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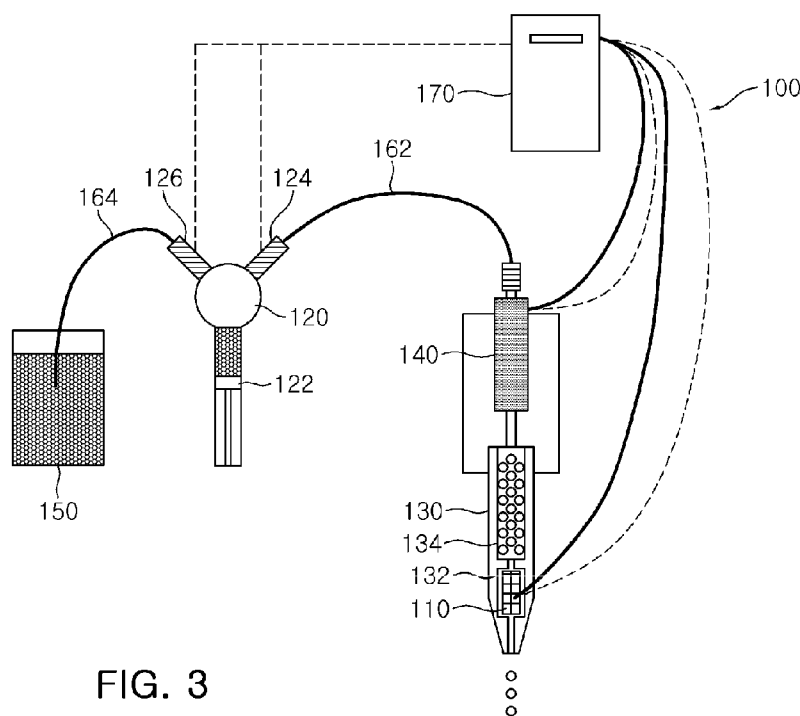


FIG. 3

(57) Abstract: There is provided a fluid discharging device including: a first pressure generating unit generating a first pressure for discharging a fluid; a second pressure generating unit generating a second pressure for discharging a fluid, and being controllable so as to change a magnitude of the second pressure; and a nozzle discharging the fluid pressurized by the first and second pressure generating units.



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FLUID DISCHARGING DEVICE AND METHOD

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 61/487,102, filed on May 17, 2011. The entire teaching of the above application is
5 incorporated herein by reference

BACKGROUND OF THE INVENTION

Field of the Invention

10 [0002] The present invention relates to a fluid discharging device and method for discharging a predetermined amount of fluid, and more particularly, to a fluid discharging device and method selectively discharging a relatively small amount of fluid and a relatively large amount of fluid in terms of flow amount and finely discharging fluid having a wide range in terms of viscosity.

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Description of the Related Art

[0003] In performing research using a biochip, quantitatively supplying a culture solution or a reagent to the biochip is a very important factor in determining the accuracy of experimental results.

20 [0004] A problem of quantitatively supplying liquid is more important in a cell chip in which a toxicity test, an anti-cancer sensitiveness test and a resistance test are necessarily required in order to develop a new medicine.

[0005] According to the related art, a liquid discharging device including a ceramic nozzle connected to a pump unit through a tube has been used in supplying liquid to the
25 biochip. Even in the case that the amount of a discharged liquid is controlled through an electronic control, the fluid discharging device has supplied a droplet having a minimal amount of liquid (several tens of microliters) through the ceramic nozzle, thereby having a difficulty in supplying a quantitative amount and a fine amount of liquid.

[0006] In order to solve this problem, an electronic pipette capable of supplying a droplet having an amount of liquid several nls or less through electronic control has been developed. However, the electronic pipette has a significant difficulty in supplying a large amount of liquid in a droplet and discharging a high viscosity material.

5 [0007] Therefore, according to the related art, a fluid discharging device for discharging a large amount of fluid and a fluid discharging device for discharging a small amount of fluid according to the quantity of discharged of fluid should be provided or a fluid discharging device for high viscosity liquid and a fluid discharging device for low viscosity liquid according to the viscosity of discharged liquid should be provided, such
10 that the use thereof is inconvenient and a high cost is incurred.

[0008] In addition, since the fluid discharging device and the electronic pipette for discharging the small amount of liquid should be alternately used according to the discharged amounts and viscosities of liquid, the time required to replace or operate the experimental devices has been increased and the accuracy of experiments has been
15 deteriorated due to a reduction in concentration of an experimenter.

