

APPARATUS FOR MAKING A MULTI-LAYER
INJECTION BLOW MOLDED CONTAINER

Food product rigid containers generally must be impermeable to oxygen. Most common structural polymers for rigid food containers are permeable to oxygen which invades the food product causing degradation or spoilage. Those polymers which are sufficiently impermeable to oxygen generally are not suitable alone for rigid containers for foods because they do not possess adequate structural properties, are moisture sensitive, or are not approved for or are of questionable safety when used in contact with foods. Ethylene vinyl alcohol copolymer (EVOH) is a transparent extrusible material possessing high impermeability to oxygen when dry, many times less permeable than acrylonitrile copolymers, but is very moisture sensitive. The oxygen barrier properties of EVOH are markedly diminished in the presence of significant quantities of water. To be useful for food packaging, particularly where extended shelf life is required, EVOH must be kept dry as by total encapsulation within polymers which have good moisture barrier properties.

Many foods are processed in the container in a pressurized cooker or retort. Retort conditions commonly are 250°F. at 30 psia steam pressure ^(121°C at 2.07 bar abs). A rigid container must survive retort conditions. It must not permanently distort during cooking or during cooling, and must not suffer an alteration of the desirable properties of its components. Polyolefins, particularly blends or copolymers of polypropylene and polyethylene, are well suited to manufacture of rigid containers and have adequate physical properties to survive retorting. Polyolefins are relatively poor oxygen barriers, but are relatively good moisture barriers. The use of polyolefins with a central core of an oxygen barrier polymer is a desired goal of the food packaging industry.

^{U.S. Patent}
~~Nohara et al~~ 3,882,259 discloses a three ply plastic bottle having a core of EVOH blended with Surlyn A brand ionomer resin and outer plies of polyethylene blended with

Surlyn A. The Surlyn A ionomer is added to both the EVOH and the polyethylene resin materials to improve adhesion between layers. The bottle is to be made by extrusion blow molding whereby the three layers are simultaneously extruded to produce a three ply tube. While still hot from extrusion, the tube is pinched together at the bottom to form a seal and inflated in a blow mold having the shape of the desired bottle.

Extrusion blow molding has four serious drawbacks when used to form multi-layer containers having a core ply of a moisture sensitive barrier material such as EVOH.

First, the pinch seal at the bottom leaves the core ply of EVOH exposed on the bottle exterior. Since EVOH and certain other barrier materials are adversely affected by moisture, exposure of the core ply at the container bottom renders the container susceptible to loss of barrier quality by intrusion of moisture. The risk that the container exterior will encounter damp conditions in storage or transport is high and the resulting loss of barrier quality will degrade or spoil the food. Further, retort conditions are such that moisture from the steam will intrude into the barrier layer through the exposed barrier at the bottom.

Second, extrusion blow molding necessarily produces scrap as a result of the pinch sealing procedure. Since the scrap contains materials from each of the three layers, reextrusion of the scrap is difficult and expensive.

Third, the pinch seal produces a bottom of non-uniform thickness and strength. The sealing takes place along a line between the abutting faces of the inner layer material. The seal line is bordered by regions of relatively thick material. When stretched during blow molding, the bottom varies in thickness in the vicinity of the pinch seal. Because of the thickness variation due to the pinch seal, the stiffness of the bottom is not uniform along all diameters. Consequently, the bottom does not evenly respond to expansion and contraction as the product changes in temperature. This lack of even

response causes unpredictable performance of the container when retorted.

Fourth, the pinch seal may create an interruption in the barrier layer. If the inside surface layer is interposed between the barrier layer at the seal, a line lacking barrier material will result. The area of the interruption may be great enough to allow sufficient oxygen to enter to be a problem.

Because of these disadvantages, extrusion blow molding cannot produce an entirely satisfactory three layer rigid container having a core barrier layer of a moisture sensitive polymer such as EVOH, particularly where the container is intended for retorting.

