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(54) **MICROFLUIDIC DETECTION SYSTEM FOR REFRIGERATOR, AND REFRIGERATOR**

(57) A microfluidic control detection system for refrigerator. The microfluidic control detection system comprises: a microfluidic biochip comprising a chip body and an elastic airbag section integrally formed by blow molding, where the chip body comprising an inlet, a detection pool, and a suction port sequentially interconnected through microchannels, and the elastic airbag section hermetically connected to the suction port; a sample liquid driving device, configured to controllably compress and release the elastic airbag section, facilitating the entry of sample liquid in contact with the inlet into the microchannels and its flow towards the detection pool via the microchannels during a deformation recovery process of the elastic airbag section; and a detection mechanism for detecting the detection pool to obtain preset detection parameters of the sample liquid. The sample liquid driving device no longer requires connecting pipelines to the microfluidic biochip, eliminating the air tightness issues between the sample liquid driving device and the microfluidic biochip and maintaining precision of sample introduction.

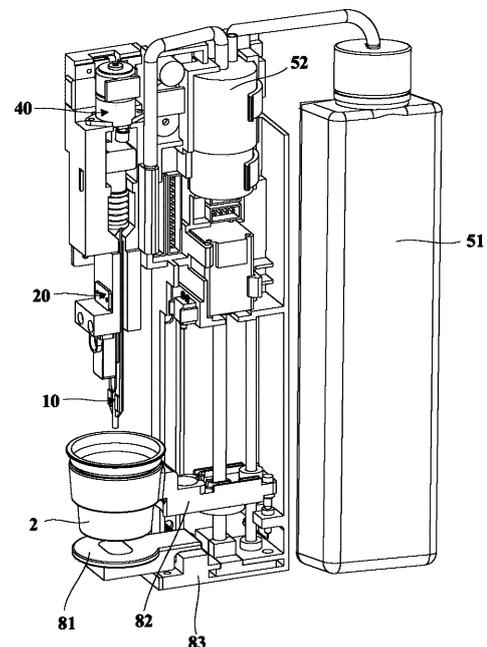


FIG. 2

EP 4 438 176 A1

Description**CROSS-REFERENCE TO RELATED APPLICATION**

[0001] The application claims priority from Chinese Patent Application No. 202111414254.4, filed November 25, 2021, entitled "Microfluidic Control Detection System and Refrigerator", all of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present application relates to the field of refrigeration technology, and more particularly to a microfluidic control detection system and refrigerator.

BACKGROUND

[0003] With the improvement of living standards, there is often a need in daily life to detect residues, viruses, nutritional elements, or other aspects of food ingredients either qualitatively or quantitatively. For instance, due to the misuse of pesticides, the fruits, vegetables, and agricultural products we buy daily may contain excessive levels of residues. If the excessive levels of residues in these foods are not discovered in time, ingestion can cause significant harm to the human body. Moreover, the currently advocated breastfeeding is best for infants only when the breast milk has normal nutritional value. However, illnesses, medication, surgery, or other situations of the nursing mother may lead to reduced nutritional element content in the secreted milk or even the presence of viruses, thereby affecting the infant's growth and health. The functionality of existing household appliances is relatively singular, and when there is a need to detect residues, viruses, nutritional elements, or other aspects of food ingredients, it necessitates the separate purchase of a dedicated detection device. This leads to a multitude of household appliances and types, occupying significant space, and does not align with the development trend of smart homes.

[0004] Among many detection methods, the use of microfluidic biochips for detection is relatively quick and compact, suitable for home use. To facilitate fluid movement within the chip, there are generally two methods: air pressure propulsion and centrifugal force propulsion. Centrifugal force propulsion relies on rotating centrifugal force to move droplets, which can only adjust unidirectional flow actions by adjusting the rotation speed. Air pressure propulsion utilizes positive air pressure and negative air pressure to bidirectionally propel fluid movement within the chip, offering high precision and controllability. However, when a suction port of the chip and a suction pipe of a pushing mechanism are connected, air tightness can be unstable and unreliable due to insufficient pressing area, uneven pressing surface, insufficient pressing force, inadequate precision of the syringe pump piston, and other reasons. To date, air tightness of air

pressure propulsion remains an unsolved technical challenge.

SUMMARY

[0005] An object of a first aspect of the present application is to overcome at least one deficiency of the existing technology by providing a microfluidic control detection system for refrigerators that offers improved sealing performance and precise sample introduction control.

[0006] A further object of a first aspect of the present application is to completely eliminate a series of adverse effects caused by air tightness issues.

[0007] An object of a second aspect of the present application is to provide a refrigerator equipped with the aforementioned microfluidic control detection system.

[0008] In accordance with a first aspect of the present application, the present application provides a microfluidic control detection system for a refrigerator, comprising:

a microfluidic biochip, comprising a chip body and an elastic airbag section, where the chip body comprising an inlet, a suction port, and a detection pool formed inside, and the inlet, the detection pool, and the suction port are sequentially interconnected through microchannels, with the elastic airbag section hermetically connected to the suction port;

a sample liquid driving device, configured to compress and release the elastic airbag section under control of the microfluidic biochip, prompting sample liquid in contact with the inlet to enter the microchannels and flow towards the detection pool via the microchannels; and

a detection mechanism, configured to detect the detection pool to obtain preset detection parameters of the sample liquid; wherein, the chip body and the elastic airbag section are integrally formed by blow molding.

[0009] In an embodiment of the present application, a reagent adding hole is positioned on a side surface of the chip body, connecting to the detection pool, allowing for addition of detection reagents into the detection pool through the reagent adding hole; and the microfluidic biochip comprises a sealing patch hermetically attached to a side surface of the chip body to seal the reagent adding hole.

[0010] In an embodiment of the present application, the elastic airbag section is configured as a threaded shape or a wavy shape extending along a length direction of the chip body; and the sample liquid driving device is configured to apply a compressive force to the elastic airbag section parallel to an extension direction of the elastic airbag section under the control of the microfluidic biochip, inducing elastic deformation of the elastic airbag section along the extension direction of the elastic airbag section.

[0011] In an embodiment of the present application, the inlet is located at a bottom of the chip body, and the elastic airbag section is positioned at a top of the chip body; and

the sample liquid driving device is situated above the microfluidic biochip and is configured to compress the elastic airbag section downwards under the control of the microfluidic biochip.

