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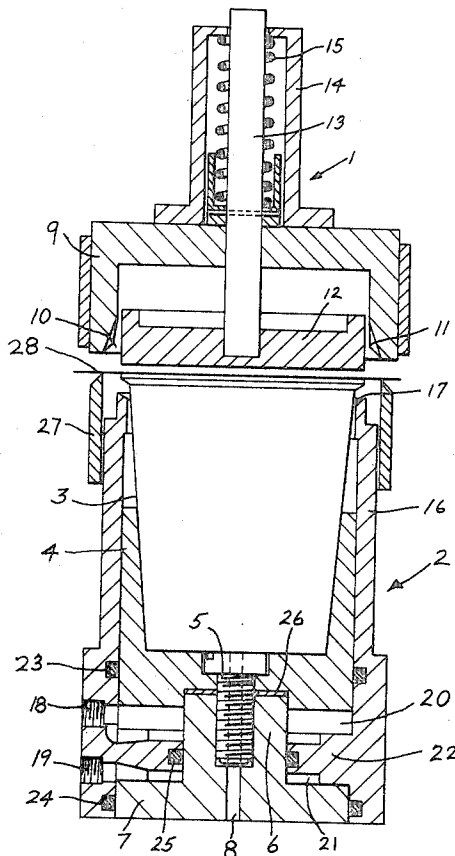
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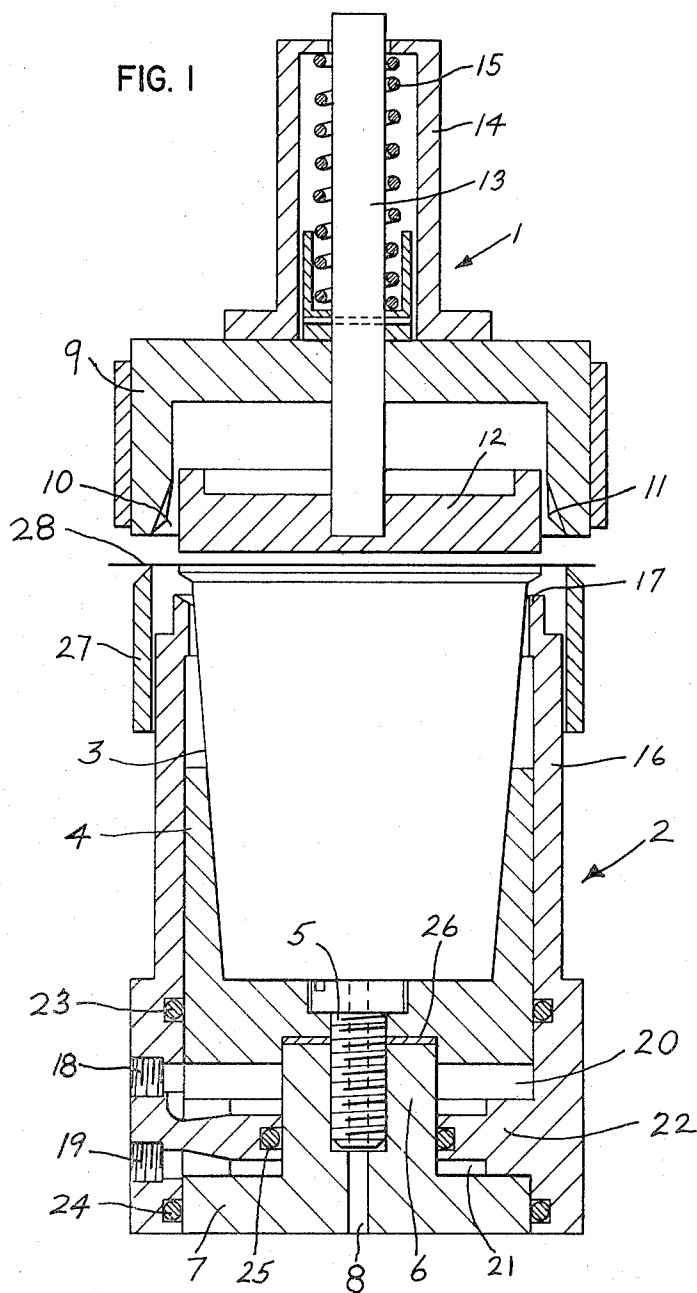
[54] **CLOSURING CONTAINERS**
 13 Claims, 4 Drawing Figs.

