Feb. 18, 1969 O. L. BROWN 3,428,210

CAN END WITH OFF CENTER RIVET

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Fig. 1

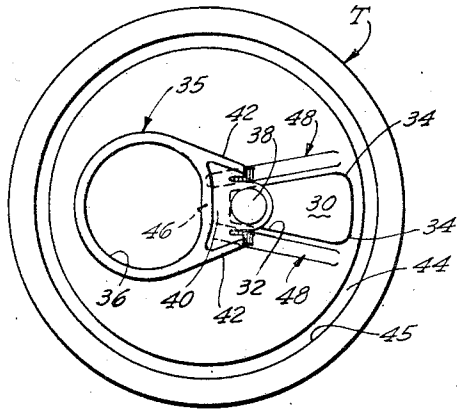


Fig. 15

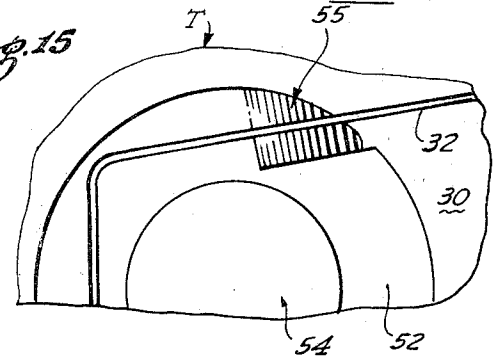


Fig. 2

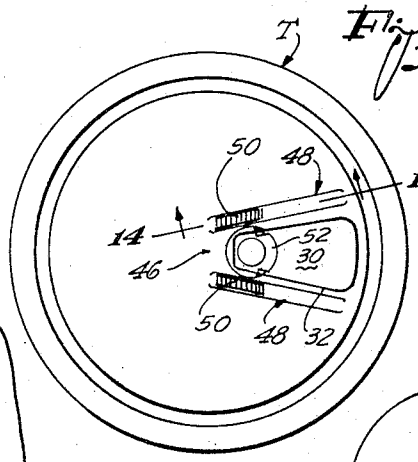


Fig. 3

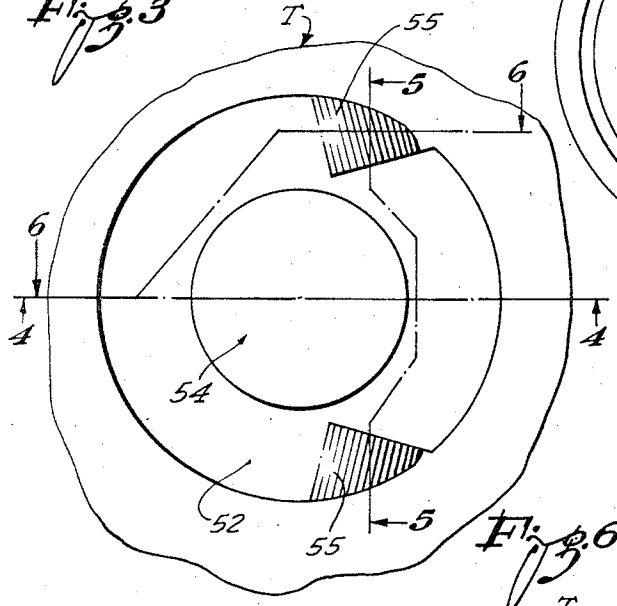


Fig. 5

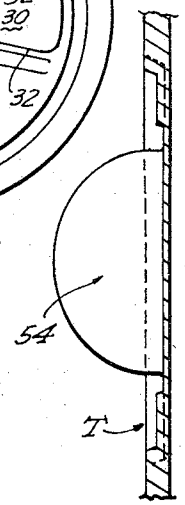


Fig. 6

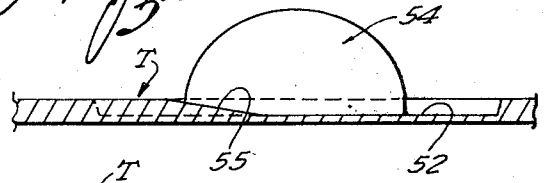
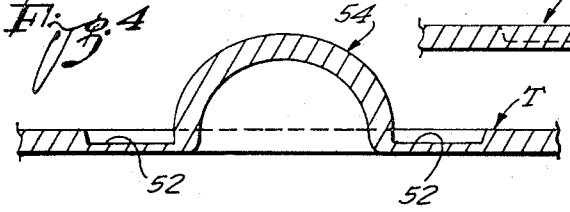


Fig. 4



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Fig. 13

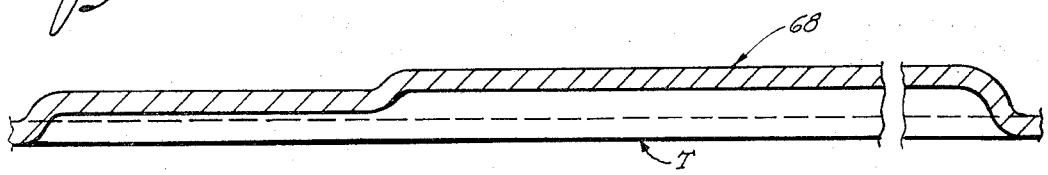


Fig. 14

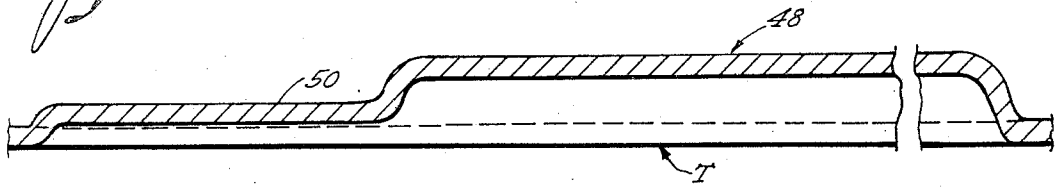


Fig. 7

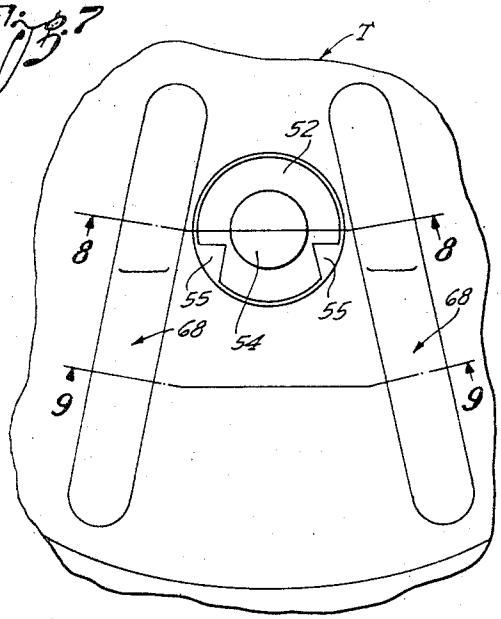
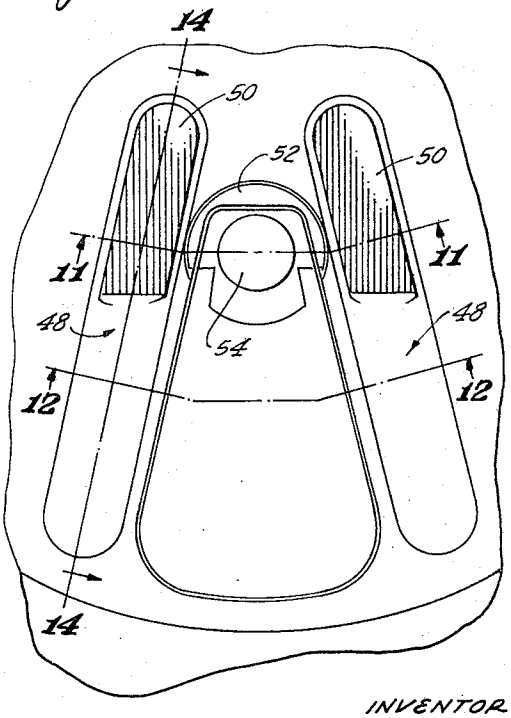