[0012] In an embodiment of the present application, the microfluidic control detection system further comprising:

a chip installation mechanism, comprising an installation slot configured to house the microfluidic biochip; and

the microfluidic biochip is configured to be inserted into the installation slot through a notch of the installation slot, with the inlet of the chip body positioned outside of the installation slot.

[0013] In an embodiment of the present application, the inlet is located at a bottom of the chip body, and the elastic airbag section is positioned at a top of the chip body; and

the installation slot is configured to extend vertically, and the microfluidic biochip is configured to be inserted into the installation slot in a direction parallel to a horizontal plane.

[0014] In an embodiment of the present application, the installation slot comprises a first slot section for housing the chip body and a second slot section for housing the elastic airbag section, with a size of the first slot section smaller than a size of the second slot section, forming a step-like section at a junction between the first slot section and the second slot section; and a bottom of the elastic airbag section rests against the step-like section.

[0015] In an embodiment of the present application, the chip installation mechanism comprises at least one clamping component positioned within the installation slot, which is configured to secure the chip body after the microfluidic biochip is inserted into the installation slot.

[0016] In an embodiment of the present application, the clamping component comprises two symmetrically arranged and spaced apart claws, configured to apply opposing elastic forces to two opposite side surfaces of the chip body after the microfluidic biochip is installed into the installation slot.

[0017] In accordance with a second aspect of the present application, the present application provides a refrigerator, comprising the microfluidic control detection system according to any of the aforementioned technical solutions.

[0018] The microfluidic control detection system of the present application comprises a microfluidic biochip, with the microfluidic biochip comprising a chip body and an elastic airbag section. The elastic airbag section is hermetically connected to a suction port of the chip body,

thereby forming a closed space within the microfluidic biochip, with only an inlet of the chip body remaining an opening for sample introduction. A sample liquid driving device expels air from inside the chip body by compressing the elastic airbag section. When the sample liquid driving device releases the elastic airbag section, the elastic airbag section returns to its original shape, prompting sample liquid in contact with inlet to enter a detection pool within the chip body. A microfluidic biochip of the present application is specially designed with an elastic airbag section, eliminating a need for connecting pipelines between a sample liquid driving device and a microfluidic biochip. Simple mechanical compression can be implemented, controlling suction volume and exhaust volume by adjusting deformation of the elastic airbag section, not only resolving air tightness issues between the sample liquid driving device and the microfluidic biochip but also maintaining precise control of sample introduction.

[0019] Furthermore, the chip body and the elastic airbag section are integrally formed by blow molding, which means the microfluidic biochip is a single component, with the chip body and the elastic airbag section merely being two different parts of the microfluidic biochip, requiring no connection between them. Thus, microfluidic biochip itself does not have any air tightness issues, meaning addition of the elastic airbag section does not introduce air tightness problems to the microfluidic biochip itself, thereby completely eliminating a series of adverse effects caused by air tightness issues to the microfluidic control detection system.

[0020] The present application integrates the microfluidic control detection system into a refrigerator, fully leveraging a storage function of the refrigerator to make a detection process more convenient and facilitating linked control between the microfluidic control detection system and the refrigerator. This higher level of automation meets the needs of smart homes.

[0021] Further details and the advantages and features of the present application will become clearer to those skilled in art from the detailed description of the specific embodiments in conjunction with the accompanying drawings below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The subsequent text will describe some specific embodiments of the present application in a detailed but non-limiting manner with reference to drawings. The same reference numerals in the drawings denote the same or similar parts or components. It should be understood by those skilled in the art that these drawings are not necessarily drawn to scale. In the drawings:

FIG. 1 shows a schematic structural diagram of a microfluidic control detection system for a refrigerator according to an embodiment of the present application.

FIG.2 shows a schematic structural diagram of internal structure of a microfluidic control detection system according to an embodiment of the present application.

FIG.3 shows a partial schematic exploded view of a microfluidic control detection system according to an embodiment of the present application.

FIG.4 shows a schematic sectional view of a microfluidic biochip according to an embodiment of the present application.

FIG.5 shows a schematic exploded view of a microfluidic biochip according to an embodiment of the present application.

FIG.6 shows a schematic sectional view of a microfluidic control detection system in a partial exploded state according to an embodiment of the present application.

FIG.7 shows a schematic structural diagram of a refrigerator according to an embodiment of the present application.

DETAILED DESCRIPTION

[0023] The present application initially provides a microfluidic control detection system for a refrigerator. The microfluidic control detection system of the present application is configured for the qualitative or quantitative detection of preset detection parameters of sample liquids. These preset detection parameters could include parameters indicating whether the amount of pesticide residue exceeds standards and/or the specific numerical value of the pesticide residue, parameters indicating whether nutritional elements meet standards and/or the specific content of nutritional elements, parameters for indicating whether specific harmful substances (such as specific viruses) exceed standards and/or specific content of specific harmful substances, among others.

[0024] FIG. 1 shows a schematic structural diagram of a microfluidic control detection system for a refrigerator according to an embodiment of the present application, FIG.2 shows a schematic structural diagram of internal structure of a microfluidic control detection system according to an embodiment of the present application, and FIG.3 shows a partial schematic exploded view of a microfluidic control detection system according to an embodiment of the present application. For ease of understanding, FIG.1 to FIG.3 also show a sample cup 2.

[0025] Referring to FIG. 1 to FIG.3, the microfluidic control detection system 1 in the present application comprises a microfluidic biochip 10, a sample liquid driving device 40, and a detection mechanism 20.

[0026] FIG.4 shows a schematic sectional view of a microfluidic biochip according to an embodiment of the present application. The microfluidic biochip 10 comprises a chip body 11 and an elastic airbag section 12. The chip body 11 comprises an inlet 111, a suction port 112, and a detection pool 113 formed inside the microfluidic biochip 10. The inlet 111, detection pool 113, and suction

port 112 are sequentially interconnected through microchannels 114, thus forming a main channel. The elastic airbag section 12 is hermetically connected to the suction port 112. The sample liquid driving device 40 is configured to compress and release the elastic airbag section 12 under control of the microfluidic biochip 10, prompting sample liquid in contact with the inlet 111 to enter the microchannels 114 and flow towards the detection pool 113 via the microchannels 114. The detection mechanism 20 is configured to detect the detection pool 113 to obtain preset detection parameters of the sample liquid. Specifically, detection reagents can be placed in the detection pool 113, so that after a reaction of the sample liquid with the detection reagents inside the detection pool 113, the detection mechanism 20 performs detection on the detection pool 113.

