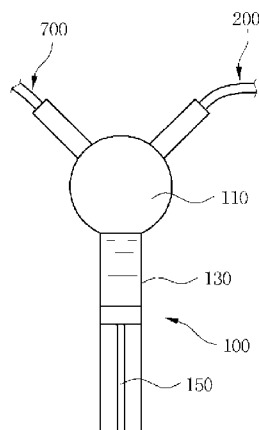




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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
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(54) **Title:** MICRO DROPLET DISCHARGING APPARATUS**FIG. 2**

(57) **Abstract:** Disclosed herein is a micro droplet discharging apparatus including: a pump unit generating discharging pressure; an electronic valve controlling the discharging of a large amount of droplet; an electronic pipette controlling the discharging of a small amount of droplet and having droplet discharged from a distal end thereof; and a controller controlling the driving of the pump unit, the electronic valve, and the electronic pipette. The micro droplet discharging apparatus may discharge the large amount of droplet and the small amount of droplet in a single apparatus, thereby making it possible to reduce time of the experiment, provide convenience to a user, and reduce a cost. In addition, the micro droplet discharging apparatus is used, such that the stop frequency of the experiment may be reduced, thereby making it possible to obtain an accurate experiment result.

MICRO DROPLET DISCHARGING APPARATUS

RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 61/487,112, filed
5 on May 17, 2011. The entire teaching of the above application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a micro droplet discharging apparatus.
10

2. Description of the Related Art

Pharmaceutical research and development is largely focused on prevention and diagnosis
of various diseases. The diagnosis of disease includes sensing biomaterials specific to particular
diseases of interest. In addition, the sensing of the biomaterial include sensing physical changes
15 caused by chemical reaction or physical behavior generated between any target material and
enzymes, microorganisms, antibodies, receptors, cells, proteins, DNAs which can yield
information about changes to the target material.

Recently, research into a biochip has been actively conducted in order to suggest an
apparatus having excellent capability to sense the biomaterial and a compact size and capable of
20 mass production. The biochip may be classified into a molecule chip, an enzyme chip, a
microorganism chip, a cell chip, a protein chip, and a DNA chip according to the kind of target
biomaterial.

In performing research using the biochip, supplying a fixed amount of liquid such as
culture solution or reagent to the biochip is a very important factor in determining accuracy of
25 experimental results.

A problem of supplying a fixed amount of 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.

According to the prior art, a liquid discharging apparatus including a ceramic nozzle connected to a pump unit through a tube has been used in supplying liquid to the biochip. Even though an injection amount is controlled through electronic control, the liquid discharging apparatus has supplied a minimal droplet amount of several ten microliters through the ceramic nozzle, thereby having a difficulty in supplying a fixed amount and a micro amount.

In order to solve the problem, an electronic pipette capable of supplying several nanoliters or less of droplet through electronic control has been developed. However, in the case of using the electronic pipette, there was a difficulty in supplying a large amount of droplet.

Therefore, there is a need to prepare both of an apparatus for discharging a large amount of droplet and an electronic pipette for discharge a small amount of droplet, thereby increasing burden in terms of a cost. In addition, the apparatus for discharging a large amount of droplet and the electronic pipette for discharging a small amount of droplet can be alternately used in order to supply a fixed amount of droplet, thereby increasing the stop frequency and the time of the experiment on the biochip.

SUMMARY OF THE INVENTION

The present invention has been made in an effort to provide a micro droplet discharging apparatus capable of controlling the amount of droplet discharged through a single apparatus as a large amount or a small amount.

According to a preferred embodiment of the present invention, there is provided a micro droplet discharging apparatus including: a pump unit generating discharging pressure; an electronic valve connected to the pump unit through a first connection pipe and controlling the discharging of a large amount of droplet; an electronic pipette connected to the electronic valve through a second connection pipe, controlling the discharging of a small amount of droplet and

having droplet discharged from a distal end thereof; and a controller controlling the driving of the pump unit, the electronic valve, and the electronic pipette so as to control the amount of droplet discharged from the electronic pipette.

When the controller drives the pump unit and the electronic valve, the pump unit may generate the discharging pressure and the electronic valve may allow liquid supplied from the pump unit to be discharged as the large amount of droplet from the distal end of the electronic pipette through opening and closing of the valve.

