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Kinkel et al.

[11] **3,715,052**

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[54] **FULL PANEL SELF-OPENING END CLOSURE**

[75] Inventors: **Christian Frederick Kinkel**, Arlington Hgts.; **Thomas Lawrence Phalin**, Cary, both of Ill.

[73] Assignee: **American Can Company**, Greenwich, Conn.

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[21] Appl. No.: **196,670**

[52] **U.S. Cl.** **220/54**

[51] **Int. Cl.** **B65d 17/24**

[58] **Field of Search** 220/54, 53, 48, 27; 113/15, 113/120

[56] **References Cited**

UNITED STATES PATENTS

3,576,272	4/1971	Colly	220/54
3,501,046	3/1970	Jasper et al	220/54

Primary Examiner—George T. Hall
Attorney—Robert P. Auber et al.

[57] **ABSTRACT**

A self-opening end closure made of a steel basis sheet metal has both a rupturable score and a shallower non-rupturable score formed in the interior surface of a generally flat central end panel of the end closure. The rupturable score is formed near the periphery of the central panel to define a large removable portion within the central panel, and the non-rupturable score is disposed closely adjacent to but radially inwardly of the rupturable score. This combination of scores and their placement in the interior surface of the central end panel make possible the commercial manufacture, within realistic manufacturing tolerance, of a self-opening steel end closure having acceptable score integrity and openability characteristics.

