

[54] THERMALLY TREATED CONTAINER WALL

[75] Inventors: **Herbert Gayner**, Monroeville; **David A. Smith**, Penn Hills, both of Pa.

[73] Assignee: **Aluminum Company of America,
Pittsburgh, Pa.**

[22] Filed: **Oct. 19, 1971**

[21] Appl. No.: 190,480

[52] U.S. Cl. 220/54, 156/257

[51] Int. Cl. B65d 17/20

[58] **Field of Search** 220/54, 53, 48, 90.6;
156/27, 257 X

[56] References Cited

UNITED STATES PATENTS

3,510,022	5/1970	Heller.....	220/90.6
3,610,462	10/1971	Saunders.....	220/90.6
3,632,461	11/1972	Gayner.....	220/53

Primary Examiner—George T. Hall

Attorney—Arnold B. Silverman

[57] ABSTRACT

A method of fabricating a container wall having an integral opening device by providing a metal sheet having an adhesive material secured to one surface thereof. The adhesive secures a continuous protective layer to the metal sheet. The protective layer is selected from

the group consisting of partially crystalline polyolefin, partially crystalline polyolefin-ethylene copolymers, polyethylene acrylate and ionomers of polyolefin. Scoring the sheet to define a removable sector therein while preventing fracture of the adhesively secured protective layer. Subsequently heating the composite metal sheet to a temperature of about 275° to 375° F for a period of about 0.2 second to 4 minutes and preferably about 300° to 350° F for about 0.5 to 3 minutes. The protective layer is stress relieved by this thermal treatment which substantially completely eliminates microvoids established in the protective layer during the scoring operation. Effecting the heating operation in such a fashion as to improve adhesive bonding of the protective layer, resist diaphragming of the protective layer and reduce feathering of the protective layer along the line of severance when the removable sector is fractured.

A container wall structure made by the process of this invention including the adhesive being selected from the group consisting of epoxy, polyester and polyurethane. The protective layer having a crystallinity in excess of about 50 percent. The adhesive bond between the protective layer and the metal sheet removable sector being of greater strength than the shear strength of the protective layer in regions underlying the score line to prevent substantial diaphragming and to limit feathering to less than about one-thirty-second inch.

4 Claims, 9 Drawing Figures

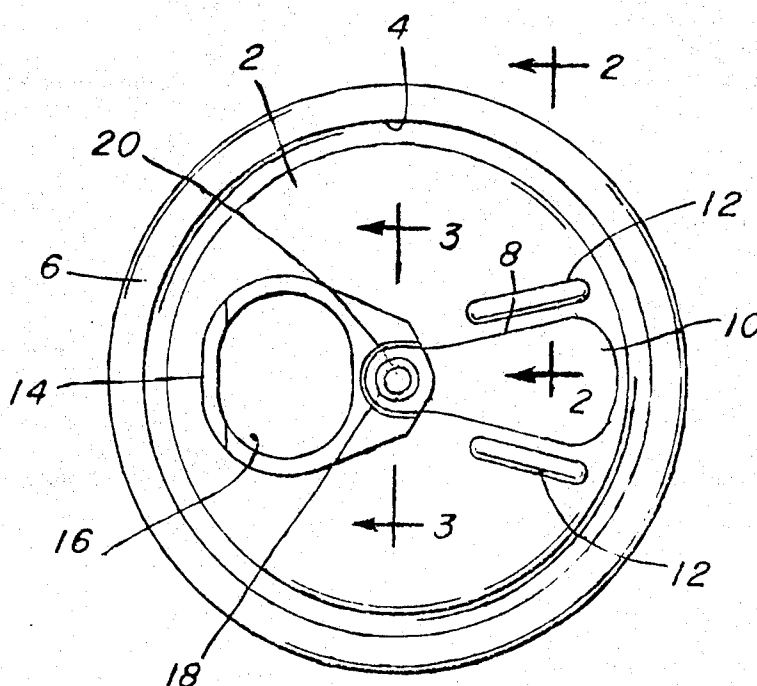


FIG. 1.

