United States Patent [19]

Brown

[11] **3,900,128**

[45] **Aug. 19, 1975**

[54] **EASY OPEN CAN END RESISTANT TO PRESSURE**

[75] Inventor: **Omar L. Brown,** Kettering, Ohio

[73] Assignee: **Ermal C. Fraze,** Dayton, Ohio

[22] Filed: **Mar. 30, 1973**

[21] Appl. No.: **346,712**

[52] **U.S. Cl.** **220/269**

[51] **Int. Cl.** **B65d 41/32**

[58] **Field of Search** 220/54, 48, 27, 90.6, 269

[56] **References Cited**

UNITED STATES PATENTS

3,478,917	11/1969	Rouse et al.	220/54
3,724,709	4/1973	Westphal	220/54
3,757,989	9/1973	Brown	220/90.6
3,795,342	3/1974	Ashton	220/54

Primary Examiner—George T. Hall

Attorney, Agent, or Firm—George F. Smyth

[57] **ABSTRACT**

An easy-open can end includes a tear strip defined by a score line which is preferably non-continuous, a pull tab being attached to the tear strip by a rivet such that the free end of the pull tab overlies the score line. A generally triangular depression is positioned in that portion of the tear strip adjacent to the rivet and operates to prevent the can end from assuming a permanently domed configuration in response to pressure within the can, the doming tending to bulge the end of the can causing the free end of the pull tab to rise above the chime. The triangular depression also assists in maintaining the free end of the tab below the chime at moderate residual pressures. In another embodiment, depression ridges are used, adjacent to but spaced from the score line and cooperate with the triangular depression to increase the resistance to permanent deformation of the can end in response to increases in pressure. Blow-off is reduced by increasing score line integrity, as described, which also assures the integrity of any protective coating on the underside of the can end. In one embodiment, the portion of the pull tab overlying the can end in the area of the depression ridges is reduced in crosssection to keep the tab close to the end, which may be enhanced by a tail on the tab which resiliently urges the tab against the end, as described hereafter. A method of forming such a can end is also described.

