US 20160271305A1

(19) **United States**
(12) **Patent Application Publication**
KURIHARA et al.
(10) **Pub. No.: US 2016/0271305 A1**
(43) **Pub. Date: Sep. 22, 2016**

(54) **SUCTION DEVICE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

(72) Inventors: **Kiyoshi KURIHARA**, Kyoto (JP); **Daisuke KONDO**, Kyoto (JP); **Hiroshi TAKEMURA**, Kyoto (JP); **Yoshinori ANDO**, Kyoto (JP)

(21) Appl. No.: **15/167,092**

(22) Filed: **May 27, 2016**

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2015/052441, filed on Jan. 29, 2015.

(30) **Foreign Application Priority Data**

Jan. 30, 2014	(JP)	2014- 015088
Apr. 30, 2014	(JP)	2014- 094272
Aug. 19, 2014	(JP)	2014- 166607

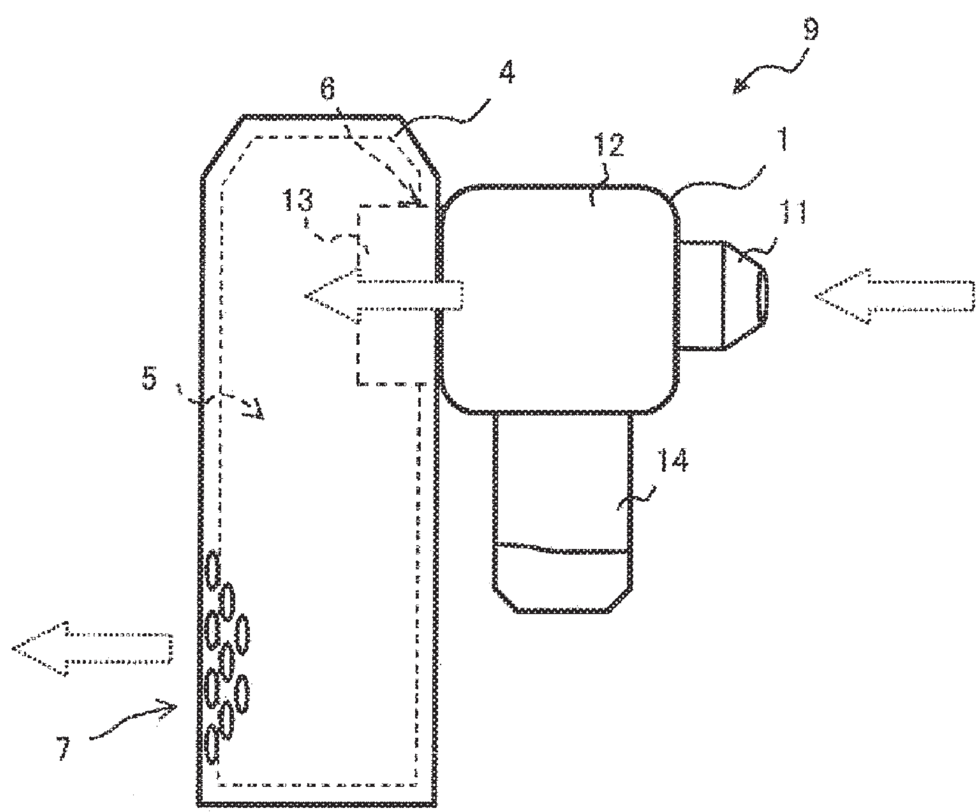
Publication Classification

(51) **Int. Cl.**
A61M 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A61M 1/0023*** (2013.01); ***A61M 1/0056*** (2013.01); ***A61M 1/0019*** (2013.01); ***A61M 1/0088*** (2013.01); *A61M 2210/0618* (2013.01); *A61M 1/062* (2014.02)

(57) **ABSTRACT**

Provided is a suction device that can suppress sound and vibration during use. A suction device includes a flow-passage forming section (**1**) having a suction port (**20**) from which fluid is sucked, a discharge port (**29**) from which the fluid is discharged, and a flow passage (**2**) which is sealed from an outside except at the suction port (**20**) and the discharge port (**29**) and through which the fluid flows, and a piezoelectric driving part (**33**) that generates a flow of the fluid in the flow passage (**2**). The piezoelectric driving part (**33**) includes a diaphragm (**37**) and a piezoelectric element (**34**) as a moving part that transmits driving force to the fluid. The moving part is entirely disposed inside the flow passage (**2**).



