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SHIPPING CONTAINER AND METHOD OF MANUFACTURE THEREOF

Original Filed July 5, 1963

Fig. 1.

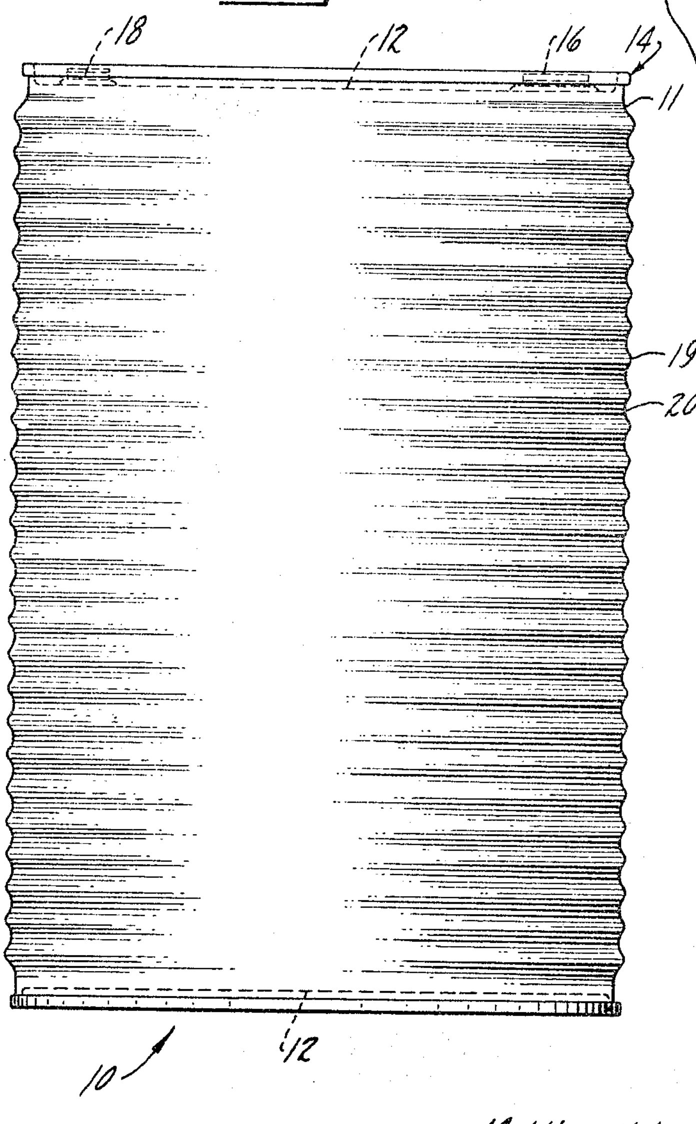
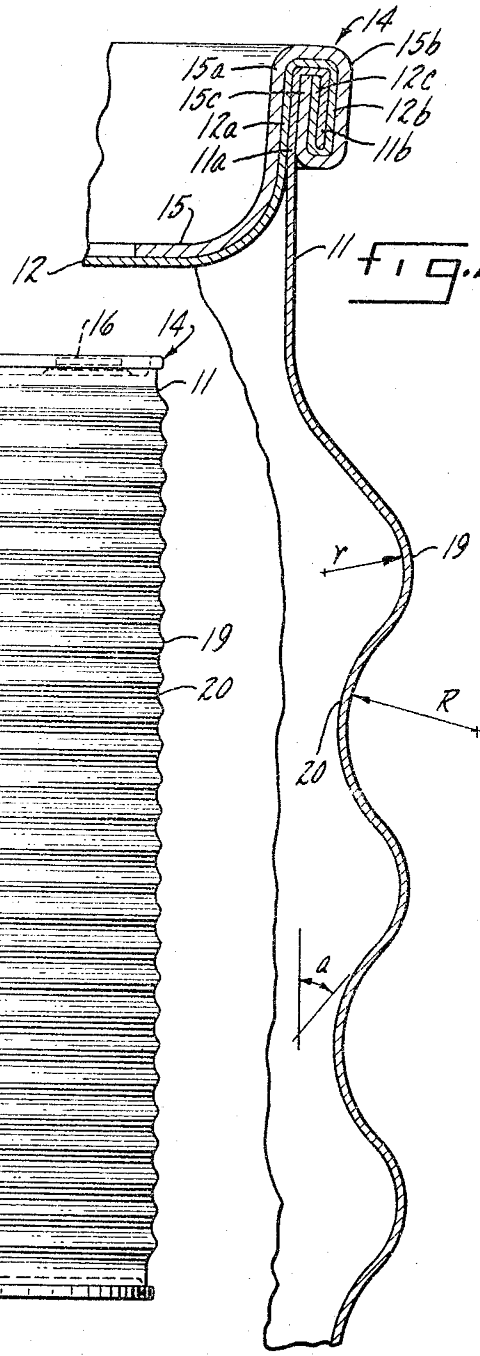


Fig. 2.



