March 25, 1958 A. VISCHER, JR 2,828,045

CLOSURE AND METHOD OF MAKING SAME

Filed Jan. 3, 1955 2 Sheets-Sheet 1

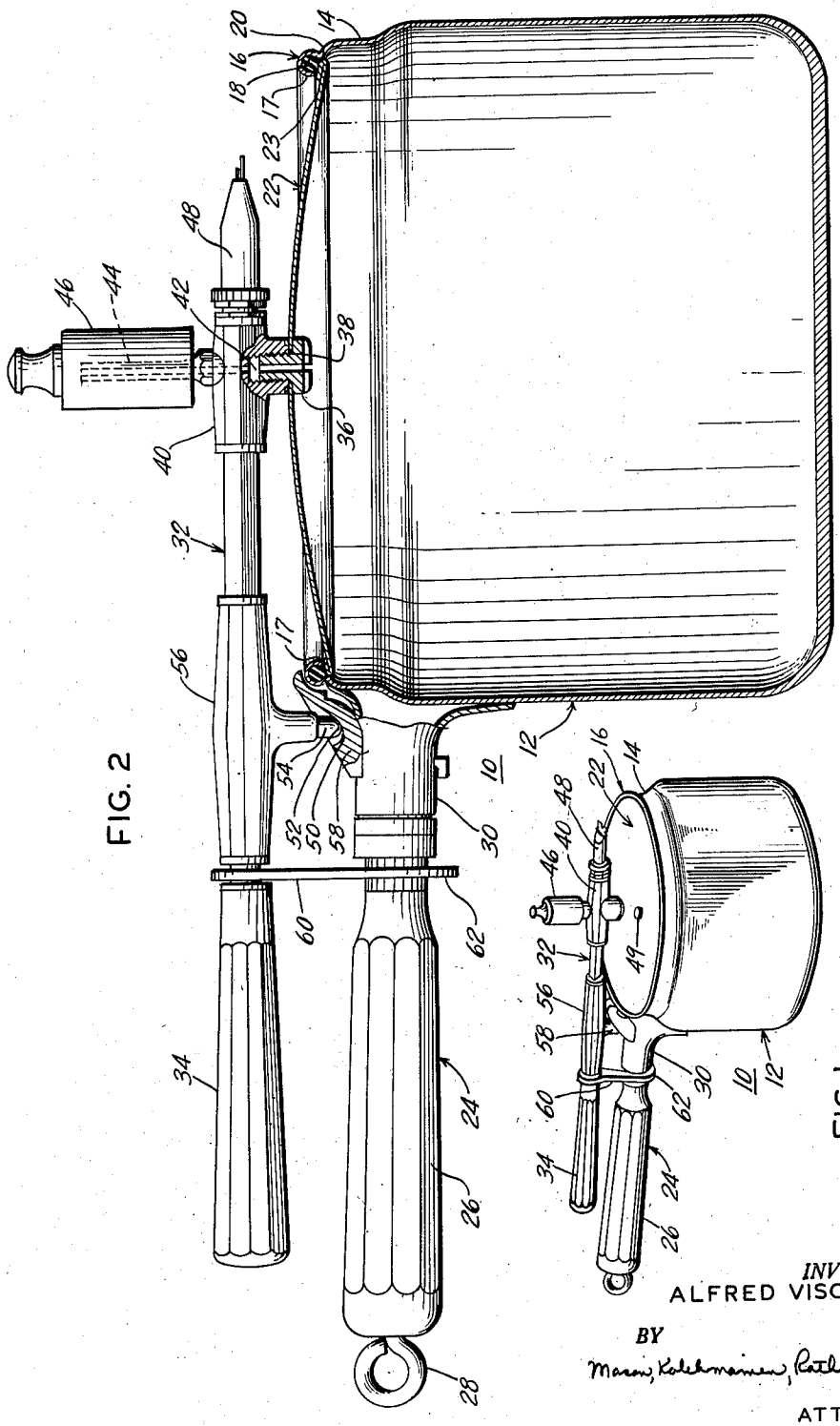

FIG. 2

FIG. 1

INVENTOR.
ALFRED VISCHER, JR.