When controller drives the electronic pipette, the electronic pipette may generate discharging pressure to allow liquid to be discharged as the small amount of droplet from the distal end of the electronic pipette.

The pump unit may generate suction pressure to suck liquid through the electronic pipette.

When the large amount of droplet is discharged to the outside, the controller may drive the pump unit and the electronic valve, such that the pump unit generates the discharging pressure and the electronic valve allows liquid supplied from the pump unit to be discharged as the large amount of droplet from the distal end of the electronic pipette through opening and closing of the valve, and stop the driving of the electronic pipette so as not to generate discharging pressure.

When the small amount of droplet is discharged to the outside, the controller may drive the electronic pipette, such that the electronic pipette generates discharging pressure to allow liquid to be discharged as the small amount of droplet from the distal end of the electronic pipette, and stop the driving of the pump unit so as not to generate the discharging pressure and the driving of the electronic valve so as to be maintained in an opened state.

The large amount of droplet may be about 20 nl or more; preferably about 20-10000 nl; more preferably about 25-1000 nl; preferably about 30-500 nl.

The small amount of droplet may be about 5 nl or less; preferably about 2 nl or less;

preferably about 1 nl or less; preferably about 0.001-1 nl; preferably about 0.1 to 1 nl.

The pump unit may be a syringe pump.

The syringe pump may include: an opening and closing valve having a first connection pipe connected thereto; a syringe connected to the opening and closing valve and having liquid
5 stored therein; and a plunger moving upward in an inside of the syringe to thereby generate the discharging pressure so as to discharge the liquid to an outside of the syringe and moving downward in the inside of the syringe to thereby generate suction pressure so as to introduce the liquid to the inside of the syringe.

The micro droplet discharging apparatus may further include a cleaning liquid storing
10 tank connected to the syringe pump through a supply pipe.

The electronic pipette may be a piezoelectric electronic pipette.

The electronic valve may be a solenoid valve.

BRIEF DESCRIPTION OF THE DRAWINGS

15 FIG. 1 is a view showing a configuration of a micro droplet discharging apparatus according to a preferred embodiment of the present invention;

FIG. 2 is a plan view of a pump unit shown in FIG. 1; and

FIG. 3 is a cross-sectional view of an electronic pipette shown in FIG. 1.

20 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Various features and advantages of the present invention will be more obvious from the following description with reference to the accompanying drawings.

The terms and words used in the present specification and claims should not be interpreted as being limited to typical meanings or dictionary definitions, but should be
25 interpreted as having meanings and concepts relevant to the technical scope of the present invention based on the rule according to which an inventor can appropriately define the concept

of the term to describe most appropriately the best method he or she knows for carrying out the invention.

The above and other objects, features and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings. In the specification, in adding reference numerals to components
5 throughout the drawings, it is to be noted that like reference numerals designate like components even though components are shown in different drawings. Further, when it is determined that the detailed description of the known art related to the present invention may obscure the gist of the present invention, the detailed description thereof will be omitted.

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

As shown in FIG. 1, a micro droplet discharging apparatus according to a preferred embodiment of the present invention is configured to include a pump unit 100 generating discharging pressure, an electronic valve 300 controlling the discharging of a large amount of
15 droplet, an electronic pipette 500 controlling the discharging of a small amount of droplet and having droplet discharged from a distal end thereof, and a controller 600 controlling the driving of the pump unit 100, the electronic valve 300, and the electronic pipette 500.

An operation principle of the micro droplet discharging apparatus according to a preferred embodiment of the present invention will be schematically described before a
20 configuration thereof is described.

When the micro droplet discharging apparatus discharges a large amount of droplet, the controller 600 drives the pump unit 100 and the electronic valve 300, and stops the driving of the electronic pipette 500. The driven pump unit 100 generates discharging pressure, and the electron valve 300 allows liquid supplied from the pump unit 100 to be discharged as a large
25 amount of droplet through the opening and closing of the valve. Here, the electronic pipette 500 of which the driving is stopped simply serves as a flow passage through which the liquid passes.

