

Dec. 25, 1962

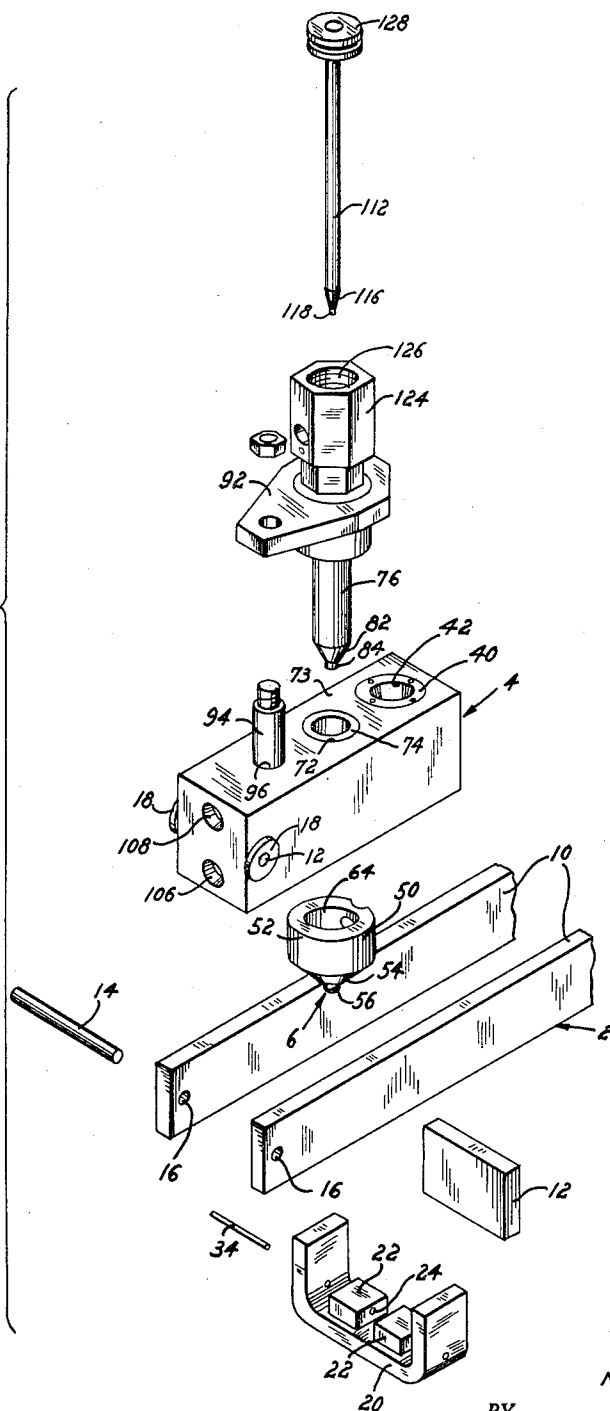
M. SCHNEIDER
VACUUM CASTING NOZZLE

3,070,126

Filed July 14, 1959

4 Sheets-Sheet 1

FIG. 1



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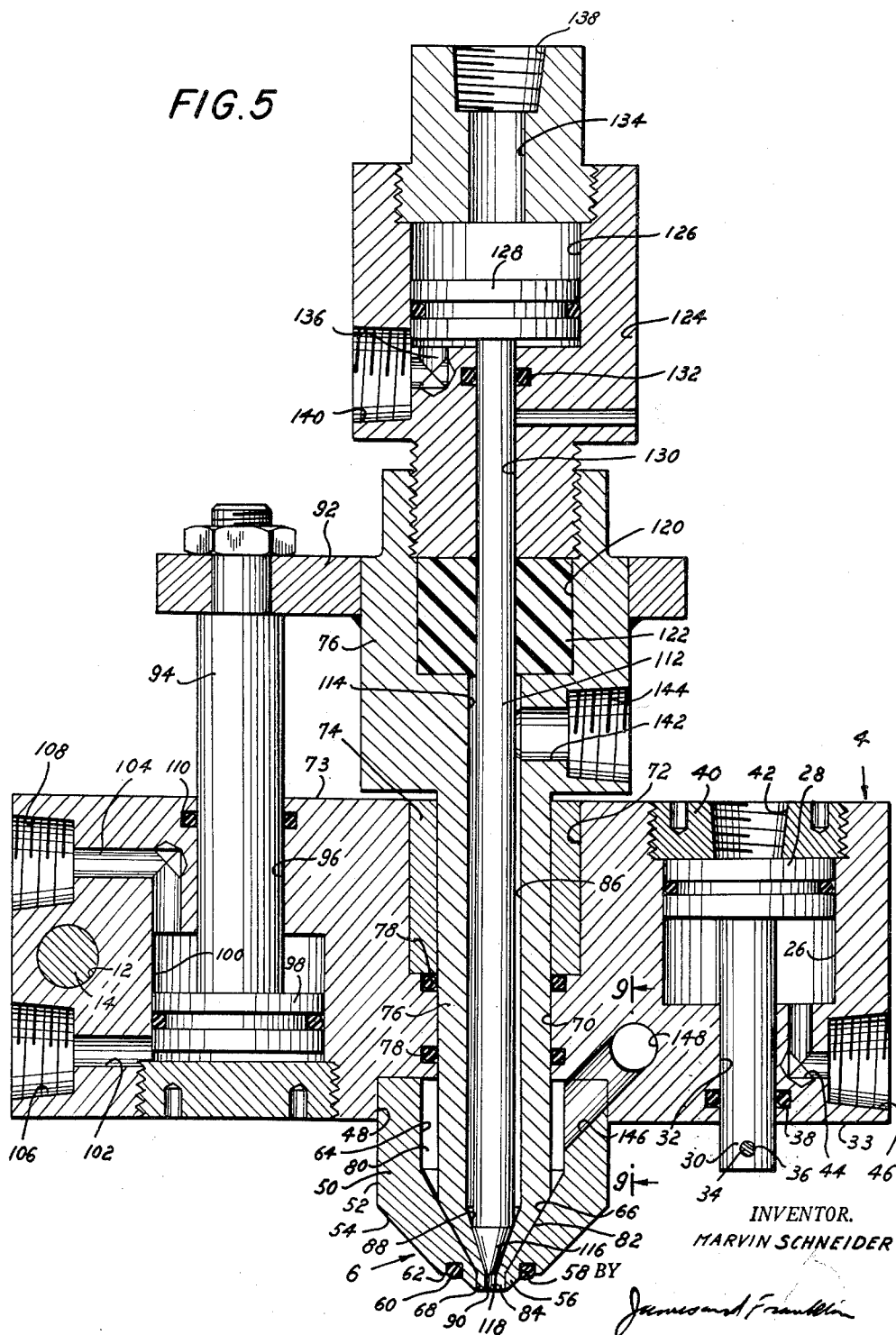
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FIG. 5



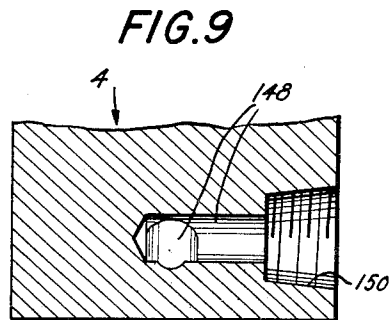
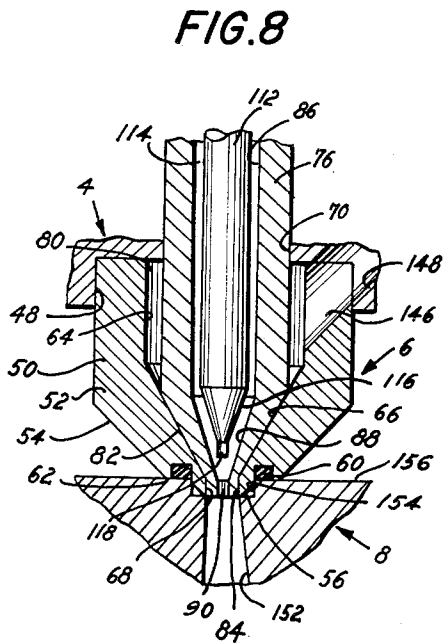
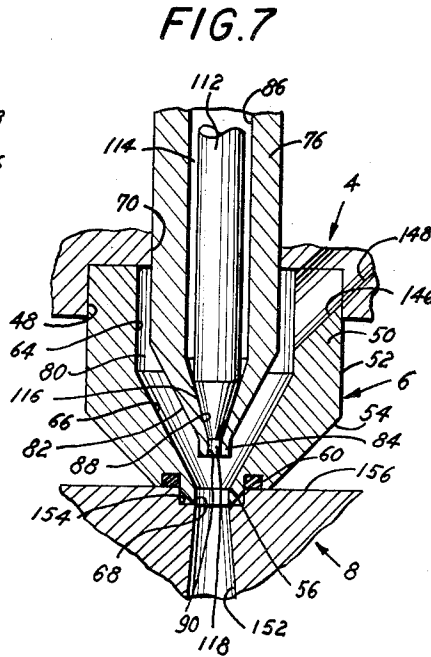
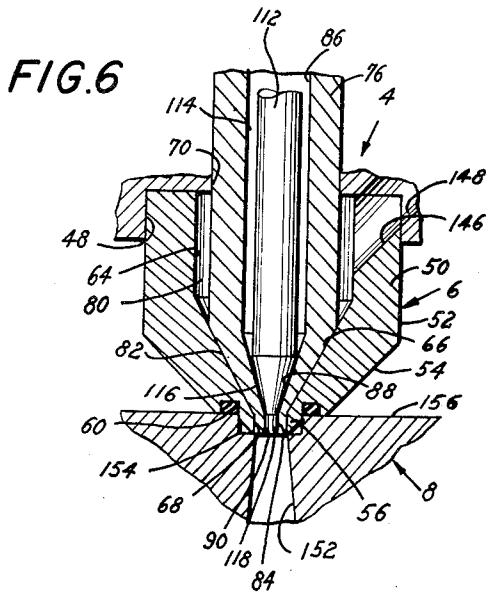
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4 Sheets-Sheet 4



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VACUUM CASTING NOZZLE

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16 Claims. (Cl. 137-637.2)

The present invention relates to a nozzle specifically designed for creating a vacuum in a mold cavity and then filling that cavity with the material to be molded or cast.

In this specification, and in the claims hereof, the term "casting" is used in its broad sense, including all processes in which material is conveyed into a cavity in order to take the shape thereof. The term "mold" generically denotes the structure in which the cavity is formed. The term "casting material" is also used broadly, and may, in given applications, be constituted by plastics, semi-solids, granular material, molten metal, or any other type of material suitable for use in a casting operation as defined. The specific embodiment of the present invention here illustrated is designed for use in conveying settable liquid plastic material into molds.

The advantages of vacuum casting are well recognized. That technique involves the evacuation of air from the mold cavity before or while the casting material is conveyed therinto. Many different techniques and apparatus have been employed to carry out this general procedure. In many instances special vented molds have been used. In other instances the vacuumizing and feeding apparatus is complicated, expensive, and not readily adaptable to differing requirements. Hence the general applicability of the vacuum casting technique has been comparatively limited.

In accordance with the present invention a simple, reliable and relatively inexpensive apparatus is provided which can be used with conventional types of molds, which is exceptionally rapid and efficient in evacuating the mold cavity and then feeding casting material thereinto, and which inherently provides for great flexibility in control. The apparatus of the present invention comprises a nozzle having a tip adapted to engage with the mold. The interior of the nozzle is provided with first and second chambers, one connected to an evacuating source and the other connected to the supply of casting material. The first chamber is defined between relatively movable outer and inner shells, and the second chamber is defined between the inner shell and a plunger received therewithin and movable relative thereto. Controllable means are provided for producing appropriate relative movement between the operative parts in order to sequentially connect one chamber and then the other to the mold cavity, thereby first evacuating that cavity and then permitting casting material to enter the cavity. The structure, including the means for providing relative movement between the operative parts, is compactly and efficiently arranged.

As here disclosed first and second independent moving means are provided respectively between the inner and outer shells on the one hand and the inner shell and the plunger on the other hand. The first moving means moves the plunger along with the inner shell without any change in their relative position, thereby to control access between the mold cavity and the first chamber only. The second moving means is carried by the inner shell, is independent of the outer shell, and controls access between the mold cavity and the second chamber only.

The nozzle is articulately mounted on a support, and additional moving means are provided for moving the nozzle relative to the support into and out from engagement with the mold to be filled. This additional moving means is independent of the first two moving means, thus

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providing for complete flexibility and control of every stage of the casting operation.

The nozzle is so designed as to minimize the formation of undesired sprues in the mold. Moreover, a particularly vexing problem from a production line point of view, particularly where large numbers of small molds are to be filled and where the casting material is quite liquid, is the tendency of the casting material to drip from the nozzle at the end of each casting operation when the nozzle is removed from the mold. The nozzle of the present invention reduces this dripping substantially to the vanishing point by providing, in conjunction with the shape of the nozzle tip and the corresponding shape of the cavity in the mold, an extremely limited space, reduced almost to the vanishing point, into which excess casting material can enter. By thus rigorously restricting the amount of casting material which can be carried on the exterior of the nozzle, dripping is substantially eliminated.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to the construction of a casting nozzle as defined in the appended claims and as described in this specification taken together with the accompanying drawings, in which:

FIG. 1 is a three-quarter perspective exploded view of the various parts of the nozzle and its support;

FIG. 2 is a side elevational view of the assembled nozzle and support;

FIG. 3 is a cross sectional view taken along the line 3-3 of FIG. 2;

FIG. 4 is a cross sectional view taken along the line 4-4 of FIG. 2;

FIG. 5 is a cross sectional view taken along the line 5-5 of FIG. 4; but with the support eliminated;

FIGS. 6, 7 and 8 are detail cross sectional views of the nozzle tip operatively positioned relative to a mold to be evacuated and filled, and showing the operative positions of the movable nozzle parts when the nozzle first engages the mold, when the nozzle is evacuating the mold cavity, and when the nozzle is permitting casting material to enter the mold cavity respectively; and

FIG. 9 is a cross sectional view taken along the line 9-9 of FIG. 5.

The specific embodiment of the casting nozzle of the present invention which is here specifically illustrated comprises a support generally designated 2 on which the nozzle body generally designated 4 is articulately mounted, that body carrying a nozzle tip generally designated 6 which is adapted to be moved into and out of operative relation with a mold generally designated 8.

The support comprises a pair of spaced bars 10 separated by a spacer plate 12, between which the body 4 is adapted to be received. One end of the body 4 is provided with an aperture 12 through which pin 14 passes, the ends of that pin being received in apertures 16 in the bars 10, and washers 18 are interposed between the body 4 and the bars 10, the body 4 being pivotable about the axis of the pin 14 relative to the bars 10.

Secured to the bars 10 in any appropriate manner, as by welding, and depending therebelow beneath the end of the body 4 remote from the aperture 14, is a U-shaped member 20 carrying a pair of spaced blocks 22 with registering apertures 24 therethrough. The body 4, at a position above the blocks 22, is provided with a cylindrical cavity 26 within which piston 28 is movable, the piston rod 30 extending down through opening 32 beyond the lower edge 33 of the body 4 and into the space between the blocks 22. A pin 34 passes through the apertures 24 in the blocks 22 and through aperture 36 in the piston rod 30. A sealing ring 38 is provided in the body 4 around the piston rod 30. The upper end of the cylinder 26 is closed by cap 40 having opening 42 therein for receiving

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an appropriate conduit fitting, and the body 4 is provided with a passage 44 communicating with the cylinder cavity 26 below the piston 28, that passage 44 leading to an opening 46 adapted to receive an appropriate conduit fitting.

The central portion of the body 4, at its lower edge 33, is provided with a recess 48 into which an outer shell 50 is appropriately received and secured in place, that shell 50 having a cylindrical outer wall 52 communicating with an inwardly and downwardly tapering wall 54 which leads to a protruding tip portion 56. A groove 53 is provided just above the tip portion 56 and a sealing ring 60 is received therein and projects beyond the horizontal wall 62 which connects the wall 54 with the tip 56. Interiorly the shell 50 is provided with an inner cylindrical wall 64 leading to a downwardly and inwardly tapered inner wall 66, which in turn leads to the vertical inner wall 68 which extends all the way to the lower surface of the tip portion 56. The shell 50 comprises the outer shell of the nozzle proper.

The body 4 is provided, in registration with the interior of the shell 50, with a vertical aperture 70 and a widened upper portion 72 extending to the top surface 73 of the body 4. A bearing bushing 74 is received within the widened portion 72.

An inner shell 76 is slidably received inside the bearing bushing 74 and the body aperture 70, and sealing rings 78 are operative between the body aperture 70 and the shell 76. That portion of the shell 76 received inside the cylindrical cavity 64 of the outer shell 50 is smaller in outer diameter than the cylindrical wall 64, thus having between itself and the outer shell 50 a clearance defining a first chamber 80. The lower end of the inner shell 76 is provided with inwardly and downwardly tapered surface 82 having the same taper as, and sealingly engageable with, the inner wall 66 of the outer shell 50. It is also provided with a tip portion 84 adapted to be snugly received in and substantially fill the space inside the inner wall 68 of the outer shell 50. The outer shell 76 has an inner cylindrical wall 86 and an inwardly and downwardly tapering bottom inner wall 88 leading to the cylindrical wall 90 which extends all the way to the tip exterior of the tip portion 84.

That portion of the outer shell 76 extending above the upper body surface 73 carries a laterally extending arm 92, to which is connected a piston rod 94 which passes through opening 96 in the body 4 and is connected to piston 98 slidable within cylindrical cavity 100 formed in the body 4. Passages 102 and 104 communicate respectively with the upper and lower ends of the cylindrical cavity 100 and extend respectively to externally accessible openings 106 and 108 adapted to receive appropriate conduit fittings. A sealing ring 110 is provided between the body 4 and the piston rod 94.

A plunger 112 is slidably receivable inside the inner shell 76, an appreciable clearance being present between the plunger 112 and the inner shell wall 86 so as to define a second chamber 114. The lower end of the plunger 112 is provided with a surface 116 tapered corresponding to the inner shell wall 88 and movable into sealing engagement therewith, and the tip of the plunger 112 is defined by a substantially cylindrical portion 118 which is snugly received within and substantially fills the space inside the inner shell wall 90. It will be noted that the lower surface of the plunger tip 118, when the latter is in its lowered position, is substantially flush with the lower surface of the tip portion 84 of the inner shell 76.

The upper portion of the inner shell 76 is provided with an enlarged space 120 registering with the second chamber 114, within which a bushing 122 is received which sealingly engages the plunger 112 and thus closes off the top of the second chamber 114.

A housing 124 is mounted on the upper end of the inner seal 76, that housing containing a cylindrical cavity 126 within which piston 128 is movable. The upper end of the plunger 112 extends through aperture 130 in the housing 124 and is connected to the piston 128. A sealing

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ring 132 is provided between the housing 124 and the plunger 112. The housing 124 is provided with passages 134 and 136 communicating respectively with the upper and lower ends of the cylindrical cavity 126, those passages extending to external openings 138 and 140 respectively adapted to receive appropriate conduit fittings.

