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Uhlig

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[54] **METHOD FOR BLOW MOLDING**

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Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,767,747**
Issued: **Oct. 23, 1973**
Appl. No.: **103,624**
Filed: **Jan. 4, 1971**

[52] **U.S. Cl.** **264/89;** 264/98; 264/296; 425/DIG. 213; 425/DIG. 215

[51] **Int. Cl.²** **B29C 17/07**

[58] **Field of Search** ..... 264/89, 94, 96–99, 264/294, 296; 425/326 B, 387 B, 242 B, DIG. 213, DIG. 215

[56] **References Cited**

UNITED STATES PATENTS

2,715,751	8/1955	Weber	264/97 X
3,032,809	5/1962	Willard	264/99
3,081,489	3/1963	Jackson et al.	264/99 X
3,224,038	12/1965	Budesheim	264/98 X
3,325,862	6/1967	Mehnert	264/98 X
3,632,261	1/1972	Gasior et al.	425/387 B X

FOREIGN PATENTS OR APPLICATIONS

38-8583	6/1963	Japan	
1,147,118	4/1969	United Kingdom	
1,193,050	5/1970	United Kingdom	264/96

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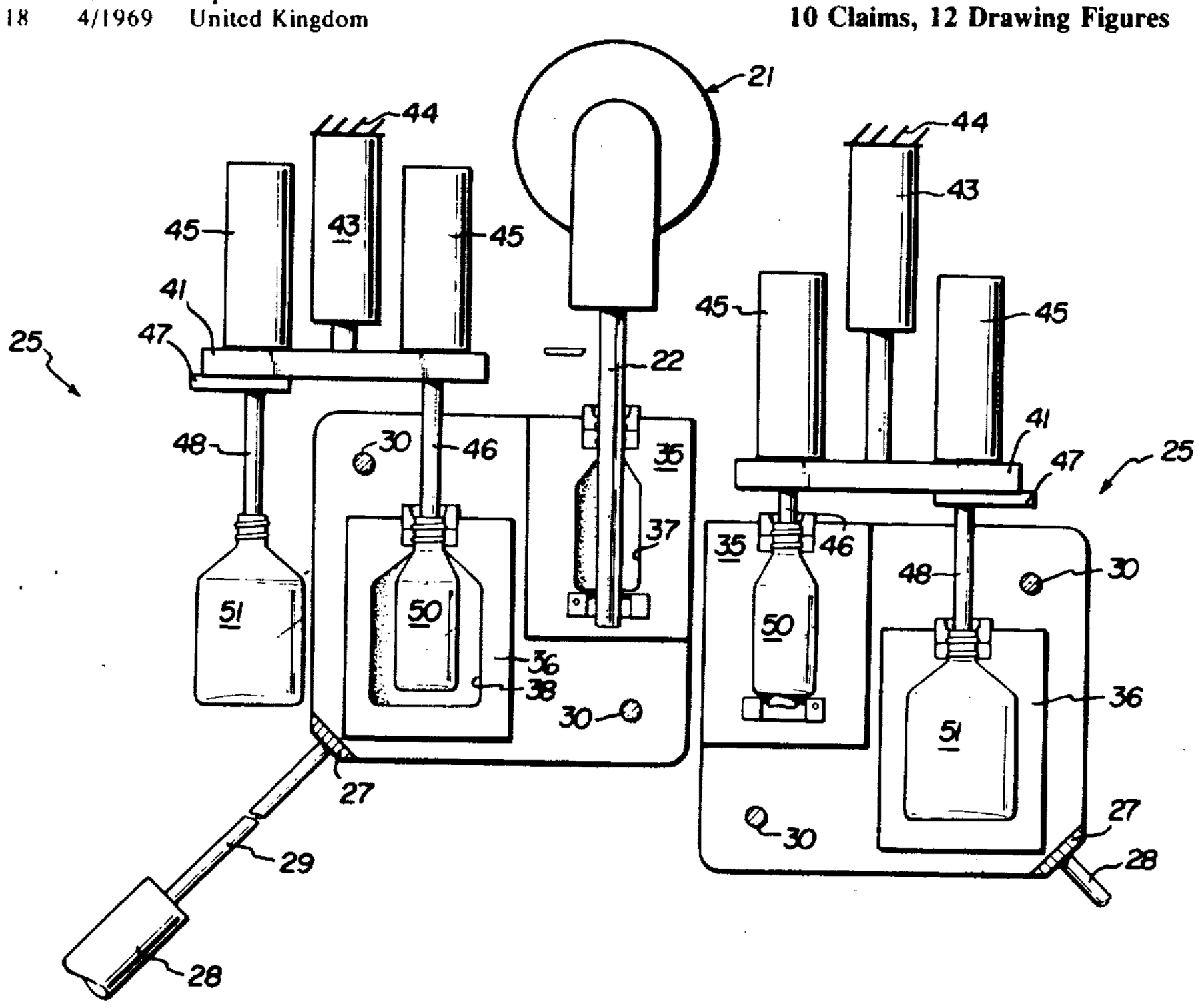
[57] **ABSTRACT**

An improved method for forming blow molded articles of enhanced physical characteristics by orienting the material during the formation of the article. A two-stage blowing operation is provided wherein a pre-form blow mold effects a uniform and controllable transfer of heat from a freely extruded tube. The pre-form is conditioned, both thermally and dimensionally, within the pre-form for most effective orientation during a subsequent final blowing operation.

Manipulatively, the disclosed method provides a completely overlapped pre-blowing and final blowing operation, and more than one set of pre-blow and final blow molds may be utilized at a single extruder orifice, if desired. Further, the direction and extent of movement of the molds adapts the method to presently existing blow molding machines, while increasing the machine output.

Successively utilized blow tubes form and reform the open or blowing end of the tube to a final configuration. In the manufacture of containers, the two successively utilized blow tubes form an accurate, dimensionally stable finish for a bottle while also severing any neck flash from the finish.