[0027] The microfluidic control detection system 1 of the present application comprises a microfluidic biochip 10, with the microfluidic biochip 10 comprising a chip body 11 and an elastic airbag section 12. The elastic airbag section 12 is hermetically connected to a suction port 112 of the chip body 11, thereby forming a closed space within the microfluidic biochip 10, with only an inlet 111 of the chip body 11 remaining an opening for sample introduction. A sample liquid driving device 40 expels air from inside the chip body 11 by compressing the elastic airbag section 12. When the sample liquid driving device 40 releases the elastic airbag section 12, the elastic airbag section 12 returns to its original shape, prompting sample liquid in contact with inlet 111 to enter a detection pool 113 within the chip body 11 and react with the detection reagents inside the detection pool 113. Furthermore, repeated compression and release of the elastic airbag section 12 by the sample liquid driving device 40 ensure thorough mixing of sample liquid with detection reagents, enhancing accuracy of detection results.

[0028] A microfluidic biochip 10 of the present application is specially designed with an elastic airbag section 12, eliminating a need for connecting pipelines between a sample liquid driving device 40 and a microfluidic biochip 10. Simple mechanical compression can be implemented, controlling suction volume and exhaust volume by adjusting deformation of the elastic airbag section 12, not only resolving air tightness issues between the sample liquid driving device 40 and the microfluidic biochip 10 but also maintaining precise control of sample introduction.

[0029] It is understandable to those skilled in art that when the microfluidic control detection system is used for detecting different preset detection parameters, the specific choices of the microfluidic biochip 10 and the detection mechanism 20 might also vary. For example, when the microfluidic control detection system is used for pesticide residue detection, the microfluidic biochip 10 it contains could be a microfluidic pesticide detection chip capable of providing conditions for pesticide liquid detection, and the detection mechanism 20 it contains could be a pesticide detection mechanism capable of de-

tecting pesticide parameters in the pesticide liquid.

[0030] In a specific embodiment, when the detection mechanism 20 is a pesticide detection mechanism for detecting pesticide parameters in pesticide liquid, a quick qualitative detection of whether pesticide residue in sample liquid exceeds standards can be conducted using the enzyme inhibition rate method. In this case, the chip body 11 further comprises a reaction pool 115 formed inside it. The reaction pool 115 is located on the main channel formed by sequentially connecting the inlet 111, the detection pool 113, and the suction port 112 and is connected between the inlet 111 and the detection pool 113, allowing sample liquid to react with reaction reagents in the reaction pool 115 before flowing into the detection pool 113. The reaction pool 115 is connected to the inlet 111 through microchannels 114, and also connected to the detection pool 113 through microchannels 114. The reaction reagent and detection reagent used for pesticide detection can be enzyme reagents and chromogenic agents, respectively. The reaction pool 115 is used for sample liquid to react with the enzyme reagent inside the reaction pool 115; the sample liquid that has reacted with the enzyme reagent flows into the detection pool 113 and reacts with the chromogenic agent in the detection pool 121. The detection mechanism 20 can be selected as a photoelectric detection mechanism, which may comprise structures such as a light source, a photosensitive element, a heating plate, and a thermostat.

[0031] In some embodiments, the chip body 11 and the elastic airbag section 12 are integrally formed by blow molding, which means the microfluidic biochip 10 is a single component, with the chip body 11 and the elastic airbag section 12 merely being two different parts of the microfluidic biochip 10, requiring no connection between them. Thus, microfluidic biochip 10 itself does not have any air tightness issues, meaning addition of the elastic airbag section 12 does not introduce air tightness problems to the microfluidic biochip 10 itself, thereby completely eliminating a series of adverse effects caused by air tightness issues to the microfluidic control detection system 1.

[0032] FIG.5 shows a schematic exploded view of the microfluidic biochip according to an embodiment of the invention. Since the chip body 11 and elastic airbag section 12 are integrally formed by blow molding, it could be inconvenient to pre-add detection reagents into the detection pool 113 formed within the chip body 11. Therefore, in some embodiments, after chip body 11 and elastic airbag section 12 are formed by blow molding, a reagent adding hole 116 can be positioned on a side surface 11a of the chip body 11, connecting to the detection pool 113, allowing for addition of detection reagents into the detection pool 113 through the reagent adding hole 116. When a reaction pool 115 is formed within the chip body 11, reaction reagents can be added to the reaction pool 115 in a similar manner (i.e., positioning a reagent adding hole 117 on a side surface of the chip body 11 connecting to the reaction pool 115). Preferably, both reagent adding

holes can be located on a same side surface of chip body 11, facilitating the sealing of the both reagent adding holes.

[0033] Furthermore, the microfluidic biochip 10 comprises a sealing patch 13 hermetically attached to a side surface 11a of the chip body 11 (e.g., the side surface with the reagent adding holes), to seal one reagent adding hole 116 and another reagent adding hole 117. Preferably, the aforementioned side surface 11a of chip body 11 can be parallel to a width direction of the chip body 11 and a length direction of the chip body 11. This is because surface area of the side surface parallel to the width direction of the chip body 11 and the length direction of chip body 11 is relatively large, making it easier to form a larger bonding surface between the chip body 11 and the sealing patch 13, thereby enhancing the seal between the chip body 11 and the sealing patch 13. Moreover, since the attachment of the chip body 11 to the sealing patch 13 is completed before installation of the microfluidic biochip 10, there are no constraints on operational space and sealing methods, thus effective and good sealing between the chip body 11 and the sealing patch 13 can be achieved.

[0034] It should be noted that material for the chip body 11 and material for the elastic airbag section 12, as well as a shape of elastic airbag section 12, are configured to allow the elastic airbag section 12 to return to its original shape under its own elastic deformation recovery force after the sample liquid driving device 40 releases the elastic airbag section 12.

[0035] In some embodiments, the elastic airbag section 12 is configured as a threaded shape or a wavy shape extending along the length direction of chip body 11. The sample liquid driving device 40 is configured to apply a compressive force to the elastic airbag section 12 parallel to an extension direction of the elastic airbag section 12 under the control of the microfluidic biochip 10, inducing elastic deformation of the elastic airbag section 12 along the extension direction of the elastic airbag section 12. That is, a direction of the compressive force applied by the sample liquid driving device 40 to the elastic airbag section 12 is consistent with the extension direction of the elastic airbag section 12. The elastic airbag section 12 can elastically contract along the length direction of the chip body 11 under compression by the sample liquid driving device 40, and after release of the elastic airbag section 12 by the sample liquid driving device 40, the elastic airbag section 12 can return to its original state by relying on its own elasticity.

