

March 3, 1936.

G. E. HOWARD

2,033,076

METHOD OF AND APPARATUS FOR FORMING HOLLOW GLASS ARTICLES

Filed June 1, 1934

6 Sheets-Sheet 1

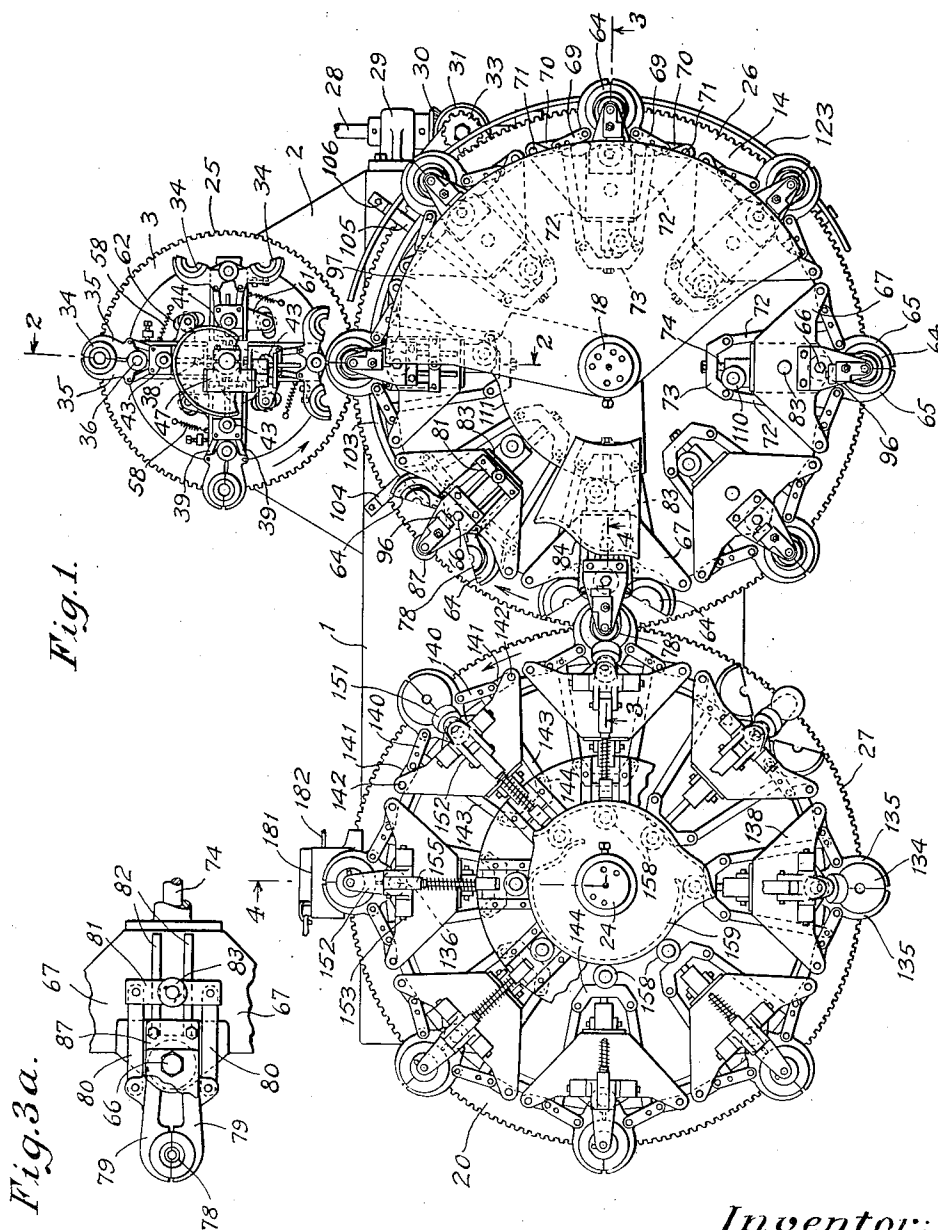


Fig. 1.

Fig. 3a.

Witness:

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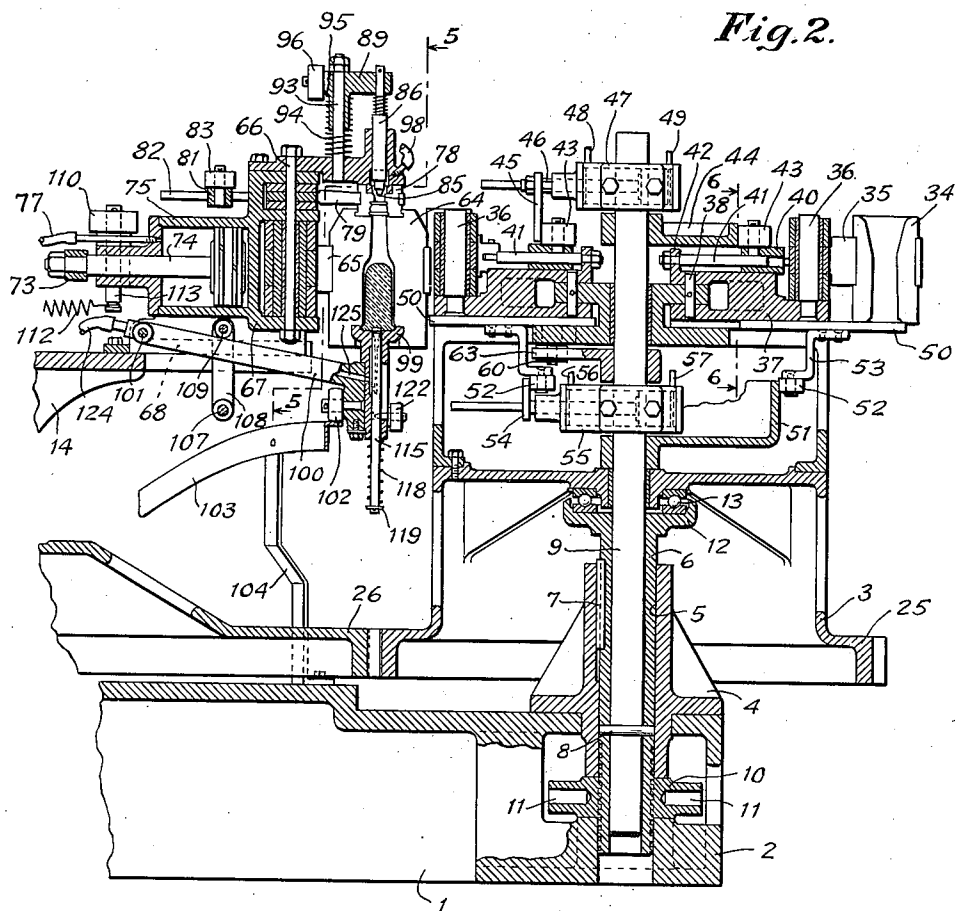
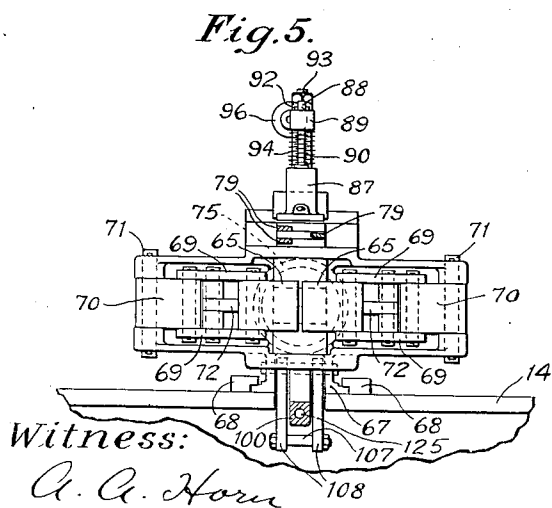
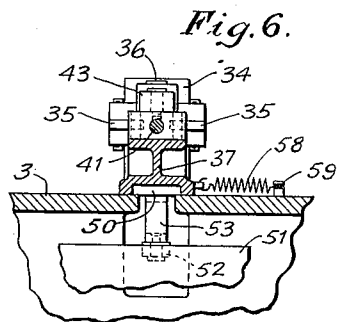
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METHOD OF AND APPARATUS FOR FORMING HOLLOW GLASS ARTICLES

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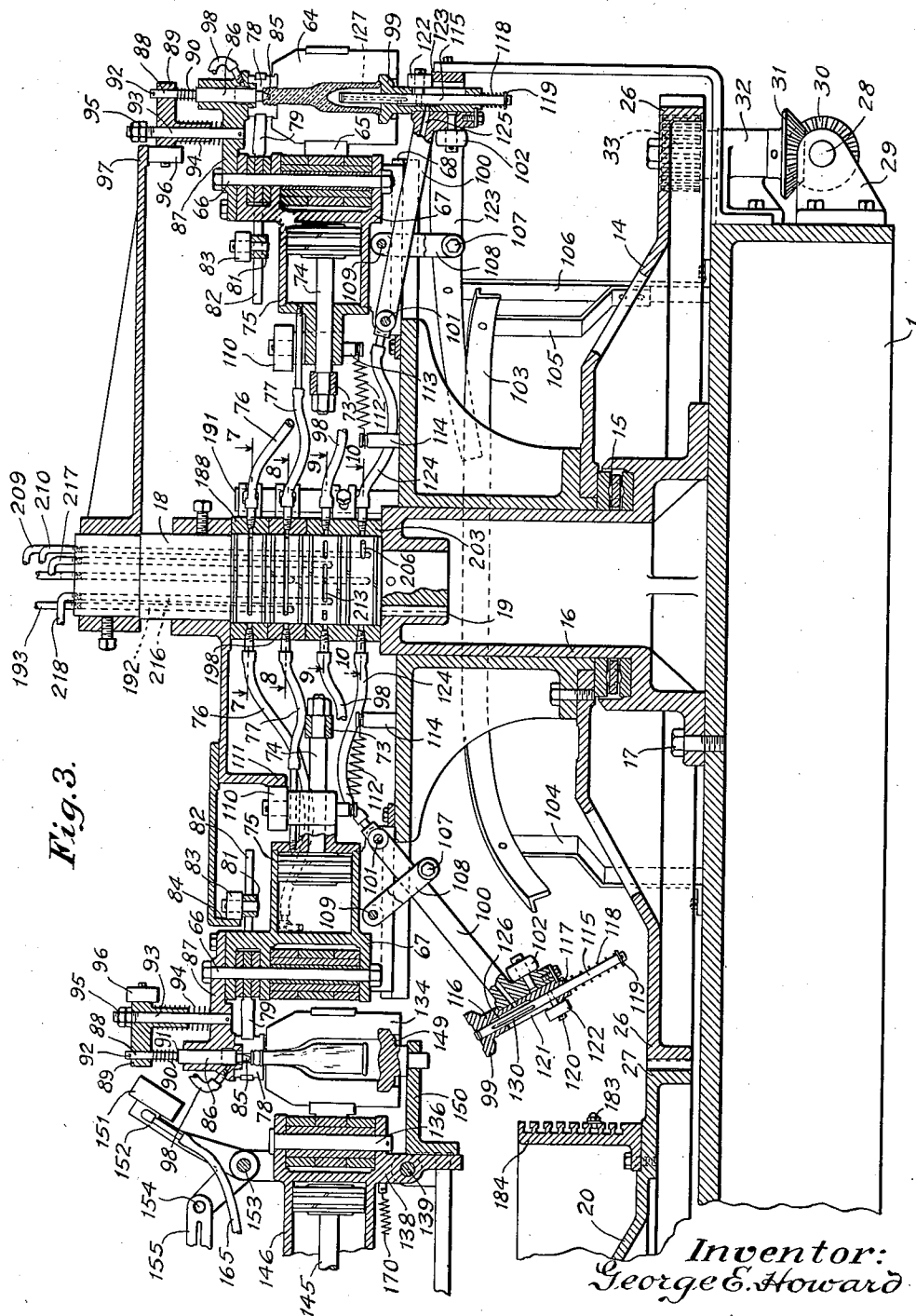


Fig. 3.

