

PATENT SPECIFICATION

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(54) METHOD OF AND APPARATUS FOR THE MANUFACTURE OF A CONTAINER

(71) We, RHEEM MANUFACTURING COMPANY, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 767 Fifth Avenue, New York, New York 10022, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a method of and apparatus for the manufacture of containers for the storage and shipping of materials.

The manufacture of plastics containers by processing moulding material within forming dies has the evident disadvantage of rendering the production of different-sized containers quite costly. Thus, moulds of diverse length and volume are required for making each uniquely sized container. Waste also occurs since container thickness is not uniformly maintainable in moulding practice, i.e. containers are unnecessarily thick-walled in corner and like areas. Manufacture of containers by other previously proposed techniques is complicated by the need for forming fibrous shells by winding and sealing laminates or joining sections and then applying a sealing lining thereto. Regarding the reference commercially-available drum, the same is a metal-reinforced plastics drum and its manufacture further entails the need for reinforcing its closure member by radial ribs as above considered.

The present application is divided from patent application No. 46176/76 (Serial No. 1572399), in which we claim a container comprising an elongate cylindrical shell of plastics material having at least one open end and a closure member of plastics material closing such open end, said closure member comprising a single thickness axially extending cylindrical rim portion encircling and sealingly secured exclusively to the

radially outer surface of said shell about said open end, an annular hingedly deformable portion continuous with said rim portion extending radially inwardly from said rim portion to the interior of the shell and a central deformable portion of the closure continuous with the annular portion completing closing of the said open end, said annular portion extending radially and axially inwardly of the open end edge of the shell deformably hingedly to support said central portion and comprising a first part continuous with the rim portion and extending radially of the shell, a second part continuous with the first part and extending axially of and substantially parallel to the shell and encircled by the shell and a third part continuous with the second part and extending to a location spaced radially interiorly of and coaxial with said shell, with said central portion being continuous with said third part and having a surface area greater than the planar area encompassed by the juncture of the annular and central portions, the construction being such that the container is resistant to impact by deformation and hingedly unfolding of the annular and central portions.

In that Application No. 46176/76 (Serial No. 1572399) we also claim a method of making a container comprising the steps of: (a) cutting plastics sheet material into a sheet of predetermined length and width; (b) forming such cut sheet into a hollow shell having a slit extending axially between open ends of said shell and defined by juxtaposed edges of said sheet; (c) sealing said slit to provide an axially extending continuous sealed seam for said shell; (d) forming closure members for said shell open ends by shaping integral plastics material to form a single thickness cylindrical rim portion, an annular hingedly deformable portion continuous with the rim portion extending radially inwardly from the rim portion and a central deformable portion continuous with the annular portion

completing closing of the annular portion with the annular portion extending radially and axially inwardly of the closure member deformably hingedly to support the central portion and with said central portion having a surface area greater than the planar area encompassed by the periphery of the central portion; and (e) sealably securing each said closure member at the periphery thereof exclusively to the outer surface of said shell adjacent a distinct one of said open ends thereof, said annular portion comprising a first part continuous with the rim portion and extending radially of the shell, a second part continuous with the first part and extending axially of and substantially parallel to the shell and encircled by the shell and a third part continuous with the second part and extending to a location spaced radially interiorly of and coaxial with said shell, the construction being such that the container is resistant to impact by deformation and hingedly unfolding of the annular and central portions.

According to one aspect of the present invention, we provide apparatus for use in securing a closure member to an open end of a shell to form a container, said apparatus including a first fixture and a second fixture supported coaxially interiorly of said first fixture, said fixtures being supported for relative movement jointly to define an annular space therebetween for, in use of the apparatus, receiving an unbonded assembly of said closure member and said shell and bonding material including magnetizable particles dispersed in plastics, at least one of said fixtures being comprised of separate arcuate segments, first means for displacing said fixtures relative to one another whereby said fixtures apply pressure to said assembly in use of the apparatus, and second means for subjecting such pressed assembly to heat energy, said second means comprising an electromagnetic field generator supported at the pressing periphery of at least one of said fixtures immediate to the pressed assembly and adapted for flexure relative to its supporting fixture, whereby said particles in the bonding material are responsive to such generated electromagnetic field to heat said plastics to its fusion point for flowing thereof into intimate contact with surfaces of said shell and said closure member in facing relation to said bonding material.