When the micro droplet discharging apparatus discharges a small amount of droplet, the controller 600 drives the electronic pipette 500, and stops the driving of the pump unit 100 and the electronic valve 300. The driven electronic pipette 500 generates micro discharging pressure to thereby discharge a small amount of droplet. Here, the electronic valve 300 of which the driving is stopped is in an opened state and only serves as a flow passage through which the liquid passes.

Hereinafter, each component of the micro droplet discharging apparatus according to a preferred embodiment of the present invention will be described in detail.

The pump unit 100, which is an apparatus converting an electrical energy into a mechanical energy, forcibly transports the liquid according to the intention using the pressure generated from the mechanical energy. When the pump unit 100 is driven according to a control signal of the controller 600, it generates discharge pressure so that a large amount of droplet is discharged.

In addition, the pump unit 100 serves to generate suction pressure to thereby suck external liquid into an inside of the apparatus through the electronic pipette 500. The pump unit 100 may be divided into a reciprocating pump, a centrifugal pump, an axial flow pump, and the like, according to a method of generating pressure.

Herein, the pump unit 100 is preferably a syringe pump. The syringe pump, which is a kind of reciprocating pump, has a simple structure and may easily control the discharging of the liquid.

As shown in FIG. 2, the syringe pump includes an opening and closing valve 100 having an external connection pipe connected thereto, a syringe 130 storing liquid, and a plunger 150 vertically moving in an inside of the syringe 130. The opening and closing valve 110 has a first connection pipe 200 connected thereto, and may change a moving direction of the liquid through the opening and closing of the valve. The opening and closing valve 110 may also have a plurality of pipes connected thereto, wherein the plurality of pipes are inserted into a cleaning

liquid storing tank, etc.

The syringe 130 is connected to the opening and closing valve 110 to store liquid. The syringe 130 may be made of various material such as glass, PVC, PTFE, etc., according to a kind of liquid stored therein.

5 The plunger 150 is driven by a motor, and a moving direction of liquid may be controlled by movement of the plunger 150. When the plunger 150 moves downward, suction pressure is generated, such that liquid is sucked into the inside of the syringe 130. In addition, when the plunger 150 moves upward, discharging pressure is generated, such that the liquid moves to the first connection pipe 200 connected to the opening and closing valve 110.

10 The electronic valve 300 serves to control the discharging of a large amount of droplet through the opening and closing of the valve. When the pump unit 100 generates the discharging pressure, the liquid is introduced into an inside of the electronic valve 300 through the first connection pipe 200, and the electronic valve 300 controls the opening and closing of the valve according to an electric signal of the controller 600 to thereby discharge droplet in unit of 20 nℓs
15 or more.

Here, the electronic valve 300 may preferably be a solenoid valve. The solenoid valve has a simple configuration and a cheap cost. When power is applied to the solenoid valve according to the electrical signal of the controller 600, the solenoid valve is opened and closed by magnetic force of a magnet included therein. A current amount applied to the solenoid valve is
20 changed to adjust an opening and closing degree of the solenoid valve, thereby making it possible to easily control the discharged amount of a large amount of droplet.

The electronic pipette 500, which is a component of finally discharging the sucked liquid, is connected to the electronic valve 300 through a second connection pipe 400. When the electronic pipette 500 is driven according to a control signal of the controller 600, it generates
25 discharging pressure to thereby discharge a small amount of droplet. In the present invention, the electronic pipette 500 may discharge a small amount of droplet of 1 nℓ or less.

Here, as the electronic pipette 500, a piezoelectric electronic pipette that may satisfy the above-mentioned condition, easily control the discharged amount of droplet and be miniaturized is preferably used. The piezoelectric electronic pipette is characterized in that the discharged amount of droplet is determined according to vibration strength of a piezoelectric material

5 including the electronic pipette 500.

Referring to FIG. 3, the piezoelectric electronic pipette 500 will be described in detail.

The piezoelectric electronic pipette 500 is configured of an inlet 510 through which liquid is introduced, a reservoir 520, a restrictor 530, a chamber 540, a piezoelectric material 550, a nozzle 560, and the like.