[0036] Specifically, the elastic airbag section 12 is configured to be a threaded tube or a corrugated tube extending along the length direction of chip body 11.

[0037] In some embodiments, the inlet 111 is located at a bottom of the chip body 11, and the elastic airbag section 12 is positioned at a top of the chip body 11. The sample liquid driving device 40 is situated above the microfluidic biochip 10 and is configured to compress the elastic airbag section 12 downwards under the control of

the microfluidic biochip 10. This means, after the microfluidic biochip 10 is installed, the length direction of chip body 11 is vertical, which facilitates not only contact of inlet 111 with sample liquid but also arrangement of the sample liquid driving device 40.

[0038] In some embodiments, the microfluidic control detection system 1 comprises a chip installation mechanism 30. The applicants recognized that since there are no air tightness issues between the microfluidic biochip 10 and the sample liquid driving device 40, there is no need to consider the sealing docking structure between the microfluidic biochip 10 and the sample liquid driving device 40 during the installation of microfluidic biochip 10. It is only necessary to ensure that the microfluidic biochip 10 remains stable and reliable once installed. Therefore, it is no need to configure the chip installation mechanism 30 of the present application as a very complex structure, as long as it can hold the microfluidic biochip 10 securely.

[0039] For an aforementioned purpose, the chip installation mechanism 30 of the present application comprises an installation slot 31 configured to house the microfluidic biochip 10. The microfluidic biochip 10 is configured to be inserted into the installation slot 31 through a notch of the installation slot 31, not only achieving effective installation of the microfluidic biochip 10 but also significantly simplifying a structure of microfluidic control detection system 1.

[0040] Further, the inlet 111 of the chip body 11 is positioned outside of the installation slot 31 to facilitate introduction of sample liquid by inlet 111 when the microfluidic biochip 10 is in its installed state.

[0041] In some embodiments, the inlet 111 is located at a bottom of the chip body 11, and the elastic airbag section 12 is positioned at a top of chip body 11. Given that the elastic airbag section 12 is elastically deformable, it is impractical to install the microfluidic biochip 10 from the bottom up.

[0042] Therefore, the installation slot 31 of the present application is further configured to extend vertically, with the microfluidic biochip 10 configured to be inserted into the installation slot 31 in a direction parallel to a horizontal plane. That is, the elastic airbag section 12 is installed parallel to the chip body 11, with the elastic airbag section 12 not causing any obstruction or impact on assembly of the chip body 11. Meanwhile, structure configuration of the installation slot 31 allows only the chip body 11 to remain stationary within the installation slot 31, permitting the elastic airbag section 12 to deform elastically within the installation slot 31 without any hindrance.

[0043] In some embodiments, the installation slot 31 comprises a first slot section 311 for housing the chip body 11 and a second slot section 312 for housing the elastic airbag section 12, with the first slot section 311 located below the second slot section 312. A size of the first slot section 311 is smaller than a size of the second slot section 312, forming a step-like section 32 at a junction between the first slot section 311 and the second

slot section 312. A bottom of the elastic airbag section 12 rests against the step-like section 32, preventing the microfluidic biochip 10 from falling downwards. Thus, the entire microfluidic biochip 10 can be supported within the installation slot 31, achieving vertical positioning of microfluidic biochip 10. The present application achieves vertical positioning of the microfluidic biochip 10 by configuring the installation slot 31 with simple structural dimensions, which simplify a positioning structure between the microfluidic biochip 10 and the installation slot 31.

[0044] FIG.6 shows a schematic sectional view of a microfluidic control detection system in a partial exploded state according to an embodiment of the present application. In some embodiments, the chip installation mechanism 30 comprises at least one clamping component 33 positioned within the installation slot 31. The clamping component 33 is configured to secure the chip body 11 after the microfluidic biochip 10 is inserted into the installation slot 31, preventing the microfluidic biochip 10 from tilting, swaying, or dislodging from the installation slot 31 during a compression process or a release process of the elastic airbag section 12 by the sample liquid driving device 40, thereby limiting a movement of the microfluidic biochip 10 in a horizontal direction.

[0045] Specifically, an accommodation space for housing the clamping component 33 can be configured within the installation slot 31, with the clamping component 33 confined to the accommodation space and capable of elastic deformation within a certain range, maintaining optimal clamping force on the chip body 11.

[0046] Furthermore, the clamping component 33 can comprise two symmetrically arranged and spaced apart claws 331. The two claws 331 are configured to apply opposing elastic forces (e.g., which are toward to each other) to two opposite side surfaces of the chip body 11 after the microfluidic biochip 10 is installed into the installation slot 31, thereby maintaining the microfluidic biochip 10 more stably.

[0047] In some embodiments, the sample liquid driving device 40 comprises a drive motor 41 and a push rod 42. The push rod 42 is connected to the drive motor 41, and the push rod 42 is configured to translate along an output shaft of the drive motor 41 when the drive motor 41 rotates. Specifically, the output shaft of the drive motor 41 could be parallel to an extension direction of the elastic airbag section 12, to use the push rod 42 to compress the elastic airbag section 12 or release the elastic airbag section 12 when the drive motor 41 rotates.

[0048] In some embodiments, the microfluidic control detection system 1 comprises a weighing platform 81 and a bracket 82. The weighing platform 81 is fixedly set on a support frame 83 and configured to measure a weight of a sample contained in a sample cup 2 placed on it. It is understandable that the weighing platform 81 can measure combined weight of the sample cup 2 and the sample contained therein, subtracting a weight of the sample cup 2 itself to obtain the weight of the sample. The weighing platform 81 can also be configured to di-

rectly detect the weight of the sample contained in the sample cup 2, such as through tare measurement. The bracket 82 is configured to move in a controlled manner or operable manner, driving the sample cup 2 to move to a highest position where the sample liquid in the sample cup 2 can contact the inlet 111 of the microfluidic biochip 10.

