

(54) Title: REINFORCED CROSS-LAMINATED BULK CONTAINER



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REINFORCED CROSS-LAMINATED BULK CONTAINER

Technical Field:

5 This invention relates generally to bulk shipping and storage containers. More particularly, the invention relates to a bulk container made of reinforced cross-laminated corrugated paperboard. In a preferred embodiment the container has interlocking full bottom flaps and is especially adapted for containing fluid products.

10 Background Art:

 In the bulk handling of materials, and especially fluid or flowable materials such as liquids, powders and granules, containers of 20 to 80 gallon capacity are commonly used to transport and store the material. These containers should be capable of withstanding the weight of the contents and of being stacked on top of one another. They should also be
15 capable of withstanding the rough handling to which they may be subjected, and be capable of being handled with mechanized equipment.

 A variety of containers have been developed in the prior art in an effort to meet these criteria, including drums made of metal or fibre, plywood bins, and corrugated paperboard containers. While plywood bins and drums made out of metal or fibre possess
20 the requisite strength and durability, they are expensive to manufacture, store and ship.

 Corrugated paperboard containers are less costly to make and generally can be collapsed for compact storage and shipment. However, when filled with a fluid product the sidewalls of the container may bulge outwardly, and depending upon the size of the container and weight of the material used in its construction it may be difficult to set up.
25 Further, a flexible bag liner is commonly used when a fluid material is to be contained, and unless special consideration is given to how the container is constructed, the liner may be damaged by elements of the container protruding into the interior of the container.

 Bulk containers may be palletized for ease and convenience of handling, and it is desirable that the container or containers efficiently fit the pallet, i.e. that they do not
30 overhang the edges of the pallet, or the edges of the pallet do not extend an excessive distance beyond the perimeter of the container or containers supported thereon. Pallets typically utilized are 40X48 or 44X44 or 44X54 inches in size and are square or rectangular

in shape. Cylindrical drums do not efficiently fit a pallet because the circular footprint of the drum leaves void spaces between adjacent drums and at the corners of the pallet.

Conventionally constructed square or rectangular containers of corrugated paperboard can be sized to fit a pallet, but if the sidewalls bulge outwardly they can extend beyond the
5 perimeter of the pallet and be subject to damage.

Conventional corrugated paperboard containers strong enough to hold fluid material are either difficult to set up from a flattened condition and/or are too hard to manufacture and/or are too expensive for the end-user. Bulging sidewalls and difficulty in setting them up from a knocked down or flattened condition are the major problems
10 with conventional designs.

There is need, therefore, for a bulk container made of corrugated paperboard that can take the place of a 20 to 80 gallon fibre drum or metal barrel, which can ship flat and be easily opened up for filling, and once it is empty, knocked down flat again for either re-use or recycling. Further, it would be desirable to have a container
15 that can fit four on a pallet, that is reinforced against bulging of the sidewalls, and that maintains proper containment thereby eliminating potential contamination.

Disclosure of the Invention:

The present invention solves the foregoing problems through a combination of
20 features, including cross lamination of a corrugated inner liner and an outer component, double score profiles on the 180 degree folds, use of re-enforcing tape such as Sesame Tape or a comparable re-enforcing strand in the liner and in the outer component, with the reinforcing tape extending perpendicular to the respective corrugations in the liner and in the outer component, and pre-breaking of the scores in the liner before
25 lamination with the outer component. The cross lamination of the inner liner and outer component, together with the cross-hatch pattern created by the direction of the reinforcing tape or strands, fortifies the sidewalls against bulge and permits use of lower grades of material in the cross corrugation liner.

In a preferred embodiment of the invention the container is sized so that four of
30 them can fit on a single pallet. Although the structural limit to a container is governed by the machines used to produce the corrugated fibreboard and the laminator with

which the components are joined, the smaller size containers are difficult to fabricate so that they can be shipped in a knocked down condition and easily erected by the user. Pre-breaking the scores of the cross laminated inner liner before it is laminated to the outer component provides ease of fabrication and makes it easier for the end-user to

5 open up the container from a knocked down condition. By pre-breaking the scores deeper definition is given to the body scores and the surface tension is reduced when the panels are folded to form the container. In accordance with the invention, an inner jig is employed during the folding operation at the point of closing the glue joints on the container. The jig helps to form a more uniform geometry by forcing the 180 degree

10 fold ends into two 90 degree pairs of double score features at the vertical corners of the container.

The resistance to folding of bulk containers, especially the smaller sizes that are in high demand, is of paramount concern, and has been one of the major weaknesses of previous designs. Resistance to folding is created by the small panel sizes and the

15 laminated construction. To overcome this resistance in the present invention, the scores in the inner liner are pre-broken before the liner is laminated to the outer component, and double scores are placed at the point of the 180 degree folds. The double scores lessen the surface tension on the outermost facing, and each of the double scores, individually, only has to fold 90 degrees in the container of the invention, together

20 forming the 180 degree fold.