Another aspect of the present invention provides a method of making a container comprising the steps of: cutting plastics sheet material into a sheet of predetermined length and width; forming such cut sheet into a hollow shell having a slit extending axially between open ends of said shell and defined by juxtaposed edges of said sheet; sealing said slit to provide an axially extending continuous sealed seam for said shell; forming a

closure member for one of said shell open ends by shaping integral plastics material; forming an assembly wherein said closure member is disposed in encircling relation to said shell adjacent said one open end and wherein bonding material containing magnetizable particles is disposed about the shell between said closure member and said shell; and securing said assembly by simultaneously applying pressure to said assembly and disposing a magnetic field generator in immediate juxtaposition with the periphery of said closure member, the pressure being applied in a direction normal to the surface of the shell by means of two fixtures arranged internally and externally of the shell with part of the assembly including the bonding material being located therebetween, thereby heating said material to its fusion point for flowing thereof into intimate contact with said closure member and said shell adjacent said one open end.

The invention will be further evident from the following detailed description given by way of example with reference to the accompanying drawings, wherein:

Figure 1 illustrates schematically the extruding and cutting of shell-forming sheet material;

Figure 2 is a top plan view of the Figure 1 sheet material formed into a hollow shell with a strip of bonding material disposed in the shell axial seam and subject to the action of fusing apparatus illustrated in section;

Figure 2a is a perspective view showing a manner of energizing the Figure 2 fusing apparatus;

Figure 3 is a frontal elevation in section of the completed Figure 2 shell with end closure members therefor;

Figure 4 is a top plan view of fusing apparatus for use in securing an end closure member to the shell;

Figure 4a shows tube 40a of the Figure 4 fusing apparatus removed therefrom; and

Figure 5 is an enlarged sectional view of the Figure 4 apparatus as seen from the line VI-VI of Figure 4 operative in a fusing operation.

Referring to Figure 1, extruder head 10 dispenses from die lip slit opening 10a continuous sheet material 12 preferably comprised of high molecular weight high density polyethylene. Cutting apparatus (not shown) selectively cuts sheet material 12 transversely of its issuing direction to form individual sheets 14 having length L and width W. The former of these dimensions is controlled by the cutting apparatus whereas the latter dimension may be varied together with sheet thickness T by substitution of extruder heads or changing the die lip opening. Opposed side edges 14a and 14b of sheet 14 are mitered at an angle of from five to forty-five degrees (Figure 2) and the sheet is then formed into a hollow cylinder. As shown in Figure 2,

mitered edges 14a and 14b are spaced slightly from one another and a strip of bonding material 16 is disposed therebetween. Strip 16 is preferably comprised of magnetizable particles, such as iron oxide, dispersed in a plastics base. With strip 16 and sheet 14 disposed as indicated in Figure 2, holding fixtures 18a and 18b, both comprised of electrically insulative material, are clamped in pressure relation to one another. These fixtures support a continuous two-loop coil of axially extending hollow copper tubing 20 which is internally cooled and excited electrically by connection to a radio frequency supply whereby edges 14a and 14b of sheet 14 are fused together, applied pressure causing the bonding agent to flow into intimate contact with the facing surfaces of the sheet edges.

Rubber hose 20a (Figure 2a) conducts coolant (water) from the right hand tubing 20 in fixture 18a to the left hand tubing 20 in fixture 18a. At the remote end of such left hand fixture 18a, the copper tubing conducts coolant and current therefrom to the right hand tubing 20 in fixture 18b. Rubber hose 20b conducts coolant thence to the left hand tubing 20 in fixture 18b. Switch plates 20g and 20h are movable horizontally in Figure 2a to engage switch plates 20c-20f to energize the tubing. On completion of the fusing operation, plates 20g and 20h are moved vertically to permit axial removal of the bonded shell.

