

(19)



(11)

EP 2 634 435 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

04.09.2013 Bulletin 2013/36

(51) Int Cl.:

F04F 10/02 (2006.01)
B65D 83/00 (2006.01)

B65D 25/20 (2006.01)

(21) Application number: **11836196.3**

(86) International application number:

PCT/JP2011/074406

(22) Date of filing: **24.10.2011**

(87) International publication number:

WO 2012/057062 (03.05.2012 Gazette 2012/18)

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

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(30) Priority: **28.10.2010 JP 2010242076**

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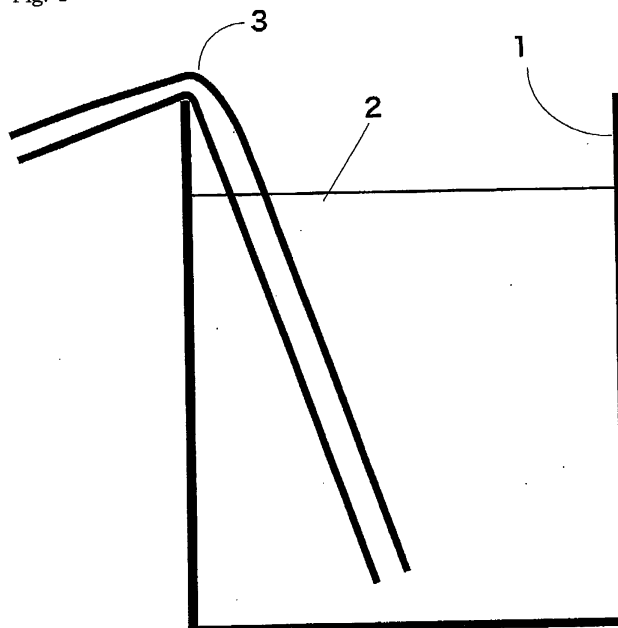
(54) **SIPHON TUBE**

(57) [Object] Although the take-out of liquid from a container by means of syphon tube has a merit of requiring no special structure on the container, activation of syphon is complex, on the contrary. Location of a valve or like in a liquid take-out path for easy activation damages possibility of realization of compact or downsized

structure, and increases risk of trouble.

[Achieving Means] With a shape of a bent portion of a syphon tube, by adopting a dimension between inner wall portions excellent in capillary effect, there can provide a structure capable of activating syphon only by inclining a container with minimal configuration without locating any movable member.

Fig. 1



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Description

Technical Field

5 **[0001]** The present invention relates to syphon tube for taking out liquid from a container.

Background Technology

10 **[0002]** The principle of siphon has been utilized from old days for delivering or transporting liquid in civil engineering work, water-control engineering work, various factory equipments, domestic appliance, and so on.

[0003] A method of taking out liquid from a container or vessel using a syphon tube is excellent in the following points in a relatively small-scale system in comparison with a method of taking out liquid using take-out port and water faucet provided at a lower portion of a container.

15 Even if a container, which had already been filled up with liquid, is not formed with a liquid take-out port, the liquid can be continuously or intermittently taken out by providing a syphon tube thereafter.

It is not necessary for a container itself to be provided with a liquid take-out structure. Accordingly, since a syphon tube is usable for a container having no projected portion, or in a certain case, the syphon tube is also usable for a container capable of being stacked compactly. Plural set of apparatus can be delivered with high efficiency, and transporting (delivering) cost can be reduced.

20 It is possible to produce a container without using any movable member to a liquid take-out path, so that there is less risk for damage.

[0004] Similarly, the method of taking out liquid from a container using a syphon tube is excellent in the following points in comparison with a method of using a pump or like means.

- 25 1) Since any movable member is not disposed in a path for pumping liquid, there is less risk for damage.
 2) Low cost construction becomes possible.
 3) Compact structure can be easily realized.

30 **[0005]** Furthermore, although, as a primary take-out method, a method of taking out liquid from a container edge portion by inclining the container may be available for a container having no specific take-out structure, a method of taking out liquid from a container using a syphon tube also has a merit in the following point.

1) The liquid take-out speed and the liquid take-out position can be determined by arranging the syphon tube, and hence, amount of liquid to be uselessly spilled out of the container can be reduced.

35 **[0006]** In the case of using the syphon tube, it is necessary, at a time of taking out the liquid, to generate a siphon state or practical siphon state in the syphon tube.

