

DESCRIPTION

FRAGILE OBJECT PRESERVING DEVICE HAVING SEAL MECHANISM

Technical Field

[0001]

5 The present invention relates to a fragile object preserving device provided with a sealing mechanism.

Background Art

[0002]

10 In recent years, new regenerative healthcare is being developed as a solution for severe heart failure. For example, there is a new approach to severe cardiac infarction based on tissue engineering. In the new approach, a temperature-responsive culture dish is used to prepare a sheet cell culture, and the sheet cell culture is
15 applied to a heart surface. The technique using a sheet cell culture enables safe transplant of a large amount of cells over a wide range and is particularly effective for treatment of cardiac diseases (such as heart failure, particularly, chronic heart failure) associated with, for
20 example, cardiac infarction (including chronic heart failure associated with cardiac infarction), dilated cardiomyopathy, ischemic cardiomyopathy, and systolic dysfunction (such as left ventricular systolic dysfunction).

[0003]

25 In order to apply such a sheet cell culture to clinical

trials, it is required, for example, to store a prepared sheet cell culture together with a preservative solution inside a container and carry the cell culture to an intensive care unit or the like where transplantation is to be performed. However, a sheet cell culture is low in absolute physical strength, and vibrations caused by carrying a container may wrinkle, break, or damage the sheet cell culture. For this reason, carrying a sheet cell culture requires highly-advanced techniques and extreme care.

[0004]

In order to accommodate those needs, various methods and containers are being developed. For example, Patent Literature 1 discloses a container for storing and transporting a membrane tissue. In the container, a storage is filled with a preservative solution to such an extent as to prevent formation of a gas layer. Accordingly, the preservative solution is prevented from rippling or flowing, and consequently, the membrane tissue is not affected by vibrations and protected from damages.

[0005]

Patent Literature 2 discloses a packaging container for a cultured tissue. The packaging container includes a container body, a lid, and an inner tray on which a cultured tissue is to be placed. In the packaging

container, a cultured tissue is placed and housed in the inner tray, and an inner tray operation unit is prepared in advance inside the packaging container. With such a structure, the packaging container facilitates ejection of the inner tray from the container body. However, the use of the packaging container may allow bubbles to remain inside the packaging container.

[0006]

Furthermore, Patent Literature 3 discloses a package for carrying a cultured cell sheet. When the package is sealed with a lid, air and a small amount of liquid medium are removed from the package. Accordingly, even though the package for a cultured cell sheet is shaken while being carried, bubbles do not move inside the liquid medium, and it is possible to prevent the cultured cell sheet from being deviated or chipped.

Citation List

Patent Literature

[0007]

Patent Literature 1: JP 2012-130311 A

Patent Literature 2: JP 2007-269327 A

Patent Literature 3: JP 2009-89715 A

Summary of Invention

Technical Problem

[0008]

Under the circumstances, the inventors have developed a technique for preserving a shape of a fragile object in a liquid and have faced such a problem that accurate dimensional design is required to make a liquid-tight container by engagement between the container and a lid. Accordingly, an object of the present invention is to provide a device for preserving a shape of a fragile object in a liquid.

Solution to Problem

10 [0009]

In forging ahead with intensive study to solve the problems, the inventors have found that dimensional deviation of a container or a lid during a production process makes it difficult to form a liquid-tight space successfully. As a result of further study, the inventors have found that the problem are solved by providing a seal between a container and a lid, whereby completing the present invention.

[0010]

20 In other words, the present invention relates to the following techniques.

[1] A device including: a container that houses a fragile object, the container having a cylindrical shape including a bottom; a lid that seals the container; and a seal, wherein the container includes a lower portion that

25

houses the fragile object; an upper portion that includes an opening; and a stepped portion provided between the lower portion and the upper portion, the lid seals the opening of the upper portion, and the seal is interposed
5 between the lid and the stepped portion to seal an opening of the lower portion.

[2] The device according to [1], wherein the upper portion has an inside diameter larger than an inside diameter of the lower portion, and the stepped portion is a
10 portion where an inside diameter of the container is sharply reduced.

[3]The device according to [1] or [2], wherein the seal includes a packing ring between the seal and the stepped portion.

15 [0011]

[4] The device according to any one of [1] to [3], wherein the packing ring has a groove perpendicular to the packing ring in a circumferential direction.

[5] The device according to any one of [1] to [4],
20 wherein the seal is pressed by the lid and the stepped portion when the lid is screwed into the container.

[6] The device according to any one of [1] to [5], wherein the opening of the upper portion is sealed with the lid simultaneously with or after sealing of the opening of
25 the lower portion by the seal.

[7] The device according to any one of [1] to [6], wherein the fragile object is a sheet cell culture.

