

[54] CLOSURE MEMBER AND METHOD
FOR CLOSING CONTAINERS

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[73] Assignee: said Heller, by said Leatherman

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[52] U.S. Cl.53/42, 53/329, 156/69,
156/272, 219/10.53

[51] Int. Cl.B65b 7/28

[58] Field of Search53/42, 329; 156/69, 272;
219/10.53

[56] References Cited

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3,460,310 8/1969 Adcock et al.53/329 X

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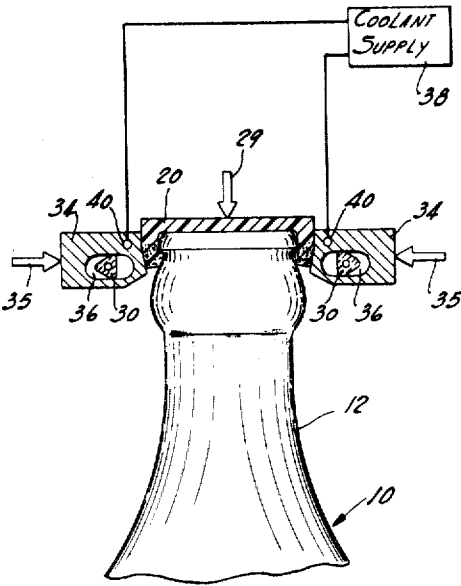
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Primary Examiner—Travis S. McGehee
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[57] ABSTRACT

A technique for capping a container utilizes a thermoplastic cap having integral means for heating portions thereof by means of a high frequency magnetic field. The steps of the method include placing the cap on the container, subjecting the heatable portions of the cap to a high frequency magnetic field to soften these portions, bringing the softened portions of the cap into engagement with the container, and cooling the cap to removably affix the cap to the container.