BY
Mason, Kolehmainen, Rathbun & Wyss

ATTORNEYS

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FIG. 4

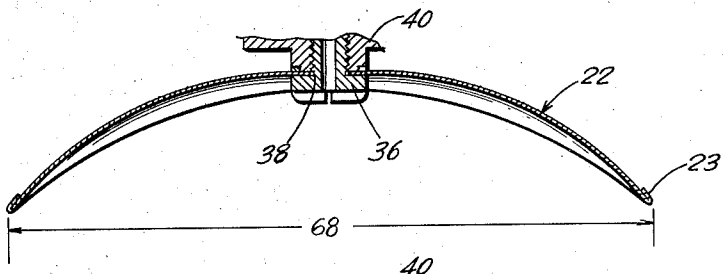


FIG. 5

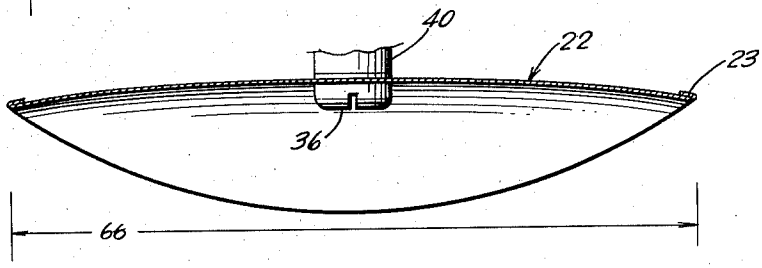
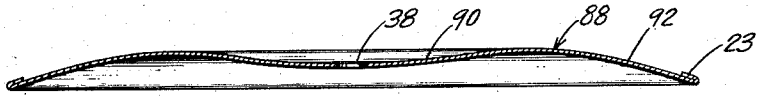


FIG. 6



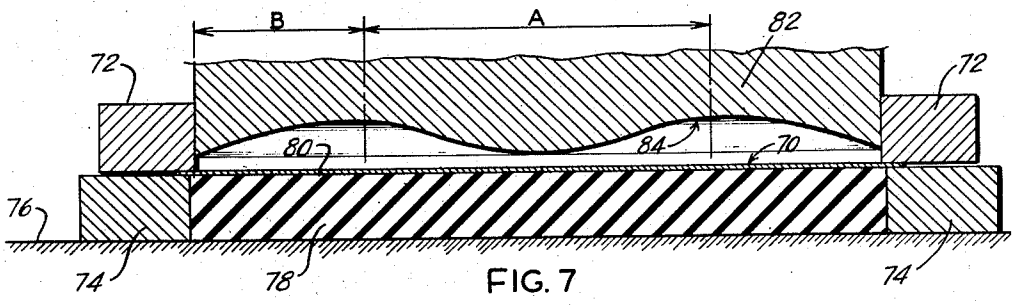
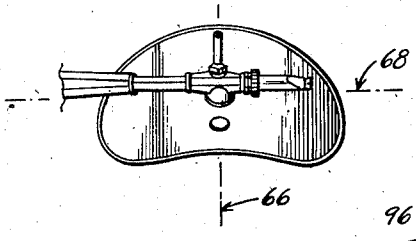


FIG. 7

FIG. 3



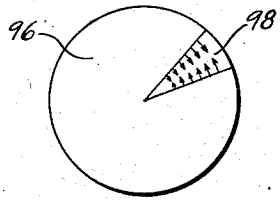


FIG. 9

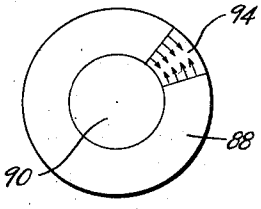


FIG. 10

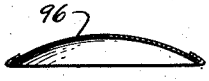


FIG. 8

INVENTOR.
ALFRED VISCHER, JR.

BY
Mason, Kalbaugh, Rathbun & Wyse

ATTORNEYS

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2,828,045

CLOSURE AND METHOD OF MAKING SAME

Alfred Vischer, Jr., Park Ridge, Ill., assignor to Vischer Products Company, Chicago, Ill., a corporation of Delaware

Application January 3, 1955, Serial No. 479,414

6 Claims. (Cl. 220—25)

The present invention relates generally to closures for containers and more particularly to improvements in closures especially adapted for pressure cookers.

