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(54) METHOD OF ERECTING BLANKS

(57) A method for erecting a pre-creased planar blank (20) into a box (22) comprises: a first step of folding a blank (20) along selected crease lines; a second step of folding a first-stage partially folded box (26) along selected crease lines; a third step of securing a first outer longitudinal sidewall (ISW1) to a first inner longitudinal sidewall (1SW) and a second outer longitudinal sidewall (2SW1) to a second inner longitudinal sidewall (2SW); a fourth step of folding a second-stage partially folded box (28) along selected crease lines to form the fully erected box (22); and a fifth step of securing a first transverse flange (1TF) to first and second longitudinal flanges (ILF, 2LF), and a second transverse flange (2TF) to the first and second longitudinal flanges (ILF, 2LF). The blank (20) can be made of any suitable material, e.g., corrugated plastic sheet.

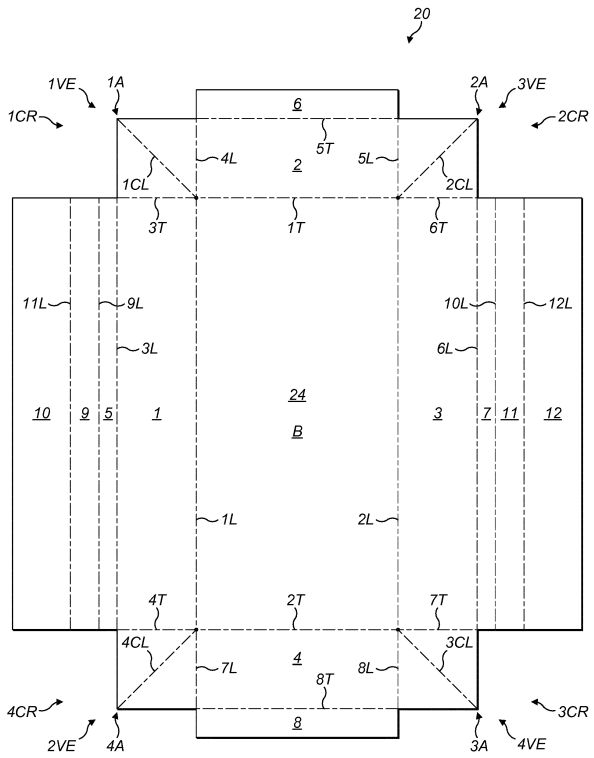

FIG. 1

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Description

Technical Field

[0001] The present disclosure relates to methods of erecting blanks, and in particular cut and pre-creased planar blanks that are erected into boxes for the transportation of food products.

Technical Background

[0002] Food products, and in particular fresh fish, are typically transported in a chilled condition in boxes formed from expanded polystyrene. Whilst expanded polystyrene has a number of advantages, including good thermal insulation properties, low thermal conductivity and low purchase cost, it also has considerable drawbacks, including non-biodegradability, a high cost to transport empty boxes and a large storage area required for empty boxes (because the volume of the empty boxes cannot be reduced), the possibility of damage to the box spoiling the food products and unsuitability for re-use because the material cannot be sterilised.

[0003] In order to overcome these drawbacks, boxes made from corrugated plastic sheet material have been proposed. The plastic sheet material is initially provided as a blank which has been cut and pre-creased along crease lines to facilitate folding and assembly into a box at the point of use. Folding and assembly of the blank to form the desired box can, however, be a laborious and time consuming operation and the present disclosure seeks to address this problem.

Summary of the Disclosure

[0004] Any reference herein to terms such as 'base', 'top', 'bottom', 'upper', 'lower' apply to the erected box in its normal use orientation, i.e., with the box opening facing upwards.

[0005] The present disclosure provides a method for erecting a pre-creased planar blank into a box. The blank can be made of any suitable material, e.g., corrugated plastic sheet which is sometimes referred to as twin-walled fluted plastic sheet. The blank material is preferably non-toxic (making it suitable for packaging and transporting food products) and preferably capable of being recycled. The blank can be cut and pre-creased along the crease lines using any suitable process. The blank includes:

- a substantially rectangular central region that forms a planar base of the erected box and is bounded by first and second longitudinal crease lines that form first and second longitudinal bottom edges of the erected box, and first and second transverse crease lines that form first and second transverse bottom edges of the erected box
- a first substantially rectangular side region adjacent the central region that forms a first outer longitudinal sidewall of the erected box, the first side region being bounded by the first longitudinal crease line, a third longitudinal crease line that forms a first longitudinal top edge of the erected box, a third transverse crease line that is an extension of the first transverse crease line and forms part of a first vertical edge of the erected box, and a fourth transverse crease line that is an extension of the second transverse crease line and forms part of a second vertical edge of the erected box
- a second substantially rectangular side region adjacent the central region that forms a first transverse sidewall of the erected box, the second side region being bounded by the first transverse crease line, a fifth transverse crease line that forms a first transverse top edge of the erected box, a fourth longitudinal crease line that is an extension of the first longitudinal crease line and forms part of the first vertical edge of the erected box, and a fifth longitudinal crease line that is an extension of the second longitudinal crease line and forms part of a third vertical edge of the erected box
- a third substantially rectangular side region adjacent the central region that forms a second outer longitudinal sidewall of the erected box, the third side region being bounded by the second longitudinal crease line, a sixth longitudinal crease line that forms a second longitudinal top edge of the erected box, a sixth transverse crease line that is an extension of the first transverse crease line and forms part of the third vertical edge of the erected box, and a seventh transverse crease line that is an extension of the second transverse crease line and forms part of a fourth vertical edge of the erected box
- a fourth substantially rectangular side region adjacent the central region that forms a second transverse sidewall of the erected box, the fourth side region being bounded by the second transverse crease line, an eighth transverse crease line that forms a second transverse top edge of the erected box, a seventh longitudinal crease line that is an extension of the first longitudinal crease line and forms part of the second vertical edge of the erected box, and an eighth longitudinal crease line that is an extension of the second longitudinal crease line and forms part of the fourth vertical edge of the erected box
- a first substantially square corner region adjacent the first and second side regions, the first corner region being bounded by the third transverse crease line, the fourth longitudinal crease line, and blank edges that define a first blank apex, and including a crease line that extends from the first blank apex to the junction of the third transverse crease line and the fourth longitudinal crease line
- a second substantially square corner region adjacent the second and third side regions, the second

corner region being bounded by the sixth transverse crease line, the fifth longitudinal crease line, and blank edges that define a second blank apex, and including a crease line that extends from the second blank apex to the junction of the sixth transverse crease line and the fifth longitudinal crease line

- a third substantially square corner region adjacent the third and fourth side regions, the third corner region being bounded by the seventh transverse crease line, the eighth longitudinal crease line, and blank edges that define a third blank apex, and including a crease line that extends from the third blank apex to the junction of the seventh transverse crease line and the eighth longitudinal crease line
- a fourth substantially square corner region adjacent the fourth and first side regions, the fourth corner region being bounded by the fourth transverse crease line, the seventh longitudinal crease line, and blank edges that define a fourth blank apex, and including a crease line that extends from the fourth blank apex to the junction of the fourth transverse crease line and the seventh longitudinal crease line
- a fifth substantially rectangular side region adjacent the first side region that forms a first longitudinal flange of the erected box, the fifth side region being bounded by the third longitudinal crease line, a ninth longitudinal crease line, and blank edges
- a sixth substantially rectangular side region adjacent the second side region that forms a first transverse flange of the erected box, the sixth side region being bounded by the fifth transverse crease line, and blank edges
- a seventh substantially rectangular side region adjacent the third side region that forms a second longitudinal flange of the erected box, the seventh side region being bounded by the sixth longitudinal crease line, a tenth longitudinal crease line, and blank edges
- an eighth substantially rectangular side region adjacent the fourth side region that forms a second transverse flange of the erected box, the eighth side region being bounded by the eighth transverse crease line, and blank edges
- a ninth substantially rectangular side region adjacent the fifth side region that forms a first part of a first inner longitudinal sidewall of the erected box, the ninth side region being bounded by the ninth longitudinal crease line, an eleventh longitudinal crease line, and blank edges
- a tenth substantially rectangular side region adjacent the ninth side region that forms a second part of the first inner longitudinal sidewall of the erected box, the tenth side region being bounded by the eleventh longitudinal crease line, and blank edges
- an eleventh substantially rectangular side region adjacent the seventh side region that forms a first part of a second inner longitudinal sidewall of the erected box, the eleventh side region being bounded by the tenth longitudinal crease line, a twelfth longitudinal crease line, and blank edges
- a twelfth substantially rectangular side region adjacent the eleventh side region that forms a second part of the second inner longitudinal sidewall of the erected box, the twelfth side region being bounded by the twelfth longitudinal crease line, and blank edges.

[0006] The method of erecting the pre-creased planar blank comprises:

a first step of folding a positioned blank along (i) the first, second, fourth, fifth, seventh and eighth longitudinal crease lines, (ii) the first, second, third, fourth, sixth and seventh transverse crease lines, and (iii) the crease lines that extend from the first, second, third and fourth blank apexes, to form a first-stage partially folded box including:

a planar base formed by the central region of the blank;
first and second longitudinal bottom edges formed by the first and second longitudinal crease lines;
first and second transverse bottom edges formed by the first and second transverse crease lines;
a first outer longitudinal sidewall formed by the first side region and orientated substantially perpendicular to the base;
a first transverse sidewall formed by the second side region and orientated substantially perpendicular to the base;
a second outer longitudinal sidewall formed by the third side region and orientated substantially perpendicular to the base;
a second transverse sidewall formed by the fourth side region and orientated substantially perpendicular to the base;
a first vertical edge formed by the third transverse crease line and the fourth longitudinal crease line;
a second vertical edge formed by the fourth transverse crease line and the seventh longitudinal crease line;
a third vertical edge formed by the sixth transverse crease line and the fifth longitudinal crease line;
a fourth vertical edge formed by the seventh transverse crease line and the eighth longitudinal crease line;
a first integral corner formed by the folded first corner region;
a second integral corner formed by the folded second corner region;
a third integral corner formed by the folded third corner region; and

a fourth integral corner formed by the folded fourth corner region;

a second step of folding the first-stage partially folded box along the third, sixth, ninth, tenth, eleventh and twelfth longitudinal crease lines to form a second-stage partially folded box including:

a first longitudinal top edge formed by the third longitudinal crease line;
a first transverse top edge formed by the fifth transverse crease line;
a second longitudinal top edge formed by the sixth longitudinal crease line;
a second transverse top edge formed by the eighth transverse crease line;
a first longitudinal flange formed by the fifth side region and orientated substantially parallel to the base;
a second longitudinal flange formed by the seventh side region and orientated substantially parallel to the base;
a first inner longitudinal sidewall formed by the ninth and tenth side regions, the first inner longitudinal sidewall having a first part formed by the ninth side region and a second part formed by the tenth side region, and wherein the second part is orientated substantially perpendicular to the base and adjacent a lower part of the first outer longitudinal sidewall and the first part extends at an angle between the second part and the first longitudinal flange; and
a second inner longitudinal sidewall formed by the eleventh and twelfth side regions, the second inner longitudinal sidewall having a first part formed by the eleventh side region and a second part formed by the twelfth side region, wherein the second part is orientated substantially perpendicular to the base and adjacent a lower part of the second outer longitudinal sidewall and the first part extends at an angle between the second part and the second longitudinal flange;
a third step of securing the first outer longitudinal sidewall to the first inner longitudinal sidewall and the second outer longitudinal sidewall to the second inner longitudinal sidewall;
a fourth step of folding the second-stage partially folded box along the fifth and eighth transverse crease lines to form the fully erected box including:

a first transverse flange formed by the sixth side region and orientated substantially parallel to the base; and
a second transverse flange formed by the eighth side region and orientated substantially parallel to the base; and

a fifth step of securing the first transverse flange to the first and second longitudinal flanges, and the second transverse flange to the first and second longitudinal flanges.

[0007] The method can further include a pre-folding step, between the first and second steps, in which the first-stage partially folded box is temporarily folded along the third and sixth longitudinal crease lines. This weakens the third and sixth longitudinal crease lines and facilitates subsequent folding of the first-stage partially folded box along the third and sixth longitudinal crease lines during the second step.

[0008] The respective outer and inner longitudinal sidewalls are secured using a suitable process, e.g., ultrasonic welding, preferably at a plurality of spaced locations along the longitudinal sides of the fully erected box. Ultrasonic welding is particularly advantageous if the box is to be used for transporting food products because it avoids the use of glues or other adhesives. But other ways of securing the respective outer and inner longitudinal sidewalls and the longitudinal and transverse flanges can be used as appropriate.

[0009] The integral corners make the box watertight. When the corner regions are folded along the crease lines that extend from the respective blank apex, they form triangular-shaped 'wings' that are preferably located between the adjacent outer and inner longitudinal sidewalls. In other words, the first and fourth integral corners are preferably neatly tucked away between the first outer and inner longitudinal sidewalls, and the second and third integral corners are preferably neatly tucked away between the second outer and inner longitudinal sidewalls so that they do not extend into the interior of the box. The third step can further include securing the first and fourth integral corners to the first inner and outer longitudinal sidewalls and the second and third integral corners to the second inner and outer longitudinal sidewalls. The respective inner and outer longitudinal sidewalls can be secured using ultrasonic welding at the corners of the fully erected box, e.g., through the folded integral corners. In this case the ultrasonic welding equipment must be capable of securing together at least four thicknesses (i.e. layers) of the blank material.

[0010] The first part of the first inner longitudinal sidewall, the first longitudinal flange, and an upper part of the first outer longitudinal sidewall preferably together define a first longitudinally-extending structure of substantially triangular cross-section in the fully erected box. Similarly, the first part of the second inner longitudinal sidewall, the second longitudinal flange, and an upper part of the second outer longitudinal sidewall preferably together define a second longitudinally-extending structure of substantially triangular cross-section in the fully erected box. Such a construction considerably improves the strength and rigidity of the box.

[0011] In the fully erected box, the longitudinal and transverse flanges define the periphery of a box opening.

[0012] The method can be carried out by a box erecting machine with multiple stations. For example, the first step (and optional pre-folding step) can be carried out by a plunging station, the second and third steps can be carried out by a primary folding and securing station, and the fourth and fifth steps can be carried out by a secondary folding and securing station.

[0013] In one arrangement, the box is held on an indexing assembly that is actuated laterally along an indexing track to move the box progressively from one station to another in a forward direction. The indexing assembly can include a twin drive chain endless conveyor and the forward movement of the indexing assembly can be driven by a servo motor and chain sprocket assembly. The indexing assembly may include a pair of indexing flights which hold the box and which are moved laterally, e.g. by the twin drive chain conveyor, to move the box progressively from one station to another in the forward direction. The pair of indexing flights may include a first indexing flight which engages the first transverse sidewall of the box and a second indexing flight which engages the second transverse sidewall of the box. The indexing assembly can include a plurality of pairs of the indexing flights so that boxes can be positioned simultaneously at different stations of the box erecting machine.

[0014] The plunging station can include a void defined by vertically-extending longitudinal and transverse fixed folding surfaces that are sized and shaped to fold the blank along the particular longitudinal and transverse crease lines and form the first-stage partially folded box. The transverse folding surfaces are preferably defined by the indexing flights. The blank can be positioned above the void and then moved downwardly into the void (i.e., 'plunged') such that the blank is folded along the particular longitudinal and transverse crease lines by the contact with the longitudinal and transverse folding surfaces. Additional fixed folding surfaces (or guides) can be shaped to fold the blank along the crease lines that extend from the blank apexes to form the integral corners as the blank is moved downwardly into the void. The additional fixed folding surfaces (or guides) can be arranged to fold the blank along the crease lines that extend from the blank apexes to form the integral corners before the blank is folded along the transverse crease lines during the plunging operation.

[0015] The blank can be held (e.g., by vacuum suction provided by one or more vacuum heads) on an overhead assembly which can position the blank accurately above the void and is actuated to move downwardly into the void. The overhead assembly can be actuated laterally along an overhead track and can be adapted to pick the blank from a stack of blanks positioned at a picking station of the box erecting machine.

[0016] The blanks can be manually stacked and the stack can be moved automatically (e.g., using a pusher) to a pre-determined position at the picking station where each blank can be picked up in turn by the overhead assembly. The box erecting machine can include a device for ensuring that only a single blank is picked from the stack by the overhead assembly. In one arrangement, the device can introduce a jet of pressurised air underneath the top blank as it is picked up by the overhead assembly to separate it from the underlying blank. The forward and reverse movement of the overhead assembly along the overhead track can be driven by a servo motor and optionally utilises a timing belt assembly. The upward and downward movement of the overhead assembly at the picking station for picking a blank and at the plunging station for plunging the blank into the void can be driven by one or more pneumatic cylinders, and typically by two linear rod pneumatic cylinders.

[0017] Once the blank is positioned within the void by the overhead assembly to form the first-stage partially folded box, it can be held (e.g., by vacuum suction provided by one or more vacuum heads) within the indexing track and released from the overhead assembly.

[0018] The pre-folding step may comprise temporarily folding the fifth and seventh side regions inwardly, towards the planar base of the first stage partially folded box, along the third and sixth longitudinal crease lines and thereafter allowing the fifth and seventh side regions to return to a position in which they are substantially co-planar respectively with the first and second outer longitudinal sidewalls. The fifth and seventh side regions return (in other words 'spring back') to the aforementioned position (in which they extend upwards in a substantially vertical direction) due to the inherent stiffness and resilience of the blank material. The step of temporarily folding the fifth and seventh side regions inwardly along the third and sixth longitudinal crease lines is typically carried out with the blank positioned in the void.

