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(54) **LIQUID TRANSFER DEVICE AND SUCTION UNIT**

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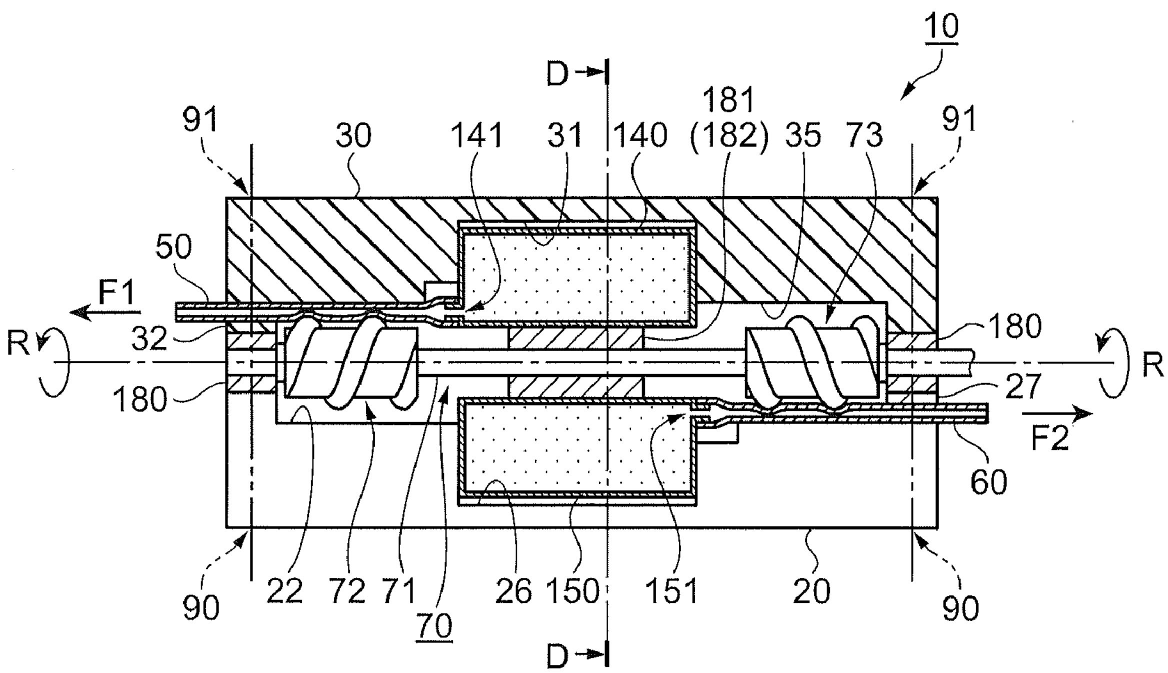
(57) **ABSTRACT**

A liquid transfer device that includes: a plurality of reservers that each store therein a liquid; a plurality of elastic tubes that are linked to the reservers and retained by a tube guide; a rotation axis that is retained to be able to rotate; and a tube depressing member whose depressing section is fixed to the rotation axis for depressing the tubes with a helical-structured convex portion provided thereto. In the liquid transfer device, when the rotation axis rotates, the liquid starts to flow by the depressing section sequentially depressing the tubes in a direction from the reservers toward a flow-out side of the liquid.



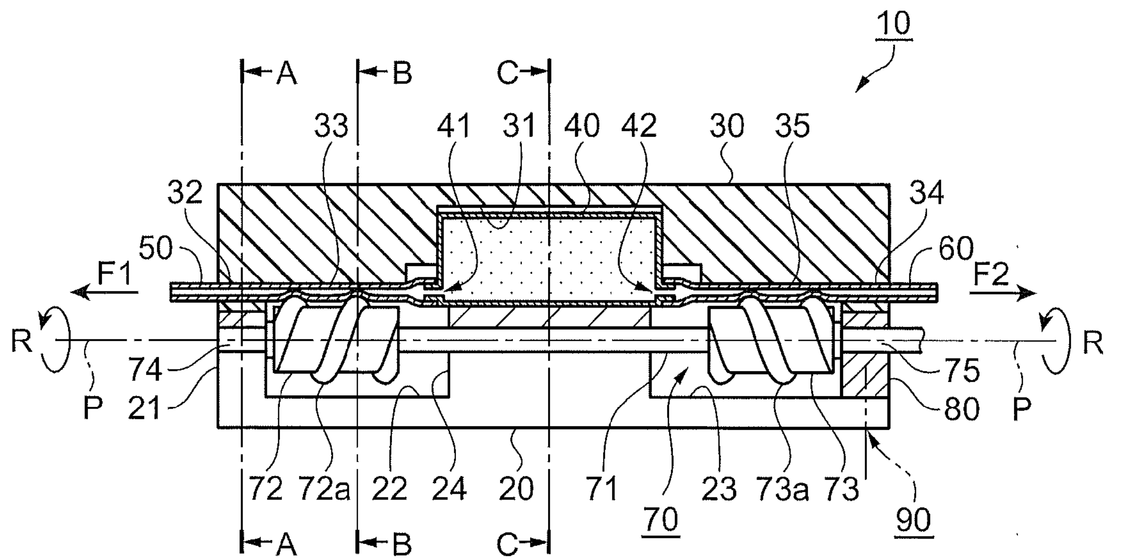


FIG. 1

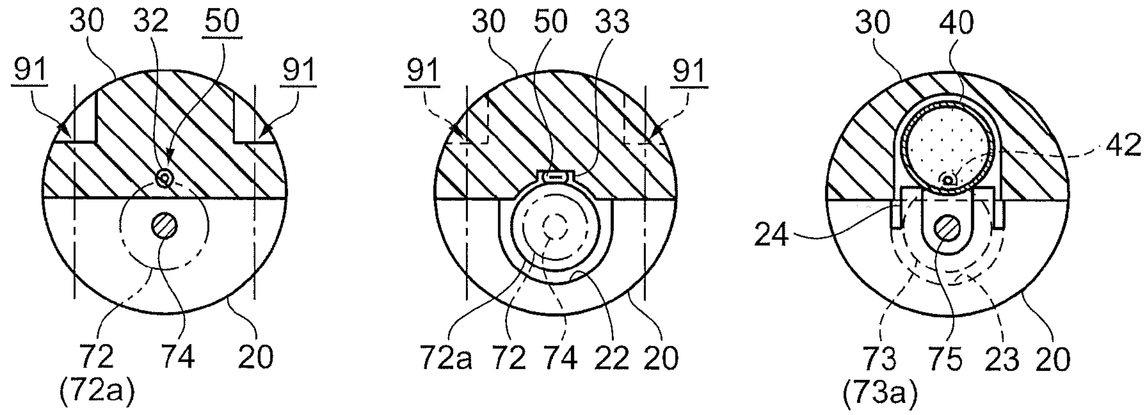
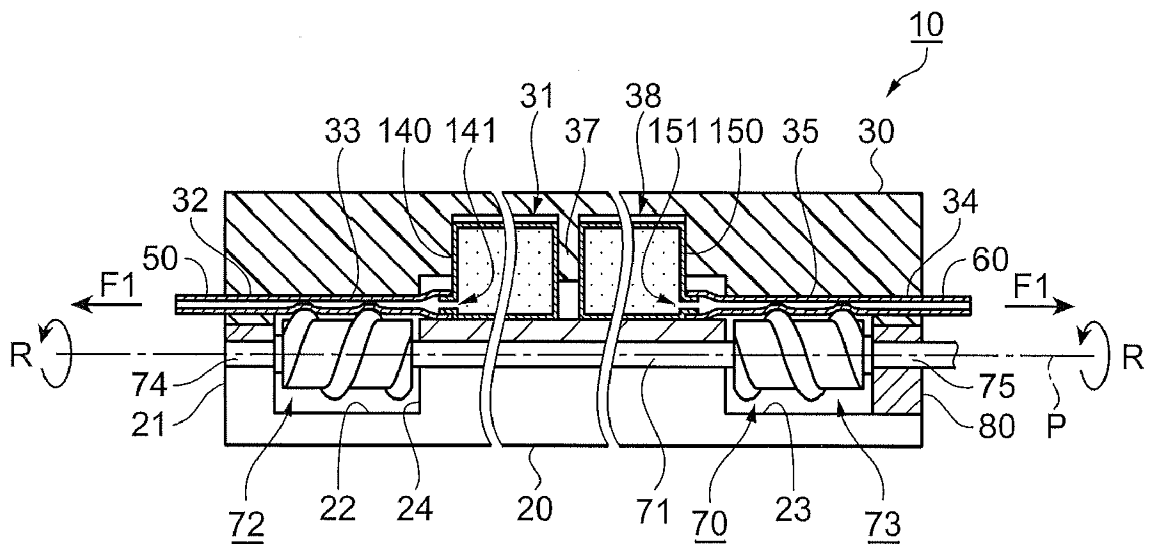


FIG. 2A FIG. 2B FIG. 2C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31
38
33
140
141
37
151
150
35
30
32
34
50
60
F1
F1
R
R
74
75
21
80
P
72
22
24
20
71
70
23
73

FIG. 3

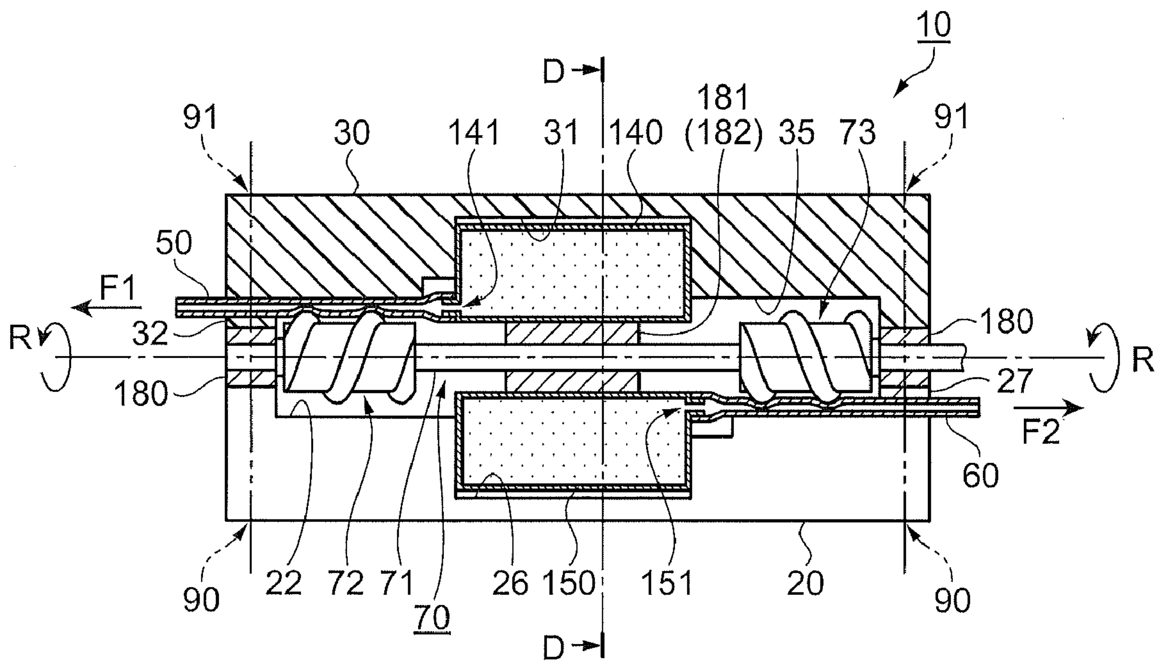
10
D
91
30
141
31
140
181
(182)
35
73
91
50
F1
32
R
180
180
R
27
F2
60
90
22
72
71
70
26
150
151
20
90
D

