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METHOD AND APPARATUS FOR FILLING HYPODERMIC SYRINGES, AMPULES, ETC.

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FIG. 1

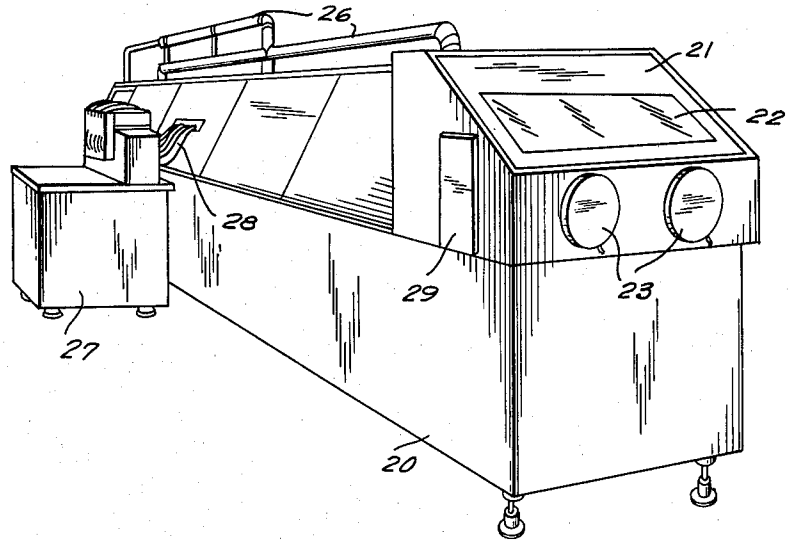


FIG. 2

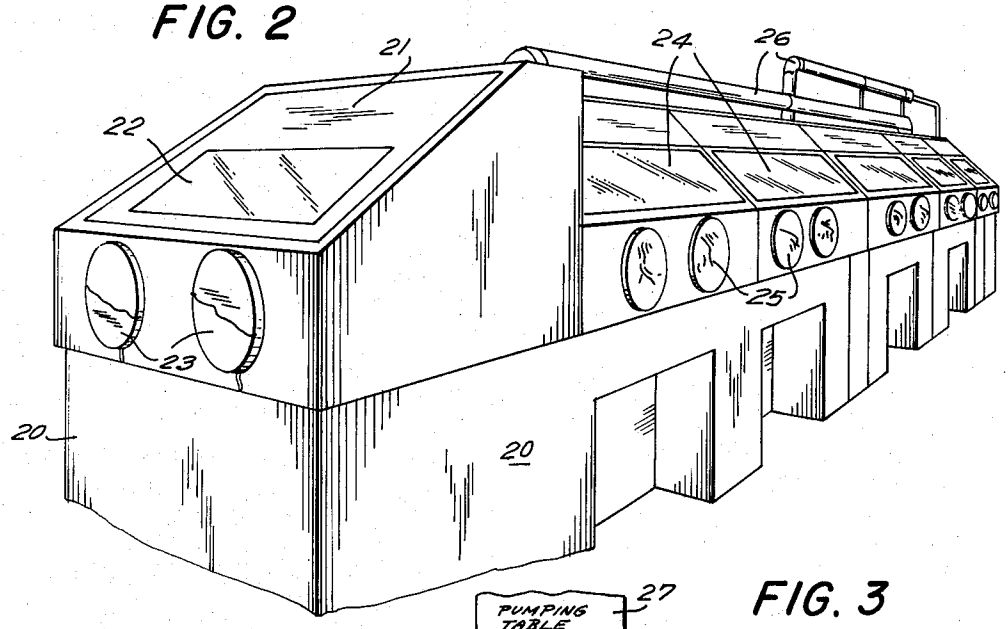
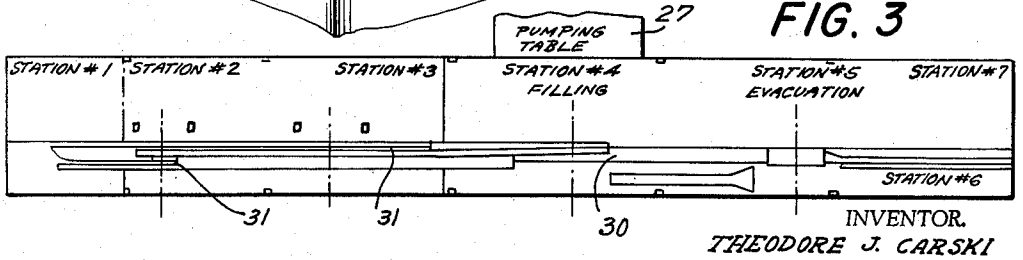


FIG. 3



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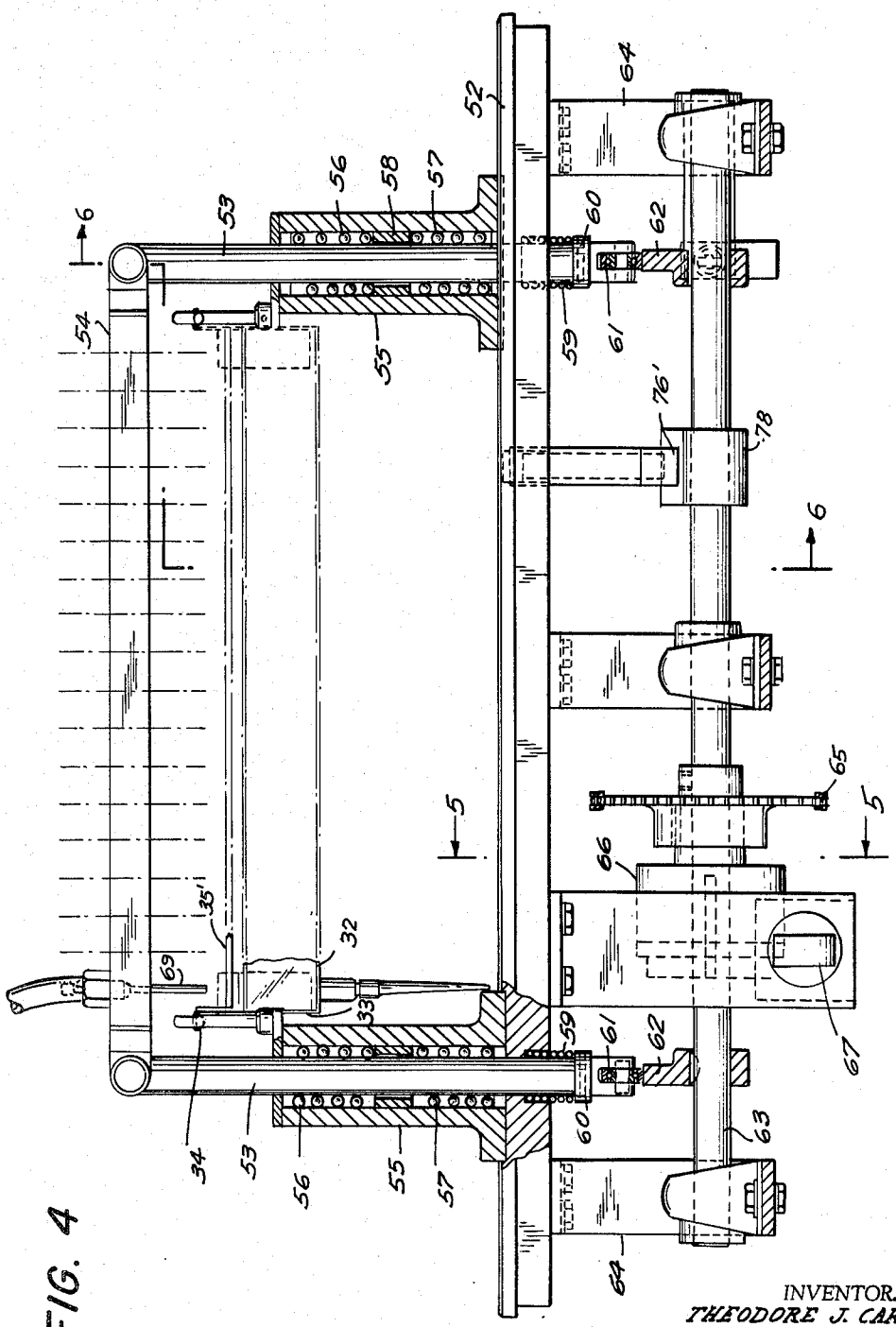