10 Claims, 12 Drawing Figures



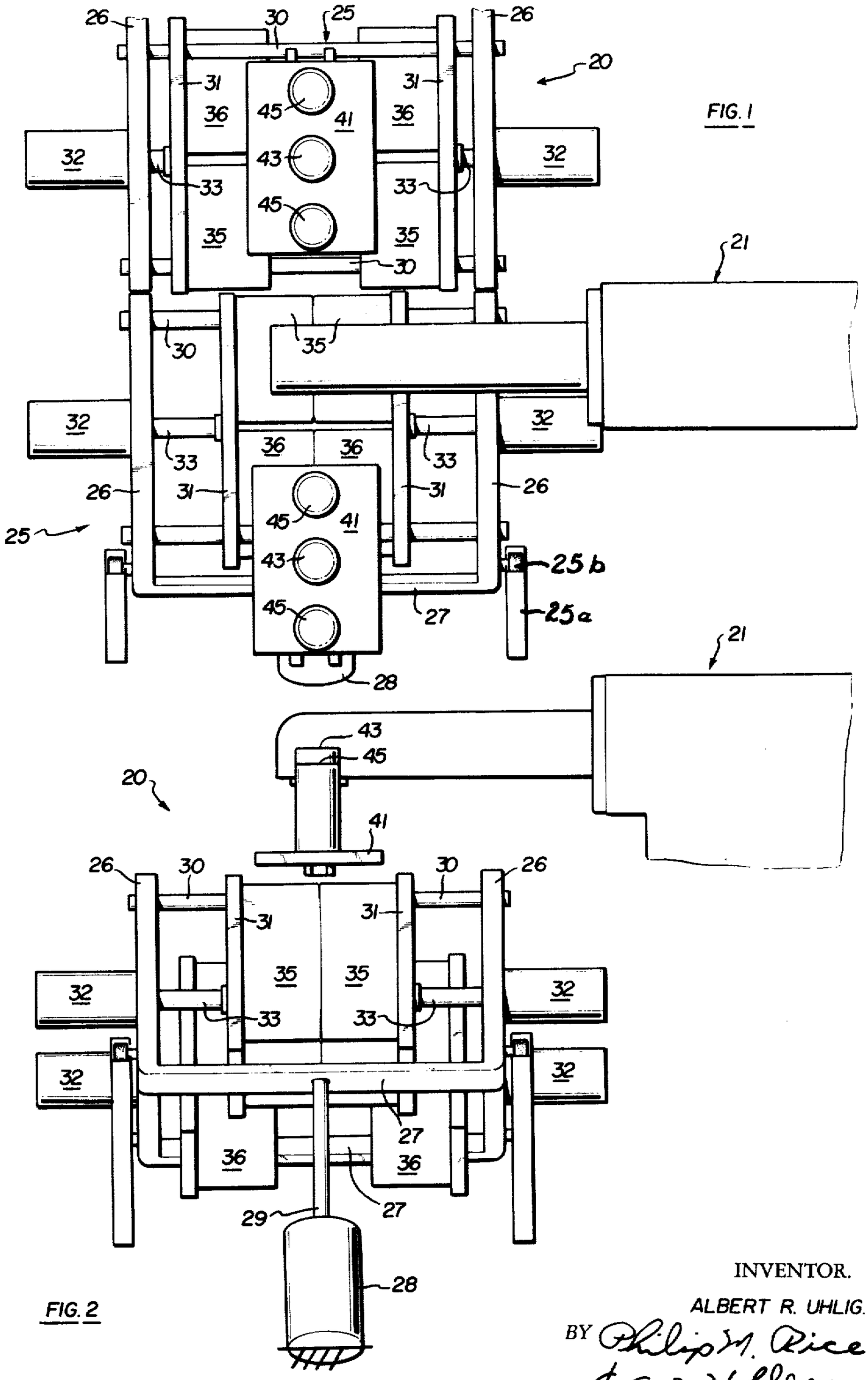


FIG. 1

FIG. 2

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FIG. 3

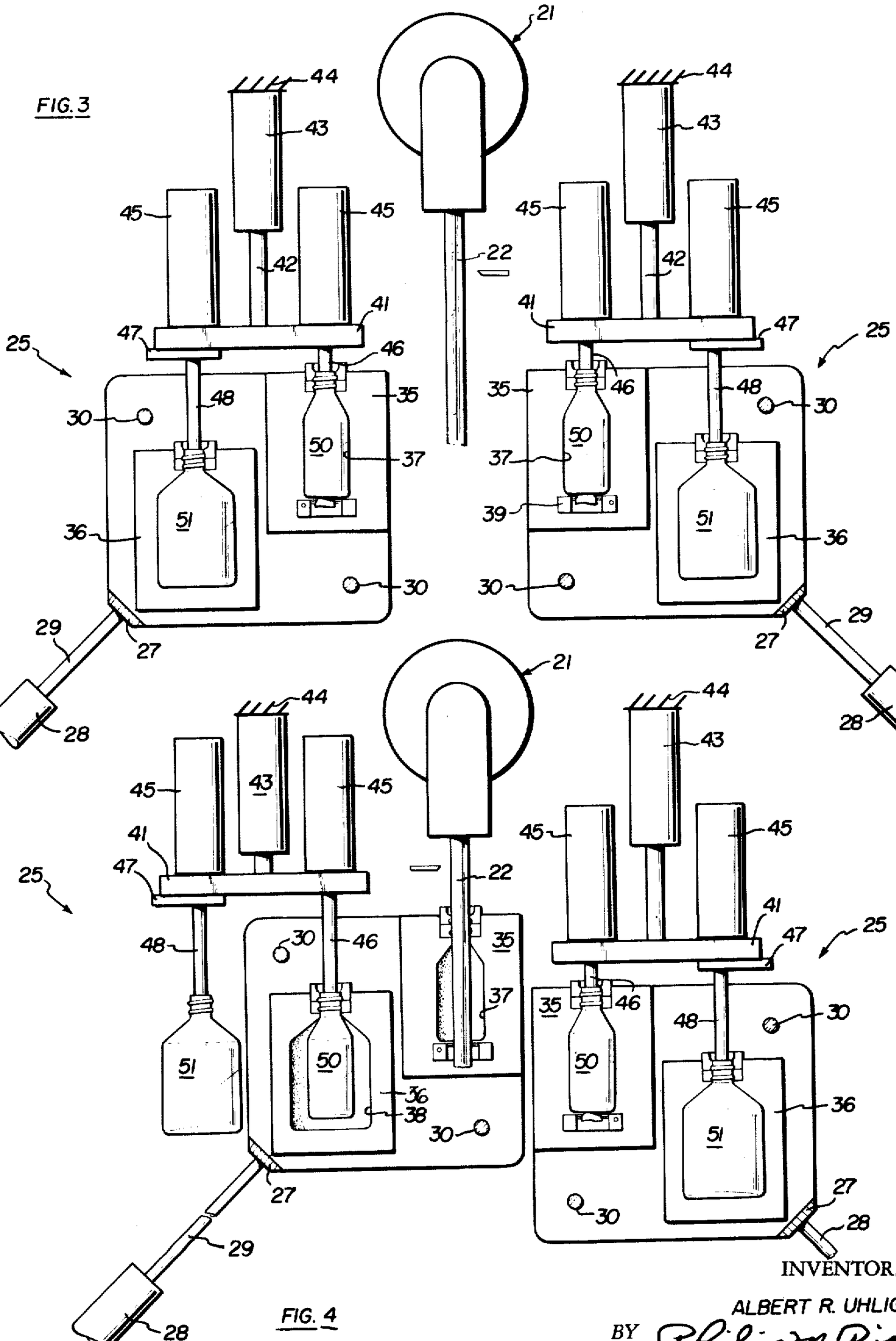

FIG. 4