FIG. 4A

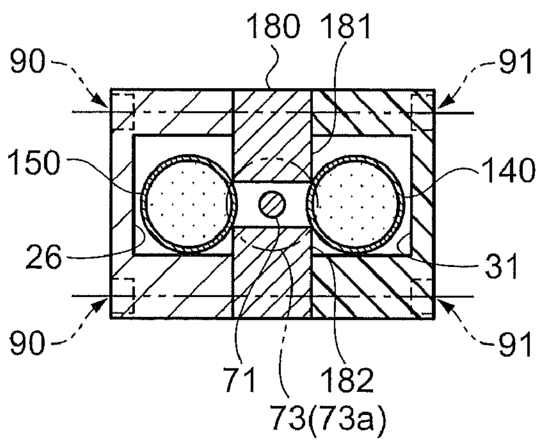
180
181
90
91
150
140
26
31
90
91
71
182
73(73a)

FIG. 4B

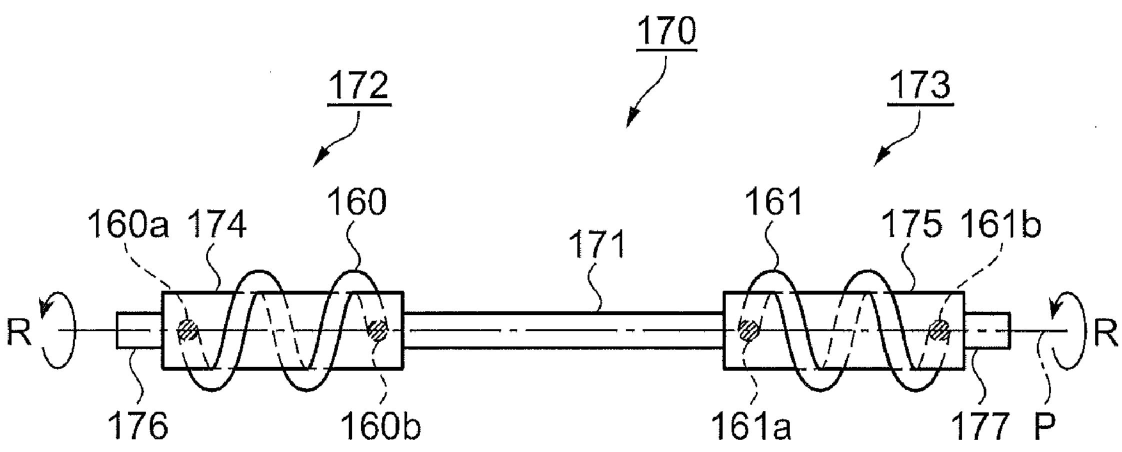
170
172
173
160a
174
160
171
161
175
161b
R
R
176
160b
161a
177
P