Fig. 10



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Fig. 8

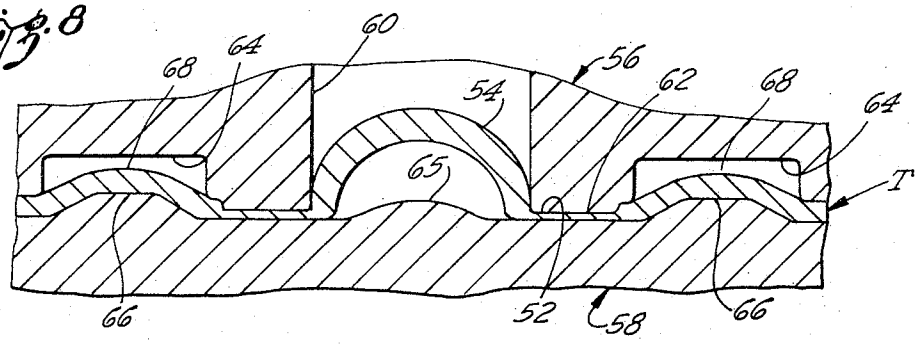


Fig. 9

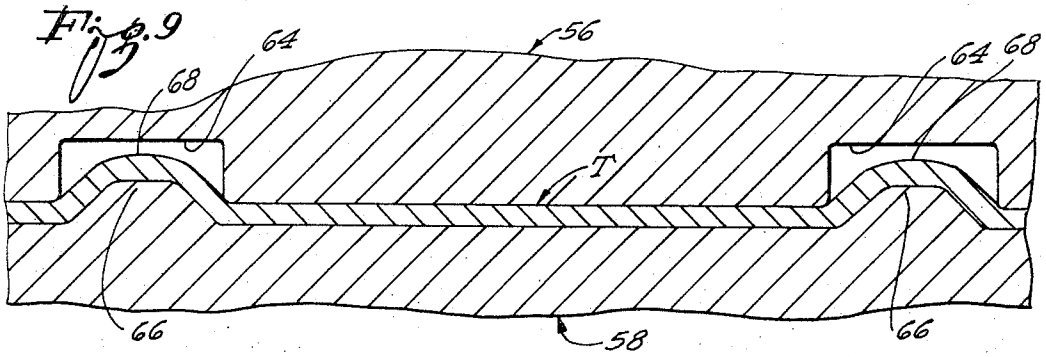


Fig. 11

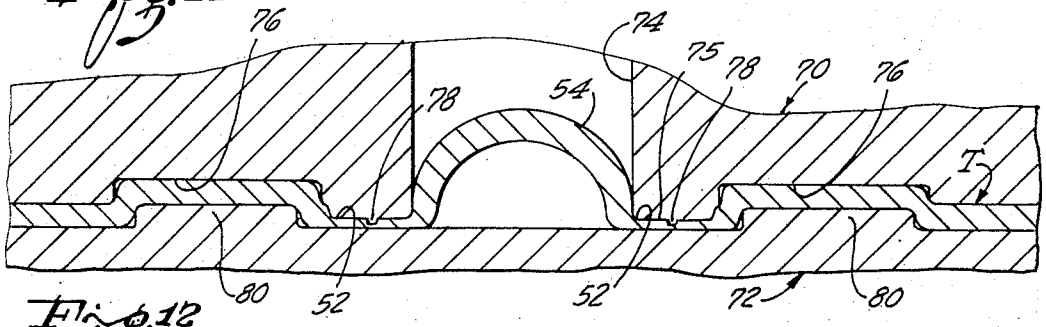
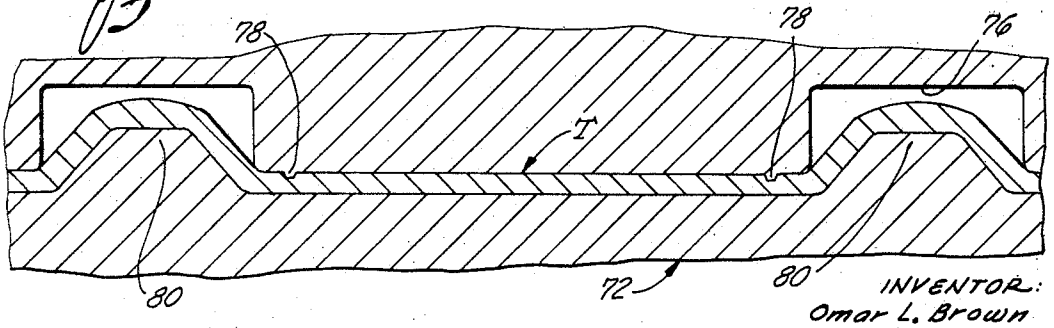