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ABSTRACT: Method and apparatus for closing a lipped container with a sheet of biaxially orientated thermoplastic by pushing down on portions of the sheet overlapping the lip of the container with a heating element which softens but does not heat-seal the sheet to the container, while at the same time clamping heat-softened overlapping portions tightly against the container to prevent them from shrinking. The pushed-down portions are then crimped under the lipped edge whereupon the portion of the sheet extending over the open top of the container is shrunk by heating to pull the crimped portions tightly underneath and against the lip. The package thus formed includes a sheet closure of biaxially orientatable thermoplastic, the closure having an outer biaxially orientated portion crimped tightly under the lip of a container without being heat-sealed thereto and an inner, taut, relatively unorientated portion extended over an open end of the container.

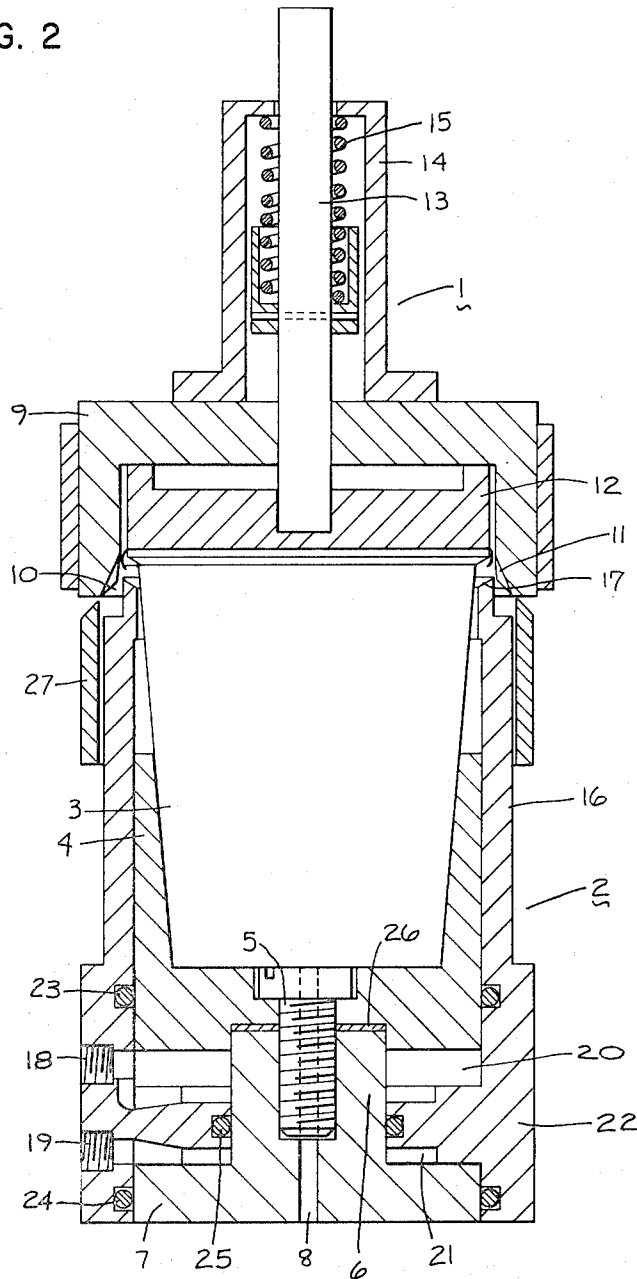




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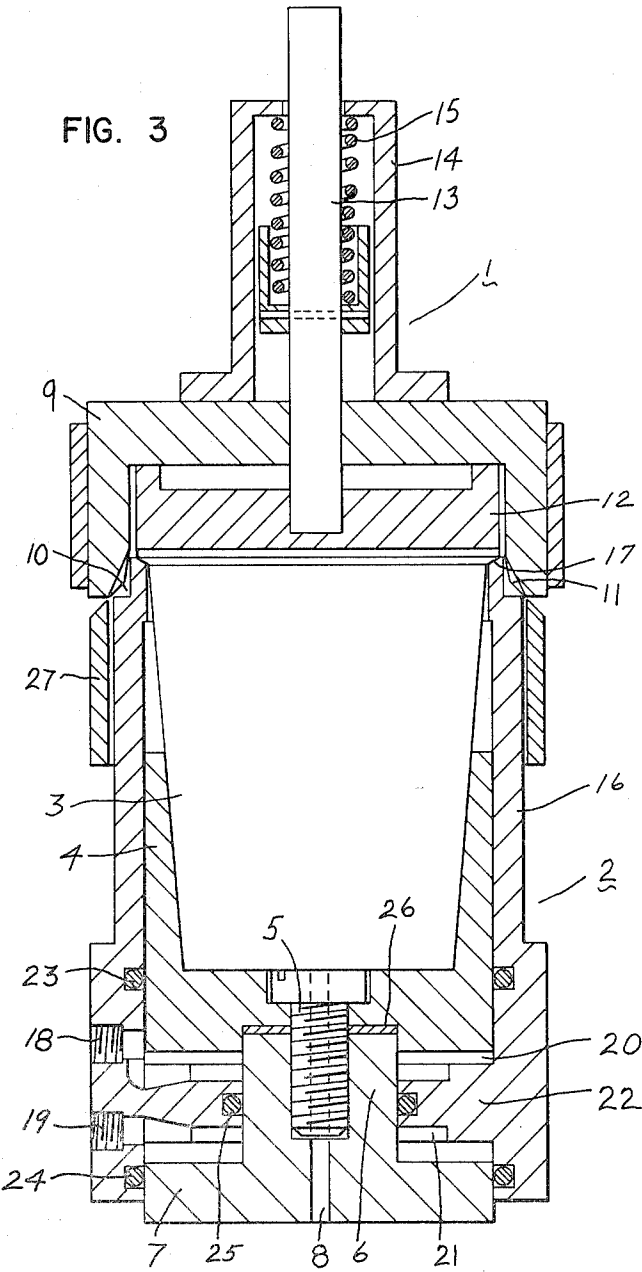
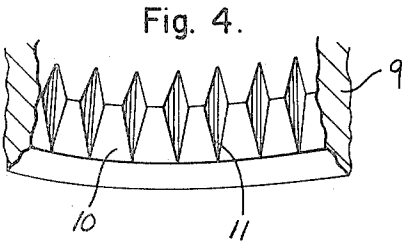
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FIG. 2



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CLOSURING CONTAINERS

BACKGROUND OF THE INVENTION

This invention relates to the closing of containers, and particularly to a new method and apparatus for applying to a lipped container a closure of biaxially orientated thermoplastic resin. The invention also relates to the closed containers so produced.

There has recently been a vast increase in the employment of small packaging containers, particularly in the food industry, and a requirement has arisen for a simple closure device that can be rapidly and cheaply applied to the mouths of a series of filled containers. Cleanliness and the possibility of automatic operation are obvious desirable characteristics of any closing system that is adopted; others, which are difficult to reconcile in practice, are ease of