United States Patent

[11] **3,580,298**

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[45] Patented **May 25, 1971**

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Continuation of application Ser. No. 550,390, May 16, 1966, now abandoned.

[54] **CONTAINER FILLING MACHINE**
15 Claims, 22 Drawing Figs.

[52] **U.S. Cl.** **141/40,** 141/90, 141/140, 141/198
[51] **Int. Cl.** **B65b 3/26**
[50] **Field of Search** 141/5, 39–41, 46–48, 50, 63, 86, 88, 90–92, 140, 141, 192, 193, 198, 214, 215, 225, 226, 285, 289, 301, 302; 251/28

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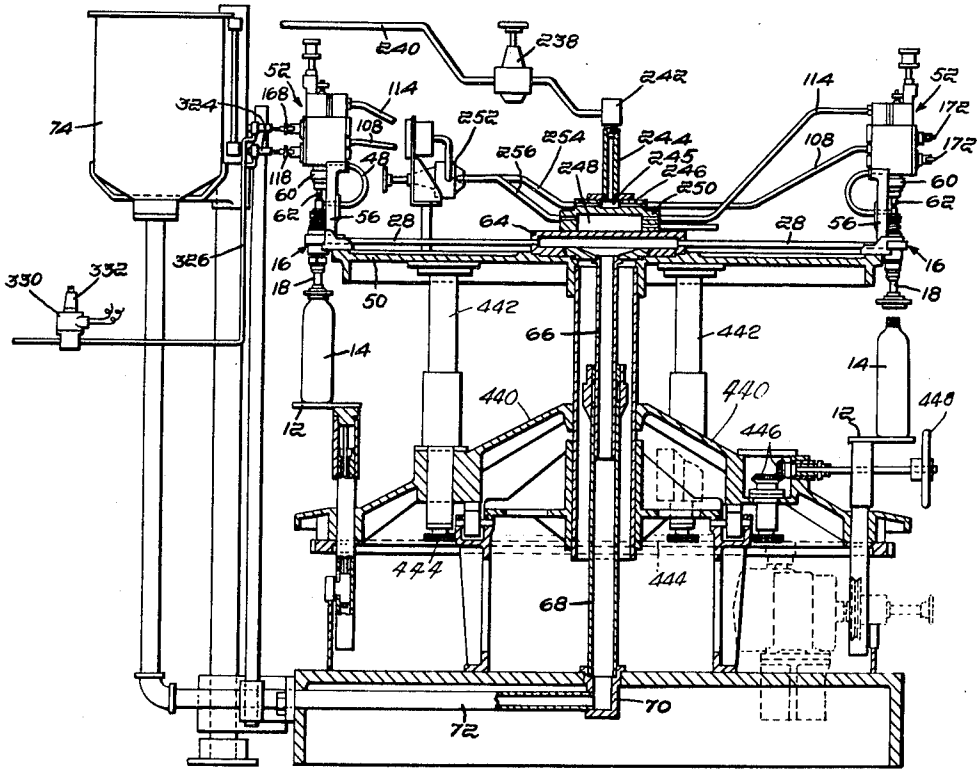
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Primary Examiner—Laverne D. Geiger
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Attorney—Roberts, Cushman & Grover

ABSTRACT: A container filling machine provided with a plurality of filling heads having provision for automatically starting and stopping the filling operation in successive filling heads which includes pneumatically operated control means for each filling head for detecting a predetermined height of the material in its container and pneumatically operated means responsive thereto for discontinuing the filling operation, the invention being characterized by improved control means facilitating adjustment of the control units for the various filling heads to obtain uniform filling heights in successive containers.



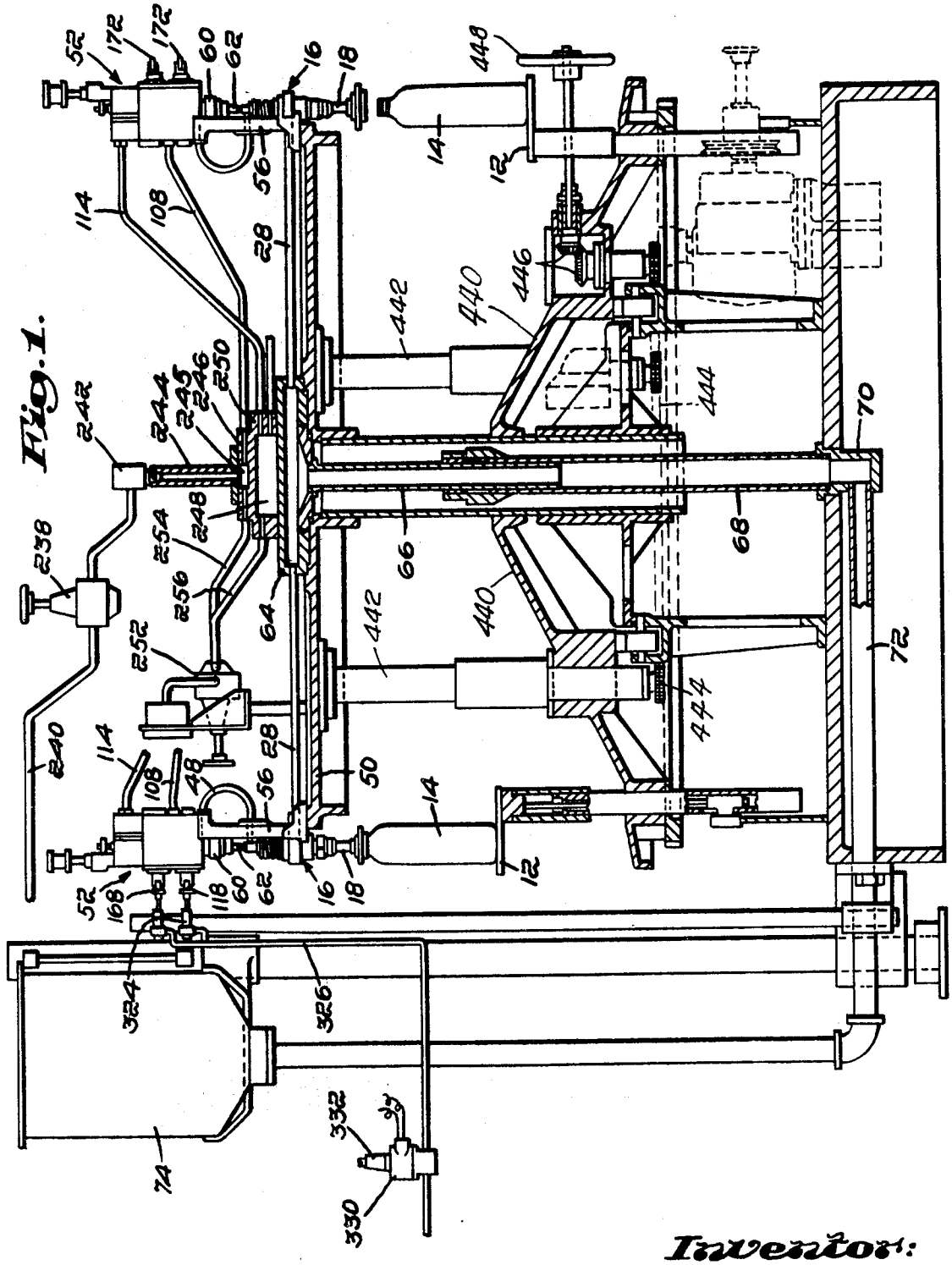


Fig. 1.

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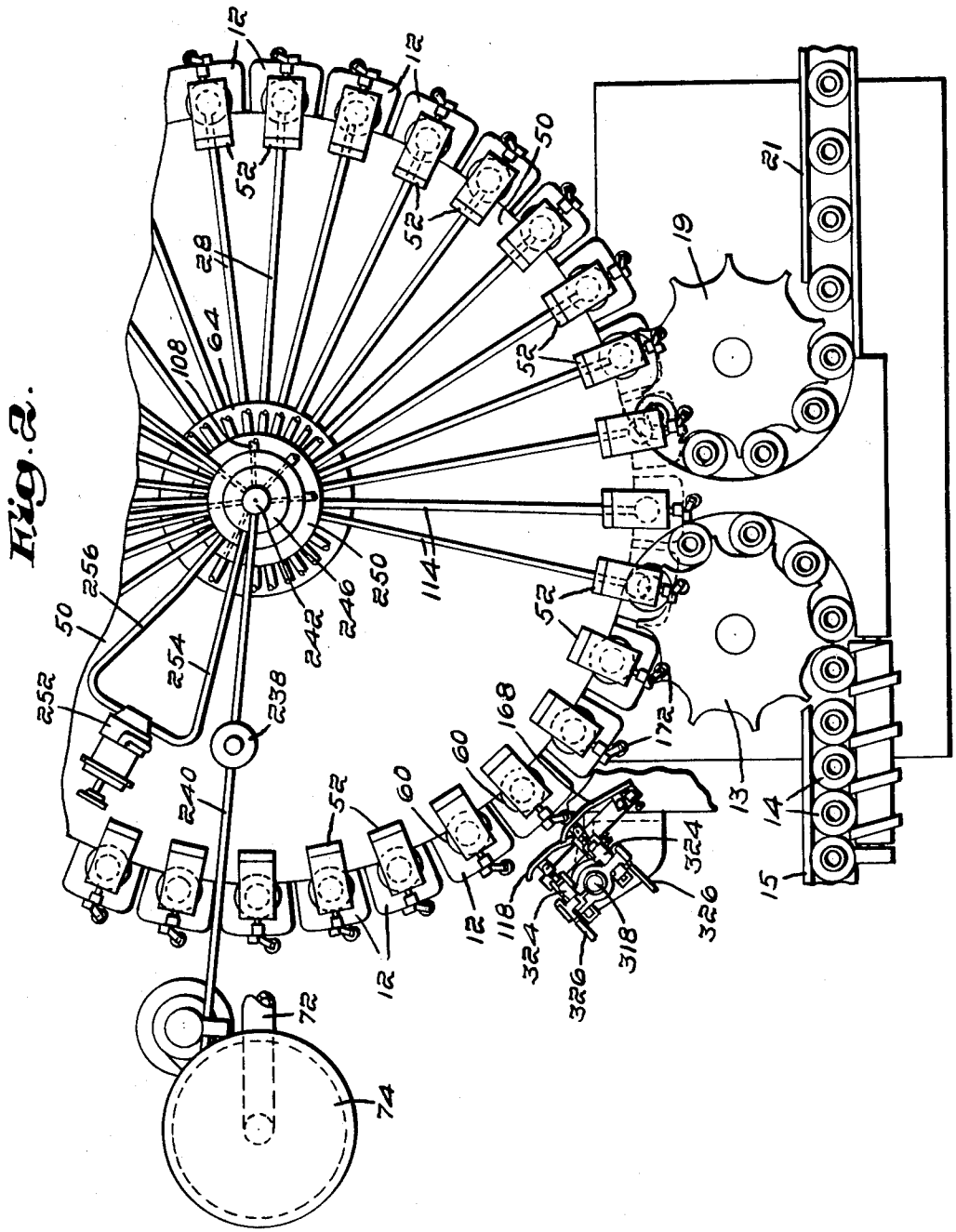


Fig. 2.

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Fig. 4.

