The present invention relates generally to the art of packaging, and in particular it relates to an improved method for the bottling of liquids in an hermetically sealed state, and to the improved resulting package.

In the packaging or bottling of liquids, it is frequently desirable or necessary to effect positive hermetic sealing of the liquid carrying receptacle. Such sealing is particularly required in cases where the packaged liquid deteriorates on exposure to air, or is of a corrosive, toxic, inflammable or explosive nature. When the liquid is packaged in a glass bottle having a threaded neck and provided with a screw cap, the use of a resilient disc shaped or annular gasket between the cap top and the upper edge of the bottle neck effects a satisfactory hermetic seal as long as the screw cap is tight. However, the seal is broken at the mere loosening of the cap. It has been proposed to cement the gasket to the top of the bottle neck by means of various adhesives. However, such an expedient is highly unfeasible in many cases and possesses numerous drawbacks and disadvantages. The above methods cannot be satisfactorily applied to the sealing of liquid-containing thermoplastic bottles since the occurrence of non-hermetic seals is much too frequent.

It is thus a principal object of the present invention to provide an improved method of packaging.

Another object of the present invention is to provide an improved method for hermetically sealing bottled liquids.

A further object of the present invention is to provide an improved method for hermetically sealing liquids in plastic bottles.

A further object of the present invention is to provide an improved method of hermetically sealing bottled liquids quickly, simply and uniformly effectively.

An associated principal object of the present invention is to provide an improved package.

Another object of the present invention is to provide an improved liquid-containing hermetically sealed plastic bottle.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawings, wherein

Figure 1 is an exploded perspective view of the elements forming the improved package, the bottle being illustrated broken away and partly in section;

Figure 2 is a front view of an induction heating electrode and bottles passing through the field of the electrode, the bottles being illustrated partially broken away;

Figure 3 is a side elevational view thereof;

Figure 4 is an enlarged detailed sectional view of the capped bottle before sealing, taken along line 4—4 of Figure 2; and

Figure 5 is an enlarged detailed sectional view of the sealed bottle taken along line 5—5 in Figure 2.

In a sense, the present invention contemplates the provision of an improved packaging method comprising introducing a material to be packaged into a receptacle of a synthetic organic thermoplastic material provided with a neck portion having an opening surrounded by a peripheral border of upwardly directed convex transverse cross section, applying a sealing diaphragm over said opening and in contact with said border, said diaphragm being formed of a second synthetic organic thermoplastic material compatible and fusible with said first thermoplastic material and having superimposed thereon and in heat transfer relation a metal sheet, applying pressure to said diaphragm in contact with said border to increase the area of contact therebetween, inductively heating said metal sheet to a temperature below the melting point thereof and above the melting points of said plastic materials to effect the fusion of said diaphragm and said neck into an integral unitary body.

Another feature of the present invention is the improved package comprising a relatively heavy walled receptacle formed of a synthetic organic thermoplastic material and having an opening surrounded by a peripheral border and a relatively thin diaphragm of a synthetic organic thermoplastic material having its peripheral border integrally fused to said border surrounding said opening.

Referring now to the drawings, which illustrate a receptacle and closure arrangement, as well as an electrode system by which the present improved method may be practiced, reference numeral 10 generally designates a self-supporting bottle-type receptacle formed of a synthetic organic thermoplastic material, such as a relatively heavy gauge polyethylene, for example of about $\frac{3}{4}$" thickness. Although polyethylene is preferred, other suitable organic thermoplastic materials may be likewise employed, such as vinylidene chloride, vinyl chloride-acetate copolymer, etc.

Bottle 10 includes a neck portion 11 joined to the body of the bottle by a shoulder 12 and of a somewhat greater thickness than the body of the bottle. Neck 11 is provided with a heavy external thread defining a helical bead 13 on the outer face thereof, extending from substantially the top of neck 11 to a point short of the bottom thereof. Opening 14 of neck 11 is surrounded by an upwardly directed border 16 of arcuate convex transverse cross section (see Figure 1), an important structural feature of my invention. While the border 16 is illustrated as being curved, it may be formed of one or more flat surfaces provided that they do not lie in a horizontal plane for any significant portion thereof.