opening when required and sufficient strength to withstand the stresses of transportation. It is also normally required for the finished container to be liquidtight and airtight. The requirement for ease of opening is particularly important where the container is intended to contain a potable liquid such as milk or squash and to be used as a drinking cup, because the cup rim needs to be clean and smooth without any residue from the closure material. Also, container cups of this kind are often intended to be used by children, who require particularly easily openable closures in order to avoid spilling the contents.

It has been proposed to employ closures made of biaxially orientated thermoplastic resins, but although these have not been unsuccessful there is a need for improvement where the requirements for fluidtightness and ease of opening exist. It has for example been proposed to employ the ability of the biaxially orientated resin to shrink by locally heating the edges of a closure cap so that these edges shrink under a lip around the edge of the container, and it has also been proposed to heat seal such a closure to the container rim or to stick it by means of an adhesive, but such methods have not been entirely successful in that a certain percentage of failures occur with the consequent spoilage of contents or leakage onto other containers in close proximity to the offending one. For example, a heat seal or an adhesive can fail where a drop of the container contents has contaminated part of the seal area. We have now also found that the temperatures necessary to effect shrinkage or a heat seal can cause embrittlement of surrounding areas of the biaxially orientated resin with consequent danger of fracture in transportation. A heat-sealed closure is furthermore difficult to remove completely and a heat-seal lacquer can leave undesirable residues.

It is therefore a principal object of this invention to provide an improved closing method which gives a closure having both excellent resistance to failure and the ability to be opened easily when required.

