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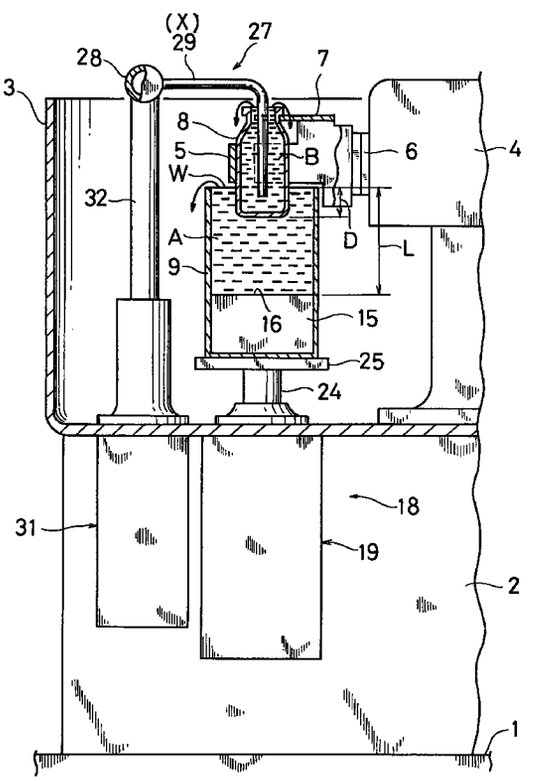
(54) Apparatus and process for ultrasonic cleaning

(57) When a bottle (8) to be conveyed horizontally by a holder (7) is moved to a position above a cleaning tank (9) for storing a first cleaning water (A), the bottle (8) is stopped for a certain period of time. Under this stopped state, a second cleaning water (B) is poured into the bottle (8) as well as the cleaning tank (9) is raised and lowered. While a bottom portion of the bottle (8) is immersed into the first cleaning water (A), an inner surface of the bottle (8) is cleaned by ultrasonic radiated from an ultrasonic transducer (15). Foreign materials peeled off from the inner surface of the bottle (8) are discharged to the outside thereof by the poured second cleaning water (B).

FIG.3



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and a process for ultrasonically cleaning a container such as an ampul and a bottle.

2. Description of Prior Art

Conventionally, when ultrasonically cleaning such a container, the container to be cleaned is immersed entirely into a cleaning water stored within a cleaning tank and the ultrasonic is radiated to the immersed container.

When explaining it more in detail, it is understood that the ultrasonic cleaning peels off stains from a surface of the container by an effect of a high pressure generated at the time of collapse of bubbles which have been produced at a contact portion between the container surface and the cleaning water by the ultrasonic. Therefore, the cleaning is advantageous because stains adhering to fine gaps can be removed in a short time by that cavitation effect.

Incidentally, the container such as an ampul and a bottle is generally required to be cleaned satisfactorily in its inner surface rather than in its outer surface.

In the above-mentioned prior art, however, since the cavitation is first generated in the outer surface of the container to be cleaned, the ultrasonic tends to attenuate there and the interior of the container can't be cleaned satisfactorily.

For solving this problem, it can be supposed to intensify the ultrasonic to be radiated to the container. In this case, however, it is apprehended that an outlook of the container becomes worse because an outer surface of the container is damaged by an excessive cavitation effect caused by that intensified ultrasonic.

SUMMARY OF THE INVENTION

It is an object of the present invention to enable the satisfactory cleaning of an inner surface of a container to be compatible with the maintaining of a good outlook of the container.

An apparatus for accomplishing the above-mentioned object has the following construction as described in claim 1.

For example, as shown in Fig. 1 to Fig. 3, an ultrasonic transducer 15 is disposed in a cleaning tank 9 for storing a first cleaning water A, a conveying means 7 is adapted to bring a container 8 to be cleaned into and out of a position above the transducer 15, a water supplying means 27 for supplying a second cleaning water B into the container 8 is arranged, a lifting mechanism 19 for raising and lowering the cleaning tank 9 is arranged, and a bottom portion of the container 8 is immersed into the first cleaning water A by the lifting mechanism 19.