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SUMMARY OF THE PRESENT INVENTION

The present invention is concerned with apparatus for making a plastic container by injection molding or by an injection blow molding technique which produces a container whose walls are multiple plies of different polymers. In particular, the container walls comprise inner and outer layers of structural polymers such as polyolefins or a blend of polyolefins on either side of a core layer of a polymer having oxygen barrier properties such as EVOH.

Injection blow molding is a process whereby a preform or parison is formed by injection molding in a cavity. The parison is transferred to a blow mold cavity and blown to the shape of the desired container. The parison can be retained on the core pin of the injection mold and transferred on the core pin to the blow molding cavity. The parison can be temperature conditioned before blow molding to achieve an optimum temperature or profile of temperatures. The core pin can be temperature controlled and the exterior of the parison can be temperature conditioned by contact with air or other fluid such that blow molding occurs at optimal conditions. Orientation can be achieved as the parison is stretched during blow molding. Injection blow molding produces no scrap and requires no pinch seal.

According to the present invention, there is provided apparatus for making a multi-layer injection moulded article, comprising:

- 1) means for creating the flow of a first polymer stream to become one surface layer of the article,
- 2) means for creating the flow of a second polymer stream to become the other surface layer of the article,
- 3) means for creating the flow of a third polymer stream between the first and second polymer streams,
- 4) means for independently terminating the flows of the said polymer streams, and
- 5) means to control the independent means to coordinate the termination of flow of the three polymer streams.

The plural layer article produced by use of the apparatus can form a parison for inflation into a finished article such as a container in a blow mold. Apparatus for producing such an article can include an injection mold and a core pin that together define a cavity for molding a parison from the polymers, which are admitted to the cavity via an entrance at the bottom thereof, means for transferring the parison to a blow molding cavity having the configuration of the article, and means for inflating the parison in the blow molding cavity to form the article.

Desirably, the apparatus comprises one injection mold, two blow molds, located one to either side of the injection mold, and two core pins mounted on a plate supported to traverse between positions in which each core pin in turn registers with the injection mold, the blowmolds being so located that a respective one of the core pins registers therewith when the other core pin is in registry with the injection mold, so that a parison can be molded while a previously-molded parison is being inflated in one or other blow mold.

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A preferred embodiment of this invention, which

will be described in detail hereinafter, has at

least three plasticators for independently melting
polymers for the different layers, and at least three

5 servo controlled hydraulically actuated injection rams
associated with the plasticators. The polymers are
supplied by the rams to an injection nozzle having
at least three independent polymer orifices, each
associated with one ram. A linear transducer for each
10 ram produces an electrical signal related to the linear
displacement of the ram. To control the hydraulic
actuator for each ram, a feedback controller is
operative in response to the algebraic sum of two
signals, i.e. that from the transducer and the time-
15 displacement schedule signal.

Apparatus according to the invention can be
constructed, for example, to inject concurrently an
additional layer between the core layer and one or
both of the surface layers, thus producing an
20 article having a wall of four or more layers.

As will be described in detail hereinafter, in
the preferred apparatus the initiation, rate, and
termination of flow for each layer are
independently and continuously controlled to provide
25 control over the thickness of each layer. The
control makes it possible to ensure that the core
layer or layers are totally encapsulated between the
surface layers. The injection molded parison is
transferred on the core pin to a blow mold cavity
30 having the shape of the container and is then

following detailed description explains how the foregoing is accomplished.

Figure 1 shows a portion of the injection blow molding machine (IBM) of the present invention. Two core pins 10A, 10B are mounted on a transversely moveable plate 40 on the axially moveable platen 42 of the machine. Core pin 10A is positioned in an injection mold 20 while core pin 10B is positioned in a blow mold 30B. When plate 40 is traversed to the left, core pin 10A will be in blow mold 30A and core pin 10B will be in the injection mold 20. A parison is removed from the mold by axial retreat of the moveable platen 42 and the plate 40 with core pins 10 is traversed either left or right to the available blow mold. Figure 1 shows blow mold 30A ready to receive the parison and shows blow mold 30B containing a parison 60B. Parison 60B is inflated with air to assume the shape of blow molding cavity 30B while parison 60A is being injected in cavity 20. The blow molds open as the platen retreats to eject the finished container. The plate 40 shuttles back and forth each cycle so that a container is blown simultaneously each time a parison is injected.