6 Claims, 3 Drawing Figures

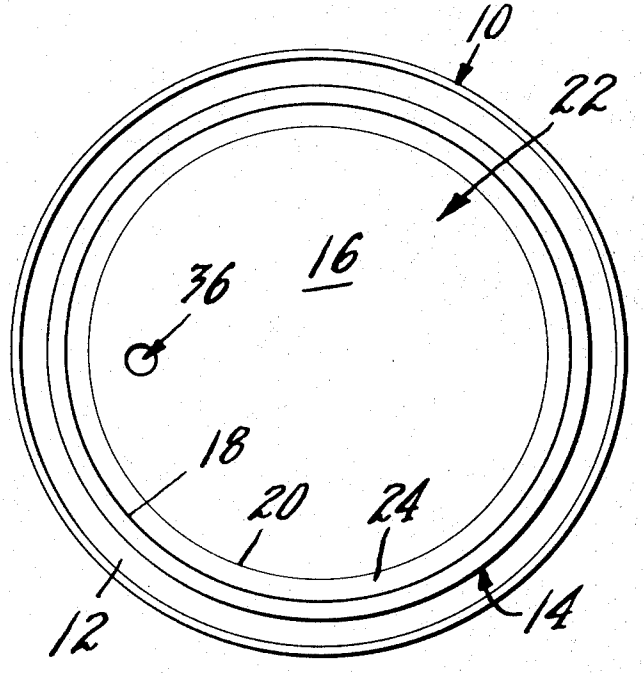


FIG. 2

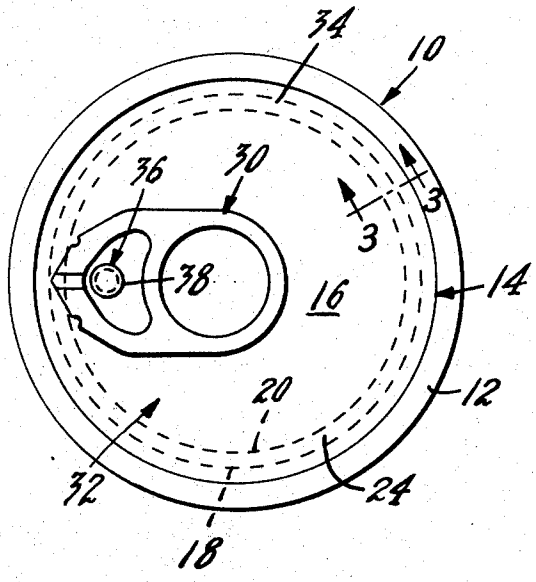


FIG. 1

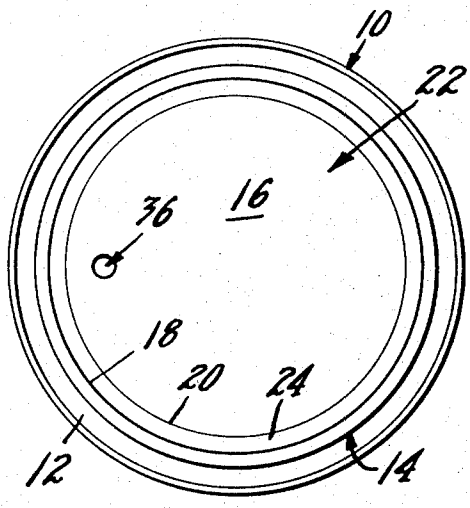
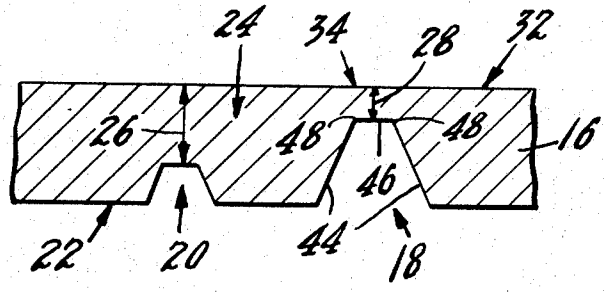


FIG. 3



FULL PANEL SELF-OPENING END CLOSURE

BACKGROUND OF THE INVENTION

The present invention broadly relates to improved "-self-opening" or "easy opening" end closures for containers, and is more particularly concerned with the combination of a rupturable score and a non-rupturable score both being formed in the interior, or product-facing, surface of an end closure made of tin-free steel or tin-plated steel sheet metal.

Heretofore, end closures of the self-opening variety, each having a rupturable score which defines a removable panel portion within the end closure, have predominately been made of aluminum rather than of steel. Aluminum has been preferred over steel because it has less tendency to work harden and it has much lower tear strength than steel. Because of less work hardening which results in lower scoring forces aluminum causes less long-term wear in scoring dies, in commercial operation. The comparative weakness of aluminum permits a broader range of residual metal thicknesses for the rupturable score while insuring satisfactory performance of the scored aluminum end closure from the standpoint of ease of opening.

More recently, however, a growing trend has developed in the container industry toward the use of steel, rather than aluminum, in the fabrication of scored, self-opening end closures, particularly in the full panel, self-opening type of steel end closure wherein a large removable portion is defined within the central panel of the end closure by a rupturable score formed in either the exterior or interior surface of the central panel closely adjacent to the periphery of the central panel.

Various types of self-opening end closures made from steel sheet metal are disclosed in recent patents, for example, U.S. Pat. Nos. 3,397,811, 3,507,418, 3,527,377, 3,543,961, and 3,563,199. These patents all disclose self-opening steel end closures having a rupturable score formed in either the interior or exterior surface of the central panel of the end closure.

The U.S. Pat. No. 3,543,961 discloses a full panel, self-opening steel end closure wherein a single rupturable score defining the removable portion is formed in the interior surface of the end closure at the juncture between the central panel and the annular, seam-defining peripheral portion of the steel end closure, while U.S. Pat. No. 3,527,377 discloses a full panel, self-opening steel end closure wherein a single rupturable score defining the removable portion is formed in the exterior surface of the end closure adjacent to the periphery of the central panel. The combination of a peripheral rupturable score and a closely associated non-rupturable or anti-fracture score both being formed in the exterior surface of an end closure, is disclosed in U.S. Pat. No. 3,406,866, and U.S. Defensive Publication Ser. No. 793,231.

However, we have found the varieties of the scored, full panel, self-opening steel end closure which are disclosed in the prior art known to us to be unsatisfactory for reasons which we will now explain.

Generally speaking, the range of residual steel metal thicknesses for any rupturable score must be wide enough to allow for the variations in the depth of scoring which will normally be experienced in any high speed commercial manufacturing operation, such

variations being caused by inherent limitations on the precision of scoring tools and by long-term wear of scoring dies, which is an especially critical problem in the scoring of steel metal. Manufacturing experience has shown that a range of score residual thicknesses of approximately 0.001 inch or greater is required for the high speed commercial scoring of steel sheet metal.

