

[54] METHOD AND APPARATUS FOR ASSEMBLING AND JOINING THERMOPLASTIC CONTAINER SECTIONS BY FRICTION WELDING

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Related U.S. Patent Documents

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[52] U.S. Cl. .... 156/73.5; 29/240; 156/256; 156/294; 228/2; 228/113; 264/68; 264/92; 264/248; 425/289; 425/388; 425/DIG. 201

[58] Field of Search ..... 156/73.5, 252, 256, 156/267, 294; 264/68, 92, 248; 425/289, 388, DIG. 200, DIG. 201; 29/240; 228/2, 113

[56]

References Cited

U.S. PATENT DOCUMENTS

Table with 3 columns: Patent No., Date, and Name. Includes entries for Slaughter, Wilcox, Schnitzius, Leibrich, Allen, Stickney, Hitzelberger, Frank, Brown, and Negoro.

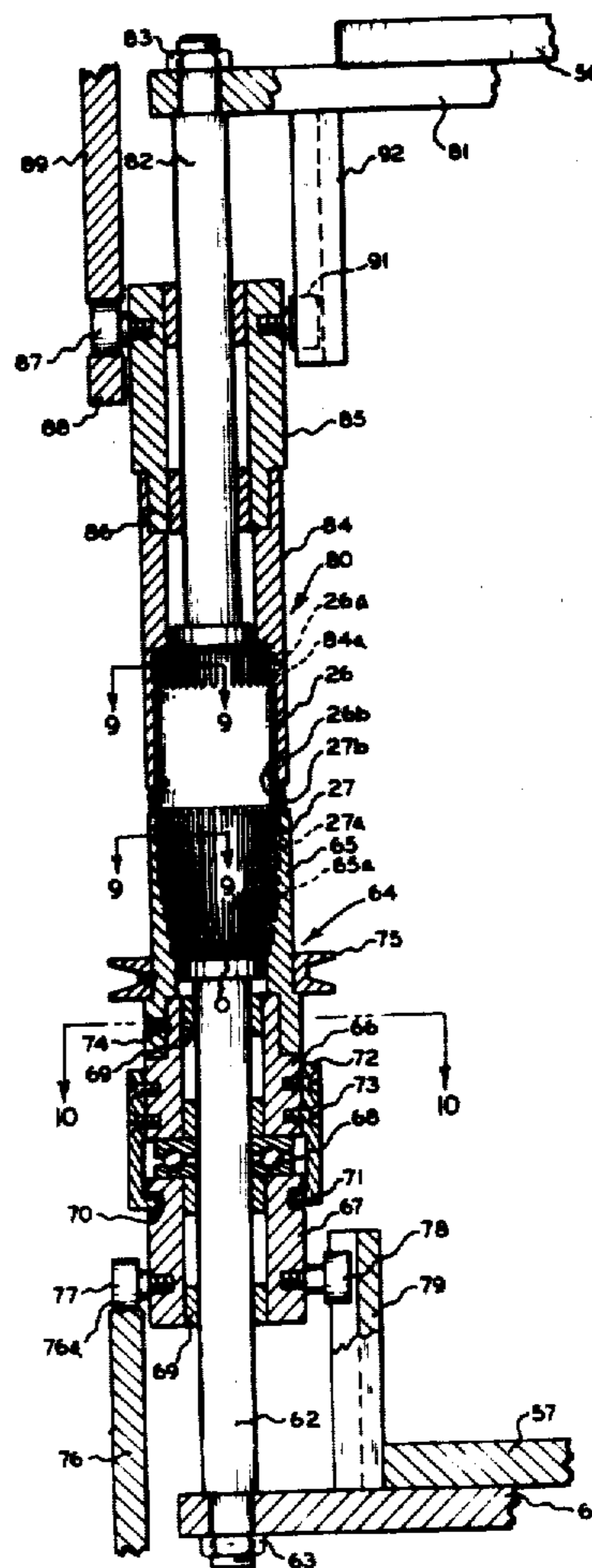
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ABSTRACT

Method and apparatus for spin-welding thermoplastic articles in which two axially mating sections are driven in rotation relative to each other and then axially abutted in mating relationship. One of the two mating sections is chucked to an inertia member which is brought up to speed by a rotary drive. The rotary drive is uncoupled as the sections are moved into axial abutment and the braking of the inertia member by the axial abutment of the sections is transformed into frictional heat which welds the sections to each other. Apparatus for spin welding sections on a production line basis is disclosed.

