



(86) Date de dépôt PCT/PCT Filing Date: 2012/02/03
(87) Date publication PCT/PCT Publication Date: 2012/08/16
(85) Entrée phase nationale/National Entry: 2013/07/19
(86) N° demande PCT/PCT Application No.: US 2012/023711
(87) N° publication PCT/PCT Publication No.: 2012/109096
(30) Priorité/Priority: 2011/02/09 (US61/441,240)

(51) Cl.Int./Int.Cl. *B65D 5/42* (2006.01),
B29C 53/06 (2006.01), *B31B 1/25* (2006.01),
B65D 65/12 (2006.01)
(71) Demandeur/Applicant:
MEADWESTVACO PACKAGING SYSTEMS, LLC, US
(72) Inventeurs/Inventors:
BATES, AARON, US;
WALLING, BRADFORD J, US;
SCHUMAKER, KYLE, US
(74) Agent: RIDOUT & MAYBEE LLP

(54) Titre : MECANISME DE REDUCTION DE LA RESISTANCE AU PLIAGE
(54) Title: FOLD-RESISTANCE REDUCING MECHANISM

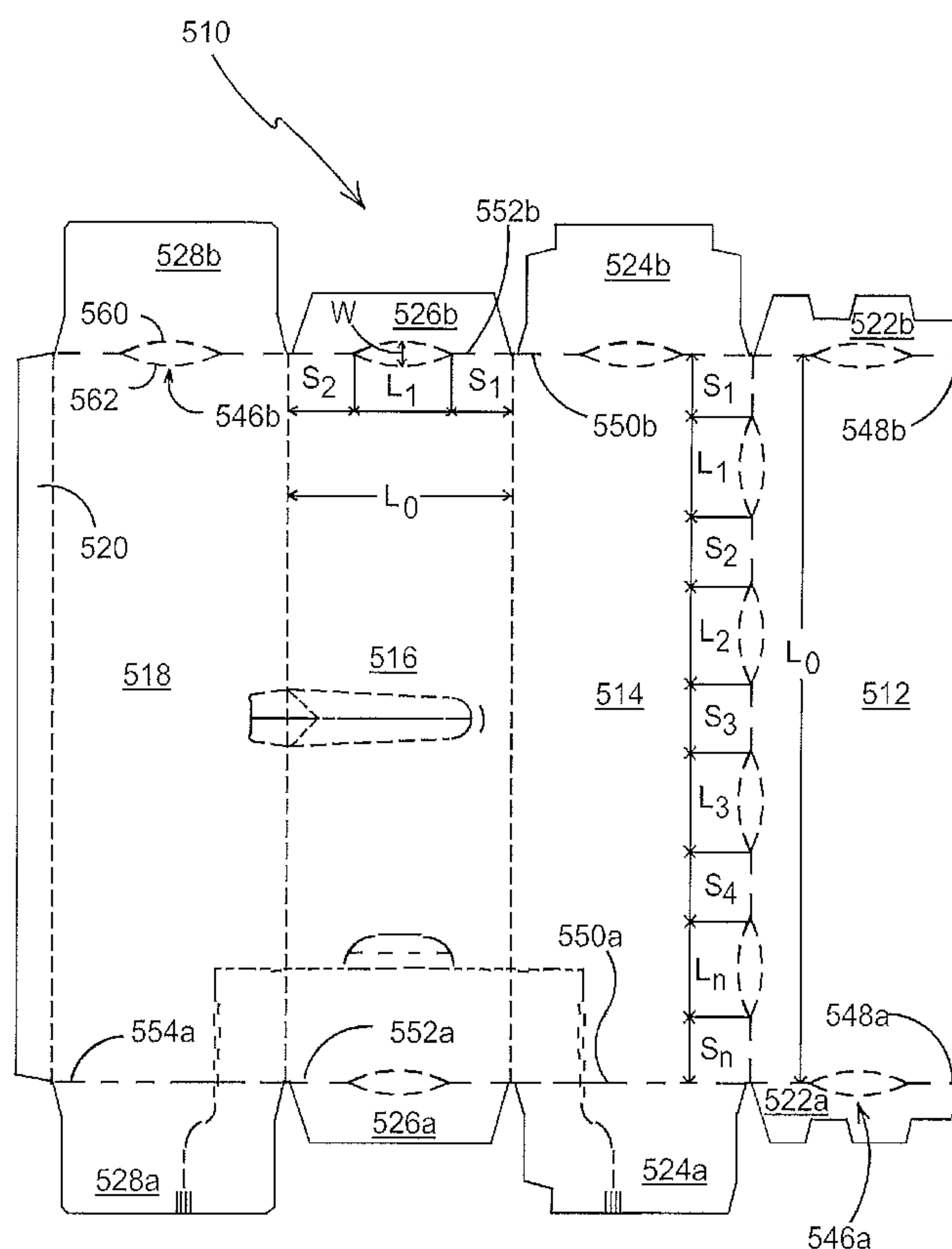


FIGURE 9

(57) **Abrégé/Abstract:**

A sheet of foldable material has a folding mechanism (46a, 46b) that is positioned to facilitate folding of the sheet into two parts. The folding mechanism includes two weakened lines (60,62) that diverge from a first location on the sheet and that converge on a second location on the sheet. The first and second locations are spaced apart and are positioned on a notional line defining a primary hinging line between the two parts of the sheet.





(10) International Publication Number
WO 2012/109096 A1

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

- (54) Title:** FOLD-RESISTANCE REDUCING MECHANISM

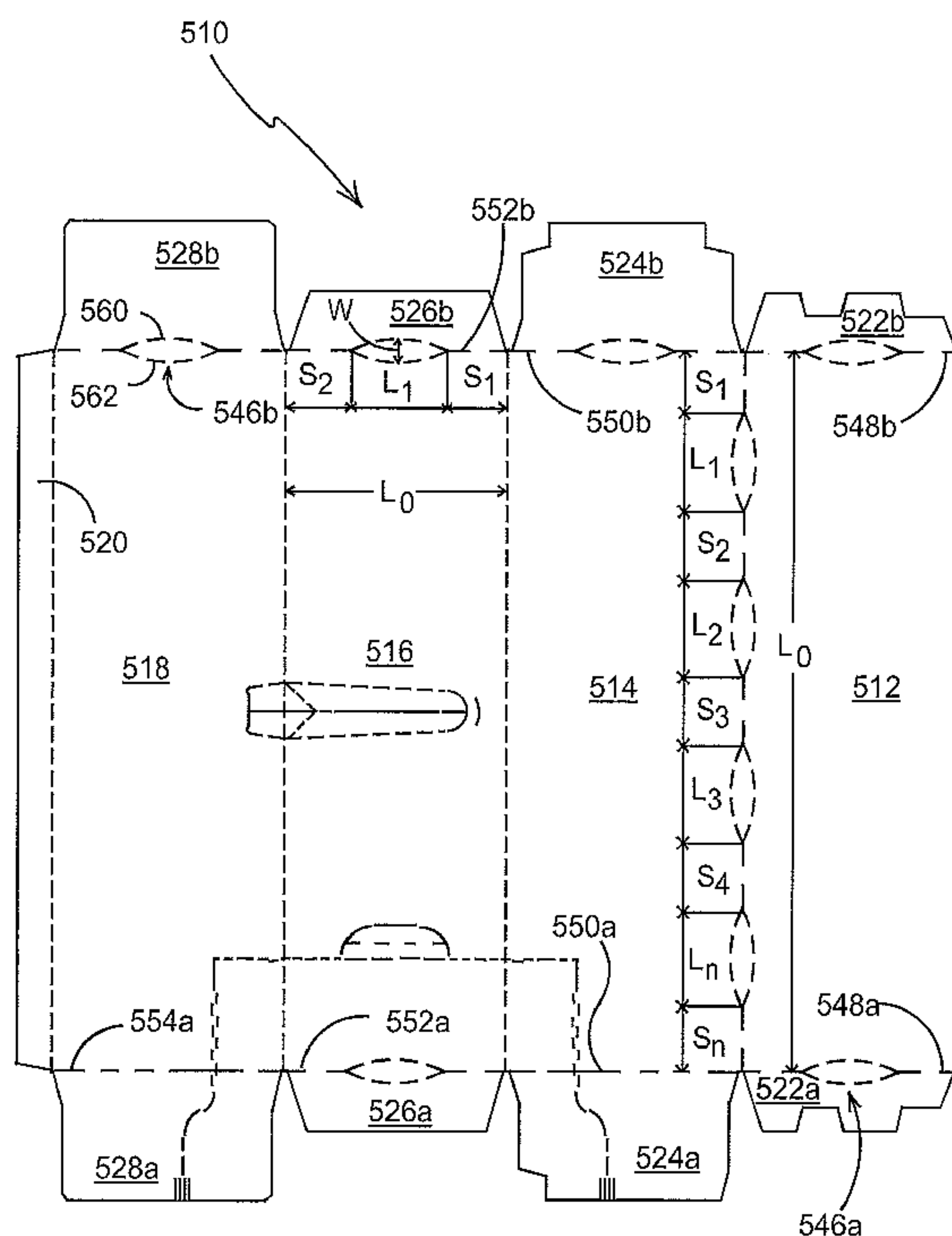


FIGURE 9

(57) Abstract: A sheet of foldable material has a folding mechanism (46a, 46b) that is positioned to facilitate folding of the sheet into two parts. The folding mechanism includes two weakened lines (60,62) that diverge from a first location on the sheet and that converge on a second location on the sheet. The first and second locations are spaced apart and are positioned on a notional line defining a primary hinging line between the two parts of the sheet.

WO 2012/109096 A1



Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

- 1 -

FOLD-RESISTANCE REDUCING MECHANISM**CROSS REFERENCE**

This application claims the benefit of U.S. Provisional Application No. 61/441,240, filed February
5 9, 2011, which is incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

The present invention relates to the folding of sheet material, such as paperboard. More
specifically the invention relates to reducing the resistance of a material to folding. A fold
10 resistance-reducing mechanism is provided by the present invention that can be used in single-
ply or multiple-ply arrangements.

BACKGROUND OF THE INVENTION

In the field of packaging, paperboard, fibreboard and other foldable sheet materials are used.
15 Folded sheet material can be constructed into a huge variety of configurations to create
packages for products. Typically, the sheet material is cut, pre-creased or scored, folded and
then glued to form a flat folded part formed blank; these blanks are then fed into machines for
automated assembly, loading of articles and completion. During the packaging process it is
often necessary for multiple layers of material to be folded together or for thick sheet material
20 to be folded. Sheet material has a resistance to being folded and a natural resilience that causes
the material to want to "springback" into its unfolded state. To create a fold, a folding force of
sufficient strength must be applied to the material. To maintain a folded state a maintaining
force must be applied.

A guide on a packaging machine is often used to create a fold and to maintain the folded state
25 of the material. For example, a paperboard carton for holding bottles may be assembled into an

- 2 -

open ended form, loaded from one or both ends with bottles and then end closure flaps folded by a guide to part form an end wall. The guide is used to fold the end flaps and to maintain the end flaps in their folded state. Adhesive is applied to them and other end flaps are then folded and adhered to that first folded end flap to create a finished composite end wall. If the
5 resistance of the material to folding is high and/or if the tendency of the material to return to its unfolded state (its "springback") is strong, the guide may not be able to create the fold and/or may not be able to maintain the folded state of the material. In such a situation an end flap may be mis-positioned or kicked-back the wrong way. The resulting carton is not a properly finished carton and is rejected.

10 The problem of addressing a material's fold resistance can occur in a number of situations, one common situation is in the packaging of heavy loads, for example 12 or 24 bottle packs that are provided with handles. Because the package contents are heavy, the handle needs to be strong. To form a strong handle, multiple-ply of material are used to provide a reinforcement. This can result in the folding of multiple plies of material around a common corner. In such
15 arrangements the fold-resistance is often high. Mechanisms to reduce the fold-resistance and/or avoid bunching of the material in the corner region are already available. For example, in US 6968992, an insert (see Figure 4) is provided to reinforce the carton. Apertures (184) are provided along fold lines (182A and 182B) to facilitate the folding of the fold lines (182A and 182B) without the bunching of the paperboard. Similarly in US5072876 to Wilson cut-out
20 portions (72) are provided along a fold line (56) to facilitate folding an end panel flap (58).

The present invention seeks to provide an improvement in technologies where folded material is used, specifically but not exclusively in the field of packaging and even more specifically, but not exclusively in the field of paperboard packaging, by providing a mechanism and method of
25 reducing a material's resistance to folding.

- 3 -

SUMMARY OF INVENTION

According to a first aspect, the invention provides a sheet of foldable material comprising a folding mechanism, the folding mechanism positioned to facilitate folding of the sheet into two parts, the folding mechanism comprising two weakened lines that diverge from a first location on the sheet and that converge on a second location on the sheet, the first and second locations being spaced apart and being positioned on a notional line defining a primary hinging line between the two parts of the sheet. Preferably, the first and second locations are positioned on opposite edges of the sheet.

Preferably, the two weakened lines are arcuate in shape and have a similar radius and have a similar maximum width as measured from said notional line. Alternatively, the two weakened lines are arcuate in shape and have a different radius and have a different maximum width as measured from said notional line and/or each arcuate line has a peak which is not positioned immediately opposite to the peak of the other arcuate line.

Preferably, the folding mechanism further comprises a weakened aspect at least in part extending between the two weakened lines. Optionally, the weakened aspect comprises an embossed region between the two weakened lines and/or the weakened aspect comprises one or more weakened lines positioned in parallel to said notional line.

Preferably, when present, the one or more weakened lines positioned in parallel to said notional line are formed by one or more, or a combination of: a full depth cut and crease line, a half depth cut and crease line, a score line, an embossed line, a perforation and a fold line. Even more preferably, the one or more weakened lines positioned in parallel to said notional line consists of two weakened lines, a first of said weakened lines is a half depth cut and crease line with each half-depth cut and crease having a length of about 0.13 inches (about 0.32cm) and wherein the second of said weakened lines is a half depth cut and crease line with each half-depth cut and crease having a length of about 0.25 inches (about 0.64cm). Even more preferably said one or more weakened lines positioned in parallel to said notional line have

- 4 -

about 80% or more of their length positioned within the area defined by the two weakened lines.

Optionally, the two weakened lines are formed by one or more or a combination of: a full depth cut and crease line, a half depth cut and crease line, an embossed line, a score line, a perforation and a fold line and preferably, said two weakened lines are each a half depth cut and crease line with each half-depth cut and crease having a length of about 0.13 inches (about 0.32cm).