Shenzhen Root 1016

FIG. 1A

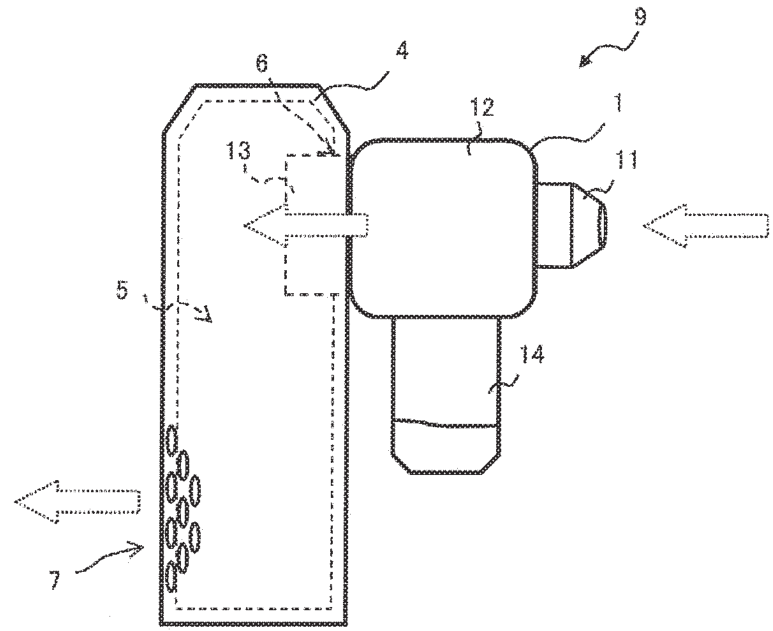

9
6
4
12
1
13
11
5
14
7

FIG. 1B

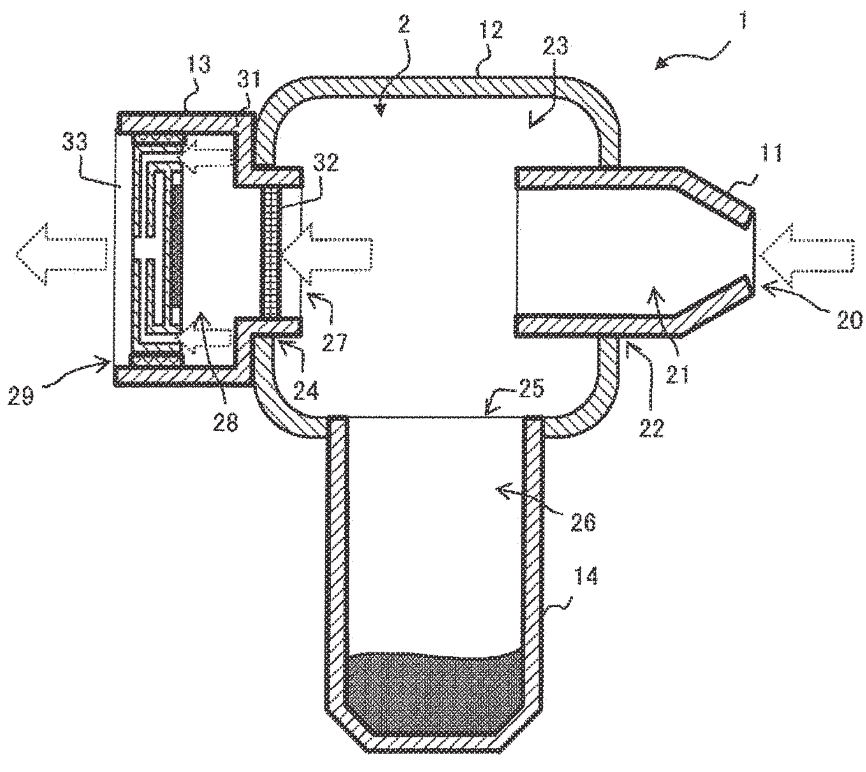

2
12
23
1
13
31
33
32
11
27
20
29
24
21
28
25
22
26
14

FIG. 2

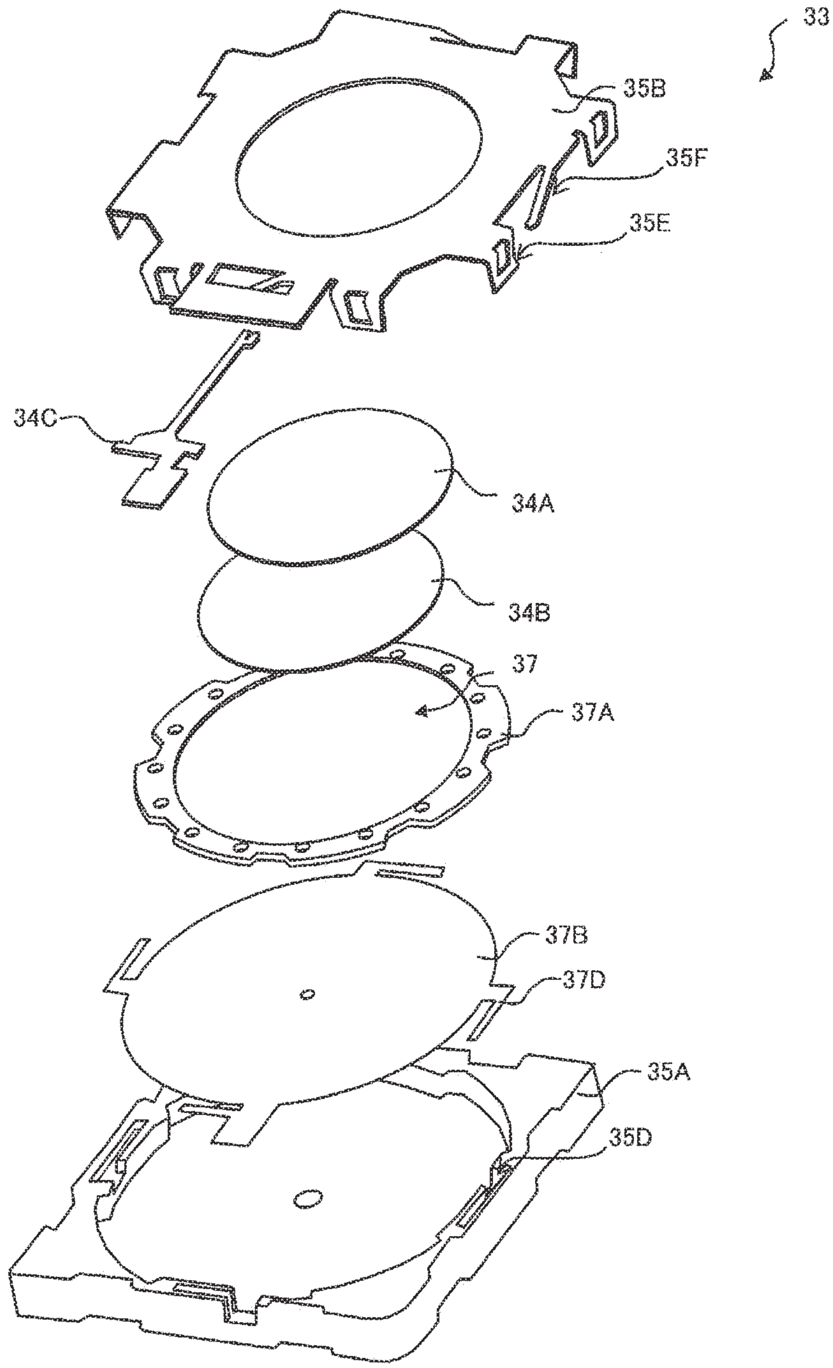


FIG. 3A

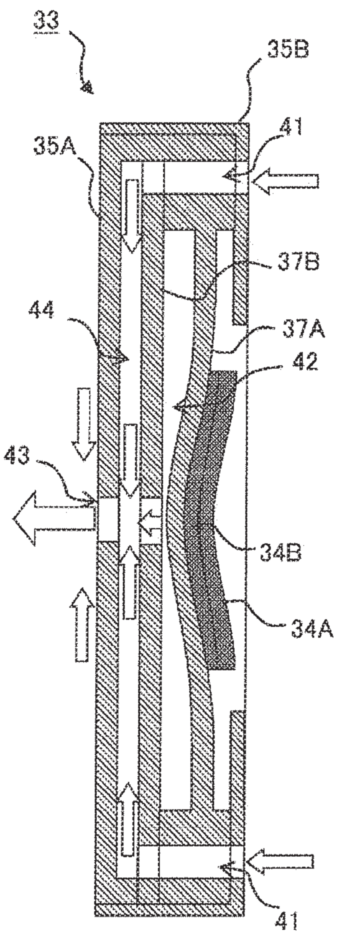

33
35B
41
35A
37B
44
37A
42
43
34B
34A
41

FIG. 3B

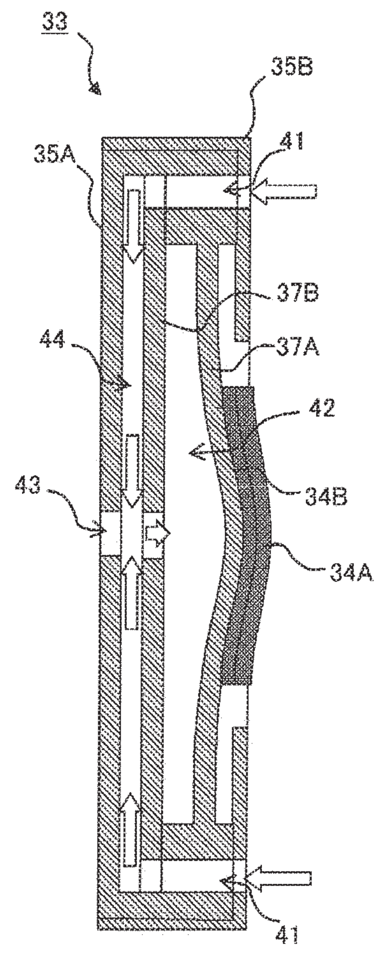

33
35B
41
35A
37B
44
37A
42
34B
43
34A
41

FIG. 4

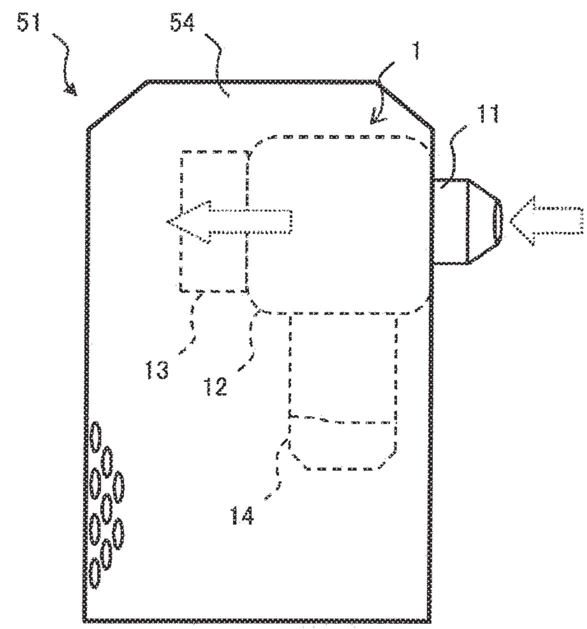


FIG. 5

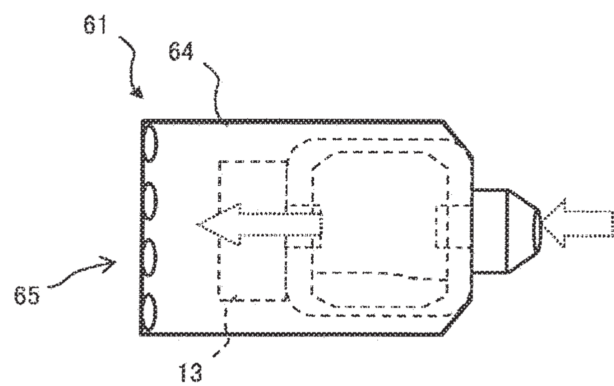


FIG. 6

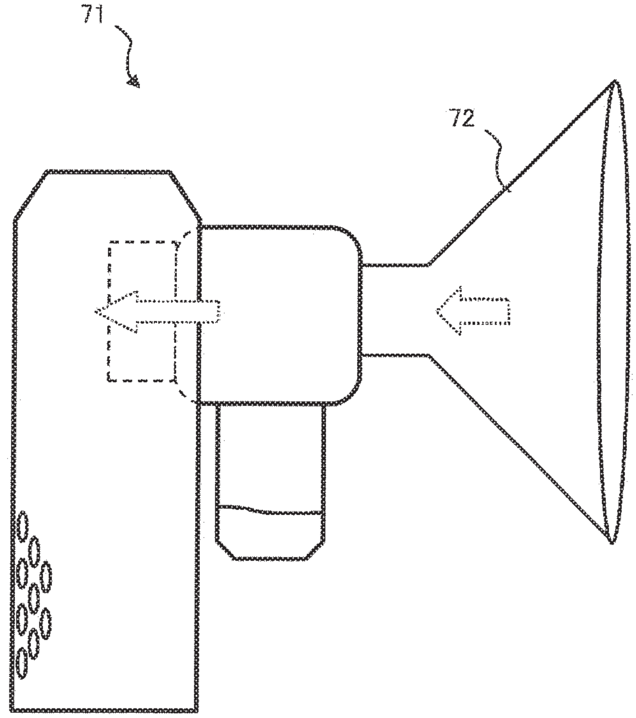


FIG. 7G

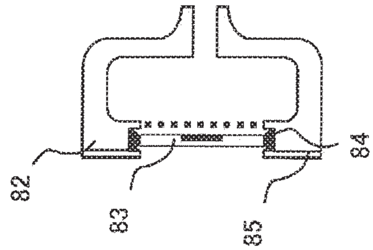


FIG. 7E

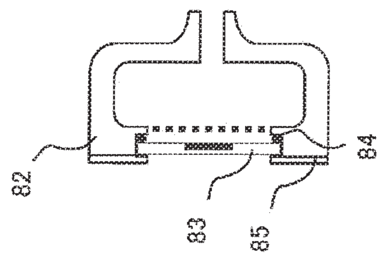


FIG. 7F

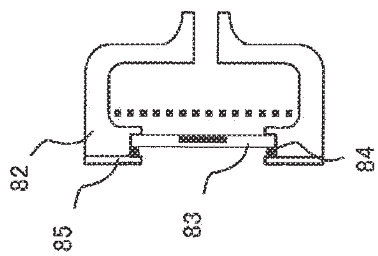


FIG. 7C

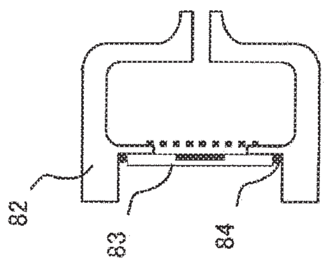


FIG. 7D

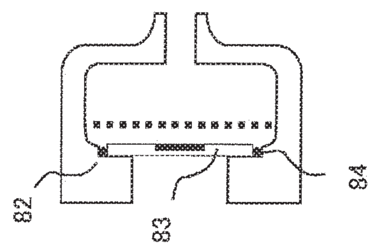