It is an additional object of this invention to provide such a method which is simple and clean to carry out using inexpensive apparatus, and is amenable to automatic operation.

Other objects will in part be obvious and will in part appear hereinafter.

SUMMARY OF THE INVENTION

These and other objects are accomplished by providing a process for closing a container which comprises placing a flat sheet of biaxially orientated thermoplastic resin over the open top of a lipped container so that it overlaps the lipped edges of the container, pushing down the overlapping portions of the sheet with a heated element while clamping tightly against the container and thus preventing any heat-softened parts of the sheet from shrinking, yet avoiding heat sealing such heat-softened parts to the container, crimping without shrinking the pushed-down portions underneath and against the lipped edges of the container, and shrinking the portion of the flat sheet that extends over the open top of the container so as to pull the crimped pushed-down portions tightly underneath and against the lipped edges of the container.

The invention further includes apparatus for closing a lipped container by means of a flat sheet of biaxially orientated thermoplastic resin placed over the open top of the container, and comprises a heatable element movable so as to push-down portions of the sheet overlapping the lipped edges of the container, means for clamping tightly against the container and thus preventing from shrinking any heat-softened parts of the sheet yet avoiding heat sealing such heat-softened parts to the container, means for crimping without shrinking the pushed-down portions underneath and against the lipped edges of the container, and means for shrinking the portion of the flat sheet that extends over the open top of the container so as to pull the crimped pushed-down portions tightly underneath and against the lipped edges of the container.

The heated element that pushes down the overlapping portions of the sheet preferably comprises a frame having interior dimensions slightly larger than the lip of the container. Preferably these dimensions are so chosen that the frame clamps the small area of biaxially orientated sheet that abuts against the outer edge of the container lip. The frame thus needs to be designed to suit the particular container being used and it is therefore preferable that the apparatus as a whole should be so designed that interchangeable frames can be fitted. Preferably the part of the heated element that first meets the resin sheet is shaped or chamfered so that the overlapping portions are progressively bent down over the lip of the container, and in an especially preferred arrangement this part of the heated element has ribs so that the sheet is heat softened at discrete areas spaced around the container rim, this assisting in the subsequent crimping operation by inducing the formation of evenly spaced crimps or pleats.

BRIEF DESCRIPTION OF THE DRAWINGS

In describing the overall invention, reference will be made to the accompanying drawings in which:

FIG. 1 is a vertical cross section of the apparatus showing the first stage in an operation of closing a container;

FIG. 2 is a cross section similar to that shown in FIG. 1 but showing the second stage in the closing operation;

FIG. 3 is a similar cross section showing the third stage; and

FIG. 4 is an enlarged perspective view of part of the heated frame, showing the arrangement of ribs on its inner surface.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, the apparatus of the invention comprises upper and lower assemblies 1 and 2 respectively which are relatively movable in the vertical direction. In the lower assembly, a filled container 3 can be placed in a holder 4 held by a screw 5 on a fixed piston 6 that is integral with a baseplate 7. A drain hole 8 in the screw and the piston permits the draining of any container contents that might be inadvertently spilled in the holder 4.

The upper assembly 1 comprises an electrically heated frame 9 vertically movable by means of a hydraulic or pneumatic cylinder (not shown) controlled by a suitable timing mechanism. The inner dimensions of the frame are just larger than those of the lipped edge of the container, and its lower part 10 is chamfered away as shown in FIG. 4. FIG. 4 also shows the disposition of ribs 11 spaced around the chamfered part of the frame. Within the frame 9 is a pressure plate 12 mounted on a vertical rod 13 that is slidably mounted in the frame 9 and a housing 14. A coil spring 15 acting between the top of the housing and a collar on the rod 13 urges the pressure plate downwardly with respect to the frame 9. The pressure plate is not separately heated but becomes hot by conduction from the frame.

Returning attention to the lower assembly 2, a cold, unheated, crimping sleeve 16 has an upper edge 17 corresponding to the lower surface of the lip of a container; it surrounds and is vertically slidable on the container holder 4 so that it can be moved into and out of contact with the container lip. Vertical movement of the crimping sleeve 16 is achieved by

the admission of a fluid under pressure through ports 18 and 19 to either of two annular spaces 20 and 21 that surround the fixed piston 6 and are situated respectively above and below a ring 22 attached to the crimping sleeve. Flexible "O"-ring seals 23, 24 and 25 and a washer 26 prevent the escape of fluid from the annular chambers, and the opening and closing of the ports is controlled by the timing mechanism.

