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INJECTION STRETCH BLOW MOLDING MACHINE

Field of the Invention

5 This invention relates to an injection stretch blow molding machine, and more particularly to a two-station machine wherein the second station is capable of stretching and blowing the parison into a hollow-molded product, and then ejecting the hollow-molded product from the machine.

10 Background of the Invention

 It is known to have blow molding machines wherein a plastic resin is converted into a hollow-molded product. A parison is formed at a first station. The parison is moved to a second station where the finished product is formed. The finished product is then moved to a third station where it is
 15 ejected from the machine. Sometimes, additional intermediate stations are employed, and machines having four stations are not uncommon. A transfer plate or disk rotates in relation to the stations to move the parison through the stations to form the finished product and then eject it from the machine. The rotating transfer plate or disk has molds to hold a portion of the parison, usually
 20 the upper or neck portion, as it moves the parison from station to station.

 It is also known to form multiple products at the same station at the same time. The mold cavities in the blow mold section typically are in two rows, where the first row is radially inward of the second row. The mold has a pair of mold halves defining the cavity which open and close radially. Thus,

the mold halves in the closed position must be sufficiently spaced from the center of the disk to allow the mold half to move radially inward upon opening.

It would be desirable to have an injection stretch blow molding machine requiring fewer than three stations in order to minimize machine size
5 and time spent transferring the parison from station to station.

Summary of the Invention

This invention provides a machine for forming hollow molded objects by injection stretch blow molding. The machine has a preform station
10 for forming a parison and a blow mold station for stretching and inflating the parison into the hollow molded object and then ejecting the hollow-molded product from the machine. The preform station and the blow mold station are disposed at diametrically opposite locations on a circumference of a circle. A transfer portion has a transfer head rotatable about an axis extending through the
15 center of the circle and having a pair of identical transfer stations located at diametrically opposite locations with respect to the axis. An indexer rotates the transfer head between two aligned positions in which one of the transfer stations is in registry with the preform station and the other transfer station is in registry with the blow mold station. Each transfer station has at least one parison
20 engaging and retaining neck mold for engaging the parison formed at the preform station and retaining the parison for transfer from the preform station to the blow mold station upon rotation of the transfer portion from one to another of the two positions.

In the preferred embodiment of the present invention, the transfer
25 portion includes a generally horizontal transfer head and a transfer shaft extending vertically through the transfer head defining a vertical axis. The transfer shaft has an indexing gear at a lower end for coupling with the indexer and a lifting hub located in proximity to an upper end. The identical transfer stations are located 180° from each other on the transfer head about the vertical
30 axis and spaced equal distances radially from the vertical axis. Each station of

the transfer head has six neck molds located in two rows of three. Each neck mold has two halves which move between an open position and a closed position.

The preform station has a preform mold below the transfer head and a preform moving platen movable between a raised position and a lowered position. The preform mold has a plurality of resin injection openings which are aligned with each of the neck molds when one of the stations of the transfer head is aligned with the preform station. The preform moving platen has a preform core pin depending downward to extend between the neck halves of the neck mold in the closed position and into the injection opening when the transfer head and the preform moving platen are in the lowered position for forming the parison retained by the neck mold.

The blow mold station has a stretch blow mold below the transfer head and a blow mold moving platen movable between a raised position and a lowered position. The stretch blow mold has a pair of mold halves defining a plurality of mold cavities aligned with each of the neck molds for receiving the parison. The mold halves move between a closed position engaging each other for stretching and blowing the parison into the hollow-molded product and an open position for ejecting the hollow-molded product. The blow mold moving platen has a blow core pin depending downward between the neck mold halves to seal the parison in the neck mold. Each blow core pin has a stretch rod extending through a bore and movably mounted to the blow mold moving platen for movement between a retracted position, an extended position for stretching the parison and an ejection position for ejecting the hollow-molded product, whereby the stretch rod stretches the parison, the blow core pin inflates the parison into the hollow-molded product and then the hollow-molded product is ejected from the machine by the stretch rod.

The stretch blow mold has a bottom plug pivotable between a closed position interposed between the mold halves and an open position spaced from the mold halves to facilitate ejection of the hollow-molded product.

The transfer head moves between the raised position and the lowered position with the blow mold moving platen. A pair of links, each mounted at a first end to the blow mold moving platen and at a second end are selectively rigidly positioned relative to the frame in proximity to the preform moving platen. A cam roller rotatably mounted on the link is generally located intermediate the ends and slideably received by the lifting hub on the transfer shaft. Movement of the blow mold moving platen moves the links and thereby the transfer head.

10 **Brief Description of the Drawings**

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangement and instrumentality shown.