FIG. 7A

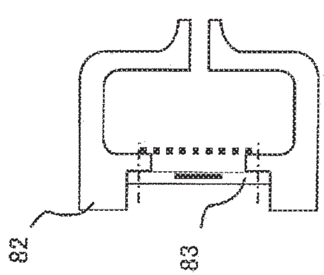


FIG. 7B

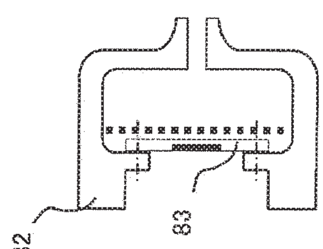


FIG. 8A

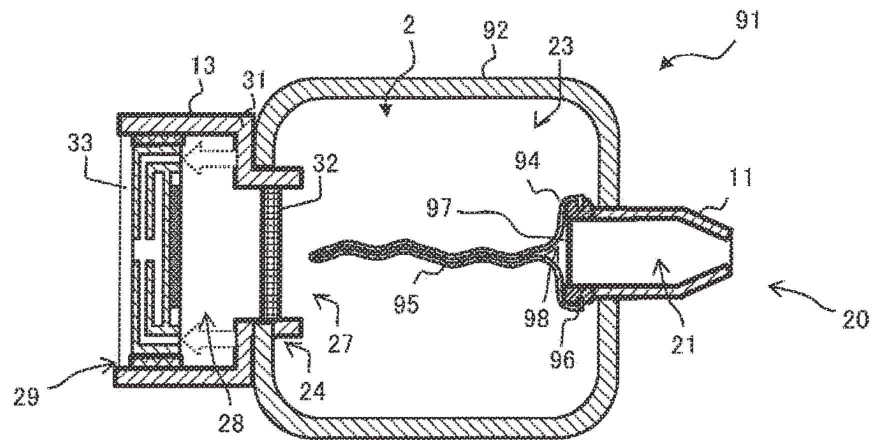

2
92
23
91
13
31
33
32
94
11
97
95
98
27
20
96
21
29
24
28

FIG. 8B

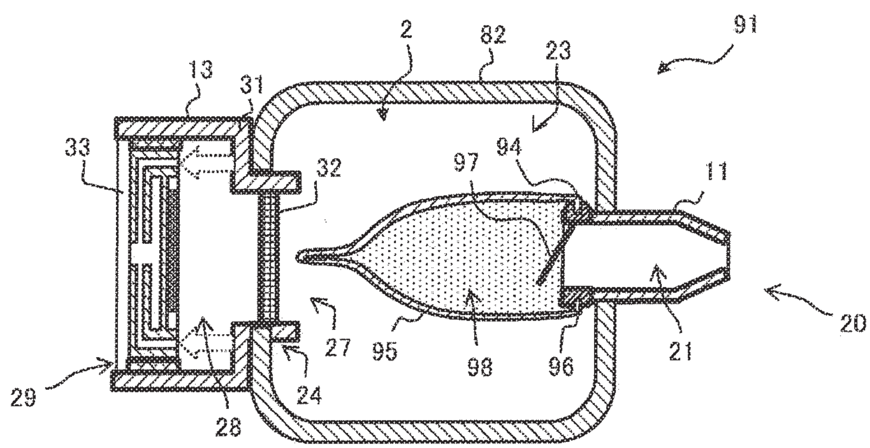

2
82
23
91
13
31
33
32
97
94
11
27
95
98
96
21
20
29
24
28

FIG. 9A

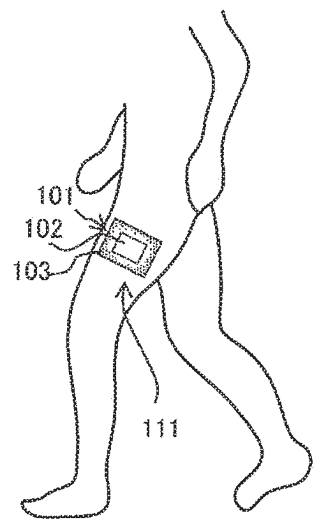


FIG. 9B

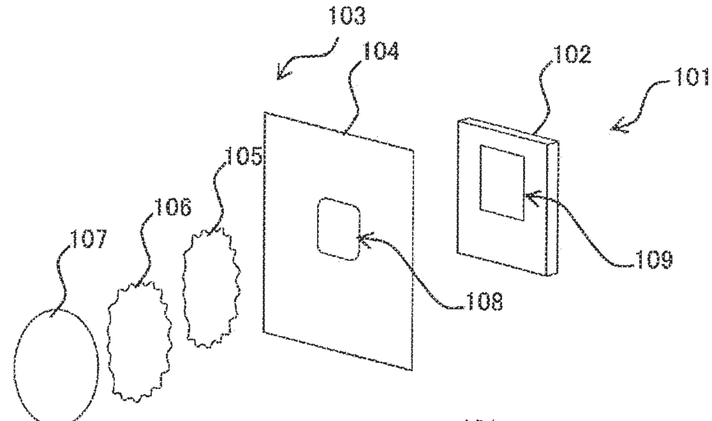


FIG. 9C

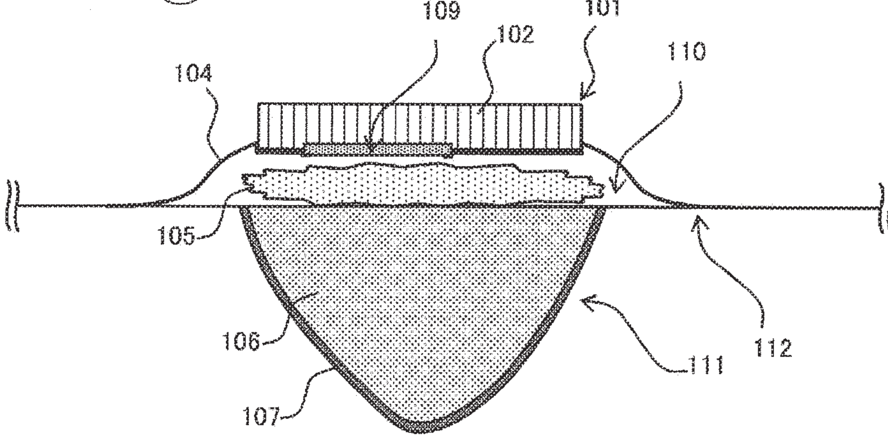


FIG. 10

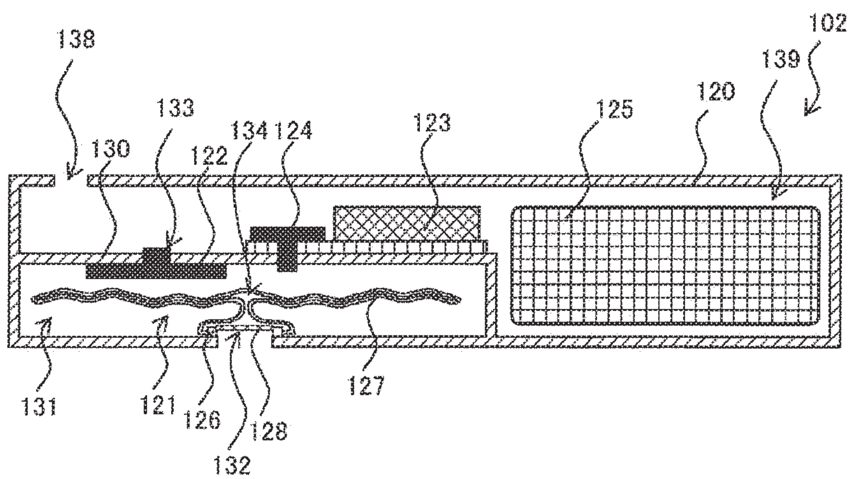

138
133
134
124
123
125
120
139
102
130
122
131
121
126
128
132
127

FIG. 11B

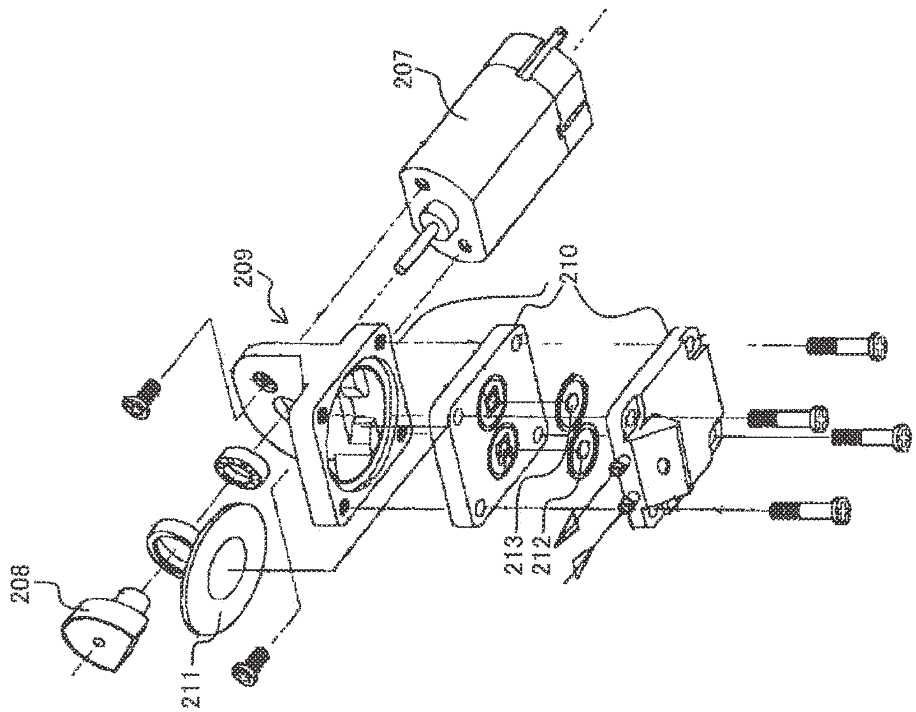
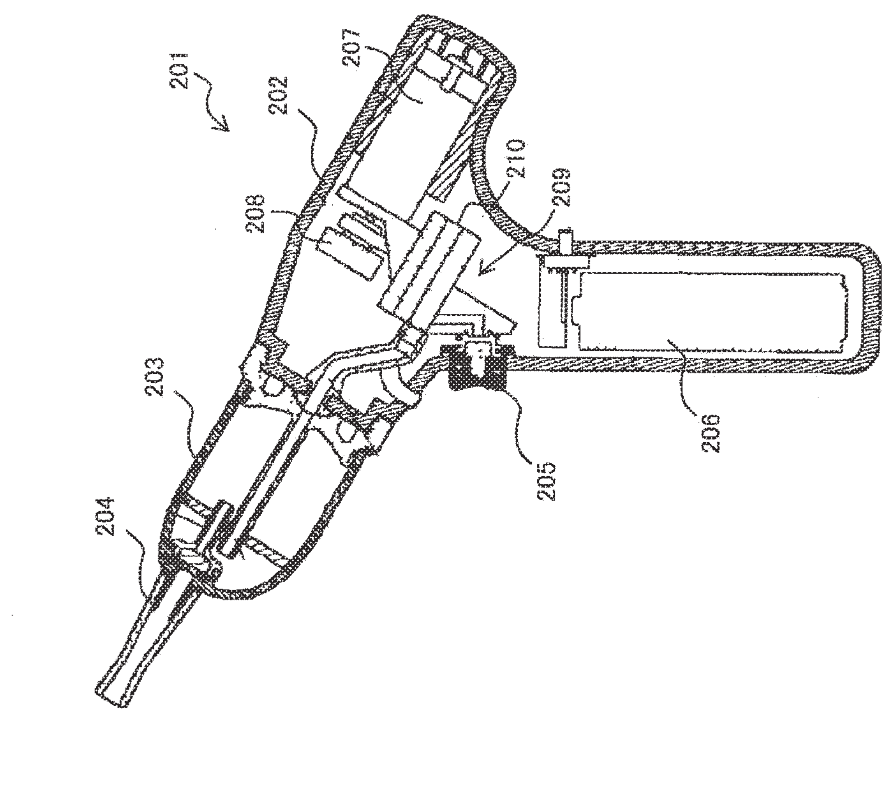


FIG. 11A



SUCTION DEVICE

FIELD OF THE DISCLOSURE

[0001] The present invention relates to a suction device used to remove a collection object such as nasal mucus.