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FIG. 5

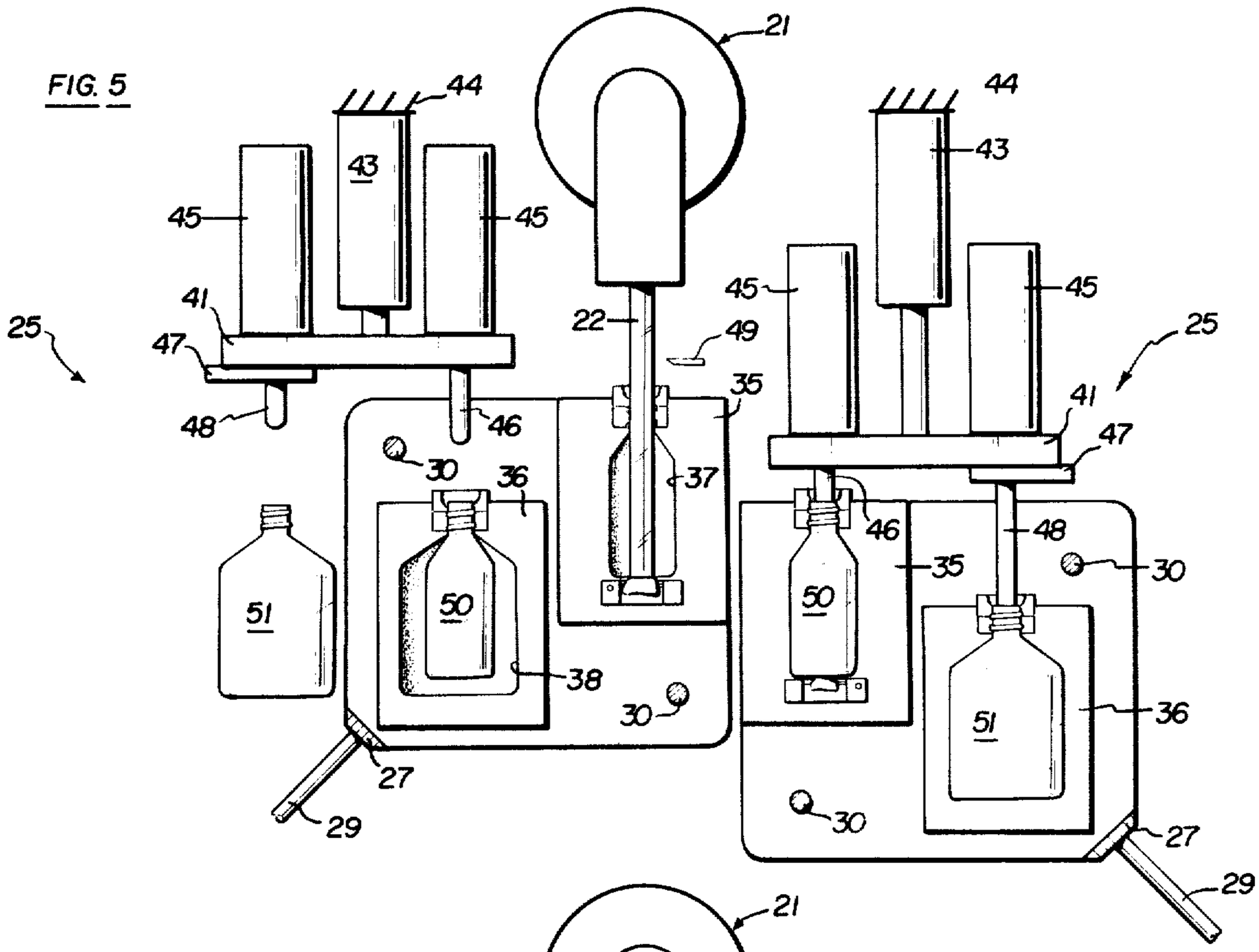
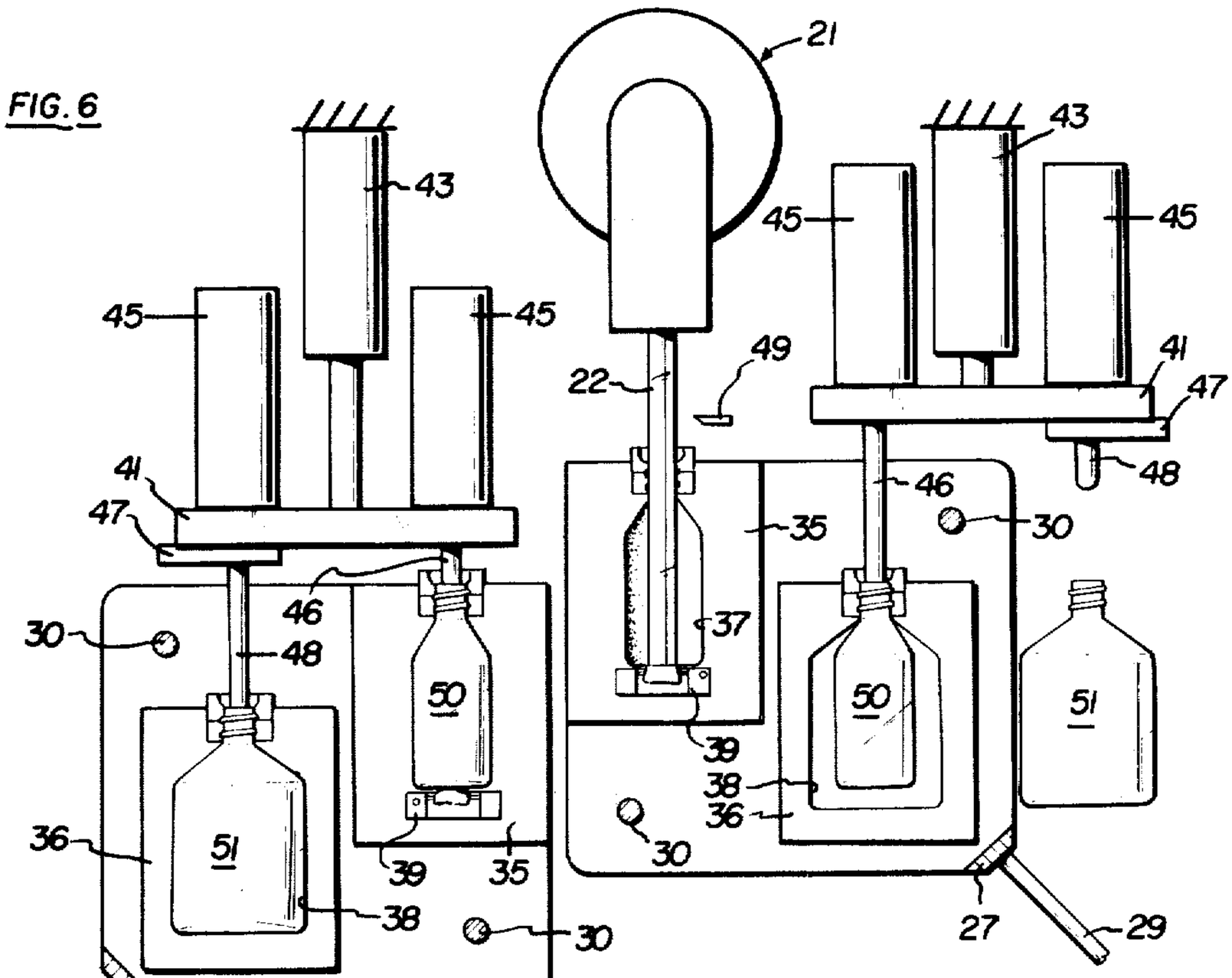


FIG. 6



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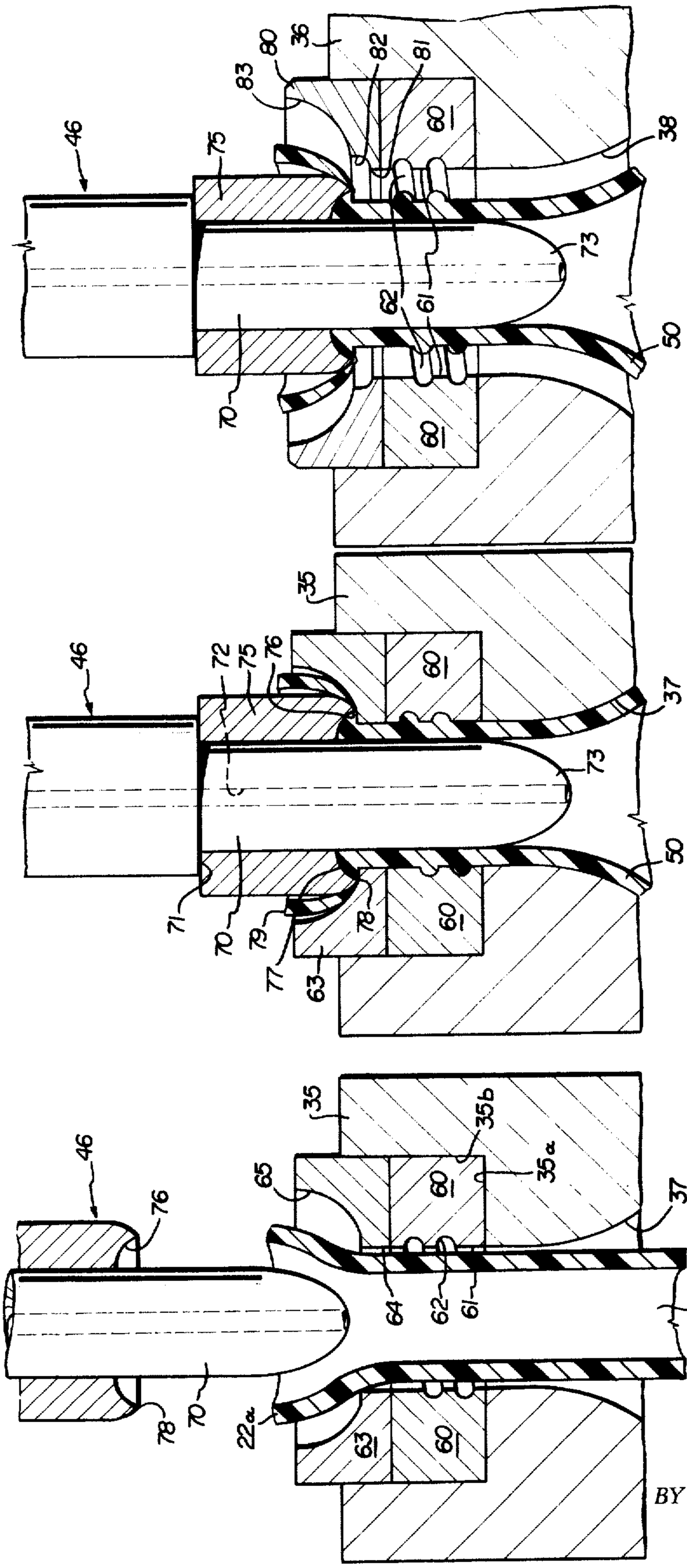