SUMMARY OF THE INVENTION

[0009] An aspect of the present invention provides a fluid discharging device and method capable of selectively discharging a relatively small amount of fluid and a
20 relatively large amount of fluid in a wide range of viscosities from low viscosity to high viscosity.

[0010] According to an aspect of the present invention, there is provided a fluid discharging device including: a first pressure generating unit generating a first pressure for discharging a fluid; a second pressure generating unit generating a second pressure for
25 discharging a fluid, and being controllable so as to change a magnitude of the second pressure; and a nozzle discharging the fluid pressurized by the first and second pressure generating units.

[0011] The first and second pressure generating units may be connected in series with

the nozzle.

[0012] The first and second pressure generating units may be connected in parallel with the nozzle.

[0013] The nozzle may have a storage space storing the fluid therein.

5 [0014] The first pressure generating unit may be installed in the storage space.

[0015] According to another aspect of the present invention, there is provided a fluid discharging method comprising discharging a relatively small amount of fluid and a relatively large amount of fluid by generating pressures having different magnitudes.

10 [0016] The discharging of the relatively small amount of fluid and the relatively large amount of fluid may include discharging different amounts of fluids by simultaneously or selectively generating the pressures having the different magnitudes.

[0017] The discharging of the relatively small amount of fluid and the relatively large amount of fluid may include discharging different amounts of fluids by adding or subtracting the pressures having the different magnitudes.

15 [0018] The discharging of the relatively small amount of fluid and the relatively large amount of fluid may include quantitatively discharging fluids having different viscosities by simultaneously or selectively generating the pressures having the different magnitudes.

[0019] The discharging of the relatively small amount of fluid and the relatively large amount of fluid may include quantitatively discharging fluids having different viscosities
20 by adding or subtracting the pressures having the different magnitudes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other aspects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in
25 conjunction with the accompanying drawings, in which:

[0021] FIG. 1 is a view showing the configuration of a fluid discharging device according to a first embodiment of the present invention;

[0022] FIG. 2 is a view showing the configuration of a fluid discharging device

according to a second embodiment of the present invention; and

[0023] FIG. 3 is a view showing the configuration of a fluid discharging device according to a third embodiment of the present invention.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] Exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0025] In describing the present invention below, terms indicating components of the present invention are used in consideration of functions of each of the components.

10 Therefore, these terms should not be interpreted as limiting the technical components of the present invention.

[0026] A fluid discharging device according to a first embodiment of the present invention will be described with reference to FIG. 1. FIG. 1 is a view showing the configuration of a fluid discharging device according to the first embodiment of the present
15 invention.

[0027] A fluid discharging device 100 according to the first embodiment of the present invention includes a first pressure generating unit 110, a second pressure generating unit 120, and a nozzle 130.

[0028] The first pressure generating unit 110 is connected to the nozzle 130, and
20 generates a first pressure P1 having a predetermined magnitude. The first pressure P1 generated from the first pressure generating unit 110 is transferred to the nozzle 130. Therefore, when the first pressure generating unit 110 is operated, a first flow amount Q1 of fluid corresponding to the first pressure P1 may be discharged.

[0029] The first pressure generating unit 110 may store a predetermined amount of
25 fluid therein. In this case, when the first pressure generating unit 110 generates the first pressure P1, the flow amount of fluid corresponding to the first pressure P1 is supplied to the nozzle 130. The fluid supplied to the nozzle 130 may be discharged through the nozzle 130 simultaneously with the operation of the first pressure generating unit 110. Meanwhile,

in the case in which a continuous supply of the fluid is required, the first pressure generating unit 110 may be directly connected to a fluid supply source.

[0030] The first pressure generating unit 110 is formed as a pressure generating device generating a predetermined pressure. The first pressure generating unit 110 may be formed to have a piezoelectric element pressurizing the fluid in a vibrating method, a heating element generating pressure through air bubbles generated during the heating of the fluid, and the like.

[0031] The second pressure generating unit 120 is connected to the nozzle 130, and generates a second pressure P2 having a predetermined magnitude. Here, the second pressure P2 may be larger than the first pressure P1. The second pressure P1 generated from the second pressure generating unit 120 is transferred to the nozzle 130. Therefore, when the second pressure generating unit 120 is operated, a second flow amount Q2 of fluid may be discharged through the nozzle 130. The flow amount discharged through the nozzle may be proportional to the second pressure P2. For reference, the magnitude of the second pressure P2 may be proportional to that of the first pressure P1; however, it may be determined to be any magnitude if needed.

