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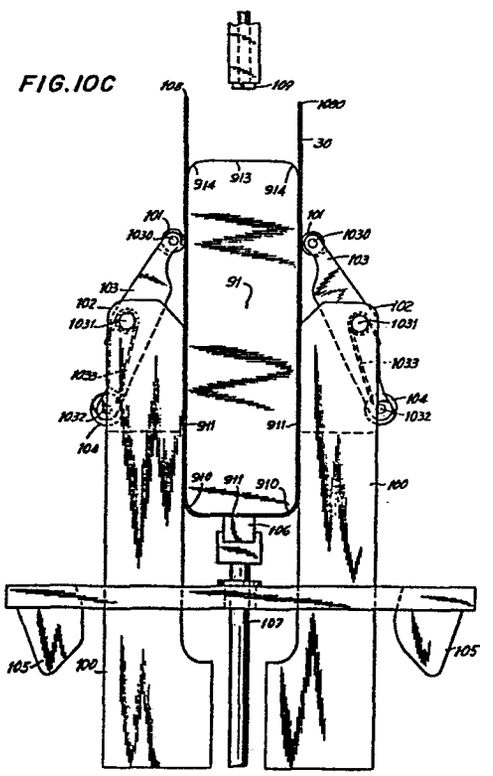
(54) Method and apparatus for forming containers.

(57) A method and apparatus for forming containers is disclosed. The apparatus includes a die (100, 170, 171) for forming a side wall with tightly radiused corners around a mandrel (91). The mandrel (91) is adjustable between a forming configuration and a discarge configuration and the side wall is formed with the mandrel in its forming configuration. An end wall (13, 53) is sealed to the side wall by an eight-piece sealing tool (120, 122, 150, 160) to form a complete container. The mandrel is then adjusted to its discharge configuration to facilitate discharge of the container and to feed another end wall to the mandrel.

FIG. 10C



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METHOD AND APPARATUS FOR FORMING CONTAINERS

Background of the Invention

This invention relates generally to the field of manufacturing containers from paperboard stock, and more particularly to producing paperboard containers having a side wall formed from a first blank and an end wall formed from a second blank.

Paperboard containers are widely used for the packaging of foodstuffs such as powdered mixes, cereals, snack chips and the like, and are suitable for packaging liquids in general, and also for packing many non-food substances, particularly those which are moisture sensitive. Such containers are often formed from pre-cut blanks comprising paperboard covered on both surfaces with a thermoplastic material such as polyethylene. The polyethylene inhibits passage through the paperboard of bacteria and other microorganisms, moisture, and the contents of the container. Additionally, the thermoplastic coating can serve as an adhesive when subjected to heat and pressure. Thus, seams or joints between overlapped edges of the blank may be made by applying heat and pressure to the area of the overlapped edges.

The sequence of operations for producing a paperboard container of this kind is as follows. A

laminate comprising paperboard covered on both surfaces with a thermoplastic material, such as polyethlyene, is formed in a web of indefinite length. Blanks of a desired size and shape are then cut out of the web. The blanks are folded or wrapped by automatic machinery in a packaging plant to form a tube which typically is provided with a closure at one end. The containers thus formed are then filled with a product by means of automatic filling apparatus after which a closure is affixed to the open end of each container.

Efficient and economical production of paperboard containers requires the use of automatic high-speed machinery to form the container side wall and to seal an end wall to the formed side wall. Special problems are encountered in producing nonround containers, especially those having tightly radiused corners, on such automatic machinery. Conventional apparatus for the formation of nonround side walls was adapted from apparatus for making round side walls. Such apparatus includes wings which pivot from a point adjacent a mandrel to wrap a side wall blank around the mandrel. The use of wings fails to give adequate control at all points on the side wall, so that the blank may not conform tightly to the shape of the mandrel.

It is also conventional to use a stripper to remove the formed side walls from the mandrel of such machinery. Depending upon the length of the side wall, which is the distance the stripper must travel to remove the side wall from the mandrel, the time required for removing the side wall from the mandrel may prohibit the use of high-speed container manufacturing machinery. In addition, it is difficult to strip a nonround container, particularly one having tightly radiused corners, from a mandrel because of the high degree of friction at the corners.

A particular difficulty in the formation of nonround containers is the sealing of the end wall to the side wall, especially at tightly radiused corners, i.e., corners with a radius of curvature of about one-half inch. In the case of a rectangular container, for example, it is conventional to use a four-piece expandable tool to seal the end wall to the side wall. The four segments are expandable to primarily seal either the four corners or the four sides of a rectangular container, and they do not apply an equal force at all points along the perimeter.

An additional difficulty in sealing an end wall to the side wall in conventional apparatus is that the end of the side wall must generally be preformed before the end wall can be attached. In conventional apparatus, the preforming and sealing steps are done at separate stations by separate apparatus. The thermoplastic coating is heated, to serve as an adhesive, before either of these steps. In order for the coating to remain sufficiently tacky through both steps, it must be overheated during the heating step. Overheating can cause localized melting of the coating resulting in "pinholes" where only bare paperboard is present, decreasing the effectiveness of the container as barrier.

Summary of the Invention

Is therefore the principal object of the invention to provide a method and apparatus which afford greater control in the manufacture of containers, and particularly a method and apparatus for producing a nonround container that avoids the problems described above.

Another object of the invention is to provide such a container that can be manufactured easily and economically.

Still another object is to provide a method and apparatus for making such a container on conventional high-speed container making machinery.

Still another object is to provide such a container of a controlled size and shape, especially one having tightly radiused corners, i.e., corners having a radius of curvature of about one-half inch.

Yet another object is to provide such a container having a continuous seal between the end wall and the side wall.

Apparatus for forming a container according to the invention includes apparatus for forming a side wall and apparatus for sealing an end wall to a side wall. Similarly, a method for forming a container according to the invention includes a method for forming a side wall and a method for sealing an end wall to a side wall.

The apparatus of the invention for forming a side wall or container includes a mandrel, a die having rollers, and sealing means. The mandrel is adjustable between a forming configuration and a discharge configuration, the forming configuration being for forming the side wall having radiused corners around the mandrel and the discharge configuration being for facilitating removal of a formed and sealed side wall from the mandrel. The die has a pair of leading edges spaced apart from each other and has a roller pivotably disposed on each leading edge. Each of the rollers is biased toward that roller on the other leading edge. The die has an interior shape to hold the blank snugly in contact to adjacent radiused corners of the mandrel. The die is movable from a first position remote from the mandrel to a second position adjacent to a portion of the surface of the mandrel for causing the rollers to contact the blank positioned between the mandrel and the die when the die is in the first

position, to force the blank against the mandrel, and to roll along the surface of the blank to wrap the blank around the surface, forming radiused corners in the blank which conform to the radiused corners of the surface of the mandrel and causing two opposing edges of the blank to overlap. A sealing means seals the overlapping edges of the blank together to form a container side wall having radiused corners. If a complete container is being formed, an end wall is attached as described below.

In a preferred embodiment of this apparatus, the shaping surface perimeter of the mandrel is approximately rectangular and includes four radiused corners. The mandrel is made of a first outer segment having two radiused corners, a second outer segment having the other two radiused corners, a central segment disposed between the outer segments, and an end plate normal to the shaping surface. When the mandrel is in the discharge configuration the outer segments are relatively close to the central segments and the end plate is relatively far from the central segment, and when the mandrel is in the forming configuration the outer segments are each spaced farther from the central segment than when the mandrel is in the discharge configuration, while the end plate is closer to the central segment than when the mandrel is in the discharge configuration.

In another preferred embodiment of the apparatus, the surface of the mandrel has at least four radiused corners and four sides, the first die has an interior shape to hold a blank snugly in contact with two radiused corners and three sides of the surface, and the second die has an interior shape to hold the blank snugly in contact with the fourth side and two other radiused corners of the surface.

An alternative embodiment of the apparatus of the invention for forming a side wall or complete container having radiused corners includes an expandable mandrel, a first die, a second die, and sealing means. The mandrel has a shaping surface, having radiused corners, for shaping the side wall. The mandrel is adjustable between two configurations, a forming configuration in which the surface of the mandrel has a perimeter substantially equal to the perimeter of the side wall to be formed, and a discharge configuration in which the perimeter of the surface is less than the perimeter of the side wall to facilitate removal of a formed and sealed side wall from the mandrel. In the discharge position, the end of the mandrel normal to the shaping surface, on which end and end wall is placed if forming a container, moves outward to assist in the discharge of the formed container. The first die is movable to a position adjacent to a portion of the surface of the mandrel for wrapping a side wall blank around part of the surface while the mandrel is in the forming configuration. The second die is movable to a position adjacent another portion of the surface for wrapping the blank around the remainder of the surface while the mandrel is in the forming configuration and for causing two opposing edges of the blank to overlap. The sealing means seals the overlapping edges of the blank together to form a container side wall having radiused corners. If a complete container is being formed, an end wall is attached as described below.

The apparatus of the invention for sealing an end wall having an end wall flange to a nonround side wall includes an outer die having an aperture, a housing supporting a plurality of movable segments, means for positioning the housing in the aperture, and means for moving the segments. The

aperture of the outer die has a nonround cross-sectional shape and has a wall with at least one roughly linear portion and at least one radiused portion. The housing supports a plurality of segments in a plane. The means for positioning the housing in the aperture position the housing so that the plane in which the segments lie is approximately normal to the linear portion of the wall of the aperture. The segments are movable in the plane between a contracted configuration and an expanded configuration. The segments when in the expanded configuration define a continuous shape approximately identical to the cross-sectional shape of the aperture wall. The continuous shape defined by the segments includes at least one roughly linear portion and at least one radiused portion and each segment defines at least a portion of a roughly linear portion or of a radiused portion of the continuous shape. When the segments are in the contracted configuration they are spaced apart from the aperture wall. The means for moving the segments moves the segments simultaneously from the contracted configuration to the expanded configuration to seal together an end wall flange and a side wall positioned between the aperture wall and the segments.

In a preferred embodiment of this apparatus, the aperture of the outer die is rectangular and has four radiused portions and four linear portions. There are eight segments and each of the four radiused portions and four linear portions of the continuous shape are defined by a segment.

In another preferred embodiment of this apparatus, there is an opening between the segments and the means for moving the segments is a cam movable into the opening for engaging the segments to move the segments into the expanded configuration. Further, the housing supporting the segments

includes a top plate and a bottom plate and each segment has a pin and a slot, with one end of the slot nearer to and one end further from the opening, the diameter of the slot being larger than the diameter of the pin. Each segment is movably supported between the top and bottom plates by the pin which is attached at one end to the top plate and at the other end to the bottom plate and which passes through the slot in the segment. A compression spring is positioned in each slot between the pin and the nearer end of the slot to hold the segments in the contracted configuration when the cam is not in the opening.

In another preferred embodiment, a compression spring is positioned around a perimeter of the segments urging the segments into the contracted configuration.

In an alternative embodiment of the apparatus of the invention for sealing an end wall to a side wall where the end wall has an end wall flange, there is an outer die having an aperture with a first wall of constant perimeter and a second wall having a radiused surface, and a sealing means. The aperture of the outer die defines a first opening and a second opening on opposite sides of the die. Adjacent the first opening is the first wall of constant perimeter. Adjacent the second opening is the second wall having a radiused surface such that the width of the aperture decreases toward the second opening. There are means for moving a side wall having substantially the same perimeter as the first wall into the first opening and against the second wall of the aperture to form a curved portion in the inserted end of the side wall. The sealing means is movable into the second opening and into an operative position adjacent the first wall of the aperture to force the curved portion of the side wall

against an additional layer of material, such as the end wall flange, which is lying against the interior of the side wall, to form a side wall flange. The sealing means is expandable towards the perimeter of the first wall to seal the additional layer of material between the side wall and the side wall flange.

In another alternative embodiment of the apparatus of the invention for sealing an end wall to a side wall, where the side wall has a mandrel positioned therewithin, an outer die has an aperture defining first and second openings on opposite sides of the die. The aperture has a wall having a radiused surface so that the width of the aperture decreases toward the second opening. Means are provided for moving the end of a side wall having substantially the same perimeter as the first opening against the radiused surface to form a curved portion on the end of the side wall. A sealing means is provided which is movable from a position remote from the die into the second opening to press the curved portion of the side wall against an end wall, positioned within and normal to the side wall and between the curved portion and the mandrel, to form a side wall flange from the curved portion and to seal the side wall flange to the end wall.

According to the method of the invention for forming a side wall having radiused corners, a side wall blank is wrapped around a mandrel by causing rollers which are pivotably disposed on the leading edges of a die to roll along the surface of the blank and press the surface of the blank against the surface of the mandrel. The die has a pair of leading edges spaced apart from each other and the rollers are pivotably disposed on each of the leading edges and biased towards those rollers on the other leading edge. The mandrel has a generally rectangular surface and radiused corners and is adjustable

between a forming configuration and a discharge configuration. The forming configuration is for forming a side wall having radiused corners around said mandrel and the discharge configuration is for facilitating removal of a formed and sealed side wall from the mandrel. The die has an interior shape to snugly hold a blank in contact with two adjacent radiused corners of the mandrel. After wrapping the side wall blank around the mandrel, the overlapping edges of the blank are sealed together to form a container side wall having radiused corners. The mandrel is then adjusted to its discharge configuration to facilitate removal of the side wall from the mandrel.

In another method of the invention for forming a side wall having radiused corners, a side wall blank is wrapped around part of the surface of a mandrel by moving a first die to a position adjacent to a portion of the surface, wherein the surface has radiused corners. The blank is wrapped around the remainder of the surface and the two opposing edges of the blank are caused to overlap by moving a second die to a position adjacent to another portion of the surface. The overlapping edges of the blank are sealed together to form a container side wall having radiused corners. The mandrel is moved into a discharge configuration in which the perimeter of the surface is less than the perimeter of the side wall to facilitate the removal of the side wall from the mandrel.

According to the method of the invention for sealing an end wall to a nonround side wall, the end of the side wall is positioned within an aperture of an outer die. The aperture has a non-round cross-sectional shape with at least one roughly linear portion and at least one radiused portion. The end of the side wall has a perimeter substantially

identical to the shape of the aperture. The end of the side wall surrounds an end wall having an end wall flange lying adjacent the interior of the side wall. A housing supporting a plurality of segments in the plane normal to the aperture wall is then positioned within the end wall flange. The segments are movable between contracted and expanded configurations. When the segments are in the expanded configuration they define a continuous shape approximately identical to the perimeter of the aperture wall, each segment defining at least a portion of a roughly linear portion or a radiused portion of the continuous shape. When the housing is positioned within the end wall flange, the segments are in the contracted configuration in which they are spaced apart from the aperture wall. The segments are then expanded simultaneously from the contracted configuration outward to the expanded configuration to seal together the end wall flange and the end of the side wall.

In an alternative embodiment of the method of the invention for sealing a side wall to an end wall, a curved portion is preformed on the end of the side wall by inserting the end of the side wall into a first opening of an outer die and moving the end along a first wall adjacent the first opening having a constant perimeter and further against a curved wall adjacent a second opening on the opposing side of the die. An end wall is positioned within the end of the side wall such that a flange on the end wall lies adjacent the interior of the side wall positioned adjacent the first wall. A side wall flange is formed by inserting a sealing means into the second opening and into position adjacent the first wall to force the curved portion of the side wall against the end wall flange. The end wall flange is sealed between the side wall and the

side wall flange by expanding the sealing means toward the perimeter of the first wall. 0160251

In another alternative embodiment of the method of the invention for sealing a side wall to an end wall, an end wall is positioned within the end of the side wall normal to the inner surface thereof. A curved portion is preformed on the end of the side wall by inserting the end of the side wall into a first opening of an outer die and moving the end along a curved wall whose perimeter decreases as it approaches a second opening on the opposing side of the die. The curved portion is formed into a side wall flange by inserting a sealing means into the second opening to force the curved portion against the end wall. The side wall flange is then sealed to the end wall by forcing the side wall flange and the end wall between the sealing means and a mandrel positioned within the side wall.

Brief Description of the Drawings

These and other features and advantages of the present invention will be understood from a consideration of a detailed description of several preferred embodiments of the invention, taken in conjunction with the accompanying drawings, in which like reference characters denote like parts throughout, and in which:

FIG. 1A is a bottom perspective view of a nonround container having a U-shaped recessed seal between the side wall and the end wall;

FIG. 1B is a cross-sectional view taken from line 1B-1B in FIG. 1A, showing the configuration of the U-shaped recessed seal;

FIG. 2A is a bottom perspective view of a nonround container having a simple recessed seal between the side wall and the end wall;

FIG. 2B is a cross-sectional view taken from line 2B-2B in FIG. 2A, showing the configuration of the simple recessed seal;

FIG. 3 is a bottom perspective view of a blank from which the side wall of the nonround containers shown in FIGS. 1A and 2A can be formed;

FIG. 4 is a perspective view of an end wall having a peripheral flange from which the end wall of the nonround containers shown in FIGS. 1A and 2A can be formed;

FIG. 5A is a bottom perspective view of a nonround container having a flat seal between the side wall and the end wall;

FIG. 5B is a cross-sectional view taken from line 5B-5B is FIG. 5A, showing the configuration of the flat seal;

FIG. 6 is a perspective view of a blank from which the side wall of the nonround container shown in FIG. 5A can be formed;

FIG. 7 is a bottom perspective view of an end wall from which the end wall of the nonround container shown in FIG. 5A can be formed;

FIG. 8 is a schematic top plan view of the apparatus of the invention disposed at the stations of a six-station machine;

FIG. 9 is an exploded perspective view of apparatus at the first station for placing the end wall on one end of a mandrel in the discharge configuration;

FIGS. 10A-10E are views of the apparatus at the second station and the sequence of steps for forming a side wall using a die having rollers;

FIG. 11A is a cross-sectional view of the mandrel in the forming configuration taken from line 11A-11A of FIG. 9;

FIG. 11B is a cross-sectional view taken from line 11B-11B in FIG. 11A, showing the mandrel in the forming configuration;

FIG. 11C is a cross-sectional view of the mandrel in the discharge configuration;

FIG. 12A is a plan view of a die and an eight-piece sealing tool for sealing the end wall and the side wall;

FIG. 12B is a cross-sectional view taken from line 12B-12B of FIG. 12A, showing the outer die preforming the end of the sidewall;

FIG. 12C is a cross-sectional view showing the sealing tool in the contracted configuration having formed the side wall flange;

FIG. 12D is a cross-sectional view showing the sealing tool in the expanded configuration forming a U-shaped recessed seal between the side wall and the end wall;

FIG. 12E is a cross-sectional view, taken from line 12E-12E of FIG. 12A, showing the sealing tool in the contracted configuration;

FIG. 12F is a cross-sectional view showing a cam inserted in the sealing tool in the expanded configuration;

FIG. 12G is a plan view of the sealing tool with its top plate removed;

FIG. 13 is a cross-sectional view of apparatus for discharging the nonround container from the mandrel;

FIG. 14 is a cross-sectional view showing the outer die and the sealing tool for forming a simple recessed seal between the side wall and the end wall;

FIG. 15A is a top plan view of an alternative eight-piece expandable sealing tool;

FIG. 15B is a cross-sectional view showing the contracted sealing tool;

FIG. 16A is a top plan view of a pressure pad for sealing the end wall and the side wall;

FIG. 16B is a cross-sectional view showing the outer die having bent the end of the side wall 90°;

FIG. 16C is a cross-sectional view showing the pressure pad forming a flat seal between the end wall and the side wall;

FIGS. 17A-17E are views showing alternative apparatus at the second station and the sequence of steps for forming a side wall using a first and second die.