Fig. 12



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Fig. 16

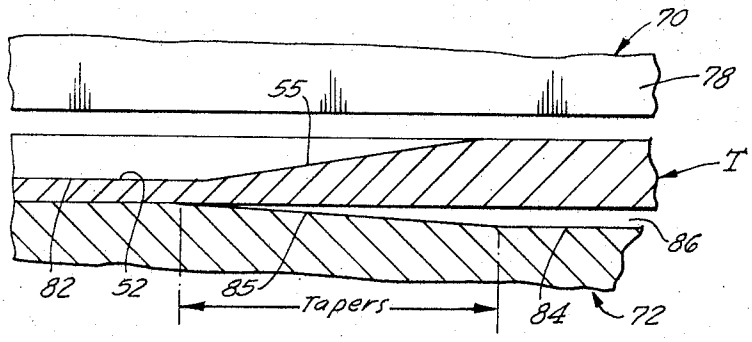


Fig. 17

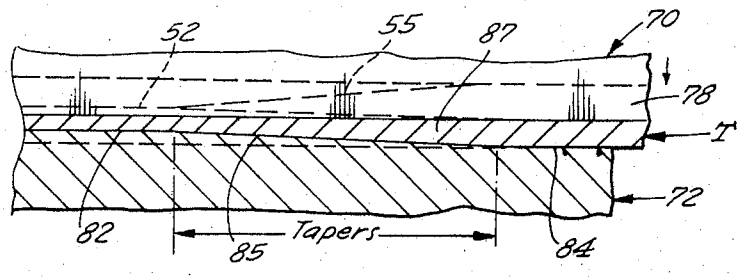


Fig. 18

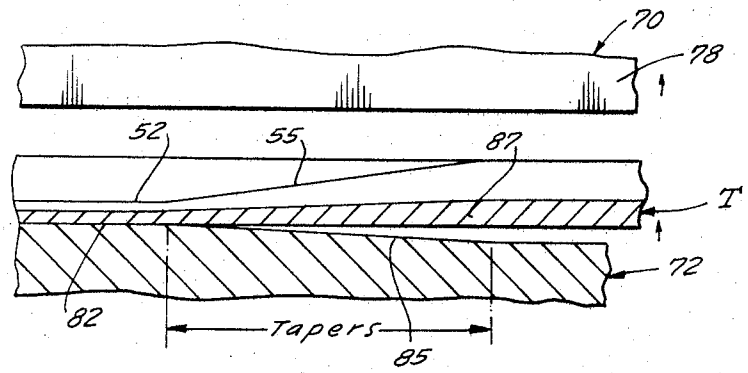
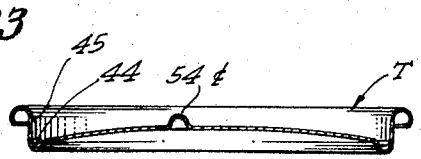


Fig. 23



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Fig. 19

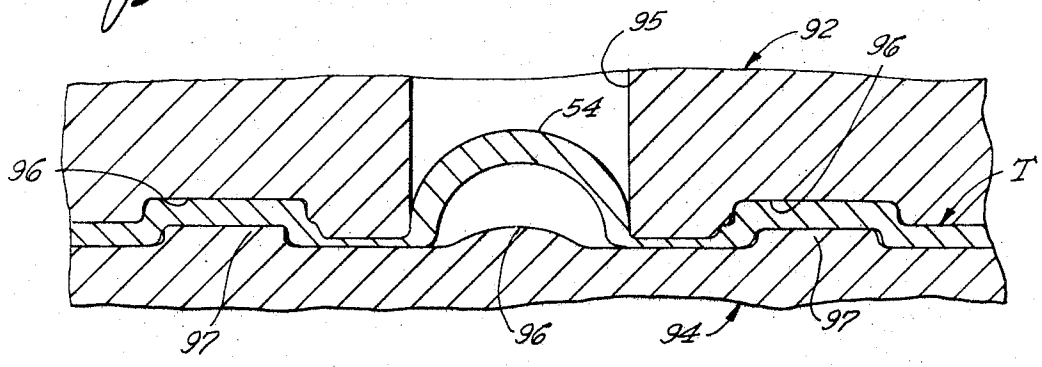
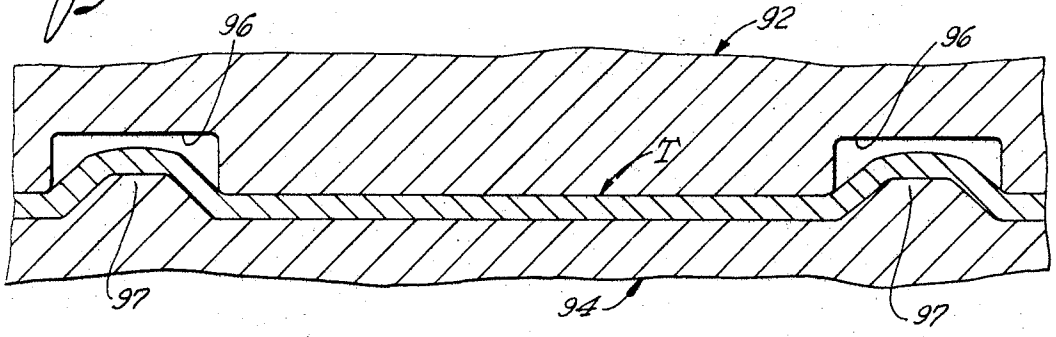


Fig. 20



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Fig. 21

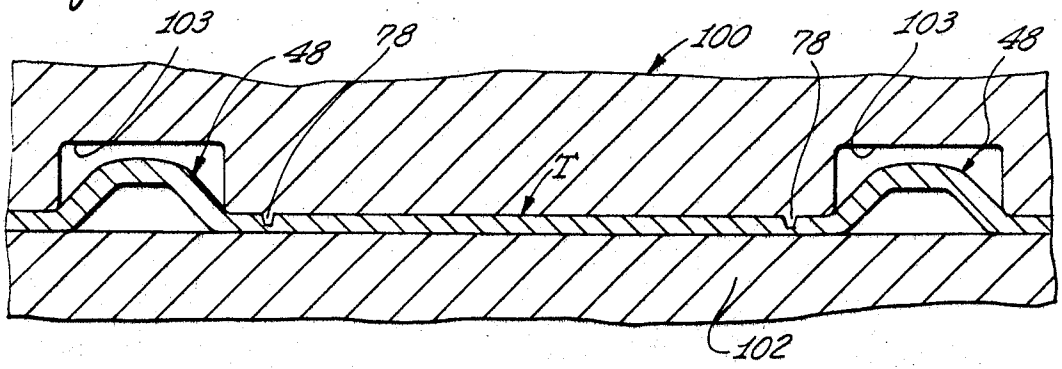
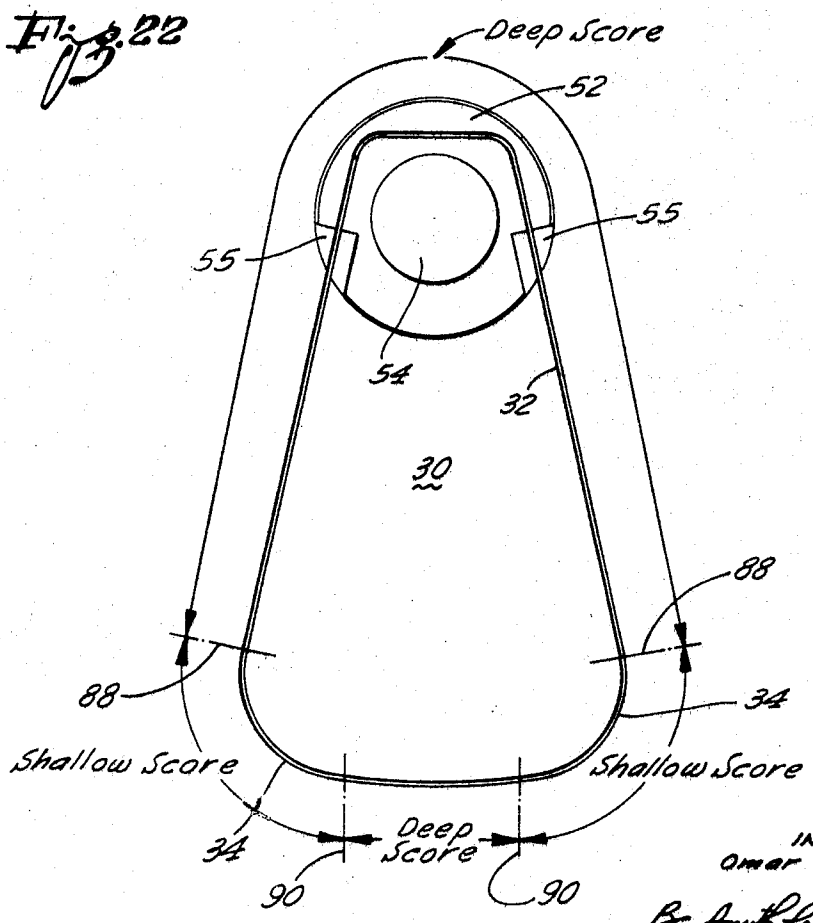