[8] The device according to any one of [7], wherein the sheet cell culture is a laminated body.

5 Advantageous Effects of Invention

[0012]

A device according to the present invention reliably creates a liquid-tight space inside a container and does not allow bubbles (gas) to enter the container.

10 Accordingly, even when the container is shaken, a fragile object is not damaged by motion of bubbles inside the container. Particularly, when the fragile object is a laminated body of sheet cell cultures, the laminated body is not deviated or chipped by motion of bubbles. In
15 addition, even though dimensions of a container or a lid are deviated during a production process, the container is reliably closed in a liquid-tight manner, which gives a great advantage in terms of design cost and production cost.

Brief Description of Drawings

20 [0013]

Fig. 1 is a cross-sectional view of a device according to a first embodiment of the present invention.

Fig. 2 is a cross-sectional view of a device according to a first modification of the first embodiment.

25 Fig. 3 is a cross-sectional view of a device according

to a second modification of the first embodiment.

Fig. 4 is a cross-sectional view of a device according to a third modification of the first embodiment.

Description of Embodiments

5 [0014]

An aspect of the present invention relates to a device including: a container that houses a fragile object, the container having a cylindrical shape including a bottom; a lid that seals the container; and a seal, wherein the
10 container includes a lower portion that houses the fragile object; an upper portion that includes an opening; and a stepped portion provided between the lower portion and the upper portion, the lid seals the opening of the upper portion, and the seal is interposed between the lid and the
15 stepped portion to seal an opening of the lower portion.

[0015]

The fragile object herein represents an object that has low physical strength and may be broken, damaged, or deformed by, for example, liquid vibration. Such an object
20 may be, for example, one provided with a thin portion, one having a band shape, or one having a sheet shape. The object having a sheet shape is not particularly limited and may be a sheet structure. Examples of the sheet structure include flat membrane tissues made of biological materials
25 such as sheet cell cultures and various kinds of films made

of plastic, paper, woven fabric, non-woven fabric, metals, polymers, or lipids. Among these examples, objects that are persistent or hardly dissolved in a liquid are preferable. The sheet structure may be polygonal or
5 circular and does not necessarily have a uniform width, thickness, diameter, and the like. The sheet structure used in the present invention may be a single layer including one sheet or a laminated body including two or more sheets. In the latter case, layers of the laminated
10 body may be, but are not necessarily, connected to each other. In a case where the layers are connected, overlapping parts may be connected thoroughly or partially. The term "fragile" according to the present invention indicates that an object is so vulnerable that it is
15 difficult or substantially impossible to evaluate tensile properties of the object, for example, by a tension testing machine in the related art (for example, one described in JIS K 7161) in which the object is fixed to a gripping tool outside a liquid. Examples of the fragile object include
20 those having a small value of each tensile property or those having difficulty in measuring tensile properties correctly with a tensile testing machine in the related art. Examples of the fragile object include those showing, in a tensile test, a breaking load of less than 10 N (Newton),
25 less than 5 N, less than 2 N, less than 1 N, less than 0.5

N, less than 0.1 N, and less than 0.05 N. The limit of a breaking load measured by a tensile test in the related art is generally about 1 N. For this reason, in an aspect of the present invention, it is preferable to use an object
5 that shows a breaking load lower than 1 N (for example, less than 0.5 N) as the fragile object.

[0016]

The fragile object herein includes, for example, a biological transplant having relatively low physical
10 strength, and examples of the transplant include cultured cells (for example, cell cultures) or collected cells. Another examples of the transplant include products produced by cells. Besides cells and/or products of cells, examples of the transplant include materials (prosthesis
15 and supporting materials) for replacing and/or supporting a predetermined part (for example, an affected part) of a living body. The transplant may have various kinds of shapes such as a sheet shape, a film shape, a lump shape, and a column shape. The transplant is used for
20 transplantation into a living body. A specific example of the transplant is a sheet cell culture.

The sheet cell culture herein represents cells connected to each other to form a sheet shape. Cells may be connected to each other directly (including cells with
25 cellular elements such as adhesion molecules involved)

and/or with an intervening substance involved. The intervening substance is not particularly limited as long as the substance connects cells at least physically (mechanically). An example of the intervening substance includes an extracellular matrix. The intervening substance is preferably derived from cells, particularly, cells that form a sheet cell culture. The cells are at least physically (mechanically) connected to each other but may be connected functionally, for example, chemically or electrically. The sheet cell culture may include one cell layer (monolayer) or may include two or more cell layers (multilayer body). Furthermore, the sheet cell culture does not necessarily have a clear layer structure and may have a three-dimensional structure with a thickness exceeding a thickness of one cell. For example, in the perpendicular cross section of the sheet cell culture, cells may be arranged non-uniformly (for example, in a mosaic manner) without being aligned uniformly in the horizontal direction. The sheet cell culture may exist as a single (one) sheet cell culture formed independently or exist as a laminated body having two or more independent single (one) sheet cell cultures being laminated. The laminated body may have sheet cell cultures laminated in, for example, two layers (two sheets), three layers (three sheets), four layers (four sheets), five layers (five

sheets), or six layers (six sheets).