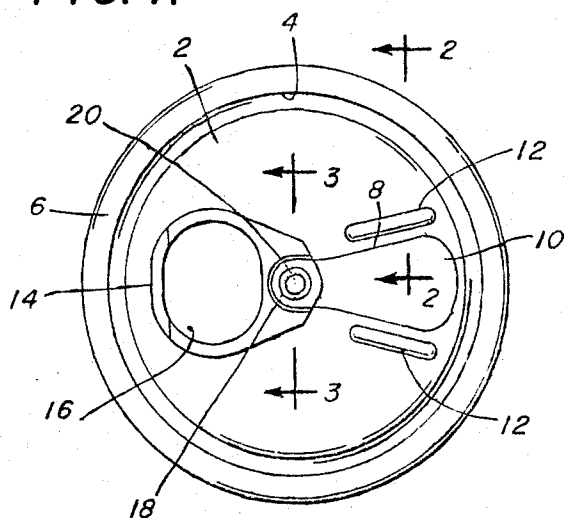


FIG. 2.

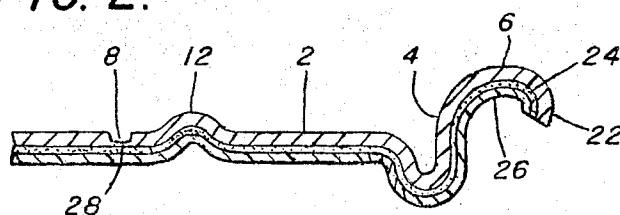


FIG. 3.

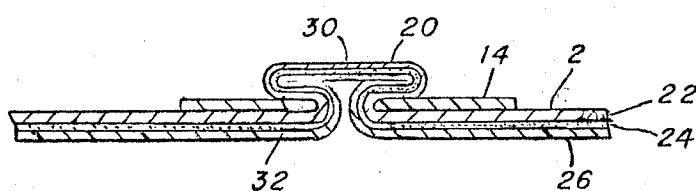


FIG. 4.

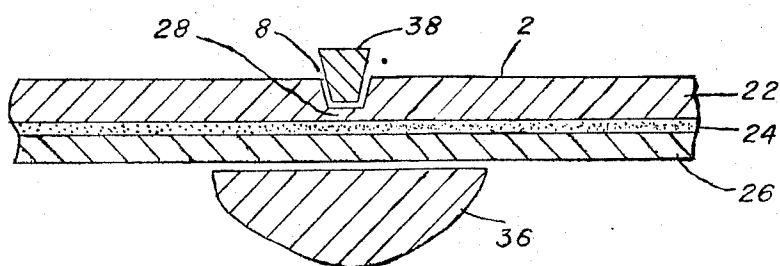


FIG. 5.

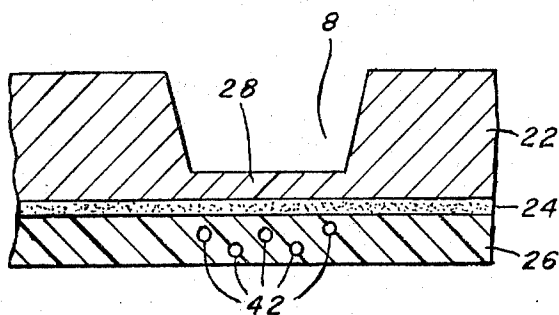


FIG. 5a.

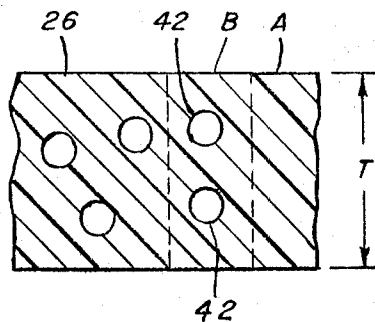


FIG. 6.

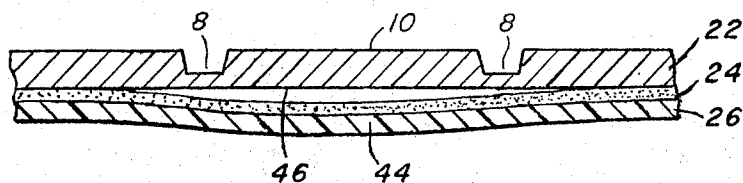


FIG. 7.

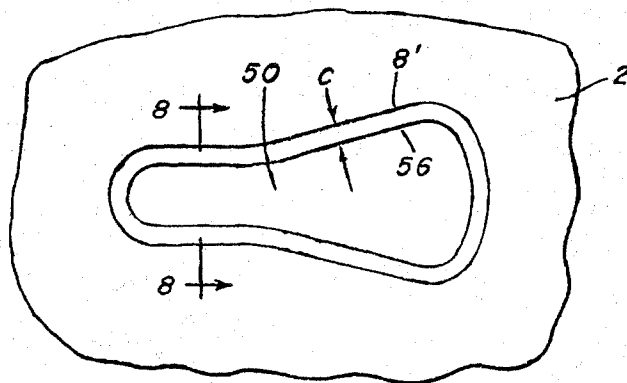
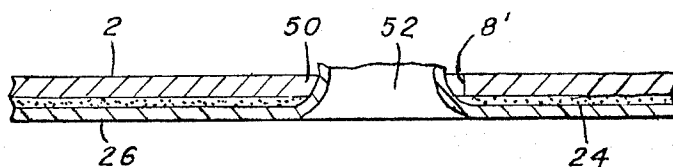


FIG. 8.