16 Claims, 8 Drawing Figures



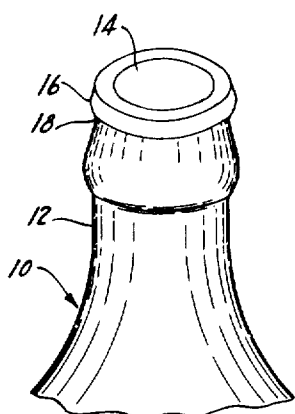


Fig. 1

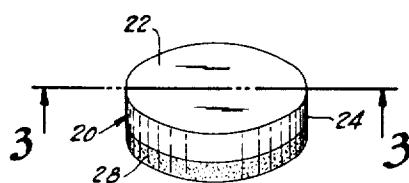


Fig. 2

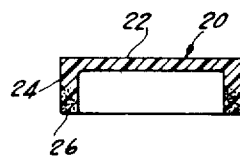


Fig. 3

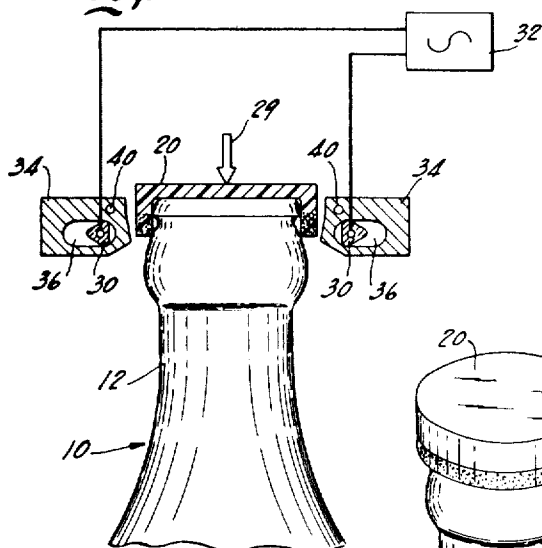


Fig. 4

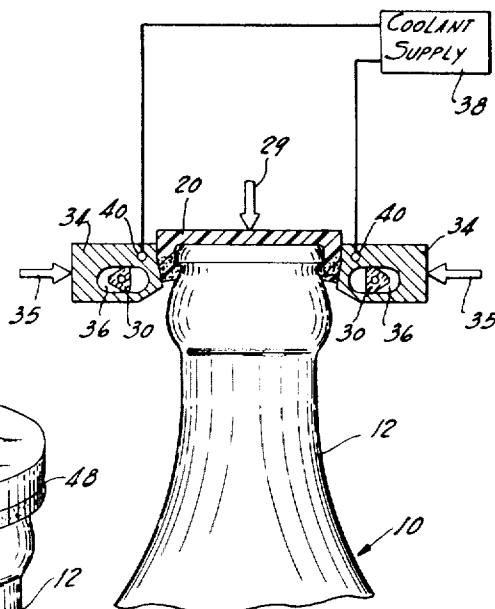


Fig. 5

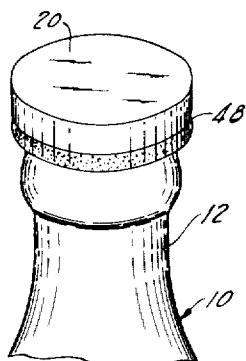


Fig. 8

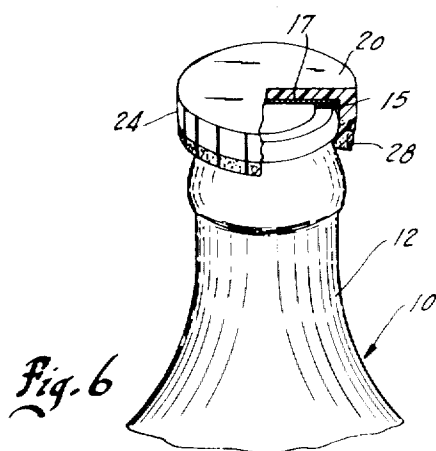


Fig. 6

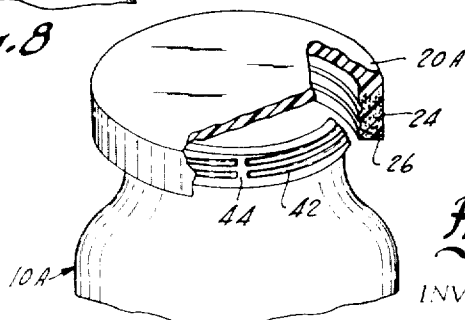


Fig. 7

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CLOSURE MEMBER AND METHOD FOR CLOSING CONTAINERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for effecting closure of a container, such as a bottle or jar, and more particularly to a method and means utilizing induction heating.

2. Description of the Prior Art

It has been a general practice for many years to close or cap bottles, such as soft drink or beer bottles, with a crimpable or deformable metal cap, commonly termed a crown seal or closure. These metal caps include a central sealing portion which spans the opening of the bottle and from which depends a deformable skirt for engaging a bead around the opening of the bottle to affix the cap to the bottle.

While the general use of crown seals indicates the satisfactory nature of such sealing techniques, several problems and disadvantages are attendant crown closure capping methods. Some of these drawbacks reside in the closure itself. Crown closures are usually formed of a ferrous material, such as sheet steel, which has a tendency to rust over a period of time unless coated with a protective finish, resulting in a breaking of the seal and/or contamination of the contents of the bottle. In order to insure a satisfactory, gas-tight seal, it is necessary to utilize a plastic liner or a cork and foil liner inside the metal cap. In order to place information on the top of the cap, it is necessary to first print and then varnish the cap top. These last two considerations substantially increase the cost of the common crimped metal closure.

The advent of plastic bottles renders more critical another shortcoming of the conventional crown closure. With plastic bottles, the crimping force applied to the cap skirt may be of a magnitude sufficient to cause damage to the plastic bottle and make formation of a seal impossible. The damage may or may not be immediately evidenced, with the result that subsequent failure of the seal may occur at a time later in the use of the sealed container. It is difficult to strengthen the opening of a plastic bottle because the outer dimension is fixed by the size of conventional bottle handling and capping machines and the inner dimension must be sufficiently large as to permit removal of the contents.

Even with glass bottles, the force needed to effect the crimping of the crown seal skirt has, on occasion, resulted in chipping along the lip of the bottle.

Because of the shortcomings of crimped metal caps, attempts have been made to utilize other materials, notably plastic, in closure devices. Many of these attempts have involved the use of plastic materials which are shrinkable by the application of moisture or heat. See, for example, U.S. Pat. No. 2,608,334 to Knocke, and U.S. Pat. No. 2,885,105 to Heyl et al. However, when sealed, internal stresses are present in shrinkable caps which are undesirable and may, in time, result in the destruction of the cap. These stresses are, in addition to the other stresses placed on the cap when in use, such as the gas pressure in carbonated beverage containers.