20 Claims, 15 Drawing Figures

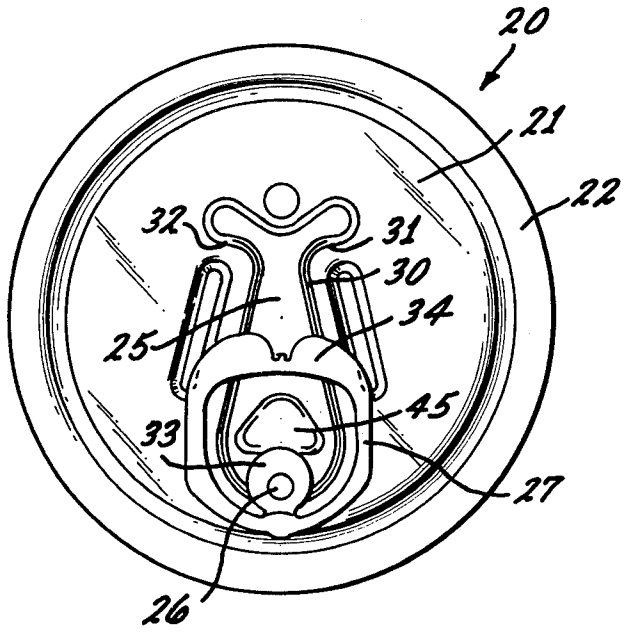


FIG. 1

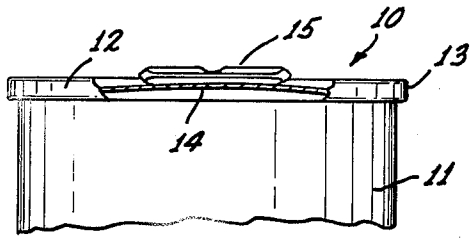


FIG. 2

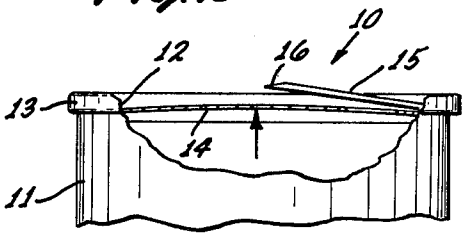


FIG. 3

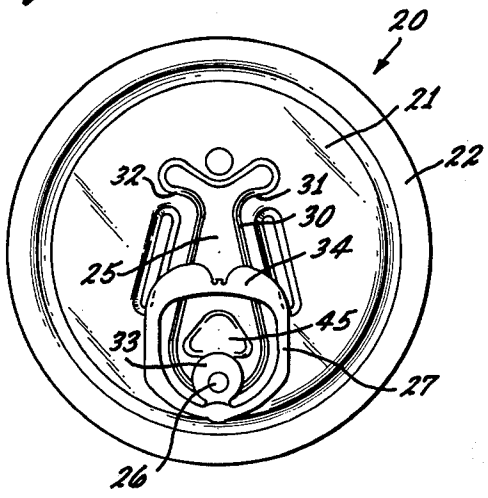


FIG. 4

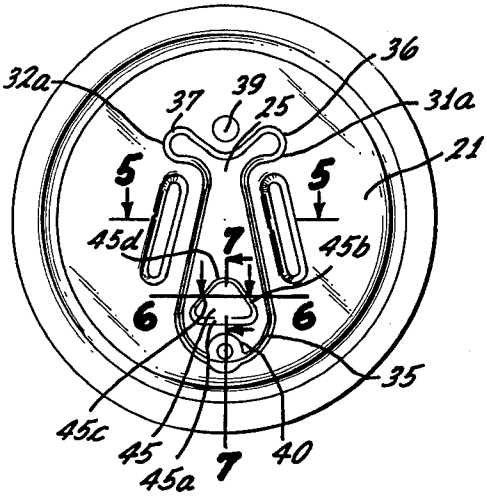


FIG. 5

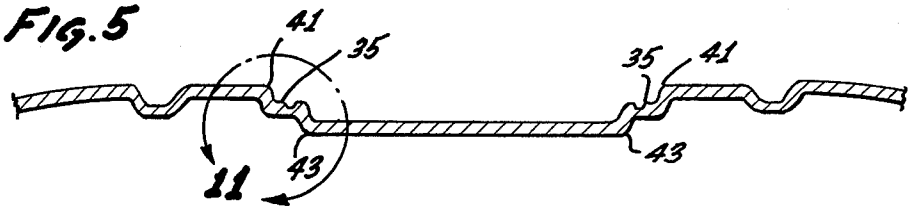


FIG. 11

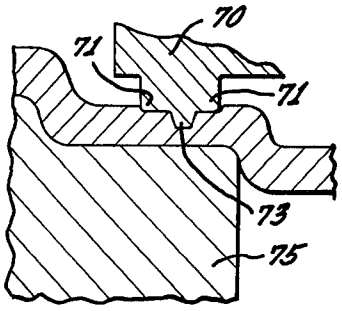


FIG. 6

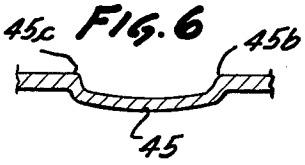


FIG. 7

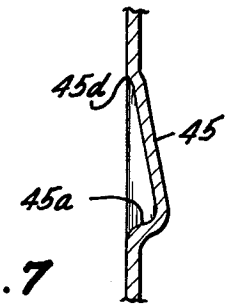


FIG. 8

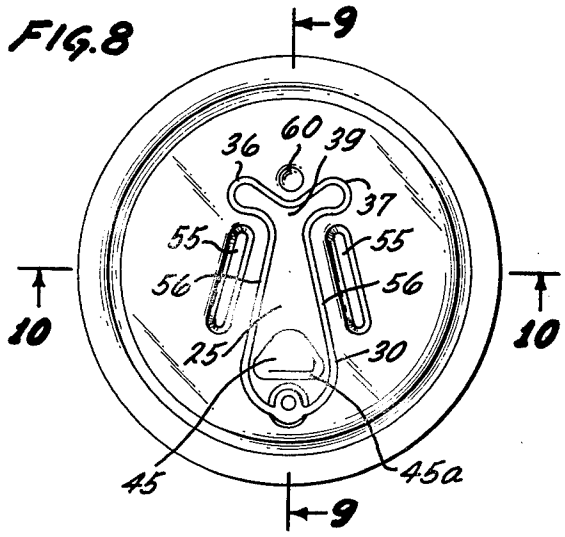


FIG. 9

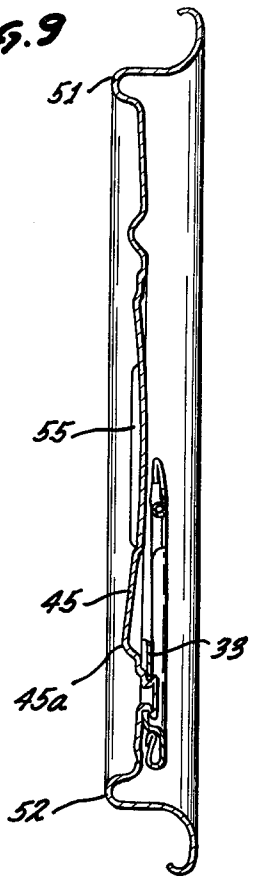


FIG. 10

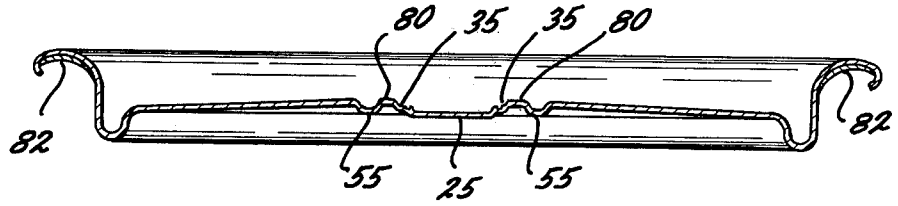


FIG. 12

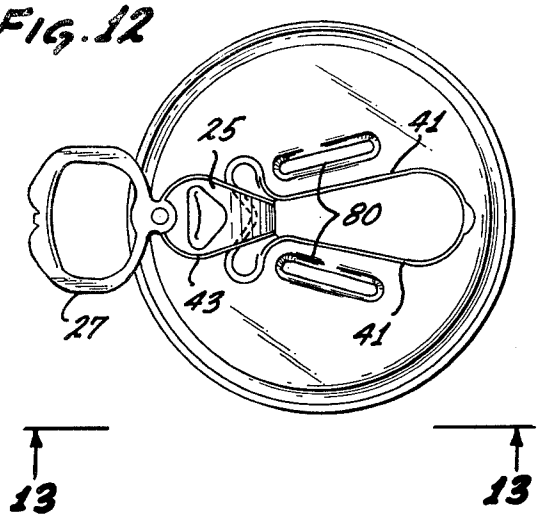


FIG. 13

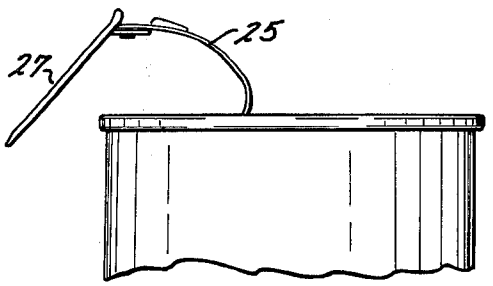


FIG. 14

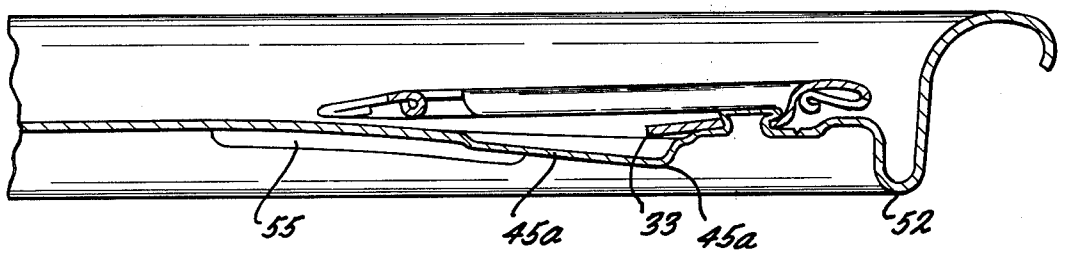
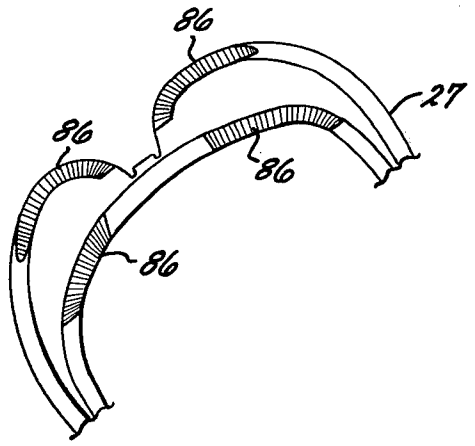


FIG. 15



EASY OPEN CAN END RESISTANT TO PRESSURE

BACKGROUND OF THE INVENTION

This invention relates to easy open cans and, more specifically, to an improved opening can with an inseparable tear strip, defined by a score line, wherein the free end of the tab attached to the tear strip is prevented from extending above the can chime in response to pressure within said cam.

The ready acceptance of easy opening cans has resulted in extended use of this type can for a substantial number of canned products, especially beverages, such as beer, soft drinks and the like, as well as other products such as puddings and other non-beverage type comestibles. This type of can is characterized by a lever or tab permanently joined to a tear strip, the latter being separable from the can top to provide a pouring spout, in the case of beverages, or to remove a substantial portion of the can top to provide access to the can contents. In the form heretofore used, the tab or top is ruptured along a continuous score line and the pull tab and tear strip, or the pull tab and top is removed and normally discarded.

The convenience of easy opening cans has created problems because of the unfortunate and indiscriminate disposal of the severed portion of the can top. For example, beach and picnic areas have had an accumulation of litter in the form of tabs and tear strips which have been removed from easy opening cans. These discarded tabs and tear strips are quite difficult to clean up because they are small and thus pass the tines of a rake. Being made normally of aluminum, they cannot be collected by magnetic means. Nonetheless, this type of can is widely used and it is definitely advantageous to provide a solution to the problem of littering while still providing to the public the convenience of easy opening cans.