THERMALLY TREATED CONTAINER WALL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a thermal treatment process for laminated container walls having integral opening devices and the product thereof. More specifically, this invention relates to a post-heating process which improves the opening characteristics of the laminated container wall and produces improved barrier properties.

2. Description of the Prior Art

It has been conventional to provide forms of container wall structures which have a score line defined removable sector to which a pull tab has been secured by means of a rivet formed integrally with the container wall. Such container walls offer the consumer the advantage of not requiring the use of a separate container opener. In addition, the removable sector is generally provided in such a fashion as to permit relative ease of opening, particularly for a consumer obtaining the mechanical lever advantage provided by a lever form of pull tab.

In one of the conventional methods of fabricating such container end walls, the undersurface of the end is coated with a suitable protective coating prior to conversion of the wall to provide the integral opening device. During scoring and rivet forming the container wall element is subjected to extreme compressively applied impact forces which cause the conventional coating on the undersurface to fracture. The protective coating must have its integrity maintained in order to avoid corrosion hazards during use of the container wall. Such hazards can be produced by corrosive attack on the metal by the container contents and, also, galvanic corrosion where bimetallic container assemblies are employed. It is, therefore, necessary in such conventional fabricating systems to provide a supplemental process step in which the damaged coating is repaired. This approach has involved the need to employ extra equipment and an extra process step to apply additional material which fills the voids and repairs the coating.

It has also been known to provide certain laminated container walls having opening devices and employing specific protective materials which are adapted to withstand the extreme forces applied during scoring and rivet formation. Such materials eliminate the need for repair coating. Such approaches are disclosed in U.S. Pat. Ser. No. 825,164, now U.S. Pat. No. 3,632,461, entitled "Laminated Container Wall Structure," and also in U.S. Pat. Ser. No. 190,479, entitled "Laminated Container Wall" and filed by applicants on even date herewith.

It has previously been suggested that thermal treatment may be beneficial in healing physical cracks created through an enamel coating during the formation of container walls from enamel coated sheet. See U.S. Pat. No. 2,086,165. This disclosure did not involve a container wall which was subjected to the severe forces of scoring and rivet forming which are encountered in forming a removable sector. In addition, it was concerned solely with a process which melts the enamel material in order to provide flow of the same into the cracks created during shaping of the article.

With respect to the types of container walls disclosed in U.S. Pat. Ser. No. 825,164 now U.S. Pat. No.

3,632,461 and Ser. No. 190,479, described above, there have been certain instances when the protective layer has diaphragmed in an undesirable fashion by partially losing its adhesive bond to the removable portion of the metal sheet. This can result in severance of the metal sheet removable sector without severance or with incomplete severance of the underlying protective layer. The result is a full opening in the metal sheet which has been restricted by the presence of an intact protective layer or an opening of smaller size in the underlying protective film. This same undesirable end result has occurred occasionally as a result of excessive stretching of the underlying protective layer during severance of the removable sector which also results in the creation of a restricted opening in the protective film.

There remains, therefore, a need for a laminated container wall which will not only provide an effective barrier which will survive the forces applied during scoring and rivet forming, but also will maintain an effective adhesive bond with the metal sheet and provide improved opening characteristics for the integral opening device.

SUMMARY OF THE INVENTION

The thermal process and resultant product of this invention have filled the above-described need. The process involves providing a metal sheet having an adhesive material secured to one surface thereof and securing to the metal sheet a continuous protective layer. The protective layer is preferably a film selected from the group consisting of partially crystalline polyolefin, partially crystalline polyolefin-ethylene copolymers, polyethylene acrylate and ionomers of polyolefin. The metal sheet is scored to define a removable sector therein, while preventing fracture of the adhesively secured protective layer. Subsequently, the composite metal sheet is heated to a temperature of about 275° to 375° F for a period of about 0.2 second to 4 minutes, preferably about 300° to 350° F for about 0.5 to 3 minutes. This thermal treatment serves to provide stress relief for the protective layer which substantially completely eliminates microvoids established in the protective layer during the scoring operation and any integral rivet forming operation.

