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(54) **DROPLET MICROFLUIDIC TRANSPORTING MODULE**

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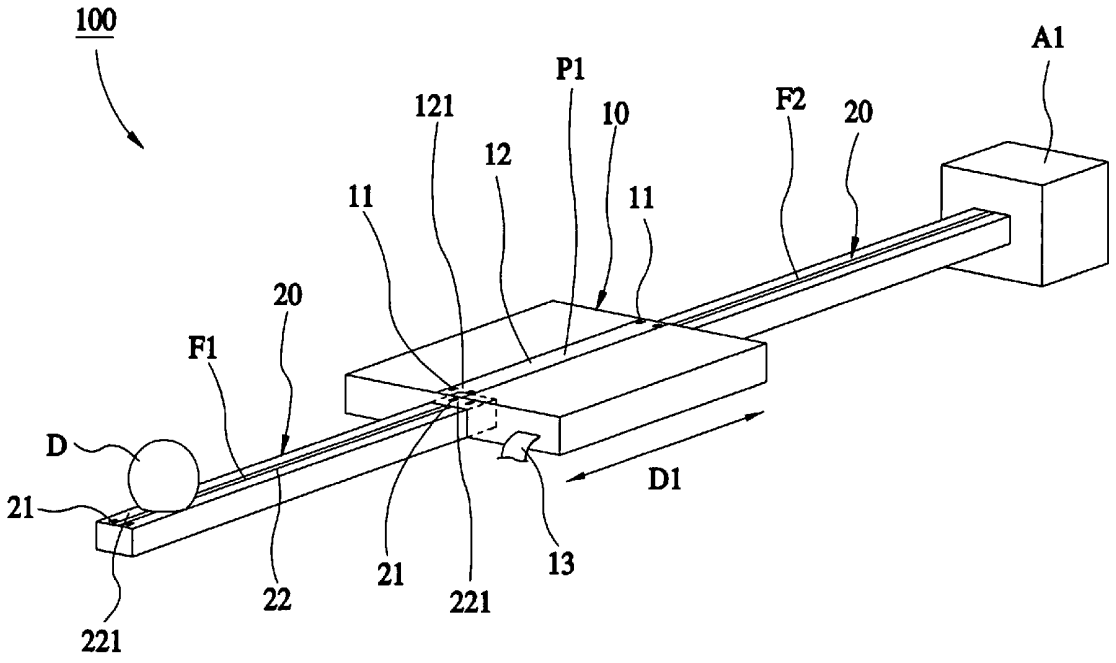
(57) **ABSTRACT**

A droplet microfluidic transporting module adapted for transporting a droplet is disclosed to include one or a number of connectors and one or a number of microfluidic transporting platform. Each connector defines a passage extending in one or multiple predetermined directions, and a first driving electrode extending along one side of the passage for the contact of the droplet to be transported. The microfluidic transporting platform is detachably electrically connected with the connector, defining a channel in communication with the passage of the connector and having a second driving electrode extending along one side of the channel for the contact of the droplet to be transported.