The numerous advantages incident to the use of easy opening cans has given rise to an industry which is developed to the point where standard procedures and equipment are now in wide spread use. For example, can bodies of the three-piece and two-piece are in use, the two-piece including a top as one component and an integral body and bottom as another component. Side soldered seamed, tin free steel and continuous welded seam cans are now in use. Standards have been established with respect to the length and diameter of the component parts and the gauge of materials use by can body makers. Variations from the accepted standards create substantial problems both from a tooling standpoint as well as increase in material costs if dimensions or gauge of materials is increased. Changes of even several thousandths of an inch either in diameter or in length are avoided, not only because of the prohibitive costs of tooling changes, but because of the significant additional costs of material if these dimensions are increased.

With the wide spread use of easy opening cans, there has been considerable variation in the processing and the conditions of use. For example, in some operations, the can is sealed and pasteurized resulting in the generation of internal pressure within the can. In other types of beverages, there is a residual pressure within the can which may increase substantially if the can is exposed to summer heats and the like. With some beverages, the under surface of the can end blank is coated with a thin protective coating to prevent undesired changes in the taste of the product during the forming operation used to convert the end blank, then the underside of the can end must be recoated, at an additional expense.

Where the processing of the can contents involves pasteurization, the internal pressure developed during pasteurization (heating to 160° to 180°F.) may cause the top of the sealed can to dome with the result that the free end of the tab rises above the can chime, as will be explained in detail later. If the can top takes a permanent set in this relative position, problems are created.