[0049] In some embodiments, the microfluidic control detection system 1 comprises a buffer solution bottle 51 and a buffer solution driving device 52. The buffer solution bottle 51 is configured to contain a buffer solution. The buffer solution driving device 52 connected to the buffer solution bottle 51, is controlled to drive the buffer solution from the buffer solution bottle 51 into a sample cup 2 on the weighing platform 81. Mixture of buffer solution and sample in the sample cup 2 produces sample liquid. Specifically, the buffer solution driving device 84 can be a peristaltic pump, diaphragm pump, or another suitable type of driving device.

[0050] In some embodiments, the microfluidic control detection system 1 comprises a housing 90. The housing 90 has an operation platform open towards a front side of the housing 90, with the weighing platform 81 at least partially located within the operation platform, facilitating users implement operations such as placing the sample cup 2 to or removing the sample cup 2 from the operation platform.

[0051] The microfluidic control detection system 1 of the present application specially comprises a weighing platform 81 fixed on a support frame 83 and a bracket 82 capable of moving the sample cup 2. During detection, users only need to place the sample cup 2 on the weighing platform 81, which measures the weight of the sample. The buffer solution driving device 52 adds an appropriate amount of buffer solution to the sample cup 2, and the bracket 82 automatically moves the sample cup 2 to the microfluidic biochip 10 for sample addition, making the sampling operation convenient, time-saving, and labor-saving, leading to a good user experience. More importantly, since the weighing platform 81 of the present application is fixed and does not move with movement of the bracket 82, the movement of the bracket 82 does not affect weighing accuracy of the weighing platform 81, ensuring high-precision measurement of the sample's weight, thereby improving accuracy of detection results from the microfluidic biochip 10.

[0052] Inventors recognized that when the sample cup 2 is weighed on the weighing platform 81, the bracket 82 should be completely detached from and not touch the sample cup 2 to avoid affecting weighing of the sample. After the weight of the sample has been measured, the bracket 82 needs to hold the sample cup 2 to move it together. That is, the bracket 82 needs to have two states: releasing the sample cup and holding the sample cup, and it should be able to automatically switch between these two states according to a detection process. To achieve an object of switching between the two states, the common design approach before the present appli-

cation was to equip the bracket with a clamping mechanism, which automatically switches between releasing the sample cup and holding the sample cup through control of the clamping mechanism's action. However, the applicants recognized that this traditional design approach is outdated and has many drawbacks. For example, the clamping mechanism increases structural complexity of the bracket and requires reserved space for action switches of the clamping mechanism to avoid interference or collision with other structures, which would increase volume of the microfluidic control detection system, making it unsuitable for refrigerators with limited space. Moreover, the holding of the sample cup, especially the release of the sample cup, needs to be highly synchronized with the detection process. That is, when the weighing platform needs to measure the weight of the sample, the clamping mechanism must be in a state of releasing the sample cup; only after the weighing platform has measured, the weight of the sample can the clamping mechanism hold the sample cup. These requirements for timing precision of control of the clamping mechanism's state switching are very high. Any slight deviation or error accumulation could easily lead to disorder in the entire detection process and result in incorrect detection results.

[0053] To address this, the inventors attempted to break away from the traditional design approach and developed a completely new bracket structure. In some embodiments, the bracket 82 is set above the weighing platform 81 and comprises an annular frame 821 that is fitted outside the sample cup 2. The bracket 82 is configured to move controllably or operably in an up and down direction, using the annular frame 821 to lift the sample cup 2 off the weighing platform 81 as it moves upwards, and during its downward movement to a lowest position, it allows the sample cup 2 to be supported on the weighing platform 81 and uses an abutting effect between the sample cup 2 and the weighing platform 81 to detach the sample cup 2 from the annular frame 821.

[0054] That is, as the bracket 82 moves upwards, the annular frame 821 naturally lifts the sample cup 2 off the weighing platform 81; when the bracket 82 moves down to a certain position, the sample cup 2 is supported on the weighing platform 81, and as the bracket 82 continues to move down to the lowest position, the abutting effect between the sample cup 2 and the weighing platform 81 causes the sample cup 2 to detach from the annular frame 821, thus, the bracket 82 does not affect weight measurement of the sample in any way. It is clear that the bracket 82 of the present application naturally switches between lifting and releasing the sample cup 2 during its lifting process, without needs for any lifting control programs or releasing control programs, making a structure of the bracket 82 simple, as well as control logic of the bracket 82.

[0055] The present application also introduces a refrigerator, as illustrated in FIG.7, illustrating a schematic structural diagram of a refrigerator according to an em-

bodiment of the present application. The refrigerator 100 incorporates the microfluidic control detection system 1 involved in any of the aforementioned embodiments, integrating the microfluidic control detection system 1 with the refrigerator 100. Given high frequency of use of refrigerators 100 in daily life and their primary function for storing food ingredients, integrating the microfluidic control detection system 1 into the refrigerator 100 facilitates users in conducting detection operations on food ingredient samples using the microfluidic control detection system 1.

[0056] By integrating the microfluidic control detection system 1 into the refrigerator 100, the present application fully leverages a storage function of the refrigerator 100, making a detection process more convenient. It also facilitates the interlinked control between the microfluidic control detection system 1 and the refrigerator 100, achieving a high level of intelligence that meets needs of smart homes.

[0057] Additionally, the refrigerator 100 comprises a cabinet 200 and a door 300. The cabinet 200 defines a storage space, and the door 300 is connected to the cabinet 200 to open and/or close the storage space. Preferably, the microfluidic control detection system 1 is mounted on the door 300, which is not only convenient for operation but also does not occupy an original storage space inside the cabinet 200, thus not affecting storage capacity of the refrigerator 100 itself.

[0058] The refrigerator 100 mentioned in the present application is broadly defined to include not only the conventional narrow sense of refrigerators but also storage devices with refrigeration, freezing, or other storage functions, such as refrigeration boxes, freezers, etc.

[0059] It should be understood by those skilled in the art that the terms "up," "down," "front," "back," "top," "bottom," and other directional or positional terms used in the embodiments of the present application are based on an actual usage state of the microfluidic control detection system 1 and the refrigerator 100. These terms are merely for the convenience of describing and understanding the technical solutions of the present application and should not be interpreted as limiting the present application to specific orientations or configurations.

[0060] Thus, it should be recognized by those skilled in art that although this document has thoroughly presented and described several exemplary embodiments of the present application, many other variations or modifications that are in accordance with the principles of the present application can be directly determined or derived from the content disclosed here without departing from the spirit and scope of the present application. Therefore, the scope of the present application should be understood and recognized to cover all such other variations or modifications.

