United States Patent

Taylor et al.

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[54] STERILE CONTAINER FILLING MECHANISM

[72] Inventors: **Arthur Sinclair Taylor,** Spring Valley; **Ellsworth Sandhage,** Pearl River, both of N.Y.; **George Bott,** Westwood, N.J.; **William Konazewski,** Pearl River, N.Y.

[73] Assignee: **American Cyanamid Company,** Stamford, Conn.

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[21] Appl. No.: **85,735**

Related U.S. Application Data

[62] Division of Ser. No. 812,142, April 1, 1969, abandoned, which is a division of Ser. No. 562,620, July 5, 1966, Pat. No. 3,453,804.

[52] **U.S. Cl.** **141/85,** 74/44, 92/13.7, 141/180, 141/242, 222/267, 222/309

[51] **Int. Cl.**.....**B65b 3/32,** B65b 43/42

[58] **Field of Search** 74/44; 92/13.7; 141/85, 180, 141/242, 243; 222/206, 395, 309, 267; 417/212, 221, 395, 493, 494, 499, 500

[56] **References Cited**

UNITED STATES PATENTS

2,334,327	11/1943	Hermann	141/85 X
3,067,786	12/1962	Rosen	141/242 X
3,277,829	10/1966	Burgert	74/44 X
3,322,167	5/1967	Rosen	141/180 X

FOREIGN PATENTS OR APPLICATIONS

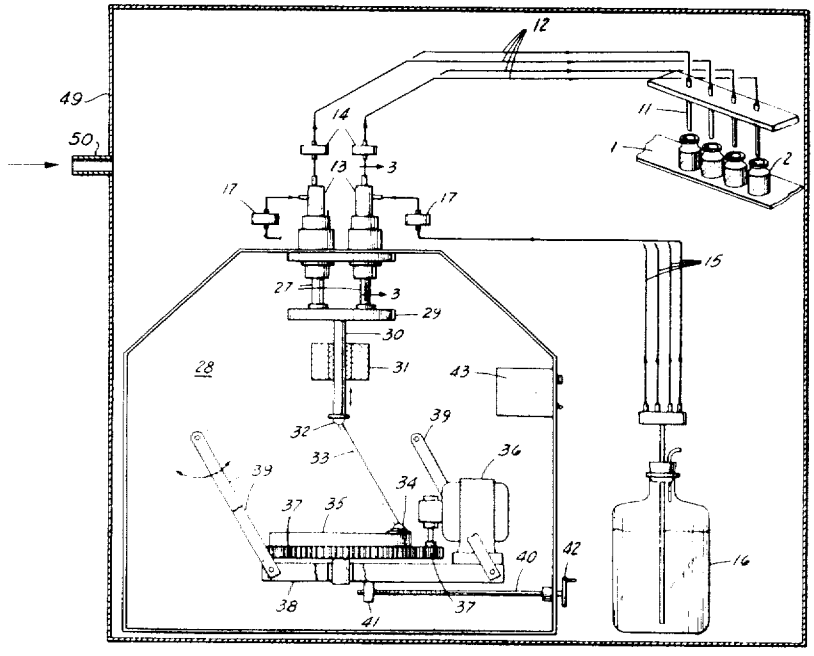
542,702	1/1942	Great Britain	74/44

Primary Examiner—Edward J. Earls
Attorney—Samuel Branch Walker

[57] **ABSTRACT**

A filling machine for sterile filling of containers such as vials is described in which a moving conveyor brings predetermined amounts of single file, empty, sterile containers under filling nozzles and holds them there until they are filled. The filling machine has a number of nozzles equal to the number of containers, each nozzle having a pumping mechanism in the form of a double-compartment chamber, the two compartments being separated by flexible diaphragms. Pumping means are provided for pumping a predetermined amount of liquid into the second chamber, the amount corresponding to the volume which is to be filled into each container through the nozzle. The diaphragm flexes and in one stroke sucks into the first compartment an amount of liquid from a source which, of course, is the same volume that is pumped out of the second compartment. Then when the pump reverses, this amount is forced into each vial through the filling nozzle. The diaphragm keeps the two liquids separated and maintains sterile conditions. Preferably pumping is effected by a rotating plate connected through a rod and bushing to a plate which moves up and down to effect pumping. The connection is via a rigid rod with a ball and socket joint at each end. The stroke and hence the volume of liquid pumped is varied by lateral displacement of the axis of the horizontal driving plate. Of course check valves are provided in all of the lines so that there can be no back-flow of the liquid being pumped into the containers.