FIG. 4

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FIG. 6

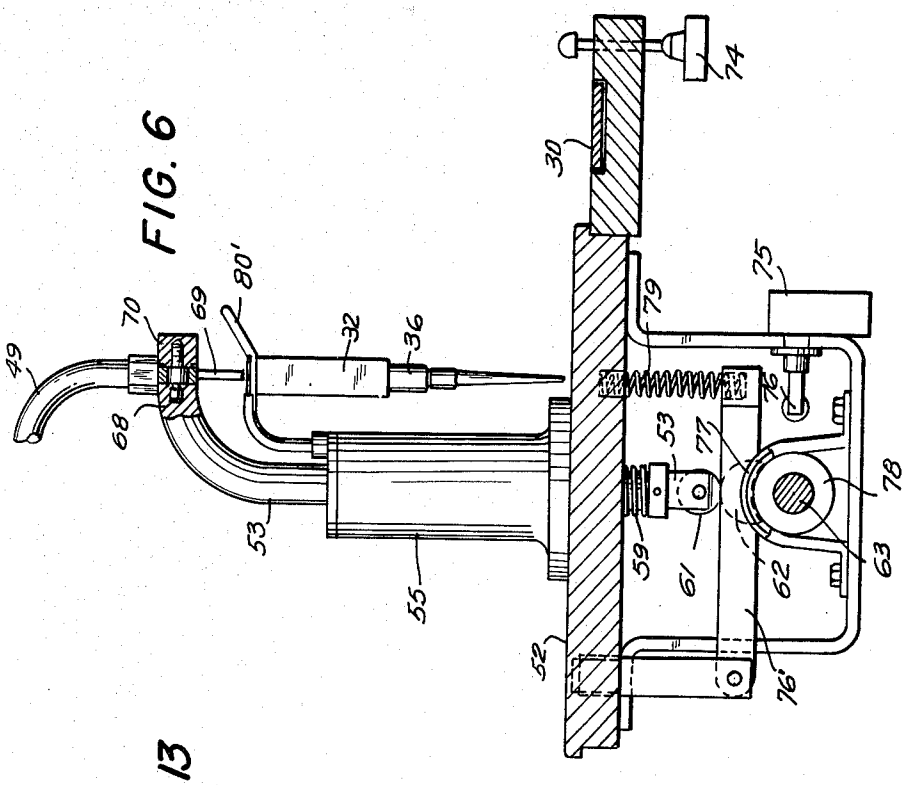


FIG. 13

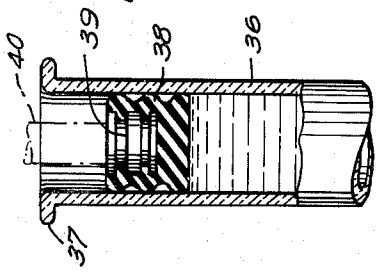


FIG. 7

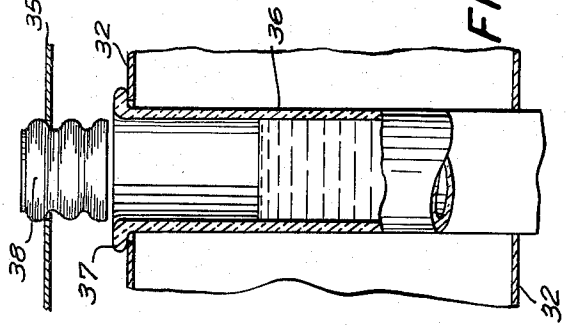
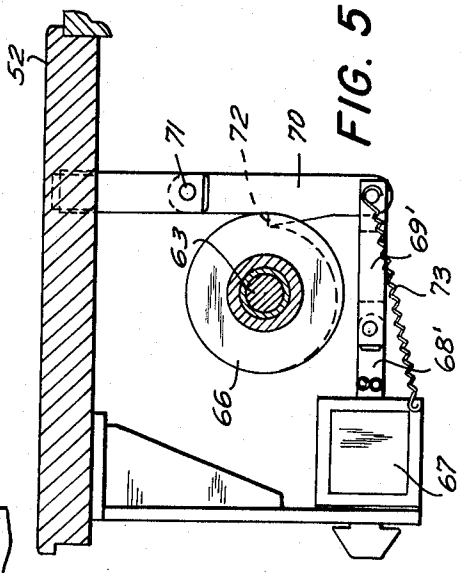


FIG. 5



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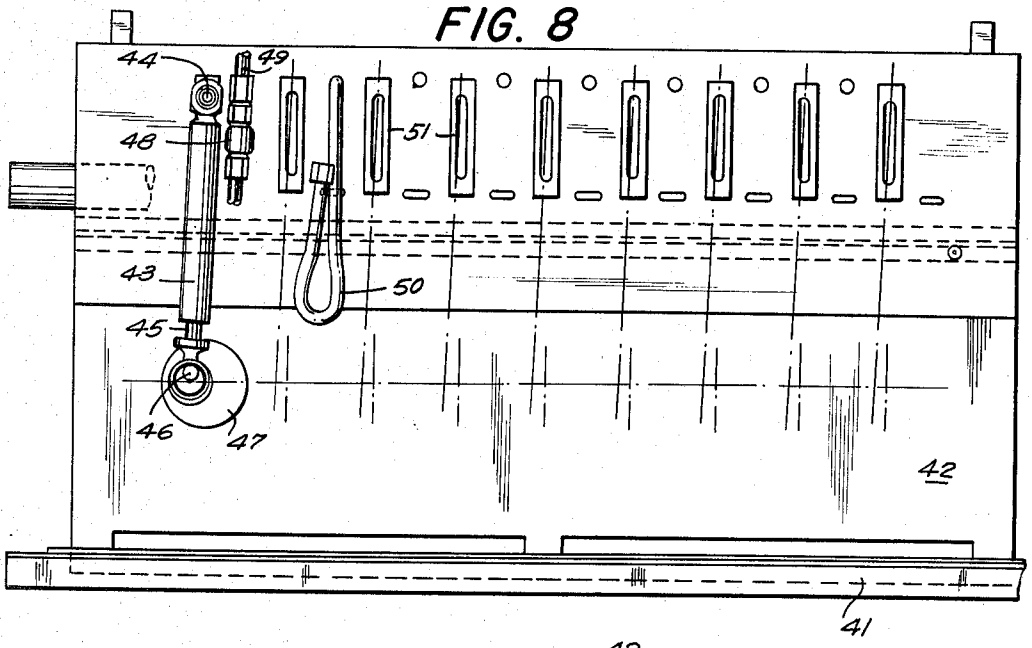
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FIG. 8



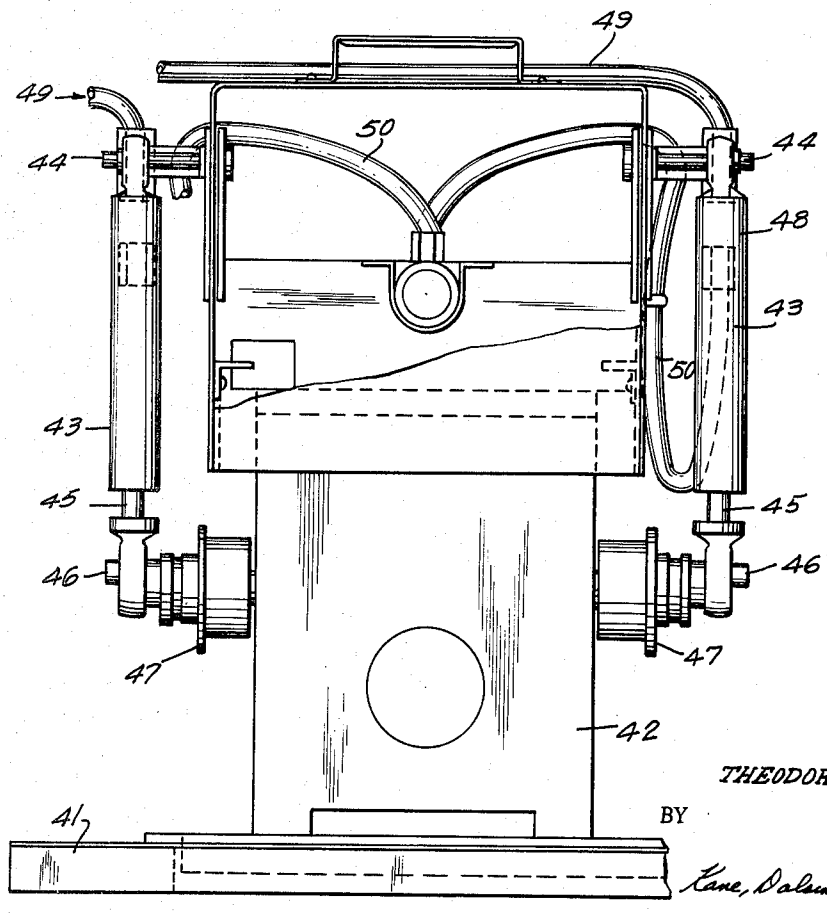


FIG. 9

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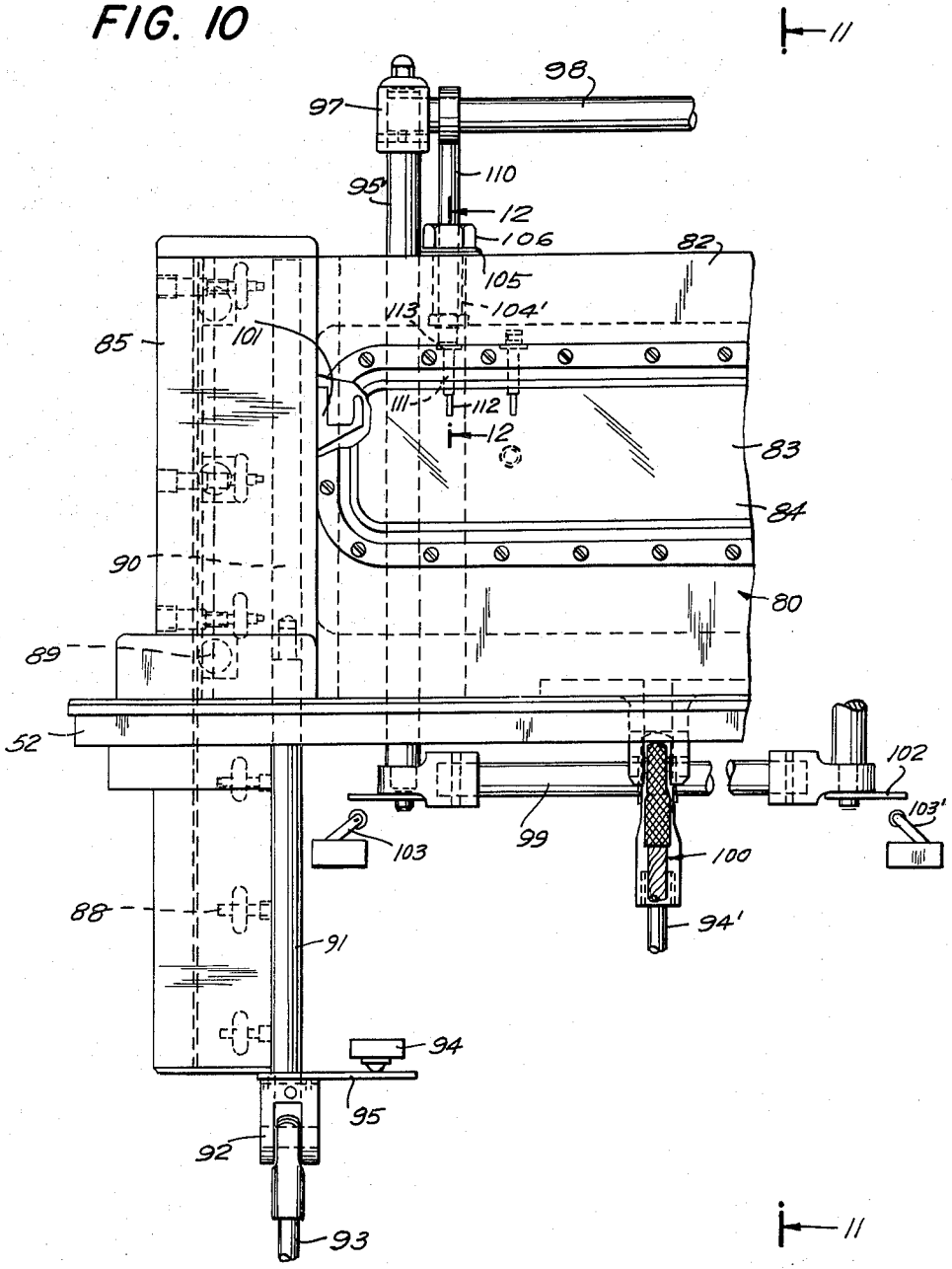
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FIG. 10