Fig. 22



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United States Patent Office 3,428,210
Patented Feb. 18, 1969

3,428,210

CAN END WITH OFF CENTER RIVET

Omar L. Brown, Dayton, Ohio, assignor, by mesne assignments, to Ermal C. Fraze, Dayton, Ohio

Filed July 15, 1966, Ser. No. 565,538
U.S. Cl. 220—54 12 Claims
Int. Cl. B65d 17/20, 7/04, 17/24

ABSTRACT OF THE DISCLOSURE

This disclosure describes an easy-opening container wall having a tab secured to a tear strip. In one form of the invention the tab has two fulcrum end portions which are adapted to bear against ribs formed integrally with the container wall. In another form, the residual web defining the tear strip is of maximum thickness along nonlinear portions of the score line adjacent the trailing end of the tear strip to thereby prevent spontaneous removal of the tear strip.

This invention relates to easy opening cans of the type commonly filled with beverages and is directed to a number of problems that relate to the fact that the tops of beverage-filled cans are inevitably of outwardly bowed or domed configuration.

Some of the problems with which the invention deals stem from the fact that no part of the top of a filled can should protrude beyond the rim of the can to interfere with stacking and handling of filled cans. In other words, all of the structure of the top end wall of a filled easy opening can must be confined to the shallow head space that is defined by the cylindrical rim flange of the can top.

If the top of a filled can bows outward excessively, the depth of the rim flange must be increased accordingly with consequent increase in cost per can in a situation where an exceedingly small fraction of a cent per can looms large in a mass production total. If the top of a filled can bows outward moderately but a tab for severing a tear strip of the can top protrudes excessively or a hollow rivet for anchoring the tab to the tear strip protrudes excessively, again a costly increase in the head space becomes mandatory. If it is possible to reduce the head space of a filled can, the cost of the can may be correspondingly reduced without reducing the capacity of the can or, instead, the capacity of the can may be increased without increasing the cost of the can.

Any measures that are taken to reduce the outward bowing of a filled easy opening can must take into consideration the metal-spreading effect of certain fabrication steps. Notably, the forming of a hollow rivet in the tear strip has a spreading effect on the sheet metal which is quite pronounced and especially so if a highly desirable method of forming the rivet is employed which involves substantial radial extrusion of the metal in an annular zone around the hollow rivet. The scoring of the metal to form the tear strip also has a spreading effect because the penetration of the sheet metal by the scoring tool displaces the metal in opposite directions.

The spreading of the sheet metal by these two fabrication steps, in effect, increases the area of the can top and the excess metal causes the can top to buckle or warp in an irregular manner. Such a can top is bistable in that the buckling of the sheet metal out of the plane of the can top is predominately in one direction and may be reversed in direction with a snap action.

The cans are filled with the liquid with the cans in upsidedown position, the can top being lowermost, and the last step is the assembling of the can bottom to the cylindrical body. During the filling operation the buckle

of the can top which is lowermost may suddenly reverse or flip with a snap action that causes some of the liquid to spill from the can with consequent reduction of the can content. Such troublesome cans are commonly termed "flippers."

Later when substantial fluid pressure develops in the filled can, the pressure causes the can top to bow outward by taking up the slack that is available in the buckle of the sheet metal. Thus the extent to which the top of the filled can is bowed outward by internal pressure depends upon the extent to which the prior steps of fabricating the can top have made available excess metal to permit the outwardly bowed configuration.

The present invention reduces the ouwtard bowing of a can top by reducing the extent to which the fabrication steps make excess metal available for the bowing. The invention also, in effect, reinforces the can top to resist the bulging of the sheet metal by the fluid pressure. In addition, the invention substantially eliminates buckling or warp of the can top and thus eliminates "flippers."

With reference to reducing the available excess metal that is created in a can top by a fabrication step, it is old in the art to offset the sheet metal of a can top in various ways to take up metal after the rivet forming and scoring operations are completed and thus contract to some degree the buckled sheet metal. Both inwardly protruding ribs and outwardly protruding ribs have been formed in can tops for this purpose of reducing the buckle. The present invention, however, is based on the discovery that superior end results may be obtained by offsetting the sheet metal simultaneously with any fabrication step that tends to spread the sheet metal. It has been found that once a buckled condition is created in a can top, offsetting the sheet metal to form ribs or the like has limited corrective effect on the buckle, but on the other hand, offsetting the sheet metal concurrently with such a fabrication step is highly effective to counteract buckling of the metal.

One reason for it being difficult to reduce a previously created buckled state by offsetting the sheet metal is that the buckled configuration per se creates resistance to remedial shifting of the sheet metal. Apparently another reason is that the stressing of the metal by the fabrication steps stiffens the sheet metal by workhardening and by orientation of the grain of the metal. The most important difference, however, between remedial action to correct a buckling that is already formed and preventative action concurrent with a metal-spreading fabrication step is that, in the first instance, the sheet metal is in a static state when the counteracting step is taken and, in the second instance, the sheet metal is in a favorable dynamic state.

Where an operation on the sheet metal of the can top pushes the metal in opposite directions from a processing zone, the invention takes advantage of this fact by simultaneously pulling the metal in the same opposite directions in the two corresponding offset zones. Thus two forces instead of one force act on a particle of metal simultaneously in the same direction, one force tending to buckle the sheet metal and the other concurrent force negating the tendency to buckle.

In the fabrication of a prevailing type of easy opening cans, a rivet-forming operation is carried out first, and subsequently the can top is scored to form the tear strip. A feature of the invention is the manner in which the successive buckling tendencies of these two operations are met by successive simultaneous countermeasures.

In one practice of the invention offset ribs are formed in the sheet metal simultaneously with the rivet forming operation to counteract the concurrent buckling tendency and subsequently the same ribs are enlarged concurrently with the scoring operation to again counteract a buckling

tendency. In a second practice of the invention, rib-forming dies act directly on the sheet metal to form ribs during the rivet forming operation, just as in the first practice of the invention. During the subsequent scoring operation, however, the dies merely clear the previously formed ribs but the sheet metal is free to slide under guidance away from the scoring zone towards the ribs to enlarge the ribs.

The invention also teaches that advantage may be taken of the fact that if two laterally spaced ribs are formed simultaneously by offsetting the sheet metal, the sheet metal between the two ribs is placed under tension. In both practices of the invention the two ribs that are offset in the metal during the rivet-forming operation are orientated to straddle the intended location of the tear strip so that the area of the intended tear strip is placed under transverse tension and a part of the displacement of sheet metal by the subsequent scoring step serves merely to relieve this tension instead of causing the sheet metal to buckle.

