May 8, 1962 E. L. BREVIK 3,033,712

EQUIPMENT AND PROCESS FOR AGITATED TANK CLEANING

Filed March 10, 1959 3 Sheets-Sheet 1

FIG. 1

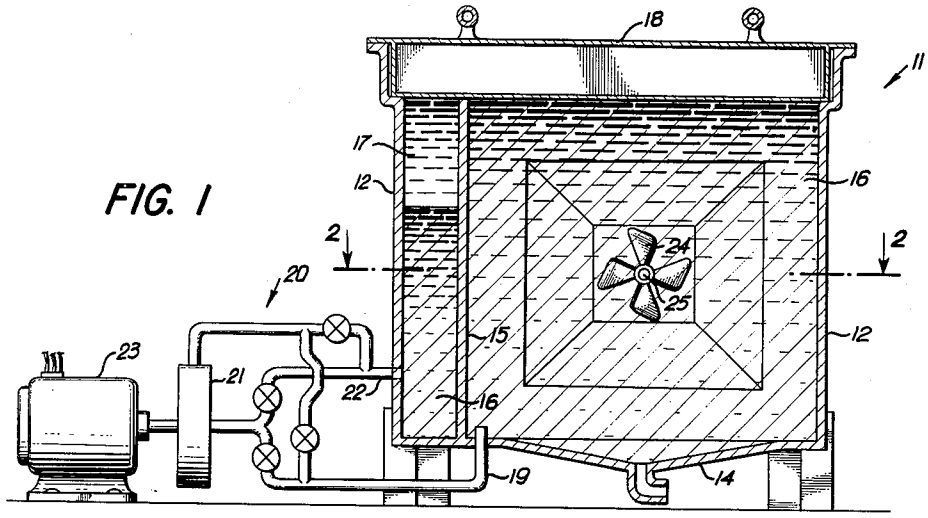
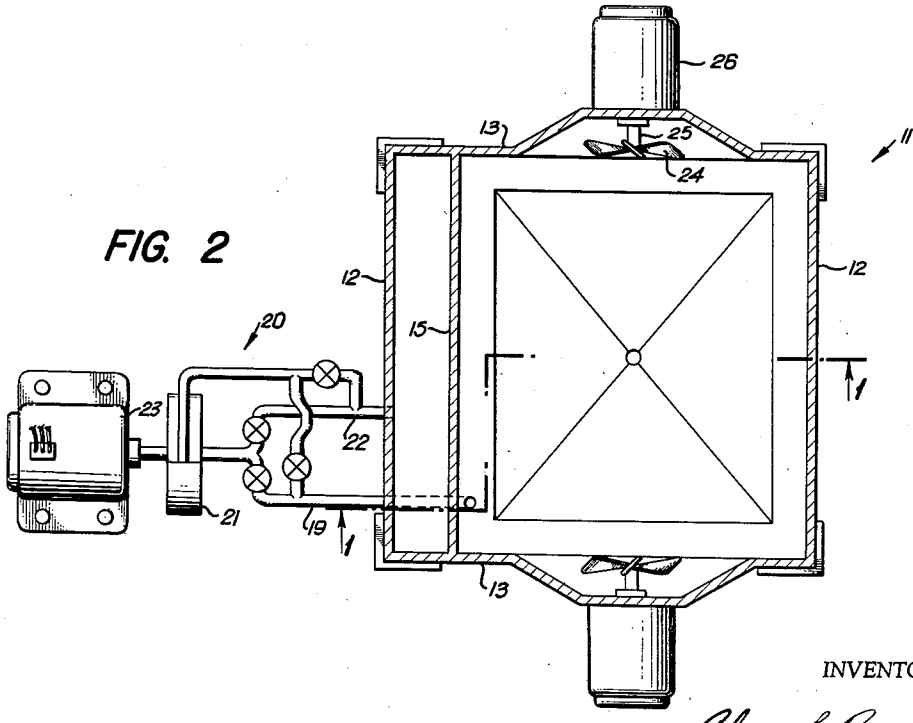


FIG. 2



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FIG. 3

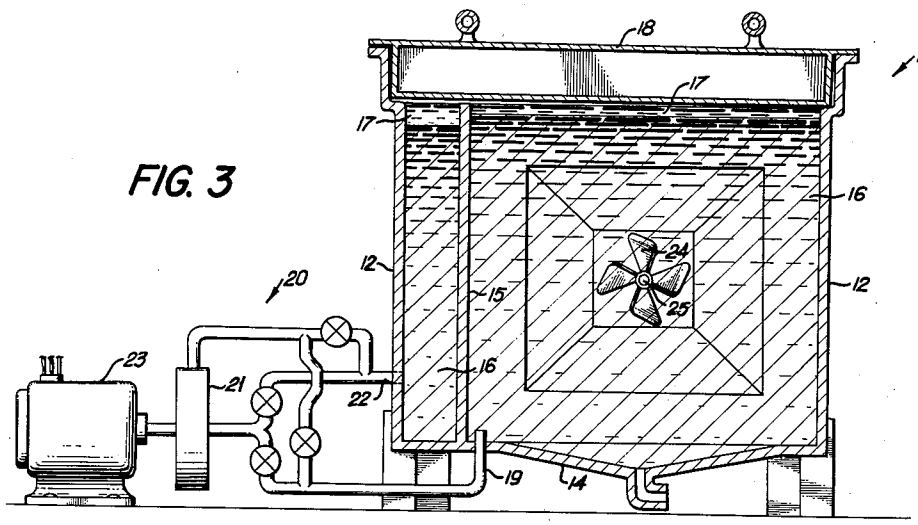
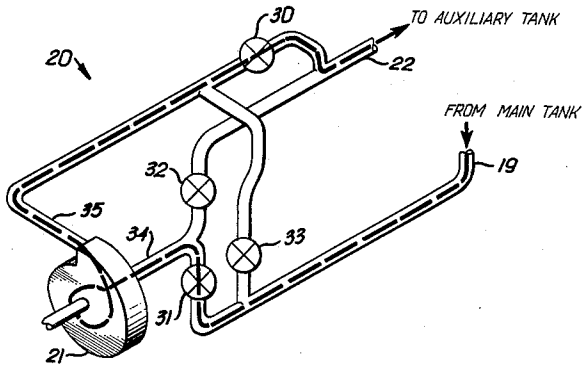


FIG. 4



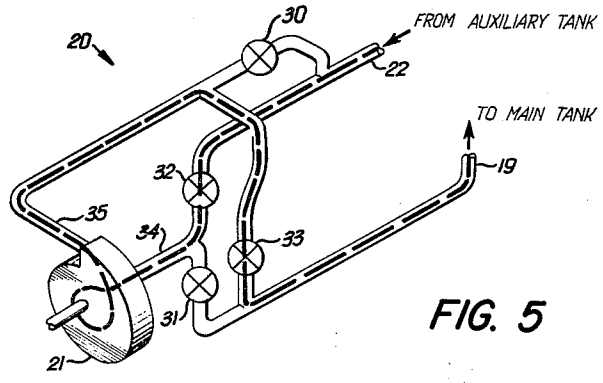


FIG. 5

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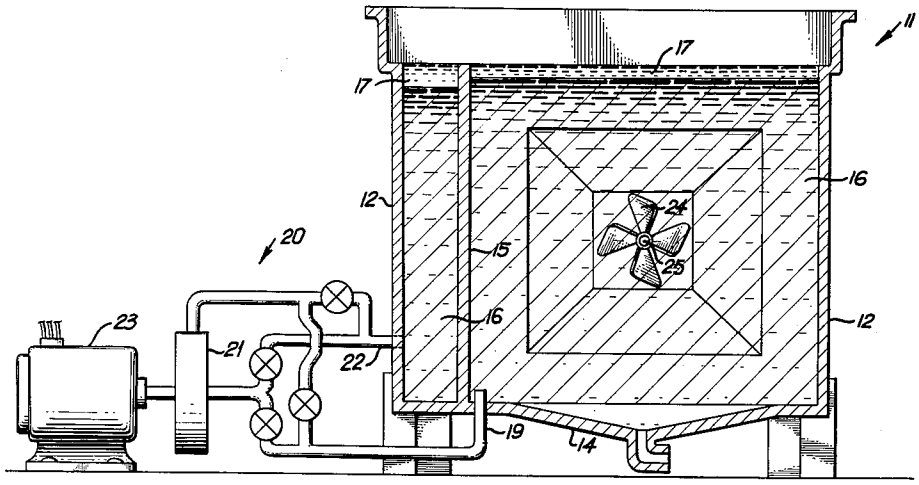


FIG. 6

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3,033,712

EQUIPMENT AND PROCESS FOR AGITATED TANK CLEANING

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9 Claims. (Cl. 134—34)

In the past it has been the practice to employ solvent type liquid for the removal of soils from numerous types of surfaces. One of the most useful methods has been to retain the solvent cleaning compound in the receptacle and remove the soil from the surface by immersion of the entire part into the liquid solvent wherein the soil is dissolved or removed and suspended in the liquid medium. Numerous types of chemical compositions have been prepared for effectuating this purpose; among these more useful compounds known to date and universally utilized for the removal of oily and carbonaceous deposits have been the chlorinated hydrocarbons. Especially effective for this purpose have been the low boiling chlorinated hydrocarbons, such as methylene chloride, boiling point 104° F., and trichloroethylene, boiling point 188° F. It is, therefore, quite evident that if either of these solvents were employed in a tank open to the atmosphere that tremendous volumes of either of these materials would be lost by evaporation to the atmosphere. Such a process would not only be prohibitively expensive but would create extreme personnel hazards resulting from the high concentration of chlorinated hydrocarbon vapors in the immediate vicinity of the tank.

To overcome this difficulty, it has been the practice to provide a floating seal in the form of a low specific gravity liquid which is immiscible in the chlorinated hydrocarbon cleaning solvent; the liquid most frequently employed for this purpose is water although other relatively high boling, low vapor pressure, immiscible liquids may be used.

To further augment the cleaning efficiency of the chlorinated hydrocarbon solvent, it has been frequently found advantageous to employ agitation to the tank. Agitation is not only desirable, but in many instances, it is mandatory if removal is to be effectuated on such soils as carbonaceous deposits resulting from the pyrolysis of fuels and lubricating oils.

It is readily apparent that any agitation employed in a system of two mutually immiscible liquids results in a mixing thereof. If a chlorinated hydrocarbon system, for instance, employing a water seal, is highly agitated, the water is dispersed throughout the cleaning solvent. It has been found that such distribution of water in the solvent greatly impairs the cleaning characteristics of the solvent and the advantages of employing agitation are eliminated; in fact, if the water is uniformly dispersed throughout the system, the cleaning results are inferior to those found in an unagitated tank, and evaporation of the chlorinated solvent is not materially reduced.

To overcome this difficulty and still maintain the advantages of agitation of the chlorinated hydrocarbon solvent, a method has been devised, as disclosed in the L. L. Northrop, Jr., Patent #2,838,289, wherein a metal baffle is so positioned in the tank as to separate the aqueous seal from the chlorinated hydrocarbon. By this method, it is possible to maintain the aqueous seal in the quiescent condition during the operation of the agitator in the cleaning zone of the tank. This approach, however, has certain inherent disadvantages in that it is almost impossible to economically construct a baffle of this type which is fluid-tight so that whenever extremely high agitation is employed in the cleaning zone, the very rapid flow of the liquid adjacent to the baffle would tend to

aspirate the liquid from the quiescent seal zone into the cleaning zone thereby mixing the seal with the solvent. Further, it is always essential that the interface between the aqueous seal and the solvent be so positioned as to be above the plane of the baffle. In the event that the interface is permitted to go below the plane of the baffle, for instance, by removal of the solvent such as that retained on the parts when they are discharged from the tank or by leakage of the solvent in the tank, it is apparent that the aqueous seal and the solvent below the baffle will mix and frequently cause complete emulsification of the aqueous seal into the solvent cleaning phase; this is particularly true if emulsifying agents or wetting agents are employed in the solvent layer to enhance the cleaning characteristics thereof. The resulting emulsion is usually very stable and must, therefore, be discarded as its cleaning efficiency is so greatly impaired as to make it useless.

It is the object of my invention to provide a method and the associated equipment wherein the aqueous seal is completely removed from communication with the solvent cleaner during periods of agitation and yet maintain the seal above the solvent at all times when the surface of the liquid is exposed to the atmosphere.

It is the further object of the invention to provide a means for removal of the aqueous seal from the solvent without excessive agitation of the immiscible liquids during the removal thereof.

It is still a further object of the invention, to provide a closure over the surface of the solvent cleaner after the aqueous seal has been removed to eliminate evaporation thereof.

Other objects and advantages will be apparent from reading the following description of one modification of the device constructed in accordance with the invention by reference to the accompanying drawings thereof, wherein;

FIG. 1 is a verical cross-sectional view of the tank along line 1—1 of FIG. 2 and showing a schematic representation of the external flow lines.

FIG. 2 is a horizontal cross-sectional view of the tank along lines 2—2, of FIG. 1 showing a schematic representation of the external flow lines.

FIG. 3 is a cross-sectional view of the tank along lines 1—1 of FIG. 2 showing the position of the aqueous seal before the tank lid is removed.

FIG. 4 is a schematic representation of the external pump systems showing the flow of the fluid from the cleaning zone into the auxiliary tank.

FIG. 5 is a schematic representation of the external plumbing showing the path of fluid flow from the auxiliary tank to the main cleaning tank.

FIG. 6 is a vertical cross-section of the cleaning tank along lines 1—1 of FIG. 2 showing the position of the liquid aqueous seal when the lid has been removed.

In FIGURES 1, 2, 3 and 6, a cleaning tank 11 is shown having oppositely disposed vertical sides 12, oppositely disposed vertical ends 13 and bottom 14. Internally, parallel to sides 12 and adjacent to one of said sides 12, a structural plate 15 is mounted by attaching to ends 13 and bottom 14. It is the purpose of plate 15 to create a small internal chamber in the tank which is completely separated from the main cleaning chamber except by means of external plumbing assembly 20 or by means of fluid flow over the top of the plate 15.

Contained within the cleaning tank 11 is a relatively high specific gravity cleaning solvent 16 and a low density liquid seal 17. An hermetically sealed lid of hollow construction 18 is provided to seal off the vapors or fumes from the tank during operation, but is completely removable from the tank for inserting or removing parts to and from the tank 11. The small retaining tank and cleaning

tanks are connected through a plumbing arrangement which is connected into the main cleaning tank by pipe **19** such that the fluid flow is through pipe **19**, pump **21**, and pipe **22** which is connected to a small cleaning tank. Pump **21**, which is shown as a centrifugal pump, is driven by an electrical motor **23**. Inside the cleaning tank, agitation is provided by propeller **24** which is connected by means of shaft **25** to another electrical motor **26**.

Referring now to FIGURES 4 and 5, the method of movement of fluid flow to and from the auxiliary tank through the plumbing arrangement **20** and back from it to the main cleaning tank is shown. As shown in FIGURE 4, valves **32** and **33** are in a closed position to prevent flow of fluid. When valves **30** and **31** are in the open position and the motor operating, the fluid flows from the main cleaning tank through pipe **19**, up through open valve **31** into the center of pump **21**; the fluid is discharged from the periphery of pump **21** into line **35** through open valve **30** into pipe **22** and back into the auxiliary tank. In FIGURE 5, the valves are placed in such a position that the flow is reversed; that is, valves **30** and **31** are in closed position and the fluid flows from the auxiliary tank into pipe **22** through open valve **32** into line **34** which passes into the center of the centrifugal pump **21**; out the periphery of pump **21** into line **35** down through open valve **33** into pipe **19** and back into the main cleaning tank.

Considering now the technique employed in the operation of the equipment, before operation starts and before parts to be cleaned are inserted in the main tank, the tank is in condition represented by FIGURE 6. The impeller **24** and motor **23** are in static condition. The solvent **16** in both the main cleaning tank and the auxiliary cleaning tank is sealed to prevent evaporation by an aqueous seal **17**.

A parts basket containing parts (not shown) is then inserted into the main cleaning tank and the cover **18** is put in place, as shown in FIGURE 3. Motor **23** is then started, actuating pump **21**. The fluid flow is operated as shown in FIG. 5, valves **30** and **31** are in a closed position, valves **32** and **33** are in the open position and the fluid flows out pipe **22** from the auxiliary tank through motor **21** and back through pipe **19** into the main cleaning tank. It should be noted that the level of the solvent **16** in the auxiliary cleaning tank is well above the discharge line **22** so that only the high specific gravity cleaning solvent **16** is pumped out of the auxiliary cleaning tank. As the fluid flows into the main cleaning tank, it tends to raise the level of the cleaning fluid **16** in this tank such that it forces the seal **17** upward, raising lid **18** such that a fluid will pass over wall **15** and back into the auxiliary tank. It should be noted that all of the seal **17** in the main cleaning tank will pass over into the auxiliary cleaning tank before any of the cleaning solvent **16** is raised into a position where it can pass into the auxiliary tank. After a sufficient quantity of cleaning solvent **16** is pumped from the auxiliary tank into the main cleaning tank, the entire aqueous seal will have passed over wall **15** into the auxiliary tank, as shown in FIGURE 1, and, therefore, the cleaning zone will contain only cleaning solvent **16** with the entire aqueous seal **17** having been completely transported into the auxiliary cleaning tank and away from any possible zone of agitation. When this condition exists as represented by FIGURE 1, motor **23** is stopped and the motor **26** is started, actuating the propellers **24** for agitating the cleaning solvent in the main cleaning tank.

Agitation is continued by propeller **24** for a sufficient length of time, until the parts have been cleaned. Motor **26** is then stopped, and valves **30** and **31** are placed in the open position with valves **32** and **33** in the closed position, the motor **23** is then started actuating pump **21** and the fluid flows from the main cleaning tank into the auxiliary tank as represented by FIGURE 4. The fluid pumped from the main cleaning tank is the high specific gravity cleaning solvent **16**; as this solvent passes in to

the auxiliary tank it will tend to raise the aqueous seal **17** which will force the lid **18** up so that the aqueous seal **17** will pass over wall **15** back into the main tank thereby sealing the solvent. After a predetermined amount of aqueous seal **17** has passed into the main cleaning tank, the valves **32** and **33** are closed, the motor **23** is stopped and the lid removed. The cleaned parts contained in the parts basket, not shown, are then removed and the tank is returned to the condition as represented by FIGURE 6.

Although the method of agitation graphically illustrated in this specification consists of a propeller driven by an electrical motor, it will be apparent to those skilled in the art that the equipment and process employed in this invention will be equally useful if other methods of agitation are employed in the cleaning zone; such methods, frequently used in agitation cleaning equipment include ultrasonic sound waves induced into the cleaning fluid by either electrical or mechanical means, high velocity recirculating systems wherein the fluid is recirculated through an external piping system and returned to the tank under high pressure, impellers and the like.

It is also my intention to include as an important but not necessarily essential part of the invention, the hermetically sealed cover. Although, the cover as shown in the drawings has an essentially plain bottom surface which is horizontal, it is apparent in some instances it will be advantageous to employ a cover whose bottom is sloped in relationship to the horizontal plane such that the slope is in a plane normal to the auxiliary tank and such that the slope proceeds uniformly downwards to the opposite side of the cover. The slope of one-half inch per foot is adquate for this purpose although greater or lesser slopes may be employed. With this configuration of cover, as the high density solvent is pumped into the cleaning zone, the low specific gravity seal will tend to migrate toward the auxiliary tank and thereby eliminate any entrapment or dead spots due to slight deformations in the cover.

It is also obvious that two auxiliary tanks placed at opposite sides of the tank could be employed and may be highly advantageous if tanks of great width are employed. The use of two auxiliary tanks would facilitate more rapid removal of low specific gravity seal without excessive agitation of the immiscible fluids and would thereby tend to prevent the intermixing of the fluids during the removal operation.

What I claim is:

1. Cleaning apparatus which comprises a cleaning tank, an auxiliary tank positioned in side-by-side relation to said cleaning tank, said auxiliary tank having a smaller volume than said cleaning tank, a solid partition separating said cleaning and auxiliary tanks, said partition extending from a position adjacent the upper end of each of said tanks to the bottom thereof, agitator means positioned in said cleaning tank, a cover positioned at the upper end of said tanks and closing said tanks, said cover abutting the upper end of said partition, means mounting said cover to permit vertical slidable movement thereof away from and toward the upper end of said partition, and means providing fluid communication between the lower ends of said auxiliary and cleaning tanks, whereby passage of liquid from one tank to the other will raise said cover, resulting in a flow of liquid from the upper end of said other tank over said partition and into said one tank.

2. Cleaning apparatus which comprises a cleaning tank, an auxiliary tank positioned in side-by-side relation to said cleaning tank, said auxiliary tank having a smaller volume than said cleaning tank, a solid partition separating said cleaning and auxiliary tanks, said partition extending from a position adjacent the upper end of each of said tanks to the bottom thereof, and blocking off fluid communication between said tanks adjacent the lower ends thereof, agitator means positioned in said cleaning tank, a hermetically sealed cover posi-

tioned at the upper end of said tanks and closing said tanks, said cover abutting the upper end of said partition, means mounting said cover to permit vertical slidable movement thereof away from and toward the upper end of said partition, external conduit means providing fluid communication between the lower ends of said auxiliary and cleaning tanks, and pump means for forcing a liquid through said conduit means from one of said tanks to the other, whereby passage of liquid from one tank to the other will raise said cover, resulting in a flow of liquid from the upper end of said other tank over said partition and into said one tank.

3. The method of cleaning metal parts in a cleaning tank employing therein a two-phase liquid system composed of a high specific gravity cleaning liquid and a low specific gravity seal liquid immiscible with said cleaning liquid, which comprises covering the cleaning tank with a lid, transferring the low specific gravity seal liquid to an auxiliary tank not subject to agitation, commencing agitation of the cleaning liquid in said cleaning tank and maintaining agitation until the parts are clean, stopping the agitation, transferring the low specific gravity seal liquid back to the cleaning tank and removing the lid.

4. The method of cleaning metal parts in a cleaning tank employing therein a two-phase liquid system composed of a high specific gravity cleaning liquid and a low specific gravity seal liquid immiscible with said cleaning liquid, which comprises covering the tank with a lid, transferring an amount of the high specific gravity cleaning liquid from an auxiliary tank into an agitation section of the cleaning tank whereby the volume of high specific gravity cleaning liquid is increased in the agitation section, thus raising the height of the low specific gravity liquid seal until it flows over a boundry wall between the agitation section and the auxiliary tank and into the auxiliary tank, continuing this transfer operation until all the low specific gravity fluid has been transferred to the auxiliary tank, starting agitation of the cleaning liquid in said cleaning tank and continuing the agitation until the cleaning of said parts is completed, stopping the agitation, pumping a portion of the high specific gravity cleaning liquid from the agitation section of said cleaning tank back into the auxiliary tank, thus raising the level of the low specific gravity liquid until a major portion of the low specific gravity liquid flows over the boundry wall and back into the agitation section of the cleaning tank, and removing the lid.

5. The method of claim 4, wherein the lid is hermetically sealed and abuts on the boundry wall between the agitation section and the auxiliary tank.

6. The method of cleaning parts in an agitated cleaning liquid, while maintaining the surface of said cleaning liquid away from exposure to the atmosphere, which comprises introducing cleaning liquid into a first zone, placing a sealing liquid over said cleaning liquid, said sealing liquid having a lower specific gravity than said cleaning liquid and being immiscible therewith, thus forming two separate liquid phases, placing parts to be cleaned in said cleaning liquid, covering said first zone, transferring said sealing liquid to a second auxiliary zone, agitating the cleaning liquid in said first zone and maintaining such agitation until said parts are clean, stopping agitation of said cleaning liquid, transferring said sealing liquid back to said first zone, uncovering said first zone, and removing said parts.

7. The method of cleaning parts in an agitated cleaning liquid, while maintaining the surface of said cleaning liquid away from exposure to the atmosphere, which comprises introducing cleaning liquid into a first zone, placing a sealing liquid over said cleaning liquid, said sealing liquid having a lower specific gravity than said cleaning liquid and being immiscible therewith, thus forming two separate liquid phases, introducing cleaning liquid into a second auxiliary zone adjacent said first zone, said first and second zones being separated by a common boundary wall, placing parts to be cleaned in the cleaning liquid in said first zone, covering the top of said first and second zones, transferring cleaning liquid from said second zone to said first zone, causing the level of the cleaning liquid in said first zone to rise and producing flow of sealing liquid over the top of said boundary wall and into said second zone, the amount of cleaning liquid transferred from said second zone to said first zone being sufficient to transfer substantially all of said sealing liquid to said second zone, agitating the cleaning liquid in said first zone and continuing agitation until cleaning of the parts is completed, stopping agitation, transferring cleaning liquid from said first zone to said second zone, causing the level of cleaning liquid in said second zone to rise and producing flow of sealing liquid over the top of said boundary wall and back into said first zone over the surface of said cleaning liquid therein, uncovering said first zone, and removing said parts.

8. The method as defined in claim 7, wherein the volume of the cleaning liquid employed is substantially greater than the volume of the sealing liquid.

9. Cleaning apparatus which comprises a cleaning tank, an auxiliary tank positioned in side-by-side relation to said cleaning tank, said auxiliary tank having a smaller volume than said cleaning tank, a solid partition separating said cleaning and auxiliary tanks, said partition extending from a position adjacent the upper end of each of said tanks to the bottom thereof, agitator means operatively associated with said cleaning tank, a cover positioned at the upper end of said tanks and closing said tanks, said cover abutting the upper end of said partition, means mounting said cover to permit vertical slidable movement thereof away from and toward the upper end of said partition, passage means providing fluid communication between the lower ends of said auxiliary and cleaning tanks, and valve means in said passage means, said valve means being operable for selectively permitting flow through said passage means in one direction from said auxiliary tank to said cleaning tank and in the opposite direction from said cleaning tank to said auxiliary tank.

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