[0019] The plunging station may include movable folding surfaces which can be actuated (e.g., by pneumatic cylinders) to temporarily fold the first-stage partially folded box along the third and sixth longitudinal crease lines, i.e., to fold the fifth and seventh side regions inwardly. The folding surfaces may be actuated to move between an operative position in which the folding surfaces contact the fifth and seventh side regions to fold them inwardly and an inoperative position in which the folding surfaces are spaced from the fifth and seventh side regions. The fifth and seventh side regions return (in other words 'spring back') to their original substantially vertical position, co-planar with the first and second outer longitudinal sidewalls, when the folding surfaces are actuated to return to the inoperative position. The folding surfaces are actuated to move to the operative position when the overhead assembly is in its lowermost position to position the blank within the void. Parts of the overhead assembly thus act as fixed folding surfaces (or guides) which facilitate folding of the fifth and seventh side regions along the third and sixth longitudinal crease lines by the movable folding surfaces.

[0020] Once the pre-folding step is complete, the first-stage partially folded box is moved to the primary folding and securing station by the indexing assembly, prefera-

bly by the indexing flights.

[0021] The primary folding and securing station can include folding surfaces that are actuated to fold the first-stage partially folded box along the third and sixth longitudinal crease lines, i.e., to fold the fifth, seventh, ninth, tenth, eleventh and twelfth side regions inwardly. The primary folding and securing station can further include a folding head that is positioned above the first-stage partially folded box and is actuated to move downwardly into the interior of the box with the above-mentioned side regions folded over (i.e., extending substantially horizontally). The folding head can include folding surfaces that are actuated (e.g., by pneumatic cylinders), when the folding head is positioned accurately within the interior of the box, to fold the box along the ninth, tenth, eleventh and twelfth longitudinal crease lines to form the first and second inner longitudinal sidewalls.

[0022] The primary folding and securing station can further include an ultrasonic welding assembly with one or more welding heads to ultrasonically weld together the adjacent outer and inner longitudinal sidewalls. With the folding head still positioned within the interior of the box to provide support, the one or more welding heads can be actuated to a welding position and switched on for a preselected period of time to perform the ultrasonic weld and secure together the first outer and inner longitudinal sidewalls and the second outer and inner longitudinal sidewalls. After being switched off, the one or more welding heads can be held in the welding position for a preselected period of time to allow the weld to set. The one or more welding heads can be actuated to return to a non-welding position and the folding head is actuated to move upwardly out of the box with its folding surfaces retracted.

[0023] The second-stage partially folded box is then moved to the secondary folding and securing station by the indexing assembly, preferably by the indexing flights.

[0024] The secondary folding and securing station can include folding surfaces that fold the second-stage partially folded box along the fifth and eighth transverse crease lines to form the first and second transverse flanges of the fully erected box. A first folding surface can be a fixed folding surface (or guide) that folds the box along the fifth transverse crease line as it is moved laterally by the indexing assembly and the fixed folding surface comes into contact with the moving vertically-extending sixth side region. A second folding surface can be actuated to fold the box along the eighth transverse crease line. The second folding surface can be actuated when the indexing assembly comes to rest and the box is positioned accurately at the secondary folding and securing station.

[0025] The secondary folding and securing station can further include an ultrasonic welding assembly with one or more welding heads to ultrasonically weld together the longitudinal and transverse flanges. The welding heads can be actuated to a welding position and switched on for a preselected period of time to perform the ultrasonic weld and secure together the longitudinal and transverse flanges where they overlap. After being switched off, the one or more welding heads can be held in the welding position for a preselected period of time to allow the weld to set. The one or more welding heads can be actuated to return to a non-welding position. The ultrasonic welding can be performed with the second folding surface in the actuated position.

[0026] The method can optionally include a sixth step of piercing the fully erected box to create one or more openings through which liquid can drain from the box. The sixth step may comprise piercing the first transverse sidewall of the erected box formed by the second substantially rectangular side region and/or may comprise piercing the second transverse sidewall of the erected box formed by the fourth substantially rectangular side region. The first transverse sidewall may be pierced at its base at one or more positions adjacent to the first transverse crease line. The second transverse sidewall may be pierced at its base at one or more positions adjacent to the second transverse crease line.

[0027] The fully erected box can be moved out of the box erecting machine, e.g., to an outlet conveyor, by the indexing assembly, preferably by the indexing flights.

[0028] The box erecting machine can include safety guards and be operated under the control of a control unit with a suitable human machine interface (HMI).

[0029] The box erecting machine can form part of a processing plant where the fully erected box is filled (e.g., with food products) and closed with a lid.

Brief Description of the Drawings

[0030]

Figure 1 is a plan view of a pre-creased planar blank which can be erected into a box;

Figure 2 is an isometric view of a first-stage partially folded box;

Figure 3 is an isometric view of a second-stage partially folded box;

Figure 4 is an isometric view of a fully erected box;

Figure 5 is an isometric cross-sectional view through the fully erected box of Figure 4;

Figure 6 is a schematic illustration of a box erecting machine for erecting the pre-creased planar blank of Figure 1 into the box of Figure 4;

Figure 7 is a detail view of a loading station and picking station showing an overhead assembly picking up a pre-creased planar blank as shown in Figure 1;

Figure 8 is a first detail view of a plunging station;

Figure 9 is a second detail view of the plunging station with the pre-creased planar blank held on the overhead assembly prior to plunging;

Figure 10 is a detail view of the plunging station of Figures 8 and 9 with the pre-creased blank plunged into a void to form a first-stage partially folded box;

Figure 11 is a detail view of the plunging station illustrating a pre-folding step;

Figure 12 is a detail view of a primary folding and securing station;

Figure 13 is a detail view of the primary folding and securing station illustrating initial folding of the first-stage partially folded box;

Figure 14 is a detail view of the primary folding and securing station illustrating further folding of the first-stage partially folded box to form a second-stage partially folded box;

Figure 15 is a detail view of an ultrasonic welding assembly at the primary folding and securing station;

Figure 16 is a detail view of a secondary folding and securing station;

Figure 17 is a detail view of the secondary folding and securing station showing a first fixed folding surface;

Figure 18 is a detail view of the secondary folding and securing station showing a second actuated folding surface; and

Figure 19 is a detail view of an outlet conveyer.

Detailed Description of Embodiments

[0031] Embodiments of the present disclosure will now be described by way of example only and with reference to the accompanying drawings.

[0032] Referring initially to Figure 1, there is shown a pre-creased planar blank 20 which is capable of being folded to form a fully erected box 22 (see Figure 4). The blank 20 is typically made of corrugated plastic sheet and is cut and pre-creased along crease lines using any suitable process.

[0033] The blank 20 includes a substantially rectangular central region 24 that forms a planar base B of the erected box 22 and is bounded by first and second longitudinal crease lines 1L, 2L that form first and second longitudinal bottom edges 1LBE, 2LBE of the erected box 22, and first and second transverse crease lines 1T, 2T that form first and second transverse bottom edges 1TBE, 2TBE of the erected box 22.

[0034] The blank 20 includes a first substantially rectangular side region 1 adjacent the central region 24 that forms a first outer longitudinal sidewall 1SW' of the erected box 22. The first side region 1 is bounded by the first longitudinal crease line 1L, a third longitudinal crease line 3L that forms a first longitudinal top edge 1LTE of the erected box 22, a third transverse crease line 3T that is an extension of the first transverse crease line and forms part of a first vertical edge 1VE of the erected box 22, and a fourth transverse crease line 4T that is an extension of the second transverse crease line 2T and forms part of a second vertical edge 2VE of the erected box 22.

[0035] The blank 20 includes a second substantially rectangular side region 2 adjacent the central region 24 that forms a first transverse sidewall 1TSW of the erected box 22. The second side region 2 is bounded by the first transverse crease line 1T, a fifth transverse crease line 5T that forms a first transverse top edge 1TTE of the erected box 22, a fourth longitudinal crease line 4L that is an extension of the first longitudinal crease line 1L and forms part of the first vertical edge 1VE of the erected box 22, and a fifth longitudinal crease line 5L that is an extension of the second longitudinal crease line 2L and forms part of a third vertical edge 3VE of the erected box 22.

[0036] The blank 20 includes a third substantially rectangular side region 3 adjacent the central region 24 that forms a second outer longitudinal sidewall 2SW' of the erected box 22. The third side region 3 is bounded by the second longitudinal crease line 2L, a sixth longitudinal crease line 6L that forms a second longitudinal top edge 2LTE of the erected box 22, a sixth transverse crease line 6T that is an extension of the first transverse crease line 1T and forms part of the third vertical edge 3VE of the erected box 22, and a seventh transverse crease line 7T that is an extension of the second transverse crease line 2T and forms part of a fourth vertical edge 4VE of the erected box 22.

[0037] The blank 20 includes a fourth substantially rectangular side region 4 adjacent the central region 24 that forms a second transverse sidewall 2TSW of the erected box 22.

[0038] The fourth side region 4 is bounded by the second transverse crease line 2T, an eighth transverse crease line 8T that forms a second transverse top edge 2TTE of the erected box 22, a seventh longitudinal crease line 7L that is an extension of the first longitudinal crease line 1L and forms part of the second vertical edge 2VE of the erected box 22, and an eighth longitudinal crease line 8L that is an extension of the second longitudinal crease line 2L and forms part of the fourth vertical edge 4VE of the erected box 22.

[0039] The blank 20 includes first, second, third and fourth substantially square corner regions 1CR, 2CR, 3CR, 4CR.

[0040] The first corner region 1CR is adjacent the first and second side regions 1,2. The first corner region 1CR is bounded by the third transverse crease line 3T, the fourth longitudinal crease line 4L, and blank edges that define a first blank apex 1A, and includes a crease line 1CL that extends from the first blank apex 1A to the junction of the third transverse crease line 3T and the fourth longitudinal crease line 4L.

[0041] The second corner region 2CR is adjacent the second and third side regions 2, 3. The second corner region 2CR is bounded by the sixth transverse crease line 6T, the fifth longitudinal crease line 5L, and blank edges that define a second blank apex 2A, and includes a crease line 2CL that extends from the second blank apex 2A to the junction of the sixth transverse crease line 6T and the fifth longitudinal crease line 5L.

[0042] The third corner region 3CR is adjacent the third and fourth side regions 3, 4. The third corner region 3CR is bounded by the seventh transverse crease line 7T, the eighth longitudinal crease line 8L, and edges that define a third blank apex 3A, and includes a crease line 3CL

that extends from the third blank apex 3A to the junction of the seventh transverse crease line 7T and the eighth longitudinal crease line 8L.

[0043] The fourth corner region 4CR is adjacent the fourth and first side regions 4, 1. The fourth corner region 4CR is bounded by the fourth transverse crease line 4T, the seventh longitudinal crease line 7L, and blank edges that define a fourth blank apex 4A, and includes a crease line 4CL that extends from the fourth blank apex 4A to the junction of the fourth transverse crease line 4T and the seventh longitudinal crease line 7L.

[0044] The blank 20 includes fifth, sixth, seventh and eighth substantially rectangular side regions 5, 6, 7, 8. The fifth side region 5 is adjacent the first side region 1 and forms a first longitudinal flange 1LF of the erected box 22. The fifth side region 5 is bounded by the third longitudinal crease line 3L, a ninth longitudinal crease line 9L, and blank edges. The sixth side region 6 is adjacent the second side region 2 and forms a first transverse flange 1TF of the erected box 22. The sixth side region 6 is bounded by the fifth transverse crease line 5T, and blank edges. The seventh side region 7 is adjacent the third side region 3 and forms a second longitudinal flange 2LF of the erected box 22. The seventh side region 7 is bounded by the sixth longitudinal crease line 6L, a tenth longitudinal crease line 10L, and blank edges. The eighth side region 8 is adjacent the fourth side region 4 and forms a second transverse flange 2TF of the erected box 22. The eighth side region 8 is bounded by the eighth transverse crease line 8T, and blank edges.

[0045] The blank 20 includes a ninth substantially rectangular side region 9 adjacent the fifth side region 5 that forms a first part of a first inner longitudinal sidewall 1 SW of the erected box 22. The ninth side region 9 is bounded by the ninth longitudinal crease line 9L, an eleventh longitudinal crease line 11L, and blank edges. The blank 20 includes a tenth substantially rectangular side region 10 adjacent the ninth side region 9 that forms a second part of the first inner longitudinal sidewall 1 SW of the erected box 22. The tenth side region 10 is bounded by the eleventh longitudinal crease line 11L, and blank edges.

[0046] The blank 20 includes an eleventh substantially rectangular side region 11 adjacent the seventh side region 7 that forms a first part of a second inner longitudinal sidewall 2SW of the erected box 22. The eleventh side region 11 is bounded by the tenth longitudinal crease line 10L, a twelfth longitudinal crease line 12L, and blank edges. The blank 20 includes a twelfth substantially rectangular side region 12 adjacent the eleventh side region 11 that forms a second part of the second inner longitudinal sidewall 2SW of the erected box 22. The twelfth side region 12 is bounded by the twelfth longitudinal crease line 12L, and blank edges.

[0047] The method of erecting the pre-creased planar blank 20 illustrated in Figure 1 will now be described with particular reference to Figures 2 to 5.

[0048] In a first step, the blank 20 is folded along (i) the first, second, fourth, fifth, seventh and eighth longitudinal crease lines 1L, 2L, 4L, 5L, 7L, 8L, (ii) the first, second, third, fourth, sixth and seventh transverse crease lines 1T, 2T, 3T, 4T, 6T, 7T, and (iii) the crease lines 1CL, 2CL, 3CL, 4CL that extend from the first, second, third and fourth blank apexes 1A, 2A, 3A, 4A. The folding carried out in this first step forms a first-stage partially folded box 26 which is best seen in Figure 2.

[0049] The first-stage partially folded box 26 includes a planar base B formed by the central region 24 of the blank; first and second longitudinal bottom edges 1LBE, 2LBE formed by the first and second longitudinal crease lines 1L, 2L; first and second transverse bottom edges 1TBE, 2TBE formed by the first and second transverse crease lines 1T, 2T; a first outer longitudinal sidewall 1SW' formed by the first side region 1 and orientated substantially perpendicular to the base B; a first transverse sidewall 1TSW formed by the second side region 2 and orientated substantially perpendicular to the base B; a second outer longitudinal sidewall 2SW' formed by the third side region 3 and orientated substantially perpendicular to the base B; a second transverse sidewall 2TSW formed by the fourth side region 4 and orientated substantially perpendicular to the base; a first vertical edge 1VE formed by the third transverse crease line 3T and the fourth longitudinal crease line 4L; a second vertical edge 2VE formed by the fourth transverse crease line 4T and the seventh longitudinal crease line 7L; a third vertical edge 3VE formed by the sixth transverse crease line 6T and the fifth longitudinal crease line 5L; a fourth vertical edge 4VE formed by the seventh transverse crease line 7T and the eighth longitudinal crease line 8L; a first integral corner formed by the folded first corner region 1CR; a second integral corner formed by the folded second corner region 2CR; a third integral corner formed by the folded third comer region 3CR; and a fourth integral corner formed by the folded fourth corner region 4CR.

[0050] In a second step, the first-stage partially folded box 26 is folded along the third, sixth, ninth, tenth, eleventh and twelfth longitudinal crease lines 3L, 6L, 9L, 10L, 11L, 12L to form a second-stage partially folded box 28 which is best seen in Figure 3.

[0051] The second-stage partially folded box 28 includes a first longitudinal top edge 1LTE formed by the third longitudinal crease line 3L; a first transverse top edge 1TTE formed by the fifth transverse crease line 5T; a second longitudinal top edge 2LTE formed by the sixth longitudinal crease line 6L; a second transverse top edge 2TTE formed by the eighth transverse crease line 8T; a first longitudinal flange 1 LF formed by the fifth side region 5 and orientated substantially parallel to the base B; a second longitudinal flange 2LF formed by the seventh side region 7 and orientated substantially parallel to the base B; a first inner longitudinal sidewall 1SW (see Figure 5) formed by the ninth and tenth side regions 9, 10, the first inner longitudinal sidewall 1SW having a first part formed by the ninth side region 9 and a second part

formed by the tenth side region 10, the second part being orientated substantially perpendicular to the base B and adjacent a lower part of the first outer longitudinal sidewall 1SW' and the first part extending at an angle between the second part and the first longitudinal flange 1LF; and a second inner longitudinal sidewall 2SW formed by the eleventh and twelfth side regions 11, 12, the second inner longitudinal sidewall 2SW having a first part formed by the eleventh side region 11 and a second part formed by the twelfth side region 12, the second part being orientated substantially perpendicular to the base B and adjacent a lower part of the second outer longitudinal sidewall 2SW' and the first part extending at an angle between the second part and the second longitudinal flange 2LF.

[0052] The method desirably includes a pre-folding step which is carried out between the first and second steps described above. In this pre-folding step, the first-stage partially folded box 26 shown in Figure 2 is temporarily folded along the third and sixth longitudinal crease lines 3L, 6L. This temporary folding tends to weaken the third and sixth longitudinal crease lines 3L, 6L and facilitates subsequent folding along those crease lines during the second step to form the second-stage partially folded box 28.

[0053] As best seen in Figure 5, the first part of the first inner longitudinal sidewall 1SW, the first longitudinal flange 1LF, and an upper part of the first outer longitudinal sidewall 1SW' together define a first longitudinally-extending structure of substantially triangular cross-section in the fully erected box 22. Similarly, the first part of the second inner longitudinal sidewall 2SW, the second longitudinal flange 2LF, and an upper part of the second outer longitudinal sidewall 2SW' together define a second longitudinally-extending structure of substantially triangular cross-section in the fully erected box 22. This construction is advantageous as it considerably improves the strength and rigidity of the box 22.