Detailed Description of
The Preferred Embodiments

Containers having a side wall and an end wall and having a round or nonround cross-sectional shape can be made according to the invention. Also according to the invention three types of seals can be made between the side wall and end wall; a U-shaped recessed seal; a simple recessed seal; and a flat seal.

FIGS. 1A and 1B show a container 10 having a U-shaped recessed seal 11 made according to one version of the invention. The container 10, which may have a round or nonround cross-sectional shape, is shown, by way of example only, as being of approximately rectangular cross section. The container 10 comprises a side wall 12 and an end wall 13. The side wall 12 is rectangular in cross section, having roughly linear portions 14 and radiused portions 15. Two opposing edges of the side wall 12 overlap and are sealed together to form a side seam 16. The end of the side wall 12 which is sealed to the end wall 13 is bent in toward the interior of the side wall 12 approximately 180° to form a side wall flange 17. The edge along the

entire perimeter of the end wall is bent down approximately 90° to form a peripheral end wall flange 18 (see FIG. 1B). The perimeter of the wall portion of the end wall 13 is approximately identical to the inner perimeter of the side wall 12 to allow the wall portion of the end wall 13 to lie in a plane normal to the side wall 12. The end wall flange 18 is sealed between the side wall flange 17 and that portion of the side wall 12 immediately adjacent the side wall flange 17.

FIGS. 2A and 2B show a nonround container 20 having a simple recessed seal 21 made according to another version of the invention. The nonround container 20, shown, by way of example only, as being of approximately rectangular cross section, comprises a side wall 22 and an end wall 13. The end wall 13 is identical to that shown in FIG. 1A, and the side wall 22 differs from that shown in FIG. 1A only in not having a side wall flange 17. As shown in Figure 2B, the end wall flange 18 is sealed to the inner surface at one end of the side wall 22.

FIG. 3 shows a blank 30 suitable for forming the side wall of the containers shown in FIGS. 1A and 2A. The blank 30 comprises paperboard or other relatively stiff, resilient, and bendable stock material 31 coated on one or, preferably, both sides 32, 33 with a thermoplastic material 34 such as polyethylene (coating thickness exaggerated). The blank can be formed into a side wall by being bent or wrapped around a mandrel so that two of its opposing edges overlap, and then having its overlapping edges sealed together.

FIG. 4 shows an end wall 13 suitable for use in the containers shown in FIGS. 1A and 2A. The end wall 13 comprises paperboard or other relatively stiff, resilient, and bendable stock material 31

coated on one, or preferably, both sides 40, 41 with a thermoplastic material 34 such as polyethylene (coating thickness exaggerated). The end wall 13 has a wall portion 42 and a peripheral end wall flange 18.

FIGS. 5A and 5B show a nonround container 50 having a flat seal 51 made according to another version of the invention. The nonround container 50, again shown, by way of example only, as being of approximately rectangular cross section, comprises a side wall 52 and an end wall 53. The side wall 52 is rectangular in cross section, having roughly linear portions 14 and radiused portions 15. Two opposing edges of the side wall 52 overlap and are sealed together to form a side seam 16. One edge of the side wall 52 is scored and is bent in toward the interior 54 of the side wall 52 about 90° to form a side wall flange 55. The end wall 53 has no peripheral flange. The perimeter of the end wall 53 is approximately the same as the inner perimeter of the side wall 52 so that the edge of the end wall 53 lies along the inner surface of the side wall 52.

FIG. 6 shows a side wall blank 60 suitable for forming the side wall 52 of the container 50 shown in FIG. 5. The blank 60 differs from the blank 30 shown in FIG. 3 only in having, along one edge 61, groups of regularly spaced scores 62 lying perpendicular to the edge 61, and a ridge 63 parallel to that edge 61 just above the scores 62. The side wall 52 is bent along the ridge 63 to form the side wall flange 55 for sealing to the end wall 53. The scores 62 permit the side wall flange 55 to lie flat against the end wall 53.

FIG. 7 shows an end wall 53 suitable for use in the container 50 shown in FIG. 5A. The end wall 53 differs from the end wall 13 shown in FIG. 4

only in not having a peripheral flange such as peripheral flange 18.

FIG. 8 is a schematic view showing, at six stations 81-86 of container-making machinery 80, the apparatus of the invention. The apparatus is shown in greater detail in FIGS. 9 through 18.

FIG. 9 shows, in an exploded view, apparatus 90 at the first station 81 for positioning an end wall 13 on one end of a mandrel 91. The mandrel 91, described in more detail below, is attached to a turret 92 at the center of the machine 80 so the mandrel 91 can be moved sequentially to each of the six stations 81-86 of the machine 80. There are six mandrels 91 attached to the turret 92 so that each of the stations 81-86 is occupied at all times (except during indexing of the turret 92).

A magazine 95 delivers an end wall 13, having an end wall flange 18, to the end of the mandrel 91, which is in its discharge configuration as described below in connection with FIGS. 11A-11C. In the discharge configuration, the end 93 of the mandrel 91 moves up against the wall portion 42 of the first end wall 13 in magazine 95. The end wall flange 18 projects approximately 90° away from the end 93 of the mandrel 91. Suction applied through ducts 94 in the mandrel 91 thereafter holds the end wall 13 on the mandrel 91, removing it from the magazine as the mandrel 91 is indexed to the next station 82. The perimeter of the wall portion 42 of the end wall 13 and the perimeter of the mandrel 91 in its forming configuration are approximately the same as the inner perimeter of the side wall 12 to be formed.

FIGS. 10A-10E show the preferred apparatus at the second station 82 for forming the side wall 12, and the sequence of operation thereof. A single die 100 having rollers 101 is used.

FIG. 10A is a partial side elevational view of the die 100 having rollers 101, and FIGS. 10B-10D are end views thereof. The die 100 has a pair of leading edges 102 spaced apart from each other, and on each leading edge 102 is a roller 101 biased towards the roller 101 on the other leading edge 102. The rollers 101 are disposed about a first shaft 1030 which is mounted at the distal end of a lever 103. The lever 103 is pivotably disposed about a second shaft 1031 which is mounted on the leading edge 102 of the die 100. Auxiliary rollers 104 are disposed about a third shaft 1032 which is mounted at the proximal end of the lever 103. Springs 1033 are coiled about the second shaft 1031 and have one end in contact with the lever 103 and the other end in contact with the die 100 to cause the rollers 101 to be spring-biased inward.

A clamp 106 is mounted on a reciprocating piston 107. The clamp 106 is movable from a first position out of contact with the mandrel 91, to a second position adjacent the shaping surface of the mandrel 91 for placing and holding the blank 30 in proper alignment against the surface of the mandrel 91 during forming of the side wall 12.

A sealing means 109 is mounted above the mandrel 91. After the die 100 is moved to its operative position, the sealing means 109 can be pushed down to contact with overlapping edges 108, 1080 of the side wall 12 for sealing of the edges.

The sequence of steps for forming a side wall 12 with the die 100 is shown in FIGS. 10B-10E. As shown in FIG. 10B, the feeder (not shown) delivers a flat side wall blank 30 (whose opposing edges 108, 1080 have previously been heated by any suitable means) between the top edges of the die 100 and the bottom of the mandrel 91 while the die 100 is in its remote position. The blank 30, which in

any case must be longer than the perimeter of the mandrel 91 on its forming configuration in order for edges 108, 1080 to overlap, is preferably fed slightly of center so that the visible edge of seam 16 will be formed in the center of the top side 913 of the mandrel 91. As shown in FIG. 10B, the clamp 106 is then moved into position to place and hold the blank 30 in alignment against the bottom of the mandrel 91 during forming.

As shown in FIG. 10C, the die 100 is then moved into position adjacent the mandrel 91 which is in its forming configuration. The rollers 101 are forced apart when auxiliary rollers 104 contact cams 105 so that rollers 101 roll up opposing sides of the mandrel 91, causing the side wall blank 30 to wrap around the mandrel 91. Because blank 30 has been fed off-center, edge 108 is higher than edge 1080 so that, when edge 108 is bent under edge 1080, edge 1080, forming the visible edge of seam 16, will be in the center of side 913.

As shown in FIG. 10D, the rollers 101 roll all the way around the top of the mandrel 91 to cause opposing edges 108, 1080 of the side wall 12 to overlap. After the die 100 and rollers 101 are in position surrounding nearly all of the mandrel 91, the sealing means 109 is moved into contact with the outer edge of the side wall 12 to seal the overlapping edges 108, 1080 together. The finished seam 16 is shown in FIG. 10E.

FIGS. 11A-11C show in greater detail the three-way expandable mandrel 91 used to form the side wall 12. The shaping surface perimeter 111 of the mandrel 91 is approximately rectangular in cross section and includes four radiused corners 910, 914. The mandrel 91 comprises in cross section a central segment 113 linearly disposed between two outer segments 114, along with an end plate 115. The cen-

tral segment 113 has opposing linear walls 911, for forming two sides of the side wall 12, and the outer segments are each shaped for forming one side and two adjacent radiused corners of the side wall 12.

The mandrel 91 is adjustable between a forming configuration and a discharge configuration. During formation of the side wall 12, the mandrel is in the forming configuration in which the perimeter of its cross section is approximately identical to the inner perimeter of the side wall 12 to be formed. In the forming configuration the two outer segments 114 are spaced farther from the central segment 113 than when the mandrel 91 is in the discharge configuration and end plate 115 is closer to central segment 113. The mandrel 91 is adjustable to the discharge configuration, in which the perimeter of its cross section is less than the inner perimeter of the side wall 12, by moving the two outer segments 114 toward the central segment 113 and moving the end plate 115 away from central segment 113. Contraction of the outer segments 114 of the mandrel 91 permits the side wall 12 to be easily removed end-first from the mandrel 91, as described below. With nonround side walls, especially those having tightly radiused corners, removal would be quite difficult without such contraction. Extension of the end plate 115 imparts an initial discharge impulse to a finished container, also as described below.

FIG. 11B shows in cross section the four-piece mandrel 91 in the forming configuration. A shaft 116, attached to end plate 115, is slidably disposed within a central chamber 1130 in the central segment 113. The shaft 116 has wider diameter portions 1160 and narrower diameter portions 1161, and a cam follower 1162 at the end thereof which is shown on the right in Fig. 11B. An air duct 1134,

supplied by tube 1133, runs through the center of the shaft 116. A spring 117 is disposed in the central chamber 1130. Near each end of the central chamber 1130 are a set of upper chambers 1131 and lower chambers 1132. In each of the upper and lower chambers 1131, 1132 is a bar 118 which is connected to an outer segment 114 of the mandrel 91. The central portion of each bar 118 is surrounded by a spring 1180. A roller 1181 is disposed at one end of each bar 118 and is in contact with the shaft 116.

At stations 82-85, mandrel 91 is in its forming configuration, as shown in FIG. 11B. The shaft 116 is forced to the right by the spring 117 in the central chamber 1130 keeping end plate 115 against central segment 113. The rollers 1181 contact the wider diameter portions 1160 of the shaft 116 forcing the outer segments 114 away from the central segment 113.

Mandrel 91 can be adjusted to its discharge configuration, as shown in FIG. 11C, when cam follower 1162 contacts a cam (not shown) on turret 92 at station 86. The cam causes the shaft 116 to move to the left, compressing the spring 117. The rollers 1181 roll down inclined surfaces 1163 of the shaft 116 as it moves to the left and stop at the narrower diameter portions 1161 of the shaft 116 causing the outer segments 114 to move into contact with the central segment 113. The leftward movement of shaft 116 also moves end plate 115 away from the central segment 113.

Apparatus (not shown) at the third and fourth stations 83 and 84 is used for heating the areas of the end wall 13 and the side wall 12 to be sealed. The heat may be applied, for example, by means of a hot gas or as radiant heat. Any conventional heating means may be used. Heat can be applied gently because the areas to be sealed are heated at

two stations, rather than one, resulting in a greater total dwell time at the heaters than in conventional apparatus. The extra heating station is available because the preforming of the end of the side wall and the attachment of the end wall to the preformed end of the side wall both take place at one station, rather than at two stations as in conventional apparatus.

Figures 12A-12G show apparatus at the fifth station 85 for forming a U-shaped recessed seal 11 between the side wall 12 and the end wall 13.

Figure 12A is a top plan view showing an outer die or pilot 120 having an aperture 121 and within the aperture 121 an expandable sealing tool 122 comprised of movable segments 1222-1229. These segments have an opening 123 between them for a cam 124 to enter and expand the segments.

Figure 12B is a cross-sectional view of an outer die 120 shown preforming the end of the side wall 12. The outer die 120 has an aperture 121 therethrough defining a first opening 1210 and a second opening 1211 on opposite sides of the die 120. The aperture 121 has, adjacent the first opening 1210, a first wall 1201 having a constant perimeter, and, adjacent the second opening 1211, a second wall 1202 having a radiused surface 1203. The width of the aperture 121 decreases toward the second opening 1211.

The outer die 120 and sealing tool 122 are mounted on a reciprocating piston 125. The piston 125 pushes the outer die 120 against one end of the side wall 12 to preform a bent edge 126. The side wall 12 may be channelled into the aperture by an angled lead 127, as shown. The end of the side wall 12 moves down the first wall 1201 and is bent at the

radiused surface 1203. The pilot 120 then stops moving as it encounters a first stop 128.

As shown in Figure 12C, the piston 125 continues forward, compressing spring 1250, moving the contracted sealing tool 122 into the second opening 1211 and into an operative position adjacent the first wall 1201 of the aperture 121 to force the bent edge 126 of the side wall 12 up against the end wall flange 18 to form a side wall flange 17. The sealing tool 122 stops moving when it encounters end plate 115 of mandrel 91.

As shown in Figure 12D, the piston 125 continues forward, compressing springs 1251, to move a cam 124 into the opening 123 between the segments. The contracted sealing tool 122 is thus moved into the expanded configuration to form a heat and pressure seal 11 between the side wall flange 17, the end wall flange 18, and the side wall 12. After sealing, the sealing tool 122 is contracted and the outer die 120 and sealing tool 122 are moved away from the mandrel 91.

Figures 12E-12G show in greater detail the expandable sealing tool 122.

Figure 12E shows in cross section the sealing tool 122 in the contracted configuration. The sealing tool 122 consists essentially of a top plate 1220, a bottom plate 1221, and segments 1222-1229 slidably disposed between the plates 1220, 1221. There is an opening 123 between the segments 1222-1229. For each segment, at least one pin 1230, attached at each end to the top and bottom plates 1220, 1221, respectively, passes through a slot 1231 in the respective segment to hold the segment between the plates 1220, 1221. The slot 1231 is larger than the diameter of the pin 1230 to allow movement of the segment about the pin 1230 and therefore with respect to the plates 1220, 1221. A compression

spring 1232 is positioned in the slot 1231 between the pin 1230 and the end of the slot 1231 nearer the opening 123 to hold the segment in the contracted configuration when the cam 124 is not in the opening 123.

As shown in Figure 12F, when the cam 124 is inserted in the opening 123 between the segments, it contacts the sloped edge 1233 of each segment forcing each segment radially outward. The spring 1232 contracts and the pin 1230 is now located toward the middle of the slot 1231.

Figure 12G is a top plan view of the sealing tool 122 with the top plate 1220 removed. There are eight segments 1222-1229 comprising four corner segments 1222-1225, two end segments 1226-1227, and two side segments 1228-1229. The segments have overlapping edges, constituting projections 1234 which fit into adjacent grooves 1235, so that when the sealing tool 122 is in the expanded configuration, a complete perimeter is formed. As previously described, each segment has a slot 1231 through which it is attached to the top and bottom plates 1220, 1221 by means of a pin 1230, and a spring 1232 within that slot 1231. When the cam 124 enters the opening 123 between the segments, all segments are moved simultaneously outward to form a heat and pressure seal of equal force along the entire perimeter of the side wall 12.

FIG. 13 shows the discharge of the container 10 off the mandrel 91 at the sixth station 86. The mandrel 91 is first moved from its forming to its discharge configuration as described above. Then pressurized air is then sent through ducts 94 connected to air passage 1131 in the mandrel 91 directing a stream of air A against the inner surface 130 of the end wall which forces the container 10 off the mandrel 91 in the direction of arrow B. The

container is given an initial impulse by the movement of end plate 115 as the mandrel 91 is adjusted to its discharge configuration. The perimeter of end plate 115 is very slightly (e.g., 0.015 inch) less than the perimeter of the remainder of the mandrel in the forming configuration, so that the container does not bind on end plate 115 as it is being discharged. Spring 117 causes the mandrel to return to the forming configuration on leaving the sixth station 86.

When the mandrel 91 returns to the first station 81, another cam on turret 92 causes the mandrel 91 to again move into its discharge configuration. As end plate 115 is extended from the mandrel, it approaches a magazine of end wall blanks. At the same time, vacuum is applied through ducts 94, so that an end wall blank is drawn to the mandrel 91. The vacuum is maintained until discharge at the sixth station 86, but mandrel 91 returns to the forming configuration after leaving the first station 81.

FIG. 14 shows alternative apparatus at the fifth station 85 for forming a simple recessed seal 21 between the side wall 22 and the end wall 13. This apparatus differs from that shown in FIGS. 12A-12G only in that the second wall 141 of the outer die 140 is a 90° corner rather than a radiused surface. The outer die 140 is pushed against one end of the side wall 22 forcing the end into the first opening 142 and up to the 90° corner, without forming a bent edge. The contracted sealing tool 122 then enters and expands to seal the end wall flange 18 to the side wall 22.

FIGS. 15A and 15B show an alternative eight-piece sealing tool 150. FIG. 15A is a top plan view of the eight-piece sealing tool 150 showing eight outer segments 1501-1508 -- two side segments 1501-1502, four corner segments 1503-1506, and two end

segments 1507-1508, surrounding a central segment 1509. A spring 151 located in a groove 152 and the perimeter of the side, corner, and end segments 1501-1508 holds these outer segments 1501-1508 in contact with the central segment 1509 when the sealing tool 150 is in the contracted configuration. Again the segments 1501-1508 have overlapping edges 153 so that when the sealing tool 150 is in the expanded configuration a complete perimeter is formed.

FIG. 15B shows in cross section the sealing tool 150 in the contracted configuration. The central segment 1509 of the sealing tool 150 is attached to a base plate 154 which is attached to a reciprocating piston 125.

In the expanded configuration, each of the side, corner, and end segments are held away from the central segment, overcoming the force of the spring 151, by at least one pneumatically-driven piston 155, disposed within an airtight chamber 156 within the central segment 1509. A compressed air supply line (not shown) is connected to the chamber 156.

FIGS. 16A-16D show alternative apparatus at the fifth station 85 for forming a flat seal 51 between the side wall 52 and the end wall 53. The apparatus comprises a pressure pad 160 and the outer die 120 previously described in FIGS. 12A-12G for preforming a bent edge 55 on the side wall 52.

FIG. 16A is a top plan view of the pressure pad 160. The perimeter of the pad 160 is slightly less than the inner perimeter of the side wall 52. Along the edge of the pad are radial grooves 161 for forming a knurled seal.