The inner shell 76, at its portion above the body 4, is provided with a passage 142 which communicates with the chamber 114, that passage extending to an external opening 144 adapted to receive an appropriate conduit fitting. The outer shell 50 and the body 4 are provided with registering passages 146 and 148 respectively which extend to an external opening 150 adapted to receive an appropriate conduit fitting. The opening 150, and hence the first chamber 80, is adapted to be connected to a vacuum pump or other suitable evacuating source. The opening 144, and hence the second chamber 114, is adapted to be connected to a source of casting material. The pairs of openings 42-46, 106-108 and 138-140 are adapted to be connected to individually controllable pressure fluid sources for actuating the various parts of the apparatus.

Mode of operation

In its initial position, with the nozzle closed and removed from the mold, pressure will be applied to the upper side of the piston 28, thus causing the body 4 to pivot upwardly in a counter-clockwise direction about the axis of the pin 14, thereby lifting the nozzle tip 6. Pressure will be applied to the upper side of the piston 98, thus causing the inner shell 76 to move downwardly relative to the outer shell 50 until the surfaces 66 and 82 engage, thereby sealing the lower end of the first chamber 80 (hereinafter termed the vacuum chamber because it is connected to vacuumizing source). Movement of the inner shell 76 to that position carries with it both the plunger 112 and the pressure motor 126, 128 for moving the plunger 112 relative to the inner shell 76. Pressure will be applied to the upper side of the piston 128, thus causing the plunger 112 to move downwardly until the surfaces 88 and 116 engage, thus sealing the lower end of the second chamber 114 (hereinafter termed the filling chamber because it contains the casting material with which the mold 18 is to be filled).

The mold 8 is provided with a cavity 152, and with an upwardly opening widened recess 154 communicating therewith and adapted to snugly receive the nozzle tip portion 56. The depth of the recess 154 is closely equal to the vertical distance between the wall 62 and the lowermost end of the tip portion 56. The upper surface 156 of the mold 8 is adapted to be engaged by the wall 62 and the sealing ring 60 of the nozzle tip 6.

When the mold 8 is in position beneath the nozzle, overriding pressure is applied to the underside of the piston 28. This causes the body 4 to pivot in a clockwise direction about the axis of the pin 14, all of the parts mounted on the body 4 moving therewith until the nozzle tip 6 is received within the mold recess 154, the sealing ring 60 engaging the mold surface 156 and thus sealing the space around the nozzle tip 6. This position of the parts is shown in FIG. 6.

Once the seal has been established between the nozzle and the mold, the next step is to evacuate the mold cavity 154. This is done by applying overriding pressure to the lower side of the piston 98. That results in a lifting of the inner shell 76 and all of the parts carried thereby to the position shown in FIG. 7, thus exposing the lower end of the vacuum chamber 80 to the mold cavity 152. Evacuation of the latter proceeds. It will be noted that since the plunger 112 moves with the inner shell 76, the seal at the lower end of the filling chamber 114 remains unbroken, and no casting material can escape from the filling chamber 114.

After the desired degree of evacuation of the mold cavity 152 has been achieved, overriding pressure is ap-

plied to the upper surface of the piston 98, thus moving the parts back to their position shown in FIG. 6, closing off the vacuum chamber 80 from the mold cavity 152 and terminating the evacuation of the latter.

Thereafter overriding pressure is applied to the lower surface of the piston 128. This lifts the plunger 112 relative to the inner shell 76, but without disturbing the position of any of the other parts. The lower end of the filling chamber 114 opens, and permits the casting material to enter the mold cavity 152. Because the relative positions of the inner and outer shells 76 and 50 have not been disturbed, the vacuum chamber 80 remains reliably sealed, and no casting material is sucked back.

After the mold cavity 152 has been filled to a desired degree, overriding pressure is applied to the upper side of the piston 128, thus restoring the plunger 112 to its lower position relative to the inner shell 76, sealing the bottom of the filling chamber 114 and cutting off the flow of casting material into the mold cavity 152. Because the tip portion 118 of the plunger 112 substantially fills the space inside the inner shell wall 90, there will be a positive ramming of a small volume of casting material into the mold cavity 152 at the end of the downward chamber-closing movement of the plunger 112. This is advantageous in facilitating the elimination of voids.