Where doming of the can occurs during processing, and if the can top takes a permanent set, it is possible that the end of the pull tab may raise above the chime. One obvious solution to this problem would be to increase the dimension of the can top such that there is a greater vertical height between the top of the can chime and the horizontal plane of the end wall of the can end. This is objectionable because it increases the amount of metal used and reduces the volume of the can. For example, if the volume of the can is reduced such that the actual contents are even slightly less than the indicated amount, certain Federal regulatory agencies will object. There have been instances in which beverage cans containing 0.02 fluid ounces less than the required and advertised amount have had to be withdrawn from the market. While the volume of the can may be altered slightly to provide a greater volume in order to assume a sufficient "safety margin", not only is this costly from the standpoint of added material in the metal of the can, but is prohibitive from the standpoint of the equipment and tooling changes required for the fabricating, filling, sealing and packageing sequence. Similarly, increasing the gauge of metal used for the top in order to acquire the strength needed to resist the pressure induced deformation results in an increase in the cost of the can end and is, therefore, likewise objectionable.

Thus, there are considerable advantages to be gained if a can end is provided which includes an inseparable tear strip, which is relatively safe to use in the sence that the incidents of lacerations are reduced. Moreover, there are additional advantages in providing a can end which achieves these sought for objectives while remaining within the standards adopted by the industry, while at the same time being sufficiently versatile to enable use with different types of beverages, and capable of withstanding different pressure conditions.

For example, there is a tendency in the industry to reduce the gauge of the material used in the can end for exonomical reasons. Likewise, there has been a tendency to reduce the vertical dimension between the top of the chime and the bottom of the chuck wall for the purpose of obtaining some small additional volume within the can itself. These practical considerations constitute significant limitations regarding improvements which can be made in the design of can ends.

DESCRIPTION OF THE PRIOR ART

It is known to use a non-continuous score line such that the tear strip is firmly attached to the can. Such a structure is shown in U.S. Pat. No. 3,327,891.

An improvement in the structure described in U.S. Pat. No. 3,327,891 is described in U.S. Application Ser. No. 103,255, filed Dec. 31, 1970 now U.S. Pat. No. 3,757,989. There, a can end having an inseparable tear strip is described wherein means are included to

substantially eliminate sharp edges along the score line, thereby substantially reducing the possibility of the user being lacerated when consuming the contents directly from the can.

SUMMARY OF THE INVENTION

The present invention relates to an easy-open can end, and the method of manufacturing such a can end, and particularly a can end structure in which the can end is structured to prevent the end from assuming a permanently domed configuration in response to increase in pressure within the can tending to raise the free end of the tab above the chime of the can. In those forms of can ends in which the staking rivet is adjacent to the chime, thus placing the pull tab in an orientation pointed towards the center of the can end, the geometry of the top is such that it aggravates the problem of pressure induced tab movement. It is to this type of can end which the present invention is primarily directed.

With a can top of this described geometry, certain conditions of processing and residual pressure may give rise to doming of the can end, and as a result of the geometry of the can top, the free end of the tab rises above the chime. While this is not objectionable if it is a temporary condition, there are circumstances under which the can top may take a permanent deformation in the domed configuration with the free end of the pull tab being permanently above the can chime.

By the present invention, a can is provided which substantially reduces, and eliminates to a great extent the problems associated with the permanent deformation of the can top tending to lift the free end of the tab above the chime.

This is accomplished in accordance with the present invention by providing a depression of a particular geometric shape in the portion of the tear strip between the rivet and the center of the can. This particular depression assists materially in recovery in the event the can end is domed sufficiently to raise the free end of the tab above the chime. It also operates to prevent the free end of the tab from remaining above the chime under conditions of elevated pressure.

An optimum configuration in accordance with this invention includes, in addition to the depression in the tear strip, a pair of depression ridges one located along each side of the score line.

The configuration just described finds particular utility in those instances in which a can end of the type described in Ser. No. 103,255, previously discussed, is used in environments in which pressure is created during the processing of the cans, i.e., pasteurization and the like. Typical of this type environment is one in which the contents of sealed cans are pasteurized creating internal pressures which may be as high as 100 pounds p.s.i. The same depression also assists in the gradual release of pressure in those instances in which the can is under moderate pressures of the range of 30 to 40 p.s.i. The elevation of the free end of the tab above the chime is also reduced substantially by arranging the tail element of the tab such that it is inclined slightly towards the top of the can, thus resiliently urging the tab downwardly against the can top. Further, the portion of the tab overlying the score line and the depression ridges is reduced in cross-sectional thickness so that the free end of the tab remains close to the can end.

In addition, the score line according to this invention is formed so that there is sufficient integrity to prevent blow-off while at the same time permitting easy rupture of the tear strip during an opening operation. The manner in which the score line is formed also tends to maintain the integrity of any protective coating on the reverse side of the can end blank.

Further objects, advantages, and modes, and such additional embodiments of the present invention will be readily apparent to those skilled in the art after they have read the Detailed Description and referred to the accompanying drawings which illustrate what are presently considered to be a preferred embodiment of the best mode contemplated for utilizing the novel principles which are defined in the Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view, with portions thereof broken away, of a can illustrative of the prior art showing the free end of the tab above the chime;

FIG. 2 is a view from the side of FIG. 1, with portion thereof broken away, of the prior art showing the free end of the tab above the chime;

FIG. 3 ia a plan view of a can top formed in accordance with the present invention;

FIG. 4 is a view similar to FIG. 3 illustrating the can top of this invention prior to the time that a tab is fastened to the tear strip;

FIG. 5 is a partial sectional view, on an enlarged scale taken along the lines 5–5 of FIG. 4;