There are several types of pressure cookers now on the market. One of these is an improved cooker which has been eminently successful and which is constructed in accordance with the teachings of my Patent No. 2,282,011. As disclosed therein, the closure member, or cover as it will be called hereafter, is of the inside fitting type having a diameter greater than that of the opening of the vessel which it is designed to seal. In order to provide for easy passage of the cover into and out of the inside of the vessel, the cover is made from a flexible resilient material, such as stainless steel and it is warped into a shape such that it can be passed through the opening in the vessel, the shape preferably being one projecting an elliptical form with major and minor axes, of which the latter is smaller than the diameter of the opening in the vessel. The cover can be warped into this shape by internal stressing as disclosed, for example, in my Patent No. 2,454,758. Once inside the vessel, the cover is caused to assume an operative or unwarped shape in which it projects a circular form so that its outer edge is seated into sealing engagement with the rim of the vessel which is provided with a seat defining surface. This change in shape is effected by the application of an upward or outward force to the cover, which, when applied, snaps the cover into its unwarped operative shape and into sealing relationship with the seat on the rim of the vessel.

Pressure cookers and other appliances provided with flexible warped covers of the foregoing type have been widely accepted and used. Some have voiced objections to them on the ground that too much force is required to change the shape from the warped to the unwarped operative shape. This has indeed been a disadvantage, particularly with women, many of whom cannot, except with difficultly, exert sufficient force to close the cover applied to a domestic pressure cooker. This disadvantage has been minimized somewhat by making the covers from thin material. This, however, is objectionable because of the resultant decrease in the pressure which can be safely maintained inside the vessel. Contrariwise, if the cover be made of heavier material so as to withstand higher pressures, then the cover becomes less flexible and harder to change from its warped shape to its unwarped operative shape.

The present invention has for its primary object the provision of a new and improved flexible closure of the above discussed type constructed and arranged so that it can be operated from its warped shape to its operative unwarped shape with the exertion of relatively lighter force.

A further object of the present invention is the provision of a new and improved flexible closure of the character set forth above enabling such covers to be made of sufficiently heavy material to withstand desired pressures and which can be operated from warped to unwarped operative shape with the expenditure of force which can be readily exerted even by users who may not be very strong.

A further and more specific object of the present invention is the provision of a new and improved flexible cover of the foregoing character in which operation of the cover from a first and warped shape to a second and operative unwarped shape is facilitated by limiting the internal stresses in the cover which have to be overcome in going from said first to said second shape, whereby such change in shape can be accomplished more readily. Moreover, specifically, it is an object to construct the cover so that these internal stresses have to be overcome only in a predetermined region of the cover, such as the outer peripheral region of the cover.

A further object of the present invention is to provide a new and improved method of making the covers.

Flexible covers of the type to which this invention relates were generally made, prior to the present invention, by a method comprising stamping a circular blank from a sheet, forming or dishing the blank in a press so that it assumes substantially the shape of a portion of the surface of a sphere, i. e., it has a concavo-convex shape, and then "working" the dished cover to work-harden it and gradually to make it assume a warped shape. The "working" may be accomplished as shown in Patent 2,454,758 according to which the dished cover is centered on a fixed pin and is frictionally engaged at diametrically opposite points at its periphery by rollers rotating in opposite directions on the surface of the cover. Another pair of rollers 90° from the first and engaging the cover near its periphery are slowly moved downwardly and inwardly, thereby to flex the cover along successive angularly incremental diameters as the cover rotates. The resulting cover assumes a shape, when unconstrained by external forces, similar to a portion of a cylindrical surface and having a generally elliptical projected area. As a result, it can be inserted into a vessel and then unwarped by the application of external force, thereby to cause its periphery to assume a circular shape and seat against the circular seat on the cooking vessel.

I have discovered that the reason for the relatively heavy force that is required to change the shape of the cover from its warped to unwarped operative shape, when made as above-described, apparently results from the fact that the internal stresses placed into the cover in working it into the warped shape are present over the entire surface of the cover. These stresses are placed in the material during the warping operation by what may be considered to be an incremental stretching of the material which produces a molecular expansion of the material. The unwarping of the cover, after it has been warped by working, requires the overcoming of all the internal stresses over the entire area of the cover and, consequently, a relatively large force is required, and the heavier the material of the cover, the larger the force that is required.

According to the present invention, the cover is so constructed that the internal stresses which have to be overcome in going from the warped to the unwarped operative position are located in only a portion, such as the outer annular portion of the cover. The central portion is relieved of these stresses so that no substantial force has to be expended in overcoming them. In fact, a reverse stress may even be set up to aid the unwarping force if the stress is not just simply relieved. This relief of stresses in the central portion is provided by initially forming it, prior to warping so that the stresses applied to it during the warping operation cause a permanent change in its shape in such a way that the stresses do not have to be overcome in going from the inoperative warped to the operative unwarped shape. According to one method of construction, this permanent strain relief of