[0017]

The sheet cell culture herein includes any kind of cells that may form the aforementioned structure. Examples
5 of the cells include, but are not limited to, adherent cells (adhesive cells). Examples of the adherent cells include adherent somatic cells (such as cardiac muscle cells, fibroblast cells, epithelial cells, endothelial cells, hepatic cells, pancreatic cells, renal cells,
10 adrenal cells, periodontal ligament cells, gingival cells, periosteal cells, skin cells, synovial cells, and cartilage cells) and stem cells (for example, tissue stem cells such as myoblast cells and cardiac stem cells; embryonic stem cells; pluripotent stem cells such as induced pluripotent
15 stem (iPS) cells; and mesenchymal stem cells). Somatic cells may be differentiated from stem cells, particularly, from iPS cells. Examples of cells that form a sheet cell culture include, but are not limited to, myoblast cells (such as skeletal myoblast cells), mesenchymal stem cells
20 (such as bone marrow, adipose tissue, peripheral blood, skin, hair roots, muscular tissue, endometrium, placenta, and cells derived from cord blood), cardiac muscle cells, fibroblast cells, cardiac stem cells, embryonic stem cells, iPS cells, synovial cells, cartilage cells, epithelial
25 cells (such as oral mucosal epithelial cells, retinal

pigment epithelial cells, and nasal mucosal epithelial cells), endothelial cells (such as vascular endothelial cells), hepatic cells (such as hepatic parenchymal cells), pancreatic cells (such as islet cells), renal cells,
5 adrenal cells, periodontal ligament cells, gingival cells, periosteal cells, and skin cells. Herein, preferable examples are cells that form a monolayer cell culture, such as myoblast cells or cardiac muscle cells, and skeletal myoblast cells or iPS cell-derived cardiac muscle cells are
10 particularly preferable.

[0018]

The cells may be derived from any organism treatable with a cell culture. Examples of the organism include, but are not limited to, humans, non-human primates, dogs, cats,
15 pigs, horses, goats, and sheep. Furthermore, one type of cell or two or more types of cells may be used for forming a sheet cell culture. In a preferred aspect of the present invention, when the number of cells that form a cell culture is two or more, a ratio (purity) of the greatest
20 number of cells, for example, a ratio of skeletal myoblast cells, is 65% or more, preferably 70% or more, and more preferably 75% or more, at the end of producing the cell culture.

[0019]

25 The sheet cell culture according to the present

invention may be a sheet cultured tissue obtained by inoculating and culturing cells in a scaffold (scaffold during cell culturing). However, the sheet cell culture is preferably composed of a material derived from a cell that
5 forms a cell culture and does not include other materials.

The sheet cell culture may be produced by any known technique.

[0020]

In an aspect of the present invention, the sheet cell
10 culture is a sheet skeletal myoblast cell culture. The reason is that maintaining a shape of a sheet skeletal myoblast cell culture in a liquid is of great significance since a sheet skeletal myoblast cell culture is so fragile that it breaks by its own weight when a part of the cell
15 culture is grabbed and that such fragility not only disables the cell culture to be carried independently but also makes it extremely difficult for the cell culture to return to the original shape when it is once folded.

[0021]

20 The container herein is not specifically limited as long as the container houses a fragile object, a liquid, and the like and prevents the liquid from leaking. The container herein may be of any type, and a commercially available container may also be used. Examples of a
25 material of the container include, but are not limited to,

polyethylene, polypropylene, Teflon (registered trademark), polyethylene terephthalate, polymethyl methacrylate, nylon 6,6, polyvinyl alcohol, cellulose, silicone, polystyrene, glass, polyacrylamide, polydimethylacrylamide, and metals (such as iron, stainless steel, aluminum, copper, and brass). In addition, the container preferably has at least one flat bottom surface for maintaining a shape of the fragile object. Examples of the container include, but are not limited to, a petri dish, a cell culture dish, and a cell culture bottle. The flat bottom surface has an area of, typically, 1.13 to 78.5 cm², preferably 12.6 to 78.5 cm², and more preferably 9.1 to 60.8 cm² but is not limited thereto.

[0022]

Herein, the liquid inside the container includes at least one component. The component is not particularly limited, and examples of the component include water, aqueous solution, non-aqueous solution, suspension, and emulsion.

The solution or liquid herein may be a fluid having fluidity as a whole and may include solid substances such as cell scaffolds and other non-liquid components such as bubbles.

[0023]

The component included in the liquid inside the

container is not particularly limited as long as the component has little influence on the fragile object. In a case where the fragile object is a membrane including a biological material-derived material, the component

5 included in the liquid inside the container is preferably biocompatible from a viewpoint of biological stability and long-term storage. In other words, the component included in the liquid is preferably one that does not cause undesired effects such as inflammatory reactions, immune
10 reactions, and intoxicating reactions against living tissue or cells, or one that causes such effects to a small extent.

Examples of the component include water, physiological saline, physiological buffers (such as HBSS, PBS, EBSS, HEPES, and sodium bicarbonate), media (such as DMEM, MEM, F12, DMEM/F12, DME, RPMI1640, MCDB, L15, SkBM, RITC80-7,
15 and IMDM), carbohydrate solutions (such as sucrose solution and Ficoll-paque PLUS (registered trademark)), seawater, serum-containing solution, Renografin (registered trademark) solution, metrizamide solution, meglumine
20 solution, glycerin, ethylene glycol, ammonia, benzene, toluene, acetone, ethyl alcohol, benzol, oil, mineral oil, animal fat, vegetable oil, olive oil, colloidal solution, liquid paraffin, turpentine oil, linseed oil, and castor oil.

25 [0024]

In a case where the fragile object is a sheet cell culture, the component included in the liquid inside the container is preferably one that enables stable storage of cells, contains the minimal amount of oxygen and nutrients
5 necessary for cell survival, and does not break cells due to osmotic pressure or the like. Examples of the component include, but are not limited to, physiological saline, physiological buffers (such as HBSS, PBS, EBSS, Hepes, and sodium bicarbonate), media (such as DMEM, MEM, F12,
10 DMEM/F12, DME, RPMI1640, MCDB, L15, SkBM, RITC80-7, and IMDM), and carbohydrate solutions (such as sucrose solution and Ficoll-paque PLUS (registered trademark)).

[0025]

The lid herein is not particularly limited as long as
15 the lid seals the container. Examples of a material of the lid include, but are not limited to, polyethylene, polypropylene, Teflon (registered trademark), polyethylene terephthalate, polymethyl methacrylate, nylon 6,6, polyvinyl alcohol, cellulose, silicone, polystyrene, glass,
20 polyacrylamide, polydimethylacrylamide, and metals (such as iron, stainless steel, aluminum, copper, and brass).

[0026]

The container herein has a cylindrical shape including a bottom. The horizontal section of the cylindrical
25 container is not particularly limited in shape as long as

the container has at least one flat bottom surface for maintaining a shape of the fragile object. For example, the container may be shaped into a triangle, a rectangle, a polygon, a circle, and an ellipse. The lid is not

5 particularly limited in shape as long as the lid and the container are engaged to create a sealed space. For example, in a case where the container is a general-purpose petri dish, the lid preferably has a circular shape. Furthermore, the lid and/or the container may include a
10 light transmissive material to make it possible to check the state of the fragile object housed in the container and the presence or absence of bubbles in the liquid.

[0027]

Herein, the lower portion of the container represents
15 the lower side of the container having the flat bottom surface that houses a liquid, a gas, a fragile object, or the like, and the upper portion of the container represents the upper side of the container, that is, a space between the opening and the lower portion of the container. The
20 stepped portion of the container represents a boundary between the lower portion and the upper portion, that is, a part where an inside diameter of the container sharply decreases or a tapered part where the inside diameter increases from the lower portion toward the upper portion.
25 The stepped portion has an annular surface with a width

obtained by a difference between the inside diameter of the lower portion and that of the upper portion. The space in the lower portion represents a housing space surrounded by the lower portion of the container, and the space in the upper portion represents a space surrounded by the upper portion of the container. The opening of the space in the lower portion represents a boundary edge between the space in the lower portion and the stepped portion, and the opening of the space in the upper portion represents an edge of the container, that is, an end of the space in the upper portion.

[0028]

The seal herein represents a portion that is interposed between the lid and the stepped portion and seals the opening in the lower portion when the lid is attached to the container. The seal has an outside diameter smaller than the inside diameter of the upper portion of the container so as to be inserted into the opening of the upper portion of the container. Furthermore, the outside diameter of the seal is larger than the inside diameter of the lower portion of the container so as not to be inserted into the opening of the lower portion of the container. Therefore, the bottom surface of the seal comes into close contact with the stepped portion so as to create a sealed space surrounded by the bottom surface of the seal and the

inner surface of the lower portion. In addition, there is a space between an outer periphery of the seal and an inner periphery of the upper portion of the container.