It will be recalled that throughout the entire sequence of mold evacuating and filling operations as thus far described the nozzle 6 has been pressed down into sealing engagement with the mold 8, as by means of the pressure exerted on the piston 28. Thus the seal around the nozzle tip 6 will remain effective. Because of the snug fit of the nozzle tip 6 within the mold recess 154, because of the proximity of the sealing ring 60 thereto, and because the lower surface of the plunger tip portion 118 is substantially flush with the lower surface of the inner shell portion 84 within which it is received, only an inconsequential amount of molding material can be present on the outer surface of the nozzle when the nozzle is removed from the mold. Therefore, when the casting operation is completed and the nozzle is lifted from the mold by the application of overriding pressure to the upper surface of the piston 28, there will be no drip from the nozzle. The amount of molding material which can be carried on the exterior of the nozzle is minimized almost to the vanishing point, and no casting material inside the nozzle can escape therefrom.

The arrangement of the parts and the moving mechanism therefor are such that each step in the overall casting process can be individually controlled when desired, yet the device lends itself to automatically programmed mass production procedures, and to ready changes in program as required. The number of moving parts are minimal, the operative connections are direct and positively acting, the construction is small yet strong and highly reliable.

While but a single embodiment of the present invention has been here disclosed, it will be apparent that many variations may be made therein, all within the scope of the instant invention as defined in the following claims.

I claim:

1. A casting nozzle comprising a support, a body articulately mounted on said support, said body carrying a first piston-cylinder assembly, said piston being operatively connected to said support to move said body relative to said support, said body carrying an outer shell having an inner wall and a lower inner surface leading to an outlet opening at the bottom thereof, an inner shell movable in said outer shell, said inner shell having an outer wall spaced from the inner wall of said outer shell to define therebetween a first chamber and having a lower outer surface sealingly engageable, for one position of said inner shell relative to said outer shell, with the lower inner surface of said outer shell, said inner shell having

an inner wall and a lower inner surface leading to an outlet opening at the bottom thereof registering with the outlet opening of said outer shell, a second piston-cylinder assembly carried by said body, its piston being operatively connected to said inner shell for moving the latter relative to said outer shell, means for sealing the upper end of said first chamber, a plunger movable in said inner shell and having an outer wall spaced from the inner wall of said inner shell to define therebetween a second chamber and having a lower outer surface sealingly engageable for one position of said plunger relative to said inner shell, with the lower inner surface of said inner shell, a third piston-cylinder assembly carried by said inner shell, its piston being operatively connected to said plunger for moving the latter relative to said inner shell, means for sealing the upper end of said second chamber, inlet connections to each of said chambers, and means for controllably supplying pressure fluid to said piston-cylinder assemblies.

2. The nozzle of claim 1, in which said outer shell has a portion projecting from the outer bottom surface thereof, said projecting portion having said outer shell outlet opening therein, said outer bottom surface carrying an externally exposed sealing member around said projecting portion.

3. The nozzle of claim 1, in which said outer shell has a portion projecting from the outer bottom surface thereof, said projecting portion having said outer shell outlet opening therein, said outer bottom surface carrying an externally exposed sealing member around said projecting portion, said inner shell having a portion receivable in said outer shell outlet opening and extending substantially to the tip of said outer shell outlet opening, said portion of said inner shell carrying said inner shell outlet opening.

4. The nozzle of claim 1, in which said outer shell has a portion projecting from the outer bottom surface thereof, said projecting portion having said outer shell outlet opening therein, said outer bottom surface carrying an externally exposed sealing member around said projecting portion, said inner shell having a portion receivable in said outer shell outlet opening and extending substantially to the tip of said outer shell outlet opening, said portion of said inner shell carrying said inner shell outlet opening, said plunger having a portion receivable in said inner shell outlet opening and extending substantially to the tip of said inner shell outlet opening.

5. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, a support on which said second shell is articulately mounted, and additional moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, relative to said support.

6. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell hav-

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ing a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, said moving means comprising first means operatively connected between said first and second shells for moving said first shell relative to said second shell, said plunger moving with said first shell, and second means operatively connected between said first shell and said plunger for moving said plunger relative to said first shell, a support on which said second shell is articulately mounted, and additional moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, relative to said support.

7. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, said moving means comprising first means operatively connected between said first and second shells for moving said first shell relative to said second shell, said plunger moving with said first shell, and second means operatively connected between said first shell and said plunger for moving said plunger relative to said first shell, said second moving means being mounted on and moving with said first shell, and a support on which said second shell is articulately mounted, and additionally moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, relative to said support.

8. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, said second shell having a portion projecting from an outer surface thereof, said projecting portion having said second outlet

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opening therein, said outer surface carrying an externally exposed sealing member around said projecting portion.

9. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, a support on which said second shell is articulately mounted, and additional moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, a relative to said support, said first mentioned moving means comprising a first piston-cylinder assembly mounted on said second shell and operatively connected between said second and first shells, and a second piston-cylinder assembly mounted on said first shell and operatively connected between said plunger and said first shell, said additional moving means comprising a third piston-cylinder assembly mounted on said second shell and operatively connected between said support and said second shell, and means for controllably supplying pressure fluid to said piston-cylinder assemblies.

10. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, inlet connections to each of said inner chambers, said second shell having a portion projecting from an outer surface thereof, said projecting portion having said second outlet opening therein, said outer surface carrying an externally exposed sealing member around said projecting portion, and in which said moving means comprises a first piston-cylinder assembly mounted on said second shell and operatively connected between said second and first shells, a second piston-cylinder assembly mounted on said first shell and operatively connected between said plunger and said first shell, and means for controllably supplying pressure fluid to said piston-cylinder assemblies.

11. In the nozzle of claim 10, a support on which said second shell is articulately mounted, and additional moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, relative to said support.

12. The nozzle of claim 10, said first shell having a portion receivable in said second outlet opening when said first shell is in its sealing position and extending substantially to the tip of said second outlet opening, said portion of said first shell carrying said first outlet opening, and

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said plunger has a portion receivable in said first outlet opening when said plunger is in its sealing position and extending substantially to the tip of said first outlet opening.

13. In the nozzle of claim 12, a support on which said second shell is articulately mounted, and additional moving means operatively connected between said support and said second shell for moving said second shell, and said plunger and first shell therewith, relative to said support.

14. A casting nozzle comprising an inner plunger, a first shell having a first inner chamber in which said plunger is received with clearance, said first inner chamber communicating with a first outlet opening, a second shell having a second inner chamber in which said first shell is received with clearance, said second inner chamber communicating with a second outlet opening, said first and second outlet openings respectively leading to the exterior of said nozzle independently of one another, said plunger being movable in said first shell between sealing and dispensing positions operatively engaged and disengaged respectively with respect to the inside of said first inner chamber so as to respectively seal and open said first outlet opening, said first shell being movable in said second shell between sealing and dispensing positions operatively engaged and disengaged respectively with the inside of said second inner chamber so as to respectively seal and open said second outlet opening, means for moving said plunger and said first shell between their respective operative positions, and separate inlet connections between each of said inner chambers and the exterior of said nozzle,

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said moving means comprising a first piston-cylinder assembly mounted on said second shell and operatively connected between said second and first shells, a second piston-cylinder assembly mounted on said first shell and operatively connected between said plunger and said first shell, and means for controllably supplying pressure fluid to said piston-cylinder assemblies.

15. The nozzle of claim 8, in which said first shell has a portion receivable in said second outlet opening when said first shell is in its sealing position and extending substantially to the tip of said second outlet opening, said portion of said first shell carrying said first outlet opening.

16. The nozzle of claim 8, in which said first shell has a portion receivable in said second outlet opening when said first shell is in its sealing position and extending substantially to the tip of said second outlet opening, said portion of said first shell carrying said first outlet opening, said plunger having a portion receivable in said first outlet opening when said plunger is in its sealing position and extending substantially to the tip of said first outlet opening.

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