the central part of the cover is provided by taking a cylindrical blank, and instead of forming it into dished or concavo-convex shape as heretofore, it is formed with a reversely dished portion before it is worked into the final warped shape. The reversely dished portion gives the cover at this stage of construction a sort of a double dished shape, there being a central concavo-convex portion and an outer annular convex-concavo part, looking down on the cover. A cross section of the cover in an axial plane simulates a sine curve. When this shape is worked to warp it, strains are developed over the entire area, but those in the central part are to a great extent permanently relieved by that part assuming a different shape and corresponding approximately to a portion of a cylinder, so that, in effect, only an outer annular portion of the cover has to be unwarped when the cover is caused to go into its operative sealing condition or shape. The result is a decidedly advantageous decrease in the force required to unwarp the cover from its warped positions.

Other objects and advantages of the present invention will become apparent from the following description of an illustrative embodiment thereof, in the course of which reference is had to the accompanying drawings, in which:

Fig. 1 is a perspective view, on a reduced scale, of a pressure cooker having a closure or cover constructed in accordance with the present invention, which cover is shown in an "operative" unwarped position in which it effectively seals the pressure cooker;

Fig. 2 is an enlarged vertical cross-sectional view through the pressure cooker shown in Fig. 1, the cooker handle and portion of the cover operating and clamping means being shown in elevation;

Fig. 3 is a perspective view of the cover removed from the pressure cooker and in its warped position or condition in which it can be readily inserted into or removed from the interior of the pressure cooker;

Fig. 4 is a cross-sectional view of the cover, the view being taken on the minor or smaller axis of the cover in its warped or inoperative position;

Fig. 5 is a view similar to Fig. 4 on the major axis of the cover;

Fig. 6 is a diametrically cross-sectional view of the cover in an intermediate stage of production, this being after formation with a reversely curved central portion and prior to warping;

Fig. 7 is a diagrammatic illustration of the apparatus used in forming the cover as shown in Fig. 6 from a circular blank;

Figs. 8 and 9 are diagrammatic cross-sectional and plan views of a prior art cover in an intermediate stage of production and the latter of which depicts the area over which the internal stresses are distributed therein; and

Fig. 10 is a diagrammatic plan view similar to Fig. 9 of a cover made in accordance with the present invention.

In the accompanying drawings, the invention is illustrated as applied to a closure for a pressure cooker but it should be understood that while the invention is particularly adapted for such apparatus, it may be utilized in connection with other kinds of apparatus.

Referring now to Fig. 1, the pressure cooker as a whole is referred to by reference character **10**. It includes a saucepan or pot **12** which may be made of suitable metal such as aluminum or stainless steel, the one shown by a deep drawn stamping of stainless steel. It is generally cylindrical in shape with an upper portion **14** of reduced diameter terminating in an inwardly and downwardly turned bead **16** defining the opening **17** of the saucepan. The bead has a generally circular section and in it is secured a seat defining resilient sealing ring or gasket **18** made of suitable liquid, oil and heat resistant material, such as synthetic rubber or the like. The underside of the ring is exposed to define a substantially plane and circular seat **20** engageable by the closure means or cover **22** when the latter is in what may be termed an operative unwarped shape and which is constructed in accordance with the present invention, as will be described in detail later herein after other structural features have been described so that the invention may be better understood. It should perhaps be noted that the cover is provided with a beaded edge **23** which strengthens the cover and engages the gasket.

A handle **24** is attached to the saucepan in suitable fashion. It includes a wooden or plastic portion **26** through which is passed a securing rod **28** securing portion **26** to a metallic handle socket **30** which may be secured to the saucepan as by spot welding. The particular construction of these elements is of no importance as far as the present invention is concerned and they will not be described in greater detail.

In order to manipulate the cover **22** between its warped position and unwarped operative position, there is attached to it a cover handle rod **32** to the outer end of which is secured a handle **34** adapted to overlie the handle portion **26** and of somewhat smaller size to facilitate manipulation of the cover. The cover is attached to the rod **32** by tubular securing element **36** passing through a central aperture **38** in the cover and threaded into a fitting **40** secured to the cover rod **32**, as by being cast thereon. The fitting is internally chambered, as shown by reference character **42** for connection to an upwardly extending tube **44** upon which is detachably seated a pressure regulator weight **46**. The fitting may have attached to it a pressure gauge or indicator **48** and the cover may be provided with an overpressure relief device such as the resilient plug **49** (see Fig. 2). The structural details of these elements likewise may take various forms as they form no part of the present invention.