[0032] The second pressure generating unit 120 may store a predetermined amount of fluid therein. In this case, when the second pressure generating unit 120 generates the second pressure P2, the flow amount of fluid corresponding to the second pressure P2 is supplied to the nozzle 130. The fluid supplied to the nozzle 130 may be discharged through the nozzle 130 simultaneously with the operation of the second pressure generating unit 120. Meanwhile, in the case in which a continuous supply of the fluid is required, the second pressure generating unit 120 may be directly connected to a fluid supply source.

[0033] The second pressure generating unit 120 is formed as a pressure generating device generating a predetermined pressure. The second pressure generating unit 120 may be formed to have a piezoelectric element pressurizing the fluid in a vibrating method, a heating element generating pressure through air bubbles generated during the heating of the fluid, and the like. The second pressure generating unit 120 may be preferably formed to

have a piezoelectric element having larger capacity than that of the piezoelectric element of the first pressure generating unit 110, a plurality of piezoelectric elements, or a small pump.

In the case in which the second pressure generating unit 120 has the plurality of piezoelectric elements, the magnitude of pressure for discharging the fluid may be

5 controlled in a wide range.

[0034] The nozzle 130 is connected to the first and second pressure generating units 110 and 120. When the pressure is generated from the first pressure generating unit 110 or the second pressure generating unit 120, the nozzle 130 discharges the flow amount of fluid corresponding to the pressure.

10 **[0035]** The nozzle 130 may include a storage space storing the fluid therein. In this case, the storage space may have a sufficient large volume so that all flow amounts corresponding to the pressure generated from the first and second pressure generating units 110 and 120 may be stored therein. For example, the storage space may be manufactured to have a size allowing for the storage of the flow amount corresponding to the pressure ($P1 +$
15 $P2$) generated by the first and second pressure generating units 110 and 120. The nozzle may be directly connected to a fluid supply source supplying the fluid.

[0036] For reference, although not shown in FIGS. 1 and 2, at least one of the pressure generating units 110 and 120 and the nozzle 130 may be connected to a separate pump device so as to intake fluid through the nozzle 130. Alternatively, the pressure generating
20 units 110 and 120 may generate a negative pressure so as to intake fluid through the nozzle 130.

[0037] Meanwhile, the flow amount discharged through a single operation of the pressure generating units 110 and 120 may be changed according to the viscosity or specific gravity of fluid. For example, a greater amount of a fluid having a relatively small
25 viscosity or specific gravity may be discharged through a single operation of the pressure generating units 110 and 120 than that of a fluid having a relatively large viscosity or specific gravity.

[0038] The change in the discharged flow amount according to the viscosity or specific

gravity of the fluid may hinder an accurate experimental value from being obtained in an experiment treating various samples.

[0039] In addition, as described in a background section of the present invention, cases in which a small amount of fluid and a large amount of fluid are discharged in the experiment treating various samples coexist. For example, an experimental object material or an additive (or an active material) tends to be discharged in a small amount, while a fixative fixing the experimental object material or other solution tends to be discharged in a large amount.

[0040] However, since a pipette generally used in a laboratory does not separately discharge a large amount of material and a small amount of material, a pipette for discharging a large amount of material and a pipette for discharging a small amount of material should be provided, respectively.

[0041] The present embodiment is intended to solve these problems. Hereinafter, a fluid discharging method of the fluid discharging device 100 for solving the problems will be described.

[0042] The fluid discharging device 100 according to the present embodiment includes at least two pressure generating units 110 and 120 providing pressures having different magnitudes, whereby the above-mentioned problems according to the related art may be solved.

1) Case in which different kinds of fluids having different viscosities or specific gravities are quantitatively discharged.

[0043] Generally, a fluid having a relatively low viscosity (or specific gravity) (hereinafter, referred to as a “general fluid”) is relatively thin, such that it is easily discharged. However, a fluid having a relatively high viscosity (or specific gravity) (hereinafter, referred to as a “viscous fluid”) is relatively thick, such that it may be difficult to discharge. For reference, in the present embodiment, viscous fluid refers to a fluid having a viscosity exceeding 20 cP and general fluid refers to a fluid having a viscosity of 20 cP or less.

[0044] In consideration of this, the general fluid and the viscous fluid are discharged by the following method.

(General fluid)

[0045] In the case in which general fluid is discharged, only the first pressure
5 generating unit 110 may be used.

[0046] General fluid is relatively thin as described above, such that a predetermined amount of fluid corresponding to the first pressure P1 of the first pressure generating unit 110 may be discharged. For example, the first pressure generating unit 110 may allow 1 nℓ of general fluid to be discharged through a single operation thereof. In the case in which 3
10 nℓ of general fluid attempt to be discharged, the first pressure generating unit 110 has to be operated three times.