Surrounding the crimping sleeve is a vertically movable circular knife 27 that is urged upwards by a spring (not shown) against the lower part 10 of the frame 9 when the latter is lowered but is prevented by means of a stop (not shown) from remaining in contact with the frame when the latter is raised.

When the apparatus is in operation, the upper assembly is moved away from the lower assembly sufficiently to enable a filled container to be placed in the holder 4 with a sheet of biaxially orientated resin 28 over its open top (this movement can be either vertical or horizontal), and the upper assembly is then brought to the position shown in FIG. 1. From this position the upper assembly is pushed quickly down to the position shown in FIG. 2, from which it will be seen that the hot pressure plate 12 has first clamped the orientated resin sheet against the container edge, holding it in position and physically preventing it from shrinking at this region, and that immediately afterwards the frame 9 has pushed down the sheet onto the knife 27 so that unwanted portions are cut away. Continuing downwardly, the frame has pushed down the parts of the sheet overlapping the container edge, heating them at the points of contact with the ribs 11 but not sufficiently to cause them to shrink. As the edges of the sheet are pushed down they become cockled around the periphery, the spaced heated portions assisting in this, and alternate parts of the cockled edges are thus forced underneath the lip of the container as shown in FIG. 2.

The position shown in FIG. 2 is quickly followed by that shown in FIG. 3. Here the crimping sleeve has moved up to crimp or pleat the pushed-down portions of the sheet against the underneath of the container lip. It is assisted in this by the spaced portions heated by the ribs 11, but still no shrinkage of the resin takes place as the crimping sleeve is cold. The position of FIG. 3 is maintained for a few seconds, during which the heat of the pressure plate 12 causes the central portion of the sheet to shrink, pulling the crimped edge portions into tight mechanical engagement with the container lip and giving the closure a smooth taut surface. The upper assembly is then moved away permitting removal of the closed container and substitution of a new one.

When it is desired to open the container, a fingernail can be inserted under the crimped edge of the closure to pull the latter upwards and either tear it or spring it over the container lip; since the closure is not sealed or adhered to the container in any way, it parts from the container without leaving residue.

The above description and particularly the drawings are set forth for purposes of illustration only and are not to be taken in a limited sense.

In the apparatus described above, the lower assembly is fixed and the upper one movable, but it would be equally suitable if the upper assembly were fixed and the lower one movable, or alternatively both assemblies can be movable towards or away from each other.

Biaxially orientated thermoplastic resins in sheet form which are useful in the invention are available commercially, and very suitable ones are the transparent sheets of biorientated polystyrene such as are sold under the name "Polyflex" (registered trademark). Other orientated resins can, however, be employed, for instance polyacrylates; polymethacrylates; polycarbonates; polyvinylchloride; polyethylene terephthalates; isotactic polypropylene and styrene copolymers, for instance a styrene-acrylonitrile copolymer or a rubber-modified high-impact polystyrene. The translucent sheets of biorientated high-impact polystyrene sold under the name "Bohips" (trademark) are also particularly suitable.

Preferably the sheet has a thickness between 0.0005 and 0.02 inch, particularly between 0.001 and 0.008 inch. A sheet of thickness 0.001 or 0.002 inch is often convenient to use.

The sheet overlaps the lipped edges of the container, that is to say the flat sheet projects beyond the edges of the container, and the extent to which it does this depends on the depth of "skirt" that is required around the rim of the final, closed container. For example, where the container is intended to be used as a drinking cup, it is desirable for the skirt to be of sufficient depth to give hygienic protection for the portion of the walls of the cup that will eventually come into contact with the lips of the user; for this purpose a skirt depth of about 0.25 to 0.5 inch is normally suitable. On the other hand, where the container is simply intended for packaging it is sufficient if the skirt is of sufficient depth to give a strong closure; for example, the edge of the sheet can coincide with the junction between the sidewall and lip of the container. A slight downwardly extending skirt is, however, generally desirable since this assists in opening the package by inserting a fingernail under the closure. Another way of assisting opening, particularly where there is no skirt, is by the inclusion of a "tear strip" of, for example, cellulose acetate film placed across the open top of the container before the sealing operation is performed and with its end protruding over the lipped container edges so that it remains trapped beneath the closure and can be pulled upwards to open the container when desired.