Claims

1. A microfluidic control detection system for a refrigerator, comprising:

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a microfluidic biochip, comprising a chip body and an elastic airbag section, where the chip body comprising an inlet, a suction port, and a detection pool formed inside, and the inlet, the detection pool, and the suction port are sequentially interconnected through microchannels, with the elastic airbag section hermetically connected to the suction port;

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a sample liquid driving device, configured to compress and release the elastic airbag section under control of the microfluidic biochip, prompting sample liquid in contact with the inlet to enter the microchannels and flow towards the detection pool via the microchannels; and

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a detection mechanism, configured to detect the detection pool to obtain preset detection parameters of the sample liquid; wherein, the chip body and the elastic airbag section are integrally formed by blow molding.

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2. The microfluidic control detection system according to claim 1, wherein:

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a reagent adding hole is positioned on a side surface of the chip body, connecting to the detection pool, allowing for addition of detection reagents into the detection pool through the reagent adding hole; and

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the microfluidic biochip comprises a sealing patch hermetically attached to a side surface of the chip body to seal the reagent adding hole.

3. The microfluidic control detection system according to claim 1, wherein:

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the elastic airbag section is configured as a threaded shape or a wavy shape extending along a length direction of the chip body; and the sample liquid driving device is configured to apply a compressive force to the elastic airbag section parallel to an extension direction of the elastic airbag section under the control of the microfluidic biochip, inducing elastic deformation of the elastic airbag section along the extension direction of the elastic airbag section.

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4. The microfluidic control detection system according to claim 3, wherein:

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the inlet is located at a bottom of the chip body, and the elastic airbag section is positioned at a top of the chip body; and the sample liquid driving device is situated

above the microfluidic biochip and is configured to compress the elastic airbag section downwards under the control of the microfluidic biochip.

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5. The microfluidic control detection system according to claims 1-4, further comprising:

a chip installation mechanism, comprising an installation slot configured to house the microfluidic biochip; and

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the microfluidic biochip is configured to be inserted into the installation slot through a notch of the installation slot, with the inlet of the chip body positioned outside of the installation slot.

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6. The microfluidic control detection system according to claim 5, wherein:

the inlet is located at a bottom of the chip body, and the elastic airbag section is positioned at a top of the chip body; and

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the installation slot is configured to extend vertically, and the microfluidic biochip is configured to be inserted into the installation slot in a direction parallel to a horizontal plane.

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7. The microfluidic control detection system according to claim 6, wherein:

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the installation slot comprises a first slot section for housing the chip body and a second slot section for housing the elastic airbag section, with a size of the first slot section smaller than a size of the second slot section, forming a step-like section at a junction between the first slot section and the second slot section; and

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a bottom of the elastic airbag section rests against the step-like section.

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8. The microfluidic control detection system according to claim 5, wherein:

the chip installation mechanism comprises at least one clamping component positioned within the installation slot, which is configured to secure the chip body after the microfluidic biochip is inserted into the installation slot.

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9. The microfluidic control detection system according to claim 8, wherein:

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the clamping component comprises two symmetrically arranged and spaced apart claws, configured to apply opposing elastic forces to two opposite side surfaces of the chip body after the microfluidic biochip is installed into the installation slot.

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10. A refrigerator, comprising the microfluidic control detection system according to any one of claims 1-9.

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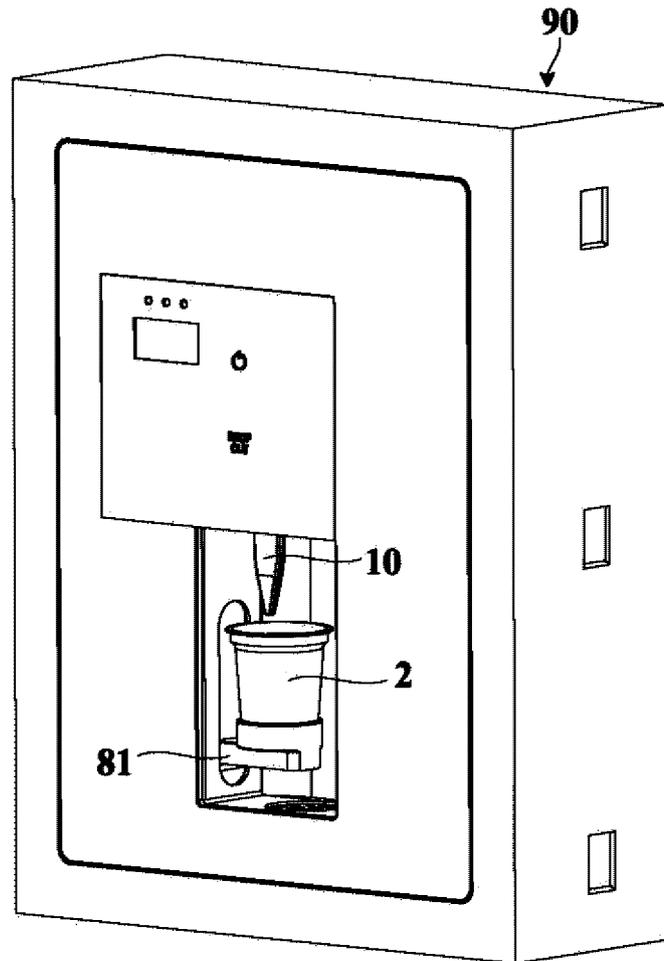