FIG. 6 is a partial sectional view, on an enlarged scale, taken along the lines 6—6 of FIG. 4;

FIG. 7 is a partial sectional view, on an enlarged scale, taken along the line 7—7 of FIG. 4;

FIG. 8 is a plan view of the underside of the can top illustrated in FIG. 3;

FIG. 9 is an enlarged view, partly in section, and partly in elevation, taken along the line 9—9 of FIG. 9;

FIG. 10 is an enlarged view, partly in section, and partly in elevation, taken along the line 10—10 of FIG. 9;

FIG. 11 is an enlarged view of that portion of the can top illustrated in FIG. 5 and designated 11 illustrating the scoring tool;

FIG. 12 is a plan view of the can end of FIG. 3 illustrating the relative position of the tear strip after the score line has been served;

FIG. 13 is a side view, in elevation, of a fragmentary portion of the can taken along the line 13—13 of FIG. 12;

FIG. 14 is an enlarged fragmentary view, partly in section, and partly in elevation, of that portion of the can end in accordance with this invention to which the tab is attached; and

FIG. 15 is a partial view, in elevation, of the underside of the free end of the tab of the can top in accordance with the present invention.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2 of the drawings which are merely illustrative of easy-open cans typical of the prior art, the can 10 includes a can body 11 to which a top 12 is attached. The top includes a chime 13 which secures the can end to the can body. The can end includes an end wall 14 and a tear strip, not shown, a tab 15 being attached to the tear strip by an integral integral rivet, not shown.

In the form shown, the tab **15** is attached by an integral rivet to that portion of the tear strip which is adjacent the chime **13** of the can. Thus, in those instances in which the interior of the sealed can is exposed to pressure, a force is generated tending to urge or bulge the end wall **14** of the can upwardly as indicated by the arrow in FIG. **2.** Due to the geometry of the can end, i.e., the location of the rivet adjacent to the chime and the orientation of the pull tab towards the center of the can top, the effect of the crowning or bulging of the end wall **14** is to alter the plane in which the rivet and the tab are normally disposed. Even small angular changes of the end wall **14** due to the pressure causes the free end **16** of the tab to rise above the chime **13.**

Where bulging occurs under conditions which create a permanent set of the end wall **14** in the crowned condition with the free end **16** of the tab above the chime, problems are created during the packaging because the free end of the chime tends to catch on conveying equipment or on cartons in which the cans are packaged. A typical operation which creates sufficient pressure to bulge the end wall of the can is pasteurization in which the sealed can is elevated in temperature (160° to 180°F.) resulting in an increase in pressure in the interior of the can which may reach as high as 100 pounds p.s.i. with the result that substantial force is exerted against the end wall and may cause a permanent deformation such that the free end **16** of the tab **15** remains above the chime **13.**

The effect of this internal pressure is most pronounced in those configurations of can ends in which the tab **15** is arranged such that the rivet is close to the chime of the can and the free end of the tab extends towards the center of the can. As will be appreciated, in those configurations in which the rivet is located in the approximate center of the can top, bulging of the can will not normally change the plane in which the tab normally lies and thus the free end of the tab does not normally raise above the chime.

In addition to geometric considerations, it has been discovered, in accordance with this invention, that if there is excess metal in the can top due to working of the metal to provide various configurations therein, the presence of excess metal favors the can end taking a permanent set in the crowned condition rather than recovering. For example, in pasteurization the temperature is increased, resulting in a substantial increase in pressure within the sealed can, and some doming of the can end takes place. After the process is complete, the can cools. If the set is permanent, the tip of the tab may remain above the chime. As is apparent from the foregoing, certain geometrics create circumstances giving rise to the problem, and if there is some excess metal available in the end, this further permanent deformation.

A typical can end with which the present invention may be used is that described in U.S. Application Ser. No. 103,255, now Pat. No. 3,757,989, which offers some singular advantages. In addition to including an inseparable tear strip, there are coined formations in the area of the score line, used to prevent formation of sharp edges, which tend to create excess metal which may be deformed under certain conditions of pressure, as heretofore described. In that structure, where the can is to be exposed to comparatively high pressures, the fact that the rivet is adjacent to the chime with the tab being directed or pointed towards the center of the can gives rise to conditions which have been discovered to cause elevation of the free end of the tab above the chime when certain pressure conditions exist. It is to this problem that the invention herein described is directed. For purposes of explanation, reference will be made to that structure although it is understood that the present invention is not limited to that structure.

Referring to FIG. **3** which illustrates a preferred form of the invention, a can end **20** is shown including an end wall **21** having a peripheral wall **22** which forms the chime when the can end is attached to a can body (not shown). A tear strip **25** is formed in the end wall **21** of the can end, and a rivet **26** is formed integral therewith for attachment of a tab **27** thereto. The tear strip **25** is defined along the major portion thereof by a score line **30** which is formed so as to pass adjacent the rivet and end in a pair of reversing curves **31** and **32.** For further explanation, reference is made to U.S. Application, Ser. No. 103,255, now U.S. Pat. No. 3,757,989.

When a user lifts the portion of the tab nearest the center of the can, the score is ruptured so that, when a finger is placed into the central opening of the tab, the tab may be lifted to sever the score and pull the tear strip **25** away from the end wall to form a pouring spout or opening. Due to the formation of the reversing curves **31** and **32** of the score line **30,** the user will not be able to tear the tear strip away from the can end. Instead, the tab and tear strip will remain attached to the can end and when the can is discarded, the tear strip and tab will be discarded along with it.