FIG. 5

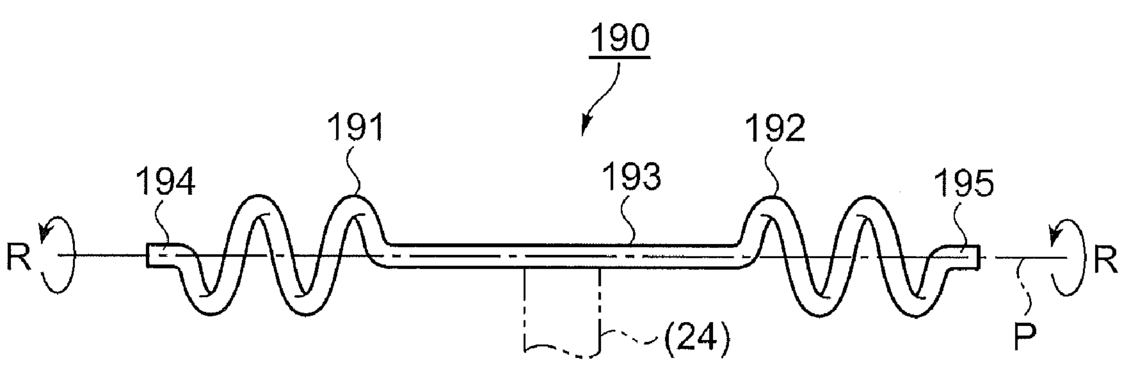
190
191
192
194
193
195
R
R
(24)
P

FIG. 6

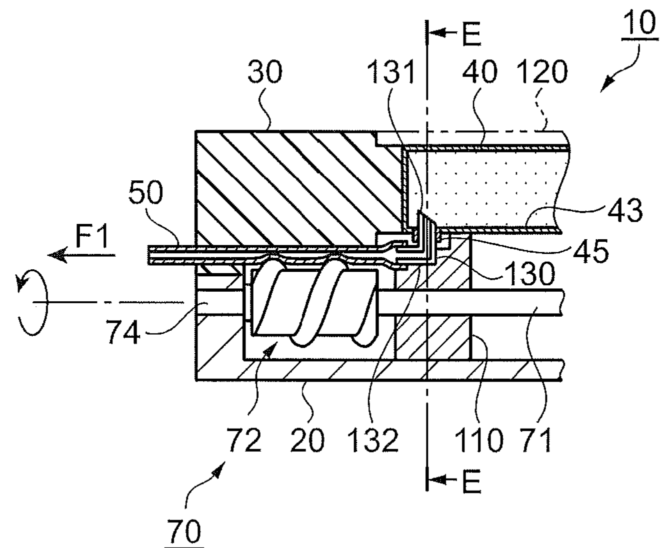

FIG. 7A

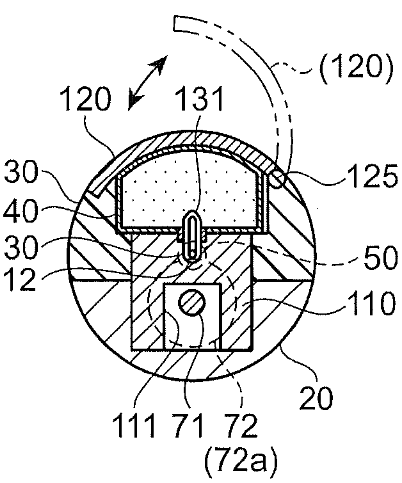

FIG. 7B

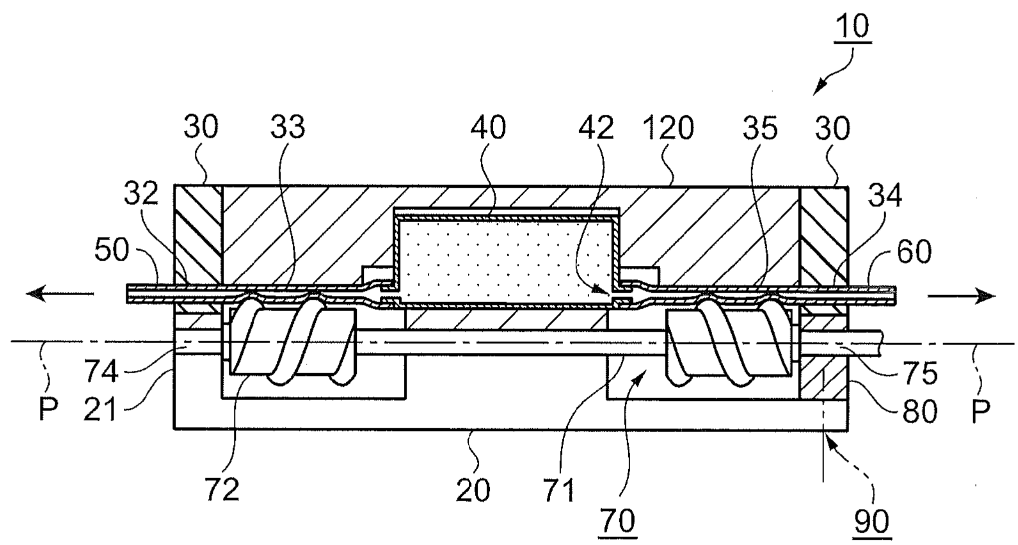

FIG. 8

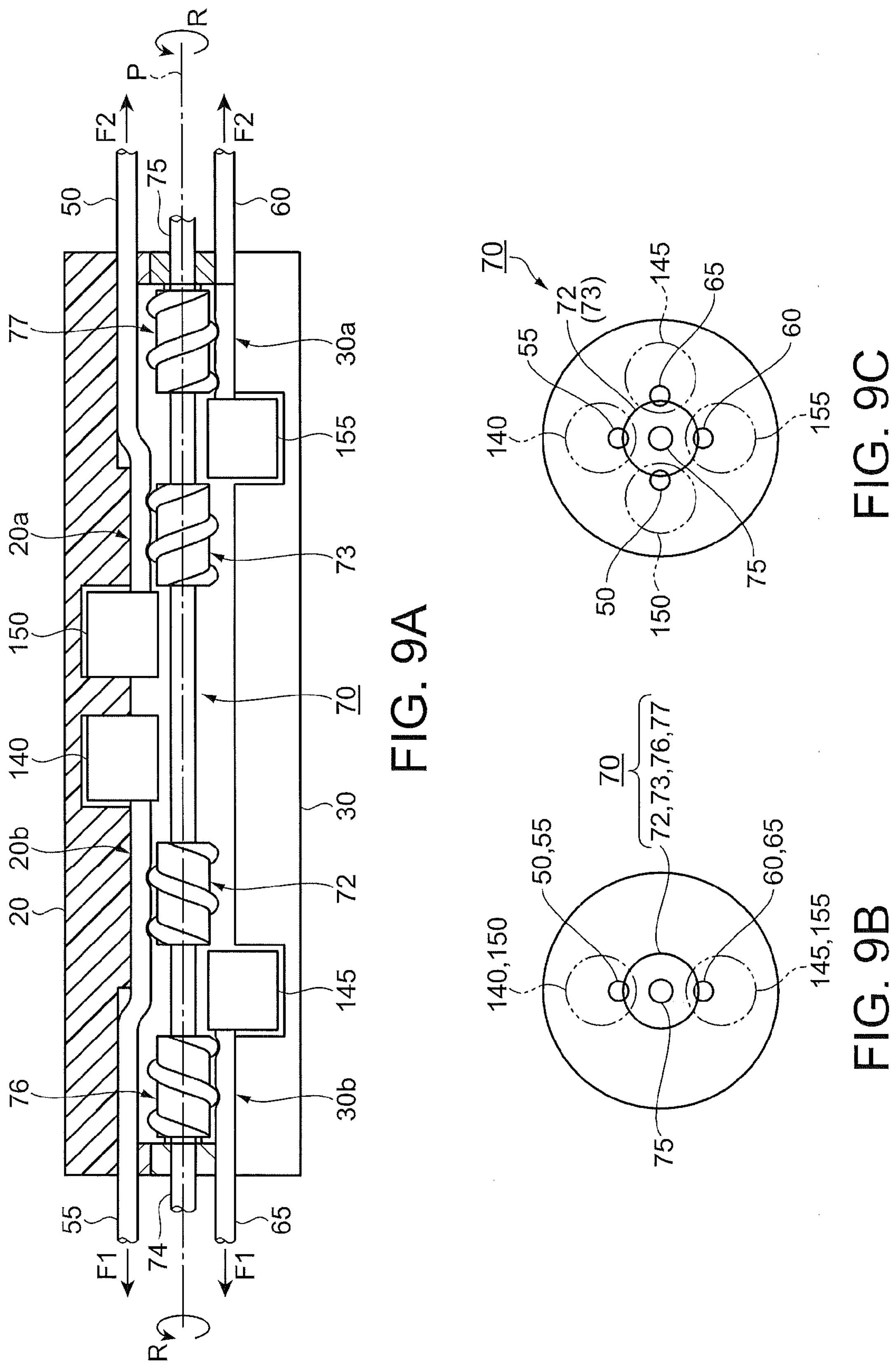

FIG. 9A

FIG. 9B

FIG. 9C

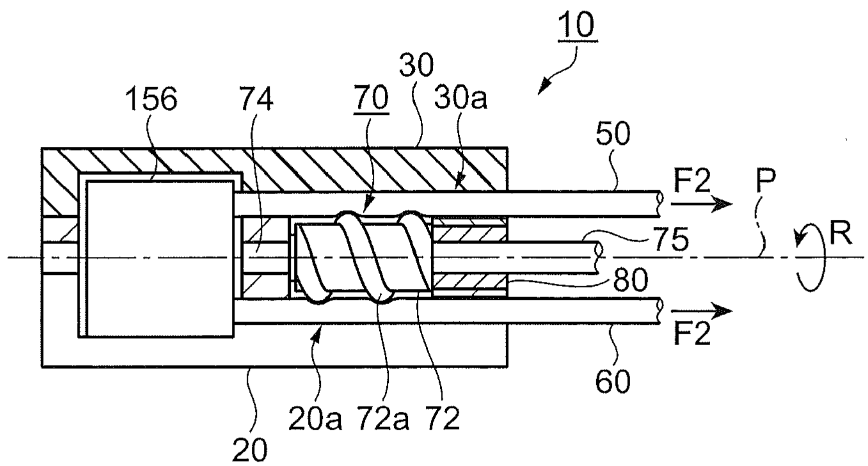

FIG.10A

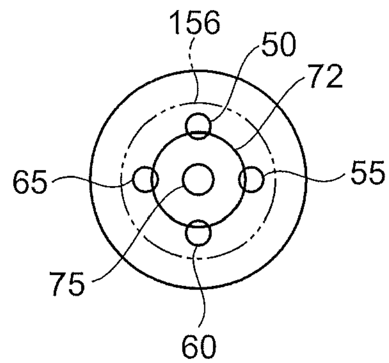

FIG.10B

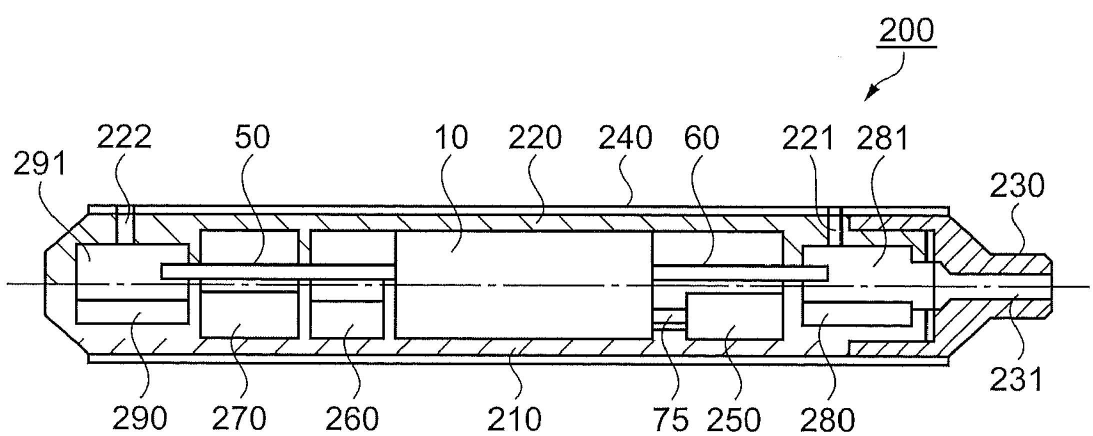

FIG.11

LIQUID TRANSFER DEVICE AND SUCTION UNIT

BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to a liquid transfer device that transfers a liquid in one or two different directions by depressing a plurality of tubes using a tube depressing member formed with a helical-shaped convex portion, and a suction unit including the liquid transfer device and an atomizer.

[0003] 2. Related Art

[0004] There has been known a tube pump (liquid transfer device) that includes a helical roller configured by a rotation axis disposed in parallel with a tube and a helical-structured convex portion formed on the rotation axis and operates to rotate the helical roller and depress the tube by the helical-structured convex portion, whereby a liquid is flowed (e.g., JP-A-2003-301778; p.p. 5 and 6, and FIG. 2).

[0005] The tube pump of JP-A-2003-301778 is of a configuration that the tube is depressed by the helical-structured convex portion formed on the rotation axis. The helical roller is thus implemented by such a simple configuration.

[0006] The problem here is that the tube pump of such a configuration has only one tube available for liquid transfer. For implementation of liquid transfer using a plurality of tubes, there requires a drive shaft with a plurality of cams, or a plurality of sets of a rotation axis with a helical-structured convex portion and a drive source such as a motor.

SUMMARY

[0007] A first aspect of the invention is directed to a liquid transfer device that includes: a plurality of reservers that each store therein a liquid; a plurality of elastic tubes that are linked to the reservers and retained by a tube guide; a rotation axis that is retained to be able to rotate; and a tube depressing member whose depressing section is fixed to the rotation axis for depressing the tubes with a helical-structured convex portion provided thereto. In the liquid transfer device, when the rotation axis rotates, the liquid starts to flow by the depressing section sequentially depressing the tubes in a direction from the reservers toward a flow-out side of the liquid.

[0008] With such a configuration that the tube depressing member is provided with a plurality of depressing sections provided as many as a plurality of tubes. There thus are effects of being able to transfer a liquid all at once from a plurality of tubes only by rotating a single tube depressing member without increasing any driving member.

[0009] A second aspect of the invention is directed to a liquid transfer device that includes: one reserver that stores therein a liquid; first and second tubes linked to the reserver in different directions; a rotation axis that is retained to be able to rotate; and a depressing member including a first depressing section that is fixed to the rotation axis and depresses the first tube using a helical-structured convex portion provided thereto, and a second depressing section that is fixed to the rotation axis and depresses the second tube using a helical-structured convex portion provided thereto with a helical direction opposite to that of the convex portion depressing the first tube. In the liquid transfer device, when the rotation axis rotates, the liquid starts to flow in two different directions by the first and second depressing sections sequentially depressing the first and second tubes in a direction from the reserver toward a flow-out side of the liquid.

[0010] With such a configuration that a single reserver is provided with two tubes each with a different linkage direction, and these tubes are depressed by a depressing section formed with two convex portions being formed with each different helical direction. As such, by rotating the tube depressing member, a liquid starts to flow in two different directions.

[0011] In the liquid transfer device of the first aspect, the reservers are first and second reservers, the tubes include first and second tubes, the depressing sections include first and second depressing sections whose helical-structured concave portions show each different helical direction, and the first tube is linked to the first reserver and the second tube is linked to the second reserver. The first and second tubes are extended in each different direction, and the liquid starts to flow in two different directions when the first and second depressing sections respectively depress the first and second tubes.

[0012] With such a configuration of including the first and second reservers respectively linked with the first and second tubes, when the first and second reservers store a different type of liquid, respectively, rotating the tube depressing member enables to transfer the two types of liquids at the same time in two different directions.

[0013] Also in such a liquid transfer device, preferably, the first and second reservers are disposed along the rotation axis.

[0014] With such a configuration that the first and second reservers are disposed along the rotation axis on a straight line, the resulting liquid transfer device can be in the shape of a long and slim tube.

[0015] Also in such a liquid transfer device, preferably, the first and second reservers are disposed around the rotation axis.

[0016] With such a configuration, compared with the above configuration in which the first and second reservers are disposed along the rotation axis, there are more effects of downsizing in the direction of liquid flow, i.e., in the liquid transfer direction.

[0017] Also in the liquid transfer device of the first aspect, preferably, the helical-structured convex portions respectively provided to the depressing sections are each a coil wound around the tube depressing member in each different helical direction.

[0018] In this way, the helical-shaped convex portion can be formed by a coil with more ease than by cutting work. Moreover, by using a coil lead having a circular cross section, as the material of the coil the surface where the first and second tubes come in contact with each other becomes smooth. Such a smooth surface leads to the effects of being able to reduce the resistance of contact of the surface at the time of depressing, thereby reducing the driving force. There are also effects of being able to increase the durability of the first and second tubes.

[0019] The coil can be varied in shape and winding outer diameter so that the convex portions can be easily changed in height, and the first and second depressing sections can be easily changed in maximum diameter. This accordingly achieves other effects of leading to the ease of adjustment in terms of the amount of liquid transfer per unit time.

[0020] Also in such a liquid transfer device, preferably, the tube depressing member is formed, as a piece, by a coil section corresponding to the convex portion of each of the depressing sections and the rotation axis.

[0021] With such a configuration in which the tube depressing member is formed as a piece by a plurality of coil sections and the rotation axis, the resulting device can be of a much simpler configuration. Such a tube depressing member can be specifically formed by wire forming or the like, thereby enabling cost reduction.

[0022] In the liquid transfer device of the first aspect, preferably, at least one of the tubes has an internal and/or external diameter different from other tubes, and the helical-structured convex portions of the depressing sections provided as many as the tubes have each different external diameter in accordance with the internal or external diameter of the corresponding tube.

[0023] When the first and second tubes have the same internal diameter, the amount of liquid transfer thereby is the same. By varying the internal and external diameters of the first and second tubes, i.e., the internal diameter being the cross-sectional area of the tube for a liquid to flow, the amount of liquid transfer can be varied between the first and second tubes only by a single tube depressing section operating in response to the rotation of the tube depressing member about the rotation axis of the shared use by the tubes. With a configuration of including the above-described first and second reservers storing each different type of liquid, any desired amount of liquid transfer can be implemented in accordance with the type of the liquid.

[0024] In the liquid transfer device of the first aspect, preferably, the tubes are retained by the tube guide while being linked to the reservers, and the tube guide including the reservers and the tubes is configured to be attachable/detachable to/from a device frame keeping hold of the rotation axis.

[0025] With such a configuration, users find it easy to make a replacement of a reserver(s) and a liquid refilling. The liquid transfer device in the embodiments of the invention is a tube pump for transferring a liquid by depressing the tubes using a tube depressing member, and once it is assembled, the tubes remain depressed by a convex portion of the tube depressing member. Accordingly, there may be a possibility that the tubes may suffer from permanent deformation if the tubes remain depressed for a long time. However, such permanent deformation of the tubes can be prevented if a tube guide is attached to a device frame only at the time of driving the liquid transfer device.

[0026] In the liquid transfer device of the first aspect, preferably, an insertion pipe is provided at an end portion of each of the tubes on a reserver side for linkage to the reservers, and a tip end portion of the insertion pipe is inserted into each of the reservers for linkage therewith, and the tubes can be inserted/removed into/from the reservers.

[0027] This configuration enables a replacement only of a reserver(s), and with a replacement of a reserver(s), a liquid refilling can be made with ease. For replacement of a reserver (s), the components, i.e., the first and second tubes and the tube guide, are not necessarily replaced because these can be good for repeated use, thereby favorably leading to economic effects.

[0028] In the liquid transfer device of the first aspect, preferably, an open/close lid is provided to a portion of the tube guide covering the reservers.

[0029] With such a configuration, the reserver(s) can be replaced when the open/close lid is open, and when the open/close lid is closed, the reservers can be retained in position at the time of driving, and can be protected from any external forces and the like.

[0030] Also in such a liquid transfer device, preferably, the open/close lid is provided in the area including the reservers and part of the tube guide supporting the tubes except end portions in the length direction thereof.

[0031] With such a configuration, by opening the open/close lid, a replacement of a reserver(s) can be made in the state that the reservers and the tubes are linked to each other.

[0032] In the liquid transfer device of the first aspect, preferably, the reservers are disposed in a multiple-connected arrangement along the rotation axis, at least one of the tubes provided as many as the reservers is linked thereto in a direction different from other tubes, and the depressing sections show each different helical direction in accordance with the direction of linkage of each of the tubes.

[0033] With such a configuration, the tube depressing member is provided with a plurality of depressing sections provided as many as a plurality of reservers, i.e., tubes, and some of the convex portions of the pressing sections show the helical direction opposite to that of the remaining. This accordingly enables to increase the amount of liquid transfer, and enables a liquid to flow in two different directions.

[0034] Also with the configuration in which a plurality of reservers are disposed in a multiple-connected arrangement along the rotation axis, the size reduction can be achieved especially in the diameter direction.