15 Figure 1 is a side elevation of a machine in accordance with the present invention with the front frame broken away at the top. The alignment cylinder and links are shown in phantom in the lowered operating position;

Figure 2 shows a top view of the transfer head for the apparatus as taken along line 2-2 in Figure 1;

20 Figure 3 is a top view of the preform station and the blow mold station as taken along line 3-3 in Figure 1;

Figure 4 is a section of the top portion of the machine in a lowered operating position;

25 Figures 5 and 5A, respectively, show cross-sectional views of the blow core pin as taken along lines 5-5 and 5A-5A, respectively, in Figure 4;

Figure 5B shows a cross-sectional view of the preform core pin as taken along line 5B-5B in Figure 5;

Figure 6 is an enlarged section view of the preform and blow mold stations in the lowered operating position;

Figure 7 is a cross-sectional view of the preform station of the apparatus as taken along line 7-7 in Figure 4;

Figure 8 shows a cross-sectional view of the guiding mechanism as taken along line 8-8 in Figure 7;

5 Figure 9 is a view similar to Figure 6 with the parison in the blow mold station blown to a hollow-molded product;

Figure 10 is a cross-sectional view of the blow mold station for the apparatus as taken along line 10-10 in Figure 4;

10 Figure 11 is an enlarged cross-sectional view of ejecting the hollow-molded product from one of the blow molds in the blow mold station;

Figure 12 is a view similar to Figure 9 with the stretch rods of the blow mold station in an ejection position and the preform station moving towards the raised position;

15 Figure 13 is a cross-sectional view of an alternative embodiment of the blow core pin;

Figure 14 is a side elevation of an alternative embodiment of the transfer drive mechanism;

Figure 15 is a section of the top portion of the machine showing an alternative embodiment of the stretch rod mechanism;

20 Figure 16 is a top view of the preform station and the blow mold station of an alternative embodiment as taken along line 16-16 in Figure 14;

Figure 17 is a top view of the transfer head for an alternative embodiment as taken along line 17-17 in Figure 14;

25 Figure 18 is a cross-sectional view of the blow mold station for an alternative embodiment as taken along line 18-18 in Figure 15; and

Figure 19 is an enlarged section view of ejecting the hollow-molded product from one of the blow molds in the blow mold station.

Description of the Invention

Referring to the drawings, where like elements are identified by like numerals, there is shown in Figure 1, a preferred embodiment of an injection stretch blow molding machine according to the invention designated
5 by the numeral 26. For clarity, some elements are not shown in all figures. The machine 26 includes a frame 28, a preform station 30, a blow mold station 32, and a transfer portion 34.

The preform station 30 has a preform mold 36 mounted on a lower preform platen 38 connected to an injection device, not shown, by a
10 primary nozzle 40 and a manifold 42. A plastic resin is melted in the injection device and extruded and forced towards the preform mold 36.

The preform station 30 has a preform moving platen 46 which is movable between a raised position and a lowered operating position (the lowered operating position is shown in Figure 4) wherein the movement is controlled by
15 a pair of preform cylinders 48 secured to the frame 28. The preform moving platen 46 has six preform core pins 50 depending downward into the preform mold 36 when in the lowered operating position to form parisons 57, shown at blow mold station 32 for clarity.

The blow mold station 32 has a stretch blow mold 54 mounted
20 to a blow bottom platen 56 for receiving parisons 57 formed at the preform station 30. A blow mold moving platen 58 of the blow mold station 32 is movable between a raised position and a lowered operating position (the lowered operating position is shown in Figure 4) wherein the movement is controlled by a blow mold cylinder 60. The blow mold moving platen 58 has six blow core
25 pins 62 depending downward in an arrangement similar to that of the preform core pins 50 of the preform station 30 for inflating the parisons 57. Each blow core pin 62 has a stretch rod 64 whose upper end 66 is attached to a stretch rod plate 68. The stretch rods 64 move between a raised position (as shown in Figure 1) and an ejection position (as shown in Figures 11 and 12) for ejecting
30 the hollow-molded product 194 and through an extended position (as shown in

Figure 6) for stretching the parisons 57 prior to or concurrent with inflating the parisons 57. The stretch rods 64 are moved by a pair of stretch rod cylinders 70 mounted to the upper portion of the blow mold moving platen 58 and extending to the stretch rod plate 68. The cylinders 70 extend, pushing the stretch rod plate 68 downward, to extend the stretch rods 64 to the extended position.

Referring back again to Figure 1, the transfer portion 34 has a generally horizontal transfer head 74 and a transfer shaft 76 extending vertically through the transfer head 74, thereby defining a vertical axis 78 along the axis of the shaft 76. The transfer head 74 has a pair of transfer stations 108 and 110 each containing six neck molds 112 (i.e., the same number and in the same arrangement as the preform core pins 50 and the blow core pins 62). The stations 108 and 110 are equally spaced on the circumference of a circle and at diametrically opposite locations with respect to the transfer shaft axis 78.

The transfer portion 34 will be further discussed with reference to Figure 1 which shows a side view, Figure 2 which shows a top view and Figures 4, 6 and 7 which show different sectional views. The transfer shaft 76 has a lifting hub 80 located in proximity to an upper end 84 and an external spline portion 86 at the lower end 88. The external spline portion 86 is received in an internal spline hub 90 of an index or output shaft 92. The index or output shaft 92 is connected to an indexer or motor 94 which rotates the transfer stations 108 and 110 in 180° increments about the vertical axis 78 to two index positions.