In the preferred apparatus employing a ribbed frame the spacing between the ribs is preferably chosen so that it is similar to the depth of the skirt, if any. Thus for example where the skirt is 0.35 inch deep the ribs can be about 0.25 to 0.5 inch apart. A smaller rib spacing, about 0.1 to 0.15 inch, is usually preferable where there is no skirt.

The timing of the various operations of the method and the temperatures of the heated frame and pressure plate are interdependent and need to be chosen by means of experiment. They depend not only on the softening point of the biaxially orientated thermoplastic resin, but also on the thickness of the sheet, the heat capacity and temperature of the container contents and the proximity of the level of these contents to the container rim. In general the time/temperature cycle must be designed to ensure that the edge portions of the biaxially orientated resin are not permitted to shrink because otherwise the resin becomes embrittled and the closure fails in use. Nevertheless, the temperature employed needs to be sufficient to heat soften these edge portions so they must be quickly clamped and crimped so that they are physically prevented from shrinking while in the heat-softened state. Another requirement is that the closure should not become heat sealed to the container; otherwise embrittlement and consequent failure will again occur and the closure will not be easily removable. It is therefore necessary to decide the time/temperature cycle after a few experiments, and it is not possible to give comprehensive instructions here. However, as an example, it has been found that when employing a biaxially orientated polystyrene sheet having a thickness from 0.001 to 0.003 inch, a temperature of 130° to 140° C., preferably from 133° to 137° C., is suitable for the heated frame, while the pressure plate reaches by conduction a temperature from 125° to 135° C. very often from 128° to 132° C. The time taken to push down the overlapping portions of the sheet is normally very short, in general it is preferably less than 0.5 second and more preferably from 0.1 to 0.25 second. The interval between pushing down the overlapping portions of the sheet and crimping them against the container edge is also preferably short, not more than 1.5 seconds and preferably from 0.2 to 1 second. After the crimping operation has been performed, it is preferable to keep the crimping sleeve in position for a further period ranging from 1 to 5 seconds and very often from 1.5 to 3 seconds, during which shrinking of the central portion of the flat sheet takes place.

The crimping sleeve is cold, that is to say its temperature is less than the softening point of the resin, for instance from 10° to 50° C.; normally atmospheric cooling is sufficient to achieve this condition, otherwise cooling by water through appropriately disposed channels or air cooling by means of a fan is easy to achieve.

In the apparatus described above, the pressure plate is heated by conduction from the heated frame, however it can be independently heated if desired; alternatively a suitable ring can be employed to clamp the heat-softened parts of the sheet, the central portion of the sheet being heated by means of a radiant heater or a blast of hot gas.

Instead of employing a knife to cut the sheet while it is in position on the container, the sheet can be in the form of a precut blank, the knife (or a similarly shaped sleeve) being then employed merely to position the blank in its proper spatial relationship to the container. This may be preferable since it is not always easy to cut a biaxially orientated resin without producing a certain amount of swarf and this might fall into the container and contaminate its contents if in-position cutting were employed.

The drain hole designated as 8 in the illustrated apparatus can be enlarged sufficiently to accommodate a plunger designed to eject the finished container at the end of the operation, or ejection can be by means of compressed air applied through the drain hole or a separate duct.

For automatic operation there can be a number of lower assemblies, each holding a filled container, which cooperate with and in turn move past one upper assembly; the motion of the lower assemblies can be continuous or discontinuous and in the former case the upper assembly would be designed to travel with each lower assembly for a short distance before being lifted and returned rapidly to intercept the next lower assembly.

In an alternative automatic arrangement, a number of pairs of upper and lower assemblies can be positioned around a carousel or turntable apparatus, a series of containers being fed to these as they move past a feed point. The filling and closing operations can then take place as the containers move around the turntable until they reach a discharge station.

Containers that can suitably be closed by the process of the invention can be of virtually any material, for example a synthetic resin, thermoplastic or thermosetting, glass, paper, cardboard, paper pulp, aluminum or sheet steel. Preferably however the container is of a thermoplastic resin, particularly a polymer or copolymer of an olefinically unsaturated monomer such as ethylene, propylene, styrene, acrylonitrile or methyl methacrylate. Especially preferred are containers of polyethylene, polystyrene (including toughened polystyrene) or styrene-acrylonitrile copolymer. Containers of a thermoplastic resin can, for example, be made by injection molding or by vacuum- or fluid-pressure forming. The containers need not have a circular mouth, the mouth can be of any desired shape, for example square, rectangular, hexagonal or oval.

