United States Patent

Tascher et al.

[15] **3,662,517**

[45] **May 16, 1972**

[54] SYRINGE FILLING APPARATUS

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[73] Assignee: **Sherwood Medical Industries Inc.**

[22] Filed: **Apr. 8, 1970**

[21] Appl. No.: **26,683**

[52] **U.S. Cl.** **53/282,** 53/308, 53/324, 53/328

[51] **Int. Cl.** **B65b 7/28,** B65b 3/04, B65b 23/22

[58] **Field of Search** .....53/37, 43, 264, 266, 281, 282, 53/306, 308, 319, 320, 324, 328, 330; 29/208 R, 208 B, 208 F

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Attorney—Hofgren, Wegner, Allen, Stellman & McCord

[57] **ABSTRACT**

A syringe filling apparatus for automatically filling a plurality of syringes serially including an indexable turret having a lower support for holding a plurality of open syringe barrels and an upper support for holding a corresponding plurality of syringe plungers in aligned position with respect to the cylinder barrels, the turret assembly indexing each syringe to a filling station where medicament is dispensed into an open cylinder barrel and the medicament level in the barrel is sensed by a photo-sensitive circuit and medicament flow controlled in response thereto, the turret assembly indexing each syringe to a second station where a vertically reciprocable tool head pushes the syringe plunger from the upper turret support, and thereafter releasing it in the aligned cylinder barrel where the tool head exerts a pressure on the outer ring of the syringe plunger in a manner to captivate the plunger piston and thus vent the entrapped air, the turret assembly indexing each syringe to a third station where each syringe plunger, which includes a plunger piston retainer sleeve for releasing the piston, has its piston releasing sleeve cammed upwardly in a manner to release the plunger piston within the associated syringe barrel sealing medicament therein, there being also provided a mechanism for vertically adjusting the turret assembly with respect to the photo-sensitive medicament level detecting means to vary the level of medicament in the barrels as desired.

9 Claims, 7 Drawing Figures

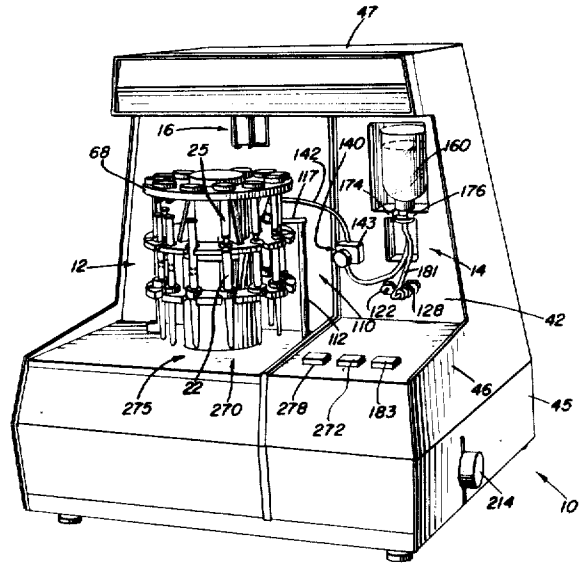


Fig. 1

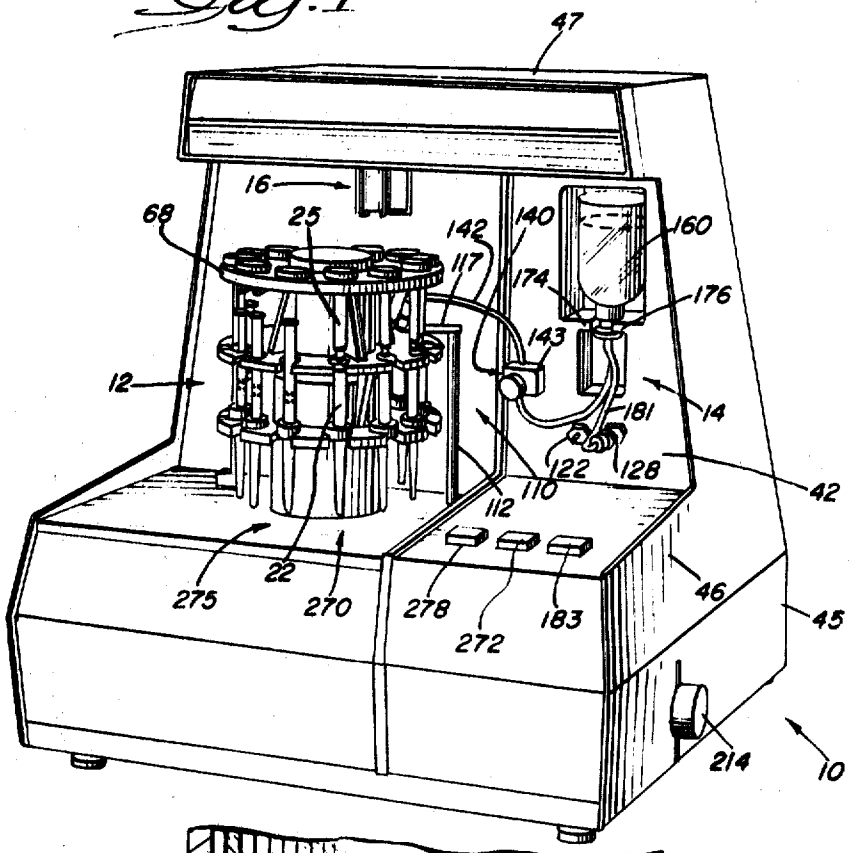
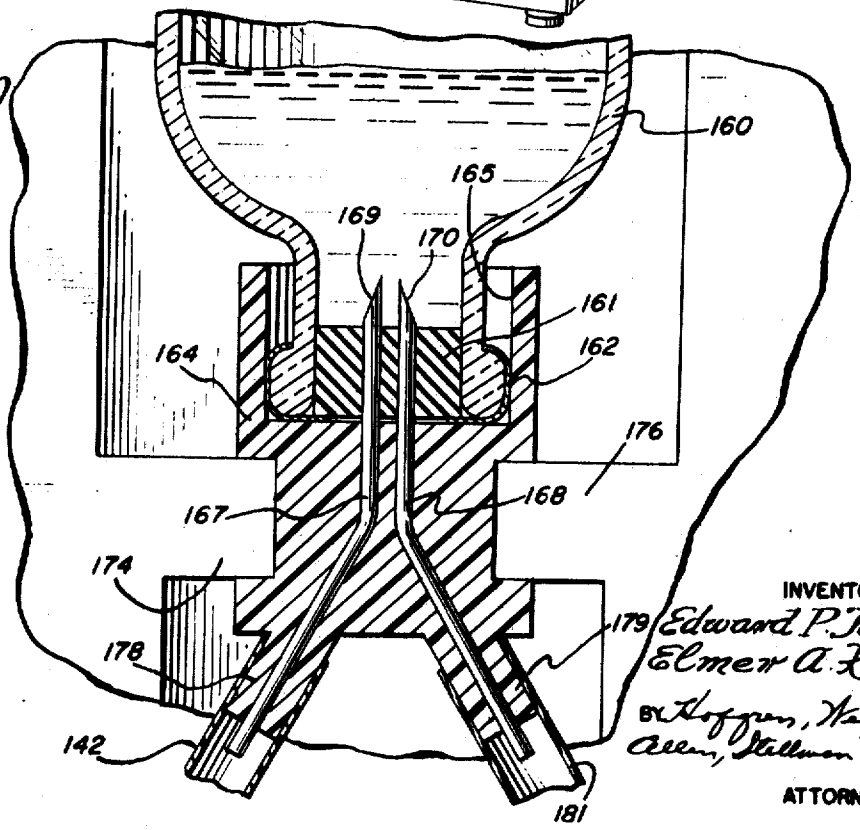