[0035] In the liquid transfer device of the first aspect, preferably, the reservers are disposed around the rotation axis, at least one of the tubes provided as many as the reservers is linked thereto in a direction different from other tubes, and the depressing sections are respectively provided with helical-structured convex portions that show each different helical direction in accordance with the direction of linkage of each of the tubes.

[0036] With such a configuration, the tube depressing member is provided with a plurality of depressing sections provided as many as a plurality of reservers, i.e., tubes, and some of the convex portions of the pressing sections show the helical direction opposite to that of the remaining. This accordingly enables to increase the amount of liquid transfer, and enables a liquid to flow in two different directions.

[0037] Also with the configuration in which a plurality of reservers are disposed around the rotation axis, the size reduction can be achieved especially in the length direction, i.e., the direction of liquid flow.

[0038] In the liquid transfer device of the first aspect, preferably, one of the reservers is disposed at one end portion of the tube depressing member, and the reservers are provided with the tubes around the depressing sections.

[0039] With such a configuration, the area for disposing the reservers can be extended to the vicinity of the outer diameter of the liquid transfer device. This accordingly enables to increase the capacity of the reservers, and to flow a large amount of liquid in one specific direction.

[0040] Also in such a liquid transfer device, preferably, the depressing sections are disposed in a multiple-connected arrangement, and at least one of the depressing sections is provided with a convex portion showing a helical direction different from other depressing sections.

[0041] With such a configuration, some of the tubes make a liquid flow out from the reservers, and other remaining tubes make the liquid flow into the reservers. It means that providing the tubes for liquid flow-in as many as the tubes for liquid flow-out can equalize the amount of liquid flow-in and flow-out. If this is the case, by linking the tubes for liquid flow-in to any external liquid storage container, the liquid can be refilled by the flow-out amount while the liquid transfer device is being driven.

[0042] A third aspect of the invention is directed to a suction unit that includes: the liquid transfer device of the first aspect; a first atomizer that atomizes a liquid coming from at least one of the tubes; a second atomizer that atomizes a liquid coming from at least another one of the tubes; a motor that provides a rotation force to the tube depressing member; a control section that includes a control circuit for controlling over the first and second atomizers, and a drive control circuit for controlling the motor to drive; and a power supply section that makes a supply of power to the control section. In the suction unit, the power supply section, the control section, the first and second atomizers, and the liquid transfer device are disposed in the inside of a tubular chassis along the longitudinal direction of the chassis, and an aperture section is provided for ejection or suction of liquid particles atomized by each of the first and second atomizers.

[0043] With the suction unit of the third aspect of the invention, the liquid stored in the reservers is transferred to the first and second atomizers by the liquid transfer device, and is atomized by the first and second atomizers so that the atomized liquid particles can be ejected or sucked.

[0044] With such a configuration of including the power supply section, the control section, the first and second atomizers, and the liquid transfer device in the tubular chassis, the satisfactory level of portability can be achieved.

[0045] In the suction unit of the third aspect, preferably, one of the aperture sections is a suction port for suction of the atomized liquid particles, and the other is an ejection port for ejection of the atomized liquid particles.

[0046] With such a configuration, the first and second reservers store therein each different type of liquid, and from the suction port, different types of liquid particles are sucked, and from the ejection port, atomized liquid particles are ejected. As such, the liquid particles can be sucked while visually observing the generating state of the liquid particles on the side of the ejection port.

[0047] Assuming that the suction unit is an artificial cigarette, from the suction port, a user can simulate smoking by sucking flavor particles, and from the ejection port, the user can eject dummy smoke particles. As such, provided is a dummy smoking unit being safe and harmless for health and environment while allowing a user to enjoy the atmosphere of smoking.

[0048] In the suction unit of the third aspect, preferably, the suction port is provided at both ends of the chassis in a length direction for suction of the atomized liquid particles.

[0049] With such a configuration in which the first and second reservers store therein each different type of liquid, different types of liquid particles can be respectively sucked from the suction port provided at two positions.

[0050] In the suction unit of the third aspect, preferably, the chassis is configured by upper and lower frames, and the upper and lower frames are configured to be attachable/detachable, and at least the liquid transfer device and the power supply section can be attached/detached thereto/therefrom.

[0051] With such a configuration in which the upper and lower frames can be separated, consumable items such as power supply section, i.e., small-sized battery, and reservers can be replaced with ease.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0053] FIG. **1** is a vertical cross sectional view of a liquid transfer device of a first embodiment.

[0054] FIGS. **2**A to **2**C are horizontal cross sectional views of the liquid transfer device of FIG. **1**, i.e., FIG. **2**A is a cross sectional view of the device along a line A-A, FIG. **2**B is a cross sectional view of FIG. **2**A along a line B-B, and FIG. **2**C is a cross sectional view of FIG. **2**A along a line C-C.

[0055] FIG. **3** is a vertical cross sectional view of a liquid transfer device of a second embodiment.

[0056] FIGS. **4**A and **4**B are diagrams showing a liquid transfer device of a modified example in the second embodiment, wherein FIG. **4**A is a cross sectional view of the liquid transfer device when viewed from the above, and FIG. **4**B is a cross sectional view of FIG. **4**A along a line D-D.

[0057] FIG. **5** is a front view of a tube depressing member of a third embodiment.

[0058] FIG. **6** is a front view of a tube depressing member in a fourth embodiment.

[0059] FIGS. **7**A and **7**B are diagrams showing a liquid transfer device of a fifth embodiment, wherein FIG. **7**A shows a part of the vertical cross sectional view of the device, and FIG. **7**B is a cross sectional view of FIG. **7**A along a line E-E.

[0060] FIG. **8** is a cross sectional view of a liquid transfer device of a sixth embodiment.

[0061] FIGS. **9**A to **9**C are diagrams showing an exemplary liquid transfer device of a seventh embodiment, wherein FIG. **9**A is a vertical cross sectional view of the device, FIG. **9**B is a layout diagram when the liquid transfer device of FIG. **9**A is viewed from the direction of a tip end, and FIG. **9**C is a layout diagram showing a modified example.

[0062] FIGS. **10**A and **10**B are diagrams showing a liquid transfer device of an eighth embodiment, wherein FIG. **10**A is a vertical cross sectional view of the device, and FIG. **10**B is a front view of the device when viewed from the direction of a tip end, i.e., right side in the drawing.

[0063] FIG. **11** is a vertical cross sectional view of an exemplary suction unit in an embodiment of the invention, showing the schematic configuration thereof.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0064] In the below, embodiments of the invention are described by referring to the accompanying drawings.

[0065] FIGS. **1** to **2**C each show a liquid transfer device of a first embodiment, FIG. **3** shows a second embodiment, FIGS. **4**A and **4**B each show a modified example of the second embodiment, FIG. **5** shows a third embodiment, FIG. **6** shows a tube depressing member of a fourth embodiment, FIGS. **7**A and **7**B each show a fifth embodiment, FIG. **8** shows a sixth embodiment, FIGS. **9**A to **9**C each show a seventh embodiment and a modified example thereof, FIGS. **10**A and **10**B each show a liquid transfer device of an eighth embodiment, and FIG. **11** shows a suction unit of an embodiment of the invention.

[0066] Note here that the diagrams to be referred to in the below are schematic diagrams in which, for convenience, components and sections are under a different scaling from those in actuality.

First Embodiment

[0067] FIG. **1** is a vertical cross sectional view of a liquid transfer device of a first embodiment, and FIGS. **2**A to **2**C are horizontal cross sectional views of the liquid transfer device of FIG. **1**, i.e., FIG. **2**A is a cross sectional view of the device along a line A-A, FIG. **2**B is a cross sectional view of FIG. **2**A along a line B-B, and FIG. **2**C is a cross sectional view of FIG. **2**A along a line C-C. In FIGS. **1** to **2**C, a liquid transfer device **10** is configured to include a reserver **40** storing therein a liquid, first and second tubes **50** and **60**, and a tube depressing member **70**. The first tube **50** is made elastic, and is extended in one direction after being linked to the reserver **40**. The second tube **60** is also made elastic, and is extended in a direction opposite to that of the first tube **50** after being linked to the reserver **40**. The tube depressing member **70** is provided for depressing both the first and second tubes **50** and **60**.

[0068] As shown in FIG. **1**, at the lower portion of the reserver **40**, i.e., in the vicinity of the bottom portion thereof, first and second outlet sections **41** and **42** are provided for ejection of a liquid to the outside of the reserver **40**. The first and second outlet sections **41** and **42** are respectively provided to the sides of the reserver **40** in the longitudinal direction, and are each formed with a tubular protrusion portion toward the outside. To these protrusion portions, the first and second tubes **50** and **60** are respectively attached.

[0069] The first and second tubes **50** and **60** are made of a material having an elasticity which allows them to deform in the cross sectional direction when being depressed, and to quickly return to the original cross sectional shape when the depressing force is released, and a resistance against any liquid for use. In the state of being linked to the reserver **40**, the first and second tubes **50** and **60** are retained with their positions controlled by a tube guide **30**. In this embodiment, the first and second tubes **50** and **60** have the same cross sectional shape, and are both extended along substantially the same straight line.

[0070] The tube guide **30** has a semicircular transverse cross section, and is configured to include, on the side of the first tube **50**, a reserver housing section **31**, a through hole **32**, and a first tube retaining groove **33** (refer to FIGS. **2**A and **2**B). The reserver housing section **31** is formed like a concave portion for housing most of the reserver **40**. The through hole **32** is inserted with the first tube **50**, and keeps hold of the first tube **50**. The first tube retaining groove **33** serves for position control over the cross sectional direction.

[0071] The tube guide **30** is configured to include, on the side of the second tube **60**, a through hole **34** and a second tube retaining groove **35**. The through hole **34** is inserted with the second tube **60**, and keeps hold of the second tube **60**. The second tube retaining groove **35** also serves for position control over the cross sectional direction.

[0072] As such, the tube guide **30** is attached with the first and second tubes **50** and **60** both being linked to the reserver **40**, thereby allowing the handling of the components as a piece, i.e. the tube guide **30**, the reserver **40**, and the first and second tubes **50** and **60**, that is, enabling attachment/detachment of those components as a piece to/from a device frame **20**.

[0073] In the tube guide **30**, in the cross sectional direction, the reserver housing section **31** is disposed with a space from the tube guide **30**, and in the longitudinal direction, controls the movement of the reserver **40**.

[0074] The device frame **20** is provided to oppose the tube guide **30**. The device frame **20** has a semicircular transverse cross section, and on the side of the tube guide **30**, is formed with concave sections **22** and **23**, and a reserver retaining section **24** being concave.

[0075] The tube depressing member **70** is made of a material with a rigidity, and in the directions of both ends, first and second depressing sections **72** and **73** of a cylindrical shape are respectively provided. To the perimeter of the first depressing section **72**, a helical-structured convex portion **72***a* is provided, and to the perimeter of the second depressing section **73**, a helical-structured convex portion **73***a* is provided.

[0076] The convex portions **72***a* and **73***a* have the same cross sectional shape but have opposite helical directions, and in the example of FIG. **1**, assuming that the convex portion **72***a* is of a left-handed helical structure, and the convex portion **73***a* is of a right-handed helical structure. The first and second depressing sections **72** and **73** are disposed on the extension of a common rotation axis P, and are coupled together by a coupling shaft **71**.

[0077] The tube depressing member **70** is respectively provided with, support shafts **74** and **75** at the ends thereof. The support shaft **74** is inserted into a through hole formed in a support frame section **21** of the device frame **20** (refer also to FIG. **2**A), and the remaining support shaft **75** is inserted into a through hole formed in a tube depressing member support frame **80**. The tube depressing member **70** is allowed to be able to freely rotate. Note that the tube depressing member support frame **80** is fixed to the device frame **20** by a screw **90** (not shown).

[0078] Although not shown, the tip end portion of the support shaft **75** of the tube depressing member **70** is protruded from the tube depressing member support frame **80**, and is coupled to a motor that is also not shown.