However, the residual metal of any rupturable score must meet the acceptable commercial standards of score integrity and ease of opening, as well as the manufacturing requirements imposed by the high speed commercial scoring operation. These two characteristics, integrity and ease of opening (also referred to as openability), of the score are both greatly influenced by the residual metal thickness of the score. This is particularly true when the score is formed in steel sheet metal.

In a conventional scoring operation wherein a scoring punch is impressed into the steel metal of the central end panel which is supported on a back-up anvil, a more or less highly cold worked, structurally damaged, and extremely brittle residual steel metal section is produced beneath the score. The characteristic of score residual integrity mainly refers to the structural quality of this residual steel metal.

Generally, the thinner the residual metal thickness, the greater the likelihood that microfractures or minute cracks will be propagated through the residual steel metal by the scoring operation and the greater the likelihood that the thin residual metal will be prematurely and inadvertently fractured by the normal abuse which the end closure will subsequently receive during the packing, shipping and other handling required of the container incorporating the end closure before the container reaches the consumer. Therefore, the minimum value of the range of the residual score metal thicknesses must be the minimum residual thickness to which the steel metal can be scored without introducing microfracture defects which are detrimental to the integrity or abuse resistance of the score.

In regard to the characteristic of ease of opening of the residual score metal, generally, the thicker the residual metal thickness, the greater the amount of work that must be expended by the consumer in fracturing the score to open the end closure. Therefore, the maximum value of the range of score residual steel metal thicknesses will be determined by the maximum amount of work that a consumer can be expected to expend in opening the end closure. For example, in the case of a 2 11/16th inch diameter steel end closure, experience has shown that the maximum amount of work that a consumer can be expected to expend in opening the full panel end closure without finding the opening operation objectionable or unpracticable is approximately 18 inch-pounds, as measured on an Instron tensile tester.

In the case of a 2 11/16th inch diameter steel, full panel, self-opening end closure having a single, peripheral, rupturable score with a trapezoidal cross-sectional profile, formed on the exterior surface of the central end panel, we have discovered that the minimum residual score metal thickness allowable, without adversely affecting the integrity or abuse resistance of the score residual, is approximately 0.0028 inch, while the maximum residual score metal

thickness allowable, without adversely affecting the openability of the score residual, is approximately 0.0025 inch, which is less than the minimum allowable score residual thickness. Therefore, it is readily apparent that standards for score residual integrity and openability cannot be achieved by placing a single score in the exterior surface of a full panel, self-opening steel end closure.

In the case of a 2 11/16th inch diameter steel, full panel, self-opening end closure having a single, peripheral, rupturable score, with a trapezoidal cross-sectional profile, formed on the interior surface of the central end panel, we have discovered that the minimum residual score metal thickness allowable, without adversely affecting the integrity or abuse resistance of the score residual, is also approximately 0.0028 inch, the same as in the case of the exterior, peripheral, rupturable score, while the maximum residual score metal thickness allowable, without adversely affecting the openability of the score residual, is approximately 0.0036 inch. Therefore, the manufacturer has only available to him a range of residual score metal thicknesses for the rupturable inside score of from approximately 0.0028 to 0.0036 inch, or approximately 0.0008 inch, which is less than the desired commercial manufacturing tolerance of about 0.001 inch or greater. It is thus readily apparent that the limitations imposed by the standards for score residual integrity and openability in this variety of a full panel, self-opening steel end closure do not permit sufficient latitude for a commercial scoring operation.

In the case of a 2 11/16th inch diameter steel, full panel, self-opening end closure having a radially outer, peripheral, rupturable score and a radially inner, shallower, non-rupturable score closely positioned near the rupturable score with both of the scores having trapezoidal cross-sectional profile and being formed on the exterior surface of the central end panel, we have discovered that the minimum residual score metal thickness allowable, without adversely affecting the integrity or abuse resistance of the rupturable score residual, is approximately 0.0019 inch, while the maximum residual score metal thickness allowable, without adversely affecting the openability of the rupturable score residual, is approximately 0.0025 inch. Therefore, in this case, the manufacturer has only available to him a range of residual score metal thicknesses for the rupturable outside score of from approximately 0.0019 to 0.0025 inch, or approximately 0.0006 inch, which again is considerably less than 0.001 inch or greater commercial manufacturing tolerance. Again, it is readily apparent that the limitations imposed by the standards for score residual integrity and openability in this variety of the full panel, self-opening steel end closure, which is disclosed in U.S. Pat. No. 3,406,866, do not permit sufficient latitude for a commercial scoring operation. Also, toward the lower end of this unacceptably narrow range, or in approaching a residual thickness of 0.0019 inch, the integrity of the rupturable residual of the outside score is borderline from the standpoint of abuse resistance.