[0054] The integral corners make the box 22 watertight. When the corner regions 1 CR, 2CR, 3CR, 4CR are folded along the crease lines 1CL, 2CL, 3CL, 4CL that extend from the respective blank apex 1A, 2A, 3A, 4A, they form triangular-shaped 'wings' 30 (best seen in Figure 5) that are located between the adjacent outer and inner longitudinal sidewalls. It will, thus, be understood that the first and fourth integral corners are neatly tucked away between the first outer and inner longitudinal sidewalls 1SW', 1SW, and the second and third integral corners are neatly tucked away between the second outer and inner longitudinal sidewalls 2SW', 2SW so that they do not extend into the interior of the box 22.

[0055] In a third step, the first outer longitudinal sidewall 1SW' is secured to the first inner longitudinal sidewall 1SW and the second outer longitudinal sidewall 2SW' is secured to the second inner longitudinal sidewall 2SW. The respective outer and inner longitudinal sidewalls 1SW' and 1SW, 2SW' and 2SW are secured to each other by ultrasonic welding at a plurality of spaced locations along the longitudinal sides of the fully erected box 22.

[0056] In embodiments of the method, the third step includes securing the first and fourth integral corners to the first inner and outer longitudinal sidewalls 1SW, 1SW' and the second and third integral corners to the second inner and outer longitudinal sidewalls 2SW, 2SW'. The respective inner and outer longitudinal sidewalls are secured by ultrasonic welding at the corners of the fully erected box 22.

[0057] In a fourth step, the second-stage partially folded box 28 shown in Figure 3 is folded along the fifth and eighth transverse crease lines 5T, 8T to form the fully erected box 22 shown in Figure 4. The fully erected box 22 includes a first transverse flange 1TF formed by the sixth side region 6 and orientated substantially parallel to the base B and a second transverse flange 2TF formed by the eighth side region 8 and orientated substantially parallel to the base B.

[0058] In a fifth step, the first transverse flange 1TF is secured to the first and second longitudinal flanges 1 LF, 2LF by ultrasonic welding, and the second transverse flange 2TF is similarly secured to the first and second longitudinal flanges 1LF, 2LF. It will be apparent from Figure 4 that the longitudinal and transverse flanges 1LF, 2LF, 1TF, 2TF define the periphery of a box opening in the fully erected box 22.

[0059] Embodiments of the method include a sixth step in which the fully erected box 22 is pierced to create one or more openings through which liquid can drain from the box 22. Typically, the first transverse sidewall 1TSW and the second transverse sidewall 2TSW of the erected box 22 are pierced to form the openings. Generally, the first transverse sidewall 1TSW is pierced at its base at one or more positions adjacent to the first transverse crease line 1T. Similarly, the second transverse sidewall 2TSW is pierced at its base at one or more positions adjacent to the second transverse crease line 2T.

[0060] The method described above is desirably carried out by a box erecting machine which is capable of providing fully automated box erection. One embodiment of a box erecting machine 50 will now be described with reference to Figures 6 to 19.

[0061] As best seen in Figure 6, the box erecting machine 50 includes multiple stations, namely: a loading station 100 at which a stack 102 of pre-creased planar blanks is manually loaded by an operator; a picking station 200; a plunging station 300 for carrying out the first folding step and the pre-folding step; a primary folding and securing station 400 for carrying out the second and third steps; and a secondary folding and securing station 500 for carrying out the fourth and fifth steps.

[0062] Referring to Figures 6 and 7, the loading station 100 accommodates a stack 102 of pre-creased planar blanks 20 which are manually stacked and loaded by a machine operator. The loading station 100 includes a transport mechanism, such as a pusher, which moves the stack 102 from the loading station 100 to a predetermined position at the picking station 200 where each

blank 20 can be picked up in turn by an overhead assembly 202. The overhead assembly 202 includes a vacuum head 204 which applies suction to an upper surface of the top blank 20 in the stack 102 at the picking station 200. The overhead assembly 202 can be actuated to move upwardly by linear rod pneumatic cylinders once suction has been applied by the vacuum head 204 to enable the top blank 20 to be picked from the stack 102. In order to facilitate removal of only the top blank 20 from the stack 102 by the overhead assembly 202, the box erecting machine 50 includes a device (not illustrated) for introducing a jet of pressurised air underneath the top blank 20 as it is picked up by the overhead assembly 202 to separate it from the underlying blank 20.

[0063] The box erecting machine 50 includes an overhead track 208 along which the overhead assembly 202 can be actuated to move laterally, between the picking station 200 and the plunging station 300. The lateral (i.e. forward and reverse) movement of the overhead assembly 202 along the overhead track 208 is controlled by a servo motor and timing belt assembly to ensure accurate positioning.

[0064] After the top blank 20 has been picked from the stack 102 by the overhead assembly 202 and moved upwardly by the linear rod pneumatic cylinders to a position in which the blank 20 is separated from the stack 102, the servo motor and timing belt assembly is actuated to move the overhead assembly 202, and hence the blank 20, from the picking station 200 to the plunging station 300 which is best seen in Figures 8 to 11.

[0065] Referring initially to Figure 8, the plunging station 300 includes a void 302 which is defined by vertically-extending longitudinal and transverse fixed folding surfaces 304, 306 that are sized and shaped to fold the blank 20 along the first and second longitudinal crease lines 1L, 2L and the first and second transverse crease lines 1T, 2T to form the first-stage partially folded box 26. The blank 20 is positioned above the void 302 by the overhead assembly 202 as shown in Figure 9. The blank 20 is then moved downwardly (i.e., 'plunged') into the void 302 by the overhead assembly 202 which causes the blank 20 to be folded along the first and second longitudinal crease lines 1L, 2L due to contact with the longitudinal folding surfaces 304 and along the first and second transverse crease lines 1T, 2T due to contact with the transverse folding surfaces 306.

[0066] Additional fixed folding surfaces (or guides) 308 are provided at the corners of the plunging station 300 and are shaped to fold the blank 20 along the crease lines 1CL, 2CL, 3CL, 4CL that extend from the blank apexes 1A, 2A, 3A, 4A to form the integral corners as the blank 20 is moved downwardly into the void 302 by the overhead assembly 202. The additional fixed folding surfaces (or guides) 308 are arranged to fold the blank 20 along the crease lines 1CL, 2CL, 3CL, 4CL before the blank 20 is folded along the first and second transverse crease lines 1T, 2T during the plunging operation.

[0067] The box erecting machine 50 includes an indexing assembly 310 that is actuated laterally along an indexing track to move the box progressively from one station to the next in a forward direction. The indexing assembly 310 includes a twin drive chain endless conveyor and the forward movement of the indexing assembly 310 is driven by a servo motor and chain sprocket assembly. The indexing assembly 310 includes a pair of indexing flights 312 which hold the box and constrain it laterally. The indexing flights 312 are themselves moved laterally by the twin drive chain endless conveyor to move the box from one station to the next in the forward direction. A first indexing flight 312a is provided to engage the first transverse sidewall 1TSW of the box and a second opposing indexing flight 312b is provided to engage the second transverse sidewall 2TSW of the box. As will be readily understood from Figures 8 and 9, the transverse folding surfaces 306 are defined by the first and second indexing flights 312a, 312b. In order to ensure efficient operation of the box erecting machine 50, multiple pairs of indexing flights 312 are provided on the endless conveyor so that boxes can be positioned simultaneously at different stations.

[0068] Once the blank 20 has been plunged into the void 302 by the overhead assembly as shown in Figure 10 to form the first-stage partially folded box 26, movable folding surfaces 314 provided on retractable folding members 316 are actuated by pneumatic cylinders 318 to temporarily fold the fifth and seventh side regions 5, 7 inwardly (best seen in Figure 11) and thereby fold the first-stage partially folded box along the third and sixth longitudinal crease lines 3L, 6L. The folding members 316 can be moved by the pneumatic cylinders 318 between an inoperative position, shown in Figure 10, in which the folding surfaces 314 are spaced from the fifth and seventh side regions 5, 7 and an operative position, shown in Figure 11, in which the folding surfaces 314 contact the fifth and seventh side regions 5, 7 and fold them inwardly. The folding members 316 are moved from the inoperative position to the operative position when the overhead assembly 202 is in its lowermost position in the void 302. In this lowermost position, parts of the vacuum head 204 act as fixed folding surfaces (or guides) with which the folding surfaces 314 cooperate to facilitate folding of the fifth and seventh side regions 5, 7 along the third and sixth longitudinal crease lines 3L, 6L.

[0069] One the pre-folding step has been completed and the folding members 316 have returned to the inoperative position, the suction applied by the vacuum head 204 is released and the overhead assembly 202 is actuated to move upwardly and then laterally back to the picking station 200 so that the next blank 20 can be picked from the top of the stack 102. In order to prevent the first-stage partially folded box 26 from being moved upwardly out of the void 302 by the vacuum head 204, suction is temporarily applied to the first and third side regions 1, 3 by vacuum heads 320 to securely retain the box 26 in the void 302.

[0070] Once the overhead assembly 202 has been ac-

tuated to move upwardly and the suction applied to the first and third side regions 1, 3 by the vacuum heads 320 has been released, the indexing assembly 310 is actuated so that the indexing flights 312 move the first-stage partially folded box 26 from the plunging station 300 to the primary folding and securing station 400 which is best seen in Figures 12 to 15.

[0071] The primary folding and securing station 400 includes pneumatic cylinders 402 which have folding surfaces 404. When the pneumatic cylinders 402 are actuated to an extended position, the folding surfaces 404 engage the fifth and seventh side regions so that the first-stage partially folded box 26 is folded along the third and sixth longitudinal crease lines 3L, 6L. As a result, the fifth, seventh, ninth, tenth, eleventh and twelfth side regions are folded inwardly as best seen in Figure 13.

[0072] The primary folding and securing station 400 also includes a folding head 406 that is positioned above the first-stage partially folded box 26 and is actuated to move downwardly by a pneumatic cylinder 408 into the interior of the box with the above-mentioned side regions folded over (i.e., extending substantially horizontally). The folding head 406 (best seen in Figure 14) includes folding surfaces 410 that are actuated again by pneumatic cylinders 412, when the folding head 406 is positioned accurately within the interior of the box, to fold the box along the ninth, tenth, eleventh and twelfth longitudinal crease lines 9L, 10L, 11L, 12L to form the first and second inner longitudinal sidewalls 1SW, 2SW.

[0073] The primary folding and securing station 400 includes an ultrasonic welding assembly 414 to weld together the adjacent outer and inner longitudinal sidewalls 1SW' and 1SW, 2SW' and 2SW. As shown in Figure 15, the ultrasonic welding assembly 414 includes three ultrasonic welding heads 416 along each side of the box to ultrasonically weld together the adjacent outer and inner longitudinal sidewalls 1SW' and 1SW, 2SW' and 2SW. With the folding head 406 still positioned within the interior of the box to provide support, the welding heads 416 are actuated to move to a welding position in which they contact the first and second outer longitudinal sidewalls 1SW', 2SW' and are switched on for a preselected period of time to perform the ultrasonic weld and secure together the first outer and inner longitudinal sidewalls 1SW', 1SW and the second outer and inner longitudinal sidewalls 2SW', 2SW. After being switched off, the welding heads 416 are held in the welding position for a preselected period of time to allow the weld to set before the welding heads 416 are then actuated to return to a non-welding position and the folding head 406 is actuated to move upwardly out of the box with its folding surfaces retracted.

[0074] The indexing assembly 310 is actuated once again so that the indexing flights 312 move the second-stage partially folded box 28 formed at the primary folding and securing station 400 to the secondary folding and securing station 500 which is best seen in Figures 16 to 18.

[0075] The secondary folding and securing station 500 includes first and second folding surfaces 502, 504 which fold the second-stage partially folded box 28 along the fifth and eighth transverse crease lines 5T, 8T to form the first and second transverse flanges 1TF, 2TF of the fully erected box 22. The first folding surface 502 is a fixed folding surface (or guide) that contacts the moving vertically-extending sixth side region 6 as the first-stage partially folded box 26 is moved laterally from the primary folding and securing station 400 into the secondary folding and securing station 500 by the indexing assembly 310. The contact between the fixed first folding surface 502 and the sixth side region 6 folds the box along the fifth transverse crease line 5T to form the first transverse flange 1TF. The second folding surface 504 is pivotally actuated by a pneumatic cylinder 506 to rotate about pivot axis 508 and thereby contact the eighth side region 8 to fold the box along the eighth transverse crease line 8T to form the second transverse flange 2TF. The pneumatic cylinder 506, and hence the second folding surface 504, is actuated only when the indexing assembly 310 comes to rest and the box is positioned accurately at the secondary folding and securing station 500.

[0076] The secondary folding and securing station 500 includes an ultrasonic welding assembly with four welding heads 512 which are actuated to ultrasonically weld together the longitudinal and transverse flanges 1LF, 2LF, 1TF, 2TF. The welding heads 512 are actuated to a welding position and switched on for a preselected period of time to perform the ultrasonic weld and secure together the longitudinal and transverse flanges 1LF, 2LF, 1TF, 2TF where they overlap. After being switched off, the welding heads 512 are held in the welding position for a preselected period of time to allow the weld to set before they are then actuated to return to a non-welding position. The ultrasonic welding is typically performed with the second folding surface 504 in the actuated position.

[0077] The indexing assembly 310 is actuated so that the indexing flights 312 move the fully erected box 22 from the secondary folding and securing station 500 to an outlet conveyor 600 which is best seen in Figure 19.

[0078] As will be understood by the person skilled in the art, the box erecting machine 50 includes safety guards and is operated under the control of a control unit with a suitable human machine interface (HMI). In some implementations, the box erecting machine 50 forms part of a processing plant where the fully erected box 22 is filled (e.g., with food products) and closed with a lid.

[0079] Although exemplary embodiments have been described in the preceding paragraphs, it should be understood that various modifications may be made to those embodiments without departing from the scope of the appended claims. Thus, the breadth and scope of the claims should not be limited to the above-described exemplary embodiments. Each feature disclosed in the specification, including the claims and drawings, may be replaced by alternative features serving the same, equiv-

alent or similar purposes, unless expressly stated otherwise.

[0080] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

Claims

1. A method for erecting a pre-creased planar blank (20) into a box (22), the blank including:

- a substantially rectangular central region (24) that forms a planar base (B) of the erected box (22) and is bounded by first and second longitudinal crease lines (1L, 2L) that form first and second longitudinal bottom edges (1LBE, 2LBE) of the erected box (22), and first and second transverse crease lines (1T, 2T) that form first and second transverse bottom edges (1TBE, 2TBE) of the erected box (22)
- a first substantially rectangular side region (1) adjacent the central region (24) that forms a first outer longitudinal sidewall (1SW') of the erected box (22), the first side region (1) being bounded by the first longitudinal crease line (1L), a third longitudinal crease line (3L) that forms a first longitudinal top edge (1LTE) of the erected box (22), a third transverse crease line (3T) that is an extension of the first transverse crease line (1T) and forms part of a first vertical edge (1VE) of the erected box (22), and a fourth transverse crease line (4T) that is an extension of the second transverse crease line (2T) and forms part of a second vertical edge (2VE) of the erected box (22)
- a second substantially rectangular side region (2) adjacent the central region (24) that forms a first transverse sidewall (1TSW) of the erected box (22), the second side region (2) being bounded by the first transverse crease line (1T), a fifth transverse crease line (5T) that forms a first transverse top edge (1TTE) of the erected box (22), a fourth longitudinal crease line (4L) that is an extension of the first longitudinal crease line (1L) and forms part of the first vertical edge (1VE) of the erected box (22), and a fifth longitudinal crease line (5L) that is an extension of the second longitudinal crease line (2L) and forms part of a third vertical edge (3VE) of the erected box (22)
- a third substantially rectangular side region (3) adjacent the central region (24) that forms a second outer longitudinal sidewall (2SW') of the erected box (22), the third side region (3) being bounded by the second longitudinal crease line (2L), a sixth longitudinal crease line (6L) that forms a second longitudinal top edge (2LTE) of the erected box (22), a sixth transverse crease line (6T) that is an extension of the first transverse crease line (1T) and forms part of the third vertical edge (3VE) of the erected box (22), and a seventh transverse crease line (7T) that is an extension of the second transverse crease line (2T) and forms part of a fourth vertical edge (4VE) of the erected box (22)
- a fourth substantially rectangular side region (4) adjacent the central region (24) that forms a second transverse sidewall (2TSW) of the erected box (22), the fourth side region (4) being bounded by the second transverse crease line (2T), an eighth transverse crease line (8T) that forms a second transverse top edge (2TTE) of the erected box (22), a seventh longitudinal crease line (7L) that is an extension of the first longitudinal crease line (1L) and forms part of the second vertical edge (2VE) of the erected box (22), and an eighth longitudinal crease line (8L) that is an extension of the second longitudinal crease line (2L) and forms part of the fourth vertical edge (4VE) of the erected box (22)
- a first substantially square corner region (1CR) adjacent the first and second side regions (1, 2), the first corner region (1CR) being bounded by the third transverse crease line (3T), the fourth longitudinal crease line (4L), and blank edges that define a first blank apex (1A), and including a crease line (1CL) that extends from the first blank apex (1A) to the junction of the third transverse crease line (3T) and the fourth longitudinal crease line (4L)
- a second substantially square corner region (2CR) adjacent the second and third side regions (2, 3), the second corner region (2CR) being bounded by the sixth transverse crease line (6T), the fifth longitudinal crease line (5L), and blank edges that define a second blank apex (2A), and including a crease line (2CL) that extends from the second blank apex (2A) to the junction of the sixth transverse crease line (6T) and the fifth longitudinal crease line (5L)
- a third substantially square corner region (3CR) adjacent the third and fourth side regions (3, 4), the third corner region (3CR) being bounded by the seventh transverse crease line (7T), the eighth longitudinal crease line (8L), and blank edges that define a third blank apex (3A), and including a crease line (3CL) that extends from the third blank apex (3A) to the junction of the seventh transverse crease line (7T) and the eighth longitudinal crease line (8L)
- a fourth substantially square corner region (4CR) adjacent the fourth and first side regions