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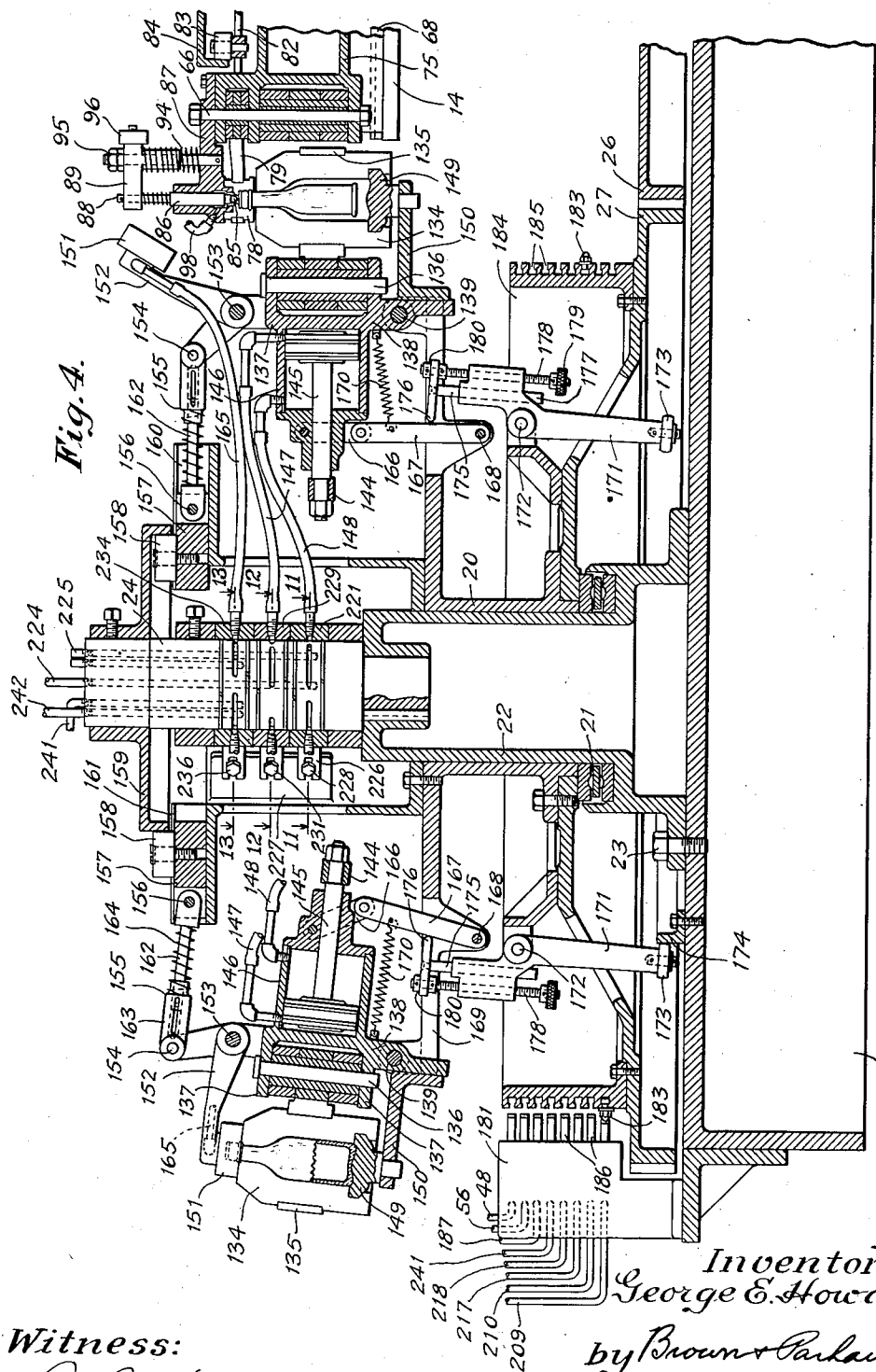
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Fig. 7.

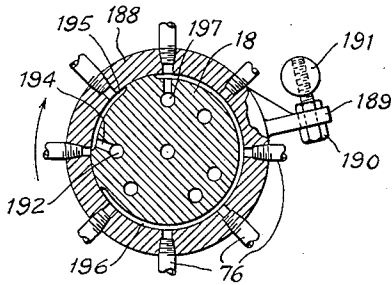


Fig. 8.

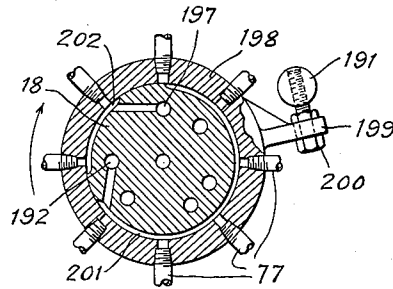


Fig. 9.

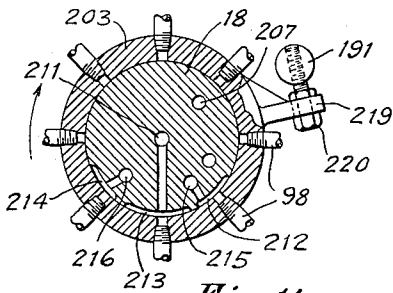


Fig. 10.

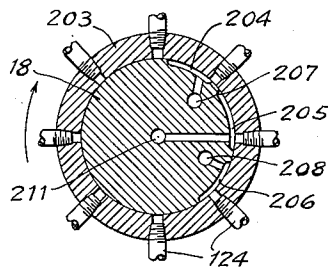


Fig. 11.

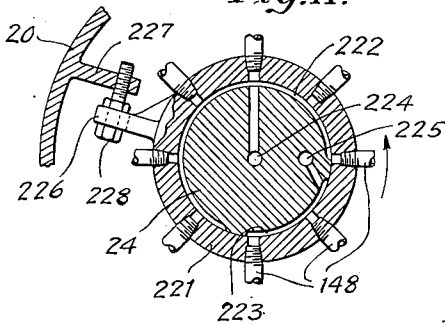


Fig. 12.

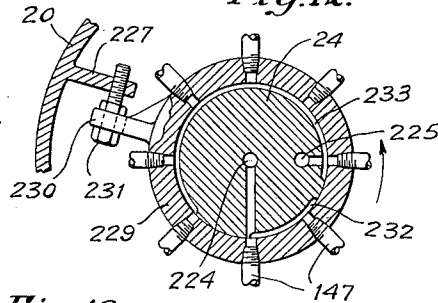
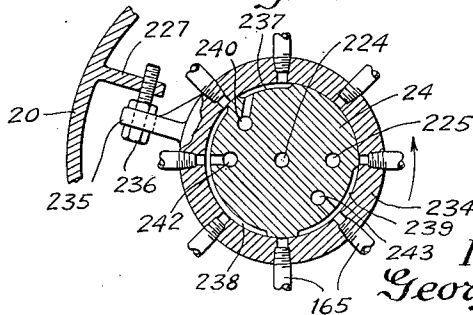


Fig. 13.



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Fig.16.

Fig.17.

Fig.14.

Fig.15.

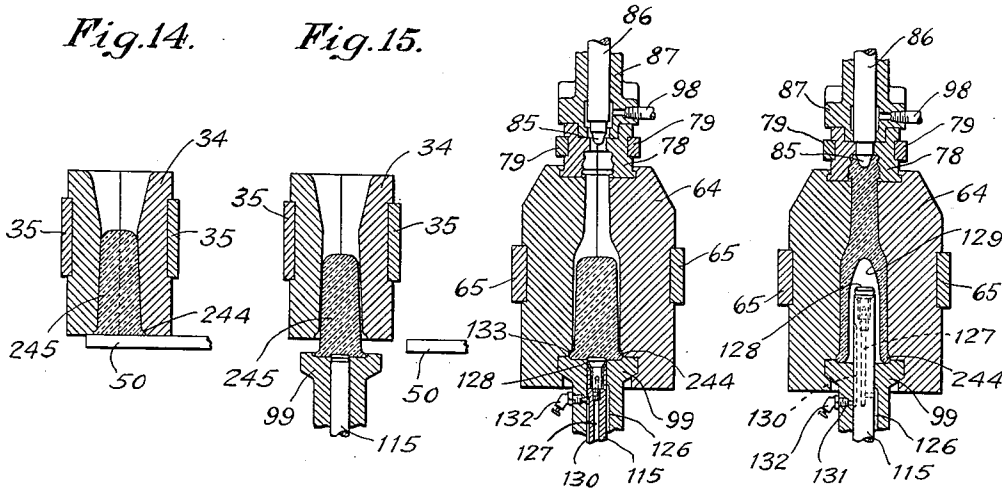
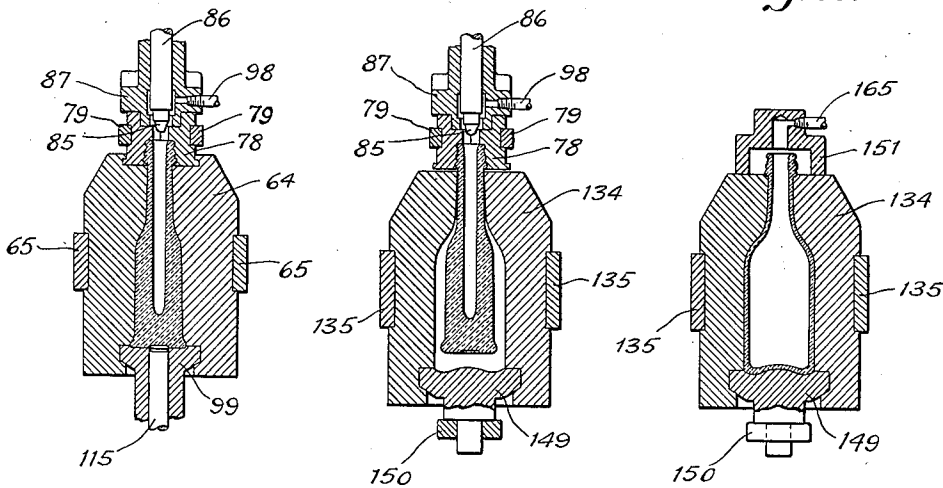


Fig.18.

Fig.19.

Fig.20.



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UNITED STATES PATENT OFFICE

2,033,076

METHOD OF AND APPARATUS FOR FORMING HOLLOW GLASS ARTICLES

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Application June 1, 1934, Serial No. 728,503

36 Claims. (Cl. 49—5)

This invention relates to a method of and apparatus for forming hollow glass articles, and more particularly to such a method and apparatus wherein the glass is maintained with the same end uppermost throughout the forming process. Apparatus which may be used for carrying out the method may be supplied with charges of glass from above in any suitable manner, as by the well known glass feeding devices now in common use, and the articles may be thereafter formed without inversion of any mold.

Among the objects of the present invention are:

(1) To provide a method and apparatus for forming hollow glass articles in which a charge of glass is supplied to one mold and molded to some extent therein; the molded charge or blank is then transferred to a second mold in which glass is forced upwardly initially to form a neck finish portion of the article to be made and to form a temporary cavity in the opposite end of the blank which is afterwards destroyed by blowing through the neck to form a hollow parison, which parison is thereafter transferred to a third mold in which it is expanded to final form.

(2) To provide in a method and apparatus of the type above set forth for the forming of a hollow ended blank incident to forming the neck portion of such a blank in the second mold by the application of pressure to the lower central portion of the glass in the mold to force this central portion only of the glass upwardly in the mold and into the neck ring while maintaining the peripheral portions of the glass in contact with the walls of the parison mold and without substantial movement, so that the parison when formed will have a length substantially the full length of the parison mold.

(3) To provide for the forming of a hollow ended blank by the application of pneumatic pressure preferably in such a manner that the pressure is effective both by its pressure effect and its dynamic effect, and preferably also to provide means for controllably balancing these two effects.

(4) To provide for the forming of a hollow ended blank as above set forth in such a manner that the glass will contact with the walls of the parison mold progressively from the bottom to the top thereof and thus substantially to eliminate such variations in the thickness of the article as finally formed as cause the defect known in the art as a "settle wave".

(5) To provide for the forming of a hollow ended blank and at the same time to provide a controlled cooling of the surface glass bounding

the depression in the hollow ended portion of the blank.

(6) To provide a novel transfer of a preliminary solid blank, having no neck finish portion between molds on two continuously moving tables or mold carriers which are laterally offset one from the other on substantially the same working level.

(7) To provide novel timing means for the forming machine, the control being such that the application of pneumatic pressure, i. e., either admission or exhaust, or both, is independently controllable for each of the molds or article forming units, such timing means to include but a single valve in a pressure line used in conjunction with a distributor synchronized with the rotation of the carrier and in a special case concentric therewith.

(8) To provide an automatic glass forming machine including a final blow mold mounted upon a rotary carrier, wherein provision is made for tilting the final blow mold to a position such that its longitudinal axis is at an angle to the vertical for the purpose and in an amount calculated to compensate at least in part for the effect of centrifugal force incident to the rotation of the carrier upon a partially formed glass article in the mold.

Other objects and advantages of the present invention will become apparent from a reading of the following specification and appended claims when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a plan view of an entire machine embodying my invention and adapted to carry out the methods thereof;

Fig. 2 is a fragmentary view substantially in vertical section on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view substantially in vertical section on the line 3—3 of Fig. 1;

Fig. 3a is a detailed view in plan showing a neck ring and its operating mechanism;

Fig. 4 is a fragmentary view in vertical section substantially on the line 4—4 of Fig. 1;

Fig. 5 is a detailed view principally in vertical section on the line 5—5 of Fig. 2, the holders for the parison body mold being shown in side elevation;

Fig. 6 is a detailed view substantially in vertical section on the line 6—6 of Fig. 2;

Figs. 7, 8, 9, and 10 are detailed views in horizontal section of the pressure distributing means on the lines 7—7, 8—8, 9—9, and 10—10 respectively of Fig. 3;

Figs. 11, 12, and 13 are detailed views in horizontal section of the pressure distributing means on the lines 11—11, 12—12, and 13—13 respectively of Fig. 3.

zontal section of the pressure distributing means on the lines 11—11, 12—12, and 13—13 respectively of Fig. 4; and

Figs. 14 to 20 inclusive are a series of diagrammatic views illustrating the various steps in the formation of a single article.