[0079] The tube depressing member **70** is disposed in parallel with the direction along which the first and second tubes **50** and **60** are extended with a predetermined distance therefrom. Herein, the predetermined distance is of a range that allows the convex portions **72***a* and **73***a* to tightly close the holes formed in the first and second tubes **50** and **60** for liquid flow therethrough, and the perimeter of the cylindrical portion of the first depressing section **72** and that of the second depressing section **73** do not come in contact with, respectively, the perimeter portion of the first tube **50** and that of the second tube **60**.

[0080] Note here that the device frame **20** is provided with the reserver retaining section **24** to be protruded below the reserver **40** so that the reserver **40** is supported thereby to be in place (refer also to FIG. **2**C).

[0081] The tube guide **30** attached with the reserver **40** is combined, to be a piece, with the device frame **20** attached with the tube depressing member **70** using a screw **91** (not shown), i.e., combined by bringing their surfaces of the chords of the semicircles very close to each other. As a result, the liquid transfer device **10** becomes a cylinder with the cross section of substantially circular. Alternatively to the position in FIGS. **2**A to **2**C example, the tube guide **30** and the device frame **20** may be fixed together by screws at a plurality of positions where fixation is possible with good balance.

[0082] Also by referring to FIGS. **1** to **2**C, described next is how to drive the liquid transfer device **10** of the embodiment. When the tube depressing member **70** is rotated in the direction of an arrow R by a motor, the convex portion **72***a* of a left-handed helical structure provided in the first depressing section **72** depresses and blocks the first tube **50**. As to the convex portion **72***a* depressing the first tube **50** as such, the depressing portion thereof sequentially moves in the direction of F**1** in response to the rotation. At this time, the liquid in the first tube **50** is moved in the direction of F**1** for flowing out. The convex portion **72***a* is set with the winding count and pitch such that at least one part of the convex portion **72***a* always blocks the first tube **50**.

[0083] Also in the second depressing section **73**, the convex portion **73***a* similarly depresses the second tube **60**, but its depressing portion sequentially moves in the direction of F**2** because the convex portion **73***a* is of a right-handed helical structure, and the liquid in the second tube **60** is moved in the direction of F**2** for flowing out.

[0084] As such, in the first embodiment described above, the tube depressing member **70** is provided with the depressing sections **72** and **73** corresponding to a plurality of tubes, i.e., the tubes **50** and **60**. This leads to effects of enabling transfer of a liquid all at once from the tubes only by rotating the tube depressing member **70** with no increase of components for driving use.

[0085] Also in the first embodiment, the first tube **50** is depressed by the helical-structured convex portion **72***a* provided in the first depressing section **72**, and the second tube **60** is depressed by the convex portion **73***a* provided in the second depressing section **73** so that a liquid is transferred to the outside from the reserver **40**. The convex portion **72***a* of the first depressing section **72** is helically structured with a helical direction opposite to that of the convex portion **73***a* of the second depressing section **73**. As such, when the tube depressing member **70** is rotated about the common rotation axis P of shared use, the liquid can be moved to flow from the reserver **40** all at once through the first and second tubes **50** and **60** in the directions of F**1** and F**2**, respectively.

[0086] Also in the first embodiment, the tube depressing member **70** is configured as a piece by the first and second depressing sections **72** and **73** and the coupling shaft **71**. As such, a small-sized liquid transfer device of a cylindrical shape, i.e., a liquid transfer device of a size especially small in the diameter direction, can be implemented with a simple configuration while enabling liquid transfer in two different directions.

[0087] Also in the first embodiment, the reserver **40** is retained by the tube guide **30** in the state that the first and second tubes **50** and **60** are linked thereto. With the configuration that the tube guide **30** including the first and second tubes **50** and **60** is attachable/detachable to/from the device frame **20**, removing the tube guide **30** from the device frame **20** allows an easy replacement of the reserver **40** attached with the first and second tubes **50** and **60**, thereby leading also to easy liquid refilling.

[0088] The liquid transfer device **10** of the first embodiment is a tube pump for transferring a liquid by depressing the tubes using the tube depressing member, and once it is assembled, the first and second tubes **50** and **60** remain depressed respectively by part of each of the convex portions **72***a* and **73***a*. As a result, the first and second tubes **50** and **60** may suffer from permanent deformation if those remain depressed for a long time. However, such permanent deformation of the first and second tubes **50** and **60** can be prevented if the tube guide **30** is attached to the device frame **20** only at the time of driving the liquid transfer device **10**.

[0089] Also in the first embodiment above, the first and second tubes **50** and **60** have the same cross sectional shape, and the tube depressing member **70** is rotated at the same rotation speed. Accordingly, the amount of liquid flowing through the first and second tubes **50** and **60** can be made the same.

[0090] Exemplified in the above first embodiment is the case where the first and second tubes **50** and **60** have the same cross sectional shape. Alternatively, the first and second tubes **50** and **60** may have different internal and/or external diameters, respectively. If this is the case, by setting the external diameters of the first and second depressing sections **72** and **73** and the maximum diameters of the convex portions **72***a* and **73***a* so as to able to open and block the respective tubes, the amount of liquid flowing through the first and second tubes **50** and **60** can be changed as appropriate.

Second Embodiment

[0091] Next, a liquid transfer device of a second embodiment is described by referring to the accompanying drawings. In the second embodiment, a reserver is characteristically configured by two parts. Herein, any difference from the first embodiment is mainly described, and any component similar to that in the first embodiment described above is not described twice, and is provided with the same reference numeral.

[0092] FIG. **3** is a vertical cross sectional view of the liquid crystal device of the second embodiment. In FIG. **3**, a reserver is configured by first and second reservers **140** and **150**. In this embodiment, the first and second reservers **140** and **150** are disposed along the rotation axis P, and the first and second tubes **50** and **60** are disposed along the rotation axis P in directions opposite to each other.

[0093] The first reserver **140** is formed with an outlet section **141** for moving a liquid to flow to the outside of the first reserver **140**, and the first tube **50** is linked thereto. On the other hand, the second reserver **150** is formed with an outlet section **151** for moving a liquid to flow to the outside of the second reserver **150**, and the second tube **60** is linked thereto.

[0094] The first and second reservers **140** and **150** may store the same or different types of liquids.

[0095] The first and second reservers **140** and **150** may have the same or different capacity.

[0096] In the tube guide **30**, a partition wall **37** is provided between the first and second reservers **140** and **150**. That is, the first reserver **140** is housed in a reserver housing section **31**, and the second reserver **150** is housed in a second reserver housing section **38** so that the first and second reservers **140** and **150** are under the position control not to move at the time of driving the liquid transfer device **10**.

[0097] In the second embodiment, the first and second reservers **140** and **150** are provided as such. When the first and second reservers **140** and **150** store therein each different type of a liquid, rotating the tube depressing member **70** enables to transfer two different types of liquids all at once.

[0098] In this case, if the first and second reservers **140** and **150** have the same capacity, the liquid flow-out can be completed substantially at the same time, and if with each different capacity, the completion time of liquid flow-out can be made different.

[0099] If the internal and/or external diameters of the first and second tubes **50** and **60** are set with various value combinations in a range of allowing to open and block the tubes, under the same rotation requirements for the tube depressing member **70**, the amount of liquid transfer can be set as appropriate in accordance with the type of a liquid to be stored, and the completion time for liquid flow-out can be made different.

[0100] With a configuration that the internal and/or external diameters of the first and second tubes **50** and **60** are set differently respectively, the value setting of allowing to open and block the tubes is made for the external diameters of the first and second depressing sections **72** and **73** and the maximum diameters of the convex portions **72***a* and **73***a*. With such a value setting, the amount of liquid flowing through the first and second tubes **50** and **60** can be changed as appropriate.

[0101] Moreover, with the configuration that the first and second reservers **140** and **150** are disposed along the rotation axis P, the resulting liquid transfer device **10** can be shaped like a long and slim tube.

Modified Example of Second Embodiment

[0102] Described next is a modified example of the second embodiment by referring to the accompanying drawings. Compared with the second embodiment described above, this modified example is characterized in that the first and second reservers **140** and **150** are disposed around the rotation axis P, i.e., the tube depressing member **70**. Therefore, any component similar to that of the second embodiment is provided with the same reference numeral, and any difference from the second embodiment is mainly described.

[0103] FIGS. **4**A and **4**B are each a diagram showing a liquid transfer device in the modified example of the second embodiment, i.e., FIG. **4**A is a cross sectional view of the liquid transfer device when viewed from the above, and FIG. **4**B is a cross sectional view of FIG. **4**A along a line D-D. In FIGS. **4**A and **4**B, the second reserver **150** is disposed on the side opposite to the first reserver **140** with the tube depressing member **70** disposed therebetween. As such, the second reserver **150** is housed in the second reserver housing section **26** provided in the device frame **20**.

[0104] The tube depressing member **70** is supported by a tube depressing member support frame **180** to be able to freely rotate. The tube depressing member support frame **180** is disposed between the device frame **20** and the tube guide **30**.

[0105] The tube depressing member support frame **180** is a plate-like frame member, and its perimeter portion is press-contacted between the device frame **20** and the tube guide **30**. Between the first and second reservers **140** and **150**, reserver support sections **181** and **182** are protruded, thereby supporting the first and second reservers **140** and **150** (refer to FIG. **4**B).

[0106] The second tube **60** linked to the second reserver **150** is protruded to the outside of the device frame **20** through the second tube retaining section **27** provided in the device frame **20**.

[0107] Also in this modified example configured as such, when the tube depressing member **70** is rotated in the direction of the arrow R, from the first tube **50**, a liquid stored in the first reserver **140** is moved to flow in the direction of F**1**, and from the second tube **60**, a liquid stored in the second reserver **150** is moved to flow in the direction of F**2**.

[0108] In FIG. **4**B, exemplified is the case where the first and second reservers **140** and **150** both have a circular cross section. The cross section is not necessarily circular in shape, and may be of a shape along the inner wall of the reserver housing section **31** of the tube guide **30** and that of the second reserver housing section **26** of the device frame **20**, respectively. The first and second reservers **140** and **150** may vary in size, i.e., liquid capacity.

[0109] If this is the case, the outlet section **141** of the first reserver **140** and the outlet section **151** of the second reserver **150** are both preferably provided in the vicinity of the bottom portion of the respective reservers. This configuration enables to reduce the amount of liquid to be left in the reservers at the time of driving the liquid transfer device **10**.

[0110] In such a modified example, if with a liquid transfer device of the capacity same as that in the second embodiment described above (refer to FIG. **3**), a reserver for use can store a larger amount of liquid.

[0111] Note that exemplified in FIG. **4**B is the case where the outer cross section of the liquid transfer device **10** is a rectangle. The cross section is not necessarily rectangular in shape, and may be of a shape along the inner wall of the reserver housing section **31** or that of the second reserver housing section **26** so as to increase the volumetric efficiency.

[0112] In the above-described modified example, removing the tube guide **30** from the device frame **20** (attached with the tube depressing member support frame **180**) allows a replacement of the first reserver **140**, and removing the device frame **20** from the tube guide **30** (attached with the tube depressing member support frame **180**) allows a replacement of the second reserver **150**.

[0113] Note here that the placement direction of the first and second reservers **140** and **150** is not restrictive to the plane direction shown in FIG. **4**B, and may be any arbitrary position, i.e., position in the rotation direction about the rotation axis P, as long as the distance between the first tube **50** and the first depressing section **72** is made the same as the distance between the second tube **60** and the second depressing section **73**.

Third Embodiment

[0114] Next, a liquid transfer device of a third embodiment is described by referring to the accompanying drawings. The third embodiment is characterized in the configuration of a tube depressing member, and any remaining components are structurally adaptable to those in the first and second embodiments described above. A description is thus given about the tube depressing member by referring to the drawing.

[0115] FIG. **5** is a front view of a tube depressing member of the third embodiment. In FIG. **5**, a tube depressing member **170** is configured to include first and second depressing sections **172** and **173**, a coupling shaft **171**, and support shafts **176** and **177**. The coupling shaft **171** serves to couple together the first and second depressing sections **172** and **173**, and the support shafts **176** and **177** are respectively provided to end portions of the tube depressing member **170**.