FIG. 9

FIG. 8

FIG. 7

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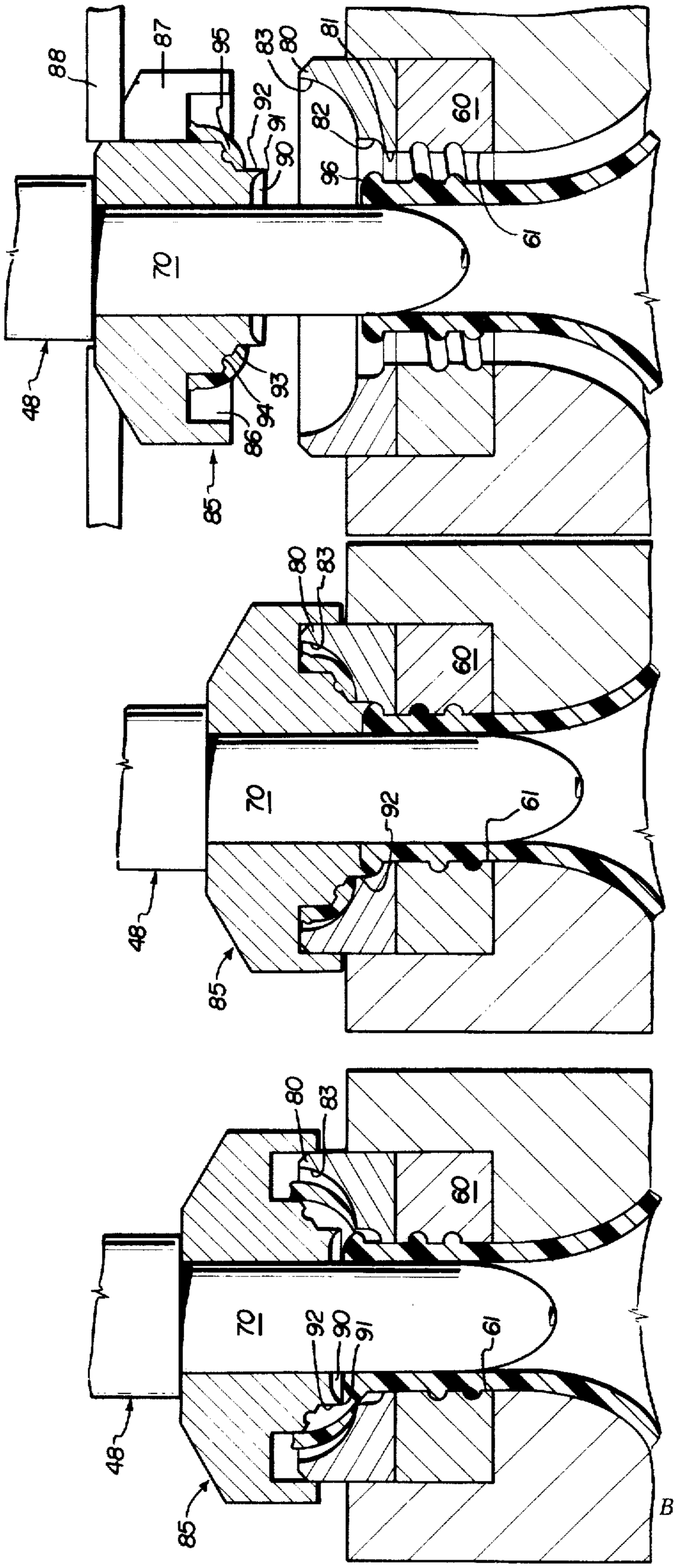

FIG. 12

FIG. 11

FIG. 10

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METHOD FOR BLOW MOLDING

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 application is a re-issue of U.S. Pat. 3,767,747, issued October 23, 1973, matured from U.S. Pat. application Ser. No. 103,624, filed January 4, 1971.

BACKGROUND OF THE INVENTION

The prior art contains several examples of attempts to utilize the phenomenon of bi-axial orientation in thermal plastic material for the blow molding of various articles. For example, U.S. Pat. Nos. 3,311,684; 3,470,282; 2,919,462, and 3,337,666 provide various blow molding arrangements. Generally, the prior art processes attempt to cool a parison to a uniform orientation temperature, stretch the parison and then blow the stretched parison into a container. Alternatively, other proposals involve the injection molding of a parison, the cooling and the reheating of the injection molded parison, and the blowing of the reheated parison to its final configuration.

Such processes are ill adapted to high production rates, and such processes are not adaptable to conventional, free extrusion blow molding machines now in use in many blow molding operations.

In view of the very substantial advantages residing in blow molding under conditions conducive to bi-axial orientation, there does exist a need for a practical, rapid, efficient blow molding method which is adaptable to the over-all free extrusion blow molding technique. If it were possible, at the same time, to eliminate extraneous flash from the article, e.g. at the neck, handle and bottom portions of a bottle, a long standing need in the art would be satisfied.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

The present invention now proposes a blow molding method which is particularly adapted for utilization with the so-called "free-extrusion" blow molding machines wherein a pendant tube of thermoplastic material is issued from a downwardly facing orifice. This is probably the simplest form of blow molding machine, and such machines are in wide usage.

In essence, this invention forms a plastic article, such as a bottle or the like, by the performance of two successive blowing operations upon a section of such a freely extruded pendant tube. The blow molds are shiftable into and out of registry with the tube, preferably in a linear path which is inclined so as to include both horizontal and vertical components of movement. This same type of linear, inclined movement has been earlier utilized in known blow molding machines, for example, in machines manufactured and sold by Bekum Maschinen-Vertrief of Berlin, Germany. Of course, other mold movements, either linear or rotary, can be utilized, but the herein disclosed specific inclined movement is preferred for adaption to known machines of the "Bekum" type.

The shiftable blow molds include openable and closable blow mold sections which move transversely of their path of linear, inclined movement, and such blow

molds are provided in pairs. One mold of the pair of blow molds is a pre-form mold having an interior body-defining blow cavity which corresponds generally to the shape of the final article, but of substantially smaller dimensions. In the manufacture of a bottle, the bottle neck in the preform mold is an exact duplicate of the final non-blown bottle neck. The second mold of the pair of blow molds has an interior cavity which conforms exactly to the size and shape of both the body and the neck of the finished article.

In operation, the pre-form molds is closed on the pendant tube hanging from the extrusion orifice, the closure of the pre-form mold pinching the tube shut to form a blowable bubble or parison. The tube entrapped in the pre-form mold is then moved with the mold laterally and vertically away from the location of the extruded tube, and a first blow tube is inserted into the portion of the tube protruding from the pre-form mold. Insertion of the first blow tube compression molds the neck of the container and air under pressure is introduced into the parison to inflate the same to the configuration of the pre-form mold. During blowing of the pre-form and during the residence time of the pre-form in the pre-form mold, the pre-form is being cooled.

After the desired amount of cooling has been accomplished in the pre-form mold, the pre-form mold is opened, and the pre-form is retained in position on the first or pre-form blow tube. The open pre-form mold is then shifted into alignment with the next successive tubular extrusion at the extrusion orifice, leaving the pre-form on the blow tube. The final blow mold is then closed on the pre-form, the first blow tube is retracted and the preform is retained interiorly of the blow mold. The blow mold, with the entrapped pre-form, is then moved into alignment with a final blow tube which is inserted into the pre-form. Air under pressure through the final blow tube inflates the pre-form to the exact shape of the final article.

The amount of cooling of the plastic material during the extrusion of the tube, the time of retention of the plastic material in the pre-form mold and the time of transfer of the pre-form to the final blow mold for blowing is all carefully correlated with the wall thickness of the pre-form and of the final article and with the material utilized in the operation, so that the final blowing is accomplished under conditions most conducive to orientation. Such conditions exist when the average wall temperature of the pre-form at the time of blowing is at a temperature within the range defined from the crystalline melting point of the material plus 20° F. to the crystalline freezing point of the material minus 20° F. At these temperatures, the maximum orientation of the material is developed and the full benefits of bi-axial orientation during blowing are obtained. Further, the size and shape of the pre-form is carefully correlated with these characteristics of the final article. Preferably, the shape of the pre-form is such that the side walls of the pre-form will all be expanded to substantially the same extent during the final blowing operation, so that the walls are bi-axially oriented to a uniform degree. In this manner, thick and thin spots in the side walls are avoided, and the occurrence of non-oriented or over-oriented localized areas is avoided. Of course, variation can be made to provide thickened portions in the walls or other portions of the article, less orientation in selected areas, etc.