I have chosen to illustrate an embodiment of my invention comprising a three-table continuously rotating forming machine, the various tables or mold carriers being mounted for rotation on vertical axes laterally offset each from the others. It will be understood, however, that certain of the principles of my invention are equally adaptable to single or two table type machines, or even to stationary type machines such as the commercial "Hartford I. S." machine, and also that if a rotary type machine be chosen as an embodiment of the invention, such machine may be either intermittently or continuously rotated.

Base structure for the machine and rotating means for the mold carriers

I have illustrated a continuous type machine having three mold carriers thereon, the first for blank molds, the second for parison molds, and the third for final blow molds, suitable means being provided for rotating the carriers continuously, for mounting the molds and for accomplishing the various forming operations.

There is shown at 1 a base for the machine which may be mounted directly upon the factory floor or may be mounted upon wheels (not shown) in the usual manner. The base 1 has a laterally offset portion 2 on which is mounted the blank mold carrier generally indicated at 3. For supporting the blank mold carrier, the extension 2 is provided with a supporting bracket member 4 (Fig. 2) having a central vertical bore 5 therein in which is mounted for vertical adjustment a sleeve-like member 6, which is splined in the member 5 as shown at 7. Within and preferably pinned to the member 6 as at 8 is a vertical column 9 about which the blank mold carrier is rotated. Intermediate the lower end of the bracket 4 and a boss on the lower web of the extension 2 is a rotatable member 10 threaded on the sleeve-like member 6 as illustrated and provided with a plurality of sockets 11, in any of which a suitable tool may be inserted for rotating the member 10 and thereby for adjusting the members 6 and 9 vertically, rotation of these members being prevented by the spline 7. By this means the blank mold carrier may be adjusted as a whole in a vertical direction in order to compensate for the height of molds and as a set-up adjustment.

The member 6 is provided at its upper end with an annular flange-like portion 12 in which is received a suitable raceway for ball bearings 13 carrying the vertical thrust incident to the weight load of the blank mold carrier 3. The blank mold carrier is thus rotatable about the column 9 and on the ball bearings 13.

As illustrated in Figs. 1 and 3, there is provided a parison mold carrier generally indicated at 14, which is suitably mounted for rotation on ball bearings 15 and about a central hollow column 16. The column 16 may be suitably secured to the base 1 as illustrated by bolts 17. The hollow column 16 supports at its upper end a central stationary column 18 in which air distributing passages are formed as will be hereinafter set forth. The column 18 is suitably stepped into the upper end of the hollow column 16 and is

also preferably splined thereto as illustrated at 19 (Fig. 3) to prevent relative rotation of these parts.

Adjacent to the other end of the main base 1, there is mounted a final blow mold carrier 20, the weight load of which is carried upon ball bearings 21 (Fig. 4). The blow mold carrier is mounted for rotation about a hollow column 22 secured to the main base 1, as by bolts 23. The hollow column 22 supports at its upper end a stationary column 24 similar to the column 18 and similarly used for distributing pneumatic pressure as will be hereinafter set forth.

The blank mold carrier 3 is provided with a peripheral ring gear 25 meshing with a ring gear 26 on the parison mold carrier 14, and this ring gear is in turn in mesh with a ring gear 27 formed integral or rigid with the blow mold carrier 20. Thus motion imparted to any one of these carriers will be imparted through the meshing gears 25, 26, and 27 to the other carriers.

I prefer to rotate all the carriers continuously, as above referred to, and for this purpose I have shown a drive shaft 28 (Figs. 1 and 3) which is preferably driven from some suitable prime mover (not shown) and preferably also driven in synchronized timed relation with the operation of a suspended charge feeding device such as is now in common use in the art, a suitable clutch (not shown) being provided for discontinuing the operation of the forming machine during the continued operation of the feeder as is now common in the art as is shown, described and claimed in Lorenz Patent No. 1,740,310, see Figs. 11, 42, and 43. There is preferably also a suitable overload shearing pin arrangement (not shown) for breaking the driving connection from the prime mover to the machine in the event that some part or parts of the machine should encounter such interference or any obstacle which will cause an overload on the drive and/or which might cause breakage of any of the machine parts. Such a shearing pin is shown, for example, in Rowe Patent No. 1,979,211, see Fig. 1. All this subject matter is common in the art and hence it has not been thought necessary to illustrate it.

The drive shaft 28 is suitably journaled in a bearing bracket 29 secured to the base 1 of the machine as illustrated, and is provided with a bevel gear 30 meshing with a bevel gear 31 secured to the lower end of a short vertical shaft journaled in a bracket 32 secured to the base 1 of the machine. At its upper end this short vertical shaft carries a pinion 33 meshing with the ring gear 26, so that motion imparted to the drive shaft 28 will be imparted through the gear train above described to rotate each of the carriers 3, 14, and 20 continuously.

Blank mold, mounting and operating means therefor (Figs. 1 and 2)

On the blank mold carrier 3, I have shown a plurality, in this case four, of blank molds 34, it being understood that as many molds may be employed on this carrier as desired with suitable changes made in the diameter of the blank mold carrier and/or of the rotating gear 25 thereof in the event that a different number of molds is chosen. The molds 34 are formed as illustrated in mating portions or halves, each supported in a mold holder 35. The holders 35 of each mold are pivoted on a common pintle 36 which is mounted upon a swing plate 37, the plate 37 being in turn mounted upon the carrier 3 for limited lateral swinging movement about the axis of a vertical

pintle 38 eccentric of the vertical axis of the blank mold carrier for a purpose to be explained hereinafter.

Means are provided for opening and closing the blank mold halves when desired, such means comprising a pair of links 39 (Fig. 1) connecting the halves respectively with a sliding crosshead 40. The crosshead 40 is arranged for sliding movement on a shaft 41 (Fig. 2) rigidly carried by the swing plate 37 as indicated at 42. The crosshead 40 carries a cam roller 43 arranged to ride around the outside of a stationary cam 44 which is carried by the stationary column 9 about which the blank mold carrier 3 is rotatable.

For opening the blank mold for transferring a blank from the blank mold to a parison mold in a manner hereinafter to be described, the rollers 43 are successively moved substantially radially inward of the blank mold carrier by a finger 45 extending downward from the piston rod 46 of a pneumatic cylinder 47 which is secured to the stationary column 9. Pressure may be conducted to the opposite ends of the cylinder 47 through pipes 48 and 49 under the control of timing means hereinafter to be described. Closing of the blank molds is accomplished by the rollers 43 successively riding up a portion of the surface of the cam 44 illustrated at the right in Fig. 1, thus moving the rollers 43 successively substantially radially outward of the blank mold carrier and successively causing the closing of the associated blank molds.

Blank mold bottom plate, mounting and operating means therefor

I have illustrated at 50 a bottom plate for each blank mold 34, this bottom plate being slidable in a substantially radial direction in guideways formed in the swing plate 37 so that the bottom plate may be slid from under a formed charge of glass or molded blank at the desired time as will be hereinafter set forth. The bottom plate 50 is normally maintained at its radial outward position by means of a stationary cam 51 secured to the center column 9 and engaging a cam roller 52 mounted upon a bracket 53 depending from the bottom plate 50.

When it is desired to move the bottom plate 50 in a substantially radial inward direction to permit the blank to drop downwardly with respect to the blank mold, the outside of the roller 52 is engaged by an upstanding finger 54 secured to the piston rod of a pneumatic cylinder 55, which is in turn secured to the center column 9, the finger 54 engaging each of the rollers 52 in succession. Pressure may be conducted to the opposite ends of the cylinder 55 through the pipes 56 and 57 under the control of timing means to be hereinafter described.

Lateral swing of the blank mold

As above set forth, the swing plates 37 are mounted for a limited swinging movement about the axis of their pivots 38. These swing plates are biased clockwise of the blank mold carrier 3 by tension springs 58 (Figs. 1 and 6) extending between suitable anchorages 59 secured to the blank mold carrier 3 and the swing plates 37. Each swing plate 37 is also provided with a roller 60 (Fig. 2) secured to a bracket 61 (Fig. 1) on a pintle which depends through an elongate aperture 62 in the table portion of the blank mold carrier 3. Each roller 60 engages the outer periphery of a stationary cam 63 (Fig. 2) and thus serves to swing the associated swing plate 37 about the axis

of its pintle 38 against the action of the tension spring 58, this action taking place during the transfer of a blank from the blank mold to the parison mold in a manner more specifically to be described hereinafter.

Parison molds, mounting and operating means therefor

The parison mold carrier 14 is provided with a plurality of parison molds arranged about its periphery, there being eight such molds illustrated in the accompanying drawings. Inasmuch as these molds are each similar to the others only one need be described.

The parison mold 64 is formed as shown in mating portions or halves secured as in the usual manner in mold holders 65 which are pivoted on a common pintle 66. The pintle 66 is mounted in suitable ears in a slide member generally indicated at 67, which is in turn arranged for substantially radial sliding movement with respect to the carrier 14 in guides 68, as best seen in Fig. 5.

For opening and closing the parison mold each of the holders 65 is connected by toggle links 69 and 70 to fixed pivot points shown as pintles 71 (Figs. 1 and 5). The links 69 are in turn connected by links 72 to a crosshead 73 (Figs. 1 and 2). The crosshead 73 is rigidly mounted on the outer end of a piston rod 74 of a pneumatic cylinder 75, which may be formed rigid or integral with a portion of the radial sliding member 67. Pressure may be conducted to the opposite ends of the cylinder 75 through pipes 76 and 77 (Fig. 3) under control of the timing means hereinafter to be described. Thus radial inward movement of the piston within the cylinder 75 will be effective to open the parison mold 64, and radial outward movement of this piston will accomplish the closing of the mold, the mold being held closed by the toggle links 69 and 70 as will be apparent from the accompanying drawings (Fig. 1).

Neck rings, mounting and operation thereof

Each parison mold 64 is provided with an associated but independently controlled neck ring, the arrangement being such that the neck ring is preferably maintained closed by the parison mold, so that when the parison mold is closed, the neck ring will likewise be held closed, but the opening of the parison mold will not open the neck ring, the opening of the latter being accomplished by independent mechanism.

As shown in the accompanying drawings, the neck ring is illustrated at 78, Figs. 1, 2, 3, 3a, and 4, and is formed in the usual manner in mating portions or halves, each of which is interchangeably secured in a holder 79. The holders 79 are preferably pivoted coaxially with the holders 65 for the parison mold on the pintle 66.

For opening the neck ring when such action is permitted by the movement of the parison mold 64 to open position, each of the holders 79 is connected by a link 80 (Fig. 3a) to a crosshead 81 which is arranged for radial sliding movement on a pair of guide rods 82 rigid with the head 67. The cross-head 81 carries a cam roller 83 arranged to engage the inner face of a stationary cam 84 carried by the stationary column 18 as illustrated in Figs. 1 and 3. Closing movement of the neck ring may be accomplished by closing the associated parison mold, the neck ring having a portion engaging within the recessed portion at the upper end of the parison mold as

clearly illustrated in the drawings Figs. 3, 16, 17, and 18.

Neck pin, mounting and operation thereof

Each of the neck rings 78 has associated therewith a neck pin 85. This neck pin 85 is preferably interchangeably mounted on the lower end of a plunger 86, which is slidably received in a bracket extension 87 rigid with the radial sliding member 67 carrying the parison mold. The plunger 86 has a reduced portion 88 extending upward through an aperture in a bracket member 89, a spiral compression spring 90 surrounding the reduced portion 88 between a shoulder 91 thereon and the under side of the bracket member 89. A suitable cross pin 92 extends through the reduced portion 88 above the bracket 89 and serves to prevent movement of the plunger 86 out of engagement with the bracket under the influence of the spring 90. Thus when the bracket 89 is moved downwardly, as will be hereinafter set forth, the neck pin 85 will be similarly moved downwardly by a force measured by the compression of the spring 90 and upward movement of the bracket 89 will serve positively to raise the neck pin 85. The bracket 89 is vertically slidable on an upstanding shaft 93 rigid with the bracket extension 87 (Figs. 2 and 3). A helical compression spring 94 extends between the upper surface of the bracket extension 87 and the underside of the bracket 89, being guided by a sleeve portion of the latter bracket which surrounds the shaft 93. The shaft 93 is provided at its upper end above the bracket 89 with a pair of lock nuts 95 to prevent excessive upward movement of the bracket 89 under the influence of the spring 94. The bracket 89 is further provided with a cam roller 96 adapted to engage the underside of a stationary cam 97 (Fig. 3), which is rigid with the stationary column 18. Thus when the roller 96 rides under the cam surface 97, the bracket member 89 will be lowered against the compression of the spring 94 and guided by the shaft 93 and the plunger 86. This will compress the spring 90 and result in the lowering of the plunger 86 and neck pin 85. When the roller 96 rides from under the cam 97, the spring 94 will be effective to force the bracket 89 upwardly to the limit permitted by the lock nuts 95 on the shaft 93, which will move the neck pin 85 upwardly, due to the engagement of the upper surface of the bracket 89 with the cross pin 92.

After the neck pin has been withdrawn due to the upward movement of the bracket 89, counterblowing pressure may be supplied through the neck opening formed by the neck pin in the mouth of the glass to counterblow the parison, this pressure being supplied to the space around the neck pin in the bracket extension 87 through a pipe 98 from the central pneumatic pressure distributor in a manner to be hereinafter specifically described, there being a suitable flexible portion in this pipe to permit of the necessary movements of the parts. The construction and the path of the air through the bracket member 87 is best illustrated in Figs. 16 to 19 inclusive.