Figure 2 shows the general layout of the injection blow molding machine and indicates the control means. Plasticators 82A, 82B, 82C feed three rams 70A, 70B, 70C for three polymer melts which are fed to a manifold block 75 which contains separate passages leading to a multi-passage nozzle 50 for the injection mold 20. The platen 42 is moved axially of the mold by a hydraulic press 44. Control circuitry means for the press and blowing cycles are indicated at press control block 110. A microprocessor 100 is programmed to control the servo hydraulics 120 which control the individual injection rams and to command the press control block 110.

Figure 3 shows one of the plural plasticators 82B for melting and supplying molten polymer B to an injection

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blow molded into the finished container. Temperature conditioning of the parison just prior to blowing can result in biaxial orientation of the various polymers to achieve desirable improvements in physical properties such as impermeability, clarity, tensile strength, impact strength, and resistance to creep. The resulting product has a barrier layer of layers which extend without interruption throughout the container, yet are completely encapsulated within the material of the inside and outside surface layers. Since the barrier layer is protected from moisture by the moisture barrier properties of the surface layers, the oxygen barrier quality is preserved.

The invention will now be described in more detail by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic view in cross-section of injection blow molding apparatus,

Figure 2 is another schematic view of the apparatus of the present invention,

Figure 3 is a simplified view of the injection apparatus of the present invention,

5 Figure 4 is a schematic view illustrating the control system for one of the injection rams of the apparatus

Figure 5 is a plot of the position of one of the injection rams as a function of time,

10 Figure 6 is a flow chart for the control system for the apparatus,

Figure 7 is a plot of ram position as a function of time for three rams,

15 Figures 8-15 are views in cross-section taken through the nozzle and cavity showing the confluence of flow of the various layers at various times during the injection cycle,

Figure 16 is a view in cross-section of the injection nozzle,

20 Figure 17 is a view in cross-section of the parison,

Figure 18 is a view in cross-section of the finished container,

Figure 19 is an enlarged view of a portion of a container wall having three layers,

25 Figure 20 is a plot of the oxygen permeability of a barrier material as a function of moisture content, and

Figure 21 is an enlarged view of a portion of a container wall having five layers.

The machine of the present invention injection molds
30 a multi-layer parison from a plurality of polymers, each separately plasticated and fed to separate injection rams. The rams of the machine force shots of polymers to appropriate nozzle passages which lead to the entrance to the injection mold cavity. Conditions are controlled
35 to advance the several polymer melts in the die cavity under non-turbulent flow conditions to preserve the polymers as discrete layers in the parison. The

ram 70B. The plasticator 82B is a conventional reciprocating screw device which forces molten polymer into the cylinder 71B of the ram when manifold valve 84B is closed and manifold valve 85B is opened and the ram is retreated to the left by hydraulic actuator 72B. When the ram cylinder 71B is charged with molten resin, valve 85B is closed. Upon a control signal from the microprocessor 100, valve 84B is opened and the servo control 120 for the ram causes the ram to advance to the right, according to a displacementtime schedule stored in the microprocessor program. A displacement transducer 76 provides an analog signal proportional to ram displacement to complete a feed-back loop for the servo 120. Polymer B forced according to the program flows past valve 84B through the manifold passages to the injection nozzle, through the nozzle passages and into the injection mold cavity where polymer B becomes the outside layer of a parison 60.

Figure 4 shows schematically the servo loop where the control signal from the microprocessor 100 (shown as voltage as a function of time) and a position signal from the displacement transducer 76 are algebraically combined in an amplifier 78 and the resulting signal is used to control the hydraulic servo 120 for the hydraulic actuator 72. A typical ram position control signal is shown in Figure 5. Since displacement is measured by transducer 76, the plot is in voltage as a function of time.