The tab **27** includes an integrally formed tail **33** positioned within the open space of the tab. As illustrated, the rivet **26** is adjacent to the chime **22,** with the tab extending generally towards the center of the can, with the free end **34** of the tab overlying the score line and the tear strip.

A similar can end has been illustrated in FIG. **4,** shown piror to the time that the rivet **26** is staked over the tail **33** of the tab **27.** As shown in FIG. **4,** the score line **30** is formed on a ledge **35** intermediate the end wall **21** and the tear strip **25.** As illustrated, the ledge is continuous and includes a pair of reversing curves **31a** and **32a,** each of which terminates in a second reversing curve **36, 37,** respectively. The ledge includes a portion **39** between the second reversing curves **36,** 37, the portion **39** forming a generally V-shaped curve, the apex of which is directed toward the tab **27.** Relative to the end wall, the ledge **35** is at approximately the same depth as the upper surface of the material **40** surrounding the unstaked rivet **26.** The portion **40** of the can end is of a reduced thickness, due to the formation of the rivet dimple **26** and, in this particular process, the portion **40** is so formed that its upper surface is approximately the same level as the upper surface of the ledge **35.** Since both elements are of approximately the same thickness and at the same depth relative to the upper surface of the end wall **21,** the score line, where formed, will be continuous and the residue, i.e., the metal between the bottom of the score line and the inner surface of the can end, will be substantially equal. This will allow the can end to be scored without creating areas of weakness in the residue which might cause microscopic tracks to be formed and result in leakage of the contents or contamination.

As illustrated in FIG. **5,** the ledge **35** is formed between a pair of vertically extending offsets **41** and **43,** the vertical offsets extending in oppsoite directions and

being spaced laterally from each other, as shown. The vertical offsets **41** and **43** function to produce protective surfaces which will prevent a user from cutting himself on the sharp edges of the severed score. In other words, when the score **30** is severed along its length, the vertical offset **41** will prevent the portion of the score at the end wall panel **21** from cutting the lips of the user and the vertical offset **43** will prevent the portion of the score on the tear strip **25** from cutting his fingers or nose when he drinks from the can. It will be realized, of course, that the illustration of the can end shown in FIG. **5** is highly enlarged. In actual practice the width of the ledge **35** will be approximately 0.030 inches. Thus, with the score positioned between the vertical offsets, the distance between the remaining edge of the severed score and the adjacent offsets will be approximately 0.015 inches or less. This dimension is small enough to prevent the score edges from cutting into the user's skin.

The can end of FIGS. **3** and **4** is a typical embodiment of the present invention, means being provided in the end wall **21** to eliminate or substantially minimize the effect of pressure within the can tending permanently to bulge the end wall with the result that the free end of the tab rises above the can chime. In the form shown, a depression **45** is provided in that portion of the tear strip **25** adjacent to the rivet **26**, and in the form illustrated, the depression is generally triangular in shape with one leg **45***a* thereof being adjacent to the rivet and the remaining legs **45***b* and **45***c* extending away from the rivet **26**.

The details of the structure of the depression **45** are shown in FIGS. **6** and **7**, wherein like reference numerals have been applied where appropriate. As illustrated, the depression **45** is of unequal depth, the deepest portion of the depression being defined the wall **45***a* closest to the rivet. The shallowest point of the depression is **45***d*, the intersection of legs **45***b* and **45***c*. The triangular depression is believed to perform several functions which may be understood from the following:

The coining operation by which the ledge **35** is formed affects a reduction in the cross-section of the stock from approximately 0.0135 inches to 0.008 inches, and thus, some metal is displaced. Due to the small amount of excess metal, particularly in a structure in which a coined ledge is present, additional metal is present such that if the pressure on the interior of the can increases significantly, the excess metal is available to permit the top to crown or bulge. Thus, one function of the depression **45** is to absorb the displaced metal arising from the presence of the ledge **35** to prevent the end from taking a permanent set when exposed to pressure.

If the solution to the problem were merely absorbing additional metal, virtually any shaped depression would accomplish that singular objective. Experience in the development of the can and of the present invention, however, has indicated that merely placing a dimple in the end, extending either downwardly or upwardly either does not perform as satisfactorily as the triangular depression **45**, heretofore described, or presents tooling problems. A possible explanation of why the triangular depression **45** works effectively may be understood in connection with FIGS. **7** through **10**, wherein like reference numerals have been used where applicable.

As will be apparent from the preceding discussion, any increase in pressure on the interior of the can will cause the can end to bulge upwardly (FIG. **10**), or to the right as viewed in FIG. **9**. In observing cans of the present invention which have been pressurized, it was noted that the portion of the tear strip **25** defined by the ledge **35** tended to bulge in a manner somewhat differently from the remaining portion of the end. Not only did the entire end crown slightly, but there was a separate and discernible crown of that portion of the tear strip defined within the ledge **35**. In each instance, the crowning was in two directions, i.e., that portion of the tear strip along the reference **9—9** of FIG. **8** was crowned in the long axis, as well as at right angles to that long axis, i.e., along the line **10—10**.