Incidentally, the first cleaning water A and the second cleaning water B may be the same water or waters having different physical properties.

A process for accomplishing the above-mentioned object has the following steps as described in claim 5.

For example, as shown in Fig. 1 to Fig. 3, the process includes the steps of: bringing in a container 8 to be cleaned to a position above a cleaning tank 9 for storing a first cleaning water A; supplying a second cleaning water B into the container 8, immersing a bottom portion of the container 8 into the first cleaning water A by raising the cleaning tank 9 by means of a lifting mechanism 19, and radiating an ultrasonic to the immersed container 8; cancelling the immersed state of the container 8 by lowering the cleaning tank 9 by means of the lifting mechanism 19; and bringing out the container 8 from the position above the cleaning tank 9.

The above-mentioned apparatus or process can have the following advantages.

The ultrasonic radiated from the ultrasonic transducer is propagated to the bottom portion of the container through the first cleaning water and propagated from the bottom portion to the second cleaning water within the container to generate cavitation at a contact portion between the second cleaning water and the inner surface of the container. Thereby, the inner surface of the container can be cleaned. At the time of that cleaning, since only the bottom portion of the container is immersed into the first cleaning water, an attenuation degree of the ultrasonic at the contact portion between the first cleaning water and the outer surface of the container is small. Therefore, a necessary amount of the ultrasonic reaches the second cleaning water within the container, so that it becomes possible to clean the inner surface of the container efficiently and satisfactorily.

Additionally, when obtaining the above-mentioned advantages, since it is unnecessary to intensify the ultrasonic radiated from the transducer, it becomes possible to prevent the outer surface of the container from being damaged by the cavitation and to maintain a good outlook of the container.

Further, since it becomes unnecessary to raise and lower the container because the cleaning tank is raised and lowered, a mechanism for conveying the container can be made simple. Accordingly, when automatically cleaning a large number of the containers, it becomes possible to remarkably reduce a manufacturing cost of the conveying mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 to Fig. 3 show an embodiment of the present invention;

Fig. 1 is a plan view of an ultrasonic cleaner;

Fig. 2 is an elevational schematic view taken along the II-II directed line in Fig. 1; and

Fig. 3 shows a condition in which a bottle is ultra-

sonically cleaned and is a view corresponding to Fig. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

One embodiment of the present invention will be explained with reference to Fig. 1 to Fig. 3.

First, a schematic construction of an ultrasonic cleaner will be explained with reference to a plan view of Fig. 1 and an elevational view of Fig. 2.

The symbol 1 designates a cleaner main body, and a basin-like casing 3 is supported by an upper surface of the cleaner main body 1 through a frame 2. A turret 4 and a guiding outer ring 5 are disposed concentrically in the casing 3. Six arms 6 are projected horizontally from an outer periphery of the turret 4, and a conveying holder (a conveying means) 7 is supported by each arm 6 respectively. The holder 7 is so constructed as to hold three bottles (containers to be cleaned) 8 and is rotated clockwise (in the plan view) intermittently at a predetermined angle. A cleaning tank 9 is arranged at a peripheral portion of the casing 3 and below the outer ring 5.

The bottles 8 are conveyed by the following procedures as indicated by the alternate long and two short dashes line in Fig. 1.

The plurality of bottles 8 are brought into a first guide 11 from a hopper (not illustrated) in the state of ordinary postures with the bottle openings kept upward and supplied to the holders 7 by a first star wheel 21. First, the holders 7 are rotated clockwise by the arms 6 and stopped at a position above the cleaning tank 9 for a certain period of time. The bottles 8 held by the holder 7 are ultrasonically cleaned with the cleaning water poured into them by a water supplying means 27 which will be explained later. Then, while being rotated clockwise by the arm 6, the holder 7 which has finished the ultrasonic cleaning is turned over vertically by the arm 6. Thereby, the bottles 8 are made to take inverted postures, so that the cleaning water having been poured into the bottles 8 is discharged. Incidentally, the openings of the inverted bottles 8 are illustrated by the broken line.

