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METHOD AND APPARATUS FOR CLEANING AMPOULES WITH THE AID OF ULTRASONIC VIBRATION

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Fig. 1.

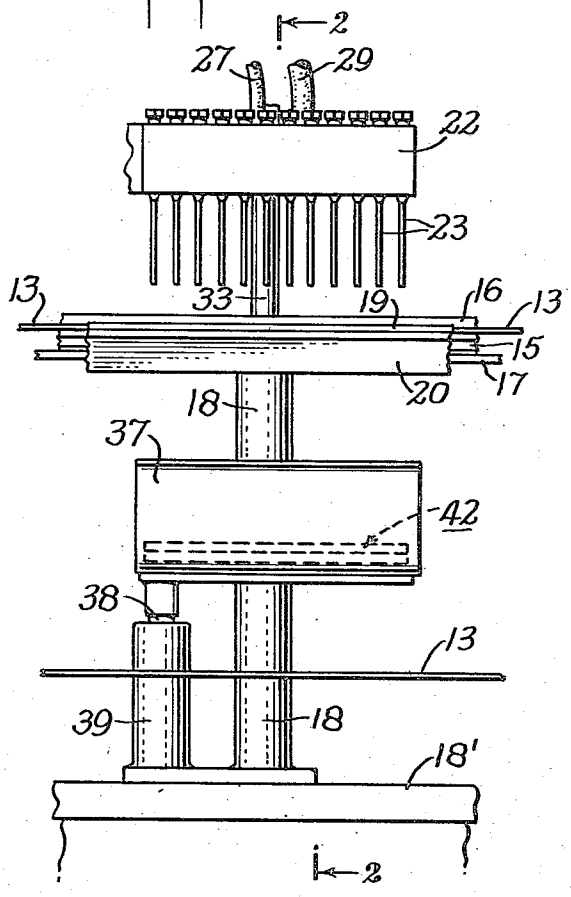


Fig. 2.

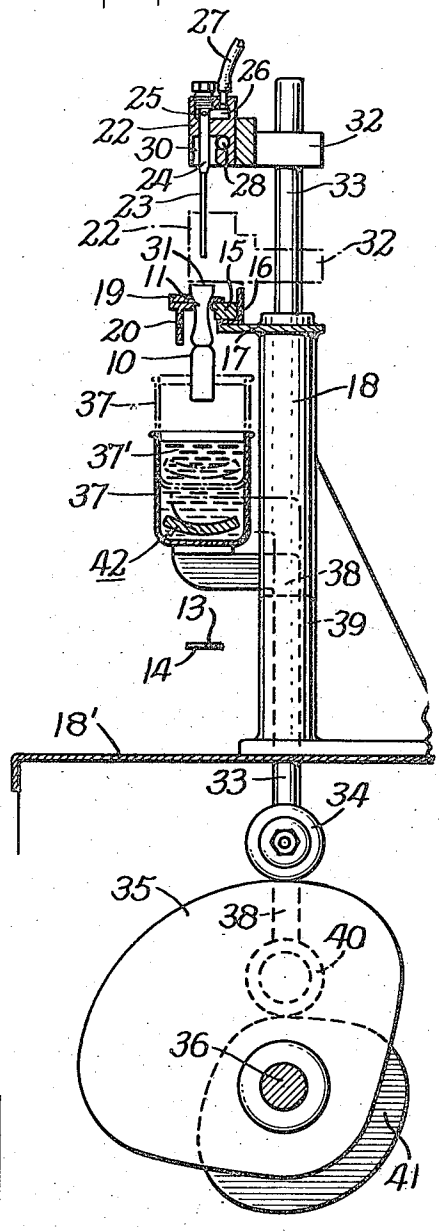
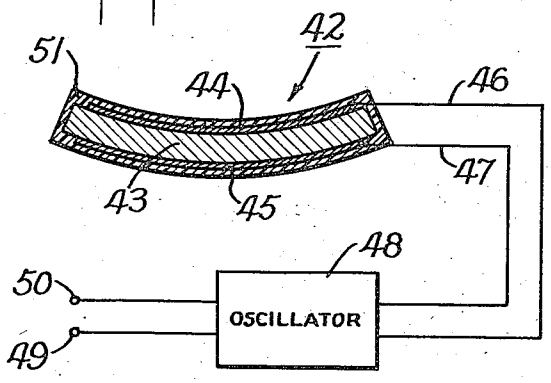


Fig. 3.



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METHOD AND APPARATUS FOR CLEANING AMPOULES WITH THE AID OF ULTRASONIC VIBRATION

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12 Claims. (Cl. 134—1)

This invention relates generally to the cleaning of vessels or containers, and more specifically concerns an improved method and apparatus for removing foreign matter from within glass ampoules intended to be used for accommodating sterile drugs and similar materials.

The cleaning of ampoules usually involves the use of a variety of cleaning agents and detergents dissolved in water or other suitable carrier and forcibly injected into each ampoule. While these porcedures have been found to remove a large part of the foreign matter and produce an acceptable product for packaging drugs, they have not been entirely satisfactory as even the most vigorous cleaning methods will not remove the extremely minute particles that either cling to the walls of the ampoule or are partially imbedded in the microscopically small crevices or interstices therein. It is an object of the present invention to effect the removal of these minute particles through the use of vibration generating means wherein high frequency vibrations are imparted to and introduced into the walls of the ampoule duirng the cleaning process.

Another object of the invention is to provide a new and improved method and apparatus that is readily adaptable to automatic and semi-automatic ampoule cleaning equipment, and which will not only expedite the cleaning process but will enable substantial simplification of the apparatus and procedures normally required.

Still another object of the invention resides in the provision of an improved device readily applicable to automatic ampoule cleaning apparatus, well adapted to effect more thorough and rapid cleaning, and characterized by its structural and operational simplicity and relatively low cost.

The above and other objects and advantages of the invention will become more apparent from the following description and accompanying drawings forming part of this application.

In the drawings:

Figure 1 is an elevational view of ampoule cleaning apparatus embodying the features of the invention;

Figure 2 is a cross-sectional view of Figure 1 taken along the line 2—2 thereof; and

Figure 3 is a diagrammatic cross-sectional view of the vibration generating means and associated energizing equipment.

As pointed out above the cleaning of ampoules has heretofore been carried out by the injection of water or other liquid under pressure into each ampoule in a manner that mechanically flushes out particles of foreign matter. While this procedure is generally satisfactory it does not effectively remove the minuter particles which, while inactivated by subsequent sterilizing processes, still remain within the ampoule and become intermixed with the fluid or other material ultimately to be held therein.

It has been found that these minute and even microscopic particles of foreign matter can be removed from within the ampoule by subjecting the cleaning fluid injected into the ampoule to high frequency pressure waves

which function to vibrate the ampoule wall and cause these minute particles to become dislodged and carried away with the cleaning liquid. Through the utilization of frequencies exceeding 20 kilocycles and preferably of the order of 400 to 500 kilocycles it has been found that highly effective and efficient cleaning action can be attained. This is brought about by reason of the differences in the physical characteristics of the ampoule wall and the particles adhered thereto which causes the particles to oscillate at periods of vibration different from those of the wall. With the particles and the ampoule wall oscillating in different ways the force tending to cause the particles to adhere to the wall is overcome with the result that the particles are shaken loose and fall away and are carried off by the washing or cleaning fluid.

One embodiment of the invention for the attainment of these ends is illustrated in the drawing and is intended to be illustrative rather than restrictive of the invention. In this form, a plurality of ampoules **10** having narrowed neck parts **11** are arranged to be carried or transported by a moving belt **13** by engagement with a plurality of spaced notches **14**. The ampoules hang from the belt, open ends upward. While only fragments of the lower and upper laps of this belt **13** are shown in the figures, it is understood that it is a continuous endless belt supported at its ends by suitable supporting and rotating equipment.

The upper lap of the belt is supported during its travel by a longitudinal guide **15** rested within an L-shaped member **16** supported by a horizontal bracket **17**. The bracket **17** is secured to the upper end of a cylindrical support member **18** mounted on the base **18'**. The ampoules are retained within the belt slots **14** by a front guide **19** supported on a longitudinal T-shaped member **20**.

In order to expedite the cleaning process, the ampoules **10** are preferably processed in groups of two or more. The belt **13** is moved intermittently (by belt advancing means of any suitable character, not shown) to transport these groups to successive processing stations of which only one (a cleaning station) is illustrated. For present purposes the ampoules **10** are shown as being processed in groups of twelve, and the cleaning head **22** is therefore provided with a group of twelve nozzles **23**. The head is positioned above the belt **13** and the injection nozzles **23** extend downwardly therefrom. Each of the nozzles **23** is provided with a tubular body part **24** disposed within the head **22** and having an opening **25** communicating with a longitudinal manifold **26**. The cleaning liquid, such as water with or without a suitable detergent, is injected into the manifold **26** by means of an inlet hose **27** whereupon it then passes through the openings **25** in the nozzle body parts **24** and thence through and out of the lower ends of the several nozzles. This action occurs each time the nozzles are moved to the lowered position shown in dotted outline in Figure 2. As the water or liquid is injected into each ampoule it is simultaneously withdrawn by means of a series of cavities **30** surrounding the nozzles and engaging the open ends **31** of respective ampoules when the head **22** is lowered. These cavities are coupled with a longitudinal opening or exhaust manifold **28** which is in turn connected to an exhaust tube **29**. In this way the cleaning liquid is forcibly introduced into and withdrawn from each ampoule and effectively removes all loose foreign matter.

The head assembly **22** is reciprocably mounted by means of a collar **32** secured to the upper end of a shaft **33**. This shaft is slideably mounted within the cylindrical column **18**. The lower end of the shaft **33** carries a cam follower wheel **34** which rides on a cam **35** secured to a central or main cam shaft **36**. Rotation of the shaft **36** in synchronism with the intermittent movement of the

belt 13 (by any suitable means, not shown) will cause the head 22 together with the nozzles 23 to be moved downwardly each time the belt 13 stops and to permit water to be injected into and withdraws from each capsule or group of ampoules coming to rest beneath the head. After a given time the cam 35 raises the head 22 whereupon the belt 13 is operated to remove one group of ampoules and bring a succeeding group to the washing station.

Beneath the upper lap of the belt 13 and in line therewith is a liquid container 37 reciprocably mounted on the upper end of shaft 38 carried within a vertical guide 39 supported on the base 18'. The bottom end of the rod 38 carries a cam follower 40 which rides on the periphery of a cam 41 on and rotated by the shaft 36. The cams 41 and 35 are so arranged and coordinated that as the cam 35 rotates to lower the head 22 the cam 41 will simultaneously raise the liquid container 37 to submerge the lower parts of the ampoules. This submergence is indicated in dotted lines in Figure 2. Similarly when the head 22 is moved upwardly (full lines, Figure 2), the cam 41 will function to move the container 37 downwardly, thus freeing the ampoules so that the belt can displace them relative to the cleaning station.

The generation of pressure waves to expedite and effect more complete cleaning of the ampoules is accomplished by an elongated transducer 42 disposed in the container 37. This transducer is preferably curved about a longitudinal axis so that it will tend to direct the pressure waves generated by vibration of the top side of the transducer toward the bottom of the ampoules 10 and thus improve the transfer of energy to the ampoules.

While any suitable transducer may be employed that is capable of generating pressure waves within the liquid 37', and more particularly pressure waves of a frequency in the range of 20 kc. to 500 kc., a ceramic plate 43 responsive to alternating current frequencies in the desired range may be used. Such a ceramic plate may comprise barium or strontium titanate or a mixture thereof or it may comprise any other suitable magnetostrictive substance such as lead zirconate. In order to set the plate 43 into oscillation, metal electrodes 44 and 45 of aluminum, silver or other suitable material having a low conductivity are plated or otherwise secured to each side of the plate 43 as shown in Figure 3. These electrodes are connected through suitable insulated wires 46 and 47 to an oscillator or high frequency generator 48 connected to a source of power by means of terminals 49 and 50. The oscillator 48 may be of any conventional structure suitable for generating alternating current frequencies in the range of 20 kc. to 500 kc. and functions to cause the transducing element 43 to enlarge and contract in synchronism with the alternations of the applied energy.

In order to prevent the electrodes 44 and 45 from being short-circuited by reason of the immersion of the transducer within the fluid 37', it is preferably completely covered by a suitable insulating material 51 of plastic, glass or the like that will present very little impedance to the transmission of energy from the ceramic plate 43 to the liquid bath 37'.

The transducer may be supported within the bath 37' by any suitable means that will hold it in position and in the desired alignment with the ampoules to be cleaned.

In the operation of the device pressure waves generated by the transducer 42 are transmitted by means of the water or other liquid 37' to the ampoules 10 and cause them to be set into vibration. Some of this energy passes through the walls and into the cleaning fluid within the ampoules 10; some of it functions to set into motion the inner wall surface of each ampoule immersed in the bath. These various vibrations combine to release minute impurity particles, and this enables them to be carried out of the ampoule by the cleaning fluid injected into it.

With the apparatus described, it has been found that the use of ultrasonic vibrations not only aids in the removal of extremely minute particles of matter but also greatly assists in the removal of the larger particles. Tests have indicated that with prior apparatus the use of as much as 200 lbs. pressure in the injection of cleaning fluid for periods of 30 seconds or more failed to effect complete cleaning, while with the use of ultrasonic vibrations as herein described, more thorough cleaning was accomplished in as little as 5 seconds and with the use of only 5 cc. of cleaning liquid. Thus a substantial saving of time and equipment as well as cleaning materials is attained. Inasmuch as many drugs and particularly those in liquid form are packaged in so-called "single dose" quantities to avoid accidental contamination of larger quantities when packaged in bulk, these savings in time, maintenance and cost of equipment constitute a substantial reduction in the cost of the packaged article.

While only one embodiment of this invention has been illustrated and described, it is apparent that modifications, alterations and changes may be made without departing from the true scope and spirit thereof.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for cleaning glass ampoules comprising means for supporting an ampoule, means for injecting a liquid into and withdrawing it from said ampoule, a bath of another liquid having vibration generating means therein, and means for submerging at least part of said ampoule into said bath during the injection and withdrawal of the first-named liquid.

2. Apparatus for cleaning glass ampoules comprising means for supporting an ampoule to be cleaned, a liquid bath, electrically actuated vibration generating means in said bath for imparting pressure waves thereto, means for submerging said ampoule in said bath, and means for injecting another liquid into and withdrawing it from said ampoule during immersion thereof in said bath.

3. Apparatus for cleaning ampoules according to claim 2 wherein said generating means is shaped to direct the pressure waves toward said ampoule.

4. Apparatus for cleaning ampoules comprising a conveyor belt for transporting ampoules to be cleaned, a cleaning head including at least one liquid injection nozzle, means for moving said nozzle into and out of successive ampoules, a liquid bath disposed beneath said belt and movable toward and away from the belt for submergence of said ampoules, and means for generating ultrasonic pressure waves in said bath.

5. Apparatus according to claim 4 wherein the last-mentioned means includes an ultrasonic transducer curved about its longitudinal axis and positioned within said bath, the radii of curvature converging toward the submerged ampoules.

6. Apparatus for cleaning ampoules comprising a conveyor belt for transporting successive groups of ampoules to be cleaned, said ampoules hanging from said belt with their open ends upward, a group of injection nozzles mounted for reciprocable movement relative to said belt for injection of cleaning liquid into successive groups of ampoules, means for reciprocating said nozzles, means operatively connected with said nozzles for withdrawing the injected liquid, a reciprocably mounted bath below said ampoules for submerging at least part of each ampoule during injection of liquid therein, means for reciprocating said bath and ultrasonic generating means in said bath for vibrating the walls of said ampoules to release minute particles of foreign matter and facilitate their removal by said injected liquid.

7. The method of cleaning ampoules comprising the steps of injecting a cleaning liquid into and removing it from an ampoule being cleaned, and simultaneously subjecting said ampoule to ultrasonic pressure waves.

8. The method of cleaning ampoules comprising the steps of immersing an ampoule to be cleaned in a bath with its open end extending upwardly from the surface of said bath, generating ultrasonic pressure waves in said

bath, and simultaneously injecting a cleaning fluid into and removing it from said ampoule.

9. In an ampoule cleaning procedure, the steps which involve advancing an ampoule open end upward to a cleaning station, then at said station submerging the lower part of said ampoule in a liquid bath in which ultrasonic pressure waves are being generated, and flushing the interior of said ampoule with a cleaning liquid during said immersion thereof in said bath.

10. In an ampoule cleaning procedure, the steps which involve intermittently advancing a train of ampoules open end upward to and past a cleaning station so that at least one ampoule is at rest at said station between periods of advancement, providing at said station a liquid bath in which ultrasonic vibrations are imparted to the liquid, submerging in said bath the ampoule or ampoules coming to rest at said station, and flushing the interior of each such ampoule with a cleaning liquid during the period of its immersion in said bath.

11. In apparatus for cleaning ampoules, a conveyor belt for transporting successive groups of ampoules to be cleaned, said ampoules being carried by said belt with their open ends upward, cleaning liquid injection and withdrawing mechanism above said belt, including injection nozzles adapted to enter said ampoules, means for effecting relative movement between said mechanism and said ampoules so that cleaning liquid may be injected into and withdrawn from successive groups of ampoules, a liquid bath below said belt, means for effecting relative movement between said bath and said ampoules so as to submerge at least part of each ampoule in said bath during injection of cleaning liquid into it, and ultrasonic generating means in said bath for vibrating the walls of the submerged ampoules to release minute particles of foreign matter and facilitate their removal by said cleaning liquid.

12. In apparatus for cleaning ampoules, a conveyor belt for transporting successive groups of ampoules to be cleaned, said ampoules being carried by said belt with their open ends upward, cleaning liquid injection and withdrawing mechanism above said belt, including injection nozzles adapted to enter said ampoules, means for moving said mechanism up and down so that cleaning liquid may be injected into and withdrawn from successive groups of ampoules, a liquid bath below said belt, means for moving said bath up and down in timed relation to the movements of said cleaning liquid mechanism so as to submerge at least part of each ampoule in said bath during injection of cleaning liquid into it, and ultrasonic generating means in said bath for vibrating the walls of the submerged ampoules to release minute particles of foreign matter and facilitate their removal by said cleaning liquid.

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