The present invention also contemplates a specific process for forming and then reforming those portions

of the article which are contacted by the blow tube for both the pre-form and the final article. By utilizing the herein suggested method in connection with the specific blow pipe arrangement, one can form a container or the like which is free of neck flash, thus eliminating a subsequent post-blowing operation.

Similarly, that portion of the extruded tube which is pinched shut in the pre-form mold normally forms bottom flash on the container. By removing the bottom flash after the pre-form is blown to shape, this flash does not interfere with the subsequent final blowing operation and the final article is free of bottom flash.

Generally, the present invention provides for the pre-form molds and the blow molds to be jointly displaceable relative to the extrusion orifice, with the pre-form sections being openable and closable jointly with the final mold sections. This arrangement not only simplifies the mold actuating mechanism, it also insures accurate registry of the blow molds with their respective blow tubes and accurate registry of the compression molded portions of the container with the appropriate portions of the blow mold sections, and a completely overlapped, efficient molding operation is obtained.

In effect, the method of the present invention subdivides the blowing and cooling of the extruded tube into two successive blowing and cooling operations. This means that the residence time of the tube in the blow mold is reduced by one-half, and by accurately overlapping the two blowing and cooling operations, the cycle time is reduced by approximately 50%. Further, it is possible to utilize multiple sets of molds, each set including a pre-form mold and a final blow mold. By alternately advancing the pre-form molds of two such sets of molds into alignment with the extrusion orifice, the production capacity of a blow molding machine can again be doubled.

It is therefore, an important object of the present invention to provide an improved method of blow molding articles from a tube depending from an extrusion orifice by enclosing and blowing the tube in a pre-form mold, and transferring the blown pre-form to a final blow mold wherein the article is blown to its final configuration under conditions conducive to bi-axial orientation of the material constituting the article.

Another important object of this invention is the provision of a method for blow molding articles from a tubular parison and including consecutively utilized pre-form and final blow molds, and individual blow tubes for the tube molds to aid in transferring the blown pre-form to the final blow mold and to provide a flash-free opening in the blow molded article.

It is a further important object of this invention to provide a method of making blown articles wherein a parison of thermal plastic material is blown into a pre-form of generally the same configuration as the final article, but of substantially less size, and the final article is blown from the pre-form as the pre-form walls are at a temperature ranging from the crystalline melting point of the material plus 20° F. to the crystalline freezing point of the material less 20° F.

Yet another, and no less important, object of this invention is the provision of a process for the manufacture of blown thermal plastic articles wherein a freely extruded tube is formed into a blowable parison interiorly of a pre-form mold, a blow tube is inserted into the parison and the parison is blown to its pre-formed shape, following which the pre-form is transferred on its blow tube to a blow mold cavity of larger size than the pre-form but of substantially the same shape, and the pre-form is blown interiorly of the blow mold to the final configuration of the article while the pre-form walls are at an average temperature most conducive to bi-axial orientation.

Other and further objects of the present invention will become apparent from the following description.

AS SHOWN IN THE DRAWINGS

FIG. **1** is a plan view of a blow molding machine of the present invention capable of carrying out the method of the present invention;

FIG. **2** is a side elevational view of the apparatus shown in FIG. **1**;

FIG. **3** is a front elevational view, with parts broken away and in section, of the apparatus of FIGS. **1** and **2** and showing one adjusted position of the apparatus and one step of the method;

FIG. **4** is a view similar to FIG. **3** showing a different adjusted position of the apparatus and a second step of the method;

FIG. **5** is a view similar to FIGS. **3** and **4** and illustrating a different adjusted position of the apparatus and a third step of the method;

FIG. **6** is a view similar to FIGS. **3** through **5** and showing yet another adjusted position of the apparatus, and a fourth step of the method; and

FIGS. **7** through **12** are fragmentary, enlarged sectional views, with parts shown in elevation, of the blow tube and mold arrangement of the present invention and capable of forming and reforming a portion of an article made in the apparatus of FIGS. **1** through **6.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in FIGS. **1** through **6,** reference numeral **20** refers generally to a blow molding apparatus of the present invention. This blow molding apparatus **20** includes a conventional screw-type extruder with the necessary drive mechanism associated therewith, the extruder mechanism being generally indicated by reference numeral **21** and being capable of issuing a pendant tube **22** therefrom.

Positioned generally below and laterally to either side of the pendant tube **22** are blow mold assemblies indicated generally at **25.** For purposes of illustration, these blow mold assemblies **25** are indicated schematically as comprising a pair of relatively massive side support plates **26** joined by transverse bar **27** to be moved in unison toward and away from the vertical plane of the pendant tube **22** by actuating cylinders **28,** the cylinders having their piston rods **29** connected to the bars **27.** This will be readily apparent from a comparison of FIGS. **3, 4, 5** and **6.** The cylinders **28** move the mold assemblies **25** in an inclined path having both vertical and horizontal components relative to the location of the extruder **21.** The inclined paths of the mold assemblies **25** are defined by similarly inclined fixed guide tracks **25a** receiving rollers **25b** carried by the side plates **26,** respectively.

The massive side plates **26** each carry a transversely extending guide rod **30** which is fixed to the plates and which serves to carry mold support plates **31** transversely movable toward and away from one another between the fixed side plates **26.** Such transverse motion is effected by mold actuating cylinders **32** mounted on each of the side plates and having their piston rods

projecting through the side plates and attached to the mold plates **31.** Of course, other actuating means for the plates **31** may be utilized, such as a single cylinder **32** and an equalizing chain, etc.

Mounted on the mold plates **31** for displacement therewith are separate pairs of pre-blow mold sections **35** and blow mold sections **36.** It will be appreciated that pre-blow molds **35** and the blow molds **36** are provided in matched pairs and that one set of pre-blow mold sections **35** and one set of blow mold sections **36** are opened and closed in unison by the appropriate cylinders **32.**

As schematically represented in FIGS. **3** through **6,** each set of the pre-blow molds cooperate to define an interior pre-blow cavity **37,** while each set of the blow molds **36** cooperate to define an interior final mold cavity **38** which conforms in all particulars to the final shape of the article being blown. In the illustrated embodiment of the invention, the blown article is a bottle and the blow mold cavity **38** accurately defines the body and neck or finish of the bottle. The pre-blow mold cavity **37** has a neck or finish portion (hereafter described in detail) which conforms to the neck of the finished article, but the body portion or the blow portion of the pre-blow mold cavity **37** is substantially smaller than (1) the body portion of the blow mold cavity and (2) the body section of the blown and finished bottle. Additionally, the pre-blow mold **35** is provided with a pair of pivoted inserts, schematically shown at **39,** which engage the bottom waste or "tail" portion of the blown pre-form and which are pivotally moved relative to the remainder of the pre-blow mold following the pre-blowing of the parison to remove the "tail," as is well known in the prior art.

Generally overlying each set of molds (comprising a pre-blow mold **35** and a blow mold **36**) is a blow tube arrangement indicated generally and schematically at **40.** Each such blow tube arrangement comprises the support plate **41** mounted at the lower end of an actuating rod **42** forming a part of an actuating cylinder **43** fixed to an overhead support, as schematically indicated at **44.** Superimposed on the support plate **40** is a pair of blow tube actuating cylinders **45** from each of which depends a blow tube **46, 48,** the blow tubes extending through the plate **41** and being connected to a supply of blow air under pressure. Mounted on the underside of the support plate **41** and adjacent the blow tube **48** for each of the blow molds **36** is a stripper plate **47.**

As thus described and as schematically illustrated in FIGS. **1** through **6,** the apparatus of the present invention is quite similar to free extrusion blow molding machines manufactured by Bekum Maschinen-Vertrieb under the classification "Bekum 120." The Bekum 120 machine does not utilize a pre-blow machine or a pre-blow mold such as the mold **35,** but rather the Bekum machine utilizes one or more identical blow molds, such as the molds **36.** Further, the blow tubes **46** in the Bekum machine are not individually and independently actuated, but rather are simultaneously actuated for blowing.

In other words, in the conventional Bekum machine, the pendant freely extruded tube is simply enclosed within a blow mold, a blow tube is inserted into the tube and the tube is blown interiorly of the single blow mold. Further, if more than one article is to be blown at a time with the Bekum machine, more than one tube **22** must be extruded. However, the actuating arrangement

for the molds including the actuating cylinders **28** and the diagonal path of movement of the mold carriage comprising the support plates **26** and the bar **27** of the present invention are generally similar to those of the Bekum machine.