Fig. 10



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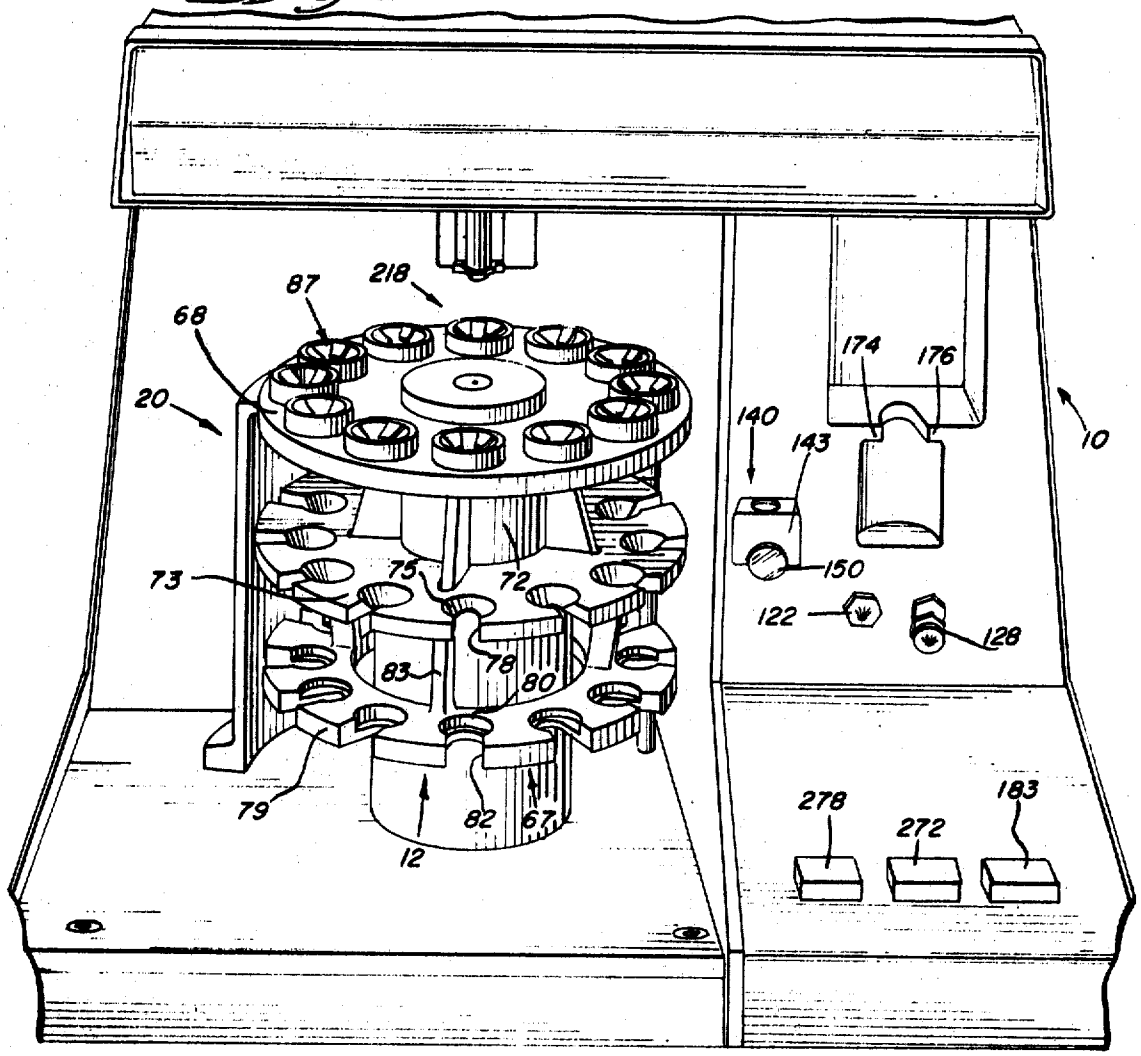
Allen, Stallman & Ward
ATTORNEYS

Fig. 2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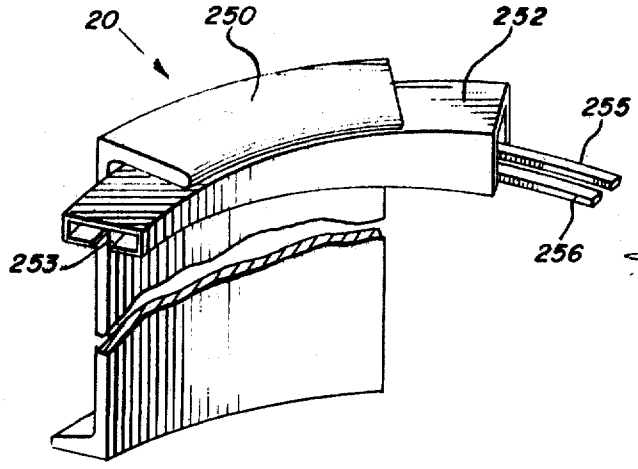
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Fig. 8