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SHIPPING CONTAINER AND METHOD OF MANUFACTURE THEREOF

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4 Claims. (Cl. 220—72)

The present application is a divisional application based upon my copending U.S. application Serial No. 293,071, filed July 5, 1963, for Shipping Container and Method of Manufacture Thereof, now abandoned, which copending application is assigned to the assignee of the present application.

The present invention relates to shipping containers and, more particularly, to an improved sidewall construction for containers of the type commonly used in transporting and storing oil products, and other liquid, semi-liquid, pulverized, or granular substances. In its principal aspects, the invention is concerned with an improved sidewall construction which is characterized by its high resistance to loads, shocks and similar forces which tend to deform or otherwise damage the containers during transportation or storage.

For a number of years there has been a persistent and increasing demand for a sturdy, light-weight shipping container which is not only capable of withstanding the rigors of transportation from the supplier to the consumer, but which is also more resistant to deformation forces during periods of storage and use. In an effort to meet the foregoing demand, there has been a recent trend by manufacturers towards the use of thinner and lighter sheet metal in the construction of both the sidewalls and the drum heads, thus minimizing the amount and weight of materials used and, therefore, both the manufacturing and transportation costs.

Let it be assumed that a 55-gallon drum is required by a consumer for use in a specified application, or range of applications. Such a drum, in order to meet the requirements of the consumer, must have or exceed minimum acceptable standards of strength which, merely by way of example, heretofore required the use of 18-gauge sheet steel. However, manufacturers have, consistent with the recent trend, attempted to make such drums of 22-gauge, or even 24-gauge, sheet steel rather than the heavier 18-gauge material, while at the same time providing drums which meet or exceed the consumer's minimum acceptable standards of strength and which are, therefore, strong enough to be suitable for use in the same applications as drums made of the heavier gauge material.

As used herein, the term "strong enough" is intended to connote a drum characterized by its ability to withstand the rigors of transportation under very unfavorable conditions during one trip without developing a leak. The drum may be deformed, but the construction should be such that those deformations that are caused by the kinds of mistreatment of filled drums usually encountered during transportation do not promote the creation of sharp wrinkles or folds, since these often rapidly develop into leaks. On the other hand, when deformations are caused they should preferably be of such a nature that it is extremely difficult (and thus more expensive than is economically justified in relation to the cost of new drums) to "recondition" the damaged drum by "ironing out" the wrinkles. The reason for this is that reconditioned drums of light-weight material always form a certain hazard from the point of view of leakage during the next trip or following trips.

The recent trend towards the use of thinner and lighter sheet material in the construction of drums has, however,

simply magnified the problems of deformation, rupture, and attendant leakage or spoilage of the contents of such drums, since such thin gauge material has not heretofore proven suitable for withstanding deformation forces of the type commonly encountered during handling, transportation and storage.

Indeed, it has been found to be very difficult to find a satisfactory compromise between the various requirements that drums must meet to conform to acceptable standards—requirements that are generally conflicting in nature in that the drums must not only be characterized by their strength, but also must be made of material which, in itself, is not as strong as that heretofore used. For example, it would serve no useful purpose to provide a light-weight drum which has a great resistance to axial forces but which collapses under a small radial load. Conversely, a drum which is highly resistant to radial loads but which collapses under small axial forces is not satisfactory. Moreover, a satisfactory drum must also possess characteristics of resistance to forces caused by oblique drops where the drum hits the ground with part of its chime. Even a drum which has sufficient strength, and what might be termed "balanced strength," in all the foregoing respects would not be satisfactory if it could not stand being rolled over a reasonable distance.

With the above considerations in mind, the container industry has devised and adopted a great number of tests of different nature for the purpose of evaluating various drum constructions with regard to both the foregoing and other requirements. Such tests are primarily intended to simulate those various types of unfavorable conditions normally encountered during handling, transportation, and storage of drums in the field.