Figure 6 is a flow chart of the system used to control the machine. The injection blow molding machine is indicated as IBM on the chart. Upon initiation of the cycle, the program checks positions of valves, rams, etc. and if all are proper, recharges the ram cylinders 71 from the plasticators 82. The IBM control circuit 110 provides an "inject" signal to the microprocessor 100. Injection is carried out according to the ram displacement-time schedule of the microprocessor and is terminated at the end of the schedule. An "injection complete" signal is sent to the IBM. The control 110 then causes the IBM to traverse to place the parison in the blow mold and to

proceed with the blow molding phase. The machine continues to cycle through this sequence. Keyboard 115 may be used to change the displacement-time schedule or to shut down the machine.

Figure 7 is a plot of ram displacement as a function of time for three rams. The positions of the rams are measured as the voltage analog output of the transducers 76 for each ram. The polymer for the inside surface layer is "A"; that for the core layer "C"; and that for the outside surface layer is "B". In this figure an upward slope indicates a forward motion of the ram to deliver polymer, a horizontal slope indicates a stopped ram, and a downward slope indicates a retreat of the ram. The significance of Figure 7 is perhaps better understood by reference to Figures 8-15, which show the flow of the polymers at the exit of the nozzle 50 and the entrance 52 of the injection mold cavity 20 at the rounded bottom of the parison. Figures 8-15 are taken at different times in the cycle and those times are keyed to Figure 7.

Figure 8 represents the conditions at the start of a cycle at time 0. The cavity 20 is empty. The entrance 52 of the cavity 20 initially contains only the polymers A and B for the inside and outside surface layers. The rams for polymers A and B begin to advance to force those polymers into the cavity. At about 100 milliseconds into the cycle the ram for the core layer, polymer C, begins to advance. Figure 9 shows that polymer C has joined the flow stream in the entrance and polymer C is about to enter the cavity. Figure 10, taken at about 520 milliseconds, shows the flow of the three polymers as the cavity continues to be filled. All three polymer layers must extend throughout the entire length of the parison. Since the flow in the mold cavity is laminar, the velocity in the middle of the stream is higher than the velocities at the cavity walls. Therefore, initiation of flow of polymer C is retarded enough (e.g., about 100 milliseconds) so that polymer C will reach the far end of the cavity just as the slower moving surface layers

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(A and B) reach the end. In this way, the far end of the parison, that which becomes the mouth end of the container, will have all layers present in their proper positions.

At about 1000 milliseconds into the injection cycle,
5 the ram for polymer A (the inside surface layer) is stopped and the ram for polymer C (the core layer) can be accelerated slightly to achieve the desired thickness of material in the bottom of the container. Polymer A is necked down in the entrance 52 is shown in Figure 11
10 until it effectively is severed as shown in Figure 12. At 110 milliseconds the ram for polymer C is stopped and the ram for polymer A is restarted. Figures 13 and 14 show polymer A advancing to pinch off polymer C in the entrance, thereby pushing the last of polymer C into the
15 cavity 20 with polymer A to bury or encapsulate to isolate polymer C from exposure at the surface of the parison. Figure 15 shows polymer A knit to polymer B at the entrance to complete the encapsulation of polymer C and to return to the conditions at the start as shown in
20 Figure 8. At the time of Figure 15 (1300 milliseconds) all three rams are retreated to depressurize the cavity to prevent expansion of the parison when the cavity is opened and to depressurize the polymers remaining in the nozzle and entrance to prevent exudation from the nozzle
25 while the cavity is open. This exudation leads to premature flow of polymers into the cavity during the next cycle which can lead to smearing of polymer C on the surfaces of the container.