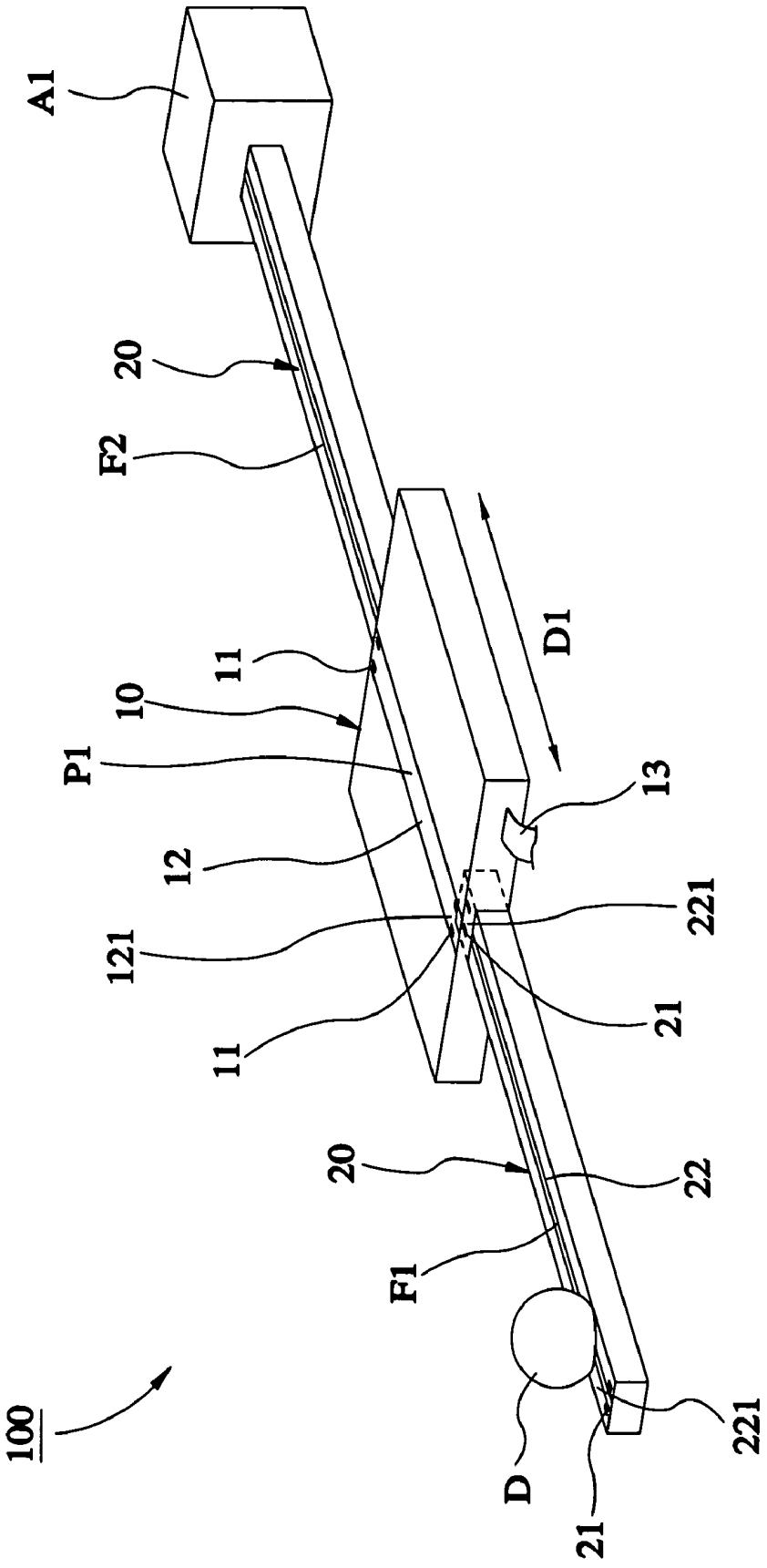


FIG.1

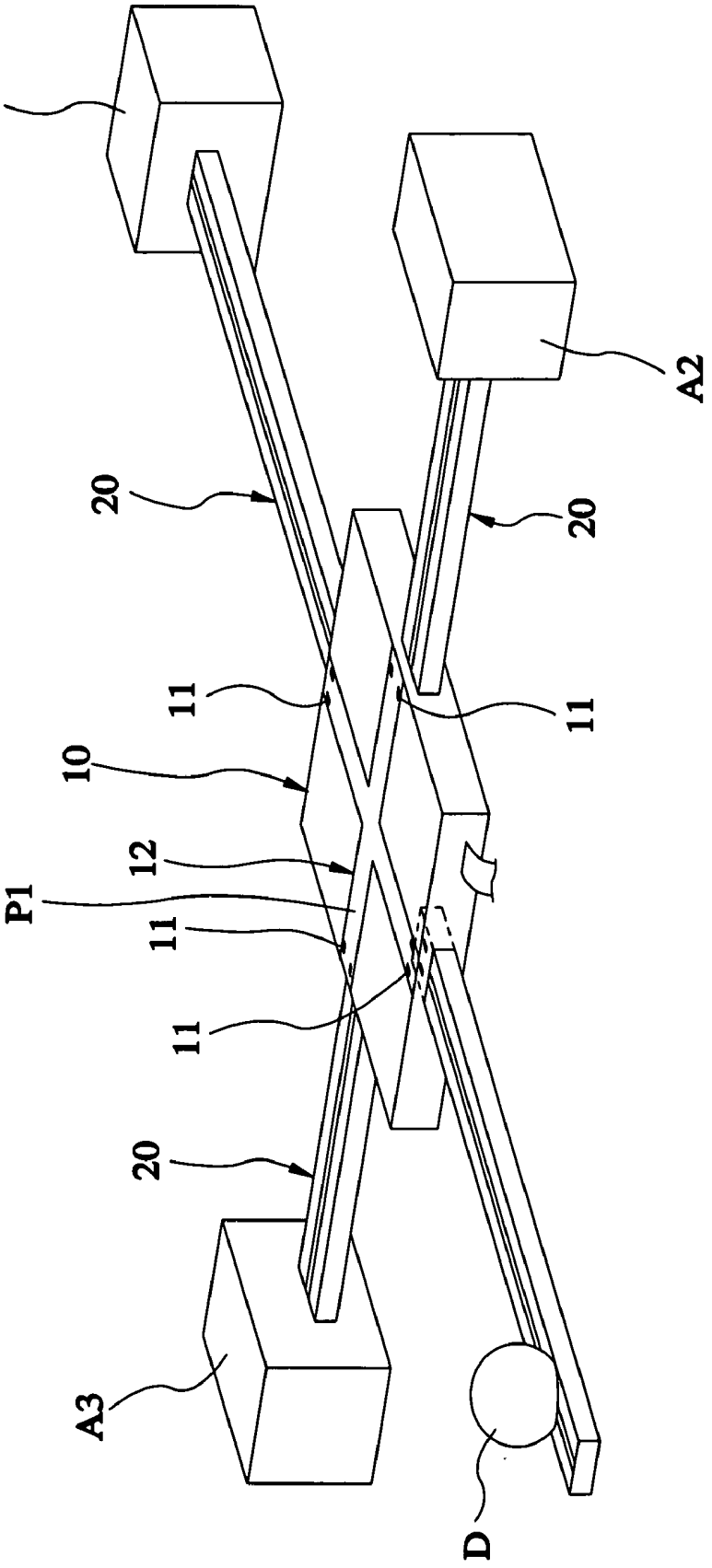


FIG.2

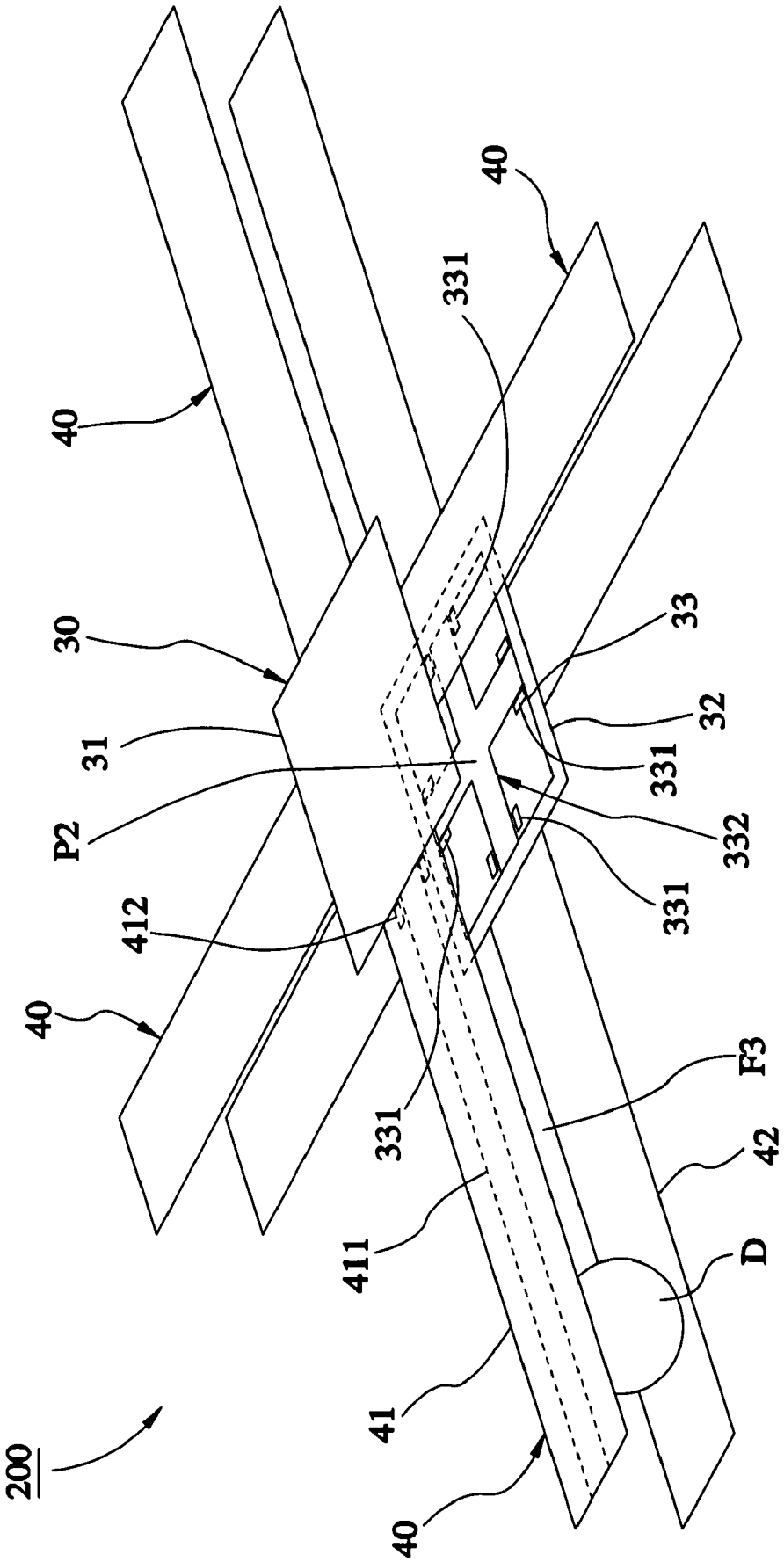

200
40
40
40
40
30
31
P2
412
331
331
331
331
33
32
331
332
F3
42
D
411
41

FIG.3

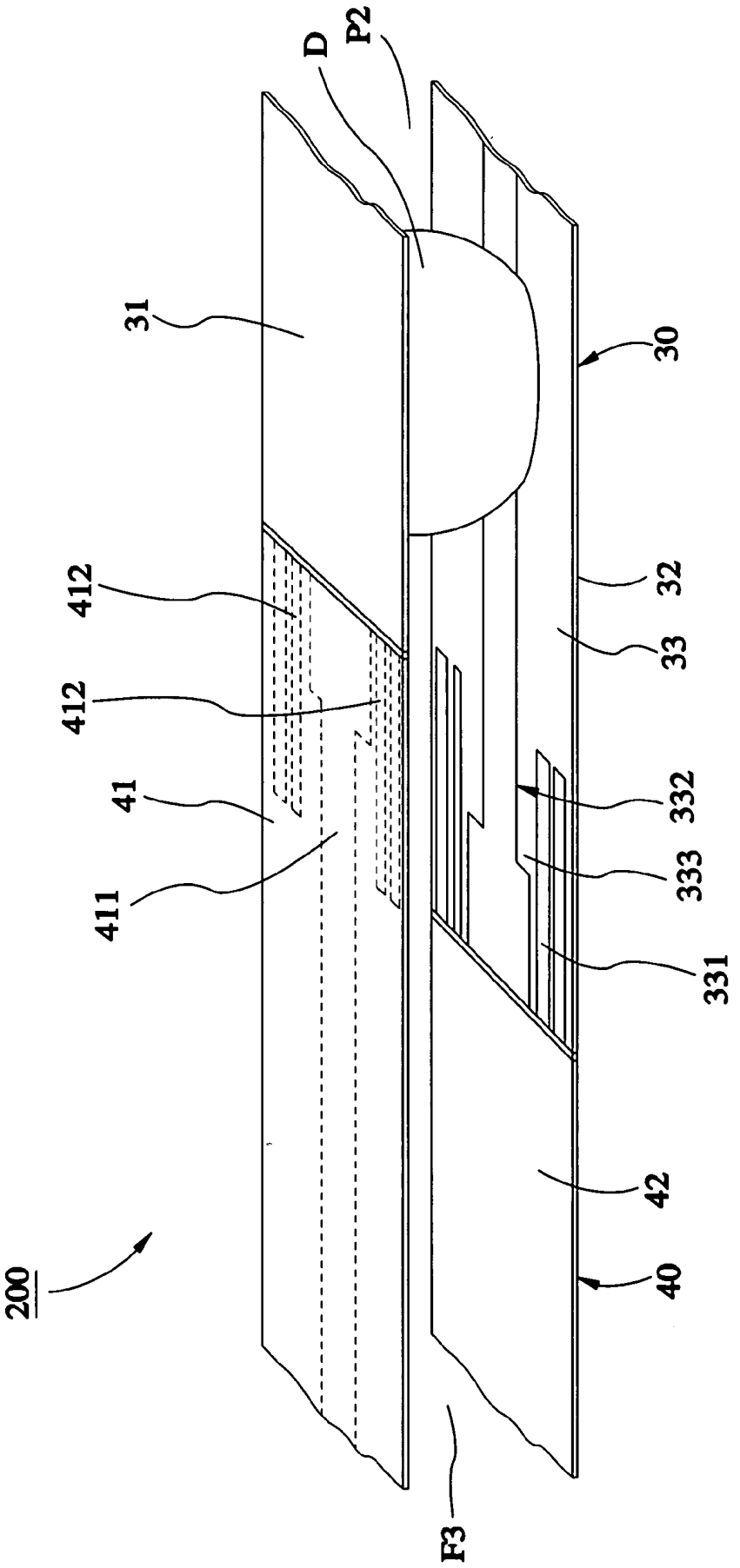


FIG.4

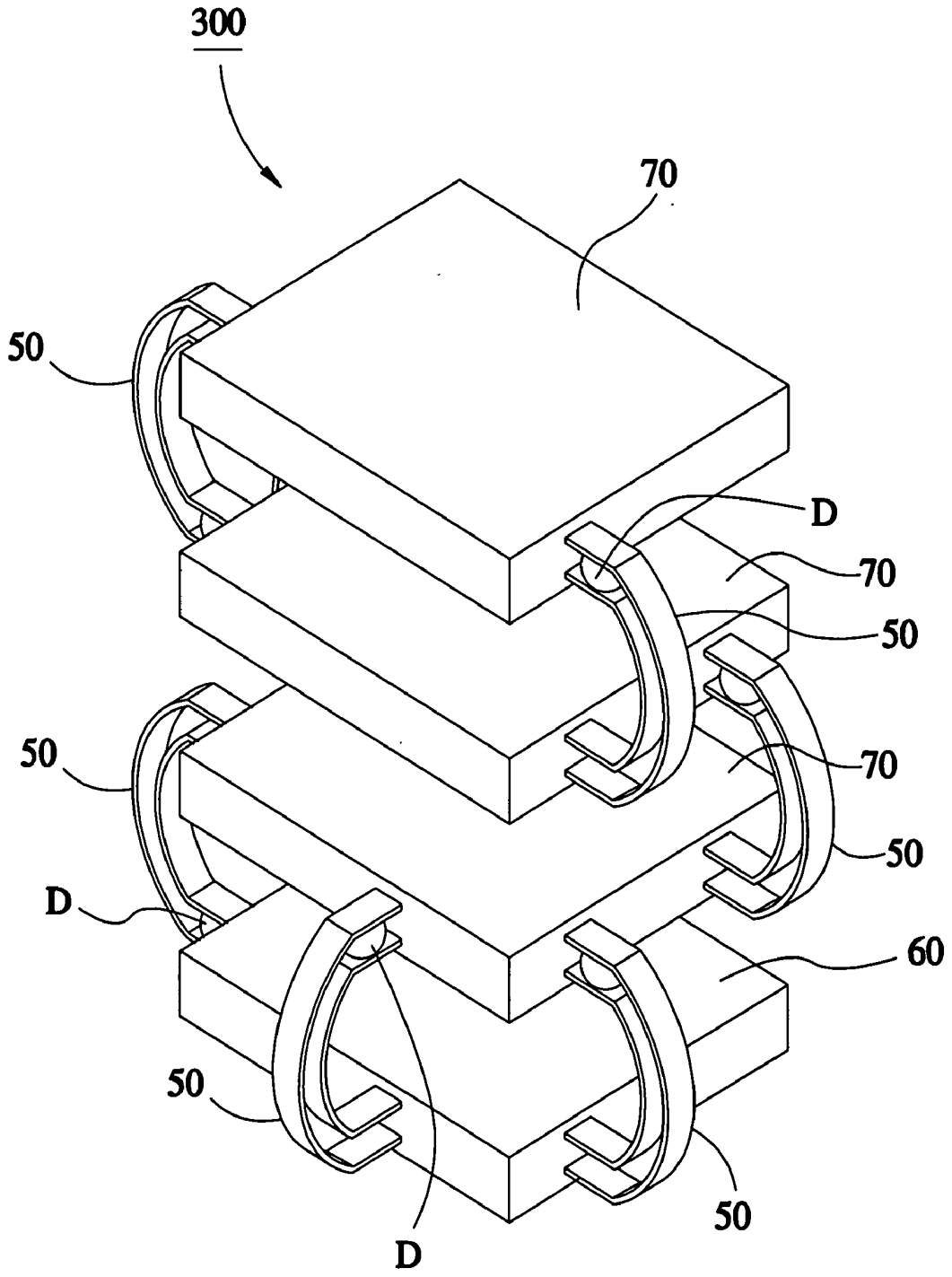


FIG.5

DROPLET MICROFLUIDIC TRANSPORTING MODULE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to microanalysis systems and more particularly to a droplet microfluidic transporting module for transporting one or several droplets.

[0003] 2. Description of the Related Art

[0004] The demand for microanalysis system (for example, biochip) for biomedical analysis and biochemical examination is increasing daily. In a biomedical analysis system or biochemical examination system, the microfluidic transporting platform that is used for transporting sample (or specimen) has a great concern with the analysis performance and result.