[0007] For generating such state, without using any external activating means, and in a case where any valve or pump structure is not provided in a liquid path of a syphon tube, the following methods have been provided, which however provide the following problems or defects.

40 **[0008]** With a method in which a syphon tube is entirely dipped in liquid to be filled up with the liquid, and then, the tube is closed to create a usable state:

According to this method, in consideration of a case when a small amount liquid remains, it is necessary for the container to have a width larger than the length of the syphon tube when the syphon tube is made of solid member, and hence, this method may not be performed depending on the shape of the container.

45 The above defect is not raised in a case of a syphon tube having flexibility, but in general, in a case where it becomes difficult to take out remaining liquid from a container having deep depth.

In addition, in a case when it is not desirable to touch the liquid by his (her) hand, this method is not available to perform.

50 **[0009]** With a method in which air is sucked out through a take-out port to fill inside the syphon tube with liquid: In a case where the suction by a mouth is not safe or has some sanitary concern, a pump, that is disclosed hereinafter, will be used. In a case of a small diameter syphon tube, this method is effective one for relatively easily reducing air residue at a top portion thereof, but an expanded structure of the pump may constitutes an obstacle for realization of compact structure, and the increasing of members increase risk of accident.

55 **[0010]** With a method in which liquid is poured into and fills a syphon tube as "priming liquid" through a port to be opened or closed formed preliminarily to a top portion of the syphon tube:

This method is mainly performed for a big work, and in this method, since the priming liquid is poured in a state of closing a liquid suction side port dipped into liquid, it is troublesome to perform this method in a small work system.

In addition, this method is not applicable to a case where it is difficult or dangerous for a worker to touch the liquid.

[0011] On the other hand, there will be provided some methods disclosed in the following Patent Documents 2 and 3 as example in which a valve or pump structure is provided in a liquid path of the syphon tube.

These documents disclose a structure capable of creating a siphon state or practical siphon state at a time of taking out liquid from a container, but because it becomes necessary to additionally provide the valve or pump structure, or other members or like for operating the valve or pump structure, it is difficult to realize a compact structure. Moreover, since movable members are disposed in the liquid take-out path, risk for damage may be increased in comparison with the case of no such members.

[0012] Hereunder, generation principle of siphon or practical siphon phenomenon will be explained.

[0013] Solid substance, herein, liquid contacting an inner surface of a syphon tube, is in a state in which the capillary effect is superior to gravity effect along a distance of about a length of a capillary length K^{-1} expressed in the following equation from a contacting portion.

[Equation 1]

$$\text{Capillary length } K^{-1} = \sqrt{\frac{\gamma}{\rho g}}$$

wherein ρ (kg/m^3) is liquid density, g (m/s^2) is gravity acceleration, and γ (N/m) is surface tension.

The capillary length is generally 2 to 3 mm on the earth with the gravity acceleration of $g = 9.8$ (m/s^2). More detail will be omitted herein because it is disclosed hereinafter in Non-Patent Document 1, for example.

[0014] The transfer into the siphon state will be explained hereunder with reference to Figs. 7 to 9. It is further to be noted that in these figures, reference numerals are commonly added to corresponding members or portions, in which reference numeral 101 is a side wall portion of a container or vessel which is filled up with liquid, 102 is a syphon tube, 103 is a liquid surface in the container, 104 is a liquid surface in the syphon tube, 105 is a liquid surface at a space (clearance) between the syphon tube 102 and the container side wall 101, and 106 represents an arrow as an index (described hereinafter) showing the capillary length in the figures.

[0015] Fig. 7 is a figure showing a state in which a container is placed on a flat plane. In this state, the level of liquid surface 103 in the container and the level of the liquid surface 104 in the syphon tube are substantially coincident with each other in the perpendicular direction except a portion in the vicinity of a portion contacting the syphon tube 102 / side wall 101. The level of the liquid surface 105 in the narrow gap or clearance has a liquid level slightly higher than the above-mentioned level.

[0016] Fig. 8 is a figure showing a state in which the container is inclined before the transfer to the siphon state, in which the level of the liquid surface 103 is slightly higher than the level of an edge portion of the side wall 101, but the liquid does not spill over by the effect of the surface tension. In this state, the level of the liquid surface 104 in the syphon tube contacts the upper surface in the syphon tube at a position slightly higher than the level of the liquid surface 103 in the container by the amount corresponding to the capillary length 106. The liquid surface 105 comes up along the edge surface of the side wall 101.