However, in the case of a 2 11/16th inch diameter steel, full panel, self-opening end closure having a radially outer, peripheral, rupturable score and a radially inner, shallower, non-rupturable score with both of the scores having a trapezoidal cross-sectional profile and being formed on the interior surface of the central end panel, we have discovered that while the minimum residual score metal thickness allowable, without adversely affecting the integrity or abuse resistance of the rupturable score residual, is approximately 0.0019 inch, the maximum residual score metal thickness allowable, without adversely affecting the openability of the rupturable score residual, is approximately 0.0036 inch.

Therefore, in this case, the manufacturer has available to him a range of residual score metal thicknesses for this variety of end closure of from approximately 0.0019 to 0.0036 inch within which to gauge the high speed commercial scoring operation. This range is thus 0.0017 inch, which substantially exceeds the commercial manufacturing tolerance of 0.001 inch or greater. It is thus readily apparent that the limitations imposed by the standards of score residual integrity and ease of opening in this variety of the full panel, self-opening steel end closure do permit sufficient latitude for a commercial scoring operation, and that this construction thus does represent a novel, patentable advance in the art. Actually, an operating residual thickness range of from approximately 0.0024 to 0.0036 inch is preferable in that it assures acceptable ease of opening and integrity of the rupturable score residual and provides sufficient latitude for the commercial scoring operation, and this range, which is included in the 0.0019 to 0.0036 inch range given above, is easily obtained with this construction. The preferred residual score metal thickness is thus 0.0030 inch with a plus or minus 0.0006 inch variation in the residual score thickness being acceptable.

SUMMARY OF THE INVENTION

The present invention relates to the combination of a rupturable score and a shallower, non-rupturable score formed in the interior surface of a generally flat central end panel of a self-opening end closure made of a steel basis sheet metal. The rupturable score is formed near the periphery of the central end panel to define a large removable portion within the end panel. The non-rupturable score is formed adjacent to the periphery of the removable portion of the central end panel inwardly from, and substantially concentric with, the rupturable score. The thickness of the residual steel sheet metal of the non-rupturable score is substantially greater than that of the rupturable score. Both scores have a generally trapezoidal cross-sectional profile. The residual steel metal thickness of the rupturable score may vary within the range of from approximately 0.0019 to 0.0036 inch, and, preferably, from 0.0024 to 0.0036 inch which insures a high speed commercial manufacturing capability, while still maintaining satisfactory performance of the steel end closure from the stand-point of score residual integrity and openability.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the interior surface of a full panel, self-opening steel end closure having formed therein the peripheral, rupturable score and closely-positioned, shallower, non-rupturable score;

FIG. 2 is a plan view of the exterior surface of the full panel, self-opening steel end closure of FIG. 1; and

FIG. 3 is an enlarged fragmentary sectional view of the double score combination taken substantially along line 3—3 of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

A full panel, self-opening end closure, generally designated **10**, embodying the instant invention is shown in FIGS. **1** and **2**. The self-opening end closure **10** is made of a steel basis sheet metal which may be either tin-free steel or tin-plated steel, and, preferably, has a circular configuration. The steel sheet metal of the end closure **10** has a thickness within the range of from approximately 0.006 to 0.012 inch, and, preferably within the range of from approximately 0.007 to 0.009 inch. The self-opening end closure **10** includes a peripheral outwardly extending annular curled flange **12** which may be interfolded with an end flange of a container body (not shown) to form an end seam (not shown). The peripheral flange **12** merges into an annular countersink wall **14** which extends downwardly from the peripheral flange **12** to an imperforate central end panel **16**.