Accordingly, it is a general aim of the present invention to provide an improved shipping container construction which not only permits the use of relatively thin light-weight sheet material as compared with the relatively thicker and heavier material heretofore required, but wherein the container is characterized by its strength and resistance to deformation forces of the type normally encountered in handling, transportation and storage. While not so limited in its application, the invention will find especially advantageous use in connection with metal containers made, for example, of 22-gauge or 24-gauge sheet steel, thus insuring saving in both manufacturing costs and dead weight.

Another object of the invention is to provide a light-weight sheet metal drum which, when subjected to the conventional performance tests adopted by the container industry, exhibits optimum performance characteristics. A related object of the invention is the provision of an improved drum construction which, because of its performance characteristics when subjected to unfavorable conditions, results in a drum characterized by its versatility and reliability in use.

In another of its important aspects, it is an object of the invention to provide an improved shaped sidewall construction for shipping containers wherein the internal axial strains created in the sheet material as an incident to shaping the latter during the sidewall forming operation are minimized, thus providing a stronger drum construction. As a consequence of attaining the foregoing objective, a drum sidewall embodying the invention permits of greater deformation, or strain, in the field before failure than has heretofore been possible.

Other objects and advantages of the invention will become apparent as the following description proceeds, taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a side elevation of a shipping container embodying the features of the present invention; and,

FIG. 2 is an enlarged, fragmentary, longitudinal section of a portion of the sidewall of the container shown in FIG. 1, and illustrating also details of the exemplary chime construction used for connecting an end member, or drum head, to the sidewall.

While the invention is susceptible of various modifications and alternative forms, a specific embodiment thereof has been shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that it is not intended to limit the invention to the particular form disclosed, but, on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the invention as expressed in the appended claims.

Referring now to the drawing, there is illustrated in FIG. 1, an exemplary shipping container or drum **10** having a generally cylindrical body or sidewall **11.** In the illustrative form of the invention, the opposite ends of the drum are closed by a pair of disc shaped end members **12** which are respectively secured to the opposite extremities of the sidewall **11** by a curled seam or chime **14.**

In order to enhance the characteristics of drum strength and resistance to deformation forces, provision is made in the illustrative drum construction for concentrating the metal in the vicinity of the chime **14,** thus substantially reinforcing the drum and permitting the latter to be tipped on its edge and rolled on the chime so as to facilitate movement thereof. To this end, and as best illustrated by reference to FIG. 2, the chime **14** is defined by adjacent layers or plies of the sidewall **11,** the drum head or end **12,** and an annular metallic reinforcing ring **15.** As here shown, the exemplary chime is comprised of eight plies—there being two plies ***11a*, *11b*** of sidewall material **11,** three plies ***12a*, *12b*, *12c*** of end material **12,** and three plies ***15a*, *15b*, *15c*** of reinforcing ring material **15.**

In formation of the eight-ply chime **14,** for example, by bending, turning, rolling or similar manufacturing procedures well known to those skilled in the art, the outermost extremities of the reinforcing ring **15** and end **12** are bent or turned over into a substantially U-shaped configuration encompassing the extremity of the sidewall **11.** The entire connection, including the extremity of the sidewall **11,** is then bent or turned over again into a second substantially U-shaped configuration. Thus, the marginal edge of the sidewall is bent once through an angle of 180° into a U-shape whereas the marginal edges of the ring **15** and end **12** are bent twice through angles of 180° into a double U-shape. In the exemplary chime therefore, the inner ply ***15a*** of the ring **15** abuts the inner ply ***12a*** of the end, while the outer ply ***15b*** of the ring abuts the outer ply ***12b*** of the end. The intermediate ply ***15c*** of the ring is received between the inner ply ***11a*** of the sidewall **11** and the intermediate ply ***12c*** of the end, while the outer ply ***11b*** of the sidewall is accommodated between the intermediate and outer plies of the end **12.** Thus, the plies ***11a*, *12a*, *15a*, *11b*, *12b*** and ***15b*** define an inverted U-shaped configuration, while the plies ***12b*, *15b*, *12c*** and ***15c*** define a U-shaped configuration.

The provision of an eight-ply chime with containers constructed in accordance with the invention has various advantages. For example, the connections between the sidewall **11** and the ends **12** are reinforced, thus minimizing the danger of deformation of the chime and separation of the end and sidewall. At the same time, the radial thickness of the chime is increased, particularly where the wall thickness of the ring **15** is greater than that of the sidewall **11,** as shown in the exemplary construction of FIG. 2. Such an increase in overall thickness of the chime materially reduces the risk of a chime cutting into the sidewall of an adjacent drum where the drums are shipped so that their longitudinal axes are other than parallel, for example, where their axes are perpendicular to one another.