[0017] Fig. 9 is a figure showing a state in which the container is inclined with an angle by which the liquid surface is transferred to the siphon state. In this state, the level of the liquid surface 103 in the container is further higher than the edge portion of the container by the amount corresponding to the capillary length. In such a state, the difference between the level of the upper surface of the inner wall of the syphon tube 102 and the level of the liquid surface 103 in the container is less than the capillary length at the highest position, and hence, the liquid surface 104 in the syphon tube exceeds over the highest position and flows outside the container.

[0018] The liquid transferred outside the container receives more remarkably affect of the gravity at a time when the distance between the inner surface levels in the syphon tube becomes larger than twice of the capillary length. In fact, the liquid surface 104 inside the syphon tube transfers downward toward the outside of the container along the syphon tube 102 through the state shown in Fig. 9. Thereafter, the liquid surface passes through the distal end of the syphon tube and flows into atmosphere outside the container, thus establishing the siphon or practical siphon state.

Further, in the case when the space is sufficiently smaller than the capillary length 106, the surface tension effectively acts to the liquid surface 105, so that the liquid surface 105 does not advance outside the container.

[0019] According to the principle mentioned above, the liquid can be effectively taken out by adopting appropriate substance and shape of syphon tube in consideration of liquid to be used and/or usable environments.

[0020] Further, it is to be noted that the index 106 of the capillary length 106 is just a plan for goal for explanation. In a normal condition, the index 106 varies depending on contacting angle between the liquid and respective portions and an angle between the wall surface and the gravity. However, as operation condition value in combination of two indexes 106 in Fig. 9, it may be considered as about twice of the capillary length. Thereafter it may be considered as less than

about twice of the capillary length by subtracting the wall thickness of the tube and float from the container.

[0021] In a case where the sectional area of the syphon tube is made large, there causes a difficulty in term of shape because, as mentioned above, the dimensional requirement between the inner wall surfaces of the syphon tube 102 had already been determined. However, this difficulty will be solved by some extent by precisely manufacturing the syphon tube.

[0022] In an actual review, the syphon tube made of substance of stainless/brass/polycarbonate/acryl/PET and having a circular section having an inner diameter of less than 6mm was used. The container made of substance of pottery/glass/steel/stainless/titanium/plastic cup was used, and water and hot water were used as liquid.

Prior Document

Patent Document

[0023]

Patent Document 1: Japanese Patent Publication No. 13297

Patent Document 2: Japanese Patent Laid-open Publication No. 2000-209978

Patent Document 3: Japanese Utility Model Publication No. SHO 24-6552

[0024] Non-Patent Document 1: "Physics of Surface Tension, Second Edition, World of Dews, Forms, Polka Dots And Ripples", authors de Gennes and others/translated by OKUMURA Ko, YOSHIOKA Bookshop; 2008

Concept of The Invention

Problems to be solved by The Invention

[0025] A problem to be solved by the present invention resides in a point such that liquid take-out start working by using a syphon tube is generally complex, and when it is intended to solve this point, it is difficult to make an equipment compact or small, which may lead to causing of risk of failure.

Means for solving The Problem

[0026] The present invention has most important characteristics of realizing siphon or practical siphon phenomenon, when a container is inclined, by designing a shape of a bent portion of a syphon tube contacting to an edge portion of a container so as to have a distance between inner wall portions of the syphon tube of less than twice a capillary length of a liquid along a predetermined range.

[0027] According to the syphon tube of the present invention, the take-out of the liquid can be easily started by inclining the container without providing any additional member, and hence, an entire structure of an equipment is not enlarged, and moreover, possibility of causing any trouble can be reduced, thus being advantageous.

Brief Description of The Drawings

[0028]

[Fig. 1] is an illustration explaining a configuration of a syphon tube to be used (Embodiment 1).

[Fig. 2] is an illustration explaining a configuration of the syphon tube of Fig. 1 in use (Embodiment 1).

[Fig. 3] is an illustration explaining a configuration of the syphon tube of Fig. 1 in use (Embodiment 1).

[Fig. 4] is an illustration explaining a configuration of a syphon tube to be used (Embodiment 2).

[Fig. 5] is an illustration explaining a configuration of the syphon tube of Fig. 4 in use (Embodiment 2).

[Fig. 6] is an illustration explaining a configuration of the syphon tube of Fig. 4 in use (Embodiment 2).