10 The reservoir 520 is supplied with the liquid through the inlet 510 to thereby accommodate the liquid, and provides the liquid to the chamber 540 through the restrictor 530 described below. The restrictor 530 serves as a flow passage communicating between the reservoir 520 and the chamber 540 described below to supply the liquid from the reservoir 520 to the chamber 540. When the chamber 540 is vibrated by the piezoelectric material 540, the
15 restrictor 530 may control the amount of liquid supplied from the reservoir 520 to the chamber 540.

The chamber 540 is connected to the restrictor 530 to communicate with the reservoir 520. In addition, the chamber 540 is connected to the nozzle 560 at a side other than the side at which it is connected to the restrictor 530. Through this structure, the chamber 540 may be
20 supplied with the liquid from the reservoir 520 and supply the liquid to the nozzle 560, thereby making it possible to enable the liquid to be discharged.

The piezoelectric material 550 may be positioned on an upper portion of the chamber 540 and generate vibration according to a control signal. That is, vibration is generated by applying voltage to the piezoelectric material 550 and is transferred to the chamber 540 through a
25 vibration plate, such that the liquid is discharged from the nozzle 560. An electrode (not shown) is formed on a surface of the piezoelectric material 550 to supply electricity from an external

power supply to the piezoelectric material 550.

The controller 600 controls the driving of the pump unit 100, the electronic valve 300, and the electronic pipette 500 in order to control the amount of droplet discharged from the electronic pipette 500. The controller 600 includes a central processing unit (CPU) therein, wherein the CPU has a driving control algorithm embedded therein. In addition, the controller 600 may further include a key input unit for allowing a user to input a set droplet discharging amount and a display displaying a driving state of the micro droplet discharging apparatus so that the user recognizes the driving state.

When the user inputs a target amount to droplet to be discharged, the controller 600 determines whether the input amount of droplet is a small amount or a large amount to thereby control the driving using different algorithms. A process in which the controller 600 controls the driving of the pump unit 100, the electronic valve 300, and the electronic pipette 500 in order to control the discharged amount of droplet will be described.

When droplet in unit of 20 nls or more is to be discharged to the outside, the controller 600 determines the droplet in unit of 20 nls or more as a large amount of droplet and drives the pump unit 100 and the electronic valve 300 and stops the driving of the electronic pipette 500. When the pump unit 100 and the electronic valve 300 are driven, the pump unit 100 generates discharging pressure and the electronic valve 300 allows liquid supplied from the pump unit 100 to be discharged as a large amount of droplet from a distal end of the electronic pipette 500 through the opening and closing of the valve. Here, the electronic pipette 500 of which the driving is stopped simply serves as a flow passage through which the liquid passes.

When droplet in unit of 1 nl or less is to be discharged, the controller 600 determines the droplet in unit of 1 nl or less as a small amount of droplet and drives the electronic pipette 500 and stops the driving of the electronic valve 300 and the pump unit 100. When the electronic pipette 500 is driven, it generates micro discharging pressure to allow the liquid to be discharged as a small amount of droplet. Here, the electronic valve 300 of which the driving is stopped is in

an opened state and only serves as a flow passage through which the liquid passes.

In addition, the micro droplet discharging apparatus according to a preferred embodiment of the present invention may further include a cleaning liquid storing tank 800 (see FIG. 1) connected to the syringe pump through a supply pipe 700 (see FIG. 1). The cleaning liquid storing tank 800 is connected to the micro droplet discharging apparatus, thereby making it possible to clean an inside of the micro droplet discharging apparatus.

A specific cleaning process of the micro droplet discharging apparatus will be described. First, when the opening and closing valve 110 closes a valve connected to the first connection pipe 200 and opens a valve connected to the supply pipe 700, the plunger 150 moves downward to thereby generate suction pressure. When the suction pressure is generated, cleaning liquid stored in the cleaning liquid storing tank 800 is supplied to an inside of the syringe 130 through the supply pipe 700. When the cleaning liquid is supplied to the inside of the syringe 130, the opening and closing valve 110 closes the valve connected to the supply pipe 700 and opens the valve connected to the first connection pipe 200. Then, the plunger 150 moves upward to generate discharging pressure, thereby moving the cleaning liquid to the first connection pipe 200. Therefore, finally, the cleaning liquid is discharged to the outside through the distal end of the electronic pipette 500, thereby cleaning the inside of the micro droplet discharging apparatus. After reagent or culture solution is discharged through the micro droplet discharging apparatus, the micro droplet discharging apparatus is cleaned through the cleaning liquid, thereby making it possible to prevent the droplet from being polluted due to residue in the inside of the micro droplet discharging apparatus and obtain an accurate test result value.