FIG. 1

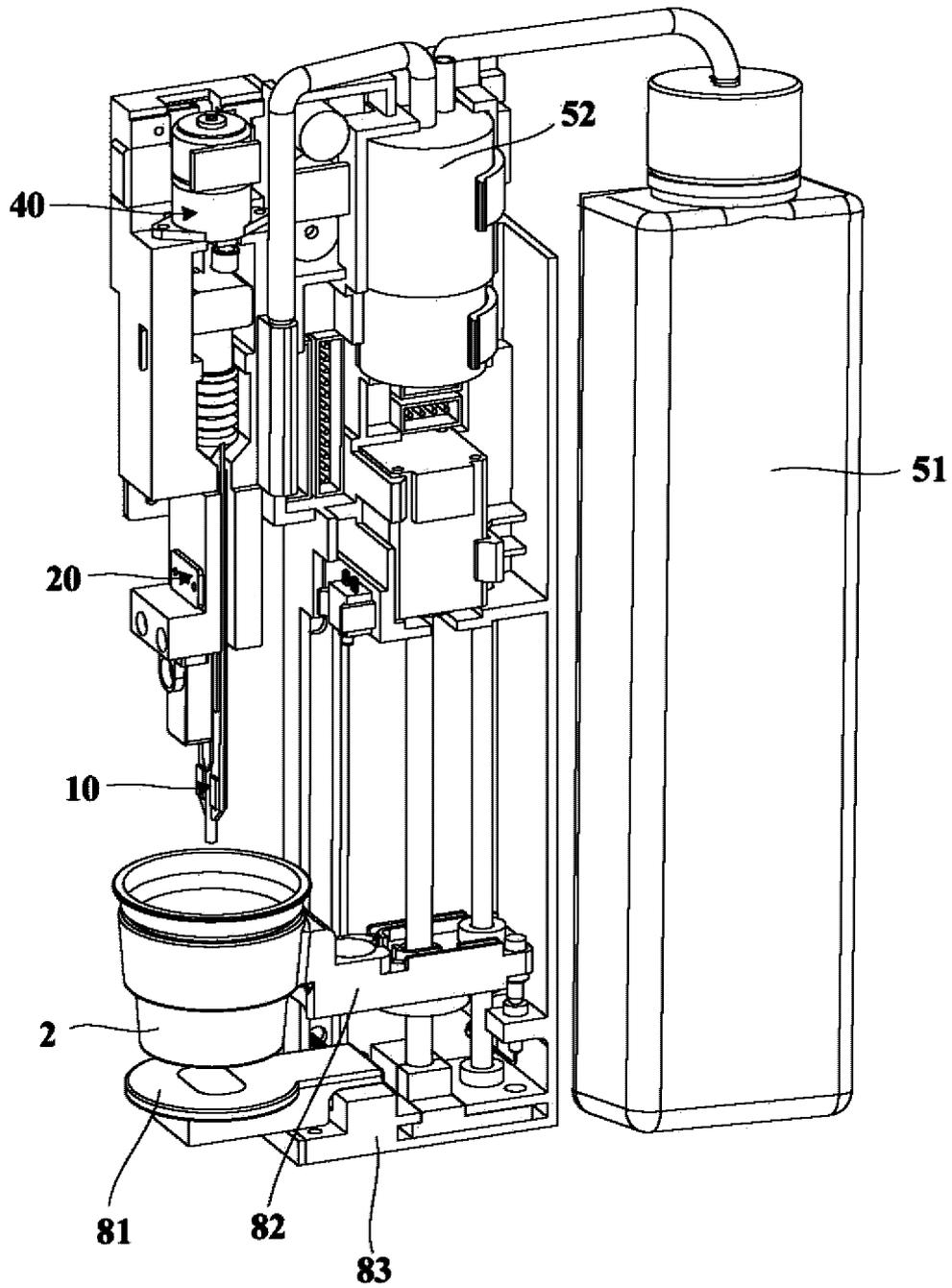


FIG. 2

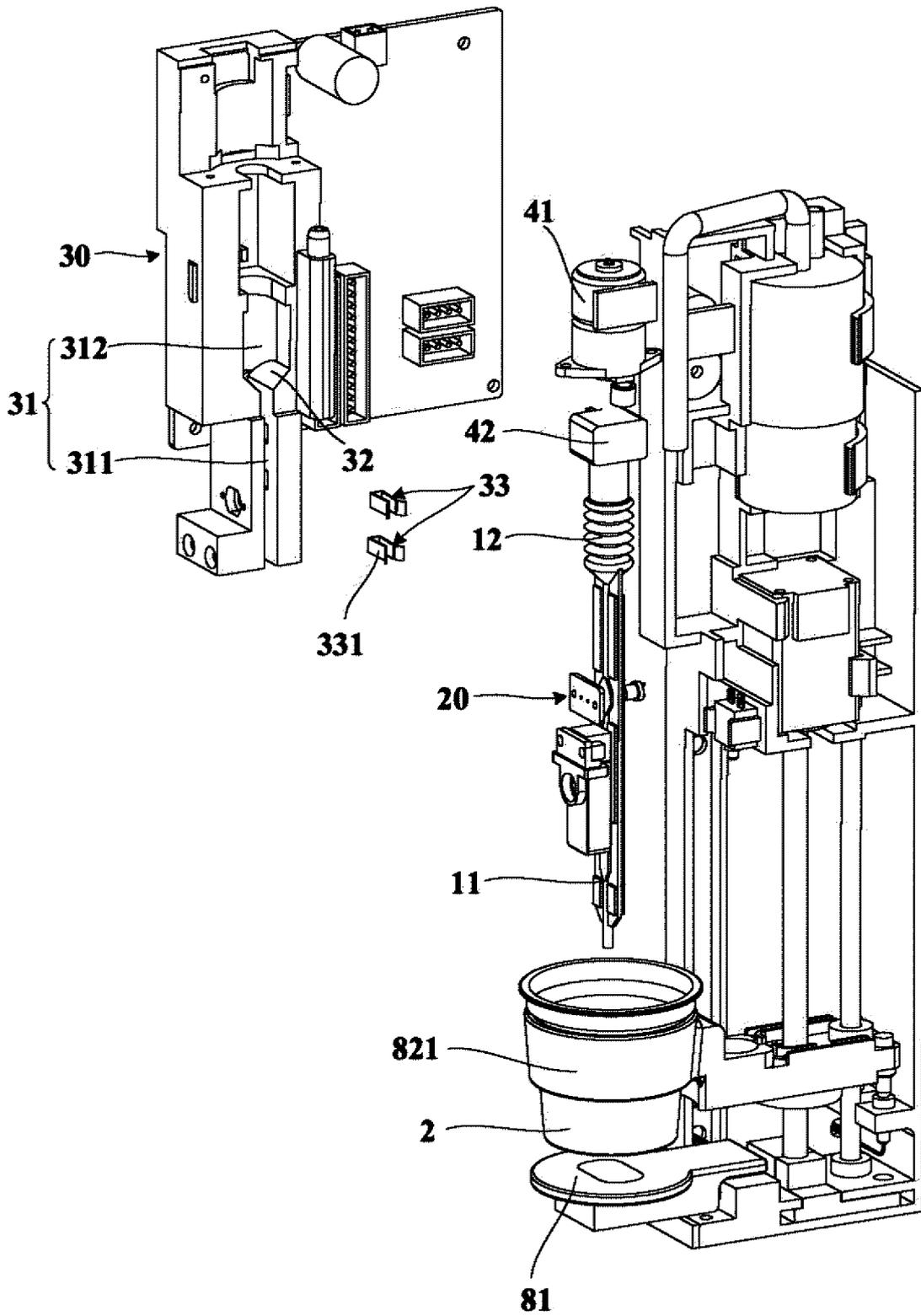