[0047] In this case, the second pressure generating unit 120 is maintained in an atmospheric pressure state or is not operated.

(Viscous fluid)

15 [0048] In the case in which viscous fluid is discharged, both of the first pressure generating unit 110 and the second pressure generating unit 120 may be used.

[0049] Viscous fluid is relatively thick as described above, such that it may be difficult to quantitatively discharge by only using the first pressure P1 of the first pressure generating unit 110.

20 [0050] For example, if 1 nℓ of general fluid is discharged through a single operation of the first pressure generating unit 110, less than 1 nℓ of viscous fluid is discharged through a single operation of the first pressure generating unit 110. Therefore, the pressure of the first pressure generating unit 110 should be compensated for in order to discharge viscous fluid and general fluid in the same amount.

25 [0051] In the present embodiment, the second pressure generating unit 120 performs this function. That is, the second pressure generating unit 120 generates pressure required for discharging a quantitative amount of viscous fluid, together with the first pressure generating unit 110.

[0052] For example, when the first pressure generating unit 110 lacks a pressure of 0.1 Pa to discharge 1 nℓ of viscous fluid having a viscosity of 30 cP, the second pressure generating unit 120 generates a pressure of 0.1 Pa. Here, the second pressure generating unit 120 may be formed to have a plurality of piezoelectric elements to thereby control the pressure generated therein.

[0053] Meanwhile, since the viscosity [Pa·s: CGS unit, 1000 cP] may be represented by a function in proportion to the pressure [Pa]. Therefore, when the viscosity of viscous fluid is known, the compensation pressure of the second pressure generating unit 120 may be calculated.

[0054] Therefore, according to the present embodiment, different kinds of fluids having different viscosities may be quantitatively discharged.

2) Case in which a large amount of fluid and a small amount of fluid are required to be discharged.

[0055] In the present case, a large amount of fluid and a small amount of fluid may be discharged by two methods.

[0056] A first method is to separately control the first pressure generating unit 110 and the second pressure generating unit 120.

[0057] That is, in the case in which a small amount of fluid is required to be discharged, a first flow amount Q1 of fluid is discharged using the first pressure generating unit 110, and in the case in which a large amount of fluid is required to be discharged, a second flow amount Q2 of fluid is discharged using the second pressure generating unit 120.

[0058] Here, since the second pressure P2 of the second pressure generating unit 120 may be set to be larger than the first pressure P1 of the first pressure generating unit 110, the second pressure generating unit 120 may allow a large amount of fluid to be discharged. The second pressure P2 of the second pressure generating unit 120 may be set to be appropriate for the discharging of the large amount of fluid.

[0059] The present method may change the magnitude of pressures of the first and second pressure generating units 110 and 120 to thereby change the discharging amount

corresponding to the small amount and the discharging amount corresponding to the large amount.

[0060] A second method is to control the first pressure generating unit 110 and the second pressure generating unit 120 in combination.

5 [0061] That is, in the case in which a small amount of fluid is required to be discharged, the first flow amount Q_1 or the second flow amount Q_2 of fluid is discharged using the first or second pressure generating unit 110 or 120, and in the case in which a large amount of fluid is required to be discharged, a third flow amount Q_1+Q_2 of fluid is discharged using both of the first and second pressure generating units 110 and 120.

10 [0062] In the case in which the small amount of fluid is discharged, only the flow amount Q_1 or Q_2 corresponding to the pressure generated from any one of the first and second pressure generating units 110 and 120 is discharged, and in the case in which the large amount of fluid is discharged, the flow amount Q_1+Q_2 corresponding to the pressure generated from both of the first and second pressure generating units 110 and 120 is
15 discharged.

[0063] According to the present method, three different flow amounts may be discharged: the discharging of the first flow amount Q_1 by the first pressure generating unit 110, the discharging of the second flow amount Q_2 by the second pressure generating unit 120, and the discharging of the third flow amount Q_1+Q_2 by the first pressure generating
20 unit 110 and the second pressure generating unit 120. Therefore, according to the present method, the discharging amount may be finely controlled.

[0064] A fluid discharging device according to a second embodiment of the present invention will be described with reference to FIG. 2. FIG. 2 is a view showing the configuration of a fluid discharging device according to the second exemplary embodiment
25 of the present invention. The second embodiment is different from the first embodiment in the arrangement of the pressure generating units 110 and 120. For reference, in the second embodiment, the same reference numerals will be used to designate the same components as those described in the first embodiment. A detailed description thereof will be omitted.