As the pressure is increased, the can end tends to move upward with the free end of the tab initially remaining in contact with the can end. As the pressure is increased further, the angular orientation of the pull tab is such that the free end thereof is above the can chime. Thereafter, if the pressure is decreased, the can end in accordance with the present invention was observed to recover even though it remained slightly crowned. Thus, it is believed that the depression **45** performs two functions, one to take up excess metal preventing a permanent set from developing. Secondly, within the range of lower pressures, the deeper portion of the depression in the area of wall **45***a* tends to pull the tab down against the end of the can, since it appears that the portion of the can end between the leg **45***a* of the depression **45** and the center of the can out to the opposite peripheral wall **51** acts as one lever element, while the portion of the can end between the deep leg **45***a* of the depression, the rivet **26** and the adjacent wall **52** acts as a separate lever within the lower pressure range. Obviously, as the pressure exceeds a certain limit, the entire can end responds. In tests of the can end in accordance with the present invention, it was observed that at 100 p.s.i., the free end of the tab was above the chime. However, as the pressure was reduced, and reached approximately 40 p.s.i., the free end of the tab became recessed below the chime and remained in engagement with the end wall even though the end wall remained slightly bulged.

To assist in preventing the end of the can from taking a permanent set at the higher pressures, a pair of depression ridges **55** may be formed in the end of the can, each depression ridge being spaced slightly from the ledge **35** as shown in FIGS. **3**, **4** and **8** through **10**. These depression ridges are formed with flat bottoms as shown in FIG. **9**, and operate as reinforcing levers to prevent the center portion of the can top from achieving a permanent set in the crowned position along the axis **9—9** of FIG. **8**. Since they are outside of the area defined by the ledge **35**, another function is believed to be that of maintaining the remaining portion of the can end from taking a permanent set in the crowned position along axis **10—10** by taking up any loose metal resulting from the long leg **56** of the ledge which is adjacent to but spaced from the respective depression ridges. Also, these ridges act as reinforcing elements in a direction along their axis.

An additional optional depression **60** is formed at the apex **39** of the V-shaped portion of the ledge **35**, principally for the purpose of taking up any loose metal which may have been created by that portion of the ledge between the two reversing curves **36** and **37**. This

depression **60** has been found useful in those instances in which the can is to be exposed to moderately high pressures, in the range of 100 pounds p.s.i.

Due to the relatively high pressures involved in operations such as pasteurization, some provision is preferably made to maintain score line integrity to prevent the entire score line from being ruptured as a result of internal pressure. Also, integrity of the score line operates to prevent "blow-off" during opening of the can. Referring to FIG. **11**, it will be observed that a scoring tool **70** is used which includes a shoulder **71** on each side of the scoring die **73**. This type of scoring die, when used in connection with a suitable die **75**, affects a reduction somewhat in the cross-section of the portion of the ledge adjacent to score line. not only does this provide integrity for the score line, but it permits formation of a score line without adversely affecting any coating which may be on the under side of the can top as previously described.

Referring now to FIGS. **12** and **13**, the relative position of the tear strip **25** and attached tab **27**, after the tear strip has been severed, is illustrated. For the reasons previously described, the edge portion of the tear strip and the remaining portion of the can top by virtue of the vertical walls **41** and **43**, operate to reduce substantially the possiblity of the user being cut.

Referring now to FIG. **14**, further stability of the tab in response to pressure may be achieved by so arranging the tail **33** of the tab **25** that it is inclined towards the can top. In practice, an angle of between 11° and 17° downward from the horizontal has operated satisfactorily inproviding a tail which resiliently urges the tab towards the can. Beyond about 17° to 18°, the metal, in the case of aluminum, has been so worked as to become permanently deformed and not resilient. This view, while on a much enlarged scale, also illustrates the details of the relative position of depression **45** with respect to the rivet and the closely adjacent can chime.

Another structural element which may be used to retain the tab close to the can top involves reducing the cross-sectional thickness of that portion of the tab which overlies the ridges **80** which are between the depression ridges **55** and the ledge **35**, as shown in FIG. **10**. These ridges are at a heighth equal to the remaining portion of the can end, while the depression ridges are of a depth approximately equal to that of the ledge **35**.

As shown in FIG. **15**, the portions **86** of the underside of the tab **27** which overly the ridges **80** have been reduced in cross-sectional dimension prior to attachment of the tab to the rivet. Reduction in cross-section of few thousandths of an inch assures that the tab remains close to the end even in the event that the pressure of the can is increased, or in the event that residual pressures tend to maintain the can crowned.

In the formation of the preferred form of can top in accordance with the present invention, the sequence of steps involves starting with a can end blank which normally includes the usual chime sealing material **82** shown in FIG. **10**. Various sealants or protective materials may be used as is known in the art. The underside of the can end blank may be coated with a protective coating, depending on the ultimate use of the formed can end. In the first operation, a bubble is formed, which is later formed into a button to be used as the rivet. At the same time as the bubble is formed into a button, depression ridges **55** are formed in the end wall. In the next sequence, the ledge **35** is formed along with the triangular depression **45** and the optional depression **60**. In the next operation, the score line **30** is formed, preferably in the manner previously described. Thereafter, the pull tab is staked to the end, the tail of the pull tab having previously been inclined between 11° and 17° for the reasons discussed. An optional step involves doming the entire top slightly depending upon whether or not the can end is to be used for beer beverages or other types of beverage.

Thus, in the various forms shown, and with reference to the preferred form including a non-removable tear strip, it will be apparent that the triangular depression and the depression ridges cooperate, and the preferred form of the present invention includes use of both the triangular depression and the depression ridges in order to provide a can end with stability over a wide range of pressures. It will be apparent, therefore, that for the more severe pressure conditions both the triangular depression and the depression ridges are desirable. However, if the can is to be used with only moderate internal pressure conditions, the use of the tringular depression operates satisfactorily from the standpoint of preventing the top from taking a permanent set. Resistance to blow-off may be enhanced by the use of score die of the type previously described in which the integrity of the score line is increased somewhat.