[0005] Comparing to the conventional continuous microfluidic platform, the droplet-based microfluidic platform developed rapidly in recent years, since it can handle small amount of sample and does not need any movable components in the platform. These characteristics make the droplet-based microfluidic platform attractive for miniaturized biomedical analysis or examination systems. However, in order to develop a miniaturized biomedical analysis or examination systems, lots of components or subsystems need to be integrated, such as sensor units, analysis units, and microfluidic components. With the increasing complexity on such systems, these components or subsystems are often manufactured separately, then proper assembly techniques are needed, especially between different droplet microfluidic platforms. Furthermore, if the integration is achieved in a planner form, the device or system may still occupy a large area.

SUMMARY OF THE INVENTION

[0006] The present invention has been accomplished under the circumstances in view. It is the main object of the invention to provide droplet microfluidic transporting module, which utilizes a detachable and plug-and-play interface design between a connector and a microfluidic transporting platform, facilitating synthesis of a complicated analysis system and alteration of analysis modules.

[0007] To achieve this and other objects of the present invention, the droplet microfluidic transporting module is adapted for transporting one or several droplets, comprising at least one connector and at least one microfluidic transporting platform. Each connector comprises at least one passage extending in at least one predetermined direction, and a first driving electrode extending along one side of each passage for the contact of the droplet to be transported. The at least one microfluidic transporting platform is detachably electrically connected with the at least one connector, each comprising a channel in communication with the at least one passage of the at least one connector and a second driving electrode extending along one side of the channel for the contact of the droplet to be transported.

[0008] Thus, the invention connects at least one connector to at least one microfluidic transporting platform to constitute a microfluidic transporting module for the connection of different analysis systems and for synthesis of a complicated analysis system.

BRIEF DESCRIPTION OF THE DRAWING

[0009] FIG. **1** is a schematic drawing showing a droplet microfluidic transporting module in accordance with a first embodiment of the present invention.

[0010] FIG. **2** shows a modified arrangement of the droplet microfluidic transporting module in accordance with the first embodiment of the present invention for 2-D direction droplet movement.

[0011] FIG. **3** is a schematic drawing showing a droplet microfluidic transporting module in accordance with a second embodiment of the present invention.

[0012] FIG. **4** is a perspective view in an enlarged scale of a part of FIG. **3**

[0013] FIG. **5** is a schematic drawing showing a droplet microfluidic transporting module in accordance with a third embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Referring to FIG. **1**, a droplet microfluidic transporting module **100** in accordance with a first embodiment of the present invention is shown for transporting a droplet D to a fluidic analysis unit A**1** for analysis, comprising a connector **10** and two microfluidic transporting platforms **20**.