Fig. 3

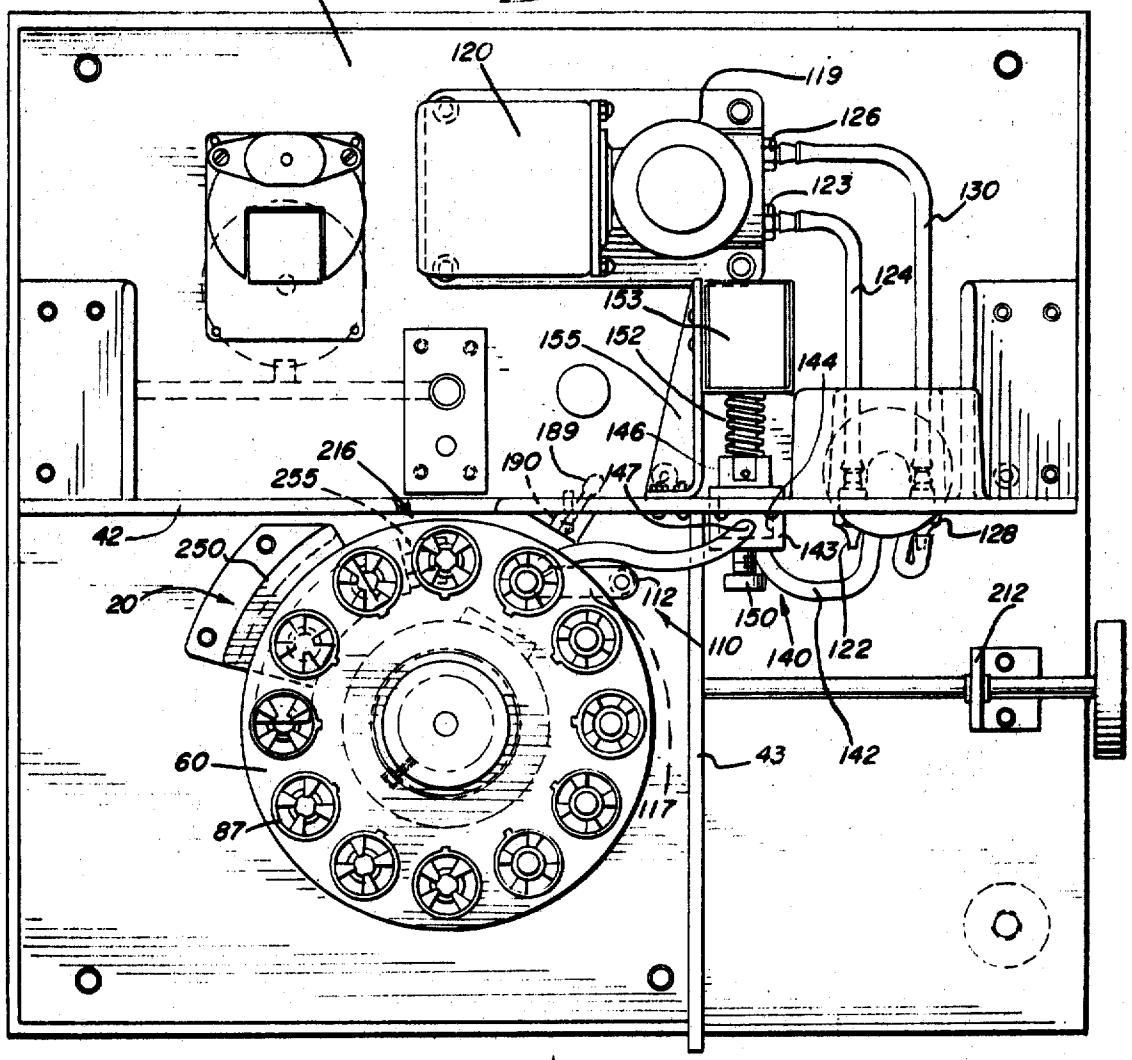

Fig. 12

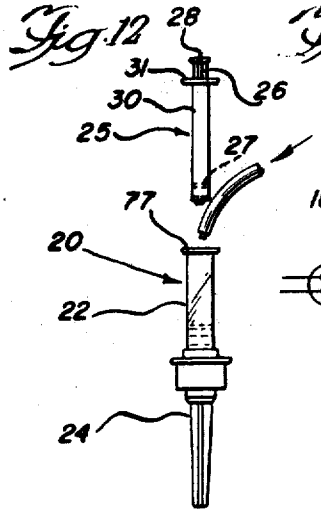

Fig. 13

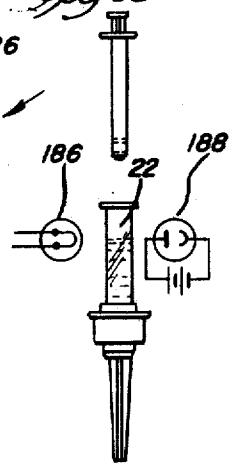

Fig. 14

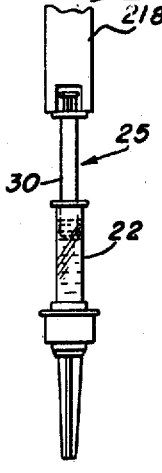

Fig. 15

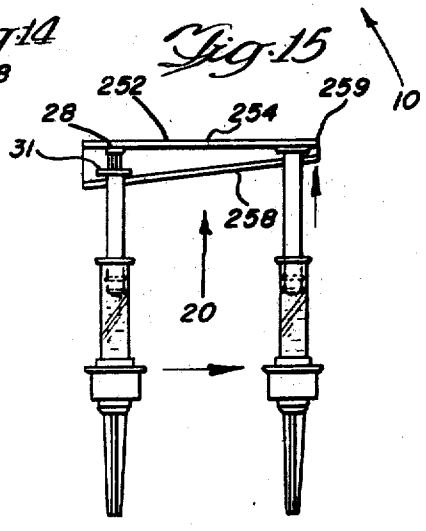

Fig. 1

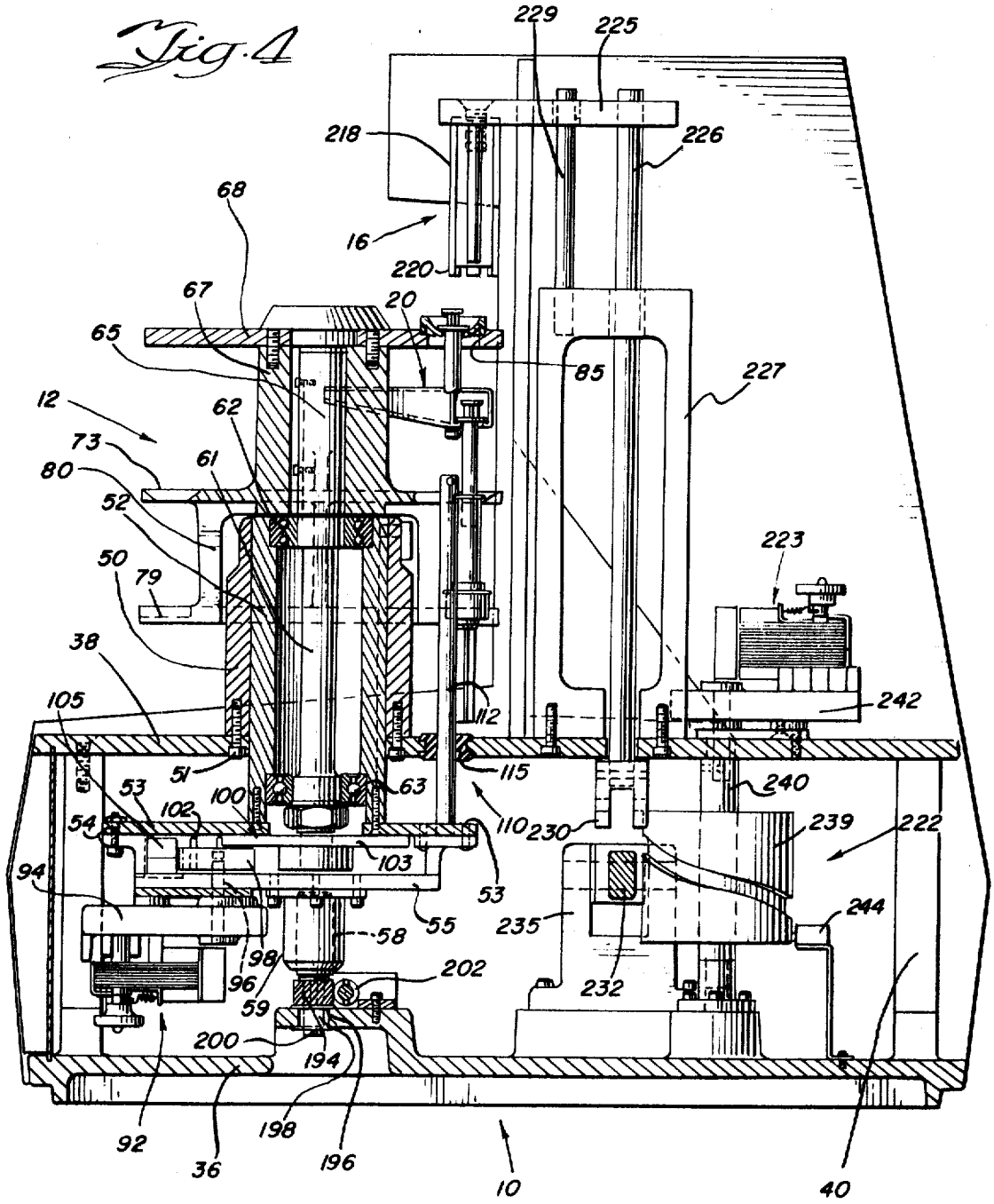
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Fig. 5

