37d$	$0.37d$

The gaskets of FIGS. **8–10** have the distances x = $0.34d$, $0.31d$ and $0.33d$ respectively.

The corners denoted by P and R in FIGS. **2–4** and **8–10** of the drawings may be sharp or rounded-off. In FIGS. **2–4** the radius of curvature at P (the beginning of the peripheral portion) is 0.01 inch (0.25 mm.). In FIGS. **8** and **9** the radii of curvature at P and R are 0.01 and 0.02 inch (0.25 and 0.51 mm.); in FIG. **10** it is 0.02 inch (0.25 mm.) at P and R. The degree of curvature at these points can be varied considerably.

Referring to FIGS. **8–10**, the height (h) of the peripheral portion of the gaskets can be varied according to the type of closure and container. In FIGS. **8–10** it is about 0.04 inch (1.0 mm.).

FIGS. **8–10** illustrate a second preferred embodiment of the invention, viz. gaskets in which the peripheral portion consists of a single step, having a flat or plateau portion the radial length of which is 65–98% of the radial length of the peripheral portion.

In FIGS. **11–13** the distances x are $0.36d$, $0.32d$ and $0.36d$ respectively and the heights of the annular ribs are 0.064, 0.080 and 0.080 inch (1.6, 2.0 and 2.0 mm.) respectively.

Two main types of moulding process have been found suitable for producing the gaskets of the invention. The first type is called "cold-moulding" and is the subject of W. R. Grace & Co's British Pat. No. 1,112,023 and overseas patents or applications. A solid insert of the gasket-forming material, e.g. a pellet as described above, is placed in an inverted container closure which preferably has been pre-warmed to assist the insert to the closure. The closure is then heated to a temperature above the softening point of the gasket-forming material, e.g. on a platen or in an oven, and the gasket is moulded by a moulding member the surface of which is kept below the softening point of the gasket material by continuous or intermittent cooling with a liquid coolant. Preferably the temperature of the moulding surface of the moulding member is kept at 100°C. A temperature of 5°–25°C, especially about 10°C, been found very suitable for polyvinyl chloride. The closure may if desired be heated by a platen during moulding.

The second type of moulding is hot-moulding which differs from the first in that the moulding member is either not positively cooled with a liquid coolant or is actually heated. The platen is also preferably heated This second type of moulding is not the most suitable for some gasket materials, e.g. mixtures of polyethylene with butyl rubber, but we have found that it can be used for moulding plasticised polyvinyl chloride. Solid plasticised polyvinyl chloride is a material which has already been gelled and once it has been gelled it behaves as an ordinary thermoplastic. It can be heated up to its softening point. We have obtained good results from gaskets moulded at about 160°C. Temperatures in the range 150°–170°C. are generally likely to be suitable for both moulding member and platen. At these temperatures the dwell time, i.e the time of residence of the moulding member in contact with the gasket material, will usually be relatively long, e.g. 3 to 6 seconds, depending on the temperature. A long dwell time is desirable to soften the upper and lower portions of the pellet of polyvinyl chloride by prolonged contact with the relatively hot moulding member.

The pressure exerted by the moulding member in hot-moulting may be relatively low, e.g. 400 p.s.i. (28 kg./sq. cm.). Generally it will not be less than 70 p.s.i. (4.9 kg/sq. cm.) or greater than 2,000 p.s.i. (140 kg./sq. cm.).

Both the above kinds of moulding process are useful in the formation of sealing gaskets in container closures, especially threaded and I.S. threadable closures, generally, regardless of the precise kind of gasket configuration which it is desired to mould. PVC gaskets may be moulded in crown shells under the above-described conditions.

The gasketted closures of the invention are preferably made from plasticised polyvinyl chloride since this is a material well recognised as being satisfactory for gasketting. The plasticised polyvinyl chloride is conveniently introduced into the closure as a pellet, normally of diameter smaller than that of the diameter of the closure. There are several advantages in the use of solid plasticised polyvinyl chloride over a plastisol. One is that a suspension grade PVC resin may be employed as contrasted to the emulsion grade resin normally used in plastisols. The suspension grade resin contains no emulsifier. Some emulsifiers so affect polyvinyl chloride that a gasket made from it can impart an unpleasant taste to a bottled drink. It is thus an advantage to be able to employ suspension grade resin. Another advantage is that pellets can be accurately placed centrally in the inverted closure and hence a more accurately placed sealing portion can be obtained than from the spin-line process. A further advantage is that the solid pellets can be conveniently obtained by cutting them from an extruded rod. Rod is easier to handle than plastisols. Whereas plastisols must have a certain viscosity, neither too high nor too low, use of a rod is free from any such limitations and therefore a wider range of different gasketting materials can be employed.