A sheet of foldable material according to any preceding claim wherein the folding mechanism further comprises one or more linear hinge lines extending between the first location and an edge of the sheet of material.

A sheet of foldable material according to any preceding claim comprising more than one folding mechanism and wherein at least one of the folding mechanisms further comprises a linear hinge line extending between the first location of that folding mechanism and the second location of the other folding mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will now be described with reference to the accompanying drawings, in which:

5

FIGURE 1. is a plan view of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded according to a first embodiment of the invention;

FIGURE 2. is a perspective view from the top, side and front end of a carton formed from the blank of Figure 1;

10

- 5 -

FIGURE 3A. is an enlarged view of a section of the blank of Figure 1 showing a mechanism of reducing the paperboard's resistance to being folded according to a first embodiment of the invention;

FIGURE 3B. is an internal perspective view of a section of the carton of Figure 1 showing an internal corner where the mechanism of reducing the paperboard's resistance to being folded is in use;

FIGURE 3C is a cross-section taken along the line X-X shown in Figures 3B and 3C, illustrating the fold-resistance reducing arrangement after folding;

FIGURE 4. is a plan view of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded according to a second embodiment of the invention;

FIGURE 4A. is an enlarged view of a section of the blank of Figure 4 showing a mechanism of reducing the paperboard's resistance to being folded according to a second embodiment of the invention;

FIGURE 5. is an internal perspective view of a section of the carton formed from the blank of 4 showing an internal corner where the mechanism of reducing the paperboard's resistance to being folded is in use;

FIGURE 6. is a plan view of a sheet of paperboard, cut and scored to form a blank for forming another style of carton, having multiple mechanisms of reducing the paperboard's resistance to being folded according to the first embodiment of the invention;

FIGURE 7. is a plan view of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded according to a third embodiment of the invention;

FIGURE 8A. is a first test specimen having a known mechanism for reducing fold resistance;

- 6 -

FIGURE 8B. is a control specimen tested without any additional mechanism for reducing fold resistance;

FIGURE 8C. is a second test specimen having a mechanism for reducing fold resistance according to the third described embodiment of the invention;

5 FIGURE 8D. is a third test specimen having a mechanism for reducing fold resistance according to the first described embodiment of the invention;

FIGURE 9 is a plan view of a sheet of paperboard, cut and scored to form a blank for forming a carton, having multiple mechanisms of reducing the paperboard's resistance to being folded according to the third embodiment of the invention;

10 FIGURE 10A is a plan view of part of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded according to a fourth embodiment of the invention;

FIGURE 10B is a plan view of part of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded
15 according to a fifth embodiment of the invention; and

FIGURE 10C is a plan view of part of a sheet of paperboard, cut and scored to form a blank for forming a carton, having a mechanism of reducing the paperboard's resistance to being folded according to a sixth embodiment of the invention.

20 DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE PRESENT INVENTION

Detailed descriptions of specific embodiments of fold-resistance reducing mechanisms and packages, blanks and cartons employing the mechanisms are disclosed herein. It will be understood that the disclosed embodiments are merely examples of the way in which certain aspects of the invention can be implemented and do not represent an exhaustive list of all of

- 7 -

the ways the invention may be embodied. Indeed, it will be understood that the fold-resistance reducing mechanisms, packages, blanks and cartons described herein may be embodied in various and alternative forms. The figures are not necessarily to scale and some features may be exaggerated or minimised to show details of particular components. Well-known components, materials or methods are not necessarily described in great detail in order to avoid obscuring the present disclosure. Any specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the invention.

10 Referring to FIGURE 1 there is shown a plan view of a cut and pre-scored sheet of paperboard material. This is a blank 10 for forming a carton 8 of the end loading type. As such the blank 10 comprises a series of main panels: first side panel 12; bottom panel 14; second side panel 16; top panel 18 and glue flap 20. Each of the main panels is hinged at each of its ends to an end closure flap. The first side panel 12 has side end closure flaps 22a, 22b hinged thereto along fold lines 48a, 48b. Bottom panel 14 has bottom end closure flaps 24a, 24b hinged thereto along fold lines 50a, 50b. Second side panel 16 has side end closure flaps 26a, 26b hinged thereto along fold lines 52a, 52b. Top panel 18 has top end flaps 28a, 28b hinged thereto along fold lines 54a, 54b and the glue strip 20 has reinforcing flaps 30a, 30b hinged thereto by fold resistance reducing mechanisms 46a, 46b. Additional fold lines 56a, 56b, 58a, 58b are provided to assist the formation of the carton 8.

The main panels are hinged together in series along fold lines 36, 38, 42 and 44. Fold lines 34 and 40 separate the side panels 12 and 16 into two halves which are shaped at their edges such that the resulting carton 8 (see Figure 2) is a gable topped carton suitable for securely packaging 24 beverage bottles. The blank 10 is provided with apertures for forming a handle arrangement. Because the final loaded carton 8 is heavy, the handles formed from the blank 10 need to be strong. The handles are therefore formed from a number of plies of material. The two top end closure flaps 28a, 28b provide the outermost ply of the handle arrangements in the form of handle components 36a, 36b. These handle components 36a, 36b each have a

- 8 -

hingeable cushioning flap and a pre-cut handle aperture. The side end closure flaps 26a, 26b; 22a, 22b are each provided with further handle components 34a, 34b, 32a, 32b that are shaped, sized and oriented to match the handle components 36a, 36b of the top end flaps 28a, 28b. The side end closure flaps 26a, 26b; 22a, 22b are positionable immediately beneath the top end closure flaps and provide a second ply of the handle structure. To further reinforce the handle structure, handle reinforcing flaps 30a, 30b are provided. These handle reinforcing flaps 30a, 30b are sized and positionable adjacent to the handle apertures formed in the top and side end closure flaps and provide a partial third layer or third ply to the handle structure.

In forming the carton and its handle structure from the blank 10, it is necessary to fold three plies of material together about the same bend or corner. Such a thickness of material can be difficult to manipulate. The aforescribed carton is merely an example of a situation where a high fold resistance may need to be reduced and hence where a fold-resistance reducing mechanism is advantageous. As such the currently described situation is only an example of how a fold-resistance reducing mechanism of the present invention may be deployed.

The fold-resistance reducing mechanism (FRRM) of the first embodiment is best illustrated in Figure 3A. The fold-resistance reducing mechanism 46a, 46b comprises a primary pair of weakened lines 60, 62 that diverge from a first common location and which converge on a second common location. In this arrangement, the primary pair of weakened lines are a pair of arcuate score lines 60, 62. The score lines 60, 62 are optionally, but preferably made up of an alternating series of 1/8 inch x 1/8 inch cuts and creases 61, 64. Between the arcuate lines 60, 62 an embossed region 59 is defined. The embossing 59 is achieved by pressing the material in a die, such that a region 59 is pressed out from the coated or printable side of the paperboard. In other words, after the area 59 has been embossed, when viewed from the printable ("good-side") the material will be recessed in that region 59. Conversely, when viewed from the non-bleached or coated side, the material will protrude in that embossed region 59.

- 9 -

Turning to the construction of the carton 8 as illustrated in Figure 2 - it is envisaged that the carton 8 can be formed by a series of sequential folding operations in a straight line machine so that the carton 8 is not required to be rotated or inverted to complete its construction. The folding process is not limited to that described below and may be altered according to particular manufacturing requirements.

To form a flat folded part formed carton, glue strip 20, along with top panel 18 and a part of the second side panel 16 are folded about fold line 40 and placed in flat face contact with the second part of the second side panel 16, bottom panel 14 and part of the first side panel 12. Glue is then applied to an outside face of the glue strip 20 and reinforcing flaps 30a, 30b. The carton is then folded about fold line 34 to bring part of the first side panel 12 and its associated side end flaps 22a, 22b into overlaying relationship with the glue flap 20, reinforcing flaps 30a, 30b and part of the first side panel 12 respectively. Pressure is then applied to the first side panel 12 and glue flap 20 and to the side end flaps 22a, 22b and reinforcing flaps 30a, 30b. This adheres the inside surface of the first side panel 12 to the outside surface of the glue flap 20 and the outside surface of the reinforcing flaps 30a, 30b to the inside surfaces of the side end closure flaps 22a, 22b. Thereby the first side panel 12 is connected to the top panel 18 and in this way a flat-folded tubular structure is formed. In this condition, the blank 10 may be supplied to a converting plant, whereat, the part formed, flat folded blank is opened into an open ended tubular structure, loaded from one or both of its open ends with articles such as bottles and then sealed to form a closed carton or package 8 as shown in Figure 2.

Each end of the carton 8 is the same and therefore the folding of only one end wall is described. Each side end closure panel 22b, 26b, is folded about its fold line 48b, 52b, such that it partially closes the end of the carton 8. In doing this, the reinforcing flap 30b that is adhered to side end closure flap 22b is also folded. The fold-resistance reducing mechanism 46b assists in the folding of the two adjacent and adhered plies of material (side end closure flap 22b and the reinforcing flap 30b).

- 10 -

The blank 10 is folded and glued such that when reinforcing tabs 30a, 30b are adhered in overlapping relationship with the side end closure flaps 22a, 22b, the fold-resistance reducing mechanism 46a, 46b overlays the first side panel 12 and side end closure flap 22a, 22b in the region of fold line 48a, 48b. The arcuate score lines 60, 62 are disposed either side of that fold line 48a, 48b with the embossed region 59 positioned directly on top of that fold line 48a, 48b. The printed outside surface of reinforcing panel 30a, 30b is pressed against and in direct contact with the inside face (or "brown-side") of the side end closure panel 22a, 22b. As such, the recessed (pressed) side of the embossed region 59 is in direct contact with side end closure panel 22a, 22b. Once each reinforcing panel/side end closure panel pair 30a/22a, 30b/22b is folded about the external fold lines 48b, 48a to create a corner of the carton 8 between the side 12 and end walls 22b/24b/26b/36b/30b, the embossed region 59 is positioned on the internal aspect of that corner, with the embossed region protruding into the carton 8. This is depicted in the line drawing of Figure 3B and the photograph of Figure 3C. These figures show the same internal view of the carton 8 looking at the internal corner between the first side panel 12 and composite end wall 22b/24b/26b/36b/30b. It can be seen that glue flap 20 is adhered on top of first side panel 12 and that the reinforcing flap 30b is disposed on top of the side end closure panel 22b. At the internal corner where the thickness of material is greatest, (because of the two overlapping plies of material), the embossed region 59 and arcuate score lines 60, 62 reduce the resistance to folding and thus make it easier to create the corner and maintain the folded corner of the carton 8. Figure 3D illustrates a cross-section taken along the line X-X shown in Figures 3B and 3C, showing the fold-resistance reducing arrangement after folding and that the material present at the corner may be reduced or distributed away from the corner due to the presence of the FRRM.

In one aspect, this embodiment of the invention works because the actual amount of material at the two-ply corner is reduced by some of that material being pressed out away from the internal corner. In a second aspect, this embodiment of the invention works because the embossing creases and weakens the material at the two-ply corner, weakening the material and thus making it easier to fold. In a further aspect, this embodiment of the invention works

- 11 -

because the amount of material fully folded is reduced. In other words, because the material between the arcuate folds is not folded to the degree that the material immediately either side of a normal prior art linear fold line would be folded to create a 90 degree corner, less work has to be done to create the corner when the FRRM is used. This makes it both easier to fold the material and easier to maintain that fold.

Referring now to Figure 6, there is shown a blank 210 for forming another end-loading gable-topped style carton. The blank 210 is slightly different to the blank 10 of Figure 1 and will be described briefly. An outer top panel 218 is hinged in series to a first side panel 216, a bottom panel 214, a second side panel 212 and an inner top panel 220. End closure panels 228a, 228b, 226a, 226b, 224a, 224b, 222a, 222b, 230a, 230b are hinged to each end of the main panels 218, 216, 214, 212, 220 respectively. A handle arrangement 236a, 236b, 237a, 237b is formed in the top end closure panels 228a, 228b, 230a, 230b. Along the hinging line 273 between the inner top panel 220 and its associated top end closure flaps 230a, 230b, a series of fold-resistance reducing mechanisms 246a, 246b are provided. Specifically, three spaced fold-resistance reducing mechanisms are evenly positioned along the fold line 273 and thereby interrupt that fold line 273.

The fold-resistance reducing mechanisms 246a, 246b illustrated in Figure 6 are the same as those described with reference to Figures 1 and 3A. In other words, although an alternative blank 210 is shown in Figure 6 and although an alternative arrangement of fold-resistance reducing mechanisms 246a, 246b is depicted, each fold-resistance reducing mechanism 246a, 246b is the same as that of the first embodiment, namely: a pair of arcuate cut-crease lines 260, 262 defining an embossed region therebetween. The fold line 273 does not extend between these arcuate cut-crease lines 260, 262, but rather is interrupted by them. Fold line 273 when viewed end-to-end comprises four short linear creased sections but is otherwise interrupted by the three fold-resistance reducing mechanisms 246a, 246b. Because the three FRRMs 246a, 246b interrupt the fold lines 273, the force required to bend the top end closure panels 230a, 230b into a 90° or substantially perpendicular position relative to inner top panel 220 is

- 12 -

reduced. This is because the applied force is required to fold only the four short linear sections the full 90° and the remaining sections of that notional and interrupted fold line 273 are not fully folded 90° and therefore require less force to be applied to them. The arcuate cut-crease lines and embossed region therebetween are also easier to fold because of the weakened
5 nature of the embossed material. This may also contribute to the reduction in fold resistance.

The provision of a series of FRRMs in the direction of and interrupting a linear fold line is preferred to the use of apertures (as in US6968992 and US5072876). This is because the use of apertures is not necessarily as effective as the use of the FRRM of the present and other
10 embodiments of the invention; because the use of apertures necessitates the handling and dispensing of the wasted cut-out portions of material which is more complicated and can cause machine jamming if not done properly; and because the presence of apertures in certain package arrangements could lead to ingress of dust or dirt or represent an aesthetic deficiency in the overall package.

15 A second embodiment of fold-resistance-reducing mechanism is shown in Figures 4 to 5A. In Figure 4 a blank for forming a similar carton to that of Figure 1 is shown. The blank 110 similarly comprises: a first side panel 112; bottom panel 114; second side panel 116; top panel 118 and glue flap 120. Each of the main panels is hinged at each of its ends to an end closure flap. The
20 first side panel 112 has side end closure flaps 122a, 122b hinged thereto along fold lines 148a, 148b. Bottom panel 114 has bottom end closure flaps 124a, 124b hinged thereto along fold lines 150a, 150b. Second side panel 116 has side end closure flaps 126a, 126b hinged thereto along fold lines 152a, 152b. Top panel 118 has top end flaps 128a, 128b hinged thereto along fold lines 154a, 154b and the glue strip 120 has reinforcing flaps 130a, 130b hinged thereto by
25 fold resistance reducing mechanisms 146a, 146b.

