A paperboard container and apparatus for producing it are disclosed. A relatively deep central portion of the container, having a side wall with at least one tightly-radiused corner portion, is formed in a first forming step, after which a second, preferably peripheral region is formed. The second region preferably comprises a ledge or shoulder formed in the side wall of the container and spaced from both the top and the bottom of the side wall. A top piece preferably rests on the ledge or shoulder, and serves as a lid.
BACKGROUND OF THE INVENTION

This invention pertains generally to forming articles from paperboard and similar sheet materials, and pertains more particularly to the formation from such materials of containers having tightly radiused portions.

One type of container that has proved quite useful in the fast food industry is a two-piece container for packaging hamburgers and other sandwiches. A container of this type ordinarily includes a bottom piece and a top piece, each being relatively deep, typically on the order of one to two inches. The lower piece usually has a shoulder or ledge formed on the inner surface of the side wall, spaced a short distance from the top of the side wall, to receive the lid. Many containers of this type are approximately square, although the side walls usually slope outward from the bottom of the lower piece. The upper and lower pieces are typically, but not necessarily approximately the same in size and shape. For esthetic and commercial reasons, it is desirable to make the corners of the container as sharp as possible.

The manufacture of such containers from styrofoam or other thermoplastics is well known. When it is attempted to make such a container from a less plastic material, such as paperboard, however, severe problems are encountered. With paperboard, it frequently happens that the material tears at the corners in the region that is being formed into the internal shoulder or ledge. This is especially likely to occur if the angle of the side walls to the vertical is less than about 25 degrees. Such tears make the product unacceptable, and occur frequently enough to
make the manufacturing process economically unattractive, the more so as the inclination of the container side walls approaches the vertical.

It is therefore the principal object of the invention to provide a reliable, economical method for manufacturing such containers of paperboard and similar materials.

Another object of the invention is to provide an apparatus for carrying out such a method.

Still another object of the invention is to provide such a method and apparatus in which a central portion of a container is drawn first, after which the shoulder or ledge is formed in the container side wall.

Still another object of the invention is to provide a container of the type described, made using the method and apparatus of the invention.

SUMMARY OF THE INVENTION

According to the method of the invention, a deep-drawn paperboard container is formed in two steps. In the first step, a first portion of the container, comprising most of the area of the container, is formed. After this step is completed, the relatively small remaining portion of the container is formed. Included in the later-formed portion are regions of the container which would be subjected to relatively high stress during conventional one-step drawing of the container. This makes it possible to form a container of the type desired reliably and without tearing.

Preferably, the first-formed portion of the container is the deep central portion, comprising the bottom portion and the side wall. The second portion, to be formed is the ledge or shoulder formed in the interior surface of the side wall.
The container lid is made as a separate piece according to any suitable method, including the conventional one-step method. Since no flange or shoulder analogous to that of the lower piece is required in the lid, a conventional one-step process is quite suitable.

According to another aspect of the invention, a region of a container which is to have bi-directional curvature is formed in two steps. In the first, the material is formed with one curvature; in the second step, the second curvature is imparted to the region, superimposed on the first.

In its preferred embodiment, the apparatus of the invention includes a female die and a male punch assembly for cooperating to form the lower piece of the container. The punch assembly includes two parts, for forming two portions of the container in sequence. The first part of the punch assembly is arranged so that it contacts a piece of material located between the punch assembly and the female die before the material is contacted by the rest of the punch assembly, and partially forms the workpiece. This imparts a first curvature to the regions of paperboard or other material that are to become bi-directionally radiused. The second part of the punch assembly then contacts and further forms the portions of the article that have been curved in one direction in the first step and are to be given a second curvature. The second part of the punch assembly preferably shapes the peripheral section of the article, to form the shoulder on the interior surface of the side walls near the top. Preferably, the first part of the punch assembly is resiliently biased toward the female die to insure that the first part makes initial contact with the workpiece. And, preferably, a draw ring surrounding the punch assembly contacts the workpiece to hold the periphery of the workpiece and to control wrinkling during formation of the container.
Other features and advantages of the invention will be understood from a consideration of the following detailed description of the preferred embodiments, taken in conjunction with the accompanying figures, in which like reference characters refer to like elements throughout.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a perspective view of one preferred embodiment of the container of the invention, with the upper and lower pieces separated.