5 Claims, 4 Drawing Figures



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SHEET 1 OF 2

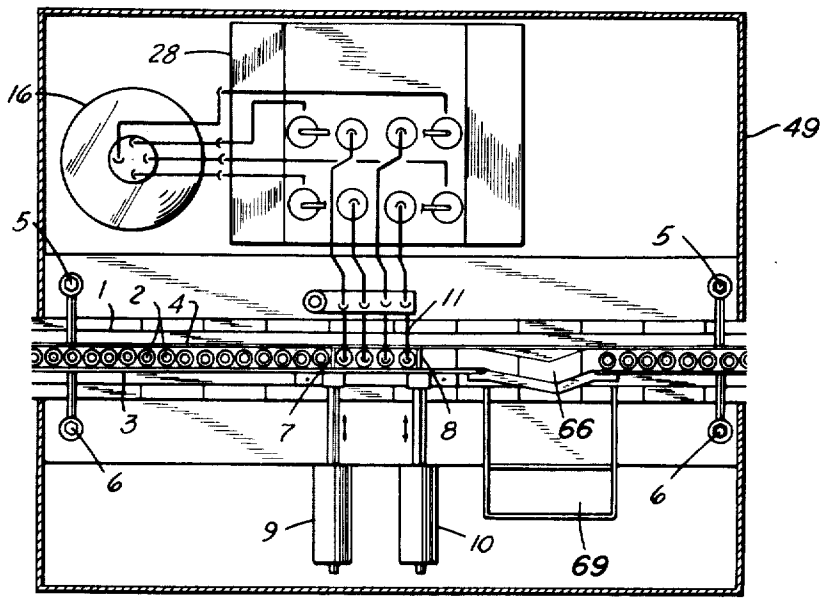


FIG - 1

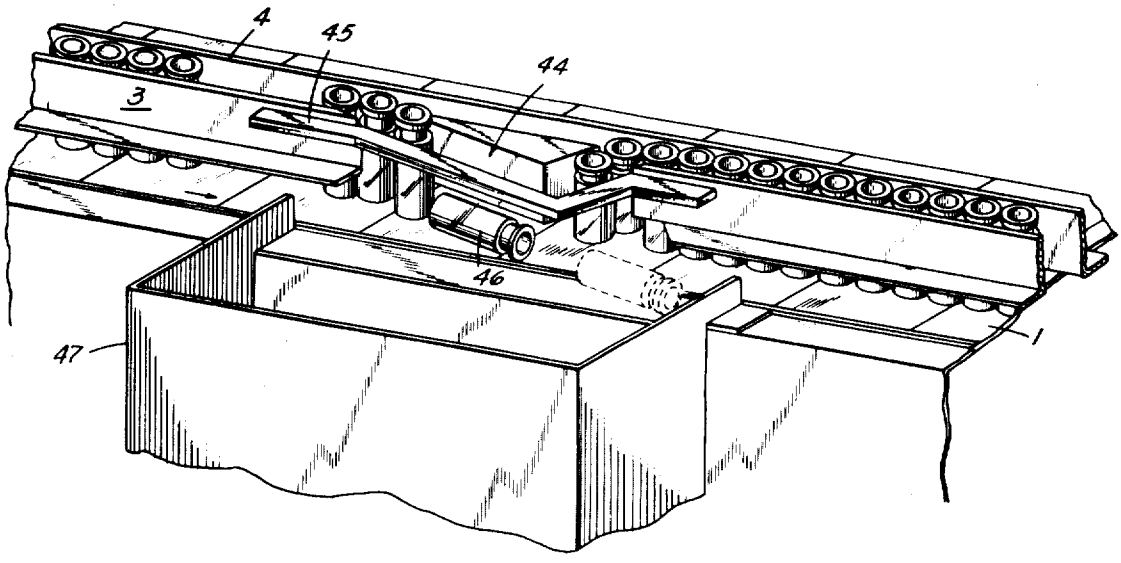


FIG - 4

INVENTORS.
ARTHUR SINCLAIR TAYLOR
ELLSWORTH SANDHAGE
GEORGE BOTT
WILLIAM KONAZEWSKI
BY
Samuel Frank Walker
ATTORNEY

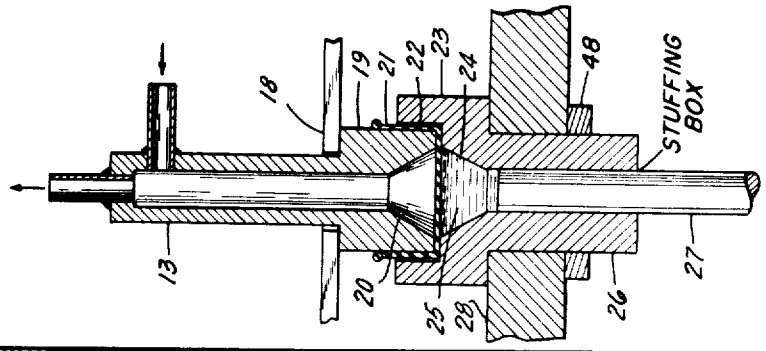


FIG - 3

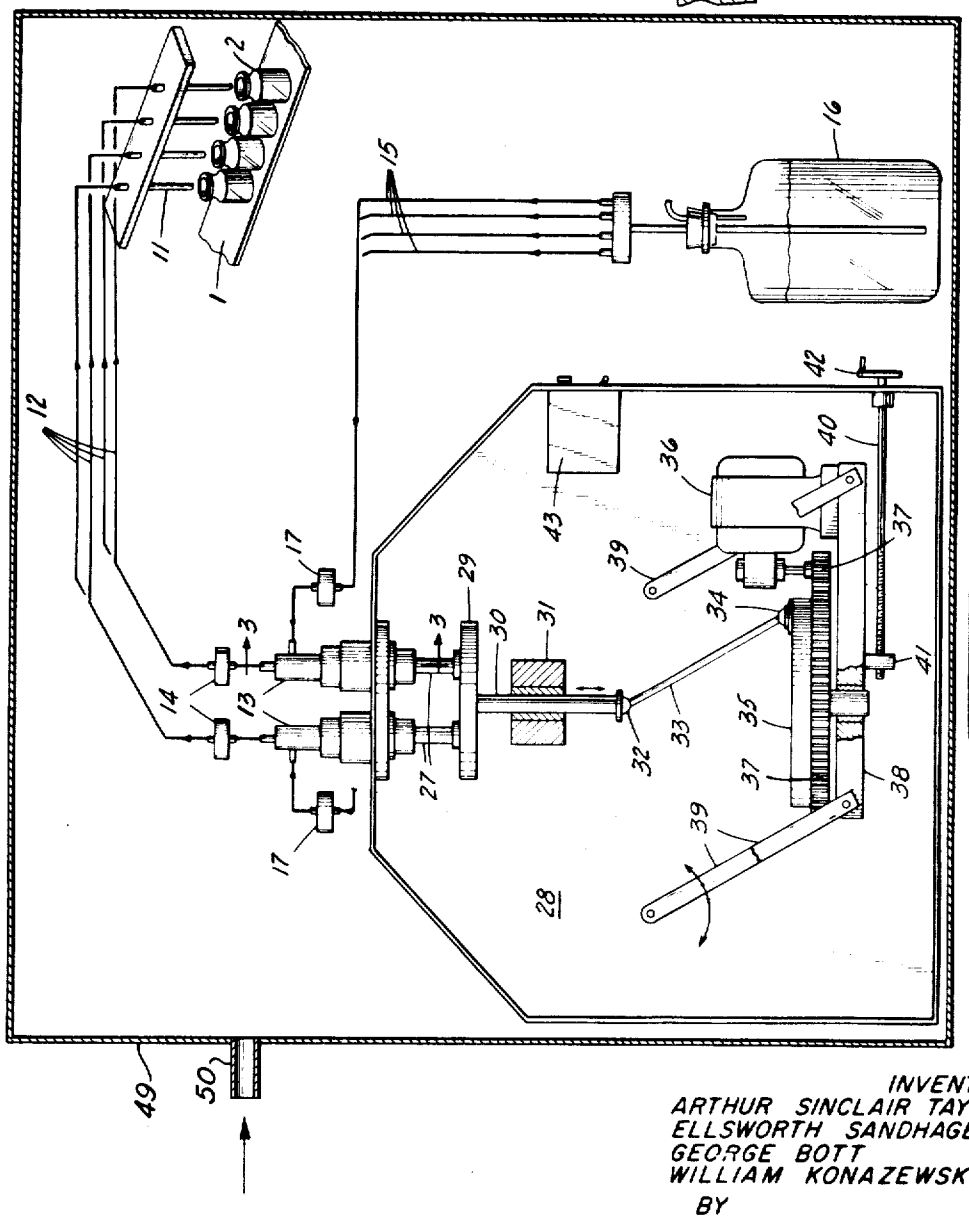


FIG - 2

INVENTORS.
ARTHUR SINCLAIR TAYLOR
ELLSWORTH SANDHAGE
GEORGE BOTT
WILLIAM KONAZEWSKI
BY
Samuel Frank Walker
ATTORNEY

STERILE CONTAINER FILLING MECHANISM

RELATED APPLICATIONS

This application is a division of our application Ser. No. 812,142, filed Apr. 1, 1969, now abandoned, which application is a division of our application Ser. No. 562,620, filed July 5, 1966, now U.S. Pat. No. 3,453,804 July 7, 1969.

BACKGROUND OF THE INVENTION

Sterile filling of vials or other containers presents a number of problems as liquid to be pumped in must not be contaminated, which is always a risk with ordinary pumping mechanisms.