[Fig. 7] is an illustration explaining detail of operation of a syphon tube (Prior Art).

[Fig. 8] is an illustration explaining detail of operation of a syphon tube (Prior Art).

[Fig. 9] is an illustration explaining detail of operation of a syphon tube (Prior Art).

Mode for embodying The Invention

[0029] A syphon tube according to the present invention will be explained hereunder with reference to two embodiments.

Embodiment 1

[0030] Fig. 1 is a view illustrating a configuration of a syphon tube to be used according to the present invention, in which reference numeral 1 denotes a container (vessel), 2 is a liquid, and 3 is a syphon tube, (the same number 3 shall apply hereinafter in Figs. 1 to 3 with respect to the syphon tube 3). The syphon tube 3 has a protruded portion outside the container 1, and Fig. 1 shows a state inclined by weight of the syphon tube 3 disposed on an edge portion of the container 1.

[0031] Fig. 2 illustrates a state of starting the take-out of the liquid from the container, and in a state in which the liquid surface level in the container 1 sufficiently gets up from the edge portion of the container, the siphon or practical siphon state is established based on the principle mentioned hereinabove in the background technology, and then, take-out flow 4 of the liquid is caused.

[0032] Fig. 3 illustrates a state in which the inclination of the container 1 is somewhat returned after the state shown in Fig. 2. In this state, since the downstream side front end of the syphon tube 3 is located to the position lower than the liquid surface level in the container 1, the take-out flow 4 continues. That is, the take-out of the liquid can be made continuously in an inclination range wider than that in the state of starting the take-out of the liquid, and in this range, the liquid take-out speed can be adjusted.

[0033] The take-out flow of the liquid is stopped in a state when the liquid surface level in the container 1 becomes lower than the downstream side front end of the syphon tube 3, or when the container 1 is returned or further inclined reversely so as to create a state in which the downstream side end portion of the syphon tube 3 is made higher than the liquid surface level in the container 1. By further inclining the container 1 in accordance with the liquid flow-out condition without stopping the take-out of the liquid, the liquid in the container 1 may be substantially entirely taken out continuously.

[0034] According to the configuration of the present embodiment mentioned above, since it is possible to start the take-out of the liquid or stop the take-out of the liquid easily from the container 1 by using merely a single member of syphon tube 3, it is particularly suitable for the applications where storage ability or portability is important. It may be further possible for the syphon tube 3 to be further improved in the storage ability or portability according to usage, for example, by adopting a dividable structure and apply flexibility except the bent portion.

Embodiment 2

[0035] Fig. 4 illustrates a state of use of the second embodiment 2 according to the present invention, in which reference numeral 5 denotes a syphon tube in this second embodiment, 6 is an extension tube, 7 is a connecting portion air-tightly connecting the syphon tube 5 and the extension tube 6, and 8 is a support member for holding the extension tube 6 and the syphon tube 5 to the container 1. With such configuration, a curved (bent) portion of the syphon tube 5 is bent by approximately 180 degrees, and the syphon tube 5 is once extended downward to a level of a bottom of the container 1, and then, the downstream side end portion is raised upward to a height level of an edge portion of the container 1.

[0036] Fig. 5 illustrates the state of starting the take-out of the liquid, and in this state, similar to the first embodiment 1, the siphon or practical siphon state is established. The level of the liquid surface is once moved downward to the turning portion of the extension tube 6, and then raised upward in the extension tube 6 positioned below the level of the liquid in the container 1 to pass the downstream side end, through which take-out flow 9 is caused.

[0037] Fig. 6 is a view showing the container 1 which is returned to the original position from the state of Fig. 5. In this state, the difference from the embodiment 1 resides in that although the take-out flow 9 is vanished, but the siphoning phenomenon is maintained and the liquid surface stays to a position 10 under the downstream side end of the extension tube 6. In this state, when the container 1 is inclined again, the take-out flow 9 is again caused at a time when the downstream side end portion of the extension tube 6 becomes lower than the level of the liquid surface in the container 1 even if the liquid surface in the inclined container 1 does not reach the edge portion of the container 1. According to such configuration, if the siphoning state is once generated, this state can be maintained until the liquid is entirely taken out from the container or the syphon tube is removed.