The ribs that are formed in the can top to forestall buckling are advantageous in that they stiffen the sheet metal to resist subsequent outward bowing of the can top by fluid pressure. With the two ribs stiffening the sheet metal and straddling the location of the hollow rivet, the hollow rivet stays in the plane of the two ribs instead of moving outward in response to internal fluid pressure. The formation of the two ribs also increases the amount of metal immediately adjacent the score lines along the two sides of the tear strip and thus reduces the extent to which the residual webs of metal along these lines are stressed or placed in tension longitudinally by the internal fluid pressure. Another advantage in the preferred practice of the invention is that the two flanking ribs are dimensioned and located to serve as lip guards when the user drinks the beverage directly from the can.

In the preferred practice of the invention, the tab that facilitates the severance of the tear strip functions as a second-class lever and fulcrums against the sheet metal adjacent opposite sides of the tear strip. In this regard, a further advantage of the invention is that the two ribs are located to receive the fulcrum pressure of the tab, the ribs serving to reinforce the can top to resist inward yielding of the metal.

Other advantages of the preferred practice of the invention result from the provision of a relatively short radially positioned tear strip with the leading end of the tear strip spaced radially from the center of the can top. One important advantage is that the hollow rivet that attaches the tab to the tear strip is spaced radially away from the region of maximum outward bowing of the can top. Another important advantage is that the off-center location of the hollow rivet provides more room for the tab. The greater amount of available space for the tab makes it possible to do one of two things, either to provide more access room for manipulation of a tab of conventional size or to employ a tab that is larger than conventional size. In the preferred practice of the invention, the tab is a ring-shaped member and the greater space that is available makes it possible to employ a relatively large tab in which the ring opening is large enough to receive a man's finger.

A further feature of the preferred practice of the invention relates to the desirability of making the tear strip as easy to move as possible without inviting spontaneous severance of the tear strip by fluid pressure. Spontaneous severance is a serious hazard because the abruptly released tear strip is projected away from the can at high velocity.

Manual severance of the tear strip is facilitated by a number of provisions including: making the tear strip of generally triangular configuration, the smaller end being the inner leading ends; employing a relatively small rivet to attach the tab to the leading end of the tear strip thereby to make it possible to make the leading end of the tear strip relatively narrow; by coining or squeezing the metal to make the metal relatively thin in the region of the leading end of the tear; scoring the metal to maximum depth around the leading end of the tear strip to leave a residual web of minimum thickness; scoring the metal to moderate depth along the two longitudinal sides of the tear strip and along the trailing edge of the tear strip.

The hazard of spontaneous severance is reduced by the two ribs inasmuch as the two ribs reduce the load in tension longitudinally of the lines of scoring along the two sides of the tear strip. The possibility of spontaneous severance is further reduced by scoring the metal relatively lightly at the two corners of the trailing end of the tear strip to make the residual web of metal relatively thick at these two points.

By virtue of the described features the tear strip readily withstands the static pressure of the fluid in the container to preclude spontaneous severance. On the other hand, it is easy to initiate severance at the leading end of the tear strip and the momentum of manually peeling away the tear strip readily overcomes the relatively thick residual web at the two rearward corners of the tear strip.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a plan view of the completed can top illustrating a selected practice of the invention;

FIG. 2 is a similar view of the can top prior to the final step of mounting a tab on the tear strip;

FIG. 3 is a greatly enlarged fragment of FIG. 2 showing how the sheet metal of the can top is squeezed in the process of forming a hollow rivet, the squeezing operation resulting in an annular zone around the hollow rivet in which the outer surface of the sheet metal is depressed to a lower level with two inclined ramps providing transitions between the two levels;

FIG. 4 is a transverse section along the line **4—4** of FIG. 3;

FIG. 5 is a transverse section along the irregular line **5—5** of FIG. 3;

FIG. 6 is a section along the irregular line **6—6** of FIG. 3 showing how a ramp makes a transition between the two levels of the outer surface of the can top;

FIG. 7 is a fragmentary plan view of a can top with a newly formed hollow rivet therein showing a pair of ribs that are formed simultaneously with the rivet;

FIG. 8 is a greatly enlarged fragmentary cross section taken along the line **8—8** of FIG. 7 showing how a pair of dies cooperate to form the rivet and the two ribs simultaneously;

FIG. 9 is a similar sectional view showing how the same two dies cooperate to form other portions of the two ribs;

FIG. 10 is a view similar to FIG. 7 showing the state of the can top after a subsequent operation in which the can top is scored to form a tear strip and simultaneously the two previously formed ribs are reformed and enlarged;

FIG. 11 is a cross-sectional view taken along the line **11—11** of FIG. 10 and showing how a pair of dies cooperate to score the can top in the region of the previously formed hollow rivet and to reform adjacent portions of the two ribs;

FIG. 12 is an enlarged cross section along the line **12—12** of FIG. 10 showing how the two dies of FIG. 11 cooperate to reform other portions of the two ribs;

FIG. 13 is an enlarged section along the line **13—13** of FIG. 7 showing the configuration of one of the ribs after the initial forming operation that is carried out simultaneously with the forming of the rivet;

FIG. 14 is an enlarged section taken along the line

14—14 of FIG. 8 and the line 14—14 of FIG. 10 and showing the final longitudinal configuration of a sheet metal rib after the rib is reformed simultaneously with the scoring of the can top;

FIG. 15 is an enlarged portion of FIG. 2 showing how the groove or line of scoring that forms the tear strip extends down a ramp to the lower surface of the depressed area surrounding the hollow rivet;

FIG. 16 is a greatly enlarged fragmentary sectional view showing how a pair of dies cooperate to form the groove or score line in each of the regions where the score line extends down a ramp to the lower surface area, the view showing the pair of dies open in preparation for the scoring operation;

FIG. 17 is a similar view showing the two dies closed against the material of the can top to carry out the scoring operation;

FIG. 18 is a similar view showing the can top released by the scoring dies;

FIG. 19 is a view similar to FIG. 8 showing how a pair of dies may be employed to form the hollow rivet and simultaneously form the two sheet metal ribs to final configuration in one operation;

FIG. 20 is a sectional view similar to FIG. 9 showing how the same pair of dies cooperate to form other portions of the two ribs;

FIG. 21 is a cross-sectional view similar to FIG. 12 showing how a pair of dies may be employed to score the can top after the two ribs have been formed simultaneously with the formation of the hollow rivet; and

FIG. 22 is a plan view of the tear strip on an enlarged scale.