SUMMARY OF THE INVENTION

The present invention fills a series of containers which are moved on a conveyor and stopped when a predetermined number are underneath filling nozzles, one for each container. The filling nozzles are connected by pipes through check valves to a pumping mechanism, one for each container. The pumping mechanism is in the form of a compartment with two chambers separated by a flexible diaphragm, such as a rubber diaphragm. The first chamber, which is connected to the filling nozzles, is also connected through a check valve to a source of liquid to be filled into the containers. The second compartment, below the diaphragm, is connected to a piston, one for each double compartment, which are all moved together, for example by a plate with rods and suitable bushings. The plate is moved through varying lengths of travel depending on the amount of liquid which is to be filled into the containers. One simple and practical modification will be described in more detail below involving a rotating plate with a rod connecting through two ball and socket joints. Volume is varied by moving the axis of the rotating plate horizontally, for example with a fine pitch screw.

It will be noted that the pumping fluid, which may be water, oil, or any other suitable fluid, never comes in contact with the liquid which is to be filled into the containers as it merely flexes the diaphragms, which keep it always separated from the liquid in the first compartments which is filled into the containers. This system of pumping and flexing the diaphragms need not be sterile and may, if desired, be in a separate housing. The remainder of the mechanism, including the filling nozzles, the conveyor and other portions of an automatic filling line, may be covered over and a sterile atmosphere maintained to prevent contamination.