17 Claims, 11 Drawing Figures



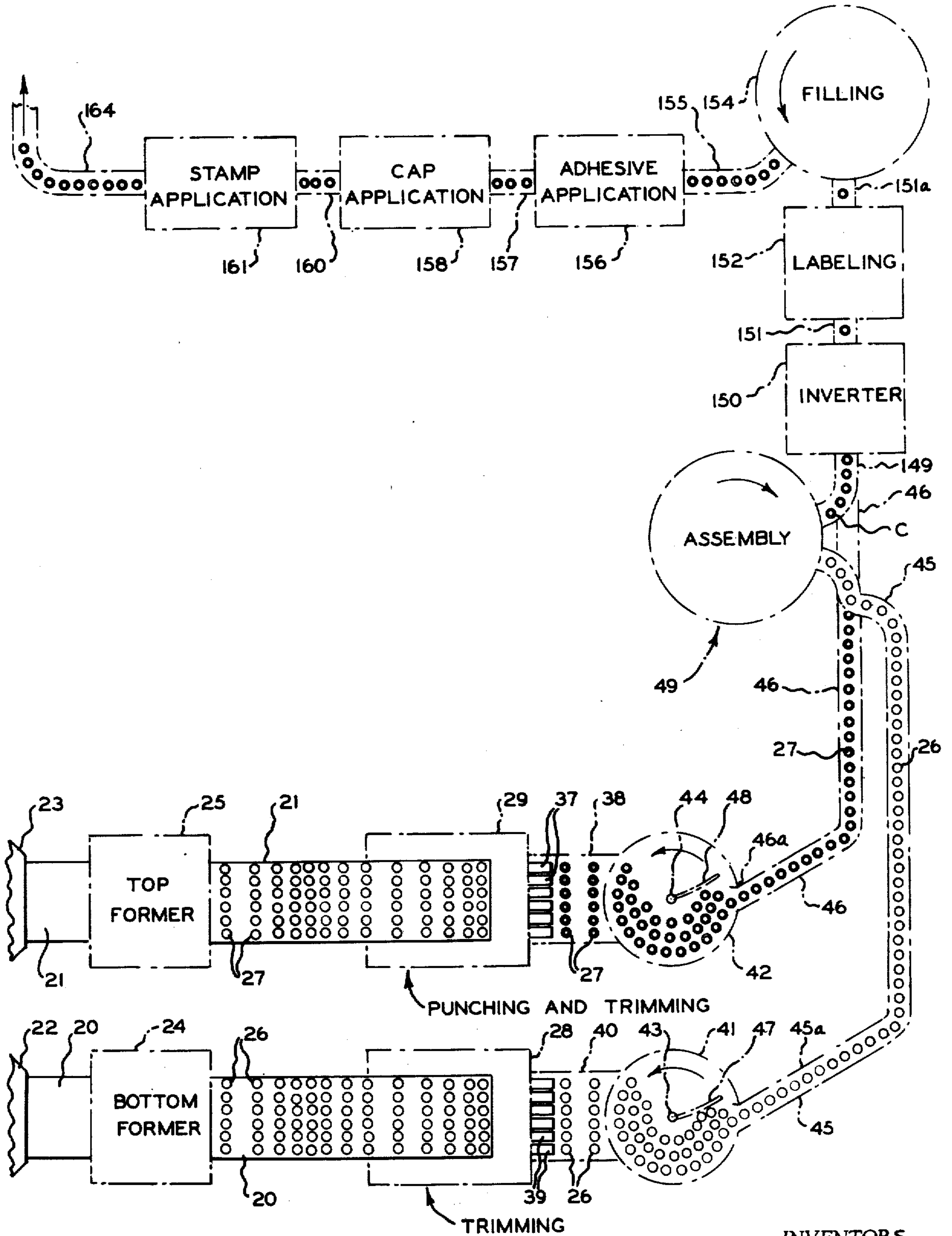


FIG. 1

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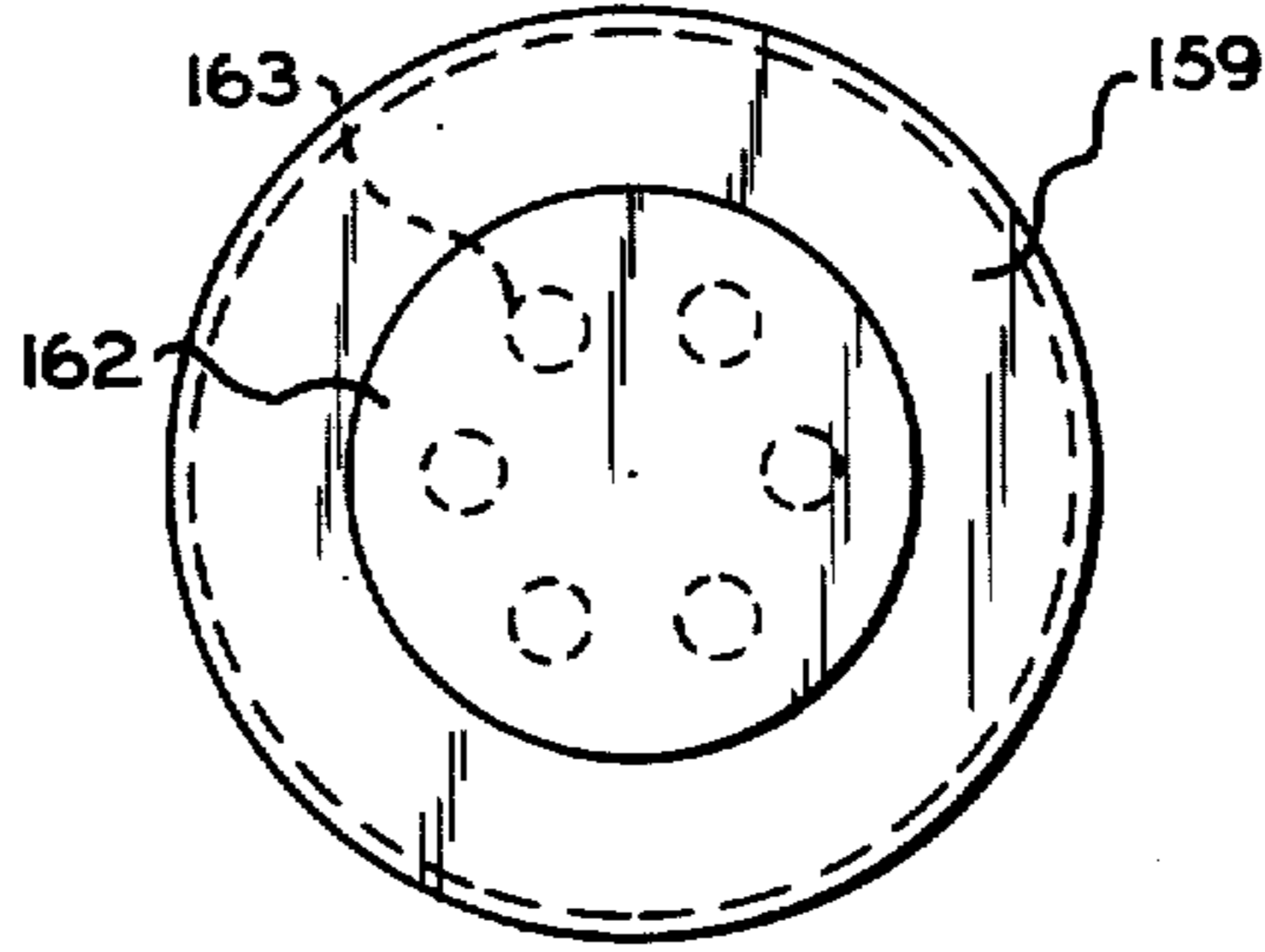


FIG. 3

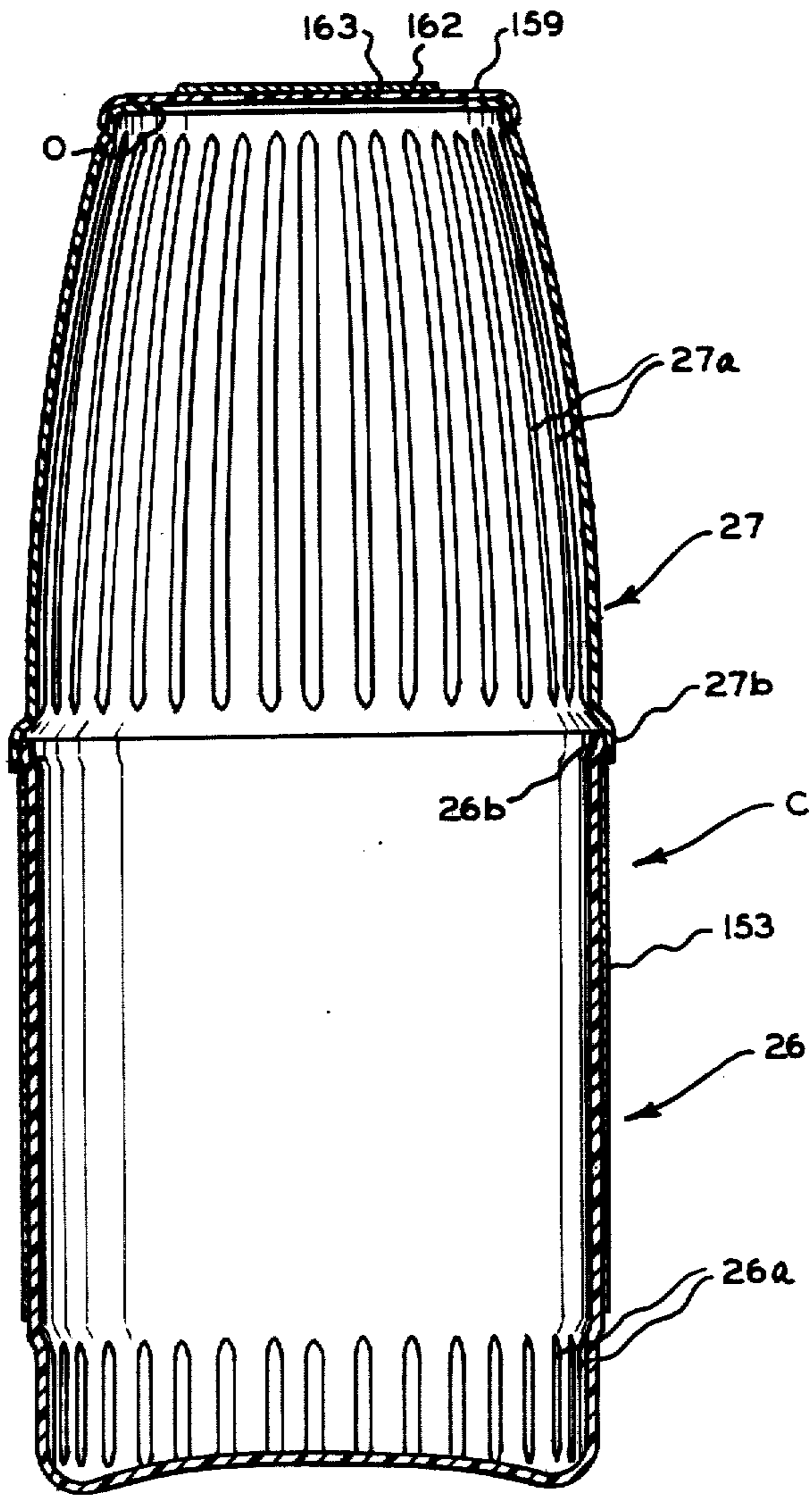


FIG. 2

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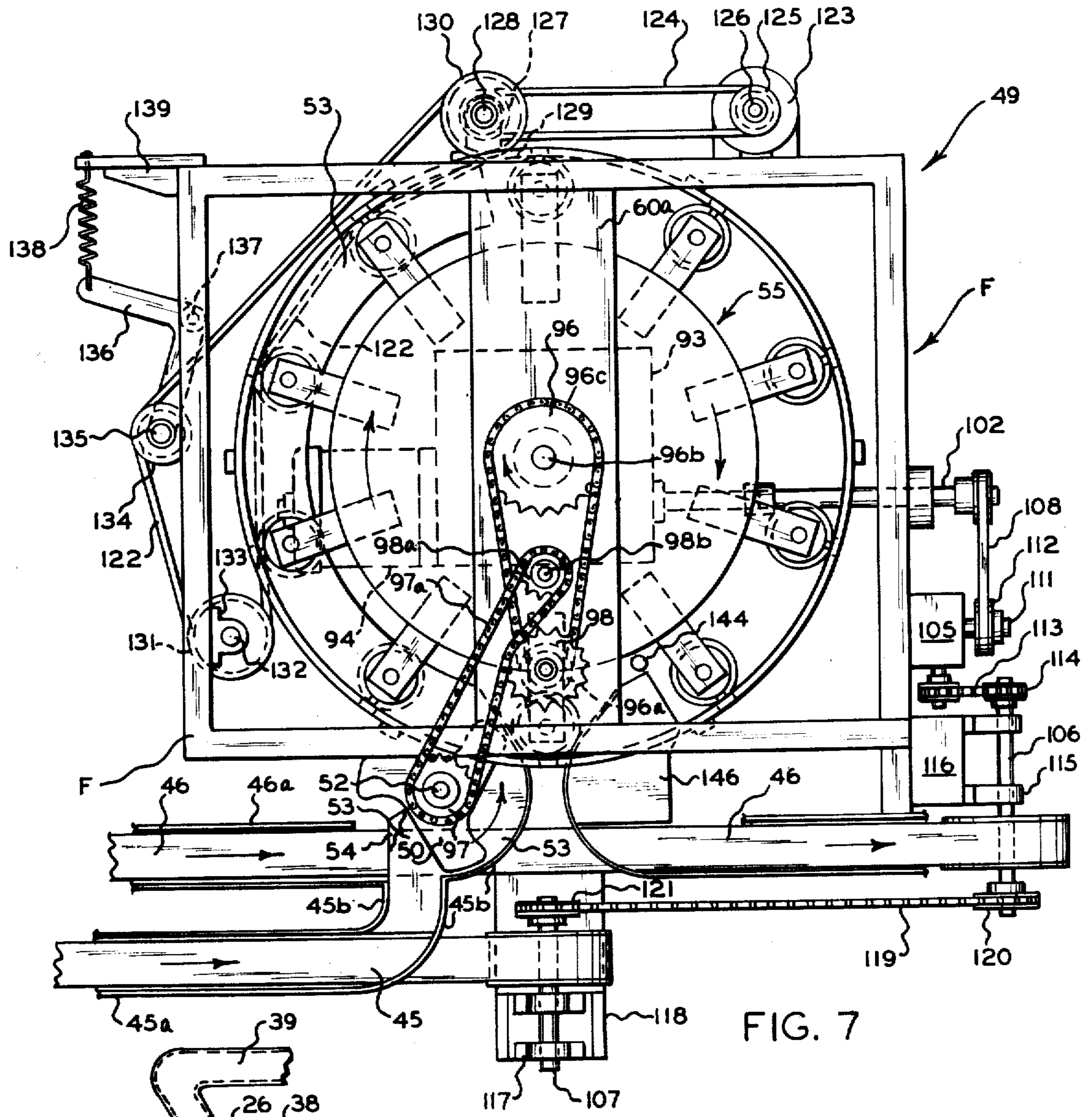