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FIG. 11

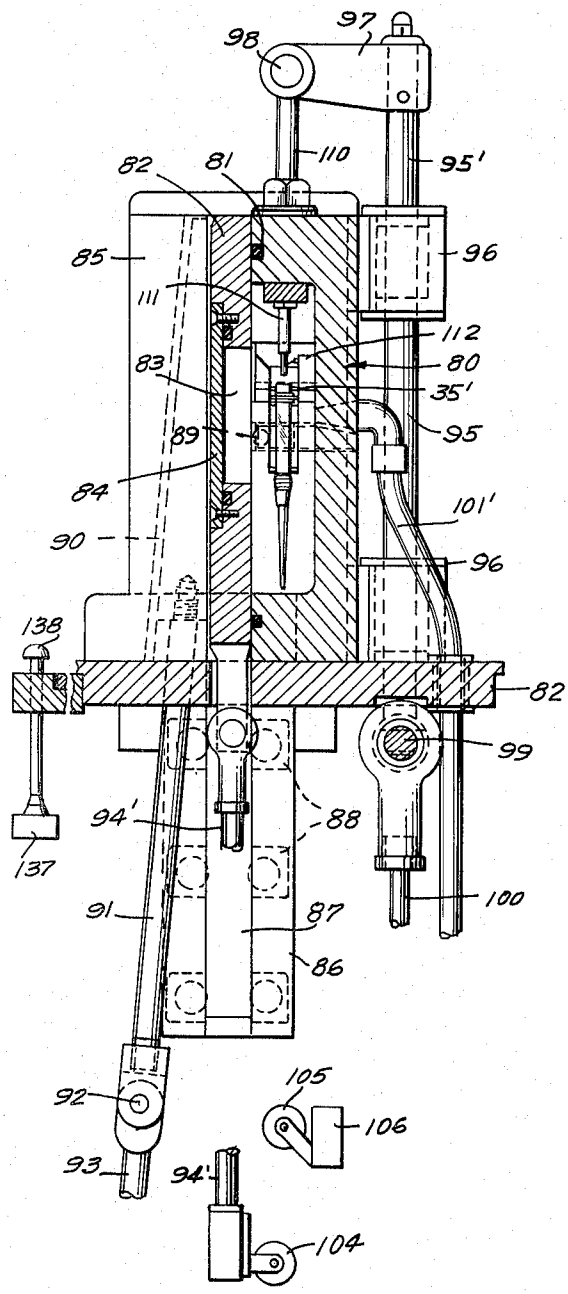
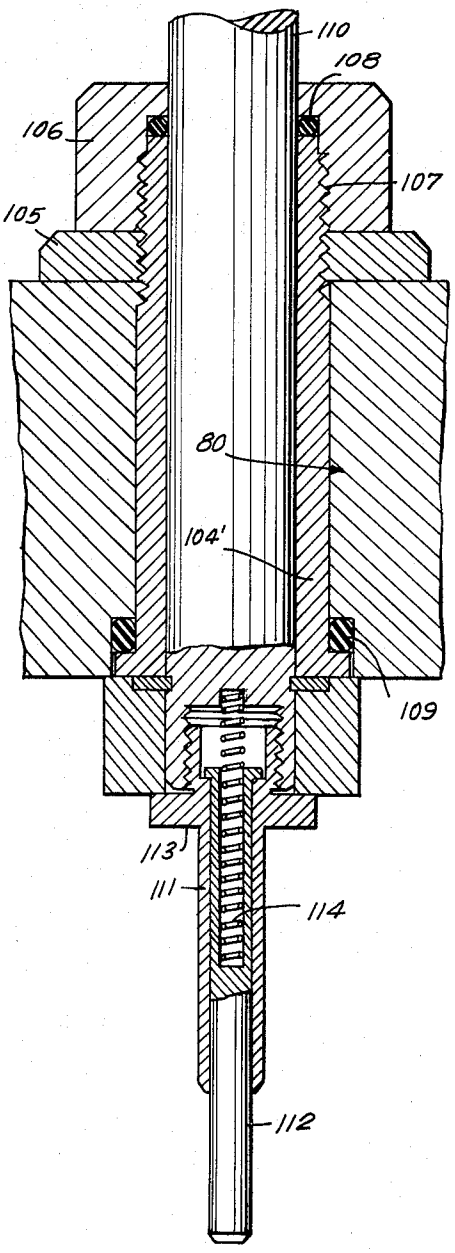


FIG. 12



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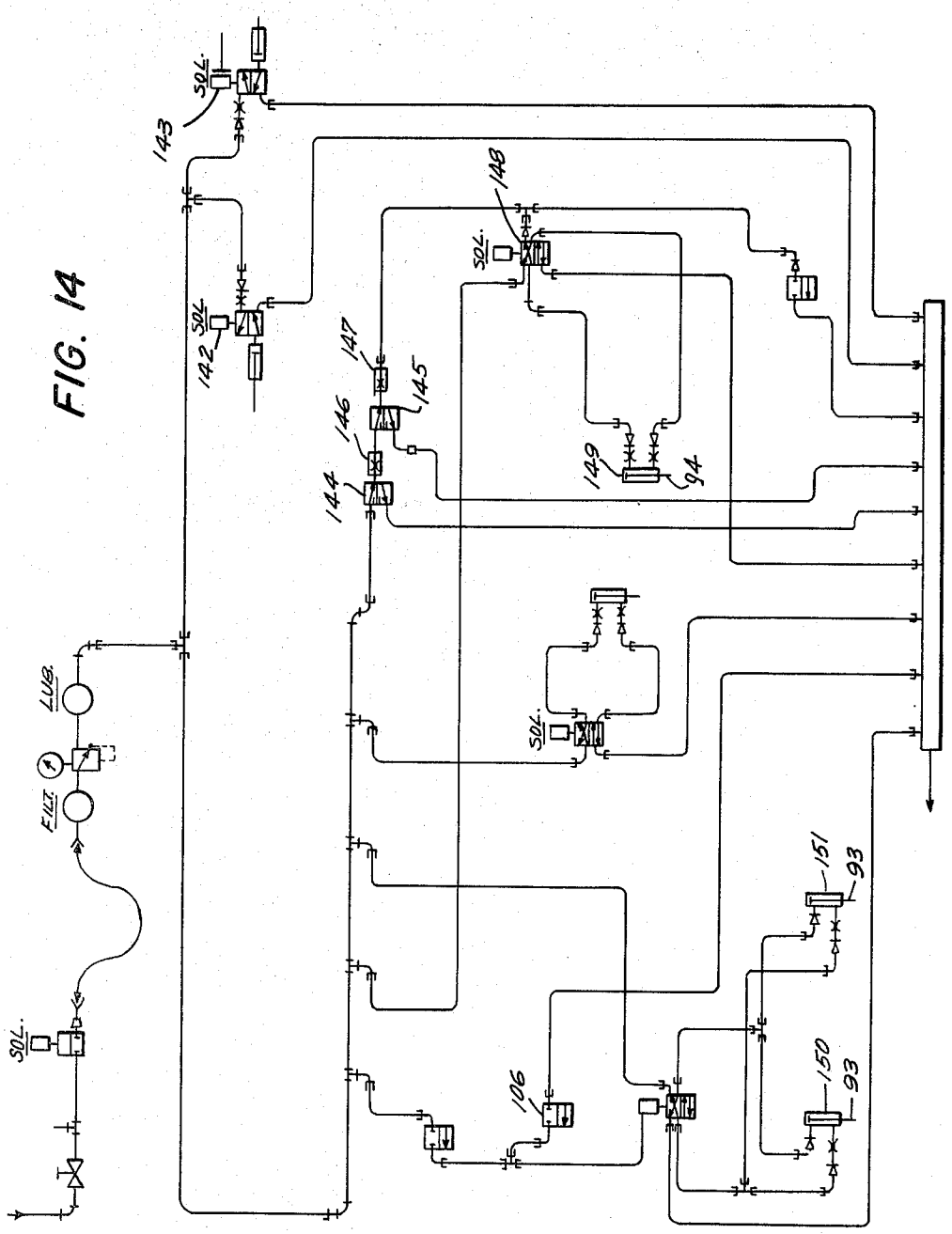
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METHOD AND APPARATUS FOR FILLING HYPODERMIC SYRINGES, AMPULES, ETC.