Subsequently, a cleaning water for the final rinse is sprayed against the inverted bottles 8 from below, so that foreign materials having large specific gravities and adhering to the inner surfaces of the bottom portions of the bottles 8 are discharged outside. After that, the inverted bottles 8 are drained off by being blown with a clean compressed air. Next, the holder 7 is turned over to its original posture while being rotated clockwise, so that the inverted bottles 8 can be restored to its ordinary posture, Subsequently, the bottles 8 are taken out of the holder 7 by a second star wheel 22 to be sent out to a second guide 12 and then are sent out to the next process such as drying-up, sterilization and so on.

Incidentally, a triangular third guide 13 is arranged between the two star wheels 21, 22.

Next, a detail construction of the ultrasonic cleaner will be explained with reference to Figs. 2 and 3.

An ultrasonic transducer 15 is arranged at a bottom portion within the cleaning tank 9. A distance L between a horizontal vibratory surface 16 of the transducer 15 and a water surface W of a first cleaning water A stored within the cleaning tank 9 is set to almost the same value as that obtained by multiplying by an odd number a quarter of the wave length of the ultrasonic radiated from the vibratory surface 16.

When explaining it more concretely, in this embodiment, the distance L is set to about 40 mm and a frequency (f) of the ultrasonic radiated from the transducer 15 is set to 28 KHz. Incidentally, a sound velocity (C) in the water is about 1500000 mm/sec.

In this case, the wave length (λ) of the ultrasonic in the first cleaning water A is defined by $\lambda = C/f = 1500000/28000 = 53.57$ mm. Therefore, the value obtained by multiplying by the odd number (herein, 3 times) a quarter of the wave length (λ) is defined by 53.57 mm $\times$ (1/4) $\times$ 3 = 40.18 mm $\fallingdotseq$ L (40 mm).

Accordingly, when the transmission frequency of a transmitter (not illustrated) connected to the transducer 15 is tuned to the 28 KHz, the ultrasonic radiated from the vibratory surface 16 is reflected by the water surface W in the maximum displaced condition, so that the interior of the cleaning tank 9 can be maintained in a resonance condition (a standing wave condition).

There is also provided an immersing means 18 for immersing the bottom portions of the bottles 8 into the first cleaning water A. The immersing means 18 is equipped with a lifting mechanism 19 for raising and lowering the cleaning tank 9. The lifting mechanism 19 is adapted to raise and lower a rod 24 (refer to Fig. 3) by a cam rotated by an electric motor (either of which is not illustrated). When a base plate 25 fixedly secured to the rod 24 is raised, as shown in Fig. 3, the bottom portions of the bottles 8 are immersed below the water surface W of the first cleaning water A by a depth D. It is preferable to set that immersion depth D to a value of at least a quarter (herein, 53.57 mm $\times$ (1/4) = about 14 mm) of the wave length of the ultrasonic.

Further, there is provided a water supplying means 27 for supplying a second cleaning water B into the bottles 8. The water supplying means 27 includes a water supplying header 28 arranged above the cleaning tank 9 and three nozzles 29 projected from the header 28 as shown in Fig. 1. The second cleaning water B can be supplied to the respective bottles 8 by the respective nozzles 29.

A rod 32 of another lifting mechanism (a switching means) 31 is connected to the header 28. Also in this another lifting mechanism 31, the rod 32 is raised and lowered by a cam rotated by an electric motor (either of which is not illustrated). As shown in Fig. 3, when the rod 32 is lowered, the nozzles 29 are inserted into the bottles 8 and switched over to its lowered position X. Further, as shown in Fig. 2, when the rod 32 is raised, the nozzles 29 are taken out from the bottles 8 and switched over to its raised position Y.

The above-mentioned ultrasonic cleaner operates as follows.