DESCRIPTION OF THE RELATED ART

[0002] For example, cold, nasal inflammation, and empyema cause a symptom, such as nasal congestion, due to excessive secretion of nasal mucus. Although nasal congestion is generally removed by nose blowing, for example, nasal mucus of infants who cannot blow their noses needs to be removed by a helper. At this time, a small amount of nasal mucus can be removed with a tissue or a cotton swab, but it is difficult to remove a large amount of nasal mucus.

[0003] Accordingly, electric suction devices capable of easily removing a large amount of nasal mucus have recently been popularized (see, for example, Patent Documents 1 and 2). FIG. **11**A is a cross-sectional view of a suction device **201** of the related art referring to Patent Document 1. FIG. **11**B is an exploded perspective view illustrating the principal part of the suction device **201**.

[0004] The suction device **201** includes a case **202**, a nasal mucus storage cylinder **203**, and a nasal mucus suction port **204**. The nasal mucus suction port **204** is a portion to be inserted in the nasal cavity, and is shaped like a cylinder. The nasal mucus storage cylinder **203** is provided between the nasal mucus suction port **204** and the case **202**, and has an internal space that stores liquid sucked from the nasal mucus suction port **204**. The case **202** serves as a grip portion of the suction device **201**, and has a power switch **205** on a part of its surface. The case **202** includes therein a battery **206**, a motor **207**, an eccentric cam **208**, and a vacuum generating means (pump) **209**. The power switch **205** switches between on and off states of driving of the motor **207**. The motor **207** is driven by power supplied from the battery **206** to turn the eccentric cam **208**. The pump **209** includes a pump body **210**, a valve **211**, and opening and closing plates (valve members) **212** and **213**. The valve **211** and the valve members **212** and **213** are attached to block up the pump body **210**. The eccentric cam **208** moves the valve **211** up and down relative to the pump body **210**. Thus, the capacity changes inside the pump body **210**, and the air pressure changes inside the pump body **210**. The valve member **212** is provided in a suction passage communicating with the nasal mucus storage cylinder **203**, and is structured to suck fluid into the pump body **210**. The valve member **213** is provided in a discharge passage communicating with the external space, and is structured to discharges fluid from the pump body **210**.

[0005] There exists a therapy called a negative pressure wound therapy for promoting the recovery of a wound site by applying a negative pressure to a surface of the wound site in the treatment of an injury or the like. For example, Patent Document 3 discloses a suction device that includes a wound dressing to be in close contact with the outer periphery of a wound site and removes an exudate from the wound site.

[0006] Patent Document 1: Japanese Unexamined Patent Application Publication No. 2001-218831

[0007] Patent Document 2: Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2010-527636

[0008] Patent Document 3: Japanese Unexamined Patent Application Publication No. 2013-255824

BRIEF SUMMARY OF THE DISCLOSURE

[0009] The suction device of the related art sometimes has a problem in that the motor sound and the vibration caused during the use are large. For example, in the case of a suction device for sucking nasal mucus, an infant moves his or her body in response to the motor sound and the vibration, and this sometimes makes it difficult to perform the operation of sucking the nasal mucus. In the case of a suction device for the negative pressure wound therapy, since the device needs to be continuously driven for a long time, the patient may experience discomfort from the motor sound and the vibration. Particularly when the suction device is worn in contact with the affected part or skin, the patient may experience significant discomfort from the vibration.

[0010] Accordingly, an object of the present invention is to provide a suction device that can suppress sound and vibration during use.

[0011] A suction device according to the present invention includes a flow-passage forming section having a suction port from which fluid is sucked, a discharge port from which the fluid is discharged, and a flow passage which is sealed from an outside except at the suction port and the discharge port and through which the fluid flows, and a driving part that generates a flow of the fluid in the flow passage. In the driving part, a moving part that transmits the driving force to the fluid is entirely disposed inside the flow passage. In particular, the driving part is preferably driven to make a fluid pressure in the flow passage on a side of the suction port a negative pressure relative to a fluid pressure outside the flow passage and to make a fluid pressure in the flow passage on a side of the discharge port a positive pressure relative to the fluid pressure outside the flow passage.

[0012] According to these structures, the leakage of the driving sound and vibration from the flow passage can be suppressed by disposing the driving part in the sealed flow passage. Portions of the driving part other than the moving part may be provided separately from the flow-passage forming section or may be provided integrally therewith. When the portions are integrally provided, the noise can be even further reduced because since portions connected between the members are reduced in the whole suction device.

[0013] Preferably, the flow-passage forming section further includes a pump chamber whose inner capacity is changed by the movement of the moving part in the flow-passage forming section, and the pump chamber constantly communicates with the outside via the flow passage.

[0014] According to this structure, a complicated mechanism, such as a valve or a valve part for opening and closing the pump chamber is unnecessary, and this can simplify the configuration of the suction device. Further, since the pressure in the pump chamber is quickly released to the atmospheric pressure via the flow passage when the driving part stops the operation, the nasal cavity or the like does not continue to adhere after the driving part stops the operation. For this reason, an operation of releasing the pressure when the operation of the driving part is stopped is unnecessary, and the suction device easily separates from the skin and has high responsiveness. In this regard, discomfort is also unlikely to be experienced by the user.

[0015] Preferably, the moving part includes a piezoelectric member that deforms by the application of a driving voltage and an elastic member to which the piezoelectric member is attached.

[0016] According to this structure, sliding does not occur in the driving part unlike a motor, and the driving sound and vibration caused in the driving part can be suppressed further.

[0017] Preferably, a total cross-sectional area of the flow passage on a discharge side is smaller than a total cross-sectional area on a suction side.

[0018] According to this structure, the driving sound and vibration leaking from the discharge side of the flow-passage forming section can be suppressed.

[0019] Preferably, a flowing direction of the fluid sucked by the driving part is substantially the same as a flowing direction of the fluid discharged by the driving part.

[0020] According to this structure, the path length of the fluid on the discharge side can be shortened (or the path length can be made about zero), and the pressure loss of the fluid caused in the path of the fluid can be suppressed. This can increase the flow rate and flow velocity of the fluid flowing from the outside and reduce the size of the device. Further, since the path of the fluid before and after the driving part is a buffer against the fluid, if the path length of the fluid is long, the time required from when the driving part starts driving to when the pressure of the fluid reaches a predetermined pressure increases. In this structure, however, since the path length of the fluid can be shortened, the buffer can be reduced. This can configure a highly responsive suction device such that the time required from when a driving part starts driving to when the pressure of fluid reaches a predetermined pressure is short.

[0021] Preferably, the suction device further includes a filter that blocks a collection object contained in the fluid.

[0022] According to this structure, the collection object contained in the fluid can be prevented from reaching the driving part, and this allows the driving part to be driven stably. Further, the filter can suppress the leakage of the driving sound and vibration from the suction side of the flow-passage forming section.

[0023] The suction device may further include a housing having an internal space that houses a rear end portion of the flow-passage forming section with the discharge port in a state in which a front end portion of the flow-passage forming section with the suction port is exposed outside, and an air vent communicating with the internal space.

[0024] According to this structure, it is possible to configure a portable suction device that can perform an operation of sucking nasal mucus and the like and to suppress the leakage of the driving sound and vibration from the discharge side of the flow-passage forming section by the housing. The housing and the flow-passage forming section may be separately provided or may be integrally provided. When the housing and the flow-passage forming section are integrally provided, the noise can also be even further reduced because portions connected between the members are reduced in the whole suction device.

[0025] Preferably, the flow-passage forming section further includes a storage unit provided on an upstream side of the driving part in the flow passage in a flow of the fluid to store a collection object contained in the fluid.

[0026] According to this structure, the collection object can be handled easily. The storage unit may be provided separately from other portions that constitute the flow-passage forming section, or may be provided integrally therewith. When the housing is provided integrally with the other portions that constitute the flow-passage forming section, the noise can also be even further reduced because portions connected between the members are reduced in the whole suction device.

[0027] The suction device may further include a protective film having an aperture communicating with the suction port and provided to be adhered to a wound site.

[0028] According to this structure, the suction device can be used for a negative pressure wound therapy. Since the driving sound and vibration are suppressed in the suction device, the discomfort of the patient who receives the negative pressure wound therapy can be suppressed, and the suction device can be easily worn in contact with the affected part or skin.

[0029] Preferably, the storage unit is a bag-shaped inner canister including a bag mouth portion communicating with the suction port and an expandable and contractable expanding and contracting portion having an internal space sealed except at the bag mouth portion.

[0030] According to this structure, the fluid sucked from the suction port can be prevented from directly flowing into the flow passage. Further, the inner canister can suppress the leakage of the driving sound and vibration from the flow-passage forming section. The inner canister and the flow-passage forming section may be separately provided, or may be integrally provided. When the inner canister and the flow-passage forming section are integrally provided, the noise can also be even further reduced because the portions connected between the members are reduced in the whole suction device.

[0031] Preferably, the bag mouth portion is detachable from the suction port.

[0032] According to this structure, the fluid sucked from the outside can be easily taken out of the suction device, and an operation of cleaning the flow passage is unnecessary.

[0033] Preferably, the bag mouth portion connects the expanding and contracting portion and the suction port in a sealed state. Preferably, the expanding and contracting portion further includes a fixing material that fixes liquid therein.

[0034] According to these structures, it is possible to more reliably prevent the leakage of the fluid from the inner canister.

[0035] Preferably, the fluid is gas.

[0036] According to this structure, since the sound caused in the driving part is likely to be transmitted via the gas, the propagation of the sound to the outside of the flow passage can be pronouncedly suppressed by the effect of blocking with the flow-passage forming section.