As a result of the faults of shrinkable caps, attention has turned to the development of thermoformable closures. One such technique completely heats a plastic

blank and then forms it around the lip of the closure. See U.S. Pat. No. 2,447,690 to Ekstedt et al. However, the high strength plastic necessary as a material for bottle closures invariably has a high softening temperature so that such a process tends to be inefficient in terms of processing speed because of the long heating time required. Further, close control of the process is rendered difficult and degradation and decomposition of the cap material may result.

U.S. Pat. No. 2,451,273 to Bright, shows a capping process in which a preformed cap is utilized and in which only the edges of the cap skirt are heated by infrared means. Such a method lessens the heating interval to some extent. However, the possibility of degradation and decomposition of the cap is increased because of the small area exposed to the infrared source. Further, quality control is difficult to maintain because the point of heating is removed from the point of application of the cap to the bottle.

Similar problems attend the use of other closure devices, such as threaded caps.

SUMMARY OF THE PRESENT INVENTION

It is therefore the object of the present invention to provide an improved means and method of closing containers which obtain high quality, high strength, rapid sealing of containers of conventional construction.

It is a further object of the present invention to provide an improved method of closing containers which provides close, selective control of temperature conditions occurring during the processing, which avoids degradation and decomposition of the closure material, and which avoids the necessity of preheating the closure member.

It is another object of the present invention to provide an improved thermal closing method which is suitable for use with high strength, high softening temperature plastics.

A further object of the present invention is to provide a container sealing process which reduces the loss of gas pressure in the container contents to a minimum.

It is yet another object of the present invention to provide a container sealing process which is adaptable to automatic operation and suitable for use in connection with existing bottling machinery.

It is a still further object of the present invention to provide a container sealing process which exerts a minimum of pressure on the container, thereby permitting use of the process with low strength plastic containers.

Another object of the present invention is to provide a container closure which is openable, not subject to deterioration such as rusting, non-contaminating to the container contents, capable of effecting a seal without a liner or other similar means, low in cost, and suitable for receiving indicia.

Briefly, the present invention comprises a technique for capping a container opening with a thermoplastic cap. The cap has a sealing portion for spanning the container opening to seal the same, and a skirt for engaging the opening lip or threads on the container for removably affixing the cap across the opening. The skirt of the cap includes a susceptor, typically iron oxide particles, which is inductively heatable responsive to exposure to a high frequency magnetic field.

The method may include the initial steps of forming a cap, as described above, and further comprises the steps of placing the cap so formed on the container with the sealing portion of the cap spanning the opening, applying pressure to the sealing portion to effect a seal of the container opening, subjecting the skirt of the cap, which defines a preformed retaining means of a substantially continuous full density thermoplastic material to a high frequency magnetic field to heat the susceptor by magnetic hysteresis effect and soften only the skirt of the thermoplastic cap to a deformable state and maintaining the integrity of the softened affixing portion, bringing the softened skirt of the cap by deflection thereof into engagement with the lip on the container to mechanically seal the container, and cooling the skirt to removably affix the cap to the container.

BRIEF DESCRIPTION OF THE DRAWING

For a more complete understanding of the nature and objects of the invention, reference may be had to the accompanying drawing in which:

FIG. 1 is a perspective view of an unsealed container which may be sealed by the means and method of the present invention;

FIG. 2 is a perspective view of a container cap constructed in accordance with the present invention;

FIG. 3 is a cross sectional view of the cap shown in FIG. 2 taken along lines 3—3 of FIG. 2;

FIG. 4 is a somewhat schematic perspective view showing an initial step in the process of the present invention;

FIG. 5 is a somewhat schematic perspective view of a subsequent step in the process of the present invention;

FIG. 6 is a perspective view showing a container capped in accordance with the present invention, the cap being broken away to reveal a modification thereof;

FIG. 7 is a partially broken away perspective view of the container cap of the present invention in use with a different type of container; and

FIG. 8 is a perspective view showing a container capped in accordance with the present invention, the cap being modified to include a frangible portion.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is suitable for the closing and sealing of containers of many different types. Thus, while not limited thereto, the process is illustratively shown in connection with bottle 10 of the type commonly used in the beverage industry. Bottle 10 contains neck 12 which terminates in opening 14 sealable by the means and method of the present invention. Opening 14 is surrounded by bead or lip 16, formed in part by recess 18. Bottle 10 may be formed of glass, plastic or other suitable substances.