Parison mold bottom plate and movements thereof

Each parison mold is provided with a bottom plate which is in turn further provided with pressure supplying means for forming a hollow ended parison. For the purposes of the present section of the description, however, the bottom

plate will be considered apart from the pressure supplying means merely as a bottom plate and the mounting and movements thereof will be described. The means for supplying pressure to form a hollow ended blank will be later described in a separate section.

Each of the parison molds 65 is provided with a bottom plate generally indicated at 99, which is preferably removably mounted on the outer end of an arm 100 pivoted on a horizontal axis at 101 to the radial sliding member 67. The arrangement is such that the bottom plate 99 may be swung upwardly into position by swinging the arm 100 about the axis of its pivot 101 and then locked in position by being engaged in a recessed portion of the parison mold 64. Upward movement of the bottom plate 99 is occasioned by a roller 102 carried thereby riding up the inclined surface of a cam 103, as best seen in Fig. 2, this cam being suitably supported by standards 104 and 105 (Figs. 2 and 3) from the base 1, the latter standard being formed as a bracket extending from a standard 106 which is in turn directly supported by the base 1. The downward limit of the tilting movement of the bottom plate 99 and the arm 100 when the parison mold 64 has been opened is determined by a cross member 107 extending between a pair of swinging arms 108 pivoted at 109 to the radial sliding member 67 as indicated in the drawings (see particularly Fig. 3 at the left).

Blank transfer from blank molds to parison molds

While I have described certain of the mechanisms by which the transfer of blanks may be effected from the blank molds to the parison molds, it is thought that a particular explanation of this operation will be helpful to an understanding of the operation of the machine as a whole.

After a blank has been formed as indicated in Fig. 14, and in this case by gravity settling of the glass to mold itself to conformity with the internal cavity of the blank mold 34, the blank mold is caused to travel through a portion of its path in alignment with a portion of the path of a parison mold throughout a zone adequate for the transferring of the blank from the blank mold to the parison mold. At the time the blank mold 34 and the parison mold 64 to receive the blank move to the common portion of their paths, the parison mold is open and the bottom 99 thereof raised to its operative position due to the roller 102 riding along a horizontal portion of the cam 103. The blank mold is closed as shown in Fig. 14.

The cooperating blank and parison molds are caused to travel with their vertical axes in registry for a material time by swinging the blank mold about the axis of the pintle 38, due to the cam roller 60 riding along a predetermined portion of the surface of cam 63 and causing swinging movement of the swing plate 37 by which the blank mold and its bottom 50 are carried. At the same time, the parison mold 64 is moved radially as may be necessary to cause its axis to travel in registry with that of the cooperating blank mold 34 by a cam roller 110 carried by the associated slide member 67 riding along the surface of a stationary cam 111 (Figs. 1 and 3) and thus moving the blank mold radially to a desired varying extent against the tension of the spring 112 which extends between a stud 113 on the radial sliding member 67 carrying the parison mold and a fixed pin 114 carried by the parison

mold carrier 14, as best seen in Fig. 3. Thus during the zone in which the axes of the blank and parison molds follow each other, the blank mold is swung laterally and the parison mold moved radially, both in response to the rotation of their several carriers and under the action of fixed cams.

In transferring a blank from a blank mold to a parison mold, the blank mold is positioned as aforesaid above the bottom 99 for the parison mold and the bottom plate 50 of the blank mold moved from under the glass by the cylinder 55 in response to the admission of pressure to the pipe 56 and the exhaustion thereof through pipe 57 of that cylinder. This action is illustrated in Fig. 15. The blank mold is then quickly opened by cylinder 47 by admitting pressure to the pipe 48 thereof and exhausting pressure through pipe 49. The parison mold is then quickly closed about the blank by admitting pressure to the operating cylinder 75 thereof through pipe 77 and exhausting pressure through pipe 76. This completes the transfer of the blank to the parison mold and brings the operation up to the point illustrated in Fig. 16. It will be understood that while all these operations are taking place, the blank mold and parison mold are continuing to travel with their vertical axes in registry as above set forth.

Parison forming means

Arranged for movement axially of each of the bottom plates 99 is an air nozzle formed on the upper end of a slide rod 115. The slide rod 115 is received in upper and lower bearings 116 and 117 in the bottom plate structure as best illustrated at the left in Fig. 3. Surrounding the lower end of the slide rod 115 below the bearing 117 is a helical compression spring 118 extending between the bearing 117 and a suitable abutment 119 formed on the slide rod 115, the spring thus tending always to move the slide rod 115 downwardly with respect to the bottom plate 99. For moving the slide rod 115 upwardly to project the nozzle upward into the parison mold, the slide rod is provided between the bearings 116 and 117 with a pintle 120 extending through a suitable slot 121 in the stem portion of the bottom plate and carrying at its outer end a cam roller 122 which is adapted to ride on a cam 123 shown in Fig. 3. The cam 123 may be supported on suitable brackets as the bracket 106 from the base 1 of the machine. Thus when the bottom plate 99 has been locked within the recess in the lower end of the parison mold 64 and the roller 122 rides up the inclined surface of the cam 123, the nozzle on the upper end of the slide rod 115 will be projected inwardly of the parison mold.

Means are provided for supplying air under pressure to the nozzle at the upper end of the slide rod 115, such means comprising a pipe 124 (Figs. 2, 3, and 10) from the lowermost distributor of the column 18 (Fig. 3) extending to the bearing of the arm 100 at 101 which carries the bottom plate 99 and thence through a bore 125 in the arm 100 and a suitable aligned bore in the hollow stem of the bottom plate 99 to a vertically elongated recess 126 formed in this hollow stem. The pressure passes thence through a lateral bore and a longitudinal bore 127 in the upper portion of the slide rod 115 to the nozzle at the upper end thereof. This nozzle is formed to direct the pressure upwardly and outwardly from the upper end of the slide rod 115 as best illustrated in Figs. 16 and 17, there being a ta-

pered plug member 128 having a hollow stud at its lower end threaded into a suitable recess formed in the upper end of the slide rod. Thus pressure admitted through the slide rod 115 will be directed upwardly and outwardly from the nozzle formed at the upper end thereof so as to supply pressure to the central lower portion of the parison mold and to supply this pressure in upward and outward directions. Thus the air pressure is effective in two ways, first, by its pressure effect to displace the glass, and, second, by its dynamic effect on the glass to force it into contact with the side walls of the parison mold.

It is contemplated that the initial depression being formed in the lower central portion of the glass may be either by the mechanical pressing action of the upper end of the slide rod effective on the glass or the pneumatic pressure action of the air supplied therethrough, or both, this division of the effective action being determined by the relative timing of the initiation of the upward movement of the slide rod 115 on the one hand and the initiation of the application of pneumatic pressure to the nozzle through the slide rod on the other.

I have further provided for the controlled exhaust or bleeding of pressure from the depression being formed in the lower end of the glass, in order first to balance in a controllable and variable manner the pressure and dynamic effects of the air in forming the cavity or depression in the glass seen at 129 in Fig. 17, and on the other hand in order to control the amount of air flowing through this depression, into and out of it, and thus to control the cooling of the surface glass bounding the depression or cavity being formed.

For this purpose, the slide rod 115 is formed with a longitudinal groove 130, best seen in Figs. 3, 16, and 17, and extending for a predetermined distance along the slide rod. After the slide rod is moved upwardly to a predetermined extent, the upper end of the groove 130 will be exposed to the inner side of the cavity 129 being formed in the glass above the upper surface of the bottom plate 99. The lower end of the groove 130 is in alignment with a lateral bore 131 in the side of the depending sleeve portion of the bottom plate 99. This bore has associated therewith a manually adjustable bleed valve 132 by which the exhausting of pressure from the depression or cavity 129 in the glass may be adjustably controlled.

Thus, if the valve 132 is opened to a material extent, the amount of air which may be bled from the cavity 129 is increased, which will increase the proportional dynamic effect of air on the glass in forming the cavity and decrease the proportional pressure effect thereof, and at the same time by permitting a larger amount of air to flow both into and out of the cavity or depression 129, the cooling of the surface glass bounding such depression will be increased and vice versa.

It is contemplated, as will be hereinafter more fully set forth, that the glass will initially contact with the lower peripheral portion only of the parison mold substantially at the recess 133 formed therein and that due to the upwardly tapering configuration of the blank as transferred to the parison mold, this will be substantially the only point at which the blank will contact with the side walls of the parison mold. If the blank is permitted to remain in the parison mold without blowing for any material time, the glass will gradually settle so as to contact

at progressively higher points with the walls of the parison mold. However, irrespective of the time of settling and the initial amount of contact between the glass and the parison mold, as the center portion of the glass is moved upwardly as seen by a comparison of Figs. 16 and 17, the glass will contact with the side walls of the parison mold progressively from bottom to top thereof and will eventually fill the neck ring 78 about the neck pin 85, this condition being illustrated in Fig. 17.

After this condition has been realized, pressure may be cut off through the slide rod 115, the slide rod retracted to the position shown in Fig. 18, the neck pin 85 substantially simultaneously retracted both by the means hereinabove described, and counterblowing pressure may then be supplied through the pipe 98 to counterblow the hollow ended blank to form a parison, as shown in Fig. 18. The parison is now completed in readiness for transfer to the blow mold.

It will be understood that due to the fact that the parison mold is formed with a recessed portion 133 and that the blank is formed with an enlarged lower portion or peripheral flange, which substantially fits such recessed portion, the lower peripheral portions of the glass will be anchored with respect to the parison mold, so that when pressure is supplied as above described or by some mechanical pressure means which might be used, to the center portion only of the glass, the peripheral portions of the glass will be maintained with little if any movement with respect to the side walls of the parison mold and a hollow ended blank will be formed extending substantially the full length of the parison mold as illustrated. The progressive contact of the glass with the side walls of the parison mold, as above described, will be effective practically to prevent such abrupt changes in section in any part of the completed article, that the article will be free from the defect known commercially as a "settle wave."

Blow molds, mounting and operation thereof

The blow mold carrier 20 is provided with a plurality, in this case eight, of final blow molds each of which is similar to the other, so that a description of one will suffice for all. The blow mold 134 is formed in the usual manner in mating portions or halves, each of which is supported interchangeably in a suitable blow mold holder 135, the holders being pivoted on a common pintle 136. The pintle 136 is suitably mounted in ears 137 in a tiltable carriage 138. The carriage 138 is arranged for tilting movement on the blow mold carrier 20 about the axis of a pintle 139, which is substantially horizontal and arranged tangentially of the blow mold carrier as best illustrated in Fig. 4.

Means are provided for opening and closing the blow molds, such means being substantially identical with the means hereinabove described for opening and closing the parison molds 64 and including pairs of toggle links 140 and 141 (Fig. 1) connecting the blow mold holders 135 with pintles 142 fixed on the tiltable carriage 138. The links 140 are shown connected intermediate their ends by links 143 with a crosshead 144 which is mounted on the inner end of piston rod 145 of a cylinder 146, which may be formed integral or rigid with the tiltable carriage 138. Pressure may be supplied to the cylinder 146 for opening and closing the blow mold through the pipes 147 and 148 from the central air distributor in a manner

hereinafter to be more specifically described. Thus when pressure is supplied through the pipe 147 to the radially outer end of the cylinder 146 and exhausted through pipe 148 from the radially inner end thereof, the associated blow mold will be opened through the linkage above described. The blow mold will be closed when pressure is reversed through the pipes 147 and 148. The toggle links 140 and 141 serve to retain the blow mold closed and locked after it has been moved to closed position by the pneumatic cylinder 146 as above set forth.

Each blow mold 134 is provided with a bottom plate 149, which may be interchangeably supported on the outer end of a bracket 150 secured to and extending from the tiltable carriage 138 as illustrated.

When it is desired to transfer a completely formed parison from a parison mold to a cooperating blow mold, the parison mold may be moved radially by the cam 111 in such a manner as to cause the axis thereof to move in substantial coincidence with the blow mold axis through a period of angular travel of these molds sufficient for the transfer of the parison.

The actual transfer is accomplished by opening the parison mold either before its arrival at the common zone of its path of travel with the blow mold or substantially as the parison mold enters such zone and thus to leave the completed parison suspended from the neck ring 78. Thereafter and during the travel of the opened parison mold, the neck ring and the blow mold through the common zone of their paths of travel, the neck ring 78 is opened by the action of the cam 84 on the cam roller 83 and the blow mold 134 closed by the admission of pressure through the pipe 148 and exhaustion thereof through the pipe 147 both of the cylinder 146 and controlled in a manner hereinafter to be described. It is contemplated that the opening of the neck ring to release the parison to the blow mold may occur either slightly before, as, or slightly after the closing of the blow mold as may be desired, according to the setting and design of the air distributing system in respect to the configuration of the cam 84.

Final blow head and operating means therefor

Each blow mold 134 is provided with an associated blow head generally indicated at 151 which may be of any conventional or desired design. The blow head 151 is mounted on the outer end of a bell crank arm 152 pivoted at 153 to the tiltable carriage 138 and having the other arm of the bell crank connected at 154 to a spring link generally indicated at 155. The opposite end of the link 155 is connected at 156 to a slide member 157 carrying a cam roller 158 for engagement with the stationary cam 159 which is secured to the stationary column 24 of the machine. The slide member 157 is suitably arranged in guideways 160 for solely radial movement, the guideways having overhanging portions 161 to prevent the dislodgment of the slide member 157 with respect to the guideways.