FIG. 7

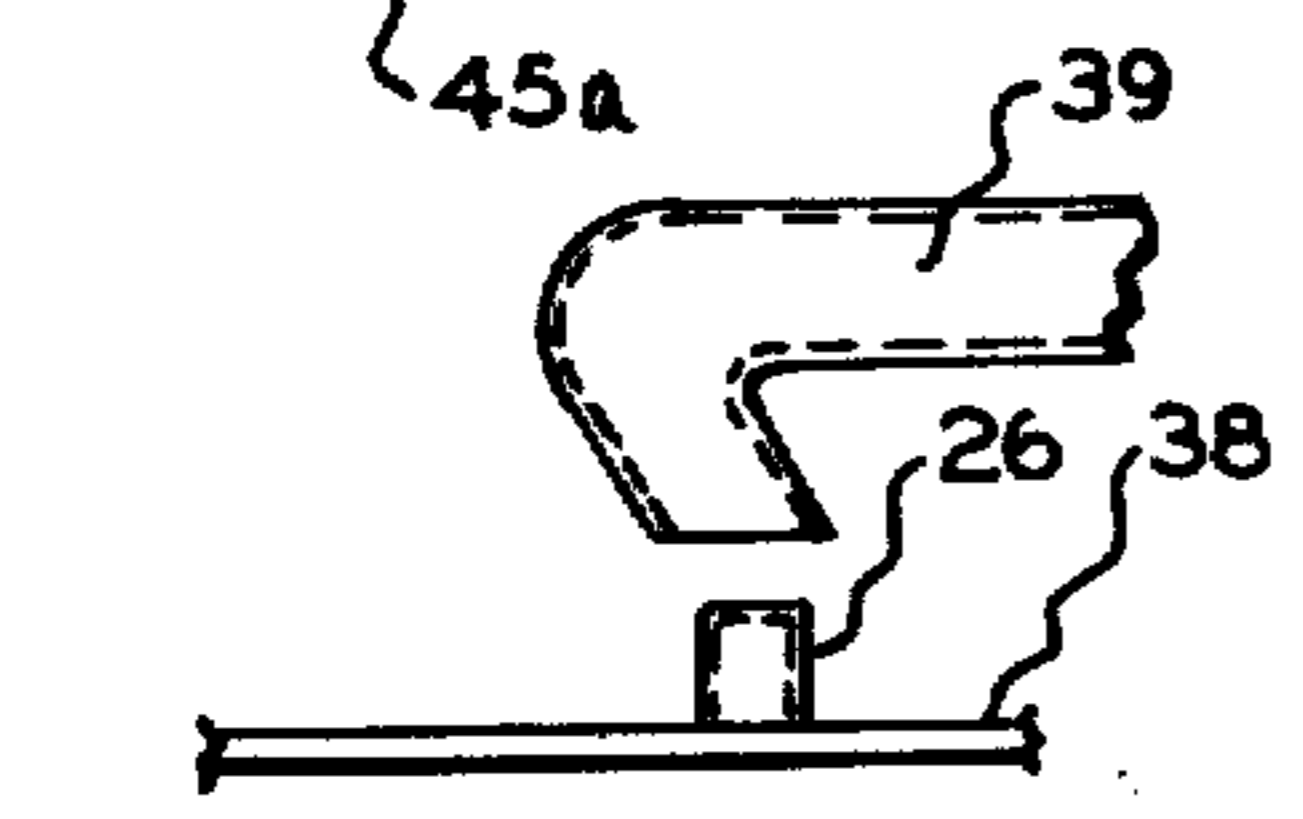


FIG. 5

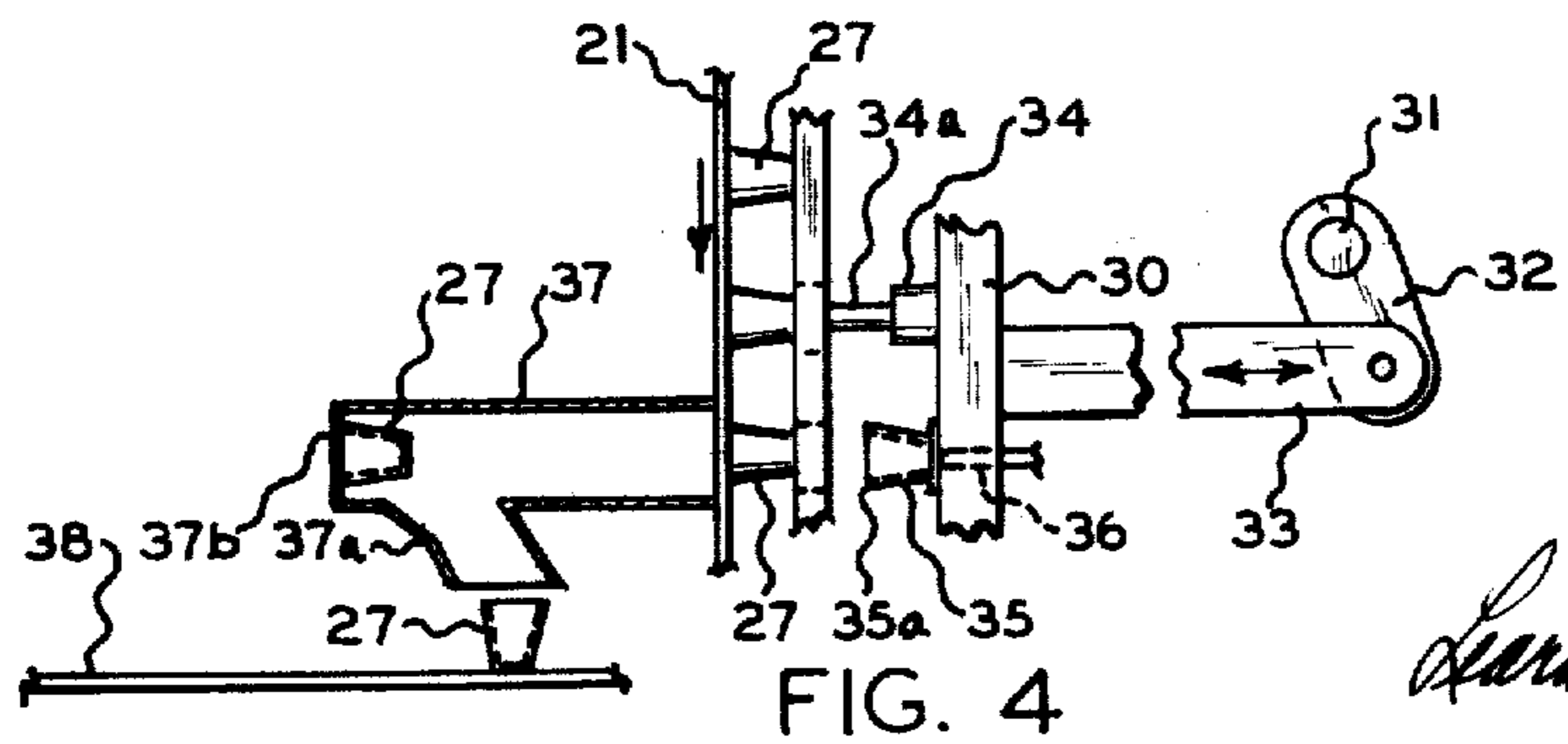


FIG. 4

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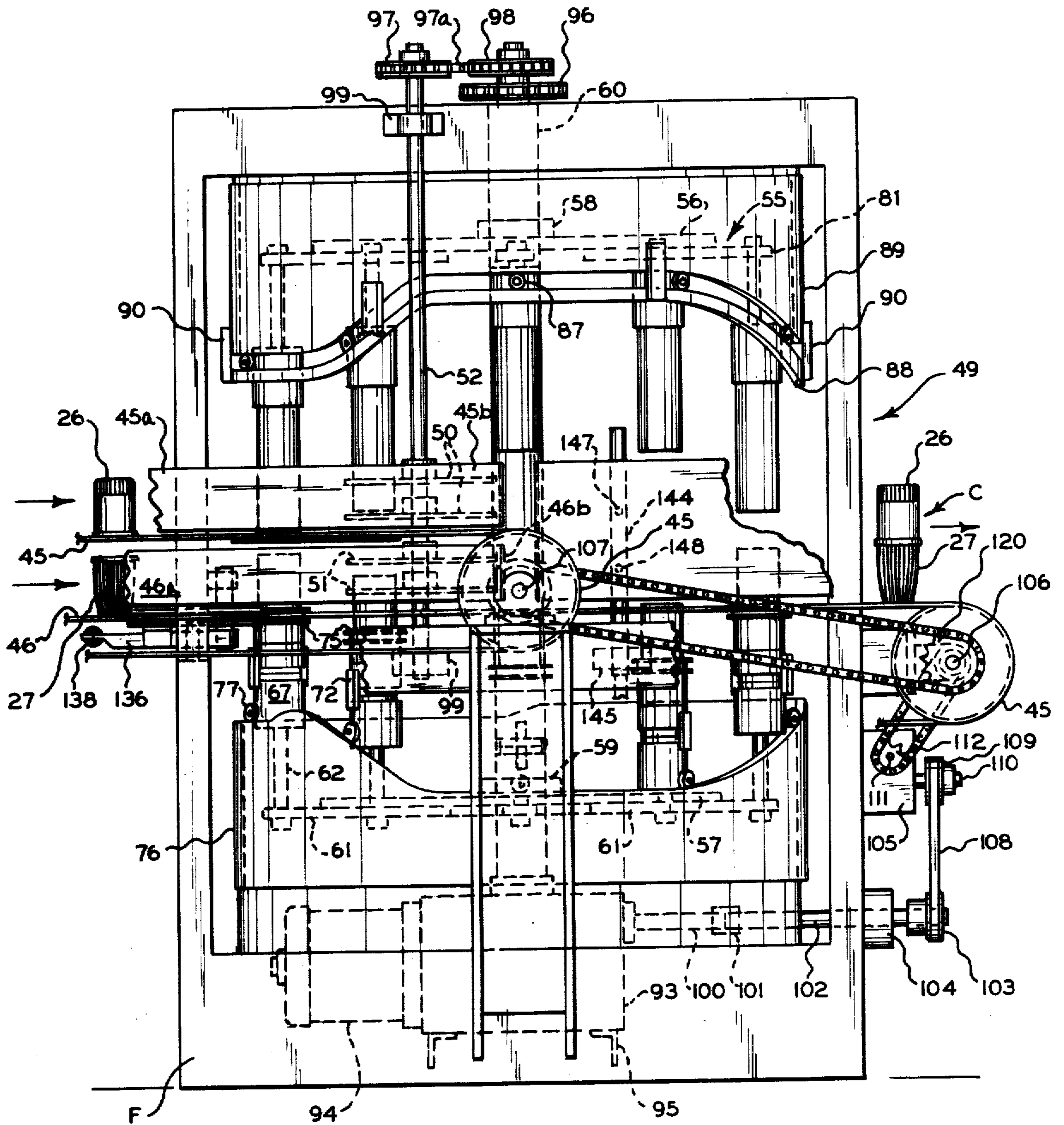