Figure 2 is a detail of Figure 1, showing the structure of a corner portion of the interior shoulder of the lower piece of the container.

Figure 3 is a top view of the preferred embodiment of the female die of the apparatus of the invention.

Figure 4 is a bottom view of the preferred embodiment of a portion of the punch assembly of the apparatus of the invention.

Figure 5 is a sectional view of the die set of Figures 3 and 4, including a surrounding draw ring, taken from section line 5-5 in Figure 3.

Figure 6 is a sectional view of the die set of Figure 5, taken from section line 6-6 of Figure 3.

Figure 7 is a top view of the part of the punch assembly shown in Figure 4.

Figure 8 is a cross-sectional view taken from section line 8-8 in Figure 7.

Figure 9 is a bottom view of the draw ring of Figure 5.

Figure 10 is a cross-sectional view of the draw ring of Figure 9, taken from section line 10-10 in Figure 9.

Figures 11-13 show the apparatus of Figures 3-10 being used to form the bottom piece of the container of Figure 1, according to the method of the invention.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 is a perspective view of a two-piece paperboard container 10 made according to the present invention. The container 10 comprises a lid 12 and a lower piece 14 that are preferably of approximately the same size and shape. Each piece 12, 14 includes a flat surface 16, 18 which is either the top or the bottom of the container, respectively, and a side wall 20, 22 continuous and integral with the flat surface 16, 18. In the embodiment shown, the container 10 is approximately square, as are the flat top and bottom portions 16, 18. The side walls 20, 22 are roughly quadrilateral, with tightly radiused angles at the corners. It is desirable for the corners to be as sharp as possible, e.g., with the radius no greater than one-sixteenth inch. (An even smaller radius, e.g., 1/32 inch or 0.015 inch, is believed to be attainable by means of the method herein disclosed.)

The lid 12 of the container is adapted to fit into the top of the side wall 22 of the lower part 14 of the container 10. For this purpose, a small ledge or shoulder 24 is provided on the interior surface of the side wall 22 of the lower piece 14, spaced a short distance from the top of the side wall, defining a narrow flange 26 extending upward from the outer edge of shoulder 24. In the embodiment shown, the flange 26 is parallel to the rest of the side wall 22, although this is not essential to the invention. The shoulder 24 is connected at its outer edge to the upper portion 26 of the side wall 22 by an angle 28 which, for esthetic reasons, should be as sharp as practical and may in fact have a radius of about 0.030".

As can be seen, in the four corners of the container, the shoulder 24 includes regions having very small radii of curvature (e.g., one-sixteenth inch) to join two adjacent panels of the side wall 22, while the
radius of curvature where the ledge 24 joins the top portion 26 of the side wall 22 is typically still smaller. The corners are thus tightly radiused in two directions. It has been found that the outer edge 28 of the shoulder 24, and most particularly the bi-directionally radiused corner portions of the shoulder, are subjected to very high stresses during formation of such a container by the usual drawing process, in which a punch having the shape of the interior of a container draws the paperboard into a complementary female die all at once in a single step. Due to the great amount of stretching required of the paperboard in some regions, a substantial percentage of containers so formed will tear in one or more of the bi-directionally radiused areas at the shoulder corners. The problem is particularly severe when the angle of the side wall 22 to the vertical is less than about 25 degrees (i.e., when the side wall 22 forms an angle between about 90 degrees and about 115 degrees, inclusive, with flat bottom portion 18). The severity of the problem increases with increasing side wall steepness, container depth, ledge width, and flange height.

It has been found that by forming the particularly vulnerable portions of the container 10, i.e., the shoulder 24 and, especially, the bi-directionally radiused portions thereof, in a separate step from the formation of the rest of the container, the likelihood of tearing is greatly reduced, and it becomes possible to form containers of this type reliably and with an economically acceptable rejection rate, even when the inclination of the side wall 22 approaches the vertical, as is often desirable commercially.