As shown in FIGS. 2 and 3, cap 20 includes a central flat disc portion 22 suitable for spanning neck 12 and opening 14 to close or seal the latter. Sealing means, such as ridges, or grooves, may be placed on the underside of central portion 22 for coaction with the portion of lip 16 adjacent opening 14. If desired, a conventional plastic or cork and foil liner may be attached to the underside of central portion 22. In many cases, and depending on the type of thermoplastic material utilized

for cap 20, such grooves or other sealing means are not needed.

A skirt 24 depends from the periphery of central portion 22. The length of skirt 24 is such that the lower or terminal portion 26 of skirt 24 is generally opposite groove 18 of bottle 10 when cap 20 is placed on the bottle.

It has been found preferable to utilize a high strength, high softening temperature plastic in the formation of cap 20, thereby to resist gas pressure generated in bottle 10 and to permit pasteurization of the bottle contents. Polycarbonate, nylon, and high softening temperature polyethylene and polypropylene have been found to be both suitable for forming cap 20 and low in cost. The caps may be formed in numerous ways, as by molding, or stamping a circular blank and hot or cold forming skirt 24. Embossed and other indicia may be easily placed on top of cap 20 during the forming process and the caps may be colored by adding colored particles and dies to the plastic material and by other techniques, such as coextrusion.

At least the terminal portion 26 of skirt 24 contains a susceptor suitable for generating heat upon exposure to a high frequency magnetic field. This is preferably accomplished by pigmenting or loading certain particles 28 into the terminal portions 26 of skirt 24, or into the entire cap. Uniformly dispersing the particles in terminal portion 26 has been found desirable. Because of the submicron size possible, it is preferable to introduce ferromagnetic oxide particles of a class consisting of Fe_2O_3 , Fe_3O_4 , and CrO_2 into terminal portion 26. Gamma Fe_2O_3 and CrO_2 have been found to be particularly useful. The aforesaid particles may typically range in size from submicron to about 20 microns. Particles having a size range of from 0.01 to 0.5 microns have been found to be highly satisfactory for use in the present invention.

The amount of such particles necessary to produce a desired heating in terminal portion 26 depends to some extent on both the type of plastic and the type of particle utilized. However, rarely has it been found necessary to use more than 30 percent pigment by weight with respect to the thermoplastic material associated therewith and heatable thereby and the use of 10 percent by weight is common.

The particles may be introduced into the cap during the molding process in the case of molded caps or during formation of the blanks in the case of stamped caps.

The high frequency magnetic field necessary to obtain heat in particles 28 is generated by coil 30, commonly termed an induction heating coil. Coil 30 is energized by a high frequency alternating current power supply 32 so as to generate a high frequency magnetic field in the interior of the coil. Magnetic fields having frequencies from as low as 0.45 megahertz on up into the microwave range have been found useful. A frequency range from 0.5 to 5 megahertz has produced highly desirable results.

Coil 30 may be mounted in a plurality of coil supports 34 which also serve as molding dies for cap 20. For this purpose, coil 30 is positioned in slots 36 in coil supports 34 so as to permit the coil supports to be reciprocated in a radial direction toward and away from the center of coil 30. Either or both of coil 30 and coil supports 34 may be cooled by coolant circulated

by coolant supply 38. Coolant supply 38 is shown as connected to channels 40 in coil supports 34 for this purpose in FIG. 5.

In the performance of the process of the present invention, cap 20 is placed across opening 14 of neck 12 so that the disc portion 22 of cap 20 seals bottle 10. See FIG. 4. Cap 20 is preferably held over opening 14 by downwardly exerted pressure, as shown by the arrow 29, to retain bottle 10 in the sealed state throughout the entire capping process, thereby to prevent contamination and retain the carbonation of the container contents. With the disc portion so located, the treated terminal portion 26 of skirt 24 is positioned opposite recess 18.