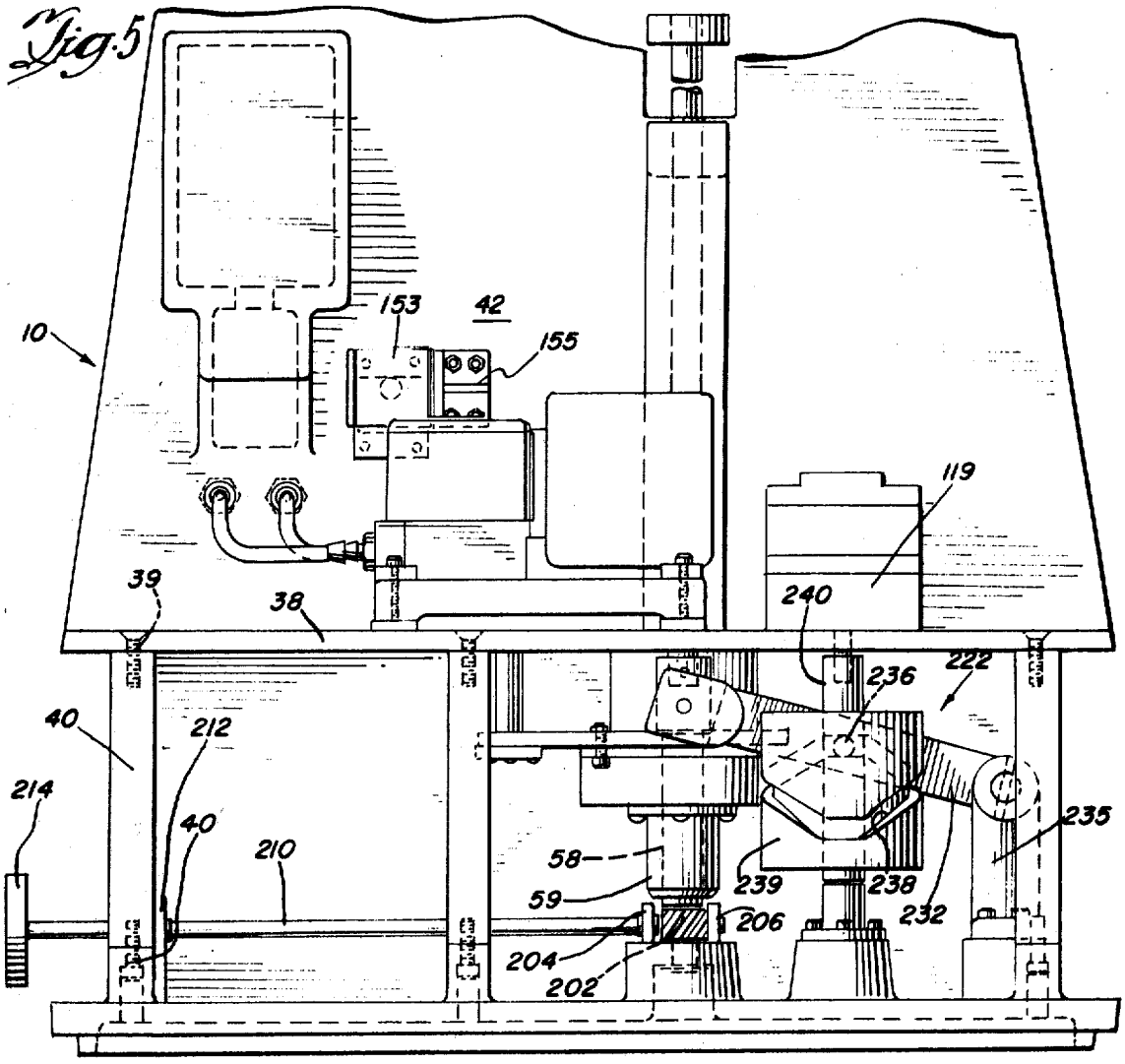


Fig. 6

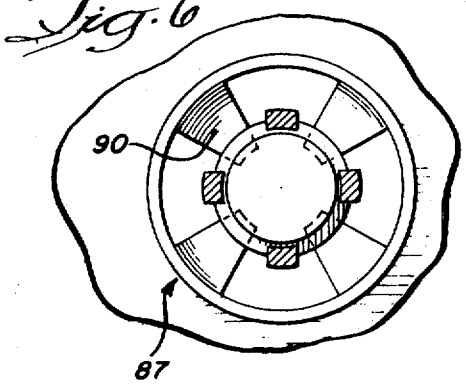


Fig. 7

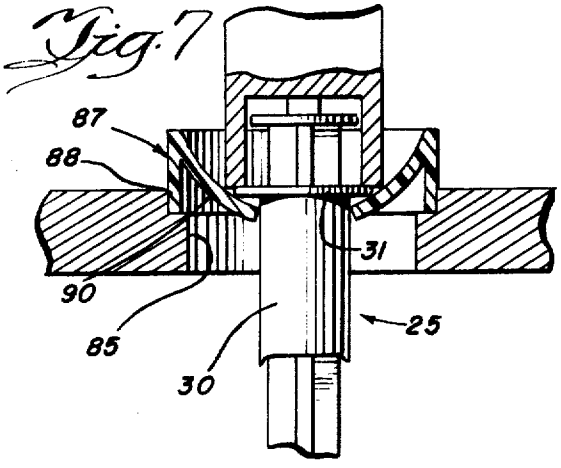


Fig. 11

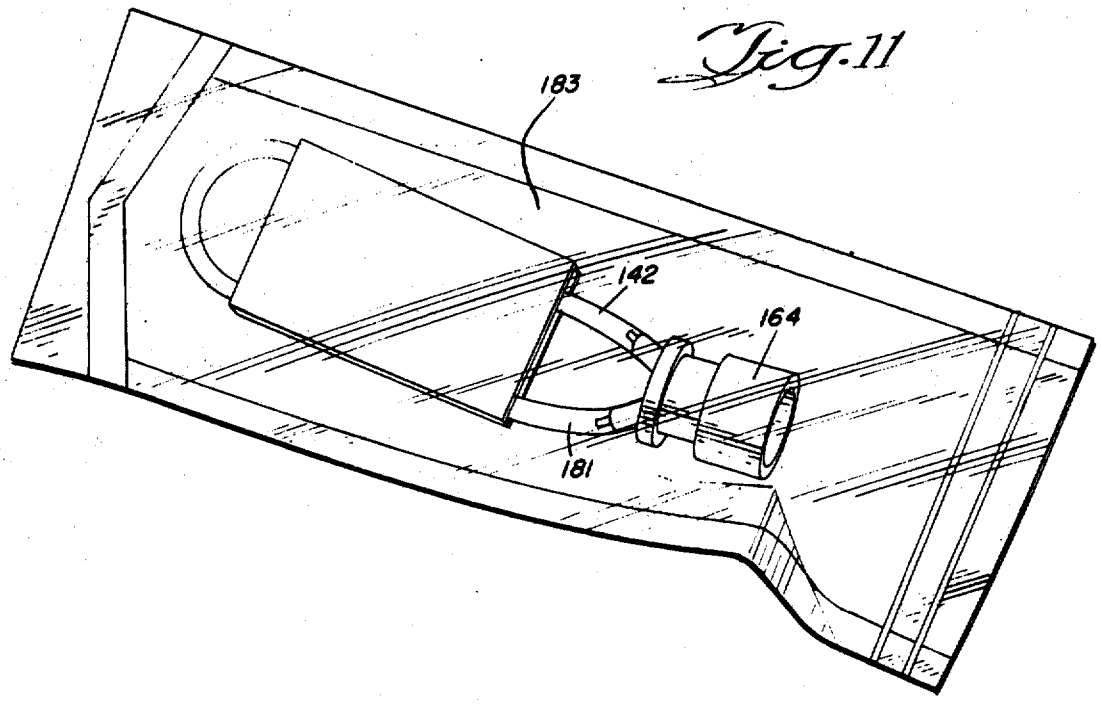
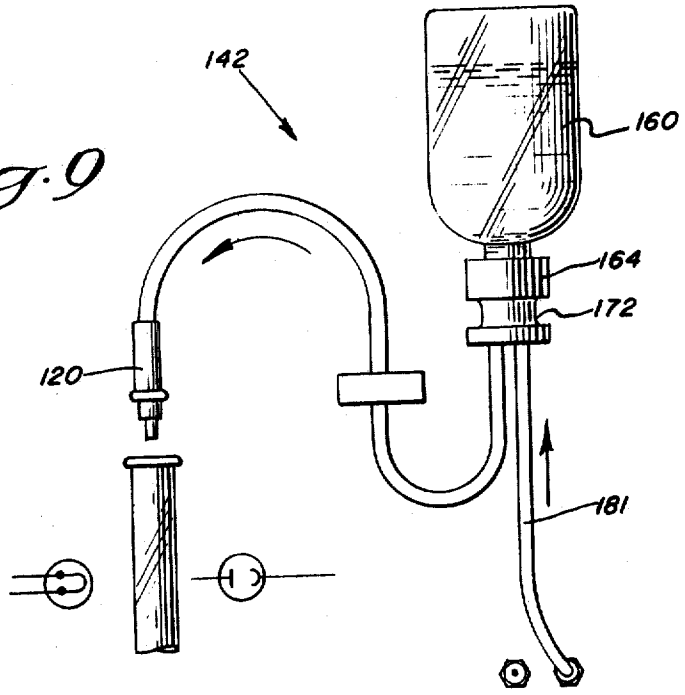


Fig. 9



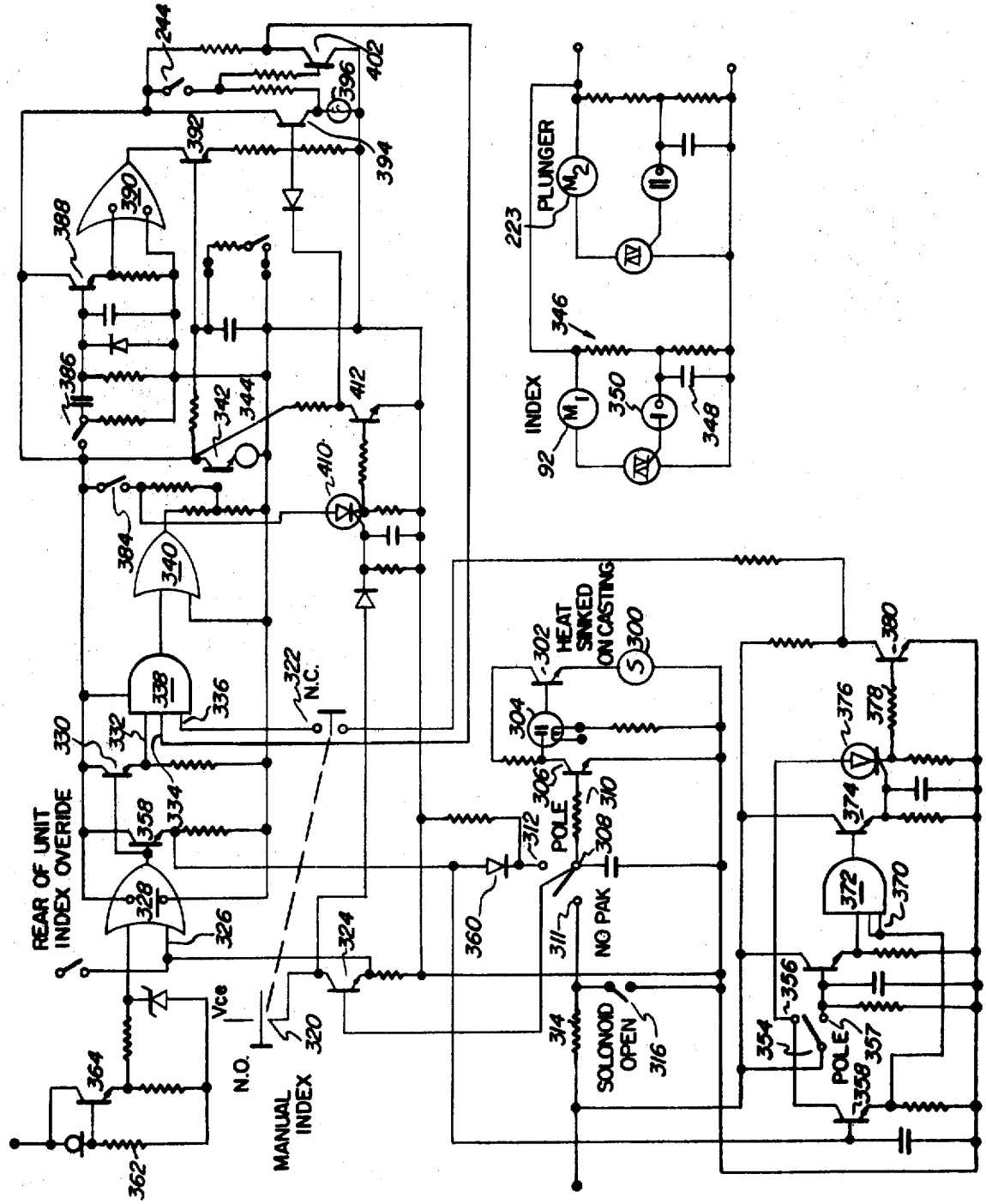

REAR OF UNIT INDEX OVERIDE
MANUAL INDEX
N.O.
N.C.
Vcc
HEAT SINKED ON CASTING
POLE
NO PAK
SOLONOID OPEN
PLUNGER
INDEX
POLE

Fig. 16

SYRINGE FILLING APPARATUS

BACKGROUND OF THE PRESENT INVENTION

There are a plurality of techniques employed in present day hospitals for filling syringes with medicament. One such technique involves the use of a prefilled medicament container having a seal over the open end thereof. The nurse or technician manually fills a plurality of syringes by inserting the needle of each syringe, one at a time, through the medicament bottle seal and thereafter withdrawing the syringe plunger until the desired level of medicament is observed in the syringe barrel at which time the technician terminates syringe plunger withdrawal and removes the syringe needle from the medicament container seal. This operation is repeated until medicament in the prefilled container is exhausted.