It is possible, using the invention, to reliably manufacture containers having bi-directionally radiused
areas in which each radius of curvature is one-eighth inch or less. For example, square containers have been made according to the method of the invention in which the radius of the corners is about 1/16", and in which the radius of the joint between the ledge 24 and the flange 26 is as little as 0.030". (For brevity, a region of paperboard having a radius of curvature no greater than about on-half inch will be termed "tightly radiused" or be said to have a "right radius of curvature" hereafter in the specification and claims). The method of the invention has been successfully used to produce containers with a side wall inclination of about 18 degrees to the vertical, a depth up to 1 5/8", ledge width up to 3/16" and flange height up to 1/4". These values are merely the largest yet tried, and are not believed to be limits to the applicability of the invention.

The preferred embodiment of the apparatus of the invention comprises a female die 30, a male punch assembly 32 and a draw ring 34 surrounding the latter. The relation of these elements is shown most clearly in Figures 5 and 6.

The female die 30 (see Figures 3, 5 and 6), which in the preferred embodiment is the lower die, comprises a block 36 of metal mounted on a base plate 38, and having a hollow 40 in its upper surface for forming the container 10. The hollow 40 has the shape to be imparted to the exterior of the container, and includes a flat portion 42 for forming the container bottom, a peripheral groove 44 around the flat portion 42 to give the container bottom a raised middle area, outward sloping side walls 46, and a shoulder 48 in the latter where the shoulder or ledge 24 will be formed in the container side wall 22.

A roughly toroidal recess 50 in the lower portion of the female die 30 accommodates a heater 52 to aid in the
quick forming and setting of the container. The heater 52 is preferably a cartridge heater, contained in a bore 54 in a heater housing 56 received in the recess 50. The heater housing is held in place in the recess 50 by means of a plate 58 bolted to the underside of block 36.

Vertical air passages 60 formed in the female die 30 lead from the lower portion of the die hollow 40 to horizontal air passages 62 at the base of block 36, which communicate with the die exterior. The air passages 60, 62 serve to evacuate air from the die hollow 40 when the paperboard is pushed into the hollow 40 by the punch assembly 32.

An ejector piston 64 is slidably received in a vertical shaft 68 in the female die 30. The piston 64 has a head 66 which is normally received in a recess 70 formed in the bottom of the die hollow 40. During formation of a container, the piston head 66 is flush with the rest of the bottom of the die hollow 40 and aids in shaping the paperboard. After the article has been formed and the punch assembly 32 has been removed from contact with the article, the piston 64 is raised to eject the finished article from the hollow 64. To limit the upward movement of the piston 64, two stop elements 72, 74 extending from the piston shaft engage the base plate 38.

An air channel 76 in the interior of the piston 64 aids in removing air from the die hollow 40 during formation of an article. If desired, an air blast can be directed upward through channel 76 to aid in the ejection of the finished article.

Two guide plates 78, 80 are bolted to the sides of block 36, and point toward the front female die 30. Guide plates 78, 80 aid in guiding the movement of a paperboard blank into place on the die 30 preparatory to
forming. The front, free end of each of the guide plates 78, 80 is tapered, as is best seen in Figure 3. Stop plates 82, 84 are also bolted to the rear portion of the female die 30, to position the blank properly for forming.

The male punch assembly 32 (see Figures 4-6) includes a central first portion 86 (hereinafter, the "central punch") and a peripheral second portion 88. The second portion 88 (hereinafter sometimes referred to as the "shoulder former") is bolted or otherwise secured to a top plate 90, which is mounted in a press (not shown) for vertical reciprocation. As can be seen, the outer part 88 of the punch assembly 32 forms the shoulder 24 in the container side wall 22 and also forms the flange 26.