FIG. 6

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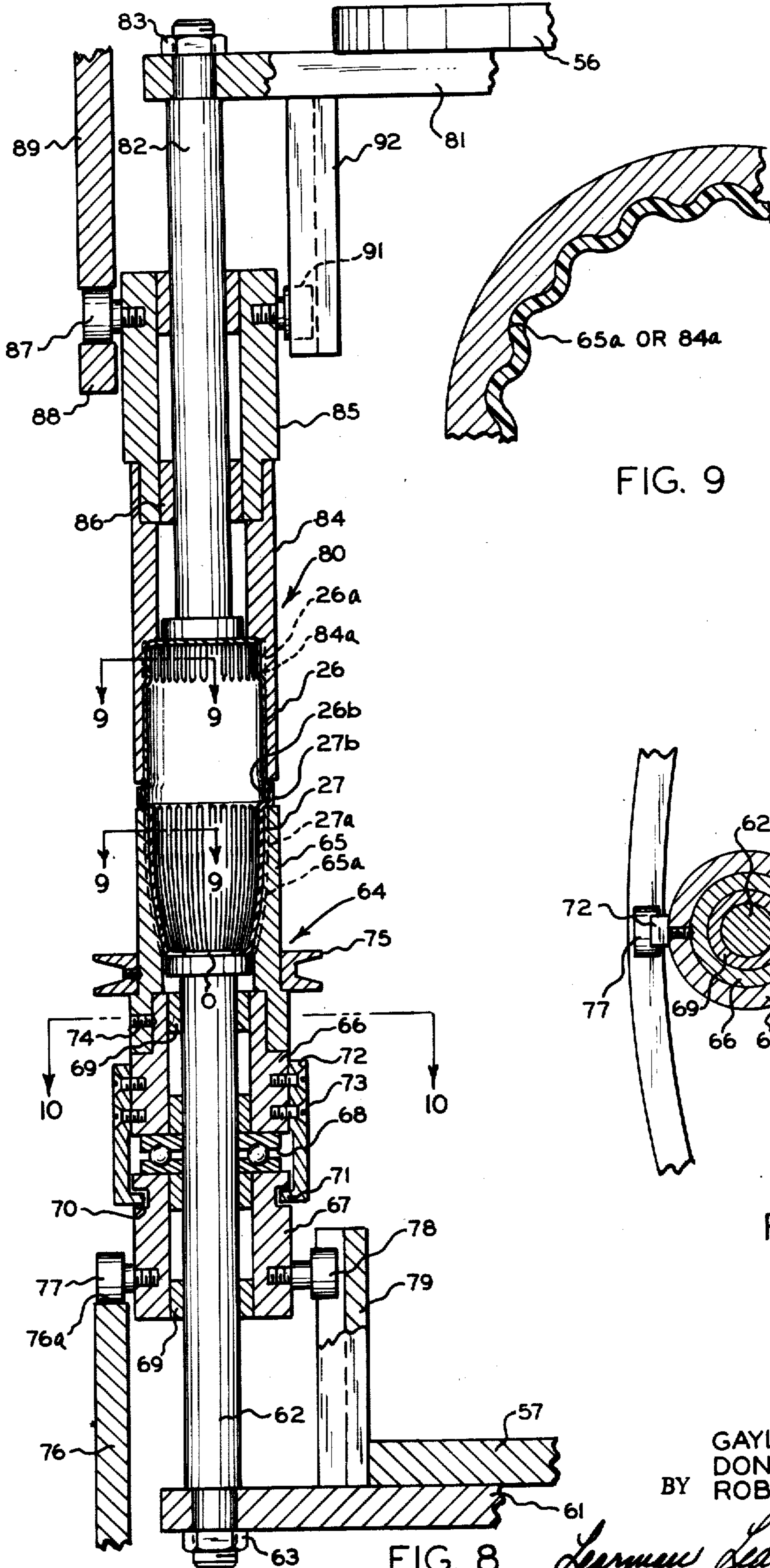


FIG. 8

FIG. 9

FIG. 10

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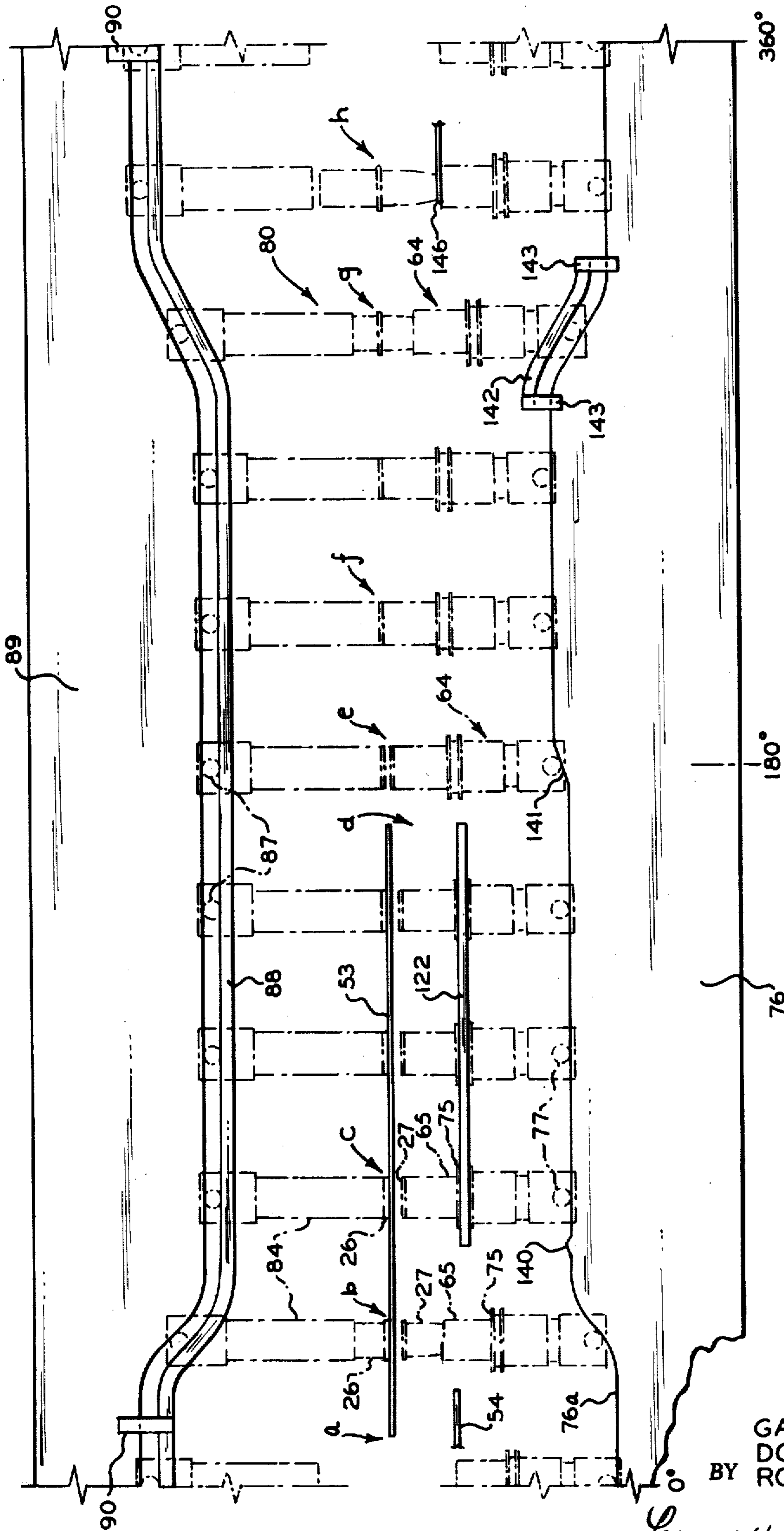


FIG. II

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## METHOD AND APPARATUS FOR ASSEMBLING AND JOINING THERMOPLASTIC CONTAINER SECTIONS BY FRICTION WELDING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to the manufacture of containers of varied design, including containers formed of organo thermoplastic materials, and more particularly to thin-walled containers suitable to carry a wide variety of products, including liquid and pulverulent detergents, which can be made so inexpensively that they can be discarded when empty. Presently, containers of this type are conventionally blow molded, although some work has been done along the lines of differential pressure forming separate sections of such containers and joining them with an adhesive or by heat sealing lateral flanges formed thereon.

We have determined that it is much less expensive to mass produce sectionally formed parts of containers, which can be efficiently and reliably joined together, than to blow mold the same containers in one piece. Further, we have found that suitable container sections can be assembled and sealed together in a rapid and continuous manner by a controlled friction welding process and that the machinery or equipment for producing containers in this manner is considerably less costly and more practical to operate and maintain than is comparable blow molding equipment. Briefly, the invention is concerned with the concept of making containers from plastic sheets that includes applying differential pressures to a first moldable sheet to form integral closed bottom container sections therein, applying differential pressures to a second moldable sheet to form integral upper container sections therein, severing the sections from those sheets and forming openings in the tops of the upper sections, traveling the bottom and top sections to an assembly area, and joining the open ends of the sections formed by their severance from the sheets in a circular seam. Another concept advanced is the preferred joinder of parts by what we term "inertia friction welding." The concept is employed, for example, to weld the overlying open ends of the container sections by applying driving forces to bring one of the sections to a predetermined speed of rotation relative to the other section, thence releasing the driving forces, and finally immediately bringing adjoining ends of the sections into snugly interfitting, lapped relation to weld the lapped ends with a controlled, friction generated heat. Because it is not possible to differential pressure form such sections to exact tolerances the diameters of the parts manufactured are selected so that the sections will always have an interference fit wherein the receiving portion of the one container section will always be slightly less in diameter than the entrant portion of the mating container section. In friction welding the parts together according to the present invention, the same controlled inertia energy is imparted to make the weld in each instance, regardless of the variance of the fit.