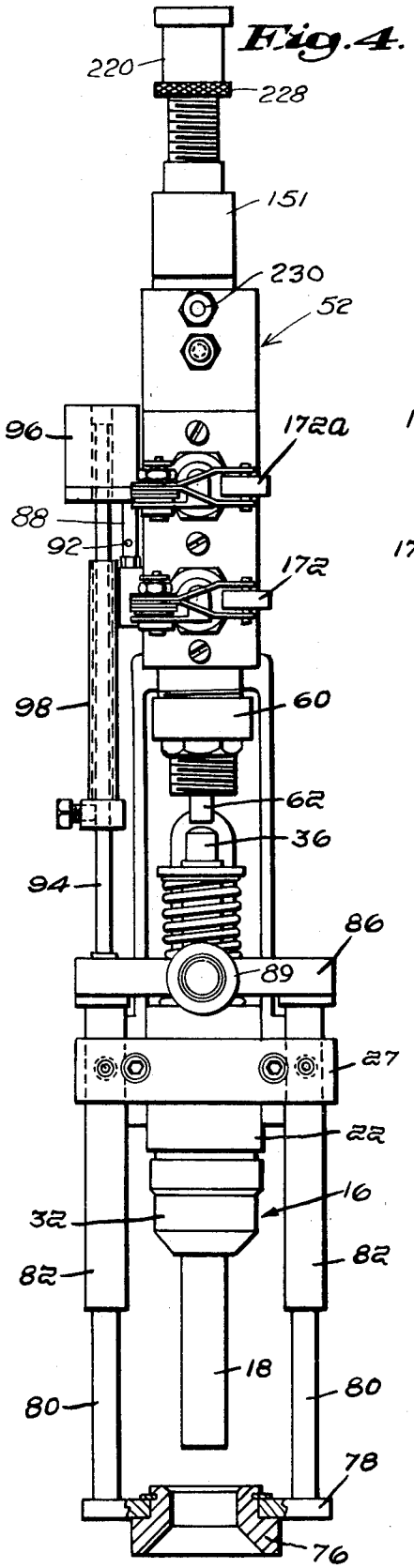
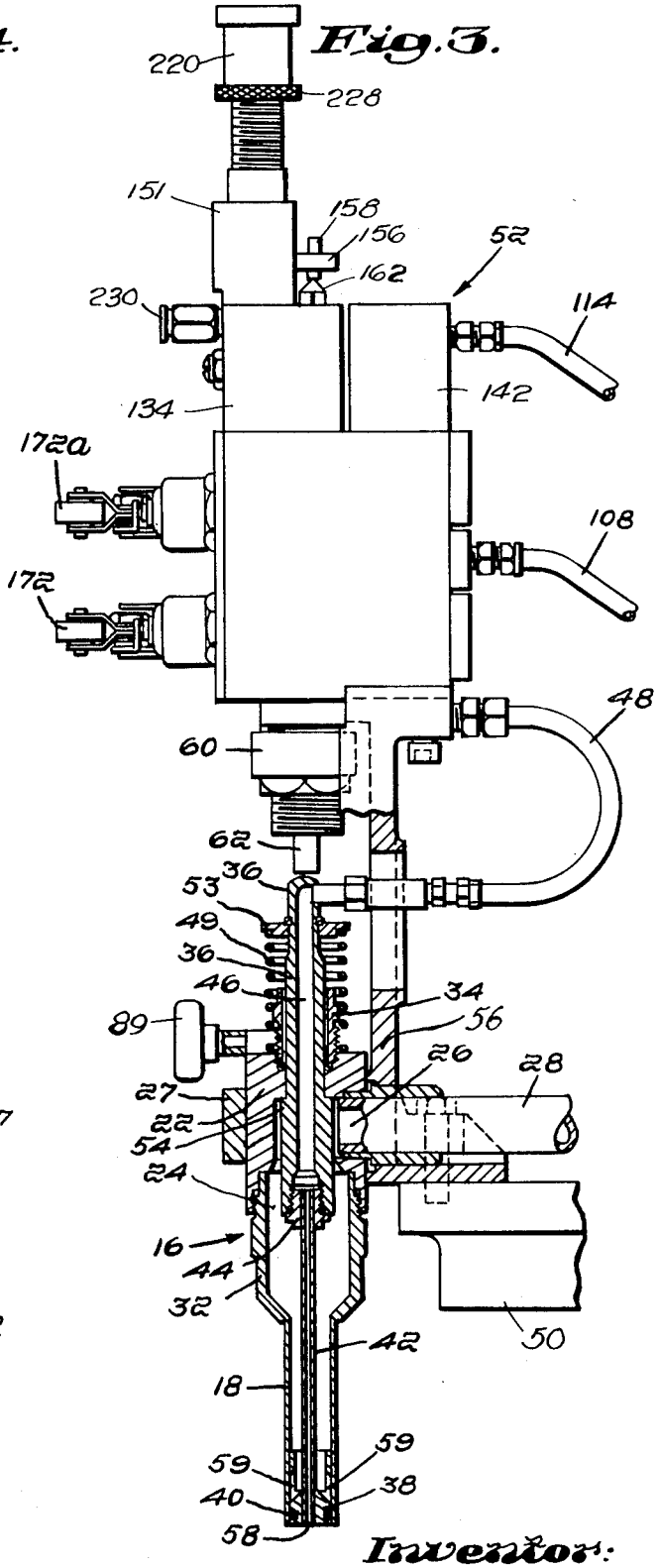
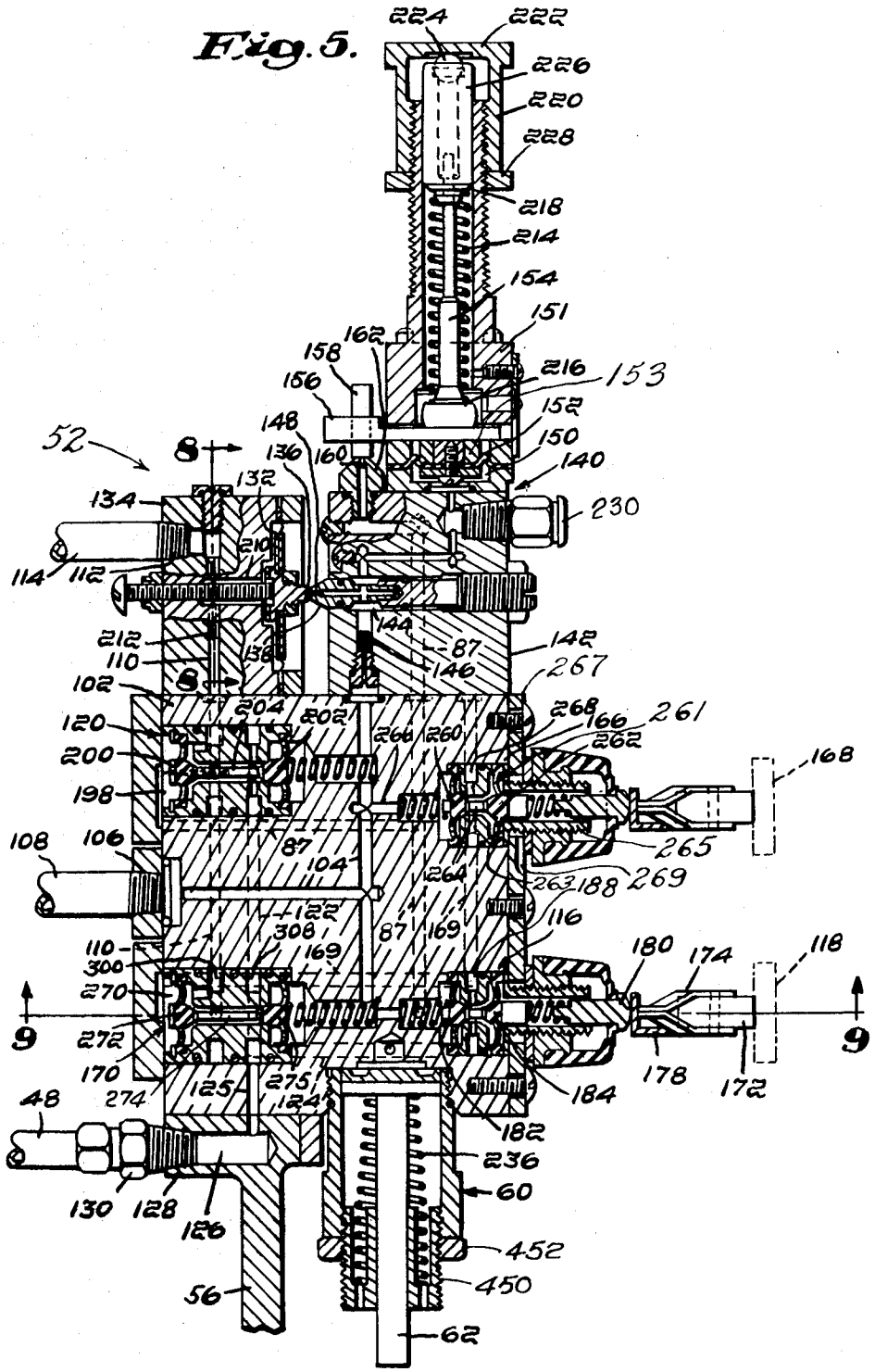


Fig. 3.

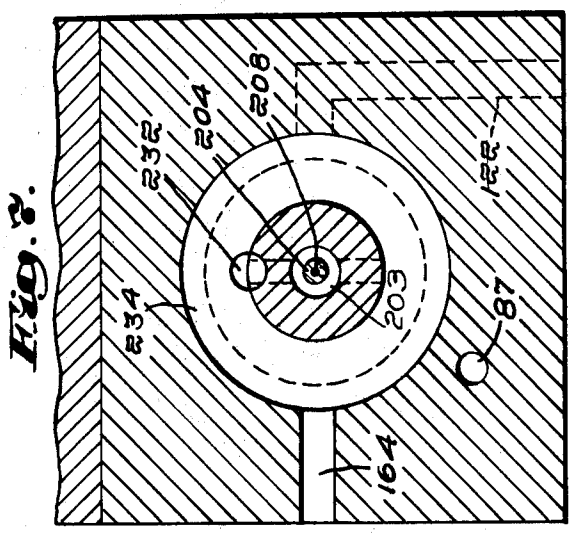


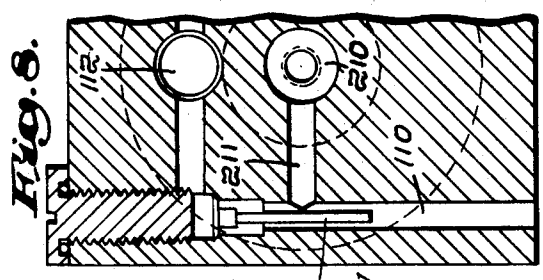
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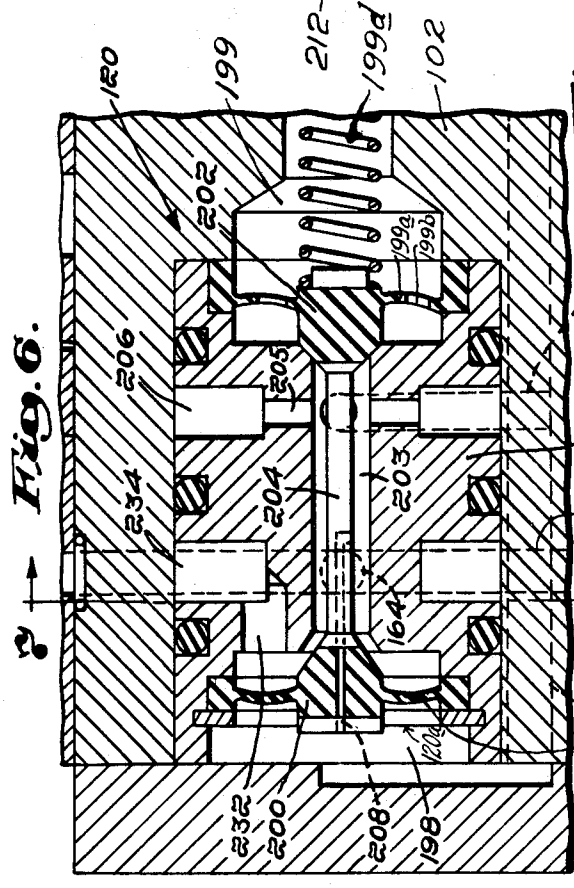
Fig. 5.

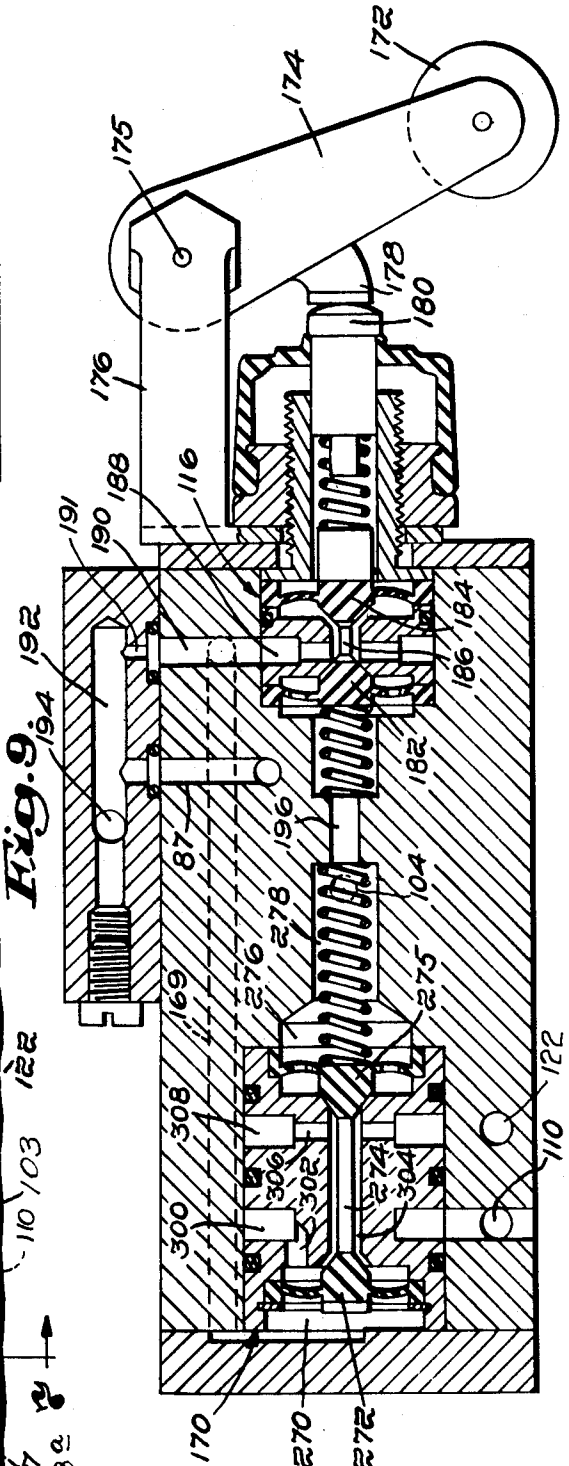


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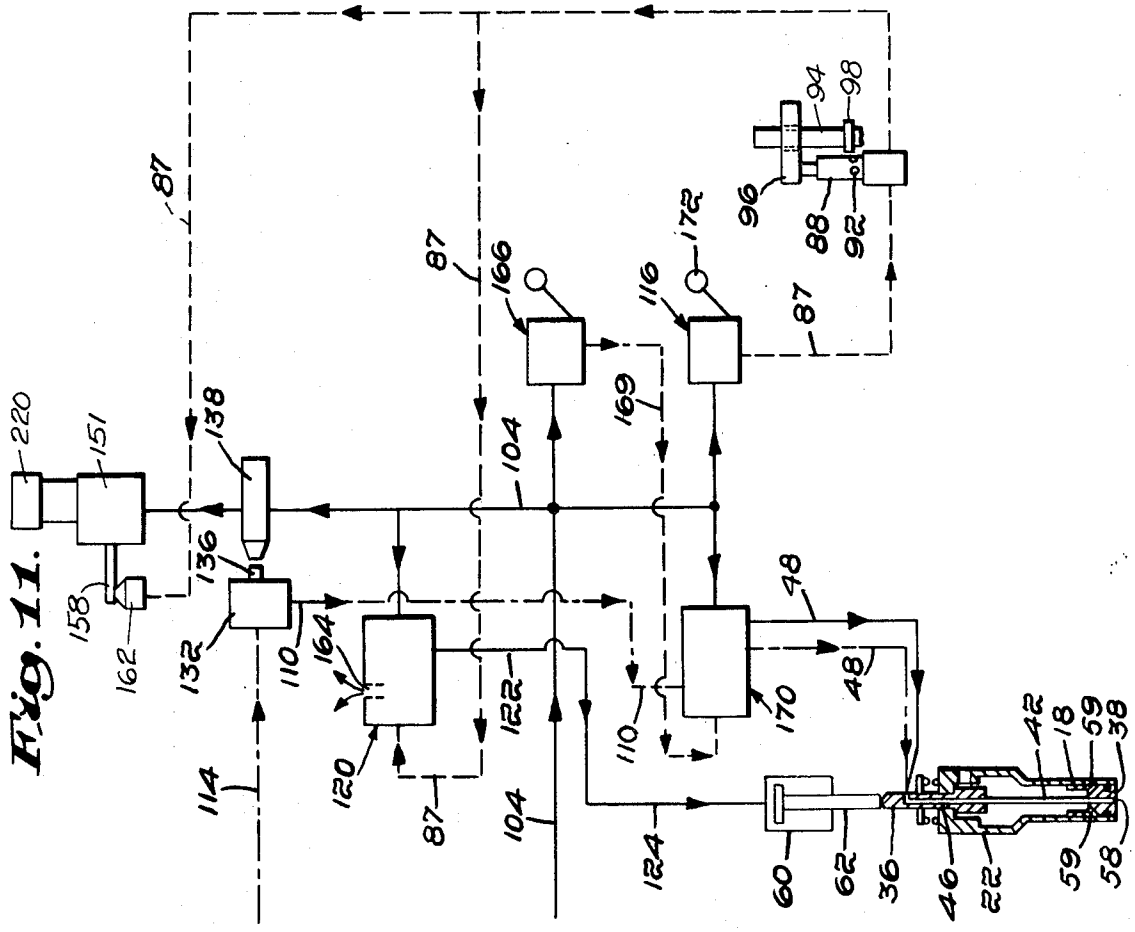


Fig. 11.