Accordingly, using this space as a channel, it is possible
5 to discharge the liquid and gas in the lower portion of the container from the opening in the upper portion of the container. In this manner, it is not required to accurately design the container and the lid to make the seal of the lid come into close contact with the inner
10 periphery of the container. Accordingly, even though dimensions of the container or the lid are deviated during a production process, the container is reliably closed in a liquid-tight manner.

[0029]

15 The seal herein may be a part of the lid or may be a separate member from the lid. For example, when a sealing member such as a packing ring is interposed, as a separate member, between the seal and a container, the seal includes a packing ring. A material of the seal may be a rigid body
20 or an elastic body as long as the material enables sealing of the edge of the container, but an elastic body is preferable. The elastic body is not particularly limited and may be, for example, silicone, plastic, or rubber. The packing ring is not particularly limited in cross section
25 and may be shaped into, for example, a triangle, a

quadrangle, a polygon, a circle, or an ellipse. The packing ring preferably has a triangular cross section, since it is easier to deform the packing ring when a pressing force is applied to a vertex.

5 [0030]

The protrusion herein represents, for example, a member having a protruding portion or a member having a bulging portion, that is, a member including a non-flat portion. The protrusion protruding toward the space in the lower
10 portion indicates that the protrusion protrudes to such an extent as to push out the liquid and gas in the lower space of the container. Those skilled in the art may freely set the size of the protrusion according to the amount or volume of the liquid.

15 [0031]

Herein, a horizontal sectional area of the protrusion represents, for example, an area of the two-dimensional cross section which appears when the protrusion is cut at the liquid level while protrusion is immersed in the liquid.
20 Accordingly, the expression "the horizontal sectional area of the protrusion tapers perpendicularly downward" indicates that, when the protrusion is immersed in the liquid while being descended perpendicularly downward from the top of the liquid, a contact area between the
25 protrusion and the liquid gradually increases.

In an aspect of the present invention, the protrusion has a dome shape and including a vertex, and preferably, the protrusion is designed to have a vertex intersecting the center line of the lid and the center line of the container. The curved protrusion may have a hyperboloid shape, a paraboloid shape, a hemispherical shape, a conical surface shape, or a pyramidal shape, but is not limited thereto.

[0032]

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the drawings.

[First Embodiment]

First, a first embodiment of the present invention will be described.

Fig. 1 is a cross-sectional view of a device according to the first embodiment of the present invention. Fig. 2 is a cross-sectional view of a device according to a first modification of the first embodiment. Fig. 3 is a cross-sectional view of a device according to a second modification of the first embodiment. Fig. 4 is a cross-sectional view of a device according to a third modification of the first embodiment. In each drawing in this application, for the purpose of illustration, note that sizes of the illustrated members are emphasized as

appropriate and are different from the actual sizes.

[0033]

As shown in Fig. 1A, a device 1 according to the first embodiment of the present invention includes a container 2 and a lid 3 that seals the container 2. The container 2 is a round container that has a cylindrical shape including a bottom. The container 2 includes an upper portion 22 and a lower portion 23. The lower portion 23 includes a housing space that houses a fragile object S and the like. The upper portion 22 has an inside diameter larger than an inside diameter of the lower portion 23. A stepped portion 24, or a part where the inside diameter of the container sharply decreases, is disposed at a boundary between the upper portion 22 and the lower portion 23. The stepped portion 24 has an annular shape parallel to a bottom surface of the container 2. The lid 3 includes a top board 36 that covers an opening 25 of the container 2. The container 2 is sealed when the lid 3 is attached to the container 2.

[0034]

The lid 3 includes a seal 32 stretching downward from the center of the top board 36 of the lid 3, a cylindrical skirt 37 drooping from a peripheral edge of the top board 36, and an engagement portion 33 protruding and disposed on an inner surface of the cylindrical skirt 37. The seal 32

has a columnar shape, including a bottom surface 34 and an outer periphery 35. The seal 32 has an outside diameter larger than the inside diameter of the lower portion 23 and smaller than the inside diameter of the upper portion 22.

5 Therefore, when the seal 32 is inserted into the container 2, the bottom surface 34 of the seal 32 comes into close contact with a surface of the stepped portion 24, which creates a space between the seal 32 and the upper portion 22. Furthermore, a height of the seal 32 from the top
10 board 36 is substantially equal to that of the upper portion 22. In other words, the device 1 includes a seal mechanism that enables sealing between the seal 32 and the stepped portion 24 and sealing between the top board 36 and the opening 25 almost at the same time when the lid 3 is
15 attached to the container 2.