FIG. 16B is a cross-sectional view showing the outer die 120 in position having preformed the edge 55 of the side wall 52. The side wall 52 is channelled into the first opening 1210 by the angled

lead 127 and then proceeds down the first wall 1201 and is bent at the radiused surface 1203.

As shown in FIG. 16C, the pressure pad 160 is then moved upward to force the bent edge 55 against the end wall 53 and to form a heat and pressure seal therebetween. The mandrel 91 positioned within the side wall 52 acts as a restraining wall.

FIGS. 17A-17E show an alternative embodiment of apparatus at the second station 82 for forming a side wall 12, and the sequence of operation thereof.

FIG. 17A shows the mandrel 91 and the first die 170 and second die 171 disposed respectively below and above the mandrel 91. The dies 170, 171 are in a remote position out of contact with the mandrel 91. A suitable feeder (not shown) delivers a side wall blank 30 between the mandrel 91 and the first die 170. The opposing edges 108, 1080 of the blank 30 which will form the side wall seam 16 are heated prior to delivery.

The first die 170 has two segments 1700, 1701 and an interior 1702 shaped to fit snugly around two radiused corners 910 and three sides 911 of the mandrel 91. An aperture 176 between the two segments 1700, 1701 defines an area for the clamp 106 to hold the blank 30 against the mandrel 91 during forming, as shown in FIG. 17B. The first die 170 is mounted on a reciprocating piston 177 and is movable from the remote position shown in FIG. 17A, to an operative position adjacent a portion of the shaping surface of the mandrel 91 as shown in FIG. 17C.

The second die 171 has two segments 1710, 1711 and an interior 1712 shaped to fit snugly around the fourth side 913 and other two radiused corners 914 of the mandrel 91 in its forming configuration. An aperture 178 between the two segments 1710, 1711 of the second die 171 defines an area for sealing means 109 to contact and seal together the overlapping edges 108,

1080 of the side wall 12. Each segment 1710, 1711 of the second die 171 is mounted on a rod 1713 connected to a reciprocating piston 1714. The second die 171 is movable from the remote position shown in FIGS. 17A-17C, to an operative position shown in FIG. 17D wherein the first die 170 is adjacent a portion of the shaping surface of the mandrel 91 and the second die 171 is adjacent another portion of the shaping surface.

As shown in FIG. 17C, the first die 170 is moved to its operative position adjacent a portion of the shaping surface of the mandrel 91 and in so moving causes the blank 30 to wrap part way around the surface. The second die 171 is then moved from its remote position, shown in FIGS. 17A-17C, to its operating position shown in FIG. 17D, adjacent another portion of the shaping surface to cause the blank 30 to wrap the rest of the way around the surface. As shown in FIG. 17E, the sealing means 109 is then moved down into contact with the outer surface of the outer side wall edge 1080 to form a heat and pressure seal between the two opposing edges 108, 1080 of the side wall 12.

The nonround containers shown in FIGS. 1A and 2A can also be made with the apparatus of the invention disposed at the stations of commercially-available box-making machinery. Examples of suitable box-making machinery which can be adapted for use with the apparatus of the invention include Paper Machinery Corp. Model G-1500 or Sherwood Tool, Incorporated Models SW-82 and SW-83.

Although the invention has been described above by reference to several preferred embodiments, many additional modifications and variations thereof will now be apparent to those skilled in the art.

Accordingly, the scope of the invention is to be limited not by the details of the illustrated embodiments described herein but only by the terms of the appended claims.

WHAT IS CLAIMED IS:

1. Apparatus for forming a container side wall, wherein said apparatus is characterized by

a mandrel (91) having a shaping surface and being adjustable between a forming configuration (Fig. 11B) in which said surface has a perimeter substantially equal to the perimeter of the side wall (12, 22, 52) to be formed, and a discharge configuration (Fig. 11C) in which the perimeter of said surface is less than the perimeter of the side wall to facilitate removal of a formed and sealed side wall from said mandrel;

die means (100, 170, 171) having a pair of leading edges (102, 1700-01, 1710-11) spaced apart from each other and having an interior shaped to hold a blank (30) snugly in contact with said surface of said mandrel; said die means being movable from a first position remote from said mandrel to a second position adjacent to a portion of said surface to contact the blank (30) positioned between said mandrel (91) and a part (101, 1700-01) of said die means in said first position, to force the blank against said mandrel, and to urge the surface of the blank to wrap the blank around the shaping surface of said mandrel, to conform to said shaping surface and to cause two opposing edges (108, 1080) of the blank to overlap; and

sealing means (109) for sealing the overlapping edges of the blank together to form the container side wall.

2. Apparatus according to claim 1 for forming a side wall having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners; said die means comprises

first die means (170) movable from a position remote from said mandrel to an operative position adjacent a portion of said surface for wrapping a side wall blank around part of said surface while said mandrel is in said forming configuration, and

second die means (171) movable from a position remote from said mandrel to an operative position adjacent another portion of said surface for wrapping the blank around the remainder of said surface while said mandrel is in said forming configuration and for causing two opposing edges of the blank to overlap; and

said sealing means seals the overlapping edges of the blank together to form a container side wall having radiused corners.

3. Apparatus for sealing an end wall to the side wall formed on the mandrel of the apparatus of claim 1 and while said mandrel is in said forming configuration, characterized by

an outer die having an aperture therethrough defining a first opening and a second opening on opposite sides of said die; said aperture having, adjacent said first opening, a first wall having a constant perimeter, and said aperture having, adjacent said second opening, a second wall having a radiused surface, the width of said aperture decreasing toward said second opening; means for moving the end of a side wall having substantially the same perimeter as said first wall into said first opening and against said second wall of said aperture to form a curved portion in said end of the side wall; and

sealing means movable from a position remote from said die into said second opening and into an operative position adjacent said first wall of said aperture to force the curved portion of the side wall against an additional layer of material lying against the interior of the sidewall to form a side wall flange, and said sealing means being expandable toward said perimeter of said first wall for sealing the additional layer of material between the side wall and the side wall flange.

4. Apparatus according to claim 1 for forming a container having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners; said discharge configuration is one in which an end plate of said mandrel normal to the shaping surface thereof is extended longitudinally of said mandrel to facilitate removal of a formed container from said mandrel and to feed an end wall to said mandrel; said die means (170, 171) comprises

first die means (170) movable from a position remote from said mandrel to an operative position adjacent a portion of said surface for wrapping a side wall blank around part of said surface while said mandrel is in said forming configuration, and

second die means (171) movable from a position remote from said mandrel to an operative position adjacent another portion of said surface for wrapping the blank around the remainder of said surface while said mandrel is in said forming configuration and for causing two opposing edges of the blank to overlap;

said side wall sealing means is arranged to seal the overlapping edges of the blank together to form a container side wall having radiused corners;

and further comprising

an outer die having an aperture having a nonround cross-sectional shape, said aperture having a wall with at least one roughly linear portion and at least one radiused portion;

a housing supporting a plurality of segments in a plane, said segments being movable in said plane between a contracted configuration and an expanded configuration;

means for positioning said housing in said aperture with said plane approximately normal to said linear portion of said wall of said aperture;

said segments, when in said expanded configuration, defining a continuous shape approximately identical to said cross-sectional shape of said aperture wall, whereby said continuous shape defined by said segments includes at least one roughly linear portion and at least one radiused portion; each said segment defining at least a portion of a respective one of said portions of said continuous shape; and said segments, when in said contracted configuration, being spaced apart from said aperture wall; and

means for moving said segments simultaneously from said contracted configuration to said exparded configuration for sealing together an end wall flange and a side wall positioned between said aperture wall and said segments.

5. Apparatus according to claim 1 for forming a container having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners; said discharge configuration is one in which an end plate of said mandrel normal to the shaping surface thereof is extended longitudinally of said mandrel to facilitate removal of a formed container from said mandrel and to feed an end wall to said mandrel; said die means (170, 171) comprises

first die means (170) movable from a position remote from said mandrel to an operative position adjacent a portion of said surface for wrapping a side wall blank around part of said surface while said mandrel is in said forming configuration, and

second die means (171) movable from a position remote from said mandrel to an operative position adjacent another portion of said surface for wrapping the blank around the remainder of said surface while said mandrel is in said forming configuration and for causing two opposing edges of the blank to overlap;

said side wall sealing means is arranged to seal the overlapping edges of the blank together to form a container side wall having radiused corners; and further comprising

an outer die having an aperture therethrough defining a first opening and a second opening on opposite sides of said die; said aperture having, adjacent said first opening, a first wall having a constant perimeter, and said aperture having, adjacent said second opening, a second wall having a radiused surface, the width of said aper-

ture decreasing toward said second opening; means for moving the end of a side wall having substantially the same perimeter as said first wall into said first opening and against said second wall of said aperture to form a curved portion in said end of the side wall; and

end wall sealing means movable from a position remote from said outer die into said second opening and into an operative position adjacent said first wall of said aperture to force the curved portion of the side wall against an additional layer of material lying against the interior of the side wall to form a side wall flange, and said end wall sealing means being expandable toward said perimeter of said first wall for sealing the additional layer of material between the side wall and the side wall flange.

6. Apparatus according to claim 1 for forming a container having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners; said discharge configuration in one in which said perimeter of said surface is less than the perimeter of the side wall and in which an end plate of said mandrel normal to the shaping surface thereof is extended longitudinally of said mandrel to facilitate removal of a formed container from said mandrel and to feed an end wall to said mandrel; said die means (170, 171) comprises

first die means (170) movable from a position remote from said mandrel to an operative position adjacent a portion of said surface for wrapping a side wall blank around part of said surface while said mandrel is in said forming configuration,and

second die means(171) movable from a position remote from said mandrel to an operative position adjacent another portion of said surface for wrapping the blank around the remainder of said surface while said mandrel is in said forming configuration and for causing two opposing edges of the blank to overlap;

said side wall sealing means is arranged to seal the overlapping edges of the blank together to form a container side wall having radiused corners; and further comprising

an outer die having an aperture therethrough defining a first opening and a second opening on opposite sides of said die; said aperture having a wall having a radiused surface, the width of said aperture decreasing toward said second opening; means for moving the end of a side wall having substantially the same perimeter as said first wall into said first opening and against said radiused surface of said aperture to form a curved portion in said end of the side wall; and

end wall sealing means movable from a position remote from said outer die into said second opening to press the curved portion of the side wall against an end wall positioned normal to the side wall and between the curved portion and said mandrel to seal the curved portion to said end wall.

7. Apparatus according to claim 1 for forming a container, characterized in that an end plate of said mandrel extending normal to the shaping surface thereof is projected longitudinally of said mandrel when in said discharge configuration to facilitate feeding of an end wall to said mandrel;

said die means (100) includes a pair of rollers each pivotably disposed on a different one of said leading edges, each roller being biased toward that roller on the other said leading edge; said rollers are arranged to contact said blank positioned between said mandrel and said die means when said die means moves from said first position to said second position, wherein said rollers roll along the surface of the blank to wrap the blank around said shaping surface; and including

means for sealing an end wall to said side wall while said mandrel is in said forming configuration.

8. Apparatus according to claim 7 for forming a container having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners; said rollers of said die means are arranged to roll along the surface of the blank to wrap the blank around said shaping surface and to form radiused corners in the blank which conform to said radiused corners of said shaping surface; said side wall sealing means seals the overlapping edges of the blank together to form the container side wall with radiused corners; and further comprising

an outer die having an aperture having a nonround cross-sectional shape, said aperture having a wall with at least one roughly linear portion and at least one radiused portion; and wherein said end wall sealing means comprises

a housing supporting a plurality of segments in a plane, said segments being movable in said plane between a contracted configuration and an expanded configuration;

means for positioning said housing in said aperture of said outer die with said plane approximately normal to said linear portion of said wall of said aperture;

said segments, when in said expanded configuration, defining a continuous shape approximately identical to said cross-sectional shape of said aperture wall, whereby said continuous shape defined by said segments includes at least one roughly linear portion and at least one radiused portion; each said segment defining at least a portion of a respective one of said portions of said continuous shape; and said segments, when in said contracted configuration, being spaced apart from said aperture wall; and

means for moving said segments simultaneously from said contracted configuration to said expanded configuration for sealing together an end wall flange and a side wall positioned between said aperture wall and said segments.

9. Apparatus according to claim 7 for forming a container for having radiused corners, characterized in that said shaping surface of said mandrel has radiused corners, said rollers of said die means are arranged to roll along the surface of the blank to wrap the blank around said shaping surface and to form radiused corners in the blank which conform to said radiused corners of said surface of said

mandrel; said side wall sealing means is arranged to seal the overlapping edges of the blank together to form a container side wall having radiused corners; and further including

an outer die having an aperture therethrough defining a first opening and a second opening on opposite sides of said die; said aperture having, adjacent said first opening, a first wall having a constant perimeter, and said aperture having, adjacent said second opening, a second wall having a radiused surface, the width of said aperture decreasing toward said second opening; means for moving the end of a side wall having substantially the same perimeter as said first wall into said first opening and against said second wall of said aperture to form a curved portion in said end of the side wall; and

said end wall sealing means is movable from a position remote from said outer die into said second opening and into an operative position adjacent said first wall of said aperture to force the curved portion of the side wall against an additional layer of material lying against the interior of the side wall to form a side wall flange, and said end wall sealing means being expandable toward said perimeter of said first wall for sealing the additional layer of material between the side wall and the side wall flange.

10. Apparatus according to claim 7 for forming a container having radiused corners, characterized in that said shaping surface of said material has radiused corners, said rollers of said die means are arranged to roll along the surface of the blank to wrap the blank around said shaping surface and to form radiused corners in the blank which conform to said radiused corners of said surface of said mandrel; said side wall sealing means is arranged to seal the overlapping edges of the blank together to form a container side wall having radiused corners; and further comprising

an outer die having an aperture therethrough defining a first opening and a second opening on opposite sides of said die; said aperture having a wall having a radiused surface, the width of said aperture decreasing toward said second opening; means for moving the end of a side wall having substantially the same perimeter as said first wall into said first opening and against said radiused surface of said aperture to form a curved portion in said end of the side wall; and

said end wall sealing means is movable from a position remote from said outer die into said second opening to press the curved portion of the side wall against an end wall positioned normal to the side wall and between the curved portion and said mandrel to seal the curved portion to said end wall.

11. The apparatus of any of claims 1,2,4,5,6,8,9 or 10, wherein said surface perimeter of said mandrel is apparoximately rectangular and includes for radiused corners, and wherein said mandrel comprises a first outer segment having two of said four radiused corners, a second outer segment having the other two of said four radiused corners, and a central segment disposed between said outer segments; said mandrel, when in said discharge configuration, having said outer segments relatively close to said central segment and, when in said forming configuration, having said outer segments each spaced farther from said central segment than when said mandrel is in said discharge configuration.

12. The apparatus of any of claims 2,4,5 or 6, wherein said surface of said mandrel comprises at least four said radiused corners and four sides, said first die has an interior shaped to hold a blank snugly in contact with two said radiused corners and three said sides of said surface, and said second die has an interior shaped to hold a blank snugly in contact with the fourth said side and two other said radiused corners of said surface.

13. The apparatus of any of claims 3, 5 or 9, wherein said additional layer of material is an end wall flange depending from said end wall.

14. The apparatus of any of claims 3, 5 or 9, wherein said sealing means comprises:

a housing supporting a plurality of segments in a plane, said segments being movable in said plane between a contracted configuration and an expanded configuration;

means for positioning said housing in said aperture with said plane approximately normal to said linear portion of said wall of said aperture;

said segments, when in said expanded configuration, defining a continuous shape approximately identical to said cross-sectional shape of said aperture wall, whereby said continuous shape defined by said segments includes at least one roughly linear portion and at least one radiused portion; each said segment defining at least a portion of a respective one of said portions of said continuous shape; and said segments, when in said contracted configuration, being spaced apart from said aperture wall; and

means for moving said segments simultaneously from said contracted configuration to said expanded configuration for sealing together said end side wall flange and said additional layer of material.

15. The apparatus of claim 4 or 14, characterized in that said segments have an opening between them, and wherein said moving means comprises a cam movable into said opening for engaging said segments to move said segments into said expanded configuration.

16. The apparatus of claim 15, characterized in that said housing comprises a top plate and a bottom plate, each of said segments having a pin, and each of said segments having a slot larger than the diameter of said pin and having one end nearer and one end further from said opening; each said segment being movably supported between said top and bottom plates by said pin attached at one end to said top plate and at the other end to said bottom plate and passing through said slot in said segment; and a respective compression spring positioned in each said slot between said pin and said nearer end of said slot for holding said segments in said contracted configuration when said cam is not in said opening.

17. The apparatus according to any one of claims 4, 8, or 14, characterized by a compression spring positioned around the perimeter of said segments for urging said segments into said contracted configuration.

18. A method for forming a container side wall, characterized by the steps of:

wrapping a side wall blank around a mandrel by moving a die means to a position adjacent to and surrounding a portion of said mandrel, said die means having a pair of leading edges spaced apart from each other ; said mandrel being adjustable between

a forming configuration and a discharge configuration, said forming configuration being for forming a side wall around said mandrel and said discharge configuration being for facilitating removal of a formed and sealed side wall from said mandrel; said die means having an interior shaped to snugly hold a blank in contact with said mandrel; said wrapping being accomplished by said die means urging the surface of the blank and pressing the surface of the blank against said surface of said mandrel;

sealing the overlapping edges of the blank together to form a container side wall; and

adjusting said mandrel to said discharge configuration to facilitate removal of said side wall from said mandrel.

19. A method according to claim 18 for forming a side wall having radiused corners, characterized by

wrapping the side wall blank around part of the surface of a mandrel by moving said die means to a position adjacent a portion of said surface, said surface having radiused corners;

wrapping the blank around the remainder of said surface and causing two opposing edges of the blank to overlap by moving another die means to a position adjacent another portion of said surface;

sealing the overlapping edges of the blank together to form a container side wall having radiused corners; and

adjusting said mandrel to said discharge configuration by causing the perimeter of said surface to be less than the perimeter of said side wall.

20. A method for sealing an end wall to a nonround side wall formed according to the method of claim 18 and while said mandrel is in said forming configuration, characterized by

positioning an end wall within the end of a side wall;

preforming a curved portion on said end of said side wall by inserting said end into a first opening of an outer die and moving said end along a first wall adjacent said first opening and having a constant perimeter and further against a curved wall adjacent a second opening on the opposing side of said die, said end wall having a flange lying adjacent a portion of the interior of said side wall positioned adjacent said first wall;

forming a side wall flange by inserting a sealing means into said second opening and into an operative position adjacent said first wall to force the curved portion of said side wall against said end wall flange, said sealing means comprising a housing supporting a plurality of segments in a plane normal to said side wall, said segments being movable in said plane between a contracted configuration and an expanded configuration, said segments when in said expanded configuration defining a continuous shape approximately identical to the perimeter of said side wall, each said segment defining at least a portion of a respective one of said roughly linear portions and said radiused portions of said continuous shape, and said segments when in said contracted configuration being spaced apart from said side wall; and

sealing said end wall flange between said side wall and said side wall flange by expanding said segments simultaneously from said contracted configuration outward to said expanded configuration.