While the cleaner is operating, as shown in Fig. 2, the ultrasonic is always radiated from the transducer 15 within the cleaning tank 9 adjusted to a resonance water stage.

Under the resonance condition illustrated in Fig. 2, first the bottles 8 are brought to the position above the cleaning tank 9 by the holder 7 and stopped there.

Subsequently, the cleaning tank 9 is raised by the base plate 25 so that the bottom portions of the bottles 8 start to be immersed into the first cleaning water A. Almost simultaneously with that, the nozzles 29 are lowered pouring the second cleaning water into the bottles 8.

Then, as shown in Fig. 3, when the cleaning tank 9 is moved to its raised position as well as the nozzles 29 are moved to the lowered position X, now the cleaning tank 9 starts to be lowered. Almost simultaneously with that, the nozzles 29 are raised. Thereby, as shown in Fig. 2, the cleaning tank 9 is restored to its lowered position as well as the nozzles 29 are restored to the raised position Y.

After that, the cleaned bottles 8 are brought out from the position above the cleaning tank 9 by rotating the holder 7 horizontally. Thereby, one cycle of the ultrasonic cleaning is finished and new bottles 8 are brought into the position above the cleaning tank 9.

While the bottom portions of the bottles 8 are immersed into the first cleaning water A, the ultrasonic of the transducer 15 is propagated to the bottom portions of the bottles 8 through the first cleaning water A and to the second cleaning water B within the bottles 8 from the bottom portions thereof, so that cavitation is generated at contact portions between the second cleaning water B and the bottle inner surfaces. Since those bottles 8 are immersed into the first cleaning water A only at their bottom portions, an attenuation degree of the ultrasonic at the contact portion between the first cleaning water A and the bottle outer surfaces is small. Therefore, a necessary amount of the ultrasonic reaches the second cleaning water B so that the inner surface of the bottle 8 can be cleaned efficiently and satisfactorily.

Thereupon, since the resonance is caused between the vibratory surface 16 of the transducer 15 and the water surface W of the first cleaning water A by setting the distance L to almost the same value as that obtained by multiplying by the odd number the quarter of the wave length of the ultrasonic, it is possible to radiate the ultrasonic of required strength by the transducer 15 of a small capacity.

Further, since it becomes unnecessary to raise and lower the bottles 8 because the cleaning tank 9 is raised and lowered, a mechanism for conveying the bottles 8 can be simplified. Accordingly, when a large number of bottles 8 are cleaned automatically, a manufacturing cost of the conveying mechanism can be reduced significantly.

By the way, in the cleaning tank 9 adjusted to the resonance water stage, since a distribution of strong and weak portions of a sound pressure is spread horizontally at an interval of a half wave length of the ultrasonic, the bottle 8 is apt to be subjected horizontally to a band-like cleaning unevenness. According to the present invention, however, since the ultrasonic cleaning is carried out while the cleaning tank 9 is being moved vertically relative to the bottles 8, the cleaning unevenness can be prevented and the outlook of the bottle 8 can be improved.

Further, during the ultrasonic cleaning, the foreign materials peeled off from the inner surface of the bottle 8 are discharged to the water surface W of the first cleaning water A by the poured second cleaning water B and then discharged outside the cleaning tank 9 from there. Therefore, also a construction for discharging the peeled off foreign materials is simple and inexpensive.

Incidentally, though the same kind of water can be used for the first cleaning water A and the second cleaning water B, waters having different physical properties may be used. For example, when a deaerated high- tension water is used as the first cleaning water A into which the bottom portions of the bottles 8 are immersed, it becomes possible to restrain the generation of cavitation by the ultrasonic. Thereby, the outer surface of the bottle 8 can be prevented more surely from being damaged. It can be supposed that the deaerated water is prepared by deaerating a water previously, deaerating the circulating water within the cleaning tank 9 by means of the ultrasonic, or the likes. When a low-tension water into which air is dissolved is used as the second cleaning water B to be poured into the bottle 8, the generation of the cavitation can be enhanced. Thereby, the inner surface of the bottle 8 can be cleaned more efficiently,

It is most preferable to set the distance L to almost the same value as that obtained by multiplying by the odd number the quarter of the wave length of the ultrasonic radiated from the ultrasonic transducer 15. But, instead of this, it may be set to almost the same value obtained by multiplying by an even number the quarter of that wave length, Further, it is not essential to set the water surface W of the first cleaning water A to the resonance water stage. Therefore, there is no problem if the distance L is set even to a value obtained by multiplying the quarter of the wave length of the ultrasonic by a decimal fraction.