Referring to Figure 3, the above-discussed seaming operation provides a completed container shell 22 having axially-extending seam 22a. End closure members 24a and 24b, formed in configuration shown in Figure 3 and preferably of like material to that of shell 22, are disposed in place on the ends of shell 22 with strips 26 of bonding material situated interiorly of the end closure members and exteriorly of shell 22 as illustrated. With shell 22, members 24a and 24b and strips 26 so arranged, the members 24b end of the assembly is placed in bonding apparatus as shown in Figure 5. This apparatus has an outer fixture 28 (Figure 4) supported in spaced radially encircling relation to an inner fixture 30, both comprised of electrically insulative material. Fixture 28 is of segmented type, including segments 28a and 28b each spanning approximately one hundred-twenty degrees and segments 28c and 28d, each spanning approximately sixty degrees. The radially outward surfaces of segments 28a-28d engage bladder 32 serviced on demand from a supply of pressurized air through conduit 34 for displacing the segments radially inwardly. Rigid outer ring 36 provides a reaction bearing surface for bladder 32. At their radially interior surfaces, segments 28a and 28b define grooves 38 (Figure 5) and fixture 30 defines

grooves 39 for receiving double loop hollow copper tubes 40a and 40b (Figures 4, 4a). Tubes 40a and 40b are used, as in the case of tubing 20 above-discussed, for applying a radio frequency induction field to unbonded assemblies disposed in channel 42 established between segments 28a-28d and fixture 30.

The manner in which the tubing is routed in Figure 4 apparatus is seen in Figure 4a which shows tube 40a removed from the Figure 4 apparatus. Tube 40a portion 40a-1 extends into fixture 30 to location L1 and the tubing then proceeds outwardly toward the viewer of Figure 4a to tube portion 40a-2 which extends in an upper groove of fixture 30 clockwise circularly to location L2. At this location, tube 40a, proceeds inwardly away from the viewer of Figure 4a to tube portion 40a-3 which extends radially outwardly to segment 28a and thence outwardly towards the viewer to an upper groove in segment 28a. Tube portion 40a-4 proceeds counterclockwise circularly in such segment 28a groove to location L3 and then proceeds inwardly away from the Figure 4a viewer to tube portion 40a-5 which proceeds radially inwardly of segment 28a to a lower groove of fixture 50. Thereupon tube 40a extends clockwise circularly in fixture 30 to location L4 whereupon tube portion 40a-6 proceeds radially outwardly to a lower groove of segment 28a and therein to location L5. At this location tube portion 40a-7 extends radially outwardly of segment 28a. Fixture 30 and segment 28a have grooves at locations L1-L4 and elsewhere running transverse of and interconnecting their upper and lower grooves to provide for travel of tube 40a between such upper and lower grooves.

With the unbonded assembly of bonded shell 22, closure member 24b and strip 26 disposed in channel 42 (Figure 5), conduit 34 is positively pressurized and segments 28a-28d press the assembly against fixture 30. Segments 28c and 28d serve to equalize pressure around the circumference of the unbonded assembly. Tubes 40a and 40b are energized whereby the part of the assembly adjacent the tubes is fused together, the applied pressure causing the bonding agent to flow into intimate contact with the surfaces of shell 22 and end closure member 24b which face strip 26.

In the embodiment shown in Figures 4, 4a and 5, tubes 40a and 40b each encompass approximately one hundred degrees of arc, mutually spaced by some eighty degrees. For a complete bonding operation, the work is rotated and two passes are needed. The invention of course contemplates a single continuous double loop tubing assembly whereby the bonding operation may be completed in a single pass mode for joining each closure member to the bonded shell.

Leaf spring 43 between base 44 and the

segments urges the segments radially outwardly of channel 42 when bladder 32 is deflated to facilitate removal of bonded assemblies. For automated removal of bonded assemblies from the bonding apparatus, ram assembly 46 is slidably supported on sleeve 44a of base 44 for movement through base opening 44b into channel 42.