21. A method according to claim 18 for forming a container having radiused corners, characterized by

positioning an end wall on the distal end of the mandrel;

wrapping the side wall blank around part of the surface of said mandrel by moving the die means to a position adjacent a portion of said surface, said surface having radiused corners;

wrapping the blank around the remainder of said surface and causing two opposing edges of the blank to overlap by moving another die means to a position adjacent another portion of said surface;

said side wall sealing step including forming a container side wall having radiused corners; and further comprising

positioning within an aperture of an outer die the end of said side wall, the wall of said aperture having a nonround cross-sectional shape with at least one roughly linear portion and at least one radiused portion, the end of said side wall having a perimeter substantially identical to said shape of said aperture wall, said end wall having a flange lying adjacent the interior of said side wall;

positioning within said end wall flange a housing supporting a plurality of segments in a plane normal to said aperture wall, said segments being movable in said plane between a contracted configuration and an expanded configuration, said segments when in said expanded configuration defining a continuous shape approximately identical to the perimeter of said aperture wall, each said segment defining at least a portion of a respective one of said portions of said continuous shape, and said segments when in said contracted configuration being spaced apart from said aperture wall;

expanding said segments simultaneously from said contracted configuration thereof outward to said expanded configuration thereof for sealing together said end wall flange and said end of said side wall; and

adjusting said mandrel to a discharge configuration facilitate removal of said container from said mandrel and to feed an end wall to said mandrel.

22. A method according to claim 18 for forming a container having radiused corners, characterized by

positioning an end wall on the distal end of the mandrel;

wrapping the side wall blank around part of the surface of said mandrel by moving the die means to a position adjacent a portion of said surface, said surface having radiused corners;

wrapping the blank around the remainder of said surface and causing two opposing edges of the blank to overlap by moving another die means to a position adjacent another portion of said surface; said side wall sealing step including forming a container side wall having radiused corners, said end wall having a flange lying adjacent a portion of the interior of said side wall; and further comprising

preforming a curved portion on said end of said side wall by inserting said end into a first opening of an outer die and moving said end along a first wall, adjacent said first opening and having a constant perimeter, and further against a curved wall adjacent a second opening on the opposing side of said die;

forming a side wall flange by inserting an expandable sealing means into said second opening and into an operative position adjacent said first wall to force the curved portion of said side wall against said end wall flange;

sealing said end wall flange between said side wall and said side wall flange by expanding said sealing means toward said perimeter of said first wall; and

adjusting said mandrel to a discharge configuration to facilitate removal of said container from said mandrel and to feed an end wall to said mandrel.

23. A method according to claim 18 for forming a container having radiused corners, characterized by

positioning an end wall on the distal end of the mandrel;

wrapping the side wall blank around part of the surface of said mandrel by moving the die means to a position adjacent a portion of said surface, said surface having radiused corners;

wrapping the blank around the remainder of said surface and causing two opposing edges of the blank to overlap by moving another die means to a position adjacent another portion of said surface; said side wall sealing step including forming a container side wall having radiused corners, said end wall being normal to the inner surface of said side wall; and further comprising

preforming a curved portion on said end of said side wall by inserting said end into a first opening of an outer die and moving said end along a curved wall whose diameter decreases as it approaches a second opening on the opposing side of said die;

forming a side wall flange by inserting a sealing means into said second opening to force the curved portion of said side wall against said end wall;

sealing the side wall flange to the end wall by forcing said side wall flange and said end wall between said sealing means and said mandrel; and

adjusting said mandrel to a discharge configuration to facilitate removal of said container from said mandrel and to feed an end wall to said mandrel.

24. A method according to claim 18 for forming a container, characterized by providing a pair of rollers each pivotably disposed on a different one of said leading edges of said die means, each of said rollers being biased toward that roller on the other said leading edge; said discharge configuration also being for facilitating feeding an end wall to said mandrel; said wrapping step being accomplished by said rollers rolling along the surface of the blank and pressing the surface of the blank against said surface of said mandrel; and further comprising

sealing an end wall to said side wall prior to adjusting said mandrel to said discharge configuration.

25. A method according to claim 24 for forming a container having radiused corners, characterized by

positioning the end wall on the distal end of the mandrel prior to said end wall sealing step; providing said mandrel with a generally rectangular surface and radiused corners, said forming configuration being for forming a side wall having radiused corners around said mandrel, said roller die means having an interior shaped to snugly hold a blank in contact with two adjacent radiused corners of said mandrel; said side wall sealing step including forming a container side wall having radiused corners;

positioning within an aperture of an outer die the end of said side wall, the wall of said aperture having a nonround cross-sectional shape with at least one roughly linear portion and at least one radiused portion, the end of said side wall having a perimeter substantially identical to said shape of said aperture wall, said end of said side wall surrounding an end wall having a flange lying adjacent the interior of said side wall; and said end wall sealing step includes

positioning within said end wall flange a housing supporting a plurality of segments in a plane normal to said aperture wall, said segments being movable in said plane between a contracted configuration and an expanded configuration, said segments when in said expanded configuration defining a continuous shape approximately identical to the perimeter of said aperture wall, each said segment defining at least a portion of a respective one of said portions of said continuous shape, and said segments when in said contracted configuration being spaced apart from said aperture wall;

expanding said segments simultaneously from said contracted configuration thereof outward to said expanded configuration thereof for sealing together said end wall flange and said end of said side wall; and

adjusting said mandrel to said discharge configuration to facilitate removal of said container from said mandrel and to feed an end wall blank to said mandrel.

26. A method according to claim 24 for forming a container having radiused corners, characterized by

positioning the end wall on the distal end of the mandrel prior to said end wall sealing step; providing said mandrel with a generally rectangular surface and radiused corners, said forming configuration being for forming a side wall having radiused corners around said mandrel, said roller die means having an interior shaped to snugly hold a blank in contact with two adjacent radiused corners of said mandrel; said side wall sealing step including forming a container side wall having radiused corners, said end wall having a flange lying adjacent a portion of the interior of said side wall;

preforming a curved portion on said end of said side wall by insertingsaid end into a first opening of an outer die and moving said end along a first wall, adjacent said first opening and having a constant perimeter, and further against a curved wall adjacent a second opening on the opposing side of said die;

forming a side wall flange by inserting an expandable sealing means into said second opening and into an operative position adjacent said first wall to force the curved portion of said side wall against said end wall flange; and said end wall sealing step includes

sealing said end wall flange between said side wall and said side wall flange by expanding said sealing means toward said perimeter of said first wall; and

adjusting said mandrel to said discharge configuration to facilitate removal of said container from said mandrel and to feed an end wall blank to said mandrel.

27. A method according to claim 24 for forming a container having radiused corners, characterized by

positioning the end wall on the distal end of the mandrel prior to said end wall sealing step; providing said mandrel with a generally rectangular surface and radiused corners, said forming configuration being for forming a side wall having radiused corners around said mandrel, said roller die means having an interior shaped to snugly hold a blank in contact with two adjacent radiused corners of said mandrel; said side wall sealing step including forming a container side wall having radiused corners; said end wall being normal to the inner surface of said side wall;

preforming a curved portion on the end of said side wall by inserting said end into a first opening of an outer die and moving said end along a curved wall whose diameter decreases as it approaches a second opening on the opposing side of said die;

forming a side wall flange by inserting a sealing means into said second opening to force the curved portion of said side wall against said end wall; and said end wall sealing step includes

sealing the side wall flange to the end wall by forcing said side wall flange and said end wall between said sealing means and said mandrel; and

adjusting said mandrel to said discharge configuration to facilitate removal of said container from said mandrel and to feed an end wall to said mandrel.

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FIG. 1A

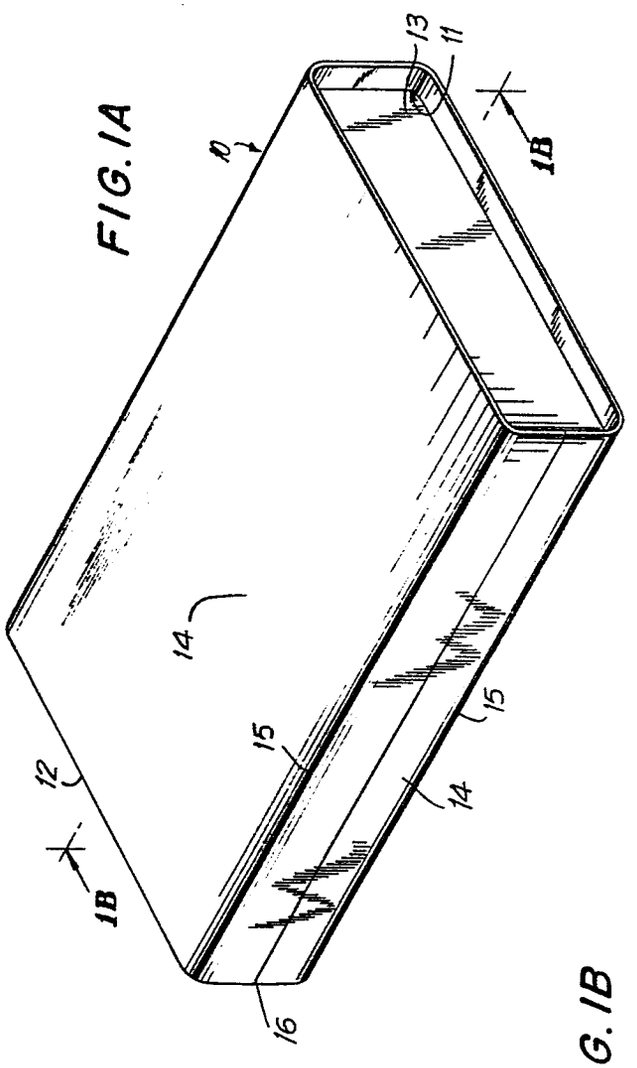

FIG. 1B

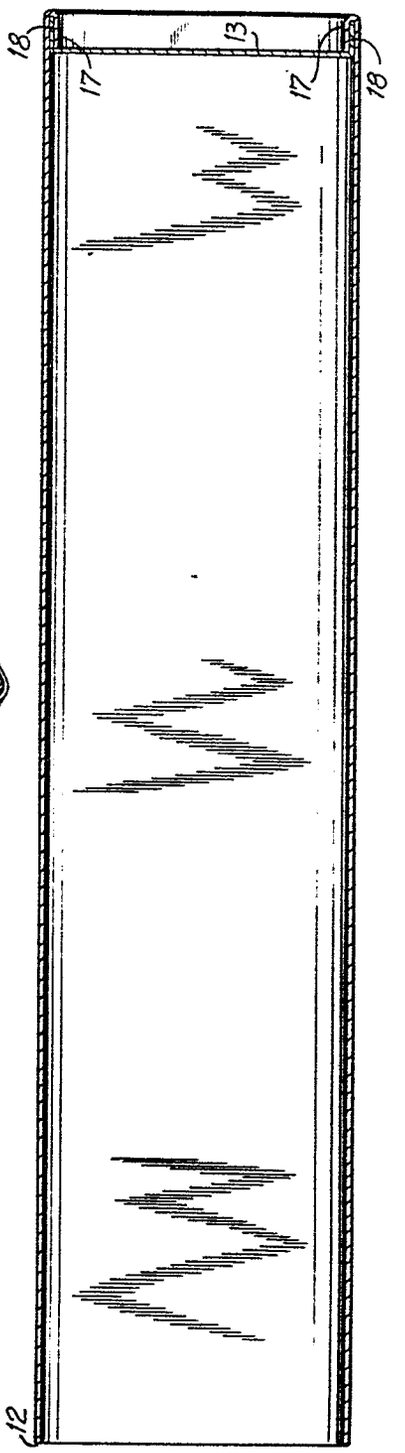

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FIG. 2A

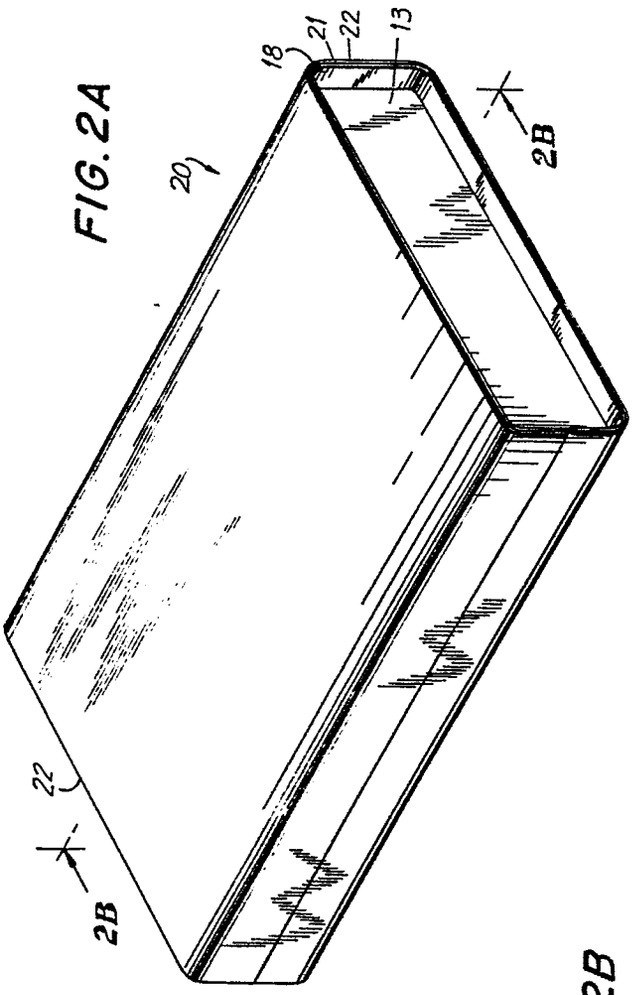
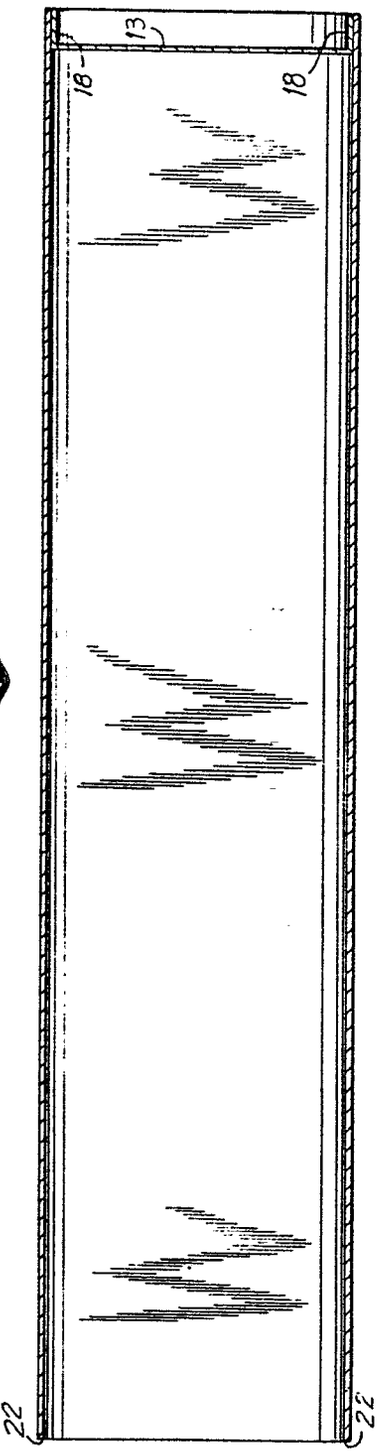


FIG. 2B



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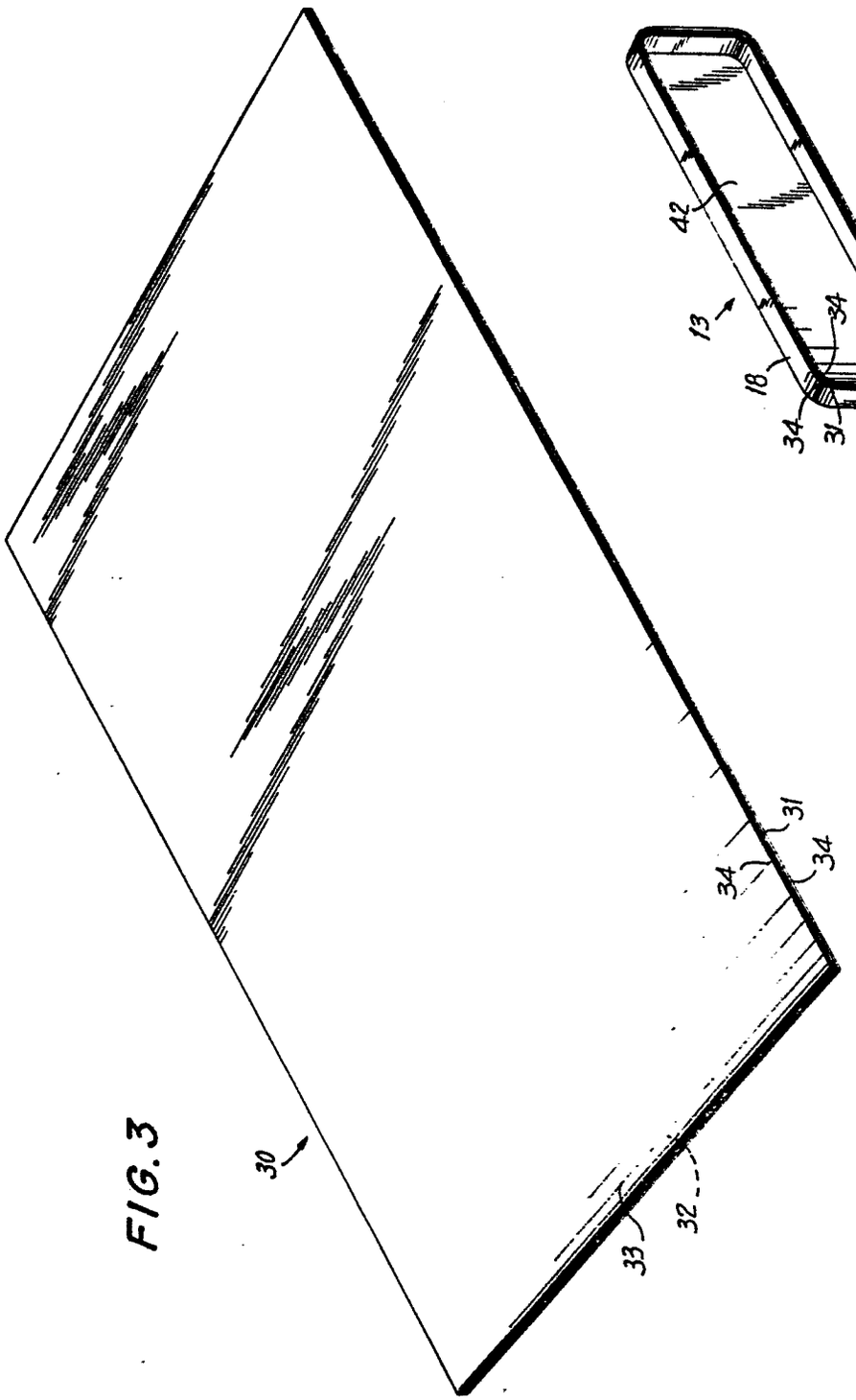

