

[54] METHOD AND TOOL FOR FORMING A SCORE

[72] Inventor: Christian F. Kinkel, Arlington Heights, Ill.

[73] Assignee: American Can Company, New York, N.Y.

[22] Filed: March 25, 1971

[21] Appl. No.: 127,950

Related U.S. Application Data

[62] Division of Ser. No. 782,919, Dec. 11, 1968, Pat. No. 3,650,006.

[52] U.S. Cl.113/15 A

[51] Int. Cl.B21d 51/26

[58] Field of Search.....113/15 R, 15 A, 116 CC, 120 Q, 113/121 R, 121 C; 83/6

[56]

References Cited

UNITED STATES PATENTS

826,601	7/1906	Page	113/15 A
3,338,199	8/1967	Taylor	113/15 A
3,583,348	6/1971	Brown	113/15 A
3,500,939	3/1970	Bozek	113/121 C
3,411,470	11/1968	Fraze	113/121 C
3,366,086	1/1968	Fraze	113/121 C

Primary Examiner—Richard J. Herbst

Assistant Examiner—Michael J. Keenan

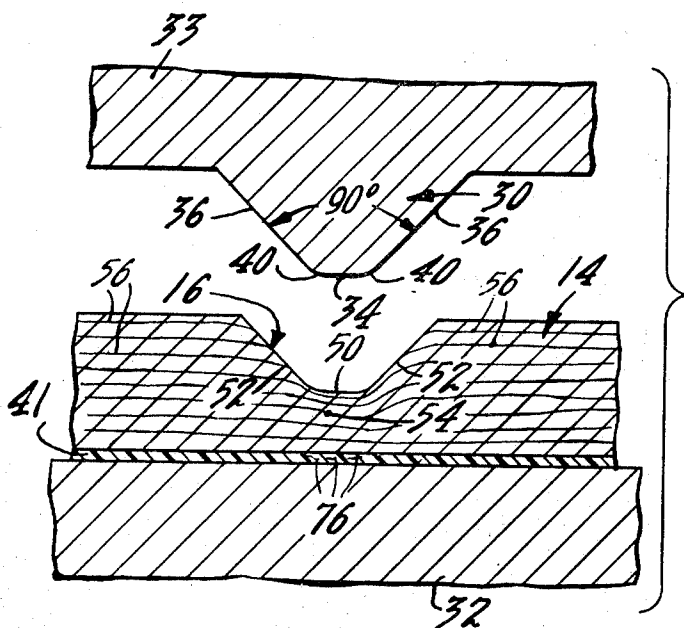
Attorney—Kenneth H. Murray et al.

[57]

ABSTRACT

A score having improved abuse and fatigue resistance qualities is formed by using a scoring punch which is specially profiled to obtain a smooth continuous flow of the displaced metal, thereby eliminating the "dead zone" of compressed, work-hardened metal which exists at the base of conventional scores.