[0035]

As shown in Fig. 1A, when the device 1 is used, a liquid L is poured into the container 2 until the liquid rises above the stepped portion 24, and then, the fragile
20 object S is housed in the lower portion 23 of the container 2. As shown in Fig. 1B, when the container 2 is covered with the lid 3, the seal 32 travels inside the container 2. After the seal 32 reaches the liquid level, the seal 32 travels further. Then, the liquid L is pushed out into a
25 space between the outer periphery 35 of the seal 32 and an

inner periphery of the container 2, which raises the liquid level. When the liquid level rises, an air A in the container 2 is pushed and discharged out of the container 2 from the opening 25. At this time, the top board 36 and the opening 25 are not in close contact with each other, which enables the liquid L and the air A to move.

[0036]

When the seal 32 travels further, the bottom surface 34 of the seal 32 and the stepped portion 24 come into close contact with each other, which offers a liquid-tight space inside the housing space (the space in the lower portion 23). Almost at the same time, the top board 36 and the opening 25 come into close contact with each other, which offers a sealed space inside the container 2 (the space in the upper portion 22). At this time, the liquid L and the gas (air) A exist in the space in the upper portion 22 of the container 2, but the container 2 is sealed triply by the top board 36 in close contact with the opening 25, the cylindrical skirt 37 in close contact with the outer periphery of the container 2, and the engagement portion 33 that engages with a lower edge of the upper portion 22 of the container 2. Accordingly, the liquid L in the upper portion 22 does not flow out and maintains hygiene.

Therefore, it is preferable to prevent the liquid from leaking out of the container 2 by adjusting the liquid

volume and capacity in advance so that the volume of the liquid pushed out of the container 2 is not larger than the capacity of the liquid-receiving space provided between the upper portion 22 of the container 2 and the lid 3.

5 [0037]

In such a configuration, if the height of the seal 32 from the top board 36 is smaller than the height of the upper portion 22, the top board 36 and the opening 25 come into contact with each other before the seal 32 and the stepped portion 24 come into contact with each other. In this case, the space in the upper portion 22 is sealed first, leaving no space for the liquid L and the air A to move, which does not allow the seal 32 to travel any more. Accordingly, the space in the lower portion cannot be made liquid-tight. On the other hand, the device 1 according to this embodiment seals the space in the upper portion 22 with the lid 3 without preventing the seal 32 from sealing the space in the lower portion 23.

[0038]

20 As described above, the device 1 according to the first embodiment of the present invention reliably creates a liquid-tight space inside a container and does not allow bubbles (gas) to enter the container. Accordingly, even when the container is shaken, a fragile object is not
25 damaged by motion of bubbles inside the container.

Particularly, when the fragile object is a laminated body of sheet cell cultures, the laminated body is not deviated or chipped by motion of bubbles.

[0039]

5 This embodiment is not limited to the above device, and those skilled in the art may design devices having different configurations and shapes. For example, at least a part of the seal 32 of the lid 3 may include an elastic body, and a height of the seal 32 from the top board 36 may
10 be made larger than a height of the upper portion 22.

Furthermore, at least a part of the seal 32 may be a seal mechanism that presses and crushes the seal 32 between the lid 3 and the stepped portion 24 to reduce a height of the lid 3 after sealing the space in the lower portion 23 with
15 the seal 32 and then seals the lid 3 and the opening 25 of the upper portion 22.

[0040]

In this manner, with the device 1 according to the first embodiment of the present invention, even though
20 dimensions of a container or a lid are deviated during a production process, the container is reliably closed in a liquid-tight manner, which gives a great advantage in terms of design cost and production cost.

[0041]

25 A first modification of the device 1 according to the

first embodiment of the present invention will now be described. Hereinafter, differences from the first embodiment will be described in detail but similarities will not be described.

5 [0042]

As shown in Fig. 2A, a device 1A according to the first modification includes a container 2 and a lid 3 that seals the container 2. An internal thread 38 is disposed on an inner periphery of a cylindrical skirt 37. The internal
10 thread 38 is screwed into an external thread 28 disposed on an outer periphery of an upper portion 22 of the container 2. When the container 2 is covered with the lid 3, and the internal thread 38 is screwed into the external thread 28, the lid 3 is connected to the container 2 with pressure.
15 In this modification, a height of a seal 32 from a top board 36 is slightly smaller than a height of the upper portion 22. Furthermore, an elastic packing ring R is disposed between the seal 32 and a stepped portion 24.