FIG. 3

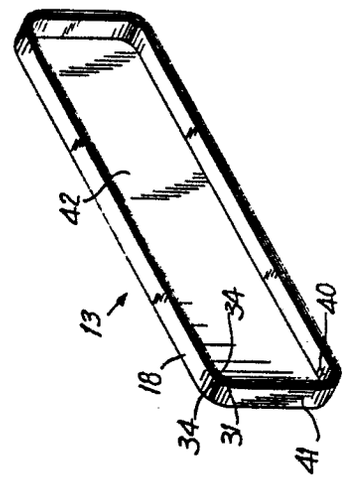

FIG. 4

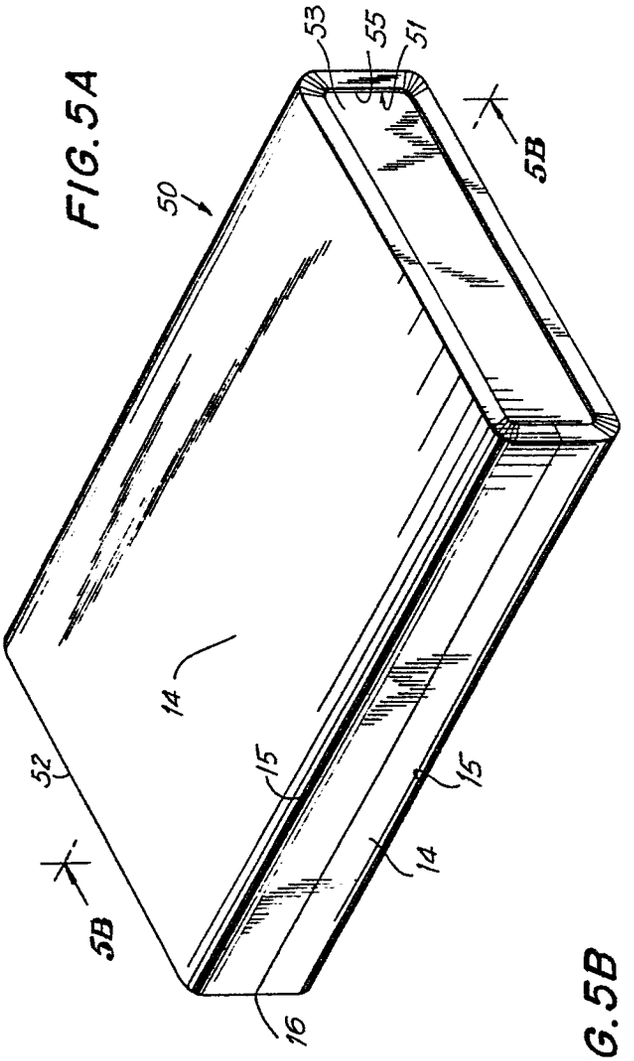

FIG. 5A

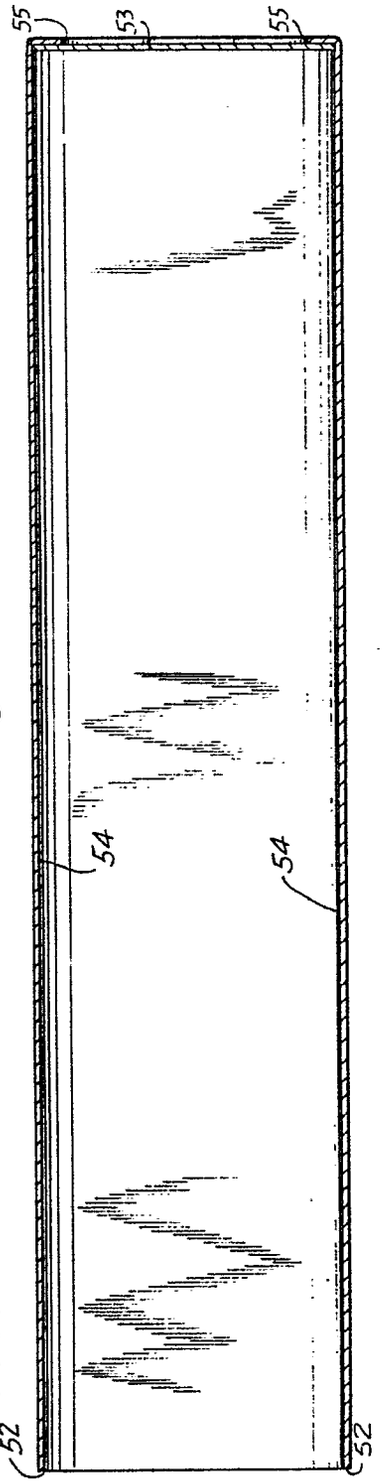

FIG. 5B

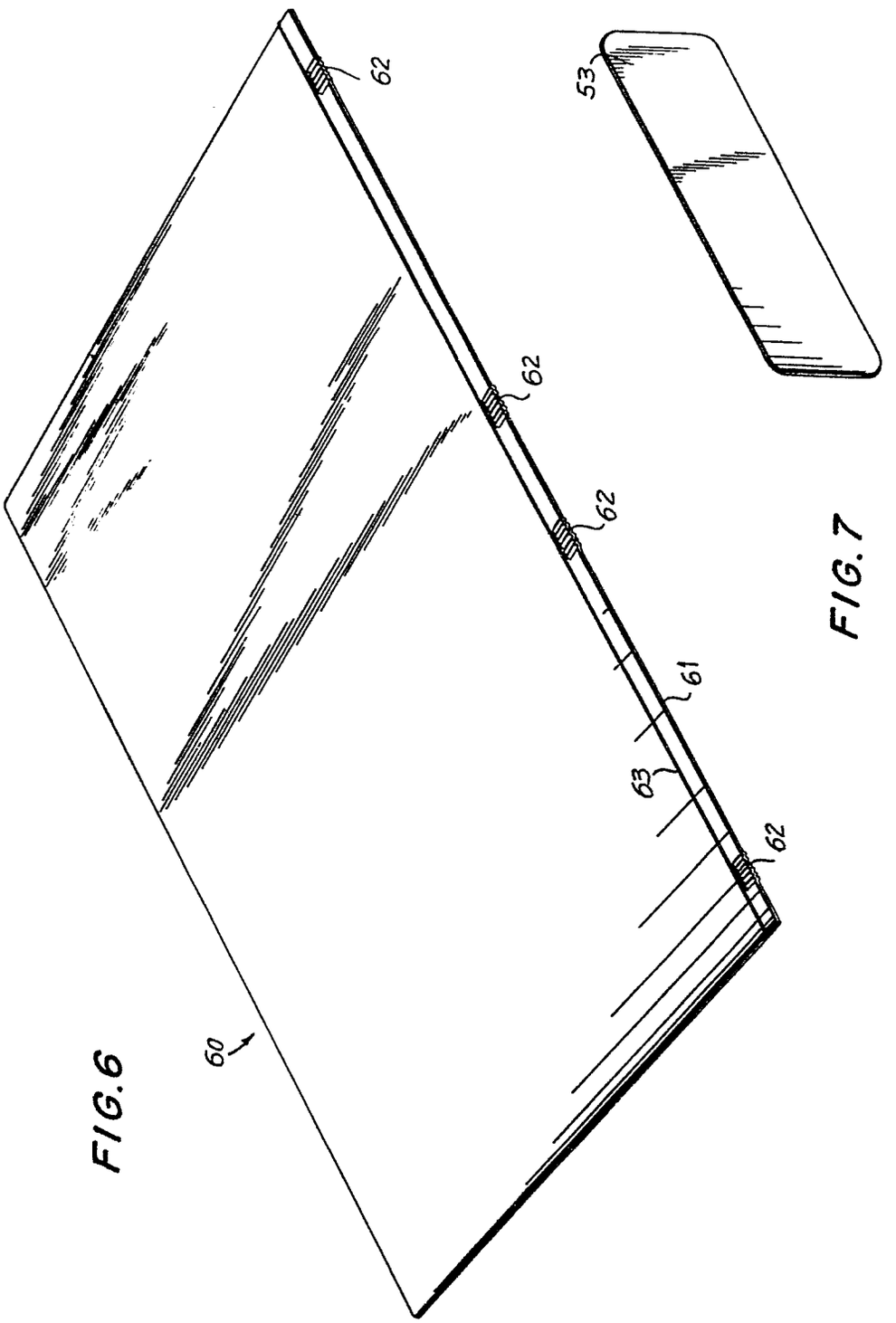

FIG.6

FIG.7

FIG.8

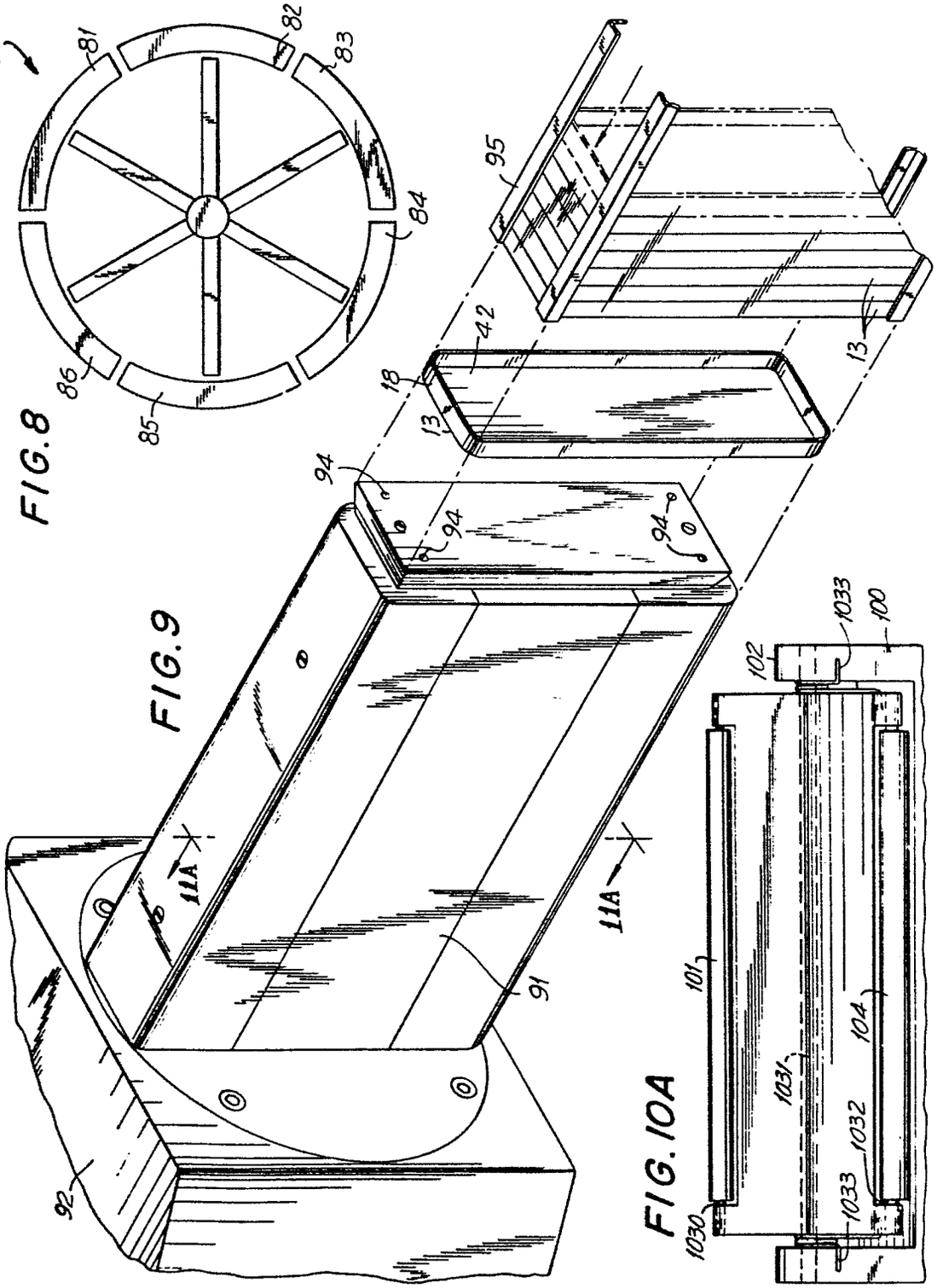

FIG.9

FIG. 10A

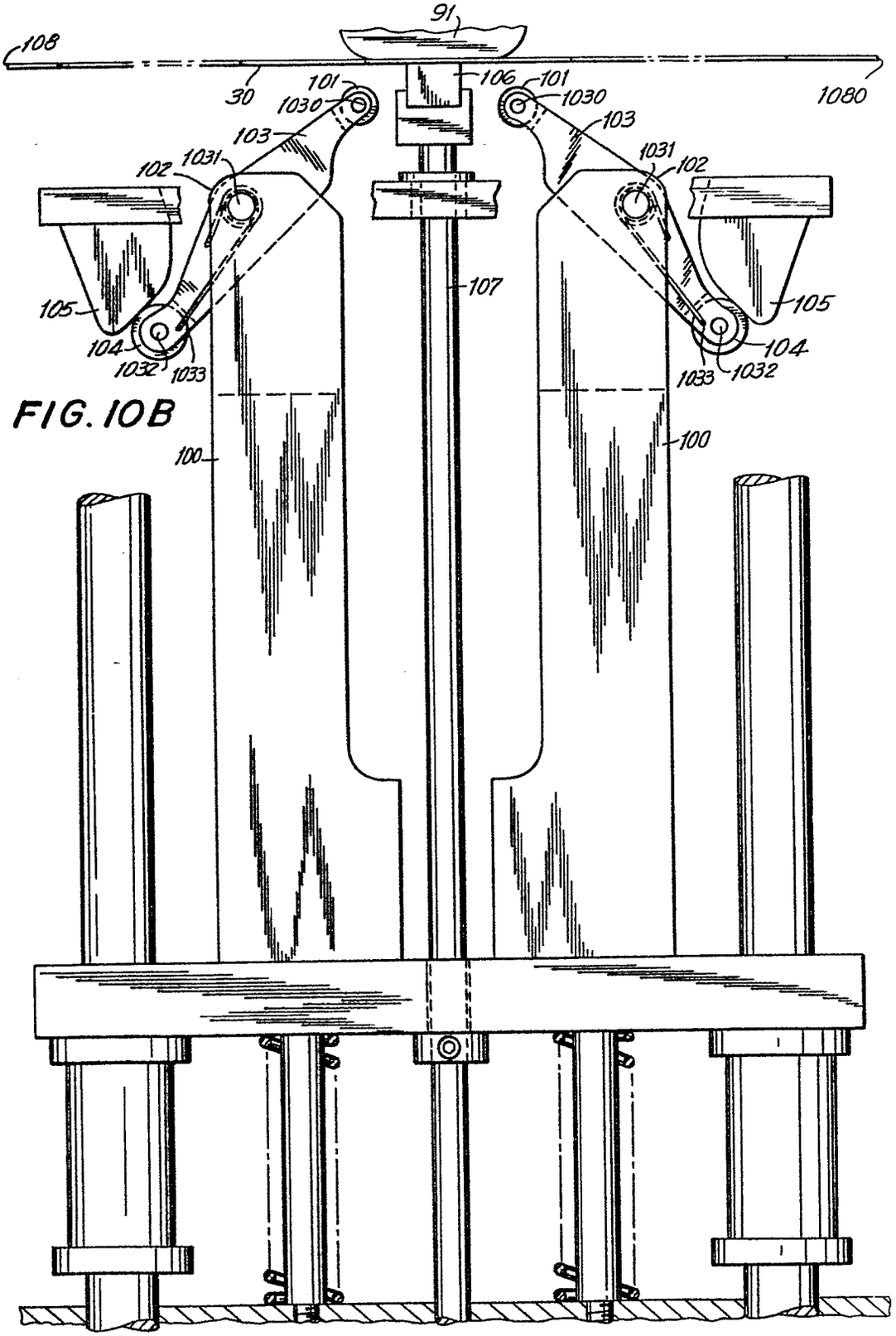
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FIG. 10B

FIG. 10C

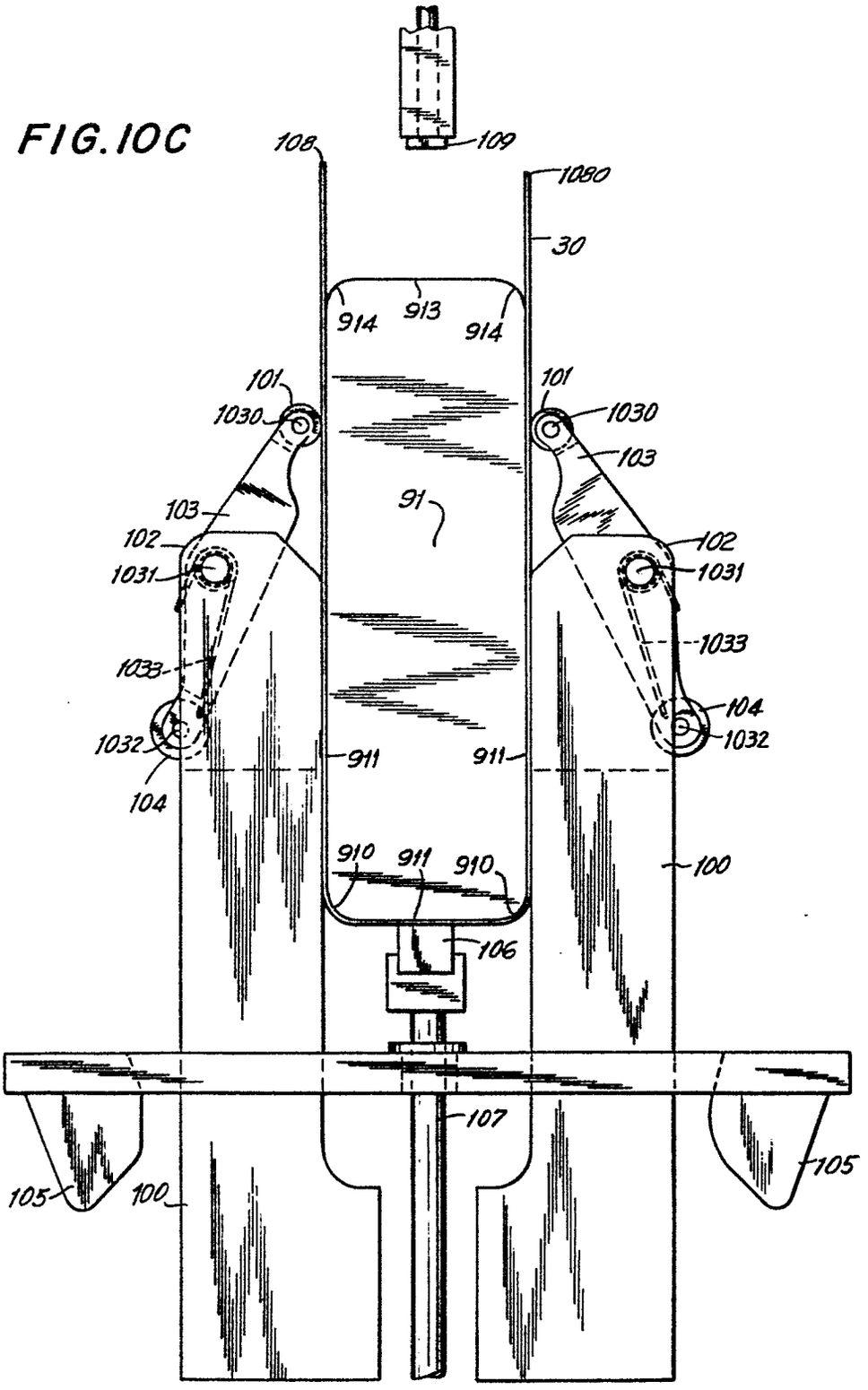
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FIG. 10D