9 Claims, 5 Drawing Figures



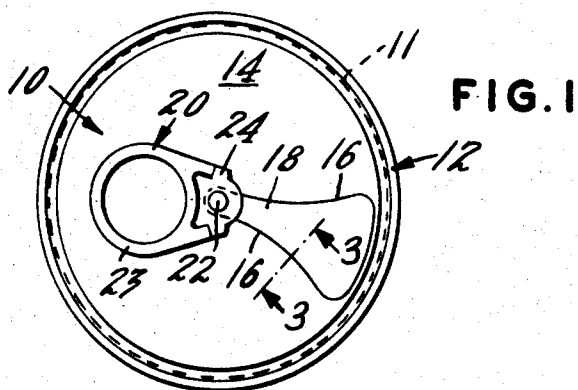


FIG. 2
PRIOR ART

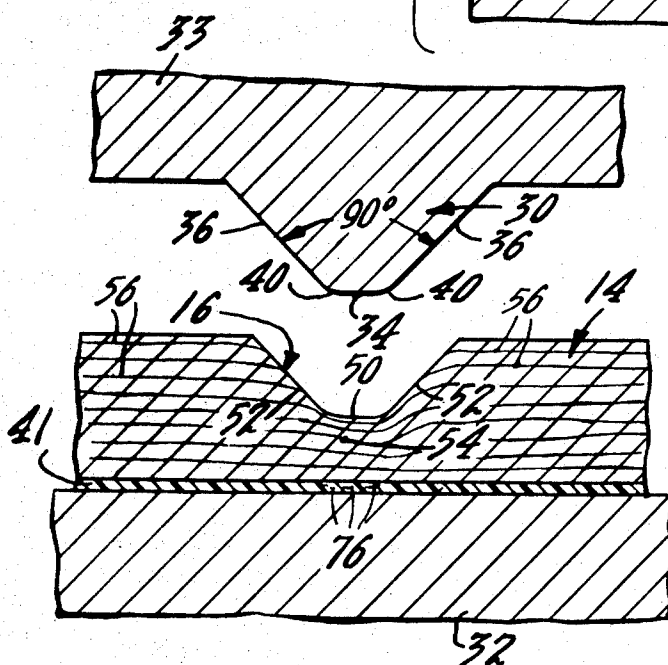
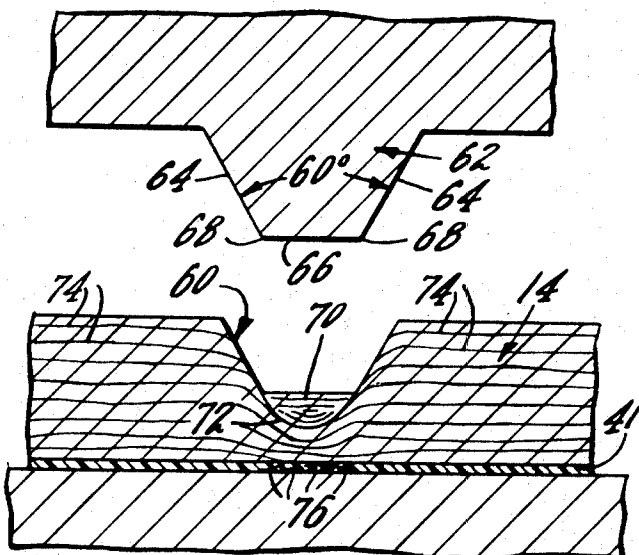


FIG. 3

INVENTOR.
CHRISTIAN F. KINKEL
BY *George P. Ziehmer*
ATTORNEY

FIG. 4

PRIOR ART

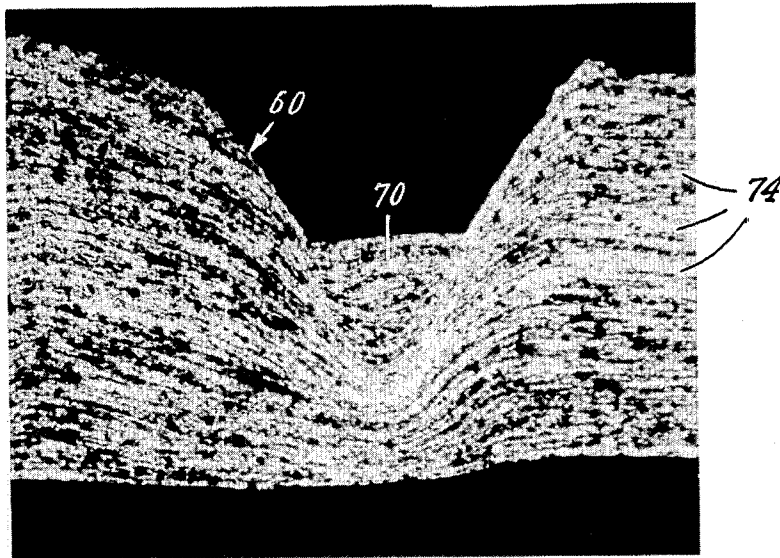
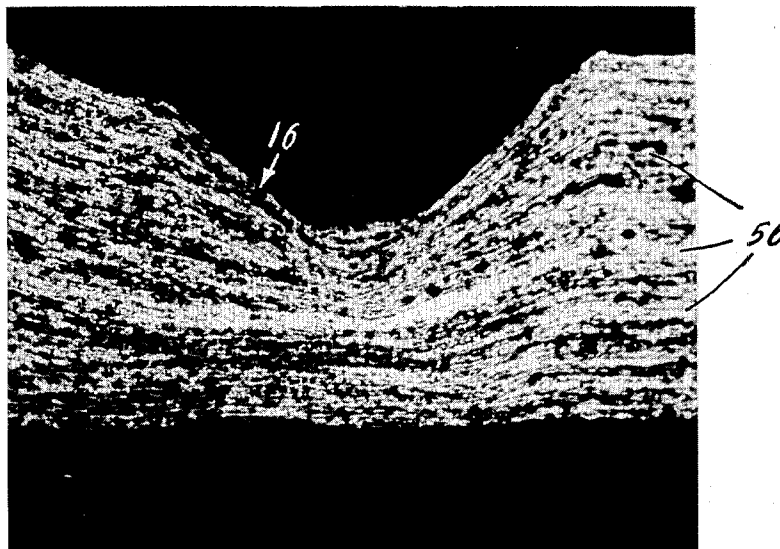