The container wall structure of this invention has a metal sheet provided with a removable sector defined by a score line. An adhesive layer is secured to the undersurface of the metal sheet with the adhesive preferably selected from the group consisting of epoxy, polyester and polyurethane. A stress relieved thermally treated continuous protective layer is secured to the undersurface of the metal sheet by means of the adhesive layer. The protective layer preferably has a crystallinity in excess of 50 percent and is bonded to the metal sheet removable sector in such a fashion that the bond therebetween has a greater strength than the shear strength of the protective layer in regions underlying the score line. As a result, severance of the score line and displacement of the removable sector automatically establishes severance of the underlying protective layer without substantial diaphragming and without undesired excessive feathering.

It is an object of this invention to provide a method of thermally treating composite container walls having integral opening devices in such a fashion as to improve adhesive bonding and barrier properties as well as facil-

itating opening of the container wall without undesired obstructions being created by the protective layer.

It is another object of this invention to provide such a method of thermal treatment of the container wall which is employed after scoring and/or rivet forming in order to stress relieve the protective layer in such a fashion as to substantially completely eliminate undesirable microvoids established in the protective layer during such scoring and/or rivet forming.

It is another object of this invention to provide such a process and product which are adapted to be employed economically in connection with the manufacture of a wide variety of types of container walls composed of a wide range of materials.

It is yet another object of the present invention to provide such a thermal post-treatment process wherein the physical position of the amorphous and crystalline portions of the protective layer is restored to a position approximating the state prior to conversion to create the integral opening device.

These and other objects of the invention will be more fully understood from the following description of the invention, on reference to the illustrations appended thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a type of laminated container walls of this invention.

FIG. 2 is a fragmentary cross sectional illustration of a form of laminated wall of this invention showing a scored portion thereof taken through 2—2 of FIG. 1.

FIG. 3 is a fragmentary cross sectional illustration taken through 3—3 of FIG. 1 showing an integral rivet portion of a laminated container wall of this invention but with a slightly modified form of tab profile.

FIG. 4 is a fragmentary cross sectional illustration showing the scoring process.

FIG. 5 is a fragmentary cross sectional illustration of a container wall showing undesirable microvoids in the protective film region underlying the score line.

FIG. 5a is an enlarged fragmentary cross sectional illustration of a portion of the protective layer shown in FIG. 5.

FIG. 6 shows a fragmentary cross sectional illustration of a container wall having undesirable diaphragming characteristics.

FIG. 7 is a fragmentary plan view of a container wall of this invention shown after the removable sector has been severed and withdrawn.

FIG. 8 is a fragmentary cross sectional illustration taken through 8—8 of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As used herein the term "container wall" and words of similar import shall refer to wall portions of containers which are provided with opening devices and shall include can ends, jar and bottle closures and other forms of container portions meeting these specifications.

Referring now more specifically to FIGS. 1 and 2, there is shown a can end having a top panel 2 and an annular chuck wall 4 which terminates in a radially outwardly directed flange 6. The top panel 2 is provided with a score line 8 which defines a removable sector 10. The term "removable sector" and words of similar import shall refer to sectors which are completely severed

from the remainder of the container wall, as well as sectors which are adapted to be partially severed and displaced sufficiently to permit access to the container contents without completely separating the same from the container wall. While for convenience of reference herein the term "score line" will be used in the singular, it will be appreciated that the removable sector 10 may be defined by one or more score lines or weakened lines provided by another fashion so long as residual metal is retained in the panel at the location of the score or weakened lines.

A pull tab 14 has an opening 16 adapted to facilitate manual engagement thereof at one end and a securing portion 18 through which fastening means, such as integrally formed rivet 20, may pass in securing the pull tab 14 to the top panel 2.

In initiating score line fracture, the pull tab is grasped in the region of opening 16 and raised in order to cause the radially innermost portion of the removable portion 10 to be severed through fracture of score line 8. Sequential severance of the remainder of score line 8 permits complete separation of removable sector 10. In the form shown in FIG. 1, the top panel 2 has a pair of elongated hollow stiffening ribs 12 disposed on opposite sides of the tear strip 10. The type of removable sector shown in FIG. 1 is that which would generally be employed with pourable container contents. The invention, however, is equally applicable to removable sectors which encompass substantially all of the top panel 2 including the so-called "full panel pull out container walls."