In a preferred embodiment the container of the invention has an interlocking bottom flap construction that minimizes the risk of failure during handling, and avoids pinching of a bag liner when a bag is used. The interlocking bottom flaps are designed to provide trouble-free continuous performance during handling even when liquids are stored

25 in the container. The interlocking bottom flaps include a pair of opposed intermediate or inner flaps that provide a full overlap on the inside of the container bottom, with a smooth surface to prevent pinching a bag liner and causing a leak when a bag is used inside the container. Both intermediate flaps have perf scores (also known as cut and crease) just past the points of overlap of the intermediate flaps to assist the user in moving the flaps to their operative

30 positions by preventing binding on the outer flaps which interlock. The interlocking structure of the outer flaps comprises a narrowed tab on the end edge of one outer flap, and a shaped slot

adjacent the end edge of the opposing outer flap. The tab has rounded corners to allow entry into the opposing slot, and the shape of the slot inhibits bending of the tab during use. The outer flap that contains the slot also has angled perf scores to facilitate bending of this flap down into the container far enough to permit the tab to be engaged in the slot during
5 set-up. Once engaged, the two interlocked flaps are pulled back up to create a stable flat surface on which the container rests during use. The shaped slot incorporates an arc so that the slot has a generally chevron shape, rather than the typical linear or rectangular geometry that is commonly seen in similar interlocks. Conventionally shaped slots apply force in a straight line across the tab when excessive force is exerted against it from product inside
10 the container, causing the tab to bend. The chevron shape of the slot of the invention helps prevent bending of the tab by dispersing the excessive pressures in a non-linear pattern.

The liner can be any flute combination, such as C, B, A, AA, AC, BC, AB, AAA, ACA, CAA, CBA, etc, and combinations thereof. The outer half-slotted-container (HSC) of the invention also can comprise any of the same flute combinations.
15 Selection of the flute combinations is governed by the desired performance level of containment and stacking strength.

The container of the invention can have any dimensions and any rectangular shape tailored to whatever a customer may want, being limited only by a manufacturer's ability to fabricate the container with the attributes of the invention disclosed herein.
20 Although the preferred construction has an interlocking, full overlapping bottom flap construction, it could comprise a set of partial flaps or flanges, if desired. A full bottom could also be constructed, but without the overlap that normally would be used in an application for liquid transport.

The preferred embodiment of container according to the invention has
25 interlocking flanges at its upper end, but it could be constructed with no flaps or flanges at its upper end, or partial flaps without interlocking characteristics, or a full flap closure with or without any overlap. The preferred embodiment comprises interlocking flanges such as shown in US Patent No. 6,076,734, the disclosure of which is incorporated in full herein by reference. Interlocking top flanges in combination with
30 the other features described earlier aids in the needed sidewall rigidity, and in turn helps prevent bulging and ensures proper product containment. Proper containment is

necessary for secure storage and transport, whether the product is a food or an industrial ingredient.

Although the preferred embodiment has two reinforcing strands of tape (Sesame Tape or comparable types or brands) on the outer component and four strands on the cross laminated inner liner, the container of the invention could have any number of reinforcing strands, from no strands to eight strands per component, limited by the functionality for customer use and the manufacturer's ability to produce.

Further, a variety of flute configurations and combinations of the outer corrugated and the inner cross laminated corrugated could be used, such as singlewall (A-flute, B-flute, C-flute or any other flute size currently available) outer, and a cross laminated triplewall (AAA, ACA, CAA, CBA or any other flute combination currently available) inner. The inner cross corrugation could be any flute combination of doublewall and still provide adequate flexural rigidity which is needed for the practical use of the container.

Brief Description of the Drawings:

The foregoing, as well as other objects and advantages of the invention, will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, wherein like reference characters designate like parts throughout the several views, and wherein:

Figure 1 is a partially exploded top perspective view of four containers according to the invention resting on a pallet.

Figure 2 is a top plan view of a blank for making the outer component of the container of the invention.

Figure 3 is a top plan view of a blank for making the inner liner of the container of the invention.

Figure 4 is a top plan view of a blank for making a cap for use on the container of the invention.

Figure 5 is a top plan view showing the inner liner laminated to the outer component preparatory to folding the container and gluing the glue flaps together.

Figure 6 shows the container in an inverted position and depicts the series of steps performed in folding the interlocking bottom flaps into operative interlocked position.

Detailed Description of the Preferred Embodiments:

5 A container made in accordance with a preferred embodiment of the invention is indicated generally at **10** in Figure 1, wherein four of the containers are shown resting on a pallet **P**.

The container is rectangular in shape and has four sidewalls **12**, **13**, **14** and **15**, joined together along vertical scores **16A**, **16B**, **16C** and **16D** at the corners, an open top end partially closed by interlocking top flanges **17A**, **17B** and **18A**, **18B**, and as seen best in 10 figure 6 a closed bottom end **19**. A cap **20** is placed over the upper end of each container and in figure 1 is shown removed from one of them.

Construction of the container is best understood with reference to figures 2-6.

Figure 2 shows a blank **B1** for making the outer component **21** of the container.

15 The blank comprises four sidewall panels **12**, **13**, **14** and **15** joined together along the respective scores **16A**, **16B** and **16C**, with a glue flap **22** foldably joined to one end edge of the blank along fold **16D** which effectively joins panel **12** to panel **15** when the container is glued up. The scores **16A** and **16B** are double scores as more fully described and illustrated in applicant's prior patent 4,693,413, the disclosure of which is incorporated in 20 full herein by reference. As described in that patent, the scores **16A** and **16B** extend along those corners joining sidewall panels that move through 180 degrees between the unfolded position of the blank and the folded flat position of a container made from the blank.