As the lifting mechanism 19 and another lifting mechanism 31, it is possible to use such ones as to employ other kinds of actuators such as a servomotor, a pneumatic cylinder with a speed controller and the likes instead of the assembly of the electric motor and the cam.

The lifting mechanism 19 may be such a one as to raise the cleaning tank 9 immediately from the lowered position or as to stop it at its lowered position for a certain period of time. Another lifting mechanism 31 is sufficient if it switches over the nozzle 29 between at least

two positions, namely one being the lowered position X and the other being the raised position Y. Further it may be such a one as to intermittently raise and lower the nozzle 29 instead of the one to continuously raise and lower it.

As a means for driving the conveying holder 7, a trolley conveyer may be employed instead of the turret 4.

Claims

1. An ultrasonic cleaner having an ultrasonic transducer (15) disposed in a cleaning tank (9) for storing a first cleaning water (A) and a conveying means (7) for bringing a container (8) to be cleaned, into and out of a position above the transducer (15),

   characterized in that there are further provided a water supplying means (27) for supplying a second cleaning water (B) into the container (8), and a lifting mechanism (19) for raising and lowering the cleaning tank (9), a bottom portion of the container (8) being immersed into the first cleaning water (A) by the lifting mechanism (19).

2. An ultrasonic cleaner as set forth in claim 1, wherein a distance (L) between a water surface (W) of the first cleaning water (A) within the cleaning tank (9) and a vibratory surface (16) of the ultrasonic transducer (15) is set to substantially the same value as that obtained by integrally multiplying a quarter of a wave length of the ultrasonic radiated from the vibratory surface (16), and

   a depth (D) of a bottom portion of the container (8) to be immersed into the first cleaning water (A) is set to at least a quarter of the wave length of the ultrasonic.

3. An ultrasonic cleaner as set forth in claim 2, wherein the distance (L) is set to substantially the same value as that obtained by multiplying by an odd number a quarter of the wave length of the ultrasonic radiated from the vibratory surface (16).

4. An ultrasonic cleaner as set forth in any one of claim 1 to claim 3, wherein the water supplying means (27) is provided with a nozzle (29) for pouring the second cleaning water (B) into the container (8), and the nozzle (29) is disposed above the cleaning tank (9), and

   the nozzle (29) is switched over by a switching means (31) to at least two positions, one being a lowered position (X) where the nozzle (29) is inserted in the container (8) and the other being a raised position (Y) where the nozzle (29) is taken out of the container (8).

5. A process for ultrasonic cleaning comprising the steps of:

   bringing in a container (8) to be cleaned to a position above a cleaning tank (9) for storing a first cleaning water (A);
   supplying a second cleaning water (B) into the container (8), immersing a bottom portion of the container (8) into the first cleaning water (A) by rasing the cleaning tank (9) by means of a lifting mechanism (19) and radiating an ultrasonic to the immersed container (8);
   cancelling the immersed state of the container (8) by lowering the cleaning tank (9) by means of the lifting meachanism (19), and
   thereafter, bringing out the container (8) from the position above the cleaning tank (9).

6. A process as set forth in claim 5, further comprising the steps of:

   lowering a nozzle (29) arranged above the cleaning tank (9) by a switching means (31) so as to be inserted in the container (8);
   pouring the second cleaning water (B) into the container (8) from the nozzle (29), carrying out the ultrasonic cleaning by an ultrasonic transducer (15) under the above-mentioned condition, and discharging foreign material peeled off by the ultrasonic cleaning to the outside of the container (8) by the poured second cleaning water (B); and
   thereafter, taking out the nozzle (29) from the container (8) by the switching means (31).