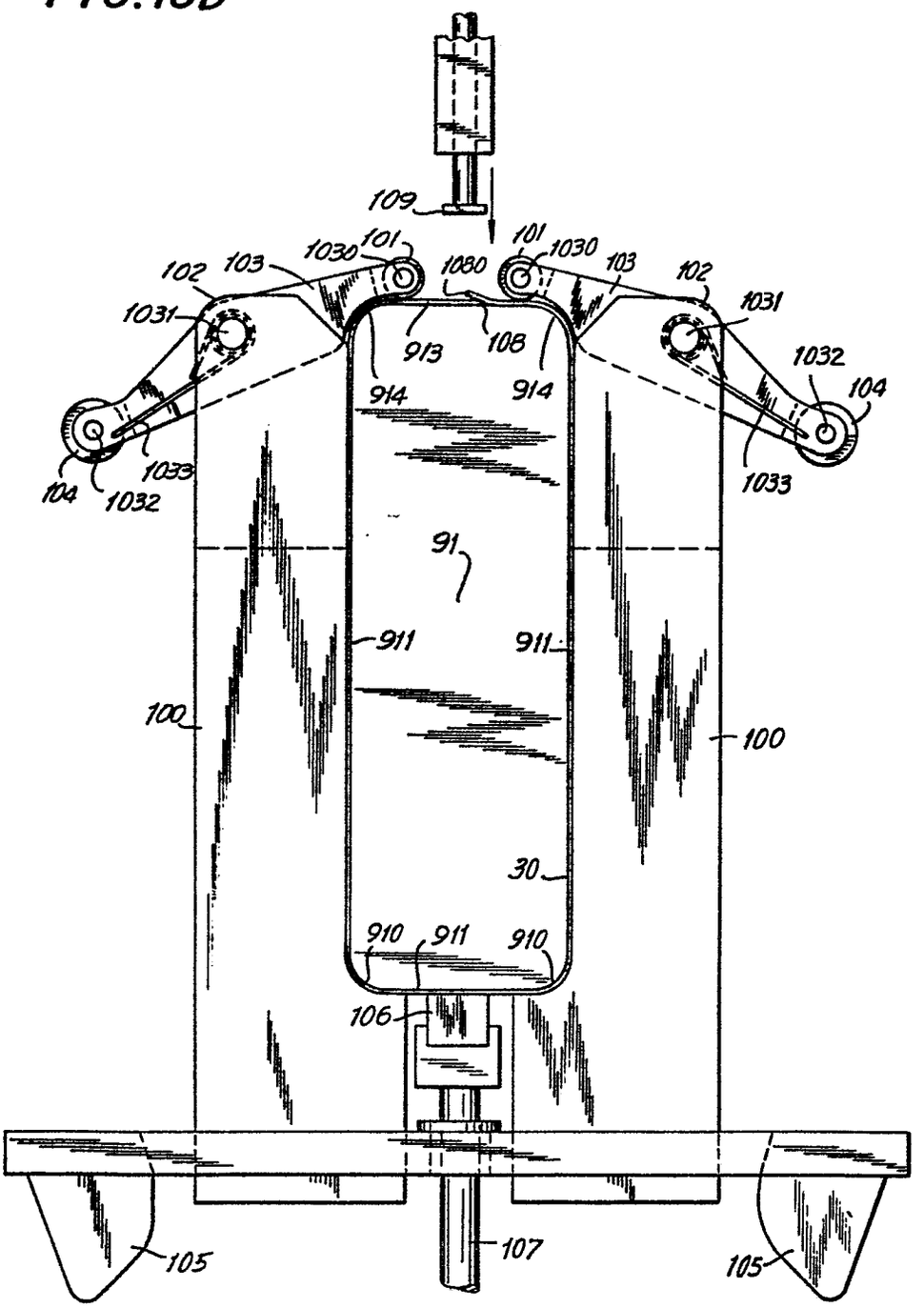
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FIG. 10E

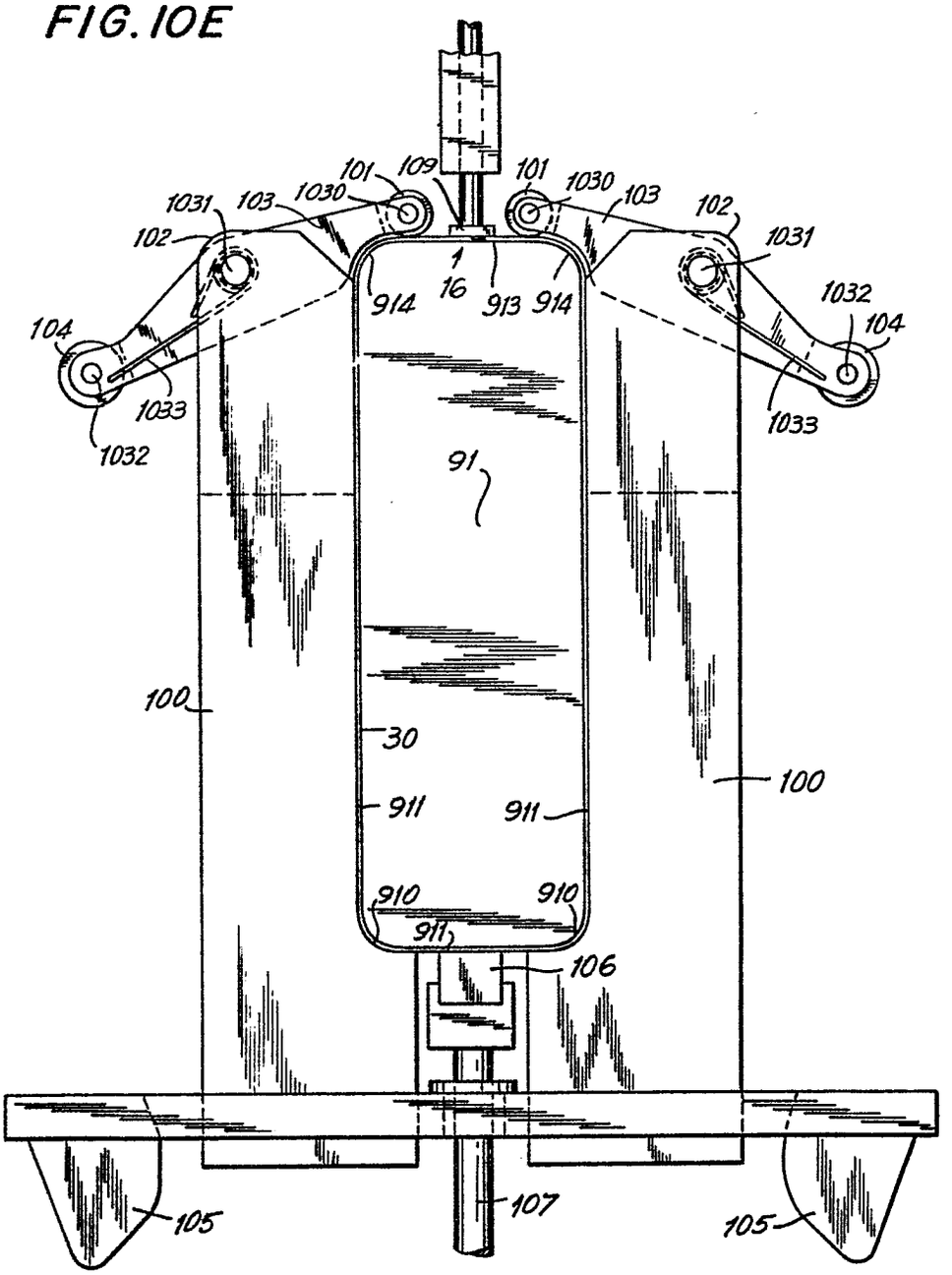
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FIG. IIB

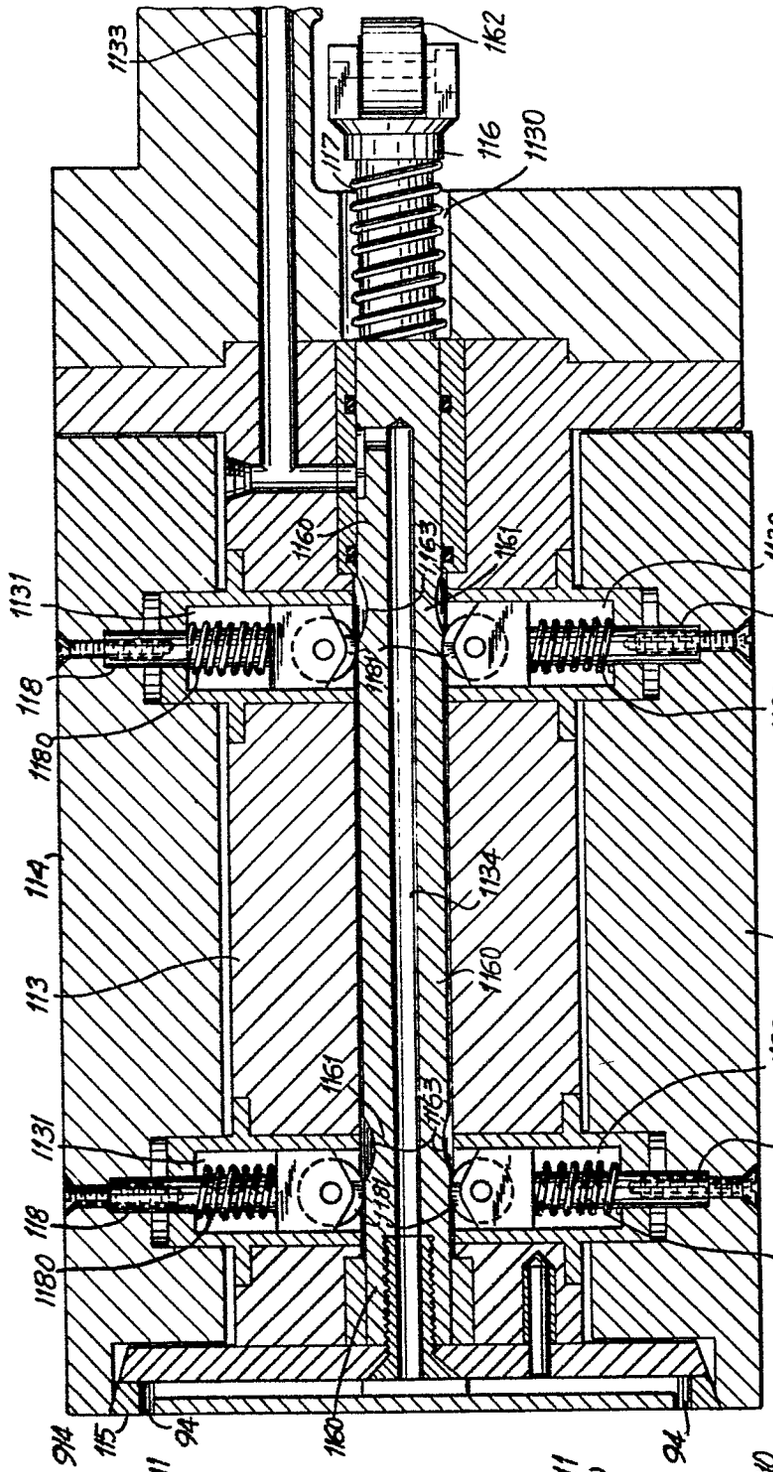
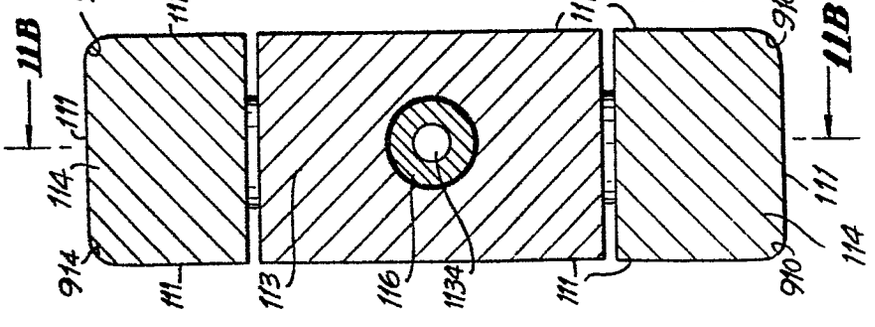


FIG. IIA



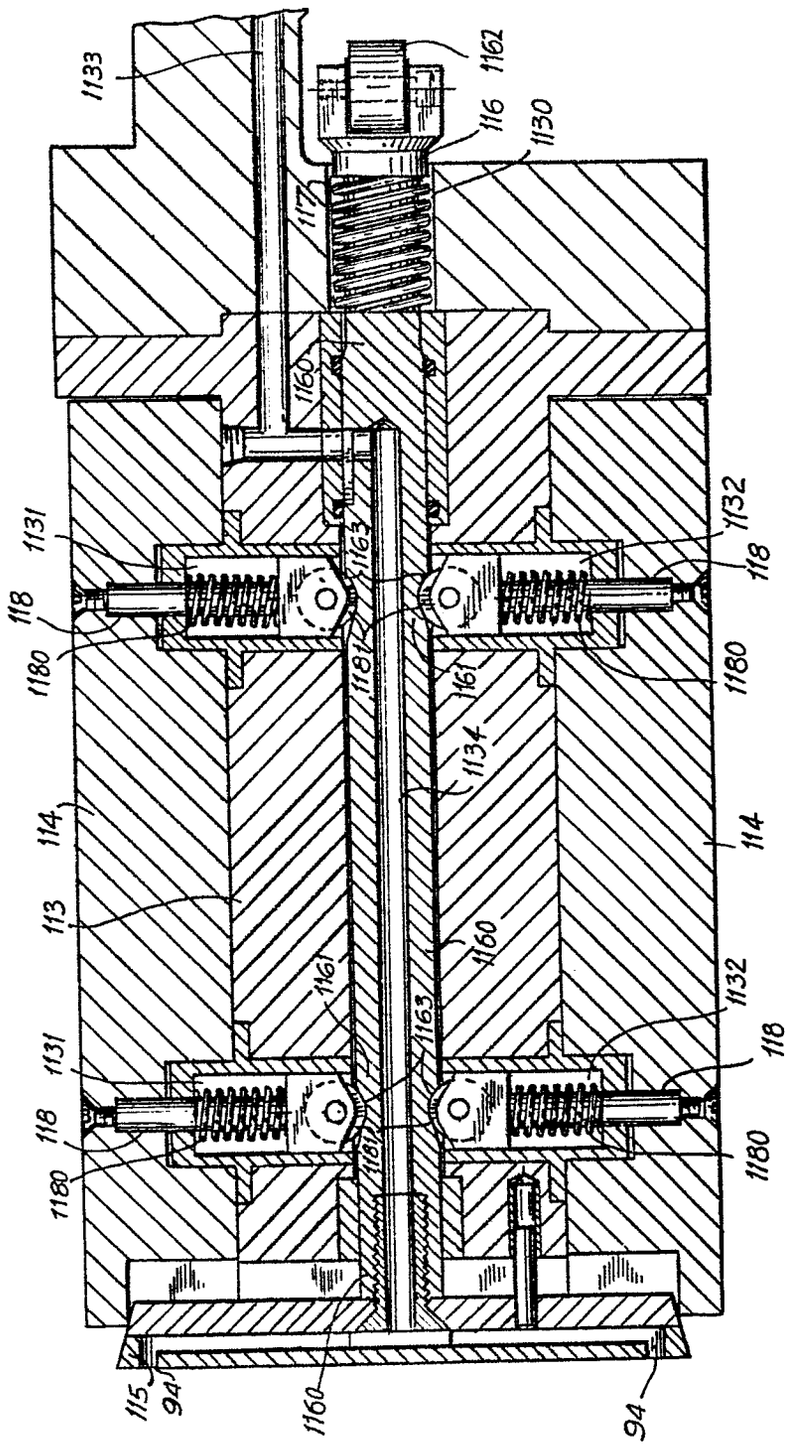

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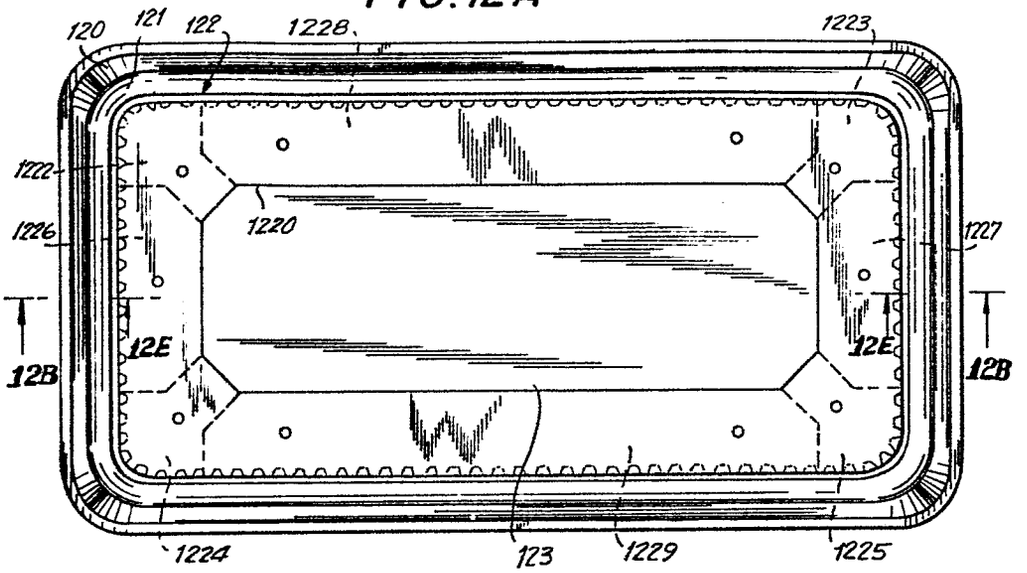
FIG. 11C