Turning now to the operation of the over-all machine illustrated in FIGS. **3** through **6,** it will be seen from FIG. **3** that both of the sets of molds **35** and **36** have been moved from the extrusion location and a pendant tube **22** for the next blowing operation is being extruded from the extruder **21.**

Next, the left hand molds **35** and **36** are opened by actuation of their cylinders **32** and the mold carrying side plates **26** and the molds are then moved diagonally upward and to the right to the position illustrated in FIG. **4** of the drawings. To accommodate such movement of the mold assembly, the corresponding cylinder **43** is actuated to retract the support plate **41** and the blow tubes **46, 48** upwardly. Of course, opening of the mold sections **35** and **36** suspends the previously blown pre-form **50** and the final blown article **51** intermediate the opened mold sections with the blown pre-form **50** and the blown article **51** remaining on their corresponding blow tubes **46, 48.** Upward retraction of the cylinder **43** moves the blow tube assembly out of the path of movement of the blow molds.

The mold assembly **25** moves to the right to an extent such that the cavity **37** of the pre-blow mold **35** is aligned vertically with the pendant tube **22.** Further, the movement of the blow mold assembly **25** to the right aligns the pre-blown shape **50** with the blow mold cavity **38,** the cylinder **45** for the blow tube **46** being actuated to adjust the height of the pre-blown shape **50** properly with respect to the height of the cavity **38.** The completely blown article **51** is positioned exteriorly of the blow mold assembly **25.**

Summarizing the operations performed in the transition from FIG. **3** to FIG. **4** of the drawings, it will be seen that the following steps are carried out: (1) Blow mold assembly **25** is opened by cylinders to separate the mold sections defining the pre-form cavity **37** and the blow mold cavity **38;** (2) Cylinder **43** is actuated to move the blow tube support plate **41** out of the path of movement of the blow molds **25;** (3) The pre-blown shape **50** and the blown shape **51** are retained on the blow tubes **46, 48;** (4) As the blow mold assembly **25** is shifted to the right and upwardly by actuation of the cylinder **28** to align the pre-blow cavity **37** with the extruded tube **22;** (5) The same shifting motion moves the blow mold cavity **36** into alignment with the pre-blown shape **50** still retained upon its blow tube **46;** and (6) The fully blown shape **51** is disposed exteriorly of the blow mold assembly **25** on its blow tube **48** in vertical alignment with the stripper **47.**

Next, transition is made from that adjusted position of the apparatus of FIG. **4** to that adjusted position illustrated in FIG. **5** of the drawings. To carry out this transition, the pre-blow mold sections **35** are closed on the pendant tube **22** and the blow mold sections **36** are closed on the pre-blown shape **50.** This step is carried out by actuation of the cylinders **32.** Next, the blow tubes **46, 48** are both retracted upwardly. Retraction of the right hand blow tube **46** withdraws the blow tube from the shape **50,** leaving the pre-blown shape **50** suspended freely within the blow cavity **38.** The retraction of the left hand blow tube **48** from the finally blown article **51** contacts the bottle neck or finish portion of the article **51** with the stripper plate **47** and

allows the finished article **51** to fall from the molding apparatus. Of course, the closure of the pre-blow mold sections **35** on the tube **22** pinches the lower open end of the tube **22** between the pivoted "tail"—removing plates **39.** This closure of the open end of the tube makes a blowable parison shape which can be subsequently inflated at the next stage of the operation. After the closing of the pre-blow mold sections **35** on the tube **22,** the tube knife **49** severs the tube above the closed pre-form mold sections.

In the next stage of the operation, the blow assembly **25** is moved to the left by retraction of the piston rod **29** upon actuation of the cylinder **28,** the closed mold sections **35** carrying with them the pinched, blowable tube therebetween and the closed blow mold sections **36** retaining therein the pre-blown section **50.** When the position of FIG. **6** has been attained, the cylinder **43** is actuated to lower the blow tube plate **41,** and the individual blow tubes **46, 48** are lowered by the cylinders **45** for insertion into the cut, blowable tube in the pre-blow mold sections **35** and into the pre-blow shape **50** in the blow molds, respectively. Next, blow air is passed through the blow tubes **46** to blow the tube and the pre-mold to the configurations illustrated in FIG. **6.** The cycle is then repeated.

Thus, it will be apparent that the utilization of the two sets of molds (i.e. a left hand set consisting of the pre-blow mold **35** and the blow mold **36** and a right hand set consisting of a second pre-blow mold **35** and a second blow mold **36**) results in a completely overlapped operation wherein substantially continuous operation is insured and maximum utilization of the capability of the extruder **21** to dispense the pendant tube **22** is obtained. Equally important is the fact that the utilization of consecutive preblowing and blowing operations reduces the cycle time by one-half.

The pre-blow operation, of course, extracts heat from the extruded tube which is pinched shut within the pre-blow mold. This means that less heat must be extracted in the final blow mold, and the cooling of the extrudable in two stages cuts the over-all residence time in the final blow mold to about one-half of that required in a single stage blow molding operation.

However, the greatest advantage of the present invention lies in the fact that it is now possible to blow mold at a temperature which is most conducive to bi-axial orientation of the material being molded. The theory and advantages of bi-axial oriented molded plastic articles is well known by this time. The substantial increases in strength, the avoidance of localized weakened portions in the molded article, and the more efficient utilization of the material constituting the article have been well established.

It has been found that the most efficient orientation of material in a blow molding operation occurs where the material is stretched by blowing while the material is at that average wall temperature (i.e. temperature throughout the thickness of the wall) which is most conducive to orientation. The average wall temperature for each essentially crystalline polymer lies intermediate the crystalline melting point of the material plus 20° F. and the crystalline freezing point of the material less 20° F. With respect to essentially amorphous polymer, such as polyvinyl chloride and polystyrene, the glass transition temperature is utilized, rather than crystalline melting and freezing temperatures. For high density polyethylene (having a density lying between 0.954 and 0.970) it is preferably to operate at a

temperature of 250° F. plus or minus 20° F. For polyvinyl chloride and polystyrene the ideal orienting temperature is 205° F. plus or minus 25° F. For polypropylene, the ideal temperature is 310° F. plus or minus 30° F.

The present invention makes possible the utilization of this phenomenon by initially only partially expanding the parison within the pre-blow mold to initially cool the article to a temperature within 20° F. above its crystalline melting point and 20° F. below its crystalline freezing point and then blowing the article to its final configuration while it is within the above recited temperature range and while the maximum degree of orientation can be obtained. Of course, the only temperature which is important is the temperature at the time which it is actually blown to its final configuration in the final blow mold. The rheological history of the pre-blown shape is of no substantial importance, but the attainment of a temperature related to the melting point and freezing point as above defined at the exact moment of blowing is important. Thus, all of the cooling which takes place during extrusion of the tube, enclosure of the tube within the pre-blow mold, the pre-blowing, the transfer to the final blow mold and the residence time in the final blow mold prior to blowing are all calculated to yield the pre-blown shape at the moment of blowing at an average wall temperature at which orientation can be best carried out and the greatest strength obtained in the blown container obtained.

Further, by correlating the shape of the pre-blown intermediate with the shape of the final blown article, it is possible to uniformly orient all portions of the bottle, so that all portions of the bottle become uniformly stretched and uniformly oriented during the final blowing operation within the critical temperature range. Thus, the shape of the pre-form will vary with the shape of the final bottle. This factor in and of itself introduces a new element of flexibility into the designing of blow molded plastic bottles capable of exhibiting the maximum physical characteristics for the material being blown. In other words, by using the pre-blow technique, of this invention, one can obtain uniform orientation and uniformly high physical properties in bottles of complex shape and of widely varying cross sectional dimensions.

Turning now to FIGS. **7 through 12,** there is illustrated in greater detail a preferred neck-forming apparatus for utilization with the over-all forming apparatus illustrated in FIGS. **1** through **6.** While the apparatus of FIGS. **1** through **6** can be utilized for blow molding of any desired article, the mechanism and the method of the present invention are particularly adapted to the formation of bottles, jugs, or the like provided with a "finish" or neck having exterior threads and an accurately formed pouring lip. That portion of the apparatus illustrated in FIGS. **7 through 12** is particularly adapted to the formation of this type of finish and this type of pour lip.