The plasticised polyvinyl chloride may of course contain any of the usual additives such as a stabiliser, pigment, filler, slip agent, lubricant. The nature of the plasticiser is not critical. Diisooctyl phthalate or any of the other usual plasticisers may be employed.

In making the gaskets of this invention it is also possible to use a variety of other gasket-forming materials apart from PVC, e.g. those described in W. R. Grace & Co's British Pat. Nos. 1,112,023, 1,112,024 and 1,112,025. Polyethylene/butyl rubber mixtures containing e.g. 40–70% by weight polyethylene and 60–30% by weight butyl rubber are generally suitable. The mixtures are preferably formed by cold-moulding.

The invention includes both the threaded or I.S. threadable closures per se and containers having the closures closed onto them. The I.S. threadable closures are of course threaded when closed onto the container and the gasket is deformed by being pressed against the rim of the container into a different configuration.

The gaskets of configuration shown in FIGS. 2 to 4 have been found especially suitable for closing by use of a Flavorlok closing head. In this kind of closing head the closure is pinched radially inwards at the corner where the skirt joins the main panel. British Patent Specification No. 975,739 describes this type of closing head.

The following Examples illustrate the invention.

EXAMPLES

The following compositions C-1 to C-5 incorporating suspension grade PVC resin were extruded into rod form of 8 mm. diameter.

Composition (parts by weight)

Components	C-1	C-2	C-3	C-4	C-5
Corvic D65/02 (PVC resin)	100	100	100	100	100
Di-isooctyl phthalate (plasticiser)	55	55	55	60	65
Low molecular weight polyethylene (Lubricant A)	—	0.5	—	—	—
Paraffin wax (Lubricant B)	—	—	0.75	0.75	—
"Vaseline" (Lubricant C)	—	—	0.75	0.75	—
FERRO 760X (stabiliser)	3	3	3	3	3

"Corvic D65/02" is a suspension grade PVC resin having K-value of 65. FERRO 760X is a calcium/zinc stearate stabiliser made by Ferro UK limited. All figures refer to parts by weight.

EXAMPLE 1

Pellets from compositions C-1 to C-4 and weighing 330 mg were cut from rods and placed centrally in 28 mm aluminium RO Flavorlok caps (Metal Closures Ltd.). The pellets were then hot-moulded on a hot moulding rig to give gaskets shown in FIG. 2. The rig used in this work had an electrically heated moulding member and platen which could be independently set to any temperature up to 250°C. Maximum forces of around 150 kg. were produced during moulding, equivalent to a pressure of about 25kg./sq. cm. The following conditions were employed:

Mould temperature	160°C
Platen temperature	210°C
Dwell time	6 secs

These caps were closed within 4 hours of moulding into dry glass (of MCA 1 finish) and the removal torque immediately after closing was determined. Results are shown in Table 1.

TABLE 1

Dry glass removal torque (gasket of FIG. 2 configuration)

Composition	Average removal torque, lb.	(kg.)
C-1	13.8	(6.3)
C-2	15.6	(7.1)
C-3	10.4	(4.7)
C-4	10.0	(4.5)

EXAMPLE 2

Compositions C-1, C-3, C-4 and C-5 were hot moulded under the conditions shown above, using the same type cap. Three gaskets of the sloping periphery type (FIGS 2, 3 and 4) and 3 annular gaskets (with annular ribs) (FIGS. 11, 12, and 13) were made from each of the four compositions and had the following film weights.

FIG. 2 330 mg.	FIG. 11 300 mg.
FIG. 3 410 mg.	FIG. 12 310 mg.
FIG. 4 370 mg.	FIG. 13 410 mg.

These were measured by weighing the pellet. Pellets of these weights fill thet "mould" formed between moulding member and cap completely and give gaskets having a centre panel thickness of 0.009 inch (230 μ) for each of the six different configurations. These the were allowed to age for 24 hours before being closed onto dry glass. The removal torques were then determined and the results (Table 2) showed that C-1 and C-3 gave the lowest removal torques.