[0037] According to the present invention, it is possible to suppress the occurrence of the driving sound and vibration and to suppress the leakage of the occurring driving sound and vibration to the outside.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0038] FIGS. **1**A and **1**B include side views of a suction device according to a first embodiment and a sectional side view of the principal part thereof.

[0039] FIG. **2** is an exploded perspective view of a piezoelectric driving part in the suction device of the first embodiment.

[0040] FIGS. **3**A and **3**B include operation views of the piezoelectric driving part in the suction device of the first embodiment.

[0041] FIG. **4** is a side view of a suction device according to a second embodiment.
[0042] FIG. **5** is a side view of a suction device according to a third embodiment.
[0043] FIG. **6** is a side view of a suction device according to a fourth embodiment.
[0044] FIGS. **7**A to **7**G include cross-sectional views of the principal part, illustrating fixing methods for a driving part.
[0045] FIGS. **8**A and **8**B include sectional side views of a suction device according to a fifth embodiment.
[0046] FIGS. **9**A to **9**C include schematic views illustrating a manner in which a suction device according to a sixth embodiment is used for a negative pressure wound therapy.
[0047] FIG. **10** is a cross-sectional view of the principal part of the suction device according to the sixth embodiment.
[0048] FIGS. **11**A and **11**B include explanatory views of a suction device of the related art.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0049] A plurality of embodiments of the present invention will be described below using some specific examples with reference to the drawings. Each of the embodiments is illustrative and the structures shown in different embodiments can be partially replaced and combined.
[0050] Hereinafter, the direction in which a suction device is directed toward, for example, an affected part to be subjected to a suction operation during use is referred to as a frontward direction, and the direction in which fluid is sucked is referred to as a rearward direction.
[0051] FIG. **1**A is a side view of a suction device **9** according to a first embodiment of the present invention.
[0052] Here, the suction device **9** is a liquid suction device for nasal mucus and the like, and includes a flow-passage forming section **1** and a housing **4**. The flow-passage forming section **1** is disposed at a front end of the suction device **9**, and is directed toward the affected part or the like during use. The housing **4** is disposed at a rear end of the suction device **9**, and is gripped by an operator or the like during use.
[0053] The flow-passage forming section **1** includes a nozzle **11**, a separator **12**, a driving unit **13**, and a storage unit **14**. The nozzle **11**, the separator **12**, the driving unit **13**, and the storage unit **14** are separably provided so that each of them can be cleaned easily. In the connecting portions among the nozzle **11**, the separator **12**, the driving unit **13**, and the storage unit **14**, unillustrated packing materials or the like are provided to hermetically seal the connecting portions. The nozzle **11**, the separator **12**, the driving unit **13**, and the storage unit **14** may be appropriately combined.
[0054] The housing **4** is a cylindrical member having closed upper and lower ends. Inside the housing **4**, an internal space **5** is provided to house unillustrated components such as a battery and a power feeding circuit. A front side of an outer surface of the housing **4** has a connecting port **6** communicating with the internal space **5**. A rear side of the outer surface of the housing **4** has a plurality of air vents **7** communicating with the internal space **5**. A rear end of the flow-passage forming section **1** is inserted in the connecting port **6**, and this connects the flow-passage forming section **1** and the housing **4**. An unillustrated packing material or the like is provided in the connecting portion between the flow-passage forming section **1** and the housing **4**, and this hermetically seals the connecting portion. The flow-passage forming section **1** and the housing **4** may be integrally provided. In this case, the noise can be further reduced because portions connected between the members are reduced in the whole suction device.
[0055] The above-described components roughly operate as follows. The nozzle **11** is used while being inserted into a nasal cavity of a patient or the like, and sucks fluid such as nasal mucus. The separator **12** separates a collection object, such as nasal mucus, and the gas contained in the fluid sucked by the nozzle **11**. The storage unit **14** stores the collection object separated by the separator **12**. The driving unit **13** sucks the gas separated by the separator **12** and discharges the gas into the internal space **5** of the housing **4**. The internal space **5** of the housing **4** communicates with an external space of the housing **4** through the plural air vents **7** so that the pressure in the internal space **5** is kept substantially equal to the air pressure in the external space. For this reason, the gas discharged by the driving unit **13** diffuses in the internal space **5** of the housing **4**, and the pressure and flow velocity thereof decrease.
[0056] To suppress the leakage of the driving sound and vibration caused in the driving unit **13** of the flow-passage forming section **1** to the outside, the plural air vents **7** are preferably provided near a lower end of the housing **4** far from the driving unit **13** disposed near an upper end of the housing **4**.
[0057] FIG. **1**B is a sectional side view of the flow-passage forming section **1**. A flow passage **2** is provided inside the flow-passage forming section **1**. The flow passage **2** connects an upper chamber **23** provided in the separator **12**, a lower chamber **26** provided inside the storage unit **14**, a flow passage **21** provided inside the nozzle **11**, and a flow passage **28** provided inside the driving unit **13** in a manner such that they communicate with one another in a sealed state.
[0058] The nozzle **11** is a cylindrical member inclined so that its outer shape narrows toward a front end. The front end of the nozzle **11** has a suction port **20** from which an external fluid containing nasal mucus and the like is sucked. Inside the nozzle **11**, the flow passage **21** is provided to communicate with the suction port **20**. The external fluid containing nasal mucus and the like is sucked from the suction port **20** into the separator **12** through the flow passage **21**. The nozzle **11** may be separable from other portions that constitute the flow-passage forming section **1**, or may be provided integrally with the other portions that constitute the flow-passage forming section **1**. When the nozzle **11** is provided integrally with the flow-passage forming section **1**, the noise can be even further reduced because the portions connected between the members are reduced in the whole suction device.
[0059] The separator **12** is a box-shaped member. A front surface of the separator **12** has an opening **22** in which a rear end of the nozzle **11** is inserted. A rear surface of the separator **12** has an opening **24** in which a front end of the driving unit **13** is inserted. A lower surface of the separator **12** has an opening **25** in which an upper end of the storage unit **14** is inserted. Inside the separator **12**, the upper chamber **23** is provided to communicate with the opening **22**, the opening **24**, and the opening **25**. In the upper chamber **23**, the rear end of the nozzle **11** and the front end of the driving unit **13** are disposed opposed to each other with a predetermined distance therebetween. The external fluid containing nasal mucus and the like is sucked from the flow passage **21** of the nozzle **11** to the upper chamber **23**, and drops downward inside the upper chamber **23**. Thus, liquid, such as nasal mucus, and gas contained in the fluid sucked by the separator **12** are separated.

The separator **12** may also be separable from other portions that constitute the flow-passage forming section **1**, or may be provided integrally therewith. When the separator **12** is provided integrally with the flow-passage forming section **1**, the noise can be even further reduced because the portions connected between the members are reduced in the whole suction device.

[0060] The storage unit **14** is a cylindrical member. Inside the storage unit **14**, the lower chamber **26** is provided. The lower chamber **26** is open at the upper end of the storage unit **14**, and stores liquid, such as nasal mucus, separated and dropped by the separator **12**. The storage unit **14** may also be separable from other portions that constitute the flow-passage forming section **1**, and may be provided integrally therewith. When the storage unit **14** is provided integrally with the flow-passage forming section **1**, the noise can also be even further reduced because the portions connected between the members are reduced in the whole suction device.

[0061] The driving unit **13** includes a cylindrical body **31**, a filter **32**, and a piezoelectric driving part **33**. The cylindrical body **31** is a cylindrical member. A front end of the cylindrical body **31** has an internal suction port **27** from which the gas separated by the separator **12** is sucked. A rear end of the cylindrical body **31** has a discharge port **29** from which the gas sucked from the internal suction port **27** is discharged. Inside the cylindrical body **31**, the flow passage **28** is provided to communicate with the internal suction port **27** and the discharge port **29**. The filter **32** and the piezoelectric driving part **33** are housed in the flow passage **28** to block up the flow passage **28**. The filter **32** is a membrane formed by nonwoven paper or sponge and provided on a front side of the piezoelectric driving part **33**, and prevents liquid, such as nasal mucus, from flowing into the piezoelectric driving part **33**. The cylindrical body **31** may also be separable from other portions that constitute the flow-passage forming section **1**, or may be provided integrally therewith. When the cylindrical body **31** is provided integrally with the flow-passage forming section **1**, the noise can also be even further reduced because the portions connected between the members are reduced in the whole suction device.

[0062] The flow-passage forming section **1** has the above-described configuration.

[0063] Next, the piezoelectric driving part **33** will be described more specifically. The piezoelectric driving part **33** corresponds to the driving part described in the claims, and sucks the gas from the flow passage **28** and discharges the gas to the discharge port **29**. Thus, the piezoelectric driving part **33** generates, inside of the flow-passage forming section **1** (flow passage **2**), a flow of fluid directed from the suction port **20** to the discharge port **29** via the flow passage **21**, the upper chamber **23**, and the flow passage **28**.

[0064] FIG. **2** is an exploded perspective view of the piezoelectric driving part **33**.

[0065] The piezoelectric driving part **33** includes a piezoelectric element **34**A, a reinforcing plate **34**B, a floating terminal **34**C, a diaphragm forming plate **37**A, an opposed plate **37**B, a case portion **35**A, and a cover portion **35**B. The piezoelectric element **34**A, the reinforcing plate **34**B, the diaphragm forming plate **37**A, and the opposed plate **37**B are stacked and fixed while being held between the case portion **35**A and the cover portion **35**B. The piezoelectric driving part **33** is disposed in a manner such that an illustrated top side, that is, a side of the cover portion **35**B faces the internal suction port **27** of the above-described cylindrical body **31** and a bottom side, that is, a side of the case portion **35**A faces the discharge port **29** of the above-described cylindrical body **31**.

[0066] The piezoelectric element **34**A corresponds to the piezoelectric member described in the claims. The piezoelectric element **34**A is disc-shaped, and has electrodes on both surfaces. The electrode provided on the bottom surface of the piezoelectric element **34**A is connected to a reference potential via another member. To the electrode provided on the top surface of the piezoelectric element **34**A, an alternating-current driving voltage is applied from a power feeding circuit (not illustrated) via the floating terminal **34**C.