A pair of links 98, running parallel to each other, extend between the blow mold moving platen 58 and an alignment cylinder 100. A cam roller 102 is located on each of the links 98 generally intermediate the two ends 104 and 106 and interposed in the lifting hub 80 of the transfer shaft 76. Movement of the blow mold moving platen 58 moves the first end 104 of the links 98, resulting in the cam roller 102 moving the transfer shaft 76 and the transfer head 74 approximately half the travel of that of the moving platen 58 between a raised

transfer position and a lowered operating position (the lowered operating position is shown in Figure 4). The cam roller 102 retains the transfer head 74 in the proper vertical position, while being capable of riding in the lifting hub 80 to allow the transfer head 74 to be rotated by the indexer 94. The spline portion 86 - internal spline hub 90 interface and a collar 107 on a locating head 109 (Figure 4) maintain the shaft 76 vertically.

The transfer head 74 is capable of moving to the lowered position without concomitant movement of the blow mold moving platen 58 for alignment of the preform mold 36 and stretch blow mold 54 with the neck molds 112. The alignment cylinder 100, which normally acts as a fixed linkage, is stroked by exhausting the cylinder 100, lowering the transfer head 74 to check the alignment of the neck molds 112, as shown in phantom in Figure 1.

Referring to Figure 2, the transfer stations 108 and 110 on the transfer head 74 are identical and register with the preform station 30 and the blow mold station 32 when rotated by the indexer motor 94 to the proper aligned position. Each station has six neck molds 112 in two sets of three 114a and 114b. The sets of three are parallel to a radial line from the transfer shaft 76. It is recognized that the stations could have a different number of molds and/or be in a different arrangement. Each neck mold 112 has an outer mold half 116 and an inner mold half 118. The inner mold halves 118 of set 114a are attached to a neck mold holder 120. The outer mold halves 116 of the set 114b are attached to a neck mold holder 122. The mold halves 116 and 118 are each mounted to the neck mold holder 120 or 122, respectively, by a pair of shoulder bolts which allows some movement of the mold halves 116 and 118 relative to the holder to compensate for tolerances which will be discussed below. The neck mold holders 120 and 122 are rigidly connected to each other through a set of neck carriers 124. The outer mold halves 116 of set 114a and the inner mold halves 118 of set 114b are likewise mounted on neck mold holders and connected to each other by a set of neck carriers 126. The neck carriers 124 and 126 are guided by a pair of guide rods 128 therein allowing the outer mold

half 116 and the inner mold half 118 to move between a closed engaging position and an open release position (the open release position is shown in Figure 11). The guide rods 128 are secured to the transfer head 74. A pair of neck mold cylinders 132, mounted on the transfer head 74 and connected to the inner neck mold holders 120, are used to pull the inner mold halves inward. The outer mold halves which are connected by the neck carrier to the inner mold halves of the other set therein is pushed out by the pulling the inner mold halves inward therein resulting in the neck molds opening. A compressed air transfer port 172 (as shown in Figure 3) projects upward from the stretch blow mold 54 to engage a manifold block 174 (as best seen in Figure 2) to provide the compressed air for the neck mold cylinders 132. Compressed air is sent to the manifold only when the neck molds need to be open. The neck mold cylinders 132 vent the compressed air to atmosphere upon compressed air no longer being sent to the cylinders 132. A set of compression springs, not shown, located in the neck mold cylinders 132 bias the neck molds to the closed engaging position.

The preform station 30 will now be fully discussed where Figure 3 shows a top view of the preform mold 36, and Figures 4 and 7 show different sectional views. The preform mold 36 has six injection openings 136 each connected to the manifold 42 by a nozzle 138. The six injection openings 136 align with the neck molds 112 of one of the stations 108 or 110 of the transfer head 74. A preform mold insert 140 defines each of the injection openings 136 and secured to by a mounting plate 144.

A preform nozzle 176 extends upward from the manifold 42 to the preform mold insert 140 and the upper portion of the preform nozzle 176 forms part of nozzle 138. The preform nozzle 176 is heated, similarly to the manifold 42. The preform mold insert 140, on the other hand, is cooled by a water jacket 178, which receives water through line 180. An outer sleeve 142 may be installed to surround the preform mold insert 140 if the insert 140 is designed for a machine with a different preform mold 36 and therefore the adapter outer sleeve 142 is required.

The preform core pin 50 extends through the neck mold 112 and is received in the injection opening 136 therein defining a parison cavity 182. The preform core pin 50 has a hollow bore 203 which receives a bubbler tube 204 (as seen in Figure 5B) wherein coolant, water, flows down the bubbler tube 204 and up around the tube 204 to cool the preform core pin 50. The preform moving platen 46 has a coolant manifold 201 with a coolant "in" duct 205 and a coolant "out" duct 207 (as seen in Figures 5B and 7) for transferring coolant to and from the preform core pins 50. Referring to Figure 6, molded plastic resin is injected through the primary nozzle 40, the manifold 42 and the preform nozzle 176 into the cooled preform mold insert 140. The difference in temperature results in the plastic resin being conditioned to a more rigid state on the preform core pin 50 and being retained by an annular pitched groove 186 on the neck mold 112 (as best seen in Figure 11) to retain the parison 57 to the neck mold 112.

The blow mold station 32 will now be fully discussed where Figure 3 shows a top view of the stretch blow mold 54, Figure 4 shows a cross sectional view of the station 32, Figures 5 and 5A show cross sections of the blow core pin 62, Figure 6 shows the molding at a point just after stretching and before inflation, Figure 9 shows the molding at a point after stretching and inflation, and Figure 11 shows the ejection of finished product.

Referring generally to Figure 3, the stretch blow mold 54 has six mold cavities 146 in two sets of three 146a and 146b aligned with the neck molds 112 of the other station 108 or 110 of the transfer head 74. Each of the sets 146a and 146b of the mold cavities 146 is defined by a pair of mold halves 148 and 150 mounted on die shoes 152 and 154. The die shoes 152 and 154 are slideably mounted on a pair of leader pins 156 located in a pair of stop plates 158. The movement of the mold halves 148 and 150 and die shoes 152 and 154 are limited by the stop plates 158. The stop plates 158 have a plurality of stops 160 (Figure 10) which engage the die shoes 152 and 154 to limit the movement of the mold halves 148 and 150 in both a closed position and an open position

(Figure 11). A plurality of outer blow mold open and close cylinders 162 are mounted to the stretch blow mold 54 and each has a rod 164 extending to the die shoe 152. Although four cylinders are shown, that number is not critical. The outer blow mold open and close cylinders 162 move the mold halves 148
5 between the open and closed position. Stops 160 ensure that the mold halves are in the proper closed or open positions. A pair of inner blow mold open and closed cylinders 166 are located between the die shoes 154 and each has a pair of rods 168 extending to both die shoes 154. The inner blow mold cylinders 166 move both mold halves 150 inward towards the open position and outward
10 towards the closed position. The die shoes 154 are stopped in the proper position by stops 160 located on the stop plates 158.

A tapered alignment pin 170 projects upward from the stretch blow mold 54 to be received by an alignment slot with bushing, not shown, in the transfer head 74 to assure alignment of a selected one of the stations of the
15 transfer head 74 with the blow mold station 32 and concurrently the other station with the preform station 30.

Referring to Figure 4, the blow core pin 62 of the blow mold moving platen 58 extends into the neck mold 112 when in the lowered position and has a stuffer portion 184 for holding the parison 57 (previously formed at
20 preform station 30) against the neck mold 112. A bottom plug 196 of the stretch blow mold 54, in addition to the mold halves 148 and 150, further defines the mold cavity 146 and shaped to define shape of bottom of hollow-molded product 194. An annular ring 198 of the bottom plug 196 is received by an annular slot 200 of the mold halves 148 and 150 (refer to Figure 11 to see the slot 200
25 without the ring 196) to ensure that the bottom plug 196 is properly located and to prevent movement of the bottom plug 196 when the mold cavities 146 are filled with compressed air as described below. A pair of bottom plug operating cylinders 202 (only one is visible in Figure 4), moves the bottom plugs 196 between a closed position and an open ejection position (as shown in Figure 11).
30 The bottom plug 196 is pivotally mounted by a rod 228 and connected to the

bottom plug operating cylinder 202 by a link 230 for movement between the closed position (Figure 10) and the open ejection position (Figure 11). Alternative methods of rotating the bottom plug 196 are recognized, such as a rotary actuator to rotate rod 228.

5 The blow mold platen 56 and the stretch blow mold 54 each have a slot or opening 206 directly below the bottom plugs 196 for passage of the hollow-molded product 194 upon ejection from the blow mold.

10 The stretch rods 64 are shown in a partially extended position in Figure 4, in which stretch rods 64 just touch the parisons 57. The stretch rods 64 extend through a compressed air manifold 208 in the blow mold moving platen 58. Seals 209, lip seals preferably, (Figure 6) seal the compressed air manifold 208 where the stretch rods 64 pass through the walls. The compressed air manifold 208 is connected to a duct 211 (as best seen in Figure 5A) which is connected to a series of ducts 210 around the bore for the stretch rod 64, 15 which extend to the stuffer portion 184 of the blow core pins 62 (Figure 5B as seen in Figure 4) to provide air to inflate the parison 57, as described below. A compressed air line 212 provides the compressed air for the compressed air manifold 208.

20 The stretch rods 64 are shown in Figure 6 in the extended position stretching the parison 57 to engage the bottom plug 196. The stretch rods 64 are moved by the pair of stretch rod cylinders 70 secured to the blow mold moving platen 58, pushing the stretch rod plate 68 and stretch rods 64. The stretch rod cylinders 70 are equipped with a relief function so that after the stretching of the parisons 57 but prior to ejecting the hollow-molded product 25 194, the force exerted on the stretch rods 64 may be relieved therein relieving the force on the hollow-molded product 194.

30 Referring to Figure 9, compressed air enters through the compressed air pipe 212 to the compressed air manifold 208 and down the ducts 211 and 210 (Figures 5A and 5) to inflate the parison 57 to the shape of the mold cavity 146 (i.e. the hollow-molded product or bottle 194 having the

finished threads 190 on the neck 192). The stuffer portion 184 of the blow core pin 62 seals the parison 57 to allow the inflating operation.

The mold halves 148 and 150 separate (Figure 11), allowing the bottom plug 196 to rotate down to the open ejection position. The neck mold 112 then is opened and the stretch rod 64 is moved to the ejection position to ensure that the hollow-molded product 194 disengages the blow core pin 62 and does not get hung up on the neck mold 112. The hollow-molded product 194 drops from the mold cavity 146 and through the slot 206 in the blow mold platen 56 and the stretch blow mold 54. Figure 12 shows a similar view with the stretch rod 64 in the extended position pushing the hollow-molded product 194 out of the mold cavity 164. The neck mold cylinder 132 has pulled the neck mold holders 120 apart therein allowing the hollow-molded product 194 to drop.

In addition to the components discussed, the injection stretch blow molding machine 26 has additional elements to ensure alignment of components. Referring to Figures 7 and 8, a rail 216 extending vertically on the frame 28 receives a rectangular rail 219 in a grooved guide track 218. A bracket 220 mounted to the preform moving platen 46 carries a "U" shaped runner 222. The "U" shaped runner 222 is resiliently mounted on bracket 220 via a pair of flexible ring devices 226 allowing slight flexure.

Rail 219 is mounted via a ball slide in runner 222 to guide the preform moving platen 46 as it moves down to the lowered operating position to make sure it remains in alignment with the neck molds 112 and the preform mold 36. The flexible ring devices 226 have some compliance so that any misalignment and binding due to run-out is compensated for by the flexible ring devices 226. The flexible ring devices 226 can compress and/or expand as necessary to account for misalignment or run-out problems.

Referring to Figure 10, the blow mold moving platen 58 similarly has bracket 220 with a resiliently mounted "U" shaped runner 222 and a guide rail 219 mounted via a ball slide to guide the movement of the blow mold moving platen 58 in runner 222 between the raised and lowered position.

Referring to Figures 1, 3 and 4, the locating head 109 is a rectangular thick block located on the frame by a pair of dowels 243 and secured by four bolts 245. The locating head 109 has a pair of center keys 244. The center keys 244 each are received by machined grooves 246 in the base of preform mold 36 and the stretch blow mold 54, respectively. In addition, the locating head 109 has two pair of precision ground die stops 248 to engage the bases and precisely radially position the preform mold 36 and the stretch blow mold 54. The center keys 244 and the die stops for the stretch blow mold 54 are located higher vertically than those for the preform mold 36 because of different vertical positions of the base.

In addition, the neck molds 112 are tapered and have a slight amount of free play, the result of being mounted by the shoulder bolts, such that upon the transfer head 74 being lowered to the lowered operating position, the neck molds 112 seat properly in the mounting plates 144 and preform mold inserts 140 of the preform mold 36 and the mold halves 148 and 150 of the stretch blow mold 54.

Description of the Operation

The injection stretch blow molding machine 26 is a continuous cycle machine. The operation of the machine is best understood by starting the discussion at the point in the cycle where both the preform moving platen 74 and the blow moving platen 58 are in the raised position and the transfer portion 20 is in the raised transfer position. At this point of the cycle, both the preform molds and the blow molds are empty. Plastic resin is heated and extruded into the injecting device. The preform moving platen 46 and the blow mold moving platen 58 are moved from the raised position of Figure 1 to the lowered operating position of Figure 4 wherein the transfer portion 34 is moved to the lowered operating position by the links 98 and the cam rollers 102 following the blow mold moving platen 58.

Upon the transfer head being lowered, the alignment slot with bushing (not shown) located in the transfer head above the stretch blow mold

54 receives the alignment pin 170 (Figure 10), moving the transfer head to adjust for any slight misalignment occurring upon the indexer 94 rotating the transfer head 74.

Referring to Figures 6 and 7, the molten plastic resin is injected
5 through the primary nozzle 40, the manifold 42 and the preform nozzle 176 into the cooled preform mold insert 140 and into the injection openings 136. The difference in temperature results in the plastic resin being conditioned to a more rigid state on the preform core pin 50 and being retained by the grooves 186 in the neck mold 112 therein forming the parison 57.

10 After the parison 57 has been formed in the parison cavity 182, the preform cylinders 48 and the blow mold cylinder 60 move the preform moving platen 46 and the blow mold moving platen 58 upward resulting in the transfer head 74 being lifted by the links 98 approximately half the distance as the blow mold moving platen 58. The parisons 57 are held by the groove 186
15 in each of the neck molds 112 with the neck mold halves 116 and 118 being held together by the compression springs located in the neck mold cylinders 132 (Figure 2). Since the transfer head 74 and the neck molds 112 are only moving approximately half the travel of the preform moving platen 46, the preform core pins 50 are raised high enough to clear the transfer head 74, the neck molds 112
20 and parisons 57.

When the moving platens 46 and 58 reach the raised position and the transfer head 74 reaches the raised transfer position, the internal spline hub 90 of the indexer 94 drives the spline 86 of the transfer shaft 76, rotating the transfer head 74 180° about the vertical axis 78 so that the first station 108,
25 which was located at the preform station 30, is now located at the blow mold station 54 and the second station 110, which was located at the blow mold station 54, is now located at the preform station 30, as seen in Figure 1. The parisons 57 formed at the preform station 30 are now located at the blow mold station 32 and the neck molds 112 at the preform station 30 are empty.

Referring to Figure 4, the preform cylinders 48 and the blow mold cylinder 60 lower the moving platens 46 and 58 to the lowered position with the transfer head 74 being moved by the links 98 at the same time to the lowered operating position. Simultaneously with plastic resin being injected into the injection opening 136 (Figures 6 and 7) as described above, the parisons 57 formed in the previous cycle in the preform station 30, which are now located in the mold cavities 146 of the blow mold station 32, are being axially stretched by the stretch rods 64 (Figures 4 and 6). Referring to Figures 6, 9 and 10, a stuffer 184 of the blow core pin 62 seals the top of the parison 57 against the neck mold 112. Compressed air is sent through the compressed air manifold 208 and down the ducts 211 and 210 (Figures 5A and 5) to inflate the parisons 57 into the shape of the mold cavity 146 forming the hollow-molded product or bottle 194. While operation of the machine has been described with the stretching operation occurring prior to the blowing operation, the stretching and blowing operations can occur simultaneously. The force on the stretch rods 64 is reduced after stretching the parison 57 by the relief function of the stretch rod cylinder 70 so that the stretch rods 64 do not stress the bottom plugs 198 or puncture the hollow-molded product 194 when the stretch blow mold 54 is opening.

Referring to Figures 11 and 12, after the parisons 57 are formed at the preform station 30 and as the preform moving platen 46 is moving upward, the mold halves 148 and 150 of the stretch blow mold 54 are moved apart by the blow mold open and close cylinders 162 and 166 (Figure 3). Prior to the mold halves 148 and 150 opening and after a short curing period, the pressure in the air manifold 208, ducts 211 and 210 and within the hollow-molded product 194 is reduced to atmospheric pressure by venting. The mold halves 148 and 150 move until the die shoes 152 and 154 each engage the stops 160 of the stop plates 158. After the mold halves 148 and 150 have moved to the open position, the bottom plug operating cylinder 202 rotates the linkage 230 moving the bottom plug 196 down and away from the mold cavity 146.

At the same time the transfer head 74 was moved to the lowered operating position, the manifold 174 on the station of the transfer head 74 (Figure 2) in alignment with the stretch blow mold 54 was lowered onto and in engagement with compressed air transfer 172 (Figure 2). After the product 194 is formed by stretching and inflating, the short curing period, the venting of pressure and the opening of the blow molds, compressed air is sent through the compressed air transfer 172 to the manifold 174 and into the neck mold cylinders 132 urging the inner mold halves inward against the bias of the springs, therein moving the neck molds to the open release position.

The stretch rod cylinders 70 push the stretch rod plate 68 beyond the extended position to the ejection position resulting in the stretch rods 64 pushing the hollow-molded product or bottle 194 off of the tip of the blow core pin 62. Gravity causes the hollow-molded products or bottles 194 to fall through the slots 206 in the base of the stretch blow mold 54 and blow bottom platen 56 to a conveying means (not shown) which conveys finished products to further operation.

As soon as the stretch rods 64 have pushed the hollow-molded products 194 free, the stretch rod cylinders 70 move the stretch rods 64 and the stretch rod plate 68 upward to the retracted position. The neck mold cylinders 132 vent to atmosphere, the neck mold cylinders 132 are exhausted by the bias force of the compression springs (not shown) moving the neck molds halves 54 and 56 to the closed engaging position. The bottom plug operating cylinder 202 rotates the bottom plug 196 upward to the closed position. The blow mold open and closed cylinders 162 and 166 move the mold halves 148 and 150 towards the closed position. As indicated above, the mold halves 148 and 150 stop moving when the die shoes 152 and 154 contact the stops 160 of the stop plates 158. It is not necessary for both mold halves 148 and 150 to reach the center location at the same time, since the stop plates 158 ensure that the mold halves 148 and 150 will stop at the correct location.

Simultaneous with the stretch rods 64 and the bottom plugs 196 moving, the blow mold moving platen 58 is moved to the raised position by the blow mold cylinder 60. As blow mold moving platen 58 is raised, the manifold 174 located in the transfer head 74 (Figure 2) separates from the compressed air transfer 172. However prior to this separation, the neck mold cylinders 132 have vented to atmosphere and the compression springs (not shown) have moved the neck molds halves 54 and 56 to the closed engaging position. With the blow mold moving platen 58 and the preform moving platen 46 in the raised position and the transfer head 74 moved by the links 98 to the raised transfer position, the indexer 94 is ready to rotate the transfer head 74 180° about the vertical axis 78 so that the parisons 57 formed at the preform station 30 are moved to the blow mold station 32 and the now empty neck molds 112 are moved from the blow mold station 32 to the preform station 30. The transfer head 74, the preform moving platen 46 and the blow mold moving platen 58 are lowered again to continue the process.

Pre-operation alignment

Prior to operation, the machine 26 may require adjustment to ensure alignment and to ensure that the proper amount of plastic resin is received in each of the injection openings 136 at preform station 30. The amount of plastic resin received in the injection opening 136 is varied using different preform mold inserts 140 and preform nozzles 176. An unique feature of the invention is that both are removable and replaceable through the top of the preform mold 36 through the removable mounting plates 144. In addition, the transfer head 74 can be lowered to the lowered operating position to check alignment without lowering the blow mold moving platen 58, by lowering the alignment cylinder 100 as shown in phantom in Figure 1.

Alternative Embodiments

Figure 13 shows an alternative embodiment of the blow core pin 62'. The stuffer portion 184' is a slidable piece relative to the rest of the core pin 62' and located in the blow core pin 62'. Upon the hollow-molded product

194 being formed, the stuffer portion 184' moves upward out of the neck 192 of the product 194. This action is achieved by compressed air being forced on a lower side 234 of an upper plate 236 of the stuffer portion 184', while air is exhausted from an upper portion 238. The stuffer portion 184' is typically held
5 in the extended position by compressed air above the upper plate 236. A sleeve 240 is slideably received by a chamber 242 in the stuffer portion 184' to allow air to pass through the ducts 210 (Figure 5) therein the air to inflate the parison 57 into the hollow-molded product 194 does not mix and interfere with the compressed air to move the stuffer portion.

10 Referring to Figure 14, an alternate embodiment to rotate the transfer portion 34' is shown. The transfer shaft 76' has a drive gear 250 at the lower end. A drive gear 252 connected to an indexer or drive means 254 constantly engages the drive gear 250 of the transfer portion 34' allowing the indexer 254 to rotate the transfer head 74 to the pair of aligned positions located
15 180° from each other about the vertical axis 78'. A collar 256 located on the blow bottom platen 56' maintains the shaft 76' vertically.

The pair of links 98' can extend from the blow mold moving platen 58' to a block 258 secured to the frame 28' instead of the alignment cylinder 100 shown in Figure 1. To move the transfer head 74' without moving
20 the blow mold moving platen 58' would require the disconnection of the links 98' from the block 258.

The transfer head 74' moves in a manner similar to that of the first embodiment, with the cam rollers 102' interposed in a lifting hub 80' of the transfer shaft 76'. Movement of the blow mold moving platen 58' would
25 move the transfer head 74'. The drive gear 250 would move axially relative to the drive gear 252, but it would maintain constant engagement.

Referring to Figure 15, an alternative method of moving the stretch rods 64' is shown. Similar to Figure 1, a stretch rod cylinder 260 extends between a stretch rod plate 262 and the blow mold moving platen 58'.
30 However, the housing of the stretch rod cylinder 260 is mounted to the stretch

rod plate 262 and the rod extends to the lower portion of the blow mold moving platen 58'. Instead of the stretch rod cylinder 70 (of Figure 1) extending to move the stretch rods 64 downward, the stretch rod cylinder 260 contracts, thereby moving the stretch rod plate 262 and stretch rod cylinder 260 downward
5 towards the lower plate of the blow mold moving platen 58'. Downward movement of the stretch rod plates extends the stretch rods 64'. Figure 18 shows a side view of the alternative embodiment of the stretch rod 64'.

Figure 16 shows an alternative embodiment to the stretch blow mold 54'. Four blow mold open and close cylinders 266 are mounted to the
10 outer die shoe 152' and each has a rod 268 that extends through the mold halves 148' and 150' to the inner die shoe 154'. The cylinders 266 move the mold halves 148' and 150' between the closed position wherein the halves 148' and 150' engage each other and an open position (Figure 19). Similar to the first embodiment, movement of the mold halves 148' and 150' is limited by the stops
15 160' of the stop plates 158', therefore as the cylinder 266 moves the mold halves 148' and 150' apart or together, upon the die shoe 152' engaging the stop plates 158' the mold half 148' stops moving. The other mold half 150' moves independently of mold half 148' until the die shoe 154' reaches a stop 160'.

Referring to Figure 17, an alternative embodiment of a transfer
20 head 270 and neck molds 272 is shown. The transfer head 270 has two stations 274 and 276 each having six bores 278 located in two rows of three 278a and 278b wherein each row is generally parallel to a radius from the vertical axis and aligned with the mold cavities 146' of the blow mold station 32' and the injection openings 136' of the preform station 30'. The neck molds 272 are
25 located in a channel 280 of the transfer head 270 and have two mold halves 282 and 284 biased by compression springs 286 to the closed position. Referring to Figure 18, the mold halves 282 and 284 have alignment pins 288 which depend downward and each are received by an opening 290 in the mold halves 148' and 150' in the stretch blow mold 54' and in the other station received in
30 holes in the preform mold 36'. Referring to Figure 19, when the mold halves

148' and 150' are opened by the blow mold open and close cylinder 66', the neck molds are urged open by the alignment pins against the bias of the compression spring 286.