The partial top flanges **17A**, **17B** and **18A**, **18B** are foldably joined to top edges of the respective sidewall panels along fold lines **23**. The top flanges are constructed 25 substantially the same as and function in substantially the same way as described and shown in applicant's prior patent 6,076,730, the disclosure of which is incorporated in full herein by reference. Thus, opposite side edges of flanges **18A** and **18B** are cut away along curvilinear lines to define a locking tab **24** on the outer end edge thereof and rounded shoulders **25** on the opposite side edges. Flanges **17A** and **17B** have notches **26** cut in their 30 outer end edges adjacent the opposite sides thereof, defining rounded corners **27** on opposite side edges of the flanges. As seen best in figure 1, when the flanges are folded

into operative position the corners **27** on flanges **17A**, **17B** engage beneath shoulders **25** on flanges **18A**, **18B**, and the side edges of tabs **24** engage in the notches **26**, with the tabs **24** on flanges **18A**, **18B** lying beneath the adjacent edges of flanges **17A**, **17B**, interlocking the flanges together. It will be noted that the notches **26** and corners **27** in the present invention
5 are rounded as distinguished from the rectilinear shape of these elements in patent 6,076,730, facilitating alignment and engagement of the interlocking portions of the flanges when they are being folded into their interlocking positions.

In the preferred embodiment shown in figure 2, substantially identical bottom flaps **30A** and **30B** are foldably joined to bottom edges of respective sidewall panels **12** and **14**
10 along folds **31**, and bottom flaps **32** and **33** are foldably joined to bottom edges of respective sidewall panels **13** and **15** along folds **34**. In a container erected from the blank the flaps **30A** and **30B** comprise inner flaps and the flaps **32** and **33** comprise outer flaps.

The flaps **30A** and **30B** are rectangular in shape, and a line of perforations define a perf score **35** across each flap adjacent but spaced from the folds **31**. When a container is
15 erected from the blank, the flaps **30A**, **30B** are disposed in opposed relationship to one another and each flap extends most of the way across the bottom of the container, with the free end edge of each flap terminating just short of a respective perf score **35** in the opposed flap. This arrangement helps facilitate folding of the flaps into operative position as depicted in figure 6. The side edge of flap **30A** is recessed slightly at **36A** adjacent glue
20 flap **22**, and one side edge of flap **30B** is recessed slightly at **36B** adjacent its outer end edge. These recessed areas provide clearance for the glue flap when the flaps are folded into their operative positions in a container erected from the blank

The side edges of flap **32** are cut away along curvilinear lines to define a narrowed locking tab **37** on the outer end edge thereof, and rounded shoulders **38** on opposite side
25 edges. The locking tab and shoulders cooperate with flap **33** as described below to lock the bottom flaps in operative position across the bottom of a container erected from the blank.

Bottom flap **33** is generally rectangular in shape and a pair of diagonal fold scores **40** and **41** extend from opposite corners of the flap closely adjacent the fold **34** to the outer end edge thereof in inwardly spaced relation to opposite side edges of the flap, defining
30 triangularly shaped corners **42**. A generally chevron shaped slot **43** is formed in

approximately the middle of the flap **33** for receiving the locking tab **37** on flap **32** as described hereinafter.

In the preferred embodiment as shown in figure 2, a pair of reinforcing strands **45** of Sesame Tape or other reinforcing strand known in the art extends across the blank from one end edge to the other approximately midway between the top and bottom edges thereof. As indicated by the arrow “**A**” in figure 2, the corrugations of the outer component **21** extend perpendicular to the top and bottom edges of the blank, and the reinforcing strands extend perpendicular to the corrugations.

A blank **B2** for making the inner liner **50** of the container of the invention is shown in figure 3. The blank **B2** is rectangular in shape and comprises four sidewall panels **51**, **52**, **53** and **54** joined together along respective scores **16A'**, **16B'** and **16C'**, with a glue flap **55** foldably joined to one end edge of the blank along fold **16D'** and which effectively joins panel **51** to panel **54** when the container is glued up. The scores **16A'** and **16B'** are double scores as more fully described and illustrated in applicant's prior patent 4,693,413, the disclosure of which is incorporated in full herein by reference. In a container erected from the blank, the scores **16A'** and **16B'** in the liner extend contiguous with the scores **16A** and **16B** in the outer component, and the scores **16C'**, **16D'** extend contiguous with the scores **16C**, **16D**, respectively. The scores **16A'**, **16B'**, **16C'** and **16D'** in the liner are pre-broken with a jig (not shown) prior to lamination of the liner **50** to the outer component **21** to facilitate fabrication of the container and to make it easier for a user to open up a flattened container into its operative position. In the preferred embodiment as shown in figure 3, a first pair of reinforcing strands **56** of Sesame Tape or other reinforcing strands known in the art is applied to a midportion of sidewall panel **52**, extending from the bottom edge thereof to the top edge, and at least one reinforcing strand **56** (two are shown in figure 3 and one in figure 5) is applied to a midportion of panel **54**, extending from the bottom edge to the top edge of that panel. As indicated by the arrow “**B**”, it will be noted that the corrugations in the liner extend in a direction perpendicular to the corrugations in the outer component. Thus, the reinforcing strands in the liner extend perpendicular to the corrugations in the liner, and as seen best in figure 5 they extend perpendicular to the reinforcing strands in the outer component in a container erected from the blank.