The process of the invention is illustrated by the following example.

EXAMPLE

This example describes a process according to the invention for closing an injection-molded polystyrene cup containing milk.

The cup was injection molded from polystyrene and had a capacity of 7 fluid ounces. It had a circular rim of diameter 2.75 inches with a lip 0.1 inch wide. The cup was filled nearly to the brim with milk at a temperature of 10° C. and placed in the holder of an apparatus as described above and illustrated in the drawings accompanying the specification. A sheet of biaxially orientated polystyrene in the form of a flat circular blank of diameter 3.5 inches and thickness 0.002 inch was placed over the open top of the cup and the upper assembly was brought down onto it within 0.2 second. The temperature of the heated frame was 135° C. while that of the pressure plate was 130° C. and the temperature of the crimping sleeve was 20° C.

0.75 second after the upper assembly was lowered, the crimping sleeve was raised and maintained in position for 2.25 seconds, during which time the heat of the pressure plate

shrank the central portion of the sheet, pulling the crimped portions into tight mechanical engagement with the cup lip. At the end of this time the crimping sleeve was lowered and the upper assembly was lifted up, and when the container was removed from the apparatus it had been found to have been closed by a strong closure with a crimped skirt 0.35 inch deep covering the cup wall beneath the lip. The closure was easy to remove when required by lifting the skirt with a fingernail and tearing the sheet of resin away, leaving the cup edge clean and free from any residue derived from the closure. Tests of similarly closed containers by dropping them onto a concrete floor demonstrated an extremely good resistance to rupture, the injection molded container itself failing before the closure in some instances.

It is obvious that many variations may be made in the products, processes and apparatus described herein without departing from the spirit and scope of this invention.

What is claimed is:

1. A process of closing a container which comprises placing a sheet of biaxially orientated thermoplastic resin over the open top of a lipped container so that it overlaps the lip of said container, pushing the overlapping portion of the sheet down with a heated element while clamping the sheet tightly against the container to prevent any heat-softened portions of the sheet which contact the container from shrinking yet avoiding heat sealing said heat-softened portions to the container, crimping the pushed-down portions underneath and against the lip of the container without shrinking said pushed-down portions and shrinking a portion of the sheet extending across the open top of the container to pull the crimped, pushed-down portions tightly underneath and against the lip of the container after dissipation of said clamping action.
2. A process according to claim 1 in which the sheet is of biaxially orientated polystyrene.
3. A process according to claim 1, wherein clamping occurs at a small area of the sheet abutting the upper surface of the container lip.
4. A process according to claim 1 wherein the sheet is heat-softened at discrete areas spaced around the periphery of the container lip so as to induce the information of evenly spaced pleats.
5. A process according to claim 1 wherein crimping occurs by moving a sleeve upwardly against the container lip with the pushed-down portion of the sheet interposed between said lip and said sleeve.
6. A process according to claim 1 wherein the portion of the sheet extending over the open top of the container is shrunk by contact with a heated plate.
7. A process according to claim 2 wherein the sheet has a thickness between 0.001 and 0.008 inch.
8. A process according to claim 2 wherein the sheet has a thickness from 0.001 to 0.003 inch, the heated element is at a temperature of from 133° to 137° C. and shrinking is carried out at a temperature of from 128° to 132° C.
9. A process according to claim 2 in which the time taken to push down the overlapping portions of the sheet is from 0.1 to 0.25 second.
10. A process according to claim 2 wherein the time interval between pushing down the overlapping portions of the sheet and crimping them against the container lip is from 0.2 to 1 second.
11. A process according to claim 5 wherein the sleeve is kept in position for a period from 1.5 to 3 seconds during which period shrinking of the portion of the sheet extending across the container occurs.
12. A process according to claim 5 wherein the temperature of the crimping sleeve is between 10° to 50° C.
13. A process according to claim 5 wherein a tear strip is placed across the open top of the container prior to sealing the sheet to the container such that said tear strip has an end protruding over the container lip which may be pulled upwardly to open the container.

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