The link 155 is preferably formed in two parts which are telescopically arranged and including the rod 162 and a sleeve member 163. These parts are urged apart by a compression spring 164 extending between suitable shoulders on the respective parts and coiled about the rod 162.

Pressure to the blow head 151 through the pipe 165 from the pneumatic pressure control means

may be controlled in a manner hereinafter to be described.

Tilting of the blow mold

I have provided means for tilting the blow mold in order to position it with its longitudinal axis at a variable angle to the vertical for the purpose of compensating to some extent at least for the effect of centrifugal force incident to the rotation of the machine on the glass therein. The tilting of the blow mold is subject to the rotation of the blow mold carrier and preferably is operated by a cam. This permits gradual increase of the angle of tilt at the rate desired to compensate for inertia lag. This construction is also particularly desirable in the event that the machine be rotated intermittently as such an operation would entail the variable tilting of the blow mold substantially in synchronism with the intermittent rotative period of movement thereof.

For the purpose of controlling the tilting of the blow mold, each of the tiltable carriages 138 is connected by a pair of toggle links 166 and 167 to a pivot point or pintle 168 fixed with respect to the blow mold carrier 20, the link 167 passing through a suitable slot 169 in the lower table or web of the blow mold carrier as illustrated. A tension spring 170 is arranged between the tiltable carriage 138 and a point on the link 167 and tends to straighten the toggle. The arrangement is such that when the toggle links 166 and 167 are straight, as illustrated at the right in Fig. 4, the longitudinal axis of the blow mold is vertical.

For tilting the blow mold, for example to the position shown at the left in Fig. 4, there is provided a lever 171 pivoted to the blow mold carrier at 172 and having a cam roller 173 at its lower end for cooperation with a stationary cam 174 which may be mounted on the base 1 of the machine. The upper end of the lever 171 has a part 175, which in the present instance is adjustably associated therewith for engagement with a point on the toggle link 167. As particularly illustrated in the accompanying drawings, the slide member 175 is shown having an abutment portion 176 for engagement with the link 167 and having a stem portion 177 freely slidable in a suitable bore in the lever 171. Arranged parallel to the stem 177 and threaded through a tapped hole in the lever 171 is a manual adjusting screw 178 having an adjusting knob 179 at its lower end. The upper end of the screw 178 is swivelly connected, as illustrated at 180, to the head of member 175, so that upon adjustment of the screw 178 by the handle or knob 179, the effective length of the lever 171 is varied by varying the point of engagement between the engaging portion 176 of the lever 171 and the link 167. Thus by lowering the engaging portion 176, by turning the screw 179 to the left, the effective length of the lever 171 will be shortened and the movement of the link 167 caused by a predetermined movement of the lever 171 increased. By the arrangement above described, I am enabled not only to control the tilting of the blow mold in response to the rotation of the blow mold carrier, but also adjustably to control the maximum degree of tilting for a predetermined variation in the configuration of the cam 174 while leaving undisturbed the other limit of movement of the blow mold, namely, the position thereof in which its longitudinal axis is vertical. When the roller 173 rides off the cam sur-

face 174, the spring 170 will be effective to straighten the toggle formed of links 166 and 167 and move the blow mold to a vertical axis position.

Timing means, air distributor, etc.

Inasmuch as many of the essential operations of my machine are performed by pneumatic pressure either applied directly as in blowing the glass from one form to another form, or indirectly as in actuating pneumatic cylinders to open and close molds, I prefer to provide an improved form of timing means particularly for controlling the distribution of air pressure in a manner such that any and all necessary adjustments are provided by relatively simple means.

In connection with the above, I prefer to provide in conjunction with my machine a series of pneumatic valves for the controlling of several of the operations in such a manner as to permit the widest possible field for adjustment. For this purpose, I have shown at 181 (Figs. 1 and 4) a valve box by which pneumatic pressure may be distributed from one or more supply lines as 182 to a plurality of pressure lines as will be hereinafter set forth and as illustrated particularly in Fig. 4. The valve box 181 is preferably of substantially the same construction as that now in use in connection with the commercial "Hartford I. S." machine, this construction being fully illustrated and described in Ingle Patents 1,843,159 and 1,843,160, both granted Feb. 2, 1932, and 1,911,119, granted May 23, 1933. In the present instance, however, instead of using a relatively small rotating drum for carrying the buttons such as are illustrated at 183 for operating the several valves I have provided a relatively large annular member 184 which may be rigid with the blow mold carrier 20 as illustrated and which provides a large annular surface in which a plurality of grooves 185 may be formed for receiving the buttons 183, so that a large number of buttons may be positioned as may be desired in any one of the grooves 185.

For the purposes of the present description, it will be sufficient to say that the valve box 181 includes a plurality of valves, in this instance eight, each of which is provided with a similar operating means generally indicated at 186 and adapted to be engaged first by a relatively short button 183 and thereafter by a longer button similar to those shown and in the same groove 185. The action of the valves and their operating means are such that when the operating means for any valve is engaged by a short button, pressure is supplied from the supply line associated with that valve, which may be the common supply line for all the valves, to the associated pipe leading to the forming machine. This pressure is continuously supplied until the valve operating means 186 is subsequently engaged by a longer button in the same groove 185 at which time pressure is cut off from the pipe leading to the forming machine and exhausted through the valve box 181 to the atmosphere. It will be understood that as many sets of short and long buttons as desired may be positioned in each of the annular grooves 185, so that each valve may be operated a plurality of times for each single rotation of the blow mold carrier.

Turning now to the forming machine and tracing its connection with the valve box 181 for operating the several instrumentalities, the cylinders 47 and 55 may be operated by valves in the valve box 181. For this purpose the active move-

ment of the piston within the cylinder 47, that is the movement thereof which opens the blank mold operated by the supplying of pressure through pipe 48, may be timed adjustably by one of the valves in the box 181. As shown, the pipe 48 is connected to the uppermost valve (Fig. 4).

The pipe 56 which supplies pressure to the cylinder 55 for retracting the bottom plate 50 from under the blank in transferring it from the blank mold to the blow mold may be connected to the second pipe counting from the top in the valve box 181.

Inasmuch as the return movement of the pistons in cylinders 47 and 55 may be operated at any time prior to the arrival of the next succeeding blank mold at the transfer zone, the timing of these operations is not critical, so that the pipes 49 and 57 of cylinders 47 and 55 respectively may be connected together and both connected to pipe 187 of the valve box 181.

Thus the timing of the operations of withdrawing the bottom plate and opening the blank mold may be adjustably timed by suitably positioning the operating buttons in the upper three grooves 185 of the member 184 and also that there may be any suitable number of buttons for performing these operations. In this instance eight sets of buttons will be required in each of these three grooves.

For performing certain of the operations such as the opening and closing of the parison and final blow molds, it is unnecessary to use the timer 181 as these operations may be suitably timed by a distributor which may be located concentric with the rotary carrier for the particular part to be timed.

As shown in Figs. 3, 7, and 8, the stationary column 18 of the parison mold carrier 14 is employed as a distributor, suitable grooves being provided part way around the column at different levels as particularly illustrated in Figs. 7 and 8 and suitable collars being located around this portion of the column and having ports therein communicating with each of the article forming units.

As shown (Figs. 3 and 7) the pipes 76 leading from the radially outer ends of cylinders 75 and employed for supplying pressure to open the parison molds all communicate with a collar 188 surrounding the column 18. This collar is not an integral part of or permanently secured to the parison mold carrier 14, but is adjustable with respect thereto as best shown in Fig. 7 by providing the collar with a bracket or extension 189 through which extends an adjusting bolt 190 which is threaded in an upstanding shaft 191 rigid with the parison mold carrier 14. Thus by adjusting the screw 190, the collar 188 may be suitably angularly adjusted with respect to the parison mold carrier thus varying the timing of the operations of all the associated means collectively.

The column 18 is provided with a plurality of longitudinal bores two of which are usable in connection with the timing of the opening of the parison mold. As shown, the bore 192 communicates through the pipe 193 (Fig. 3) with a source of live air under pressure, this pressure being adequate to operate pneumatic cylinders to open and close the parison mold. The bore 192 communicates through a lateral bore 194 with a groove 195 extending a short way around the column 18. Another groove 196 extends around another portion of the column and communicates through a lateral bore with a longitudinal

bore 197 which is open to the atmosphere at the upper end of the column 18 and thus serves for purposes of exhaust.

It will be seen from a comparison of Figs. 1 and 7, that the parison molds are opened substantially at the transfer zone for parisons to the blow molds and maintained open part way to the transfer zone for blanks from the blank molds to the parison molds at which time pressure is cut off which maintains the molds open and the molds may then be closed by application of pressure to the opposite ends of the cylinders 75. Pressure is exhausted from the radially outer ends of the cylinders 75 in a zone beginning substantially at the zone of transfer of the blanks from the blank molds to the parison molds and extending almost to the zone of transfer of parisons from the parison molds to the blow molds.

Considering now Figs. 3 and 8, there is illustrated a second collar 198 with which the pipes 77 leading to the radially inner ends of the cylinder 75 communicate. This collar is similarly provided with an extension 199 adjustable with respect to the shaft 191 by a screw 200. The column 18 at this level is provided with a pair of grooves 201 and 202 communicating respectively with the live air bore 192 and the exhaust bore 197.

From a comparison of Figs. 1 and 8, it will be seen that the pipes 77 come into communication with groove 201 during the period that the blanks are being transferred from the blank molds to the parison molds, thus closing the parison molds. The parison molds are then maintained closed, due to their associate pipes 77 remaining in communication with the groove 201 until just prior to the molds arriving at the transfer zone from the parison molds to the blow molds. The pipes 77 are open to exhaust substantially as or shortly prior to the arrival of the molds at this latter transfer zone and are maintained open to exhaust until somewhat before the molds arrive at the transfer zone with the blank molds.

It will be seen that the only adjustment provided for the timing of the opening and closing of the parison molds is one in which the collars 188 and 198 may be rotated with respect to the parison mold carrier which will control the timing of the opening and closing of all the parison molds collectively. This is all that is normally necessary in this connection and hence no further adjusting means are provided.

In connection with the distributing of air for supplying blowing pressure to blow the glass in the molds, I prefer to provide an arrangement by which the application, that is the initiation and/or cutting off of the blowing pressure may be independently controlled for each of the molds or mold units. By the use of some such arrangement, I am enabled to use the machine in the simultaneous manufacture of differently shaped articles by the use of suitably shaped molds, such differently shaped articles requiring in some instances different blowing times and different time cycles.

As shown, each of the pipes 124 leading to the air nozzles in the slide rods 115 for blowing the glass upwardly in the molds is connected to a distributor collar 203 (Figs. 3 and 10) and means are provided for controlling both the initiation and cutting off of pressure through these pipes independently for each mold and independently as regards the time of initiation and time of cutting off of such pressure.

If the total time of application of blowing pres-

sure were less than the time required for any mold to travel an angular distance corresponding to the distance between adjacent molds, the problem would be greatly simplified, but in the present instance I have illustrated an arrangement by which this pressure may be controlled as above set forth when the total time of application of the pressure is greater than the time for any one mold to travel a distance between adjacent molds.

Under these circumstances there are three sectors around the column 18 provided with independent grooves 204, 205, and 206, these sectors or grooves being separated by spaces substantially equal to the width of the ports in the interior of the collar 203. The grooves 204 and 206 at the beginning and end of the zone through which blowing pressure is desired to be applied are each of less angular extent than the distance between adjacent molds. These grooves are respectively connected to and through bores 207 and 208 respectively with pipes 209 and 210 which lead to the valve box 181 in a manner not particularly illustrated. The center groove 205 may be of any desired angular extent and is connected through a lateral bore with a central bore 211 which is in constant communication with a source of air under the pressure desired for use in blowing the glass. The short angular extent of the grooves 204 and 206 insures that only one of the pipes 124 is in communication with each of these grooves at any one time. Under these circumstances, the valves in the valve box 181 may be operated independently for each of the molds, so as adjustably to control the timing of application and cutting off of pressure for each of the molds independently. The intermediate period of each application of blowing pressure is in constant communication with a supply of pressure, so that during this intermediate period pressure will be supplied substantially continuously. The short periods during which no pressure is supplied intermediate the travel of any pipe 124 between the grooves 204 and 205 and between the grooves 205 and 206 are so short as to make little or no difference in the application of pressure and in the operation of the machine. It will be understood that there will be eight sets of buttons for operating the valves communicating with the pipes 209 and 210 respectively, so that the application of pressure is made independent for each unit and the initiation and cutting off of pressure are independent each of the other for any one unit.

