PATENT SPECIFICATION

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(54) A SELF-CLOSING CLOSURE UTILIZING A SINGLE DIAPHRAGM

(71) We, KENOVA AB., a Swedish Body Corporate, of 5 Kosterögatan, 21124 Malmö, Sweden, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a self-closing closure unit adapted to be connected to a tube or other container.

Self-closing closures for tubes or the like for dispensing flowable material upon the application of pressure upon the tube have been well known for many years. Continuing efforts have been made to develop such closures which are inexpensive to manufacture and yet absolutely secure for cutting off the flow of material and sealing the tube upon the relaxation of pressure on the tube.

United States Patent No. 2,025,810 which issued on December 31, 1935 to W. Dinnes teaches a self-closing closure using a single diaphragm. In this device a planar diaphragm having an aperture therein is formed to have a rest position surrounding the top of a stem. Upon application of pressure on the tube, the diaphragm is bowed outwardly to open the valve and upon release of pressure the patent states that the diaphragm returns to its rest position. Any small amount of pressure on the tube would tend to deflect the diaphragm outwardly so that the closure is not secure. This closure unit was built to be threaded onto the neck of a tube.

Subsequently, devices were developed in which the closure became an integral part of the tube itself. However, these closure devices were often relatively complicated and expensive to make, have not been secure in their closure of the tube, or have had other operational disadvantages.

It is therefore an aim of the present invention to improve self-closing closures for dispensing tubes or other containers.

With this aim in view, the invention is directed to a self-closing closure unit adapted to be connected to a tube of other container the contents of which may be pressurised, for example by squeezing the container, the closure unit comprising a first member having a peripheral portion and a central upwardly projecting valve stem having an outer surface, and a diaphragm member which includes:

(a) a relatively thick skirt to a base portion of which is connected the peripheral portion of the first member to form the assembled closure unit;

(b) a relatively thin, resilient diaphragm integral with the skirt and extending inwardly towards the valve stem; and

(c) a substantially tubular portion surrounding the stem and spaced therefrom, and terminating in an open lip which makes a close, sliding fit with the outer surface of the stem to form a valve with the stem;

the said diaphragm being formed to have an unstressed concave configuration (as viewed from above) prior to assembly of the closure, whereby assembling of the closure unit causes the valve stem to press against the said lip to close the valve and stress the diaphragm to reduce its concavity, the diaphragm being deformed to a convex configuration to open the valve in response to pressure being applied to the diaphragm by pressurised container contents, the diaphragm being biased by the inherent resilience of the diaphragm member to return to its stressed concave valve-closing position.

It will thus be seen that the diaphragm moves from a concave to a convex position during the operation of the closure to provide adequate discharge area for the substance being dispensed, and returns automatically to a concave position to provide a tight seal when dispensing terminates. The above construction also reduces the cost of the closure unit and improves the closing security of tubes or the like for dispensing flowable material upon the application of pressure to the tube.

Some examples of closure units in

accordance with the invention are shown in the accompanying drawings, in which:

Figure 1 is a cross-section through one embodiment of the closure of the invention inserted into the open end of a tube;

Figure 2 is a cross-section through the embodiment of Figure 1 taken on the line 2-2 in Figure 1;

Figure 3 is a schematic representation of the movement of the diaphragm of Figure 1;

Figure 4 is a cross-section through a second embodiment of the invention;

Referring first to Figure 1, it will be seen that a closure 10 is inserted in the end of a tube 12 having a wall 14, enclosing a flowable substances 15 in the tube. The closure 10 includes a first member 16, called herein a disc, and a diaphragm member 18. As embodied herein, the disc member 16 includes a support 20 and a valve stem 22. The diaphragm member includes a flange or skirt 24, a diaphragm 26 extending inwardly toward the stem 22, and a tubular portion 28.

The support 20 of the disc 16 has a plurality of cut-out areas 21, as shown in Figure 2, for allowing the flowable material dispensed by the tube 12 to be forced through the support member of the disc. Preferably, the support member 20 is formed with three spoke-like members 23 intersecting at the longitudinal axis of the tube on which intersection is supported the valve stem member 22. The support 20 should be of sufficient strength that the valve stem 22 is substantially immovable as the material dispensed by the tube is forced through the support.

As embodied herein, the stem 22 has a circular cross section and extends upwardly beyond the end of the tube, the surface of the stem being preferably gradulated as to its cross ection to form a cone-like surface. Preferably, toward the outer end of the stem, a portion 30 is more steeply graduated, forming a frustum of a cone and at the end of the stem a collar portion 32 is again less steeply graduated, and may be cylindrical.