Like the blank 10 for forming a carton having an FRRM according to the first embodiment of the invention, the main panels 112, 114, 116, 118, 120, are hinged together in series along fold

- 13 -

lines 136, 138, 142 and 144 and end closure panels are provided for closing the ends of the carton. The end closure structure and handle structure is similar to that of Figure 1 and is not further described, except for the fold-resistance reducing mechanism 146a, 146b. An enlarged view of the FRRM 146a, 146b of the second embodiment is shown in Figure 4A. The FRRM 146a, 146b comprises a central vertical crease line or line of demarcation 165; a pair of substantially parallel crease lines 163 and 167 and a pair of arcuate cut-crease lines 160, 162. Preferably, but optionally, the arcuate or radiused cut-crease lines 160, 162 converge on the central line of demarcation 165. In the arrangement illustrated, the pair of parallel crease lines 163, 167 pass outside the boundary defined by the arcuate lines 160, 162. It is envisaged that in other embodiments, the pair of parallel crease lines 163, 167 do not pass outside of the boundary defined by the arcuate lines 160, 162. In this second embodiment of the invention, the fold-resistance reducing mechanism 146a, 146b utilises the pair of parallel crease lines 163, 167 to assist the weakening and creasing of the area 159 between the arcuate crease lines 160, 162. As such, the area 159 is not embossed in this embodiment. In other non-illustrated embodiments it is envisaged that the area 159 between the arcuate lines will be embossed as well as one or more crease lines 163, 167, 165 being utilised to create a weakened folding region that reduces the fold-resistance.

A carton is assembled from the blank 110 in a similar process as the blank 10 and therefore the folding process of blank 110 is not described. An internal view of the carton formed from the blank 110, with the top end closure panel 128a not having been secured in place, is shown in Figures 5A and 5. It can be seen that at the internal corner (between side end panel 122a and side panel 112) that the material in the area 159, between the arcuate cut-creases 160, 162 is bunched inwardly of the carton. The presence of the arcuate cut-creases 160, 167, together with the linear score lines 163, 167 and central line of demarcation 165 encourages the weakened area of material 159 to protrude away from the internal corner being made when the side end panel 122a is folded relative to the side panel 112. The amount of material present along the internal corner is thereby reduced and the amount of force required to create that corner likewise reduced. As described above, less of the material at the corner is being fully

- 14 -

folded 90°; some of the material is folded to a lesser degree and thus the resistance to being folded is reduced.

Turning now to the third embodiment of fold-resistance reducing mechanism, this is illustrated in the blanks 310 and 510 of Figures 7 and 9. The fold-resistance reducing mechanism 346a, 346b is formed of two arcuate cut-crease lines 360, 362, 560, 562. The area defined by the arcuate cut-crease lines is not embossed and no other lines of weakening or demarcation are present in that area. The fold-resistance reducing mechanism 346a, 346b, 546a, 546b comprises only the pair of arcuate cut-crease lines 360, 362, 560, 562 positioned along fold line (for example 348a, 348b, 350b, 352b, 352a, 548a, 548b, 550b, 552b, 552a).

Some optional, yet preferable features of the FRRM 346a, 346b, 546a, 546b of the third embodiment is illustrated in Figure 9 by the labels and definitions below. These optional parameters may in some arrangements also apply to the fold-resistance reducing mechanisms of the first and second illustrated embodiments.

L_0 = The entire length of the hinge connection between two adjacent panels (For example, the length of the hinge connection between top panel 516 and top end closure flap 526b or for another example the length of the hinge connection between side panel 514 and bottom panel 512.)

$S_1, S_2, S_3... ..S_n$ = The length of a linear portion of fold line on the hinge connection between two adjacent panels.

$L_1, L_2, L_3... ..L_n$ = The maximum length of the fold-resistance reducing mechanism, in other words, the length between the two converging points of the arcuate lines of the FRRM.

W = The maximum width or distance between the arcuate lines of the FRRM.

- 15 -

Preferably, $L_0 > L_1 + L_2 + L_3 + \dots + L_n$. In other words, it is preferable that the fold-resistance reducing mechanisms 346a, 346b, 546a, 546b do not extend along the entire length of a fold or hinge connection between two adjacent panels.

5

Preferably the length of each FRRM ($L_1, L_2 \dots L_n$) is greater than about 1/3 inch (about 0.9cm) and preferably less than about 5 inches (about 13cm). Put in mathematical terms:

$$1/3'' \leq (L_1, L_2, L_3 \dots L_n) \leq 5''$$

10 Each FRRM is preferably spaced from the terminations of the hinge connection (L_0) and/or from an adjacent FRRM ($L_2, L_3 \dots L_n$). Therefore $S_1, S_2, S_3 \dots S_n$ is preferably greater than zero.

In the third embodiment, the force required to bend the hinge connection between two adjacent panels and thus place those panels at an angle relative to one another is lessened by
 15 the presence of the fold-resistance reducing mechanism or fold assist 346a, 346b, 546a, 546b. This is because the material in the region defined by the arcuate lines is not folded to the full extent. For example, panel 526b is to be folded 90° relative to top panel 516. A 90° corner is to be created and the material along the hinge connection must be creased for this to happen. The material along S_1, S_2 , (the two linear fold portions) is creased to permit a 90° corner to be
 20 created, however the material in the region between the two arcuate portions is only folded about 45°. This material effectively takes a "short-cut" and is angled more obtusely than the corner created between the two panels 526b, 516 along the sections S_1, S_2 .

The third embodiment represents the invention in a more basic form than in the second and first embodiments. In the second and third embodiments, additional creasing mechanisms are
 25 provided to cause the region between the arcuate cut-crease lines to collapse, crease or fold inwardly and project from the internal corner created.

- 16 -

To demonstrate the benefit provided by the invention, tests were carried out on samples – these samples are illustrated in Figures 8A - 8D. The test is described below:

Tested Samples

In Figures 8A to 8B three test specimens 401, 403, 404 and a control specimen 402 are

5 illustrated. The test and control samples 401, 402, 403, 404 are each tested to determine:

- (1) The resistance to bending of a score in a folding paperboard carton, and
- (2) The score bend springback, or "fight" shown by a bent sample after a standard period of time.

10 The test and control specimens are each formed from the same paperboard material having a thickness of about 0.027 inches (about 0.069cm) and are identically shaped and sized being about 3 inches long by about 1 inch wide (approximately 7.6cm by 2.5cm).

In each case a different fold mechanism in the crease zone is tested. In Figure 8B the control sample 402 is illustrated; In Figure 8A a sample 401 having a known fold resistance reducing mechanism is illustrated; in Figure 8C a sample 403 having an FRRM according to the third illustrated and described embodiment is illustrated and finally, in Figure 8D, a sample 404 having an FRRM according to the first illustrated and described embodiment is illustrated.

All tests were carried out in accordance with the TAPPI T577 standard using a PCA Score Bend Tester (Model #202-100A). The samples were each preconditioned for at least 12 hours at 72°-104°F (about 22°- 40°C) and 10% - 35% Relative Humidity. The samples were conditioned for at least 12 hours at 50% $\pm$ 2% Relative Humidity and 73.4° $\pm$ 1.8°F (23° $\pm$ 1°C). The samples were tested at 50% $\pm$ 2% Relative Humidity and 73.4° $\pm$ 1.8°F (23° $\pm$ 1°C).

25 Each test sample 401, 402, 402, 404 was clamped in the test machine and a sufficient mass applied to the non-clamped end of the test sample to fold the sample about the tested fold mechanism and fold it until the unclamped half is positioned at 90° relative to the clamped half.

- 17 -

Once a 90° fold is made, the mass required is recorded (scorebend) the machine is then reset after 20 seconds and then the springback value recorded.

Each of the fold mechanisms of the control sample 402, and test samples, 401, 403, 404 is described below and the scorebend and spring back results and averages provided in table 1 below.

In the control sample of Figure 8B, the sample was divided into two halves by weakened line 415 that comprised a few alternating cuts and nick portions such as a series of three cuts and two nick portions. The sample 402 was folded about this weakened cut-nick line 415 to create a two-ply sample having a horizontal score line 420 disposed a top a horizontal score line 420. The score lines 420 are each demarcation lines which are pressed into the paperboard to create an embossed line having a depth of 0.029 inches (about 0.074cm) and a width of about 0.096 inches (about 0.24cm). The score lines 420 may be described as embossed or debossed depending upon the frame of reference. When the score 420 is being viewed from the side of the paperboard from which it is made by pressing, the score is seen as a depression and may be described as debossed. However when the paperboard is viewed from the opposite side, the score 420 is seen as a projection and this is described as embossed. The depth of the score 420 is measured between the unaffected surface of the paperboard and the new position of the upper surface of the depressed score 420. This is depicted in Figure 8E.

The control sample 402 was clamped in the test machine and a sufficient weight applied to the non-clamped end of the test sample 402 to fold the sample about the pair of overlaid score lines 420 and fold it until the unclamped half was positioned at 90° relative to the clamped half. On average, the mass in grams required to achieve this fold was 710g.

In the first test sample of Figure 8A the sample was divided into two halves by means of a weakened line 415 that comprised a few alternating cuts and nick portions. The sample 401 was folded about this weakened cut-nick line 415 to create a two-ply sample having a horizontal score line 420 (having a depth of 0.029 inches (about 0.074cm) and a width of about

- 18 -

0.096 inches (about 0.24cm)) disposed atop a pair of substantially parallel cut-score lines 472, 470. The pair of substantially parallel cut-score lines 472, 470 was disposed such that the score line 420 of the outermost ply of the folded sample 401 was positioned roughly between them. As viewed in Figure 8A, the top most cut-score line 472 was comprised of a series of alternating
5 cuts 473 and creases 475. Each cut 473 and crease 475 was about 0.125 inch (1/8inch, about 0.32cm) long. Each crease 475 was about 0.029 inches (about 0.074cm) deep (as defined in Figure 8E) and about 0.096 inches (about 0.24cm) wide; and each cut 473 was a full-depth through-cut. The lowermost cut-score line 470 was comprised of a series of alternating cuts 477 and creases 479. Each cut 477 and crease 479 was about 0.25 inch (1/4inch, about 0.64cm) long
10 and about 0.096 inches (about 0.24cm) wide. Each crease 479 was about 0.029 inches (about 0.074cm) deep (as defined in Figure 8E) and each cut 479 was a full-depth through-cut. On average, the scorebend weight in grams required to achieve the fold was 705g.

In the second test sample of Figure 8C (corresponding to the third embodiment), the sample 403 was again divided into two halves by means of a weakened line 415 that comprised a series
15 of alternating cuts and nick portions. The sample 403 was folded about this weakened cut-nick line 415 to create a two-ply sample having a horizontal score line 420 (having a depth of 0.029 inches (about 0.074cm) and a width of about 0.096 inches (about 0.24cm)) disposed atop a pair of arcuate cut-crease lines 460, 462. Each arcuate line 460, 462 was comprised of a series of alternating cuts 464 and creases 461. Each cut 464 and crease 461 was about 0.125inch
20 (1/8inch, about 0.32cm) long and about 0.096 inches (about 0.24cm) wide. Each crease was about 0.029 inches deep (about 0.074cm). The maximum width (W) between the peaks of the two arcuate lines 460, 462 is about 1/8 inch (0.125 inch, about 0.32cm). The arcuate lines are each sections of a circle having a radius of 2 1/32 inches (2.031 inches about 5.16cm). Each cut 464 was a full depth cut. On average, the mass in grams required to achieve the fold was 550g.

25 Finally, in the test sample 404 of Figure 8D (corresponding to the first embodiment), this sample was again divided into two halves by means of a weakened line 415 that comprised a series of alternating cuts and nick portions. The sample 404 was folded about this weakened

- 19 -

cut-nick line 415 to create a two-ply sample having a horizontal score line 420 (having a depth of 0.029 inches (about 0.074cm) and a width of about 0.096 inches (about 0.24cm)) disposed atop a pair of arcuate cut-crease lines 460, 462. Between the arcuate cut-crease lines the area 459 was embossed. The embossing was achieved by pressing the paperboard of the sample between a pair of upper and lower dies, as such the paperboard was sandwiched and pressed to form an embossment (or debossment) in the area 459. In this arrangement, the embossed area had a depth of about 0.022 inches (about 0.056cm). This depth is determined in a similar manner to score depth as discussed above and illustrated in Figure 8E.

Each arcuate line 460, 462 was comprised of a series of alternating cuts 464 and creases 461. Each cut 464 and crease 461 was about 0.125 inch (1/8inch, about 0.32cm) long. Each crease was about 0.029 inches deep (about 0.074cm) and about 0.096 inches (about 0.24cm) wide. Each cut 464 was a full depth cut. The maximum width (W) between the peaks of the two arcuate lines 460, 462 is about 1/8 inch (0.125 inch, about 0.32cm). The arcuate lines 460, 462 are each sections of a circle having a radius of 2 1/32 inches (2.031 inches about 5.16cm). On average, the mass in grams required to achieve this fold was 471g. In other words, the fold-resistance reducing mechanism of the first embodiment of the invention resulted in a 33% reduction in the force/mass required to create the 90° fold or corner when compared to the control sample 402.

In the following two tables, the test results are presented. For each type of sample (401 – 404) four samples were tested and the scored bend and spring back of each sample is given in the table. Table 1 shows the scorebend results whereas table 2 shows the springback results. The average of the test results is given in the right-hand column.

Table 1 (Scorebend)

	1	2	3	4	Average
Sample 401	756	626	691	746	705
Control 402	695	762	732	649	710

- 20 -

Sample 403	598	512	544	544	550
Sample 404	439	501	440	503	471

Table 2 (Springback)

	1	2	3	4	Average
Sample 401	582	465	515	565	532
Control 402	524	613	557	499	548
Sample 403	446	386	392	399	406
Sample 404	333	382	341	420	369

The results demonstrate that the invention can reduce a material's resistance to being folded by as much as 33%. In sample 404, the reduction in force/mass required to make a 90° corner was 33% less than in sample 402. In other words, a two-ply arrangement of paperboard can be folded to create the 90° fold using a force or mass that is between about 20% and about 35% less than the force required to create a 90° fold in the same sheet material using only a linear fold or score line of similar length in each ply of material.