Figure 5 shows the inner liner **50** laminated to the outer component **21** to form a laminated blank **57** from which the container is erected. It will be noted that the liner is shifted to the left as viewed in this figure, with the glue flap **55** on the liner projecting beyond the glue flap **22** on the outer component, and the opposite end of the liner inset
5 relative to the adjacent end of the outer component, defining a space **58** for attachment of the glue flap **55**.

To set up a container from its flattened condition to its expanded operative condition, it is opened into a tubular configuration and the partial top flaps are folded into their operative interlocked position as described previously herein. The container is then
10 inverted so that it rests on its top end, and the bottom flaps are folded into their operative interlocked positions as depicted in figure 6. Flaps **30A** and **30B** are first folded inwardly into the container, followed by inward folding of flap **33** and then flap **32**. The flaps are pressed downwardly into the container until the locking tab **37** engages in slot **43**, and the flaps are then pulled outwardly into a generally flat position across the bottom of the
15 container. It will be noted that the perf scores **35** in flaps **30A** and **30B** and the folds **40** and **41** in flap **33** enable these flaps to deform slightly during the folding operation to facilitate set up of the container.

A blank **B3** for making the cap **20** is shown in figure 4. The blank comprises a rectangular center panel **60** with substantially identical end flaps **61** and **62** foldably joined
20 to opposite end edges thereof along folds **63**, and substantially identical side flaps **64** and **65** foldably joined to opposite side edges thereof along folds **66**. As seen in figure 1, the flaps **61**, **62** and **64**, **65** interlock with one another to form a cap skirt **67**. The interlocking construction of cap **20** is substantially the same as that for the liner tray **110** disclosed in US patent 7,172,108. Thus, flaps **61** and **62** each has an assembly flap **68** on opposite side
25 edges thereof, with an outer corner cut away at **69** to define a locking tab **70** that is inserted into angled slit cuts **71** in the flaps **64** and **65** adjacent opposite ends thereof.

While particular embodiments of the invention have been illustrated and described in detail herein, it should be understood that various changes and modifications may be made in the invention without departing from the spirit and intent of the invention as
30 defined by the appended claims.

WHAT IS CLAIMED IS:

1. A reinforced cross laminated bulk container made of corrugated paperboard and having a rectangular configuration, said container comprising:

an outer corrugated component having opposed sidewalls and opposed end walls joined together along vertical scores at corners of the container, said sidewalls and end
5 walls having top, bottom and side edges, and said outer component having corrugations running in a first direction;

an inner corrugated liner laminated to the outer component and having opposed sidewalls and opposed end walls joined together along vertical scores at corners of the container, said sidewalls and end walls having top, bottom and side edges substantially
10 coterminous with the top, bottom and side edges of the respective side and end walls of said outer component, and said inner liner having corrugations running in a second direction perpendicular to the first direction; and

said outer component and said inner liner each having at least one reinforcing strand therein extending perpendicular to the corrugations thereof, wherein said at least one
15 reinforcing strand in said liner extends perpendicular to and crosses the at least one reinforcing strand in said outer component.

2. A container as claimed in claim 1, wherein:

at least two said vertical scores disposed diagonally opposite to one another in said inner liner and in said outer component comprise double scores to relieve stress in said scores when said container is moved between an opened up tubular configuration and a
5 flattened configuration.

3. A container as claimed in claim 2, wherein:

bottom flaps are foldably joined to the bottom edges of said outer component to at least partially close the bottom of said container.

4. A container as claimed in claim 3, wherein:
top flanges are foldably joined to the top edges of said outer component to at least partially close the top of said container.
5. A container as claimed in claim 1, wherein:
said sidewalls have a greater width dimension than said end walls;
the corrugations of said outer component extend vertically and the corrugations of said inner liner extend horizontally;
- 5 said at least one reinforcing strand in said outer component extends horizontally substantially midway between the top and bottom edges thereof; and
said at least one reinforcing strand in said inner liner comprises at least one reinforcing strand extending vertically in each said sidewall substantially midway between opposite side edges thereof.
6. A container as claimed in claim 5, wherein:
said at least one reinforcing strand comprises a plurality of reinforcing strands in each of said inner liner and said outer component.
7. A container as claimed in claim 6, wherein:
at least two said vertical scores disposed diagonally opposite to one another in said inner liner and in said outer component comprise double scores to relieve stress in said scores when said container is moved between an opened up tubular configuration and a
5 flattened configuration.
8. A container as claimed in claim 7, wherein:
bottom flaps are foldably joined to the bottom edges of said outer component to at least partially close the bottom of said container.
9. A container as claimed in claim 8, wherein:
top flanges are foldably joined to the top edges of said outer component to at least partially close the top of said container.

10. A container as claimed in claim 1, wherein:

bottom flaps are foldably joined to the bottom edges of said outer component to close the bottom of said container, said bottom flaps comprising a pair of opposed inner flaps that extend inwardly across the bottom of the container toward and into overlapping relationship with one another, and a pair of opposed outer flaps that extend inwardly across the bottom of the container toward and into overlapping relationship with one another, said outer flaps having an interlocking structure to lock the bottom flaps in closed position across the bottom of the container.