1500 milliseconds marks the end of the injection
30 phase of the machine cycle for this example. Subsequent to the end of the injection phase of the cycle, manifold valves 84, 85 are actuated and the ram cylinders 71 are recharged with their polymers by the plasticators 82. The injection mold is opened by retreating the hydraulic
35 press 44 to withdraw the core pin 10 from the cavity 20. The parison just formed is transferred to one of the blow mold cavities 30A, 30B and the container which was blow

molded simultaneously with the injection cycle is ejected from the blow mold in which it was finished.

Figure 16 shows a nozzle 50 appropriate for injection of a parison having a three layer wall. Polymer B, which forms the outside surface layer, is delivered by the ram 70B to an annular distribution channel 54B which distributes the polymer circumferentially of the nozzle structure. Polymer B advances along a conical passage 56B to an annular orifice 58B at the exit of the nozzle which leads to the injection cavity. Similarly, polymer C, which forms the core layer, is delivered by ram 70C to annular distribution channel 54C and thence along conical passage 56C to annular orifice 58C. Polymer A, which forms the inside surface layer, is delivered by the ram 70A to a passage 56A which exits at the center of the concentric flows issuing from orifices 58B and 58C. A nozzle shut off valve 59 can be moved axially to arrest flow of polymer A.

Figures 17 and 18 compare the parison 60 as injection molded with the finished container. The neck portion 62 remains virtually unchanged during blow molding. The parison is held by the chilled neck portion while the hot and soft parison is blown. Thus, the neck 62 including the flange 64 is essentially formed in the injection mold. The remainder of the parison walls are thinned as the parison is stretched during blow molding.

Figure 18 shows that the core layer C extends throughout the flange 64, but does not penetrate the flange edge. This is accomplished in large part by selection of the delay time in starting the ram for the core polymer. The flange 64 will be employed in a double seam seal when a metal end is crimped, by well known techniques, onto the container mouth to close the filled container. Since the flange represents a significant area, it is important that the core layer extend well into the flange. The programmed flows of the various polymers also ensure that the core layer is not exposed at the sprue mark at the central exterior of the container.

Figure 19 is an enlargement of the container wall within the circle of Figure 18. Layer A is the inside surface layer formed from polymer A in the foregoing description. Layer B is the outside surface layer, formed from polymer B. Layer C is the core or barrier layer formed from polymer C. The thinnest layer is the relatively expensive barrier polymer C. The relative thickness of the three layers is controlled by controlling the relative flow rates of the three polymers by microprocessor control of the displacement rates of the rams. A preferred wall structure is a layer of a blend of high density polyethylene and polypropylene on each face of a core barrier layer of ethylene vinyl alcohol copolymer (EVOH).

Figure 20 shows how the oxygen barrier quality of the EVOH layer is thin, only a small quantity of water will cause a large increase in oxygen permeability. For this reason, the EVOH layer must adequately be protected against the intrusion of moisture.

Polyolefins do not adhere well to EVOH. Adhesion can be improved by adding adhesion promoters to the polyolefin, the EVOH or both. Another approach is to provide an intermediate layer of an adherent polymeric material which adheres to the polyolefin and the EVOH. Such materials include modified polyolefins sold under the name Plexar by the Chemplex Company of Rolling Meadows, Illinois. These comprise a blend of a polyolefin and a graft copolymer of high density polyethylene and an unsaturated fused ring carboxylic acid anhydride. The polyolefin component of the blend can be polyethylene or preferably is an olefin copolymer such as ethylene vinyl acetate. ~~Schroeder application S.N. filed 26 December 1978 teaches the use of these materials to bond to EVOH.~~ The materials themselves are disclosed in U.S. patents 4,087,587 and 4,087,588. We have found these modified polyolefins to be suitable as interlayers to improve adhesion between the polyolefin surface layers and the EVOH core layer.

~~Another suitable material for use as an interlayer to~~

Another suitable material for use as an interlayer to improve adhesion between the EVOH polyolefins are maleic anhydride grafted polyolefins sold under the name Admer by Mitsui Petrochemical Industries of
5 Tokyo, Japan.