As will be apparent from the foregoing, a much improved easy-open can end is provided which is capable of withstanding considerable pressures, e.g., 100 p.s.i. without taking a permanent set such that the end of the pull tab remains above the can chime. As pressure is reduced, e.g., 35–40 p.s.i., the can end recovers and the end of the pull tab assumes a position below the chime. These advantages have been achieved using can end stock of conventional gauge and bodies of standard dimensions. Thus, an improved easy-opening can end usable over a wide variety of pressure conditions is provided.

Many modifications, alterations and similar changes to the above-described embodiments of this new and improved structure will now become apparent to those skilled in the art without exceeding the protected scope of this invention as defined in the following claims.

WHEREFORE, what is claimed as the invention is:

1. An easy-open can end comprising:

an end wall surrounded by a peripheral wall which defines the can chime,

a score line in said end wall defining a tear strip, tear strip being in said end wall and including a portion adjacent to said peripheral wall,

a tab means including a free end for pulling said tear strip away from said end wall by severing along said score line to form an opening which is larger adjacent said chime than in the center of said end wall,

a means affixing said tab means to said tear strip,

said free end of said tab means being positioned to overlie at least a portion the score line of said tear strip,

means in said tear strip of said can end for preventing said can end from assuming a permanently domed configuration when exposed to pressure from within said can tending to bulge said can end and permanently raising the free end of said tab means above said chime,

said means in said tear strip being a depression adjacent to said means for affixing said tab means, and

said depression having a depth in the portion thereof adjacent to said affixing means which is greater than the remaining depth of said depression.

2. The can of claim **1** wherein

said depression is generally triangular in shape and of unequal depth,

said depression being oriented such that one leg of the triangle is adjacent to said affixing means and the remaining two legs extend away from said affixing means,

and the portion of said depression defined by the said one leg being deeper than the remaining portion of said depression.

3. The can of claim **1** wherein

said score line includes predetermined configurations therein for preventing the complete severance of said score line, thereby preventing complete detachment of said tear strip from said end wall.

4. The can end of claim **1** further including

means defining an offset formed within said tear strip,

said offset extending substantially perpendicular to the major portion of said tear strip and being positioned immediately adjacent to said score line and defining the means for substantially reducing penetration of a consumer's skin by the edges of said score line on said tear strip and said end wall when these edges contact the consumer's skin.

5. The can end of claim **1** wherein

said depression is generally triangular in shape and positioned between said means affixing said tab and the free end of said tab.

6. The can end of claim **1** wherein

said affixing means is positioned between the center of said can and said peripheral wall,

and the free end of said tab means being located between the center of said can end and said peripheral wall.

7. The can end of claim **1** further including depression ridges adjacent to but spaced from said score line.

8. The can end of claim wherein

said tab means includes a tail extending inwardly of said tab means,

said affixing means being a rivet intergral with said can end and affixed to said tail and said tail being inclined toward said can end to maintain said tab resiliently urged toward said can end.

9. The can end of claim **7** wherein said depression ridges include bottom portions which are essentially flat.

10. The can end of claim **1** wherein said tear strip includes means to prevent complete severance of said score line.

11. The can end of claim **1** further including

means forming a ledge intermediate the end wall and the tear strip,

and said score line being located on said ledge.

12. The can end of claim **1** further including

means forming a ledge intermediate the end wall and the tear strip,

said ledge being continuous and including a pair of reversing curves,

each of said reversing curves terminating in a second reversing curve,

and the portion of said ledge between said second reversing curves forming V-shaped curve, the apex of which is directed toward said tab.

13. The can end of claim **12** wherein

said score line is located on said ledge and terminates short of said second reversing curve to prevent complete severance of said tear strip.

14. The can end of claim **12** wherein

the portion of said ledge adjacent to said score line is of reduced cross-sectional thickness.

15. The can end of claim **12** further including

means forming a depression between the apex of said V-shaped curve and the chime of said can.

16. The can end of claim **13** further including

means forming depression ridges adjacent to but spaced from said ledge.

17. The can end of claim **16** wherein

said tab overlies a portion of said depression ridges and the portion of said can end between said ledge and the depression ridges,

and the portion of said tab overlying the portion of said can end between said ledge and depression ridges being flattened to maintain the free end of said tab close to said can end.

18. An easy-open can end comprising

an end wall and a chime,

a tear strip in said wall,

a score line in said end wall defining said tear strip,

tab means attached to said tear strip and having a free end extending toward the center of the can end,

said score line having force reversing curves formed therein to prevent complete removal of said tear strip from said end wall when said score line is severed,

means in said tear strip closely adjacent to said score line for preventing penetration of user's skin by the edge of said score line remaining on said tear strip when said score line is severed by pulling said tear strip away from said end wall,

means in said tear strip of said can end for preventing the free end of said tab means from extending above said chime in response to pressure within said can tending to bulge said end wall,

said means in said tear strip being a depression adjacent to the location of attachment to said tab means, and

said depression having a depth in the portion thereof adjacent to the location of attachment to said tab means which is greater than the remaining depth of said depression.

19. The can end of claim **18** wherein

said means in said can end further includes depression ridges adjacent to said score line.

20. The can end of claim **18** wherein

said depression is generally triangular in shape.

* * * * *