Referring to Figure 3, end closure members 24a and 24b include a first (hinge) portion 24-1 having one part 24-1a extending axially of shell 22 and encircling the outer surface of the shell and another part 24-1b extending to end locations radially interiorly of and coaxial with the shell. The closure members have a second (central) portion 24-2 continuous with and hingedly supported by portion 24-1. Portion 24-2 is itself preferably bowed axially of shell 22 such that it has linewise surface extent S₁ between diametrically opposed ones, e.g. L_A and L_B of end locations of portion 24-1 in excess of the diametric spacing S₂ between such end locations. Closure member 24a may have bung hole fittings, one being shown at 24c in Figure 3. As will be appreciated, the closure member hinge and central portions are preferably parts of an integral plastics structure formed by a moulding operation.

Example 1

The side edges of an extruded sheet of high molecular weight high density polyethylene (HDPE), 38 inches in width, 70.5 inches in length and 0.135 inch in thickness are mitered at an angle of 10° and the sheet is formed into a cylindrical shell as in Figure 2 having a diameter of 22.5 inches and an axially extending slit between the mitered edges. A strip of bonding material comprised of HDPE containing iron oxide particles and having a thickness of 0.015 inch and a width of 0.625 inch is placed in the slit and extends throughout the slit length. Bonding fixtures are next pressed against the shell slit as in Figure 2 and are energized from a radio-frequency supply to subject the bonding material to an electromagnetic field, heating the material to its fusion point and flowing the material into intimate contact with the mitered edges, thus sealing the shell slit throughout its length.

End closure members are moulded of high molecular weight HDPE in the configuration shown in Figure 3 and have an average thickness of 0.187 inch. The line surface extent of the end closure members (S₁ in Figure 3) is four percent longer than the spacing (S₂ in Figure 3) between diametrically opposed end locations of the hinge portion. The end closure members are assembled with the shell and with a bonding material strip therebetween as in Figure 3, comprised of HDPE containing iron oxide particles and having a thickness of 0.015 inch and a width of 0.750

inch. Bonding fixtures are next pressed against the assembly as in Figure 5 and are energized from a radio-frequency supply to subject the bonding material to an electromagnetic field, heating the material to its fusion point and flowing the material into intimate contact with the surfaces of the end closure members and shell facing the material.

Example 2

The side edges of an extruded sheet of high molecular weight HDPE, 13.5 inches in width, 36.5 inches in length and .085 inch in thickness are mitered at an angle of 10° and the sheet is formed into a cylindrical shell as in Figure 2 having a diameter of 11.5 inches and an axially extending slit between the mitered edges. A strip of bonding material comprised of HDPE containing iron oxide particles and having a thickness of .010 inch and a width of 0.375 inch is placed in the slit and extends throughout the slit length. The shell slit is sealed throughout its length in the manner set forth in Example 1.

End closure members are moulded of high molecular weight HDPE in the configuration shown in Figure 3 and have an average thickness of .085 inch. The line surface extent of the end closure members (S₁ in Figure 3) is two percent longer than the spacing (S₂ in Figure 3) between diametrically opposed end locations of the hinge portion. The end closure members are assembled with the shell and with a bonding material strip therebetween as in Figure 3 comprised of HDPE containing iron oxide particles and having a thickness of .010 inch and a width of 0.5 inch. The assembly is secured in the manner set forth in Example 1.

Example 3

A high molecular weight HDPE shell is extruded in cylindrical form through a circular die slot opening. The shell is 13.5 inches in length, having a diameter of 11.5 inches and .085 inch in thickness. End closure members with an average thickness of .085 inch are moulded of high molecular weight HDPE in the configuration of Figure 3 except that their line surface extents (S₁ in Figure 3) are equal to the spacings (S₂) between diametrically opposed end locations of the hinge portion, i.e. central portion 24-2 is flat. End closure members so formed are secured to the shell in the manner set forth in Example 1.

Example 4

A single end closure member of .085 inch average thickness is moulded of high molecular weight HDPE in the configuration of Figure 3 except that their line surface extents are equal to the spacings (S₂) between diametrically opposed end locations of the hinge portion, i.e. central portion 24-2 is flat. The end closure member is secured to a HDPE injection moulded one-piece pair

having a height of 13.5 inches, a diameter of 11.5 inches and .085 inch in average thickness, using the bonding method set forth in Example 1.