A somewhat similar arrangement is employed in connection with the distribution of pressure through the pipes 98 supplying pressure through the neck rings for counterblowing the glass in the parison molds. In this case the pipes communicate the same distributor ring or collar 203, but at a different level than that at which the pipes 124 communicate therewith. A series of grooves 212, 213 and 214 (Fig. 9) are provided about the column 18 for communication with the pipes 98, grooves 212 and 214 communicating through bores 215 and 216 with pipes 217 and 218 respectively which lead to the valve box 181. The central groove 213 communicates through a lateral bore with the central bore 211 in the column 18 and thus with the constant source of blowing pressure or live air. Here again the arrangement is such that the initiation and cutting off of pressure are independent each of the other and the application of pressure to each of the molds may be separately controlled

by suitably arranging the respective sets of buttons 183 around the annular member 184 in the same manner as above described in connection with the application of pressure through the lower end of the parison molds. The collar 203 is in addition provided with an extension 219 which may be adjustably connected to the shaft 191 in the same manner as above described for the collars 188 and 198, so as to vary the timing of the application of blowing air to all the molds collectively. In this case, it will be seen that the timing of both of the pressure applications to both ends of the parison mold will be varied simultaneously by adjusting the screw 220 connecting the extension 219 with the standard 191, any other or further variations which may be desired being accomplished by suitable adjustment of the buttons 183 controlling the associated valves of the timer.

Turning now to the blow mold carrier shown particularly on Fig. 4 and referring also to Figs. 11, 12, and 13, the pipes 148 leading from the radially inner ends of cylinders 146 and effective when pressure is applied to close the blow molds 134 are all connected to a collar 221 which surrounds the stationary column 24 of the blow mold carrier as best shown in Fig. 4. The column 24 within the collar 221 is provided with two aligned grooves 222 and 223 which are connected respectively with the bores 224 and 225 extending axially of column 24 and connected respectively to a source of live air under pressure and to the atmosphere for exhaust. Thus the pipes 148 are opened to pressure as the associated blow molds move into the transfer zone for the parisons from the parison molds thereto, as seen at the right in Figs. 1 and 11. Pressure is continuously applied through the pipes 148 until just prior to the take-out zone which is substantially at the bottom as seen in Fig. 11. At this point, the pipes 148 come into registry with the exhaust groove 223 permitting the opening of the blow molds by pressure applied to the opposite ends of the cylinders 146. The collar 221 is provided with an extension 226 which is connected with a web 227 rigid with the blow mold carrier 20 by an adjusting screw 228. Thus the collar may be adjusted angularly about the column 24 with respect to the blow mold carrier for effecting a group adjustment of the time periods of application and exhaust of pressure to all the blow mold operating cylinders 146 simultaneously.

The pipes 147 for supplying pressure to the radially outer ends of the cylinders 146 and thus for opening the blow molds when such action is desired all communicate with a collar 229 located above the collar 221, as seen in Fig. 4. This collar is similarly provided with an extension 230 (Fig. 12) connected with the web 227 by an adjusting screw 231 for group adjustment of the time of opening of the final blow molds. The column 24 within the collar 229 is provided with two aligned grooves 232 and 233 connected respectively with the live air bore 224 and the exhaust bore 225. The arrangement is such that the final blow molds will be opened at the desired time for permitting removal of the completed articles and the radially outer ends of the cylinder 146 will be open to exhaust at the time the molds travel through the transfer zone of parisons from the parison molds to the blow molds as seen at the right in Fig. 12, such ends of the cylinders 146 being continuously open to exhaust for a period of time extending substantially up to the time

of arrival of the final blow molds at the take-out zone.

The pipes 165 leading to the several final blow heads 151 all communicate with a collar 234 located above the collar 229 about the center column 24. This collar 234 is similarly provided with an extension 235 connected to the web 227 of the blow mold carrier 20 by an adjusting screw 236 for group adjustment of the blowing times for all the blow molds. In alignment with the ports communicating with the pipes 165 in the collar 234 are three grooves 237, 238, and 239. These grooves communicate respectively with bores 240 leading to the pipe 241 which in turn leads to the valve box 181, the bore 242 leading to a constant supply of live air for blowing articles in the final blow molds and a bore 243 which is open to atmosphere at the upper end of the column 24 for exhausting any pressure remaining in the blow heads. The arrangement here shown is one in which the initiation only of the period of application of final blowing pressure is controlled by a valve in the box 181 and in a manner similar to that described for controlling blowing pressure for blowing the parisons. In this case the application of final blowing pressure continues until just prior to the opening of the final blow molds for the removal of the completed articles. It will be noted, however, that this arrangement provides almost as complete a freedom of adjustment as the arrangement above described in connection with Figs. 10 and 11 for controlling the application of air for blowing the parisons in that the application of the initiation of the blowing pressure may be individually controlled as to each mold by the associated valve in the box 181, there being the same number of pairs of buttons 183 for controlling this valve as there are molds on the final blow carrier, this is eight in the present instance. However, if it is desired to control the timing of the termination of the application of final blowing pressure this may be done by the adjustment of the angular position of collar 234 with respect to the blow mold carrier, although of course this adjustment will affect all the molds to the same extent rather than the molds individually. However, this adjustment is usually adequate in this particular relationship as it is normally the practice to continue the application of final blowing pressure until just prior to the opening of the final blow molds.

From the above, it will be seen that I have provided a means by which the operation of the mold opening and closing cylinders for the several molds may be suitably adjusted as a group, that is all the parison molds may be opened or closed at different times and all the blow molds may be opened or closed at different times, the opening and closing of the blank molds only being individually adjustable. On the other hand, the application of blowing pressures at the several stages of the process may be individually controlled for each mold so that articles of different shapes may be made on the machine simultaneously in different mold units by suitably setting up the machine. Also these results are accomplished by the use of a single valve in the air line supplying pressure for any one of these operations, that is, such as the initiation of the application of pressure for expanding a parison to final form in the blow mold.

Operation of the machine

Having now described the construction and

particular operations of the several instrumentalities of my machine, I will describe the operation thereof in forming a single article of hollow glassware.

The blank molds 34 are adapted to be supplied with glass in any suitable manner, as for example by an automatic glass feeding device such as are now in common use in the art. The blank molds may be supplied with glass at any desired point in the rotation thereof, preferably between the position of the blank mold 34 at the top and that at the left of the blank mold table, as seen in Fig. 1.

The blank mold 34 is provided with a lower peripheral recess 244 to form a lower peripheral flange portion on the blank, as illustrated, the remainder of the blank being molded as a solid mass into conformity with the internal configuration of the blank mold, which is preferably so shaped as to form an upwardly tapering blank as shown at 245. The molding of the blank in the blank mold may be accomplished as illustrated merely by permitting time for the glass to settle in the mold and thus to mold itself into conformity with the internal cavity of the mold. Inasmuch as the settling of glass in a blank mold in various ways is common in the art, it is contemplated that any practicable method of blank formation is to be considered within the purview of this invention.

The blank is next transferred from the blank mold to the parison mold, as described above in the section entitled "Blank transfer from blank molds to parison molds", by moving the blank mold in registry with the parison mold bottom 99 for a predetermined period of time, withdrawing the blank mold bottom from beneath the blank to permit it to settle on the parison mold bottom as illustrated in Fig. 15, then opening the blank mold 34 and quickly closing the parison mold 64 around the blank before it has time to settle to a point such that the glass cannot be enclosed by the parison mold. The parison mold cavity as illustrated in Fig. 16 is so shaped as to provide a lateral clearance between it and the upwardly tapering body portion of blank which is progressively greater from the bottom to the top thereof. This cavity is further provided with a lower peripheral recess to accommodate the lower flanged portion of the blank as illustrated at 133, Fig. 16.

The blank is then permitted to remain in the parison mold without further action thereon for a predetermined period of time during which the glass may settle further and to permit reheating of the blank. At the termination of this time, the slide rod 115 is moved upwardly and pressure is simultaneously supplied therethrough under control of the timing means above described to form a cavity as illustrated at 129 (Fig. 17) in the lower central portion of the glass and to force the glass upwardly in the mold so as progressively to contact with the walls of the mold from bottom to top thereof and to fill the neck ring about the neck pin. This action has been fully described above in connection with the description of these parts. During this action, the lower peripheral flange portion 244 on the glass anchors that portion of the glass with respect to the parison mold and requires that the parison be formed in the manner illustrated.

After this operation has been completed in forming a hollow ended blank, as shown in Fig. 17, the neck pin 85 and the slide rod 115 are retracted, and after a corkage reheat time coun-

terblowing pressure is supplied through the pipe 98 under the control of the timing means hereinabove described to counterblow the hollow ended blank to form a completed parison as shown in Fig. 18.

The parison is then transferred from the parison mold 64 to the blow mold 134 in the manner hereinabove described during the follow movement of these two molds and by opening the parison mold, dropping the parison mold bottom plate 99, closing the final blow mold, and opening the neck ring 78. The parison is then permitted to rehear and stretch while in the blow mold for a period of time predetermined by the setting of the timing means above described and during perhaps a quarter of a revolution of the blow mold carrier. At the end of this time, the parison is blown to the final form of the desired article by pressure supplied through the blow head 151 from the pipe 165 under control of the timing means above described.

While I have described but one apparatus embodiment of my invention and particularly described a certain method by which articles may be formed, it will be understood that many changes and modifications may be made both in method and apparatus and that certain of the special combinations of apparatus and/or methods may have independent utility in other, and to some extent, dissimilar combinations. I do not wish to be limited, therefore, except by the scope of the appended claims, which are to be construed as broadly as the state of the prior art permits.

I claim:

1. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion of glass at the upper end thereof while maintaining the lower peripheral portion of the glass relatively stationary with respect to the walls of the parison mold and thus forming a hollow ended blank extending the full length of the parison mold and having a neck finish portion thereon, expanding the glass to the shape of the parison mold to form a completed parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

2. The method of forming hollow glass articles, which comprises the steps of supplying a charge of plastic glass to a blank mold through the open upper end thereof, maintaining such charge in the mold for a time sufficient for the glass to flow under the influence of gravity to a shape in conformity with the side and bottom portions of such mold, transferring the glass as thus molded to a parison mold having a foot forming portion at its lower inside periphery while maintaining the same end of the glass uppermost, maintaining the glass in the parison mold until the glass forms a foot at the lower outer periphery thereof to anchor this portion against substantial movement longitudinally of the parison mold, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion at the upper end thereof and thereby forming a

hollow ended blank substantially the full height of the parison mold, expanding the blank thus formed to the shape of the parison mold by applying fluid pressure through the neck portion thereof and thereby forming a parison, transferring the parison thus formed to a final blow mold, and blowing it to final form therein.

3. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly tapering solid body portion, transferring the glass thus molded to a parison mold having a recess to accommodate the footed portion or peripheral flange of the blank and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and the blank transferred thereto from the bottom upwardly, maintaining the blank in the parison mold without the application of external forces thereon for a time sufficient for the glass substantially to fill the lower peripheral recessed portion of the parison mold and thus to anchor this portion of the glass against substantial movement longitudinally of the mold, forcing the center portion only of the glass upwardly in the parison mold to cause the glass to contact with the side walls of the mold in a progressive manner from the bottom to top thereof and initially to form a neck finish portion at the upper end of the glass and thus to form a hollow ended blank, expanding the glass to the shape of the parison mold to form a completed parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

4. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, supplying a fluid under pressure through the lower end of the parison mold to force the center portion only of the glass upwardly in the parison mold and initially to form a neck finish portion of glass at the upper end thereof while maintaining the lower peripheral portion of the glass relatively stationary with respect to the walls of the parison mold and thus forming a hollow ended blank extending the full length of the parison mold, expanding the glass to the shape of the parison mold to form a completed parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

5. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly tapering solid body portion, transferring the blank thus molded while maintaining the same end of the glass uppermost to a parison mold having a recess to accommodate the footed portion or peripheral flange of the blank and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and the blank transferred thereto from the bottom upwardly, supplying a fluid under pressure through the lower end of the parison mold to force the center portion only of the glass upwardly in the parison mold and

initially to form a neck finish portion of glass at the upper end thereof while maintaining the lower peripheral portion of the glass relatively stationary with respect to the walls of the parison mold by the recess at the lower portion thereof and thus forming a hollow ended blank extending the full length of the parison mold, expanding the blank thus formed to the shape of the parison mold to form a completed parison by supplying fluid under pressure through the neck finish portion thereof, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

6. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion of glass at the upper end thereof by the joint pressure and dynamic effect of air supplied to the depression being formed in the lower central portion of the glass at progressively higher points therein as the depression is enlarged and thus forming a hollow ended blank substantially the full length of the parison mold, expanding the blank thus formed to the shape of the parison mold and thus forming a completed hollow parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

7. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold having an internal configuration such as to form a blank with the lower footed portion or peripheral flange and an upwardly tapering solid body portion, transferring the blank thus molded while maintaining the same end of the glass uppermost to a parison mold having a recess to accommodate the footed portion or peripheral flange of the blank and having substantially straight sides thereabove to provide a substantially greater lateral clearance between it and the glass transferred thereto from the bottom upwardly, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion of glass at the upper end thereof by the joint pressure and dynamic effect of air supplied to the depression being formed in the lower central portion of the glass at progressively higher points therein as the depression is enlarged and thus forming a hollow ended blank substantially the full length of the parison mold, expanding the blank thus formed to the shape of the parison mold to form a completed parison by supplying fluid under pressure through the neck finish portion thereof, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

8. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion of glass at the upper end thereof by the joint pressure and dynamic effect of air supplied through the center portion of the

bottom of the parison mold, controlling the balance between the pressure and dynamic actions of the air in shaping the glass in the parison mold and controlling the cooling of the surface glass bounding the depression being formed therein by venting a predetermined portion of the blowing air out of the depression being formed in the lower central portion of the glass and thus forming a hollow ended blank the full length of the parison mold, expanding the hollow ended blank thus formed to the shape of the parison mold and thus forming a completed hollow parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

9. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, forcing the center portion only of the glass upwardly in the parison mold and initially forming a neck finish portion of glass at the upper end thereof by the joint pressure and dynamic effects of blowing air supplied through the center portion of the bottom of the parison mold through a nozzle which is vertically moved upward during the blowing and as the depression is formed in the bottom of the glass so as to cause the air to be effective dynamically on progressively higher portions of the glass as blowing proceeds, controlling the balance between the pressure and dynamic actions of the air in forcing the glass upwardly and controlling the cooling of the surface glass bounding the depression being formed in the glass by venting a portion of the blowing air out of the depression being formed in the lower central portion of the glass and thus forming a hollow ended blank the full length of the parison mold, expanding the hollow ended blank thus formed to the shape of the parison mold and thus forming a completed hollow parison, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

10. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold to conform with the internal configuration of the side and bottom portions of such mold, transferring the glass from the blank mold to a parison mold while maintaining the same end of the glass uppermost, moving a blowing nozzle upwardly through the bottom of the parison mold in a direction substantially axially thereof, admitting blowing air through such nozzle in a direction upwardly and outwardly from the upper end thereof to form a blowing cavity in the glass extending upward from the bottom central portion thereof and thereby forcing the center portion only of the glass upwardly in the parison mold to form a neck finish portion of glass at the upper end thereof by the joint pressure and dynamic effect of air supplied through such nozzle, controlling the balance between the pressure and dynamic actions of the air in forcing the glass upwardly and controlling the cooling of the surface glass bounding the depression being formed in the glass by venting an adjustable proportion of the air out of the depression being formed in the lower central portion of the glass and thus forming a hollow ended blank the full length of the parison mold, expanding the blank thus formed to the shape of the parison mold and thus forming a completed hol-

low parison by admitting blowing air through the neck finish portion thereof, transferring the parison thus formed to a final blow mold, and blowing the parison to final form therein.

11. The method of forming hollow glass articles, which comprises the steps of molding a charge of plastic glass in a blank mold having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly tapering solid body portion, transferring the blank thus molded while maintaining the same end of the glass uppermost to a parison mold having a recess to accommodate the footed portion or peripheral flange of the blank and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and the glass transferred thereto from the bottom upwardly, moving a blowing nozzle substantially axially upwardly in the parison mold through the center portion of the bottom thereof and concomitantly supplying blowing air through such nozzle in upward and outward directions to form a depression in the lower central portion of the glass and to force the center portion of the glass upwardly with respect to the mold into the upper portions of the parison mold and into a neck mold cooperating therewith and thereby to form a hollow ended parison substantially the full length of the parison mold and having a neck finish portion at the upper end thereof, balancing the pressure and dynamic effects of the blowing air admitted through the blowing nozzle and controlling the cooling of the surface glass bounding the depression being formed in the glass by adjustably controlling the exhausting of air from the depression being formed during at least a part of the time such air is being supplied through the blowing nozzle, retracting the blowing nozzle downwardly, supplying blowing pressure through the neck finish portion of the hollow ended blank thus formed to expand the glass to the shape of the parison mold and thereby to form a hollow parison conforming to the internal configuration of the parison mold, transferring the parison thus formed by its neck finish portion to a final blow mold, and blowing the parison to final form therein.

12. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold, a permanently upright parison mold, a bottom for said parison mold, means for transferring a blank molded in said blank mold to said parison mold without material deformation thereof in such manner that the blank, after the initial part of the transfer, will rest and be supported on said parison mold bottom while it is still laterally surrounded by said blank mold, means for removing said blank mold from about the blank subsequent to the initial part of the transfer as aforesaid, means for thereafter causing said parison mold to surround said blank and support it laterally in cooperation with said parison mold bottom, a neck ring cooperable with the upper end of said parison mold, means operating subsequent to the completion of the transfer as aforesaid for forcing glass upwardly in said parison mold and into said neck ring initially to form a neck finish portion of glass, means for expanding the glass into conformity with the shape of the internal cavity of said parison mold and thereby to form a completed parison, a final blow mold, means for transferring the parison from said parison mold to said final blow mold, and means for blowing the parison to final form in said final blow mold.

13. Apparatus for forming hollow glass articles,

comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring a blank molded in said blank mold to said parison mold in such manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, means for forcing the center portion only of the blank upwardly in said parison mold without substantially moving the lower peripheral portions of the glass with respect to said parison mold and thereby initially forming a hollow ended blank extending the full length of the parison mold and having a neck finish portion formed in said neck ring, means for thereafter expanding the hollow ended blank into conformity with the internal configuration of said parison mold and completing the formation of a hollow parison, a final blow mold, means for transferring the parison thus formed to said blow mold, and means for blowing the parison to final form in said blow mold.

14. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly tapering solid body portion, a permanently upright parison mold separate and distinct from said blank mold and having a lower portion recessed to receive the footed portion or peripheral flange of a blank formed in said blank mold and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and a blank transferred thereto from the bottom upwardly, means for transferring a blank from said blank mold to said parison mold while maintaining the same end of the blank uppermost, a neck ring cooperable with the upper end of said parison mold, means for forcing the center portion only of the glass upwardly in the parison mold to cause the glass to contact progressively with the side walls of said mold from bottom to top thereof and to fill said neck ring and thereby to form a neck finish portion thereon while leaving substantially undisturbed the peripheral portions of the glass in contact with the side walls of the parison mold cavity, means for thereafter expanding the hollow ended blank thus formed into conformity with the internal cavity of the parison mold and thereby forming a hollow parison, a final blow mold, means for transferring the completed parison to said final blow mold, and means for blowing the parison to final form in said final blow mold.

15. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring a blank from said blank mold to said parison mold in such manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, means for supplying a fluid under pressure through the lower end of said parison mold to force the center portion only of the glass upwardly therein and initially to form a neck finish portion of glass in said neck ring while maintaining the lower peripheral portion of the glass relatively stationary with respect to the walls of said parison mold and thus forming a hollow ended blank extending the full length of the parison mold, means for thereafter ex-

panding the hollow ended blank thus formed to conformity with the internal cavity of said parison mold to form a completed hollow parison, a final blow mold, means for transferring the parison thus formed to said final blow mold, and means for blowing the parison to final form in said final blow mold.

16. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring the blank molded in said blank mold to said parison mold in such manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, a pressure supplying nozzle movable substantially axially of said parison mold through the bottom thereof, means for moving said nozzle axially of the parison mold, means for supplying fluid pressure through said nozzle to force the center portion only of the glass upwardly in the parison mold and initially to form a neck finish portion of glass at the upper end thereof in said neck mold by the joint pressure and dynamic effect of the fluid pressure supplied through said nozzle and during the axial movement thereof inwardly of said parison mold and thereby forming a hollow ended blank substantially the full length of the parison mold, means for thereafter expanding the hollow ended blank into conformity with the internal configuration of said parison mold thus forming a completed hollow parison, a final blow mold, means for transferring the completed parison to said final blow mold, and means for blowing the parison to final form in said final blow mold.

17. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly tapering solid body portion, a permanently upright parison mold having a recess at its lower portion to accommodate the footed portion or peripheral flange of a blank and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and a blank transferred thereto, means for transferring a blank molded in said blank mold to said parison mold in a manner such as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, an air nozzle movable substantially axially through the bottom of said parison mold and arranged to direct air upwardly and outwardly from such nozzle, means for moving the nozzle in a direction axially of the parison mold and inwardly thereof during the supplying of air therethrough, means for supplying air through the nozzle during the inward movement of the nozzle into the parison mold to form a depression in the lower central portion of the glass while the peripheral portion is substantially anchored with respect to the parison mold by the recess thereof and the flange portion of the glass and thereby to force the glass upwardly in the parison mold and into said neck ring to form a neck finish portion thereon, means for thereafter supplying pressure through said neck ring to expand the glass into conformity with the internal configuration of said parison mold to complete the formation of a hollow parison, a final blow mold, means for transferring the parison as thus completed from said parison mold to said final

blow mold, and means to blow the parison to final form in said final blow mold.

18. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring a blank molded in said blank mold to said parison mold in such manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, an air nozzle movable substantially axially through the bottom portion of said parison mold and arranged to direct air upwardly and outwardly from the upper end thereof, means to move said air nozzle inwardly and outwardly with respect to said parison mold, means for supplying blowing pressure through said air nozzle during the inward movement thereof to force the center portion only of the glass upwardly in said parison mold and into said neck ring and thereby initially to form a neck finish portion at the upper end of the glass and complete the formation of a hollow ended blank, means for venting a predetermined portion of the air out of the lower end of the depression being formed in the lower central portion of the glass and thereby to control the balance between the pressure and dynamic effects of the blowing air serving to form such depression, means for thereafter supplying pressure through said neck ring to expand the hollow ended blank into conformity with the internal configuration of said parison mold and thereby to complete the formation of a hollow parison, a final blow mold, means for transferring the parison from said parison mold to said final blow mold, and means to blow the parison to final form in said final blow mold.

19. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring a blank molded in said blank mold to said parison mold in such manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, an air nozzle movable substantially axially through the bottom portion of said parison mold and constructed and arranged to direct air upwardly and outwardly from the upper end thereof, means to move said air nozzle in directions substantially axially of said parison mold, means for supplying air under pressure through said air nozzle during the inward movement thereof with respect to said parison mold to force the center portion only of the glass upwardly in said parison mold and into said neck ring and thereby to form a neck finish portion on the upper end of the glass and complete the formation of a hollow ended blank, means for venting the air from the lower end of the depression being formed in the lower central portion of the glass, means for adjustably controlling the exhausting of air through said venting means adjustably to control the balance between the pressure and dynamic effects of the blowing air on the glass and also to control the rate of cooling of the surface glass bounding the depression being formed, means for thereafter supplying pressure through said neck ring to expand the hollow ended blank into conformity with the internal configuration of said parison mold and thereby to complete the formation of a hollow parison, a final blow mold, means for transferring the pari-

son thus formed to said final blow mold, and means for blowing the parison to final form in said final blow mold.

20. Apparatus for forming hollow glass articles, comprising a permanently upright blank mold adapted to mold the side and bottom portions of a glass blank, a permanently upright parison mold separate and distinct from said blank mold, means for transferring a blank molded in said blank mold to said parison mold in such a manner as to maintain the same end of the blank uppermost, a neck ring cooperating with the upper end of said parison mold, an air nozzle movable substantially axially through the bottom portion of said parison mold and arranged to direct air upwardly and outwardly from the upper end thereof, means to move said air nozzle inwardly and outwardly with respect to said parison mold in a direction substantially axially thereof, means for supplying blowing pressure through said air nozzle during the inward movement thereof to force the center portion only of the glass upwardly in said parison mold and into said neck ring and thereby to form a neck finish portion on the upper end of the glass and complete the formation of a hollow ended blank, a groove formed in said air nozzle and arranged to communicate between the interior of the depression being formed in the glass in the lower central portion of the parison mold and the outer atmosphere after said air nozzle has been moved upwardly a predetermined amount, means for adjustably controlling the venting of air from the interior of the depression through said groove to control the balance between the pressure and dynamic effects of the blowing air serving to form such depression and also to control the rate of cooling of the surface glass bounding the depression being formed, means for thereafter expanding the hollow ended blank into conformity with the internal configuration of said parison mold and thereby to complete the formation of a hollow parison, a final blow mold, means for transferring the parison from said parison mold to said final blow mold, and means for blowing the parison to final form in said final blow mold.

21. Apparatus for forming hollow glass articles, comprising a rotary carrier, a permanently upright blank mold thereon adapted to mold the side and bottom portions of a glass blank, a second rotary carrier mounted for rotation about an axis laterally offset from the axis of the first rotary carrier, a permanently upright parison mold mounted on said second rotary carrier, means for transferring a blank molded in said blank mold to said parison mold in such a manner as to maintain the same end of the blank uppermost, a neck ring also mounted on said second rotary carrier and cooperable with the upper end of said parison mold, means for forcing the center portion only of the glass upwardly in said parison mold without substantially moving the lower peripheral portions of the glass with respect to said parison mold and thereby initially forming a hollow ended blank extending the full length of the parison mold and having a neck finish portion in said neck ring, means for thereafter expanding the hollow ended blank into conformity with the internal configuration of said parison mold to complete the formation of a hollow parison, a third rotary carrier laterally offset from the first and second named rotary

carriers, a final blow mold on said third rotary carrier, means for transferring a parison formed in said parison mold to said blow mold, and means for blowing the parison to final form in said blow mold.