- 5 In Figures 10A-10C, some further variations of the Fold-resistance reducing mechanism of the present invention are illustrated.

In Figure 10A, a fold-resistance reducing mechanism 646b of a fourth embodiment of the invention is shown wherein a pair of arcuate cut-crease lines 662, 660 are disposed either side of an interrupted fold line 652b. The arcuate lines 660, 662 converge on the interrupted fold line 652b such that each of the two terminations of arcuate line 660 is coincident with one of the two terminations of the arcuate line 662. The arcuate line 662 is shaped such that it peaks to the left of a centre point between the terminations of the arcuate lines 660, 662. The arcuate line 660 is shaped such that it peaks to the right of a centre point between the terminations of

- 21 -

the arcuate lines 660, 662. As such, the FRRM 646b is asymmetric about a notional line running along interrupted fold line 652b. The arcuate lines 660, 662 are similarly skewed and have a similar maximum spacing from the notional line running along interrupted fold line 652b. (In other words the maximum width of each arcuate line 660, 662 is the same). This arrangement is
5 illustrated without an embossed area between the arcuate lines and without any other weakening in that area (for example score or cut-crease lines), however, in other envisaged embodiments, the arrangement does have an embossed area between the arcuate lines and/or some other form of weakening in that area (for example score or cut-crease lines).

In Figure 10B, a fold-resistance reducing mechanism 746b of a fifth embodiment of the
10 invention is shown wherein a pair of arcuate cut-crease lines 762, 760 are disposed either side of an interrupted fold line 752b. The arcuate lines 760, 762 converge on the interrupted fold line 752b such that each of the two terminations of arcuate line 760 is coincident with one of the two terminations of the arcuate line 762. The arcuate lines 760, 762 are similar sin shape, each having a peak that is disposed roughly centrally along the interrupted fold line 752b. The
15 peak of arcuate line 760 is opposite the peak of arcuate line 762. However, the maximum width of arcuate line 762 (measured from a notional line along 752b) is greater than the maximum width of arcuate line 760. As such the FRRM is asymmetric about a notional line running along interrupted fold line 752b. This arrangement is illustrated without an embossed area between the arcuate lines and without any other weakening in that area (for example score or cut-crease
20 lines), however, in other envisaged embodiments, the arrangement does have an embossed area between the arcuate lines and/or some other form of weakening in that area (for example score or cut-crease lines).

In Figure 10C a fold-resistance reducing mechanism 846b of a sixth embodiment of the
invention is shown wherein a pair of arcuate cut-crease lines 862, 860 are disposed either side
25 of an interrupted fold line 852b. The arcuate lines 860, 862 converge on the interrupted fold line 852b such that each of the two terminations of arcuate line 860 is coincident with one of the two terminations of the arcuate line 862. The arcuate line 862 is shaped such that it peaks

- 22 -

to the left of a centre point between the terminations of the arcuate lines 860, 862. The arcuate line 860 is shaped such that it peaks to the right of a centre point between the terminations of the arcuate lines 860, 862. The maximum width of arcuate line 862 (measured from a notional line along 852b) is greater than the maximum width of arcuate line 860. This arrangement is
5 illustrated without an embossed area between the arcuate lines and without any other weakening in that area (for example score or cut-crease lines), however, in other envisaged embodiments, the arrangement does have an embossed area between the arcuate lines and/or some other form of weakening in that area (for example score or cut-crease lines).

It can be appreciated that various changes may be made within the scope of the present
10 invention, for example, the carton, packaging or other arrangement in which the fold-resistance reducing mechanism is used may take many and various forms and is not limited to the end-loading style of carton illustrated in the figures. Nor is the invention limited in its application to paperboard, it is envisaged that the invention may usefully be employed with other types of foldable sheet material including paper, cardboard and plastics materials. Nor is the invention
15 limited in its application to multiple plies of material being folded together. The invention may be utilized in a one-ply arrangement. Where a high grade or caliper material having a high thickness or stiffness is used, the fold assisting mechanism of the present invention may be beneficially applied.

20 The size and shape of the score, cut-crease, crease, cut and fold lines of the fold assisting mechanism of the present invention may take many and various forms.

Preferably, the hinge connection between two adjacent panels is in part defined by a fold line, weakened line, score line, cut-crease line or any other form of hinge connection that is
25 interrupted by a fold resistance reducing mechanism. In some envisaged embodiments, the hinge connection between two adjacent panels is defined entirely by the fold-resistance reducing mechanism and no other hinging, fold or other weakened connection between the two adjacent panels exists.

- 23 -

The main weakened lines 60, 62, 160, 162, 260, 262, 360, 362, 460, 462, 560, 562, 660, 662, 760, 762, 860, 862 are preferably arcuate. However, it is envisaged that in other embodiments of the invention the primary pair of weakened lines are not arcuate but contain linear portions for example the main pair of weakened lines may be a shallow "V"-shape and/or the main pair of weakened lines may be curvilinear.

Embossing between the main weakened lines 60, 62, 160, 162, 260, 262, 360, 362, 460, 462, 560, 562, 660, 662, 760, 762, 860, 862 is optional, but where used the embossing may be of various, shapes and depths. It is preferable, that the embossing is fully between the primary pair of weakened lines, however in other envisaged arrangements the embossing stops short of some or all of the weakened lines.

The embossing when made is preferably uniform in depth, though in some arrangements, the embossing is deeper in some areas than in others. For example closer to a notional linear hinge connection between two panels the embossing is deeper. In other embodiments closer to a notional linear hinge connection between two panels the embossing is shallower. In some embodiments the embossing has an area that is shaped similarly to the shape of the area defined by the primary pair of weakened lines of the fold-resistance reducing mechanism. In some embodiments the embossing does not have an area that is shaped similarly to the shape of the area defined by the primary pair of weakened lines of the fold-resistance reducing mechanism. For example, the embossing may be in the shape of cross-hatching and as such parts of the area are embossed and other parts are not.

It will be recognised that as used herein, directional references such as "top", "bottom", "front", "back", "end", "side", "inner", "outer", "upper" and "lower" do not limit the respective panels to such orientation, but merely serve to distinguish these panels from one another. Any reference to hinged connection should not be construed as necessarily referring to a single fold line only; indeed it is envisaged that hinged connection can be formed from one or more of the

- 24 -

following, a short slit, a frangible line or a fold line without departing from the scope of the invention.

- 25 -

CLAIMS

1. A sheet of foldable material comprising a folding mechanism, the folding mechanism positioned to facilitate folding of the sheet into two parts, the folding mechanism comprising two weakened lines that diverge from a first location on the sheet and that converge on a second location on the sheet, the first and second locations being spaced apart and being positioned on a notional line defining a primary hinging line between the two parts of the sheet.
2. The sheet of foldable material according claim 1 wherein the two weakened lines are arcuate in shape and have a similar radius and have a similar maximum width as measured from said notional line.
3. The sheet of foldable material according to claim 1 wherein the two weakened lines are arcuate in shape and have a different radius and have a different maximum width as measured from said notional line.
4. The sheet of foldable material according to claim 3 wherein each arcuate line has a peak which is not positioned immediately opposite to the peak of the other arcuate line.
5. The sheet of foldable material according to any preceding claim wherein the folding mechanism further comprises a weakened aspect at least in part extending between the two weakened lines.
6. The sheet of foldable material according to claim 5 wherein the weakened aspect comprises an embossed region between the two weakened lines.

- 26 -

7. The sheet of foldable material according to any preceding claim wherein the first and second locations are positioned on opposite edges of the sheet.
8. The sheet of foldable material according to claim 5 or 6 wherein the weakened aspect comprises one or more weakened lines positioned in parallel to said notional line.
9. The sheet of foldable material according to claim 8 wherein the one or more weakened lines positioned in parallel to said notional line are formed by one or more, or a combination of: a full depth cut and crease line, a half depth cut and crease line, a score line, an embossed line, a perforation and a fold line.
10. The sheet of foldable material according to claim 8 wherein the one or more weakened lines positioned in parallel to said notional line consists of two weakened lines, a first of said weakened lines is a half depth cut and crease line with each half-depth cut and crease having a length of about 0.13 inches (about 0.32cm) and wherein the second of said weakened lines is a half depth cut and crease line with each half-depth cut and crease having a length of about 0.25 inches (about 0.64cm).
11. The sheet of foldable material according to any preceding claim wherein the two weakened lines are formed by one or more or a combination of: a full depth cut and crease line, a half depth cut and crease line, an embossed line, a score line, a perforation and a fold line.
12. The sheet of foldable material according to claim 11 wherein said two weakened lines are each a half depth cut and crease line with each half-depth cut and crease having a length of about 0.13 inches (about 0.32cm).

- 27 -

13. The sheet of foldable material according to any of claims 8, 9 or 10 wherein one or more weakened lines positioned in parallel to said notional line have at least about 70% of their length positioned within the area defined by the two weakened lines.
14. The sheet of foldable material according to any preceding claim wherein the folding mechanism further comprises one or more linear hinge lines extending between the first location and an edge of the sheet of material.
15. The sheet of foldable material according to any preceding claim comprising more than one folding mechanism and wherein at least one of the folding mechanisms further comprises a linear hinge line extending between the first location of that folding mechanism and the second location of the other folding mechanism.
16. The sheet of foldable material according to any preceding claim wherein the folding mechanism reduces the force required to create a 90° fold between the two panels compared to the force required to create a 90° fold in that same sheet material between the two panels but using only a linear fold or score line.
17. The sheet of foldable material according to claim 16 wherein the force required to create the 90° fold is between about 20% and about 35% less than the force required to create a 90° fold in the same sheet material using only a linear fold or score line of similar length.
18. A blank for forming a carton, the blank formed from a sheet of foldable material according to any preceding claim.
19. A carton comprising a sheet of foldable material according to any preceding claim.

- 28 -

20. The carton according to claim 19 comprising an additional panel of foldable sheet material disposed atop and folded with the sheet of material having the folding mechanism, the additional panel of material having a linear hinge line disposed in alignment with the notional hinge line of the folding mechanism of the sheet of foldable material such that a corner is formed of two-ply of material.
21. The carton according to claim 19 wherein the sheet of material having the folding mechanism is the innermost ply of material and the folding mechanism is disposed on the internal aspect of the corner.
22. The package comprising a carton according to claim 19, 20 or 21 and one or more articles.
23. A sheet of foldable material having a folding mechanism substantially as described herein with reference to and/or as illustrated by the accompanying Figures.
24. A blank or carton for packaging articles formed from a sheet of foldable material having a folding mechanism substantially as described herein with reference to and/or as illustrated by the accompanying Figures.