After the predetermined number of containers are filled, the conveyor moves them on in single file through other stations which effect stoppering, final loading onto trays, and the like, as is described in the parent application and which is also described in a divisional application, Ser. No. 812,084, filed Apr. 1, 1969, now U.S. Pat. No. 3,490,574 which is directed to the overall organization of the whole filling line. Preferably the conveyor is a smooth conveyor and moves continuously, the predetermined number of containers being stopped by fences synchronized with the filling mechanism and holding the containers underneath the filling nozzles for a time at least as long and usually slightly longer than the period of filling.

When the conveyor proceeds to move on the filled containers, it passes through a rejecting device which rejects any filled containers which may have tipped on their sides and spilled their contents. The filling mechanism of the present invention is not concerned with the mechanisms at stations before and after the filling, and so only the portion of the conveyor carrying the containers under the filling nozzles and the portion rejecting tipped or spilled containers is shown.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a portion of a conveyor and the filling mechanism and spilt-container rejecting mechanism;

FIG. 2 is an elevation, partly in section and partly in isometric, of the filling mechanism;

FIG. 3 is an enlarged section along the line 3—3 of FIG. 2 of a single pumping mechanism, and

FIG. 4 is an elevation of the spilt or tipped vial rejecting means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference has been made above to the desirability of maintaining the apparatus of the present invention, or at least the filling portions thereof, under sterile conditions. This is effected by conventional means, namely a housing and means for introducing a sterile atmosphere. The invention is in no way concerned with particular design of housing, and therefore, such a housing is shown at 49 with a pipe 50 leading to a source of sterile atmosphere. The showing of the housing is purely diagrammatic and is shown, partially broken away, in FIG. 2. FIG. 1 of course shows portions of the housing in cross section only and the housing is not illustrated in FIG. 4 as it would obscure the drawings. It will be noted that in FIG. 2 the housing is shown surrounding the pumping means as well, which is one of the variants described above. Of course, as there stated, it may, if desired, only surround the filling mechanism, leaving the pumping mechanism outside of the sterile environment.

FIG. 1 shows a continuously moving, smooth surfaced conveyor 1 on which a series of vials 2 are moved in single file between tracks 3 and 4, the track width being adjusted by screws 5 and 6 for different size vials. Only one conveyor and one line is shown in FIGS. 1, 2 and 4, but of course multiple lines may be used with suitable duplication of the filling mechanism which will be described. Fences 7 and 8 are moved by cylinders 9 and 10. The cylinders move the fences in controlled synchronism with the filling mechanism, either pneumatically or hydraulically. First the fence 8 is inserted, and when the desired number of vials has backed up against this fence, shown as 4 in the drawings, fence 7 is inserted, and the two fences hold the four vials stationary while the smooth conveyor moves underneath them. The conveyor also moves underneath the vials which have backed up behind fence 7. This is shown in FIG. 1.

The four vials are held under four filling nozzles 11, which are best seen in the upper right hand corner of FIG. 2, but for simplicity the track and the fences are omitted. The vials are held rigidly in position during the filling operation.

The four filling nozzles 11 are connected through four pipes 12 to four pumps 13, two of which show in FIG. 2. Check valves 14 prevent back-flow of liquids. Each pump chamber is connected through its own inlet pipe 15 to a source of liquid 16, individual check valves 17 being provided to prevent back-flow. A bulk of a biological liquid is shown in the container 16. Each pump chamber 13 is held against vertical movement by the frame or plate 18, which can be seen in FIG. 3. This is not shown in FIG. 2 in order not to obscure the illustration. The frame or plate 18 engages a shoulder or enlarged portion 19 on each pump chamber. In this enlarged portion there is a tapering enlarged bore 20 which forms a frusto-conical chamber of predetermined dimensions and communicates with the cylindrical portion 13 of each pump.