There are several disadvantages to this technique, one being the slowness in filling, another being the probability of inaccurate barrel filling resulting from technician error, and still another and perhaps the most important is the possibility of contamination. The contamination may result from the insertion of different needles into the same container seal and may also result from the manual handling of the syringes and needles by the technician.

It is therefore a primary object of the present invention to eliminate or ameliorate the problems in prior art syringe filling techniques by providing an automatic machine for filling syringes.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention an automatic syringe filling machine is provided, particularly suitable for use in filling syringes at the hospital in an accurate, rapid and aseptic manner. The present filling machine consists of a 12 syringe turret having a lower support for holding a plurality of syringe barrels and an upper support for holding a corresponding plurality of syringe plunger assemblies aligned but spaced above the open syringe barrels. A drive and control mechanism is provided for indexing the turret and each syringe to three operating stations.

At the first operating station the control circuit senses the presence of an empty syringe barrel signaling a dispensing circuit to begin filling the syringe, and when a predetermined level of medicament is in the syringe barrel a photo-sensitive circuit terminates the dispensing operation.

In response to the completion of the filling cycle, the control circuit initiates a turret indexing drive to index the filled syringe to the second station which is the plunger assembly set station. At this station a tool head reciprocates downwardly from above the upper turret support pushing a plunger assembly from a holder, that includes a plurality of resilient fingers, in the upper support. The action of the tool head is such that exerts a pressure on the outer ring of the plunger in such a manner as to captivate the plunger piston in the piston retainer sleeve. The piston retainer sleeve at this point in the cycle holds the piston in a compressed position so that the plunger has a loose fit in the cylinder barrel. Thus when the plunger assembly contacts medicament, only a small amount of air is entrapped between the plunger assembly and the medicament.

Again in response to the completion of filling the next succeeding syringe, the automatic control circuit controls the indexing mechanism to index the turret thereby positioning the first filled syringe at the third station which is the plunger piston release station. At this station a cam arrangement is provided that cams the piston retaining sleeve upwardly releasing the piston in the cylinder barrel and sealing the medicament within the cylinder barrel. The turret continues to index in this fashion and the syringes arrive one at a time at an unloading station where the operator of the machine removes the filled and assembled syringes.

For the purpose of controlling the level of medicament within the cylinder barrels, an adjusting mechanism is provided for axially shifting the entire turret assembly on its

frame. Since the photocell associated with the medicament level sensing circuit is stationary with respect to the frame, this adjustment shifts the syringe barrels with respect to the photocell so that the photocell "sees" a different axial location in the syringe barrel and thus controls filling of the syringe barrels to varying levels as desired. This adjustment may be employed also to compensate for varying medicament viscosities.

The automatic control circuit provided in accordance with the present invention completely automatically cycles the filling machine. A single index button is provided for indexing the turret primarily during initial loading of the machine until the first syringe arrives at the filling station, although this button may be employed in other situations. In response to an unfilled syringe being present at the filling station, the automatic control assumes complete control over all machine functions to properly fill the cylinder barrel, and actuate the plunger insert mechanism at the second station. The control circuit is provided with inhibit circuitry which prevents turret indexing while the plunger insert mechanism is reciprocating and also prevents the plunger insert mechanism from operating while the turret is indexing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a syringe filling machine with a disposable dispensing unit in operative position;

FIG. 2 is a perspective view of the syringe filling machine shown in FIG. 1 with the syringe elements and disposable dispensing unit removed;

FIG. 3 is a top elevation, with the cover removed, of the syringe filling machine shown in FIG. 1;

FIG. 4 is a side elevation, partly in section, of the syringe filling machine;

FIG. 5 is a rear elevation of the filling machine, with the cover removed, with parts broken away for clarity;

FIG. 6 is an enlarged fragmentary view of one of the upper turret support plunger holders;

FIG. 7 is an enlarged fragmentary section of one of the upper turret support plunger holders;

FIG. 8 is a subassembly view of the plunger assembly camming station;

FIG. 9 is a subassembly illustration of the disposable dispensing unit in relation to a syringe barrel shown schematically at the filling station;

FIG. 10 is an enlarged fragmentary section of the disposable dispensing unit container cap;

FIG. 11 is a subassembly view of the disposable dispensing unit in a prepackaged condition;

FIG. 12 is a schematic view of a syringe at the filling station;

FIG. 13 is a schematic illustration of a syringe at the filling station showing the fluid level sensing photocell;

FIG. 14 is a schematic illustration of a syringe at the plunger insert station;

FIG. 15 is a schematic illustration of two syringes passing through the plunger camming station; and

FIG. 16 is a schematic diagram of a solid state control circuit for the syringe filling machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings and more particularly FIGS. 1 to 5, an automatic syringe filling machine **10** is illustrated preferably adapted for use at a hospital. The filling machine **10** is seen to include, generally, an indexable turret assembly **12** for holding the syringe parts, a disposable dispensing unit **14** for delivering medicament to open syringe barrels at a syringe filling station, a plunger insert assembly **16** for releasing the syringe plungers from the turret assembly support therefor, and a camming assembly **20** at a cam station for the purpose of camming the syringe plunger assembly to a condition where a sealing piston associated with the syringe plunger is released within the syringe barrel.

To more clearly understand the construction and operation and advantages of the present device, it will be helpful to describe one type of syringe that the present device is particularly suitable for filling and assembling. Referring to FIG. 12, syringe 20 is seen to consist of a syringe barrel 22 with a needle assembly (not shown) inserted within a sheath assembly 24. The sheath assembly 24 is more fully described in the Robert Klohr et al application, Ser. No. 26,681, filed Apr. 8, 1970, entitled "Rigid Container Assembly for Syringe" and the application of Marvin A. Stumpf and Elmer A. Koenig, Ser. No. 860,223, filed Sept. 23, 1969, entitled "Breech Loaded Syringe and Method of Breech-loading Syringes," both assigned to the assignee of the present invention. It should be noted that the syringe 20 is placed in the sheath 24 prior to insertion in the turret assembly 12. The syringe 20 also includes a syringe plunger assembly 25 that includes an inner plunger 26 having a rubber piston 27 on the end thereof and a flange 28 at the upper end thereof. Surrounding the piston plunger 26 is a piston retainer sleeve 30 having a flange 31 at the upper end thereof.

In the position shown in FIG. 12 the sleeve 31 is in its active position surrounding and compressing the piston 27. Sleeve 30 has a clearance when inserted within the syringe barrel 22 so that it will slide into the barrel with a loose fit that will permit the venting of entrapped air. As will appear hereinafter, after plunger 25 is inserted within a filled cylinder barrel 22, the sleeve 30 is raised releasing piston 27 and permitting the resilient piston to expand within the syringe barrel 22, sealing medicament therein. For a more detailed description of the construction syringe 20 reference should be made to the copending applications of Robert Klohr et al and Marvin A. Stumpf et al, cited above.

Returning to a description of the filling mechanism in more detail, and particularly FIGS. 1 to 5, the filling machine 10 is seen to include a lower frame member 36 and an upper frame member 38 spaced apart by vertical struts 40 fastened to frame members 36 and 38 by fasteners 39 and 40', as shown in FIG. 5. Projecting upwardly from the upper frame member 38 is a vertical plate 42 separating the front and rear portions of the machine 10. Suitable cover members 45, 46 and 47 are provided for enclosing the frame members and the portions of the mechanism which do not have to be manipulated by the operator in normal use.

As shown clearly in FIG. 4, the turret assembly 12 includes a stationary annular post member 50 threadedly fastened on the left-hand forward side (as viewed in FIG. 1) of frame member 38 by fasteners 51. Slidable in the post 50 is a turret support sleeve 52 that is carried by frame members 53. Suitable means are provided for preventing the rotation of sleeve 52 in post 50. Frame member 53 is fixed by fasteners 54 to a parallel frame plate 55. The frame member 55 is in turn supported vertically by threaded member 58 threadedly received in a boss 59 carried by the plate 55.