11. A container as claimed in claim 10, wherein:

said interlocking structure comprises a locking slot formed in a first of said outer flaps, and cut away opposite side edges of an opposed second said outer flap defining a projecting locking tab on a free outer end edge of said second outer flap, said locking tab being engaged in said locking slot.

12. A container as claimed in claim 11, wherein:

said locking slot is substantially chevron shaped so that force exerted on said tab by weight of product in said container is distributed non-linearly to inhibit bending of said locking tab.

13. A container as claimed in claim 12, wherein:

diagonal folds extend across said second outer flap from spaced locations at an outer free edge thereof to adjacent opposite ends of the folded connection of said second outer flap to said outer component, defining triangular outer corners on said second outer flap that deflect to facilitate movement of the bottom flaps relative to one another during set up of the container.

14. A container as claimed in claim 13, wherein:

a line of perforations extends across each said inner flap adjacent its folded connection with said outer component to permit deflection of said inner flaps as they are being moved into operative folded positions across the bottom of said container.

15. A container as claimed in claim 1, wherein:

at least some of the vertical scores in said inner liner are pre-broken prior to lamination of the inner liner to the outer component to facilitate fabrication of said container and to make it easier for a user to open the container from a flattened position
5 into its expanded operative position.

16. A container as claimed in claim 15, wherein:

at least two said vertical scores disposed diagonally opposite to one another in said inner liner and in said outer component comprise double scores to relieve stress in said scores when said container is moved between an opened up tubular configuration and a
5 flattened configuration.

17. A blank of corrugated paperboard for making a reinforced bulk container, comprising:

an outer component having a plurality of sidewall panels and end wall panels foldably joined together along spaced parallel scores, said sidewall and end wall panels
5 having top and bottom edges;

said outer component having corrugations extending perpendicular to said top and bottom edges; and

at least one reinforcing strand extending across said outer component perpendicular to said corrugations and approximately midway between said top and bottom edges.

18. A blank as claimed in claim 17, wherein:

an inner liner having a plurality of sidewall panels and end wall panels foldably joined together along spaced parallel scores is laminated to said outer component, said sidewall and end wall panels of said liner having top and bottom edges;

5 said liner having corrugations extending parallel to said top and bottom edges thereof; and

at least one reinforcing strand extending across at least one said sidewall perpendicular to said corrugations and approximately midway between opposite side edges of said at least one said sidewall.

19. A blank as claimed in claim 18, wherein:

top flanges are foldably joined to said top edges of said sidewalls and end walls, said top flanges having interlocking structure for locking them together in a container erected from said blank.

20. A blank as claimed in claim 19, wherein:

bottom flanges are foldably joined to said bottom edges of said sidewalls and end walls, said bottom flanges having interlocking structure for locking them together in a container erected from said blank.

21. A blank as claimed in claim 18, wherein:

at least some of said spaced parallel scores in said inner liner are pre-broken prior to lamination of said inner liner to said outer component.

22. A method of making a blank of reinforced corrugated paperboard for use in making a bulk container that may be shipped in a flattened condition and opened up into an operative expanded position at a point of use, comprising the steps of:

5 providing an outer component of corrugated paperboard having corrugations running in a first direction and having a plurality of sidewalls and end walls foldably joined together along spaced parallel scores;

providing an inner liner of corrugated paperboard having corrugations running in a second direction perpendicular to said first direction and having a plurality of sidewalls and end walls foldably joined together along spaced parallel scores;

5 laminating said inner liner to said outer component with said sidewalls, end walls and spaced parallel scores of said liner disposed in aligned, juxtaposed relationship with the sidewalls, end walls and spaced parallel scores of said outer component, and so that the corrugations of the liner extend perpendicular to the corrugations of said outer component; and

10 pre-breaking the spaced parallel scores in said liner prior to laminating said liner to said outer component.

23. A method as claimed in claim 22, including the steps of:
- applying at least one reinforcing strand to said liner in a direction perpendicular to the spaced parallel scores therein;
- applying at least one reinforcing strand to said outer component in a direction
- 5 perpendicular to the spaced parallel scores therein; and wherein
- at least some of the spaced parallel scores in said liner and in said outer component are double scores.