The enlarged portion 19 is surrounded by cap 21, which may be of rubber or any other suitable elastomer. The whole fits tightly in an enlarged portion 22 of a pumping compartment 23. An enlarged frusto-conical chamber 24 of the same general shape as the chamber 20 abuts against the rubber diaphragm 21. This chamber is filled with a liquid 25 and is continuously maintained full with no gas space. The liquid may be any suitable liquid which is incompressible, such as water, oil, and the like. In a lower cylindrical portion, a piston 27 can move up and down as will be described. The pumping chambers 23 are held in a cover 28 by a locking plate 48. The cover 28 is shown in full in FIG. 2. The pistons 27 are accurately dimensioned and each piston has the same cross-section. Suitable stuffing box is provided to prevent leakage of liquid around the piston rods. This is indicated in FIG. 3 but not shown in detail in order not to interfere with the clarity of the illustration.

All four piston rods 27 are mounted in a rigid plate 29 which in turn is mounted on a single rod or shaft 30 journaled in a journal 31. The double arrow in FIG. 2 indicates the oscillating travel of this shaft. At its lower end it is connected to a rigid rod 33 through a ball and socket joint 32. The other end of the rod is mounted on a rotating plate 35 through a second ball and socket joint 34. This plate is rotated by the motor 36 through gears 37 and is journaled in a plate or framework 38. This framework is capable of lateral movement but cannot tilt. The lateral movement is determined by the four parallel arms 39 which are journaled in the cover 28. In FIG. 2 two of these arms are shown in full and two broken away. The arc of movement is indicated by the curved double arrow. The lateral position of the framework or plate 38 is determined by the threaded rod 40 which is threaded into a projection 41 on the framework. The rod can be turned from outside of the wall 28 by means of the hand wheel 42. Adjustment of the position of the framework 39 determines the stroke of the rod 30, which is variable in order to pump different amounts of liquid 25 depending on the adjustment of the wheel 42. It will be noted that there is an additional advantage that the whole mechanism within the wall 28 is kept from contact with the outside, which aids in preventing contamination. Access to the mechanism for periodic maintenance is through an opening (not shown).

It will be noted that the lowermost position of the rod 30 and therefore the pistons 27 is fixed regardless of adjustment of the hand wheel 42. Movement of the framework 38 results in a vertical displacement so that the lowermost position of the rod 30 remains fixed. In other words, the variation in the stroke of the pistons 27 is brought about by the change in the topmost position which they reach with different lateral adjustments of the position of framework 38. A single adjustment by the hand wheel 42 effects this change or adjustment in the amount of liquid 25 pumped without requiring any second adjustment of the lowermost position that the rod 30 reaches. This is a practical advantage as varying volumes of liquid can be pumped with a single adjustment instead of requiring more than one as in many other filling devices. Adjustment is simplified and complication is reduced to a minimum, which is a practical and important operating advantage. Another advantage that adds to simplicity and reliability is that the pumping mechanism which pumps liquid 25 has no valves, which reduces risk of leakage or other malfunction. The present invention should therefore not be confused, as far as the filling operation is concerned, with more complicated pumping mechanisms which require valves.

When a set of four vials are to be filled, a single revolution of the plate 35 causes the eccentrically located ball joint 34 to impart an upward and downward movement to the rod 30. This causes the four pistons 27 to move up and down a definite amount which is accurately adjusted by the wheel 42 to correspond to a particular volume which is to be filled into each vial. This is the only adjustment required. On the down stroke the elastic diaphragm 21 is pulled down to a horizontal position, which sucks up liquid from the container 16 into each pump chamber. On the return up stroke an amount of liquid in each pump chamber 13, exactly corresponding to the volume of liquid 25 moved by the piston 27, is pumped out through the check valves 14, lines 12 and orifices 11. This accurately measured volume is thus transferred to each vial.

It should be noted that the pumping mechanism, including the fluid 25, does not come into contact with the biological which is pumped into the vials. There is a complete separation of the two systems by the elastic caps 19. Sterility can therefore be maintained and there is no possibility of either leaks or contamination. At the same time, the caps 19 can be removed for cleaning and disinfecting, for example when a different biological is to be filled in, and of course at such time can be replaced if desired. These elastic caps are relatively cheap, but they do have a long life and so there is no risk of their failing by attempting to run them too near their normal life span. These features which maintain complete sterility and at the same time completely accurate measuring out of the volumes filled into the vials are one of the most important advantages of the present invention, particularly in its aspect as a subcombination including the filling mechanism.