FIG. 12A



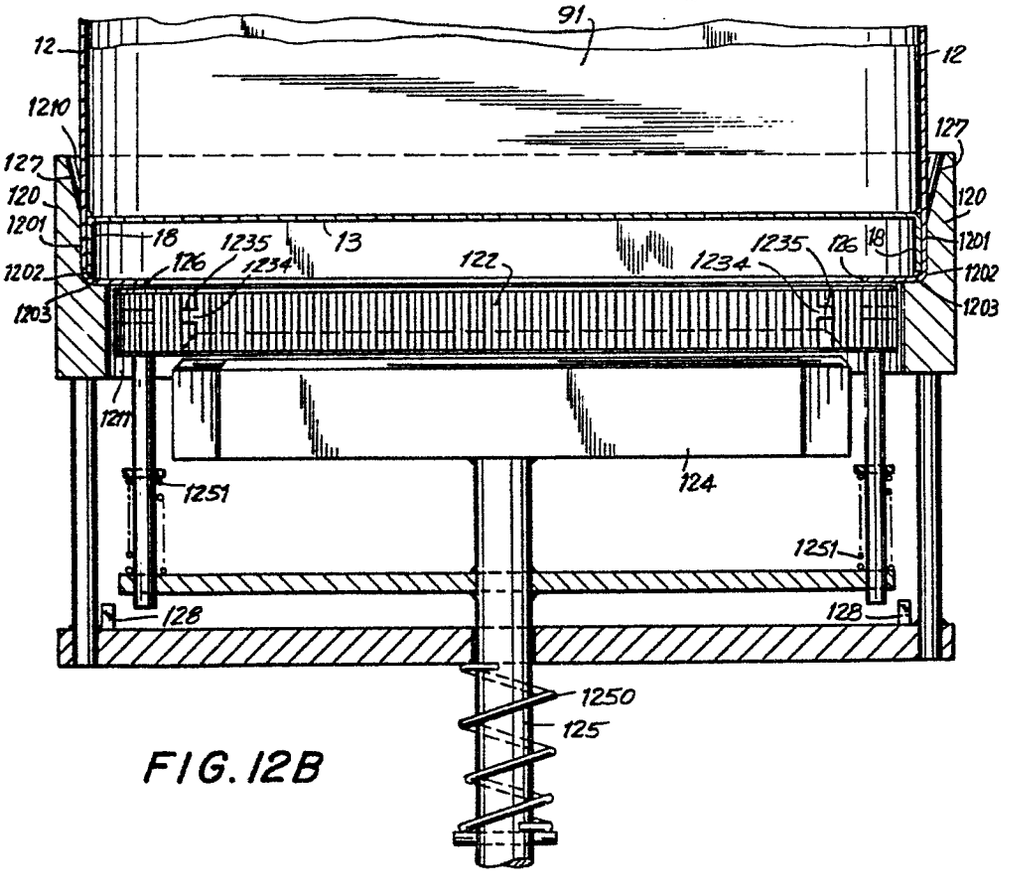


FIG. 12B

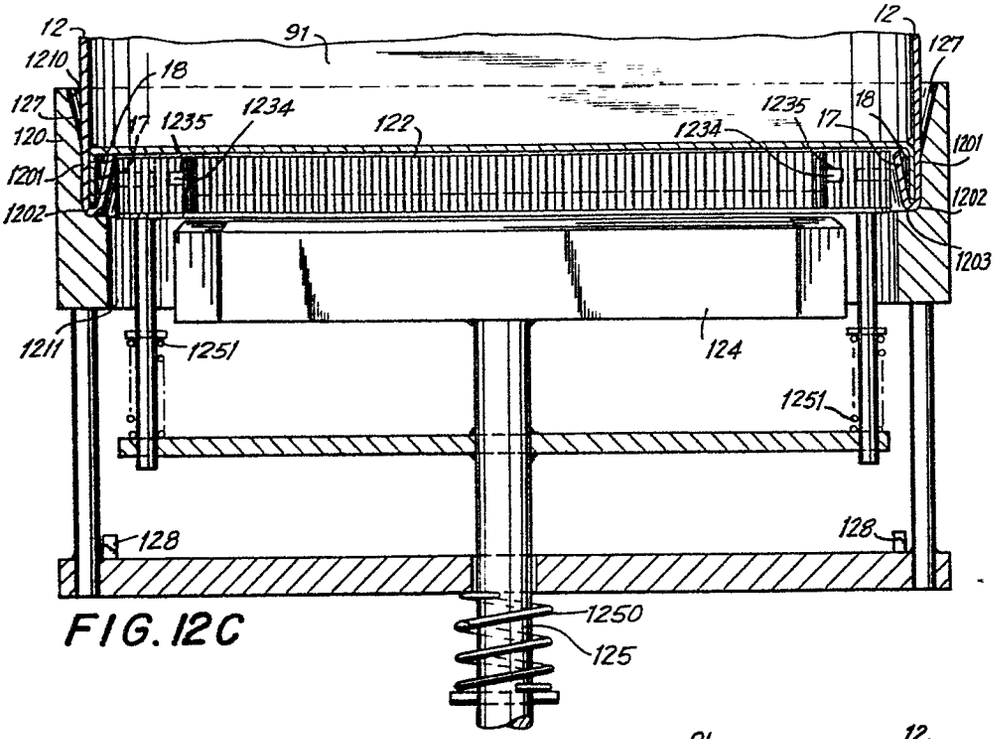


FIG. 12C

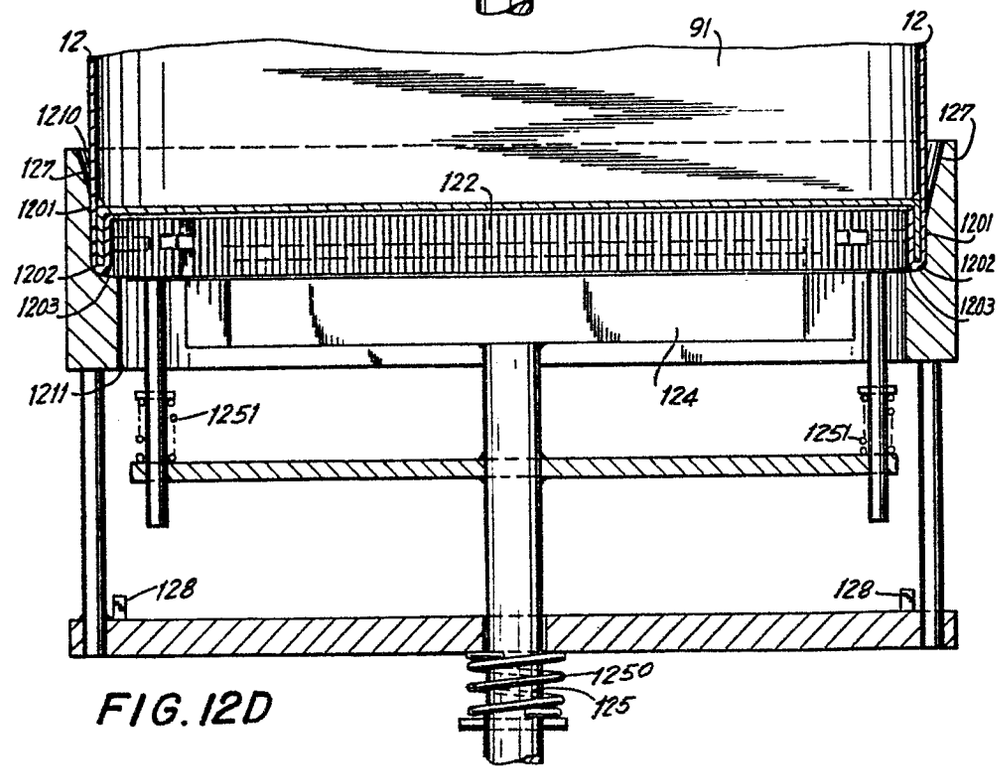


FIG. 12D

FIG. 12E

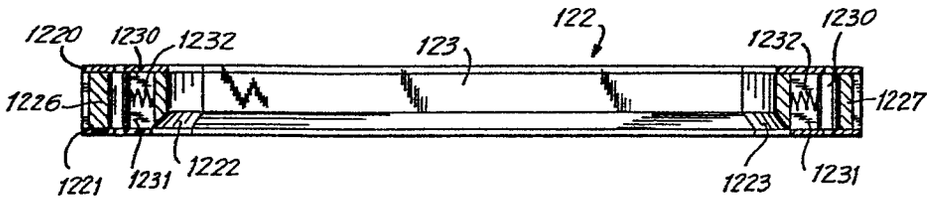


FIG. 12F

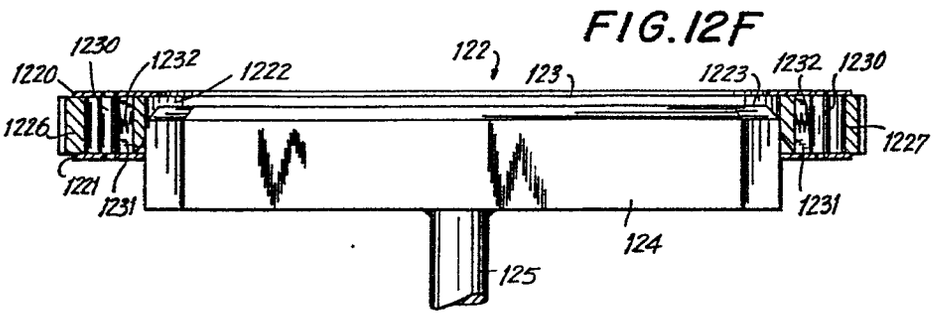


FIG. 12G

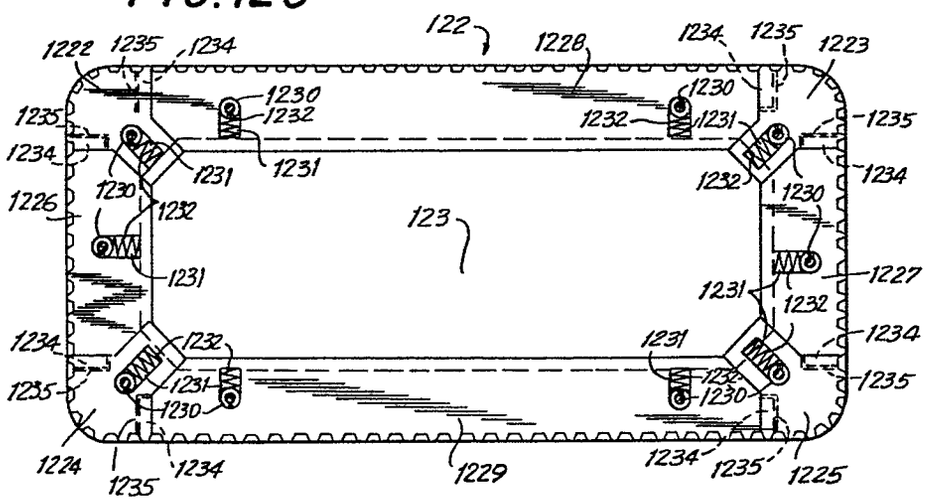


FIG. 13

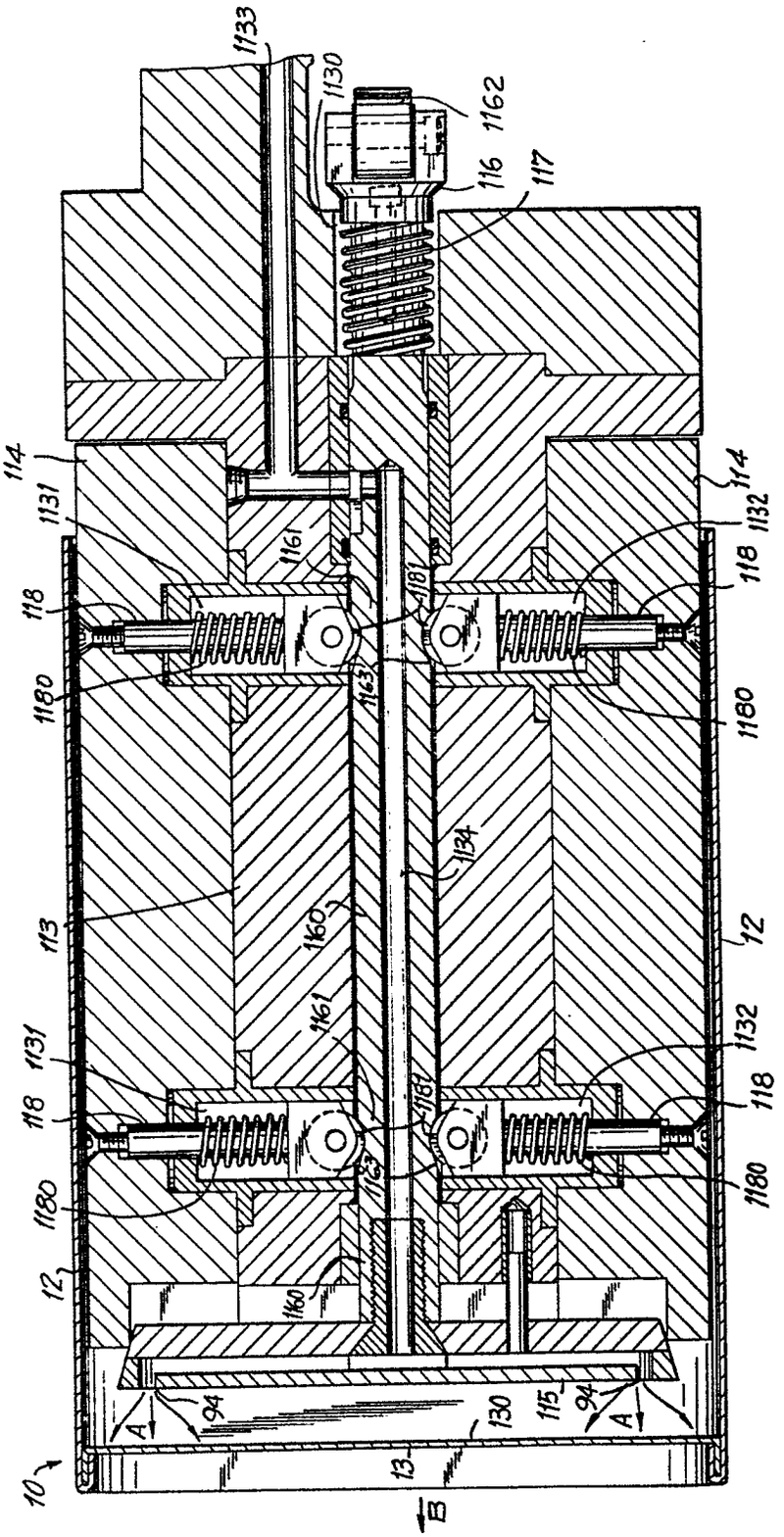

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FIG. 14

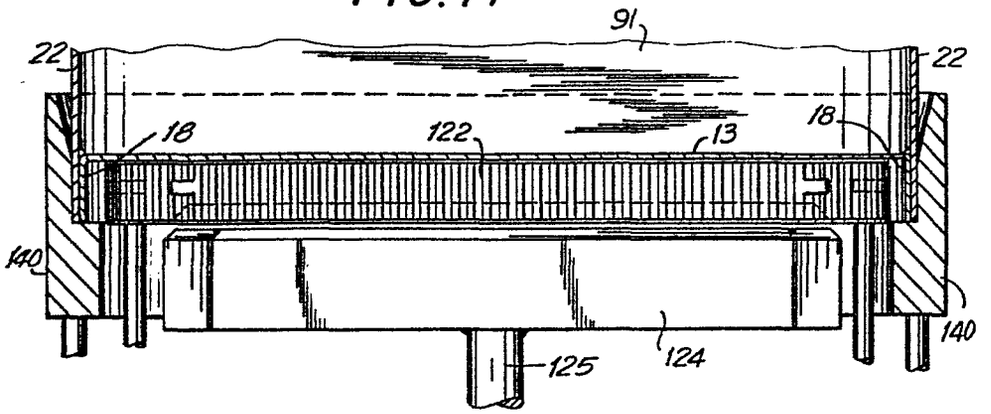

FIG. 15A

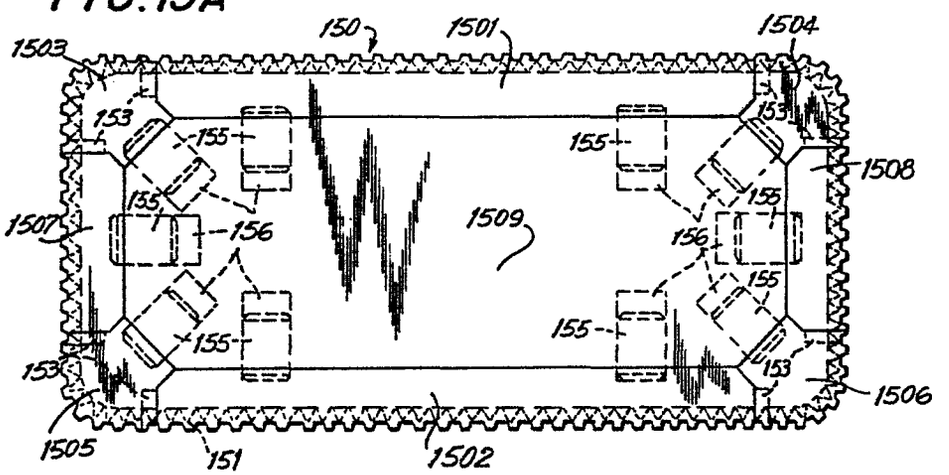

FIG. 15B

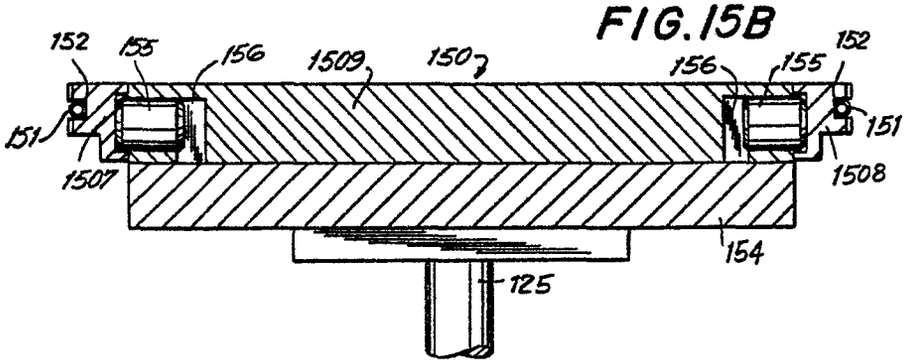

FIG. 16A

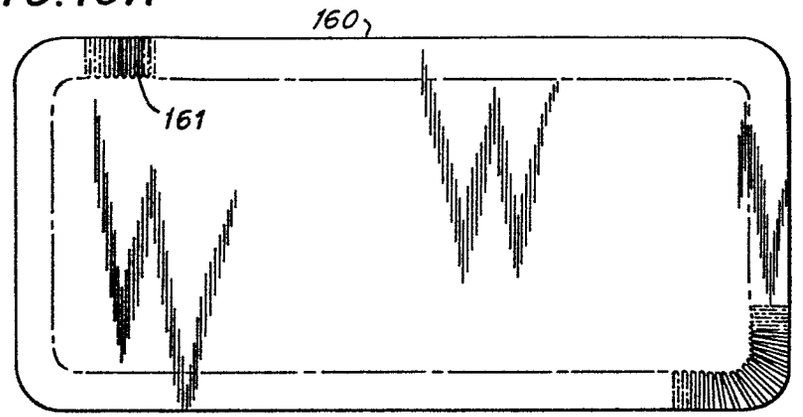

FIG. 16B

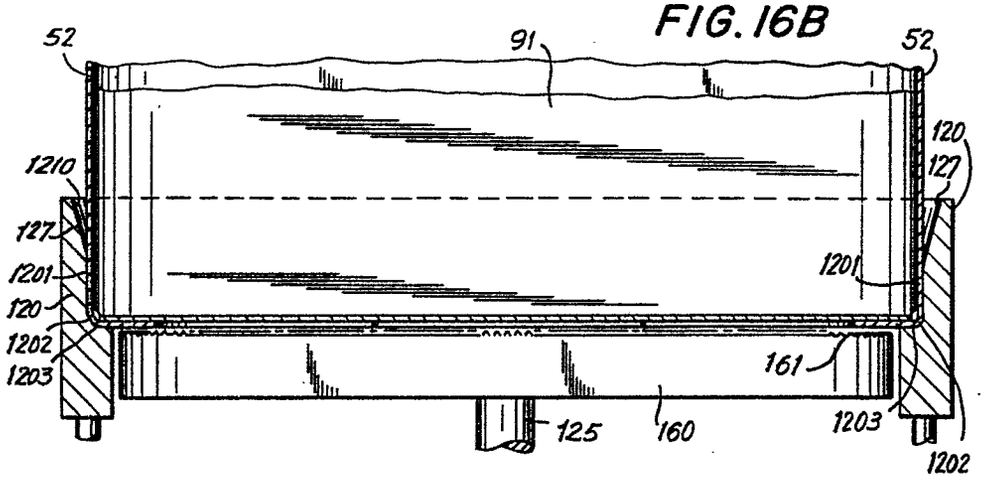

FIG. 16C

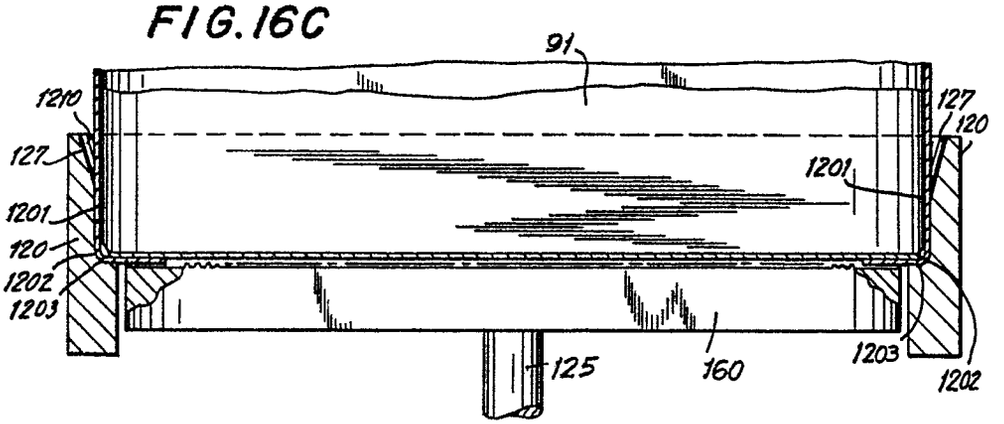

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FIG. 17A

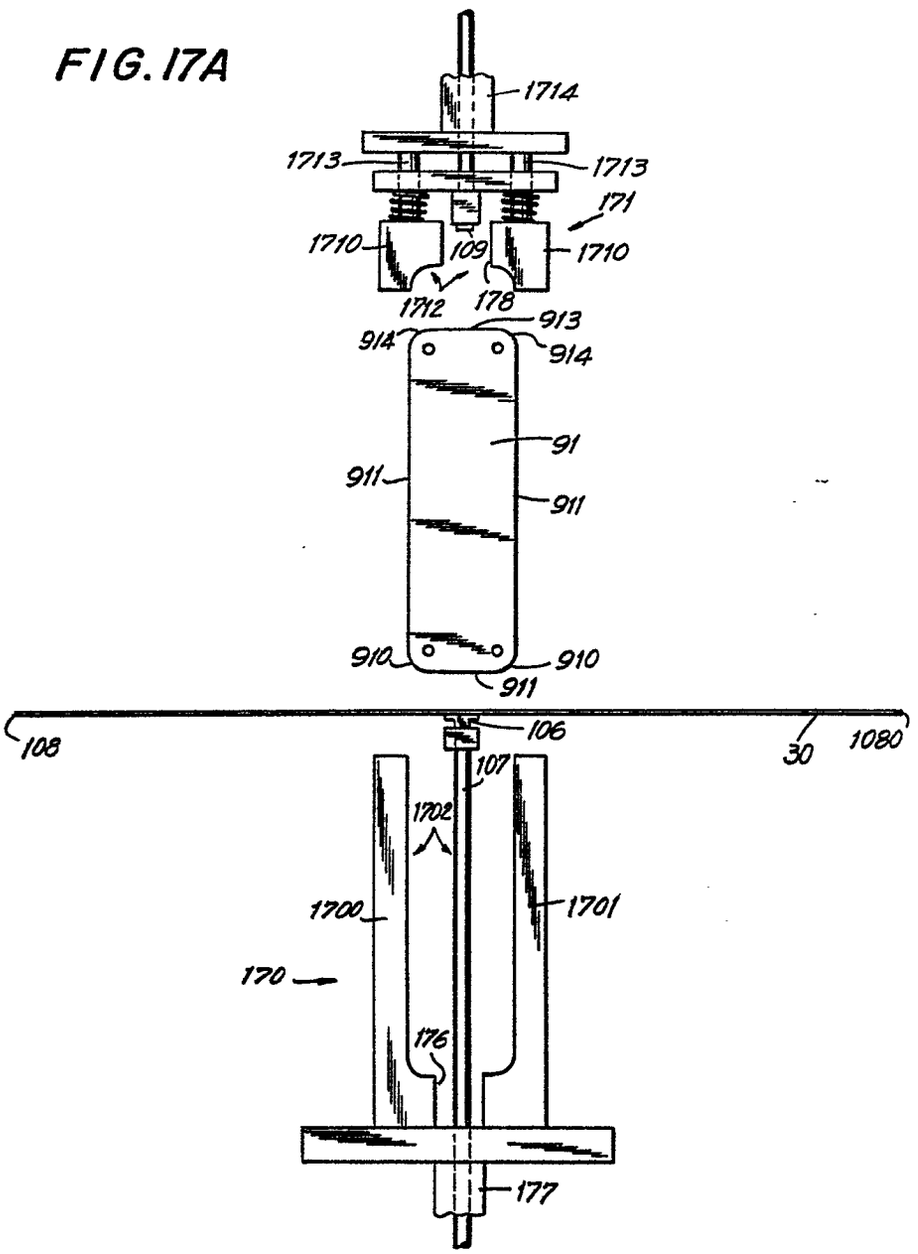

FIG.17B

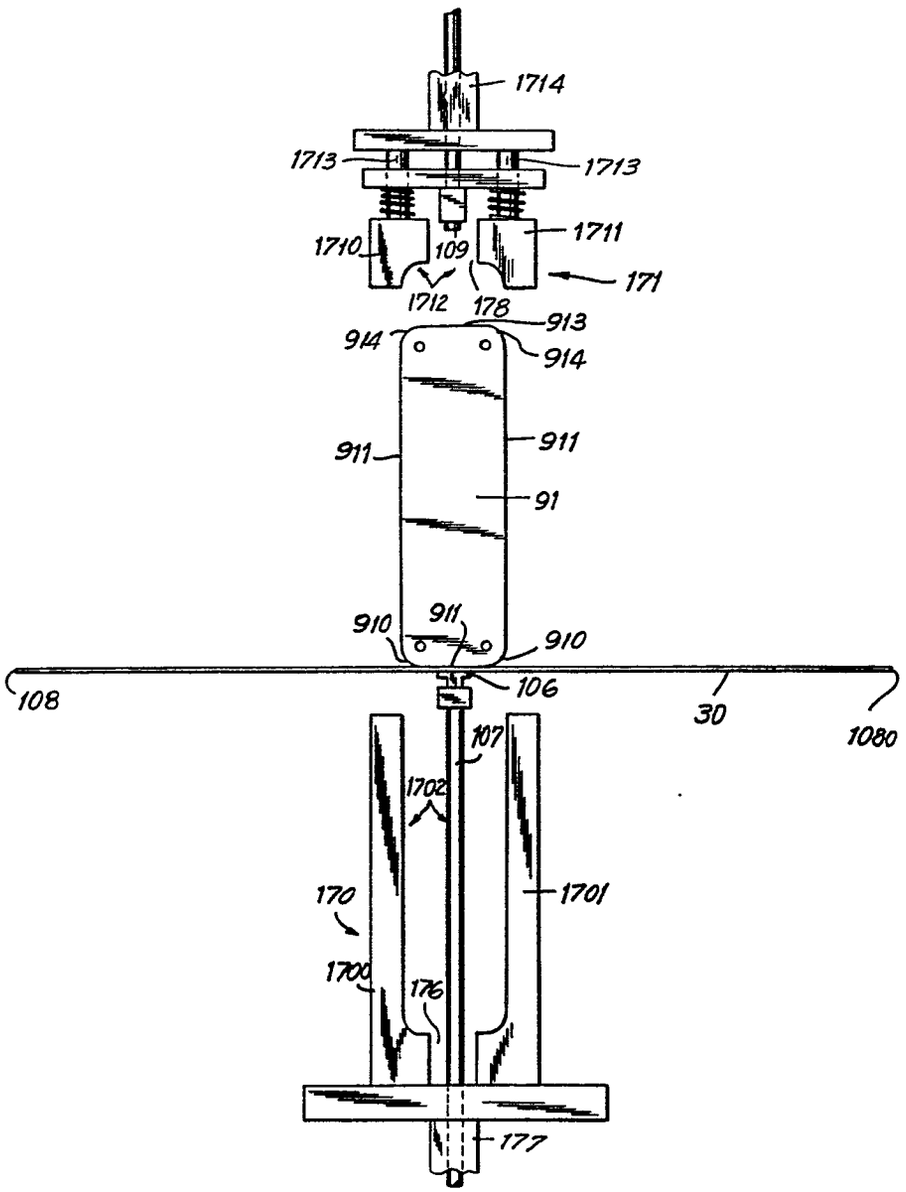
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FIG. 17C