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FIG. 14



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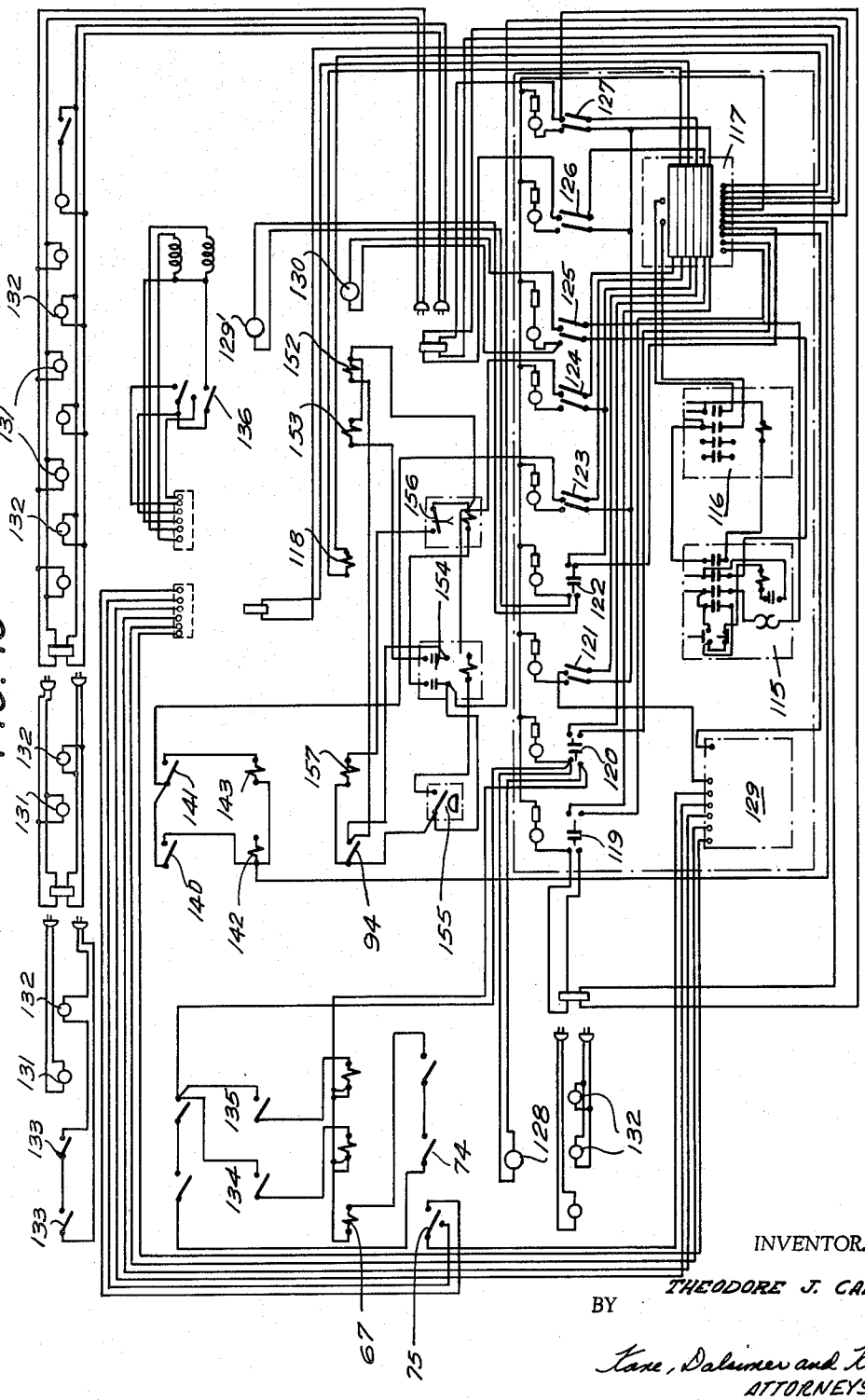
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FIG. 15



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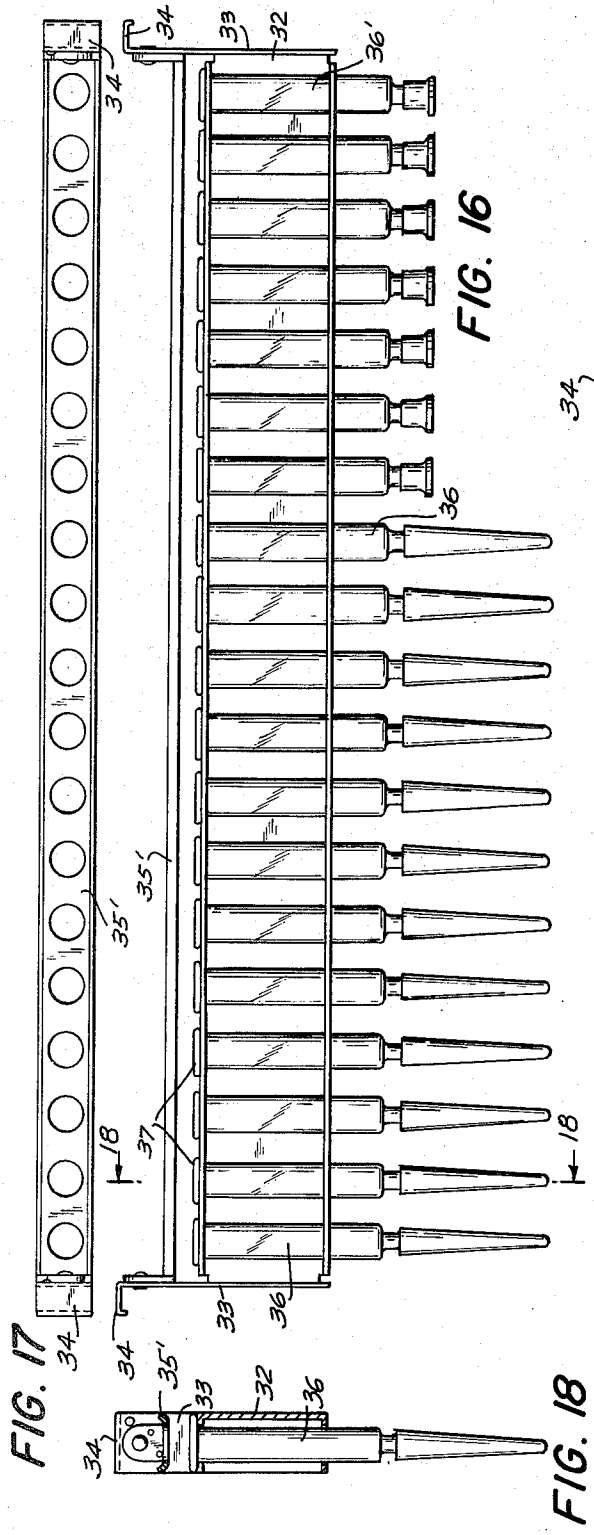


FIG. 16

FIG. 17

FIG. 18

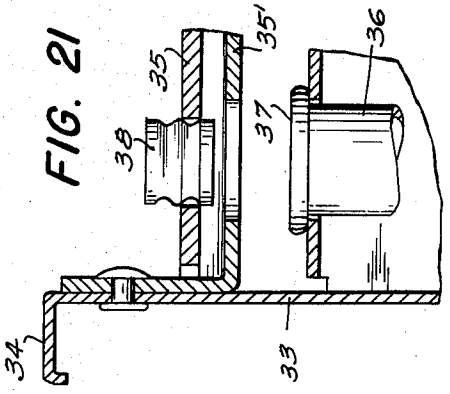


FIG. 21

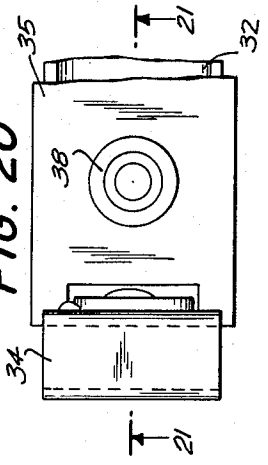


FIG. 20

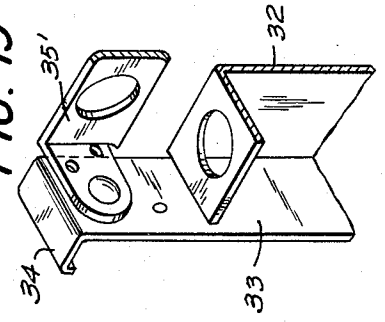


FIG. 19

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United States Patent Office 3,245,194 Patented Apr. 12, 1966

3,245,194

METHOD AND APPARATUS FOR FILLING HYPODERMIC SYRINGES, AMPULES, ETC.

Theodore J. Carski, Baltimore, Md., assignor to B-D Laboratories, Inc., East Rutherford, N.J., a corporation of Delaware

Filed July 31, 1962, Ser. No. 213,748
12 Claims. (Cl. 53—22)

This invention relates to a novel method of filling syringes, cartridges and ampules, with a precisely predetermined volume of medicaments and thereupon sealing the unit with the medicament free of entrapped air or microbial contaminants without it being necessary to manipulate the piston or stopper of the resultant assembly.

Moreover, the present method may be practiced by personnel having only ordinary skills and training. So practiced, a large number of units may be properly filled with minimum expense.

Another object is that of designing a machine by means of which the present method may be practiced; that machine embodying relatively few parts cooperating with freedom from difficulty for long periods of time to precisely and efficiently fill units such as syringes, vials, etc.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating particular embodiments of the invention, and in which:

FIG. 1 is a perspective view taken towards one side of the machine;

FIG. 2 is a similar view taken towards the opposite side of the apparatus;

FIG. 3 is a plan view showing schematically the several stations or zones of the machine;

FIG. 4 is a transverse sectional view showing a preferred layout of mechanism at the filling station of the machine;

FIGS. 5 and 6 are sectional side views taken along the lines **5**—**5** and **6**—**6** respectively, in the direction of the arrows as indicated in FIG. 4;

FIG. 7 is a fragmentary and partly sectional side view of a syringe or unit in filled condition and preparatory to being sealed by a piston or stopper;

FIG. 8 is a face view of the mechanism for dispensing the liquid medicament;

FIG. 9 is a side view of that portion of the apparatus;

FIG. 10 is a fragmentary face view of the casing portion and structure adjacent thereto which provides the vacuum chamber of the apparatus;

FIG. 11 is a transverse sectional view taken through the chamber along the line **11**—**11** in the direction of the arrows as indicated in FIG. 10;

FIG. 12 is a sectional view in enlarged scale taken along the lines **12**—**12** in the direction of the arrows as also indicated in FIG. 10;

FIG. 13 is a view similar to FIG. 7, but showing the unit in filled and sealed condition;

FIG. 14 is a diagram of a fluid pressure system preferably forming a part of the apparatus;

FIG. 15 similarly shows the electrical system;

FIG. 16 is a front elevational of a preferred rack assembly for supporting units and which may also support closures or pistons therefor;

FIG. 17 is a plan view thereof;

FIG. 18 is a sectional side view taken along lines **18**—**18** and in the direction of the arrows in FIG. 16;

FIG. 19 is a fragmentary perspective view of the upper end portion of a rack assembly;

FIG. 20 is a plan view thereof with the parts shifted; and

FIG. 21 is a sectional front view taken along the line **21**—**21** and in the direction of the arrows in FIG. 20.

As before brought out, the present invention is of

primary value when employed in the filling of hypodermic syringes with proper amounts of medicament. Accordingly, syringe unit have been shown in the drawings, and the invention will be correspondingly described. Such description, however, is to be regarded as merely illustrative in that the method and apparatus may be advantageously practiced and used in similarly filling other units with proper amounts of liquid. Those units may for example be cartridges, ampules and vials. Therefore, except where otherwise limited by the language of the claims, the method and apparatus herein disclosed may be employed in connection with units other than hypodermic syringes.

Thus, referring to FIGS. 1 and 2, it will be seen that the reference numeral **20** indicates the base of the apparatus. The latter has an upper forward end defined by an inclined surface **21**, provided with a viewing window **22**. Also, ports **23** are formed at this end. These are closed by gloves adjacent the arm-encircling portions of gloves which receive the hands and forearms of attendants who extend their hands through the ports to manipulate parts within the cabinet. Those parts, in accordance with usual technique, are only contacted with the inner sterile surfaces of the gloves and thus do not become contaminated.

Similarly, the side face of the casing as viewed in FIG. 2 is provided with a number of transparent panels **24**, which permit operators to view the interior of the cabinet. Adjacent each of the stations or zones embraced in the machine, further pairs of ports **25** are provided. These again mount the arm-encircling portions of pairs of gloves.

Accordingly, operators at those stations conveniently defined by panels **24**, will be able to manipulate, without contaminating the adjacent elements within the cabinet. Air supplying and exhausting pipes such as **26** are conveniently connected to the cabinet at their one end and to air filtering and treating apparatus at their opposite ends.

The end of the cabinet shown in FIGS. 1 and 2, and having the port **23**, is the forward or entrance end of the machine. Its opposite end will define the delivery or discharge station of the apparatus. Conveniently, an auxiliary cabinet, **27**, as shown in FIG. 1, may be disposed adjacent the main enclosure and be connected therewith through tubes generally indicated at **28**. Those tubes will be coupled with pumps as hereinafter described in order to cause a flow of liquids in precisely predetermined volumes into the units to be filled. It is preferred to employ a separate cabinet such as **27**, rather than to incorporate in the machine, as in FIG. 1, all the metering apparatus necessary for filling operations.

As shown in diagrammatic manner in FIG. 3, a horizontal supporting surface is provided within the main cabinet. This surface is divided, for example, into seven zones or stations. The first of these is within the area of the hood provided by parts **21** and **22**. This functions as a receiving station for the syringes or other units together with parts accessory thereto and racks for supporting those units and parts. One or more suitable closures as at **29** in FIG. 1 are provided at this station to permit introduction of the units of the assembly on to the corresponding deck portion. The operator at this station will be able to manipulate the parts of the assemblies by passing her hands through ports **23** and into the gloves associated therewith. Also, she will be able to move those parts towards station **2** or **3** by means of conveyor **30** which passes through an opening in an air-lock panel (not shown) separating station **1** and **2**.

Other operators will be able to freely view those parts through ports **25** and viewing the interior through windows **24** will be enabled to partially assemble the syringes held in components. At station **4** the syringes are prop-

erly filled with medicament. At station 5 the filled units are evacuated and sealed and pass through an air-lock panel (not shown) by means of which a plenum effect within the cabinet is maintained. Stations 6 and 7 are opposite glove ports 25 in the same air lock. These stations are used to store and remove necessary components. Conveniently a single or multiple conveyor indicated at 30 provides for the movement of parts from one to the other end of the cabinet. Also as indicated at 31 a multiple track structure may exist such that different racks may follow adjacent parallel paths and thereupon be arrested from further movement until an operator at stations 2 or 3 releases them.

As afore indicated it is preferred that the unit be disposed in groups each supported by a rack. Similarly, the stoppers or plungers which seal the units, after filling, are preferably disposed in racks. The general type of structure preferred in this connection is shown in the prior United States patent to Carski, 2,532,604 of December 5, 1960. This structure is shown in FIGS. 16 to 21 of the present drawings. It will include a generally U-shaped bar 32, the legs of which are formed with perforations through which the bodies of units 36 extend (see also FIG. 7). The arms 33 of the rack conveniently have their upper ends projecting outwardly as at 34. These outstanding portions provide guides and supports for the racks as hereinafter described. Additionally, a rack member may be provided for the plungers or stoppers to be associated with the units. This member, 35, in common with rack 32–34 is preferably formed of sheet metal and provided with openings. The ends of rack 35 are conveniently notched so that portions are furnished which straddle the vertically extending arms 33 of the rack. In this manner rack 35 is retained in association with rack 32–34, but is capable of being readily detached therefrom.

A member 35′ may be pivotally connected to the upper end of arms 33. Accordingly, it is capable of being swung to a position overlying bar 32 and retaining units against displacement from the rack. The units as shown (see also FIGS. 7 and 13) may include cylindrical body portions 36 provided with outstanding flanges 37 adjacent their upper open ends, and which flanges embrace a diameter greater than the openings in the base portions 32 of each rack and the openings of member 35′. Accordingly, the unit will be suspended from, and retained within, the rack. Ordinarily, an assembly including a rack filled with syringes or their equivalents will be introduced at station 1. Stoppers or pistons have been shown at 38. These may be introduced just prior to station 4 or from station 1 outward.

In the case of the units being syringes, the stoppers are conveniently provided with recesses 39 having surfaces such that they may be retained in association with plunger or piston rods 40. (FIG. 13) So retained they may be projected or retracted within the bores of units 36. The stoppers or pistons 38 are formed of natural or synthetic rubber, or any other suitable material embodying resiliency and flexibility. Their bore-contacting surfaces are conveniently provided with a suitable number of grooves, in accordance with conventional practice. The diameters of the openings in stopper or plunger racks 35 or 35′ will be less than that of the ridges defined by the grooves. Therefore, those stoppers will be retained in association with racks until deliberately displaced therefrom. No difficulty will be experienced in positioning and retaining these stoppers or plungers on the racks, in that they may be readily compressed for insertion into the rack openings.

Therefore, the operator occupying position at station 1 may, for example, by means of the conveyor 30 directly pass to station 4 racks filled with syringes and stoppers. If hypodermic syringes are involved and they permanently mount cannulas at their outer ends, (see left side of FIG. 16) then those cannulas or needles and the adjacent tips of the syringe may in each instance be encased by a sheath. If no needles are mounted by the syringes, as in the right side of FIG. 16, then the bored tips of the syringe barrels may be encased by caps at stations 2 and 3. Preferably, the sheaths or caps are applied to the syringe barrels and needles at the time the latter are sterilized and before their introduction through the closure 29. In the event that units other than hypodermic syringes are being filled in the present machine, then if those units should include in their assemblies caps or the equivalent thereof, similar procedures may be followed.

Thus, at station 4 the units to be filled are disposed in racks 32–34. Members 35′ are swung to overlie the units. This will, in all events, prevent displacement of the units. The piston-stoppers are associated with racks 35. The operator at stations 2 and 3 will regulate the transfer of the racks to station 4 in accordance with the availability of that station to receive units to be filled. In any event, the racks will eventually pass to station 4 by the movement of conveyor 30 and if desired by a cart member, or similar expedient. Adjacent that station cabinet 27 is disposed. The mechanism preferably within the main cabinet and serving as a filling station has been shown in FIGS. 4 and 5 and 6, the cabinet mounts mechanism shown to best advantage in FIGS. 8 and 9.

In the latter figures the numeral 41 indicates a deck which conveniently is the main supporting surface of cabinet 27. This deck carries a housing 42. Along each side of the latter pipetting assemblies are disposed. These conveniently may be of the type shown in my prior Patent 2,148,899 of February 28, 1939. The number of assemblies will correspond to the number of syringes or equivalent units which are filled as a single group. Each assembly will embrace a cylinder 43, pivotally supported as in 44 adjacent its upper end. The plunger rod 45 of the unit is connected to an eccentrically disposed pin or rod 46 carried by a rotatable member 47. It is apparent as the latter turns the plunger connected to rod 45 will be reciprocated. In accordance with the teachings of my prior patent, pin 46 should be susceptible to eccentric adjustment in order to vary the volume of liquid delivered from cylinder 43 during the projection stroke of the plunger.

A fitting 48 is connected with each cylinder or barrel 43. This fitting is in turn coupled with tubes 49 and 50 and may conveniently enclose check valves for the controlled flow of the liquid medicament. The outer ends of tubes 50 connect with a reservoir of such liquid. Tubes 49 connect one with each of filling nozzles hereinafter described. A preferably common drive (not shown) actuated by an electric motor serves to rotate cams 47 in unison. Also, the pins or rods carried by the several cams will at all times occupy similar positions. Therefore, with the motor operating liquids will be drawn through tubes 50 into the cylinders 43 as rods 45 retract. One of the valves within fitting 48 will seal upon a completion of its suction stroke and thus prevent a return flow. As the plungers within the barrel 43 are projected the liquid will be discharged through tubes 49; the valves within the several fittings 48 unsealing to permit this flow.

Those valves, subject to a slight aspirating action, will seal to prevent a return flow. Mouting plates 51 are conveniently provided for the ready association with or detachment of the pipetting unit from the general assembly so that they may be cleaned. By vertical adjustment of pivot 44, a variety of different cylinders 43 may be accommodated. Tubes 49 are connected one to each of filling elements disposed within the cabinet in order to charge the hypodermic syringes or equivalent liquid-receiving units with medicament. Plate 51 is used to raise or lower the position of pivot 44 so as to permit adjustment for various syringe lengths to assume a com-

plete ejection of liquid at each stroke of the plunger. Precise volumes delivered are determined by adjustments of crank pin 46.

The structure at this station 4 (see FIG. 3) is best illustrated in FIGS. 4, 5 and 6. In these views the numeral 52 designates the deck surface within the main cabinet. A pair of posts 53 extend slidably through openings in this deck. These posts support between them a transverse member 54. Conveniently hollow supports or columns 55 are mounted by deck 52 and present bores through which posts 53 extend to points below deck 52. Ball bushings 56 and 57 are located within the bores of columns 55. Their outer ends are supported against movement. Their inner ends bear against a spacer 58.

Below deck 52 the posts may be encircled by springs 59 which urge them in downward directions. The upper ends of the springs conveniently bear against lower surfaces of deck 52. Their opposite ends bear against collars 60 secured to the posts. Adjacent the lower ends of the latter anti-friction members in the form of rollers 61 are mounted for rotation. These bear against cams 62 secured to a shaft 63 rotatably mounted by brackets 64 below the deck. A sprocket 65 is rotatably mounted by shaft 63 and coupled thereto by a single revolution clutch 66. A solenoid indicated at 67 is preferably employed to control engagement and disengagement of the clutch parts. When engaged and with drive 65 operative it is apparent that shaft 63 will rotate. As it rotates cams 62 will permit downward movement of posts 53 and member 54 carried thereby under the urging of spring 59. This movement will preferably continue for a considerable arcuate movement of the shaft. Dwell periods will of course be provided by cams 62. However, during the remainder of one cycle of rotation cam 62 will engage rollers 61 to shift posts 53 upwardly.

Referring to FIG. 6, it will be seen that the upper ends of posts 53 are angularly offset as indicated at 68. Each of tubes 49 is connected to one of a series of nozzles 69 which extend downwardly. These parts are supported by, for example, clamps 70. The number of nozzles 69 provided should correspond to the number of units to be filled and the spacing of those nozzles should correspond to the spacing of the units as defined by the openings in the body 32 of the rack supporting the same. Clutch 66 has its parts remaining in engagement for one revolution. To effect this result an armature 68' extends from the solenoid and is pivotally coupled to a link 69' which is similarly secured at its outer end to the lower end of a bar 70. The upper end of the latter is pivotally supported as at 71 below deck 52. Cooperating latch faces 72 form parts of the bar 70 and single revolution clutch 66. The bar is caused to assume a predetermined position, by means of a spring 73. Under this the latch structure obstructs turning of the clutch. Energization of solenoid 67 results from a momentary closing of switch 74. To prevent an over running of shaft 63, a suitably energized brake structure is preferably provided. This may include a pivotally supported link 76' carrying a friction shoe 77 bearing against the periphery of a drum or angular member 78 secured to shaft 63. Contact under proper force is conveniently assured by employing a spring 79 resting against the outer end of link 76' to cause the brake shoe or equivalent to restrain rotation of shaft 63.

Columns 55 each mount supports 80' in line with the row of nozzles 69. These supports provide mountings for the ends 34 of the rack body 32. Accordingly, as shown in FIGS. 4 and 6 a unit-carrying rack may be thus positioned with the bores of the supported units each underlying one of the nozzles 69. Upon closing switch 74 solenoid 67 will be energized so that its armature will shift against the action of spring 73 and release latch 72. Under the continuous drive existing at 65 shaft 63 will now rotate.

That rotation will be in a clockwise direction through 360°. During the first 90° posts 53 will lower to assume proper entry and positioning of the nozzles within the bores of the units. At this time cam 62 engages actuator 76 of switch 75. Accordingly a circuit is energized to initiate operation of the pipetting members (FIGS. 8 and 9). This will result in the discharge of precisely measured quantities of liquid medicament through the nozzles during the next 180° of rotation of shaft 63.

Under the final 90° rotation of shaft 63, posts 53 and the nozzles will be slowly raised to prevent foaming of the liquid. Upon the parts approaching a fully elevated position, the latch faces 72 will subsequently engage, that position of the parts has been shown in FIG. 5. Under those circumstances further rotation of shaft 63 will cease. Accordingly, the operator may remove the rack with the filled units from brackets 80' so that these units may be transferred to the evacuating station 5 as shown in FIG. 3.

The detailed structure present at this station is shown to best advantage in FIGS. 10, 11 and 12. It will be understood while the rack may be moved from one station to another in any desired manner, that preferably supporting members in the nature of small carts will be employed so that mobile support will be assured the units especially after they are filled. During such movement the units associated with the racks will be retained against displacement by maintaining members 35' in a position overlying such units. With members 35 empty, filling of the units as aforedescribed is feasible. However, in the event that rack 35' carries stoppers or pistons, that rack will be swung out of alignment during the filling operation. If a wholly detachable rack is employed to support stoppers or plungers, then rack 35 will not be associated with rack 32–34 until the units carried by the latter have been filled and it is in position at, or adjacent to, the evacuating station 5 as in FIG. 3.

A preferred form of assembly present at the evacuation station has been shown in FIGS. 10, 11 and 12. Referring primarily to the first two of these views, the deck within the cabinet has again been indicated by the numeral 52. Mounted upon this deck is a housing 80, which includes a body U-shaped in section and preferably provided with a groove in its outer face to accommodate an O-ring 81 or similar seal which extends beyond that face. A door in the form of a slidably mounted panel 82 cooperates with body portion 80 to furnish a complete enclosure. Panel 82 is preferably formed with a sight opening 83 sealed by a window 84 against the passage of air. Adjacent opposite side edges of deck 52 extensions 85 overlap the end zones of panel 82 beyond the outer face of the latter. Extension 85 may form part of the housing portion 80. Deck 52 is provided with an opening of an area adequate such that panel 82 may pass therethrough.

Below the deck (FIG. 11), members 86 are disposed and provide guide ways 87 within which the front and rear faces of the panel adjacent its side edge zones may be accommodated. Conveniently anti-friction members as indicated at 88 may extend into the guideway 87 so that the panel may be freely shifted from the position shown in FIGS. 10 and 11 to a point where the upper edge clears the cavity defined between the legs of the housing portion 80. Under those conditions that cavity will be freely accessible for the purpose of removing therefrom or introducing into the same rack assemblies as aforedescribed.

Panel 82 is normally maintained at a position such that it clears the O-ring or equivalent sealing element 81. This is achieved by employing a suitable number of spring pressed balls as indicated at 89 to extend outwardly from that face of housing 80 which is adjacent panel 82. Thus, the latter will tend to assume a position to the left of that illustrated in FIG. 11. To assure a proper seating relationship between the panel and housing, wedges 90 are conveniently employed. These are disposed within extensions 85. The parts are so propor-

tioned that upon the panel having been moved to a position of maximum elevation, the projection of wedges **90** will urge the panel laterally into sealing engagement with sealing member **81** and the face of housing **80** carrying the latter. Upon wedges **90** being retracted the spring pressed balls or equivalent will immediately cause panel **82** to move out of sealing relationship with housing portion **80**. Therefore panel **82** will not abrade or otherwise damagingly engage seal **81**.

Attached to the lower ends of each of wedges **90**, are rods **91**. The latter may be pivotally connected as at **92**, to crank rods **93**. As rods **91** project and retract, switch **94** is actuated by brackets or extensions **95'** carried by those rods. Rods **94'** are likewise pivotally secured to the lower edge zones of panel **82**. Additional rods **95** may be slidably supported for vertical movement within guides **96** secured to the rear face of housing **80**. These rods adjacent their upper ends mount brackets **97** supporting between them a horizontal member **98** in a position overlying the space defined within housing **80**. The lower ends of rods **95** are connected by a horizontally extending member **99** to which a rod **100** is pivotally coupled.

It is apparent that as the rod **94'** is sequentially shifted the enclosure defined by body portion **80** and panel **82** will be established with its parts in sealing relationship or else the panel will be shifted to a position such that the interior of the body **80** is rendered accessible. Likewise rods **95'** will be shifted to cause horizontal member **98** to be lowered or raised. That member having connected with its a series of pusher pins as hereinafter described, it follows that the latter will be reciprocated. Brackets **101** are provided one adjacent each end of the cavity defined by body portion **80**. These brackets receive and retain the syringe rack **32–34**. A tube **101'** has one end connected with a source or suction; its opposite end is connected to the interior of the housing cavity. In addition to controls such as **94–95** as aforedescribed, additional controls involving brackets **102** secured against movement with respect to horizontal member **99** and switches **103** actuated thereby may be provided. Also, as shown in FIG. 11 a one way roller trip **104** may be carried by rod **94'** to engage with the actuator **105** of a valve **106** to control reciprocation of the shafts **93**.

Pusher pin assemblies (FIG. 12) are mounted by the upper arm of U-shaped housing **80**. To this end that arm is provided with transversely extending bores corresponding in number to the number of syringes mounted within a rack. Bushings **104'** are disposed one within each of these bores. These are retained in position conveniently by means of nuts **105** above which threaded caps **106** engage their threaded upper end portions **107**. O-rings **108** and **109** provide for an air-tight seal between rods **110**, the bushing **104'** and body portion **80**. Rods **110** have their upper ends connected to the adjacent horizontal member **98** and mount at their lower ends downwardly extending sleeves **111**. Pins **112** have their lower ends extending below sleeves **111**. They are preferably retained by flanges **113** bearing against the inner faces at the base portions of sleeves **111**. Springs **114** have their opposite ends bearing against the lower surfaces of rods **110** and the surface of a pin **112**. In this manner the latter is yieldingly urged to assume a projected position. The force exerted by spring **114** in addition to the weight of an engaged pin **112**, should be just beyond that required to displace a piston or stopper element **38** from its rack **35**.

The lower ends of sleeves **111** and pins **112** extend into the chamber defined by body portion **80** and within which a rack assembly is disposed. It is apparent that as rods **95'** are reciprocated, rods **110** will be similarly moved to project and retract pins **112**. In retracted position, those pins will be elevated to an extent such that a rack assembly may readily be disposed within the chamber or removed therefrom. The pins **112** will each align with one of the openings in racks **35**, or **35'**. Therefore, when pins **112** are projected incident to a lowering of rods **95'**, their reduced end portions will extend into the recesses of the plunger-pistons or stoppers as indicated at **40** in FIG. 13 and cause a flexing of the stoppers as the latter are projected into contact with the upper surface of medicament within a syringe or ampule **36**. When that contact occurs, downward movement of a closure element **38** will cease because of the resiliency of spring **114** which will allow the pin **112** to remain stationary despite continued downward movement of plunger **110**. Thus, regardless of the level of the liquid within the bore of a syringe or ampule the piston or stopper will merely be shifted to a position at which it rests on the upper surface of the liquid and will not cause that liquid to be squeezed past it to a position to one side or even above the inserted element **38**. However, by downward projection of the stopper-piston, any residual air will be displaced between its lower face and the upper surface of the liquid medicament.

Motor means for operating the components of an apparatus such as the present may be power actuated as desired. This, at the evacuation station, may generally correspond to those heretofore described at the filling station. It is preferred to employ both electrical and pneumatic pistons each according to operations to be performed at any given station or throughout substantially the entire length of the main cabinet. Attention is therefore directed to FIGS. 14 and 15 in which the first diagrammatically illustrates the pneumatic system as generally preferred and FIG. 15 similarly shows the wiring diagram.

Referring to FIG. 15 the numeral **115** indicates the main control switch. As it is closed components **116**, **117** and **118** connected therewith are energized. Thereafter switches **119** to **127** inclusive may be operated to control various circuits. A closing of switch **119** initiates driving of conveyor **30**. Upon switch **120** being closed, the control circuit at filling station **4** (FIG. 3) as well as the motor **128** for that station, are energized. Switch **121** energizes torque control **129**. Switch **122** controls the operation of motor **129'**. Switch **123** energizes the circuit controlling evacuation. Switch **124** similarly controls the timing circuit at that station. A motor driven vacuum pump **130** is controlled by switch **125**. Switch **126** controls the operation of lights **131** providing hood illumination lamps within the cabinet through the length of the same and switch **127** controls ultra-violet lamps **132** similarly distributed throughout the length of the cabinet. Thus, with switches **119** to **127** inclusive closed, the machine is ready to operate.

As afore brought out, the supplies are introduced at the forward end of the machine through door **29**. These supplies will include the parts of the rack assembly, units such as syringes, vials, ampules, etc. Plungers, or stoppers and tip caps may be introduced at this station, or at station **4**. Connected with the door or doors **29** to be operated thereby, are cut-out switches **133** controlling the energization and de-energization of the ultra-violet light or lights within this zone of the machine, so that when the door is opened the light will be de-energized. The several supply assemblies may be conveniently disposed in separate receptacles. Also, the racks at points between at least certain of the stations may be supported in carts (not shown) which are capable of moving with the conveyor. Obviously, other supporting expedients may be resorted to.

In the event that syringes **36'** which do not permanently mount needles are to be filled, then at stations **2** and **3** the tips of those syringes are provided with sealing caps by operators stationed at the first two panels **24** as shown in FIG. 2. Also, at stations **2** and **3** the units to be filled are supported by racks **32–34** while stoppers or pistons **38** are properly mounted in racks **35**, or **35'**. The filled racks are transported by conveyors **30** to filling

station 4. There they are mounted on arms 80' as shown in FIG. 6.

Those arms or brackets are fixedly disposed in predetermined positions. When a rack is not properly positioned thereon, switches 134 and 135 adjacent those arms will be in open positions so that the control circuits at this station will not function. If, however, the rack is properly positioned, then the switches will be closed. Therefore, when switch 74 (FIG. 6) is closed, it will energize a circuit to energize solenoid 67 shown in FIG. 5. Accordingly, the armature 68' will be shifted to a release clutch 66, for a single revolution. This will similarly result in a rotation of shaft 63, as aforedescribed. Accordingly, rods 53 will lower under the influence of springs 59 as the portions of cams 62 shift from the position shown in FIGS. 4 and 6. With 90° rotation of shafts 63, nozzles 69 reach a proper filling position.

Simultaneously, the actuator 76 of switch 75 will be shifted by one of the cams 62. This will close a circuit controlling the operation of the mechanism associated with auxiliary cabinet 27.

That mechanism will involve a clutch structure such that cams 47 and the crank ends 46 carried thereby rotate merely through a single revolution. Thereafter a brake mechanism will operate, assuring that plungers 45 remain in the fully projected position shown in FIG. 9 until a further energization of the circuit controlled by switch 75 occurs. This mechanism will functionally correspond to clutch 66, latch faces 72 and solenoid 67, as heretofore described in connection with FIGS. 5 and 6. Therefore, the clutch provided as part of the assembly in the auxiliary cabinet, will be engaged. Sinmultaneously, the brakes assuring against a rotation of crank ends 46 will be released. Therefore, a pumping stroke will occur in connection with the several cylinders 43. Consequently, liquid will be drawn from the medicament reservoir through tubes 50 and be discharged through tubes 49. So discharged, it will precisely fill through the discharge nozzles 69, each one of the syringes or other units carried by the rack with an amount of medicament corresponding to the setting of the parts. As the cranks 46 complete one revolution a cam will strike against an actuator for a switch (corresponding respectively to parts 62 and 76) to thus close control circuits. These will respectively de-energize the clutch serving to drive the cranks 46 of the several pipetting units and energize the brake to arrest those cranks in predetermined positions as shown in FIG. 9. Accordingly, the units below nozzles 69 will have been properly filled. Simultaneously, cams 62 will have completed one revolution, thus raising the arms 53 and withdrawing nozzle 69 from the units which have been charged with medicament. The switch thus actuated to control the de-energization of the clutch and energization of the brake governing the operation of the pipetting unit, as in FIGS. 8 and 9, has been indicated at 136 in FIG. 15. According to the present teachings, it is to be noted that by properly timing the sequence at the filling station "hanging drops" are eliminated from nozzles 69. In this manner the accuracy of the dosage as discharged from those nozzles will be maintained.

The procedure embraces a proper timing of the operating cycle of the pipette 43 in relation to the movements of nozzles 69. As heretofore described, those nozzles are lowered to extend into the bore of the syringes or other units and the medicament is discharged through them up to a predetermined quantity. The nozzles are raised to the position shown in FIG. 6, at which their lower ends are clear of the body of discharged medicament. By timing the projection and retracting of plungers 45 within pipetting cylinders 43, in a proper manner those plungers will have a minute retractive movement after nozzles 69 have cleared the bodies of medicament. Accordingly an aspirating action will occur such that the medicament will be slightly withdrawn into the bores of the nozzles at that instant. Thereby the danger of adhering drops will be overcome.

The rack together with the filled units is now removed from arms or brackets 80'. It is transported by cart or otherwise to the evacuation station 5 as in FIG. 3. At that station the operator removes the racks with the filled units and associates therewith a stopper or plunger rack 35, if rack 35' does not carry these elements. Of course, if the latter be the case, then the plunger or stopper rack may be simply swung to a position where its openings register with the openings supporting units 36. Also, if instead of being previously filled with elements 38, it may at that time receive them.

In any event, at that time panel 82 as well as wedges 90 will be in their retracted or lowered positions. Accordingly, the filled rack assembly may be disposed within the cavity defined by body member 80. So disposed it will be suspended from brackets 101. At that time one or more switches 137 (FIG. 11) operated by actuator 138 are closed. These switches have been indicated at 140 and 141 in FIG. 15. Solenoids 142 and 143 are therefore energized. This results in a controlled flow of compressed air through the pneumatic system of the apparatus as shown schematically in FIG. 14.

In that view, the numerals 144 and 145 indicate solenoid controlled valves. Check valves 146 and 147 are disposed adjacent the same and serve to provide for safety control. With the opening of valves 144 and 145 pilot valve 148 is opened to permit air under pressure to flow into cylinder 149. Within the latter a piston is disposed and connected with rod 94 controlling the movement of panel 82 as especially shown in FIG. 11. This will cause panel 82 to be elevated to a position where it closes the cavity defined by housing 80. As the panel is so elevated actuator 104 connected to rod 94' will strike actuator 105 to open valve 106. The latter controls the flow of air under pressure into cylinders 150 and 151. These latter house pistons connect to rods 91 which are in turn coupled to wedge members 90, as in FIG. 11. Accordingly, under the influence of fluid pressure, rods 91 will move upwardly to correspondingly shift the wedge members which will thus bear against panel 82 and cause it to shift laterally to assume an air-tight relationship with housing member 80. In so moving the spring plungers, or balls 89, will be retracted and the O-ring or equivalent seal 81 will be operatively compressed.

As rods 93 reach a completely elevated position, brackets 95 will engage the actuators of switches 94. This will result in energization of solenoid-controlled valve 152 to shift it to closed position and energize solenoid-controlled valve 153 to open position through normally closed contacts in relay 154. (See FIG. 15.) Vacuum pump 130 will now evacuate the enclosure defined by body member 80 and panel 82. This will occur through suction acting through hose 101'. It will be understood that a suitable vacuum gauge is preferably connected to the rack-containing enclosure so that the value of the vacuum may be accurately determined. A vacuum-controlled switch 155 causes a closing of the circuit at this point when a vacuum, as predetermined, is achieved. With such closing the coil in relay 154 is energized, thus opening the normally closed contacts controlling solenoid valve 152. This will return that valve to a closed position thereby disconnecting the enclosure defined by housing 80 in panel 82 from the vacuum source. Accordingly, that enclosure will be held under vacuum of predetermined value.

The normally open contacts in relay 154 close. This serves to energize the coil included in timer 156. The timer is adjustable and may accordingly be preset for any desired interval within a given range. When this interval has elapsed, the contacts of the timer close to energize solenoid-controlled valve 157. This controls the flow of air into a cylinder (not shown) controlling the movement of pistons to which rods 95' and 100 are connected.