(4, 1), the fourth corner region (4CR) being bounded by the fourth transverse crease line (4T), the seventh longitudinal crease line (7L), and blank edges that define a fourth blank apex (4A), and including a crease line (4CL) that extends from the fourth blank apex (4A) to the junction of the fourth transverse crease line (4T) and the seventh longitudinal crease line (7L)

• a fifth substantially rectangular side region (5) adjacent the first side region (1) that forms a first longitudinal flange (1LF) of the erected box (22), the fifth side region (5) being bounded by the third longitudinal crease line (3L), a ninth longitudinal crease line (9L), and blank edges

• a sixth substantially rectangular side region (6) adjacent the second side region (2) that forms a first transverse flange (1TF) of the erected box (22), the sixth side region (6) being bounded by the fifth transverse crease line (5T), and blank edges

• a seventh substantially rectangular side region (7) adjacent the third side region (3) that forms a second longitudinal flange (2LF) of the erected box (22), the seventh side region (7) being bounded by the sixth longitudinal crease line (6L), a tenth longitudinal crease line (10L), and blank edges

• an eighth substantially rectangular side region (8) adjacent the fourth side region (4) that forms a second transverse flange (2TF) of the erected box (22), the eighth side region (8) being bounded by the eighth transverse crease line (8T), and blank edges

• a ninth substantially rectangular side region (9) adjacent the fifth side region (5) that forms a first part of a first inner longitudinal sidewall (1SW) of the erected box (22), the ninth side region (9) being bounded by the ninth longitudinal crease line (9L), an eleventh longitudinal crease line (11L), and blank edges

• a tenth substantially rectangular side region (10) adjacent the ninth side region (9) that forms a second part of the first inner longitudinal sidewall (1SW) of the erected box (22), the tenth side region (10) being bounded by the eleventh longitudinal crease line (11L), and blank edges

• an eleventh substantially rectangular side region (11) adjacent the seventh side region (7) that forms a first part of a second inner longitudinal sidewall (2SW) of the erected box (22), the eleventh side region (11) being bounded by the tenth longitudinal crease line (10L), a twelfth longitudinal crease line (12L), and blank edges

• a twelfth substantially rectangular side region (12) adjacent the eleventh side region (11) that forms a second part of the second inner longitudinal sidewall (2SW) of the erected box (22), the twelfth side region (12) being bounded by the twelfth longitudinal crease line (12L), and blank edges;

wherein the method of erecting the pre-creased planar blank (20) comprises:

a first step of folding a positioned blank along (i) the first, second, fourth, fifth, seventh and eighth longitudinal crease lines (1L, 2L, 4L, 5L, 7L, 8L), (ii) the first, second, third, fourth, sixth and seventh transverse crease lines (1T, 2T, 3T, 4T, 6T, 7T), and (iii) the crease lines (1CL, 2CL, 3CL, 4CL) that extend from the first, second, third and fourth blank apexes (1A, 2A, 3A, 4A), to form a first-stage partially folded box (26) including:

a planar base (B) formed by the central region (24) of the blank (20);
first and second longitudinal bottom edges (1LBE, 2LBE) formed by the first and second longitudinal crease lines (1L, 2L);
first and second transverse bottom edges (1TBE, 2TBE) formed by the first and second transverse crease lines (1T, 2T);
a first outer longitudinal sidewall (1SW') formed by the first side region (1) and orientated substantially perpendicular to the base (B);
a first transverse sidewall (1TSW) formed by the second side region (2) and orientated substantially perpendicular to the base (B);
a second outer longitudinal sidewall (2SW') formed by the third side region (3) and orientated substantially perpendicular to the base (B);
a second transverse sidewall (2TSW) formed by the fourth side region (4) and orientated substantially perpendicular to the base (B);
a first vertical edge (1VE) formed by the third transverse crease line (3T) and the fourth longitudinal crease line (4L);
a second vertical edge (2VE) formed by the fourth transverse crease line (4T) and the seventh longitudinal crease line (7L);
a third vertical edge (3VE) formed by the sixth transverse crease line (6T) and the fifth longitudinal crease line (5L);
a fourth vertical edge (4VE) formed by the seventh transverse crease line (7T) and the eighth longitudinal crease line (8L);
a first integral corner formed by the folded first corner region (1 CR);
a second integral corner formed by the folded second corner region (2CR);
a third integral corner formed by the folded third corner region (3CR); and
a fourth integral corner formed by the folded

fourth corner region (4CR);

a second step of folding the first-stage partially folded box (26) along the third, sixth, ninth, tenth, eleventh and twelfth longitudinal crease lines (3L, 6L, 9L, 10L, 11L, 12L) to form a second-stage partially folded box (28) including:

a first longitudinal top edge (1LTE) formed by the third longitudinal crease line (3L);
a first transverse top edge (1TTE) formed by the fifth transverse crease line (5T);
a second longitudinal top edge (2LTE) formed by the sixth longitudinal crease line (6L);
a second transverse top edge (2TTE) formed by the eighth transverse crease line (8T);
a first longitudinal flange (1LF) formed by the fifth side region (5) and orientated substantially parallel to the base (B);
a second longitudinal flange (2LF) formed by the seventh side region (7) and orientated substantially parallel to the base (B);
a first inner longitudinal sidewall (1SW) formed by the ninth and tenth side regions (9, 10), the first inner longitudinal sidewall (1SW) having a first part formed by the ninth side region (9) and a second part formed by the tenth side region (10), and wherein the second part is orientated substantially perpendicular to the base (B) and adjacent a lower part of the first outer longitudinal sidewall (1SW') and the first part extends at an angle between the second part and the first longitudinal flange (1LF); and
a second inner longitudinal sidewall (2SW) formed by the eleventh and twelfth side regions (11, 12), the second inner longitudinal sidewall (2SW) having a first part formed by the eleventh side region (11) and a second part formed by the twelfth side region (12), wherein the second part is orientated substantially perpendicular to the base (B) and adjacent a lower part of the second outer longitudinal sidewall (2SW') and the first part extends at an angle between the second part and the second longitudinal flange (2LF);

a third step of securing the first outer longitudinal sidewall (1SW') to the first inner longitudinal sidewall (1SW) and the second outer longitudinal sidewall (2SW') to the second inner longitudinal sidewall (2SW);
a fourth step of folding the second-stage partially folded box (28) along the fifth and eighth transverse crease lines (5T, 8T) to form the fully erected box (22) including:

a first transverse flange (1TF) formed by the sixth side region (6) and
orientated substantially parallel to the base (B); and
a second transverse flange (2TF) formed by the eighth side region (8)
and orientated substantially parallel to the base (B); and

a fifth step of securing the first transverse flange (1TF) to the first and second longitudinal flanges (1LF, 2LF), and the second transverse flange (2TF) to the first and second longitudinal flanges (1LF, 2LF).

2. A method according to claim 1, further including a pre-folding step, between the first and second steps, in which the first-stage partially folded box (26) is temporarily folded along the third and sixth longitudinal crease lines (3L, 6L).

3. A method according to claim 1 or claim 2, wherein when the corner regions (1CR, 2CR, 3CR, 4CR) are folded along the crease lines (1CL, 2CL, 3CL, 4CL) that extend from the respective blank apex (1A, 2A, 3A, 4A), they form triangular-shaped wings (30) that are located between the adjacent outer and inner longitudinal sidewalls, and wherein the third step further includes securing the first and fourth integral corners to the first inner and outer longitudinal sidewalls (1SW, 1SW') and the second and third integral corners to the second inner and outer longitudinal sidewalls (2SW, 2SW').

4. A method according to any preceding claim, wherein the first part of the first inner longitudinal sidewall (1SW), the first longitudinal flange (1LF), and an upper part of the first outer longitudinal sidewall (1SW') together define a first longitudinally-extending structure of substantially triangular cross-section in the fully erected box (22), and wherein the first part of the second inner longitudinal sidewall (2SW), the second longitudinal flange (2LF), and an upper part of the second outer longitudinal sidewall (2SW') together define a second longitudinally-extending structure of substantially triangular cross-section in the fully erected box (22).

5. A method according to any preceding claim, wherein the method is carried out by a box erecting machine (50) with multiple stations.

6. A method according to claim 6, wherein the first step is carried out by a plunging station (300), the second and third steps are carried out by a primary folding and securing station (400), and the fourth and fifth

steps are carried out by a secondary folding and securing station (500).

7. A method according to claim 6 when ultimately dependent on claim 2, wherein the pre-folding step is carried out by the plunging station (300).

8. A method according to any of claims 5 to 7, wherein the box is held on an indexing assembly (310) that is actuated laterally along an indexing track to move the blank (20) progressively from one station to another.

9. A method according to any of claims 6 to 8, wherein the plunging station (300) includes a void (302) defined by vertically-extending fixed folding surfaces (304, 306) that are sized and shaped to fold the blank (20) along the particular longitudinal and transverse crease lines and form the first-stage partially folded box (26), preferably wherein the blank (20) is positioned above the void (302) and moved downwardly into the void (302) such that the blank (20) is folded along the particular longitudinal and transverse crease lines by the contact with the folding surfaces (304, 306), and preferably wherein additional fixed folding surfaces (308) are shaped to fold the blank (20) along the crease lines that extend from the blank apexes (1A, 2A, 3A, 4A) to form the integral corners as the blank (20) is moved downwardly into the void (302).

10. A method according to claim 9, wherein the blank (20) is held on an overhead assembly (202) which positions the blank (20) accurately above the void (302) and is actuated to move downwardly into the void (302), preferably wherein the overhead assembly (202) is actuated laterally along an overhead track (208) and is adapted to pick the blank (20) from a stack (102) of blanks (20) positioned at a picking station (200) of the box erecting machine (50), preferably wherein the blanks (20) are manually stacked and the stack (102) is moved automatically to a predetermined position at the picking station (200) where each blank (20) can be picked up in turn by the overhead assembly (202), and preferably wherein the box erecting machine (50) includes a device for introducing a jet of pressurised air underneath the top blank (20) as it is picked up by the overhead assembly (202) to separate it from the underlying blank (20).

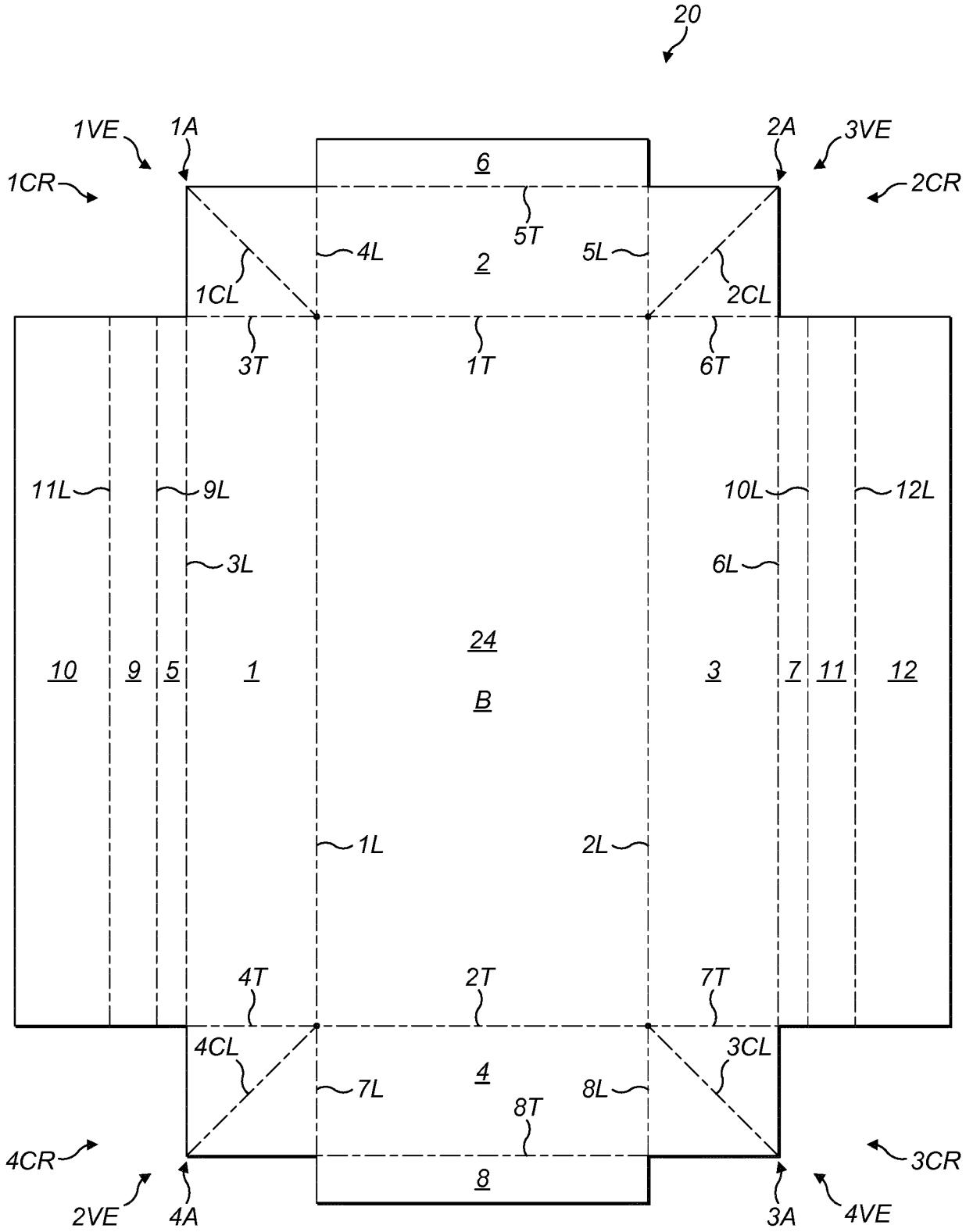
11. A method according to claim 2 or any of claims 3 to 10 when dependent or ultimately dependent on claim 2, wherein the pre-folding step comprises temporarily folding the fifth and seventh side regions (5, 7) inwardly, towards the planar base (B) of the first stage partially folded box (26), along the third and sixth longitudinal crease lines (3L, 6L) and thereafter allowing the fifth and seventh side regions (5, 7) to return to a position in which they are substantially co-planar respectively with the first and second outer longitudinal sidewalls (1SW', 2SW').

12. A method according to any of claims 6 to 11 when dependent or ultimately dependent on claim 2, wherein the first-stage partially folded box (26) is moved to the primary folding and securing station (400) by the indexing assembly (310) once the pre-folding step is complete, preferably wherein the primary folding and securing station (400) includes folding surfaces (404) that are actuated to fold the first-stage partially folded box (26) along the third and sixth longitudinal crease lines (3L, 6L), preferably wherein the primary folding and securing station (400) further includes a folding head (406) that is positioned above the first-stage partially folded box (26) and is actuated to move downwardly into the interior of the box (26) with the side regions folded over and preferably wherein the folding head (406) includes folding surfaces (410) that are actuated, when the folding head (406) is positioned accurately within the interior of the box, to fold the box along the ninth, tenth, eleventh and twelfth longitudinal crease lines (9L, 10L, 11L, 12L) to form the first and second inner longitudinal sidewalls (1SW, 2SW).

13. A method according to claim 12, wherein the second-stage partially folded box (28) is moved to the secondary folding and securing station (500) by the indexing assembly (310) and preferably wherein the secondary folding and securing station (500) includes folding surfaces (502, 504) that fold the second-stage partially folded box (28) along the fifth and eighth transverse crease lines (5T, 8T) to form the first and second transverse flanges (1TF, 2TF) of the fully erected box (22).

14. A method according to claim 13, wherein a first folding surface (502) is a fixed folding surface that folds the box along the fifth transverse crease line (5T) as it is moved laterally by the indexing assembly (310) and the fixed folding surface comes into contact with the moving vertically-extending sixth side region (6), and wherein a second folding surface (504) is actuated to fold the box along the eighth transverse crease line (8T) when the indexing assembly (310) comes to rest and the box is positioned accurately at the secondary folding and securing station (500).

15. A method according to any preceding claim, further comprising a sixth step of piercing the fully erected box (22) to create one or more openings through which liquid can drain from the box (22).