In the selected embodiment of the invention shown in FIG. 1, the can top, generally designated T, has a tear strip **30** formed by a continuous groove or score line **32**, the tear strip being of generally triangular configuration with straight sides. The tear strip has an inner relatively narrow leading end that is blunt in plan configuration, the leading edge being substantially perpendicular to the longitudinal axis of the tear strip. It has been found that squaring the leading end in this manner to form two corners and to bring the score line close to the rivet at the leading end of the tear strip greatly facilitates initiation of severance of the tear. The tear strip has a relatively wide trailing end that is formed with rounded corners **34**. A suitable sheet metal tab **35** of a well known type has a relatively large opening **36** to receive the user's finger and is connected to the tear strip **30** by means of a hollow rivet **38** that is formed in the tear strip, the rivet extending through an aperture in the tab and being headed or staked into overlapping engagement with the rim of the aperture. In the construction shown, the tab **35** has a sheet metal tongue **40** that serves as a pliable connection between the tab and the hollow rivet. The tab is in the form of a second-class lever that is of forked construction to provide two fulcrum end portions or fulcrum arms **42** which straddle the tear strip and are shaped and dimensioned to exert fulcrum force against the can top adjacent opposite sides of the tear strip and outside of the area of the tear strip.

As shown in FIG. 1, the can top is of a conventional cross-sectional configuration being formed with an outer circumferential groove **44** and an upstanding peripheral flange **45** which in the completed can is joined to the cylindrical body of the can to form the rim or chime of the can. It is to be noted in FIG. 1 that the tear strip **30** is substantially shorter than the radius of the can as measured inside the circumferential groove **44** and that the inner or leading end of the tear strip is spaced substantially from the center of the can top, the can top center being indicated by the numeral **46**. By virtue of the tear strip **30** being dimensioned and located in this manner, the hollow rivet **38** is spaced a substantial distance from the center **46** of the can top.

It is apparent in FIG. 1 that the off-center location of the hollow rivet **38** also provides more room for the tab **35** within the circumference defined by the peripheral flange **45**. The invention takes advantage of this fact by making the tab **35** larger than would otherwise be possible, the tab being unique in this respect in that the opening **36** is large enough to receive a man's finger. It is also to be noted that even though the tab is relatively large, the off-center positioning of the hollow rivet makes available so much space for the tab that, with the tab located on the same diameter as the tear strip, there is a liberal clearance between the handle end of the tab and the upstanding flange **45** to provide room for manual access to the underside of the tab.

An important feature of the invention is the provision of a pair of outwardly protruding ribs **48** that are formed in the sheet metal of the can top along opposite sides of the tear strip **30** just outside the area of the tear strip. The two ribs **48** are in convergent positions to conform to the triangular configuration of the tear strip and extend well beyond the leading end of the tear strip into the central area of the can top.

It may be seen in FIG. 1 that the two fulcrum arms **42** of the tab **35** rest on the two ribs **48** respectively, the ribs strengthening the sheet metal to resist inward flexure of the can top in response to the fulcrum force exerted by manipulation of the tab. Preferably, the inner end portions of the two ribs **48** that lie under the fulcrum arms **42** are partially flattened, the flattened zones being shaded and designated by numerals **50** in FIGS. 2 and 10. FIG. 14 is a longitudinal section through one of the ribs and shows how the flattened portion **50** of a rib **48** is less elevation than the remained of the rib, the partial flattening of the rib reducing the extent to which the rib elevates the corresponding fulcrum arms **42** of the tab.

The hollow rivet **38** is initially formed by an operation which involves thinning the sheet metal of the can top in an annular zone **52** around the rivet, the annular zone being formed by a squeezing operation which displaces the metal radially inward to form the hollow rivet. The squeezing operation also displaces the sheet metal radially outward and it is this radial outward displacement of metal that tends to increase the extent to which the can top bulges into the head space. The initial configuration of the hollow rivet that results from the radially inward displacement of the metal is indicated by numeral **54** in FIGS. 2–8, 10, 11, 15, 19 and 22.

The operation of squeezing the metal to form the hollow rivet to its initial configuration is preferably but not necessarily carried out in such manner as to depress the level of the annular zone **52** relative to the remainder of the can top. In the preferred practice of the invention the squeezing of the metal also forms two ramps **55** on opposite sides of the hollow rivet and as shown in FIG. 6, each ramp **55** provides a transition between the lower level of the depressed annular zone **52** and the higher level of the surrounding metal of the can top.

It is contemplated that the hollow rivet in the can top will be formed to its initial configuration in one operation and that the can top will be scored to form the tear strip **30** in a separate and subsequent operation. In one practice of the invention and two ribs **48** are formed in two stages, the ribs being partially formed in one stage simultaneously with the formation of the hollow rivet and being completely formed in a second stage simultaneously with the scoring operation. FIGS. 7 and 13 show the configuration of the ribs at the end of the first stage and FIGS. 10 and 14 show the ribs at the end of the second stage. This particular practice of the invention will now be described.

FIGS. 8 and 9 show how an upper die **56** and a lower die **58** cooperate to form the hollow rivet to its initial configuration **54** and simultaneously partially form the two sheet metal ribs, i.e., form the two sheet metal ribs to an initial configuration. The upper die **56** has a central cavity **60** which is surrounded by an annular land **62**. In addition the under face of the upper die **56** is formed with

two channels **64** in which the two sheet metal ribs of the can top are to be formed to their initial configuration.

The lower die **58** has a shallow boss **65** that registers with the cavity **60** and promotes the formation of the hollow rivet in the cavity. The lower die **58** is further formed with elongated projections **66** which conform to the configuration in plan of the channels **64** of the upper die and which offset the sheet metal into the channels to form the partially completed ribs which are designated **68** in FIGS. 7, 8, 9 and 13.

It may be noted that the elongated projections **66** of the lower die **58** are somewhat angular in cross section to make the corresponding ribs angular in cross section. FIG. 8 shows how portions of the two channels **64** in the upper die and corresponding portions of the elongated projections **66** in the lower die are relatively shallow to make the inner end portions of the two ribs **68** correspondingly shallow and FIG. 9 shows how the remainder of the channels **64** are deeper and the corresponding portions of the projections **66** are also deeper to make the outer end portions of the two ribs higher than the inner end portions.

As shown in FIG. 8, the annular land **62** squeezes the sheet metal to a relatively thin thickness, the squeezing action causing the formation of the rivet to its initial configuration and causing the formation of the depressed annular zone **52**. The land **62** is cut away in two opposite regions to cause the land to form the two previously mentioned ramps **55**.

It may be readily appreciated that the squeezing of the metal to form the hollow rivet also has the effect of displacing the sheet metal radially outwardly to increase the bulging of the can top. The simultaneous production of the partially formed ribs **68** in the can top, however, takes up metal as the metal is being spread by the rivet-forming operation and does so to such extent that the formation of the rivet has substantially no bulging effect on the can top. In addition the formation of the two ribs by the first operation by virtue of drawing the sheet metal in opposite directions from the intended area of the tear places the sheet metal in the intended area under transverse tension.

The second operation in this first practice of the invention is to score the metal to form the tear strip **30** and to simultaneously deepen the two ribs in the can top to negate the bulging effect of the scoring operation. This second operation is carried out by a pair of dies of the character shown in FIGS. 11 and 12, the dies comprising an upper die **70** and a lower die **72**. The upper die **70** has a central cavity **74** dimensioned to clear the initial configuration **54** of the hollow rivet. An annular land **75** surrounds the cavity **74** to make contact with the depressed annular zone **52** of the can top and the upper die is formed with a pair of channels **76** conforming to the plan configuration of the partially formed ribs **68**. The upper die **70** is further provided with an integral scoring element **78** with a portion of the scoring element extending along the annular land **75**.