FIG. 1

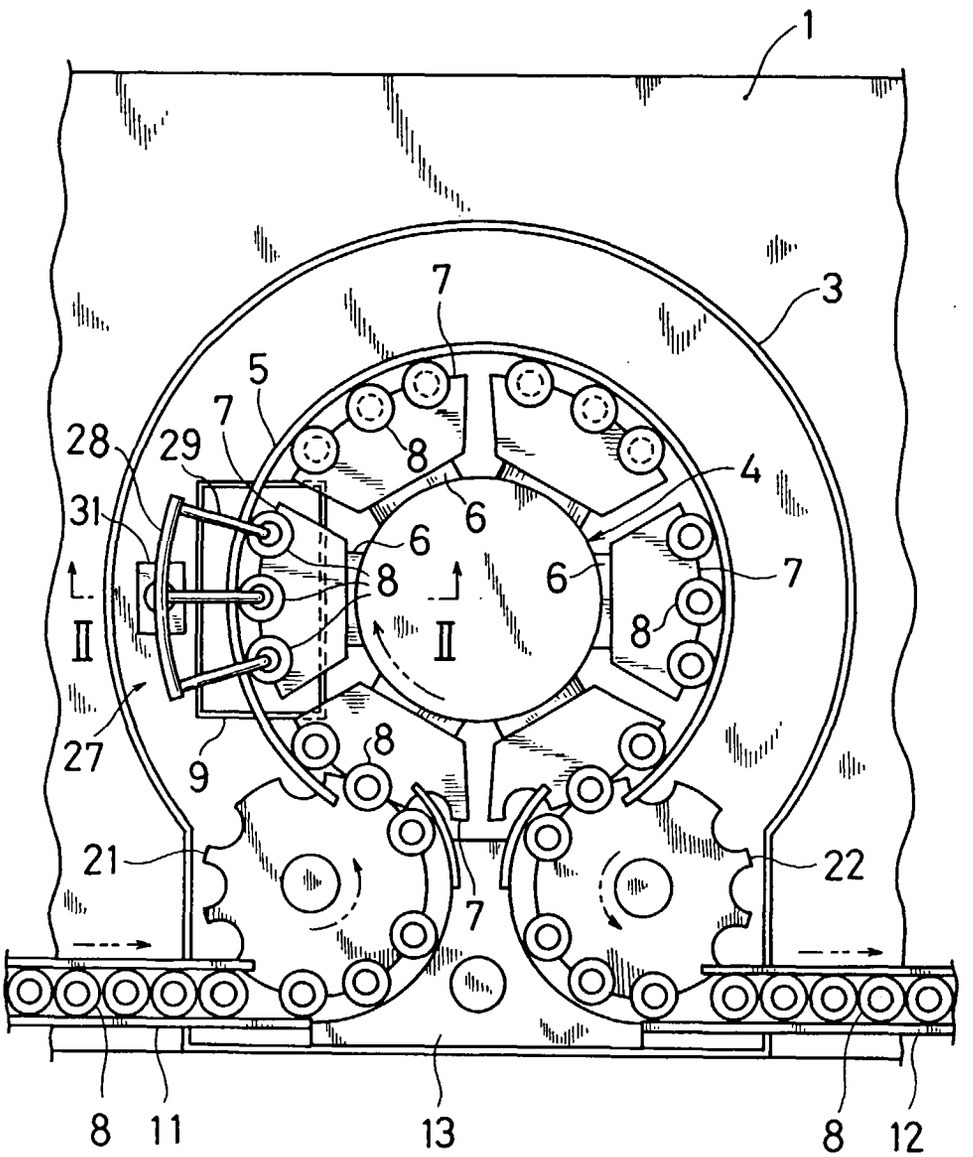

FIG. 2

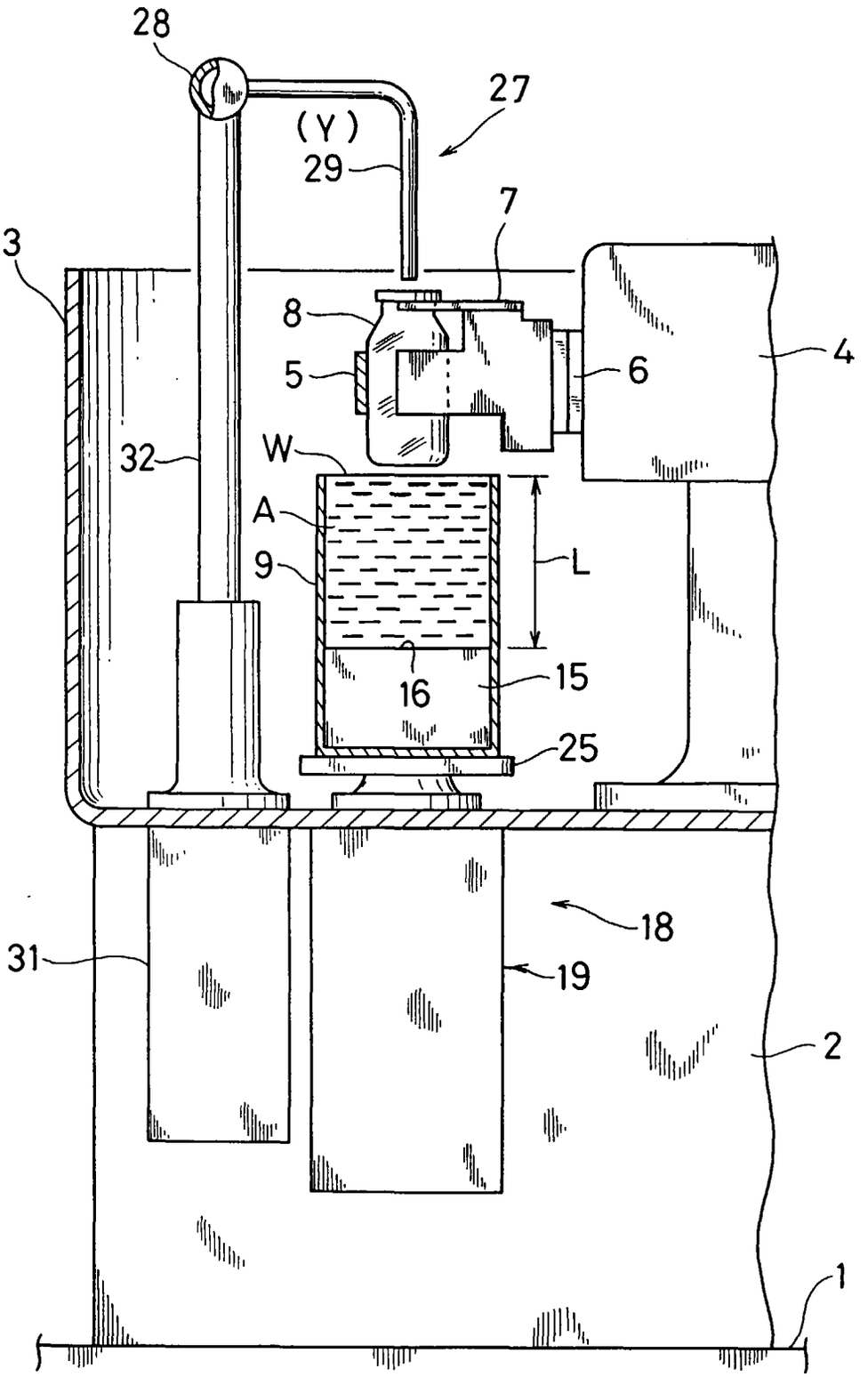

FIG.3