[0065] In the present embodiment, the first pressure generating unit 110 is mounted on the nozzle 130. That is, in the fluid discharging device 100 according to the second embodiment, the first pressure generating unit 110 and the second pressure generating unit 120 are connected in series.

5 [0066] This may significantly facilitate the slimness of the fluid discharging device 100.

[0067] In the case in which the first pressure generating unit 110 is formed as a piezoelectric element, it may be easily installed in the inside of the nozzle 130. Likewise, in the case in which the second pressure generating unit 120 is formed as a piezoelectric
10 element or a small pump, it may also be directly installed in the nozzle 130.

[0068] The fluid discharging device 100 configured as described above perform the discharging of a small amount of fluid and a large amount of fluid by the same method as that of the first embodiment. The small amount of fluid may be discharged by using the first pressure generating unit 110, and the large amount of fluid may be discharged by using the
15 second pressure generating unit 120.

[0069] Meanwhile, in the present embodiment, the first and second pressure generating units 110 and 120 are connected to each other in series, such that the sum of pressures of the first and second pressure generating units 110 and 120 may be easily generated. Therefore, the present embodiment is very effective in discharging the large amount of
20 fluid using the first and second pressure generating units 110 and 120.

[0070] Hereinafter, a fluid discharging device according to a third embodiment of the present invention will be described with reference to FIG. 3. The third embodiment has a form in which the features of the second embodiment are more specifically implemented. For reference, in the third embodiment, the same reference numerals will be used to
25 designate the same components as those described in the second embodiment. A detailed description thereof will be omitted.

[0071] The fluid discharging device 100 according to the third embodiment of the present invention includes the first pressure generating unit 110, the second pressure

generating unit 120, the nozzle 130, an electronic valve 140, a storage tank 150, and a control device 170.

[0072] The first pressure generating unit 100 is formed as a small piezoelectric element.

Therefore, the first pressure generating unit 100 may be installed in the nozzle 130. For

5 reference, in the present embodiment, the first pressure generating unit 110 is installed in a first space 132 formed in the inside of the nozzle 130. The first pressure generating unit 110 installed in the first space 132 applies pressure to fluid stored in the first space 132 to allow the fluid to be discharged through the nozzle 130. Here, the first space 132 is a small space allowing for the storage of several nℓs of fluid therein, and the first pressure generating unit
10 110 generates the pressure required for discharging several nℓs (preferably, 1 nℓ or less) of fluid.

[0073] The second pressure generating unit 120 is formed as a small pump. For

example, the second pressure generating unit 120 may be a syringe pump generating a positive pressure and a negative pressure (or a vacuum pressure) by the reciprocating

15 movement of a piston 122. The second pressure generating unit 120 generates the pressure required for discharging several tens of nℓs (preferably, 20 nℓs) of fluid. The second pressure generating unit 120 is connected to the nozzle 130 or the first pressure generating unit 110 via a first tube 162.

[0074] The second pressure generating unit 120 includes a first valve 124 and a second

20 valve 126.

[0075] The first valve 124 is installed to be connected to the first tube 162. The first valve 124 controls pressure and the movement of fluid between the nozzle 130 and the second pressure generating unit 120.

[0076] For example, when it is necessary to supply the fluid from the second pressure

25 generating unit 120 to the nozzle 130 or to apply pressure thereto, the first valve 124 is opened so that the fluid stored in the second pressure generating unit 120 and the pressure of the second pressure generating unit 120 may be transferred to the nozzle 130. However, when the fluid is supplied from the storage tank 150 to the second pressure generating unit

120 (when the second pressure generating unit 120 generates a negative pressure), the first valve 124 is closed so that the fluid stored in the nozzle 130 does not move to the second pressure generating unit 120.

[0077] The second valve 126 is installed to be connected to a second tube 164. The
5 second valve 126 controls pressure and the movement of fluid between the second pressure generating unit 120 and the storage tank 150.

[0078] For example, when the fluid is supplied from the storage tank 150 to the second pressure generating unit 120 (when the second pressure generating unit 120 generates a negative pressure), the second valve 126 is opened so that the fluid stored in the storage
10 tank 150 may move to the second pressure generating unit 120. However, when it is necessary to supply the fluid from the second pressure generating unit 120 to the nozzle 130 or to apply pressure thereto, the second valve 126 is closed so that the fluid stored in the second pressure generating unit 120 and the pressure of the second pressure generating unit 120 is not transferred to the storage tank 150.