The drum **10** (FIG. 1) may, in a conventional manner, be provided with a suitable filling and discharge opening and a vent hole. Such openings may conveniently be formed in one end member **12** and closed by means of separable bungs, plugs, screw caps, or similar closure devices, here shown generally at **16** and **18.**

In accordance with one of the important aspects of the present invention, the drum body or sidewall **11** is formed over substantially its entire length with a multiplicity of radially outwardly extending peripheral beads separated by a plurality of radially inwardly extending peripheral furrows, with the alternate beads and furrows being so interrelated and associated with one another as to form a container sidewall construction which exhibits optimum performance characteristics in terms of "balanced strength" and resistance to deformation forces. In the exemplary sidewall construction shown in FIG. 1, twenty-six such beads **19** are formed in the sidewall **11,** the beads being respectively spaced apart by twenty-five furrows **20.**

Of course, while twenty-six beads **19** and twenty-five furrows **20** have been shown, it will be understood that the particular number of beads and furrows may vary without departing from the invention. It is important, however, that the beads and furrows be interrelated and associated with one another in accordance with particular criteria that I have discovered and which are set forth hereinbelow. However, by way of example, when a 55-gallon drum is manufactured in accordance with these criteria, it will generally include from twenty-three to twenty-seven beads alternating with twenty-two to twenty-six furrows, assuming, of course, that the drum is of generally standard overall dimensions; i.e., on the order of approximately thirty-two inches in height (as measured from end member to end member) and formed from a cylindrical blank having an inside diameter of approximately twenty-two and one half inches.

As best illustrated by reference to FIG. 2, the top portion of each of the beads **19** and the bottom portion of each of the furrows **20** have a smoothly curved radial cross-section, and respective ones of the flanks of each bead blend smoothly into a flank of each of the adjacent furrows. In the preferred form of the invention shown in FIG. 2, the radial cross-section of each bead **19** and of each furrow **20** comprise circular arcs which blend directly into one another. I have discovered that advantageous results are obtained in terms of "balanced strength" where the ratio of the radius r of the bead arcs are on the order of 0.4 to 1.0, and preferably 0.6, times the radius R of the furrow arcs.

In the preferred form of the invention, the included angle α between the radial tangent to the flank of each bead **19** (at the point where the bead flank blends into the flank of an adjacent furrow **20**) and the longitudinal axis of the sidewall **11** is on the order of 35°. I have discovered that advantageous results can be obtained, again in terms of "balanced strength," if the angle α lies within the range of 20° to 50°.

I have further discovered that the ratio between the height of the beads **19** (or the depth of the furrows **20**) and the axial distance between the centers of the tops of the beads (or between the centers of the bottoms of the furrows) plays a part in obtaining the optimum correspondence of axial strength to radial strength of the drum—this ratio preferably being on the order of 0.25. That is, the beads and furrows serve to increase the resistance of the sidewall **11** to radial loads, while reducing the resistance thereof to axial loads. Thus, when provided with deeper beads **19,** the sidewall will be stronger radially, but weaker axially. Conversely, with shallower beads, the sidewall will be weaker radially and stronger axially. I have found that advantageous results are obtained in terms of "balanced strength" if the difference between the smaller diameter of the sidewall, as measured at the bottom of the furrows **20,** and the larger diameter of the sidewall, as measured over the top of the beads **15,** lies in the region from 0.4 to 0.6 times the axial distance between the centers of the tops of adjacent beads.

While those skilled in the art will appreciate that the present invention is not limited to containers having particular given capacities, it has been found, by way of example, that very satisfactory results are attained with 55-gallon drums made in accordance with the invention wherein the sidewall **11** is formed with twenty-three to twenty-seven beads **19** alternating with twenty-two to twenty-six furrows **20**; the outside diameters of the drum are approximately 22$^{15}/_{16}$ inches as measured at the bottom of the furrows **20**, and approximately 23½ inches as measured at the tops of the beads; the outside diameter of the chime **14** is on the order of approximately 22⅞ inches; the axial distance between the tops of adjacent beads is on the order of 1$^{3}/_{16}$ inches; and the axial distance between the ends **12** of the drum **10** is approximately 31$^{13}/_{16}$ inches. Additionally, the radius r of curvature of the beads **19** is on the order of $^{5}/_{16}$ of an inch, while the radius R of curvature of the furrows **20** is on the order of ½ inch.