FIG. 5



METHOD AND TOOL FOR FORMING A SCORE

This application is a division of co-pending application Ser. No. 782,919, filed Dec. 11, 1968, now U.S. Pat. No. 3,650,006.

BACKGROUND OF THE INVENTION

Recent years have seen tremendous increases in the production of "easy-open" metal cans wherein a portion of a wall of the can body or end is provided with a score which is impressed into the metal to a depth sufficient to weaken it to such an extent that it can be ruptured by the consumer to create a dispensing opening without requiring the use of separate opening tools. Such cans are used in great numbers in the packaging of beer and beverages, and their use for other products is constantly expanding.

Practical manufacturing requirements dictate that the scores in such cans be made by impressing a scoring punch into the container wall while the latter is supported on an anvil, and that the punch profile be formed with a flat bottom wall in order to extrude the metal laterally from beneath the punch in such manner as to create a space into which the upper portion of the punch can move without splitting the metal. A sharp V-edged punch is ordinarily not used, since it effects a hatchet-type metal cutting or wedging operation rather than an extruding operation on the metal, and this is undesirable in that uncontrolled splitting or cracking of the metal frequently results.

The scoring tools heretofore used have been formed with a flat bottom wall about 0.005 to 0.006 inches in width and with diverging side walls which extend equilaterally upwardly from the ends of the flat bottom wall at an included angle of about 60° and intersect the bottom wall in sharp corners.

After the scoring punch has been impressed into the metal of the can wall, the metal of the score residual e.g., the thinnest portion of the score, which portion is disposed below the flat bottom score wall which is formed by the flat bottom surface of the scoring punch determines to a great extent the characteristics of the score.

One of the problems which has been heretofore encountered with scored cans has been the fact that the scores are generally not shielded and are thus subjected to physical abuse during shipment and storage of the cans, with the result that they are sometimes prematurely ruptured. This is particularly true when the cans are scored deeply enough to permit them to be opened easily, since in such cases the residual is quite thin.

I have discovered that one of the reasons why conventional scores do not resist abuse better than they do is the fact that their residuals contain a substantial amount of metal which has been compressed and work-hardened by the scoring tools, and is consequently much less resistant to rupture than non-work-hardened metal would be. This workhardened metal is located in the area of the residual immediately below the flat bottom wall of the score, and the area containing such metal will in this specification hereinafter be designated as the "dead zone." The dead zone is produced because the scoring punch profiles heretofore used have not permitted the metal in this area to flow away from beneath the scoring tools as they are impressed into the can wall but instead have produced forces on this metal which have trapped it beneath the

flat faces of the punch and have subjected it primarily to compressive forces.

The dead zone extends downwardly from the base of the score and is generally bullet-shaped or hemispherical in cross section, being set off from the adjacent metal by a more or less distinct curvilinear surface which forms an interface between the generally flat horizontal pattern of the granular structure of the compressed metal in the dead zone and the generally curvilinear pattern of the granular structure of the surrounding metal which has been free to flow during the scoring operation. This interface constitutes a boundary between these two clearly defined masses of metal, and since there is little or no continuity or homogeneity of granular structure across this boundary, it constitutes an area of weakness, or potential fracture, in the score residual. It is this area of weakness, together with the fact that the work-hardened metal in the dead zone is more brittle than the surrounding metal and is thus less resistant to fatigue and rupture, that results in the conventional score being so prone to premature cracking when subjected to abuse or vibration.

I have discovered that the abuse and fatigue resistance of the score can be substantially increased if the dead zone can be minimized or completely eliminated, and I have discovered that this can be accomplished by the use of a scoring punch which is profiled to permit the metal in the container wall to flow freely during the scoring operation. An example of a punch suitably profiled to obtain this result is one having a flat bottom wall having an initial width of about 0.0035 inches, and having an upwardly and outwardly diverging lateral wall extending from each end of the flat bottom face at an angle of about 45°, so that the included angle between the diverging side walls is about 90°. In order to facilitate free flow of the metal during the scoring operation, the corners at which the flat bottom wall and the lateral walls of the punch intersect, are rounded off to a radius of about 0.002 inches, thus reducing the flat bottom wall to a width of about 0.002 inches.