As indicated generally in FIGS. **3** through **6** and specifically in FIGS. **7** and **8,** the pre-form mold sections **35** are provided with sectional, semi-cylindrical finish inserts **60** which are seated in recesses formed at the upper confronting portions of the pre-form molds **35.** These recesses are provided by horizontal ledge surfaces **35a** which are semi-circular in shape and by vertical surfaces **36b** which are semi-cylindrical in shape. The semi-cylindrical inserts **60** are retained in place by conventional means (not shown). The interior surfaces

of the insert **60** defines a complete cylindrical wall **61** provided with radially outwardly extending recesses **62** conforming to the threads to be formed on the neck or finish of the container.

Superimposed on the finish inserts **60** are striker inserts **63** which are generally semi-cylindrical in configuration and which have interior surfaces **64** forming continuations of the surfaces **62** and upwardly opening, radially enlarged recesses **65** for a purpose to be hereafter more fully described. The blow tube **46** which cooperates with the finish insert **60** to form the bottle finish is provided with a reduced diameter, lower extremity **70** joined to the blow tube **46** through a radially outwardly extending shoulder **71** (FIG. **8**). The blow tube **46** and the lower end **70** thereof serves to define an interior air passage **72** open at its lower end onto a smoothly rounded lower extremity **73.**

Surrounding the reduced lower end **70** of the blow pipe **46** and seated against the shoulder **71** is a forming sleeve **75** which is telescopic into the recess **65** of the striker block **63.** This sleeve **75** is provided with a lower arcuate recess **76** terminating in a sharpened cutting edge **78.**

In operation, and by a comparison of FIGS. **7** and **8,** it will be seen that the tube **22** as extruded has an outside diameter slightly smaller than the outside diameter of the finish, which outside diameter is determined by the combined diameter of the semi-cylindrical surfaces **61** of the finish inserts **60.** Further, the tube, as extruded and cut has a flared open upper end **22a** into which the lower extremity **70** of the blow tube **46** is inserted. To facilitate entry of the blow tube into the extruded tube **22,** blow air may be emitted from the blow tube as it is lowered into the tube **22** to retain the end **22a** open.

The blow tube **46,** of course, is lowered into the blow tube **22** by the cylinder **45** only after the extruded tube **22** has been entrapped within the pre-form mold **35** and pinched shut by the mold inserts **39,** and then only after the pre-form mold sections **35** have been moved to their position of FIG. **3** by retraction of the cylinders **28.** Thus, when the blow tube extension **70** is lowered into the extruded tube **22,** the tube is expanded radially by the extension **70** which has an exterior diameter larger than the interior diameter of the tube. The entry of the extension **70** into the tube thus compression molds the finish of the container. Contact of the sleeve **75** with the flared open upper end **22a** of the tube will shape a portion of the tube forced into the recess **76** to a convex or "crowned" configuration, indicated by reference numeral **77.** The tube **22** is engaged outwardly of this convex portion **77** by the severing edge **78** of the sleeve **75** to substantially completely sever the flared waste or end portion **79** of the tube from the blown and compression formed remainder of the tube.

Thus, at the conclusion of the steps illustrated in FIGS. **7** and **8** of the drawings, the threaded portion of the finish of the final container has been compression formed by the blow tube **46** and the reduced end **70** thereof cooperating with the finish inserts **60.** That portion of the tube which will ultimately form the lip or pouring edge of the container has been pre-formed to a convex shape by the sleeve **75** and the waste portion **79** of the container has been substantially severed from the container lip, but not completely severed therefrom.

Next, the blow air through the blow tube **46** is shut off, the mold section **36, 36** are opened, and the mold sections are shifted from their position in FIG. **3** to their positions of FIG. **4.** At this time, the blow tube **46** and the blown pre-form **50** carried thereby is positioned in the blow mold cavity **38,** as illustrated in FIG. **9.** The blow mold sections **36** are recessed at the neck region as described in connection with the pre-form molds **35** above and identical finish inserts **60** are carried by the blow mold sections **36.**

However, different striker insert sections **80** are utilized. As best shown in FIG. **9,** these striker insert sections **80** carried by the blow mold sections **36** are again generally semi-cylindrical in exterior configuration and are provided with a lower semi-cylindrical opening **81,** registering with the openings **61** in the finish insert section **60.** Upper, enlarged, concave opening **82** joins the opening **81** with an upper, substantially enlarged concave portion **83.**

As above described, once the blow molds are closed onto the blown pre-form **50,** the blow tube **46** is retracted and the blow tube **48** is introduced thereinto.

As best illustrated in FIGS. **10** through **12,** the blow tube **48** is provided with the same lower, reduced extension **70** joined to the blow tube **48** by the radially outwardly extending shoulder **71.** Encircling the reduced diameter extension **70** of the blow tube **48** is a cutting sleeve indicated generally at **85** (FIGS. **10–12**). This cutting sleeve **85** is provided at its lower surface with an outer, upwardly extending recess **86** communicating with one or more vertical slots **87** into which project stripping fingers **88.** The purpose of these slots **87** and fingers **88** will later be described.

The lower extremity of the cutting sleeve **85** is provided with a downwardly opening, concave recess **90** surrounded by a sharpened cutting edge **91** located between the recess of **90** and a cylindrical exterior conical wall **92** which mates closely with and slides axially into the recess **82** of the striker insert **80** heretofore described. A frustoconical wall **93** joins the wall **92** with the exterior recess **86** heretofore described, and this wall is interrupted by a locking groove **94.**

Turning now to FIG. **10,** it will be seen that the lower reduced projection **70** of the blow tube **48** enters the preform threaded neck which has been accurately positioned and retained in place by closure of the finish inserts **60** onto the neck. Next, the cutting sleeve **85** telescopes over the insert **80,** and the recesses **90** and **82** cooperate to restrike or reform the previously formed extremity **77** of the bottle to the finally desired configuration of the pour lip **96.** At the same time, the telescopic surfaces **92, 82** and the edge **91** severs from the remainder of the bottle those portions of the originally extruded tube lying beyond the pouring lip **96,** these portions being indicated by reference numeral **95.** The confining of this waste portion **95** between the surfaces **83** and **93** will force a portion of the material into the groove **94,** thereby interlocking the severed material with the surface **93.**

Upon retraction of the blow tube **48** from its position in FIG. **11** to its position of FIG. **12,** the heretofore described stripper fingers **88** move into and through the slots displacing the waste portion from the surface **93.** Generally the opening of the blow molds will release the finally formed bottle and the final retraction of the blown end extension **70** from the formed neck of the finished article will strip the article from the apparatus as has been described heretofore in connection with FIG. **5** of the drawings. Preferably, the stripping fingers **88** form a part of the stripper plate **47.**

From the foregoing description, it will be appreciated that the two stage blowing of the extruded tube **22** carries with it several advantages. Not only is the tube conditioned, both dimensionally and thermally for the final blowing under conditions most conducive to orientation, but the finish of the bottle is pre-formed and then reformed to its final accurate shape and any flash or waste at the finish is eliminated. The resultant compression forming of the neck and threads, the accurate formation of the pouring lip, and the elimination of flash all take place during the pre-form blowing and the final blowing of the container and no extra time or manipulation is required to carry out these steps. As a consequence, the cycle time is not increased by the neck forming and flash severing operations.

What is claimed is:

1. In a method of making a blown thermoplastic article having enhanced physical characteristics due to molecular orientation of the article during its formation, successively (1) extruding a tubular parison, (2) blowing the tubular parison into a pre-form which more closely approximates the shape of said article than did the extruded tube and (3) blowing the pre-form into the configuration of the final article and cooling said pre-form intermediate steps (2) and (3) above to the average wall temperature conducive to molecular orientation during the performance of step (3), the improvement comprising the steps of simultaneously closing a pre-form blow mold onto the parison and closing a final blow mold pre-form, a previously blown pre-form, simultaneously moving the closed molds, carrying the parison and blown pre-form, from the orifice to a blowing location, carrying out step (2) above in the closed pre-form mold at said blowing location, carrying out step (3) above in the final mold at said blowing location, simultaneously opening both molds while supporting the blown pre-form at said blowing location independently of the molds, and jointly moving the two open molds toward the orifice to repeat the method.