In the preferred embodiment, the central punch 86 is mounted on the peripheral shoulder former 88 in such a manner as to be resiliently biased toward the female die 30. In the embodiment shown, the shoulder former 88 has four cylindrical bores 94 provided in its lower surface. Smaller bores 96 are located in the upper surface of the shoulder former 88, each directly above a corresponding lower bore 94. Each of the lower bores 94 contains a cylindrical spring 98 the lower end of which rests on the upper surface of the central punch 86, biasing the latter downward. A hollow bore 100 connects the upper with the lower bore and slidably receives the main shaft of a bolt 102, whose enlarged head 104 is received in the upper bore 96 and limits the downward travel of the bolt 102 in the bore 100. The lower end of the bolt 102 has a reduced diameter and is threadedly secured in the central punch 86. The action of the springs 98 bias the central punch 86 downward, to the lower limit of the movement of the bolt 102 in the bore 100.
The draw ring 34 surrounds the outer part 88 of the punch assembly 32, and is free to slide vertically relative thereto. The lower surface of the draw ring 34 is complementary to the peripheral upper surface of the female die 30, which slopes slightly downward and outward in the depicted embodiment. The purpose of the draw ring 34 is to contact a sheet of material (whether a blank or a portion of a web) at about the same time as does the central punch insert 86, and to hold down the periphery 10 of the portion of material being worked to control wrinkling during formation of the article.

Plate-shaped draw ring stops 106 are attached to the front and back lower edges of the top plate 90 by bolts 108 or the like. The lower extremity of each draw ring stop 106 is turned in toward the draw ring 34, as is best shown in Figure 4. Generally bar-shaped stop pads 110 are received in recesses provided for them in the outer surface of the draw ring 34, and are bolted in place. As can be seen from Figure 4, the stop pads 110 cooperate from the in-turned portion of the ring stops 106 to limit the lower travel of the draw ring 34 relative to the shoulder former 88 of the punch assembly 32. This limit is selected to insure that the draw ring 34 contacts the paperboard at the same time as does the central punch 86.

The vertical movement of the draw pad 34 is controlled by four air cylinders 112 received in cylindrical bores 92 provided for them in the upper surface of the draw ring 34. One corner of each of these bores 92 is formed by a recess in the periphery of the shoulder 88 of the punch assembly 32.

The shoulder former 88 is preferably hollow, to save weight. In addition, the hollow interior 114 of
shoulder former 88 communicates with the exterior via air passages 116 and, via vertical bores 118 formed in central punch 86, with the lower surface of the punch assembly 32, to aid in removing air from between the punch assembly 32 and the paperboard during formation. Draw ring 34 also has horizontal air passages 120 to convey air from passages 116 to the die exterior when draw ring 34 and shoulder former 88 are resting on female die 30.

The operation of the apparatus of the invention can be understood most easily from Figures 11-13. Figure 11 shows the preferred embodiment of the apparatus of the invention at the beginning of the process, with a flat paperboard blank 122 received in position on top of the female die 30 and with the punch assembly 32 raised above the die 30. As can be seen, the springs 98 preload the central portion 86 of the punch assembly 32 downward, and the draw ring 34 is also at the lower limit of its travel. As the punch assembly 32 and the draw ring 34 descend, the draw ring 34 and the central punch 86 contact the paperboard more or less simultaneously. As shown in Figure 12, the draw ring 34 grips and clamps the periphery of the blank 122, preventing wrinkling during formation of the article. The downward-biased central punch 86 forms the central portion of the container. The drawing of the paperboard by the central punch 86 also performs the portion of the paperboard that will become ledge or shoulder 24 and flange 26, by stretching that portion into a planar collar at the top of die 30. After the central portion of the container has been completely formed, the continued downward motion of the punch assembly 32 moves the shoulder former 88 into contact with the paperboard 122, pressing the preformed planar upper portion of the paperboard into the final desired shape, with shoulder 24 to receive the container lid.
It has been found that by thus forming the main portion of the container 10 first, and then forming the relatively small peripheral ledge 24 and flange 26, the paperboard is saved from the very high stresses to which it would be subjected in conventional one-step forming. It has been found that the use of the method and apparatus of the invention results in the reliable production of a container of the desired shape and characteristics, without tearing at the shoulder or elsewhere.