Referring now to FIGS. 2 and 3, there is shown a portion of the container wall illustrated in FIG. 1. The container wall has a metal sheet or panel portion 22 which is provided with an adhesive layer 24. A protective layer 26, which may be applied as either a coating or film with the latter being preferred, is continuous and is preferably continuously bonded to the metal sheet by means of adhesive 24.

The metal sheet 22 is preferably composed of aluminum or steel, as well as alloys thereof. In a typical structure an aluminum-magnesium alloy in a thickness of about 0.008 to 0.0135 inch in the unscored portions is employed. The residual material 28 underlying the score line 8 would have a metal thickness of about 0.0025 to 0.0045 inch. For purposes of simplicity of description the term "metal sheet" as employed herein will be used to refer to both the individual sheet elements out of which an individual container wall will be formed and also to the parent stock out of which a number of individual container walls may be formed. While in general it will be most convenient to establish the composite adhesively bonded material and then sever individual container wall blanks which are substantially scored, riveted and converted to container walls, this preference is in no fashion critical to the practice of the present invention.

The adhesive layer 24 may conveniently be applied as a coating. The adhesive material 24 is preferably applied in an amount of about 1.0 to 5.0 mg/in² with about 1.0 to 3.0 mg/in² being the preferred amount. The adhesive is preferably selected from the group consisting of epoxy, polyester and polyurethane. It will be appreciated that various additives, catalysts and modifying agents may be employed with the adhesives, should the same be desired. An epoxy modified poly-

urethane adhesive employed with a conventional catalyst, for example, has been found to be effective.

The protective layer 26 is preferably continuous and is preferably substantially continuously bonded to the metal sheet 22 by means of the adhesive 24. The protective material 26 is preferably selected from the group consisting of partially crystalline polyolefin, partially crystalline polyolefin-ethylene copolymers, polyethylene acrylate and ionomers of polyolefin. Among the specifically preferred materials are polypropylene and a polypropylene-ethylene copolymer wherein the ethylene content is about 2 to 10 percent, by weight, with an ethylene content of about 2 to 5 percent, by weight, being preferred. The protective material will preferably have a crystallinity of about 50 to 60 percent, with about 50 to 40 percent being amorphous. The protective layer 26 is preferably applied as a film. Generally the layer 26 will have a thickness of about 1 to 4 mils with about 2.5 to 3.5 mils being preferred for maximum performance at the lowest material cost.

Referring now more specifically to FIG. 3 there is shown a portion of the top panel 2 of FIG. 1 including the integral rivet 20 and the pull tab 14. It is noted that the rivet 20 is provided with a transverse wall 30 and rivet sidewall 32. The sidewall 32 passes through an opening in the pull tab 14 and the enlarged head portion provided by transverse wall 30 and the upper portion of sidewall 32 serve to complete the mechanical joint and resist relative separating movement of the pull tab 14 and top panel 2. It is noted that in the form shown the transverse wall 30 has a thickness which is slightly less than the thickness of the top panel 2 and substantial deformation of top panel 2 has been effected in the local region where the rivet 20 appears. While the rivet may be formed by a number of conventional rivet forming techniques, it will be appreciated that the barrier properties of the protective layer 26 will be maintained in this region of severe mechanical forming which has been subjected to the application of substantial forces.

Referring now to FIG. 4, there is shown a pair of complementary tools employed to effect scoring in the top panel 2. An underlying anvil 36 having a flat upper surface cooperates with an overlying indenter tool 38 to establish score line 8, while retaining score line residual material 28. In practice the score line is established by creating a relative closing movement between the indenter tool 38 and anvil 36 in such a fashion as to provide a high impact force to the local regions to be scored. This force may frequently create a pressure of about 100,000 to 300,000 pounds per square inch. The score line 8 is created by severance and physical dislocation of portions of the panel and/or compressively established flow of metal away from the score line region. In any event, it is desired that the final product have an intact protective layer 26 effectively adhesively bonded to the metal sheet 22, even in regions underlying the score line 8.

It has been found that although the laminate materials employed in the container walls described herein will withstand the rivet forming and scoring operations without the creation of mechanical voids or cracks extending completely through the protective layer 26 and also without excessive thinning thereof, some changes do occur. It is believed that these changes result from a molecular change within the material out of which the protective layer 26 is composed. As the impact

forces are applied, it is believed that the polymer chains are distorted as a result of the crystalline portions of the polymer being more rigid and moving more slowly than the amorphous portions. This results in a structural distortion of the polymer chains with the stretching producing microscopic voids within the structure.