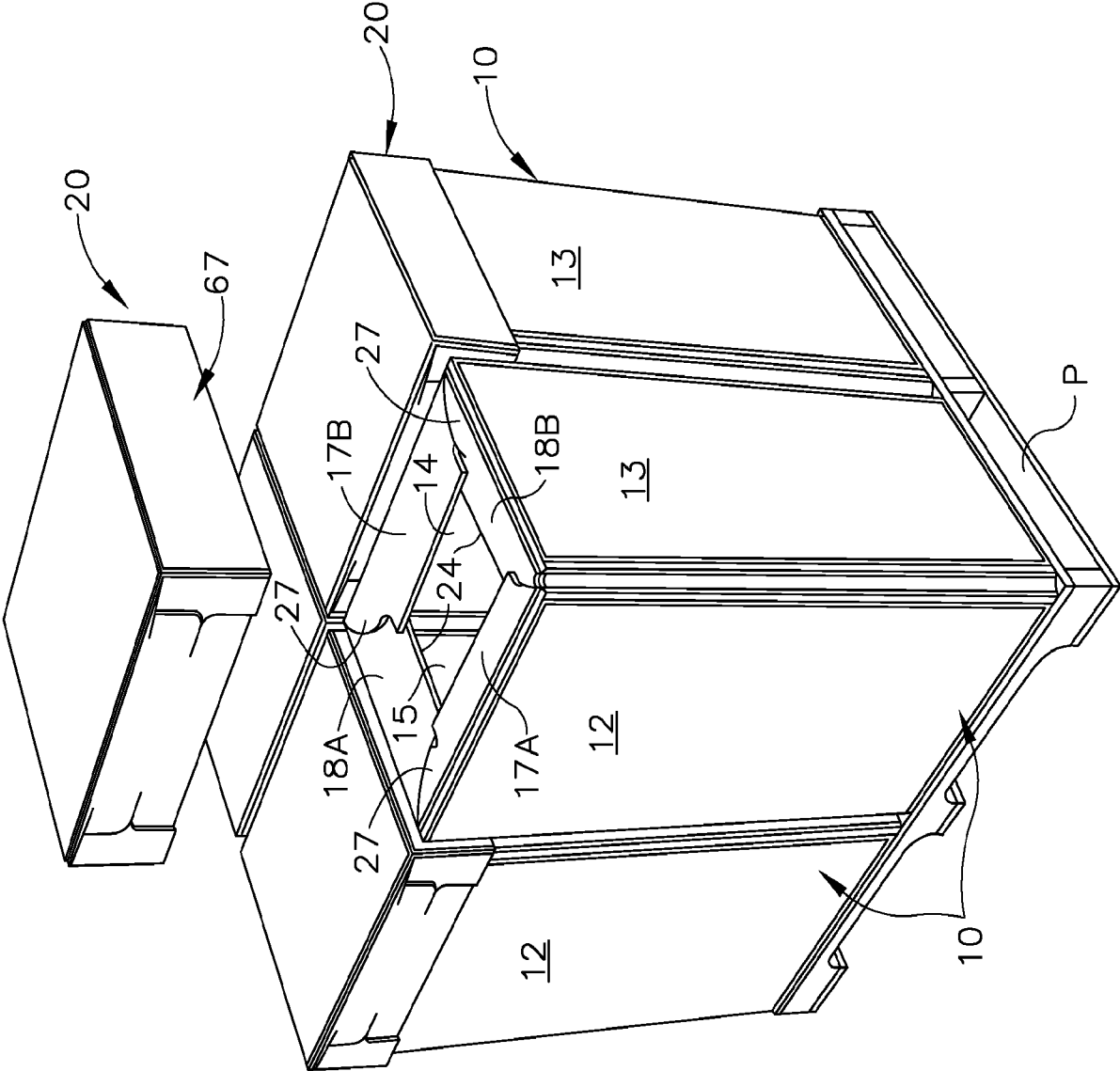


FIG. 1

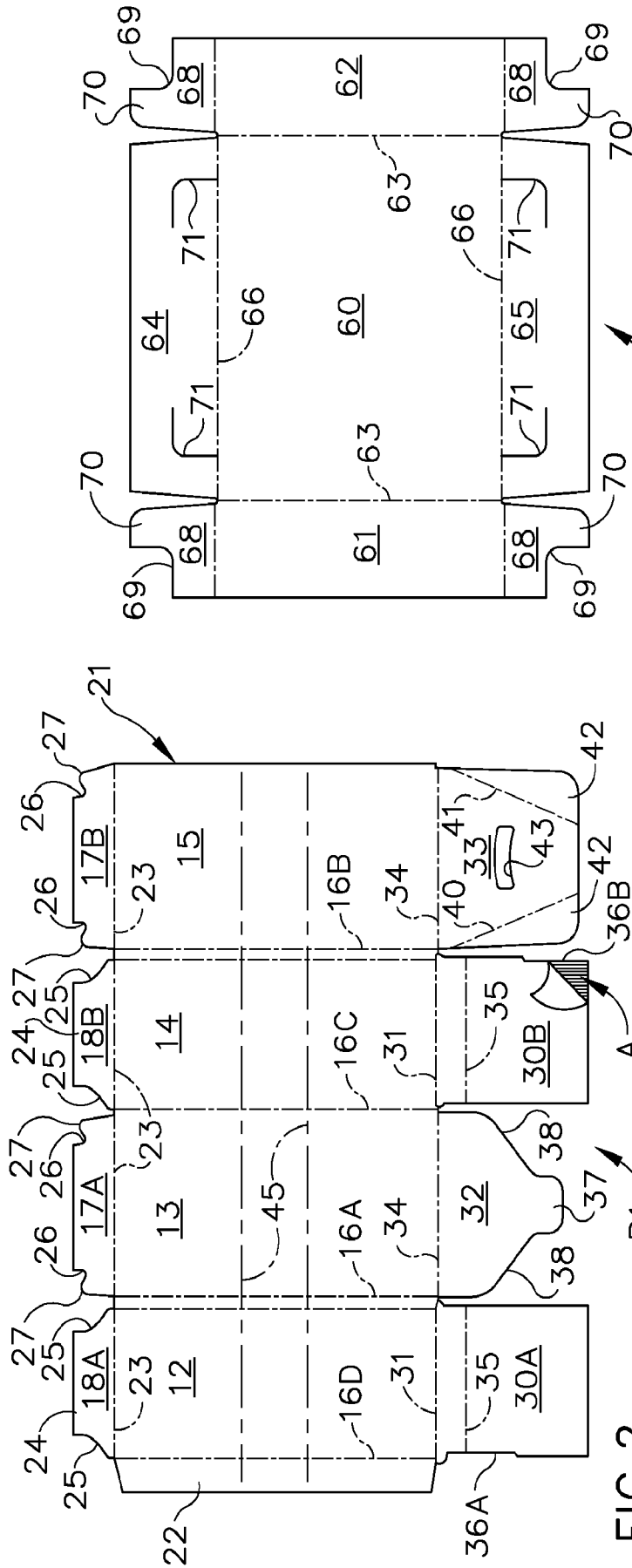