One of the prime objects of the invention is to provide continuous processing machinery for continuously and reliably forming containers in the indicated manner at a

high rate of speed corresponding to the speed of operation of machinery for labeling, filling, and capping the containers so that the latter machinery can operate at full speed in a continuous processing line.

Another object of the invention is to provide machinery of the character described which is eminently suitable for the production of a large variety of containers of diverse shape and size, including bottles for holding liquids wherein the bottles have threaded necks on which caps may be screwed or necks on which caps may be snapped.

A further object of the invention is to provide continuously operating equipment for furnishing the tops and bottoms in inverted position, and for receiving the tops and bottoms and accurately vertically positioning them, so that they may be joined together with the precision required in an economical and reliable manner.

Another object of the invention is to provide continuously traveling, multiple station elements for, not only receiving and guiding the interference fitting container tops and bottoms, but also revolving one relatively to the other and thence moving the end edges of the tops and bottoms into interfering fitting relation to friction weld them together in a manner which takes into consideration the fact that the character of the interference fit will vary in each instance because the container sections cannot be differential pressure formed to exact tolerances. This problem is solved by bringing the parts to a constant predetermined relative speed and disconnecting the parts from the part driving mechanism immediately prior to forcing them into interfitting relation.

A further object of the invention is to provide machinery of the character described which is adaptable to position and weld interference fitting container sections of various shapes and sizes with only a simple adjustment of the speed of rotation imparted to the one container section in each instance.

Still a further object of the invention is to provide machinery of the character described which will operate continuously over long periods of time without the need of interruption for repair or adjustment, so that the container forming, labeling, filling, and capping line may operate continuously and rapidly without shut-down.

Other objects and advantages of the invention will be pointed out specifically or will become apparent from the following description when it is considered in conjunction with the appended claims and the accompanying drawing, in which:

FIG. 1 is a plan view schematically illustrating the processing line;

FIG. 2 is a schematic, side elevational view of one of the completed product-filled containers;

FIG. 3 is a top plan view thereof;

FIG. 4 is a partly sectional, somewhat schematic, fragmentary side elevational view illustrating a punching and trimming machine which may be employed for the container top sections;

FIG. 5 is a similar view illustrating the discharge end of a trimming machine which may be used to trim the container bottom sections;

FIG. 6 is a front elevational view of the assembly machine with separate container parts illustrated on the incoming portions of the conveyors at the left end of the view and an assembled container leaving on the discharge portion of one of the conveyors at the right end of the view;



FIG. 7 is a top plan view thereof with the container parts omitted in the interests of clarity;

FIG. 8 is a partly sectional, fragmentary, enlarged elevational view of one of the guide assemblies for joining the separately formed top and bottom sections of a container;

FIG. 9 is an enlarged, sectional plan view taken on either of the lines 9—9 of FIG. 8;

FIG. 10 is a sectional plan view taken on the line 10—10 of FIG. 4; and

FIG. 11 is an enlarged, side elevational view schematically indicating the development of the stationary, circular cam tracks for controlling the vertical movement of the container assembling guide tube assemblies.

Referring now more particularly to the accompanying drawings, in which preferred embodiments of the invention only have been disclosed, FIG. 1 shows thermoplastic sheets 20 and 21 proceeding from molding heads 22 and 23 which are of conventional construction and are adapted to continuously extrude the webs or sheets 20 and 21 from a plastic material which provides the desired molding characteristics and is of the thickness and width required for the capacity of the forming machines 24 and 25 which differential pressure form the container bottom sections 26 and top sections 27 in the sheets 20 and 21. Alternatively, the sheets 20 and 21 could be supplied from rolls of the plastic sheet material and heated to the desired degree of softness in machines 24 and 25 which may be of the type illustrated in the book "Fundamentals of Sheet Forming," published in 1960 by The Dow Chemical Company and referred to therein as the Brown Machine Co. continuous forming machine.

The preferred plastic material is high impact polystyrene plastic of a composition suitable for extruding in web form, but other suitable plastics may be used, such as polyethylene and polyvinylchloride. In FIGS. 2 and 3 we have shown the container C which is formed when a bottom section 26 and slightly tapering top section 26 are joined. It is to be understood that the particular container shown is depicted only as a matter of example and the invention also contemplates the formation of containers of widely varying shape and size.

### THE TRIMMING MACHINES

From the vacuum forming machines 24 and 25 the sheets 20 and 21 are shown proceeding to a trimming machine 28 and a punching and trimming machine 29, respectively, of the design manufactured by Brown Machine Company of Beaverton, Michigan. A punching and trimming machine is illustrated schematically in FIG. 4 and, as shown, includes a platen 30 movable horizontally toward and away from the vertically moving plastic web 21, as indicated. The web 21, as it proceeds from the forming machine 25, is looped upwardly in the usual manner and then extends vertically down through the punching and trimming machine 29. The continuously operating platen 30 is driven from a motor driven drive shaft 31 through a crank arm 32 and connecting rod or arm 33.

Mounted on the platen 30 are a row of punches 34 having parts 34a sized to punch the openings O (FIGS. 2 and 8) in the end walls of the cup-like sections 27 which are drawn intermittently downwardly a row or increment at a time to dispose successive cups 27 opposite the punches 34. Also mounted on the platen 30 are a row of open ended, ring, die members 35 having cutting edges 35a which sever the sections 27 from the web

21, the dies 35 being hollow to receive the cuplike sections 27, as shown, and there being an air nozzle 36 for each die 35 for blowing the severed section 27 into an inverter tube 37 (see FIGS. 1 and 4). Each tube 37 includes a downwardly inclined spout portion 37a leading from a closed rear portion 37b to the endless conveyor belt 38 which leads away from the punching and trimming machine 29. The portion 37b of each tube 37 is of less length than the axial length of a container section 27 so that when air pressure blows a container section 27 into engagement with the end wall of the section 37b it can then fall by gravity through the spout 37a to an inverted position with its larger end disposed upwardly. The air blown through nozzles 36 which are connected to a suitable source of air under pressure can be interrupted intermittently by conventional valving to permit this to occur.

The trimming machine 28 is of the same construction except that no punch 34 is necessary since the bottom sections 26 are to have closed ends. The tubes 37 are also replaced by tubes 39, as shown in FIG. 5, which deliver the bottom sections or cups 26 from the trimming machine 28, as shown in FIG. 1. The air under pressure blown through tubes 39 from similar nozzles 36 may be blown continuously and deposits the bottom sections 26 in turned over position, as shown in FIG. 5. As indicated in FIG. 8, the sections 26 and 27 are later joined with the tops and bottoms in the position in which they are shown in FIGS. 4 and 5 so that the container C is formed in an upside down position.

From the conveyors 38 and 40 the sections 26 and 27 proceed respectively to rotary accumulator tables 41 and 42 which rotate on shafts 43 and 44 and deliver the sections 26 and 27 to conveyor lines 45 and 46, respectively. The conveyors 45 and 46 are made up of endless belt conveyors placed in end-to-end relation and include side guide rails 45a and 46a which assist in removing the sections 26 and 27 to the conveyors 45 and 46, respectively. Fixed flexible guide bands 47 and 48 assist in directing the containers to the conveyors 45 and 46, which deliver the container sections 26 and 27 to the assembly machine generally designated 49, belt conveyor 45 being elevated with respect to the position of belt conveyor 46, as shown in FIG. 6. As shown in FIGS. 6 and 7, the conveyors 45 and 46 lead to vertically spaced pairs of star wheels 50 and 51 mounted on a shaft 52 opposite conveyors 45 and 46, respectively, to transfer the container sections 26 to the assembly machine. As shown in FIG. 7, the guide rails 45a have curvilinear portions 45b and a floor portion or shelf 53 to support container sections 26 is provided leading from the conveyor belt 45, as shown, and extending around under the star wheels 50 and thence arcuately through substantially 180°. A curvilinear portion 46b is similarly provided for the guide rail 46a, along with a floor or shelf portion 54 which supports the container sections 27 as they are transferred by the star wheels 51.

### THE ASSEMBLY MACHINE

The star wheels 50 and 51 deliver the container sections 26 and 27 to a carrier assembly generally designated 55 which is mounted for clockwise rotation (FIG. 7) by a rectilinear framework or frame F and includes an upper disk or plate 56 and a lower disk or plate 57 (see FIG. 6) supported from collars 58 and 59 mounted on a central shaft 60 for revolving the carrier 55. Bearing platforms 60a span the framework F to journal shaft 60.

Mounted by the lower support plate 57 are radially extending support bars 61 for pedestal posts 62 (see FIG. 8) which can be secured in position by nuts 63 as shown. A lower guide tube assembly generally designated 64 surrounds each pedestal post 62 and comprises a sleeve 65 shaped to receive one of the container sections 27. Each sleeve 65 is supported for vertical sliding movement relative to pedestal post 62 by a pair of slide bearings 66 and 67 between which is sandwiched a roller bearing 68. The bearings 66 and 67 include post engaging bushings 69, and an annular groove 70 is provided in each slide bearing 67 for accommodating the flange 71 of a connecting plate 72 which can be secured to the superjacent slide bearing 66 with screws 73. Screws 74 or the like may be employed to secure each sleeve 65 to the upper slide bearing 66, and fixed on each sleeve 65 is a belt accommodating pulley 75 by means of which the sleeve 65 and slide bearing 66 may be rotated relative to the slide bearing 67.

As the rotary carrier 55 moves slowly in its circular path, the vertical position of the guide tube assembly 64 is determined by a stationary circular cam track 76 fixed to frame F having an upper cam surface 76a on which a follower roller 77 mounted by the lower slide bearing 67 rides. Also mounted on each slide bearing 67 is a guide roller 78 accommodated within a channel member 79 mounted by the carrier lower plate 57 to guide each assembly 64 in its vertical travel.