[0067] The reinforcing plate **34**B has substantially the same outer shape as that of the piezoelectric element **34**A, and is joined to the bottom surface of the piezoelectric element **34**A. The reinforcing plate **34**B is provided to suppress the deformation due to the difference in linear expansion coefficient between the piezoelectric element **34**A and the diaphragm forming plate **37**A, and is formed of a material having a linear expansion coefficient higher than those of both the piezoelectric element **34**A and the diaphragm forming plate **37**A (or a material having a linear expansion coefficient lower than those of both of them).

[0068] The diaphragm forming plate **37**A is disc-shaped. A peripheral edge portion thereof is thick, and a center portion thereof is recessed from the peripheral edge portion on both surfaces. One principal surface of the peripheral edge portion of the diaphragm forming plate **37**A is in contact with the cover portion **35**B, and the other principal surface is in contact with the opposed plate **37**B. The center portion of the diaphragm forming plate **37**A forms a diaphragm **37**, and is joined to the bottom surface of the piezoelectric element **34**A with the reinforcing plate **34**B being disposed therebetween. The diaphragm **37** corresponds to the elastic member described in the claims, which makes bending vibration along with the driving of the piezoelectric element **34**A. Therefore, the diaphragm **37**, the piezoelectric element **34**A, and the reinforcing plate **34**B constitute the moving part described in the claims.

[0069] The opposed plate **37**B has a through hole in its center, and has a plurality of engaging pieces **37**D projecting outward from its outer periphery. The opposed plate **37**B substantially has the same size as that of the peripheral edge portion of the diaphragm forming plate **37**A, is opposed to the center portion (diaphragm **37**) of the diaphragm forming plate **37**A with a distance therebetween, and is in contact with the peripheral edge portion of the diaphragm forming plate **37**A. For this reason, a space serving as a pump chamber **42** to be described later is formed between the opposed plate **37**B and the diaphragm **37**.

[0070] The opposed plate **37**B, the diaphragm forming plate **37**A, and the reinforcing plate **34**B are formed of a conductive material. One of the plural engaging pieces **37**D projecting outward from the outer periphery of the opposed plate **37**B also functions as a terminal for connecting the electrode on the other principal surface of the piezoelectric element **34**A to the reference potential.

[0071] The case portion **35**A is shaped like a box having an internal space that houses the piezoelectric element **34**A, the reinforcing plate **34**B, the floating terminal **34**C, the diaphragm forming plate **37**A, and the opposed plate **37**B, has a through hole serving as a discharge-side flow passage **43** to be described later in the center of an inner bottom surface, and has engaging grooves **35**D for engaging with the plural engaging pieces **37**D of the opposed plate **37**B in an inner side wall portion. The depth of the engaging grooves **35**D is less than the thickness of the side wall portion of the case portion. Thus, a space serving as a connecting chamber **44** to be described later is formed between the inner bottom surface of the case portion **35**A and the opposed plate **37**B.

[0072] The cover portion **35**B is shaped like a lid covering the case portion **35**A, and includes engaging claws **35**E to be engaged with the outer side surface of the case portion **35**A and elastic pieces **35**F for pressing the engaging pieces **37**D of the opposed plate **37**B against the engaging grooves **35**D of the case portion **35**A.

[0073] Here, the depth of the engaging grooves **35**D in the case portion **35**A is substantially equal to the total thickness of the opposed plate **37**B and the peripheral edge portion of the diaphragm forming plate **37**A. Thus, the diaphragm forming plate **37**A is fixed while being held between the case portion **35**A and the opposed plate **37**B.

[0074] FIGS. **3**A and **3**B include cross-sectional views of the piezoelectric driving part **33**.

[0075] Inside the piezoelectric driving part **33**, a suction-side flow passage **41**, a pump chamber **42**, a discharge-side flow passage **43**, and a connecting chamber **44** are provided.

[0076] The suction-side flow passage **41** is a space provided on an outer side of the outer peripheries of the diaphragm forming plate **37**A and the opposed plate **37**B inside the case portion **35**A. The connecting chamber **44** is a space provided between the inner bottom surface of the case portion **35**A and the opposed plate **37**B inside the case portion **35**A. The pump chamber **42** is a space provided between the diaphragm forming plate **37**A and the opposed plate **37**B inside the case portion **35**A. The discharge-side flow passage **43** is a through hole provided in the inner bottom surface of the case portion **35**A. The suction-side flow passage **41** and the discharge-side flow passage **43** communicate with each other with the connecting chamber **44** being disposed therebetween. The pump chamber **42** communicates with a position of the connecting chamber **44** with which the discharge-side flow passage **43** communicates so as to be opposed to the discharge-side flow passage **43**.

[0077] In the piezoelectric driving part **33** having this structure, when an alternating-current driving voltage is applied to the piezoelectric element **34**A, the piezoelectric element **34**A attempts to expand and contract in the in-plane direction of the principal surface. However, since the piezoelectric element **34**A is joined to the diaphragm **37** with the reinforcing plate **34**B being disposed therebetween, it makes bending vibration in a concentric manner together with the reinforcing plate **34**B and the diaphragm **37**. Specifically, when the piezoelectric element **34**A attempts to contract, the diaphragm **37** convexly bends toward the pump chamber **42** (rearward), as illustrated in FIG. **3**A. Conversely, when the piezoelectric element **34**A attempts to expand, the diaphragm **37** convexly bends toward the piezoelectric element **34**A (frontward), as illustrated in FIG. **3**B. In this way, the piezoelectric element **34**A and the diaphragm **37** make bending vibration, and periodic volume variation and pressure variation correspondingly occur in the pump chamber **42**.

[0078] When the volume of the pump chamber **42** decreases, the pump chamber **42** applies a positive pressure to the connecting chamber **44**. Then, gas in the connecting chamber **44** is discharged outside through the discharge-side flow passage **43**. When the volume of the pump chamber **42** increases, the pump chamber **42** applies a negative pressure to the connecting chamber **44**. Then, the gas in the suction-side flow passage **41** is sucked into the connecting chamber **44**. The gas in the suction-side flow passage **41** and an external gas are led into the gas discharged from the discharge-side flow passage **43** by the action of inertial force on the flow of gas produced in this way. Then, a flow of the gas from the suction-side flow passage **41** to the discharge-side flow passage **43** stationarily occurs in the piezoelectric driving part **33**.

[0079] In the piezoelectric driving part **33** having the above-described structure, the diaphragm **37**, the piezoelectric element **34**A, and the reinforcing plate **34**B corresponding to the moving part are entirely housed in a sealed interior (flow passages **2** and **28**) of the flow-passage forming section **1**. Hence, the driving sound and vibration caused in the piezoelectric driving part **33** are unlikely to leak outside from the flow-passage forming section **1**. Further, since the filter **32** is provided in front of the piezoelectric driving part **33**, the driving sound and vibration caused in the piezoelectric driving part **33** are unlikely to leak toward the front side of the flow-passage forming section **1**. Still further, since the housing **4** is provided on the rear side of the piezoelectric driving part **33**, the driving sound and vibration caused in the piezoelectric driving part **33** are unlikely to leak toward the rear side of the flow-passage forming section **1**.

[0080] In the piezoelectric driving part **33**, the members do not rub (slide) against one another, and this can make the caused driving sound and vibration less than in the motor-powered driving part of the related art. In the piezoelectric driving part **33**, a member for closing the flow passage, such as a valve and a valve part, is not provided, and the suction-side flow passage **41** and the discharge-side flow passage **43** constantly communicate with each other. Therefore, the negative pressure in the flow passage **2** can be quickly released to the atmospheric pressure via the suction-side flow passage **41** and the discharge-side flow passage **43** of the piezoelectric driving part **33** only by stopping the piezoelectric driving part **33**, and this can remove the adhesion of the nozzle **11** to the affected part. For this reason, the operation of opening the valve or the valve part is unnecessary, and the nozzle **11** easily separates from the skin. This rarely causes discomfort to the user. Further, a complicated mechanism, such as a valve or a valve part, is unnecessary, and this can improve the responsiveness when a negative pressure is generated and when the negative pressure is released.

[0081] Further, the piezoelectric driving part **33** is configured so that the total cross-sectional area of the discharge-side flow passage **43** opening on the rear side is less than the total cross-sectional area of the suction-side flow passage **41** opening on the front side. This structure can reduce the driving sound and vibration of the piezoelectric driving part **33** leaking outside from the piezoelectric driving part **33** through the discharge-side flow passage **43**.

[0082] In this structure, the piezoelectric driving part **33** is configured so that fluid is sucked from the front side and the fluid is discharged to the rear side by making the flowing direction of the sucked gas and the flowing direction of the discharged gas substantially the same, as shown by dotted arrows in FIGS. **1**A and **1**B. With this structure, the path of the fluid can be made substantially linear and the path length of the piezoelectric driving part **33** on the rear side can be made extremely short (the path length is about zero) in the flow-passage forming section **1** that houses the piezoelectric driving part **33**. Then, the pressure loss of the fluid occurring inside the flow-passage forming section **1** can be suppressed, the flow rate and flow velocity of the fluid sucked by the flow-passage forming section **1** can be increased, and the size of the flow-passage forming section **1** can be reduced. Further, since the path length of the fluid decreases on the front and rear sides of the piezoelectric driving part **33**, buffers against the fluid can be reduced. Thus, it is possible to shorten the time required from when the piezoelectric driving part **33** starts driving to when the pressure of the fluid reaches a predetermined pressure and to improve the operation responsiveness of the suction device **9** and the flow-passage forming section **1**.

[0083] The suction device **9** according to this embodiment can be configured as described above.

[0084] The power feeding circuit for feeding power to the driving unit **13** described in the embodiment may be provided integrally with the driving unit **13** without being provided inside the housing **4**. When the power feeding circuit is integrally provided, the structures of the housing **4** and the like are omitted, and the configuration can be simplified further. The shapes of the nozzle **11** and the storage unit **14** are not limited to the cylindrical shape, and may be other shapes. For example, when the suction device **9** is used as a breast-milk suction device or a phlegm suction device, the nozzle **11** may be shaped like a funnel or a straw. The structure for separating the gas and the collection object (liquid) contained in the fluid in the flow passage **2** may be different from the above-described one. For example, the gas and the liquid contained in the fluid can be easily separated by dividing the flow passage **2** into a plurality of chambers and connecting the chambers or adopting a valve structure. The structure of the piezoelectric driving part **33** may be different from the above-described one. For example, the number of the discharge-side flow passages and the number of the suction-side flow passages provided in the piezoelectric driving part **33** and the paths thereof and the like can be changed appropriately. The portions of the piezoelectric driving part **33** except for the diaphragm **37**, the diaphragm forming plate **37**A, and the reinforcing plate **34**B corresponding to the moving part may be appropriately provided integrally with the members that constitute the flow-passage forming section **1**. When the portions are integrally provided, the noise can be even further reduced because the portions connected between the members are reduced in the whole suction device.