15 [0079] For reference, the first and second valves 124 and 126 may be controlled according to a control signal of the control device 170.

[0080] The nozzle 130 discharges the fluid according to the pressure generated from the pressure generating units 110 and 120. The nozzle 130 includes the first space 132 and a second space 134. The fluid to be discharged is stored in the respective spaces 132 and 134.
20 Here, a volume of the first space 132 may be the same as that of the first flow amount Q1 to be discharged by the operation of the first pressure generating unit 110, and a volume of the second space 134 may be the same as that of the second flow amount Q2 to be discharged by the operation of the second pressure generating unit 120.

[0081] The electronic valve 140 is installed in the nozzle 130 or the first tube 162. The
25 electronic valve 140 is connected to the control device 170, such that the degree of opening and closing thereof is controlled by the control signal of the control device 170. The electronic valve 140 is used to finely control the flow amount of fluid supplied from the second pressure generating unit 120. Therefore, the electronic valve 140 may be omitted in

some cases.

[0082] The storage tank 150 stores the fluid to be discharged or a cleaning solution therein. The storage tank 150 is connected to the second pressure generating unit 120 to supply the fluid or the cleaning solution thereto. For reference, in the case in which the intake of fluid may be directly performed through the nozzle 130, the storage tank 150 may be omitted.

[0083] The control device 170 controls the operations of the pressure generating units 110 and 120 and the valves 124, 126, and 140. The control device 170 controls the operating states of the above-mentioned components so that a small amount of fluid or a large amount of fluid may be discharged according to a user's selection.

[0084] For example, the control device 170 operates only the first pressure generating unit 110 in the case in which the small amount of fluid is required to be discharged, and operates only the second pressure generating unit 120 in the case in which the large amount of fluid is required to be discharged.

[0085] An operating sequence of the fluid discharging device 100 according to the discharging of the small amount of fluid and the discharging of the large amount of fluid is as follows:

[0086] First, the following preparing operation is performed for fluid discharging.

1) Filling the inside of the second pressure generating unit 120 with a fluid

[0087] In a state in which the first valve 124 is closed and the second valve 126 is opened, a negative pressure is generated in the inside of the second pressure generating unit 120. At this time, the fluid in the storage tank 150 moves to the second pressure generating unit 120 to fill the inside of the second pressure generating unit 120.

2) Filling the inside of the nozzle 130 with the fluid

[0088] In a state in which the second valve 126 is closed and the first valve 124 and the electronic valve 140 are opened, a positive pressure is generated in the second pressure generating unit 120. At this time, the fluid stored in the second pressure generating unit 120 fills the spaces 132 and 134 of the nozzle 130.

[0089] When the preparation for fluid discharging is finished through the above-mentioned process, the discharging of the small amount of fluid and the discharging of the large amount of fluid are performed according to the user's selection. The discharging of the small amount of fluid and the large amount of fluid may be performed as follows:

1) Discharging of the small amount of fluid

[0090] The small amount of fluid is discharged through the operation of the first pressure generating unit 110. When the user selects the discharging of the small amount of fluid, the control device 170 operates the first pressure generating unit 110. In this case, the first pressure P1 is generated in the inside of the first space 132, and the fluid stored in the first space 132 is discharged to the outside of the nozzle 130. Here, the discharging amount of the fluid is defined as a volume of the first space 132.

2) Discharging of the large amount of fluid

[0091] The large amount of fluid is discharged through the operation of the second pressure generating unit 120. When the user selects the discharging of the large amount of fluid, the control device 170 operates the second pressure generating unit 120, and opens the first valve 124 and the electronic valve 140. In this case, the fluid stored in the first space 132 and the second space 134 is discharged to the outside of the nozzle 130 by the second pressure P2 generated from the second pressure generating unit 120. Here, the discharging amount of the fluid is defined as an amount corresponding to one stroke of the piston 122.

[0092] As set forth above, according to exemplary embodiments of the present invention, a plurality of pressure generating units are selectively operated, whereby a relatively small amount of fluid and a relatively large amount of fluid may be discharged according to a user's convenience.

[0093] Therefore, there is no need to include a plurality of fluid discharging devices for discharging different amounts of fluid.

[0094] In addition, according to exemplary embodiments of the present invention, a

magnitude of pressure for discharging fluid may be arbitrarily changed, such that fluids having different viscosities, particularly, bio materials having a high viscosity may also be quantitatively discharged.

[0095] Therefore, a biochemical experiment treating materials having various
5 viscosities may be performed precisely and accurately.