FIG. 2

FIG. 4

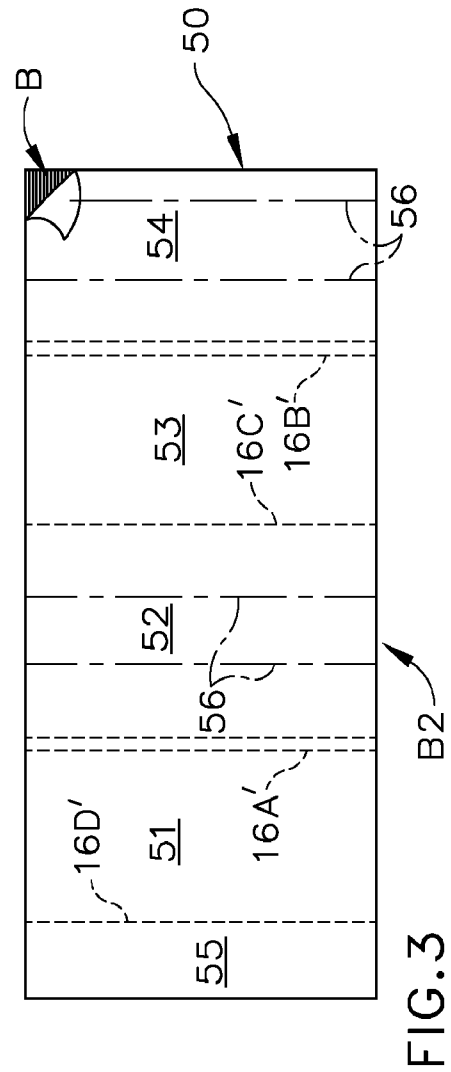


FIG. 3