Directly above each lower guide tube assembly 64, the upper carrier plate 56 mounted an upper guide tube assembly generally designated 80 on radially extending support bars 81. Each support bar 81 mounts a pedestal post 82 which can be secured in position by a nut 83 and which is surrounded by a container section 26 accommodating sleeve 84 which fixes to a slide bearing 85 mounting the sleeve 84 for vertical movement on post 82. Each bearing 85 includes post engaging bushings 86 and also mounts a follower roller 87 which rides on a circular cam 88 which is connected to the stationary annular portions 89 of the frame by bars 90. Similarly provided on each slide bearing 85 is a guide roller 91 which is guided in its vertical travel by a channel stabilizer member 92 mounted by each support bar 81.

The shaft 60 and associated parts are driven from a speed reducer 93 connected with an electric motor 94, the speed reducer shown being mounted on angle supports 95 (see FIG. 6). Mounted on drive shaft 60 is a sprocket 96 mounted on a stub shaft 96b which connects to a sprocket 96a, there being a chain 96c trained around sprockets 96 and 96a. Sprocket 97 mounted on the star wheel shaft 52 is driven by a chain 97a trained around a sprocket 98 on shaft 96b, the chain 97a also being trained around an idler sprocket 98a mounted on a stub shaft 98b. The star wheel shaft 52 is supported from bearings 99 mounted by the frame F, as shown, and it is in this manner that the infed star wheels 50 and 51 are driven.

Another output shaft 100 for speed reducer 93 is coupled as at 101 to a shaft 102 and drives a pulley 103 which is mounted on the end of shaft 102, a bearing 104 being provided on the end wall of the frame F to support the shaft 102. The pulley 103, through the medium of a gear box 105, drives a shaft 106 which powers endless belt conveyor 46, and a shaft 107 which powers endless belt conveyor 45, the gear box 105 being connected with pulley 103 through the medium of a belt 108 trained around a pulley 109 mounted on the gear box input shaft 110. The gear box output shaft 111

mounts a sprocket 112 around which is trained a chain 113 connecting with a sprocket 114 (FIG. 7) on shaft 106, bearings 115 for supporting shaft 106 being mounted by a block 116 from the frame F. The drive is transmitted from shaft 106 to shaft 107, which is supported by bearings 117 mounted on the support platform 118, by a chain 119 trained around a sprocket 120 on shaft 106 and a sprocket 121 on shaft 107.

As apparatus from an inspection of FIGS. 2 and 8, the container sections 27 are ribbed or corrugated as at 27a and the interior of sleeve 65 is likewise ribbed or corrugated as at 65a so that once the container sections 27 are seated within sleeve 65 they are prevented from rotating relative to sleeve 65. Similarly, the container sections 26 include ribbed or corrugated portions 26a and the interior of the sleeve 84 of each upper guide tube assembly is similarly corrugated as at 84a to receive a container section 26, so that rotation of the container section 26 in the sleeve 84 is precluded. It will further be noted that the sections 27 have laterally and thence vertically or axially extending lip or flange portions 27b for receiving the terminal ends 26b of the container sections 26. It is to be understood that there is an interference fit between the lip sections 26b and 27b so that once they are assembled in interfitting, overlapping relation, as in FIG. 8, the rotation of one relative to the other will produce a friction which generates heat. Generally speaking, the exterior diameter of the terminal lip or edge portion 26b will be .002 to .010 inch larger than the interior diameter of the lip portion 27b which receives it. This variance will not be constant, of course, since it is impossible to form these containers to exact tolerances in mass production differential pressure forming operations. It is for this reason that the rotatably driven bottom holder or sleeve portions 65 are brought up to speed before the sections 26 and 27 are brought into interfitting relation, and the drive released prior to the time the container sections are brought into interfitting relation. This is [mechanically] mechanically much simpler than using difficulty adjustable breakaway clutches or the like, particularly where traveling station machines are employed. With the mass or weight of sleeve 65 remaining the same in each instance and the drive imparted to pulley 75 bringing the sleeve 65 to a predetermined speed of rotation in each instance, the same rotary energy is imparted to the container section 27 in each instance, regardless of the relative tightness of the fit. With the same level of energy being imparted in each instance, the spin weld achieved will be uniform, even though the interference fit differential may be .002 in one instance and .008, for example, in another instance, and a uniformly strong weld can be achieved every time. Whereas in one instance the freely spinning container section 27 may be halted in its relative rotation with the stationary container 26 within a few revolutions after the two parts are interfitted, the next container section 27 may spin through several additional revolutions relative to its mating section 26 prior to the time the weld is achieved and relative rotation ceases. In each instance, however, the same energy is imparted and the same controlled liquid-tight weld is achieved.

A belt for driving the pulleys 75 when they reach a certain stage (see FIG. 3) in the rotation of carrier 55 from the location of entry of the sections 26 and 27 opposite star wheels 50 and 51 is shown at 122 in FIG. 7. A motor 123 mounted on the frame F drives the belt 122 through the medium of a belt 124 trained around a

pulley 125 on the armature shaft 126 of motor 123, the belt 124 being trained around a pulley 127 mounted on a shaft 128 journaled by a bearing 129 also mounted on the frame F. Mounted by the stub shaft 128 is a pulley 130 around which belt 122 is trained, and it will be seen that at its opposite end belt 122 is trained around a pulley 131 mounted on a shaft 132 supported by a bearing 133 from the frame F. Belt 122 is maintained taut by an idler pulley 134 mounted on a shaft 135 on a bell crank lever 136 which is pivoted to the frame F as at 137, there being a spring 138 connected with the opposite end of bell crank lever 136 which creates a tension tending to pull belt 122 outwardly as shown. Spring 138 is connected with a bracket 139 which is fixed to frame F.

FIG. 11 illustrates the shape of the stationary circular cams 76 and 88-89. In FIG. 11 the various lobes on the cam can be located relative to the shelf or floor 53, which begins at point a at the star wheel members 50 and extends, as shown in FIG. 7, almost 180° from this point. The various diagrammatic representations show successive positions of the lower and upper guide tube assemblies 64 and 80, respectively, as they move clockwise (FIG. 7) from the point a through 360°. At position b the container section 27 has been received on the floor section 54 and is about to be delivered to the lower sleeve 65. Also, the container section 26 has been received on the shaft or floor 53 and the upper sleeve 84 is commencing to descend over the container section 26. At the point c the container section 27 is seated in the sleeve 65 and the container section 26 in the receiving sleeve 84. Just prior to the time the upper and lower guide tube assemblies reach position c, the lower guide tube assembly 64 has traveled over a rather sharp lobe 140 provided on cam surface 76a, which jars the container 27 sufficiently to align the ribs or flutes of the container section 27 with the corrugations 65a in the sleeve 65 and properly seats the section 27 if it is not already properly seated. Also, just prior to the time the assemblies 64 and 80 reach position c, the pulley 75 engages the belt 122 and as the upper and lower guide tube assemblies move continuously along, the sleeve 65 is brought to a predetermined speed of rotation. At point d the guide tube assemblies pass beyond the belt 122 but, of course, the lower sleeve assembly 64 continues to spin freely. It will be seen that a lobe 141 is provided on the cam surface 76a to raise the lower guide tube assembly 64 and fit the flange 27b of the container section 27 around the flange 26b of the container section 26. The spin welding operation takes place between positions e and f, with the extent of the relative rotation governed by the state of the interference fit between flanges 26b and 27b. At location g the lower and upper guide tube assemblies 64 and 80, respectively, are being lowered and raised, respectively, and at position h they are fully lowered and raised, respectively, so that the completed container C can be discharged to the leading end of conveyor belt 46. A cam roller retainer part 142 mounted to the cam 76 by bars 143 insures the downward travel of the lower guide tube assembly 64.

Finally, at the discharge end of the machine a stationary air jet pipe 144 (see FIGS. 6 and 7) mounted by a bracket 145 is employed to blow the completed container C from the discharge shelf 146 on which it is deposited by the lower pedestal post 62 to the conveyor 46, the air pipe 144 which is connected with a suitable source of air under pressure having a pair of openings

147 and 148 horizontally spaced to direct a stream of air at the sections 26 and 27, respectively.

From the conveyor 46 the completed containers moved on a conveyor 149 (see FIG. 1) to a conventional inverting device which turns them end for end and travels them on a conveyor 151 to a labeling machine 152 which applies adhesive to a label and secures the label to the container section 26, as shown in FIG. 2, at 153. Then completed containers pass on a conveyor 151a to a conventional filling machine 154 which fills them with a material such as detergent through the opening O in the top section 27. Thereafter the containers C proceed on a conveyor 155 to an adhesive applying machine 156 which applies adhesive to the tops of the containers C and from there, on a conveyor 157, to a machine 158 for applying the perforated caps 159 to the containers C as shown in FIG. 2. Alternatively, the caps could be friction welded in place in a machine similar to that described. Finally, the containers move on a conveyor 160 to a stamp application machine 161 which applies a stamp 162 over the perforate openings 163 in caps 159, and the containers then move on conveyor section 164 to machines for packing them in cartons.

It will be plain that FIG. 1 schematically depicts an assembly line in which the plastic material is fed to formers at one end and the completed containers leave the line at the opposite end. It is believed apparent that the disclosure teaches new and novel methods of forming containers and novel apparatus for forming the containers.

#### THE OPERATION

In operation the top forming machine forms the eventual top sections 27 of the containers and the bottom forming machine the eventual bottom sections 26 of the containers in the plastic webs 20 and 21, respectively. Webs 20 and 21 are then led through trimming and punching and trimming machines 28 and 29, respectively. In the trimming machine the die members 35 remove the container sections 26 from the web 20 and they are blown by air from nozzles 36 through rows of tubes 39 to the conveyor 40, with the lips 26a thereof disposed in engagement with the belt conveyor 40. In the punching and trimming machine 29 the container sections 27 have openings O punched in their end walls by punches 34a and they are removed from the web 21 by dies 35 and blown out tubes 37 by the intermittent jets of air issuing from air jet nozzles 36. Tubes 37 are so shaped that they invert the container sections 27 so that the end walls thereof, with the openings O therein, engage the surface of conveyor belt 38.