It will be understood that if desired, the female die could be the upper die, and that with either arrangement, either the upper or the lower die or both could be reciprocated. In addition, it will be understood that both dies can be heated, if desired, or that neither die need be heated if the characteristics of the paperboard in question and the dwell time permit heating to be dispensed with.

Although the invention has been disclosed and discussed in detail with respect to the preferred embodiments thereof, many variations and modifications thereof will now be apparent to those skilled in the art. Accordingly, the scope of the invention is to be limited, not by the details of the embodiment described herein, but only by the terms of the appended claims.
WHAT IS CLAIMED IS:

1. Apparatus for forming from paperboard a container of the type having a side wall with at least one relatively tightly-radiused corner region comprising a female die and a male punch for cooperating with the die, and having a small ledge defined in its side wall for receiving a lid, characterized by the fact that the punch assembly has a first part for forming in cooperation with the die a container without said ledge, and a second part for cooperating with said die to form a ledge in the side wall of the container and spaced from both the top and the bottom of the side wall, said first part of said punch assembly being mounted relative to said second part in such a manner as to engage a piece of paperboard located between said die and said punch assembly to form the container without the ledge before said second part engages the paperboard to form the ledge.

2. The apparatus of claim 1 characterized by the fact that said first part of said punch assembly is mounted with resilient bias toward said female die and away from said second part.

3. The apparatus of claim 1 or 2, characterized by the fact that it comprises a draw ring for holding a piece of paperboard at points peripheral to said die and said punch assembly during formation of a container.

4. The apparatus of one of claims 1 to 3, characterized by the fact that said punch assembly and said die are shaped to form a container having a side wall inclined at an angle between about 90 degrees and about 115 degrees, inclusive, to the bottom of the container.

5. The apparatus of one of claims 1 to 4, characterized by the fact that said die and said first and second parts of said punch assembly are roughly square in cross-section.
6. The apparatus of one of claims 1 to 4, characterized by the fact that said die and said first and second parts of said punch assembly are oval in cross-section.

7. The apparatus of claim 1, characterized by the fact that said die and said punch assembly are for forming a container having at least one corner region having a radius of curvature of no more than about 1,6 mm.

8. A method for forming a paperboard container, characterized by the fact that it comprises the steps of first forming at least a portion of a sheet of paperboard to define a bottom surface and a side wall of said container, said side wall having at least one tightly-radiused corner region, and then forming a shoulder in said side wall at a location spaced from both the top and the bottom of said side wall.

9. The method of claim 8, characterized by the fact that said container is approximately square.

10. A method according to claim 8 or 9 for forming a paperboard container, characterized by the fact that the side wall has at least one region having a first curvature with a first tight radius of curvature, and then forming at least a portion of said one region to impart thereto a second curvature, having a second tight radius of curvature, in a direction different from that of said first curvature.

11. The method of claim 10, characterized by the fact that said first and second radii of curvature are each less than about 3,2 mm.

12. The method of claim 11, characterized by the fact that said first radius is no more than about 1,6 mm, and said second radius is about 0,76 mm.
13. A paperboard container, characterized by the fact that it comprises:
   a unitary piece drawn from paperboard and having a side wall and a bottom portion continuous and integral with said side wall, and having a peripheral ledge formed in said side wall and spaced both from said bottom portion and from the top of said side wall,
   said side wall having at least one tightly radiused corner portion with a first radius of curvature, and
   said ledge having a portion with a second tight radius of curvature.

14. The container of claim 13 characterized by the fact that the depth of said container is at least 38 mm.

15. The container of claim 13 or 14 characterized by the fact that it comprises a lid to fit within said side wall portion and to rest on said ledge.

16. The container of one of claims 13 to 15 characterized by the fact that said side wall is inclined to said bottom portion at an angle between about 90 degrees and about 115 degrees, inclusive.

17. The container of one of claims 13 to 16 characterized by the fact that said radii of curvature of both are no more than about 1,6 mm.

18. The container of claim 17, characterized by the fact that said first radius of curvature is no more than about 1,6 mm and said second radius of curvature is no more than about 0,76 mm.