In carrying out the present invention, provision is made for minimizing the danger of deformation and failure of the vulnerable chime assemblies as an incident to rolling of the drum. Such drum failures have heretofore been particularly prevalent in the vicinity of the chime **14** when the drum is rolled along the ground or other uneven surfaces. To accomplish this, the chime **14** is offset radially inward with respect to the tops of the beads **19**, and, in the preferred form of the invention as shown in FIG. 2, also with respect to the outside diameter as measured at the bottoms of the furrows **20**. The arrangement is such that when a drum **10** is rolled along on its sidewall **11**, the relatively vulnerable chimes **14** are kept clear of the surface on which the drum is being rolled. For example, in the exemplary 55-gallon drum described above, the chimes are kept free of the ground since the outside diameter of the chime **14** (approximately 22⅞ inches) is less than the outside diameter of the beads **19** (approximately 23½ inches). Moreover, even greater protection for the chimes is insured where the outside diameter thereof is slightly less than the outside diameter of the furrows **20** (e.g., less than 22$^{15}/_{16}$ inch outside diameter of the furrows in exemplary 55-gallon drum), since in this instance the chimes **14** are kept free of the ground even when the beads **19** collapse because of excessive loads which may occur, for example, when a filled drum is rolled along an uneven surface.

It will be appreciated by those skilled in the art that a given piece of sheet metal is capable of only a certain percent of elongation or strain before failure occurs. A certain amount of the permissible elongation will, of necessity, occur during the sidewall shaping operation. For example, in the formation of drums in accordance with the invention, a substantially cylindrical metal blank is shaped by forming alternating beads and furrows therein. The beads and furrows may be formed in various ways, such as rolling, locally expanding, or locally shrinking the blank. These operations will, of course, change the circumferential dimension of the blank at axially spaced points, thus circumferentially straining the blank. At the same time, some axial elongation or strain is also created in the sidewall due to elongation of the blank material.

I have found that in carrying out the present invention, the drum sidewall is preferably formed by a shaping operation wherein the blank material on both sides of each bead is permitted to move towards the bead as the latter is formed. This permits the formation of a sidewall **11** embodying the invention wherein the strains in the formed sidewall are primarily limited to circumferential strains, while axial strains are substantially minimized in the finished sidewall. Consequently, the finished drum **10** is capable of absorbing greater punishment in the field than would otherwise be possible since the sidewall material is capable of greater longitudinal or axial elongation in the field before it will fail.

To this end, when the beads **19** (or furrows **20**) are formed in the blank one at a time, the opposite extremities of the blank are maintained free of axial constraint, thus permitting the blank material on each side of the bead (or furrow) being formed to move axially towards the bead (or furrow). Alternatively, in those instances where two or more beads are formed simultaneously, for example, by the use of internal expansible die members, the die members are preferably mounted to move axially towards one another during the expanding operation, thus permitting the blank material at both sides of each bead being formed to move towards the bead. Similarly, two or more of the beads may be formed simultaneously by the use of an inflatable and deflatable bag mounted within external die members, the blank being placed between the bag and the dies and the dies being permitted to move axially towards one another. This latter type of equipment is described in greater detail in the copending application of Oscar J. Van Leer and Christian Ragettli, Serial No. 850,247, filed November 2, 1959, now Patent No. 3,099,311.

Tests have demonstrated that where a shaped sidewall similar to that shown in FIGS. 1 and 2 was formed by methods which inhibited axial movement of the blank material on both sides of the bead during the shaping operation, the axial distance between two points on the uniformed blank remained the same as the axial distance between the same two points (chosen, for example, to coincide with the tops of two adjacent beads) on the finished sidewall section. At the same time, the distance between the two points as measured along the surface of the shell increased. By way of example, a finished sidewall section which measured 1.25 inches from the top of one bead to the top of the adjacent bead (and hence, 1.25 inches between the same two points on the unformed blank), measured 1.512 inches along the surface of the sidewall. Therefore, the average net axial strain or elongation of the blank was on the order of 21%.