From the belts 38 and 40 the container sections 27 and 26 move to the accumulator tables 42 and 41 and thence in single file on conveyors 46 and 45 to the assembling machine 49. The sections 27 are transferred by star wheel portions 50 to the shelf 53, and the sections 26 are transferred from the conveyor 45 to the shelf 54 and thence to the sleeves 65 on the lower guide tube assemblies 64. After the container section 27 is settled in a sleeve 65 by the cam or lobe portion 140, the belt 122 rapidly brings the sleeve 65 to a predetermined speed of rotation and thence cam lobe 141 seats the lip sections 26b within the lip portions 27b. Because the bottom portions 26 are not substantially tapered, they do not lose their alignment when they are mounted on position above the top sections 27, as might occur if the tapering sections were disposed in the above position at the time

of effecting juncture of the sections. Frictional heat is, of course, generated during the time the lip portion 27b is moving axially up around the lip section 26b and for a short time thereafter. The speed of rotation (which, for example, may be in the neighborhood of 2000 r.p.m.) is predetermined with relation to the mass of the rotating portion of the lower guide tube assemblies 64 so that a predetermined amount of energy will be absorbed by the material regardless of the character of the interference fit of sections 26b and 27b.

When a speed of 2600 r.p.m. is employed with a part 27 weighing about half an ounce and having an interior diameter at the lip 27b of about 2 13/16 inches, the combined mass of the rotating members 75, 65, 66, 72, 73, and upper race of bearing 68 of each assembly 64 may be, for example, 5½ pounds. The predetermined inertia energy potential with which each part 27 is loaded is then a function of the combined mass of all the rotating parts of each lower shell holder assembly 64 and the speed of rotation of the surface of the part to be welded. Once the rotative energy is imparted to the loaded part 27 and the drive of belt 122 is released, it is only necessary to maintain the first freely rotating part engaged with and in a state of rotation relative to the part 26 to frictionally heat and fuse the parts together to a state in which the part 27 no longer rotates relative to the part 26. As noted previously, regardless of the state of the fit, the same amount of energy is transmitted each time and the same liquid-tight weld or seal is always achieved. Because the pulleys 75 are disengaged from the belt 122 prior to the time any welding occurs, the parts are never forcibly rotated relatively to the extent that a weld once secured is ruptured and only a predetermined energy is supplied. Finally, air jets directed from openings 147 and 148 blow the completed container C to the conveyor 46, from which it proceeds to the inverter, labeler, filling machine, adhesive applying machine, cap applicator, and stamp applicator, as noted.

It should be apparent that we have perfected a container forming line of extreme practicality which makes proper allowances for the fact that the container sections 26 and 27 cannot be formed with absolute precision in mass production operations and which forms and assembles the container sections in a most expeditious manner.

It is to be understood that the drawings and descriptive matter are in all cases to be interpreted as merely illustrative of the principles of the invention, rather than as limiting the same in any way, since it is contemplated that various changes may be made in the various elements to achieve like results without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. A method of joining thermoplastic hollow sections in end-to-end relation comprising: applying a drive to bring one of the sections to a state of relative rotation with the other section; releasing said drive while permitting said one section to spin; and bringing said sections into end-to-end engaging relation while said sections have relative rotation to weld the sections together with the controlled frictional energy created by their engaging relation during relative rotation.

2. A method of joining thermoplastic hollow sections in end-to-end relation comprising: applying a drive to bring one of the sections to a predetermined speed of rotation relative to the other section; releasing said drive while permitting said one section to spin; and

bringing said sections axially into snug overlapping relation to weld the lapped sections with a controlled frictional energy.]

3. A method of forming thin-walled, thermoplastic containers comprising: differential pressure forming container upper sections in a web; differential pressure forming container lower sections in another web of a size such that said upper and lower sections would be received one by the other with an interference fit; advancing said webs to a separation station and separating at said separation station said upper and lower sections from said webs and forming openings in the tops of said upper sections [joining together open ends of the sections formed by their separation from the webs; applying a drive to bring certain of the sections] while said webs are at said separation station; advancing said separated upper and lower sections to a joining station; axially aligning mating pairs of upper and lower sections in axially spaced alignment with each other at said joining station and advancing the aligned sections through said joining station; driving one of each set of an aligned upper and lower section in rotation while said sections are moving through said joining station to bring the rotated section to a predetermined state of relative rotation with [their] its mating [sections releasing said drive while permitting said certain sections] section; discontinuing driving of the rotating section and permitting the rotating section to spin freely; and moving said [certain sections] freely rotating section and its mating [sections] section relatively axially while said [certain sections are] rotating section is spinning to bring the end edges [thereof] of said mating sections into interference fitting, lapped engagement to generate a frictional heat which weld said sections together in a circular seam.

4. In apparatus for assembling snugly fitting, mating thermoplastic container parts; first conveyor means for supporting opposed pairs of mating parts for coaxial rotation relative to each other and for moving said opposed pairs of mating parts through a path of travel in opposed end-to-end paired relation; driven rotation inducing means extending alongside a first portion of said path for driving one of each of said opposed pairs of mating parts in rotation during [a] its transit of said first portion of said path of travel only [for bringing] to bring said one of said parts to a state of [relative] rotation [with the other] relative to the opposed part; and means for moving [said] the last mentioned opposed parts relatively axially into lapped end engagement [during another] as said last mentioned parts move along a second portion of said path of travel, and while said one of said [mating] last mentioned parts has relative rotation with the other [mating part] of said last mentioned parts to generate frictional heat welding the parts together.

5. Apparatus for assembling upper and lower, mating thermoplastic container shells comprising: carrier means movable through a path of travel; lower guides thereon receiving certain of said container shells, said lower guides including relatively rotatable parts; upper guides on said carrier means, and vertically aligned with said lower guides, receiving mating conveyor shells and vertically aligning them with said certain shells; drive means engaged by said lower guides during a portion of said path of travel to bring said certain shells to a predetermined speed of rotation relative to their mating shells; and means for moving at least one of said upper and lower guides axially during another portion of said path of travel, and while said certain shells have relative rotation with their mating shells to move the edges of

mating shells into engagement and generate frictional heat welding the edges together.

6. A method of joining thermoplastic parts comprising: rotating the parts relatively to impart a predetermined relative rotation energy thereto; releasing one of the parts to permit it to spin freely; and bringing said parts into engagement while said one part is spinning freely; said energy being such that it creates sufficient frictional heat to weld said parts together when they are brought into engagement but is less than that which would rupture the weld which is made.]

7. Apparatus for joining thermoplastic parts comprising: means for holding one of said parts from rotating; means for revolving another part relative thereto at a speed to impart a predetermined relative energy thereto and then releasing the revolving part to spin freely; and means for moving said parts into engagement while said one part is spinning freely so that the relative rotation creates frictional heat which welds the parts together, the energy imparted being such that the relative rotation creates sufficient frictional heat to weld the parts together but is less than that which would rupture the weld which is made.]

8. In container forming apparatus; means for receiving a first web with thermoplastic container bottom parts formed therein and severing said parts from said web; first conveyor means leading therefrom; means for removing said parts to said first conveyor means and disposing them in inverted position thereon; means for receiving a second web with thermoplastic container upper parts having a bell-shaped edge formed therein, punching filling openings in the ends of said upper parts, and severing them from said web; second conveyor means leading therefrom; means for removing said upper parts to said second conveyor means and disposing them in inverted position; assembly means receiving said inverted bottom parts above said inverted upper parts and traveling them relatively axially into end-to-end lapped engagement; and means for friction welding said engaged parts together.

9. In apparatus for assembling snugly fitting thermoplastic container top and bottom parts; means for holding a container top part and a container bottom part in axially spaced apart edge-to-edge disposition; drive means for relatively rotating said holding means to bring one of the parts up to a predetermined state of relative rotation with the other; means for disengaging said drive means and said holding means to permit said holding means for said one of said parts to spin freely; and means for substantially immediately moving one of said parts in an axial direction relative to the other to bring said parts into engagement while said parts have relative rotation and generate a controlled frictional heat for welding the parts together in a circular seam.]

10. In apparatus for assembling thermoplastic container top and bottom, mating shells in which the top shell edges receive the bottom shell edges but are of less internal diameter than the bottom shell edges; frame means; a rotary carrier mounted thereon and movable through an annular path of travel; means for revolving said carrier; lower vertical guide sleeve assemblies on said carrier mounted for vertical axial movement thereon; a stationary annular cam track on which said assemblies ride; each assembly including an upper sleeve for receiving one of said shells rotatably mounted on a lower sleeve; upper vertical guide sleeve assemblies for receiving mating shells mounted by said carrier for vertical axial travel in vertical alignment with said

lower assemblies; a stationary annular cam track on which said upper assemblies ride; pulleys mounted on the upper sleeves of the lower guide assemblies to travel therewith on said carrier; and endless belt means supported by said frame means in the path of travel of said pulleys with said carrier through a portion of said path of travel so that said lower assemblies and the shells carried thereby are brought up to a predetermined speed of rotation as the lower assemblies are revolved and then are released when the pulleys travel beyond said belt means; one of the cam tracks being so configured that the upper and lower guide sleeve assemblies have relative axial movement to bring the edges of the top and bottom shells into interengaging relation after said lower assemblies pass beyond said endless belt means and the friction heat generated by said interengagement during relative rotation welds said shells together in a circular seam.

11. The combination defined in claim 10 in which the upper sleeves of said lower guide assemblies and the upper guide assemblies are fluted for receiving fluted container shells.

12. The combination defined in claim 11 in which said cam track for the lower guide sleeve assemblies has a sharp lobe joining said assemblies to seat the shells in the upper sleeves thereof prior to the time the pulleys engage said belt means.