Referring now to FIGS. 5 and 5a, there is shown the score line 8 and an underlying portion of the protective material 26 which is illustrated as having a plurality of microscopic voids 42 (shown in somewhat distorted enlarged fashion for clarity of illustration). It is believed that these voids will in most cases contain a vacuum. Referring to FIG. 5a, it is seen that in the region designated A, the protective layer 26 has a thickness T which amounts to the full web thickness of the protective layer 26. This full thickness T serves as a barrier to passage of potentially corrosive materials through the layer. As the penetration of a given potentially corrosive material through protective layers 26 is related to the thickness of the material, region A provides maximum resistance to such penetration. It is seen that region B has microvoids 42 which reduce the effective thickness of the protective layer 26 and therefore provide local reductions in barrier effectiveness in regions underlying the score line 8 as well as regions adjacent to the areas of heavy force application. Thus, although the microvoids 42 do not provide physical openings in the barrier material which would permit direct contact with the undersurface of metal sheet 22 they do reduce the effective barrier thickness in these regions. They serve to create an undesired path through which potentially corrosive materials may pass in order to reach metal sheet 22.

It has been found that the thermal process of this invention extinguishes substantially all of the undesired microvoids 42 and thereby improves the barrier characteristics of the protective layer. In addition, advantages in improved adhesion and opening characteristics of the container wall, which will be described below, are effected. The thermal treatment process of this invention involves post-heating of the container wall, preferably after both scoring and rivet information have been effected and the container wall is converted to its final structural form. Heating is effected at about 275° to 375° F for a period of about 0.2 second to 4 minutes and preferably is effected at about 300° to 350° F for about 0.5 to 3 minutes. In selecting a time and temperature within these ranges one may balance the added benefits obtained within the preferred range with the desired final properties and economies involved in high speed fabrication. While the most effective thermal posttreatment is obtained within the preferred range, definite benefits of the invention may be obtained within the broader recited range. One of the most practical means of post-heating involves the use of induction heating. Induction heating facilitates the use of reduced heating periods and corresponding increases in production rate.

Heating effects a thermally induced stress relief which substantially completely eliminates the microvoids established in the protective layer 26 resulting from the molecular structural distortion which occurs during scoring, rivet forming and possibly during wall forming. Thermal treatment within this range is believed to produce no ultimate change in the percentage of crystalline structure which exists in the protective layer 26. It serves to restore the structure to one ap-

proximating the original molecular state and eliminate the undesired dislocations which occur as a result of the difference in rate of movement between the crystalline and amorphous phases during scoring and rivet information.

It is believed that beginning at about 185° F the molecular structure experiences crystallite loosening but no melting. At about 275° F some melting is believed to occur with the smaller crystals liquefying first. Heating within the ranges of this invention to relieve stored energy is such that a certain degree of melting is established and crystallinity is lost until the protective layer 26 is cooled. The melting is such, however, that no readily visible change in the general shape of layer 26 and no substantial additional crystallization are induced. The structure, upon cooling, returns to what is essentially its original state with the original crystal structure being recreated and the amorphous-crystalline balance being maintained. It is generally best to operate within the preferred temperature range, i.e., 300° to 350° F in order to expedite the stress relief.

Referring to FIG. 6, another form of potential failure of a laminated wall construction will be considered. As used herein, the term "diaphragming" shall refer to the creation of unbonded regions between the metal panel 22 and the protective layer 26 of sufficient size to provide a void therebetween. More specifically, diaphragming will be employed to refer to such unbonded regions which occur between the undersurface of the removable sector 10 and the underlying portion of the protective layer 26. As is shown in FIG. 6, the protective layer 26 underlying the removable sector 10 has an unadhered portion 44 which is disposed in spaced underlying relationship with respect to panel undersurface portion 46. While the adhesive 24 has been shown as adhered to unadhered portion 44, it might have adhered to removable sector 10 or partially to portion 44 and partially to sector 10. The manner in which the bond fails is not critical.

When diaphragming exists, it will be appreciated that severance of score line 8 in order to withdraw removable sector 10 will not automatically produce severance of protective layer portion 44 in the desired manner. As a result, it may be necessary for the consumer to employ a separate implement in order to sever the diaphragmed protective portion 44 and gain access to the container contents. In the preferred form of the invention the bond between panel portion 46 and protective layer portion 44 would be such that it would exceed the strength of the protective layer in regions underlying score line 8. Severance of score line 8 will automatically produce severance of the underlying adhered protective layer portion 44 to create an opening in the protective layer 26 of the general proportions of that of the removable sector automatically and without independent effort on the part of the consumer. It has been found that the thermal post-treatment process of this invention, within the temperatures recited above, substantially completely eliminates diaphragming and produces the desired improved adhesive bonding in this region and thereby facilitates automatic severance of the protective layer 26 during container opening.