[0085] Next, a suction device according to a second embodiment of the present invention will be described. FIG. **4** is a side view of a suction device **51** according to the second embodiment.

[0086] While the suction device **51** has almost the same configuration as the configuration of the above-described first embodiment, it includes a housing **54** having a structure different from the structure in the above-described first embodiment. The housing **54** houses, among a nozzle **11**, a separator **12**, a driving unit **13**, and a storage unit **14** that constitute a flow-passage forming section **1**, the separator **12**, the driving unit **13**, and the storage unit **14**. Only the nozzle **11** protrudes outside.

[0087] The present invention may be configured like the suction device **51**. According to this configuration, the driving sound and vibration caused in the driving unit **13** and leaking to the separator **12** and the storage unit **14** can be unlikely to leak outside.

[0088] Next, a suction device according to a third embodiment of the present invention will be described. FIG. **5** is a side view of a suction device **61** according to the third embodiment.

[0089] While the suction device **61** has almost the same configuration as the configuration of the above-described first embodiment, it includes a housing **64** having a structure different from the structure in the above-described first embodiment. The housing **64** is shaped like a cylinder extending in the front-rear direction, and has air vents **65** at a position opposed to a rear side of a driving unit **13**.

[0090] The present invention may be configured like the suction device **61**. This configuration can reduce the size of the suction device **61** and can make the path of fluid linear as a whole. This can further suppress the pressure loss occurring in the path of the fluid.

[0091] Next, a suction device according to a fourth embodiment of the present invention will be described. FIG. **6** is a side view of a suction device **71** according to the fourth embodiment.

[0092] While the suction device **71** has almost the same configuration as the configuration of the above-described first embodiment, it includes a nozzle **72** having a structure different from the structure in the above-described first embodiment. The suction device **71** is configured as a breast-milk suction device, and the nozzle **72** is shaped like a funnel to be fit the shape of breasts.

[0093] The present invention may be configured like the suction device **71**. This can configure a compact and silent breast-milk suction device.

[0094] Next, fixing methods for the driving part in the suction device will be described.

[0095] In FIGS. **7**A and **7**B, a flow-passage forming section **82** and a piezoelectric driving part **83** are fixed by screwing. When the flow-passage forming section **82** and the piezoelectric driving part **83** have high elasticity, they can be hermetically sealed only by screwing. However, a seal material is preferably provided on a contact surface between the flow-passage forming section **82** and the piezoelectric driving part **83**. A suction-port side surface of the piezoelectric driving part **83** is in contact with the flow-passage forming section **82** in FIG. **7**A, and a discharge-port side surface of the piezoelectric driving part **83** is in contact with the flow-passage forming section **82** in FIG. **7**B. Since a flow of fluid occurs from the suction port side toward the discharge port side inside the flow-passage forming section **82**, the flow-passage forming section **82** and the piezoelectric driving part **83** can be in closer contact with each other when the discharge-port side surface of the piezoelectric driving part **83** is in contact with the flow-passage forming section **82**, as illustrated in FIG. **7**B.

[0096] In FIGS. **7**C and **7**D, the flow-passage forming section **82** and the piezoelectric driving part **83** are fixed by fitting with an elastic member **84** located on an outer periphery being disposed therebetween. The elastic member **84** is, for example, an adhesive or a rubber packing material.

[0097] In FIGS. **7**E and **7**F, the flow-passage forming section **82** is provided with a lid member **85** to hold the piezoelectric driving part **83** from the suction port side and the discharge port side, and the flow-path forming section **82** and the piezoelectric driving part **83** are thereby fixed. In this case, it is also preferable to provide an elastic member **84**.

[0098] In FIG. **7**G, the flow-passage forming section **82** is provided with a piezoelectric lid member **85** to hold and fix an elastic member **84** from the suction port side and the discharge port side, and the driving part **83** is clamped by the elastic member **84** from the outer peripheral direction to fix the piezoelectric driving part **83**.

[0099] By various methods described above, the flow-passage forming section and the piezoelectric driving part can be connected in a sealed state. The flow-passage forming section and the piezoelectric driving part may be fixed by other appropriate methods.

[0100] Next, a suction device according to a fifth embodiment of the present invention will be described. FIGS. **8**A and **8**B include side views of a suction device **91** according to the fifth embodiment.

[0101] While the suction device **91** has almost the same configuration as the configuration of the above-described first embodiment, it includes a flow-passage forming section **92** having a structure different from the structure in the above-described first embodiment. The flow-passage forming section **92** includes an inner canister **94** instead of the storage unit **14** provided in the first embodiment.

[0102] The inner canister **94** is roughly shaped like a bag, and is housed inside the flow-passage forming section **92** (flow passage **2**). The inner canister **94** has an inner space **98** therein, and includes a bag mouth portion **96** and an expanding and contracting portion **95**. The expanding and contracting portion **95** is a bag-shaped member formed of a resin material such as PET, and is expandable and contractable (herein plastically deformable). The expanding and contracting portion **95** may be formed of an elastic material, such as rubber, to be elastically deformable. The bag mouth portion **96** is an annular member attached at an aperture of the expanding and contracting portion **95**, and is attached to a rear end portion of a nozzle **11** in a sealed state inside the flow-passage forming section **92** (flow passage **2**). The bag mouth portion **96** is detachable from the rear end portion of the nozzle **11**. The bag mouth portion **96** is provided with a check valve **97** that does not block the flow of the fluid flowing from the nozzle **11** into the expanding and contracting portion **95**, but blocks the flow of the fluid flowing out from the expanding and contracting portion **95** into the nozzle **11**.

[0103] Before use of the suction device **91**, the inner canister **94** is in a contracted state in which the inner space **98** of the bag mouth portion **96** is crushed. When the suction device **91** is driven in such a state, a driving unit **13** discharges the air inside the flow passage **2** from a discharge port **29** to the outside. Thus, the pressure inside the flow passage **2** becomes a negative pressure, and the expanding and contracting portion **95** expands. Thus, the pressure in the inner space **98** of the expanding and contracting portion **95** also becomes a negative pressure, and the inner space **98** sucks an external fluid from the nozzle **11**. When the inner canister **94** is completely expanded, the external fluid cannot be further sucked from the nozzle **11**. Hence, the inner canister **94** is detached from the rear end portion of the nozzle **11**, and is replaced with a new inner canister **94**. This allows the external fluid to be sucked from the nozzle **11** again.

[0104] By providing the inner canister **94** inside the flow-passage forming section **92** as in the suction device **91**, viscous liquid, such as nasal mucus, can be prevented from directly flowing into the flow passage **2**, and the suction device **91** can be prevented from being put into an inoperable state by clogging of the flow passage and the like in the driving unit **13**. Further, the sucked fluid can be taken out of the suction device **91** by replacing only the inner canister **94**, and an operation of cleaning the flow-passage forming section **92** is unnecessary.

[0105] The present invention may be configured like the suction device **91**. This can configure a more convenient suction device. The inner canister **94** may be separable from other portions that constitute the flow-passage forming section **92**, or may be provided integrally with the other portions that constitute the flow-passage forming section **92**. When the inner canister **94** is provided integrally with the flow-passage forming section **92**, the noise can be even further reduced because portions connected between the members are reduced in the whole suction device.

[0106] Next, a suction device according to a sixth embodiment of the present invention will be described. FIG. **9**A is a schematic view illustrating a use mode of a suction device **101** according to the sixth embodiment.

[0107] The suction device **101** according to this embodiment is used for a negative pressure wound therapy. The negative pressure wound therapy is a therapy that promotes recovery of a wound site by keeping the wound site in a wet state with a wound dressing in a healing process of the wound site. The suction device **101** includes a suction unit **102** and a wound dressing **103**. The wound dressing **103** is adhered around a wound site **111** of a patient who receives the negative pressure wound therapy in order to cover the wound site **111**. The suction unit **102** is attached to a surface of the wound dressing **103**, and applies a negative pressure around the wound site **111** covered with the wound dressing **103** in a sealed state to suck an exudate generated from the wound site **111**.

[0108] FIG. **9**B is an exploded perspective view illustrating the outline structure of the suction device **101**. FIG. **9**C is a schematic view illustrating a worn state of the suction device **101** on the wound site.

[0109] The wound dressing **103** includes a protective film **104**, an absorbing member **105**, a covering member **106**, and gauze **107**. The gauze **107**, the covering member **106**, the absorbing member **105**, and the protective film **104** are arranged in this order from a side of the wound site **111**.

[0110] The gauze **107** is disposed in contact with a mucous membrane exposed in a wound interior of the wound site **111**.

[0111] The covering member **106** is shaped to match the shape of the wound interior, and is then disposed on an upper side of the gauze **107** to fill the wound interior. The covering member **106** is formed of a porous material that transmits liquid. As the covering member **106**, for example, polyurethane foam that is easily shaped to match the shape of the wound site can be used.

[0112] The absorbing member **105** is disposed on an upper side of the covering member **106**. The absorbing member **105** absorbs liquid and holds the absorbed liquid. As the absorbing member **105**, for example, cotton or a gel in which highly water-absorbing polymers are dispersed can be used.

[0113] The protective film **104** is a film that prevents the passage of liquid and gas, and has an aperture **108**. An adhesive (not illustrated) for adhering to the skin is applied on a surface of the protective film **104** on the wound site side. The outer shape of the protective film **104** has an area larger than those of the absorbing member **105**, the covering member **106**, and the gauze **107** so as to cover the absorbing member **105**, the covering member **106**, and the gauze **107** entirely. The protective film **104** is adhered to a skin surface **112** around the wound site **111** with its outer peripheral portion exposed from the absorbing member **105**, the covering member **106**, and the gauze **107** being used as an adhesive surface. Thus, a closed space **110** is formed between the protective film **104** and the wound site **111**.

[0114] The suction unit **102** has an outer shape like a thin box, and has a suction port **109** in a principal surface to be attached to the wound dressing **103**. The suction unit **102** is attached to the wound dressing **103**, for example, by an adhesive tape. The suction port **109** of the suction unit **102** is disposed as opposed to the aperture **108** of the protective film **104**, and sucks the fluid (exudate) from the closed space **110** covered with the wound dressing **103**.