It has been found that dies having these configurations permit a smooth, continuous extrusion of substantially all of the metal which is displaced in the scoring operation, and thus prevent or minimize the formation of a dead zone in the score residual, thereby providing a score having superior strength and abuse resistance qualities. However, it has been found that such a score can be opened just about as easily as a score having a dead zone. Some tolerances in these dimensions are of course, permissible, while still providing suitable results.

It is believed that the reason why the dead zone is eliminated, or substantially minimized, is that the profile of the punch introduces a horizontal force component on the metal in the residual very soon after penetration of it is begun, and that this horizontal force component quickly increases until it is equal to the vertical force component, whereas in conventional punches heretofore used, the vertical component substantially exceeded the horizontal component. This equalization of forces is believed to produce minimal stresses in the residual metal, and, in conjunction with the rounded corners of the punch, creates a condition which is very conducive to the free flow of metal during formation of the score.

An additional benefit derived from this free flow of metal is that the enamel coating which is normally provided on the undersurface of the wall beneath the residual is less subject to fracture during the scoring operation and thus the finished can is better protected from, and more resistant to corrosive attack by the product than is a can scored in the conventional manner.

SUMMARY OF THE INVENTION

A scoring punch having a narrow flat bottom wall, equilaterally and upwardly diverging side walls which include an angle of about 90°, and rounded corners at the intersections of the bottom and side walls, is used to produce a score wherein the dead zone of work-hardened metal in the residual is minimized or completely eliminated, thus, rendering the score stronger and more resistant to abuse. It is believed that this result is effected because the scoring punch profile permits a free flow of metal during the scoring operation, and does not "lock" the metal in the residual area thus producing a residual in which the metal is homogeneous with the metal in the adjacent areas.

Referring now to the drawings,

FIG. 1 is a plan view of the upper end of an easy-open metal can formed with a score embodying the principles of the instant invention;

FIG. 2 is a fragmentary cross-sectional view on a greatly enlarged scale, taken through conventional scoring tools and the scored metal after completion of the hitherto conventional scoring operation, the view showing the dead zone which has heretofore been produced in the score residual;

FIG. 3 is a view similar to FIG. 2 but showing scoring tools, and the resultant score, embodying the principles of the instant invention, the view being taken substantially along the line 3—3 in FIG. 1;

FIG. 4 is a photomicrograph, on a further enlarged scale, taken through a conventional score of the type shown in FIG. 2, the view clearly illustrating the dead zone; and

FIG. 5 is a photomicrograph, similar to FIG. 4, but taken through a score which embodies the principles of the instant invention, the view clearly illustrating the substantial absence of a clearly defined dead zone.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 of the drawings discloses a can end 10, made of steel or aluminum (which term includes suitable aluminum alloys) which is secured to the upper end of a cylindrical can body 11 in a suitable end seam such as a double seam 12. The end 10, as shown, is of a type widely used in the packaging of beer and beverages, and is formed with a countersink central panel 14 in which is formed an endless score 16 which sets off a removable tear-out panel portion 18 which is of a radially elongated key-hole configuration.

In order to provide for removal of the tear-out portion 18, there is provided a rigid lift tab 20 which is secured to the inner end of the portion 18 by a rivet 22 which is formed integral with the portion 18 and extends through a hole which is formed in the end portion 24 of the lift tab 20. The rivet 22 may be of the type disclosed in the U. S. Pat. No. 3,191,797, granted to E. C. Frazee on June 29, 1965.

To effect removal of the tear out portion 18, the tab 20 is provided with a ring type handle 23 which when lifted by the consumer, causes the tab 20 to fulcrum on its edge 26 and to exert an upward force on the inner portion of the tear out portion 18 and to thus initiate rupture of the score 16 in the area adjacent the rivet 22. Continued upward pulling on the tab 20 causes a tearing through of the score 16 for its full length, thus detaching the panel portion 18 from the can end 10 and creating an opening through which the liquid contents of the filled can may be poured.

As seen in FIG. 3, the score 16 is formed by a score punch 30 which is indented into the panel 14 to a predetermined depth while the can end 10 is supported on a suitable anvil 32. The punch 30 and anvil 32 are of course, rigidly mounted in a suitable press, the punch 30 being formed integral with a base plate 33.