Rotatably mounted in the sleeve 52 is turret drive shaft 61 supported for rotation in bearings 62 and 63. Shaft 61 has a projection 65 extending vertically from the level of bearing 62 which is keyed to a lower wheel-like turret member 67. Fastened by suitable threaded fasteners to the lower turret member 67 is an upper turret member 68 which is annular in configuration.

Referring to FIG. 2, the lower turret member 67 has an upper annular portion 72 from which projects an annular plate 73 having a plurality of conical apertures 75 that are adapted to receive syringe barrel flange 77 as shown in FIG. 12. A radial slot 78 is provided associated with each of the conical recesses 75 to permit insertion of the cylinder barrel.

Suspended from support plate 73 is a similar annular support plate 79 having a plurality of stepped annular recesses 80 therein aligned with the conical recesses 75. The annular recesses 80 are sized to receive the enlarged portion of the sheath 24 shown in FIG. 12, and radial slots 82 are provided associated with each of the recesses 80 to permit clearance for the lower portion of the sheath 24 during loading and unloading of the syringe in the turret. The lower support plate 79 is suspended by integral struts 83 shown clearly in FIGS. 2 and 4.

The upper turret support plate 68 has a plurality of stepped openings 85 therein (see FIG. 4) in annular array, and in alignment with and corresponding in number to the conical recesses 75 in plate 73 and the stepped recesses 80 in the lower plate 79. Seated within the stepped recesses 85, as best shown in FIGS. 6 and 7 are plunger holders 87, constructed of a resilient plastic material. The plunger holders 87 have an annular portion 88 seated within the stepped bore 85 and four arcuate, generally radially extending cradle fingers 90 which project approximately to the diameter of syringe plunger sleeve 30 as shown in FIG. 7. The plunger holders 87 hold plungers 25 by engaging the underside of the sleeve flanges 31. Fingers 90 have sufficient resiliency so that when the upper surface of the flange 31 is pushed downwardly by the plunger assembly, described in more detail below, the flange 31 will force the resilient fingers 90 downwardly permitting the plunger 25 to be released from holder 87.

In the exemplary turret construction shown there are holders for the barrel and plunger assemblies of 12 syringes, although, as will appear clear to those skilled in this art, a greater or lesser number of plunger holding locations may be provided.

For the purpose of indexing the turret 12, a turret indexing motor 92 is provided shown clearly in FIG. 4. Motor 92 is carried by the underside and affixed to a gearbox 94 which is fastened to the underside of turret frame member 55. Gearbox 94 provides a suitable reduction in speed from the output shaft of motor 92. Gearbox 94 has an output shaft 96 which drives a cam wheel 98 of a Geneva assembly 100.

The Geneva assembly assures the proper indexing movement of the turret 12 under the essentially constant speed rotation of motor 92. It should be understood, however, that motor 92 is turned on and off, however, at the end of each indexing movement.

The Geneva movement includes cam member 98 having a plurality of pins 102 projecting upwardly therefrom which enter cam slots in a star wheel 103 affixed to the lower end of turret drive shaft 61. Star wheel 103 has the conventional shape in Geneva assemblies and includes a plurality of generally radial slots (not shown) into which the pins 102 enter and slide driving the wheel 103 and shaft 61 to succeeding index positions. A microswitch 105 is provided between frame members 55 and 53, as shown in FIG. 4, for sensing the position of the indexing motor cam 98 to control the indexing motor 92 as well as the plunger assembly as will appear more clearly in the hereinafter described control circuit.

A syringe barrel filling station 110 is provided as shown in FIGS. 1, 3 and 4 and is seen to include a vertical support member 112 fixed to the turret frame plate 53 as shown in FIG. 4 and extending through and slidable within a grommet 115 in the main upper frame member 38. Vertical support 112 extends approximately to support plate 73 and has connected thereto a generally, horizontally extending nozzle support member 117 as shown in FIGS. 1 and 3.

The nozzle support member 117 releasably holds a nozzle 120 as shown in FIG. 9 in a manner such that medicament issuing from the nozzle does not in any way contact the nozzle support.

For the purpose of supplying medicament to the nozzle 120 and from the nozzle into an empty syringe at station 110, a pneumatic pump 119 is provided in the rear of machine 12 fixed to the upper main frame member 38 as shown in FIG. 3. Pump 119 is driven by a motor 120' and also carried by the frame 38. It should be understood that pump 119 is an air pump and that no medicament is conveyed through the pump eliminating the possibility of pump contamination by medicament.

A pump inlet fitting 122 is fixed within vertical wall 42 and opens to the front of the machine permitting ambient air to be drawn into the pump 119. Interconnecting fitting 122 with pump fitting 123 is a flexible tube 124. Pump outlet fitting 126

is interconnected to a pump outlet fitting **128** also on the front panel **42** by tubing section **130**. Fitting **128** may have a check valve associated therewith only permitting flow from the fitting **128**. In this manner the inadvertent reversal of flow and drawing of medicament into the pump through tube **130** may be prevented. A suitable air filter may be provided associated with inlet line **124** if desired.

The delivery of medicament from dispensing unit **14** to the filling station **110** is controlled by a pinch valve **140**. This valve operates generally by occluding flexible dispensing tube **142** and in this manner is not contaminated by contact with medicament. The pinch valve **140** includes a stationary valve member **143** having a rearwardly opening aperture **144** therein for receiving a reciprocable slide valve member **146**. Valve member **143** also has a vertical opening **147** therethrough which receives the tube **142**. For the purpose of holding the tube **142** in position within opening **147** a threaded member **150** is provided threaded into the closed end of valve member **143** and engageable with the forward side of tube **142**. The slide member **146** is adapted to move forwardly and pinch the tubing **142** to a fully occluded position, preventing flow through the tube.

The pinch valve member **146** is biased to its occluding position by coil spring **152** and selectively withdrawn to a valve open position by a solenoid **153** (FIGS. **3** and **5**) fixed to the vertical plate **42** by a horizontally extending bracket member **155**. Thus when solenoid **153** is energized by the control circuit described below, the valve member **146** will be withdrawn partially from the stationary valve member **143** permitting the dispensing tube **142** to open initiating medicament flow to the nozzle **120** filling the syringe barrel at station **110**.

The disposable dispensing unit **14** is shown clearly in FIG. **9** and is seen to include a prefilled disposable medicament bottle **160** which has at its open end as shown in FIG. **10** a seal **161** held in position by a retainer **162**. The prefilled medicament bottle **160** is by itself a conventional container. After the supply of medicament in bottle **160** is exhausted the bottle is thrown away.

Included in the dispensing unit **14** is a plastic container cap **164** having a counterbore **165** therein slidable over the retainer **162** during capping of the bottle **160**. Cap **164** has two angular connectors **167** and **168** molded integrally therewith. The connectors are metal tubes having projecting beveled ends **169** and **170**, respectively, which pierce the seal **161** as the cap **164** is placed on the end of the container. While the cap **164** may be readily removed from the bottle **160**, although they are generally thrown away together, the friction between connectors **167**, **168** and the seal **161** normally retains the cap **164** and bottle **160** together as a unit.

The exterior of cap **164** has an annular recess **172** which is releasably but snuggly engaged by spaced tracks **174** and **176** formed integrally in the frame panel **42** as shown in FIGS. **1**, **2** and **10**. In this manner the cap **164** and bottle **160** may be readily inserted and held on panel **42**, as well as easily removed therefrom after dispensing the medicament in the bottle **160**.

The cap **164** has integral projections **178** and **179** surrounding the connector tubes **167** and **168**, which serve as fittings for dispensing tube **142** and air pressure tube **181**. The opposite end of tube **181** is releasably connected to the pump outlet fitting **128** on the front panel **42**. As described above, the other tube extending from cap **164**, i.e. dispensing tube **142**, has a stepped nozzle **120** formed integrally on the end thereof.

As seen in FIG. **11**, cap **164** and tubes **142** and **181** are, prior to use, prepackaged in a flexible plastic aseptic container **183**. Thus the dispensing unit will remain in an aseptic condition until just prior to use when the container **183** is opened.

In readying the filling machine **10** for operation and with the use of each new medicament container **160**, a container **183** is opened and a new dispensing unit withdrawn therefrom. Cap **164** is pushed over the end of the bottle **160** piercing seal **161** with the sharp connector ends **169** and **170**. Tube **181** is then connected to the pump outlet fitting **128** and the dispensing tube **142** is threaded through opening **147** in pinch valve **140**. Nozzle **120** is then inserted within the nozzle holder **117** and the dispensing unit is ready for operation. A suitable circuit is provided for energizing solenoid **153** at this time to permit the insertion of tubing **142**, as will appear below in the description of the control circuit of FIG. **16**.