According to the preferred embodiment of the present invention, the electronic valve controlling the discharging of a large amount of droplet, the electronic pipette controlling the discharging of a small amount of droplet, and the controller controlling the driving of the pump unit, the electronic valve, and the electronic pipette are included, thereby making it possible to discharge both of the large amount of droplet and the small amount of droplet in a single

apparatus.

In addition, according to the preferred embodiment of the present invention, functions of two droplet discharging apparatuses are integrated in a single droplet discharging apparatus, thereby making it possible to provide convenience to a user and reduce a cost.

5 Further, the droplet is discharged using the micro droplet discharging apparatus according to the preferred embodiment of the present invention, such that the stop frequency of the experiment may be reduced, thereby making it possible to obtain an accurate experiment result and reduce the time of the experiment.

Although the preferred embodiments of the present invention have been disclosed for
10 illustrative purposes, they are for specifically explaining the present invention and thus a micro droplet discharging apparatus according to the present invention is not limited thereto, but those skilled in the art will appreciate that modifications and alterations are possible, without departing from the scope and spirit of the invention. Accordingly, such modifications and alterations should also be understood to fall within the scope of the present invention. A specific protective
15 scope of the present invention could be defined by the accompanying claims.

CLAIMS

What is claimed is:

1. A micro droplet discharging apparatus comprising:
5 a pump unit generating discharging pressure;
an electronic valve connected to the pump unit through a first connection pipe and
controlling the discharging of a large amount of droplet;
an electronic pipette connected to the electronic valve through a second connection pipe,
controlling the discharging of a small amount of droplet and having droplet discharged from a
10 distal end thereof; and
a controller controlling the driving of the pump unit, the electronic valve, and the electronic
pipette so as to control the amount of droplet discharged from the electronic pipette.
2. The micro droplet discharging apparatus as set forth in claim 1, wherein when the
15 controller drives the pump unit and the electronic valve, the pump unit generates the discharging
pressure and the electronic valve allows liquid supplied from the pump unit to be discharged as the
large amount of droplet from the distal end of the electronic pipette through opening and closing of
the valve.
- 20 3. The micro droplet discharging apparatus as set forth in claim 1, wherein when controller
drives the electronic pipette, the electronic pipette generates discharging pressure to allow liquid to
be discharged as the small amount of droplet from the distal end of the electronic pipette.
4. The micro droplet discharging apparatus as set forth in claim 1, wherein the pump unit
25 generates suction pressure to suck liquid through the electronic pipette.

5. The micro droplet discharging apparatus as set forth in claim 1, wherein when the large amount of droplet is discharged to the outside, the controller drives the pump unit and the electronic valve, such that the pump unit generates the discharging pressure and the electronic valve allows liquid supplied from the pump unit to be discharged as the large amount of droplet from the distal end of the electronic pipette through the opening and closing of the valve, and stops the driving of the electronic pipette so as not to generate discharging pressure.

6. The micro droplet discharging apparatus as set forth in claim 1, wherein when the small amount of droplet is discharged to the outside, the controller drives the electronic pipette, such that the electronic pipette generates discharging pressure to allow liquid to be discharged as the small amount of droplet from the distal end of the electronic pipette, and stops the driving of the pump unit so as not to generate the discharging pressure and the driving of the electronic valve so as to be maintained in an opened state.

7. The micro droplet discharging apparatus as set forth in claim 1, wherein the large amount of droplet is about 20 nl or more.

8. The micro droplet discharging apparatus as set forth in claim 1, wherein the small amount of droplet is about 1 nl or less.

9. The micro droplet discharging apparatus as set forth in claim 1, wherein the pump unit is a syringe pump.

10. The micro droplet discharging apparatus as set forth in claim 9, wherein the syringe pump includes:

an opening and closing valve having a first connection pipe connected thereto;

a syringe connected to the opening and closing valve and having liquid stored therein; and
a plunger moving upward in an inside of the syringe to thereby generate the discharging
pressure so as to discharge the liquid to an outside of the syringe and moving downward in the
inside of the syringe to thereby generate suction pressure so as to introduce the liquid to the inside
5 of the syringe.