As embodied herein, the skirt 24 of the diaphragm member 18 is relatively thick and interconnects with the periphery of the support 20 of the disc member 16 to form a closure unit, the unit being inserted into the end of the wall 14 of the tube 12. The resilient diaphragm 26 is formed to be concave (as viewed from above) in the normal rest position of the diaphragm member. The diaphragm 26 in its unstressed concave configuration prior to assembly thereof has a "negative" angle of about 5° to 15° with a plane perpendicular to the longitudinal axis of the tube. The tubular portion 28, integral with the diaphragm 26 and the skirt 26, extends upwardly around and spaced from the stem 22 and terminates in an open circular lip portion 34. Lip 34 makes a close, sliding fit with the outer surface of the stem 22 in the closed position of the closure to form a valve with the stem.

In the embodiment of Figure 1, the tubular portion 28 of the diaphragm member 18 includes a frusto-conical portion 36 extending along and spaced from the stem 22 and a more sharply inclined portion 38 terminating in the lip 34. The lip 34 is shaped to fit snugly into the intersection of the more sharply graduated portion 30 and the collar 32 of the stem 22.

The valve stem 22 is pressed into and against the lip 34 of the diaphragm member 18 to lift the diaphragm 26 about 2° from its unstressed concave position when the diaphragm member and the disc member are assembled to form the closure unit. As a result of the pressure of the stem against the lip 34, the rest position, i.e. the stressed concave position of the diaphragm 26 of the assembled closure forms a "negative" angle of substantially 3° to 13° with a plane normal to the longitudinal axis of the tube, as shown in Figure 3.

When the disc member 16 and the diaphragm member 18 are fitted together in end-to-end abutting relationship substantially no radial pressure is developed thus avoiding any adverse effect on the action of the diaphragm.

Preferably, in the closed position the lip 34 abuts the valve stem at the intersection of the frustum of the cone 30 and the cylindrical portion 32 and is formed to have a surface complementary to the intersection.

The height of the valve stem 22 may vary, as convenient, along with the height of the tubular portion 28 of the diaphragm member for function and aesthetic purposes. In any case, however, the height of the stem and the dimensions of the portions of the diaphragm member should be so inter-related that, upon assembly, the stem lifts the diaphragm member by an angle of about 2° from its formed rest position to its assembled rest position.

As embodied herein, under this arrangement the inherent bias of the diaphragm member forms a secure closure between the lip 34 of the diaphragm member 18 and the collar and frusto-conical portions of the stem 22. Thus, a tight valve seal against leakage or post-dispensing drippage is provided.

It is advantageous for the user of the tube to be able to actuate the valve to dispense the contents of the tube without having to exert undue pressure on the tube. The flowability of the material to be dispensed is a factor which must be taken into consideration.

For free-flowing products, the diameter of the diaphragm 26 may be, for example, 15-35 millimeters (preferably 20-35 mm) and the negative, assembled rest angle of the planar portion of the diaphragm member preferably is about 10°. For pasty products, the corresponding negative angle would be about 12°.

If the diameter of the diaphragm 26 is increased the same lever arm movement is achieved by a smaller negative rest angle. For diameter up to 60 millimeters, assembled negative rest angles down to 5° are normal. For practical purposes, a formed negative angle of 5° to 15° for the diaphragm with a resulting 3° to 13° assembled negative angle, is operative.

The skirt 24 of the diaphragm member 18 may be formed with a bulging ring 40 for snap-fitting into a channel 42 in the wall of the tube. If the closure 10 is snap-fitted into the tube 12, care must be taken in the design of the closure so that excessive radial pressure is not exerted on the diaphragm member 18 so as to affect the closure relationship of the diaphragm member 18 with the stem 22. It is preferred that no substantially radial pressure be applied to the closure member 10 by the wall of the tube and, if radial pressure is developed, such pressure should not exceed that which would cause the negative angle of the diaphragm to move more than ±1°.

It is apparent that the closure 10 may be secured in the tube 12 by means other than snap-fitting, as known in the art, such as by soldering, thermo-setting adherents, or rolling reverse flanges. When the closure unit 10 is secured in the tube 12 by one of these alternative means, substantially no radial forces would normally be applied to the diaphragm member 18.

As embodied herein, the skirt 24 of the diaphragm member 18 should be relatively thick with respect to the diaphragm 26 in order to sustain the radial pressures applied when the diaphragm 26 is forced outwardly by pressure on resilient portions of the tube 12. Also, the diaphragm 26 must be relatively thin to permit it to be moved relatively easily from its closed concave position to its open convex position.

Preferably the diaphragm member 18 is formed by injection moulding plastic material such as polypropylene, but other forms of manufacture and material can be used. The diaphragm 26 has a thickness of about 0.20 to 0.40 mm. It is apparent that the material forming the diaphragm member must be strong enough to avoid rupture while retaining the resiliency to deflect under manual pressure on the tube.