The use of interlayers on each side of the EVOH oxygen barrier layer results in a five layer container. To produce such a container, the three passage nozzle of Figure 16 is replaced with a five passage nozzle of
10 similar construction. Where the inside and outside surface layers are of the same polymer one ram can be used for both those layers. The flow from that ram is divided and proportioned with part supplying the central axial passageway to form the inside surface layer and
15 the balance supplying the outermost nozzle annular orifice. The two additional nozzle orifices are located just inside and just outside the nozzle orifice for the EVOH barrier layer. The two additional annular nozzle orifices can be supplied with the interlayer
20 polymer from a single ram, the flow being divided and proportioned. Thus, a three ram machine can produce a five layer parison. Greater control can be exercised over the polymer flows by using a machine with an independently controllable ram for each layer.
25 A nozzle shut off valve can be employed to selectively control the polymer flows. The three layers of interlayer polymer and the barrier polymer can be treated as a single core layer. A five layer wall is shown in Figure 21 wherein layers A and B are the
30 inside surface layers of polyolefin, layer C is the barrier layer of EVOH, and two layers D are the interlayer material.

EXAMPLE I

Five layer containers having a capacity of about
35 5 1/2 ounces (163 ml) of 202 x 307 size (i.e. 2 1/8 x
37 1/16", or 5.4 x 8.7 cm), weighing about 11 g were made

using a five orifice nozzle on a three ram machine. The inside and outside surface layers were polypropylene-polyethylene block copolymer (Hercules Profax 7631). The adhesive interlayers were ethylene vinyl
5 acetate copolymer blended with a graft copolymer of high density-

polyethylene and a fused ring carboxylic acid anhydride (Plexar 1615-2). The oxygen barrier was EVOH (Kuraray EVAL EP-F, available from Kuraray Co. Ltd., Osaka, Japan). The layers were well adhered. The barrier extended to the flange lip and was completely encapsulated.

EXAMPLE II

Five layer containers similar to those of Example I were made wherein the inside and outside surface layers were polypropylene (EXXON E612); the interlayer material was Plexar III, a blend of ethylene vinyl acetate copolymer and a graft copolymer; and the barrier was EVAL EP-F. The layers were well adhered. The barrier layer extended to the lip of the flange and was completely encapsulated.

EXAMPLE III

Five layer containers similar of those of Example I were made wherein the inside and outside surface layers were a 50-50 blend of polypropylene (EXXON E612) and high density polyethylene (Chemplex 5701); the interlayer material was Plexar III; and the barrier layer was EVAL EP-F. The layers were well adhered. The barrier layer extended to the lip of the flange and was completely encapsulated.

EXAMPLE IV

Five layer containers similar to those of Example I were made wherein the inside and outside surface layers were a copolymer of propylene and ethylene (Hercules Profax 7631); the interlayer material was maleic anhydride grafted polyolefin (Mitsui Admer QB 530); and the barrier layer was EVAL EP-F. The layers were well adhered. The barrier layer extended to the lip of the flange and was completely encapsulated.

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In the making of the containers of Examples I-IV

the injection schedule began feeding the inside and outside surface layer polymer then the polymer for the adhesive interlayer was started and substantially

5 simultaneously the barrier layer polymer was started.

The flows of the adhesive interlayer polymer and the barrier layer polymer were terminated before the outside surface layer polymer flow was terminated.

The words SURLYN, ADMER, PROFAX, EXXON and
10 CHEMPLEX used hereinbefore are Registered Trade
Marks.

Features of the molding processes disclosed herein form the subjects of the claims of our copending applications 8106700 (Serial No. 2,070,507A)
15 and 8309410.



Claims:

1. Apparatus for making a multi-layer injection molded article, comprising:

- 5 1) means for creating the flow of a first polymer stream to become one surface layer of the article,
- 2) means for creating the flow of a second polymer stream to become the other surface layer of the article,
- 10 3) means for creating the flow of a third polymer stream between the first and second polymer streams,
- 4) means for independently terminating the flows of the said polymer streams, and
- 15 5) means to control the independent means to coordinate the termination of flow of the three polymer streams.