There should be no topmost area present which will permit the accumulation of any liquid. Furthermore, the convexity should be such as to permit the compression of a portion thereof to a planar configuration upon the application of reasonable pressure, as will be developed hereinafter.

In order to effect the hermetic sealing of opening 14, I provide a multi-layer gasket 17 of circular configuration and of a diameter approximately equal to the outer diameter of neck 11. Gasket 17 includes a thin circular sheet or diaphragm 18 of a synthetic organic thermoplastic material which is compatible and fusible with the material forming bottle 10. Diaphragm 18 should be of a fragile nature and preferably formed of the same material as bottle 10, for example polyethylene, and be formed of other materials such as vinyl chloride, vinylidene chloride and polyesters such as polyethylene phthalate (Mylar). Superimposed upon diaphragm 18 is a thin metallic intermediate circular disc 19 preferably formed of aluminum or similar material, and in heat transfer relationship with diaphragm 18. A cushioning member 20, also in the form of a circular disc, is superimposed upon metal disc 19 and is formed of a suitably re-
slient material such as paper or the like. Discs 18, 19 and 20 may be permanently or temporarily secured to each other by any suitable adhesive. In its preferred form, the material forming the multi-layer gaskets is supplied as a sheet and the gaskets punched therefrom.

A screw cap 21 is provided, of non-metallic material, such as a thermostatic organic plastic material, and of conventional construction, including a top wall 22 and a depending peripheral collar 23 provided on its inner face with a thread 24 which mates with thread 13 on bottle neck 11. Gasket 17 nests in the screw cap 21 and the layer 20 extends the under surface of the top wall 22 thereon.

In order to effect a hermetic seal between gasket 17 and the opening into bottle 16, there is provided a solenoid electrode 26 which, in the preferred form, includes three turns of a metal tubing, such as copper, each turn including a pair of lower transversely spaced longitudinal arms and upper longitudinally spaced transverse arms to provide a longitudinally extending channel shaped electrode having a downwardly directed trough so as to provide a zone of high intensity magnetic field.

The ends of the solenoid electrode 26 are provided with coupling members 27, and the electrode is connected to a source (not shown) of circulating, cooling water. The terminals of the electrode 26 are also connected to a source of high frequency inductive heating current in the usual manner. A frequency of 450 kilocycles per second and a power source having a capacity of about 2½ kilowatts has been found to be highly satisfactory. An endless belt having a longitudinally extending horizontal run 28 is disposed below the electrode 26.

In practicing the improved method of the present invention, a material to be packaged, such as a liquid, is introduced into bottle 10 and screw cap 21 carrying gasket 17 is applied to the neck of the bottle. The cap 21 is tightly screwed into position to effect a deformation or flattening of the upper end of the border 16, as illustrated in Figure 4 of the drawing. Thereafter, the capped bottle is placed on conveyor 28 and transported therealong so that the upper portion of the cap neck of the bottle passes through and along the electrode trough in the high frequency magnetic field of high intensity. As a result, metal disc 19 is heated by induction to a temperature sufficiently high to soften and melt the thermoplastic diaphragm 18 as well as the abutting section of the bottle 16. A fusion is effected between the peripheral border of diaphragm 18 and neck 16 of bottle 10, as illustrated in Figure 5 of the drawings, to provide an integral mass. It should be noted that, upon the melting and fusion of diaphragm 18 and bottle 16, the area of contact increases and there is a slight release of the downward pressure of the screw cap 21. The dimensions of diaphragm 18 and metal disc 19, as well as the intensity of the magnetic field, the time of exposure thereto and the pressure on the screw cap, are highly important and are dependent upon the materials employed and the dimensions of the bottle.

The improved method has been successfully employed under the following conditions. There were employed thin walled blown polyethylene bottles having necks with a 1" diameter opening and upwardly directed borders substantially as illustrated in the drawing. The bottle wall thickness was approximately 5/64 inch and the neck wall thickness approximately 1/16 inch. The gasket 17 includes a diaphragm 18 of 4 mil polyethylene, a disc 19 formed of 1 mil aluminum, and a cushioning disc 20 formed of 50 lb. kraft paper. The cap was screwed on the neck of the bottle with a torque of approximately 25 to 40 inch pounds. As a result, the top of the cushion bottle 16 was compressed to a relatively flat annulus of 3/32" width. The bottle was then placed on conveyor 28 and transported along electrode 26, being exposed to the high frequency magnetic induction field for a period of one second. The high frequency magnetic field raised the temperature of aluminum disc 19, which

effected the fusion of the peripheral border of diaphragm 18 to the bottle neck 11, forming a zone of integral material at the area of contact which increased by reason of the softening of the material and the pressure of the screw cap to a width of about 5/64 inch.