Another advantage is that the pressure of liquid over the elastic diaphragms 19 is uniformly distributed, and since it is incompressible an exactly measured amount is pumped each time. There is no problem of varying pressure by flexing of a diaphragm as in an ordinary diaphragm pump and thus, although it may appear at first sight as if the pumps described above resemble ordinary diaphragm pumps, they actually operate under a

different system, namely a perfectly uniform transfer of movement without any non-uniform flexing of the diaphragm. Ordinary diaphragm pumps, while they would perhaps maintain sterility as long as the diaphragms did not break, will not perform the exact measuring that is effected in the present invention because the diaphragms are moved from portions and are therefore not subjected to a perfectly uniform liquid pressure over the whole of their surface. At the same time, one of the advantages of ordinary diaphragm pumps, namely that they can handle suspensions of solids and liquids, is fully maintained. In other words, the present invention not only performs a new result of completely accurate measurement under sterile conditions, but this is obtained without any disadvantage and thus the present invention is suitable for filling suspensions of solids in liquids as well as pure liquids. This is a practical advantage as some biologicals or other liquid materials do contain solids suspended therein.

After the four vials have been filled, the fence **10** is retracted on command of the filling mechanism and the four vials proceed to move forward in their track on the conveyor belt. When all four have passed the location of the fence **10**, the latter is moved forward and fence **9** is withdrawn so that another set of four vials may move under the filling nozzles and the filling sequence described above is then repeated.

The four vials now move to a portion of the track which provides discarding of vials which may have tipped over. This location, which is an abrupt jog, is shown at **44** in FIG. **1** and is illustrated in greater detail in FIG. **4**. At the start of the jog the outer fence **3** is developed into a portion **45** which contacts the upper parts of the vials but which leaves a space between it and the conveyor **1** that is greater than the diameter of the largest vial which is to be filled on the machine. As a result, if a vial tips and falls on its side, as is shown at **46**, the conveyor belt causes it to slide underneath the portion **45** of the fence, and it is discharged into a bin **47**. This position is shown in dashed lines in FIG. **4**. The vials which have remained upright are of course held by the upper portion of the fence **45** and move on in their regular single file, as can be seen at the right of FIG. **4**. Theoretically the fence and the smooth surface of the conveyor belt should preclude any vial tipping, and in practice this holds true for most vials. However, in a large run an occasional one will tip, and the discharge location **44** takes care of this situation. It will be noted that if a vial tips onto its side the liquid will be discharged onto the conveyor belt. Any spilled liquid is carried along by the conveyor **1** until it turns up to approach the portion shown in FIG. **1**. At this point a sponge full of disinfectant, (not shown), touches the surface of the conveyor **1** and wipes off any spilled liquid. This assures the maintenance of a sterile environment on the conveyor belt.

As has been pointed out above, the automatic ejection of tipped or improperly oriented containers may be before the filling station instead of after or in addition thereto. The mechanism is, of course, the same in its structure regardless of whether it is located in the portion of the track before fence **7**. Therefore, no ejection means is shown on the drawings before the filling station as this would result in obscuring the drawing and would not add any information since it would involve merely a duplication of the mechanism at the discharge location **44**. In a practical operating machine there is considerable advantage in automatically ejecting improperly oriented vials both before and after filling, and in such a machine of course the ejection mechanism is duplicated at the other position.

At this point it is of interest to note that it is possible to operate multiple lines of vials. This requires, of course, filling two tracks, doubled filling mechanisms as described above, duplicated tipped vial discharge points, and duplication of the stoppering mechanism which will be described below. No problem is presented by the fences **7** and **8** because they move in from the outside, and of course the waste bins for tipped vials, shown in FIG. **4**, can be on the outside for each of the lines. Theoretically more than two lines could be filled at the same time, which would require operating fences **7** and **8** from the top or otherwise providing for location of multiple actuating cylinders. The capacity of the filling station of the present invention is so high that adequate output is obtained with a single line, although in certain cases two lines can be filled simultaneously. The above discussion is primarily for the purpose of emphasizing that the present invention is not limited to filling a single line of containers or even a pair of lines.