[0015] The connector **10** is a plate member covered with a conducting membrane, (for example, indium tin oxides conducting membrane), comprising two first connection electrodes **11** respectively disposed at the two distal ends thereof, a first driving electrode **12** formed between the first connection electrodes **11** and defining an intersection area **121** at each of the two distal ends of the plate member, a passage P**1** defined above the first driving electrode **12** in a one-dimensional direction D**1**, and an input/output terminal **13** electrically connected to the first driving electrode **12** for transmitting signal and receiving external power supply so that the electrodes **11** and **12** can receive external power supply. Further, the first driving electrode **12** is controllable by a program to apply a voltage to the droplet D, controlling the movement of the droplet D.

[0016] The microfluidic transporting platforms **20** are narrow elongated platforms respectively prepared from a flexible polymer substrate (for example, poly ethylene terephthalate) and coated with a layer of conducting membrane (for example, indium tin oxides conducting membrane). Each microfluidic transporting platform **20** comprises two second connection electrodes **21** respectively disposed at the two distal ends thereof, a second driving electrode **22** formed between the two second connection electrodes **21** and defining with each of the two distal ends of the plate member a respective intersection area **221**, and a channel F**1** defined above the second driving electrode **22** in communication with the passage P**1** of the connector **10**.

[0017] In actual use, we can detachably connect the connector **10** or the microfluidic transporting platforms **20** to (the male or female connector of) the fluidic analysis unit A**1** to have the passage P**1** or channel F**2** in communication with the inside of the fluidic analysis unit A**1**, and then connect the input/output terminal **13** of the connector **10** to an external control apparatus and power supply device, and then detachably connect the microfluidic transporting platforms **20** to the connector **10** by, for example, snap means to have the second connection electrodes **21** be electrically connected with the first connection electrodes **11** and the intersection areas **121** of the connector **10** be abutted against one intersection area **221** of each of the microfluidic transporting platforms **20**. When installed, the second driving electrode **22** is controllable by a program to output a voltage, i.e., to support the plug-and-play function, causing the droplet D to move in proper order, subject to an electrowetting effect, along the left

channel F1, the intersection areas **121** and **221**, the passage P1 and the right channel F2 to the inside of the fluidic analysis unit A1 for further analysis operation.

[0018] It is to be understood that the right-sided microfluidic transporting platform **20** can be eliminated from the droplet microfluidic transporting module **100** and the connector **10** can be directly and electrically connected to the fluidic analysis unit A1, achieving the same droplet D transporting effect. Further, when wishing to change the target sample to be analyzed, a matching fluidic analysis unit is used to substitute for the fluidic analysis unit A1 without changing the whole analysis system like conventional techniques, i.e., the droplet microfluidic transporting module **100** of the present invention can be used repeatedly, facilitating analysis operation and saving much time.

[0019] Of course, the first driving electrode **12** and the first connection electrodes **11** can extend in two-dimensional directions, as shown in FIG. **2** and in consequence, the passage P1 extends in two-dimensional directions for enabling the droplet D to be moved in two-dimensional directions. Thus, the connector **10** can be connected with at least three fluidic analysis units A1~A3 either directly or through the microfluidic transporting platforms **20**, improving analysis performance, saving much time and, simplifying the operation procedure.

[0020] As stated above, the invention provides a detachable and plug-and-play interface design of the connector **10** and microfluidic transporting platforms **20**, facilitating synthesis of a complicated analysis system and alteration of analysis modules.

[0021] Referring to FIGS. **3** and **4**, a droplet microfluidic transporting module **200** in accordance with a second embodiment of the present invention is shown similar to the structural arrangement shown in FIG. **2**, i.e., the passage of the connector of this second embodiment extends in two-dimensional directions for allowing transmission of a droplet on a two-dimensional plane, with the exception that the connector **30** and the microfluidic transporting platforms **40** according to this second embodiment commonly have a double-plate transporting structure.