It is to be noted that the portions of the channels **76** of the upper die **70** shown in FIG. 11 are relatively shallow to conform with the previously mentioned partially flattened portions **50** of the previously described completed sheet metal ribs **48**. As shown in FIG. 12, the remaining portions of the two channels **76** are relatively deep to permit the corresponding portions of the completed can top ribs **48** to be relatively high.

The lower die **72** has a pair of projections **80** to mate with the two channels **76** of the upper die. As shown in FIG. 11, the two projections **80** are relatively shallow where the completed can top ribs are to be shallow and, as shown in FIG. 12, the projections are of greater elevation where the cross sections of the completed ribs are to be higher.

It is apparent from a comparison of FIGS. 11 and 8 that the second stage of forming of the can top ribs **48** results in appreciably flattening and widening of the inner end portions **50** of the sheet metal ribs and a comparison of FIG. 12 with FIG. 9 shows that the second stage results in both broadening and deepening the remaining portions of the rivet. The relieving of the transverse tension of the sheet metal and the taking up of additional sheet metal by the ribs compensate for the spreading of the metal in the opposite lateral directions by the scoring element **78** and thus nullifies the tendency of the scoring operation to increase the bulging of the can top.

It may be seen in FIG. 11 that the scoring element **78** penetrates the metal in the depressed annular zone **52** to great depth to leave an exceedingly thin residual web but outside of the annular zone the scoring element **78** penetrates the sheet metal to lesser depth to leave a thicker residual web as shown in FIG. 12. As shown in FIGS. 10 and 15, the groove that forms the score line extends down the two ramps **55** into the depressed annular zone **52** to loop around the initially formed rivet **54** and thereby form the leading end of the tear strip **30**. The manner in which the upper die **70** and the lower die **72** cooperate to form this portion of the groove **32** is indicated by FIGS. 16–18.

As best shown in FIG. 16, the lower die **72** is formed with a plateau **82** that conforms with the area of the depressed annular zone **52** of the can top and the lower die is further formed with a planar working face **84** that conforms with the remainder of the can top. FIG. 16 also shows how the lower die **72** is formed with a slope **85** which is a shoulder of the plateau, there being two shoulders **85** to conform to the two ramps **55** of the can top. Each slope **85** forms a transition from the level of the plateau **82** to the lower level of the planar working face **84** of the die in the same manner that the corresponding ramp **55** of the can top forms a transition from the level of the metal outside the annular zone **52** to the lower level in the annular zone. It is important to note, however, that the inclination of the slope **85** of the lower die is substantially less than the inclination of the corresponding ramp **55** of the can top. In this region around the leading end of the tear strip, the scoring element **78** of the upper die **70** conforms at its lower edge with a plane that is parallel to the working surface **84** of the lower die **72**

FIG. 16 shows the upper and lower dies **70** and **72** retracted with a can top resting on the plateau **82** of the lower die in preparation for the scoring operation. It may be noted that there is a clearance space **86** between the lower surface of the can top and the lower planar surface **84** of the lower die **72**. When the two dies **70** and **72** are operated for a scoring operation, the two dies close towards each other with consequent flexing of the can top as shown in FIG. 17, the flexed can top following the inclination of the die slopes **85** and making contact with the lower planar working face **84** of the lower die.

FIG. 17 shows the two dies **70** and **72** at their minimum spacing in carrying out the scoring operation. It may be noted that by virtue of the inclination of each slope **85** being less than the inclination of the corresponding ramp **55**, the penetration of the scoring element **78** into the metal progressively increases down the length of each ramp with the result that the thickness of the residual web **87** left by the scoring tool progressively decreases to a minimum thickness in the annular zone **52**.

FIG. 18 shows how the sheet metal springs back from the planar working face **84** of the lower die when the two dies are retracted. FIG. 18 further clearly shows how the residual web **87** left by the scoring tool progressively decreases as the residual web approaches the annular zone **52**.

In the preferred practice of the invention the residual web **87** formed by the score line **32** is of minimum thickness at the leading end of the tear strip and is of moderate thickness along the two longitudinal sides of the tear strip as well as along the trailing end of the tear strip. At each of the two corners **34** of the tear strip, however, the residual web is of maximum thickness. For example, referring to FIG. 22, if the nominal thickness

of the sheet metal stock is .0145" the residual web in the depressed annular zone **52** at the leading end of the tear strip may be only .0035–.0040" thick. The thickness of the residual web increases along each of the two ramps **55** to a thickness of .0055–.0065" and this thickness dimension prevails along the two straight sides of the tear strip outside of the annular zone **52**. Between the two lines **88** and **90** in FIG. 22 that bound each of the two corners **34** of the tear strip, the residual web may have the relatively great thickness of .009" to .012" and between the two lines **90** at the trailing end of the tear strip the residual web may again be of the moderate thickness .0055–.0065".

As may be understood from the previous discussion of FIGS. 16–18, the edge of the scoring element **78** that forms the leading end of the tear strip and the two straight sides of the tear strip is parallel to the planar working face **84** of the lower die **72**. In the region of each of the two corners **34**, however, the striking surface of the scoring element is reduced in height to make the residual web correspondingly thick.

The fact that the residual web is exceedingly thin at the leading end of the tear strip greatly facilitates initiation of the severance of the tear strip by initial lifting of the ring portion of the tab **35**. Once the leading end of the tear strip is severed the severance is continued along the two straight side edges of the tear strip by a single hand motion and the momentum of this hand motion easily overcomes the resistance of the thicker residual web portions at the two corners **34** of the tear strip. Thus the thickening of the residual web at the two corners **34** provides the required insurance against spontaneous severance of the tear strip by fluid pressure but at the same time does not offer undue resistance to the final manual separation of the tear strip from the can top.

After the hollow rivet is formed to the initial hollow configuration **54** and the can top is scored with the two sheet metal ribs formed in two stages as described, the can top is ready for the final operation of attaching the tab to the tear strip. This final operation consists first, of placing the tab on the can top with the hollow rivet extending through the aperture in the tongue **40** of the tab and, then, staking or spreading the outer end of the hollow rivet in a suitable manner to reform the hollow rivet into overlapping engagement with the tab.

The second practice of the invention illustrated by FIGS. 19, 20 and 21 differs from the first practice in that the two can top ribs **48** are substantially completely formed in one operation simultaneously with the forming of the hollow rivet.

FIGS. 19 and 20 show an upper die **92** and a lower die **94** that cooperate to form the hollow rivet and to form the two ribs simultaneously to their final configuration. The upper die **92** has the usual cavity **95** and the lower die **94** has the usual shallow boss **96** to cooperate for the forming of the hollow rivet. The upper die has the usual pair of channels **96** and the lower die has the usual corresponding elongated projections **97** for cooperation with the channels to form the two can top ribs **48** in one operation. As may be seen in FIG. 19, portions of the channels **96** and of the projections **97** are relatively shallow to cooperate to form the partially flattened portions **50** of the sheet metal ribs **48** and, as may be seen in FIG. 20, the remaining portions of the channels **96** and the projections **97** are deeper to deepen the remaining portions of the sheet metal ribs.