[0096] While the present invention has been shown and described in connection with the exemplary embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the invention as defined by the appended claims.

CLAIMS

What is claimed is:

1. A fluid discharging device comprising:
a first pressure generating unit generating a first pressure for discharging a fluid;
5 a second pressure generating unit generating a second pressure for discharging a fluid, and being controllable so as to change a magnitude of the second pressure; and
a nozzle discharging the fluid pressurized by the first and second pressure generating units.
- 10 2. The fluid discharging device of claim 1, wherein the first and second pressure generating units are connected in series with the nozzle.
3. The fluid discharging device of claim 1, wherein the first and second pressure generating units are connected in parallel with the nozzle.
- 15 4. The fluid discharging device of any of the above claims, wherein the nozzle has a storage space storing the fluid therein.
5. The fluid discharging device of claim 4, wherein the first pressure generating unit is
20 installed in the storage space.
6. The fluid discharging device of any of the above claims wherein said first pressure generating unit generating a first pressure for discharging a first flow amount, Q_1 , between 0.1 and 10000 nl; preferably between 0.15 and 1000 nl; preferably between 1 and 100 nl.
- 25 7. The fluid discharging device of any of the above claims wherein said second pressure generating unit generating a second pressure for discharging a second second flow

amount, Q_2 , between 0.1 and 10000 nl; preferably between 0.15 and 1000 nl; preferably between 1 and 100 nl.

8. The fluid discharging device of any of the claims wherein said said first pressure
5 generating unit generating a first pressure for discharging a fluid discharges a first fluid and
said second pressure generating unit generating a second pressure for discharging a fluid
discharges a second fluid wherein said second fluid has a higher viscosity than said first
fluid at 23°C and atmospheric pressure.

10 9. The fluid discharging device of any of the above claims wherein said said first
pressure generating unit comprises a first piezoelectric element.

10. The fluid discharging device of any of the above claims wherein said said second
pressure generating unit comprises a second piezoelectric element.

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11. The fluid discharging device of any of above claims 9 or 10 wherein said first
piezoelectric element is a piezoelectric disc.

12. The fluid discharging device of any of claims 9, 10 or 11 wherein said second
20 piezoelectric element is a piezoelectric disc.

13. The fluid discharging device of any of claims 6-12 wherein said first fluid
comprises a protein, DNA or RNA and combinations thereof.

25 14. The fluid discharging device of any of claims 6-13 wherein said second fluid
comprises a culture solution.

15. A fluid discharging method comprising discharging a relatively small amount of fluid and a relatively large amount of fluid by generating pressures having different magnitudes.

5 16. The fluid discharging method of claim 15, wherein the discharging of the relatively small amount of fluid and the relatively large amount of fluid includes discharging different amounts of fluids by simultaneously or selectively generating the pressures having the different magnitudes.

10 17. The fluid discharging method of any of claims 15-16, wherein the discharging of the relatively small amount of fluid and the relatively large amount of fluid includes discharging different amounts of fluids by adding or subtracting the pressures having the different magnitudes.

15 18. The fluid discharging method of any of claims 15-17, wherein the discharging of the relatively small amount of fluid and the relatively large amount of fluid includes quantitatively discharging fluids having different viscosities by simultaneously or selectively generating the pressures having the different magnitudes.

20 19. The fluid discharging method of any of claims 15-18, wherein the discharging of the relatively small amount of fluid and the relatively large amount of fluid includes quantitatively discharging fluids having different viscosities by adding or subtracting the pressures having the different magnitudes.