13. The method of joining together first and second thermoplastic parts, that includes loading said first part with rotatable means to augment the mass of the part itself, imparting rotation to said loaded first part to create a rotative inertia energy potential, then substantially freeing the loaded first part for rotation by the energy so created, and maintaining said first freely rotating part engaged with and in a state of relative rotation with said second part to frictionally heat and fuse the parts together to a state of non-relative rotatability.]

14. The method of claim 13 in which the total energy utilized for said heating and fusion is derived substantially entirely from said rotating energy potential of the loaded first part.]

15. The method of claim 13 in which said second part is held against rotation during said heating and fusion.]

16. The method of claim 13 in which said parts are frictionally interengaged only after creation of said first member energy potential.]

17. The method of claim 13 in which said parts are hollow sections, the end of one being received within and in engagement with the end of the other section.]

18. The method of claim 13 in which said first section is loaded by a predetermined mass which is brought to predetermined rotative speed to create predetermined rotative energy.]

19. For joining together a succession of [parts] pairs of axially extending first and second thermoplastic parts, one of which has an annular surface receivable within a surrounding annular surface of the other part for engagement and fusion therewith but at varying degrees of tolerances between the surfaces of different pairs, the method that includes loading each first part with rotatable mass to augment the mass of the part itself, [imparting] feeding pairs of the first and second parts to pairs of holders positioning them in axially spaced apart relation and moving the holders and pairs consecutively bodily in a path of movement; as said parts are moving in said path of movement, consecutively engaging the holders

for the first parts of each pair peripherally with a driven member having a drive surface disposed along a portion of the path of movement and traveling at a predetermined speed in view of said loading to impart rotation to [the] each loaded first part to create a rotative inertia energy potential, the continuing to move the pairs of holders and pairs of parts in the path of movement to a location beyond said drive surface and substantially freeing the loaded first part for rotation by the energy so created, maintaining the freely rotating part with its said surface engaged with and in a state of relative rotation with the said surface of the second part to frictionally heat and fuse the parts together, and limiting relative rotation of the parts variably as between different pairs in accordance with their initial surface tolerances in relation to a uniform application of said energy potential.

[20. The method of claim 19 in which said parts are hollow container sections.]

[21. The method of claim 20 in which said second part is held against rotation during said heating and fusion and in which said surfaces are frictionally engaged only after creation of said first member energy potential.]

[22. The method of claim 21 in which said first sections are loaded by the same predetermined mass which is brought to the same predetermined speed to create the same predetermined potential rotative energy applicable to the successive container section pairs.]

[23. Apparatus for joining thermoplastic sections in end-to-end relation comprising: means for applying a drive to bring one of the sections to a state of relative rotation with the other section; means for releasing said drive to permit said one section to spin freely; the means for bringing said sections into end-to-end engaging relation after said drive is released and while said sections have relative rotation to weld the sections together with the frictional energy created by their engaging relation during relative rotation.]

24. In apparatus for assembling thermoplastic container top and bottom, mating shells in which the top shell edges receive the bottom shell edges but are of less internal diameter than the bottom shell edges; frame means; a rotary carrier mounted thereon and movable through an annular path of travel; means for revolving said carrier; lower vertical guide sleeve assemblies on said carrier mounted for vertical axial movement thereon; a stationary annular cam track on which said assemblies ride; each assembly including an upper sleeve for receiving one of said shells rotatably mounted on a lower sleeve; upper vertical guide sleeve assemblies for receiving mating shells mounted by said carrier for vertical axial travel in vertical alignment with said lower assemblies; a stationary annular cam track on which said upper assemblies ride; pulleys mounted on the upper sleeves of the lower guide assemblies to travel therewith on said carrier; and endless belt means supported by said frame means in the path of travel of said pulleys with said carrier through a portion of said path of travel so that said lower assemblies and the shells carried thereby are brought up to a predetermined speed of rotation dependent upon the mass of said sleeves on the lower guide sleeve assemblies and the pulleys thereon as the lower assemblies are revolved and then are released when the pulleys travel beyond said belt means; means for driving said endless belt means at a speed to bring said lower assemblies and the shells carried thereby to said predetermined speed of rotation; one of the cam tracks being so configured that the upper and lower guide sleeve assemblies have relative axial movement to bring the edges of the top and bottom shells

into interengaging relation after said lower assemblies pass beyond said endless belt means and the friction heat generated by said interengagement duration relative rotation welds said shells together in a circular seam.

25. Apparatus for assembling pairs of mating thermoplastic container shells comprising: carrier means; sets of first guides thereon receiving certain of said container shells; sets of second guides on said carrier means, and axially aligned with said first guides to provide a plurality of guide assemblies movable in a path of travel, receiving mating conveyor shells and axially aligning them with said certain shells to form pairs of shells to be mated; means for driving the carrier means and moving the first and second guides in paths of travel; driven means having a drive surface disposed along a portion of the path of travel of a guide in each guide assembly and traveling at a predetermined speed to bring one of the shells of each pair to a predetermined speed of relative rotation with its mating shell; and means for moving at least one of said first and second guides of each assembly axially during another subsequent portion of the path of travel of each guide assembly beyond said driven surface and while said certain shells have relative rotation with their mating shells to move the edges of mating shells into engagement and generate frictional heat welding their edges together.

26. The apparatus set forth in claim 25 in which said latter means is operated responsive to a predesignated travel of said guide assemblies through a continuous path of travel.

27. Apparatus for assembling pairs of mating thermoplastic container shells comprising: carrier means; sets of first shell guides thereon receiving certain of said container shells; sets of second shell guides on said carrier means, and axially aligned with said first guides to provide a plurality of guide assemblies movable in a path of travel, receiving mating conveyor shells and axially aligning them with said certain shells to form pairs of shells to be mated; means for driving the carrier means and moving the first and second guides in paths of travel; drive means operable during movement of a guide assembly through a predetermined portion of said path of travel to drive one of the guides of each guide assembly and bring one of the shells of each pair to a predetermined speed of relative rotation with its mating shell; and means for releasing said drive means and moving at least one of said first and second guides of each assembly axially during another subsequent portion of the path of travel of each guide assembly to move the edges of mating shells into engagement while certain shells have inertial relative rotation with their mating shells to generate frictional heat welding their edges together.

28. Apparatus as set forth in claim 27 wherein said drive means is operable responsive to movement of each guide assembly through a predetermined portion of said path of travel, and said means for moving said guides to engage said shells is also operable responsive to a predetermined movement of each guide assembly in said path of travel.

29. A method for assembling pairs of mating thermoplastic container shells comprising: loading certain shells to sets of first shell guides; loading mating shells to sets of second shell guides; axially aligning pairs of loaded first and second guides to provide a plurality of guide assemblies; moving the guide assemblies consecutively in a path of travel; applying a drive to one of the shells of each pair to bring it to a predetermined speed of relative rotation with its mating shell during a predetermined movement of each guide assembly in said path of travel; and releasing said drive and moving at least one of said first and second guides of each assembly axially during a subsequent portion of the

path of travel of each guide assembly while certain shells have relative rotation with their mating shells to move the edges of mating shells into engagement and generate frictional heat welding their edges together.

30. The method of claim 29 wherein said drive is applied by moving one of said guides of each guide assembly into peripheral engagement with a driven means having a drive surface disposed along a portion of the path of travel of a guide in each guide assembly and whose drive speed is correlated with the speed of movement of said guide assemblies.

31. A method of assembling pairs of mating thermoplastic hollow container sections comprising: loading certain container sections to sets of first guides; loading mating container sections which are to be individually assembled with each of said certain sections to sets of second guides; moving the loaded first guides consecutively in a first path of travel; moving the loaded second guides consecutively in a second path of travel, so related to the first path of travel that said first and second guides are axially aligned during at least a portion of said first and second paths of travel; applying a drive to bring one of the sections of each pair to be assembled to a predetermined speed of relative rotation with its mating section during a predetermined movement of the guide to which it has been loaded in its path of travel; and releasing said drive and thereafter moving appropriate pairs of said first and second guides axially together during a subsequent portion of the path of travel of each said guide, at a time when said first and second guides are

axially aligned and while certain sections are permitted to have relative rotation with their mating sections to move the edges of mating sections into engagement and generate frictional heat welding their edges together.

32. Apparatus for securing pairs of mating thermoplastic container sections in axially assembled position comprising: a frame; sets of first container section guides, for receiving certain of said container sections, supported by the frame for movement in a first path of travel; sets of second container section guides, for receiving mating container sections, supported by the frame for movement in a section path of travel so related to said first path of travel that said first guides and second guides are axially aligned during at least a portion of said first and second paths of travel; means for moving the first and second guides in said paths of travel; drive means, operable during movement of each guide in one of said sets through a predetermined portion of its path of travel to drive each such guide and bring one of the sections of each pair to be assembled to a predetermined speed of relative rotation with its mating section; and means for releasing said drive means and moving appropriate first and second guides holding mating container sections relatively axially during another subsequent portion of the path of travel of each said guide, while said first and second guides are axially aligned, to move the edges of mating sections into engagement while certain sections have inertial relative rotation with their mating sections to generate frictional heat welding their edges together.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. Re. 29,448

Dated October 18, 1977

Inventor(s) Gaylord W. Brown et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 14, change "organo" to --organic--

Column 2, line 50, change "drawing" to --drawings--

Column 3, line 39, change "26" second occurrence to --27--

Column 5, line 30, change "mounted" to --mounts--

Column 5, line 40, change "portions" to --portion--

Column 6, line 9, change "apparatus" to --apparent--

Column 6, line 27, change "with" to --will--

Column 7, line 13, change "bell" to --belt--

Column 8, line 66, change "on" to --in--

Column 13, line 6, change "the" (first occurrence) to -then--

Column 13, line 33, change "the" to --and--



UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. Re. 29,448 Dated October 18, 1977

Inventor(s) Gaylord W. Brown et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 14, line 3, change "duration" to --during--

Column 15, line 12, change "of" (first occurrence) to --for--

**Signed and Sealed this**

*Eleventh Day of April 1978*

[SEAL]

*Attest:*

**RUTH C. MASON**  
*Attesting Officer*

**LUTRELLE F. PARKER**  
*Acting Commissioner of Patents and Trademarks*