2. In a method of making a container or the like of thermoplastic material, the steps of extruding a freely pendant tube from an annular orifice, enclosing the tube in a pre-form blow mold positioned at said orifice and having an interior cavity, separating the enclosed tube from the orifice, shifting said mold-enclosed tube from the orifice, inserting a first blow tube into the mold-enclosed tube, blowing the tube to the shape of the pre-form mold cavity, opening the pre-form mold while supporting the blown pre-form on the blow tube, enclosing the blown pre-form in a final blow mold having an interior cavity conforming to the shape of the container, withdrawing the first blow tube, moving the pre-form enclosed in the final blow mold to a second and different blowing location, inserting a second blow tube into the pre-form and blowing the pre-form to the shape of the final container.

3. In a method of making a blow container of thermoplastic material, the steps of extruding a freely pendant tube from an annular orifice spaced from separate pre-form blowing and final blowing stations, consecutively blowing said tube into a pre-form and into a final container in separate pre-form and final blow molds positioned at said stations, respectively, reciprocating said molds in fixed spaced relation on a common movable support located generally beneath said orifice, the reciprocation of said support relative to said orifice simultaneously (1) moving the pre-form mold and the final blow mold toward the orifice, and (2) moving the

pre-form mold carrying the tube and the final blow mold carrying the pre-form to their respective pre-form blowing and final blowing stations, opening said molds, simultaneously prior to movement (1) of said support, closing said molds simultaneously prior to movement (2) of said support, and supporting said blown pre-form independently of either of said molds whenever said molds are both opened to retain the pre-form in position to be enclosed by said final blow mold upon completion of movement (1) of said support.

4. In a method of making a blown article of thermoplastic material, the steps of extruding a tube, enclosing a portion of said tube in a pre-form blow mold while the tube is located at the extrusion location, separating the mold-enclosed tube portion from the orifice, transferring the mold-enclosed tube portion to a first blowing location, inserting a blow tube into said mold-enclosed tube portion, blowing the tube portion into a pre-form, opening the pre-form blow mold while supporting the pre-form on the blow tube, moving the pre-form mold back to the extrusion location, enclosing the blow tube-supported pre-form in a final blow mold, transferring the blown pre-form interiorly of the final blow mold to a second blowing location, blowing the pre-form interiorly of the final blow mold, opening the final blow mold to expose the final blown article, and returning the final blow mold to said first blowing location.

5. In a method of blow molding a thermoplastic article, the steps of extruding a freely pendant tubular parison at a parison location, the extrusion of said parison being performed while a previously extruded parison is enclosed in a pre-form mold at a pre-blowing location and while a previously formed pre-blown shape is enclosed in a final blow mold at a final blowing location, simultaneously blowing both said parison and said pre-form by inserting blow pipes therein, respectively, simultaneously opening said pre-blow mold and said final blow mold while retaining the pre-blown shape in position on said blow pipe at said pre-blow location, transferring the open pre-blow mold and final blow mold from their respective locations toward said parison, closing the pre-blow mold on said parison and closing the final blow mold on said pre-blown shape, withdrawing the blow pipe from said pre-blown shape, simultaneously moving the pre-blow mold and the enclosed parison and the final blow mold and the enclosed pre-blown shape to said pre-blow location and said final blowing location, respectively, and finally blowing said parison at said pre-blow location interiorly of said pre-blow mold to the pre-blown shape and blowing the pre-blown shape interiorly of the final blow mold to the final blown configuration.

6. In a method blowing a thermoplastic article, the steps of extruding a freely pendant tubular parison at a parison location, simultaneously with the extrusion of said parison performing the steps of (1) blowing a previously extruded parison at a pre-blowing location to a pre-blown shape and (2) blowing a previously formed pre-blown shape to a final blown configuration at a final blowing location, said steps (1) and (2) being performed in a pre-blow mold and a final blow mold, respectively, simultaneously opening said pre-blow mold and said final blow mold while retaining the pre-blown shape in position at said pre-blow location, transferring the open pre-blow mold and final blow mold from their respective locations toward said parison, closing the pre-blow mold on said parison and closing the final blow mold on said pre-blown shape,

simultaneously moving the pre-blow mold and the enclosed parison and the final blow mold and the enclosed pre-blown shape to said pre-blow location and said final blowing location, respectively, and finally blowing said parison at said pre-blow location interiorly of said pre-blow mold to the pre-blown shape and blowing the pre-blown shape interiorly of the final blow mold to the final blown configuration.

7. In a method of blow molding a thermoplastic article, the steps of extruding a freely pendant tube from an annular orifice spaced from separate pre-form and final blow molds shiftable towards and away from the orifice, shifting the pre-form blow mold into alignment with said orifice while shifting the final blow mold toward the orifice, closing the pre-form blow mold on the tube while closing the final blow mold on a previously blown preform supported on a blow pipe in spaced relation to the orifice, withdrawing said blow pipe, shifting said mold-enclosed tube and said mold-enclosed pre-form from the orifice, inserting blow pipes into the mold-enclosed tube and the mold-enclosed pre-form, blowing the tube to the shape of a pre-form mold, blowing the pre-form to the shape of the final article, opening both molds while supporting the blown pre-form on a blow pipe, and shifting both blow molds toward the orifice to repeat the method.

8. In a method of blow molding a thermoplastic article, the steps of:

(1) extruding a freely pendant tubular parison from an annular orifice,

(2) blowing the tubular parison in a first blow mold to a pre-form which more closely approximates the shape of said article than did the extruded parison,

(3) blowing the pre-form in a second blow mold to the configuration of the final article,

(4) jointly reciprocating said first and second blow molds so that the two blow molds are collectively movable to a total of three stations, only the first mold being movable to a first of said stations at which step (1) above is carried out, only the second mold being movable to a second of said stations spaced from said first station, and both of said blow molds being movable to a third station which is intermediate said first and second stations, two of said stations being blowing stations at which steps (2) and (3) above are carried out,

(5) substantially simultaneously (a) closing said first mold onto said parison at the first station and (b) closing said final blow mold onto a previously blown pre-form at the third station,

(6) substantially simultaneously (a) moving the closed first mold from the first station to the third station and (b) moving the closed second mold from said third station to said second station;

(7) substantially simultaneously (a) opening said first mold at the third station to expose a blown pre-form and (b) opening said final blow mold at the second station to expose a final blown article,

(8) substantially simultaneously and preparatory to repeating step (5) above (a) returning the open first mold to said first station and (b) returning the open second mold to said third position,

(9) supporting said pre-form at said third station independently of both the first and second molds during the performance of steps (7) and (8) above, and

(10) performing steps (2) and (3) above intermediate the performance of steps (5) and (7) above.

9. In a method of making a blown plastic article by successive blow molding operations carried out in separate sectional pre-form and final blow molds carried by a common support reciprocable to two positions relative to an extrusion station, the steps of: (1) moving said support to a first position with the sectional blow molds both open, the pre-form mold being aligned with a parison depending at the extrusion station and the final mold being aligned with a blown pre-form pendantly suspended at a second station; (2) closing both molds; (3) moving said support with both molds closed to position the pre-form mold at said second station and to position the final mold at a third station; (4) while said molds are closed, blowing the parison to the configuration of the pre-form blow mold and blowing the blown pre-form to the configuration of the final blow mold; (5) opening both said molds after the performance of step (3) to expose the blown pre-form at the second station and to expose the final blown article at said third station; (6) repeating step (1) preparatory to the next blowing cycle; and (7) pendantly suspending the blown pre-form at said second station from a blow pipe during the performance of steps (5) and (6).

10. In a method of blow molding plastic articles, the steps of: (1) extruding a parison at a first station; (2) closing a pre-form blow mold on said parison at said first station; (3) closing a final blow mold on a previously blown parison at a second station; (4) moving the closed pre-form blow mold to said second station and moving said closed final blow mold to a third station; (5) blowing the pre-form in said closed pre-form blow mold and blowing the final article in said closed final blow mold; (6) opening the pre-form blow mold at said second station while supporting the blown pre-form independently of said pre-form blow mold; (7) opening the final blow mold at said third station to release the final blown article therefrom; and (8) returning the open pre-form mold to the first station and returning the open final blow mold to said second station, preparatory to the next cyclic performance of steps (2) and (3) at said first and second stations respectively.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : Re. 29,065
DATED : Dec. 7, 1976
INVENTOR(S) : Albert R. Uhlig

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

Col. 11, line 30, delete "pre-form," and insert therefor

--- on ---.

Signed and Sealed this

Thirteenth Day of *May 1980*

[SEAL]

Attest:

SIDNEY A. DIAMOND

Attesting Officer

Commissioner of Patents and Trademarks