Accordingly, member 98 will be lowered carrying with it the rods 110 and spring-pressed pins, or fingers, 112. Due to the sealing expedients such as 108 and 109 (FIG. 12), there will be no leakage into the enclosure or chamber containing the rack. In this manner the closure or piston elements 38 are displaced from rack 35 into contact with the upper surface of the medicament within unit 36. As rod 100 moves to a position just short of its extreme lower station, the brackets 102 carried by member 99 will operate the air valve 103 controlled thereby to cause air flow to cylinders 150 and 151 and retraction of rods 93 to thus withdraw the wedges.

As wedges 90 move, brackets 95 will release switches 94. Accordingly, the solenoids governed thereby are de-energized so that the control valves at 152 shift to open position. Accordingly, the chamber within which the rack assembly is disposed is vented to fill to pressure as existing within the cabinet. As the vacuum within that chamber decreases switch 155 returns to an open position. This de-energizes the coil in relay 154 to open the contacts and de-energize the coil of timer 156. Under these circumstances, relay 154 is in its normal position and ready for the next cycle of operation. As timer 156 de-energizes the contact therein opens and de-energizes a solenoid-controller valve causing the cylinder governing the movements of rod 100 to shift the latter to its upper position. So shifted, pins 112 will have their lower ends occupy positions such that the rack assembly may be lifted without interference from brackets 101.

As a condition of atmospheric pressure is set up within the enclosure defined by body 80 and panel 82, pressure will act upon the upper faces of the plungers or pistons within the units which have been filled.

Those elements being in face-to-face contact with the body of liquid medicament, will firmly bear against the surface of the liquid with no danger of air bubbles coming in being within the bore of the units. By control, corresponding to actuators 102 and valve assembly 103, air under pressure flows into the cylinder supporting the piston with which rod 94' is connected. This occurs as wedges 90 reach points adjacent their lowermost positions. Accordingly, panel 82 will be lowered to a position where the rack assembly with its contained units may be removed and replaced by a succeeding assembly. During the downward movement of the panel 82 it is apparent that it will be shifted away and out of damaging contact with seal 81 by virtue of the spring-pressed elements 89 or their functional equivalents. After removal of the rack of filled and sealed units from the chamber at the evacuation station it may again be associated with conveyor 30 for removal from the machine.

As will be understood by the present method, the volume delivered into the syringe or other unit is not dependent on the capacity of that unit, nor is it necessary to additionally manipulate the plunger stopper in any manner to achieve a space filled with medicament and completely free of air. Accordingly, a completely accurate dosage may be relied upon and the danger of injecting air into the circulatory system of a patient is avoided. There being no entrapped air in the unit, the hazard of microbial contaminants is avoided as in the case of a procedure requiring puncturing or manipulation of the plunger stopper to free entrapped air.

As is well known, liquids dissolve a quantity of gases such as air. This is dependent not only upon the solubility of the gas, but also the temperature of the solution and the pressure exerted on that solution. As will be appreciated, according to the present technique it is subjected to low pressure just sufficient to release the dissolved gases as well as the atmosphere above the solution within the units. Therefore, with the solution held at reduced pressure for an interval of time, the dissolved gases escape from the solution before the closure is completed. In the event that air bubbles or pockets are created under unusual circumstances and after a unit is filled, these bubbles will be entrapped within the grooves forming a part of the closure 38. Accordingly, the air bubbles will be isolated from the solution. Additionally, if desired and according to one aspect of the method, harmful gases may be purged from within the interior of units prior to their being filled by single or multiple floodings of the housing 80–82 with inert gases with intervening vacuum action so as to flush any such gases or air from within a unit. The introduction of inert gases may be achieved through tube 101 or else a second tube (not shown) may communicate with the chamber for this purpose. Under such technique the timing and control apparatus of the present assembly will be adjusted and amplified to provide for the desired sequence of operation.

Under all circumstances the value of the vacuum should be just short of the point where the solution will begin to boil. The temperature of the solution or medicament may, of course, be lowered to a desired degree by suitable refrigeration. Ordinarily the maintenance of the desired degree of vacuum for a time interval from one-half to thirty seconds is adequate to equilibrate the solution with the atmosphere. Due to the fact that the pins 112 are relatively pointed and of reduced area adjacent their lower ends which contact the closure elements 38, no difficulty will be experienced in causing a flexing of the pistons or stoppers—with consequent venting of gas —as the closure elements are shifted to positions in contact with the upper surface of the medicament.

From the foregoing it is obvious that, among others, the several objects of the invention as specifically aforenoted are achieved. It is apparent that numerous changes in construction and rearrangement of the parts, as well as variations in the method and the steps thereof, may be resorted to without departing from the spirit of the invention as defined by the claims.

I claim:

1. A method of filling a syringe or similar container with a precise quantity of liquid and sealing the container with a flexible stopper, said method comprising the steps of filling each of a plurality of containers with a precise quantity of liquid by projecting liquid discharge nozzles coupled with a supply of said liquid into each of the containers and thereafter discharging the precise quantity of liquid, after the precise quantity of liquid has been discharged into each of the containers and before the nozzles are retracted from the associated container applying a slight suction to the liquid supply to ensure that no drop of liquid is hanging from the nozzles when they are retracted, placing a stopper above the open top of each of the containers, subjecting the surface of the liquid in each of the containers to a vacuum, moving the stoppers for each of the containers and forcing these stoppers into the open top of the associated containers and into contact with the whole of the upper surface of the liquid in each of the containers such that any gas trapped in the containers between the stopper and the upper surface of the liquid causes the edges of the stopper to flex due to the stoppers being flexible and any entrapped gas escapes between the stoppers and the side walls of the associated container as the stopper is finally forced into contact with the surface of the liquid to thereby seal the containers.

2. A method according to claim 1, in which the containers is purged of harmful gases by enclosing the containers in a housing and flooding the housing with an inert gas before the container is filled with liquid.

3. A method according to claim 1, in which the containers is sealed in a refrigerated enclosure to enable a greater vacuum to be applied to the liquid without the liquid boiling than would otherwise be the case.

4. An apparatus for filling a syringe or similar container and sealing such container with a flexible stopper, said apparatus comprising a filling station having a liquid supply and a plurality of nozzles coupled therewith and arranged to simultaneously discharge a precise quantity

of liquid into a plurality of syringes or similar open topped containers, means for lowering the nozzles into the containers before the discharge of liquid therein and for retracting the nozzles following the disccharge of liquid, suction means for applying a slight suction to the liquid supply after the discharge of liquid to ensure that no drop of liquid is hanging from the nozzles when they are retracted, a housing, support means in the housing for a plurality of the filled containers, support means in the housing for a plurality of stoppers for the containers, means for evacuating the housing, and plunger means for simultaneously transferring the stoppers from their support means into the open top of the containers into contact with the whole upper surface of the liquid in the associated container to seal the containers.

5. An apparatus according to claim 4, in which the plunger means is carried telescopically by a part with which the plunger means is arranged to yield against resilient action upon continued movement of the part after the stoppers has come fully into contact with the liquid in the associated container.

6. An apparatus according to claim 4, in which said housing has an opening, a removable panel provides an access into the housing, said removable panel forming a part of the wall of the housing, the panel being movable into and out of positions in which it is coextensive with the opening in the housing and being arranged, when it is coextensive with the opening, to be moved normally to its plane into sealed contact with the parts of the housing surrounding the opening as the panel moves away

7. An apparatus according to claim 6, in which the panel is moved normally to its plane to seal the housing by means of movable wedge surfaces.

8. An apparatus according to claim 6, in which means are provided for positively moving the panel in a direction normal to its plane away from the parts of the housing surrounding the opening as the panel moves away from the position in which it is coextensive with the opening.

9. An apparatus according to claim 4, which is arranged so that no liquid can be discharged through the nozzles until a rack for holding the containers is properly seated on a support at the filling station.

10. An apparatus according to claim 4, in which a conveyor for carrying filled but unsealed containers extends from the filling station to the housing.

11. An apparatus for filling and sealing a syringe or similar container, the apparatus comprising a filling station having a nozzle which is arranged to discharge a precise quantity of liquid into a syringe or similar open topped container, and a housing enclosing both a support for the filled container and a support for a stopper for the container, an apparatus in which said housing has an opening, a removable panel provides an access into the housing, said removable panel forming a part of the wall of the housing, the panel being movable into and out of positions in which it is coextensive with the opening in the housing and being arranged, when it is coextensive with the opening, to be moved normally to its plane into sealed contact with the parts of the housing surrounding the opening to make the housing airtight, the panel is moved normally to its plane to seal the housing by means of movable wedge surfaces, means for evacuating the chamber and means for transferring the stopper from its support into the container into contact with the whole upper surface of the liquid in the container to seal the container.

12. An apparatus for filling and sealing a syringe or similar container, the apparatus comprising a filling station having a nozzle which is arranged to discharge a precise quantity of liquid into a syringe or similar open topped container, and a housing enclosing both a support for the filled container and a support for a stopper for the container, an apparatus in which said housing has an opening, a removable panel provides an access into the housing, said removable panel forming a part of the wall of the housing, the panel being movable into and out of positions in which it is coextensive with the opening in the housing and being arranged, when it is coextensive with the opening, to be moved normally to its plane into sealed contact with the parts of the housing surrounding the opening to make the housing airtight, means are provided for positively moving the panel in a direction normal to its plane away from the parts of the housing surrounding the opening as the panel moves away from the position in which it is coextensive with the opening, means for evacuating the chamber and means for transferring the stopper from its support into the container into contact with the whole upper surface of the liquid in the container to seal the container.

References Cited by the Examiner

UNITED STATES PATENTS

2,130,761	9/1938	Bickford	53—112
2,174,745	10/1939	Hoffman et al.	53—112 X
2,353,985	7/1944	Barr	53—101 X
2,517,569	8/1950	Huzenlaub	53—112 X
2,896,381	7/1959	Lange	53—112 X
2,998,686	9/1961	Pirro	53—101
3,007,294	11/1961	Hagen et al.	53—112 X
3,110,309	11/1963	Higgins	128—272 X

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