The combination of a rupturable score **18** and a non-rupturable score **20** are formed in the interior surface **22** of the central end panel **16**. The radially outer rupturable score **18** is positioned adjacent to the periphery of the central end panel **16** to define a large removable portion **24** within the central panel **16** which becomes detached from the end closure **10** when the score **18** is completely ruptured. The radially inner non-rupturable score **20** is positioned adjacent to the periphery of the removable portion **24** inwardly from, and preferably substantially concentric with, the rupturable score **18**.

As is clearly shown in FIG. **3**, the non-rupturable residual steel metal section **26** of the non-rupturable score **20** has a substantially greater thickness than the rupturable residual steel metal section **28** of the rupturable score **18**, the differential in the thicknesses preferably being approximately 0.0025 inch. The center-to-center spacing between the rupturable score **18** and the non-rupturable score **20** is preferably approximately 0.060 inch. The non-rupturable score **20** functions to protect the rupturable score **18** from premature, inadvertent rupture in the manner described in U. S. Pat. No. 3,406,866 hereinbefore mentioned.

The thickness of the rupturable residual steel metal section **28** of the rupturable score **18** ranges from approximately 0.0019 to 0.0036 inch, which permits satisfactory performance of the steel end closure from the standpoint of score residual integrity and openability and provides sufficient latitude for the commercial scoring operation. Actually, an operating residual thickness range of from approximately 0.0024 to 0.0036 inch is preferable in that it assures acceptable ease of opening and integrity of the rupturable score residual section **28** while still providing sufficient latitude for the commercial scoring operation. The thickness of the rupturable residual steel metal section **28** of the rupturable score **18** is preferably approximately 0.0030 inch.

The thickness of the non-rupturable residual steel metal section **26** of the non-rupturable score **20** may vary within a range comparable to that of the rupturable residual steel metal section **28** of the rupturable score **18** so that the differential in the thicknesses of the respective residual metal sections **26**, **28** will be maintained at approximately 0.0025 inch.

In order to provide means for rupturing the rupturable score **18**, when desired, an opening tab **30** is fastened to the removable portion **24** on the exterior surface **32** of the central end panel **16** at a location adjacent to the exterior surface **34** of the rupturable residual steel metal section **28** of the rupturable score **18** by a hollow rivet **36**. The rivet **36** is integral with the removable portion **24** and has a peripheral portion **38** which overlies and bears down on the opening tab **30** to secure it on the removable portion **24**.

The opening tab **30** has a handle portion **40** into which the finger of a user may be inserted and a nose portion **42** which will be urged downwardly into contact against the exterior surface **34** of the rupturable residual steel metal section **28** of the rupturable score **18** when the user raises the handle portion **40** of the opening tab **30** to initiate pop or rupture of the rupturable score residual steel metal section **28**. After the handle portion **40** has been rocked upwardly and forwardly to a substantially vertical position in relation to the central end panel **16** to complete the initial rupture of the portion of the residual section **28** adjacent to the nose portion **42** of the tab **30**, the user exerts a pulling force upward and rearwardly in relation to the central end panel **16** to achieve the rupture of the remaining portion of the rupturable score residual section **28** and detachment of the removable portion **24** from the remaining peripheral portion of the central end panel **16** of the steel self-opening end closure **10**.

As shown in the enlarged sectional view of the double score combination in FIG. **3**, both the rupturable score **18** and the non-rupturable score **20** preferably have a generally trapezoidal cross-sectional profile. The rupturable score **18** includes two steeply inclined, and oppositely disposed, side walls **44** which convergently extend from the interior surface **22** of the central end panel **16**, and a substantially flat base wall **46** which is in a plane generally parallel to the interior surface **22** of the central end panel **16** and meets the side walls **44** preferably at generally sharp corners of intersection **48**. Alternatively, the corners of intersection **48** could be arcuate-shaped instead of being sharp. The base wall **46** preferably has a width within the range of 0.0015 to 0.0035 inch. The non-rupturable score **20** has substantially the same structural features as the rupturable score **18** except for the above-described substantial difference between the thickness of the non-rupturable residual steel metal section **26** and the thickness of the rupturable residual steel metal section **28**.