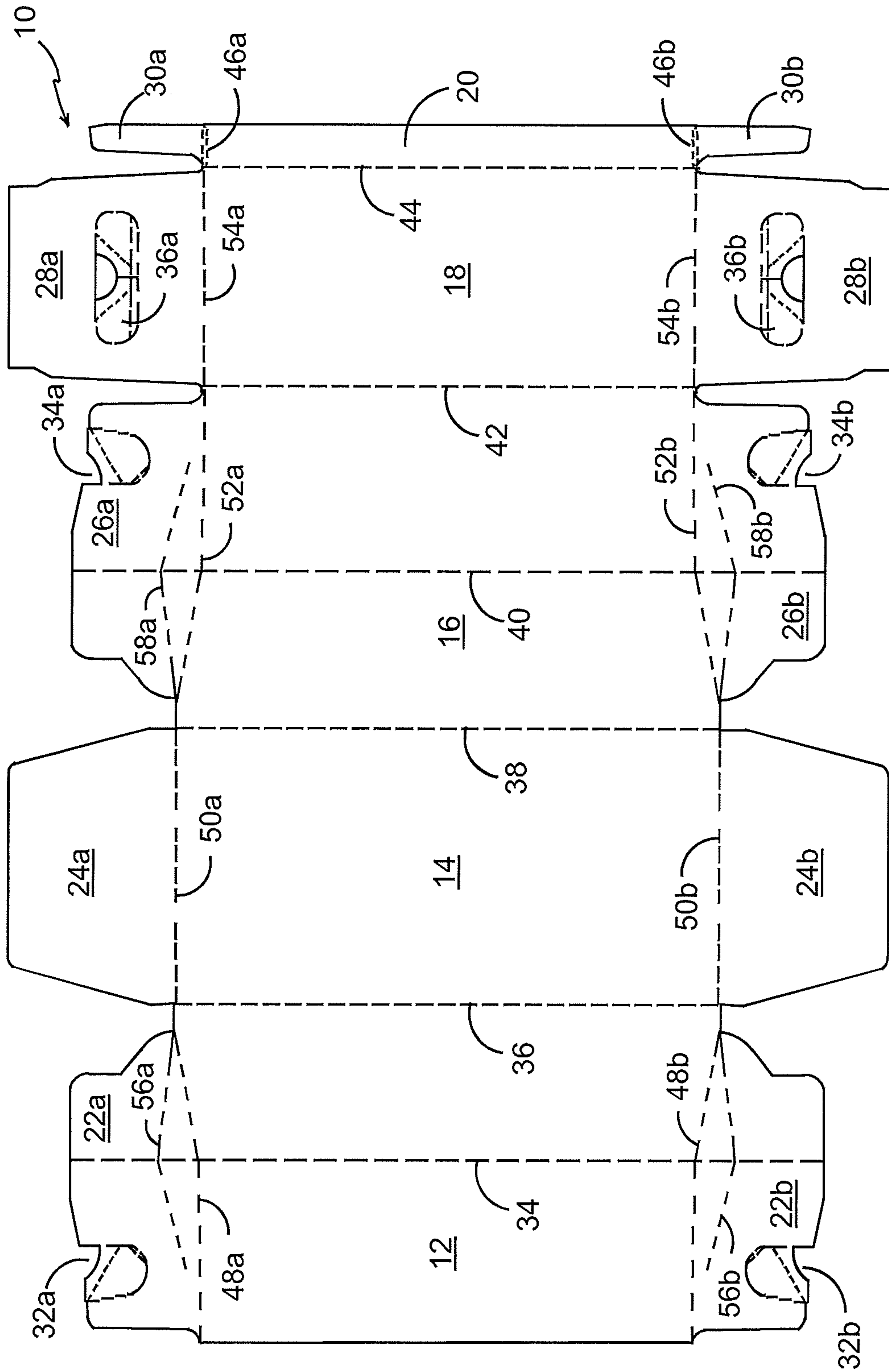
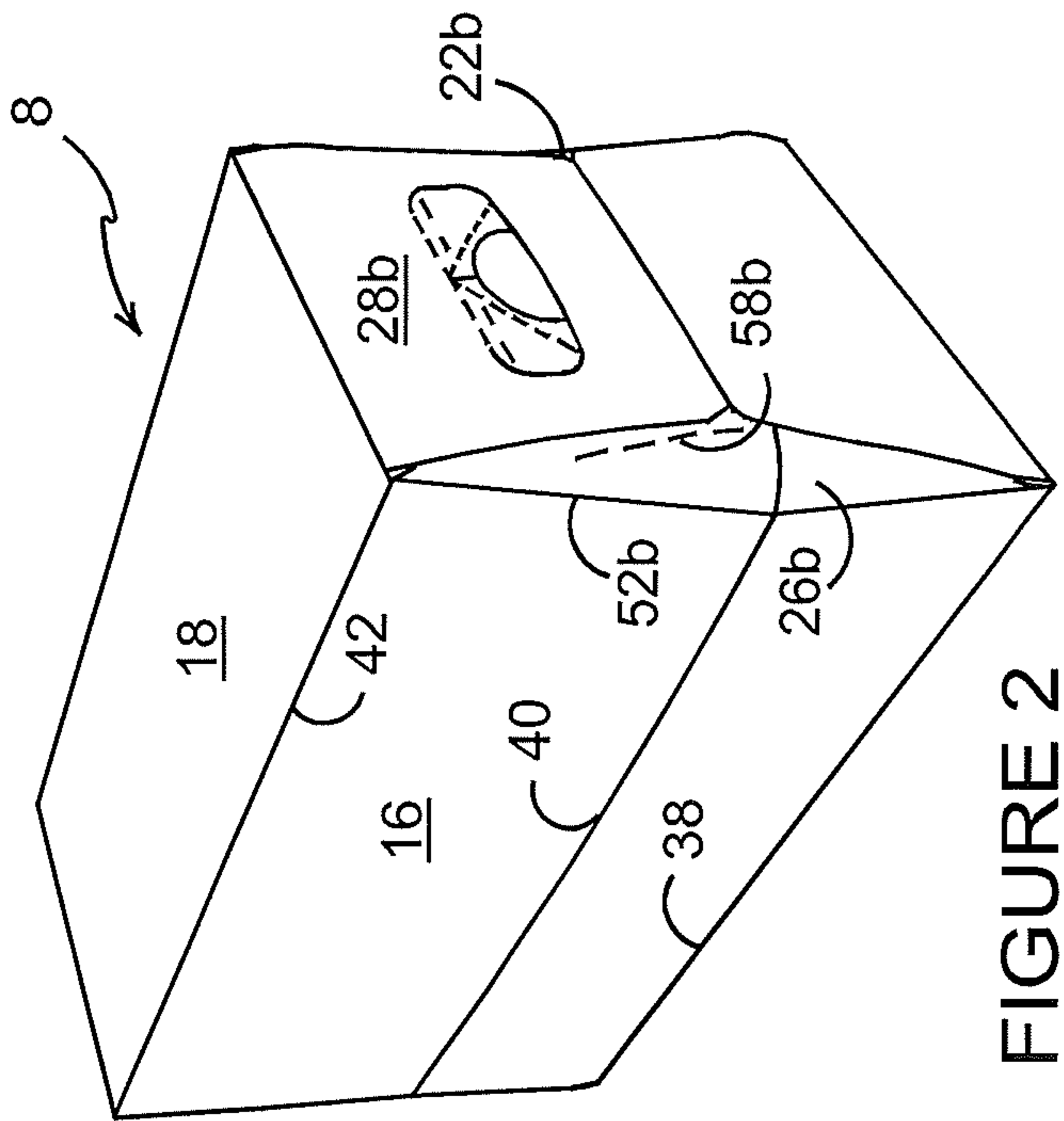
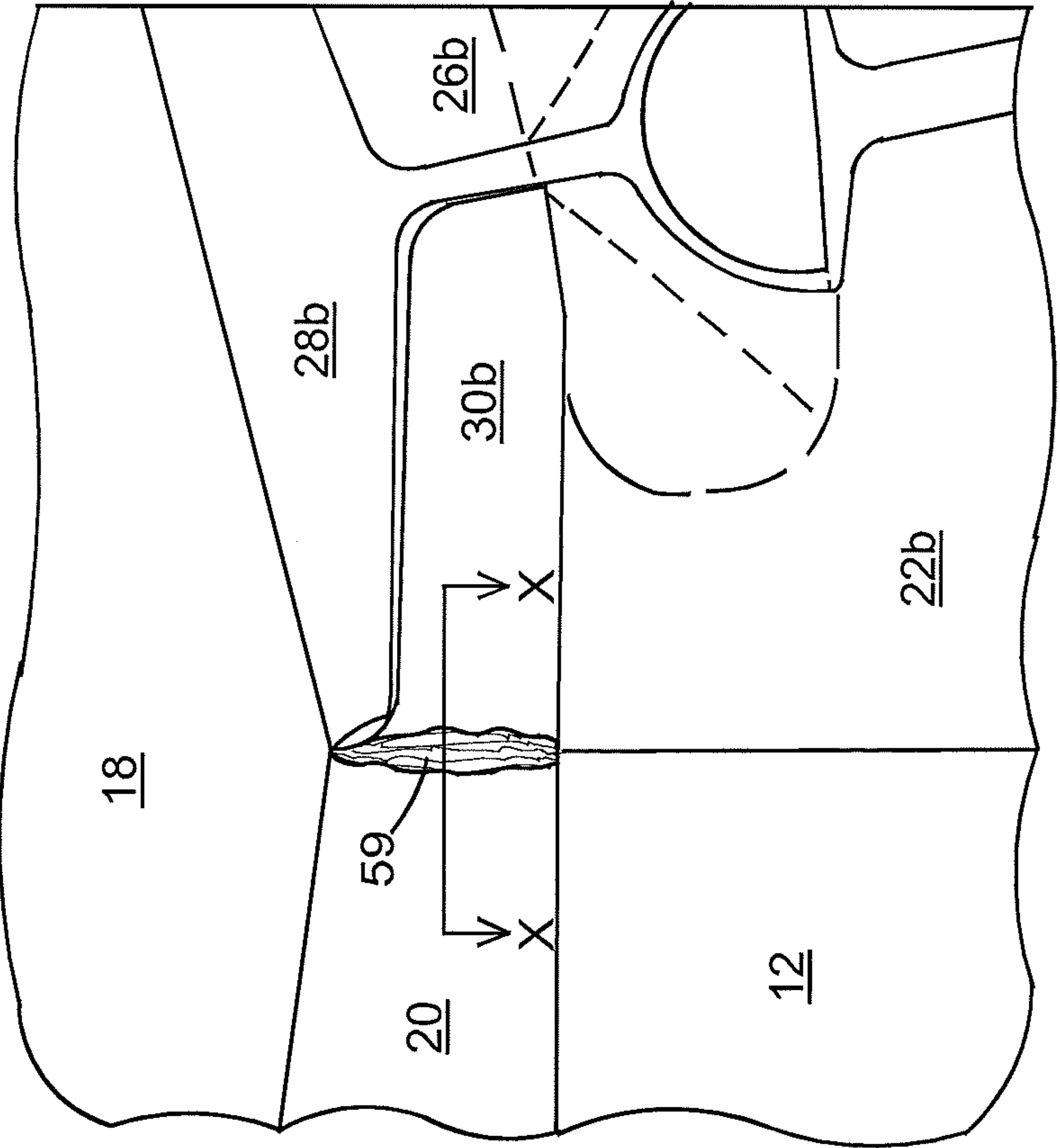
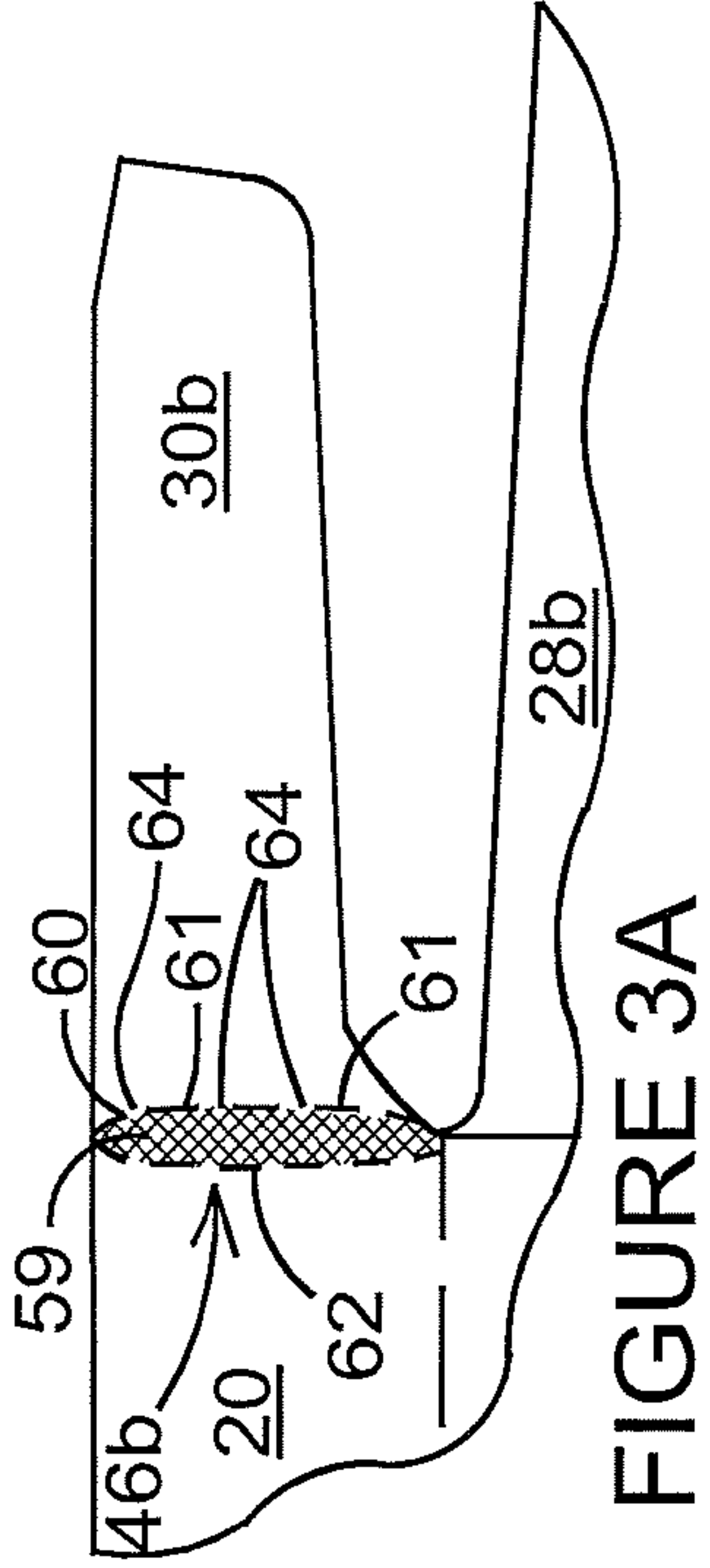