As embodied herein, in the open position of the valve the diaphragm 26 forms a "positive" angle not to exceed 8°, and preferably not to exceed 5°, with a plane perpendicular to the longitudinal axis of the tube. Preferably the positive angle is between 3° and 5°.

With the specifications stated, as embodied herein, the diaphragm 26 will return to its concave rest position when pressure is released on the tube.

The operation of the above-described self-closing closure is such that the action of the diaphragm is practically instantaneous both in opening and in closing the tube. Due to the built-in bias on the diaphragm member, the diaphragm 26 does not deflect until a predetermined value of pressure is reached. This pressure will normally vary, depending on the valve dimensions, from about 20 to 200 millibars.

Upon the application of opening pressure to the tube, there is a relatively large axial movement of the diaphragm from its negative-angle closed position to its positive-angle opened position. This movement lifts the lip 34 away from the stem to an extent that a large dispensing passage for the tube contents is provided between the stem 32 and the interior of the tubular portion 28 of the diaphragm member. The substance being dispensed can flow relatively unrestricted past the stem 22 and through open lip 34.

The valve does not leak when the tube is subject to pressure less than the predetermined value, and also cuts off cleanly the substance being dispensed and provides a tight seal when the pressure on the tube is released and the diaphragm returns to its negative rest position.

In the preferred embodiment of Figure 4 the tubular portion 28 of the diaphragm member 18 is formed with a collar portion 44 having a substantially constant diameter and a sharply inclined portion 46 forming a frustum of a cone and terminating in the lip 34. The planar portion 26 and the collar portion 44 form a stiff hinge where they intersect. In this embodiment a wider passage is provided for the flow of material between the stem 22 and the tubular portion 28 of the diaphragm member 18.

The disc member 16 and the diaphragm member 18 may be very inexpensively formed, for example, of synthetic plastics material by injection moulding as known in the art and may be conveniently assembled as a closure unit by snap-fitting, welding or other known methods.

Although Figures 1-4 illustrate the invention as applied to a tube, the self-closing closure illustrated therein is equally suited for any dispensing container having at least one resilient wall, in which the contents of the container are dispensed through the closure by pressure on the contents of the container by means of the resilient wall.

The positive and negative angles of the diaphragm have been described with respect to the longitudinal axis of the tube. It is apparent that the angles of the diaphragm may also be computed with respect to the longitudinal axis of the stem with the same results.

WHAT WE CLAIM IS:—

1. A self-closing closure unit adapted to be connected to a tube or other container the contents of which may be pressurised, for example by squeezing the container, the closure unit comprising a first member having a peripheral portion and a central upwardly projecting valve stem having an outer surface, and a diaphragm member which includes:

(a) a relatively thick skirt to a base portion of which is connected the peripheral portion of the first member to form the assembled closure unit;

(b) a relatively thin, resilient diaphragm integral with the skirt and extending inwardly towards the valve stem; and

(c) a substantially tubular portion surrounding the stem and spaced therefrom, and terminating in an open lip which makes a close, sliding fit with the outer surface of the stem to form a valve with the stem;

the said diaphragm being formed to have an unstressed concave configuration (as viewed from above) prior to assembly of the closure, whereby assembling of the closure unit causes the valve stem to press against the said lip to close the valve and stress the diaphragm to reduce its concavity, the diaphragm being deformed to a convex configuration to open the valve in response to pressure being applied to the diaphragm by pressurised container contents, the diaphragm being biased by the inherent resilience of the diaphragm member to return to its stressed concave valve-closing position.

2. A closure unit according to claim 1, wherein the valve stem has a longitudinal axis and the diaphragm in its unstressed concave configuration is disposed at an angle of substantially 5° to 15° to a plane perpendicular to the longitudinal axis, and wherein assembly of the closure member reduces the angle by about 2°.

3. A closure unit according to claim 2, wherein the diaphragm in its convex fully open position forms an angle not exceeding 8° with the plane perpendicular to the longitudinal axis of the stem.

4. A closure unit according to claim 3, wherein the said angle formed by the diaphragm in its said fully open position lies within the range of 3° to 5°.

5. A closure unit according to any one of claims 1-4, wherein the diaphragm diameter does not exceed about 60 millimeters.

6. A closure unit according to any one of claims 2 to 4, wherein the diameter of the diaphragm is about 20-35 millimeters and the said angle of the diaphragm in its stressed concave condition is about 10° to 12°.

7. A closure unit according to any preceding claim, wherein the first member is connected to the skirt bottom in end-to-end abutting relationship.

8. A container having a closure according to any preceding claim secured in an opening of the container by means which do not generate radial forces between the container and the closure.