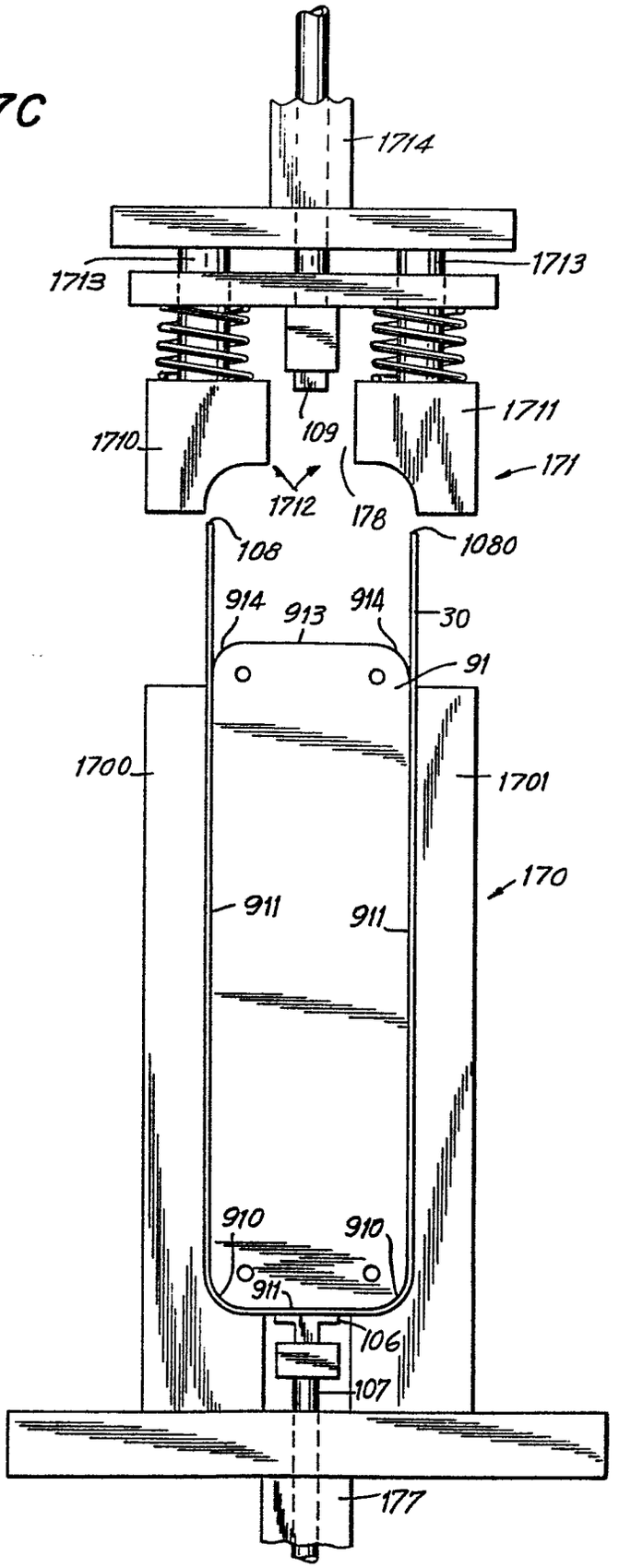
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FIG. 17D

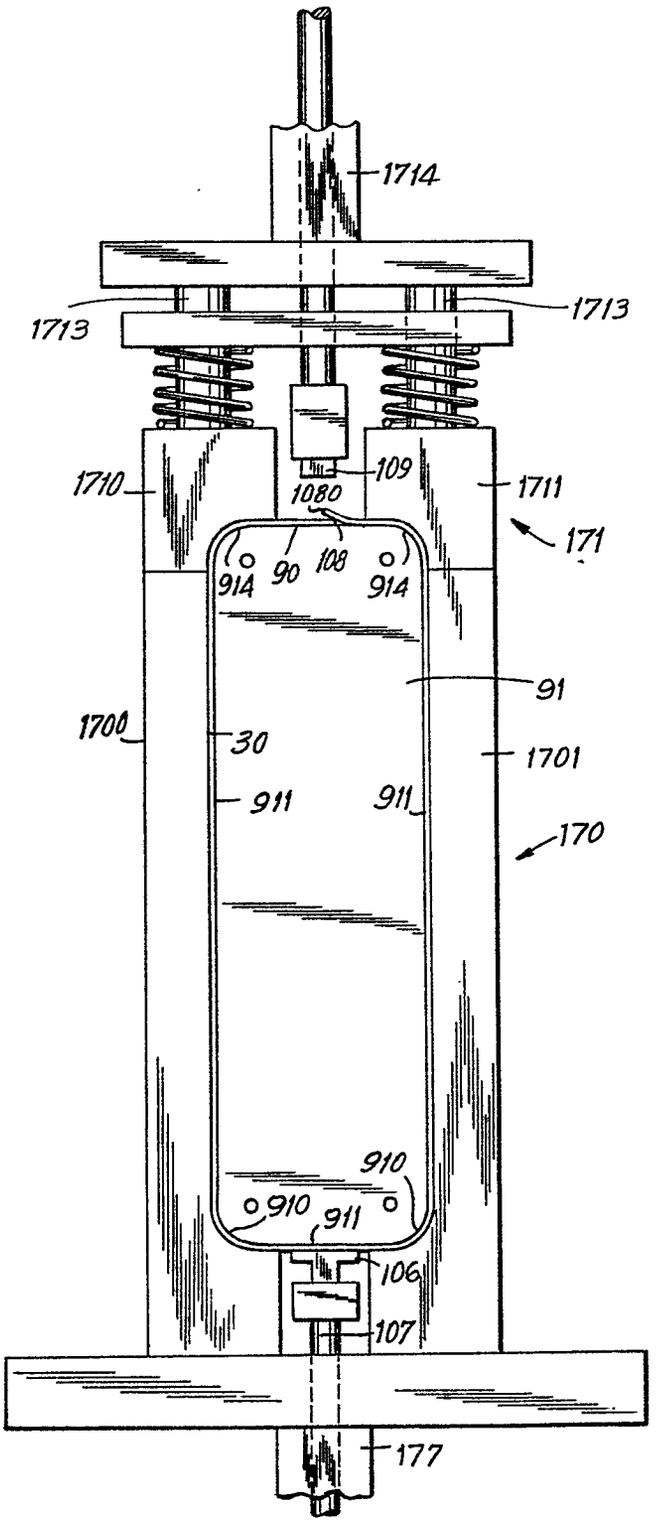
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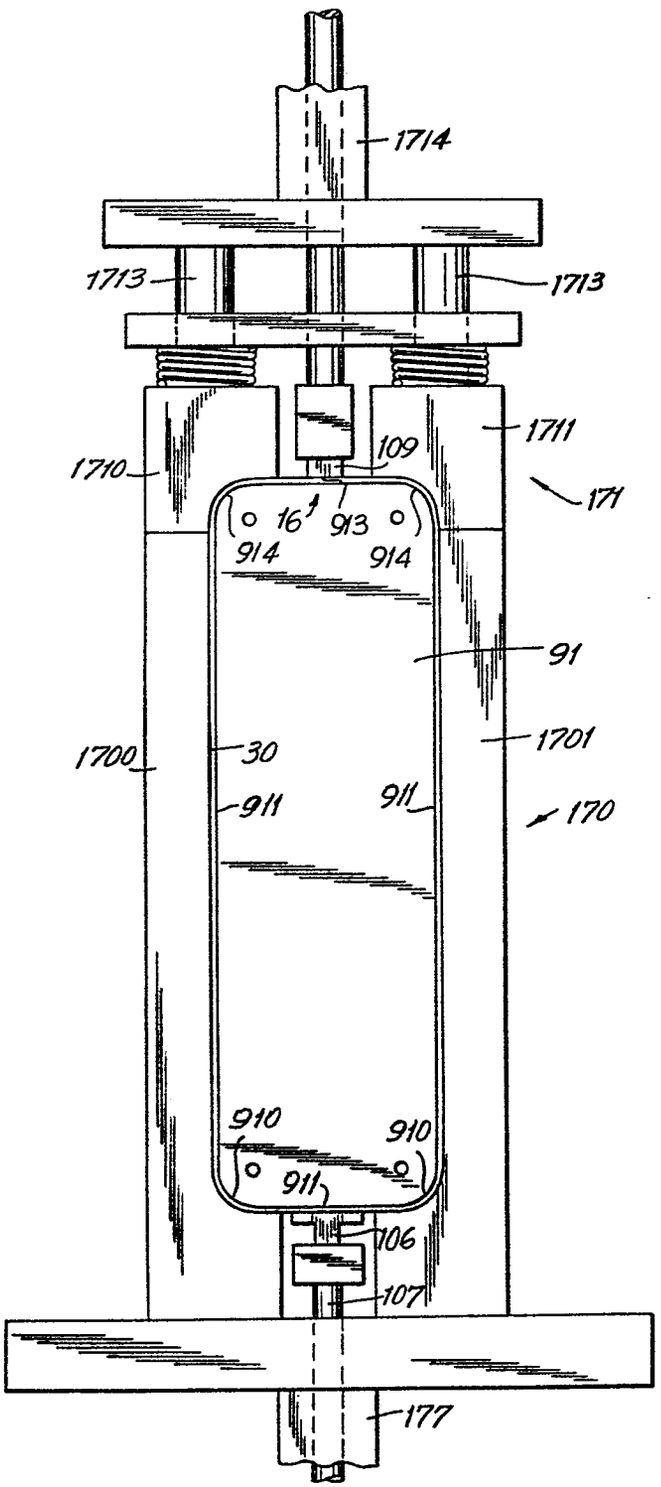
FIG. 17E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European Patent Office

EUROPEAN SEARCH REPORT

0160251

Application number

EP 85104672.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	US - A - 4 349 345 (R.E. BODENDOERFER) * Fig. 1,2,6,7,8; abstract; column 4, lines 62-66 *	1-27	B 31 B 1/28 B 31 B 1/32
Y	GB - A - 938 578 (CARTONMASTER LTD) * Fig. 3,4,5; page 3, lines 13-27 *	1-27	
Y	DE - C - 933 546 (JAGENBERG-WERKE AG) * Fig. 1,2; page 3, lines 16-35 *	1-27	
A	GB - A - 2 103 538 (UNILEVER PLC)		TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 31 B
A	US - A - 3 012 483 (N.A. LEIBREICH)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	11-07-1985	SÜNDERMANN

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