20
1VE
1A
2A
3VE
1CR
2CR
6
5T
4L
2
5L
1CL
2CL
3T
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6T
11L
9L
10L
12L
3L
6L
24
10
9
5
1
3
7
11
12
B
1L
2L
4T
2T
7T
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4
7L
8L
8T
4CR
3CR
8
2VE
4A
3A
4VE

FIG. 1

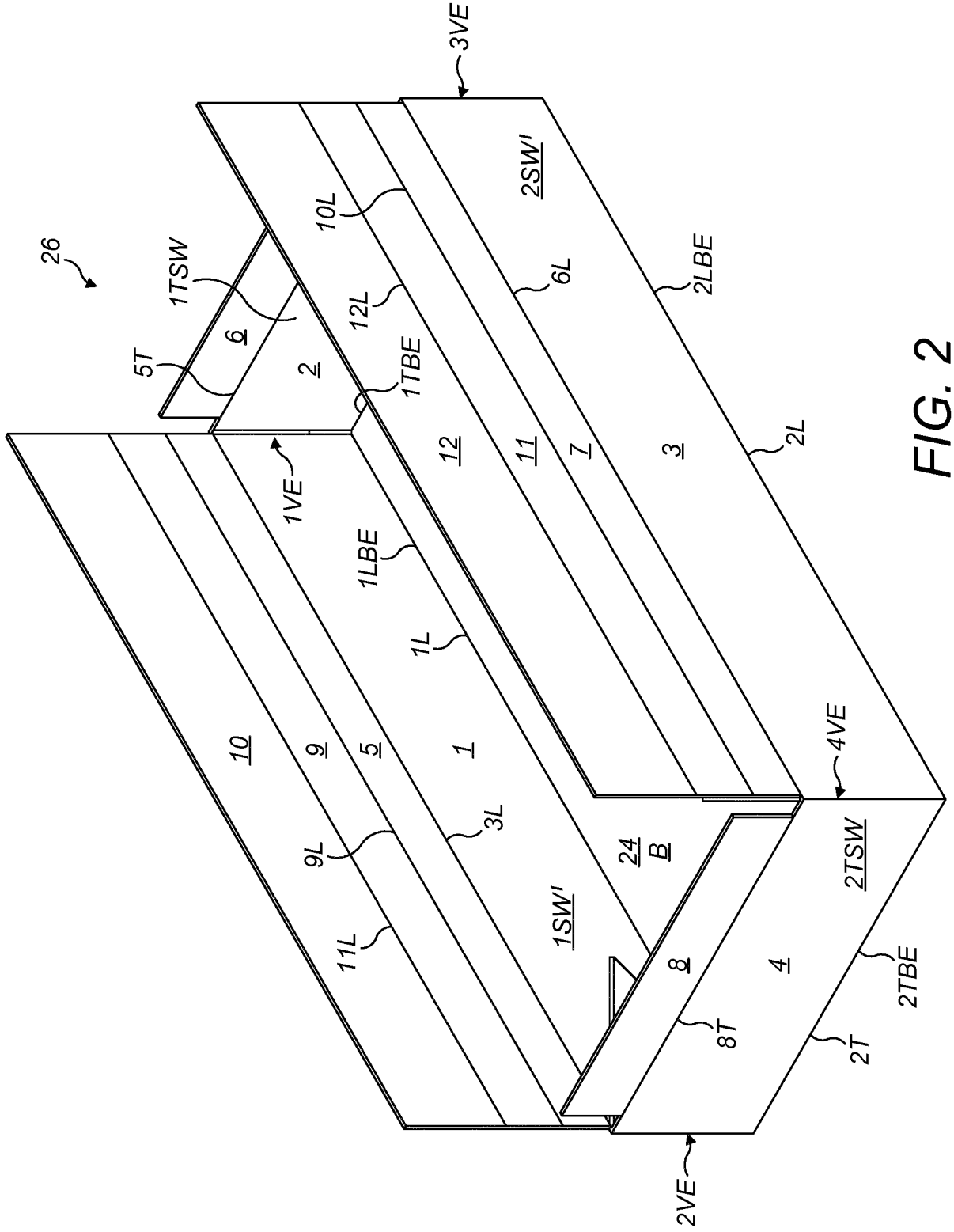
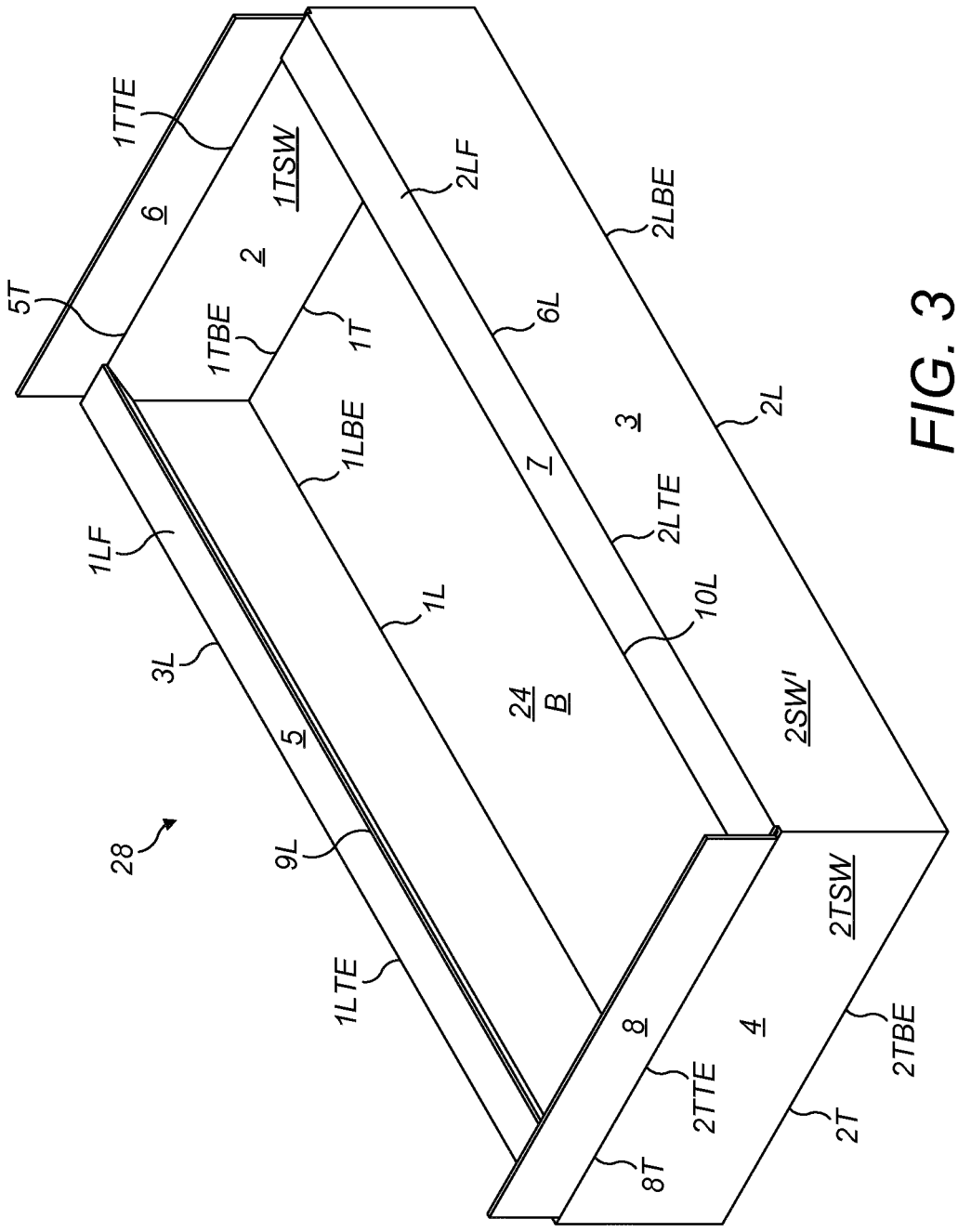

26
1TSW
6
5T
2
1TBE
12L
10L
2SW'
6L
2LBE
3VE
12
11
7
3
2L
1VE
1LBE
1L
10
9
5
1
3L
9L
11L
1SW'
24
B
4VE
2TSW
8
4
8T
2T
2TBE
2VE

FIG. 2


1TTE
6
1TSW
2LF
2LBE
5T
2
1TBE
1T
6L
1LBE
3
2L
7
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1L
10L
3L
24
B
2SW'
5
28
9L
2TSW
1LTE
8
4
2TBE
2TTE
2T
8T

FIG. 3

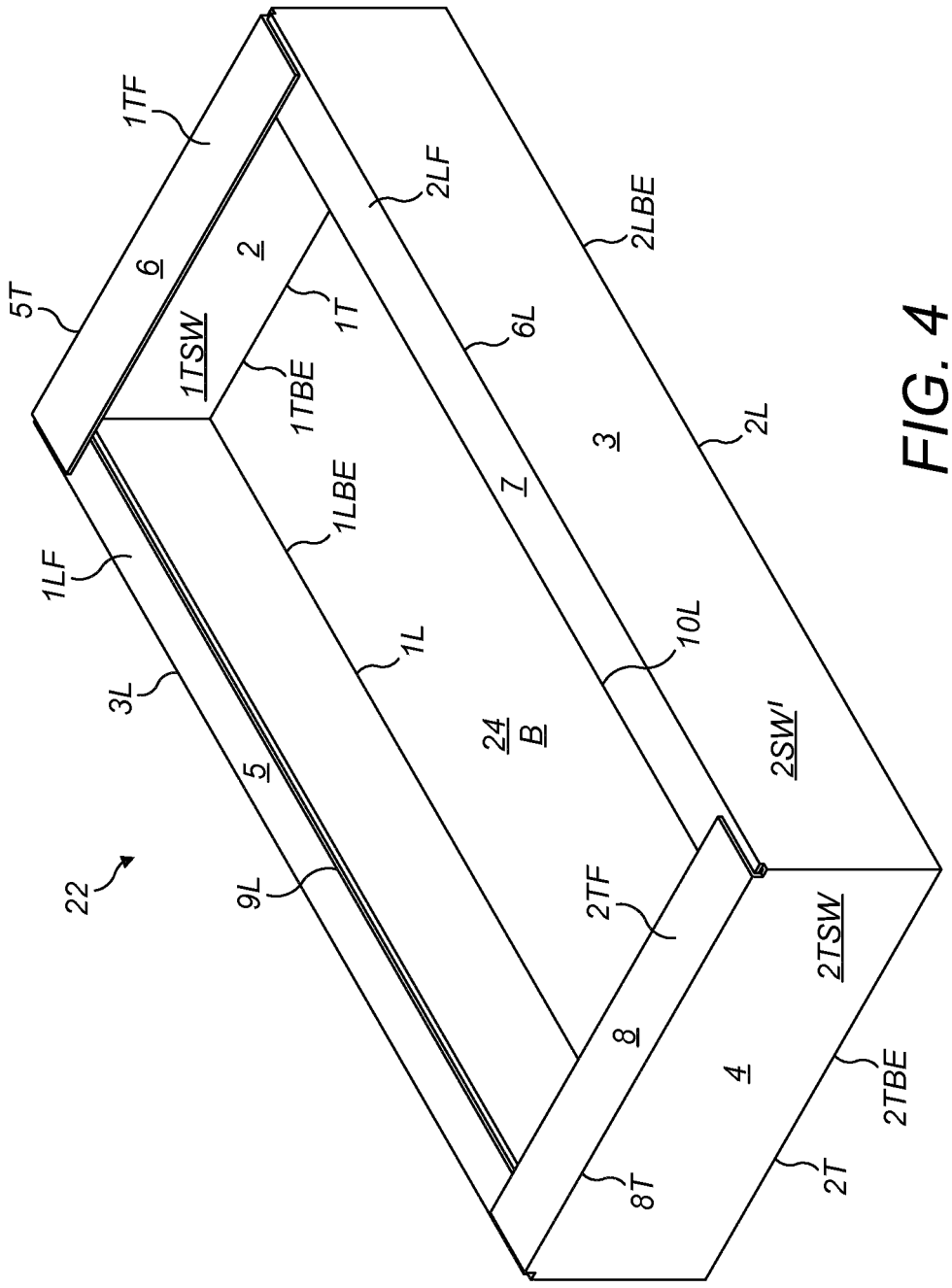
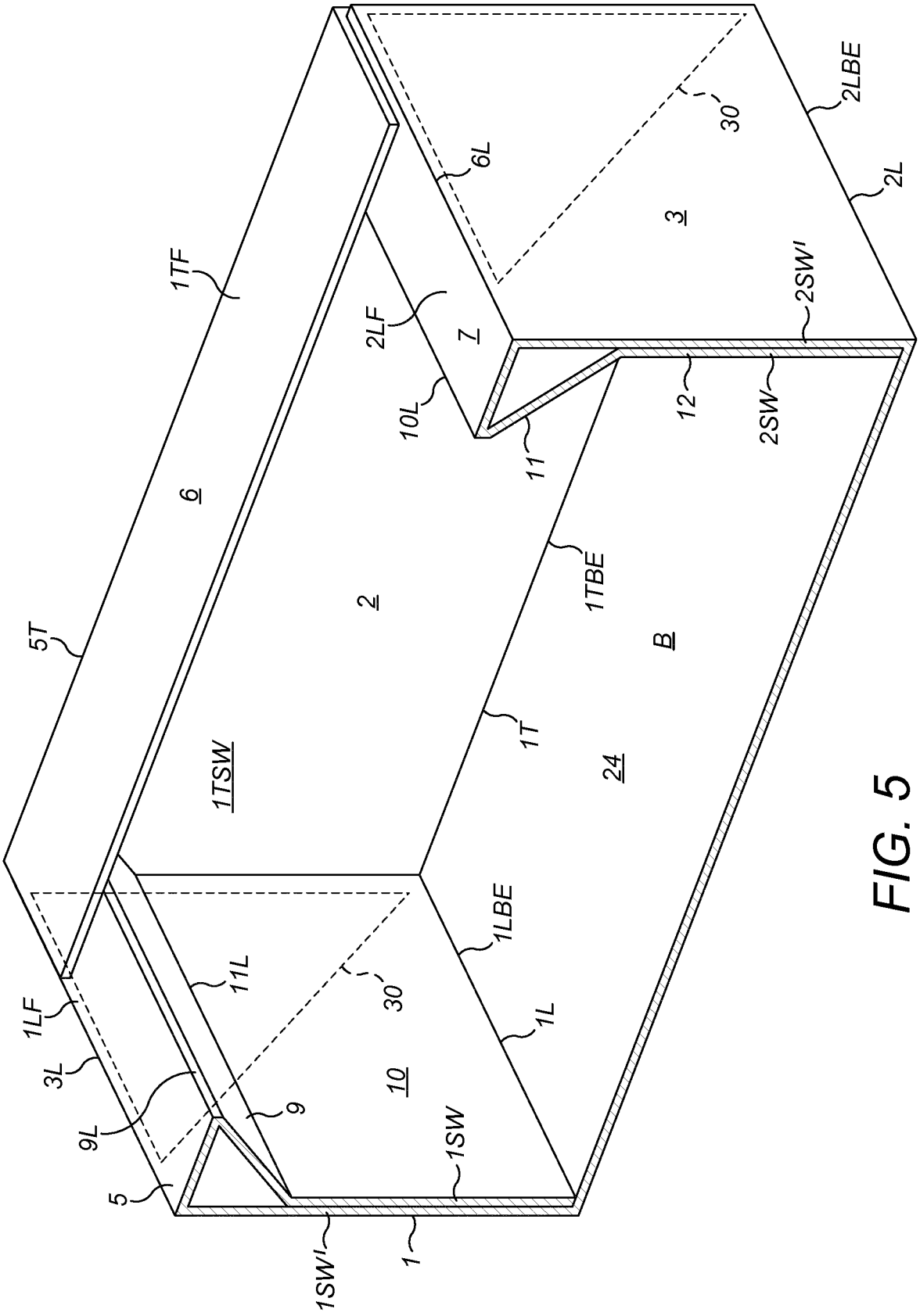

1TF
6
5T
2
1TSW
1TBE
1T
2LF
2LBE
6L
2L
3
7
1LBE
1LF
3L
1L
10L
5
24
B
2SW'
22
9L
2TF
2TSW
8
4
2TBE
8T
2T

FIG. 4


1TF
6
5T
2
1TSW
7
2LF
10L
6L
30
3
2LBE
2L
2SW'
12
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11
1TBE
B
1T
24
1LBE
1L
11L
30
1LF
3L
9L
5
9
10
1SW
1SW'
1