[0043]

20 As shown in Fig. 2A, when the device 1A is used, a liquid L is poured into the container 2 until the liquid rises above the packing ring R, and then, a fragile object S is housed inside a lower portion 23 of the container 2. As shown in Fig. 2B, when the lid 3 is attached to the
25 container 2, and the internal thread 38 is screwed into the

external thread 28, the seal 32 travels inside the container 2, and the seal 32 is brought into close contact with the packing ring R. Accordingly, a liquid-tight space is created inside the lower portion 23. When the lid 3 is
5 screwed into the container 2, the packing ring R is pressed and crushed by the seal 32, and the top board 36 is brought into close contact with an opening 25. Accordingly, the container 2 is sealed.

[0044]

10 As described above, the first modification of the device 1 according to the first embodiment of the present invention reliably creates a liquid-tight space inside a container and does not allow bubbles (gas) to enter the container. Accordingly, even when the container is shaken,
15 a fragile object is not damaged by motion of bubbles inside the container. Particularly, when the fragile object is a laminated body of sheet cell cultures, the laminated body is not deviated or chipped by motion of bubbles. In addition, even though dimensions of a container or a lid
20 are deviated during a production process, the container is reliably closed in a liquid-tight manner, which gives a great advantage in terms of design cost and production cost.

[0045]

Next, a second modification of the device 1 according
25 to the first embodiment of the present invention will be

described. Hereinafter, differences from the first modification of the first embodiment will be described in detail but similarities will not be described.

[0046]

5 As shown in Fig. 3A, a device 1B according to a second modification includes a container 2 and a lid 3 that seals the container 2. In this modification, the lid 3 includes a protrusion 31 that protrudes downward from a bottom surface 34 of a seal 32 when the lid 3 is attached to the
10 container 2. The protrusion 31 has a dome shape, including a vertex that has a horizontal sectional area tapering perpendicularly downward. The protrusion 31 pushes out a gas and a liquid inside a space in a lower portion 23 when the lid 3 is attached to the container 2. Furthermore, an
15 upper end of the protrusion 31 has an outside diameter smaller than an inside diameter of the lower portion 23 of the container 2 so as not to bring an outer periphery of the protrusion 31 into contact with an inner periphery of the container 2. On an upper surface of a packing ring R',
20 a groove (not shown) is disposed in a direction perpendicular to the circumferential direction of the packing ring R'.

[0047]

As shown in Fig. 3A, in this modification, when the
25 device 1B is used, it is not required to put a liquid L

until the liquid L rises above a stepped portion 24. As shown in Fig. 3B, when the protrusion 31 disposed in the seal 32 travels inside the space in the lower portion, the gas and liquid inside the space in the lower portion 23 are pushed out by the protrusion 31 toward a space in an upper portion. At this time, a surface of the protrusion 31 is inclined relative to the liquid level (horizontal plane). Accordingly, buoyancy tends to be applied to bubbles and the like in the liquid, and the bubbles are pushed out for sure. In addition, since the horizontal sectional area of the protrusion 31 tapers perpendicularly downward, a distance between the outer periphery of the protrusion 31 and the inner periphery of the lower portion 23 gradually reduces when the lid 3 is attached to the container 2. Accordingly, it is possible to push out the liquid L gently into the space in the upper portion 22 and to prevent the liquid L in the container 2 from flowing.

[0048]

When the dome-shaped protrusion 31 is immersed in the liquid L, first, the vertex with a small area touches the liquid level, and then, the contact area gradually increases, which minimizes ripples of the liquid L in the container 2. The circular dome-shaped protrusion 31 pushes out the liquid L uniformly and radially along the circular dome. Accordingly, the liquid L in the container 2 does

not move in one direction in a radial direction, and consequently, the liquid L in the container 2 is prevented from flowing.

[0049]

5 When the seal 32 travels further, the bottom surface 34 and the packing ring R' come into contact with each other, but the gas and liquid in the lower portion 23 move through the groove of the packing ring R'. Furthermore, when the lid 3 is screwed, the bottom surface 34 presses the packing
10 ring R' and crushes the groove, whereby creating a liquid-tight space inside the container. In other words, in this modification, due to the groove disposed in the packing ring R', it is possible to crush the packing ring R' easily even when, for example, the space in the lower portion 23
15 is filled with a liquid. Here, if the packing ring R includes no groove, the liquid L has no space to move when a space F (not shown) surrounded by the bottom surface 34 of the seal 32, the packing ring R', and the lower portion 23 becomes liquid-tight. Accordingly, the liquid volume in
20 the space F filled with the liquid L cannot be changed, that is to say, a height of the packing ring R' cannot be reduced. Therefore, it becomes difficult to seal an opening 25 of the container 2.