[0022] According to this second embodiment, the connector **30** comprises a top plate **31**, a bottom plate **32**, and a control substrate **33** arranged on the top side of the bottom plate **32**. The control substrate **33** comprises a first connection electrode **331** at each of the four sides thereof, a cross-shaped first driving electrode **332** arranged on the top surface thereof, a passage P2 defined above the first driving electrode **332** between the top plate **31** and the bottom plate **32**, and an intersection area **333** defined between the first driving electrode **332** and each first connection electrode **331**. Further, each microfluidic transporting platform **40** comprises a top plate **41** and a bottom plate **42**. The top plate **41** comprises a second driving electrode **411** and a second connection electrode **412**, and a channel F3 defined below the second driving electrode **411** between the top plate **41** and the bottom plate **42**. The bottom plate **42** has a water-repellent layer (not shown) on the surface thereof.

[0023] By means of the aforesaid structure, a droplet D can be transported on a two-dimensional plane steadily. In addition, the connector **30** is connectable with at least three fluidic analysis units (the number of fluidic analysis units is relatively increased when increasing the connector amount). Therefore, when compared to conventional designs, the invention effectively improves analysis performance, saves much time and, simplifies the operation procedure.

[0024] FIG. **5** shows a droplet microfluidic transporting module **300** in accordance with a third embodiment of the present invention. This third embodiment is substantially similar to the aforesaid second embodiment with the exception that the flexible material property of the microfluidic transporting platforms **50** allows multiple connectors **60** and substrates **70** (for example, biochips) to be stacked up to constitute a three-dimensional fluidic receiver system so that multiple droplets D can be moved along the microfluidic transporting platforms **50** in three-dimensional directions. Thus, the invention effectively reduces analysis system space occupation, facilitating fabrication of a multipurpose micro biochemical and biomedical analysis and examination system, and providing convenience for use and carrying. Further, the interface design of the connectors **60** and the microfluidic transporting platforms **50** allows connection of different analysis platforms (for example, substrates **70**) to be connected together by the connectors **60** or the microfluidic transporting platforms **50** without changing the design or using external adapter means. Therefore, the invention facilitates assembling or replacement of different analysis platforms (substrates **70**) so that the whole analysis system is highly expandable for wide range application.

[0025] Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.

What is claimed is:

1. A droplet microfluidic transporting module for transporting one or several droplets, comprising:

at least one connector, each said connector comprising at least one passage extending in at least one predetermined direction and a first driving electrode extending along one side of each said passage for the contact of the droplet to be transported; and

at least one microfluidic transporting platform detachably and electrically connected with said at least one connector, each said microfluidic transporting platform comprising a channel in communication with the at least one passage of said at least one connector and a second driving electrode extending along one side of said channel for the contact of the droplet to be transported.

2. The droplet microfluidic transporting module as claimed in claim **1**, wherein said at least one microfluidic transporting platform is flexible.

3. The droplet microfluidic transporting module as claimed in claim **1**, wherein each passage of each said connector extends in two-dimensional directions for guiding said droplet in the two-dimensional directions.

4. The droplet microfluidic transporting module as claimed in claim **3**, wherein each said microfluidic transporting platform is curved to enable said droplet to move in three-dimensional directions.

5. The droplet microfluidic transporting module as claimed in claim **1**, wherein said at least one connector each comprises a first connection electrode disposed at each of two distal ends thereof; each said microfluidic transporting platform comprises a second connection electrode disposed at each of two distal ends thereof for electrically connecting to the first connection electrodes of said at least one connector.

6. The droplet microfluidic transporting module as claimed in claim **1**, wherein the first driving electrode of each said connector comprises an intersection area, and the second driving electrode of each said microfluidic transporting platform comprises an intersection area facing the intersection area of the first driving electrode of one said connector.

7. The droplet microfluidic transporting module as claimed in claim **1**, wherein one said connector comprises an input/output terminal electrically connected to the first driving electrode of each said connector for transmitting signal and receiving power supply.

8. The droplet microfluidic transporting module as claimed in claim **1**, wherein said at least one connector is directly electrically connected to at least one fluidic analysis unit, keeping the passage of each said connector in communication with the inside of said at least one fluidic analysis unit.

9. The droplet microfluidic transporting module as claimed in claim **1**, wherein said at least one microfluidic transporting platform is directly electrically connected to at least one fluidic analysis unit, keeping the channel of each said microfluidic transporting platform in communication with the inside of said at least one fluidic analysis unit.

10. The droplet microfluidic transporting module as claimed in claim **1**, wherein each said connector comprises a conducting membrane, and the first driving electrode of each said connector is arranged on the conducting membrane of the respective connector.

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