FIG. 5

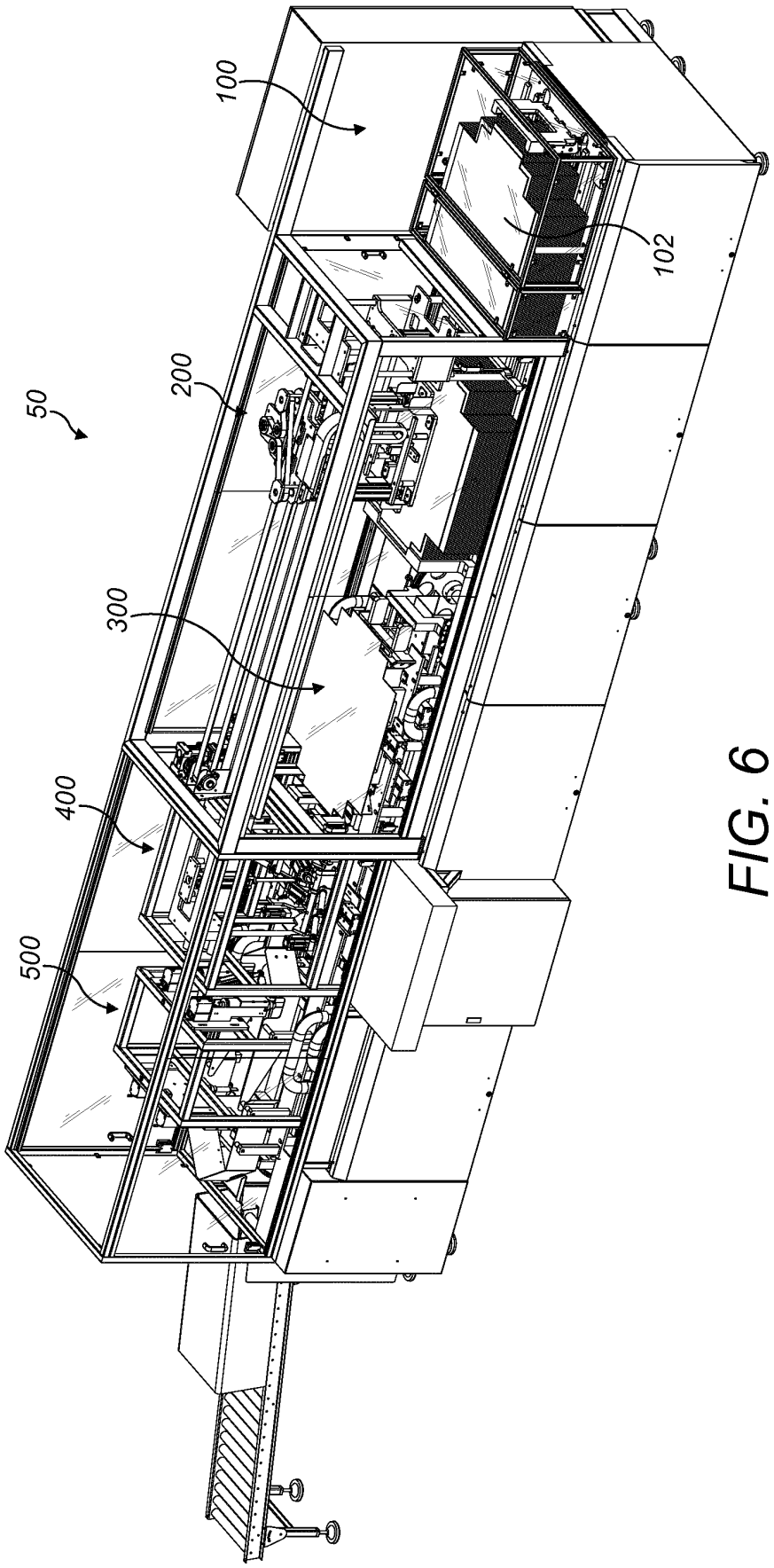

FIG. 6

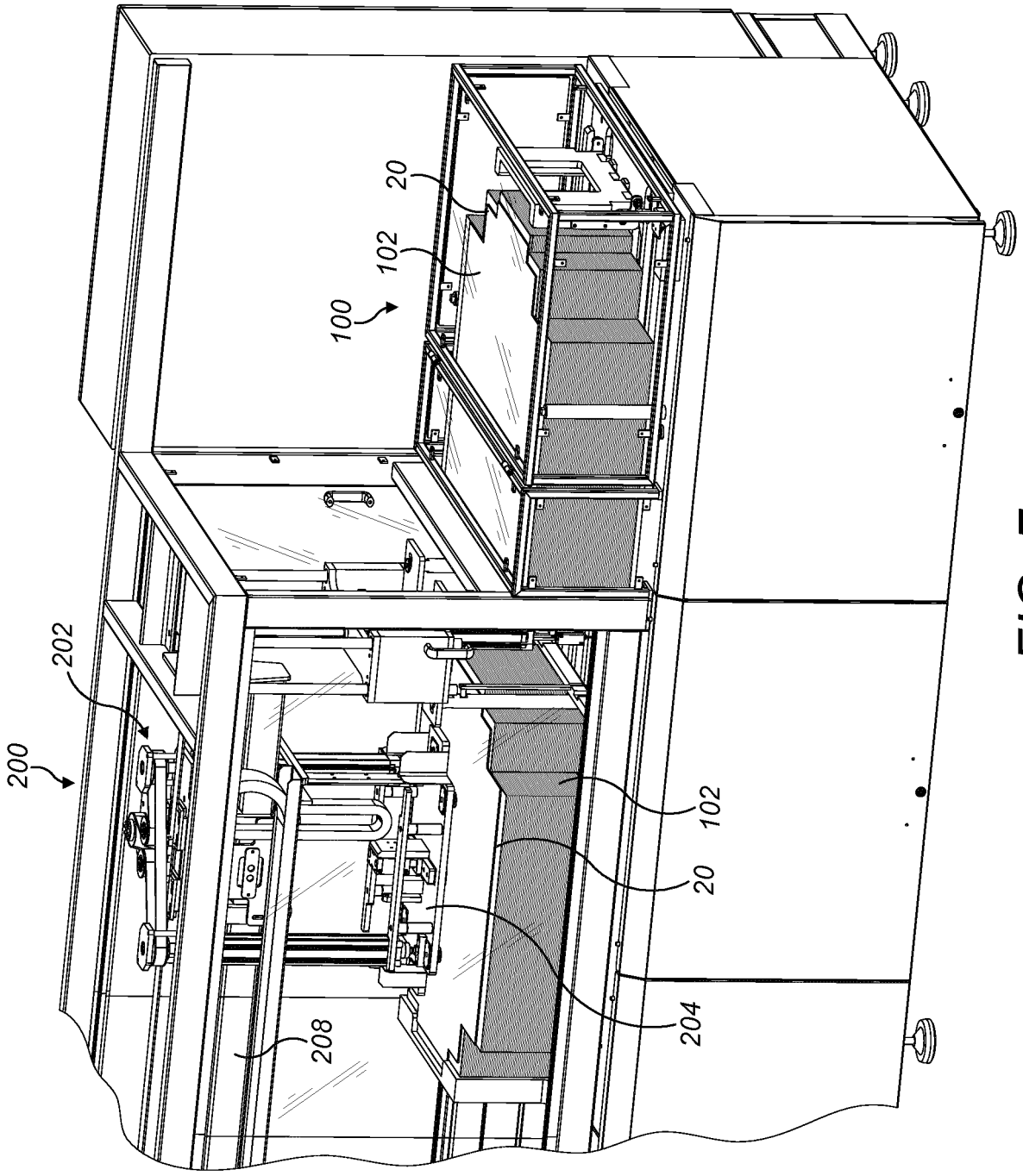

FIG. 7

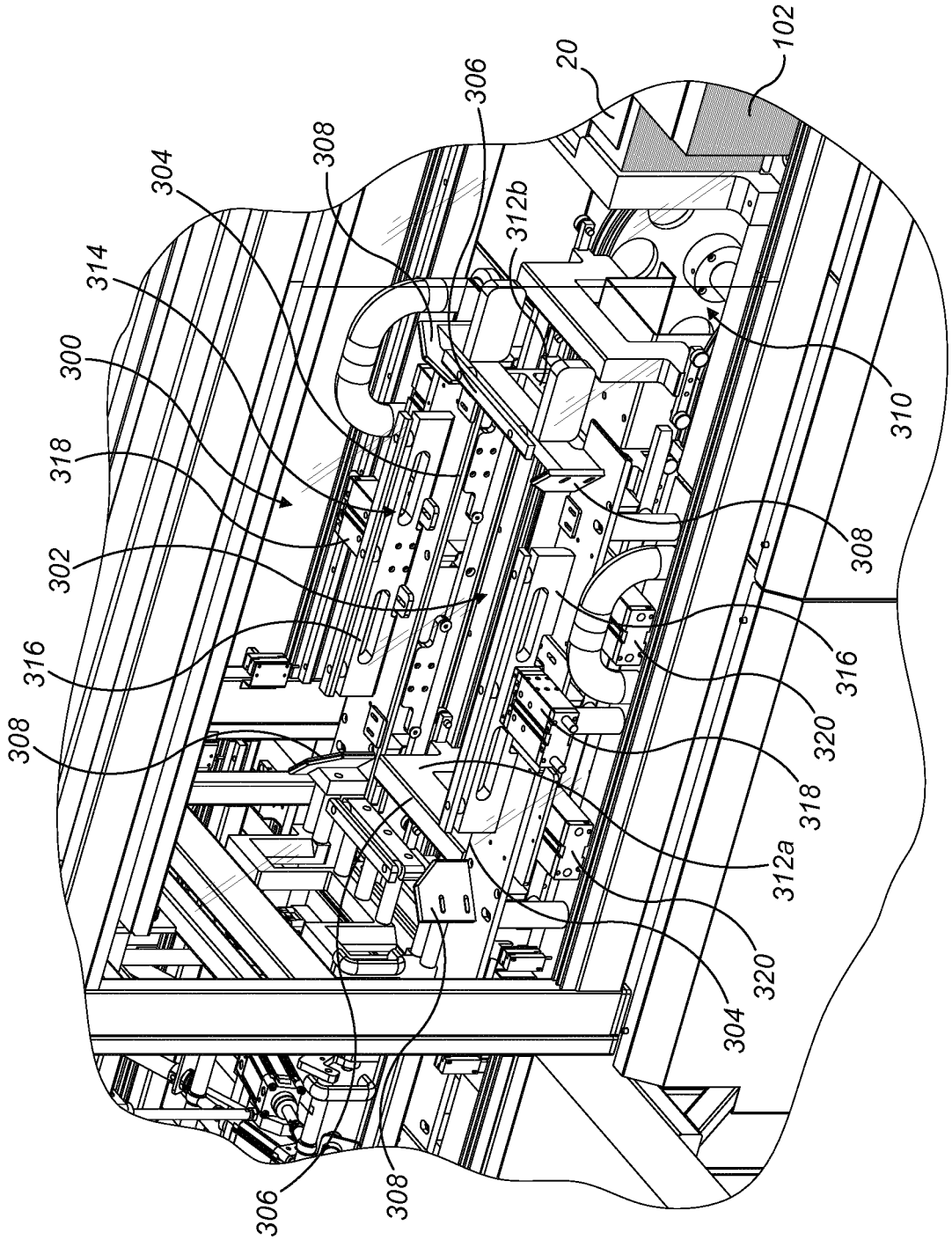
102
20
306
308
304
312b
314
300
318
302
316
310
308
316
320
318
312a
320
304
306
308