However, tests have also demonstrated that when a sidewall having the same finished shape and made of the same material is formed by methods which permit axial movement of the blank material on either side of the bead, the axial elongation of the material can be limited by controlling the relationship between the radial expansion and axial contraction of the forming dies. By way of example, a finished sidewall section which measured 1.25 inches in an axial direction from the top of one bead to the top of the adjacent bead, and 1.512 inches along the shell surface between the same two points (i.e., both dimensions being identical to the corresponding dimensions set forth above where axial movement of the blank material was inhibited), the original axial length of the unformed section was 1.484 inches. That is, the beads moved axially toward one another by .234 inch during the forming operation. In this case, the average net axial strain was on the order of 2%, a substantial reduction over the 21% average net axial strain encountered where no axial movement of the blank is permitted.

I have found that advantageous results in terms of "balanced strength" can be achieved where the relationship between radial expansion and axial contraction is controlled so that the average net axial strain of the sidewall material as measured from top to bottom of the shell is on the order of 2%, and preferably does not exceed 5%. As used herein, and in the appended claims, the term "axial strain" is intended to connote the strain as measured longitudinally along the sidewall **11**, it being understood that elongation measured in the finished product is not purely axial in view of the undulating nature of the sidewall. Moreover, while the illustrative container shown in FIG. 1 has been illustrated as having twenty-six beads **19** spaced apart by twenty-five furrows 20, it will be understood that either more or less beads and furrows could be provided. However, I have found that the advantageous results of the present invention are achieved only where there are at least three, and preferably more, beads 19. Therefore, in the appended claims the invention has been defined in terms of a container sidewall and method of manufacture thereof, wherein the sidewall is provided with a "multiplicity" of beads and it is intended that the term multiplicity connote at least three beads.

In keeping with the present invention, the drum 10 is preferably formed from a cylindrical blank having a diameter smaller than the diameter of the shaped sidewall as measured at the bottom of the furrows, thus permitting the unformed extremities of the sidewall to be formed into a chime 14 having an external diameter which is smaller than the external furrow diameter.

I claim as my invention:

1. A sidewall for use with a generally cylindrical sheet metal shipping container of the type having a pair of end members respectively connected to the opposite extremities of the sidewall, said sidewall having a multiplicity of radially outwardly extending peripheral beads spaced axially from one another with the spacing between adjacent beads defining a plurality of radially inwardly extending peripheral furrows, the top portion of each of said beads and the bottom portion of the adjacent furrows defining a smoothly curved radial cross section, the respective flanks of each of said beads blending smoothly into a flank of each of the adjacent furrows, said sidewall having an average net axial strain as measured from top to bottom thereof of about 2%.

2. A sidewall for use with a generally cylindrical sheet metal shipping container of the type having a pair of end members respectively connected to the opposite extremities of the sidewall, said sidewall having a multiplicity of three or more radially outwardly extending peripheral beads spaced axially from one another with the spacing between adjacent beads defining a plurality of radially inwardly extending peripheral furrows, the top portion of each of said beads and the bottom portion of the adjacent furrows defining a smoothly curved radial cross section, the respective flanks of each of said beads blending smoothly into a flank of each of the adjacent furrows, said sidewall having an average net axial strain as measured from top to bottom thereof less than 5%.

3. The method of making a shaped metal sidewall for a sheet metal container comprising the steps of forming a substantially cylindrical blank of sheet metal, locally expanding said blank in a radial direction at a multiplicity of axially spaced points to form a series of three or more radially outwardly extending peripheral beads alternating with radially inwardly extending peripheral furrows while permitting the blank material at both sides of each bead being formed to move towards said bead, stopping said expanding operation when said blank is formed with alternating beads and furrows over substantially its entire length with the exception of the marginal edges at the extremities of the blank, and controlling the relationship between radial expansion and axial contraction of the blank so that the average net axial strain of the sidewall as measured from top to bottom thereof is on the order of 2%.

4. The method of making a shaped metal sidewall for a sheet metal container comprising the steps of forming a substantially cylindrical blank of sheet metal, locally expanding said blank in a radial direction at a multiplicity of axially spaced points to form a series of at least three radially outwardly extending peripheral beads alternating with radially inwardly extending peripheral furrows while permitting the blank material at both sides of each bead being formed to move towards said bead, stopping said expanding operation when said blank is formed with alternating beads and furrows over substantially its entire length with the exception of the marginal edges at the extremities of the blank, and controlling the relationship between radial expansion and axial contraction of the blank so that the average net axial strain of the sidewall as measured from top to bottom thereof is less than 5%.

References Cited by the Examiner

UNITED STATES PATENTS

1,200,748	10/1916	Munger	220—72
1,825,030	9/1931	Vaughn	113—120
1,886,803	11/1932	Giesler	113—120

FOREIGN PATENTS

129,753 11/1927 Switzerland.

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