[0116] Note here that these components, i.e., the first and second depressing sections **172** and **173**, the coupling shaft **171**, and the support shafts **176** and **177**, are coupled together on the extension of the common rotation axis P.

[0117] The first depressing section **172** is provided with a first coil **160** as a helical-structured convex portion, which is wound around a first depressing shaft **174** of a cylindrical shape. At both ends of the first coil **160**, fixing portions **160***a* and **160***b* are provided to be inserted respectively to hole portions drilled in the first depressing shaft **174**. Utilizing the elasticity of the first coil **160**, the fixing portions **160***a* and **160***b* are fixed to the first depressing shaft **174**.

[0118] On the other hand, the second depressing section **173** is provided with a second coil **161** as a helical-structured convex portion, which is wound around a second depressing shaft **175** of a cylindrical shape. At both ends of the second coil **161**, fixing portions **161***a* and **161***b* are provided to be inserted, respectively to hole portions drilled in the second depressing shaft **175**. Utilizing the elasticity of the second coil **161**, the fixing portions **161***a* and **161***b* are fixed to the second depressing shaft **175**.

[0119] Herein, assuming that the first coil **160** is of a left-handed helical structure, the second coil **161** is of a right-handed helical structure.

[0120] The support shafts **167** and **177** respectively correspond to the support shafts **74** and **75** of the first embodiment (refer to FIG. **1**), and the tube depressing member **170** is rotated about the support shafts **176** and **177** as the rotation axis.

[0121] As such, similarly to the first embodiment, when the tube depressing member **170** is rotated in the direction of the arrow R, on the side of the first depressing section **172**, a liquid is moved to flow in the direction of F**1**, and on the side of the second depressing section **173**, a liquid is moved to flow in the direction of F**2** (refer to FIG. **1**).

[0122] As described above, with such a configuration in which the first and second coils **160** and **161** each serve as a helical-structured convex portion, the convex portions can be formed by wire forming or the like so that the helical-structured convex portions can be formed with much ease than by cutting works. Moreover, the material of a coil in use is of a coil lead having a circular cross section, thereby being able to make smooth the surfaces which come in contact with the first and second tubes **50** and **60**. Such a smooth surface leads to the effects of being able to reduce the resistance of contact of the surface at the time of depressing, thereby reducing the driving force. There are also effects of being able to increase the durability of the first and second tubes **50** and **60**.

[0123] Note that the cross sectional shape of the first and second coils **160** and **160** is not necessarily circular as long as the surfaces which come in contact with the first and second tubes **50** and **60** are shaped like a smooth arc.

[0124] Moreover, the first and second coils **160** and **161** can be varied in shape and winding outer diameter so that the convex portions can be easily changed in height, and the first and second depressing sections **172** and **173** can be easily changed in maximum diameter. This accordingly achieves the effects of leading to the ease of adjustment in terms of the amount of liquid transfer per unit time.

Fourth Embodiment

[0125] Described next is a liquid transfer device of a fourth embodiment by referring to the accompanying drawings. The fourth embodiment is characterized in the configuration of a tube depressing member, and any remaining components are structurally adaptable to those in the first and second embodiments described above. A description is thus given about the tube depressing member by referring to the drawings. FIG. **1** is also referred to.

[0126] FIG. **6** is a front view of a tube depressing member of the fourth embodiment. In FIG. **6**, a tube depressing member **190** is a coil member, which is configured to include a first coil section **191** serving as a first depressing section, a second coil section **192** serving as a second depressing section, a coupling shaft **193**, and support shafts **194** and **195**. The coupling shaft **193** serves to couple together the first and second coil sections **191** and **192**, and the support shafts **194** and **195** are respectively provided at tip end portions of the first and second coil sections **191** and **192**.

[0127] Note here that these components, i.e., the support shaft **194**, the coupling shaft **193**, and the support shaft **195** are provided on the extension of the common rotation axis P.

[0128] The maximum outer diameters of the first and second coil sections **191** and **192** respectively correspond to the maximum outer diameters of the first and second coils **160** and **161** of the third embodiment (refer to FIG. **5**), i.e., correspond to the helical-structured convex portions **72***a* and **73***a* of the first embodiment (refer to FIG. **1**). The support shafts **194** and **195** respectively correspond to the support shafts **74** and **75** of the first embodiment (refer to FIG. **1**), and the tube depressing member **190** rotates about the support shafts **194** and **195** as the rotation axis.

[0129] In this embodiment, because the tube depressing member **190** is formed as a piece by a coil lead, the coupling shaft **193** may not be rigid enough. In consideration thereof, part of the reserver retaining section **24** being a protruded from the device frame **20** (refer to FIG. **1**) is used as a reinforcing section, thereby ensuring the depressing amount and force of the first and second coil sections **191** and **192** with respect to the first and second tubes **50** and **60**.

[0130] As such, in the fourth embodiment, similarly to the third embodiment described above, when the tube depressing member **190** is rotated in the direction of the arrow R, on the side of the first coil section **191**, a liquid is moved to flow in the direction of F**1**, and on the side of the second coil section **192**, a liquid is moved to flow in the direction of F**2** (refer to FIG. **1**).

[0131] In the tube depressing member **190** of this embodiment, the first and second coil sections **190** and **191** are formed as a piece, thereby leading to the simpler configuration to a further extent. Such a tube depressing member **190** can be formed by wiring forming or the like so that the cost reduction can be achieved thereby. Moreover, the first and second coil sections **191** and **192** can be varied in shape and winding outer diameter similarly to those in the third embodiment, thereby leading to the effects of being able to easily adjust the amount of liquid transfer per unit time.

Fifth Embodiment

[0132] Described next is a liquid transfer device of a fifth embodiment by referring to the accompanying drawings. The fifth embodiment is characterized in that a reserver is configured so as to be attachable/detachable to/from a tube. The liquid transfer device of this embodiment is structurally adaptable to those in the first to fourth embodiments described above, and thus the liquid transfer device of the first embodiment is exemplified as a basic configuration. The sides of the first and second tubes **50** and **60** are of the same configuration, and thus the side of the first tube **50** is described as an example. FIG. **1** is also referred to.

[0133] FIGS. **7**A and **7**B each show a liquid transfer device of a fifth embodiment, i.e., FIG. **7**A shows a part of the vertical cross sectional view of the device, and FIG. **7**B is a cross sectional view of FIG. **7**A along a line E-E. In FIGS. **7**A and **7**B, at the end portion of the first tube **50** on the side of the reserver **40**, an insertion pipe **130** is inserted.

[0134] The insertion pipe **130** is formed by being bent like a letter L, and one end portion **132** thereof is inserted to the first tube **50**. The other end portion thereof, i.e., an insertion section **131** whose tip end portion is cut at an acute angle, is inserted to the bottom portion of the reserver **40**, and the first tube **50** and the reserver **40** are linked together via the insertion pipe **130**.

[0135] A septum **45** is provided at the bottom portion of the reserver **40**, and a linkage is established by inserting the insertion section **131** of the insertion pipe **130** to the septum **45**. By removing the reserver **40** from the insertion pipe **130**, the reserver **40** can be removed from the liquid transfer device **10**. At this time, because the septum **45** is tightly sealed by its own elasticity, no liquid leaks from the reserver **40**.

[0136] At the position between the device frame **20** and the lower portion of the insertion pipe **130**, i.e., the side opposite to the reserver **40**, an insertion pipe retaining frame **110** is disposed. The insertion pipe retaining frame **110** is provided with an insertion pipe guidance section **112** (refer to FIG. 7B) shaped like a groove for position control over the insertion pipe **130**, thereby preventing any possible deformation of the first tube **50** at the time of inserting the reserver **40**. On the side of the device frame **20** of the insertion pipe retaining frame **110**, a concave section **111** is provided for preventing the insertion pipe retaining frame **110** from coming in contact with the coupling shaft **71** of the tube depressing member **70**.

[0137] As shown in FIG. 7B, on the side of the tube guide **30** from which the reserver **40** is removed, i.e., the upper portion in the drawing, an open/close lid **120** is provided. One end portion of the open/close lid **120** is attached to the tube guide **30** to be able to freely open and close by a hinge **125** of the tube guide **30**. The other end portion of the open/close lid is provided with a hook mechanism (not shown) for attachment of the open/close lid **120** to the tube guide **30** to be able to open and close.

[0138] As such, when the open/close lid **120** is removed from the tube guide **30**, the reserver **40** becomes insertable/removable to/from the first and second tubes **50** and **60**, thereby allowing a replacement only of the reserver **40** and liquid refilling with ease. For a replacement of the reserver **40**, the components, i.e., the first and second tubes **50** and **60** and the tube guide **30**, can be good for repeated use, thereby favorably leading to economic effects.

[0139] With such a configuration of allowing a replacement of a reserver, the reserver **40** can be replaced by opening the open/close lid **120**, and when the open/close lid **120** is closed, the reserver **40** can be protected from external forces or the like while being in a position at the time of driving.

Sixth Embodiment

[0140] Described next is a liquid transfer device of a sixth embodiment by referring to the accompanying drawings. The sixth embodiment is characterized in the configuration of allowing attachment/detachment of a reserver attached with a tube. The liquid transfer device of this embodiment is structurally adaptable to those in the first to fifth embodiments described above, and thus the liquid transfer device of the first embodiment (refer to FIG. **1**) is exemplified as a basic configuration, and any component different from that of the first embodiment is mainly described.

[0141] FIG. **8** is a cross sectional view of a liquid transfer device of the sixth embodiment. In FIG. **8**, the tube guide **30** is provided with the open/close lid **120** in the area including the reserver **40** and part of the tube guide **30** supporting the first and second tubes **50** and **60** except end portions in the length direction thereof.

[0142] To be specific, the tube guide **30** is open except at a portion where the first tube **50** provided in the tube guide **30** is inserted into the through hole **32**, and at a portion where the second tube **60** is inserted into the through hole **34**. The open/close lid **120** is provided so as to cover this open portion.

[0143] As shown in FIG. 7B, one end portion of the open/close lid **120** is attached to the tube guide **30** to be able to freely open and close by the hinge **125** provided in the tube guide **30**. The other end portion is provided with a hook mechanism (not shown), and the open/close lid **120** can be attached to the tube guide **30** to be able to open and close.

[0144] The open/close lid **120** is provided with the tube retaining grooves **33** and **35** so as to respectively perform position control over the first and second tubes **50** and **60** when the open/close lid **120** is closed, and to allow easy removal of the first and second tubes **50** and **60** when the open/close lid **120** is open.

[0145] As such, when the open/close lid **120** is open, the reserver **40** being linked with the first and second tubes **50** and **60** becomes insertable/removable, thereby allowing a replacement not only of the reserver **40** but also of the first and second tubes **50** and **60**. This favorably leads to easy liquid refilling. That is, before driving of the liquid transfer device **10**, the reserver **40** can be stored with no attachment to the first and second tubes **50** and **60** so that the first and second tubes **50** and **60** can be protected from any possible deformation due to depression.

Seventh Embodiment

[0146] Described next is a seventh embodiment by referring to the accompanying drawings. Compared with the liquid transfer devices of the first to sixth embodiments described above, the seventh embodiment is characterized in including a larger number of tubes, and a tube depressing member including depressing sections as many as the tubes.

[0147] FIGS. **9**A to **9**C are diagrams showing an exemplary liquid transfer device of the seventh embodiment, i.e., FIG. **9**A is a vertical cross sectional diagram, FIG. **9**B is a layout diagram when the liquid transfer device of FIG. **9**A is viewed from the direction of a tip end, and FIG. **9**C is a layout diagram showing a modified example. In the liquid transfer device **10** of FIGS. **9**A and **9**B, a plurality of reservers **140**, **145**, **150**, and **155** are disposed in a multiple-connected arrangement along the rotation shaft P, i.e., the tube depressing member **70**, and the reservers **140**, **145**, **150**, and **155** are linked with tubes **50**, **55**, **60**, and **65**, respectively.