TABLE 2

Dry glass removal torque for hot-moulded gaskets

Composition	Gasket Configuration	Av. removal torque, lb. (kg.)		Std. Deviation lb. (kg.)	
C5	FIG. 11	8.1	(3.7)	2.1	(0.95)
C1	do.	4.6	(2.1)	1.1	(0.50)
C3	do.	4.5	(2.0)	0.9	(0.41)
C4	do.	4.9	(2.2)	0.9	(0.41)
C5	FIG. 2	19.0	(8.6)	3.6	(1.4)
C1	do.	5.3	(2.4)	0.5	(0.23)
C3	do.	7.2	(3.3)	0.8	(0.36)
C4	do.	6.8	(3.1)	1.0	(0.45)

The ability of these closures to seal a pressurised container was ascertained by determining the 'venting pressure'. This is the pressure at which a closed cap begins to allow the leakage of gas contained in the bottle and is usually determined by blowing nitrogen in through a hole in the bottom of a capped bottle which is submerged under water. The nitrogen pressure is increased until bubbles appear from under the cap; the pressure at which this occurs is taken as the venting pressure for the cap under test.

Caps lined with compositions **C-5, C-1, C-3** and **C-4** moulded with moulding members were closed onto MCA **1** finished glass bottles using a Flavorlok closing head. The venting pressures of these closures were then determined. (See Table **3**). Results showed that only caps having gaskets moulded to the configuration of FIGS. **2** and **4** withstood a pressure greater than 100 p.s.i. (7 kg./sq. cm.). The gaskets of FIG. **3** performed less well than FIGS. **2** and **4**. It may be speculated that this is due to a difference in the point at which the sealing pressure is greatest, which is probably a function of the distance *x*.

TABLE 3

Venting pressure for cold-moulded gaskets (p.s.i.)

Gasket configuration	C-5	C-1	C-3	
FIG. 2	100+, 100+	100+, 100+	100+, 100+	100+, 100+
FIG. 3	—	40, 90	20, 60	—
FIG. 4	—	100+, 100+	100+, 100+	—
FIG. 11	100+, 100+	100, 100+	30, 70	—
FIG. 12	—	40, 35	80, 30	
FIG. 13	—	70, 80	40, 70	

(Metric equivalents: 20 p.s.i. = 1.4 kg./sq. cm;
30 p.s.i = 2.1 kg./sq. cm; 35 p.s.i. = 2.4 kg./sq. cm;
40 p.s.i. = 2.8 kg./sq. cm; 60 p.s.i. = 4.2 kg./sq. cm;
70 p.s.i. = 4.9 kg./sq. cm; 80 p.s.i. = 5.4 kg./sq. cm;
90 p.s.i. = 6.3 kg./sq. cm; 100 p.s.i. = 7.0 kg./sq. cm.)

EXAMPLE 3

In this Example gaskets were cold-moulded using the apparatus of FIG. **14.** Referring to FIG. **14,** caps are fed from a cap hopper to a conveyor system **21** which takes them to an oven **22** in which they are pre-heated. The warm caps pass to a rotary turret **23,** above which is located a pellet-inserting device. Pellets of a gasket-forming thermoplastic material are inserted into the warm caps and are conveyed by conveyor **24** to a second oven **25** in which the pellets are heated to soften them. The caps containing the softened pellets are passed to a rotary moulding turret **26** where moulding members are brought down into the closure to mould the pellet. The moulding members are cooled by contact, whether direct or indirect, with a liquid coolant. Conveniently the coolant is water and is passed through channels in the moulding member.

The caps employed in this Example were Flavorlok caps 28 mm. in diameter. They were pre-heated in oven 22° to 120°C. Pellets of 300 mg. weight of compositions **C-1, C-3, C-4** and **C-5** were inserted and the second oven was at a temperature of 180°C. A moulding member was used to give gaskets of FIG. **2** and its surface temperature during moulding was about 10°C. No problems of sticking of the gasket material to the moulding member were encountered even though the moulding members were only polished and not given any special non-stick treatment. Caps produced in this way had centre panel thickness of 0.009 inch (230 microns) and the gaskets were of good quality for all four compositions moulded. All these caps were closed with a Flavorlok head onto glass bottles. Removal torque and venting pressure results are shown in Table 4. Spun-lined caps containing a commercial plastisol of PVC at a film weight of 450 mg. were used as controls. The sealing performance of these caps was also evaluated by closing the caps onto 3 volume carbonated packs. (A 3 volume carbonated pack is that pack which contains three times it own volume of dissolved carbon dioxide). The results are shown in Table **5.**