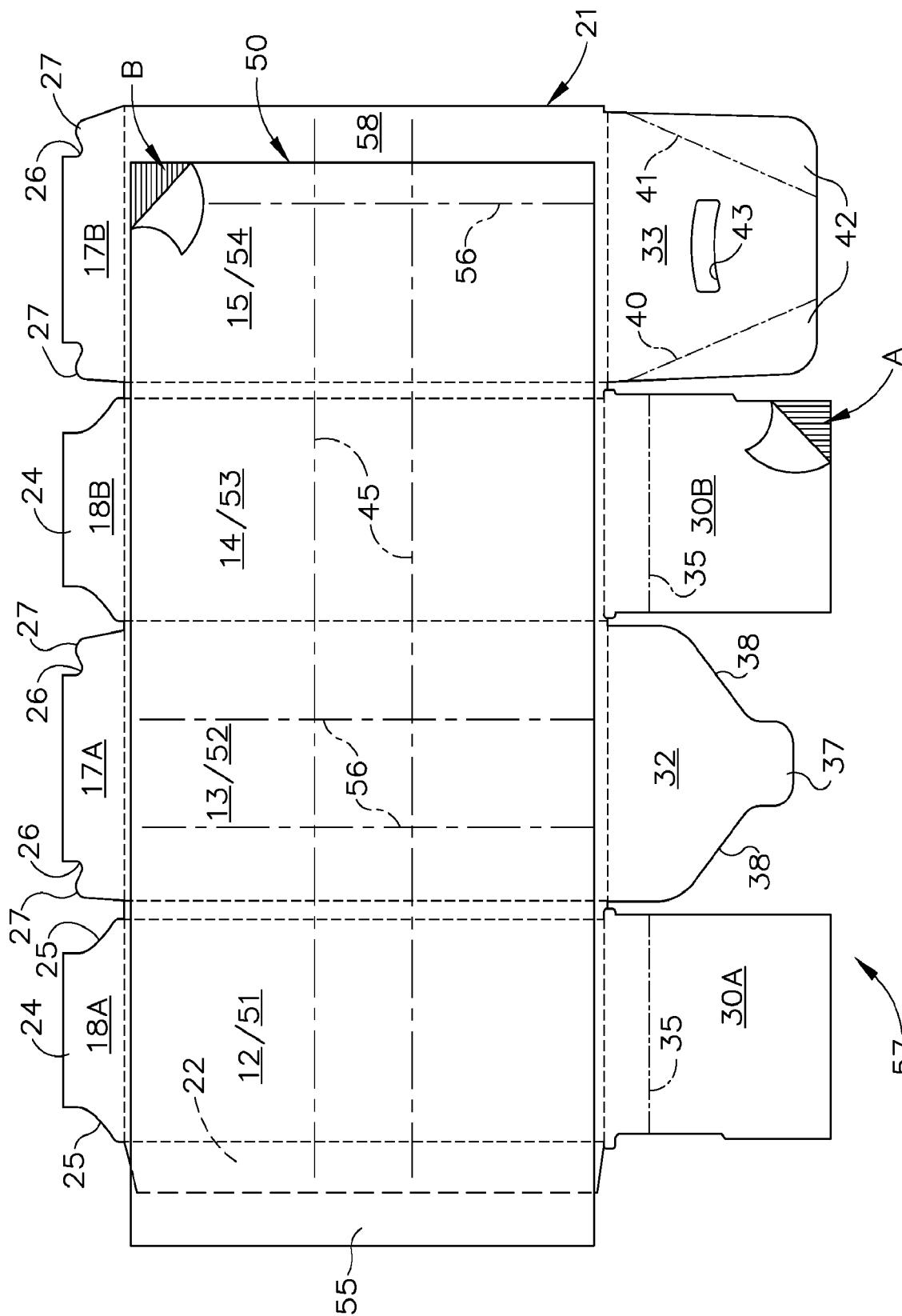


FIG. 5

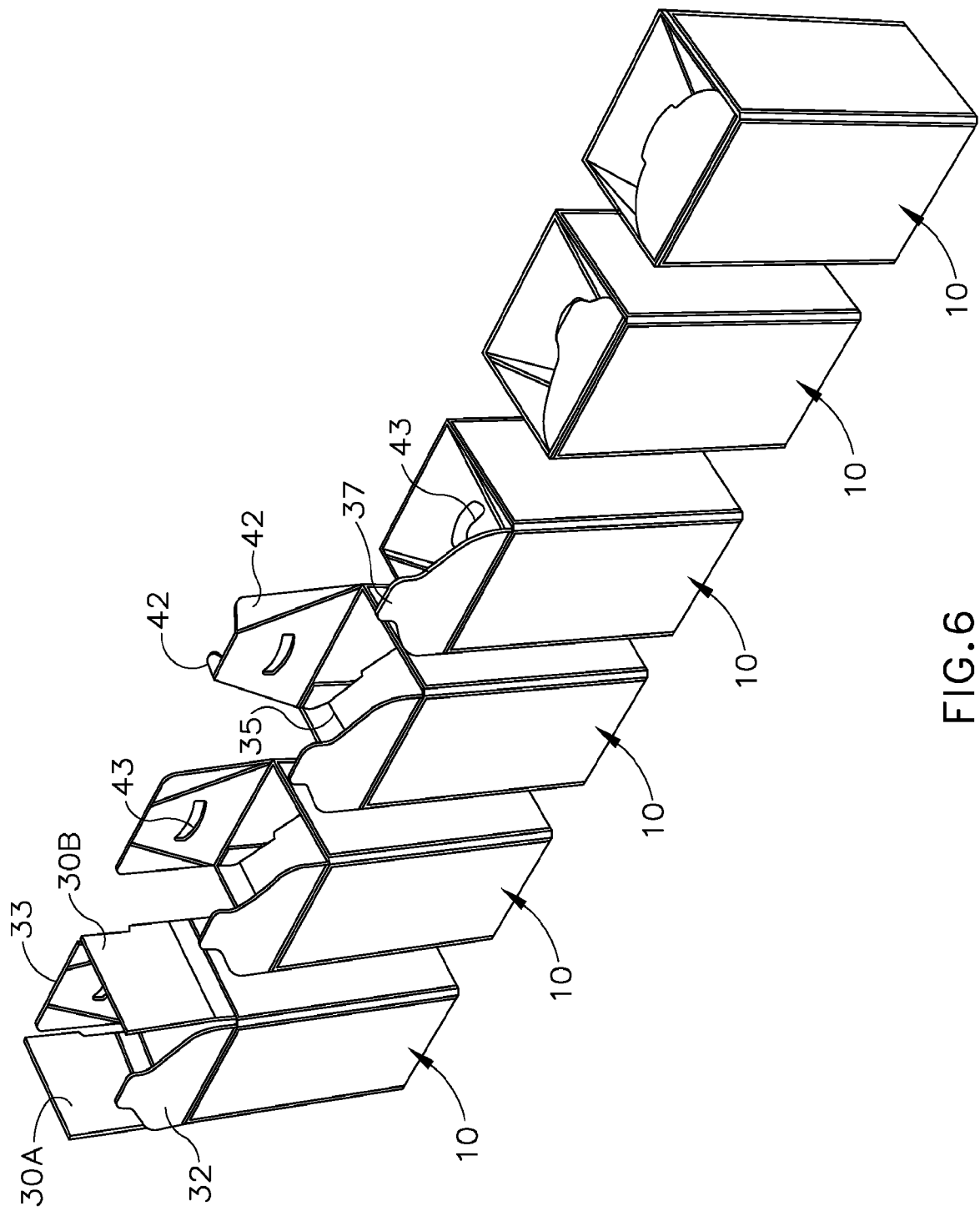


FIG.6