Referring now to FIGS. 7 and 8, another advantage produced by the thermal treatment process of this invention will be considered. It has been noticed that with respect to some laminated container wall structures, which do not have diaphragming infirmities, an

additional problem may be encountered. In effecting severance of the removable sector 10 the underlying adhered portions of the protective film will sever, but prior to severance will be subjected to permanent elongation which causes the protective layer 26 to define an access opening which is smaller than the opening defined by the score line 8 in metal panel 22.

As is shown in FIGS. 7 and 8, the container panel 2 has had the removable sector 10 (not shown in this view) separated therefrom in order to establish an opening 50 in the metal panel 2, which is defined by the remaining portion 8' of the score line 8. The underlying protective material 26 has been stretched transversely inwardly and partially upwardly with respect to opening 50 and defines a smaller opening 52. For convenience of description herein the term "feathering" shall be used to refer to the projection of the protective layer 26 into the opening 50 in order to define a restricted opening 52. While a certain minor degree of feathering is not objectionable, any feathering which materially restricts opening 50 in such a fashion that restricted opening 52 is substantially smaller is objectionable. As is shown in FIG. 7, the feathered projection 56 of protective layer 26 extends into opening 50 by a distance "C," when considered in plan, and restricts opening 50 to that extent. It is generally desirable to restrict the average feathered projection 56 in such a fashion that the dimension "C" will be less than about one-sixteenth inch, with less than about one thirty-second inch being preferred. It has been found that the thermal post-treatment of this invention produces a substantial improvement in reducing the extent of feathering. Post-treatment at the temperatures recited above will generally restrict the amount of feathering to the preferred limits.

In order to confirm the effectiveness of the thermal post-treatment of this invention in reducing or extinguishing diaphragming and feathering, two series of tests were performed in which identical container walls were treated in the same fashion, but for the absence of thermal treatment of some samples and the use of thermal treatment in others. This provided a direct basis for isolated comparison of the effect of thermal treatment of this invention. The results of these tests are reported in the following examples.

EXAMPLE 1

Several groups of aluminum can ends made from an aluminum-magnesium alloy in the extra hard H19 temper (5051-H19) were provided with one of several types of laminated films. The films were secured to the aluminum ends by means of an epoxy modified, polyurethane adhesive. The ends in Groups A, C and E were provided with a 3 mil polypropylene film and the ends in Groups B and D were provided with a 3 mil polypropylene-3 percent ethylene, by weight, copolymer film. The ends were scored in a conventional fashion to define removable sectors therein. Integral rivets were formed in the ends in a conventional fashion. The metal sheets out of which the ends in Groups A and B were made were laminated at a laminating roll temperature of about 225° F, while the sheets out of which the Groups C, D and E ends were made were laminated at a laminating roll temperature of about 300° to 320° F. A portion of the ends of each group were post-heated at a laminating roll temperature of about 325° F for 2 minutes, while the remainder of the ends in each group

were subjected to no thermal post-treatment. The ends were then opened to evaluate opening characteristics, deiphragming and feathering. They were rated according to the following schedule:

- excellent — easy opening, no diaphragming, no feathering
- good — easy opening, no diaphragming, feathering less than one-sixteenth inch
- fair — moderately easy opening, no diaphragming, feathering greater than one-sixteenth inch
- poor — hard opening, some diaphragming and feathering
- failure — hard opening, diaphragming and feathering

Group	Thermal Post-Treatment	Grade	Feathering
A	No	Fair	1/8 inch
A	Yes	Excellent	0
B	No	Fair	1/16 inch
B	Yes	Good	1/32 inch
C	No	Good	1/32 inch
C	Yes	Excellent	0
D	No	Good	1/32 inch
D	Yes	Good	1/32 inch
E	No	Fair	5/64 inch
E	Yes	Excellent	0

These results show the superiority of the identical laminated container walls employed with a thermal post-treatment as compared with those without such thermal treatment. The only groups of ends rated "excellent" were post-treated, while all groups of ends rated "fair" were not post-treated. The only groups of ends wherein no feathering was experienced were the post-heated ends.