FIG. 8

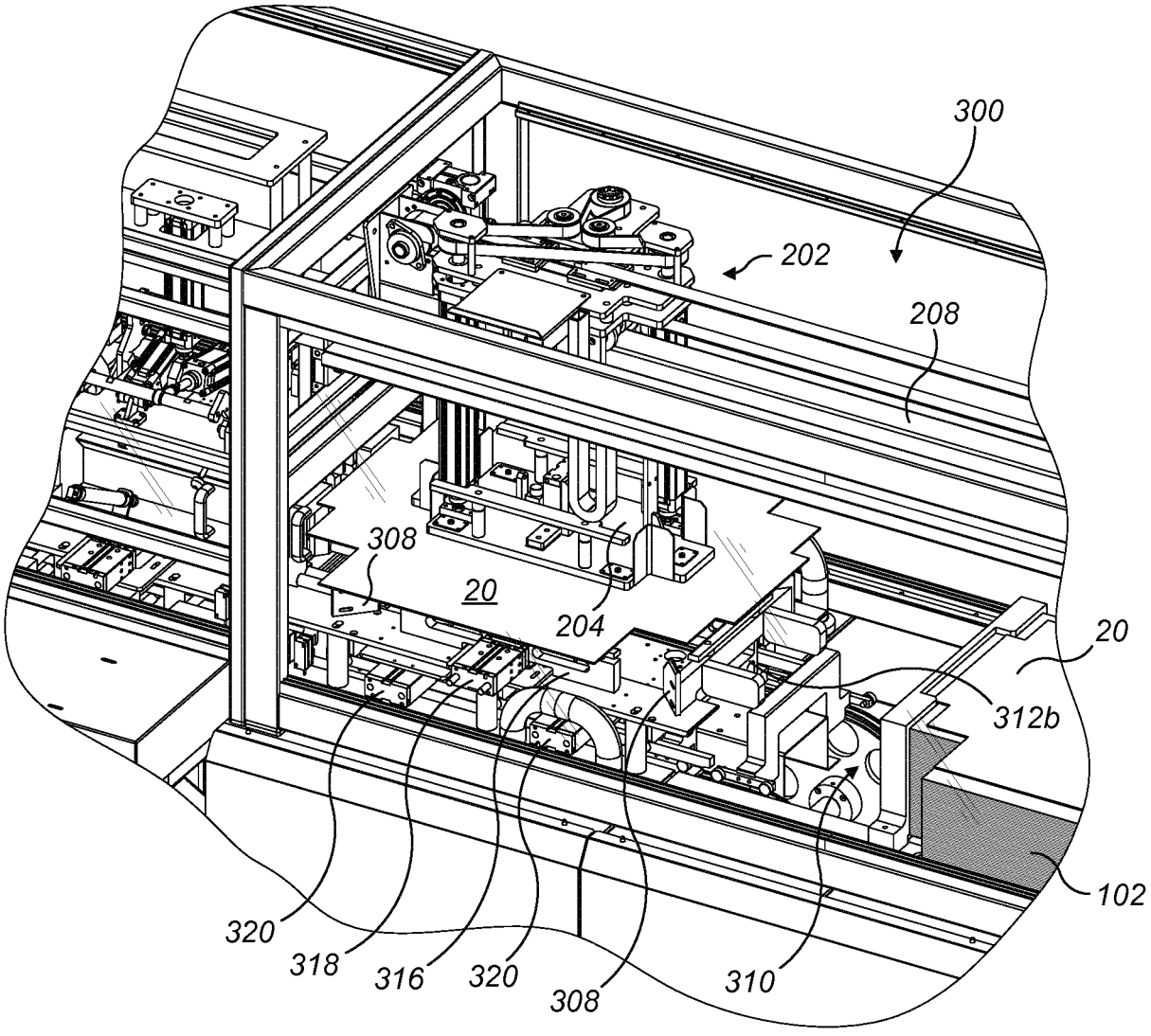

FIG. 9

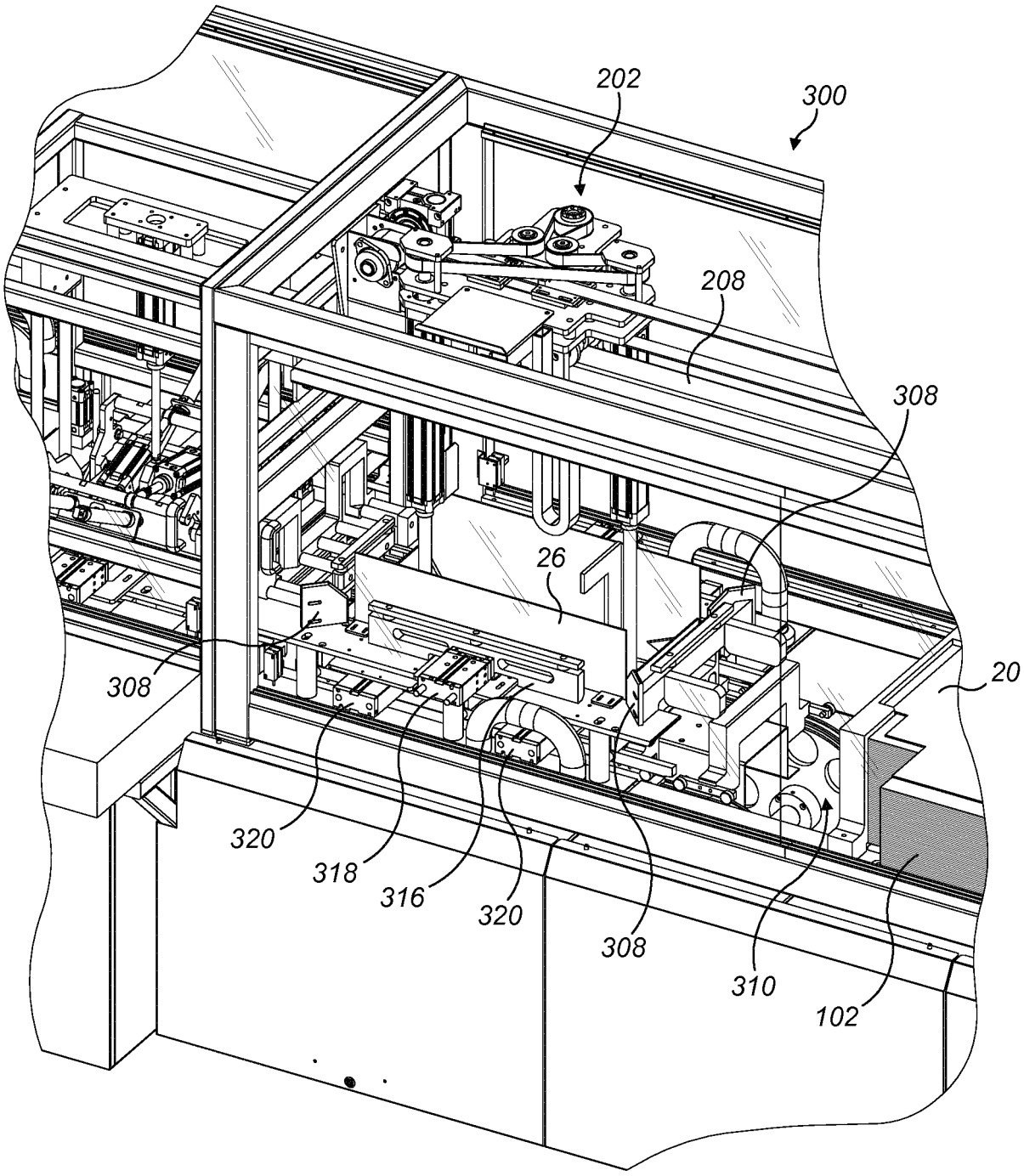

FIG. 10

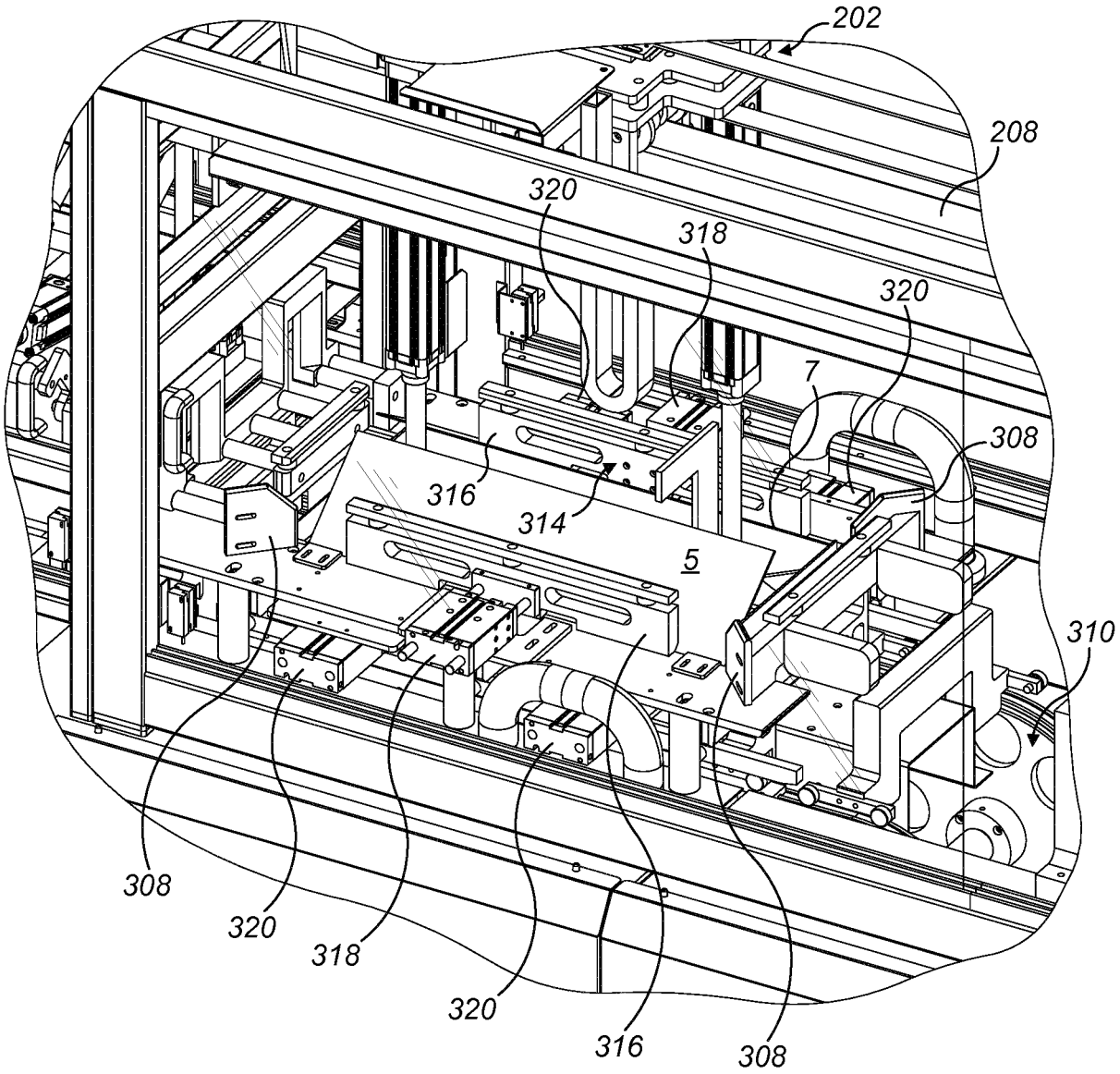

FIG. 11

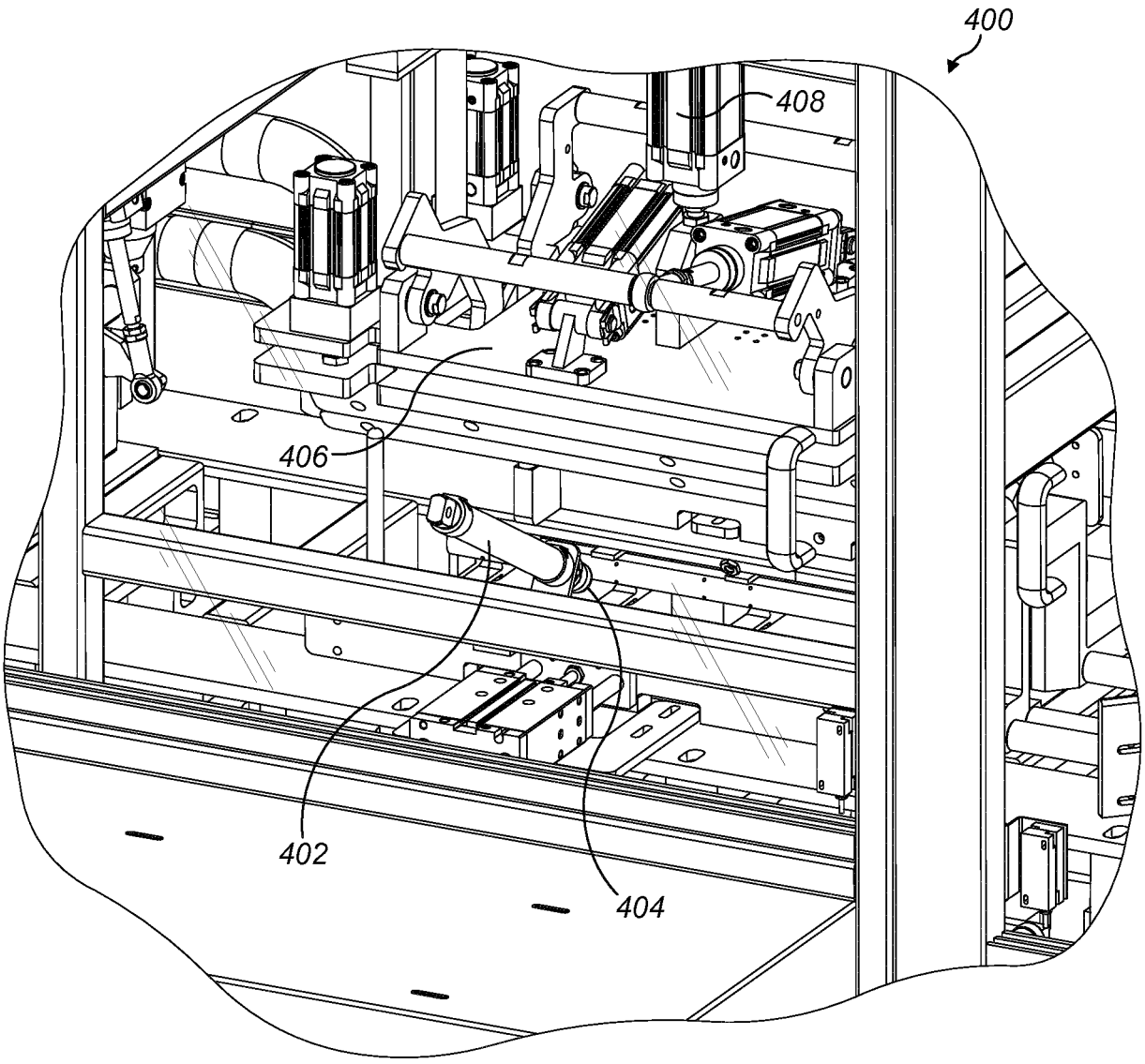

FIG. 12

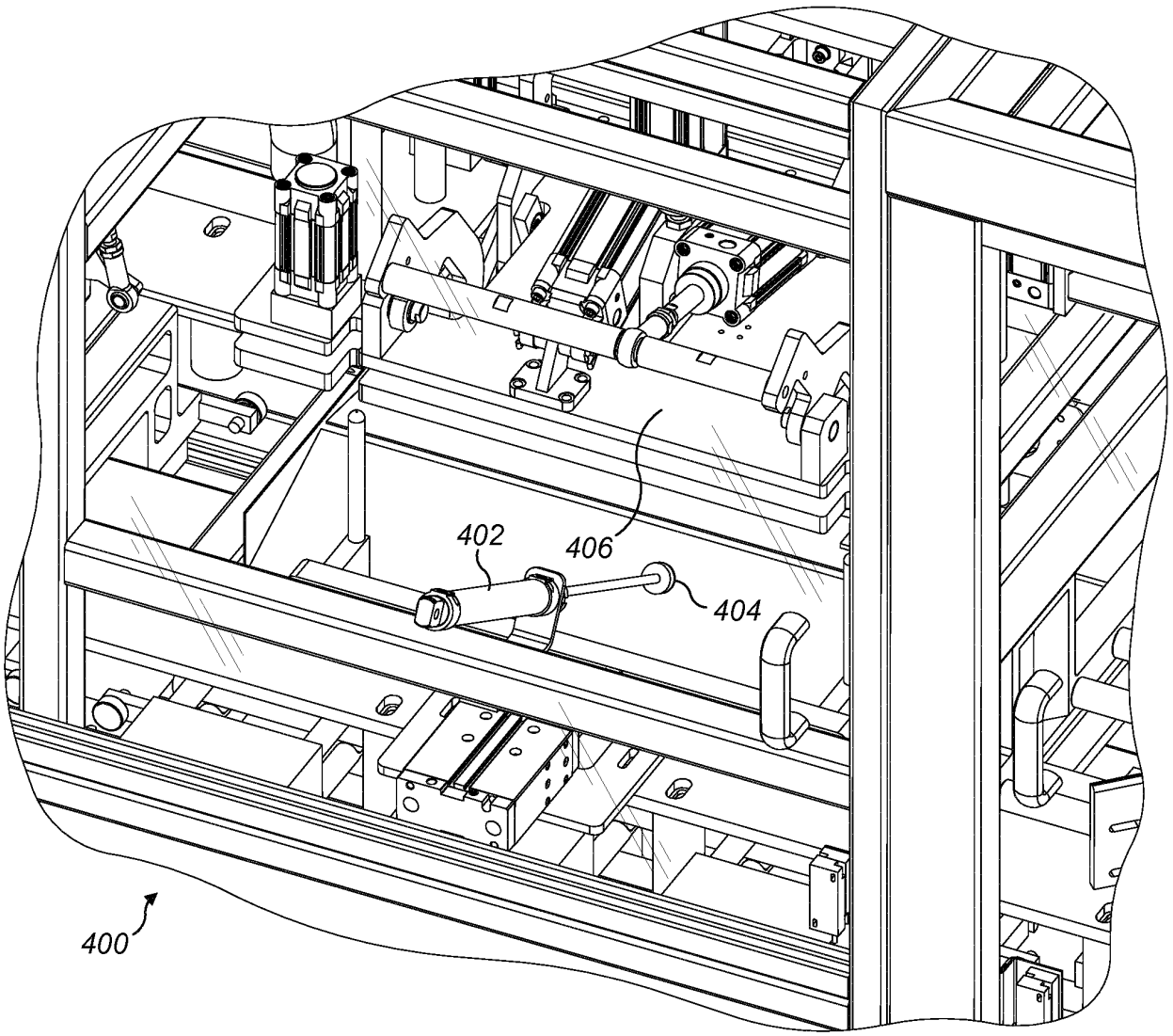

FIG. 13

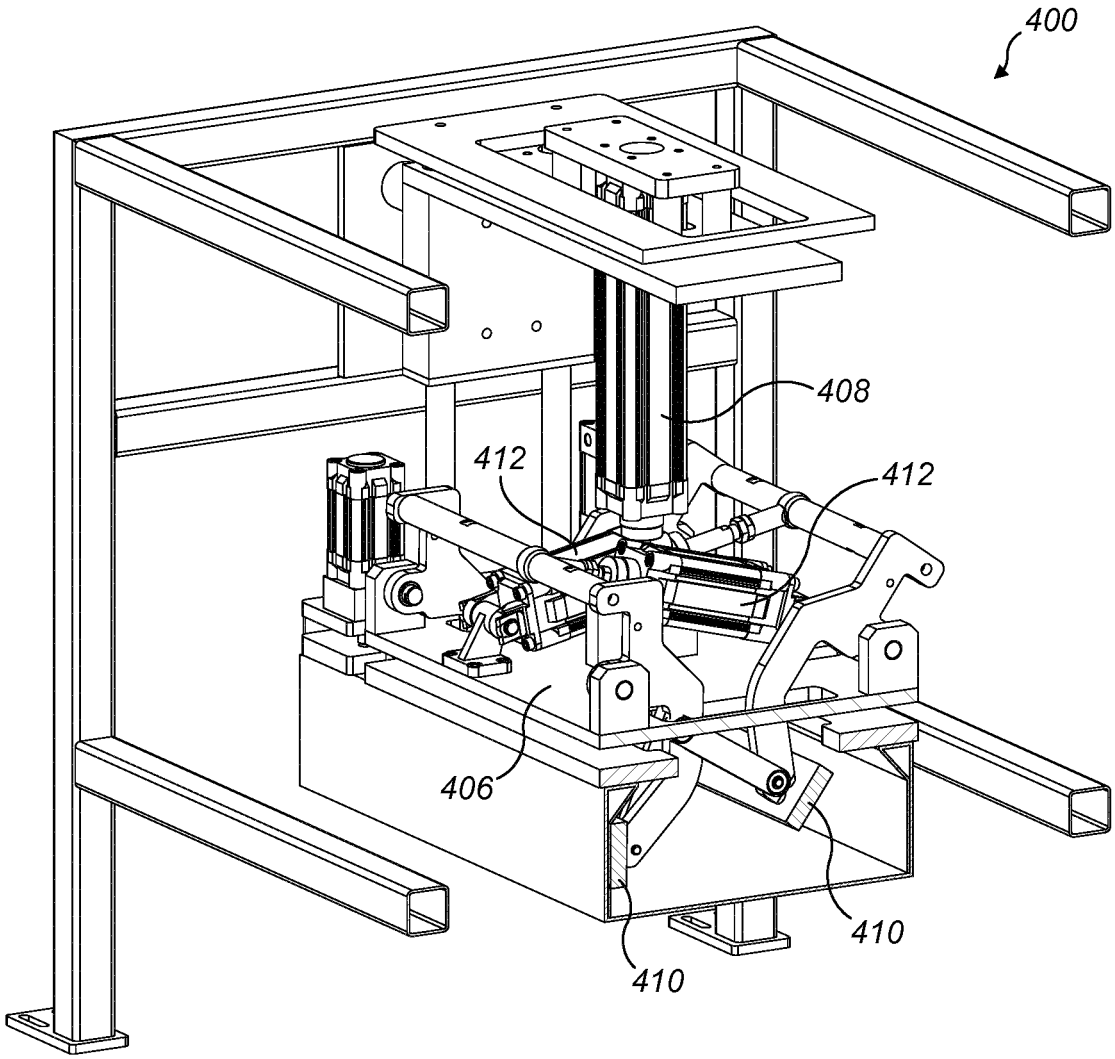

FIG. 14

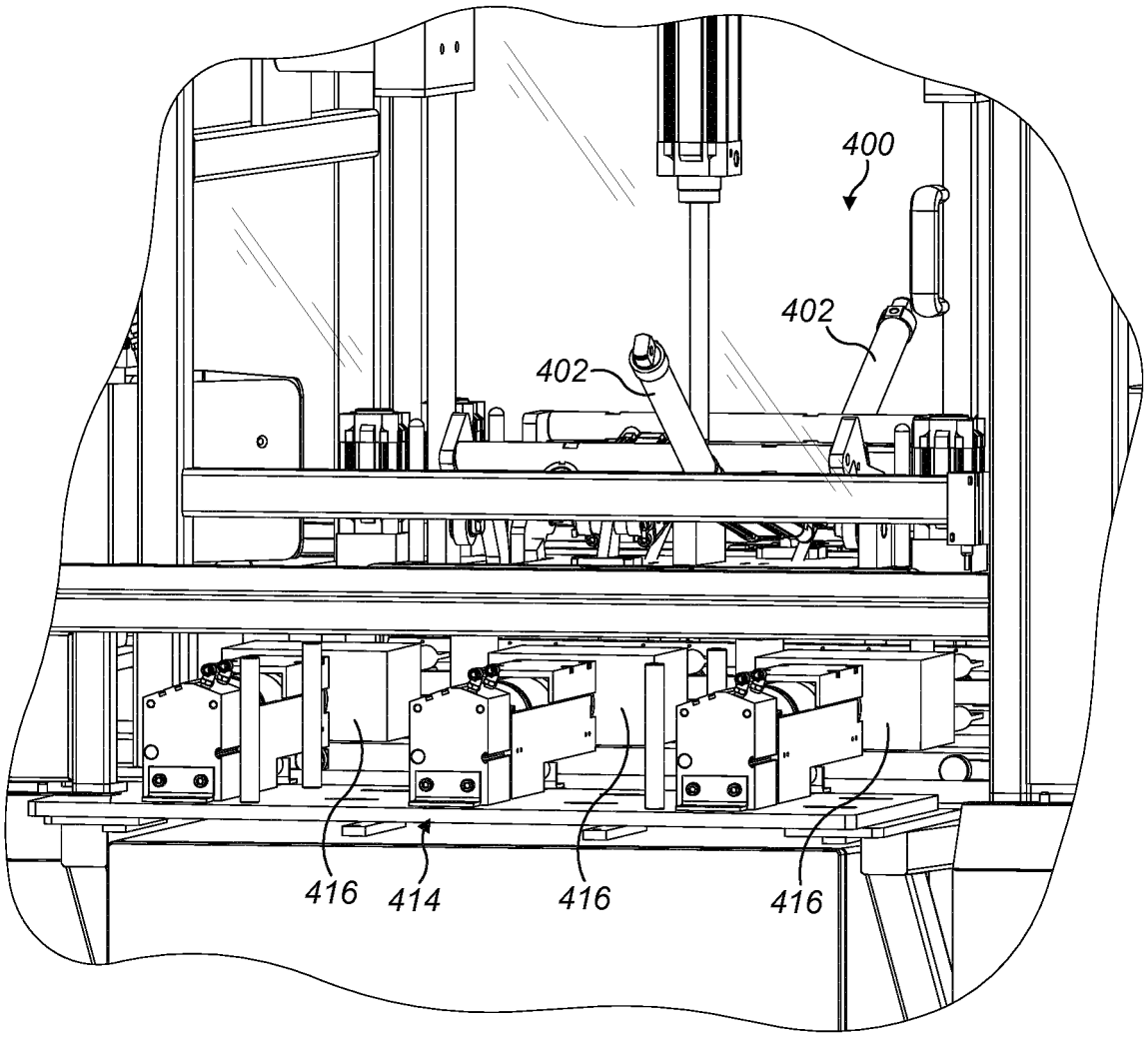

FIG. 15

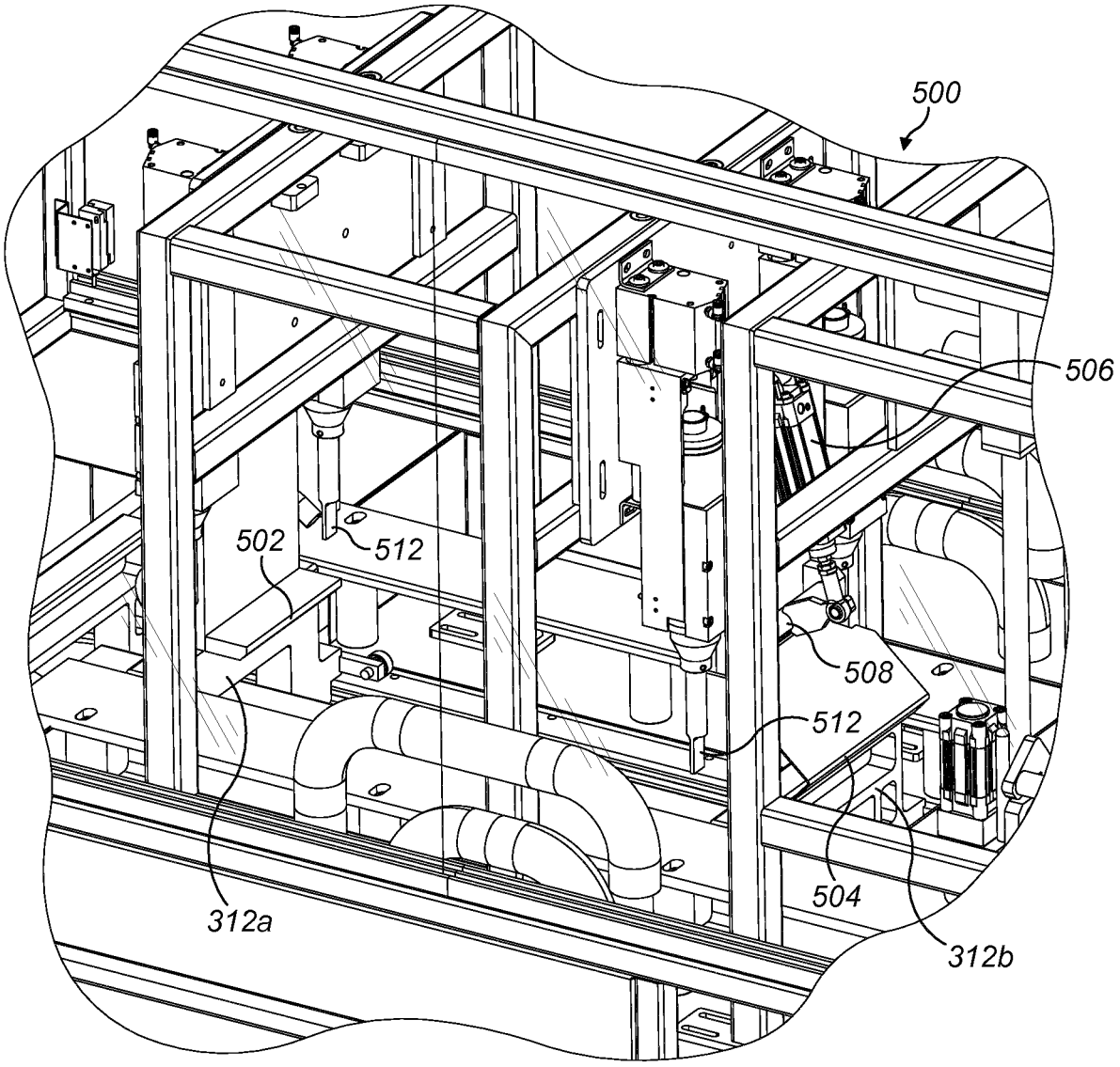

FIG. 16

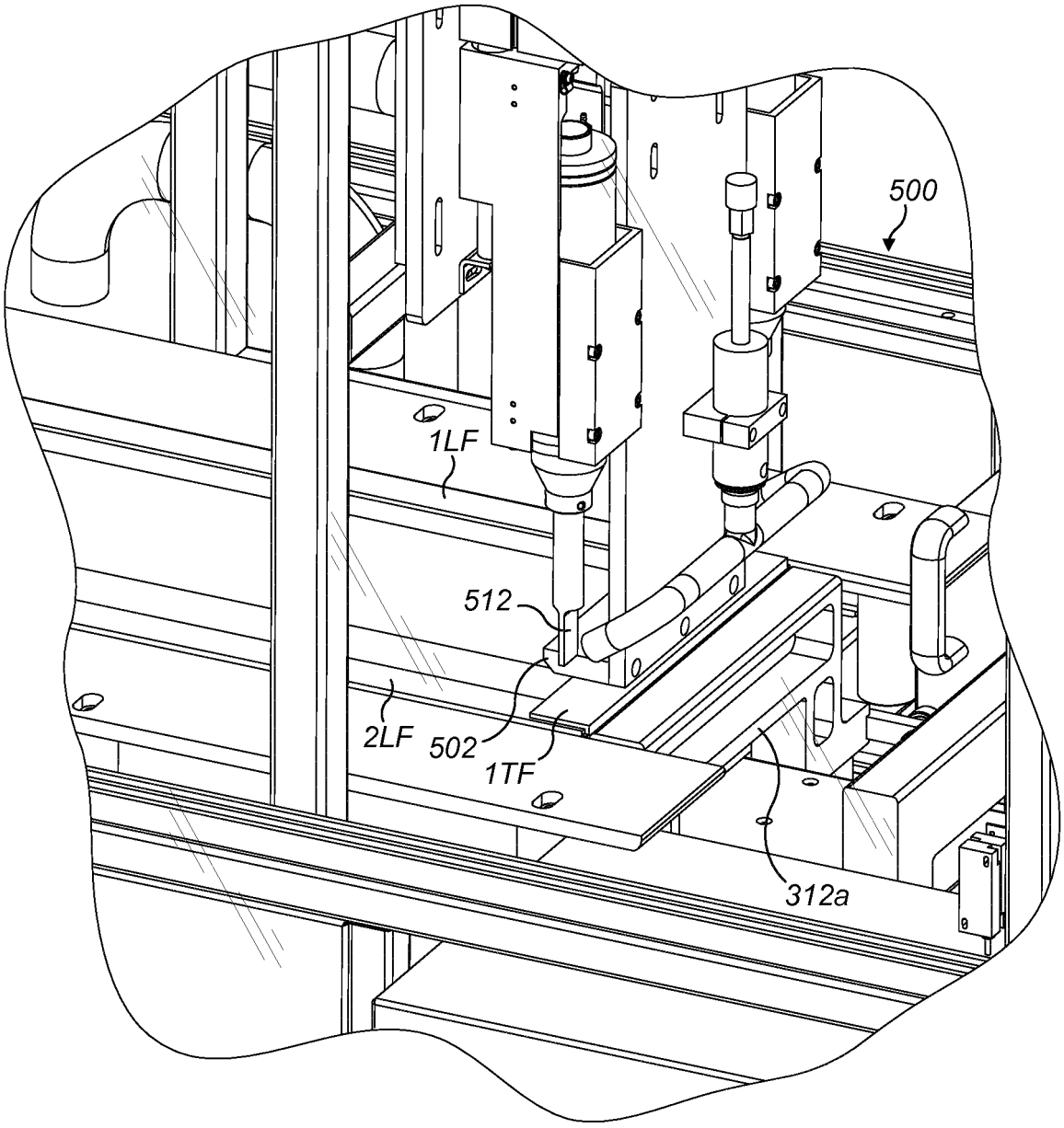

FIG. 17

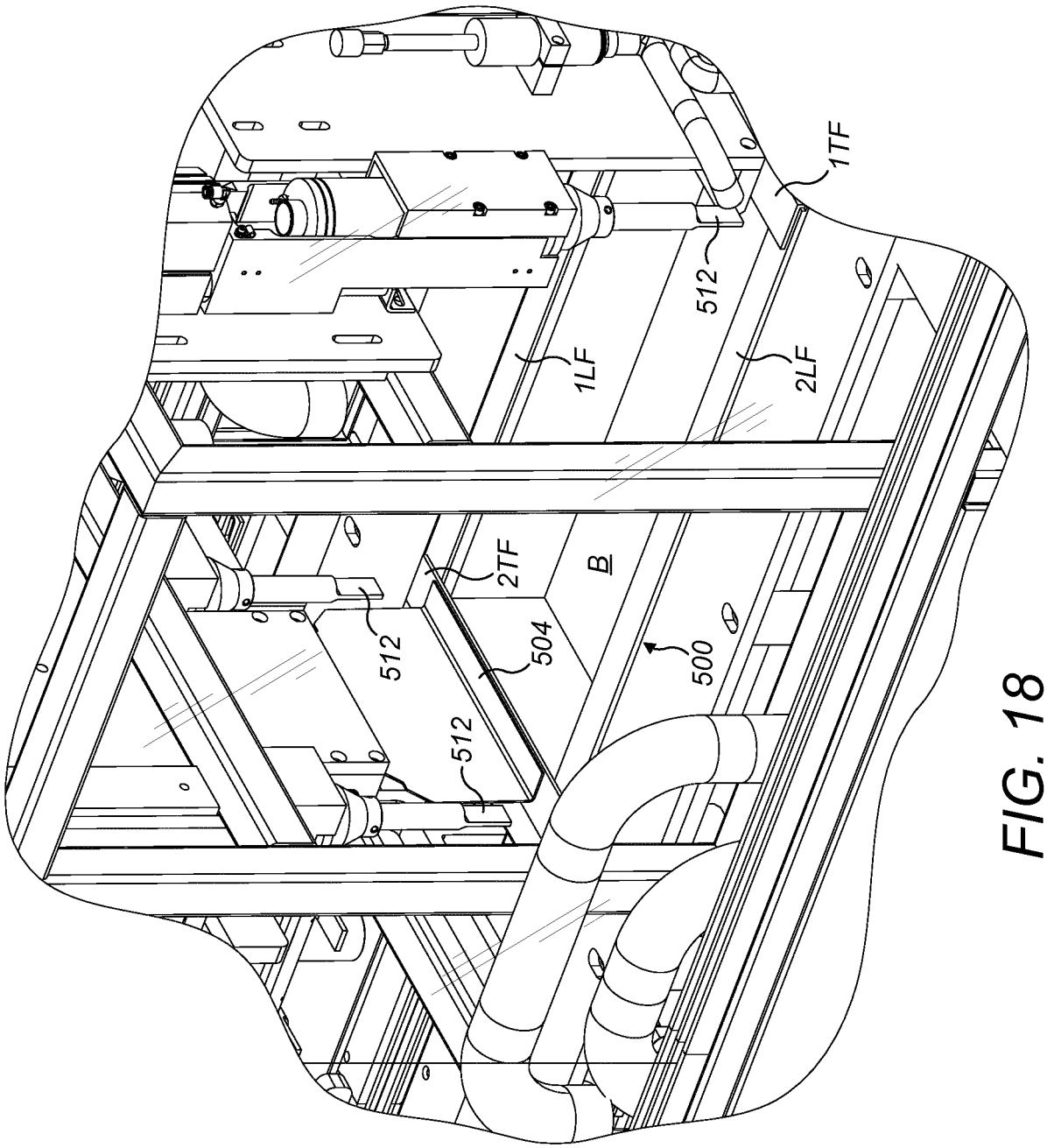

FIG. 18

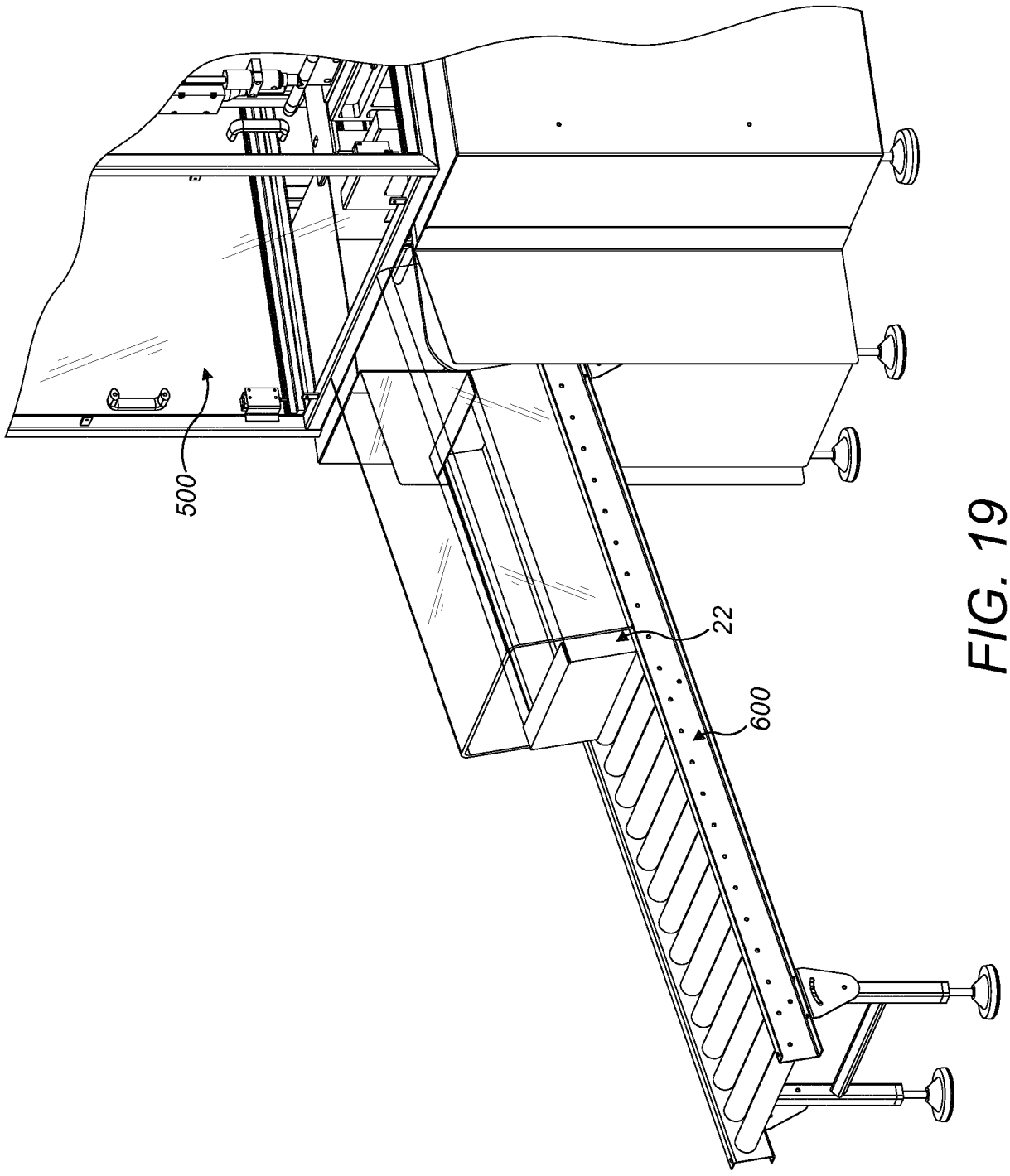

FIG. 19

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EUROPEAN SEARCH REPORT

Application Number
EP 16 20 5216

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP S43 21435 Y1 (REIPAKKU KK) 9 September 1968 (1968-09-09) * figures 1-5 *	1-15	INV. B65D5/00 B65D5/24 B31B50/44 B31B50/52 B31B100/00 B31B110/35
A	FR 2 044 362 A5 (TAILLEUR FILS ET CIE) 19 February 1971 (1971-02-19) * figures 3, 4 *	1-15	
A	US 6 460 758 B1 (FENTON JASON M [GB] ET AL) 8 October 2002 (2002-10-08) * figures 6, 7 *	1-15	
A	US 2009/170678 A1 (SMITH MICHAEL J [US] ET AL) 2 July 2009 (2009-07-02) * figure 1 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B65D
B31B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 April 2017	Sundqvist, Stefan

CATEGORY OF CITED DOCUMENTS

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03-04-2017

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