When the power supply of the machine **10** is turned on by a button **183** on the front of the machine **10**, pump motor **120'** begins pumping air through passage **130**, through tube **181** and into the container bottle through connector **168**. This pressurizes the bottle tending to force medicament through outlet tube **142**. At this time, however, valve **140** would be closed preventing the flow of medicament to the open syringe at the filling station **110**. As each syringe moves into the loading station **110**, the valve **140** is automatically opened for a time sufficient to fill the syringe barrel to a predetermined level and then the valve is closed preventing further flow.

After the medicament in bottle **160** is exhausted or if it is desired to change bottles to a different medicament, the tubing **142** is unthreaded from valve **140** and the tubing **181** is disconnected from pump outlet fitting **128**. Bottle **160** and cap **164** are then removed from the tracks **174** and **176** and the entire unit may be thrown away. If the bottle **160** is not empty, cap **164** may be removed therefrom retaining bottle **160** for later use with a new dispensing unit **14**, if desired.

For the purpose of controlling the level of medicament in the syringe barrel at the filling station **110** a photo-sensitive circuit is provided including a light **186** as shown in FIG. **13** and a photocell **188**. The light **186** is mounted on the post **50**, which is stationary, adjacent filling station **110** while the photocell **188** is positioned on the opposite side of the syringe barrel at the filling station. Such a location is shown schematically at **189** in FIG. **3** wherein the photocell receives a signal from light **186** through passage **190** in the frame **42**. As will be described in more detail below, photocell **188** turns on whenever an unfilled syringe barrel **22** arrives at filling station **110**, controlling the valve **140** to dispense medicament into the syringe barrel. When the level of medicament reaches the level of the "window" of the photocell **188**, the photocell turns off which effects the closure of valve **140** and the termination of the flow of medicament to the syringe barrel.

To vary the level of medicament within the syringe barrel **22**, provision is made for vertically adjusting the entire turret **12**. Toward this end and as shown clearly in FIG. **4**, the threaded member **58** which vertically supports the turret assembly, has a worm gear **194** rotatably fixed to the lower end thereof slidably engaging a thrust washer **196** on the lower frame member **36**. Member **58** has a lower projecting portion **198** which extends through frame **36** and is held in position by a retainer assembly **200**. A suitable bearing may be provided in frame member **36** for supporting the lower end portion **198** of the threaded member **58**. The rotation of worm gear **194** causes threaded member **58** to rotate vertically in boss **59** adjusting the entire turret assembly including frame members **53**, **55**, sleeve **52**, lower support member **67**, upper support member **68**, and nozzle support **112**.

To rotate the worm gear **194**, a worm wheel **202** is provided mounted in bearing bosses **204** and **206** as shown in FIG. **5**. Gear **202** is rotated by rod **210** which extends through a bearing boss **212** from the main machine housing, and carries a manual rotating knob **214** on the distal end thereof as shown in FIGS. **1** and **5**.

By adjusting the height of the turret assembly **12**, the vertical positioning of the syringe at the filling station **110** may be adjusted with respect to the light **186** and photocell **188** both of which are stationary with respect to the frame and do not adjust vertically with the turret.

The plunger insert mechanism **16** operates at a station indicated generally at **216** in FIGS. **2** and **3**. As will appear hereinafter, the turret **12** indexes in a counterclockwise direction as viewed in FIG. **3** so that the plunger insert station **216** is the second operating station for each of the syringes.

Upon arrival at the plunger insert station **216**, a tool head **218**, as shown in FIG. **4**, is lowered engaging flange **31** on sleeve **30** of the syringe pushing the syringe plunger **25** from the holder **87**. As the plunger piston **27** engages the syringe barrel **22**, the tool head **218** continues its stroke and captivates the piston **27** as shown in FIG. **12**.

As seen in FIG. **4**, the tool head **16** includes an annular member having a plurality of fingers **220** on the lower end thereof. The fingers **220** are sufficiently long so that the tool head **218** can fit over the piston plunger flange **28** without engaging the same. Tool head **28** is reciprocated vertically by cam and follower assembly **222** driven by a plunger motor **223**.

Tool head **218** is fastened to a horizontal bar **225** which is fixed to the upper end of a vertically reciprocable rod **226** slidable in a guide member **227** fixed to the upper surface of frame member **38**. A guide rod **229** is provided on guide member **227** for the purpose of preventing any pivotal movement of the toolhead **218** about rod **226**. Rod **226** has a lower bifurcated end **230** which is pivotally connected to one end of a link **232** (shown in section FIG. **4**), the other end of the link being pivoted on a stationary support member **235**. Intermediate the ends of the link **232** and carried thereby is a cam follower **236** as shown in FIG. **5** slidable in a trackway **238** in a cylindrical cam **239**. Cam **239** is supported on a shaft **240** and driven by motor **223** through a gearbox **242** fixed to the upper surface of frame member **38**. The plunger cam **239** rotates a complete revolution for each reciprocation of plunger **218**. The plunger motor is deenergized after each revolution of cam **239**. Toward this end a microswitch **244** is provided to sense the retracted position of toolhead **218**.

The third and final station of the machine **10** is the camming station **20** at which the sleeve **30** of each syringe is raised with respect to the piston **27** releasing the plunger in the syringe barrel. It should be understood however that the camming station **20** does not shift the piston **27** axially within the barrel **22**, but merely raises the sleeve **30** to permit the rubber piston **27** to expand within the barrel sealing medicament therein as well as placing the plunger in an operative condition.

Toward this end, and as viewed in FIGS. **3**, **4** and **8**, an arcuate segmental support member **250** is provided at the camming station that extends above the lower support plate **73** but below the upper support plate **68**. Support **250** carries an arcuate tapered camming channel **252** having a slot **253** in the lower channel portion that has a sufficient width to receive the sleeve **30** but is smaller than the diameter of the sleeve flange **31**. Guides **255** and **256** fixed to the cam member **252** may extend toward station **216** as shown in FIG. **3** to guide the sleeve **30** into the camming channel **252**. As seen in FIG. **15**, the camming channel has an upper surface **254** and a lower surface **258** which converge toward the exist end **259** of the channel. The upper portion **254** of the channel serves to hold the piston plunger flange **28** while the lower portion **258** cams the sleeve flange **31** upwardly until flush with the plunger piston flange **28** as shown in the right-hand syringe in FIG. **15**.

After the partially sheathed syringes leave the camming station **20**, they may be removed by the technician.

While the operation of the filling machine **10** is believed apparent from the above description, the following description will be helpful to summarize the operation.

After the operator loads the medicament dispenser **14** in the position and the power button **183** is depressed, the empty syringes are loaded into the turret approximately at location **270** shown in FIG. **1** by loading the sheathed barrels in lower support members **73** and **79** and the plunger assemblies **25** in the upper turret plate **68**. Button **278** is provided for actuating solenoid **153** independently of the automatic control to permit opening valve **140** for the purpose of inserting the tube **142** therein. The operator then depresses a manual index button **272** which indexes the turret **12** to the next station. With the turret indexed one increment, the operator then loads another barrel and plunger, and thereafter presses the manual index button **272** again indexing the turret one position. The operator continues loading syringes in the turret in this fashion and the only other operation required of the operator is the removal of the filled syringes from location **275**, all of the remaining functions of the machine being performed entirely automatically. The operator continues the manual depression of button **272** after loading each of the syringes until the first empty syringe arrives at the syringe loading station **117**. The presence of a syringe barrel is sensed by a suitable switch, described in more detail below, at the filling station **110**, and an indication that the syringe is unfilled is provided by photocell **188** causing energization of solenoid **153** opening valve **140** initiating the filling of the syringe at station **110**. When the level of the medicament in the syringe at the filling station reaches the photocell sensing level shown in FIG. **13**, the signal from photocell **188** ceases causing the control circuit to deenergize solenoid **153** closing valve **140** and terminating the flow of medicament to the syringe.

In response to the completion of filling the first syringe, index motor **92** is energized rotating turret **12** to the next station placing the first syringe at plunger station **216** and the second syringe at the filling station **110**. In response to the completion of indexing the motor **223** is energized driving the tool head **218** downwardly and releasing a plunger assembly **25** in the aligned syringe barrel **22**. As the tool head **218** continues its downward stroke the piston **27** engages syringe barrel **22**. The entrapped air builds up sufficient pressure to captivate the piston **27** which permits all but a small amount of residual air to escape.

Upon completion of the plunger cam **239**, a switch, such as switch **244**, in the control circuit is opened thereby which enables the circuit driving the turret index motor **92** so that upon receipt of a signal indicating that a cylinder barrel in station **110** is filled, indexing will again occur.

The first syringe is then indexed into the camming station **20** whereat, after one indexing movement, it just begins to enter the cam channel **252**. After two subsequent indexing movements as shown in FIG. **3**, the first syringe will be completely through the cam member **252** wherein the plunger holding sleeve **30** is shifted upwardly releasing the piston within the cylinder barrel and completing the filling and plunger inserting operation of the machine. This sequence of operation occurs in step-by-step fashion completely automatically, requiring only that the operator load syringes at station **270** and unload syringes at station **275**. Operation is discontinued by again pressing the power button **183** which terminates all functions of the filling device **10**.