5 While the invention has been disclosed by way of particularly preferred embodiments, various changes and modifications thereof will be evident to those skilled in the container, bonding and related arts. Where in
10 extruded sheet form the shell axial slit need not have mitered edges nor strip bonding material disposed therein but may have non-mitered edges joined directly to one another by fusion or like techniques or by use of a
15 common backing member joined thereto.

WHAT WE CLAIM IS:

1. Apparatus for use in securing a closure member to an open end of a shell to form a container, said apparatus including a
20 first fixture and a second fixture supported coaxially interiorly of said first fixture, said fixtures being supported for relative movement jointly to define an annular space, therebetween for, in use of the apparatus,
25 receiving an unbonded assembly of said closure member and said shell and bonding material including magnetizable particles dispersed in plastics, at least one of said fixtures being comprised of separate arcuate
30 segments, first means for displacing said fixtures relative to one another whereby said fixtures apply pressure to said assembly in use of the apparatus, and second means for
35 subjecting such pressed assembly to heat energy, said second means comprising an electromagnetic field generator supported at the pressing periphery of at least one of said
40 fixtures immediate to the pressed assembly and adapted for flexure relative to its supporting fixture whereby said particles in the bonding material are responsive to such
45 generated electromagnetic field to heat said plastics to its fusion point for flowing thereof into intimate contact with surfaces of said shell and said closure member in facing
relation to said bonding material.

2. Apparatus as claimed in claim 1, wherein said first fixture is segmented and wherein said first means comprises inflatable
50 means situated radially outwardly of and engageable with said segments and rigid means disposed radially outwardly of said inflatable means for defining a bearing
reaction surface for said inflatable means.

3. Apparatus as claimed in claim 1 or 2, wherein said second means comprises radio-frequency energizable tubing means
55 supported by at least one of said fixtures and defining an interior hollow for receiving a cooling medium.

4. Apparatus as claimed in claim 1, 2 or 3, wherein said second means comprises radio-frequency energizable tubing means
60 supported by at least one of said fixtures and of extent less than the perimeter of said

assembly and adapted for said flexure relative to its supporting fixture for movement into confronting relation with said assembly in the course of pressing thereof.

5. A method of making a container comprising the steps of cutting plastics sheet
70 material into a sheet of predetermined length and width; forming such cut sheet into a hollow shell having a slit extending axially
75 between open ends of said shell and defined by juxtaposed edges of said sheet; sealing said slit to provide an axially extending continuous sealed seam for said shell; forming a closure
member for one of said shell open ends by
80 shaping integral plastics material; forming an assembly wherein said closure member is disposed in encircling relation to said shell
adjacent said one open end and wherein
bonding material containing magnetizable
85 particles is disposed about the shell between said closure member and said shell; and securing said assembly by simultaneously
applying pressure to said assembly and disposing a magnetic field generator in
90 immediate juxtaposition with the periphery of said closure member, the pressure being applied in a direction normal to the surface of the shell by means of two fixtures arranged
internally and externally of the shell with part
95 of the assembly including the bonding material being located therebetween, thereby heating said material to its fusion point for
flowing thereof into intimate contact with said
closure member and said shell adjacent said
100 one open end.

6. A method as claimed in claim 5, wherein the slit is sealed by disposing in said
slit material containing magnetizable
particles and then subjecting said material to
105 an electromagnetic field thereby heating said material to its fusion point and flowing said material into intimate contact with said sheet edges.

7. A method as claimed in claim 5 or 6, wherein the assembly is secured in a series of
110 successive increments with a magnetic field generator comprised of generator segments, pressure being applied fully circumferentially of the assembly in each such increment with
the assembly being rotatively moved between
115 said successive increments for disposing said generator segments in immediate juxtaposition with successive periphery portions of the assembly so as successively to cover the entire
periphery of the closure member.
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8. Apparatus for use in securing a closure member to an open end of a shell to form a container, such apparatus being constructed
and arranged to operate substantially as
125 herein described with reference to and as illustrated in the accompanying drawings.