The cover handle rod **32** and handle **34** are used to insert the cover into and remove it from the saucepan and likewise to force it into seating and sealing engagement with the previously referred to seat **20** defined by the ring **18**. As will be described later, the cover is insertable into and removable from the interior of the saucepan when it is in warped shape, this being one in which it has a major axis and a minor axis, the latter being less than that of the opening **17** in the saucepan whereby the cover can be inserted into the saucepan. The cover is movable into engagement with the seat **20** and caused to change its shape so as to effect engagement between its outer rim portion and the seat defining ring. This movement and change in shape is effected by the application of an external upwardly directed force to the cover, which force is applied by a pivotal movement of the cover handle and rod. As illustrated, this pivotal movement is about a pivot seat **50** which pivotally receives a pivot defining toe **52** formed at the lower end of a pivot rod **54** secured to the cover handle rod by the cast portion **56**. The pivot seat **50** is shown formed in a seat fitting **58** secured to the upper side of handle socket **30**. The arrangement is thus such that the cover can be placed inside the saucepan after which the pivot toe can be placed in the pivot seat and the cover handle **34** moved toward handle **26**, thereby to move the cover into place and unwarp it. The cover can be held in place by suitable means, such as by a latch **60** rotatably mounted on rod **32** and having a hook shaped outer portion **62** adapted to hook underneath handle **24**.

The warped shape of the cover is best shown in Fig. 3. As illustrated, it has a major axis **66** substantially at right angles with the handle and a minor axis **68** which is substantially in line with the handle **26**. The major axis is greater in length than the diameter of the opening **17** in the saucepan while the minor axis is shorter. Because of this, the cover may be inserted through the opening in the direction of its major axis until the leading edge of the cover abuts against the inner wall of the saucepan. Thereafter, the cover may be tilted so as to bring its edge completely within the saucepan beneath the sealing surface **20**. Then by raising the center of the

cover, it will be guided by the upper reduced diameter portion 14 of the pan into the position in which it is shown in Fig. 2, with its beaded edge 23 in engagement with the seat 20, as shown in Fig. 2. To raise the cover to this position, the toe 50 of the pivot rod 54 is inserted into the seat 52 and the handles 26 and 34 pressed together as heretofore described, thus applying an upwardly directed force to the center of the cover. The cover is then latched in position by swinging the latch hook 60 clockwise into latching position.

When the cover is in the unconstrained shape shown in Figs. 3, 4 and 5, the internal stresses are in equilibrium. After insertion of the closure within the container, the closure is brought into contact with the seat 20 along diametrically opposite portions of its peripheral edge. Thereafter, the handles 26 and 34 are pressed together to raise the central portion of the closure, and the extent to which the diametrically opposite portions of the closure are brought into contact with the seating gasket 20 is progressively increased. As the closure is drawn against the seating gasket, the force required to bring the edge of the closure into contact with the seating surface becomes less and less as the closure approaches its symmetrical unwarped shape in which the sealing is completed and finally the closure moves into its sealing position with a snap action.

The force necessary to operate the cover into operative position in which it is shown in Fig. 2 is reduced by the present invention, thus enabling the cover to be made of desired heavy gauge material and still operated with a force that can be readily exerted by women. This is accomplished by constructing the cover so that internal stresses in only a portion, such as the outer portion, of the cover have to be overcome in going from the inoperative to the operative position. The construction of a cover of this character will now be described in connection with Figs. 6 to 10, inclusive.

Referring first to Fig. 7, it illustrates diagrammatically the apparatus for making the cover from a circular blank 70 of suitable material, such as stainless steel. The blank is securely clamped at its peripheral edge between annular clamping elements 72 and 74, one of which, such as 72, is movable and the other of which may be secured to a bed plate 76. Within clamping element 74 is a circular backing element 78 of resilient material, such as rubber, having a planar upper surface 80 which supports the underside of the blank 70.

The apparatus includes a movable forming die 82 having a work surface 84 configured to form the blank 70 in such manner as to enable the central but not the peripheral portion of the resulting cover to relieve itself of strains when it is warped, and thereby to enable the completed cover to be operated more readily. As illustrated, the work surface 84 of the die 72 includes a central downward concave portion extending over a diameter shown by reference character "A" and a reversely curved convex outer annular portion having a radial length B.