Referring to FIG. **16** an exemplary control circuit is illustrated for the present syringe filling machine **10**. As noted above, an operator interface with this circuitry is provided by the three push button switches **183**, **272** and **278** on the front of the machine, or control panel. Button **183** is connected to a switch (not shown) which connects AC power to the motors **92**, **223**, and **120** and dc supplies power for operation of the control circuitry shown. The valve open button **278** is connected to close switch **316** for energizing solenoid coil **300** of solenoid **153** which is in the emitter leg of transistor **302**. This permits the initial insertion of tube **142** through the valve **140**.

The base of transistor **302** is connected through relay contact **304** which is closed when power turns ON, to the collector of transistor **306**, and the base of transistor **306** is connected to a double-pole, single-throw switch **308** through resistor **310**. Switch **308** is located at the filling station **110** and is positioned so that contacts **312** are closed when a syringe barrel is in the filling station and contacts **311** are closed when no syringe barrel is in the station. Contact **311** of switch **308** is connected to positive DC voltage through resistor **314** and to ground through normally open solenoid control switch **316**.

At the beginning of operation of the machine, switch **308** assumes contact position **311** and solenoid switch **316** is open thereby keeping transistor **306** conducting and transistor **302** non-conducting, precluding actuation of solenoid coil **300** and maintaining the solenoid valve **140** in its closed position.

To effect the step-by-step manual indexing during the initial loading of the machine by depressing button **272**, as described above, button **272** is connected to actuate the manual index switch **318**. Switch **318** has one normally open contact **320** and one normally closed contact **322**. The closing of contact **320** causes transistor **324** to turn ON which in turn causes a high voltage to be applied to input **326** of "OR" gate **328**. The output of "OR" gate **328** goes high causing transistor **330** to conduct supplying a high voltage to input **332** of "AND" gate **338**. The other inputs **334** and **336** of "AND" gate **338** will normally be high at this stage of the sequence and thus the output of **338** will go high causing an output from "OR" gate **340** turning transistor **342** ON lighting bulb **344**. The light from bulb **344** activates photo-resistor **346** which causes capacitor **348** to charge until neon bulb **350** fires causing triac **352** to cycle thereby activating the index motor **92**, moving the turret to the next index position. Switch **384**, which corresponds to switch **105** in FIG. **4**, closes as soon as movement of the index cam **98** is initiated and thereafter switch **384** control index motor **92**, the "OR" gate **340** providing only a triggering signal. After cam **98** indexes the turret one station, a suitable projection on the cam opens switch **384** terminating operation of the index motor **92** by turning off the transistor **342** and bulb **344**.

When the first empty syringe is indexed over to the fill station **110**, switch **308** senses the presence of a syringe barrel and closes contacts **312**.

At the same time, the level photocell provides a signal to photo-resistor **362** indicating an unfilled syringe. This turns, or maintains, transistor **364** OFF which, in turn, causes an output from "OR" gate **328**, turning transistor **358** "OFF" which through diode **360**, switch **308**, transistor **306** and transistor **302** activates solenoid coil **300** opening valve **140**. This initiates the filling operation.

When medicament in the syringe rises to the level of the photocell **188**, photo-resistor **362** causes transistor **364** to turn "ON" which causes a high voltage to appear at input **382** of "OR" gate **328**. The output of "OR" gate **328** goes high turning transistor **358** ON, which through the solenoid control circuitry deactivates solenoid coil **300** closing the solenoid valve **140** as previously explained.

The same signal from the output of "OR" gate **358** is applied to the base of transistor **330** and turns it ON. The output of transistor **330** is applied to input **332** of "AND" gate **338** turning gate **338** which turns "OR" gate **340** ON. When the output of "OR" gate **340** goes high, transistor **342** conducts and bulb **344** lights. The light from bulb **344** quits photo-resistor **346** and initiates the indexing motor **92** in the same manner as described above with respect to the manual index. Switch **384** holds the motor until the turret has made one indexing movement.

Upon completion of each indexing cycle, a syringe just filled is indexed to the plunger position **216**. At this point the indexing motor cam **98** closes a microswitch **386**, which may be adjacent switch **105**, turning transistor **388** ON causing the output of "OR" gate **390** to go high, causing transistor **392** to conduct which turns transistor **394** ON. Bulb **396** in the emitter leg of transistor **394** then lights, activating photo-resistor **398** in the plunger motor circuitry, energizing the plunger motor **223** in the same manner that the indexing motor **92** is activated. Upon activation of plunger motor **223**, the plunger motor cam **239** closes switch **244** keeping the plunger motor activated for a full cycle. At the end of the cycle the plunger motor cam reopens switch **244** and the plunger motor cycle is complete.

Upon completion of the plunger cycle, transistor **402** turns OFF, and a previously applied indexing inhibit signal from the output of transistor **402** to input **334** of "AND" gate **338** is removed, an indexing is enabled.

If the operator, for some reason, does not remove the completely filled syringes and a filled syringe is inadvertently indexed to the filling station **110**, photocell **188** will turn OFF, providing a high output from "OR" gate **328**, turning transistor **358** ON. This provides a high potential signal at the base of transistor **368** which, through switch **354** and the following inhibit circuitry, causes transistor **380** to conduct applying a low potential input at **336** of "AND" gate **338** precluding any subsequent indexing of the turret until an empty syringe is sensed at the filling station **110**. It should be understood that switch **354** is located to sense the presence of a syringe barrel at station **110** in the same manner as switch **308**. Switch **354** is constructed so that contacts **356** are closed when the syringe is sensed at station **110** and contacts **357** are closed when no syringe is sensed at station **110**.

A further feature in the control circuit, associated with the manual indexing function of manual index switch **320**, is that upon closing of the manual index switch, a control is supplied to the anode of SCR **410** which drives the base of transistor **412** keeping the transistor **394** from conducting thereby precluding plunger operation.

We claim

1. A medicament filling device for a syringe of the type having a barrel member and a plunger, comprising: frame means, a syringe filling station on said frame means for supporting a syringe to be filled, means for filling the syringe barrel through the breech end thereof, means for inserting the plunger after filling, the plunger having a resilient portion, said plunger including means compressing the resilient portion, and means releasing the resilient portion after insertion of the plunger.

2. A medicament filling device for a syringe of the type having a barrel member and a plunger as defined in claim **1**, wherein said means for inserting the plunger includes means for releasing the plunger prior to contact with the medicament in the syringe barrel.

3. A medicament filling device for a syringe of the type having a barrel member and a plunger as defined in claim **1**, including a lower support for supporting the syringe barrel, an upper support for supporting the syringe plunger in spaced relation to the syringe barrel, and said means for inserting the plunger including a reciprocable toolhead assembly for forcing said plunger from the upper support.

4. A medicament filling device for a syringe of the type having a barrel member and a plunger as defined in claim **3**, wherein the upper support includes a plurality of resilient fingers for releasably supporting the plunger.

5. A medicament filling device for a syringe of the type having a barrel member and a plunger, comprising: frame means, a syringe filling station on said frame means for supporting a syringe to be filled, means for filling the syringe barrel through the breech end thereof, means for inserting the plunger after filling, said syringe plunger being of the type having a piston plunger and a sleeve, means on said frame means for shifting said sleeve to activate the piston plunger so that the sleeve releases the piston into the syringe barrel.

6. A medicament filling device for syringes of the type having a barrel member and a plunger, comprising: frame means, a turret assembly on said frame means having a lower support for holding a plurality of syringe barrels, said turret assembly having an upper support for holding a plurality of syringe plungers above and in alignment with the syringe barrels, means on said frame means for filling said syringe barrels at a predetermined first station, means on said frame means for inserting said plungers into said barrels at a predetermined second station, said plungers having a resilient portion and means for compressing the resilient portion, and means for releasing the resilient portion after insertion of the plunger.

7. A medicament filling device for syringes of the type having **1** barrel member and a plunger, comprising: frame means, a turret assembly on said frame means having a lower support for holding a plurality of syringe barrels, said turret assembly having an upper support for holding a plurality of syringe plungers above and in alignment with the syringe barrels, means on said frame means for filling said syringe barrels at a predetermined first station, means on said frame means for inserting said plungers into said barrels at a predetermined second station, said plungers each including a piston plunger

and a sleeve for holding the piston inactive, means on said frame means for shifting the plunger sleeves with respect to the piston plungers to activate the pistons.

8. A medicament filling device for syringes of the type having a barrel member and a plunger as defined in claim 7, wherein said means for shifting the sleeve means includes an arcuate cam assembly on said frame means receiving portions of said sleeves and said piston plungers.

9. A medicament filling device for syringes of the type having a barrel member and a plunger as defined in claim 6, including means for shifting the turret assembly in a vertical direction.

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