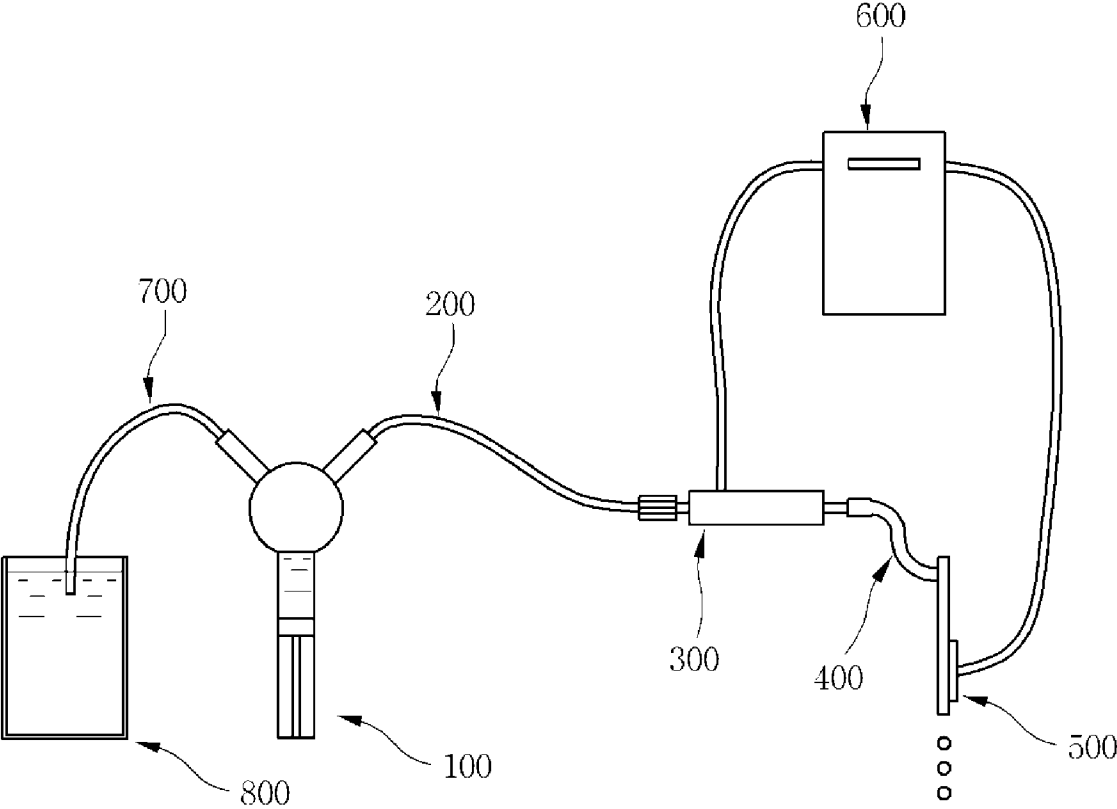
11. The micro droplet discharging apparatus as set forth in claim 9, further comprising a
cleaning liquid storing tank connected to the syringe pump through a supply pipe.

10 12. The micro droplet discharging apparatus as set forth in claim 1, wherein the electronic
pipette is a piezoelectric electronic pipette.