The blank formed by the die 82 has a cross section such as illustrated in Fig. 6, which shows a cover element 88 in an intermediate stage of production, i. e., after initial forming and prior to warping but which has been provided with the peripheral bead 23. The cover has a shape corresponding to the work surface 84 and including a central downward concave part 90 with a diameter A and an outer annular part 92 which is reversely bent and has a radial length B. The partially completed cover shown in Fig. 6 is yet unwarped and unconstrained. It is in the shape of what might be considered a surface of revolution and the bead is in a single plane, horizontal as shown.

To complete the cover, it is "worked" as described heretofore and in Patent 2,454,758. This working stretches the cover over its entire surface by increments to cause a molecular expansion over the entire surface. When this is done the central area changes its shape permanently from concave to convex to relieve that area of major internal stresses, but the stresses remain in the outer annular portion. The relief of stresses in the central portion results in a change in shape from the concave to a convex shape (as viewed in cross section) as shown in Fig. 6 to that shown in Figs. 3, 4 and 5, wherein the central part becomes convex after having been formed in a concave form.

The resulting cover is internally stressed only over the outer annular position, as shown diagrammatically in Fig. 10. This figure shows the cover in an intermediate stage corresponding to that of Fig. 6 and as indicated by reference character 88. After warping, there are practically no internal stresses in the central portion which have to be overcome to change the shape of the cover from its warped to unwarped operative condition. Only the internal stresses in the outer annular portion 92 have to be overcome. These stresses have been diagrammatically illustrated for a small angular portion indicated by reference character 94.

The foregoing is distinctly different from a prior art cover 96 illustrated in an intermediate stage of production in Figs. 8 and 9. The cover 96 is dish-shaped overall. When it is worked to warp it, it is internally stressed over its entire surface, as indicated diagrammatically for the angular portion 98, and, after working to warp the cover, the stresses in the entire cover have to be overcome to change the shape of the cover from its warped position to its operative unwarped position, and this requires a considerably greater force than with a cover constructed in accordance with the present invention.

The central permanently relieved portion may be a fairly substantial part of the cover. For an approximately seven inch cover the central part may have a diameter of about four and one-half inches. The overall height of this cover in its intermediate stage of production as shown in Fig. 6 may be about five-sixteenths inch and the depth of the convex central portion may be about one-eighth inch. These proportions may be varied and they may be different for covers of different size.

A cover constructed in accordance with the present invention can be operated very readily, even by comparatively weak persons, without sacrificing safety. Also heavier covers can be made for greater safety which can be readily operated.

While the present invention has been illustrated and described in connection with an illustrative embodiment thereof, the details thereof are not intended to be limitative of the invention except insofar as set forth in the accompanying claims.

I claim:

1. A closure for a circular opening in a container comprising a flexible resilient dished work-hardenable circular metallic sheet internally stressed over only its outer annular region to assume a warped shape when not subjected to external stresses, and being operable upon application of external stresses into an operative position to close said opening.

2. A closure for a circular opening in a container comprising a flexible, resilient, dished, work-hardenable circular metallic sheet internally stressed over only a substantial annular portion spaced from the center of the sheet so as to assume a warped shape when not subjected to external stresses, and being operable upon application of external stresses into an operative position to close said opening.

3. A method of making a closure for a circular opening from a blank of flexible resilient work-hardenable metal comprising the steps of forming the blank into a generally circular dished shape with a central concavo-convex portion and an outer annular reversely curved portion and then internally stressing the formed shape to cause it to assume a warped shape having a generally elliptical projected area.

4. A method of making a closure for a circular opening from a blank of flexible resilient work-hardenable metallic material comprising the steps of forming the blank into a generally circular dished shape having a central concave portion and an outer annular convex curved portion, the central concave portion having a depth less than the overall height of the dished blank and a diameter approximately half that of the blank, and then internally stressing the formed shape to cause it to assume a warped shape having a generally elliptical projected area with a minor axis less than the diameter of the opening and a major axis longer than that of the opening.

5. A method of making a closure for a circular opening from a blank of flexible resilient work-hardenable metallic material comprising the steps of forming the blank into a generally circular dished shape having a central concave portion and an outer annular convex curved portion, then internally stressing the formed shape to cause it to assume a warped shape having a generally elliptical projected area with a minor axis less than the diameter of the opening and a major axis longer than that of the opening.

6. A method of making a closure for a circular opening from a blank of flexible resilient work hardenable metal comprising the steps of forming the blank with a central portion dished in one direction and an annular concentric portion surrounding said central portion dished in the opposite direction, then internally stressing the blank to cause it to assume a warped shape with the central portion reversing its dish in the opposite direction to relieve the internal stresses in said central portion.

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