The punch 30 has a key-hole shaped contour which produces the key-hole shaped score 16, and in cross-sectional profile (see FIG. 3) is formed with a narrow flat bottom wall 34 and two equiangularly inclined lateral walls 36, each of which extends upwardly at an angle of about 45° from the vertical so that an angle of about 90° is included between them. The corners of intersection 40 between the bottom wall 34 and the inclined side walls 36 are rounded off to a radius of about 0.002 inches. The flat bottom wall 34, prior to the rounding off of the corners 40, preferably has a width of about 0.0035 inches, and after rounding off of the corners 40 has a width of about 0.002 inches.

These dimensions are of course subject to permissible variations which will still provide satisfactory scores. Thus, the 90° included angle between the walls 36 has a tolerance of about plus or minus 10°, the 0.0035 flat bottom has a tolerance of about plus 0.0005 or minus 0.0015 inches, and the 0.002 radius of the rounded corners 40 has a tolerance of about plus or minus 0.0005 inches.

As seen in FIG. 3, the scoring operation is effected by impressing the punch 30 into the end panel 14 while the latter is supported on the anvil 32, the depth of penetration of the punch being limited by a suitable stop (not shown) which is incorporated in the scoring press mechanism. The end panel 14 may be made of any suitable metal such as aluminum or steel and is usually provided with a protective undercoating 41 of an organic resin which, in the finished can, forms an inner lining which functions as a protective barrier to prevent contact between the contents of the can and the corrodible metal of the panel 14. As used in present commercial production, the metal stock of the end 10 varies from about 0.008 to 0.015 inches in thickness, when made of aluminum.

As the punch 30 is forced downwardly against the panel 14, it subjects the metal in the panel 14 to both horizontal and vertical force components which cause it to be extruded away from the walls of the punch 30 and permit the punch to move downwardly into the metal until its motion is stopped by the press mechanism, thus producing the score 16 which embodies the principles of the invention.

As seen in FIG. 3, which is a view taken after the punch 30 has been withdrawn from the scored panel, the score 16 has a cross-sectional configuration which is substantially complementary to the configuration of

the punch 30, and consists of a bottom wall 50 and a pair of diverging, equilaterally inclined side walls 52. The dimensions and angles of these score walls 50, 52 are, in general, identical or at least quite similar to those of the punch walls 34, 36.

The area 54 immediately below the bottom wall 50 is known as the score residual and generally ranges in thickness from 0.003 to 0.006 in commercial production. As seen in FIG. 3 and in FIG. 5, which is a cross-sectional microphotograph of an actual score 16, the flow pattern 56 of the granular structure of the metal in the residual 54 is substantially continuous with, and comprises an extension of, the flow pattern of the metal in the adjacent areas of the panel 14, and it can be seen that the metal throughout the residual is substantially homogeneous with and not greatly differentiable from the adjacent metal.

In contrast, FIGS. 2 and 4 illustrate a score 60 which is a conventional score heretofore made by a conventional scoring punch 62 having inclined side walls 64 which include an angle of about 60°, and a flat bottom wall 66 which intersects the side walls 64 in sharp corners 68 and which has a width of about 0.005 inches.

As illustrated in FIG. 2 and clearly seen in FIG. 4, the residual of the conventional score 60 is formed with an area 70 of metal in its upper portion which is clearly non-homogeneous with and differentiable from the metal which surrounds it. This area 70, which is herein referred to as the dead zone, is formed of metal which has been trapped or "locked in" beneath the punch face 66 and is severely compressed and work-hardened, and is thus quite brittle. The dead zone is separated from the surrounding metal along an interface 72 of curved or bullet-shaped cross-sectional configuration, and as clearly seen in FIG. 4, there is a readily distinguishable break in the flow pattern 74 of the granular structure of the metal at this interface, the pattern of the metal in the dead zone being generally horizontal and the pattern of the surrounding metal declining sharply and in general approaching a tangential relationship to the interface 72.

The exact nature of the interface 72 is not clearly known, but it is believed to be a form of incipient shear plane and to definitely comprise a surface of weakness which is more readily fracturable than the other metal in the residual, and it is therefore less resistant to abuse. It has been determined through testing procedures that scores of the type shown in FIG. 5 are more than twice as resistant to abuse and fatigue than are scores of the type shown in FIG. 4, when the residuals of each are of the same thickness.