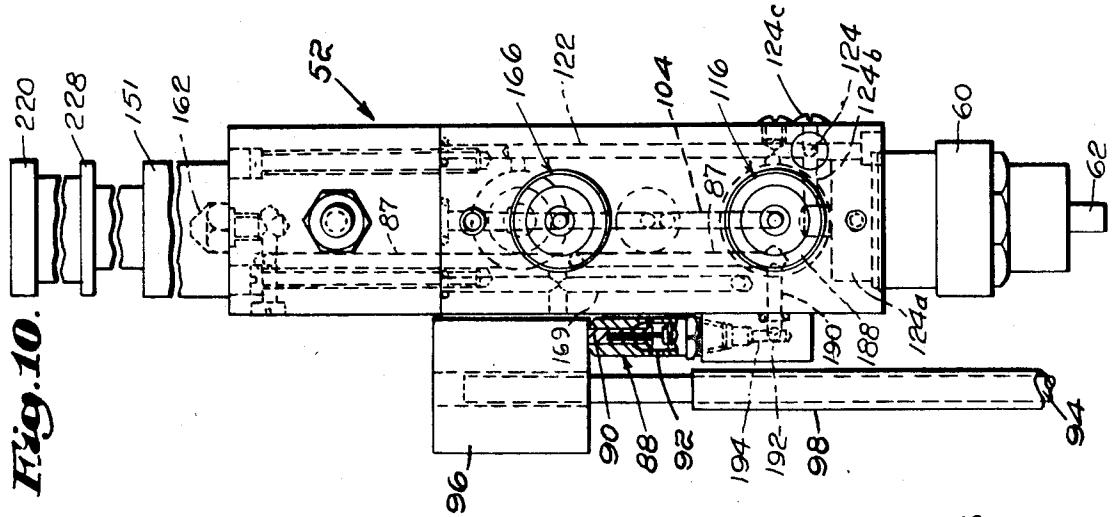


Fig. 10.

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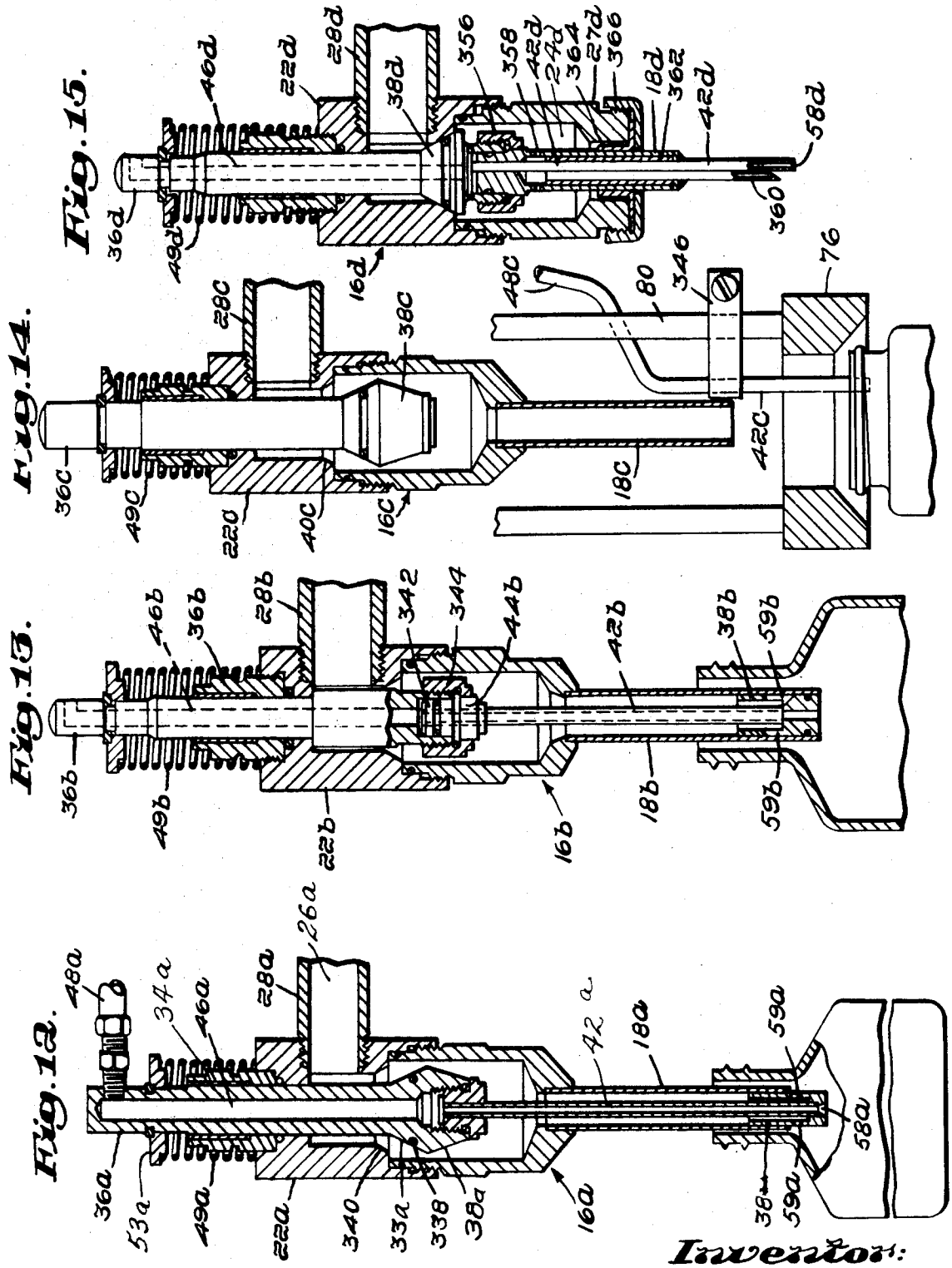
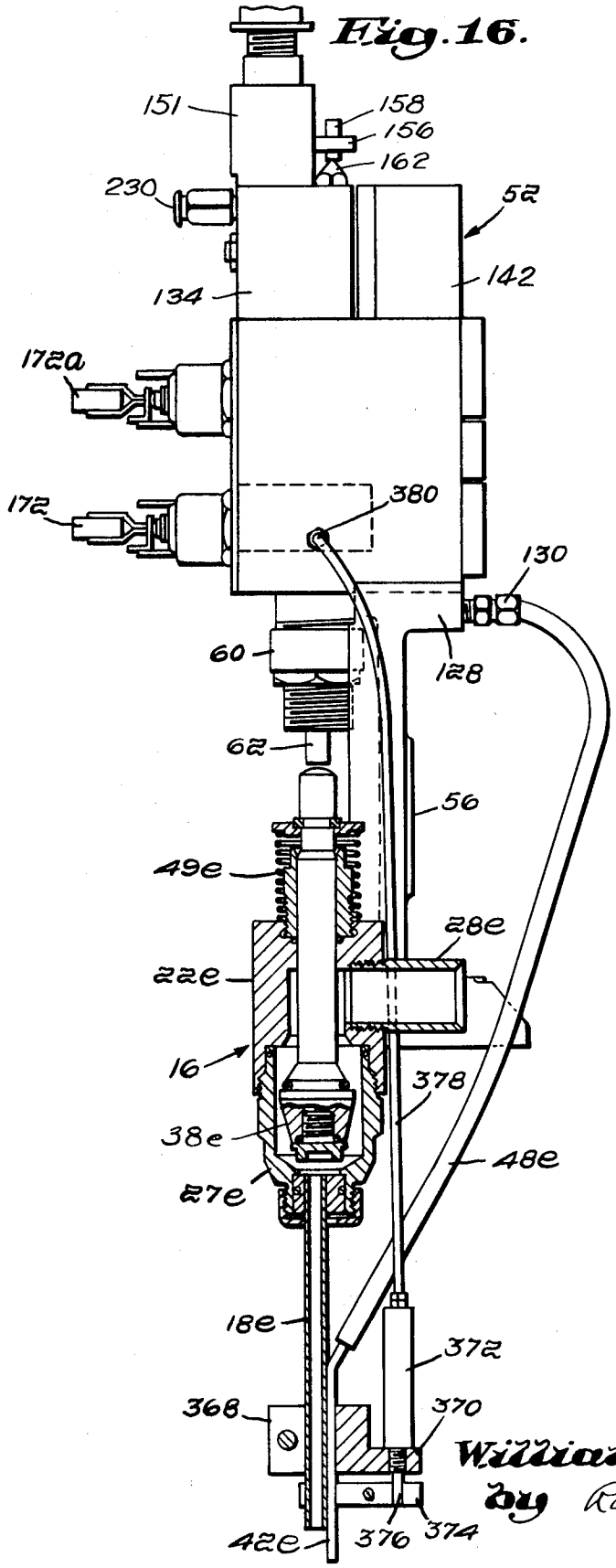

Fig. 15.
Fig. 14.
Fig. 13.
Fig. 12.
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Fig. 16.



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Fig. 17.

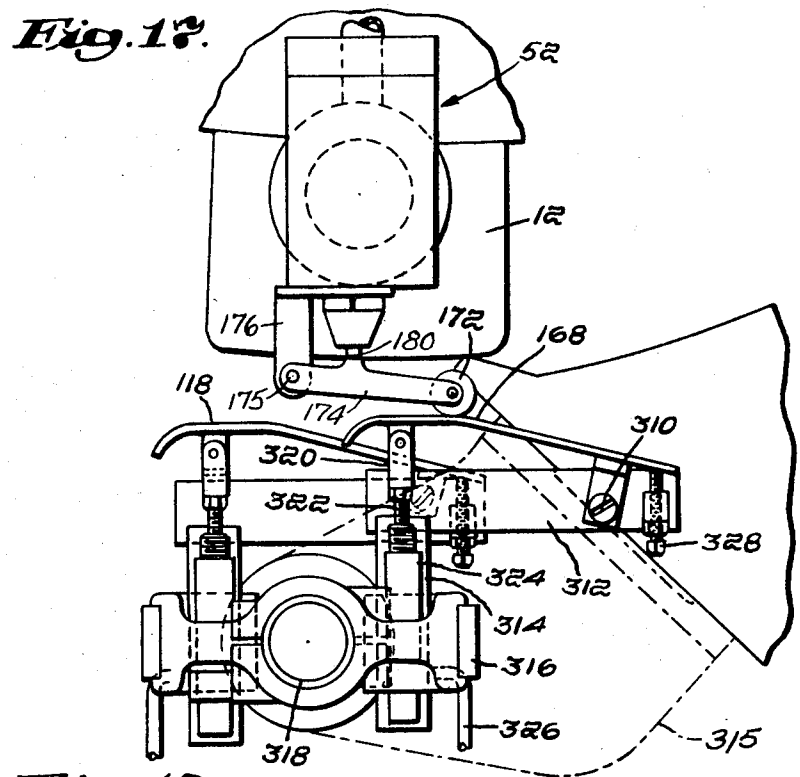
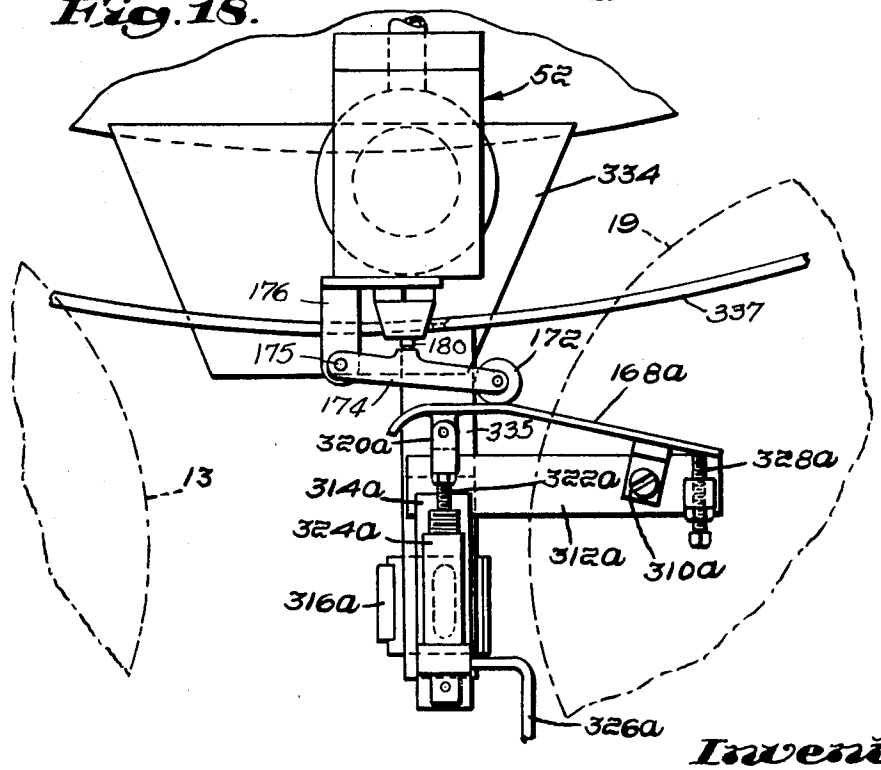


Fig. 18.



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Fig. 19.

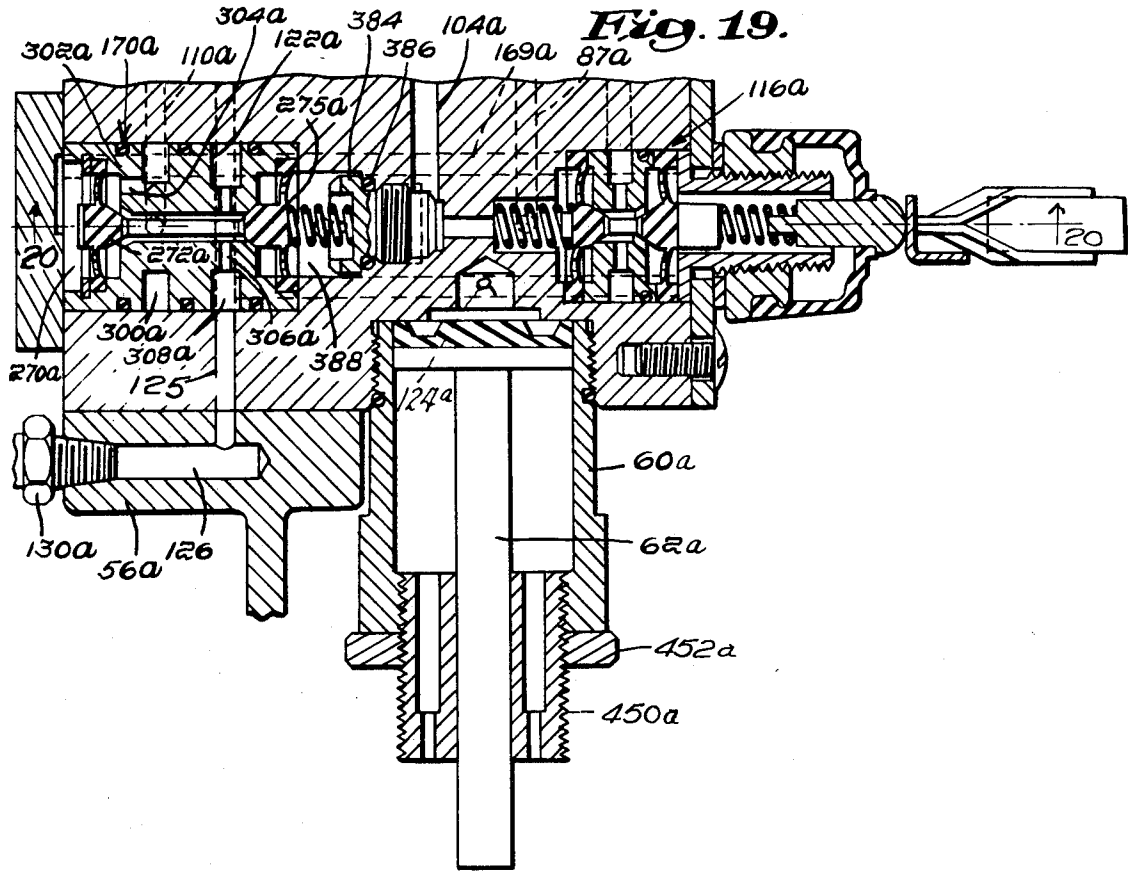
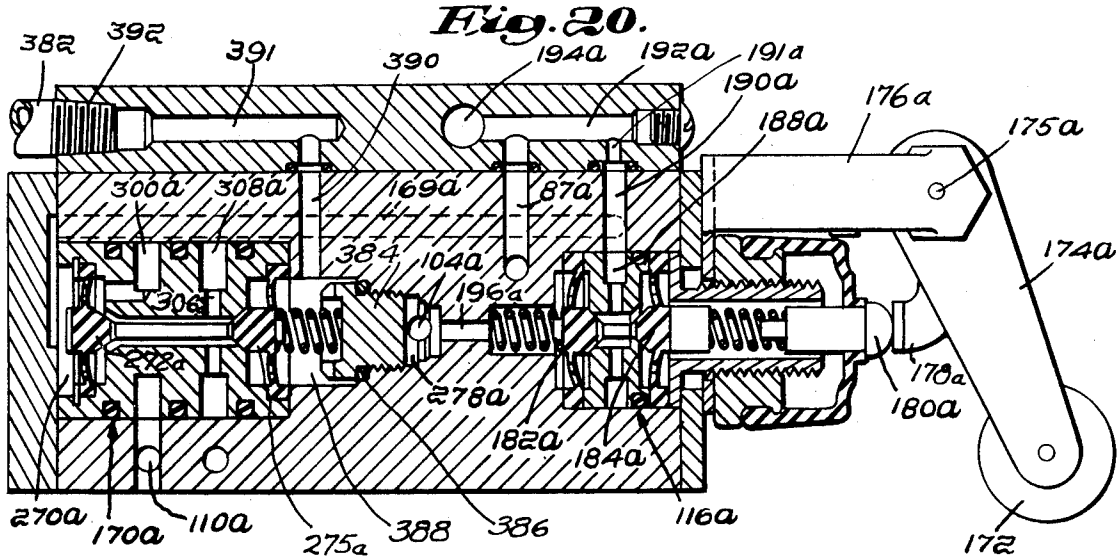
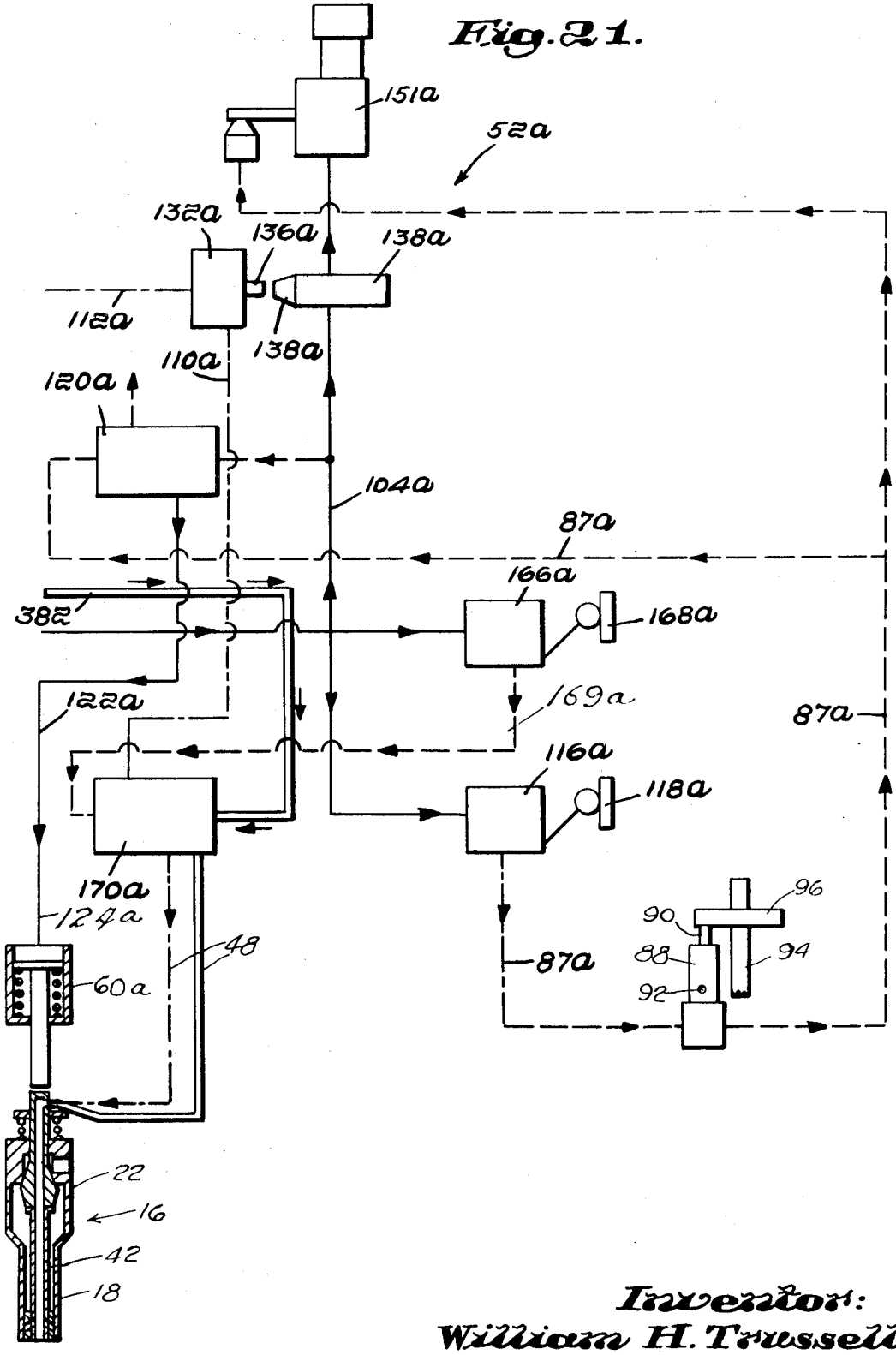


Fig. 20.



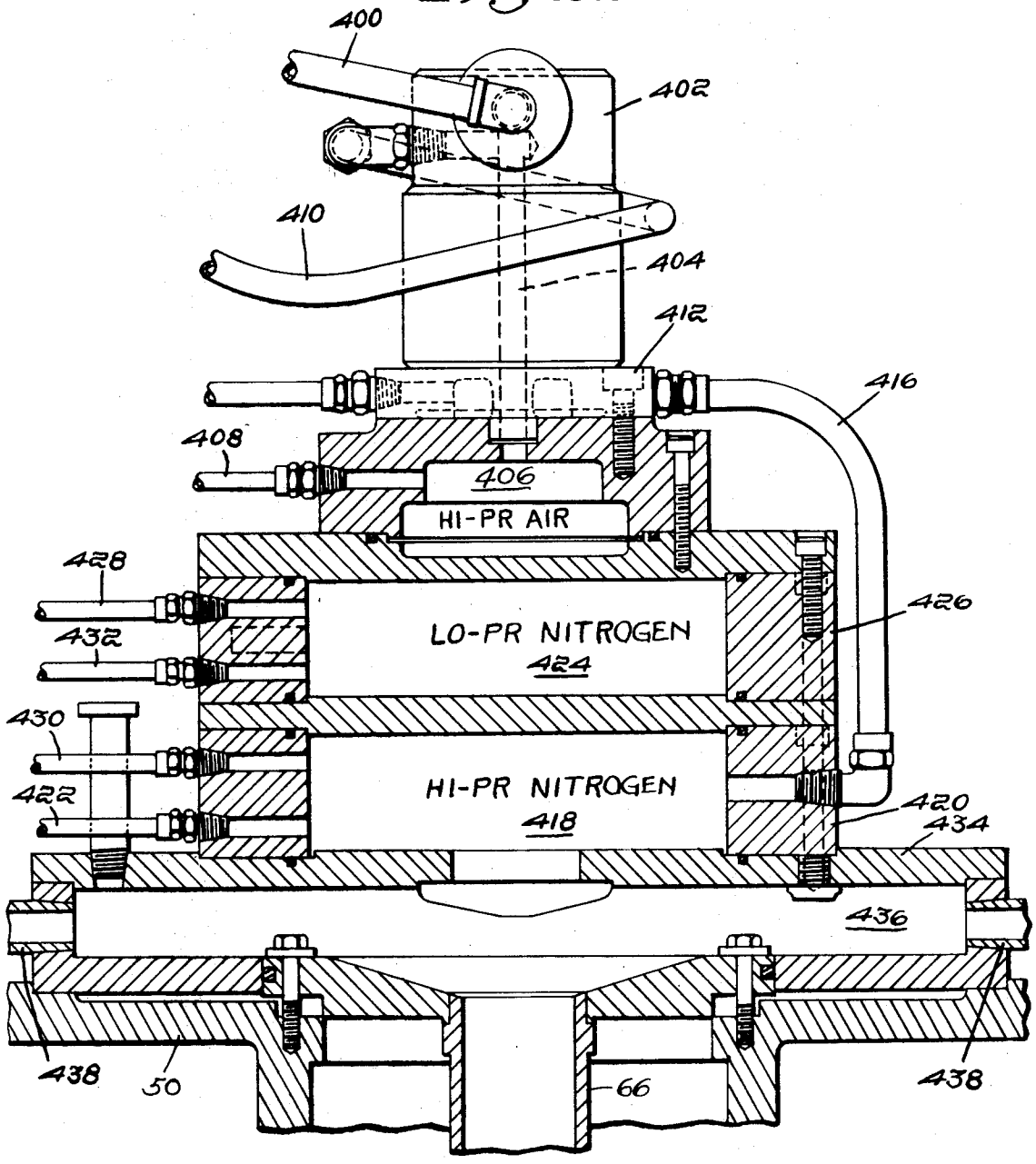
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Fig. 21.



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Fig. 22.



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CONTAINER FILLING MACHINE

This application is a continuation of application Ser. No. 550,391, filed on May 16, 1966, now abandoned.

This invention relates to a container filling machine of the gravity or pressure feed-type and comprises an improvement in the container filling machine illustrated and described in U.S. Pat. No. 3,182,691, issued May 11, 1965. The machine disclosed in the patent operates on a novel principle wherein air at low pressure is conducted through a nozzle into the container being filled during the bottle filling operation, and when the liquid level reaches a height in the bottle to block off escape of low pressure air through the end of the nozzle, a back pressure is built up to actuate pneumatically operated control means to effect closing of the liquid dispensing valve to discontinue the flow of liquid into the container.

In practice, it was found that in the operation of such prior machines the individual pneumatically operated control unit associated with each filling nozzle, while efficient in use, was difficult to adjust in order to cause successive filling units to operate in a manner such as to obtain uniform filling heights in successive containers.

Accordingly, it is one object of the invention to provide a novel and improved container filling machine having pneumatically operated control means of improved structure wherein the individual control unit associated with each filling nozzle may be easily and quickly adjusted in a manner such that successive filling units may be controlled to obtain uniform filling heights in successive containers.

Another object of the invention is to provide a novel and improved container filling machine having novel control means whereby the filling units for successive containers may all be adjusted simultaneously to change the filling heights uniformly in each container in a novel and efficient manner.

The invention has for another object to provide a novel and improved container filling machine provided with a novel structure of pneumatically operated control unit wherein provision is made for clearing the low pressure air nozzle of any accumulated material therein at the end of each filling operation in a simple and efficient manner.

A further object of the invention is to provide a novel and improved container filling machine of the character specified having novel provision for purging successive containers with an inert gas prior to and during the filling operation.

With these general objects in view and such others as may hereinafter appear, the invention consists in the container filling machine and in the various structures, arrangements, and combinations of parts hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings illustrating the preferred embodiment of the invention:

FIG. **1** is a vertical cross-sectional view of a container filling machine embodying the present invention;

FIG. **2** is a plan view of the machine shown in FIG. **1**;

FIG. **3** is a detail view in side elevation and partly in cross section of a filling head and its associated pneumatic control unit;

FIG. **4** is a front elevation of the unit shown in FIG. **3**;

FIG. **5** is a detail view in cross section of the pneumatic control unit shown in FIG. **3**;

FIG. **6** is a cross-sectional view of a valve unit shown in FIG. **5** but at a larger scale;

FIG. **7** is a detail view in cross section of a portion of the valve unit shown in FIG. **6** as seen from the line **7–7** of FIG. **6**;

FIG. **8** is an enlarged cross-sectional detail view of a low pressure air passageway adjacent the pressure sensing diaphragm as seen from the line **8–8** in FIG. **5**;

FIG. **9** is an enlarged cross-sectional view of a portion of the control unit as seen from the line **9–9** of FIG. **5**;

FIG. **10** is a front elevation of the control unit shown in FIG. **5**;

FIG. **11** is a schematic view of the air lines and the valve elements comprising the control unit shown in FIG. **5**;

FIGS. **12**, **13**, **14**, **15** and **16** are detail views of different types of filling head units adapted for use in the present machine;

FIG. **17** is a plan view detail of the cams for operating the pneumatically operated control unit;

FIG. **18** is a detail view of a cam shown in a different position for operating the control unit to effect clearing of the low pressure air nozzle;

FIG. **19** is an enlarged cross-sectional view of a portion of a modified form of a pneumatic control unit adapted for clearing successive low pressure air nozzles with pressurized inert gas;

FIG. **20** is an enlarged cross-sectional view taken on the line **20–20** of FIG. **19**;

FIG. **21** is a schematic view of the air lines and the valve elements comprising the modified control unit embodying provision for purging successive containers with an inert gas; and

FIG. **22** is a cross-sectional detail view of a modified form of central air distributing manifold for use when the containers are purged with an inert gas.

Referring now to the drawings, only those portions of the container filling machine which are necessary to an understanding of the present invention have been herein illustrated and described, reference being made to U.S. Pat. No. 3,182,691, above referred to, for a more complete description thereof. In general, the present invention is embodied in a rotary bottle filling machine wherein a plurality of elevating platforms **12** are mounted to move in a circular path and to which successive bottles **14** to be filled are transferred by a transfer spider **13** from an intake conveyor **15**, see FIG. **2**. During continuous rotation in a circular path, the platforms **12** are arranged to be elevated to present the bottles in operative relation to their respective filling heads indicated generally at **16**, the filling nozzles **18** thereof extending into the mouths of the bottles as shown. Upon completion of the filling operation the elevating platforms **12** are again lowered to a transfer level, and the filled bottles are transferred by a discharge spider **19** onto a discharge conveyor **21** to be delivered from the machine.

The filling head units **16** are carried by and rotatable with a rotary supporting disc **50**, and each filling head unit has associated therewith a pneumatic control unit indicated generally at **52** supported above its filling head. Each control unit **52** is supported by an individual bracket **56** secured to and extended from the rotary supporting disc **50** as shown. Each control unit **52** includes a pneumatically operated cylinder **60** having a piston **62** arranged to cooperate with its filling head unit **16** to control the flow of liquid into the bottle. The filling head units **16** are arranged in circumferentially spaced relation and in vertical alignment with their respective elevating platforms **12** and the bottles **14** carried thereby. As shown in FIG. **3**, each filling head unit comprises a hollow cylindrical nozzle block **22** providing a chamber **24** having an inlet **26** connected with a liquid supply conduit **28**. Each nozzle block is supported by an extension **27** from its individual bracket **56** secured to the rotary supporting disc **50**, the control unit **52** being supported at the upper end of the bracket as shown. The lower end of the nozzle block **22** is provided with a hollow tapering nozzle carrying portion **32** threadedly secured to the block and which forms a continuation of the chamber **24**. The nozzle **18** is secured to or extended from the lower end of the tapering portion **32**. The upper end of the nozzle block **22** is provided with an adapter **34** threadedly secured thereto which forms a bearing for the stem **36** of a vertically movable liquid control valve **38**. In the embodiment illustrated in FIG. **3**, the valve **38** comprises a cylindrical member having an upstanding tubular portion and slidingly fitted in the lower end of the nozzle **18**, the valve seat comprising an O-ring **40** carried by the cylindrical member. The valve stem **36** is provided with a relatively small diameter tubular extension or air nozzle **42** carried by an adapter **44** threadedly secured to the lower end of the stem, the lower end of the air nozzle **42** being secured to and extended through the valve **38**.

The upper end of the air nozzle 42 communicates with a central passageway 46 formed in the valve stem 36, and the upper end of the passageway 46 is connected through a sidewall opening by a flexible conduit 48 to a source of low pressure air from the pneumatically operated control unit 52, as will be described.

A relatively heavy coil spring 49 interposed between the upper surface of the nozzle block 22 and a collar 53 carried by the stem 36 is arranged to urge the valve 38 upwardly into its closed position as shown. The stem 36 is also provided with a shouldered portion 54 which engages a shouldered portion formed in the nozzle block 22 to limit the upward movement of the valve. The lower end of the air nozzle 42 provides an outlet 58 open to the atmosphere. As illustrated, the small diameter air nozzle 42 extends into the liquid nozzle 18 providing an annular space therebetween. The valve 38 is closed at its lower end except for the air outlet 58, the sidewalls of the valve being provided with a plurality of liquid escape openings 59 as shown.

In operation, when the valve 38 is moved downwardly, it is telescopically extended from the lower end of the nozzle 18 to expose the openings 59 and permit the liquid to flow into the container. Conversely, when the valve 38 is moved upwardly to its closed position, the valve will be drawn upwardly within the nozzle 18, as shown, to close the liquid escape openings 59 and thus terminate the flow of liquid into the container.

The liquid supply conduit 28, as seen in FIG. 1, is radially extended from a central liquid distributing manifold 64 from which similar conduits 28 extend to each filling head. The manifold 64 is mounted on and rotatable with the rotary supporting disc 50 on which the filling head units 16 are mounted. A central depending pipe 66 connected to and in communication with the manifold chamber is telescopically and rotatably received in a central stationary upstanding pipe 68. The lower end of the pipe 68 is connected to an adapter 70, and a supply pipe 72 extends from the adapter to a supply tank 74. The liquid may flow from the tank by gravity to the distributing manifold and to the various filling heads, or the supply tank may be pressurized to effect a faster delivery of the liquid to the filling heads and into the bottles.

In operation, a continuous line of containers, such as bottles 14, on the intake conveyor 15 are transferred onto successive platforms 12 by the transfer spider 13. During the continuous movement of the platform in a rotary path, it is elevated to present the bottle into operative filling position with its nozzle 18 extended into the mouth of the bottle. As the bottle is elevated, it engages a nozzle guide 76 which is provided with a flared opening arranged to receive the neck of the bottle to align it with its nozzle as shown in FIG. 4. The nozzle guide 76 is carried by and detachably connected to a plate 78 supported on the ends of spaced slide rods 80 movable vertically in slide bearings 82. The slide bearings 82 are adjustably supported in the extension 27 in which the nozzle block 22 is also adjustably supported. The upper ends of the slide rods 80 are connected by a tie bar 86 which rests on top of the slide bearings 82 when the nozzle guide 76 is in its lowered position as shown. The nozzle guide is maintained in its lowered position by gravity, and in operation when the bottle is moved upwardly to engage the nozzle guide, the slide rods together with the tie bar 86 move upwardly. Conversely, when the platforms 12 are subsequently lowered, the nozzle guide and its slide rods are lowered, the tie bar 86 coming to rest on top of the slide bearings to limit the downward movement. In practice, a cam, not shown, cooperates with a roller 89 carried by the tie bar 86 to elevate the nozzle guide 22 at the end of the filling operation to release the containers for transfer to the discharge spider 19. Provision is made for preventing operation of the pneumatic control unit 52 in the event that no container 14 is present on the platform 12 when it is elevated so as to prevent opening of the liquid control valve 38 at such time. As will be hereinafter described, the pneumatic control unit 52 is provided with pilot line 87, see FIG. 5, which is arranged to receive a momentary pulse of high pressure air to initiate the filling cycle. The pilot line 87 communicates with a normally closed air exhaust valve 88 carried by and secured to one side of the control unit 52 as shown in FIGS. 4 and 10. In operation, the normally closed air exhaust valve 88 is maintained in its open position until a container is elevated into operative filling position. The exhaust valve 88 comprises a housing provided with a chamber in communication with a conventional spring pressed tire valve, the stem of which extends into and elevates a button 90 above the housing when the valve is closed. The wall of the chamber has an exhaust opening 92 which is open to the atmosphere, and in operation, when the button 90 is depressed downwardly to open the tire valve, air from the pilot line 87 may pass through the valve into the chamber and out through the exhaust opening 92, thus rendering the pilot line 87 inoperative to activate the control unit 52. Conversely, when the button 90 is elevated by the tire valve stem to cut off the escape of air from the pilot line, the control circuit is rendered operative to activate the control unit.

As shown in FIG. 4, the tie bar 86 is provided with an upstanding rod 94 having a weight 96 slidingly mounted on the upper end thereof and which is arranged to engage and depress the button 90 to open the tire valve to permit escape of air through the exhaust port 92 when the nozzle guide 76 is in its lowered position. A weight elevating member comprising an elongated sleeve 98 is adjustably secured to the upstanding rod 94, and in operation, the upper end of the sleeve 98 is arranged to engage and lift the weight off the button 90 when a container is elevated into filling position. Thus, the button is spring pressed upwardly to permit closing of the tire valve. As a result, the pilot line is sealed so that when high pressure air is admitted to the pilot line 87 by a momentary pulse of air, the control unit is in readiness to initiate a filling cycle as will be hereinafter more fully described. Conversely, if no container is present, the weight 96 will not be lifted, and the tire valve will remain open to exhaust the pilot line through the opening 92, thus rendering the control unit 52 inoperative to start the filling cycle. Thus, in operation, if no container is present, the control unit 52 will not be activated to open the liquid control valve 38.

Referring now to FIG. 5, the pneumatically operated control unit 52 comprises, in general, a metal block 102 having bored portions therein for receiving the various control valves and having passageways therein for connecting selected control elements. The passageways include a high pressure air line or circuit 104 having an inlet 106 connected by a flexible conduit 108 to a source of high pressure air; a low pressure air line or circuit 110 having an inlet 112 connected by a flexible conduit 114 to a source of low pressure air; and the pilot line 87 arranged to be energized by a momentary pulse of high pressure air from the line 104 to initiate the filling operation at a time when a bottle is elevated into filling position to effect closing of the valve 88.

In general, and as also diagrammatically illustrated in FIG. 11, the control valves include a two-way normally closed trip valve 116 arranged to be opened by a stationary cam 118 during operation of the machine to admit a momentary pulse of high pressure air into the pilot line 87; a three-way normally closed pilot valve 120 in communication with the pilot line 87 and arranged to be opened when the pilot line 87 is energized by a momentary pulse of high pressure air, the valve 120 also having provision for maintaining the pilot line energized to hold the valve 120 open to high pressure air during the filling operation. Opening of the pilot valve 120 admits high pressure air from the line 104 through the valve 120 and through passageways 122, 124 to the cylinder 60 to extend its piston 62 which serves to depress the valve stem 36 of the filling head to start the filling operation.

As more specifically illustrated in FIG. 6, the pilot valve 120 comprises a middle or intermediate chamber 203 and end chambers 198 and 199 at opposite ends thereof formed in a core piece 103 recessed into the block 102, and a valve element 120*a* supported in the chambers. At the ends of the mid-

dle chamber **203** where they enter the end chambers there are conical valve seats. The valve element **120***a* has heads **200** and **202** situated in the end chambers and a stem **204** connecting them which extends through the intermediate chamber and is supported for longitudinal movement on the one hand to engage one valve head with its seat and disengage the other from its seat, and on the other hand to disengage the one valve head from its seat and engage the other valve head with its seat. Such longitudinal movement is afforded by flexible diaphragms **198***a* and **199***a* to which the heads are secured and by means of which the valve element is mounted at its ends in the end chambers. The end chamber **199** at the outer side of the diaphragm **199***a* is in communication with the high pressure line **104**. The end chamber **198** at the outer side of the diaphragm **198***a* is in communication with the pilot line **87**. Between the valve seats there are radial ports **205** in communication at one end with the middle chamber **203** and at their other ends with an annular passage **206** formed in the core. The annular passage **206** is in turn in communication with the passages **122** and **124**. The diaphragm **199***a* contains ports **199***b* through which the pressure fluid from the high pressure line is free to flow from the end chamber **199** into the intermediate chamber **203** when the valve head **202** is open. The stem **204** has an axial passage **208** which extends from substantially midway between the opposite ends of the spindle **204** through the valve head **200** and provides communication between the intermediate chamber **203** and the end chamber **198** in both the open and closed positions of the valve. The portion of the end chamber **198** inwardly of the diaphragm **198***a* contains an axial port **232** which is in communication with an annular passage **234** formed in the core **103** and this in turn is in communication with an exhaust passage **164** open to the atmosphere.

The low pressure air line **110** is under pressure at all times and is arranged to pass through a valve unit **170**, to be described, which is in communication with a passageway **125** in the block **102** which leads to a passageway **126** formed in the upper end **128** of the support bracket **56**. The passageway **126** is provided with a nipple **130** which connects the flexible conduit **48** to passageway **46** in the stem **36** and to the air nozzle **42** forming a part of the filling head unit **16**. The low pressure air line **110** also communicates with a preconvoluted rolling diaphragm **132** housed in an extended portion **134** of the block **102** and which is arranged to be actuated by the back pressure in the low pressure air line when the outlet **58** of the air nozzle **42** is blocked by the liquid when it reaches a predetermined height in the container. The diaphragm **132** carries a valve member **136** arranged to cooperate with a jet member **138** which is in communication with the high pressure air line **104**. The jet member **138** forms part of a pneumatic high pressure control unit indicated generally at **140** which is formed in a second extension **142** of the block **102**.

The pneumatic control **140** embodies fluid conductor means comprising a chamber **144** which communicates with the high pressure air line **104** through a restricted throat portion **146** arranged to offer a substantial resistance to the flow of air therethrough, and the jet member **138**, also in communication with the chamber **144**, is provided with a small discharge orifice **148**. In operation, the jet member **138** may be adjusted to space the discharge orifice a predetermined distance from the valve member **136** of the diaphragm, and when the back pressure in the low pressure air line effected by blocking of the air nozzle **42** causes the diaphragm to move the valve member **136** toward the jet **138** a minute distance to reduce the discharge of air from the jet **138**, a substantial rise in residual pressure occurs in the chamber **144**. The chamber **144** also communicates with a chamber **150** formed in a block **151** supported on the extension **142**, the chamber **150** having a resilient upper wall or rolling diaphragm **152** which carries a piston **153** and an adjustable spring loaded stem **154** arranged to be elevated when the pressure in the chamber **144** is increased. The stem **154** carries an arm **156** provided with a pin **158** which cooperates with a normally closed air escape orifice **160** formed in a jet **162** in communication with the pilot line **87**.

Thus, in operation, when the diaphragm **132** is actuated in response to back pressure in the low pressure air line **110** when a predetermined filling height is reached, the pressure in he pneumatic control **140** is increased to raise the pin **158** from the air escape orifice **160**, thus bleeding air from the pilot line **87** to reduce the pressure therein and causing the pilot valve **120** to be spring closed. Closing of the valve **120** cuts off the supply of high pressure air to the passageways **122**, **124** permitting the piston **62** to be spring returned to its inoperative position, thus permitting the liquid control valve **38** to close to cut off the flow of liquid into the container. Closing of the pilot valve **120** to cut off the high pressure air also opens the lines **122**, **124** to an atmospheric exhaust port **164** to effect rapid discharge of the air in the cylinder **60** and rapid closing thereof.

As further illustrated in FIGS. **5** and **11**, provision is also made in the present pneumatically operated control unit for clearing the low pressure air nozzle **42** of any material which may be accumulated therein during the filling operation by directing a momentary surge of high pressure air through the nozzle at the end of the filling cycle and prior to starting a succeeding filling cycle. As shown in FIG. **5**, in general, this is accomplished by means of a normally closed three-way trip valve indicated generally at **166** which is arranged to be opened by a stationary cam **168** during the operation of the machine. Opening of the valve **166** admits air from the high pressure line **104** to a line **169** which leads to a three-way normally closed valve unit **170** arranged to cut off the flow of low pressure air from line **110** through the valve **170** at this point and to admit a momentary surge of high pressure air from line **104** through the valve **170** and through the passageways **125**, **126** to the low pressure air nozzle **42** to clear the same.

From the description thus far, it will be seen that successive containers **14** supported on their platforms **12** are elevated to extend the nozzles **18** into the containers in operative filling position, and elevation of a container into filling position operates to close the tire valve **88** to seal the pilot line **87** in readiness to actuate the control unit **52** to start the filling operation during rotation of the containers with their respective control units.