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having a height of 13.5 inches, a diameter of 11.5 inches and .085 inch in average thickness, using the bonding method set forth in Example 1.

5 While the invention has been disclosed by way of particularly preferred embodiments, various changes and modifications thereof will be evident to those skilled in the container, bonding and related arts. Where in
10 extruded sheet form the shell axial slit need not have mitered edges nor strip bonding material disposed therein but may have non-mitered edges joined directly to one another by fusion or like techniques or by use of a
15 common backing member joined thereto.

WHAT WE CLAIM IS:

1. Apparatus for use in securing a closure member to an open end of a shell to form a container, said apparatus including a
20 first fixture and a second fixture supported coaxially interiorly of said first fixture, said fixtures being supported for relative movement jointly to define an annular space, therebetween for, in use of the apparatus, receiving an unbonded assembly of said
25 closure member and said shell and bonding material including magnetizable particles dispersed in plastics, at least one of said fixtures being comprised of separate arcuate segments, first means for displacing said
30 fixtures relative to one another whereby said fixtures apply pressure to said assembly in use of the apparatus, and second means for subjecting such pressed assembly to heat energy, said second means comprising an
35 electromagnetic field generator supported at the pressing periphery of at least one of said fixtures immediate to the pressed assembly and adapted for flexure relative to its
40 supporting fixture whereby said particles in the bonding material are responsive to such generated electromagnetic field to heat said plastics to its fusion point for flowing thereof into intimate contact with surfaces of said
45 shell and said closure member in facing relation to said bonding material.

2. Apparatus as claimed in claim 1, wherein said first fixture is segmented and wherein said first means comprises inflatable means situated radially outwardly of and engageable with said segments and rigid means disposed radially outwardly of said inflatable means for defining a bearing reaction surface for said inflatable means.

3. Apparatus as claimed in claim 1 or 2, wherein said second means comprises radio-frequency energizable tubing means supported by at least one of said fixtures and defining an interior hollow for receiving a cooling medium.

4. Apparatus as claimed in claim 1, 2 or 3, wherein said second means comprises radio-frequency energizable tubing means supported by at least one of said fixtures and of extent less than the perimeter of said

assembly and adapted for said flexure relative to its supporting fixture for movement into confronting relation with said assembly in the course of pressing thereof.

5. A method of making a container comprising the steps of cutting plastics sheet material into a sheet of predetermined length and width; forming such cut sheet into a hollow shell having a slit extending axially between open ends of said shell and defined by juxtaposed edges of said sheet; sealing said slit to provide an axially extending continuous sealed seam for said shell; forming a closure member for one of said shell open ends by shaping integral plastics material; forming an assembly wherein said closure member is disposed in encircling relation to said shell adjacent said one open end and wherein bonding material containing magnetizable particles is disposed about the shell between said closure member and said shell; and securing said assembly by simultaneously applying pressure to said assembly and disposing a magnetic field generator in immediate juxtaposition with the periphery of said closure member, the pressure being applied in a direction normal to the surface of the shell by means of two fixtures arranged internally and externally of the shell with part of the assembly including the bonding material being located therebetween, thereby heating said material to its fusion point for flowing thereof into intimate contact with said closure member and said shell adjacent said one open end.

6. A method as claimed in claim 5, wherein the slit is sealed by disposing in said slit material containing magnetizable particles and then subjecting said material to an electromagnetic field thereby heating said material to its fusion point and flowing said material into intimate contact with said sheet edges.

7. A method as claimed in claim 5 or 6, wherein the assembly is secured in a series of successive increments with a magnetic field generator comprised of generator segments, pressure being applied fully circumferentially of the assembly in each such increment with the assembly being rotatively moved between said successive increments for disposing said generator segments in immediate juxtaposition with successive periphery portions of the assembly so as successively to cover the entire periphery of the closure member.

8. Apparatus for use in securing a closure member to an open end of a shell to form a container, such apparatus being constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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