[0115] FIG. **10** is a cross-sectional view of the suction unit **102**.

[0116] The suction unit **102** includes a flow-passage forming section **120**, an inner canister **121**, a piezoelectric driving part **122**, a driving circuit **123**, a pressure sensor **124**, and a battery **125**. The flow-passage forming section **120** has an inner partition **130**. The inner partition **130** divides the internal space of the flow-passage forming section **120** into a flow passage **131** and a housing inner chamber **139**. The flow-passage forming section **120** has an aperture at a position that does not face the housing inner chamber **139** but faces the flow passage **131**, and the aperture forms a suction port **132** of the flow passage **131**. The inner partition **130** also has an aperture, and the aperture forms a discharge port **133** of the flow passage **131**. The flow passage **131** is sealed except at the suction port **132** and the discharge port **133**. The flow-passage forming section **120** also has an air vent **138** at a position that does not face the flow passage **131** but faces the housing inner chamber **139**. The air vent **138** allows the housing inner chamber **139** to communicate with the external space to make the pressure in the housing inner chamber **139** substantially equal to the outside pressure. The housing inner chamber **139** houses the driving circuit **123**, the pressure sensor **124**, and the battery **125**.

[0117] The piezoelectric driving part **122** is attached at the discharge port **133** in the flow passage **131**. The battery **125** supplies power to the piezoelectric driving part **122** and the pressure sensor **124** via the driving circuit **123**. The pressure sensor **124** detects the air pressure in the flow passage **131**. The driving circuit **123** controls the piezoelectric driving part **122** so that the air pressure in the flow passage **131** becomes constant.

[0118] The inner canister **121** is housed in the flow passage **131**, and is attached at the suction port **132** of the flow passage **131**. The inner canister **121** has an outline shape like a bag, has an internal space **134** therein, and includes a bag mouth portion **126** and an expanding and contracting portion **127**. The expanding and contracting portion **127** is a bag-shaped member formed of a resin material such as PET, and is expandable and contractable (here, plastically deformable). The bag mouth portion **126** is an annular member attached at an aperture of the expanding and contracting portion **127**, and is attached in a sealed state to the suction port **132** of the flow passage **131**. The bag mouth portion **126** is detachable from the suction port **132**. The bag mouth portion **126** is provided with a check valve **128** that does not block the flow of the fluid flowing from the suction port **132** into the expanding and contracting portion **127** but blocks the flow of the fluid flowing out from the expanding and contracting portion **127** to the suction port **132**. In the internal space **134** of the inner canister **121**, a fixing material for fixing an exudate, such as cotton or a gel in which highly water-absorbing polymers are dispersed may be provided.

[0119] Before the use of the suction unit **102**, the inner canister **121** is in a contracted state in which the internal space **134** of the expanding and contracting portion **127** is crushed. When the suction unit **102** is driven in such a state, the piezoelectric driving part **122** discharges the air inside the flow passage **131** from the discharge port **133** to the housing inner chamber **139**. Thus, the pressure inside the flow passage **131** becomes a negative pressure, and the expanding and contracting portion **127** attempts to expand. Thus, the pressure in the internal space **134** also becomes a negative pressure, and the external fluid is sucked from the suction port **132**, that is, the exudate is sucked from the closed space **110** between the protective film **104** and the wound site **111**. When the inner canister **121** is completely expanded, the exudate cannot be sucked further. Hence, the inner canister **121** is taken out from the inside of the flow-passage forming section **120** and is replaced with a new inner canister **121**. This allows the exudate to be sucked from the closed space **110** between the protective film **104** and the wound site **111** again.

[0120] By providing the inner canister **121** as in the suction device **101**, the exudate can be prevented from directly flowing into the flow passage **131**, and the suction device **101** can be prevented from being put into an inoperable state by clogging of the flow passage and the like in the piezoelectric driving part **122**. Further, the exudate can be taken out of the suction device **101** by replacing only the inner canister **121**, and an operation of cleaning the flow passage **131** is unnecessary.

[0121] The present invention may be configured like the suction device **101**. This configuration can make the suction device used for the negative pressure wound therapy highly convenient. While the suction unit **102** is directly attached to the wound dressing **103** in this embodiment, the wound dressing **103** and the suction unit **102** may be connected by a tube or the like and the suction unit **102** may be attached at a position far from the wound site **111**. The inner canister **121** may be separable from other portions that constitute the flow-passage forming section **120**, or may be provided integrally with the other portions that constitute the flow-passage forming section **120**. When the inner canister **121** is provided integrally with the flow-passage forming section **120**, the noise can be even further reduced because portions connected between the members are reduced in the whole suction device.

[0122] The present invention can be carried out by any configuration other than the above-described configurations as long as it corresponds to the configuration described in the claims.

[0123] While the suction device sucks a liquid which is a collection object in the embodiments of the present invention, the collection object may be a solid or gel substance other than the liquid. While the suction device sucks a gas serving as a fluid to be sucked together with the collection object in the embodiments of the present invention, the fluid to be sucked together with the collection object may be a liquid, such as water, or a colloid solution. In this case, a gel or a solid having a specific gravity higher than that of the fluid can be separated and stored as the collection object. The present invention is also applicable to, for example, a dust collection device for collecting minute dust and powder dust and a device for collecting an extra glue or adhesive applied to a workpiece. The configuration of the present invention is effective when these devices are used in a silent environment and when vibrations of these devices are suppressed.

[0124] **1** flow-passage forming section
[0125] **2** flow passage
[0126] **4** housing
[0127] **5** internal space
[0128] **6** connecting port
[0129] **7** air vent
[0130] **9** suction device
[0131] **11** nozzle
[0132] **12** separator
[0133] **13** driving unit
[0134] **14** liquid container
[0135] **20** suction port
[0136] **21**, **28** flow passage
[0137] **22**, **24**, **25** aperture
[0138] **23** upper chamber
[0139] **26** lower chamber
[0140] **27** internal suction port
[0141] **29** discharge port
[0142] **31** cylindrical body
[0143] **32** filter
[0144] **33** piezoelectric driving part
[0145] **34**A piezoelectric element
[0146] **34**B reinforcing plate
[0147] **35**A case portion
[0148] **35**B cover portion
[0149] **37**A diaphragm forming plate
[0150] **37**B opposed plate
[0151] **41** suction-side flow passage
[0152] **42** pump chamber
[0153] **43** discharge-side flow passage
[0154] **44** connecting chamber
[0155] **91** suction device
[0156] **92** flow-passage forming section
[0157] **94** inner canister
[0158] **95** expanding and contracting portion
[0159] **96** bag mouth portion
[0160] **101** suction device
[0161] **102** suction unit
[0162] **103** wound dressing
[0163] **104** protective film
[0164] **120** flow-passage forming section
[0165] **121** inner canister
[0166] **126** bag mouth portion
[0167] **127** expanding and contracting portion

1. A suction device comprising:

a flow-passage forming section having a suction port for sucking a fluid, a discharge port for discharging the fluid, and a flow passage through which the fluid flows, wherein the flow passage is sealed from an outside except at the suction port and the discharge port; and

a driving part for generating a flow of the fluid in the flow passage,

wherein the driving part comprises a moving part for transmitting a driving force to the fluid and the moving part is entirely disposed inside the flow passage.

2. The suction device according to claim **1**, wherein the driving part is driven to make a fluid pressure in the flow passage on a side of the suction port a negative pressure relative to a fluid pressure outside the flow passage and to make a fluid pressure in the flow passage on a side of the discharge port a positive pressure relative to the fluid pressure outside the flow passage.

3. The suction device according to claim **1**,

wherein the flow-passage forming section further includes a pump chamber having an inner capacity changed by a movement of the moving part in the flow-passage forming section, and

wherein the pump chamber constantly communicates with the outside via the flow passage.

4. The suction device according to claim **1**, wherein the moving part includes a piezoelectric member deformed by an application of a driving voltage and an elastic member having the piezoelectric member attached.

5. The suction device according to claim **1**, wherein a total cross-sectional area of the flow passage on a discharge side is smaller than a total cross-sectional area of the flow passage on a suction side.

6. The suction device according to claim **1**, wherein a flowing direction of the fluid sucked by the driving part is substantially the same as a flowing direction of the fluid discharged by the driving part.

7. The suction device according to claim **1**, further comprising:

a filter for blocking a collection object contained in the fluid.

8. The suction device according to claim **1**, further comprising:

a housing having an internal space housing a rear end portion of the flow-passage forming section with the discharge port wherein a front end portion of the flow-passage forming section with the suction port is exposed to an outside, and an air vent communicating with the internal space.

9. The suction device according to claim **1**, wherein the flow-passage forming section further includes a storage unit provided on an upstream side of the driving part in the flow passage in a flow of the fluid to store a collection object contained in the fluid.

10. The suction device according to claim **9**, further comprising:

a protective film having an aperture communicating with the suction port and provided to be adhered to a wound site.

11. The suction device according to claim **9**, wherein the storage unit is a bag-shaped inner canister including a bag mouth portion communicating with the suction port and an expandable and contractable expanding and contracting portion having an internal space sealed except at the bag mouth portion.

12. The suction device according to claim **11**, wherein the bag mouth portion is detachable from the suction port.

13. The suction device according to claim **11**, wherein the bag mouth portion connects the expanding and contracting portion and the suction port in a sealed state.

14. The suction device according to claim **11**, wherein the expanding and contracting portion further includes a fixing material for fixing a liquid therein.

15. The suction device according to claim **1**, wherein the fluid is gas.

16. The suction device according to claim **2**, wherein the flow-passage forming section further includes a pump chamber having an inner capacity changed by a movement of the moving part in the flow-passage forming section, and

wherein the pump chamber constantly communicates with the outside via the flow passage.

17. The suction device according to claim **2**, wherein the moving part includes a piezoelectric member deformed by an application of a driving voltage and an elastic member having the piezoelectric member attached.

18. The suction device according to claim **3**, wherein the moving part includes a piezoelectric member deformed by an application of a driving voltage and an elastic member having the piezoelectric member attached.

19. The suction device according to claim **2**, wherein a total cross-sectional area of the flow passage on a discharge side is smaller than a total cross-sectional area of the flow passage on a suction side.

20. The suction device according to claim **3**, wherein a total cross-sectional area of the flow passage on a discharge side is smaller than a total cross-sectional area of the flow passage on a suction side.

* * * * *