As illustrated in FIG. **2**, the cam **118** for actuating the valve **116** is arranged in the path of a roller **172** carried by an arm **174** pivotally mounted at **175** in a bracket **176** attached to the block **102** as better shown in FIG. **9**. An extension **178** from the arm **174** is arranged to depress a spring pressed plunger **180** forming a part of the valve **116** as shown in FIGS. **5** and **9**. The valve **116** includes a conical spring pressed normally closed valve member **182** carried by a flexible disc having openings therein. The valve **116** also includes a similar valve member **184** carried by a flexible disc and which is normally open as shown. The valve members **182**, **184** are connected by a stem **186**, and intermediate the valve members is an annular passageway **188** in communication with the chamber of the air exhaust valve **88**, as shown in FIGS. **9** and **10**, through passageways **190**, **192**, **194** when the no-bottle no-fill tire valve is open. The pilot line **87** is also in communication with the passageway **192**. The high pressure air from line **104** is under pressure at all times and enters through passageway **196** to the area adjacent the seated valve member **182**. Thus, in operation, when the plunger **180** is depressed by the cam **118**, the valve members are shifted to permit high pressure air to enter the annular passageway **188** through the central passageway and then through connecting radial passageways as shown. In the event that no container is present, the tire valve will remain open so that the momentary pulse of air effected by the cam will be exhausted through the port **92** to prevent energizing of the pilot line **87**. However, when a container is present and the same is elevated into filling position to lift the weight **96** off the button **90**, the tire valve will be closed when the cam **118** depresses the plunger **180**, and as a result, a momentary pulse of high pressure air will enter the

pilot line 87. The pilot line is connected to the end chamber 198 of the pilot valve 120. Accordingly, when the high pressure air is supplied to the pilot line the valve element 120*a* will be shifted in a direction to engage the head 200 with its seat and disengage the head 202 from its seat thus to admit high pressure air from the line 104 into the central chamber 203 and through the radial ports 205 to the annular passage 206 which is in communication with the lines 122, 124 leading to the cylinder 60 to start the filling cycle. A spring 199*b* is desirably applied to the outer side of the head 202 to assist in closing the valve. The passageway 208 in the stem permits the high pressure air to flow from the center chamber 203 into the end chamber 198 at the outer side of the diaphragm 198*a* to thereby hold the valve element in its open position.

When the liquid in the container reaches a predetermined height, such as to cut off the escape of low pressure air from the outlet 58, the back pressure built up in the low pressure line 110 enters a chamber 210 in back of the diaphragm 132 to reduce the gap and consequently impede the escape of air between the valve member 136 and the jet member 138. It will be observed that the low pressure air supply is provided with a relatively small inlet tube 212 comprising a Venturi tube, the end of which extends beyond the inlet 211 to the chamber 210, as shown in FIG. 8, so that in practice the air entering the line 110 will not be initially directed to the diaphragm chamber to give a false signal. On the other hand, when back pressure is developed in the line 110, the Venturi tube prevents the low pressure air from being absorbed into the supply and causes the increase in pressure to be directed to the diaphragm chamber 210. As previously described, movement of the valve member 136 toward the jet 138 causes an increase in pressure in the pneumatic unit 140 to lift the pin 158 off the air escape orifice 160 to exhaust the air in the pilot line 87. In practice, the jet 138 may be adjusted relative to the valve member 136 to obtain a predetermined increase in pressure when the diaphragm 132 is moved a distance sufficient to elevate the spring pressed stem 154 and to exhaust the pilot line 87 when a predetermined filling height is reached. As illustrated in FIG. 5, a spring 214 interposed between a shoulder 216 of the stem 154 and a collar 218 slidingly mounted on the stem may be adjusted by an adjusting cylinder 220 threadedly engaged with the block or housing 151. The cap 222 of the cylinder engages a ball 224 set in a hollow slide rod 226 in which the upper end of the stem is received, the lower end of the rod 226 engaging the collar 218. A check nut 228 is provided to hold the cylinder in its adjusted position.

As a result, in practice each individual unit may be easily and quickly adjusted so that the pressure exerted by the spring 214 may be varied whereby it will be overcome by a relatively small increase in the pressure built up in the chamber 150 in a manner such that a uniform filling height may be maintained in each unit. In other words, the jet member 138 may be initially adjusted to provide a predetermined uniform gap between the jet and the valve 136 which provides a predetermined pressure in each control unit 140, as determined by a test gauge inserted into a normally closed adapter 230 as shown in FIG. 5. Thereafter, the spring pressure on the stem 154 may be individually adjusted so that any small increase in pressure in the control unit 140 above the initial setting will overcome the spring 214 to lift the pin 158 and bleed the pilot line 87.

Immediately upon exhausting the pilot line 87, the valve 120 is shifted by its spring to close off the high pressure air and to open the central chamber 203 to the atmosphere through the exhaust opening 164. As shown in FIGS. 6 and 7, the air in the cylinder pressure line 122, 124 may exhaust into the annular passageway 206 and through radial passageways 205 into the central chamber 203. The air then passes by the open valve member 200 and through a communicating passageway 232 into an annular passageway 234 which communicates with the exhaust opening 164. In this manner, the cylinder 60 is quickly evacuated to effect rapid spring closing of the liquid control valve 38 when a predetermined filling height is reached in the container. It will be observed that the chamber 198 of the pilot line 87 is also exhausted at this time through the small passageway 208 formed in the stem 204, the air passing into the central chamber 203 and out through the exhaust opening 164 as described. In the embodiment of the invention illustrated in FIG. 5, the piston 62 of the cylinder is provided with a spring 236 which returns the piston to its retracted position when the line 122, 124 is exhausted. As shown in FIG. 3, the valve stem 36 is also provided with a spring 49 to effect retraction of the valve 38 to cut off the flow of liquid into the container. However, in practice, it was found that the piston spring 236 may be eliminated in some instances, and in such cases, retraction of the stem 36 by the spring 49 is sufficient to also return the piston 62 to its retracted position since the stem is in contact with the lower end of the piston as shown.

From the above description it will be seen that the individual control units 52 associated with each filling head may be easily and quickly adjusted to obtain a uniform filling height in successive containers by merely adjusting the tension of the spring 214. Another important feature of the present invention resides in the provision of a pressure regulating valve 238 (FIG. 1) in the high pressure air line 240 leading from the source of high pressure air which may be adjusted to change the filling height in all of the containers simultaneously. As above described, the residual pressure in the control unit 140 is initially set to provide a uniform initial pressure in the chamber 144 of each unit. This chamber pressure is proportional to the initial regulated pressure in the high pressure supply line 240 leading to the high pressure lines 104 in each control unit 52. This chamber pressure is set by adjustment of the jet member 138 so that a slight increase in pressure in the chamber 144 in response to movement of the diaphragm valve 136 will overcome the force of the spring 214 to elevate the spring pressed stem 154 to exhaust the pilot line and close the liquid control valve 38. It was found in practice that by varying the pressure of the high pressure air in the supply line 240 by adjustment of the regulating valve 238, the pressure in the chamber 144 of the control unit 140 will likewise be changed proportionately in each control unit. Thus, if the main line pressure is reduced, the pressure in the chamber 144 will be reduced proportionately so that the diaphragm valve 136 will have to be moved closer to the jet 138 to effect an increase in pressure in the chamber 144 sufficient to elevate the pin 158 and exhaust the pilot line. In other words, the back pressure in the low pressure line 110 caused by blocking off the outlet 58 will be gradually increased over a small interval of time after initial blocking to a point where the valve 136 will be moved closer to the jet 138 to effect such increase in pressure in the chamber 144 during which time the liquid will still be flowing into the container to obtain a higher filling height than that previously obtained with a different main line pressure. In practice it was found that the filling height could be varied as much as one-half inch in each container simultaneously by varying the pressure in the main supply line 240 by means of the pressure regulating valve 238.

As illustrated in FIG. 1, the main supply line 240 leads to a fitting 242 mounted on and arranged to permit rotation of an upstanding inlet pipe 244 in communication with a central high pressure air chamber 245 of an air distributing manifold 246 from which the high pressure air conduits 108 extend. The low pressure air supply lines 114 lead to the chamber 248 of a central low pressure manifold 250. Air to the low pressure chamber 248 is supplied from the high pressure chamber 245 through a pressure regulator 252 supported on the rotary disc 50 and which is arranged to reduce the pressure of the air supplied to the low pressure chamber. As shown, a pipe 254 leads from the chamber 245 to the regulator, and a pipe 256 leads from the regulator to the chamber 248.

Referring again to FIG. 5 for a more detailed description of the provision for clearing the pressure sensing nozzle 42 after each filling operation, it will be seen that the trip valve unit 166 is similar to but not exactly the same in structure and

mode of operation as the trip valve unit **116** and is provided with a normally closed valve member **260** and a normally open valve member **262** connected by a stem **264**. High pressure air is directed from the line **104** through a passageway **266** to a chamber in back of the normally spring closed valve **260**. When the valve unit **166** is shifted by its cam **168**, the valve member **262** is closed and the valve member **260** is opened to admit air past the valve **260** into a chamber intermediate the two valve members and through radial openings to an annular chamber **268** in communication with the line **169**. The line **169** leads to a chamber **270** in back of a valve member **272** forming a part of the valve unit **170**. The valve member **272** is connected by a stem **274** to a normally closed valve member **275** which is movable in a chamber **276** connected by a passageway **278** to the high pressure air line **104**.

As illustrated in FIGS. **5** and **9**, during the filling operation the low pressure air from line **110** passes into an annular chamber **300** formed in the valve unit **170** and through a connecting passageway **302** and past the normally open valve member **272** into a central chamber **304** intermediate the valve members **272, 275**. The low pressure air in the chamber **304** then passes through radial openings **306** to a second annular chamber **308** formed in the valve unit **170**. The passageway **125, 126** leading to the pressure sensing nozzle **42** is in communication with the annular chamber **308** as shown. Thus, in operation, the low pressure air may pass through the valve unit **170** during the filling operation. However, when the valve unit **166** is shifted by the cam **168** after the filling operation is completed, high pressure air from the line **169** enters the chamber **270** to shift the valve members **272, 275** to the right to close off the entrance of low pressure air past valve member **272** and to open valve member **275**, thus permitting high pressure air from chamber **276** to pass around the valve member **275** into the intermediate chamber **304** and through the radial passageways **306** to the annular passageway **308** in communication with the passageways **125, 126** leading to the low pressure air sensing nozzle **42**, thus effecting clearance of any accumulated material therein by a blast of high pressure air. It will be noted that the valve member **272** is closed when the valve member **275** is opened so that no high pressure air is directed into the low pressure line **110** which might otherwise provide a false signal to the diaphragm **132**. It will be understood that the nozzle clearing operation comprises merely a momentary blast of air and that the valve unit **170** immediately returns to its normal position to direct low pressure air to the sensing nozzle. As shown in FIG. **5**, when the three-way cam operated valve **166** returns to its normal position with the valve member **260** closed and the valve member **262** opened, the line **169** and chamber **270** is vented through the open valve member **262**, then through openings in the diaphragm **261** supporting the valve member **262**, then through openings in the flange **263** of the retainer **265**, then through the clearance opening in the cover **267** and finally through a slotted portion **269** of the cover to the atmosphere. The valve **170** is thus permitted to shift to the left by virtue of the spring in the chamber **276, 278**. It will also be noted that each trip valve unit **116** and **166** has a relatively small movement to seat and unseat their respective opposed valve members. Hence, the button **180** is spring pressed outwardly so that when the valve is actuated by its cam, the button **180** is permitted an ample overthrow by virtue of the spring.

As illustrated in detail in FIG. **17**, the cams **118** and **168** are mounted in the path of their respective rollers **172** of the control units **52**, the cam **168** for effecting clearing of the sensing nozzle **42** preceding the cam **118** for initiating the filling operation so that the sensing nozzle **42** is cleared and the material discharged directly into its bottle prior to start of the filling operation. As herein shown, each cam **118, 168** is similarly supported with the nozzle clearing cam **168** mounted above and preceding the cam **118** for starting the filling cycle. One end of each cam is pivotally mounted at **310** in a horizontal bar **312** extending from a bar **314** which is adjustably supported in a vertical bar **316** clamped to a supporting post **318**. The post **318** is supported by a bracket **315** attached to the machine frame. The other end of each cam is connected by a link **320** to the piston stem **322** of an air cylinder **324**. During operation of the machine, air is supplied to the cylinder **324** by a supply pipe **326** which is connected to a regulated source of compressed air. Thus, each cam is extended and maintained in the path of its respective rollers **172** by a cushion of air in the cylinders, movement of the cams toward the control units being limited by adjustable screws **328** carried by the bar **312**.

In practice, the air to the cylinders **324** is controlled by a solenoid valve **330** in the supply pipe **326**, the solenoid valve being connected in the motor circuit, not shown, in a manner such that the valve **330** (FIG. **1**) is opened when the motor is started and closed when the motor is stopped. When the air is shut off by the solenoid valve **330**, the air entrapped in the supply line **326** serves to maintain the cams in their operative extended position as controlled by an exhaust needle valve **332** carried by the solenoid valve **330** and which permits the entrapped air to slowly bleed from the supply line. The advantage of this expedient is that when the motor is stopped and the air to the cylinders is cut off, the rotary filling heads with their control units continue to rotate for a short distance until they coast to a stop. Thus, the cams are maintained in operative position during this relatively short interval in order to effect nozzle clearing of the units which pass the cams and also to initiate the filling operation of such units. On the other hand, if the cylinders **324** were immediately exhausted, the cams **118, 168** would retract immediately with an uncontrolled exhaust and those filling units which passed the cams would not be energized to clear their sensing nozzles **42** or to initiate a filling operation resulting in an empty container in the line when the machine is again started. Another advantage of a controlled exhaust is that if a filling head came to rest with its roller **172** against its cam **118** to open the valve **116**, high pressure air would continue to signal initiation of a filling cycle unless the cam was subsequently retracted by means of the controlled exhaust valve **332** provided with the solenoid valve **330**.

In a modified form of the filling machine, it is sometimes preferred not to clear the sensing nozzle **42** into a container about to be filled. In such cases, the position of the cam **168** for effecting a momentary blast of air through the nozzle is mounted in a position between the intake and discharge spiders where the circular path is free of containers, as shown in FIG. **18**. When the nozzle **42** is cleared by a blast of air in this position, the cleared material may be collected in a removable drip pan **334** supported beneath the filling head units. The cam for triggering the clearing operation in its modified position is designated by the numeral **168*a***, and the manner of supporting the cam is similar to that shown in FIG. **17**, the parts being identified by the same numbers with the addition of the letter *a* except that the vertical bar **316*a*** is adjustably attached to a bracket **335** secured to a stationary rail **337** attached to the machine frame.