[0148] The tubes **50** and **60** are extended in the direction opposite to that of the tubes **55** and **65**. The tube depressing member **70** is provided with first to fourth depressing sections **72**, **73**, **76**, and **77** on a straight line of the rotation axis P respectively corresponding to the tubes **50**, **55**, **60**, and **65**. The reservers **140** and **150** are disposed all in the same direction with respect to the tube depressing member **70**. As shown in FIG. **9**B, the reservers **145** and **155** are disposed on the side opposite to the reservers **140** and **150** with respect to the tube depressing member **70**.

[0149] The third tube **55** is linked to the first reserver **140**, and is disposed between the first depressing section **72** and a tube retaining groove **20***b*. As such, the third tube **55** is able to be depressed by the first depressing section **72**, but is bent at a point not to come in contact with the third depressing section **76**. The fourth tube **65** is linked to the third reserver **145**, and is disposed at a position to be depressed by the third depressing section **76** while being retained by a tube retaining groove **30***b*.

[0150] On the other hand, the first tube **50** is linked to the second reserver **150**, and is disposed between the second depressing section **73** and the tube retaining groove **20***a*. As such, the first tube **50** is able to be depressed by the second depressing section **73**, but is bent at a point not to come in contact with the fourth depressing section **77**. The second tube **60** is linked with the third reserver **155**, and is disposed at a position to be depressed by the fourth depressing section **77** while being retained by the tube retaining groove **30***a*.

[0151] In this example, the first and third depressing sections **72** and **76** are respectively formed with convex portions of the same helical direction for both moving a liquid to flow in the direction of F**1**. The remaining second and fourth depressing sections **73** and **77** are respectively formed with convex portions of the helical direction opposite to the first and third depressing sections **72** and **76** for both moving a liquid to flow in the direction of F**2**.

[0152] The first and second reservers **140** and **150** are disposed between the first and second depressing sections **72** and **73**, the third reserver **145** is disposed between the first and third depressing sections **72** and **76**, and the fourth reserver **155** is disposed between the second and fourth depressing sections **73** and **77**. With such a configuration, as shown in FIG. **9**B, the resulting liquid transfer device **10** can be small in outer diameter even with a plurality of reservers provided therein.

[0153] Note here that the liquid transfer device **10** is driven in a manner similar to that in the first embodiment (refer to FIG. **1**) or that of the second embodiment (refer to FIG. **3**), and thus no further description is given.

[0154] In this embodiment, exemplified is the case with four reservers, but a larger number of reservers can be surely provided. If this is the case, the tubes and the depressing sections can be provided as many as the reservers.

[0155] As such, with the configuration of the seventh embodiment, liquid transfer is enabled with a single tube depressing member **70** depressing a plurality of tubes, and this favorably leads to the effects of being able to increase the amount of liquid transfer without increasing the number of components.

[0156] Also in the configuration of the embodiment, the tube depressing member **70** is provided with the first and second depressing sections **72** and **73** respectively formed with convex portions of each different helical direction. The first and second tubes **50** and **60** move a liquid to flow in the direction of F**2**, and the third and fourth tubes **55** and **65** move a liquid to flow in the direction of F**1**. As such, compared with the first embodiment described above, the amount of liquid transfer can be increased.

[0157] Moreover, with a plurality of reservers being disposed in a multiple-connected arrangement along the rotation axis P, i.e., axial direction of the tube depressing member **70**, the resulting liquid transfer device can be reduced in size especially in the diameter direction even with a plurality of reservers provided therein.

[0158] As an alternative configuration, at least one of the tubes provided as many as a plurality of reservers may be linked in the direction opposite to those of the remaining tubes, and in accordance with the linkage direction of the tubes, i.e., direction of extension, the depressing sections each may have opposite helical direction.

[0159] If this is the case, the amount of liquid flow can be varied depending on the direction of liquid flow, and any desired amount of liquid flow can be set in accordance with target uses.

Modified Example of Seventh Embodiment

[0160] Described next is a modified example of the seventh embodiment by referring to FIG. **9**C. This modified example is characterized in the configuration that a plurality of reservers are disposed around the rotation axis P. Any component different from that of the seventh embodiment is mainly described. FIG. **9**A is also referred to, and any functional component same as that in the drawing is provided with the same reference numeral. In FIG. **9**C, the first to fourth reservers **140**, **150**, **145**, and **155** are disposed around the rotation axis P, i.e., the tube depressing member **70**.

[0161] The tube depressing member **70** is provided with the first and second depressing sections **72** and **73** sharing the same rotation axis P, and the first and second depressing sections **72** and **73** are provided with helical-structured convex portions each showing a different helical direction. The first to fourth reservers **140**, **150**, **145**, and **155** are disposed between the first and second depressing sections **72** and **73** each with a space in the circumferential direction.

[0162] The first reserver **140** is linked with the third tube **55**, the second reserver **150** is linked with the first tube **50**, the third reserver **145** is linked with the fourth tube **65**, and the fourth reserver **155** is linked with the second tube **60**. The third and fourth tubes **55** and **65** are extended along the rotation axis P, i.e., in the direction different from that of the first and second tubes **50** and **60**.

[0163] The first and second depressing sections **72** and **73** are provided with the convex portions showing each different helical direction. As such, liquids are moved to flow in the directions different from each other through the first and second tubes **50** and **60**, through the third and fourth tubes **55** and **65**.

[0164] With such a configuration of the modified example, the first to fourth reservers **140**, **150**, **145**, and **155** are disposed around the rotation axis P and between the first and second depressing sections **72** and **73**. Accordingly, the resulting liquid transfer device can be reduced in size especially in the length direction, i.e., direction of liquid flow.

[0165] Also possible is a configuration of adapting the technical scope of the seventh embodiment described above and that of the modified example of the seventh embodiment. As a possible configuration, the third reserver **145** may be disposed at the position same as the first reserver **140** of FIG. **9**A in the axial direction, and the fourth reserver **155** may be disposed at the position same as the second reserver **150** in the axial direction.

[0166] Exemplified in the first to seventh embodiments described above is the configuration in which a liquid is moved to flow in two different directions. Alternatively, the tubes may be extended from the reservers all in the same direction so as to flow a liquid in the same direction, e.g., the configuration of including the second reserver **150** and the first tube **50**, the fourth reserver **155** and the second tube **60**, and the tube depressing member **70** with the second and fourth depressing sections **73** and **77**, which are described in the seventh embodiment (refer to FIG. **9**A).

[0167] Such a configuration enables to implement a small-sized liquid transfer device whose amount of liquid flow is large in one specific direction. Note that, in this case, the second and fourth reservers **150** and **155** may be disposed at the same position in the axial direction. As shown in FIG. **9**C, the first to fourth reservers **140**, **150**, **145**, and **155** may be disposed around the rotation axis P, and the tubes may be disposed in the same direction so that the resulting configuration allows liquid transfer of a larger amount in one specific direction.

Eighth Embodiment

[0168] Described next is a liquid transfer device of an eighth embodiment by referring to the accompanying drawings. The eighth embodiment is characterized in that a single reserver is linked with a plurality of tubes being extended in the same direction. Note here that any functional component same as that in the first embodiment described above (refer to FIG. **1**) is provided with the same reference numeral, and not described twice.

[0169] FIGS. **10**A and **10**B are diagrams showing the liquid transfer device of the eighth embodiment, i.e., FIG. **10**A is a vertical cross sectional view of the device, and FIG. **10**B is a front view when the liquid transfer device is viewed from the direction of a tip end, i.e., right side in the drawing. In FIGS. **10**A and **10**B, a reserver **156** is disposed at one end portion of the tube depressing member **70**, and the reserver **156** is provided with the first to fourth tubes **50**, **60**, **55**, and **65** around the first depressing section **72**.

[0170] The first to fourth tubes **50**, **60**, **55**, and **65** are all linked to one end portion of the reserver **156**, and are extended in the direction opposite to the reserver **156**. As such, the direction of liquid flow in the respective tubes is the direction of F**2**.

[0171] With such a configuration, the area for placement of a reserver can be extended to the vicinity of the outer diameter of the liquid transfer device **10** so that the reserver **156** can be increased in capacity, and a large amount of liquid can be moved to flow in one specific direction.

[0172] Moreover, when four of the tubes, i.e., the first to fourth tubes **50**, **60**, **55**, and **65**, are disposed as shown in FIG. **10**B, in the course of a liquid gradually reducing in the reserver **156**, the number of tubes available for liquid flow can be varied, e.g., four, two, and then one, so that the amount of liquid flow can be changed in accordance with the stored amount of the liquid.

[0173] If the first to fourth tubes **50**, **60**, **55**, and **65**, are disposed on the bottom portion side of the reserver **156**, i.e., the side of the second tube **60** of FIG. **9**B, all of the four tubes remain available for liquid flow until the liquid in the reserver **156** is completely drained.

Modified Example of Eighth Embodiment

[0174] Described next is a modified example of the eighth embodiment. Although the modified example is not shown, a description is given by referring to FIGS. **10**A and **10**B. In the liquid transfer device **10** of the modified example, a plurality of depressing section of the tube depressing member **70** are disposed in a multiple-connected arrangement. At least one of the plurality of depressing sections is provided with a helical-structured convex portion of a helical direction opposite to those of others. In this case, the tubes which are provided as many as the depressing sections and are to be depressed thereby are each bent so as not to come in contact with other depressing sections. As a possible configuration, the first and second tubes **50** and **60** may be depressed by the depressing sections each formed with a helical-structured convex portion of one helical direction, i.e., the convex portion **72**_a_ of FIG. **10**A, and the third and fourth tubes **55** and **65** may be depressed by the depressing sections each formed with a helical-structured convex portion of the other helical direction.

[0175] If this is the case, the first and second tubes **50** and **60** flow a liquid out from the reserver **156**, and the third and fourth tubes **55** and **65** flow the liquid into the reserver **156**. It means that providing the tubes for liquid flow-in as many as the tubes for liquid flow-out can equalize the amount of liquid flow-in and flow-out. In this configuration, by linking the tubes for liquid flow-in to any external liquid storage container, the liquid can be refilled by the amount of flow-out while the liquid transfer device is being driven.

Suction Unit

[0176] Described next is a suction unit using the liquid transfer device **10** described in the first to seventh embodiments above. Note that the suction unit according to the invention is of sucking a liquid after atomizing it into particles by an atomizer, and is provided to atomize various types of liquids such as flavor liquid and liquid drug preparations. The suction unit is provided as a smoking unit such as electronic cigarette being safe and harmless for human health and environment, and an oral suction unit for liquid drug preparations. In this embodiment, the suction unit is exemplified by a smoking unit.

[0177] FIG. **11** is a vertical cross sectional view of an exemplary suction unit in an embodiment of the invention, showing the schematic configuration thereof. Exemplified here is a configuration using the liquid transfer device of the first embodiment (refer to FIG. **1**). In FIG. **11**, in a suction unit **200**, the liquid transfer device **10** is disposed to the tubular chassis configured by upper and lower frames **220** and **210** substantially at the center portion in the longitudinal direction. As shown in FIG. **1**, the liquid transfer device **10** is configured to include the reserver **40** storing therein a flavor liquid, the first and second tubes **50** and **60**, and the tube depressing member **70**.

[0178] The suction unit **200** is configured to include a motor **250** and a second atomizer **280**. The motor **250** is disposed on the right side of the liquid transfer device **10** in the drawing for providing a rotation force to the tube depressing member **70**. The second atomizer **280** is disposed in the vicinity of the tip end portion of the second tube **60** for atomizing a flavor liquid coming from the second tube **60**.

[0179] On the other hand, on the left side of the liquid transfer device **10** in the drawing, provided are a control section **260**, a battery **270** serving as a power supply, and a first atomizer **290**. The first atomizer **290** is disposed in the vicinity of the tip end portion of the first tube **50** for atomizing a flavor liquid coming from the first tube **50**.