5 The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

10 In brief summary, and referring to Figure 1, the injection stretch blow molding machine 26 forms parisons 57 in the preform mold 36. The parisons 57 are retained in the neck mold 112 of the transfer head 74. The transfer head 74 is raised with the blow mold moving platen 58 via the links 98 to a raised transfer position allowing the indexer 94 to rotate the parisons 57 from a position aligned with the preform station to a position aligned with the blow mold station 32. The transfer head 74 is lowered therein lowering the
15 parisons 57 into the blow mold cavities 146. The blow core pins 62 seal the parison 57 in the neck molds 112 and blow mold cavities 146. The stretch rods 64 move to the extended position stretching the parison. The parison is inflated to form the finished hollow-molded product. The mold halves move to the open position, the bottom plug rotates to the open ejection position. The neck mold
20 move to the open position and the ejection rods move to the ejection position ejecting the hollow-molded product. Simultaneous to the blow mold station 32 forming and ejecting the hollow-molded product, the other station of the transfer head, which is at a diametrically opposite location on the transfer head is in registry with the preform station is retaining newly formed parisons 57.



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CLAIMS

1. A machine (26) for forming hollow molded objects (194) by injection stretch blow molding, comprising:
 - 5 a preform station (30) for forming a parison (57);
 - a blow mold station (32) for stretching and inflating the parison into the hollow molded object and then ejecting the hollow-molded product from the machine;
 - the preform station and the blow mold station being
 - 10 disposed at diametrically opposite locations on a circumference of a circle;
 - a transfer portion (34) having a transfer head (74) rotatable about an axis extending through the center of the circle and having a pair of identical transfer stations (108,110) located at diametrically opposite locations with respect to the axis;
 - 15 indexing means (94) for rotating the transfer head (74) between two aligned positions in which one of the transfer stations is in registry with the preform station and the other transfer station is in registry with the blow mold station; and
 - each transfer station (34) having at least one parison
 - 20 engaging and retaining means (112) for engaging the parison formed at the preform station (30) and retaining the parison for transfer from the preform station to the blow mold station (32) upon rotation of the transfer portion from one to another of the two positions.
2. A machine as in claim 1 further comprising:
 - 25 adjustment means (100) for moving the transfer head between a raised transfer position for rotating the transfer head between the aligned positions and a lowered operating position for forming the parison and the hollow-molded product;
 - the preform station having a preform mold (36) below the
 - 30 transfer head having an injection opening (136) aligned with each of the parison



engaging and retaining means of the aligned station of the transfer head and the preform station having a preform moving platen movable between a raised position and a lowered position and having a preform core pin (50) depending downward and extending through the transfer head and into each of the injection openings when the transfer head and the preform moving platen are in the lowered position for forming the parison engaging and retaining means; and

10 the blow mold station having a stretch blow mold below the transfer head having a mold cavity (146) aligned with each of the parison engaging and retaining means of the aligned station of the transfer head for receiving the parison and forming the hollow-molded product, and the blow mold station having a blow mold moving platen (58) movable between a raised position and a lowered position and having a blow core pin (62) depending downward to extend through the transfer head and to seal the parison in the parison engaging and retaining means and each blow core pin (62) having a stretch rod (64) extending through a bore wherein the stretch rod stretches the parison in the mold cavity and the blow core pin blows the parison into the hollow-molded product and then the hollow-molded product is ejected from the machine.

25 3. A machine as in claim 2 wherein the stretch rods



are movably mounted to the blow mold moving platen for movement between a retracted position, an extended position for stretching the parison and an ejection position for ejecting the hollow-molded product.

5 4. A machine as in claim 2 or 3 wherein the stretch blow mold is modular and removable as one unit.

10 5. A machine as in claim 2, 3 or 4 wherein the stretch blow mold has at least one set of the blow mold cavities defined by a pair of mold halves (148, 150) wherein the mold halves move between a closed position engaging each other for stretching and blowing the parison into the hollow-molded product and an open position for ejecting the hollow-molded product.

15 6. A machine as in claim 5 wherein the stretch blow mold has a bottom plug (196) rotatable between a closed position interposed between the mold halves and an open position spaced from the mold halves for ejecting the hollow-molded product.

20 7. A machine as in claim 6 wherein the stretch blow mold has a stop means (160) for limiting the movement of each of the mold halves in both the closed position and the open position.

25 8. A machine as in claim 6 wherein the stretch blow mold has a pair of stop plates (158), a die shoe (154) mounted to each of the mold halves, a pair of leader pins (156) carried by the stop plates slideably



receiving the die shoes for guiding the movement of the mold halves, and the stop means are stops (160) machined on the stop plates for engaging the die shoes.

5 9. A machine as in any one of claims 2 to 8 wherein the transfer portion has a transfer shaft extending through the transfer head and the transfer shaft having coupling means at an end for coupling with the indexing means and a lifting hub (80) located in proximity to the other end; and

10 the adjustment means for moving the transfer head between the raised transfer position and the lowered operating position is a link having a first end mounted to the blow mold movable platen and a second end selectively rigidly positioned relative to the frame in
15 proximity to the preform movable portion, and a cam roller rotatably mounted on the link generally intermediate the ends and slideably received by the lifting hub on the transfer shaft so that the transfer head moves between the raised position and the lowered
20 position with the blow molded movable platen.

10. A machine as in claim 9 wherein the second end of the link (98) is secured to an alignment cylinder (100) wherein the cylinder moves the second end of the link from a normal operating position to a lower pre-
25 operation alignment position.

11. A machine as in claim 9 wherein the coupling





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means is the transfer shaft having a spline (86)
received by an internal spline hub (90) of the indexing
means.

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