The advantage of effecting the nozzle clearing operation in a position other than when the nozzle is inserted into a container is that, in practice, a container may not be present at the clearing station because of a void in the line of supply of containers, and when the nozzle clearing operation is performed without a container present on the elevating platform **12**, the cleared material will be discharged onto the platform. It is also possible that when a relatively small neck bottle is being filled, a discharge of high pressure air into the bottle with the cleared material may pressurize the bottle to an extent such that the pressurized air will not have entirely escaped out of the mouth of the container by the time the closely spaced cam **118** effects initiation of a filling cycle. As a result, such pressure could back up through the low pressure nozzle **42** and into the line **110** to give a false signal to the diaphragm **132** to thus prematurely terminate the filling cycle.

In practice, various types of filling nozzles **16** may be used which are adapted for different types of materials being run. The filling nozzle **16** shown in FIG. **3**, wherein the liquid con-

trol valve 38 is disposed at the end of the nozzle may be used for most free-flowing liquids and is designed to prevent dripping of the nozzle after the filling operation is completed. Referring now to FIG. 12, the filling head therein shown is provided with a liquid control valve 38*a* which comprises a conical valve formed on the stem 36*a* and having an O-ring 338 arranged to seat against a conical surface 340 formed in the nozzle block 22*a* below the liquid inlet pipe 28*a*. In this embodiment the lower end of the air nozzle 42*a* is also provided with a tubular valve member 38 telescopically fitted into the lower end of the liquid nozzle 18*a* which is provided with liquid escape openings 59*a* exposed when the valve is extended, as shown, and closed by the nozzle 18*a* when the valve is retracted. The remaining portions of the filling head shown in FIG. 12 are similar to those shown in FIG. 3 and are designated by the same numerals with the addition of a letter *a*. This type of nozzle may be used with advantage in cases where the material being run is not subject to dripping from the nozzle.

The filling head shown in FIG. 13 is similar to that shown in FIG. 3 except that the mounting for the low pressure air nozzle 42*b* which carries the valve member 38*b* is secured to the stem 36*b* during assembly in a manner such as to present the liquid discharge openings 59*b* directed toward the wider sides of a container which is oval in cross section. In some instances, depending on the product and the shape of the container, it may be preferred to direct the liquid toward the narrower walls. The upper end of the nozzle 42*b* is carried by an adapter 44*b* which has an extension 342 having a press fit into the lower end of the stem 36*b*. In operation, the stem 36*b* and air nozzle 42*b* do not rotate relative to the nozzle block 22*b*. In assembly, the nozzle 42*b* is pressed into the stem in a position to direct the liquid discharge openings 59*b* laterally toward the wider walls of the container and is maintained in this position by a check nut 344 threadedly engaged with the exterior of the stem and in locking engagement with the end of the adapter 44*b*. When filling into a cylindrical container, directional discharge openings are not required since the container walls are equally distant from the liquid nozzle. However, when a bottle, oval is cross section is run, nondirectional discharge outlets might cause the liquid to flow against a closely spaced wall, resulting in excessive turbulence of the liquid which might interfere with the filling operation. Thus, the expedient of directing the discharge outlets 59*b* toward the more distantly spaced walls avoids such turbulence. As above stated, in some instances it may be desirable to direct the liquid toward the narrower walls.

FIG. 14 illustrates another modified form of filling head wherein the air nozzle 42*c* is disposed outside the liquid nozzle 18*c* leaving the inside diameter of the liquid nozzle free of any obstructions. This type of filling head is particularly adapted for use when running relatively thick or viscous fluids. As herein shown, the filling nozzle 18*c* is entirely open without an air nozzle extending therethrough whereby to provide a maximum cross-sectional inside diameter area for the viscous material to flow thereby providing a maximum flow per unit of time to substantially reduce the filling time for the viscous material. Also, the valve member 38*c* for cooperation with the valve seat 40*c* is not extended into the nozzle 18*c*. As shown in FIG. 14, the air nozzle 42*c* is carried by a clamp member 346 adjustably secured to one of the nozzle guide slide rods 80. The upper end of the air nozzle 42*c* is curved and extended laterally and is connected to a flexible conduit 48*c*, the other end of which is connected to the nipple 130 leading to the low pressure air line 110 of the control unit 52.

In operation, when the container is elevated into seating engagement with the nozzle guide 76, the air nozzle 42*c* is extended into the container to a predetermined height in the container, and during further elevation of the container with its platform 12, the air nozzle 42*c* and the nozzle guide 76 move together to present the container into operative filling position to the nozzle 18*c*. In this elevated filling position the end of the air nozzle 42*c* extends a short distance below the end of the filling nozzle in the usual manner to sense the height of the liquid when it reaches the end of the air nozzle to discontinue the filling operation by closing the inlet valve 38*c*. In this type of filling head there is no upward movement of the air nozzle at the end of the filling operation. In other words, the end of the air nozzle remains in the same position relative to the end of the liquid nozzle during the filling operation and after the filling operation is completed. At the end of the filling cycle, the elevating platform is lowered with its container, at which time the nozzle guide 76 together with the air nozzle 42*c* is also lowered until it comes to rest in its fully lowered position whereupon the container is further lowered away from the air nozzle to permit the container to be transferred to the discharge conveyor.

FIG. 15 illustrates an embodiment of a filling head wherein both the liquid filling nozzle 18*d* and the low pressure air sensing nozzle 42*d* are connected to move together. This type of filling head is also particularly adapted for running viscous or semiviscous materials. It will be seen that when using the type of filling head shown in FIGS. 12 or 13 wherein the lower valve member 38 or 38*b* is telescopically extended during the filling operation, any material collected on the outer surface of the valve during the filling operation will be wiped off by the end of the liquid nozzle when the valve is retracted. With a nonviscous material, such wiping does not present any problem. However, when a viscous material is used, the material wiped off may collect around the end of the liquid nozzle in a large ring which might interfere with the filling operation. In the embodiment shown in FIG. 15, this problem is avoided by moving both nozzles together without any wiping action. As illustrated, the nozzle 18*d* is fitted into the end of the valve stem 36*d* and is retained therein by a check nut 356. The low pressure air nozzle 42*d* extends through the upper end of the nozzle 18*d* into a chamber which communicates with the air passageway 46*d* formed in the stem 36*d*. When the valve 38*d* is opened, the liquid entering the chamber 24*d* may pass through openings 358 in the wall of the nozzle 18*d* and into a relatively small liquid nozzle 360. The air nozzle and liquid nozzle may be joined together by welding or brazing and are extended through a sleeve 362 within the nozzle 18*d* as shown. The nozzle 18*d* is guided by a bushing 364 retained at the bottom of the extension 27*d* of block 22*d* by a flanged nut 366 as illustrated. The air nozzle 42*d* extends a short distance below the end of the liquid nozzle 360, and in operation, when the valve 38 *d* is opened, both nozzles are lowered simultaneously. Thereafter, when the liquid reaches a height such as to block the air from the outlet 58*d*, the pneumatically operated unit 52 is actuated to permit the valve 38*d* to be spring closed. Thus, the end of the liquid nozzle 360 is disposed above the material in the container during the filling operation and is never immersed into the material so that the outer surface thereof is free of any accumulation of viscous material. Another advantage of using the structure shown in FIG. 15 is that when a relatively narrow mouthed container is to be filled, the two small nozzles arranged side-by-side providing two contiguous tubes, when fitted into the relatively narrow circular mouth of the container, provides more space in the mouth on each side of the tubes for air in the bottle to escape when displaced by the liquid during the filling operation. Such air escape space in the present embodiment is proportionately greater for the same diameter container mouth than the design wherein the air nozzle is disposed within the liquid nozzle. It will be appreciated that failure of the air to escape rapidly from the mouth might buildup the pressure in the container during the filling operation to give a premature signal to the diaphragm 132 of the control unit which would discontinue the filling operation before a predetermined height is reached.

Another modification of the filling head nozzle structure is shown in FIG. 16 wherein the low pressure air nozzle 42*e* is also mounted outside the liquid nozzle 18*e* but in a manner such as to be capable of movement vertically relative to the liquid nozzle. As herein shown, the liquid nozzle 18*e* is secured in the lower end of the nozzle block extension 27*e*.

Clamped to the fixed liquid nozzle **18***e* is a bracket **368** having an extension **370** which supports an air cylinder **372**. The low pressure air nozzle **42***e* is slidingly extended through the bracket **368** in contiguous engagement with the liquid nozzle **18***e*, as shown, and a second bracket **374** clamped to the air nozzle **42***e* is connected to the piston rod **376** of the cylinder **372**. The upper end of the air nozzle **42***e* is connected by a flexible conduit **48***e* to the nipple **130** in the upper end **128** of the support bracket **56** and which communicates with the low pressure passageway **126**, **125** of the control unit **52**. The air cylinder **372** is connected by a flexible conduit **378** to a nipple **380** in communication with the passageway **124** of the control unit **52** which leads to the cylinder **60**. In operation, when the pilot valve **120** is opened to direct high pressure air through passageway **122**, **124** to the cylinder **60**, the air is simultaneously directed through the conduit **378** to the cylinder **372** to extend its piston rod and lower the air nozzle **42***e* below the end of the filling nozzle. Subsequently, when the opening in the end of the air nozzle **42***e* is blocked by the liquid reaching a predetermined height to automatically effect shifting of the valve **120**, the air in the cylinder **60** is exhausted, whereupon the valve **38***e* is spring closed, and likewise the air in the cylinder **372** is also exhausted, whereupon the piston rod **376** is spring returned to elevate the air nozzle **42***e* to its initial position. As described in connection with the structure shown in FIG. **14**, one advantage of employing the structure shown in FIG. **16** is that it eliminates any obstruction within the liquid nozzle to provide a greater cross-sectional area for viscous materials to flow through the nozzle, thus affording a relatively faster filling time.

In accordance with another feature of the invention, the present pneumatic control unit **52** is adapted to purge the containers with an inert gas, such as nitrogen, prior to and during the filling operation. In practice, the control unit **52***a* may be similar to the control unit **52** except that low pressure nitrogen is substituted for the low pressure air in line **110**, and the lower portion of the control unit is modified, as shown in FIGS. **19** and **20**, to provide a momentary surge of high pressure nitrogen for the nozzle clearing operation from a line **382** through the valve unit **170***a* instead of a surge of high pressure air as provided in the unit shown in FIG. **5**.

As diagrammatically indicated in FIG. **21**, the low pressure air line **110***a* is connected to a source of low pressure nitrogen at the inlet **112***a* so that in operation nitrogen is arranged to flow continuously through the valve **170***a* and into the container during the filling operation in the manner previously described in connection with the structure shown in FIG. **5**. In operation, when the trip valve unit **166***a* is actuated to shift the control valve **170***a*, the low pressure nitrogen line **110***a* is cut off and the valve unit **170***a* is opened to the high pressure nitrogen line **382**. Thus, the empty container is provided with a momentary surge of high pressure nitrogen to clear the sensing nozzle **42** of any material accumulated therein and to also provide an initial purging of the container with the inert gas. Thereafter, the valve unit **170***a* is automatically returned to its normal position, as previously described, to deliver low pressure nitrogen from line **110***a* through the valve **170***a* to the sensing nozzle **42**. Immediately after the nozzle clearing operation, the trip valve unit **116***a* is actuated to initiate the filling operation during which time the low pressure nitrogen continues to flow through the nozzle **42** into the container. Thus, the containers are purged with an inert gas prior to and during the filling operation to reduce to a minimum any air in the container which might be detrimental to the product being run.

As illustrated in detail in FIGS. **19** and **20** and diagrammatically in FIG. **21**, it will be seen that in the modified structure of control unit **52***a* the high pressure air in line **104***a* communicates with a chamber **278***a* and passageway **196***a* to admit the air to the pilot line **87***a* when the trip valve unit **116***a* is actuated in the same manner as in the structure shown and described in connection with FIG. **5**. Also, the high pressure air in line **104***a*. is in communication with the pilot valve **120***a* to admit air to the cylinder line **122***a* and **124***a* to the cylinder **60***a*, the same as previously described. High pressure air is also in communication with the air jet **138***a*. Similarly, high pressure air is in communication with the trip valve **166***a* to admit high pressure air to the line **169***a* leading to the chamber **270***a* for shifting the valve unit **170***a*. However, as shown in FIGS. **19** and **20**, the high pressure air is sealed off from the right-hand end of the valve unit **170***a* by an adapter **384** having an O-ring **386**. Instead, the chamber **388** defined by the end of the adapter **384** and the valve member **275***a* is in communication with passageways **390**, **391** connected to the inlet **392** of the high pressure nitrogen conduit **382**. Thus, in operation, when the trip valve unit **166***a* is actuated and the valve unit **170***a* is shifted, the valve member **272***a* is closed to cut off the low pressure nitrogen and the valve member **275***a* is opened to admit high pressure nitrogen past the valve member **275***a* and through the radial passageways **306***a* to the annular passageway **308***a* in communication with the passageway **125**, **126** leading to the sensing nozzle **42** as previously described in connection with the structure shown in FIG. **5**.

FIG. **22** illustrates the center section in the modified form of the machine wherein provision is made for supply high pressure air; low pressure nitrogen; and high pressure nitrogen from central supply chambers and through radially extended conduits connected to successive pneumatically operated control units **52***a*. As therein shown, high pressure air is supplied by a pipe **400** to a cylindrical bearing member **402** arranged to permit rotation of the central air manifolds with the machine. The high pressure air passes through a central pipe **404** directly into the high pressure air chamber **406** from which the flexible conduits **408** extend for connection to their individual control units **52***a*. High pressure nitrogen is supplied by a pipe **410** connected to a source of supply thereof and which is in communication with a hollow chamber formed in the bearing member **402** which is in communication with an intermediate manifold **412**. The manifold **412** is connected by a pipe **416** to the chamber **418** of the high pressure nitrogen manifold **420** from which flexible conduits **422** extend for connection to their respective control units **52***a*. Low pressure nitrogen is supplied to the chamber **424** of manifold **426** from a pressure regulator, not shown, similar to that shown in FIG. **1**, by a conduit **428**, the pressure regulator being connected to the high pressure nitrogen chamber **418** by a conduit **430**. Flexible conduits **432** extended radially from the low pressure chamber **424** are connected to their respective control units **52***a*. The center section also includes the liquid manifold **434** whose chamber **436** receives the liquid from the supply in the manner shown in FIG. **1** and which is provided with radially extended pipes **438** connected to the nozzle blocks **22** of their respective filling heads **16**.

In the operation of the machine, the containers **14** are elevated on their platforms **12** into filling relationship to their respective nozzles at which time the normally open exhaust valve **88** is closed to cut off the exhaust of the pilot line through the ports **92**. Thereafter, the filling operation is initiated by triggering the valve unit **116**, and the filling cycle is terminated when the liquid in the container blocks the opening **58** of the sensing nozzle **42**. In the event that the liquid in the supply is depleted before it reaches the predetermined filling height, or failure of the container to receive sufficient material to reach the low pressure outlet during its continuous movement in a circular path, or in the event of failure of the low pressure air supply, no signal will be received by the control unit to exhaust the pilot line **87** so that the valve unit **120** will remain in its operative filling position. However, as each filling unit approaches the container discharge end of its cycle, the elevator **12** lowers its container, and simultaneously therewith, the nozzle guide **76** with its supporting structure is also lowered, thus effecting opening of the tire valve by lowering of the weight **96** onto the button **90** of the exhaust valve **88**. Thus, the pilot line is exhausted through the ports **92** to effect shifting of the valve unit **120** in readiness for a succeeding cycle of operation.