EXAMPLE 2

The tests performed in Example 1 were repeated with the use of a slightly modified anvil die structure which had a large radius of curvature rather than being flat. The following results were obtained:

Group	Thermal Post-Treatment	Grade	Feathering
A	No	Good	1/32 inch
A	Yes	Good	1/32 inch
B	No	Fair	3/32 inch
B	Yes	Excellent	0
C	No	Fair	3/32 inch
C	Yes	Excellent	0
D	No	Good	1/32 inch
D	Yes	Excellent	0
E	No	Good	3/64 inch
E	Yes	Excellent	0

These tests also confirm the general superiority of the thermally treated ends as compared with those which received no post-treatment. All four of the groups of ends which received an excellent rating and zero feathering belong to the post-treated groups, while those in the group which was not thermally post-heated were rated either as fair or good, with feathering ranging as high as three thirty-seconds and three sixty-fourths inch.

It will be appreciated, therefore, that the thermal treatment process of this invention and the resultant product provide improved barrier properties for the protective layer as well as providing improved adhesive bonding between the metal sheet and the protective layer. In addition, undesired opening characteristics such as diaphragming and feathering are eliminated with the result being improved opening characteristics for the container wall. All of this is accomplished by the specific stress relieving, thermal post-treatment of this

invention which is believed to substantially completely eliminate molecular structural dislocations established within the protective layer during severe mechanical working of the container wall. This is accomplished without permanently effecting a meaningful alteration in the crystallinity of the protective layer. All of this is accomplished in an economical fashion without requiring major investment in additional equipment or the use of additional materials such as would be required in connection with repair coating practices.

Whereas particular embodiments of the invention have been described above for purposes of illustration, it will be evident to those skilled in the art that numerous variations of the details may be made without departing from the invention as defined in the appended claims.

We claim:

1. A container wall structure comprising a metal sheet having a score line defined removable sector, an adhesive layer secured to one surface of said metal sheet, said adhesive composed of a material selected from the group consisting of epoxy, polyester and polyurethane, a stress relieved thermally treated continuous protective layer secured to said metal sheet undersurface by means of said adhesive layer, said continuous protective layer composed of a material selected from the group consisting of partially crystalline polyolefin, partially crystalline polyolefin-ethylene copolymers, polyethylene acrylate and ionomers of polyolefin, said protective layer having a crystallinity in excess of about 50 percent, and said adhesive bond between said protective layer and said metal sheet removable sector being of greater strength than the strength of said protective layer in regions underlying said score line, whereby severance of said score line and displacement of said removable sector automatically establishes severance of said underlying protective layer without substantial diaphragming and without feathering exceeding about one thirty-second inch.
2. The container wall structure of claim 1 including said protective layer has a thickness of about 2.5 to 3.5 mils in regions not underlying said score line, and said protective film is selected from the group consisting of polypropylene and a polypropylene-ethylene copolymer having an ethylene content of about 2 to 10 percent by weight.
3. The container wall structure of claim 2 including said protective layer being substantially free of microvoids, and said protective layer having stress relieved properties resulting from thermal treatment at about 275° to 375° F for about 0.2 second to 4 minutes and having greater barrier properties than would be present in the protective layer in the absence of said thermal treatment.
4. The container wall structure of claim 3 including said protective layer having stress relieved properties resulting from thermal treatment at about 300° to 350° F for about 0.5 to 3 minutes, said bond between said protective layer and said metal sheet is substantially continuous, and said protective film is a polypropylene-ethylene copolymer having an ethylene constituent of about 2 to 5 percent by weight.

* * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,762,598 Dated October 2, 1973

Inventor(s) Herbert Gayner & David A. Smith

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

Before the abstract insert "The portion of the term of the patent subsequent to May 29, 1990 has been disclaimed."

Column 1, line 51	Delete "Pat." before "Ser. No."
Column 1, line 53	Delete "Pat." before "Ser. No."
Column 1, line 67	Delete "Pat." before "Ser. No."
Column 6, line 42	Change "information" to --formation--
Column 6, line 52	Change "posttreatment" to --post-treatment--
Column 7, lines 4 & 5	Change "information" to --formation--
Column 9, line 3	Change "deiphragming" to --diaphragming--

Signed and sealed this 23rd day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

Disclaimer

3,762,598.—*Herbert Gayner*, Monroeville, and *David A. Smith*, Penn Hills, Pa.
THERMALLY TREATED CONTAINER WALL. Patent dated
Oct. 2, 1973. Disclaimer filed June 11, 1973, by the assignee, *Aluminum
Company of America*.

Hereby disclaims the portion of the term of the patent subsequent to
May 29, 1990.

[*Official Gazette November 6, 1973.*]