The second step of scoring the sheet metal to form the tear strip is carried out by a pair of dies designated **100** and **102** in FIG. 20. The two dies **100** and **102** are similar to the previously described pair of scoring dies **70** and **72** except that the channels **103** in the upper die **100** are large enough to clear the previously formed sheet metal ribs **48**. It is also to be noted that the two dies confine the sheet metal with freedom for the sheet metal to slip towards the two previously formed ribs **48**.

Two factors cooperate to compensate for the spreading of the sheet metal by the scoring operation and thus prevent buckling of the can top. One factor is that the prior operation of forming the two ribs has drawn the sheet metal in opposite directions from the intended area of the tear strip to leave the sheet metal across the area under a state of transverse tension. The relief of this transverse tension by the scoring operation partially compensates for the tendency of the scoring operation to buckle the can top.

The second factor is that the scoring dies **100** and **102** provide ample clearance for increase in depth of the previously formed ribs **48** and at the same time the two dies confine the metal between the ribs to a plane with freedom for the sheet metal to shift towards the two ribs. Any tendency of the scoring operation to increase the buckle in the can top serves instead to displace metal into the two ribs.

My description in specific detail of the selected embodiments of the invention will suggest various changes, substitutions and other departures from my disclosure within the spirit and scope of the appended claims.

I claim:

1. In the construction of a container wherein a wall of the container is scored to leave a residual web along a score line to form a tear strip with consequent buckling of the container wall and a tab is connected to the leading end of the tear strip for manual severance of the tear strip, the improvement comprising:

said tab being a second-class lever connected to the leading end of the tear strip;

said lever being forked to form two fulcrum end portions extending beyond the connection with the tear strip;

said fulcrum end portions straddling the tear strip to fulcrum against the container wall outside of the area of the tear strip;

portions of the container wall outside of the area of the tear strip along both sides of the tear strip being offset outwardly in the form of ribs;

said ribs being located under the two fulcrum end portions respectively of the lever to serve the purposes, first, of reducing said buckling, second, to locally stiffen the container wall to resist the fulcrum pressure of the tab, and third, to reduce the tension along the residual web longitudinally thereof along the two sides of the tear strip.

2. An improvement as set forth in claim **1** in which said ribs are partially flattened in the regions of the two fulcrum end portions of the tab to reduce the extent to which the ribs elevate the fulcrum end portions.

3. In the construction of a container wherein a circular end wall of the container is scored to form a tear strip and a tab is connected to the leading end of the tear strip for manual severance of the tear strip, the improvement comprising:

said tab being a second-class lever connected to the leading end of the tear strip by a hollow rivet formed in the tear strip;

said lever being forked to form two fulcrum end portions extending beyond the connection with the tear strip;

said fulcrum end portions straddling the tear strip to fulcrum against the container wall outside the area of the tear strip;

portions of the container wall outside of the area of the tear strip along both sides of the tear strip being offset outwardly in the form of ribs;

said ribs being located under the two fulcrum end portions respectively of the lever to serve the purposes of, first, reducing said bulging, second, locally stiffening the container wall to resist the fulcrum pressure of the tab, and third, to reduce the tension along

the residual web longitudinally thereof along the two sides of the tear strip;

said tear strip being positioned substantially radially of the circular end wall with the leading end of the tear strip pointing towards the central area of the end wall but terminating substantially short of the center of the circular end wall to space the hollow rivet substantially from said center; and

said ribs extending past the leading end of the tear strip towards the central area of the circular end wall.

4. An improvement as set forth in claim 3 in which said tab is of the general configuration of a ring with the off-center location of the rivet permitting the ring configuration to be of larger diameter than would be possible with a centrally located rivet.

5. In the construction of a container wherein a wall of the container is scored to form a residual web along a score line to define a tear strip having a leading end and a trailing end, the improvement to preclude spontaneous severance of the tear strip by confined fluid pressure without causing the tear strip to offer undue resistance to manual severance, said improvement comprising:

the configuration of the tear strip being characterized by corners at the trailing end of the tear strip;

the residual web being of least thickness around the leading end of the tear strip to facilitate initiation of manual severance of the tear strip;

the residual web being of moderate thickness along the two longitudinal side edges of the tear strip for moderate resistance to progressive manual severance along the side edges;

the residual web being still thicker at the corners of the trailing end of the tear strip to resist spontaneous severance without offering undue resistance to continuation of the severance of the tear strip by the momentum of the progressive severance along the side edges.

6. An improvement as set forth in claim 5 in which the thickness of the residual web across the trailing end of the tear strip between the corners is less than the thickness at the corners to reduce the resistance to final separation of the tear strip from the container.

7. In the construction of a container wherein a wall of the container is scored to form a residual web along a score line to define a tear strip having a leading end and a trailing end, the improvement to preclude spontaneous severance of the tear strip by confined fluid pressure without causing the tear strip to offer undue resistance to manual severance, said improvement comprising:

the residual web being of least thickness around the leading end of the tear strip to facilitate initiation of severance of the tear strip;

the residual web being of moderate thickness along the longitudinal sides of the tear strip to preclude spontaneous severance of the tear strip without offering undue resistance to progressive severance along the two longitudinal sides of the tear strip after severance is initiated; and

the residual web being of greatest thickness at two laterally spaced regions of the trailing end of the tear strip to preclude spontaneous severance without offering resistance to continuation of the severance of the tear strip by the momentum of said progressive severance along the longitudinal sides of the tear strip, portions of said residual webs located at said regions being nonlinear.

8. The improvement set forth in claim 7 in which a hollow rivet is formed in the leading end of the tear strip for attaching a tab to the tear strip and in which the full width of the leading end of the tear strip in an area surrounding the rivet is of substantially less thickness than said wall of the container to reduce the resistance to flexure of the leading end and thus facilitate initiation of severance of the tear strip.

9. An improvement as set forth in claim 7 in which the thickness of the web between said two points along the trailing end of the tear strip is less than the thickness at said two points to reduce the resistance to final separation of the tear strip from the container.

10. An improvement as set forth in claim 7 in which the leading end of the tear strip is of blunt configuration in plan with pronounced front corners to facilitate initiation of the severance of the tear strip.

11. In the construction of a container wherein a wall of the container is scored to form a tear strip and a tab is connected to the leading end of the tear strip for manual severance of the tear strip, the improvement to facilitate severance of the tear strip, comprising:

said wall of the container being reduced in thickness with the outer surface of the wall correspondingly depressed in a zone including the leading end of the tear strip;

the container wall being formed with two ramps on the opposite sides respectively of the tear strip with the ramps inclining downward to the depressed surface of said zone; and

the scoring along the two sides of the leading end of the tear strip extending down the two ramps respectively.

12. An improvement as set forth in claim 11 in which the depth of the residual web is thinner in said zone than along the sides of the tear strip outside of the zone, the residual web progressively increasing downward along each of the two ramps.

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