From the above description, it will be seen that the present container filling machine is provided with novel pneumatically operated control units capable of being individually adjusted in a convenient manner so as to provide a uniform filling height in successive containers by merely rotating the adjusting cylinder **220** to change the resistance of the spring **214** relative to the residual pressure in the chamber **144** of the air pressure control unit **140**. In practice, the air control unit **140** cooperating with the preconvoluted diaphragm **132** may be broadly termed a pressure responsive amplification device. Prior to the present invention, it was necessary to make time-consuming adjustments to the individual piston strokes of the air cylinders **60** to vary the extension of the sensing nozzle into the container whereby to obtain a uniform filling height in all of the containers. Another important feature consists in the provision of the resilient fabric-backed rubber rolling diaphragm **132** responsive to the increase in pressure when the liquid in the container reaches the open end of the sensing tube **42**, such rolling diaphragm being capable of uniform response in each unit for cooperation with its adjustable jet member **138** to effect discontinuance of the filling operation. Prior to the present invention, a stretchable diaphragm was employed, as illustrated in U.S. Pat. No. 3,182,691 and which sometimes varied from one unit to another making it difficult to obtain uniform response in all of the units. The provision of a pilot valve and a pilot line for shifting the valve also provides a more efficient and positive structure for initiating and discontinuing the filling operation as compared to the structure disclosed in the patent.

In practice, the air pressure in the high pressure air line **104** is on the order of 50 to 60 pounds per square inch and the pressure in the low pressure air line **110** is on the order of about 2 to 5 inches of water pressure. The residual pressure in the chamber **144** of the control unit **140** is determined by the gap between the diaphragm valve member **136** and the jet member **138** which is initially adjusted to provide a pressure of about 34 pounds per square inch when the main line pressure is about 60 pounds per square inch and with the orifice **148** in the jet member open to the atmosphere, and with no diaphragm pressure present. Thus, in operation, when the diaphragm is moved a relatively short distance to lessen the gap between the valve member **136** and the jet member **138** in response to the back pressure caused by blocking of the opening in the low pressure air nozzle **42**, the pressure in the chamber will be increased, and when this pressure increases to about 36 pounds per square inch, the spring **214** will yield and the pin **158** will be lifted off the orifice **160** to exhaust the pilot line to the atmosphere and cause pilot valve **120** to return to its normal position and discontinue the filling operation. Thus, it will be seen that adjustment of the spring **214** will change the timing of the operation of the liquid control valve **38** to permit adjustment of the filling height. It will also be seen that by regulating the main line pressure and consequently the chamber pressure, all of the units will be effected to vary the filling height in all of the units simultaneously. It will also be observed that the provision of a communicating passageway **208** in the stem **204** of the pilot valve unit **120** not only maintains the pilot line energized during the filling operation but also serves to assist in bleeding the pilot line when the valve is shifted to discontinue the filling operation. Such communicating passageway also assists in affording a rapid shifting of the valve unit **120** and rapid closing of the liquid control valve **38**.

It will also be seen that in a modified form of the present control unit is adapted to purge the containers with an inert gas prior to and during the filling operation. In this embodiment of the invention, the pressure in the high pressure air line **104*a*** also has an operating range of from 50 to 60 pounds per square inch and the supply pressure to the low pressure nitrogen line **110*a*** has an operating range of from 2 to 5 inches of water pressure. The supply pressure to the high pressure nitrogen circuit for clearing the sensing nozzle **42** and for initially purging the container may be on the order of 5 to 10 pounds per square inch. It will be understood that the above pressure values are given by way of example only and that such pressures may be varied in accordance with particular circumstances.

As illustrated in FIG. **1**, the rotary supporting disc **50** is supported for rotation with a supporting member **440** by vertically extended tie rod unit **442** which may be adjusted vertically through manually operated mechanism including a chain and sprocket drive **444**, bevel gears **446** and hand wheel **448** so as to enable preliminary adjustment of the height of the supporting disc **50**, and the filling heads **16** carried thereby relative to the elevating platforms **12** for different heights of bottles. However, in practice, such preliminary adjustment may not be uniform for each individual filling head **16** and its associated platform **12** because of manufacturing tolerances and the like. It will be understood that the position of the end of the liquid nozzle **18** and its associated air nozzle **42** for sensing the height of the liquid in the container must be extended a substantially uniform distance into its respective container to establish a substantially uniform discharge position relative to its container for each filling unit. In practice, accurate positioning of the end of the sensing nozzle **42** in the container may be accomplished by adjusting the downward stroke of the piston **62** of the cylinder **60** for each unit. In other words, the lowered position of the sensing nozzle **42** in the container when the valve **38** is opened may be uniformly adjusted for each unit to take care of any discrepancies caused by tolerances permitted in manufacturing of the units.

As illustrated in FIG. **5**, the downward limit of the stroke of the piston **62** may be adjusted by means of a threaded insert **450** carried by the cylinder and a check nut **452**. Thus, in practice, after preliminary adjustment of the height of all of the units relative to the elevating platforms **12**, as above described, each individual filling head is finally adjusted to limit the stroke of its piston so that when the end of the air nozzle **42** is stroked downwardly, the height from the upper surface of the elevating platform **12** in its elevated position to the end of the air nozzle **42** in its lowered position will be uniform for each filling head.

Referring again to FIG. **9**, it will be observed that in practice when a momentary pulse of high pressure air from line **104** is directed into the pilot line **87** upon opening of the cam operated valve **116** at a time when no container is present, the air might not escape rapidly enough through the relatively small discharge opening provided by the conventional tire valve so that the pressure remaining in the pilot line might be sufficient to inadvertently open the pilot valve **120** to start a filling cycle without a container present to receive the liquid. In order to avoid this condition, a relatively small diameter passageway **191** is provided between the passageways **190**, **192**, as shown in FIG. **9**, whereby to reduce the pressure entering the pilot line **87** to a value such that the air may escape through the tire valve without effecting inadvertent operation of the valve **120**.

As illustrated in FIGS. **14** and **16**, it will be observed that the air nozzles **42*c*** and **42*e***, respectively, which are disposed outside of their liquid nozzles are each movable relative to their liquid nozzles. However, in practice, it will be apparent that the air nozzle **42*c*** or **42*e*** could be clamped directly to its filling nozzle so that no relative movement will occur between the air and filling nozzles.

As illustrated in FIG. **10**, the passageway **122**, **124** from the valve unit **120** to the chamber of the cylinder **60** is shown as being of uniform diameter so as to permit direct passage of the air without restriction to effect relatively rapid opening and closing of the liquid supply valve **38** as previously described herein. However, in some instances a relatively slow retraction of the air nozzle **42** and closing of the liquid supply valve **38** may be desired. For example, when a high level of fill near the top of the container is required, sudden retraction of the air nozzle **42** and closing of the control valve **38** might cause a splash of the last portion of liquid discharged from the nozzle during the closing movement of the control valve. In order to effect such relatively slow retraction of the air nozzle **42**, the

passageway **122**, **124** may be provided with a restricted orifice or metering pin adjacent the chamber of the cylinder. As shown in FIG. **10**, the passageway **124** communicates with the chamber **124***a* through a lateral passageway **124***b* and a screw **124***c* may extend into the passageways at the intersection of passageways **124**, **124***b* to serve, in effect, as a metering pin in order to restrict the passage of air to the chamber and thus effect a relatively slow operation of the control valve and its associated air nozzle **42** so that the final discharge from the liquid nozzle will flow gently into the container.

Pressure is employed to effect operation of the apparatus herein described and when the occasion demands as explained therein an inert gas may be employed in place of atmospheric air. For this reason and to embrace the use of atmospheric air and/or any inert gas, the term "fluid pressure" is employed in the claims.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what I claim is:

1. In a container-filling machine, a filling assembly comprising a nozzle for delivering material to the mouth of the container to fill the same, a sensing device having an end adjacent the nozzle operable by impingement of the material in the container therewith to produce a signal, a filling valve for controlling flow of material through the nozzle to the container, a fluid pressure system connected to a source of fluid at superatmospheric pressure in which control is achieved by varying the level of the superatmospheric pressure in the system, comprising fluid conductor means connected in said system to which said superatmospheric pressure is supplied, pneumatically operable means connected to said fluid conductor means, said pneumatically operable means being constantly operated upon by said superatmospheric pressure in said fluid conductor means, and including a pressure operable valve embodying a diaphragm-supported pressure operable valve element movable between first and second positions to effect opening and closing of the filling valve, said diaphragm-supported valve element being adapted to be held in each of said positions by fluid pressure, means embodied in said pressure operable valve operable to hold said valve element at said first position once it is moved to said first position so long as said holding pressure is maintained unchanged, means for moving said valve element to said second position in response to a change in said holding pressure effected by an increase in pressure in said fluid conductor means, said fluid conductor means containing an outlet through which said superatmospheric pressure fluid flows at a predetermined rate such as to maintain an inoperative superatmospheric pressure in said fluid conductor means, and means operable in response to said signal to modify the flow of said superatmospheric pressure fluid through said outlet opening in a manner to change the pressure in said fluid conductor means from an inoperative to an operative pressure.

2. Apparatus according to claim **1**, comprising adjustable means operable to vary the response of the pneumatically operable means to the change of pressure in said fluid conductor means.

3. Apparatus according to claim **1**, wherein the fluid conductor means comprises a chamber and the outlet is an orifice through which said fluid under pressure flows at a predetermined rate, and the means operative in response to a signal from the sensing means to change the flow of fluid through said orifice is a diaphragm supported adjacent the orifice for movement relative thereto in response to said signal from said sensing means.

4. Apparatus according to claim **3**, wherein the means operative in response to a signal from the sensing means is a diaphragm supported adjacent the orifice, the sensing means comprises an air conducting sensing tube supported with one end adjacent the nozzle and the other end adjacent the diaphragm, and wherein there is means supporting the diaphragm in confronting relation to the orifice with its center substantially in alignment therewith, and means for adjusting the initial distance between the diaphragm and the orifice.

5. Apparatus according to claim **1**, comprising a normally open exhaust valve in said fluid pressure system which maintains the superatmospheric pressure in said system below operating level, and means operable by positioning a container in filling position to close said normally open exhaust valve.

6. Apparatus according to claim **5**, comprising means for moving a container to a filling position and removing it therefrom following filling, said means being operable successively to close the normally open exhaust valve and thereafter open the exhaust valve.

7. Container-filling apparatus comprising a plurality of filling assemblies according to claim **1**, comprising means connecting the fluid pressure system of each assembly to a common source of regulated superatmospheric fluid pressure such that the initial pressure in each fluid conductor system is proportional to said regulated pressure, and means for varying said regulated pressure and consequently the pressure in each of said fluid pressure systems simultaneously.

8. Apparatus according to claim **1**, wherein an exhaust valve embodied in said pneumatically operable means is operable by a change in pressure in the fluid conductor means to change the holding pressure supplied to said pneumatically operable valve.

9. Apparatus according to claim **1**, wherein said diaphragm supported, pressure operable valve element is adapted to be held in a normally closed position, and there is means embodied in said pressure operable valve operable by delivery of a pulse of superatmospheric pressure thereto to move said valve element to its open position.

10. Apparatus according to claim **1**, wherein the pneumatically operable means includes a cylinder containing a piston and means connecting the piston to said filling valve, and wherein said pressure operable valve supplies fluid pressure to said cylinder to effect opening of said filling valve.

11. Apparatus according to claim **10**, wherein there is spring means operable when said pressure operable valve is returned to its closed position to return said filling valve to its closed position.

12. Apparatus according to claim **10**, wherein said pressure operable valve contains an exhaust opening normally closed when said pressure operable valve is in its open position and open when said pressure operable valve is in its closed position, and means connecting said exhaust opening to said cylinder to induce rapid venting of the cylinder and hence retraction of the piston and closing of said filling valve.

13. Apparatus according to claim **1**, wherein there is means including a conductor tube for supplying low pressure air continuously to a sensing tube in said sensing device and a second pressure operable valve interposed in said conductor tube and connected into said fluid pressure system, movable from a first position in which it permits free flow of the low pressure air supplied to the sensing tube from the conductor tube and blocks pressure from the fluid pressure system to a second position in which it blocks flow of low pressure air from said conductor tube to the sensing tube and permits flow of pressure from said fluid pressure system through the sensing tube, and means for shifting said second pressure operable valve, momentarily from said first position to said second position following completion of a filling operation and then returning it to its first position to inject a charge of superatmospheric pressure from the fluid pressure system through said sensing tube so as to clear the same.

14. Filling apparatus according to claim **1**, wherein there is means including a conductor tube for supplying a gaseous medium continuously to a sensing tube in said sensing device and wherein said pneumatically operable means includes a second conductor tube for supplying a gaseous medium at a higher pressure than that supplied to said sensing tube, a second pressure operable valve interposed in said first con-

ductor tube and connected to said second conductor tube, said second pressure operable valve being movable from a first position in which it permits free flow of the lower pressure gaseous medium through the sensing tube and blocks access of the higher pressure gaseous medium thereto, to a second position in which it blocks the lower pressure gaseous medium from the sensing tube and permits the higher pressure gaseous medium to flow therethrough, and for shifting said second pressure operable valve from said first position to said second position and back again following the conclusion of each filling operation.

15. In a container-filling machine, a filling assembly comprising a nozzle for delivering material to the mouth of the container to fill the same, a sensing device having an end adjacent the nozzle operable by impingement of the material in the container therewith to produce a signal, a filling valve for controlling the flow of material through the nozzle to the container, a fluid pressure system connected to a source of fluid at superatmospheric pressure in which control is achieved by varying the level of the superatmospheric pressure in the system, comprising fluid conductor means connected in said system to which said superatmospheric pressure is supplied, pneumatically operable means connected to said fluid conductor means, said pneumatically operable means being constantly operated upon by said superatmospheric pressure in said fluid conductor means, a diaphragm exposed to the superatmospheric pressure in said fluid conductor means, an exhaust valve in said fluid pressure system, said diaphragm being operably connected to said exhaust valve, spring means opposing movement of the diaphragm, means for adjusting the yield at a predetermined operative pressure, said fluid conductor means containing an outlet through which said superatmospheric pressure fluid flows at a predetermined rate such as to maintain an inoperative superatmospheric pressure in said fluid conductor means, and means operable in response to said signal to modify the flow of said superatmospheric pressure fluid through said outlet opening in a manner to change the pressure to said fluid conductor means from an inoperative to an operative pressure.