FIGURE 1



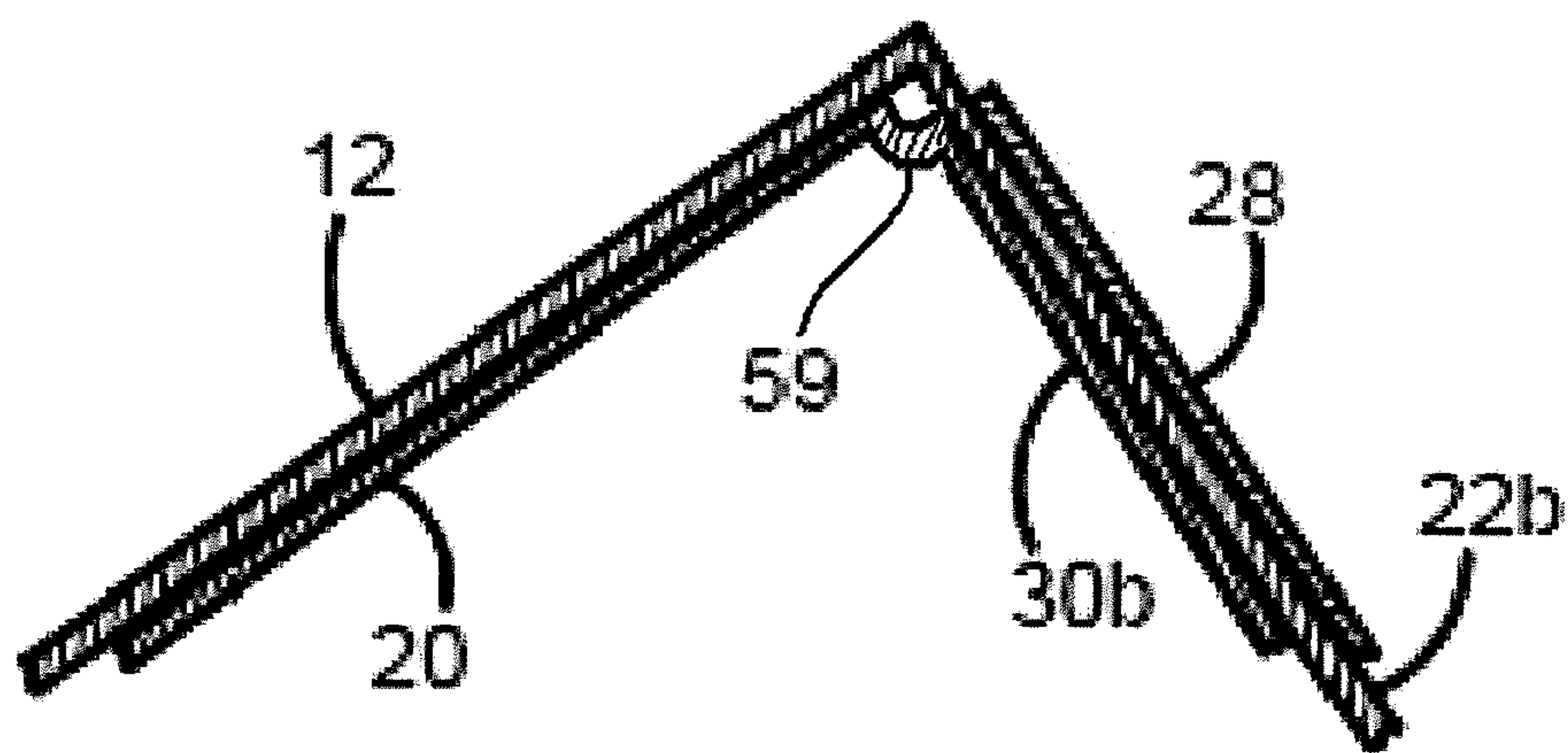


FIGURE 3C

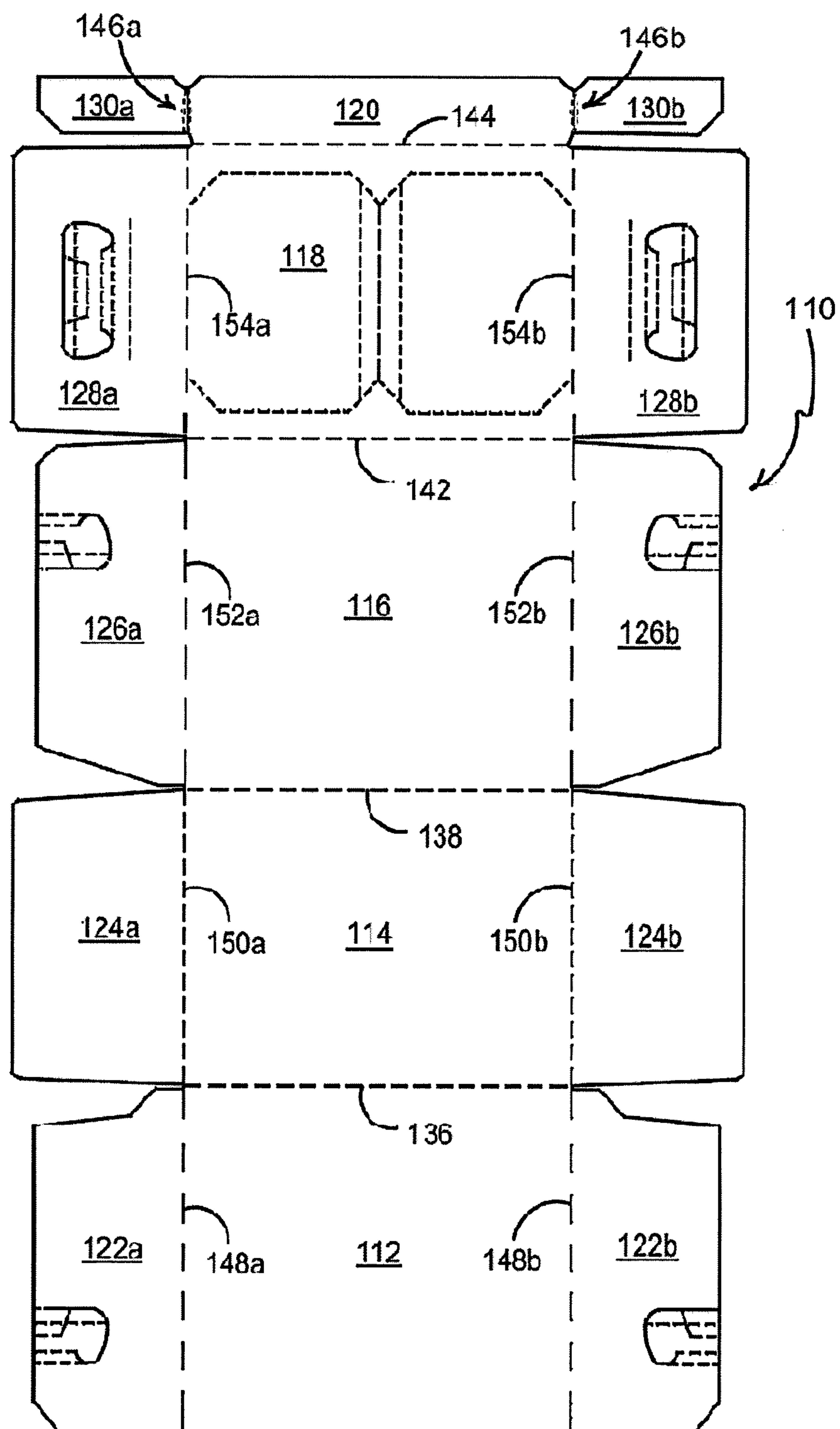


FIGURE 4

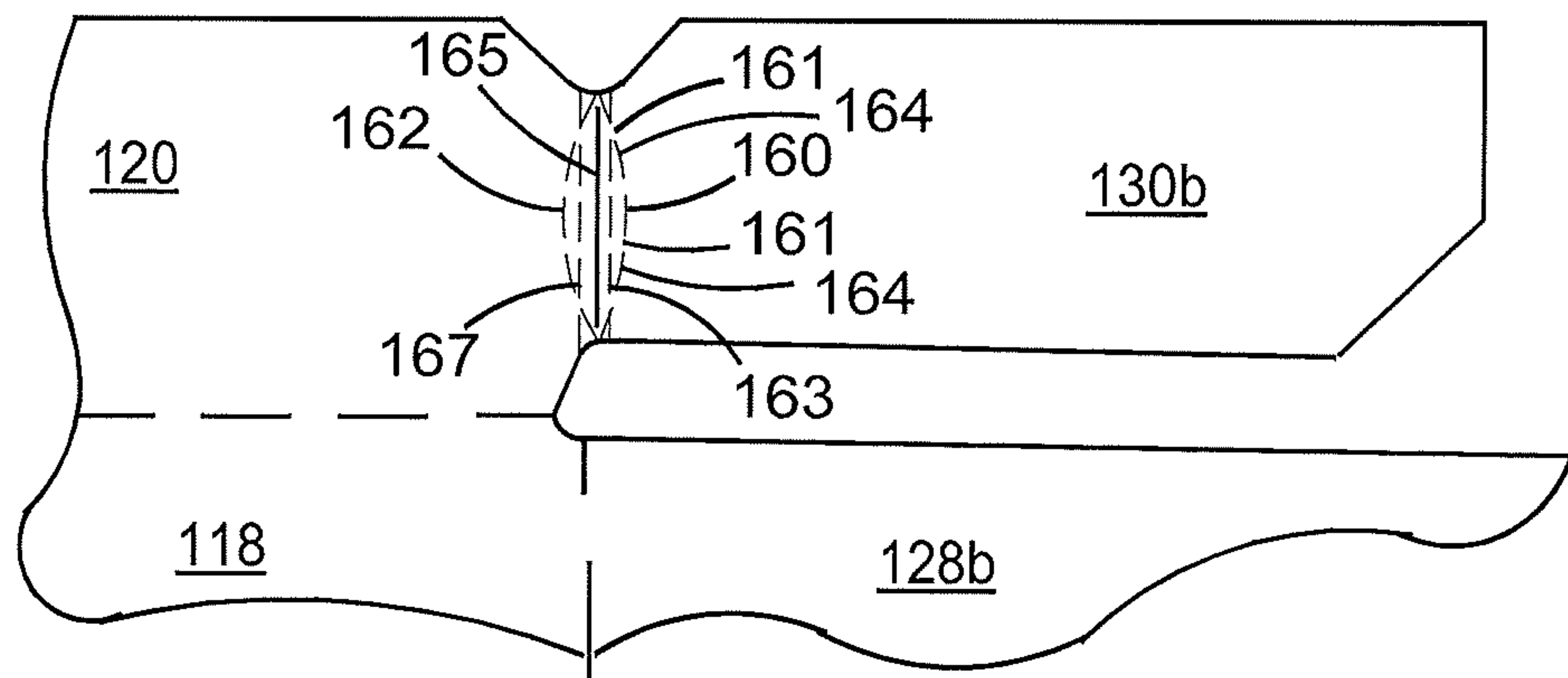


FIGURE 4A

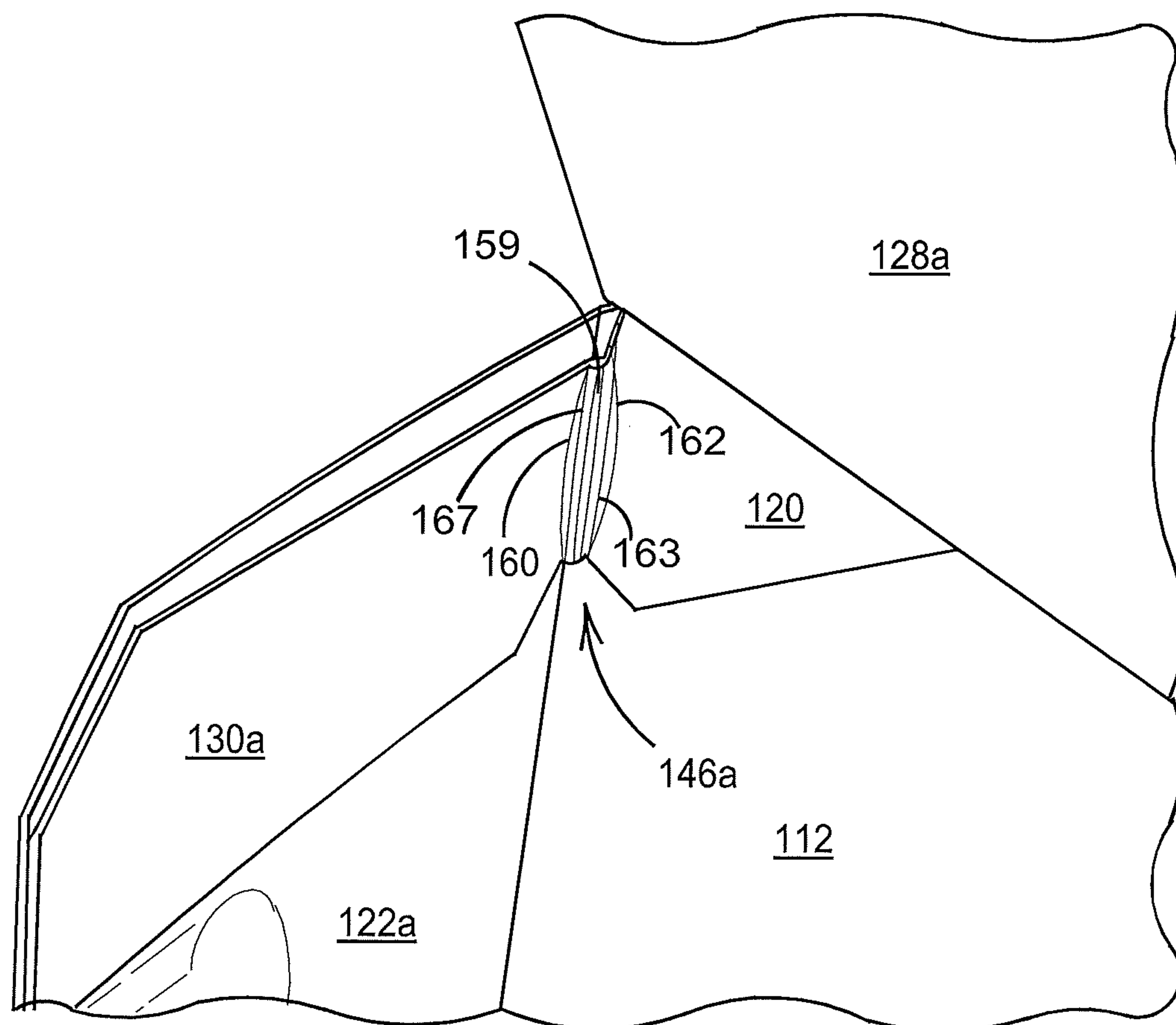


FIGURE 5