[0050]

25 As described above, the second modification of the

device 1 according to the first embodiment of the present invention reliably creates a liquid-tight space inside a container and does not allow bubbles (gas) to enter the container. Accordingly, even when the container is shaken,
5 a fragile object is not damaged by motion of bubbles inside the container. Particularly, when the fragile object is a laminated body of sheet cell cultures, the laminated body is not deviated or chipped by motion of bubbles. In addition, even though dimensions of a container or a lid
10 are deviated during a production process, the container is reliably closed in a liquid-tight manner, which gives a great advantage in terms of design cost and production cost.
[0051]

Next, a third modification of the device 1 according to
15 the first embodiment of the present invention will be described. Hereinafter, differences from the first embodiment will be described in detail but similarities will not be described.

As shown in Fig. 4A, a device 1C according to the third
20 modification includes a container 2, a lid 3 that seals the container 2, a packing ring R, and a mesh plate M. In this modification, the packing ring R has a diameter smaller than an inside diameter of an upper portion 22 of the container 2 and larger than an inside diameter of a lower
25 portion 23. The mesh plate M has a mesh network and allows

a liquid L to pass therethrough. The mesh plate M has a diameter larger than the inside diameter of the lower portion 23 of the container 2 and smaller than the diameter of the packing ring R so that the mesh plate M is placed on
5 a stepped portion 24.

[0052]

As shown in Fig. 4B, when using the device 1C, the mesh plate M is placed on the stepped portion 24 of the container 2, and then, a fragile object S and the liquid L
10 are put in the container 2. At this time, the liquid L passes through the mesh plate M, but the fragile object S remains on the mesh plate M. Furthermore, the liquid L is poured into the container 2 until the liquid rises above the packing ring R. Then, the container 2 is sealed with
15 the lid 3 to create a liquid-tight space. As shown in the drawing, the fragile object S is preserved in the liquid-tight space between the mesh plate M and the seal 32 of the lid 3. When using the fragile object S, the lid 3 is removed, and the mesh plate M is taken out. Accordingly,
20 the fragile object S is taken out of the container 2 without being directly grabbed, which minimizes damages of the fragile object S.

[0053]

Although the present invention has been described with
25 reference to the illustrated embodiments, the present

invention is not limited thereto. For example, an annular dent for receiving the packing ring R or R' may be disposed on a lower surface of the seal 32, and the packing ring R or R' may be allowed to fit into the dent. Such a structure makes the lower surface of the seal 32 level with a lower surface of the packing ring R or R' and makes it difficult for bubbles to remain inside the container.

Furthermore, for example, a recess may be disposed in the stepped portion of the container, and the recess may hold a liquid pushed out from the container. With such a structure, even when the lid is removed, the liquid held in the recess does not return to the container. Accordingly, it is possible to prevent not only a flow of the liquid in the container but also contamination of a fragile object.

Still further, a packing ring may be interposed between the lid and the edge of the container so as to enhance sealing performance.

In the present invention, each component may be replaced with any component that exhibits similar function.

Alternatively, any component may be added to any component.

Reference Signs List

[0054]

1, 1A, 1B Device

2, 2A, 2B Container

22 Upper portion

- 23 Lower portion
- 24 Stepped portion
- 25 Opening in upper portion
- 26 Opening in lower portion
- 5 27 Engagement portion
- 28 External thread
- [0055]
- 3, 3A, 3B Lid
- 31 Protrusion
- 10 32 Seal
- 33 Engagement portion
- 34 Bottom surface
- 35 Outer periphery
- 36 Top board
- 15 37 Cylindrical skirt
- 38 Internal thread

CLAIMS

1. A device comprising:

a container that houses a fragile object, the container having a cylindrical shape including a bottom;

5 a lid; and

a seal mechanism including a seal,

wherein the container comprises a lower portion that houses the fragile object; an upper portion that includes an opening; and a stepped portion provided between the

10 lower portion and the upper portion,

the upper portion has an inside diameter larger than an inside diameter of the lower portion, and the stepped portion is a portion where an inside diameter of the container is sharply reduced,

15 the lid seals the opening of the upper portion,

the seal is interposed between the lid and the stepped portion to seal an opening of the lower portion,

the seal mechanism includes a packing ring between the seal and the stepped portion,

20 the packing ring has a groove perpendicular to the packing ring in a circumferential direction.

2. The device according to claim 1, wherein the seal is pressed by the lid and the stepped portion when the lid is

25 screwed into the container.

3. The device according to claims 1 or 2, wherein the opening of the upper portion is sealed with the lid simultaneously with or after sealing of the opening of the lower portion by the seal.

4. The device according to any one of claims 1 to 3, wherein the fragile object is a sheet cell culture.

10 5. The device according to any one of claims 1 to 4, wherein the sheet cell culture is a laminated body.