13. The micro droplet discharging apparatus as set forth in claim 1, wherein the electronic
valve is a solenoid valve.

1/2

FIG. 1



2/2

FIG. 2

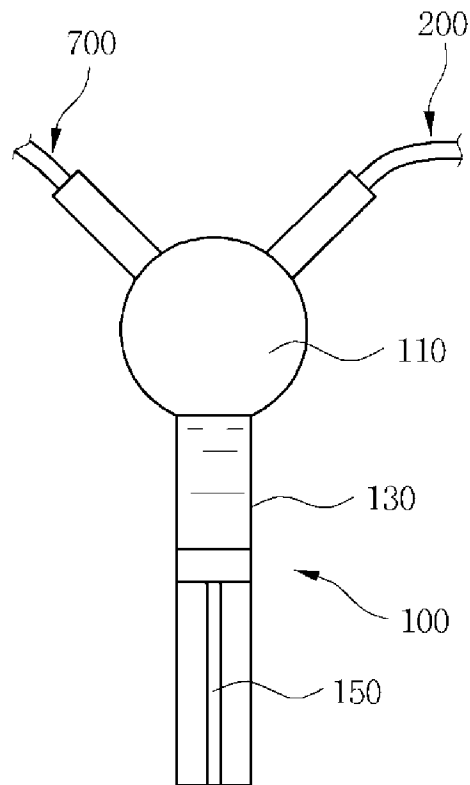
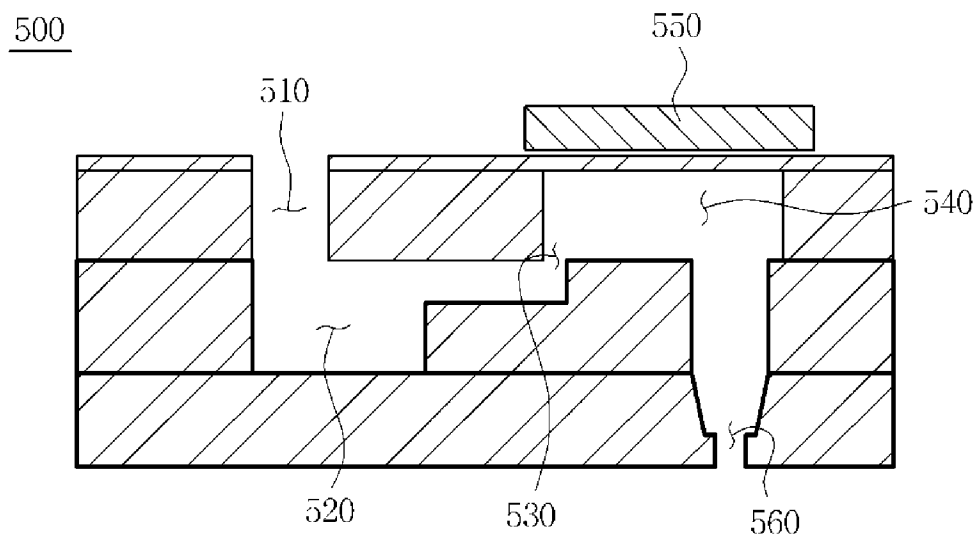


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/38278

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B05B 1/08 (2012.01)

USPC - 239/102.2; 506/23

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) - B05B 1/08 (2012.01)

USPC - 239/102.2; 506/23

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents, Non-Patent Literature. USPC 29/890.1; 506/40. Search term limited.Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
USPTO PubWEST. Google Scholar. Search terms: control, drop, droplet, electric, electronic, micro, microdrop, microdroplet, microliter, micropipet, micropipette, micropipettor, nano, nanodrop, nanodroplet, nanoliter, nanopipet, nanopipette, nanopipettor, nl, pipet, pipette, pipettor, pressure, pump, size, valve, volume

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 2005/0056713 A1 (Tisone et al.) 17 March 2005 (17.03.2005) para [0012], [0057], [0076]-[0079], [0132], [0195], [0196], [0220], [0244]-[0252]; Abstract; Fig. 3, 17	1-10, 12, 13 ----- 11
Y	US 2007/0153033 A1 (Wu et al.) 5 July 2007 (05.07.2007) para [0042]	11
Y	US 2008/0227663 A1 (Tisone et al.) 18 September 2008 (18.09.2008) Figures; para [0071]-[0140]	1-13
Y	US 6,589,791 B1 (LaBudde et al.) 5 July 2003 (05.07.2003) Figures; col 2-6	1-13
Y	US 6,599,479 B1 (Kietzmann et al.) 29 July 2003 (29.07.2003) Figures; col 2-6	1-13
Y	US 6,220,075 B1 (Papen et al.) 24 April 2001 (24.04.2001) Figures; col 2-8	1-13

☐ 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

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"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

25 July 2012 (25.07.2012)

Date of mailing of the international search report

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Name and mailing address of the ISA/US

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