The rupturable score **18** in being formed in the interior surface **22** of the central end panel **16** acts as a notch which concentrates stresses applied when completely opening or rupturing of the rupturable residual steel metal section **28** by means of pulling the opening tab **30** upwardly and rearwardly in relation to the central end panel **16** after the initial pop or fracturing of the residual section **28**. For that reason, the total work required to completely rupture the residual steel metal section **28** of the interiorly-formed rupturable score **18** is greatly reduced from that required to completely rupture the residual section of an exteriorly-formed rupturable score having the same residual metal thickness. This unique function of the interior rupturable score provides the advantage of ease of opening at a substantially greater score residual metal

thickness than attainable with the exterior rupturable score where the stresses are spread over a larger area of the interior surface of the residual section opposite to the outside rupturable score.

The end closure **10** of the present invention is made of a steel basis sheet metal, such as tin-free steel or tin-plated steel. In the case of tin-plated steel, the substrate of steel sheet metal has a layer of tin on the steel surface which is to become the interior surface of the end closure. Also, preferably, the substrate of steel sheet metal has a layer of tin on the steel surface which is to become the exterior surface of the end closure. Each of the tin layers may have a weight within the range of approximately 0.25 pound/base box to 1.35 pound/base box. Preferably, the tin layer on the interior surface of the steel sheet metal has a weight of approximately 0.75 pound/base box, and the tin layer on the exterior surface of the steel sheet metal has a weight of approximately 0.25 pound/base box.

At an initial stage in the manufacture of end closures, generally circular blanks are punched from a continuous web of steel sheet metal. Then, the blanks are converted into basic ends ordinarily having a flange portion, a countersink wall and a flat central panel. Preferably the tin layers are applied to the steel sheet metal when it is in the initial web form by any suitable process of application, for example, by a conventional electrodeposition or hot-dipping process.

Also, the tin layers respectively preferably have non-metallic protective coatings applied thereon. As was preferred in the case of the tin layers, the protective coatings are preferably applied to respective tin layers when the steel metal is in the web form before the blank has been punched from the web of steel material. The protective coatings may be applied to the tin layers by any suitable process of application, for example, by a conventional rolling or spraying process.

The double score combination of the end closure **10** is formed by a conventional double scoring tool which is impressed into the central end panel **16** while the end closure **10** is supported on a suitable anvil. The double scoring tool preferably has a cross-sectional profile which is substantially complementary to the desired profiles of the double scores.

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 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.

We claim:

1. In a full panel, self-opening end closure made of a steel basis sheet metal and capable of being fabricated on a mass production basis which includes a high speed scoring operation wherein the depth of scoring may vary within the limits of approximately plus or minus 0.0005 inch from the desired scoring depth, the combination comprising:

a rupturable score formed in the interior surface of a central end panel of the end closure adjacent to, and radially inwardly from, the periphery of said end panel to define a removable portion within said end panel, said rupturable score having a generally trapezoidal cross-sectional profile; and

a non-rupturable score formed in the interior surface of said central end panel adjacent to the periphery of said removable portion radially inwardly from, and substantially concentric with said rupturable score, said nonrupturable score having a generally trapezoidal cross-sectional profile, the thickness of the residual steel metal of said non-rupturable score being substantially greater than that of said rupturable score.

2. In a full panel, self-opening end closure, the combination according to claim **1**, wherein the thickness of the residual steel metal of said rupturable score ranges from approximately 0.0019 to 0.0036 inch, which permits satisfactory performance of the steel end closure from the standpoint of score residual integrity and openability.

3. In a full panel, self-opening end closure, the combination according to claim **1**, wherein the thickness of the residual steel metal of said rupturable score preferably ranges from approximately 0.0024 to 0.0036 inch, which permits satisfactory performance of the steel end closure from the standpoint of score residual integrity and openability.

4. In a full panel, self-opening end closure, the combination according to claim **1**, wherein the thickness of the residual steel metal of said rupturable score is preferably approximately 0.0030 inch, which permits satisfactory performance of the steel end closure from the standpoint of score residual integrity and openability.

5. In a full panel, self-opening end closure, the combination according to claim **1**, wherein the end closure is made from tin-plated steel sheet metal.

6. In a full panel, self-opening end closure, the combination according to claim **1**, wherein the end closure is made from tin-free steel sheet metal.

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