TABLE 4

Removal torques and venting pressures for caps with cold-moulded gaskets of Example 3

Compound	Mean removal torque, lb. (kg.)		Standard Deviation lb. (KG)	
C-5	11.0	(5.0)	2.5	(1.1)
C-1	5.4	(2.4)	0.9	(0.41)
C-3	5.2	(2.4)	0.5	(0.23)
C-4	5.6	(2.5)	0.6	(0.27)
Control (spun-lined plastisol)	8.4	(3.8)	1.1	(0.50)

In all cases the venting pressure was greater than **100** p.s.i. (**7** kg./sq. cm.).

TABLE 5

Sealing performance on 3 volume carbonated pack (stored inverted for 24 hours and shaken)	
C-5	1 leaker from 5 replicates
C-1	0 leaker from 5 Replicates
C-3	0 leaker from 5 Replicates
C-4	0 leaker from 5 Replicates
Control (spun-lined plastisol)	0 leaker from 5 Replicates

EXAMPLE 4

In a bottling trial on a commercial bottling line it was found that gaskets of the invention having the FIG. 2 configuration could be closed more squarely onto the bottle with a Flavorlok closing head than gaskets of the FIG. 11 configuration made by the same moulding process. This result was given for gaskets obtained by hot- or by cold-moulding.

Evaluation of bottles from the commercial line closed with caps provided with gaskets of the FIG. 2 configuration and control caps provided with spinline gaskets of a commercial plastisol showed that the FIG. 2 gaskets gave lower removal torques in most instances. Results are shown in Table 6 below.

TABLE 6

Removal torques
(a) 4 hours after closing

	Mean removal torque lb. (KG.)		Standard Deviation lb. (kg.)	
C-5	15.8	(7.2)	2.6	(1.2)
C-1	9.0	(4.1)	1.6	(0.72)
C-3	9.8	(4.4)	1.0	(0.45)
C-4	9.6	(4.4)	1.4	(0.64)
Control	10.2	(4.6)	0.9	(0.41)

(b) 24 hours after closing

	Mean removal torque 10 lb. (KG.)		Standard Deviation lb. (kg.)	
C-5	12.4	(5.6)	2.0	(0.91)
C-1	9.7	(4.4)	2.1	(0.95)
C-3	10.1	(4.6)	1.2	(0.54)
C-4	10.3	(4.7)	0.8	(0.36)
Control	10.0	(4.5)	0	(0)

A re-closing test was carried out. 1 cap with gasket made from each composition and having the FIG. 2 configuration was opened and reclosed 10 times. No damage occurred to the gasket and the sealing performance was satisfactory when bottles closed with the caps were inverted and shaken.

EXAMPLE 5

The apparatus shown in FIG. 15 was employed for hot-moulding gaskets. It differs from that of FIG. 14 as follows: The cap-heating oven was replaced by a short loop 27 of gas-heated cap-conveying chain. This was maintained at 120°C by an electrical sensor which was coupled to a solenoid-operated gas valve. Caps were transferred directly from the inserter turret 23 to the rotary moulding turret 26 by transfer wheels 28 which replaced the second oven of FIG. 14. Both the moulding members and the platens were gas-heated by two separate gas rings 30 which surrounded the turret 26 through an angle of 270°. These gas rings were regulated through two electrical sensors which controlled

solenoid operated gas valves in a manner identical with the temperature control on the cap heating chain. Temperature control was found to be best if the sensors were adjusted to touch the platens and moulding members as the turret revolved. For this work the machine operated at 220 caps per minute, this speed giving a sufficiently long dwell time (4 seconds).

Compositions C-1 and C-3 were both hot moulded to the FIG. 2 configuration in vinyl-lacquered 28 mm. Flavorlok caps. The optimum moulding temperatures were found to be:

Moulding surface of moulding member	160°C
Platen	180°C

Some problems of gasket material sticking to the moulding member were encountered when using polished stainless steel moulding members. A new set of moulding members were cut from mild steel and chromed. These had a much smoother finish and a higher thermal conductivity. No further sticking problems were encountered.