We claim:

1. A filling machine for containers moved in at least one line in single file comprising in combination:

a. a number of filling nozzles equal to a predetermined plural number of containers in each single file, and positioned thereover,

b. an equal number of double compartment chambers each having a first compartment and a second compartment, the compartments being separated from each other by flexible diaphragms,

c. means connected together to move as a unit for pumping through periodic pumping cycles a separate, equal, predetermined volume into each second chamber to maintain each said second chamber full of liquid in the absence of gases, the pumping means pumping the predetermined volumes of liquid into each second compartment during each pumping cycle, whereby the diaphragms are flexed and the volume of each first compartment is thereby changed by the same amount,

d. a source of liquid to be filled into the containers and one way flow connections from said source to the first compartments of each chamber whereby when the diaphragm in each of said double compartment chambers moves during one portion of the pumping cycle the liquid to be filled is sucked into the first compartment and means connecting said first compartments to each filling nozzle, whereby in each pumping cycle the same volume of liquid is fed to the filling nozzles as is pumped into the second compartment of each chamber, the diaphragm being subjected at all times to a uniform, substantially hydraulic pressure, and there is complete separation of the liquid to be filled from the pumping liquid,

e. the pumping means for pumping liquid into the second compartment are piston elements rigidly

connected to a plate, the plate being at right angles to the axes of the pistons, a rod, the rod connected to the plate and bushing means surrounding said rod and permitting motion of the rod and the plate parallel to the axes of the pistons but preventing tipping thereof, and

f. a rotary plate parallel to the plate attached to the piston elements and connected eccentrically of its axis of rotation to the rod through a connecting rod and a ball and socket joint, supporting means for said rotary plate, a prime mover means mounted on said supporting means for rotating said rotatable plate, parallel link means movably carrying said supporting means, and means for adjustably moving said supporting means in the plane of the rotary plate to vary the stroke of all of the pistons in the second chambers simultaneously, whereby the pistons in all of the second chambers are moved in unison through a predetermined stroke depending on the eccentric location of the ball and socket joint on the rotatable plate.

2. A filling machine according to claim 1 comprising means for maintaining at least the filling portion thereof in contact with the liquid to be filled in sterile condition.

3. A filling machine according to claim 2 comprising means for maintaining the filling portion thereof in contact with the liquid to be filled in sterile condition, the means including a housing around the portions of the machine to be maintained in sterile condition and the means for adjustably moving the rotating means in the plane of the rotatable plate comprising a threaded shaft and means for turning said shaft to move adjustably the supporting means, including the prime mover means and means for rotating the rotatable plate.

4. A machine according to claim 1 in which the predetermined number of containers positioned below the filling nozzles are positioned by means including a smooth, continuously moving conveyor, guide tracks thereabove of the width of a container cross-section, whereby containers are moved in single file between the guide tracks, two means for holding containers from travel between the guided tracks by the conveyor, a first movable means for stopping the movement of containers in single file in the guide tracks and located to stop a container in position under the last of the filling nozzles, a second means for stopping the motion of the file of containers located so that the last container passing it is positioned under the first filling nozzle, means for actuating the first moving means to cause containers to back up against it and means with a suitable delay for actuating the second moving means after the predetermined number of containers have been positioned under the filling nozzles, means for deactivating the first moving means after filling of the containers is complete and similar deactivating means for actuating the second moving means after a delay sufficient to permit the predetermined number of containers to pass the first moving means and means after said second delay to actuate the first moving means and the second moving means in timed sequence to repeat the cycle.

5. A machine according to claim 4 in which the first and second moving means are retractable fences movable across the guide tracks above the conveyor at a level to contact moving containers.

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