[0180] These components configuring the suction unit **200** are disposed in the chassis substantially linearly in the longitudinal direction, and are shaped as a whole into a long and slim pillar.

[0181] In this embodiment, the first and second atomizers **290** and **280** are each a surface acoustic wave element. The control section **260** includes a control circuit for drive control over the first and second atomizers **290** and **280**, and a drive control circuit for control over the motor **250** to drive. The battery **270** supplies power to the control section **260**.

[0182] The components described above are each disposed in a concave portion formed in the lower frame **210**, and are fixed in position by mounting the upper frame **220** to the lower frame **210**. Herein, on the side of the second atomizer **280**, provided is a grip port section **230** having a suction port **231** for flowing and sucking the atomized liquid particles. The tip end portion of the grip port section **230** is formed long and slim for easy gripping, and the other end thereof is attached so as to sandwich the end portions of the upper and lower frames **220** and **210**.

[0183] By referring to FIG. **8**, described next is how to use the suction unit **200** configured as such. In accordance with a drive signal coming from the control section **260** the motor **250** is driven, and the tube depressing member **70** of the liquid transfer device **10** is then rotated. The first and second depressing sections **72** and **73** of the tube depressing member **70** respectively depress the first and second tubes **50** and **60**, and in response, a flavor liquid in the reserver **40** is supplied to the surfaces of the first and second atomizers **290** and **280** from the first and second tubes **50** and **60**, respectively.

[0184] The first and second atomizers **290** and **280** excite surface waves in response to a drive signal, i.e., excitation signal, coming from the control section **260**, thereby atomizing a flavor liquid into liquid particles. The liquid particles atomized by the second atomizer **280** remain in a space **281** above the second atomizer **280**, and when a user takes a suck at the grip port section **230**, the particles are sucked from the suction port **231**.

[0185] Note here that the upper frame **220** is formed with an air guide hole **221** for a linkage between the space **281** and the outside for helping the user to take a suck at the suction port **231** by capturing air from the outside.

[0186] The flavor liquid here means a liquid which does not include substances alleged to be hazardous to health and found in the smoke of general cigarettes such as nicotine and tar, but enables users to enjoy the flavor and taste of cigarettes. The smoking unit of this embodiment is of sucking such a flavor liquid after atomizing it into liquid particles by an atomizer.

[0187] On the other hand, on the side of the first atomizer **290**, the liquid particles atomized by the first atomizer **290** remain in a space **291** above the first atomizer **290**, and is ejected naturally from a through hole **222**, corresponding to an ejection port in this embodiment, formed in the upper frame **220**.

[0188] Note here that the upper and lower frames **220** and **210** and the grip port section **230** are attached as a piece and inserted into a tubular member **240**. The tubular member **240** is formed so as to allow close placement of the upper and lower frames **220** and **210**, and to allow insertion/removal thereof.

[0189] As such, by removing the grip port section **230** from the tubular member **240**, the upper and lower frames **210** and **220** are separated from each other, thereby enabling a replacement of the battery **270** being a consumable item and the liquid transfer device **10**. The inspection and maintenance of the control section **260** and the motor **250** can be also performed.

[0190] Further, with the liquid transfer device **10** of the fifth embodiment (refer to FIGS. **7**A and **7**B) described above, a replacement of the reserver **40** can be solely completed by opening the open/close lid **120** of the tube guide **30**, thereby enabling a easy refill a flavor liquid.

[0191] Still further, with the liquid transfer device **10** of the sixth embodiment (refer to FIG. **8**) described above, a replacement of the reserver **40** having the tubes linked with can be completed by opening the open/close lid **120**.

[0192] As such, with the suction unit **200** described above, a flavor liquid stored in the reserver **40** is transferred to the first and second atomizers **290** and **280** by the liquid transfer device **10**, and the flavor liquid is atomized so that the resulting liquid particles can be available for suction.

[0193] In this case, the grip port section **230** is provided on the side of the second atomizer **280**, and the through hole **222**, i.e., ejection port, is provided on the side of the first atomizer **290** for liquid particles. With this configuration, a user can enjoy dummy smoking with the smell and atmosphere of smoking. What is more, the user can take a suck while checking the amount of atomization and others.

[0194] When employing the configuration of the second embodiment (refer to FIG. **3**) described above, i.e., including the first and second reservers **140** and **150**, the first and second reservers **140** and **150** store therein each different type of flavor liquid. Users thus can enjoy different types of flavors and scents. If the second reserver **150** stores therein a flavor liquid for dummy smoking, and if the first reserver **140** stores therein a flavor liquid smells like the smoke of cigarette, the atmosphere of dummy smoking can be enhanced to a further extent.

[0195] With the configuration of including the grip port section **230** formed with the suction port **231** on both sides of the first and second atomizers **290** and **280**, the liquid particles can be sucked from two different directions. With the configuration of including two reservers, different types of liquid particles can be sucked from the grip port sections provided at two positions.

[0196] Moreover, because the upper and lower frames **220** and **210** are inserted into the tubular member **240**, the attachability/detachability between the upper and lower frames **220** and **210** can be of a satisfactory level. The tubular member **240** can be of various types of designs in terms of color and surface treatment, thereby implementing designs meeting users' tastes and preferences.

[0197] The suction unit **200** of the embodiment of the invention is shaped like a tube, thereby achieving a good portability.

[0198] The suction unit described above is an example using the liquid transfer device of the first embodiment described above (refer to FIG. **1**), i.e., the device including one reserver. Alternatively, the liquid transfer device of the second embodiment (refer to FIGS. **3** to **4**B) can be used, i.e., the device including two reservers. If this is the case, the first and second reservers **140** and **150** can store each different type of scented-liquid.

[0199] Moreover, using the liquid transfer device **10** of the seventh embodiment (refer to FIGS. **9**A to **9**C) enables suction and ejection of a large amount of liquid particles, and using the liquid transfer device of the eighth embodiment (refer to FIGS. **10**A and **10**B) enables suction of a much larger amount of liquid particles.

[0200] In the above, the suction unit described above is exemplified by a smoking unit. This is surely not restrictive, and the suction unit can be adapted for a unit of sucking various types of liquids, e.g., flavor liquid and liquid drug preparations, after atomization thereof. When the sucking unit is used for oral medication using liquid drug preparations, for example, adjusting the oscillation frequency of the atomizer can change the particle diameter of the liquid, thereby being able to be used as a device for medication specifically for oral cavity, bronchus, lung, and others.

[0201] The entire disclosure of Japanese Patent Application Nos: 2007-097210, filed Apr. 3, 2007 and 2007-324325, filed Dec. 17, 2007 are expressly incorporated by reference herein.

What is claimed is:

1. A liquid transfer device, comprising:
a reserver that stores therein a liquid;
a plurality of elastic tubes that are linked to the reservers and retained by a tube guide;
a rotation axis that is retained to be able to rotate; and
a tube depressing member in which a depressing section is fixed to the rotation axis for depressing the tubes with a helical-structured convex portion each provided thereto, wherein
when the rotation axis rotates, the liquid starts to flow by the depressing section sequentially depressing the tubes in a direction from the reserver toward a flow-out side of the liquid.

2. A liquid transfer device, comprising:
a reserver that stores therein a liquid;
a first tube and a second tube linked to the reserver in different direction;
a rotation axis that is retained to be able to rotate; and
a depressing member including a first depressing section that is fixed to the rotation axis and depresses the first tube using a helical-structured convex portion provided thereto, and a second depressing section that is fixed to the rotation axis and depresses the second tube using a helical-structured convex portion provided thereto with a helical direction opposite to the convex portion depressing the first tube, wherein
when the rotation axis rotates, the liquid starts to flow in two different directions by the first depressing section and the second depressing sections sequentially depressing the first tube and the second tube in a direction from the reserver toward a flow-out side of the liquid.

3. The liquid transfer device according to claim **1**, wherein
the reserver include the first reserver and the second reserver,
the tubes include the first tube and the second tube,
the depressing section include the first depressing section and the second depressing section whose helical-structured concave portions each have different helical direction, and
the first tube is linked to the first reserver and the second tube is linked to the second reserver, the first and second tubes are extended in each different direction, and the liquid starts to flow in two different directions when the first depressing section and the second depressing section respectively depress the first tube and the second tube.

4. The liquid transfer device according to claim **3**, wherein
the first reserver and the second reserver are disposed along the rotation axis.

5. The liquid transfer device according to claim **3**, wherein
the first reserver and the second reserver are disposed around the rotation axis.

6. The liquid transfer device according to claim **1**, wherein
the helical-structured convex portions respectively provided in the depressing sections are each a coil wound around the tube depressing member in different helical direction.

7. The liquid transfer device according to claim **6**, wherein
the tube depressing member is formed, as a piece, by a coil section corresponding to the convex portion of each of the depressing sections and the rotation axis.

8. The liquid transfer device according to claim **1**, wherein
at least one of the tubes has an internal and external diameter different from other tubes, and the helical-structured convex portions of the depressing sections provided as many as the tubes have different external diameter in accordance with the internal or external diameter of the corresponding tube.

9. The liquid transfer device according to claim **1**, wherein
the tubes are retained by the tube guide while being linked to the reserver, and
the tube guide including the reserver and the tubes is configured to be attachable to, and detachable from a device frame keeping hold of the rotation axis.

10. The liquid transfer device according to claim **1**, wherein
an insertion pipe is provided at an end portion of each of the tubes on a reserver side for linkage to the reserver, and
a tip end portion of the insertion pipe is inserted into each of the reserver for linkage therewith, and the tubes can be inserted into, and removed from the reservers.

11. The liquid transfer device according to claim **1**, wherein
a lid is provided to a portion of the tube guide covering the reserver.

12. The liquid transfer device according to claim **11**, wherein
the lid is provided in a area including the reserver and part of the tube guide supporting the tubes except end portions in the length direction thereof.

13. The liquid transfer device according to claim **1**, wherein
the reserver is disposed in a multiple-connected arrangement along the rotation axis,
at least one of the tubes provided as many as the reserver is linked thereto in a direction different from other tubes, and
the depressing section show different helical direction in accordance with the direction of linkage of each of the tubes.

14. The liquid transfer device according to claim **1**, wherein
the reserver is disposed around the rotation axis,
at least one of the tubes provided as many as the reserver is linked thereto in a direction different from other tubes, and
the depressing section are respectively provided with helical-structured convex portions that show each different helical direction in accordance with the direction of linkage of each of the tubes.

15. The liquid transfer device according to claim **1**, wherein
the reserver is disposed at one end portion of the tube depressing member, and
the reserver is provided with the tubes around the depressing section.

16. The liquid transfer device according to claim **15**, wherein

the depressing section is disposed in a multiple-connected arrangement, and

at least one depressing section is provided with a convex portion showing a helical direction different from other depressing sections.

17. A suction unit, comprising:

the liquid transfer device of claim **1**;

a first atomizer that atomizes a liquid coming from at least one of the tubes;

a second atomizer that atomizes a liquid coming from at least another the tube;

a motor that provides a rotation force to the tube depressing member;

a control section that includes a control circuit for controlling the first atomizer and the second atomizer, and a drive control circuit for controlling the drive of the motor; and

a power supply section that supplies power to the control section, wherein

in a tubular chassis, the power supply section, the control section, the first atomizer and the second atomizer, and the liquid transfer device are disposed along the longitudinal direction of the chassis, and

an aperture section is provided for ejection or suction of liquid particles atomized by each of the first atomizer and the second atomizer.

18. The suction unit according to claim **17**, wherein

one of the aperture sections is a suction port for sucking the atomized liquid particles, and the other of the aperture sections is an ejection port for ejecting the atomized liquid particles.

19. The suction unit according to claim **17**, wherein

the suction port is provided at both ends of the chassis in the length direction for sucking the atomized liquid particles.

20. The suction unit according to claim **17**, wherein

the chassis is configured by upper and lower frames, and

the upper and lower frames are configured to be attachable/detachable, and at least the liquid transfer device and the power supply section can be attached thereto, and detached therefrom.

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