The centre panel thickness of the gaskets was changed by increasing or decreasing the compression on the moulding turret spring. The film weight and centre panel thickness were as follows:

Film weight	Corresponding centre panel thickness	
300 mg.	0.009''	(230 microns)
240 mg.	0.005''	(125 microns)
200 mg.	0.001''	(25 microns)

EXAMPLE 6

Example 5 was repeated except that the gasket configuration were those of FIGS. 5 to 10, and the caps were 28 mm. RO Coronet aluminium caps (Metal Box Ltd.). The centre panel thickness was set at 0.007 inch (180 microns) and the film weight was increased under these conditions until the smallest mould was filled. Several hundred examples of caps having this profile were run off before the film weight was increased to fill the next smallest mould. In this way it proved possible to obtain good mouldings of gaskets of the FIGS. 5 to 7 configurations at film weights of 140, 200 and 240 mg. respectively. The mouldings of gaskets of the FIGS. 8 to 10 configurations were less well defined.

EXAMPLE 7

Composition C-1 was cold-moulded into vinyl-lacquered crown shells for taste test purposes. Pellets weighing 290 mg. were placed centrally in crowns and heated for 2 minutes at 210°C in an air circulating oven. The crown shells were then removed and cold-moulded on a hand-operated toggle press, the moulding member being at room temperature. (Taste test results showed that C-1 had very good taste characteristics comparable to the best plastisols currently available).

I claim:

1. In a container closure, suitable for a container having a threaded neck, said closure having a top portion, an integral skirt which extends downwardly from the top portion and is adapted to be secured on the container by threads complementary to said threads on the container neck and a gasket within the closure which,

considered in its configuration before the closure is closed onto the container, has a substantially flat central panel and a peripheral portion adjoining said panel at an adjoinment edge, the improvement which comprises a said peripheral portion having a thickness which is at all points greater than the thickness of the central panel and increases continuously, stepwise, or part-continuously and part-stepwise, radially outwards from the adjoinment point to the skirt of the closure, the radial length (x) between the centre of the closure and the adjoinment edge being from 25 to 45% of the maximum internal diameter of the closure (d).

2. A closure according to claim **1** wherein the said increase of thickness is continuous radially outwards to the skirt of the closure.

3. A closure according to claim **1** wherein the peripheral portion of the gasket includes a stepped skirt portion.

4. A closure according to claim **3** wherein the skirt portion consists of a single step adjoining the skirt of the closure.

5. A closure according to claim **3** wherein the said increase of thickness is continuous radially outwards to the skirt portion.

6. A closure according to claim **2** wherein the acute angle (β) between the slope of the peripheral portion and the central panel is from 20° to 80°.

7. A closure according to claim **5** wherein the acute angle (β) between the slope of the peripheral portion and the central panel is from 20° to 80°.

8. A closure according to claim **2**, wherein the increase of thickness has a constant gradient, thereby producing a planar slope to said peripheral portion.

9. A closure according to claim **5**, wherein the increase of thickness has a constant gradient, thereby producing a planar slope to said peripheral portion.

10. A closure according to claim **1** wherein x is 37 to 42% of d.

11. In combination, a container closure selected from closures having an internal thread therein and those which are threadable in situ on the container, a circular top portion to said closure, an integral skirt to said closure extending downwardly from said top portion, and, seated within said closure, a gasket which, considered in its configuration before the closure is closed onto the container, comprises a substantially flat central panel and a peripheral portion adjoining said panel at an adjoinment edge, wherein said peripheral portion has the following configurational characteristics:

1. It has a thickness which is at all points greater than the thickness of said central panel;
2. Its thickness over at least part of its radial length from the adjoinment point to the skirt of the closure increases towards the skirt with a constant gradient, and any remaining part of said peripheral portion consists of a flat part adjoining the skirt and in a substantially parallel plane to the plane of said central panel;
3. Said gradient of the peripheral portion defines an acute angle (β) with said central panel, within the range 20° to 50°;
4. The radial length of any said flat part of the peripheral portion is 5 to 20% of the total radial length of the peripheral portion; and
5. The radial length between the centre of said closure and the adjoinment edge is from 25 to 45% of the internal diameter of the closure.

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