9. A closure unit according to any of claims 2 to 6 or claims 2 and 7 which includes a said container having a tubular opening into which the closure unit fits with a snap action, the arrangement being such that, when the closure unit and the container are assembled, the radial force which the container exerts on the closure unit does not change the said angle of the diaphragm by more than ±1°.

10. A container fitted with a closure unit according to any one of claims 1 to 7, wherein the valve is adapted to open in response to a pressure of about 20-200 millibars on the container.

11. A self-closing closure unit substantially as described herein with reference to Figures 1-3 or Figure 4 of the accompanying drawings.

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1583494 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig. 1

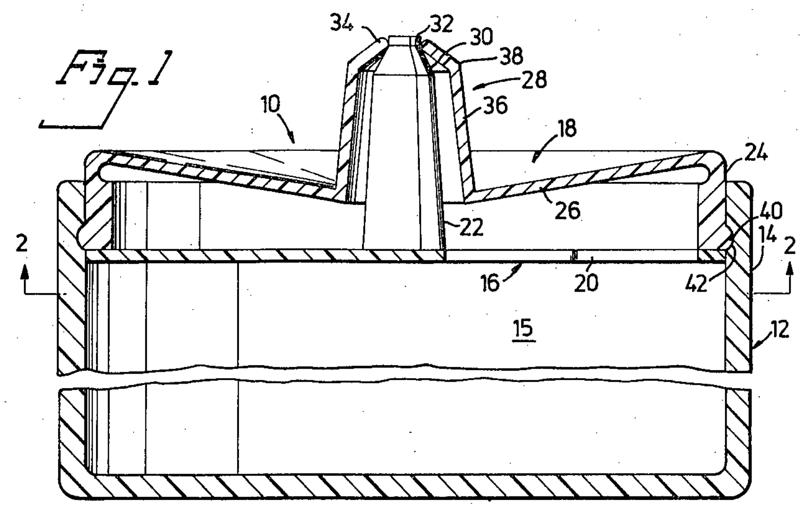
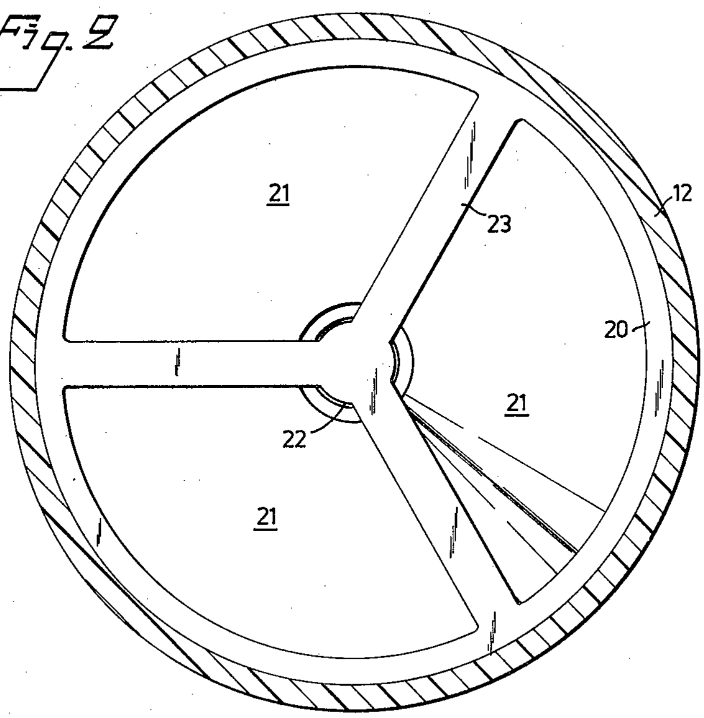


Fig. 2



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2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 2

Fig. 4

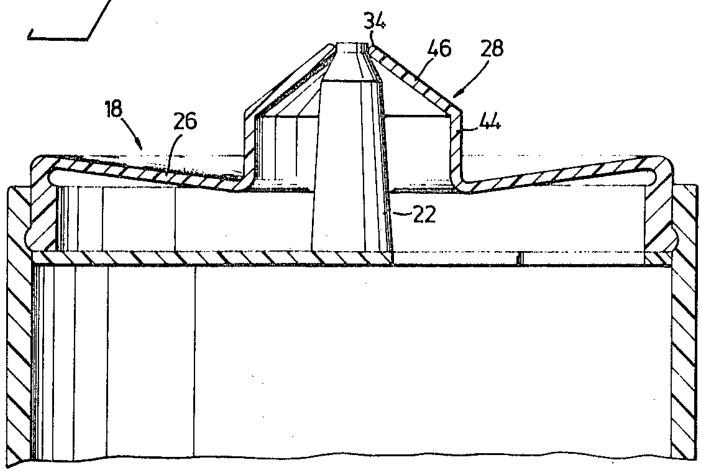

Fig. 3