As stated, FIGS. 4 and 5 are photomicrographs of actual cross-sections of scores, and clearly illustrate the flow pattern of the granular structure of the metal and its deformation by the scoring tools. The granular structure is more clearly discernable in metal of higher temper, such as hard aluminum alloy. When very soft metal is used, the granular structure is not so clearly seen. However, in such cases, metallographic examination under polarized light can be used to reveal the flow pattern of the metal and thus determine the presence or absence of the dead zone.

The diffusion of the compressive force on the metal of the residual which is effected by the scoring punch 30 produces an additional benefit in that it substantially

reduces the incidence of fracturing of the protective lining 41 in the area immediately below the residual 54 during the scoring operation over that which is produced in the corresponding area of the lining 74 of FIG. 2 by the conventional scoring punch 62. This fracturing, which is indicated by the hair lines 76 in the protective linings in FIGS. 2 and 3 is produced by the compressive forces which are exerted by the scoring punches, and the reduction therein which is produced by the scoring punch 30 is important in that it renders the lining 41 more resistant to penetration by the product which is packed in the filled can.

It will be understood that the improved score of the instant invention is not limited to use in a container of the type disclosed in FIG. 1, but may be used advantageously in many other types of scored, easy-open cans. It may, if desired, be used as an inside score in cans and still provide many of the advantages, hereinbefore described.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts, and that changes may be made in the steps of the method described and their order of accomplishment without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. A scoring punch for forming a score in a metal article, comprising:

a generally flat bottom wall having a width within the range of about 0.002 to 0.004 inch;

side walls which are, oppositely and equilaterally, steeply inclined outwardly from the ends of said bottom wall; and

corners of intersection between said bottom wall and said side walls which are uniformly rounded off to a radius within the range of about 0.0015 to 0.0025 inches.

2. The scoring punch, according to claim 1, wherein: said bottom wall between said rounded corners of intersection is about 0.002 inch in width.

3. The scoring punch, according to claim 1, wherein: said corners of intersection are rounded off to a radius of about 0.002 inch.

4. The scoring punch, according to claim 1, wherein: said side walls together form an included angle within the range of about 80° to 100°.

5. A scoring punch for forming a score in a metal component of a container, comprising:

a generally flat bottom wall having a width of about 0.002 inch;

side walls which are, oppositely and equilaterally, steeply inclined outwardly from the ends of said bottom wall; and

corners of intersection between said bottom wall and said side walls which are uniformly rounded off to a radius of about 0.002 inch.

6. A method of forming a score in a metal component of a container, said score defining a removable section within said component and the residual metal of said component beneath said score having a thickness within a predetermined range which allows

for fracturing of said residual metal in order to remove said removable section from said component, comprising the step of:

impressing a scoring punch, having a generally flat bottom wall of a width within the range of about 0.002 to 0.004 inch, side walls which are, oppositely and equilaterally, steeply inclined outwardly from the ends of said bottom wall, and corners of intersection between said bottom wall and said side walls which are uniformly rounded off to a radius within the range of about 0.0015 to 0.0025 inch, into the metal component to cause the metal of said component to flow free away from beneath said punch to form the score with the residual metal of said component beneath said score having a granular structure which is continuous and homogeneous with that of the metal in adjacent areas of said component.

7. A method of forming a score in a metal component of a container, according to claim 6, wherein: said side walls of said punch together form an included angle within the range of about 80° to 100°.

8. A method of forming a score in a metal component of a container, said component having a metal stock thickness within the range of about 0.008 to 0.015 inch, said score defining a removable section

within said component and the residual metal of said component beneath said score having a thickness within the range of about 0.003 to 0.006 inch which allows for fracturing of said residual metal in order to remove said removable section from said component, comprising the step of:

impressing a scoring punch, having a generally flat bottom wall of a width of about 0.002 inch, side walls which are oppositely and equilaterally, steeply inclined outwardly from the ends of said bottom wall, and corners of intersection between said bottom wall and said side walls which are uniformly rounded off to a radius of about 0.002 inch, into the metal stock of the component to cause the metal of said component to flow free away from beneath said punch to form the score with the residual metal of said component beneath said score having a granular structure which is continuous and homogeneous with that of the metal in adjacent areas of said component.

9. A method of forming a score in a metal component of a container, according to claim 8, wherein: said side walls of said punch together form an included angle within the range of about 80° to 100°.

* * * * *

30

35

40

45

50

55

60

65