[0038] The configuration of the second embodiment 2 is very effective in a case where the liquid is taken out on and off in small amount while finely adjusting the strength of the take-out liquid flow 9. The connecting portion 7 is effective because the syphon tube 5 and the extension tube 6 are separated for easy cleaning thereof, for example. When the extension tube 6 is composed of an elastic material to be capable of being bent, the syphon tube having storage ability and portability can be provided.

[0039] It is further to be noted that the present invention is not limited, in application, to the described embodiments

and widely usable for equipment, device and the like for taking out liquid from containers or vessels.

Industrial Applicability

- 5 **[0040]** The present invention is applicable for an industry for manufacturing equipments, devices and the like for taking out liquid from containers.

Reference Numerals

10 **[0041]**

- 1 --- container
2 --- liquid
3 --- syphon tube (Embodiment 1)
15 5 --- syphon tube (Embodiment 2)
6 --- extension tube (Embodiment 2)

Claims

- 20 1. A syphon tube that takes out a liquid in a container, wherein a shape of a bent portion of a syphon tube contacting to an edge portion of a container has a distance between inner wall portions of the syphon tube of less than twice a capillary length of a liquid along a predetermined range, and when the container is inclined, siphon or practical siphon phenomenon is caused.

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Fig. 1

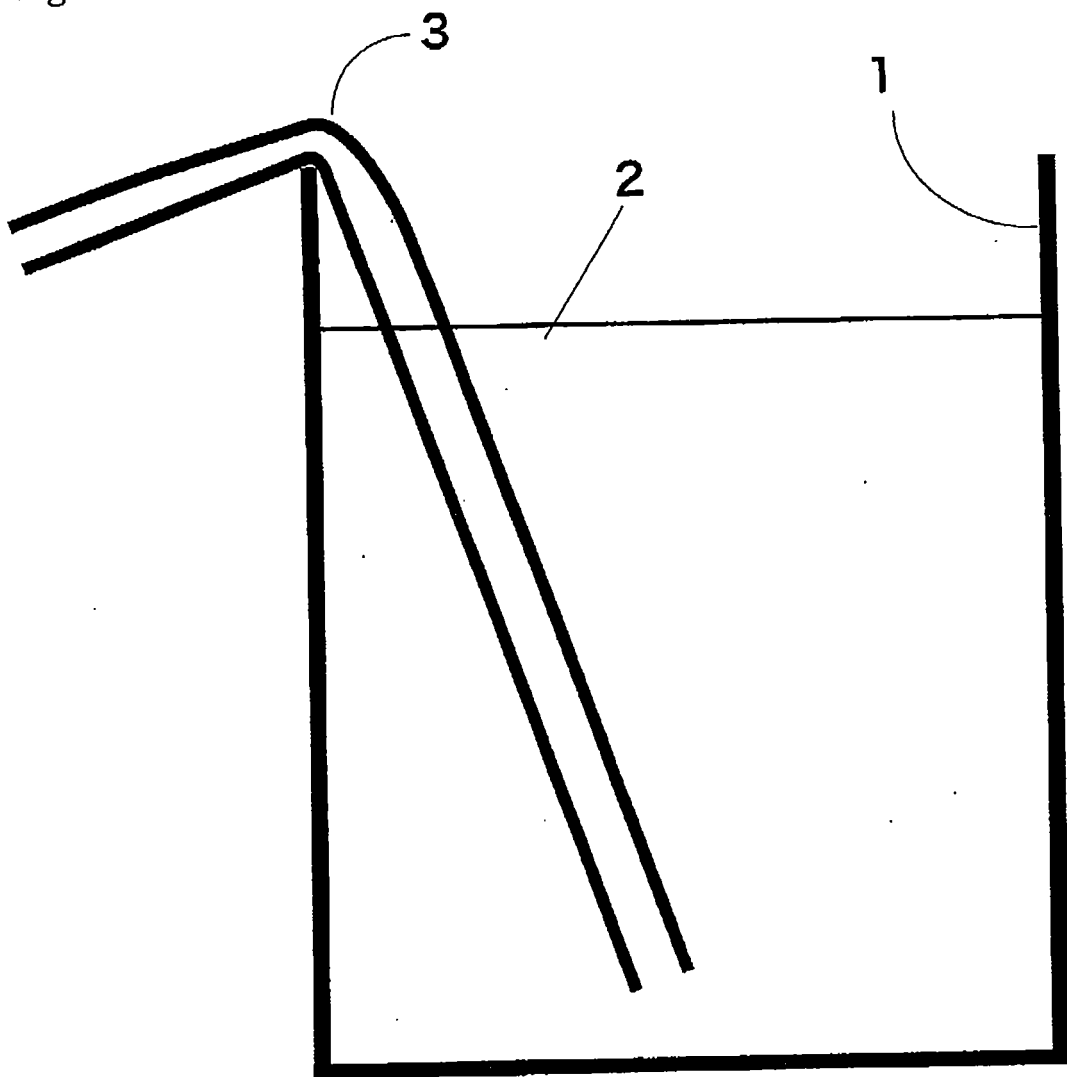


Fig. 2

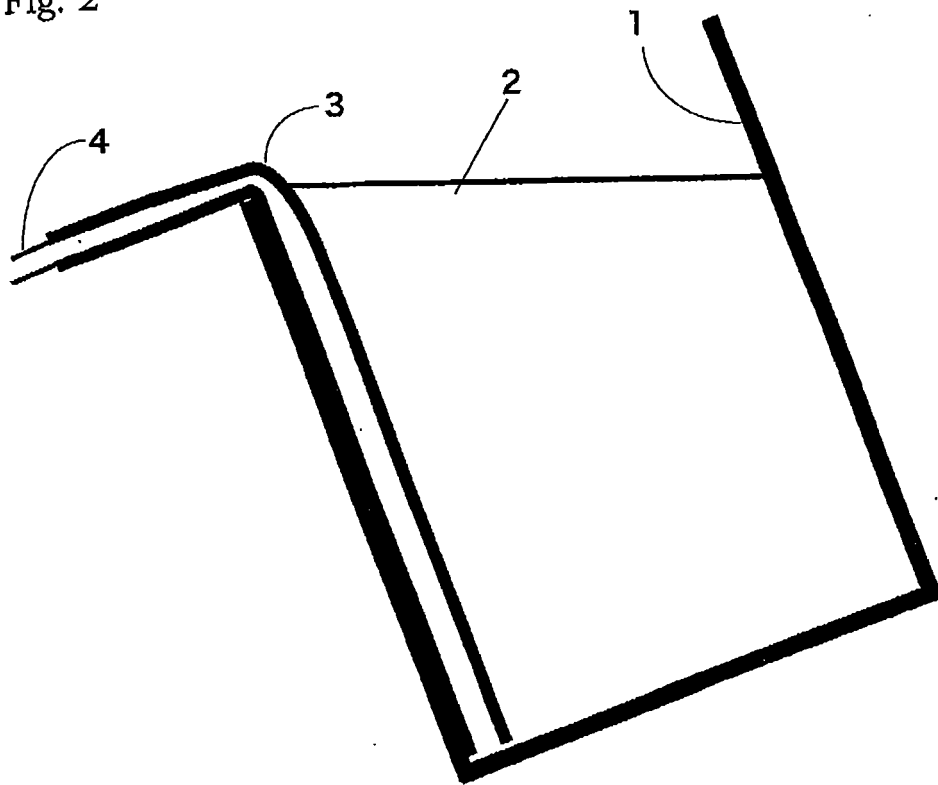


Fig. 3

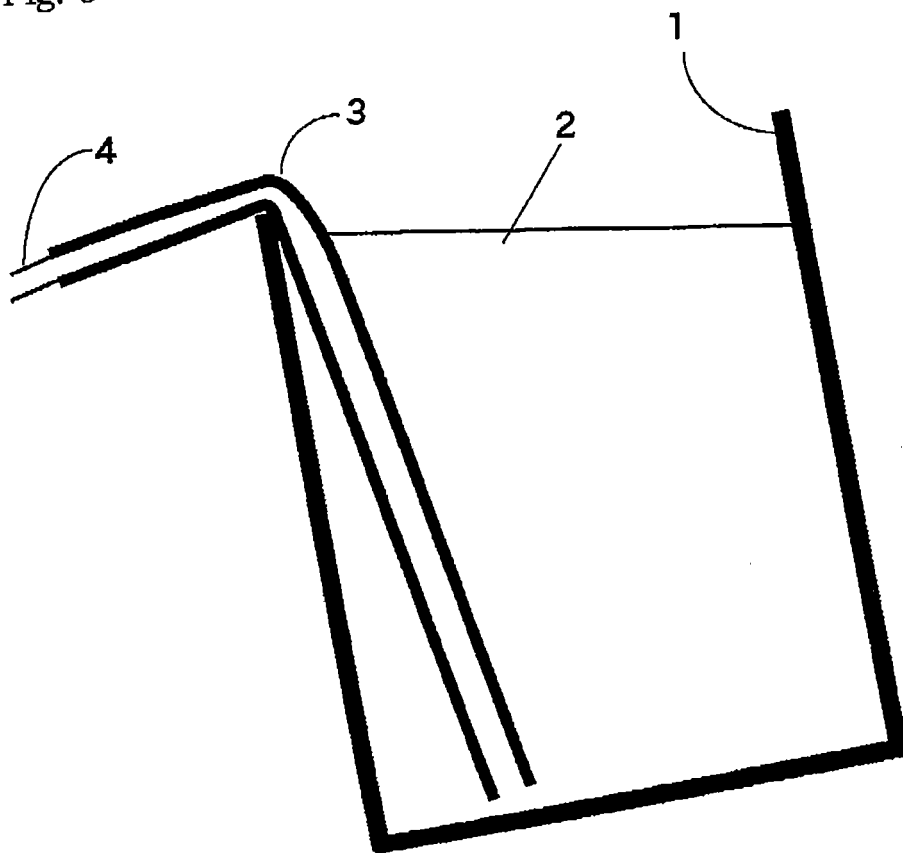


Fig. 4

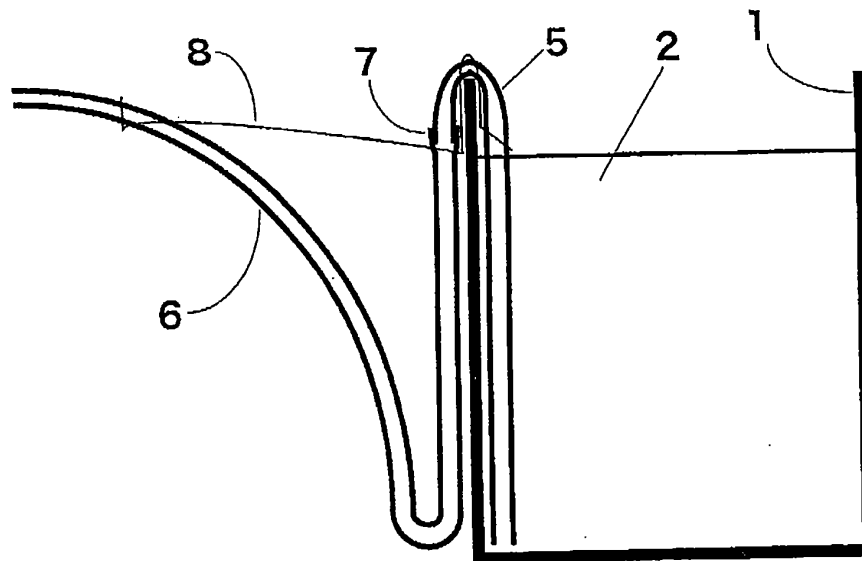


Fig. 5

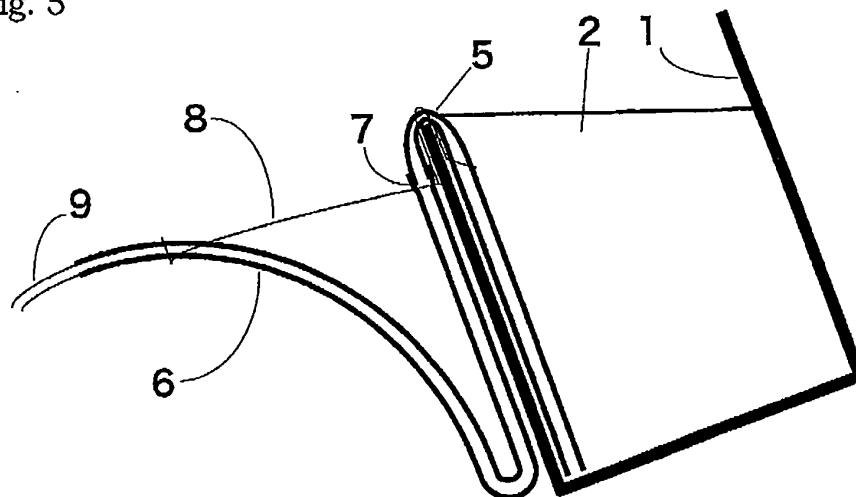


Fig. 6

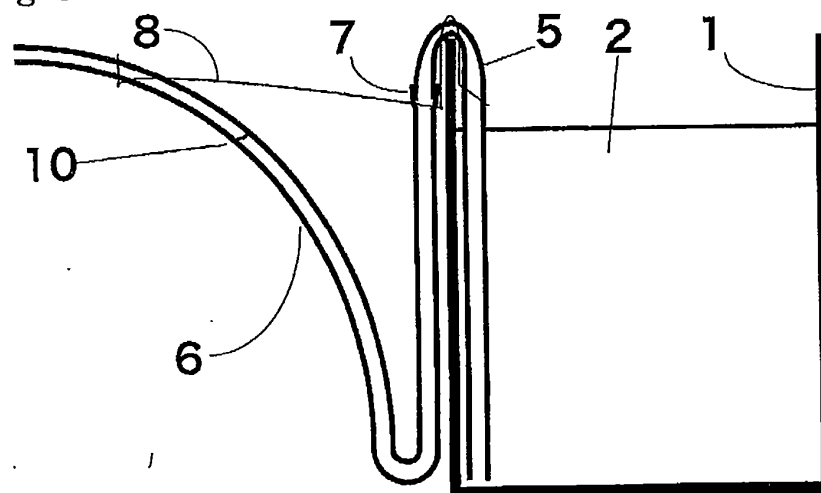


Fig. 7

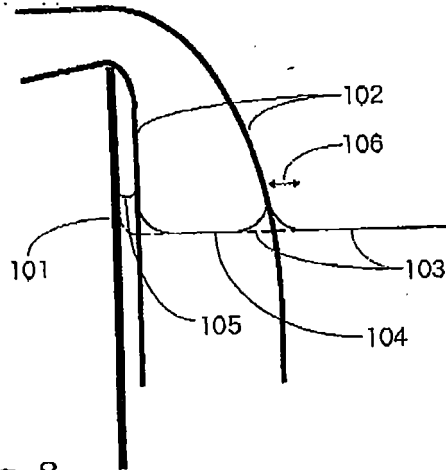


Fig. 8

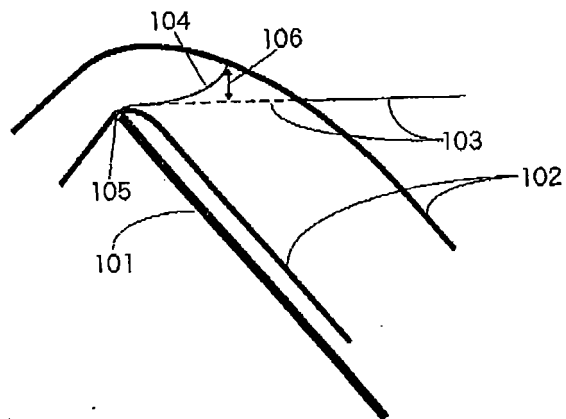
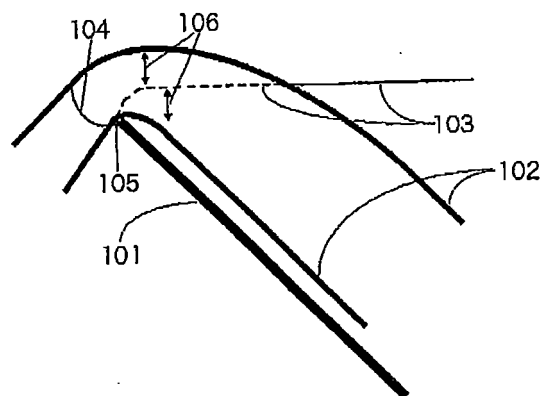


Fig. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/074406

A. CLASSIFICATION OF SUBJECT MATTER

F04F10/02(2006.01)i, B65D25/20(2006.01)i, B65D83/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04F10/00-10/02, B65D25/20, B65D25/38, B65D83/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-85320 A (Masao TSURUOKA), 05 April 2007 (05.04.2007), paragraphs [0003], [0014]; fig. 1A-B & US 2008/0060703 A1 & EP 1862676 A1 & WO 2006/100802 A1 & CN 101142414 A	1

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
02 November, 2011 (02.11.11)Date of mailing of the international search report
15 November, 2011 (15.11.11)Name and mailing address of the ISA/
Japanese Patent Office

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 13297 A [0023]
- JP 2000209978 A [0023]
- JP SHO246552 B [0023]

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