20 2. Apparatus according to claim 1, wherein the means for independently terminating the flows are coordinated by the control means such that the first polymer stream is terminated first, then the third polymer stream, and thereafter the second polymer stream.

25 3. Apparatus according to claim 1 or claim 2 including means for independently controlling the flows of the said polymer streams.



4. Apparatus according to claim 3, wherein the control means which coordinate flow termination further coordinate the operation of the flow control means during each injection cycle.

5 5. Apparatus according to claim 1, 2, 3 or 4, wherein the means which create the said flows are operative independently of one another, and the control means which coordinate flow termination further coordinate the operation of the
10 said flow creating means.

6. Apparatus according to any of claims 1 to 5, wherein for each polymer stream there is provided polymer-displacing means to create the flow thereof and means to control operation of the
15 polymer displacing means, and the means which control and coordinate generates time-displacement schedule signals which are fed to the means which control operation of the polymer-displacing means.

7. Apparatus according to claim 6, wherein
20 the polymer-displacing means for each polymer stream includes a ram.

8. Apparatus according to claim 7, wherein each ram is fed with polymer from a plasticator connected thereto.

25 9. Apparatus according to claim 7 or claim 8, wherein the means which control operation of each



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polymer-displacing ram includes a hydraulic actuator having a feedback servo controller responsive to the algebraic sum of the time-displacement schedule signal and a ram position signal produced by a linear
5 transducer sensitive to displacement of the ram.

10. Apparatus according to any of claims 1 to 9, which comprises a mold cavity to receive the polymer streams via an injection which injects the first polymer in a central stream surrounded by an annular
10 stream of the second polymer, and which injects the third polymer in an annular stream between the first and second polymer streams.

11. Apparatus according to any of the preceding claims, which comprises an injection mold
15 and a core pin together defining a cavity for molding a parison from the polymers, which are admitted to the cavity via an entrance at the bottom thereof, means for transferring the parison to a blow molding cavity having the configuration of the
20 article, and means for inflating the parison in the blow molding cavity to form the article.

12. Apparatus according to claim 11, wherein the blow molding cavity is shaped to mold an



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article in the form of a rigid, multi-layer container.

13. Apparatus according to claim 11 or claim 12, which comprises one injection mold, two
5 blow molds, located one to either side of the injection mold, and two core pins mounted on a plate supported to traverse between positions in which each core pin in turn registers with the injection mold, the blow molds being so located that a
10 respective one of the core pins registers therewith when the other core pin is in registry with the injection mold, so that a parison can be molded while a previously-molded parison is being inflated in one or other blow mold.

15 14. Apparatus according to claim 13, wherein the injection mold has an injection nozzle therein located to confront the end of whichever core pin is presented in the injection mold, the nozzle having a plurality of concentrically-arranged orifices
20 for expelling at least three polymer streams into the mold, to form a parison comprising at least three layers, namely two surface layers and a core layer therebetween, and the said control means are so arranged to coordinate the means for independently
25 terminating the flows that injection of the polymer



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which forms the surface layer against the core
pin ceases first, then the polymer which forms
the core layer and finally the polymer which
forms the surface layer against a surface of the mold
5 confronting the core pin.

15. Apparatus according to any of the
preceding claims, including means for introducing
a fourth polymer stream between the first and third
polymer streams, means for introducing a fifth
10 polymer stream between the second and third
polymer streams, and means for controlling and
for terminating the flows of the fourth and fifth
polymer streams.

16. Apparatus for making a multilayer
15 molded article, substantially as herein
described with reference to and as shown in the
accompanying drawings.

The text of the specification has been reproduced by photocopying the applicants original
typescript. It may contain a few amendments which are difficult to read. The original
typescript containing these amendments may be inspected on the premises of the Patent Office