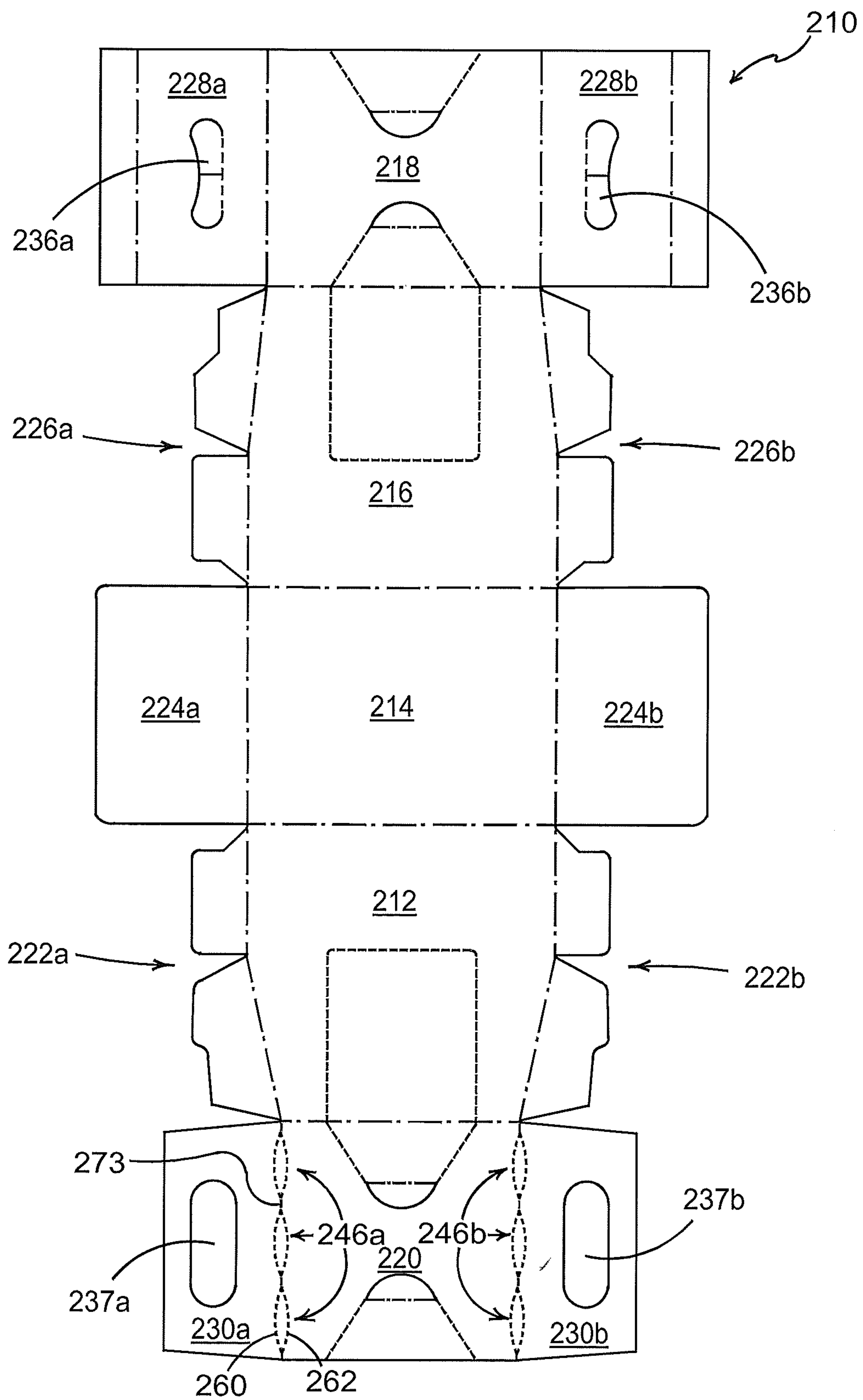


FIGURE 6

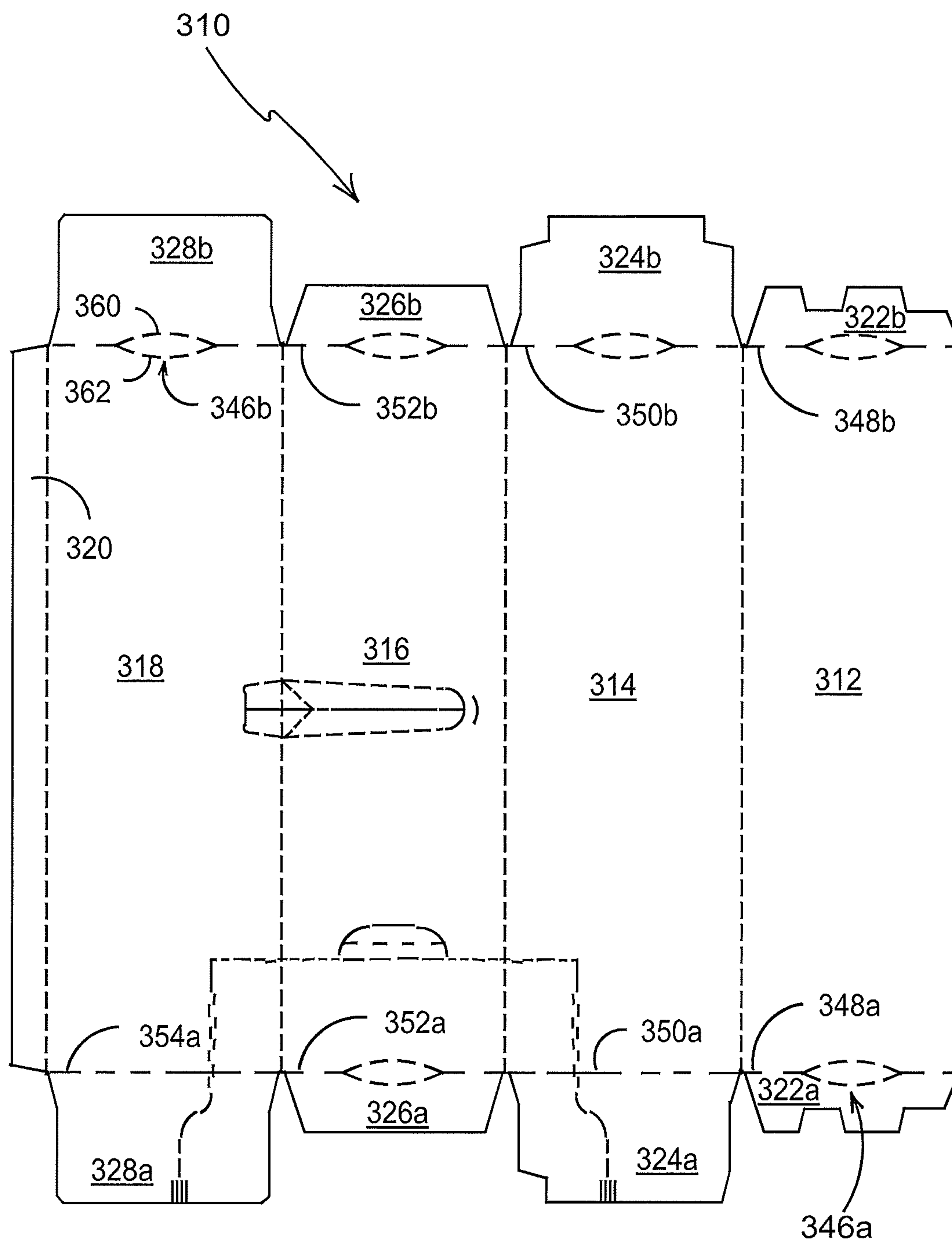


FIGURE 7

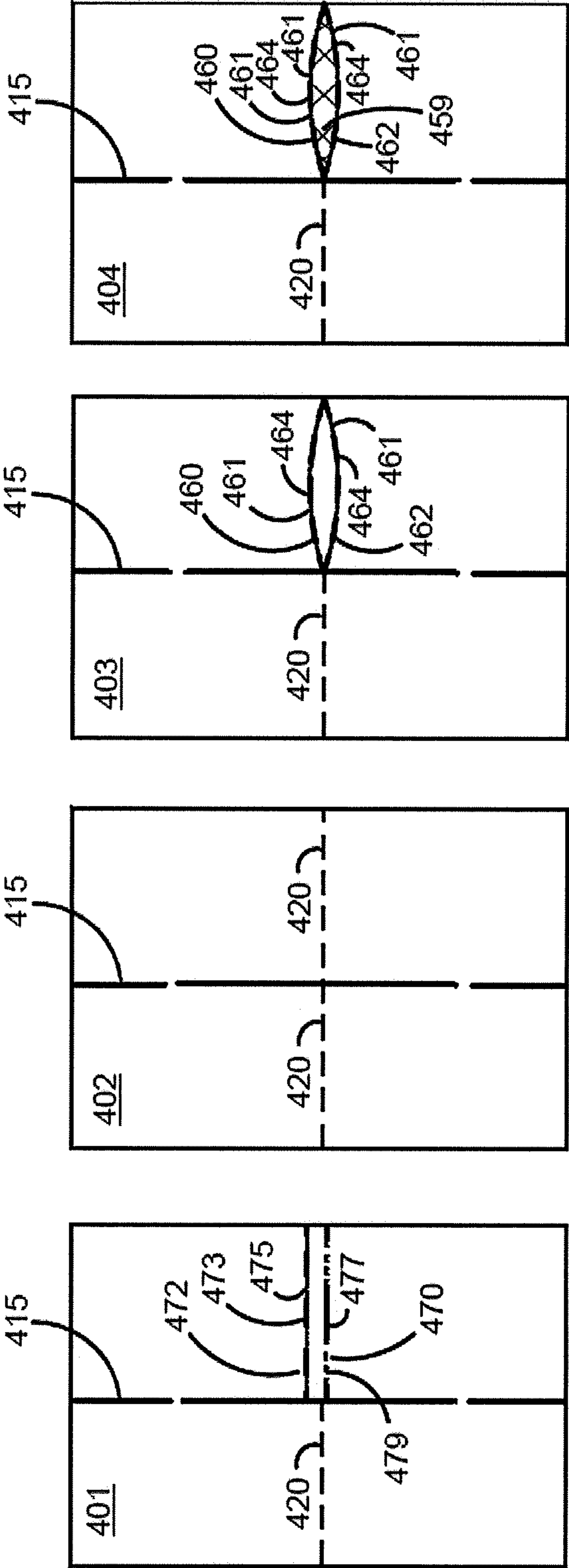


FIGURE 8D

FIGURE 8C

FIGURE 8B

FIGURE 8A

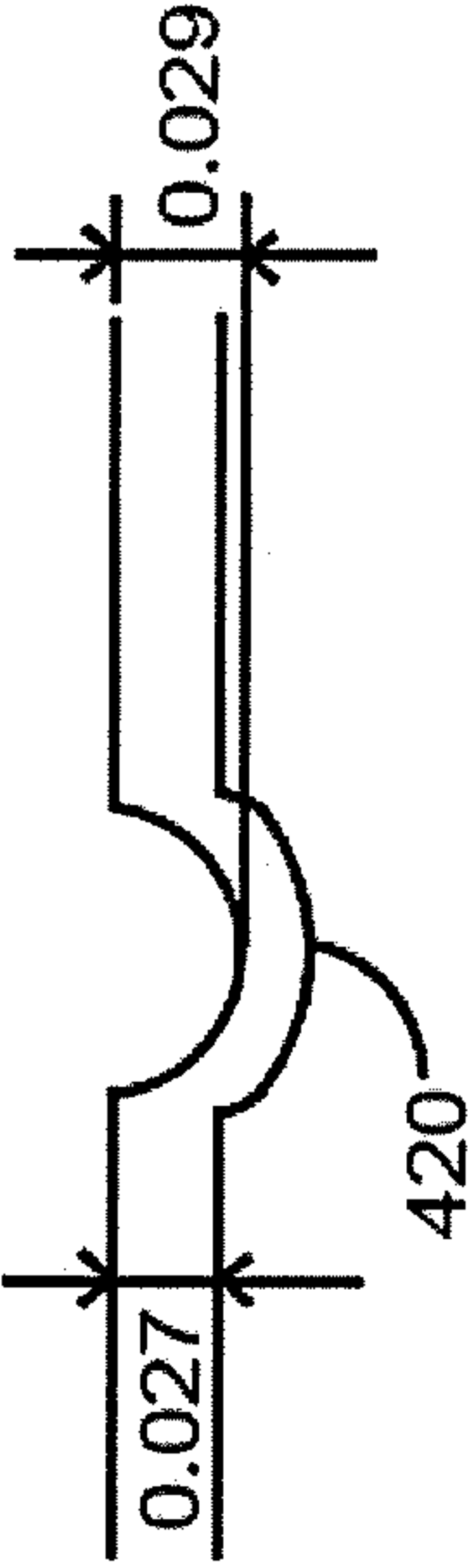


FIGURE 8E