Induction heating coil 30 is placed around the terminal portion 26 of skirt 24 and energized by high frequency alternating current source 32. The energization of coil 30 creates a high frequency magnetic field which generates heat in susceptor particles 28 causing the thermoplastic material in the terminal portion 26 of skirt 24 to soften. The uniform dispersion of particles 28 causes uniform heating of terminal portion 26. When skirt 24 has softened to the desired degree, magnetic coil 30 may be disconnected from high frequency source 32 to stop heat generation in terminal portion 26. Because of the efficiencies obtainable with the technique of the present invention, only a short period of time is required to obtain the necessary softening of skirt 24. Times on the order of 0.1 second are common. When cap 20 is used on plastic bottles, the temperature of terminal portion 26 may remain below the sealing temperature of the plastic bottle in order to permit removal of cap 20. The close control of temperature which may be obtained by the selection, amount, and size of particles 28 and the strength and duration of the magnetic field created by magnetic coil 30 insures that no degradation or decomposition of the thermoplastic material of cap 20 will occur.

Coil supports 34 are then moved inwardly, as shown by arrows 35, to laterally press the now deformable skirt 24 into contact and mechanical abutting interengagement with neck 12 at recess 18. The inner surfaces of coil supports 34 may be formed so as to develop a bead in terminal portion 26 which engages recess 18 to secure cap 20 on bottle 10. Because of the readily deformable condition of skirt 24, only a slight amount of pressure is necessary to secure cap 20 on bottle 10, thereby permitting the use of the process on plastic containers. Skirt 24 may be simultaneously subjected to heating and pressure if desired. Coolant may be circulated through channels 40 from coolant supply 38 to cool coil supports 34 and cap 20. When skirt 24 of cap 20 has been cooled to the rigid state to set the affixing portion in the deflected position, coil supports 34 are retracted, the pressure indicated by 29 is removed, and the capping operation is complete. The capped bottle is shown in FIG. 6 which also shows cork gasket 15 and foil liner 17.

Cap 20 may be removed by removing terminal portion 26 from recess 18, with or without rupturing skirt 24. A conventional crown seal bottle opener may be used for this purpose. Depending on the properties of the plastic used to form cap 20, the cap may be used to reclose container 10. For this purpose, a resilient plastic may be used in cap 20 so that the cap may be

replaced across opening 14 and terminal portion 26 reinserted in recess 18 by a downwardly exerted force such as 29.

FIG. 8 shows a modification of cap 20 in which a groove 48 is formed in skirt 24 immediately above terminal portion 26. Coil supports 34 may be formed with a suitable projection for forming groove 48 as skirt 24 is pressed onto neck 12. In the alternative, groove 48 may be preformed in cap 20. Groove 48 may be located such that skirt 24 can be broken by inserting a bottle opener in the groove, thereby permitting removal of cap 20. Or, the depth of groove 48 may be made such that skirt 24 may be broken by grasping disc portion 22 and raising or twisting it with respect to terminal portion 26. Terminal portion 26 may be sealed to container 10 to facilitate removal of disc portion 22. In the case of a plastic container, this may be accomplished by heating terminal portion 26 to heat sealing temperatures during the capping operation. Other types of break open seals may, of course, be designed.

It will be appreciated that the present invention is suitable for use with containers having other types of retaining means besides recess 18. As noted immediately above, in the case in which terminal portion 26 is heat sealed to the container, the retaining means may simply comprise the portions of the container adjacent opening 14. The invention may also be used with containers having threads 42 adjacent opening 14, as shown in FIG. 7. Cap 20a of FIG. 7 is formed in the same manner as cap 20 in FIGS. 2 and 3. The steps of the capping process proceed in the same manner as the steps of the capping process described above, with the heated and deformable portion 26 of skirt 24 being pressed onto threads 42 of container 10a to form threads on the interior of skirt 24. Cap 20a may be removed by unscrewing it off neck 12 of container 10a. The container may be reclosed by replacing cap 20a. If desired, interruptions 44 may be placed in threads 42 so that skirt 24 is pressed into the interruptions during the capping process to form lugs which engage in the interruptions. These lugs prevent accidental loosening or removal of cap 20a from container 10a.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. A method of closing a container opening with a thermoplastic cap, said cap having a sealing portion for spanning the opening to seal the same and an affixing portion for engaging a preformed retaining means on said container opening for removably affixing the cap across said opening, at least the affixing portion of the cap being of a substantially continuous full density thermoplastic material having means incorporated therein for heating said affixing portion by magnetic hysteresis effect of a high frequency magnetic field, said method comprising the steps of:

placing the cap on the container with the sealing portion spanning the opening and the affixing portion in spaced relation to said retaining means;
applying pressure to said closure to mechanically seal the container;
subjecting the affixing portion of the cap to a high frequency magnetic field by magnetic hysteresis

heating to soften only the affixing portion of the thermoplastic cap to a deformable state and maintaining the integrity of the softened affixing portion, said temperature essentially corresponding to the temperature sufficient to soften the affixing portion and permit the deflection of the affixing portion;

pressing the softened affixing portion of the cap laterally by an outer force applied to the full density affixing portion and thereby deflecting the softened affixing portion toward and into mechanical abutting interengagement with the preformed retaining means on the container; and

cooling the affixing portion to set the affixing portion in the deflected position and removably affix the cap to the container.

2. The method of claim 1, suitable for closing a thermoplastic container having a predetermined heat sealing temperature wherein the step of heating the affixing portion of the cap is further defined as subjecting the affixing portion of the cap to a high frequency magnetic field to heat the affixing portion of the thermoplastic cap to a temperature less than the heat sealing temperature of the container.

3. The method of claim 1, further comprising the initial steps of:

forming a cap of thermoplastic material to include a sealing portion for spanning the container opening to seal the same and an affixing portion for engaging the retaining means on the container opening; and

dispersing, in at least the affixing portion of the cap, particulate means heatable as a result of magnetic hysteresis upon exposure to a high frequency magnetic field.

4. The method of claim 3, suitable for closing a thermoplastic container having a predetermined heat sealing temperature including the step of selecting a thermoplastic material for the cap having a heat softening temperature below the heat sealing temperature of the thermoplastic container and wherein the step of heating the affixing portion of the cap is to a temperature less than the heat sealing temperature of the container.

5. The method of claim 1, including the step of placing a gasket means between the sealing portion of the cap and the opening of the container, said gasket means defining a mechanical pressure seal.

6. The method of claim 1, further defined as subjecting the affixing portion of the cap to a magnetic field having a frequency of from 0.5 to 5 megahertz.

7. The method of claim 3, further defined as subjecting the affixing portion of the cap to a magnetic field having a frequency of from 0.5 to 5 megahertz.

8. The method of claim 3, further defined as dispersing in at least the affixing portion of the cap, ferromagnetic particles selected from a class consisting of Fe_2O_3 , Fe_3O_4 and CrO_2 .

9. The method of claim 8, further defined as dispersing in at least the affixing portion of the cap, ferromagnetic particles selected from a class consisting of Fe_2O_3 and CrO_2 .

10. The method of claim 3, further defined as dispersing in at least the affixing portion of the cap, particulate means having a particle size ranging from submicron to 20 microns.

11. The method of claim 3, further defined as uniformly dispersing the particulate means in at least the affixing portion of the cap.

12. The method of claim 3, further defined as forming the cap from polycarbonate material.

13. The method of claim 3, further defined as forming the cap from a resilient material so as to permit reclosure of the container with the cap subsequent to initial removal of the cap.

14. The method of claim 3, further defined as forming the cap with a frangible portion permitting removal of the cap from the container.

15. The method of claim 14, suitable for closing a thermoplastic container further defined as further subjecting the affixing portion of the cap to a high frequency magnetic field to heat the affixing portion of the thermoplastic cap to a heat sealing temperature to seal the affixing portion to the container.

16. The method of claim 14, suitable for closing a thermoplastic container having a predetermined heat sealing temperature, further defined as forming the frangible portion of the cap intermediate the sealing portion and the affixing portion and as subjecting the affixing portion of the cap to a high frequency magnetic field to further heat the affixing portion of the thermoplastic cap to a temperature greater than the heat sealing temperature of the container to seal the affixing portion to the container.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,706,176 Dated December 19, 1972

Inventor(s) ALFRED F. LEATHERMAN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Cover Page

Column 1, at [73] Assignee: after "said" delete "Heller"
and insert --- William C.
Heller, Jr. ---.

Signed and sealed this 29th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents