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CLEANING SYSTEM AND METHOD FOR FLUID CONTAINERS

Field of Invention

The present invention relates to cleaning of fluid containers. In particular, the present
5 invention relates to a system and a method for cleaning and sterilizing fluid tanks.

Background

Water tanks are used for storing and supplying water to buildings, for example, high-
rise buildings. These water tanks are typically located on top of the buildings to allow
10 gravity-assisted delivery of water in these water tanks at sufficient pressure to
occupants of the buildings. To ensure that these water tanks are clean and free of
sediments, debris and algae, these water tanks require regular maintenance. Regular
maintenance of the water tanks therefore helps to ensure that the water delivered to
the occupants for purposes such as drinking or bathing is of acceptable quality.

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A common problem associated with cleaning and sterilizing water tanks is the
wastage of water arising from cleaning water tank walls. A conventional water tank
wall cleaning process, as shown in the steps of FIG. 1, requires draining of potable
water from water tanks through draining pipes of the water tank until the water in the
20 water tank reaches a level of 15 to 20 cm from the bottom of the water tank. To
prevent sludge or any debris from entering the draining pipes and other pipes
connected to the water tank, a strainer is affixed to the openings of each of the
draining pipes while the openings of all the other pipes connected to the water tank
are covered in a step 100 before draining commences. Debris and sludge are then
25 manually cleared from the inside surfaces of walls of the water tank in a step 102.

The inside surfaces of the walls of the water tank are cleaned using soft cleaning
implements, preferably soft plastic tools or soft brushes, in a step 104, to ensure that
the inside surfaces of the walls of the water tank are not scratched. The inside
30 surfaces of the walls of the water tank are then thoroughly washed and flushed using
water in a step 106 to substantially remove any remaining foreign particles that may
compromise the quality of water. This process is repeated in a step 108 if necessary



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until the water tank is free from any foreign particles. However, water that is used for flushing and washing the water tank during the water tank wall cleaning process is subsequently drained off as polluted water and therefore wasted.

- 5 Another common problem associated with cleaning and sterilizing water tanks is the elaborate procedures required during sterilization of water tanks thereby leading to unnecessary wastage of water. FIG. 2 shows a conventional water tank sterilization process wherein the water tank is again filled with water in a step 200. Sterilizing chemicals containing chlorine are then gradually introduced into the water tank in a
10 step 202 while the water tank is being filled with water in the step 200 to ensure thorough mixing thereof with the water in the water tank.

The general guideline for the amount of chemical to add to the water is preferably about 50 mg of free chlorine for each litre of water. Alternatively, ordinary bleaching
15 powder of 35% chlorine concentration with a proportion of preferably about 150 gm per 1000 litres of water may be used. Sodium hypochlorite with an equivalent concentration is also another alternative to the chlorine additive. In a step 204, the water tank is then filled to a predetermined overflow level with water containing the sterilizing chemicals. The water containing the sterilizing chemicals is then kept in
20 the water tank for a predetermined duration for sterilization of the water tank. The predetermined duration depends on the containment capacity of the water tank but is typically 24 hours.

During this period, the openings to all pipes connecting to or leading out from the
25 water tank are blocked to prevent the sterilizing chemicals contained in the water from entering the pipes leading to households as the mixture of sterilizing chemical and water may be unsafe for human consumption. After the predetermined duration, the mixture of water and sterilizing chemicals in the water tank is completely drained off. The water tank is then refilled with potable water in a step 206. In a step 208,
30 water samples are then drawn from the water contained in the water tank at a point of preferably 450 mm below the surface of the water in the water tank. The water

samples are then sent to an authorized laboratory for bacteriological and chemical analysis.

Depending on the results from the bacteriological and chemical analysis, different
5 courses of action are available and taken in a step 210. If the results are satisfactory,
the entire water tank is completely drained and refilled with potable water. However
if the results are unsatisfactory, the entire water tank is still drained off completely but
with the water tank sterilization process being again repeated thereafter. An
indication of how wasteful the water tank sterilization process is given by the fact that
10 for each time the water tank is completely drained, 500 m³ of water is discharged and
therefore wasted. In addition, after each repetition of the water tank sterilization
process, the water tank is again drained and refilled with potable water. The water
tank sterilization process may be repeated a few times. Each building typically has
six water tanks. Thus to service all the water tanks of each building, 9000 m³ of water
15 is wasted even if the water tank sterilization process is repeated only twice.

There is therefore a need for a method and a system for cleaning water tanks that
reduce water wastage compared to the conventional methods and systems for water
tanks cleaning.

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Summary

The present embodiment of the invention disclosed herein provides a system and a
method for cleaning fluid containers, or specifically, for cleaning water tanks for
containing water. Through the combined application of filtration and ozonation
25 processes, a water tank and water contained within the water tank are substantially
cleaned without excessive water wastage.

In accordance with a first aspect of the invention, there is disclosed a cleaning system
for fluid containers. The cleaning system comprises a processing channel being
30 configurable for fluid communicating with a container to thereby form a flow path
along the processing channel and a container. The container is used for containing
fluid. The cleaning system further comprises a drive assembly being integral with the

processing channel for transporting fluid through at least a portion of the flow path and a filtration assembly being integral with the processing channel for substantially filtering fluid being transported along at least a portion of the flow path. Additionally, the cleaning system comprises a sterilization assembly for cooperating with the processing channel for interacting with and thereby substantially sterilising fluid. The fluid is transported along at least a portion of the flow path.

In accordance with a second aspect of the invention, there is disclosed a cleaning method for fluid containers. The cleaning method comprises the steps of preparing a container for cleaning the container. The step of preparing the container comprises the step of configuring a processing channel for fluid communicating with the container to thereby form a flow path along the processing channel and the container. The container is used for containing fluid. The cleaning method further comprises the step of cleaning at least one of the container and fluid contained in the container. The step of cleaning at least one of the container and fluid contained in the container further comprises the steps of transporting fluid through at least a portion of the flow path by a drive assembly being integral with the processing channel and substantially filtering fluid being transported along at least a portion of the flow path by a filtration assembly being integral with the processing channel. Additionally, the step of cleaning at least one of the container and fluid contained in the container further comprises the step of substantially sterilising fluid transported along at least a portion of the flow path by a sterilization assembly interacting with at least a portion of the flow path.

Brief Description Of The Drawings

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

FIG. 1 shows a flowchart of a water tank wall cleaning process in a conventional water tank cleaning method;

FIG. 2 shows a flowchart of a water tank sterilization process following from the water tank wall cleaning process of FIG. 1;

FIG. 3 shows a system configuration of components of a cleaning system for water tanks for containing water according to an embodiment of the invention, the cleaning system being coupled to a water tank;

FIG. 4 shows a flowchart of a cleaning process for water tanks for containing water using the cleaning system of FIG. 3;

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FIG. 5 shows a flowchart of sub-steps of a water tank wall cleaning step in the cleaning method of FIG. 4;

FIG. 6 shows a system configuration of the components of the cleaning system of FIG. 3 with a cleaning person in the water tank;

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FIG. 7 shows a system configuration of the components of the cleaning system of FIG. 3 with the water tank being filled with water when being sterilised; and

FIG. 8 shows a flowchart of the sub-steps of a water tank sterilization step of the cleaning process of FIG. 4.

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Detailed Description

A cleaning method and a system therefor are described hereinafter for addressing the foregoing problems. Through the combined application of filtration and ozonation, an embodiment of the invention provides a system and a method for fluid containers, for example water tanks, to reduce water wastage through the reuse of water during cleaning of the fluid containers.

Embodiments of the invention described hereinafter are in accordance with Figs. 1 to 8 of the drawings, in which like elements are numbered with like reference numerals.

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A cleaning system 300, according to an embodiment of the invention, for cleaning a water tank 302 for containing water therein is described with reference to FIG 3. The water tank 302 typically has removable covers and is constructed from reinforced concrete or mild steel.

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The cleaning system 300 comprises a primary pump 304, a secondary pump 306, a sterilization assembly and a filtration assembly. The sterilization assembly comprises an ozone generator 308 for generating ozone (O_3). The sterilization assembly further comprises a venturi 309 for drawing ozone from the ozone generator 308 into fluid
10 flowing through the venturi 309. The ozone generator 308 is preferably a food-grade ozonator.

The primary pump 304, the secondary pump 306, the sterilization assembly, an intake conduit 310, an exhaust conduit 316 and the filtration assembly are inter-connected
15 for forming a processing channel. The processing channel controls and processes fluids flowing through it.

The cleaning system 300 further comprises the intake conduit 310 having a first end 312a and a second end 312b, and a particle strainer 314 fitted to the first end 312a of
20 the intake conduit 310. The second end 312b of the intake conduit 310 is coupled to an inlet of the primary pump 306. Each of the primary pump 304 and the secondary pump 306 is preferably a centrifugal pump or a displacement pump.

The intake conduit 310 is preferably decouplable from the primary pump 304 for
25 portability and stowability.

The particle strainer 314 prevents particles larger than a predetermined size from entering the intake conduit 310 from the water tank 302 as this may damage the primary pump 304 and the secondary pump 306. The primary pump 304 and the
30 secondary pump 306 form a drive assembly for transporting fluid through the processing channel. Each of the primary pump 304 and the secondary pump 306 is

preferably constructed from glass-reinforced thermoplastic, able to be self-primed and operable on an alternating current (AC) power supply.

5 The cleaning system 300 also further comprises the exhaust conduit 316 having a first end 318a coupled to an outlet of the venturi 309 of the sterilization assembly and a second end 318b coupled to a sprinkler manifold 322.

10 Together, the intake conduit 310 and the exhaust conduit 316 form two extremities of the processing channel, with each being structurally flexible. Once the processing channel is in fluid communication with the water tank 302, a flow path 323 is formed through the processing channel and the water tank 302 for fluid flow along the processing channel.

15 The filtration assembly preferably comprises a filtration system 324 having an inlet coupled using a conduit to an outlet of the primary pump 304. The filtration system 324 is preferably portable and has removable filters to facilitate filter replacement. The filtration system 324 substantially filters debris or any form of sediment from fluid passing therethrough.

20 An outlet of the filtration system 324 is further coupled using a conduit to an inlet of the secondary pump 306, which functions as a booster pump to ensure sufficient fluid pressure is maintained within the processing channel. An outlet of the secondary pump 306 is in turn coupled to the ozone generator 308 via an inlet of the venturi 309. The venturi 309 also positionally couples the secondary pump 306 and the exhaust
25 conduit 316.

The venturi 309 is shaped and dimensioned to draw a predetermined amount of ozone (O_3) generated by the ozone generator 308 and inject the ozone into the fluid flowing through the feed of the venturi 309 to thereby provide sterilized water at the outlet of
30 the venturi 309, which is coupled to the exhaust conduit. The sterilized water then flows through the exhaust conduit 316 and is discharged into the water tank 302 via the sprinkler manifold 322.

The sprinkler manifold 322 enables the sterilized water to be dispersed substantially evenly throughout the water tank 302. This facilitates even mixing of the sterilized water with and improved oxidation of water already contained in the water tank 302.

5 With reference to FIG 4, which shows a flowchart of a water tank cleaning method 400 according to an alternative embodiment of the invention, water supply valves (not shown) for controlling water supply to the water tank 302 are turned off in a step 402 to stop the supply of water to the water tank 302.

10 The water tank 302 is then drained to a level of 15 to 20 cm from the bottom of the water tank 302 to allow workers safe access into the water tank 302. As the water tank 302 is substantially covered, the only access into the water tank 302 is through an opening that is covered by water tank covers (not shown). Therefore, the water tank covers are unbolted and opened up in a step 404.

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With the water tank covers opened, a visual inspection is performed on the water tank 302 to assess additional repair work that is required prior to cleaning thereof. Any defective water installations and fittings in the water tank 302 are replaced in a step 406 if they are found to be faulty. Water installations and fittings include overflow
20 pipes, washout pipes, distribution mains, gate valves, sluice valves, ball valves and floats, leaking joints of mains/water tanks and other devices typically used with water tanks.

When the repair work is completed in the step 406, the inside surfaces of the walls of
25 the water tank 302 are cleaned in a step 408. However, before cleaning the inside surfaces of the walls of the water tank 302, openings of pipes connected to the water tank 302 must be properly plugged with preferably rubber plugs and covered up with cloth in a step 500 with reference to the flowchart of FIG 5, to prevent scrap or washed sediments from being deposited in the pipes.

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Next, the cleaning system 300 is coupled to the water tank 302 in a step 407. When coupling the cleaning system 300 to the water tank 302, the first end 312a of the

intake conduit 310, with the particle strainer 314 attached, is inserted into the water tank 302 and disposed in substantial proximity to the bottom of the water tank 302. The exhaust conduit 316 is also inserted into the water tank 302 but with the sprinkler manifold 322 being disposed in substantial proximity to the top of the water tank 302.

5 It is preferred that the particle strainer 314 and the sprinkler manifold 322 be spaced substantially apart. The coupling of the cleaning system 300 to the water tank 302 enables the flow path 323 to be formed along the processing channel and the water tank 302.

10 With reference to FIG 6, the inside surfaces of the walls of the water tank 302 are washed and cleaned by spraying the inside surfaces of the walls of the water tank 302 with a pressurized water jet from a fluid-jet cleaning gun 602 in a step 502. The fluid-jet cleaning gun 602 is preferably operated by a cleaning person 604 who has been self-disposed within the water tank 302.

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During cleaning of the inside surfaces of the walls of the water tank 302 in the step 408, a circulating pump (not shown) is positioned inside the water tank 302 to substantially remove debris and any other form of sediments by vacuum suction. Simultaneously, the water in the water tank 302, which has previously been drained to
20 a pre-determined level to allow the cleaning person 604 safe access into the water tank 302, is drawn into the cleaning system 300 to undergo filtration and sterilization when being passed through the processing channel of the cleaning system 300 in a step 504. This is repeated when the water flowing along the flow path 323, undergoes circulation through the processing channel of the cleaning system 300. This ensures
25 that the water in the water tank 302 is maintained substantially clean during cleaning of the inside surfaces of the walls of the water tank 302 in the step 408 through water reuse and which therefore leads to substantially reduced water wastage. Once the inside surfaces of the walls of the water tank 302 are substantially cleaned in a step 506, circulation of the water through the processing channel of the cleaning system
30 300 stops.

If painting of the inside surfaces of the walls of the water tank is required after cleaning, the inside surfaces of the walls of the water tank 302 are dried preferably using a cloth before painting thereof commences in a step 410.

5 After the inside surfaces of the walls of the water tank 302 have been cleaned in the step 408, and painted if necessary in the step 410, the water tank 302 undergoes a sterilization step 412. With reference to FIG. 7 and FIG. 8, the water tank 302 is fully filled with water in a step 800. Once the water tank 302 has been filled with water, the water in the water tank 302 undergoes circulation through the processing channel
10 of the cleaning system 300 along the flow path 323.

When processed by flowing through the processing channel of the cleaning system 300, the water undergoes filtration by the filtration assembly in a step 804, followed by sterilization by the sterilization assembly in a step 806. Depending on the capacity
15 of the water tank 302, the water in the water tank 302 is circulated preferably four times through the processing channel of the cleaning system 300 before stopping in a step 810. The water that has been substantially ozonated by the sterilization assembly when being circulated through the processing channel of the cleaning system 300 is subsequently discharged from the processing channel of the cleaning system 300 into
20 the water tank 302 to substantially sterilise the water tank 302 when coming into contact therewith.

Water samples (not shown) are then taken from the water tank 302 in a step 812 for bacteriological and chemical analysis by an approved water pathology center. If the
25 bacteriological and chemical shows that the water samples do not meet a predetermined standard, the sterilization step 412 is repeated and water samples again taken thereafter for reanalysis. Following the sterilization step 412, the cleaning system 300, specifically the intake conduit 310 and the exhaust conduit 316 are decoupled from the water tank 302 before the tank covers of the water tank 302 are
30 closed in a step 414.

In the foregoing manner, a cleaning system and a cleaning method for water tanks for containing liquids generator are disclosed for addressing the foregoing disadvantages of conventional water tank cleaning approaches. Although a number of embodiments of the invention are disclosed, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made without departing from the scope and spirit of the invention.

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Claims

1. A cleaning system for cleaning fluid containers, the cleaning system comprising:
 - a processing channel comprising:
 - an intake;
 - an exhaust, at least one of the intake and the exhaust being configurable with a container to thereby provide a flow path through the processing channel and the container, the container for containing fluid therein;
 - a drive assembly for transporting fluid along at least a portion of the flow path;
 - a filtration assembly for substantially filtering fluid being transported along at least a portion of the flow path; and
 - a sterilization assembly for interacting with and thereby substantially sterilising fluid being transported along at least a portion of the flow path.
2. The cleaning system as in claim 1, the intake being configurable for interacting with and receiving fluid contained in the container into the processing channel.
3. The cleaning system as in claim 2, the intake being a structurally manipulatable conduit being one of couplable to and insertable into the container for fluid communicating therewith.
4. The cleaning system as in claim 2, the intake having a particle strainer being couplable thereto.
5. The cleaning system as in claim 1, the exhaust being structurally manipulatable and configurable for discharging fluid transported through the processing channel into the container.
6. The cleaning system as in claim 5, the processing channel comprising:

a sprinkler manifold couplable to the exhaust for dispersing the fluid discharged therefrom into the container.

7. The cleaning system as in claim 1, the processing channel comprising:
at least one connector for interconnecting at least two of the drive
5 assembly, the sterilisation assembly and the filtration assembly.
8. The cleaning system as in claim 1, the drive assembly comprising:
at least one of a fluid pump, a drive pump and a centrifugal pump.
- 10 9. The cleaning system as in claim 1, the drive assembly being one manually
powered and motorised.
10. The cleaning system as in claim 1, the sterilization assembly comprising:
an ozonator for generating ozone (O₃) for delivery into the fluid
15 flowing along the flow path.
11. The cleaning system as in claim 10, the sterilization assembly further
comprising:
a venturi for coupling the ozonator to the processing channel,
20 wherein fluid flow through the venturi draws ozone generated by the
ozonator thereinto for the substantial sterilization thereof.
12. The cleaning system as in claim 1, the filtration assembly comprising:
at least one replaceable filter.
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13. The cleaning system as in claim 1, the drive assembly comprising:
a first fluid pump,
wherein the filtration assembly is positionally disposed between the
first fluid pump and the sterilization assembly along the flow path.
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14. The cleaning system as in claim 13, the drive assembly further comprising:
a second fluid pump,

wherein the second fluid pump is positionally disposed between the sterilization assembly and the filtration assembly along the flow path.

15. The cleaning system as in claim 1, the container being a water tank for
5 containing water.
16. A cleaning method for containers for containing fluids, the cleaning method comprising the steps of:
- 10 preparing a container for cleaning thereof comprising the steps of:
- providing a processing channel comprising an intake and an exhaust; and
- 15 configuring at least one of the intake and exhaust with the container to thereby provide a flow path through the processing channel and the container, the container for containing fluid therein; and
- cleaning at least one of the container and fluid contained in the container comprising the steps of:
- 20 transporting fluid along at least a portion of the flow path by a drive assembly being integral with the processing channel;
- substantially filtering fluid being transported along at least a portion of the flow path by a filtration assembly being integral with the processing channel; and
- 25 substantially sterilising fluid being transported along at least a portion of the flow path by a sterilization assembly being integral therewith.
17. The cleaning method as in claim 16, the step of preparing the container for cleaning thereof further comprising the steps of:
- 30 removing at least a portion of fluid contained in the container, at least a portion of the container being formed by a plurality of walls; and
- cleaning at least one of the plurality of walls.

18. The cleaning method as in claim 17, the step of cleaning at least one of the plurality of walls comprising the step of:
discharging at least a fluid stream onto at least one of the plurality of walls.
- 5 19. The cleaning method as in claim 16, the step of preparing the container for cleaning thereof further comprising the steps of:
filling at least a portion of the container with fluid.
- 10 20. The cleaning method as in claim 16, wherein the step of configuring at least one of the intake and the exhaust comprises:
structurally configuring the intake for interacting with and receiving fluid contained in the container into the processing channel.
- 15 21. The cleaning method as in claim 20, the step of providing the processing channel with an intake comprising the step of:
providing the processing channel with a structurally manipulatable conduit being one of couplable to and insertable into the container for fluid communicating therewith.
- 20 22. The cleaning method as in claim 20, the step of providing the processing channel with an intake comprising the step of:
coupling a particle strainer to the intake.
- 25 23. The cleaning method as in claim 16, wherein the step of configuring at least one of the intake and the exhaust comprises:
configuring a structurally manipulatable exhaust for discharging fluid transported through the processing channel into the container.
- 30 24. The cleaning method as in claim 23, the step of providing the processing channel with a structurally manipulatable exhaust comprising the step of:
providing the exhaust with a sprinkler manifold coupled thereto for dispersing the fluid discharged therefrom into the container.

25. The cleaning method as in claim 16, the step of configuring a processing channel for fluid communicating with the container comprising the step of:
 providing at least one connector for interconnecting at least two of the drive assembly, the sterilisation assembly and the filtration assembly.
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26. The cleaning method as in claim 16, the step of transporting fluid along at least a portion of the flow path by a drive assembly comprising the step of:
 transporting fluid along at least a portion of the flow path by at least one of a fluid pump, a displacement pump and a centrifugal pump.
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27. The cleaning method as in claim 16, the step of transporting fluid along at least a portion of the flow path by a drive assembly comprising the step of:
 transporting fluid along at least a portion of the flow path by a drive assembly being one manually powered and motorised.
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28. The cleaning method as in claim 16, the step of substantially sterilising fluid being transported along at least a portion of the flow path by a sterilization assembly comprising the step of:
 providing the sterilization assembly with an ozonator for generating ozone (O₃) for delivery into the fluid flowing along the flow path.
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29. The cleaning method as in claim 16, the step of substantially sterilising fluid being transported along at least a portion of the flow path by a sterilization assembly further comprising the step of:
 providing a venturi for coupling the ozonator to the processing channel,
 wherein fluid flow through the venturi draws ozone generated by the ozonator thereinto for the substantial sterilization thereof.
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30. The cleaning method as in claim 29, the step of substantially filtering fluid being transported along at least a portion of the flow path by a filtration assembly comprising the step of:
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providing the filtration assembly with at least one replaceable filter.

31. The cleaning method as in claim 16, the step of configuring a processing channel for fluid communicating with the container comprising the steps of:
5 providing the drive assembly with a first fluid pump; and
 positionally disposing the filtration assembly between the first fluid pump and the sterilization assembly along the flow path.
32. The cleaning method as in claim 16, the step of configuring a processing channel for fluid communicating with the container further comprising the
10 steps of:
 providing the drive assembly with a second fluid pump; and
 positionally disposing the second fluid pump between the sterilization assembly and the filtration assembly along the flow path.
- 15 33. The cleaning method as in claim 16, further comprising the step of:
 analysing at least one of the sterility and cleanliness of the fluid contained in the container at least one of in tandem with and following the step of cleaning at least one of the container and fluid contained in the container.
- 20 34. The cleaning method as in claim 33, further comprising the step of:
 repeating the step of cleaning at least one of the container and fluid contained in the container.
- 25 35. A cleaning system for cleaning fluid containers, the cleaning system comprising:
 a processing channel being structurally configurable for fluid communicating with a container to thereby provide a flow path through the processing channel and the container, the container for containing fluid therein, the processing channel comprising:
30 a drive assembly for transporting fluid along at least a portion of the flow path;

a filtration assembly for substantially filtering fluid being transported along at least a portion of the flow path; and

a sterilization assembly for interacting with and thereby substantially sterilising fluid being transported along at least a portion of the flow path.

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