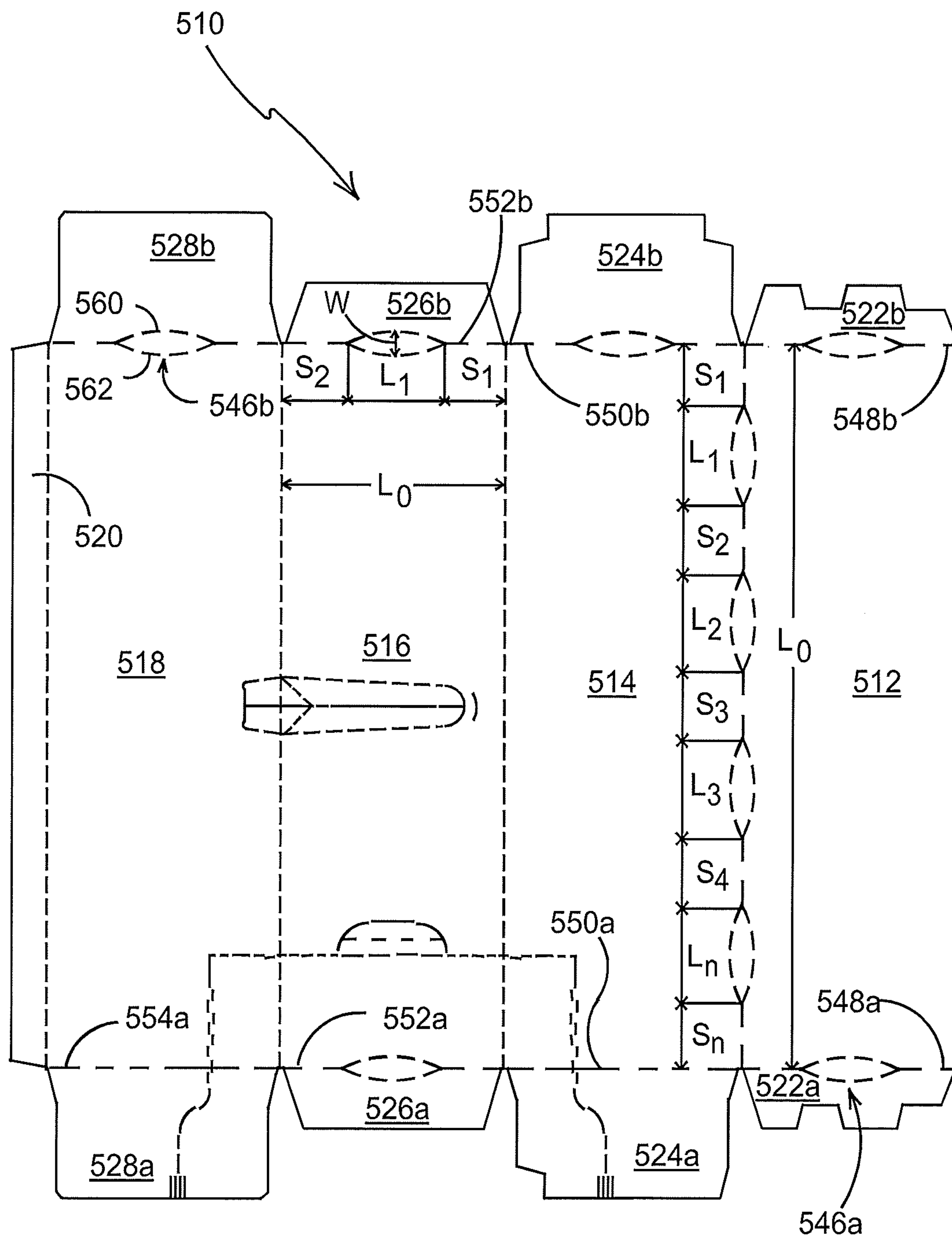
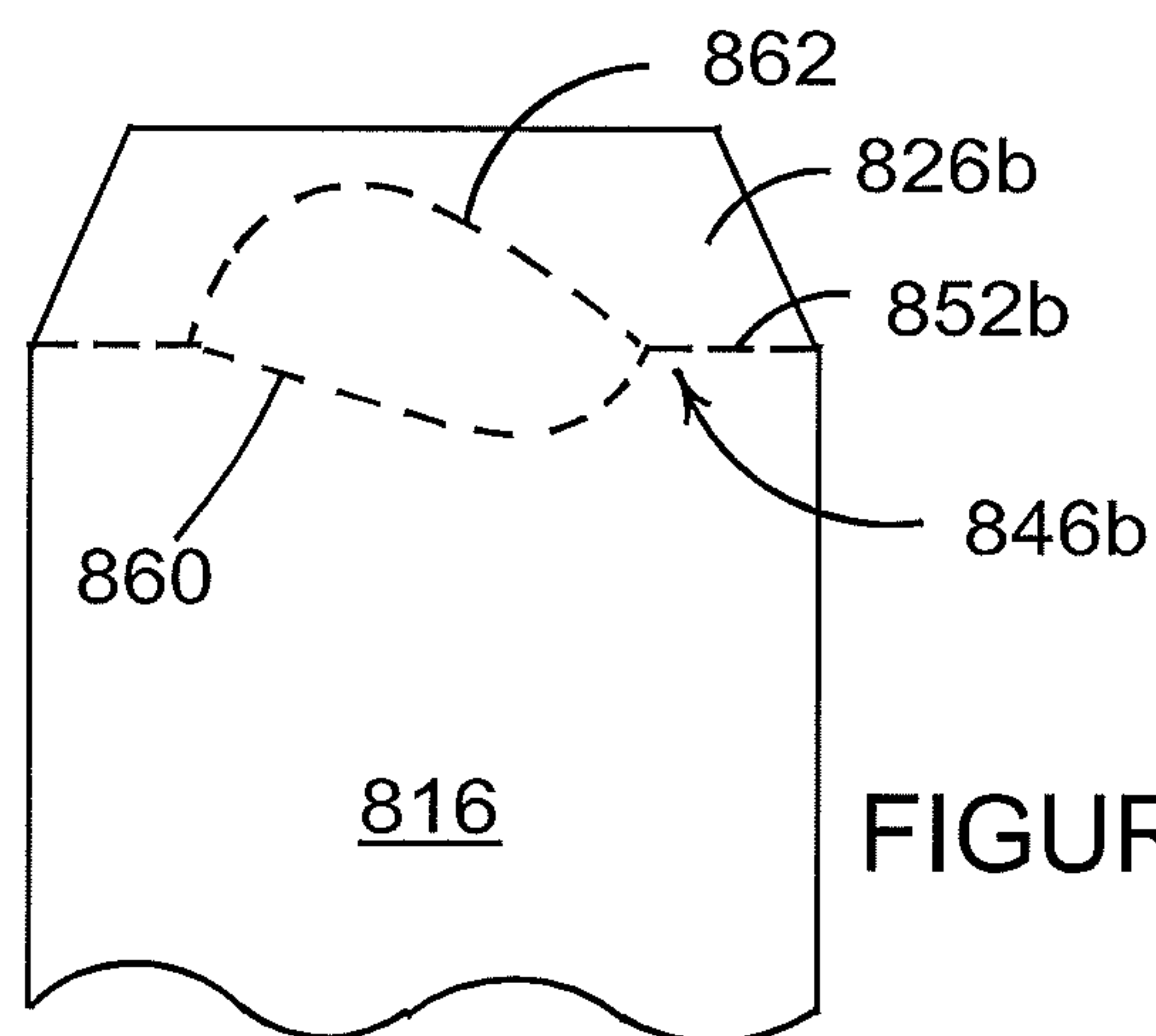
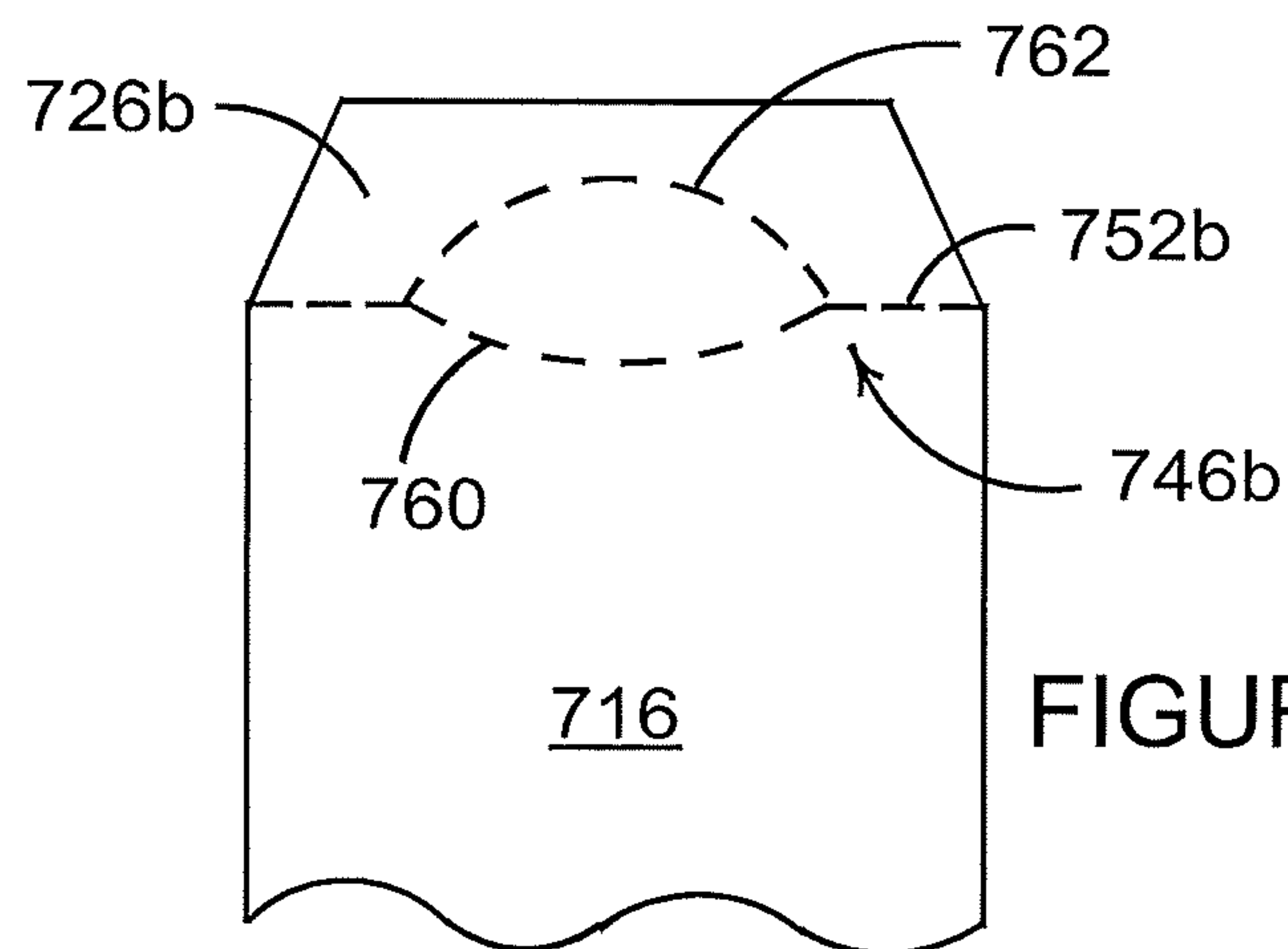
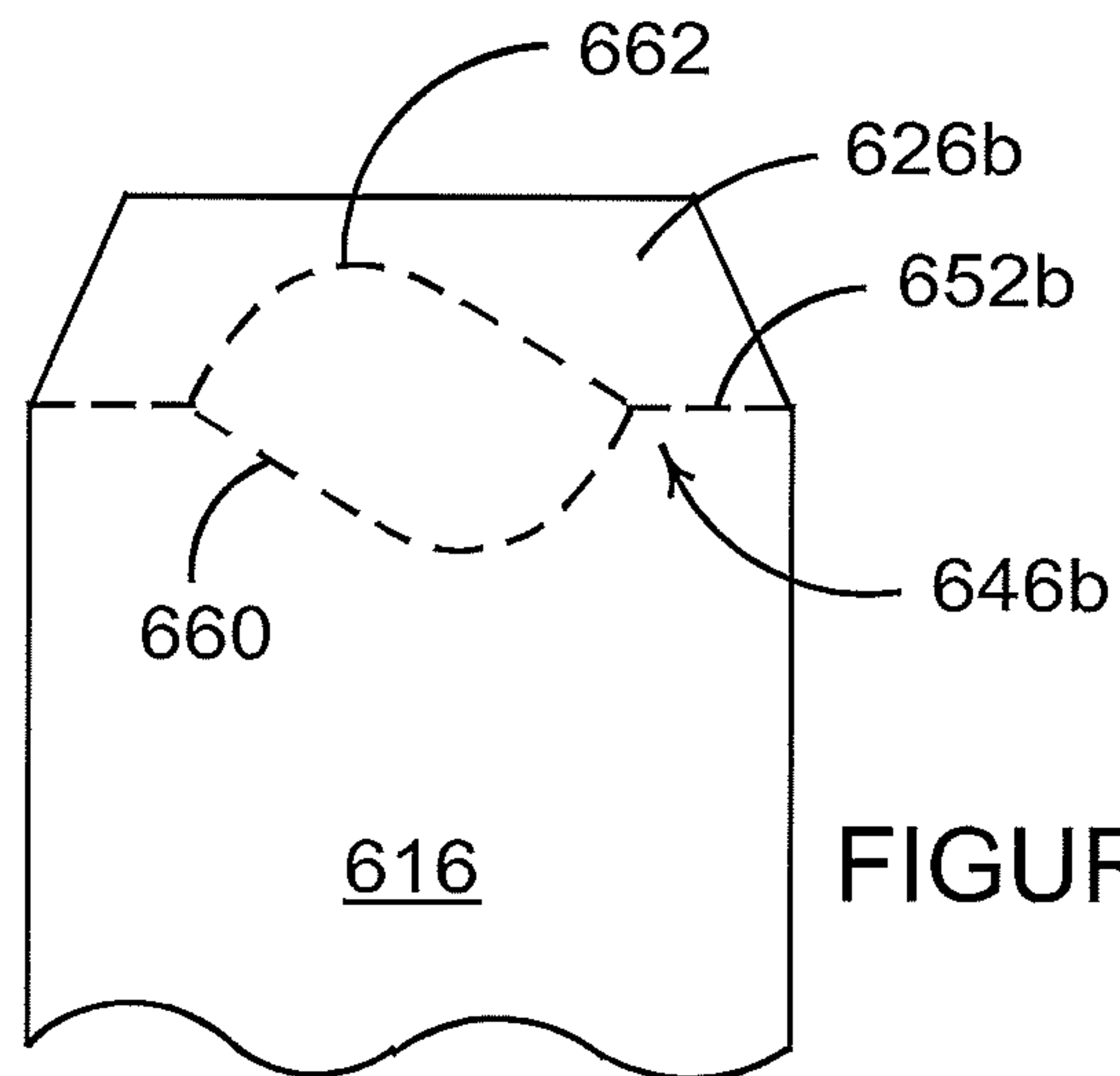


FIGURE 9



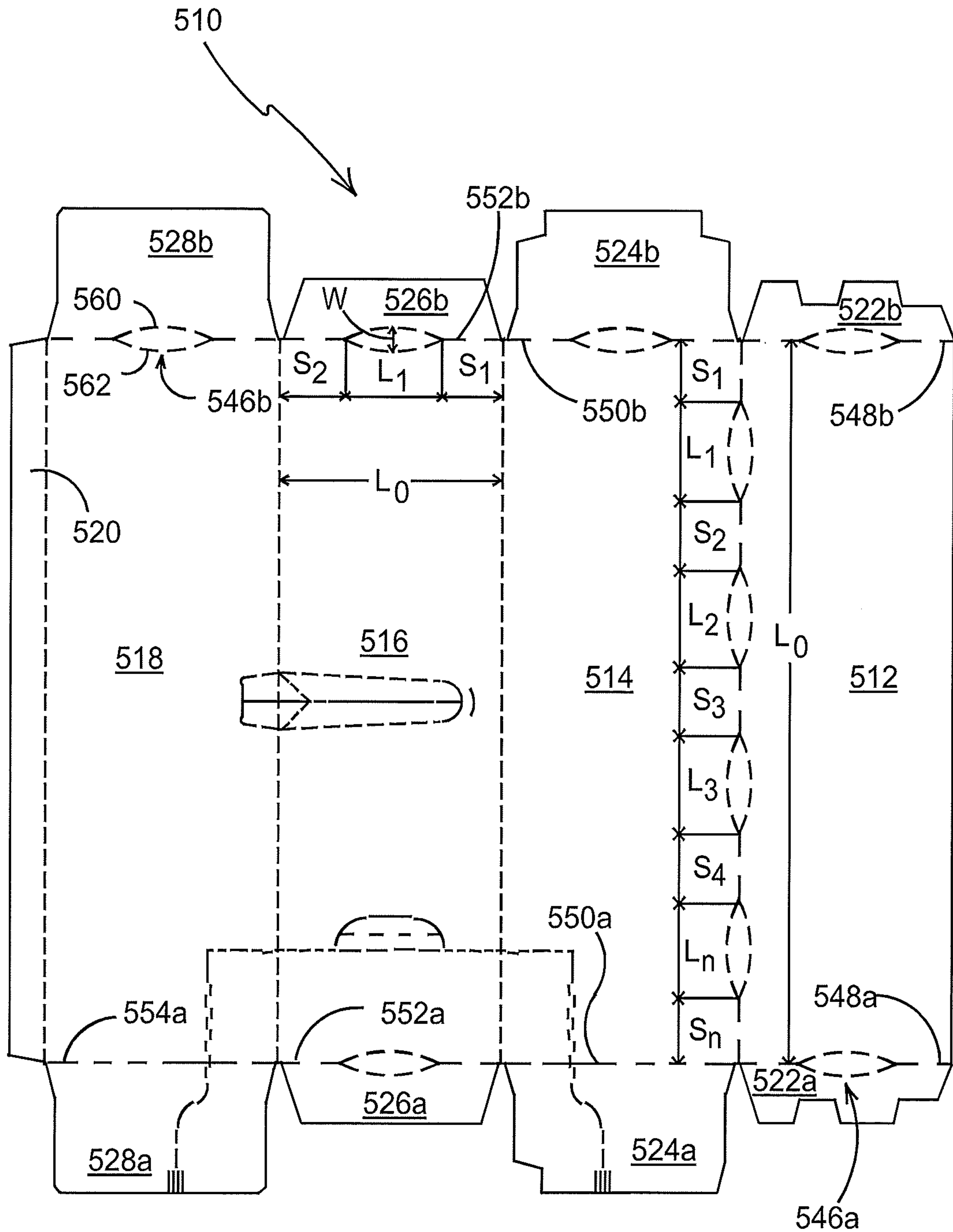


FIGURE 9