1/2

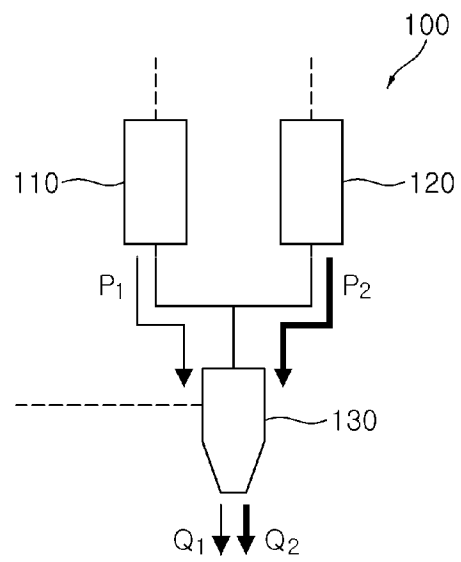


FIG. 1

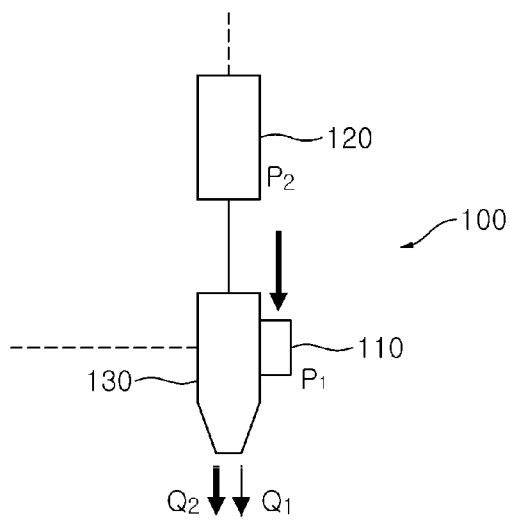


FIG. 2

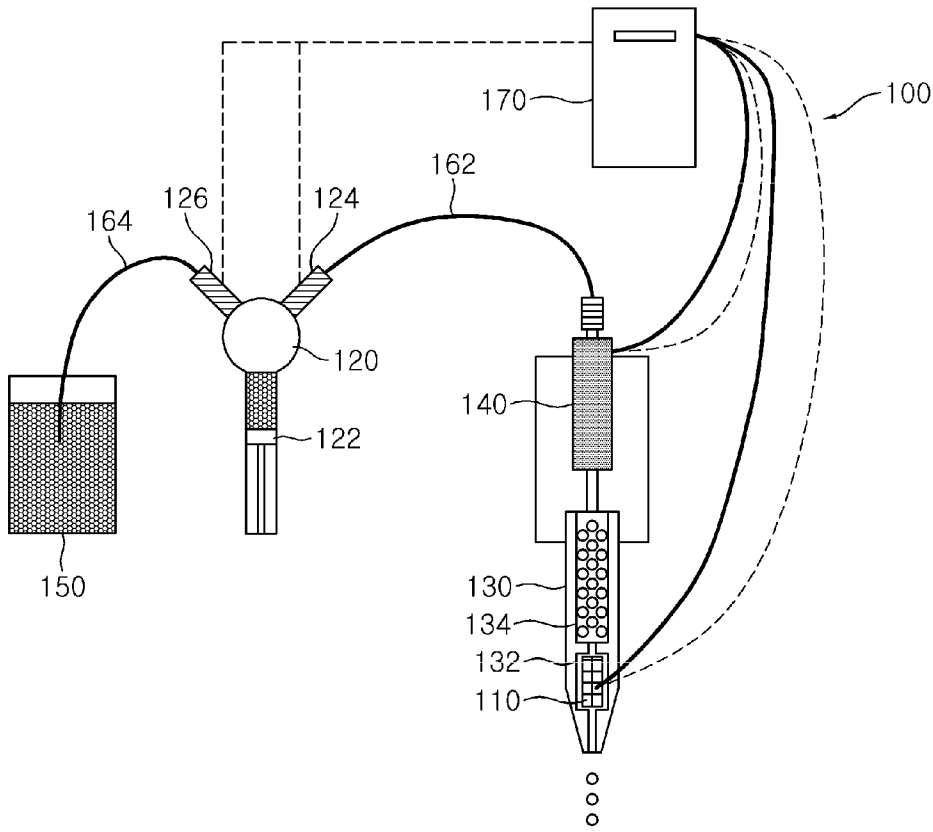


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/038273

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G01F 11/02 (2012.01)

USPC - 222/265

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - G01F 11/00, 11/02, 13/00 (2012.01)

USPC - 222/252, 265, 333

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

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

Patbase, Google Patent, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,558,127 B2 (MARUYAMA et al) 06 May 2003 (06.05.2003) entire document	1-5, 15-17
A	US 6,527,031 B1 (YANAGITA et al) 04 March 2003 (04.03.2003) col 55, lines 15-67, col 56, lines 1-67, col 57, lines 1-64, fig 40-43	1-5, 15-17
A	US 5,808,559 A (BUCKLER) 15 September 1998 (15.09.1998) col 7, lines 25-67, col 8, lines 19-67, fig 1, 3, 4	1-5, 15-17
A	US 4,436,822 A (ESEIFAN) 13 March 1984 (13.03.1984) col 3, lines 42-68, col 4, lines 1-56, fig 1-3	1-5, 15-17

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

01 August 2012

Date of mailing of the international search report

17 AUG 2012

Name and mailing address of the ISA/US

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P.O. Box 1450, Alexandria, Virginia 22313-1450

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PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/038273

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 6-14, 18-19
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.