It is important to note that disc 19 should be raised to a temperature below its melting point but above the melting point of the diaphragm 18. Exposing the disc 19 to the induction field for too long a time would result in the melting of the disc 19 and for too short a time would not effect the proper fusion between the diaphragm 18 and the bottle neck 11. It should be noted that if diaphragm 18 is too thin, it would rupture before an adequate sealing is effected, and if it is too thick there is not sufficient heat transfer to bottle 16 to effect proper fusion thereof with diaphragm 18. Furthermore, if the metal disc 19 is too thin, it would melt before proper fusion is effected and if it were too thick the resulting heat generated could be excessive.

After the bottle has passed under electrode 26, cap 21 is slightly loosened by reason of the release of pressure resulting from the fusion of diaphragm 18 to bottle neck 11.

In employing the method above set forth, caps 21 were tightened onto the bottle necks by conventional automatic means. The bottles sealed by the method hereof are hermetically tight, and no defects were noted although large numbers of bottles were continuously sealed in the manner above set forth. In order to gain access to the contents of the sealed bottle, it is necessary to puncture or fracture the diaphragm 18. It cannot be readily separated from the bottle neck 11 since it forms an integral part therewith.

While there has been described and illustrated preferred embodiments of the present invention, it is apparent that numerous alterations and omissions may be made without departing from the spirit thereof.

I claim:

1. An improved packaging method comprising introducing a material to be packaged into a receptacle of synthetic organic thermoplastic material, provided with a neck portion having an opening surrounded by a peripheral border of upwardly directed, convex, transverse cross-section, applying a sealing diaphragm over said opening and in contact with said border, said diaphragm being formed of a second synthetic organic thermoplastic material compatible and fusible with said first thermoplastic material, and having superimposed thereon and in heat transfer relationship therewith a metal sheet, applying pressure to said diaphragm in contact with said border to distort the interface and to increase the area of contact therebetween, inductively heating the metal sheet to a temperature below the melting point thereof and above the melting points of said plastic materials thereby to effect fusion of said diaphragm and said neck into an integral unitary body.

2. An improved packaging method comprising introducing a material to be packaged into a receptacle of synthetic organic thermoplastic material, provided with a neck portion having an opening surrounded by a peripheral border of upwardly directed, curved, convex, transverse cross-section, applying a sealing diaphragm over said opening and in contact with said border, said diaphragm being formed of a second synthetic organic thermoplastic material compatible and fusible with said first thermoplastic material, and having superimposed thereon and in heat transfer relationship therewith a metal sheet, applying pressure to said diaphragm in contact with said border at least partially to flatten said convex border to increase the area of contact between said diaphragm and said border, thereafter, inductively heating the metal sheet to a temperature below the melting point thereof and above the melting points of said plastic materials thereby to effect fusion of said diaphragm and said neck into an integral unitary body.
3. An improved packaging method comprising introducing a material to be packaged into a bottle formed of a synthetic organic, thermoplastic material and provided with an externally threaded neck portion surrounded by a peripheral border of upwardly directed, convex, transverse cross-section, applying a sealing diaphragm over said opening and in contact with said border, said diaphragm being formed of a second synthetic organic thermoplastic material and having superimposed thereon and in heat transfer relationship therewith a metal sheet, applying a screw cap to said threaded neck and tightening said screw cap to apply pressure to said diaphragm in contact with said border at least partially to flatten said convex border to increase the area of contact between said diaphragm and said border, thereafter, inductively heating said metal sheet to a temperature below the melting point thereof and above the melting points of said plastic materials to effect the fusion of said diaphragm and said neck into an integral unitary body.

4. An improved packing method in accordance with claim 3, wherein the neck of said bottle is continuously moved through a high frequency magnetic field to effect the inductive heating thereof.

5. The improved method in accordance with claim 2, wherein said receptacle and sealing diaphragm are formed of polyethylene.

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