22. Apparatus for forming hollow glass articles, comprising a rotary carrier, a permanently upright blank mold thereon having an internal configuration such as to form a blank with a lower footed portion or peripheral flange and an upwardly extending tapering solid body portion, a second rotary carrier laterally offset from the first named rotary carrier, a permanently upright parison mold therein having a lower portion recessed to receive the footed portion or peripheral flange of a blank formed in said blank mold and having substantially straight sides thereabove to provide a progressively greater lateral clearance between it and the blank transferred thereto from the bottom upwardly, means for transferring a blank from said blank mold to said parison mold while maintaining the same end of the blank uppermost, a neck ring also mounted on the second named carrier and cooperable with the upper end of said parison mold, means for forcing the center portion only of the blank upwardly in the parison mold to cause the glass to contact progressively with the side walls of the parison mold from bottom to top thereof and to fill said neck ring and thereby to form a neck finish portion thereon while leaving substantially undisturbed the peripheral portions of the glass in contact with the side walls of the parison mold cavity, means for thereafter expanding the hollow ended blank thus formed into conformity with the internal cavity of the parison mold and thereby to form a hollow parison, a third rotary carrier laterally offset from the first and second rotary carriers, a final blow mold on said third rotary carrier, means for transferring the completed parison to said final blow mold, and means for blowing the parison to final form in said final blow mold.

23. Apparatus for forming hollow glass articles, comprising a rotary carrier, means for rotating said carrier continuously, a blank mold on said carrier adapted to be supplied with charges of glass through its open upper end and formed to mold a blank having a lower footed portion or peripheral flange thereabout and an upwardly tapering solid body portion, a second rotary carrier laterally offset from the first named rotary carrier, means for rotating said secondary rotary carrier continuously, a parison mold on said second rotary carrier adapted to receive a blank formed in said blank mold and having an internal configuration for the reception of such blank including a recessed portion at its lower end for receiving the footed portion or peripheral flange of the blank and substantially straight sides thereabove to provide a progressively greater lateral clearance between the blank transferred thereto and the side walls of the parison mold, a neck ring mounted on said second rotary carrier and cooperable with the upper end of said parison mold, an air nozzle movable vertically through the bottom of said parison mold and arranged to discharge air upwardly and outwardly from the upper end thereof, means for venting an adjustable proportion of the air out of the lower end of said parison mold subject to the vertical movement of said air nozzle thereinto, means for supplying air through said air nozzle as it is moved upwardly into the parison mold and for thereby forming

ing a depression in the lower central portion of the glass by forcing such portion upwardly in the parison mold and into said neck ring and forming a neck finish portion thereon in a manner such that the glass will progressively contact with the side walls of said parison mold and with the neck mold from the bottom upwardly, means for thereafter supplying air under pressure through said neck ring to expand the glass into conformity with the internal cavity of said parison mold and thus to form a completed hollow parison, a third rotary carrier laterally offset from the first and second named rotary carriers, means to rotate said third carrier continuously, a final blow mold on said third rotary carrier, means for transferring a parison from said parison mold to said final blow mold, means for supplying blowing pressure to the inside of the parison in said final blow mold, to blow it to final form therein, and means subject to the rotation of said carriers for timing the operations of all the above named means.

24. Apparatus for forming hollow glass articles, comprising a blank mold having an internal configuration to mold the sides of a glass blank, a bottom for said blank mold for molding the bottom portion of a glass blank and serving as the sole support for such blank, a second mold adapted to receive a blank from said blank mold, a bottom for said second mold, means to open and close each of said molds, means including certain of the above recited means for transferring a blank molded in said blank mold to said second mold when their vertical axes are in registry, said transferring means being so constructed and arranged as to transfer the blank which was formed as aforesaid by removing said blank mold bottom to permit the blank to settle on and be solely supported by said second mold bottom, opening said blank mold and closing said second mold about the blank, and means to expand the blank thus transferred into conformity with the internal cavity of said second mold.

25. Apparatus for forming hollow glass articles, comprising a blank mold having an internal configuration to mold the sides of a glass blank, a bottom for said blank mold for molding the bottom portion of a glass blank, a parison mold adapted to receive a blank from said blank mold, a bottom for said parison mold, independent means for opening and closing each of said molds, means including the mold opening and closing means for transferring a blank molded in said blank mold to said parison mold when their vertical axes are in registry by removing said blank mold bottom to permit the blank to settle on the parison mold bottom, opening said blank mold and closing said parison mold about the blank, means operating subsequent to the completion of the transfer as aforesaid to expand the blank into conformity with the internal configuration of said parison mold and initially to form a neck finish portion at the upper end thereof, a final blow mold, means for transferring the parison thus formed from said parison mold to said final blow mold, and means for blowing the parison to final form in said final blow mold.

26. Apparatus for forming hollow glass articles, comprising a rotary blank mold carrier, a blank mold thereon having an internal configuration to mold the sides of a glass blank, a laterally movable bottom for said blank mold carried by said blank mold carrier, a rotary parison

mold carrier laterally offset from said blank mold carrier, a parison mold thereon, a bottom for said parison mold also carried by said parison mold carrier, a neck ring carried by said parison mold carrier and cooperable with said parison mold, means for moving the blank mold and parison mold carriers in synchronism to bring the blank and parison molds to a position such that their vertical axes are in registry, means effective while the vertical axes of the molds are in registry for transferring a blank from said blank mold to said parison mold including means for laterally moving the blank mold bottom from beneath the blank mold to permit the blank to settle upon the parison mold bottom, means for then opening the blank mold, means for closing the parison mold about the blank, means operating subsequent to the completion of the transfer as aforesaid for expanding the blank into conformity with the internal cavity of said parison mold and initially for forming a neck finish portion thereon, a rotary final blow mold carrier laterally offset from the first and second named carriers, a final blow mold thereon, means for transferring the finished parison by its neck from said parison mold to said final blow mold, and means for blowing the parison to final form in said final blow mold.

27. Apparatus for forming hollow glass articles, comprising three rotatable mold carriers arranged adjacent to each other for rotation about different vertical axes, means for rotating said carriers continuously, a blank mold on one of said carriers having an internal configuration such as to mold the sides of a glass blank, a bottom for said blank mold for molding the bottom portion of the glass blank, said blank mold and bottom being mounted on their carrier for movement with respect thereto about a vertical axis eccentric of the axis of rotation of said carrier, a parison mold on the second of said carriers adapted to receive a blank from said blank mold, a bottom for said parison mold, said parison mold and its bottom being mounted on their carrier for movement solely in a direction substantially radial thereof, independent means for opening and closing said blank mold and said parison mold, independent cam operated means for moving said blank mold and said parison mold with respect to their respective carriers in such a coordinated manner as to cause them to travel through a predetermined portion of their paths of travel with their vertical axes substantially in coincidence, means including said mold opening and closing means and the mold moving means for transferring a blank from said blank mold to said parison mold during the period that their vertical axes are in coincidence by removing the blank mold bottom to permit the blank to settle on the parison mold bottom and thereafter opening said blank mold and closing said parison mold about the blank, means to expand the blank thus transferred to said parison mold into conformity with the internal configuration of said parison mold and to form a neck finish portion at the upper end thereof, a final blow mold on the third of said carriers, means for opening and closing said final blow mold, means for transferring a parison formed in said parison mold to said final blow mold including the means for moving the parison mold with respect to its carrier, means for opening the parison mold and closing the final blow mold, and means for blowing the parison to final form in said final blow mold.

28. Apparatus for forming glass articles, comprising a rotary carrier, a plurality of article forming units thereon, each of which is arranged to be operated as to at least one operation by pneumatic pressure supplied thereto, an annular ring rotatable with said carrier, a pressure pipe from each of said units having a port opening through said annular ring, a stationary member as to which said annular ring is rotatable having a recess communicating successively and individually with each of the port openings in said annular ring and thus with each of said units, a second recess in said stationary member adjacent to but separated from the first named recess and adapted to register with said port openings, a pneumatic pressure supply line for the first named recess, a single valve controlling the flow of pneumatic pressure through said pneumatic pressure supply line, independently adjustable means for operating said valve for each of said units respectively, and means for continuously supplying pneumatic pressure to the second named recess, whereby pneumatic pressure may be supplied to each of said units for a total time greater than the time for said carrier to move a distance equal to the angular spacing between two adjacent units and one limit of the time of supplying such pressure may be independently and adjustably controlled for each of said units respectively.

29. Apparatus for forming glass articles, comprising a rotary carrier, a plurality of article forming units thereon, each of which is arranged to be operated as to at least one operation by pneumatic pressure supplied thereto, an annular ring rotatable with said carrier, a pressure pipe from each of said units having a port opening through said annular ring, a stationary member as to which said annular ring is rotatable having three adjacent recesses aligned with said port openings and separated by spaces substantially equal to the width of one of said port openings, means for continuously supplying pneumatic pressure to the middle one of said three recesses, a pneumatic pressure supply line communicating with each of the endmost recesses, a single valve in each of said pneumatic pressure supply lines, and independently adjustable valve operating means individual to each of said units for operating each of said valves, whereby pneumatic pressure may be supplied to each of said units for a total time greater than the time for said carrier to move the distance equal to the angular spacing between two adjacent units and both limits of the total time of supplying such pressure may be independently and adjustably controlled for each of said units respectively.

30. Apparatus for forming glass articles, comprising a rotary carrier, a plurality of article forming units thereon, each of which is arranged to be operated as to at least one operation by pneumatic pressure supplied thereto, a fluid pressure distributor concentric with said carrier for distributing pneumatic pressure to each of said units individually and successively, a pneumatic pressure supply line to said distributor, a single valve for said pneumatic pressure supply line, independently adjustable means individual to each of said units for operating said valve, and means for adjusting said distributor so constructed and arranged that each of said valve operating means may be individually adjusted for individually controlling the timing of the supplying of pneumatic pressure to the respective units and the timing of the supplying of pressure to

all of said units may be collectively adjusted by adjusting said distributor.

31. Apparatus for forming glass articles, comprising a rotary carrier, a plurality of article forming units thereon, each of which is arranged to be operated as to at least one operation by pneumatic pressure supplied thereto, an annular ring or collar rotatable with said carrier, a pressure pipe from each of said units having a port opening through said annular ring or collar, a stationary column as to which said annular ring or collar and said rotary carrier are rotatable and having two recesses in alignment with said port openings for supplying pressure fluid thereto, said recesses being separated by a distance substantially equal to one of said port openings, a pneumatic pressure supply line for one of said recesses, a single valve controlling the supply of pneumatic pressure through said pneumatic pressure supply line, individually adjustable means for operating said valve for each of said units respectively, means for continuously supplying pneumatic pressure to the other named recess, and means for angularly adjusting said annular ring or collar with respect to said carrier, whereby pneumatic pressure may be supplied to each of said units for a total time greater than the time for said carrier to move a distance equal to the angular spacing between two adjacent units, one limit of the time of supplying pneumatic pressure may be independently adjustably controlled for each of said units respectively, and the timing of the supplying of pressure to all of said units may be collectively adjusted by adjusting the angular position of said annular ring or collar with respect to said carrier.

32. Apparatus for forming hollow glass articles, comprising a rotary carrier, a blow mold mounted thereon for tilting movement with respect thereto in a direction substantially radial of said carrier, and cam means for controlling the position and tilting movements of said blow mold in a manner such as will tend to compensate for the action of centrifugal force exerted on a glass article being formed in said blow mold.

33. Apparatus for forming hollow glass articles, comprising a rotary carrier, a blow mold mounted thereon for tilting movement with respect thereto in a direction substantially radial of said carrier, cam means for controlling the position and tilting movements of said blow mold in a manner such as will tend to compensate for the action of centrifugal force exerted on a glass article being formed in said blow mold, and means for adjustably controlling the limit of the tilting movement of said blow mold away from a vertical axis position.

34. Apparatus for forming hollow glass articles, comprising a rotary carrier, a blow mold mounted thereon for tilting movement with respect thereto in a direction substantially radial of said carrier, a toggle linkage connecting said blow mold and said carrier and so constructed and arranged that when the toggle linkage is in a straightened position, the longitudinal axis of the blow mold is substantially vertical, and cam means for moving said toggle linkage to an angular position to tilt the longitudinal axis of said blow mold with respect to the vertical in a direction and in an amount calculated to compensate for the action of centrifugal force incident to the rotation of said carrier and effective on a glass article being formed in said blow mold.

35. Apparatus for forming hollow glass articles, comprising a rotary carrier, a blow mold mounted

thereon for tilting movement with respect thereto about a substantially horizontal axis arranged tangentially of said carrier, a toggle linkage connecting said blow mold and said carrier and so constructed and arranged that when the toggle linkage is in a straightened position, the longitudinal axis of the blow mold is substantially vertical, a stationary cam, means including a follower movable by said cam for moving said toggle linkage to an angular position to tilt the longitudinal axis of said blow mold with respect to the vertical in a direction and amount calculated to compensate for the action of centrifugal force incident to the rotation of said carrier and effective on a glass article being formed in said blow mold, and means for adjusting the last named means adjustably to control the limit of tilting movement of the longitudinal axis of said blow mold with respect to the vertical for a predetermined varia-

tion in the effective contour of said cam without affecting the movement of the blow mold to the vertical axis position it occupies when said toggle linkage is straightened.

36. In the manufacture of hollow glass articles, that method of transferring a neckless blank from a preliminary mold in which it was formed to a secondary mold in which it is to be expanded to a desired hollow form, which comprises the steps of withdrawing the bottom of the preliminary mold from beneath the glass during a time that the bottom of the secondary mold is in substantially vertical alignment below the glass and thus allowing the glass to settle onto the secondary mold bottom, opening the preliminary mold, and closing the secondary mold to enclose the glass while it is supported on the bottom of the secondary mold.

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