FIG. 3

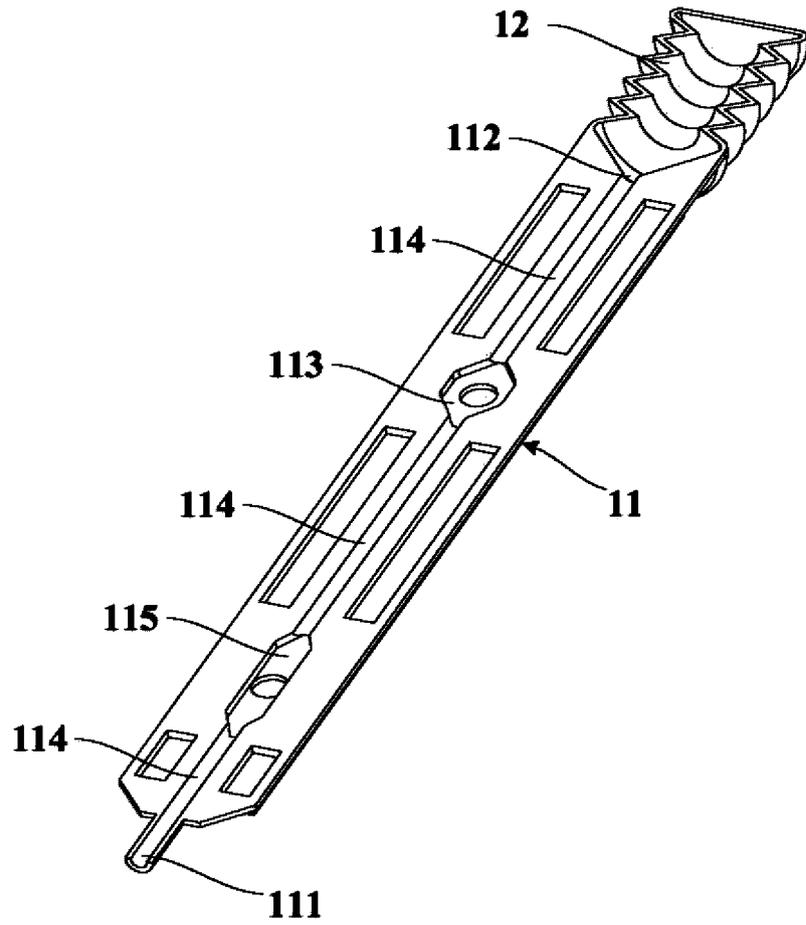


FIG. 4

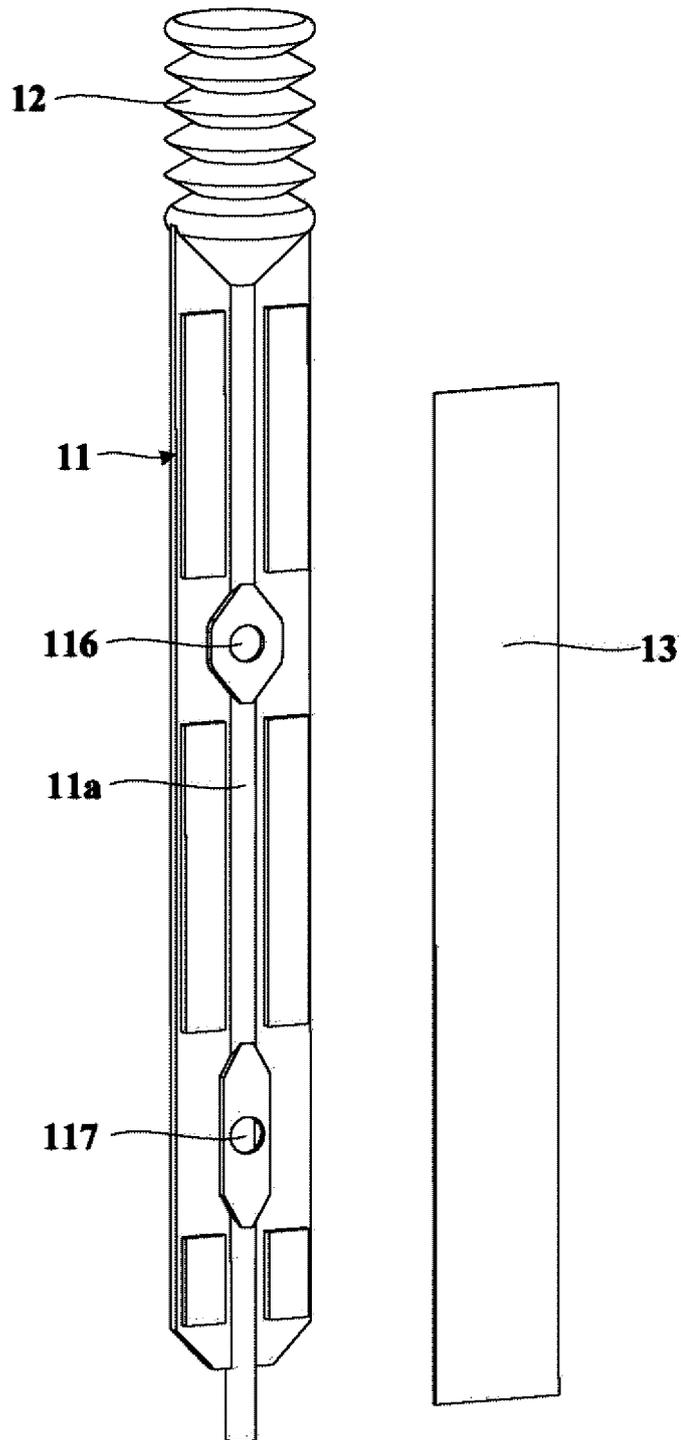


FIG. 5

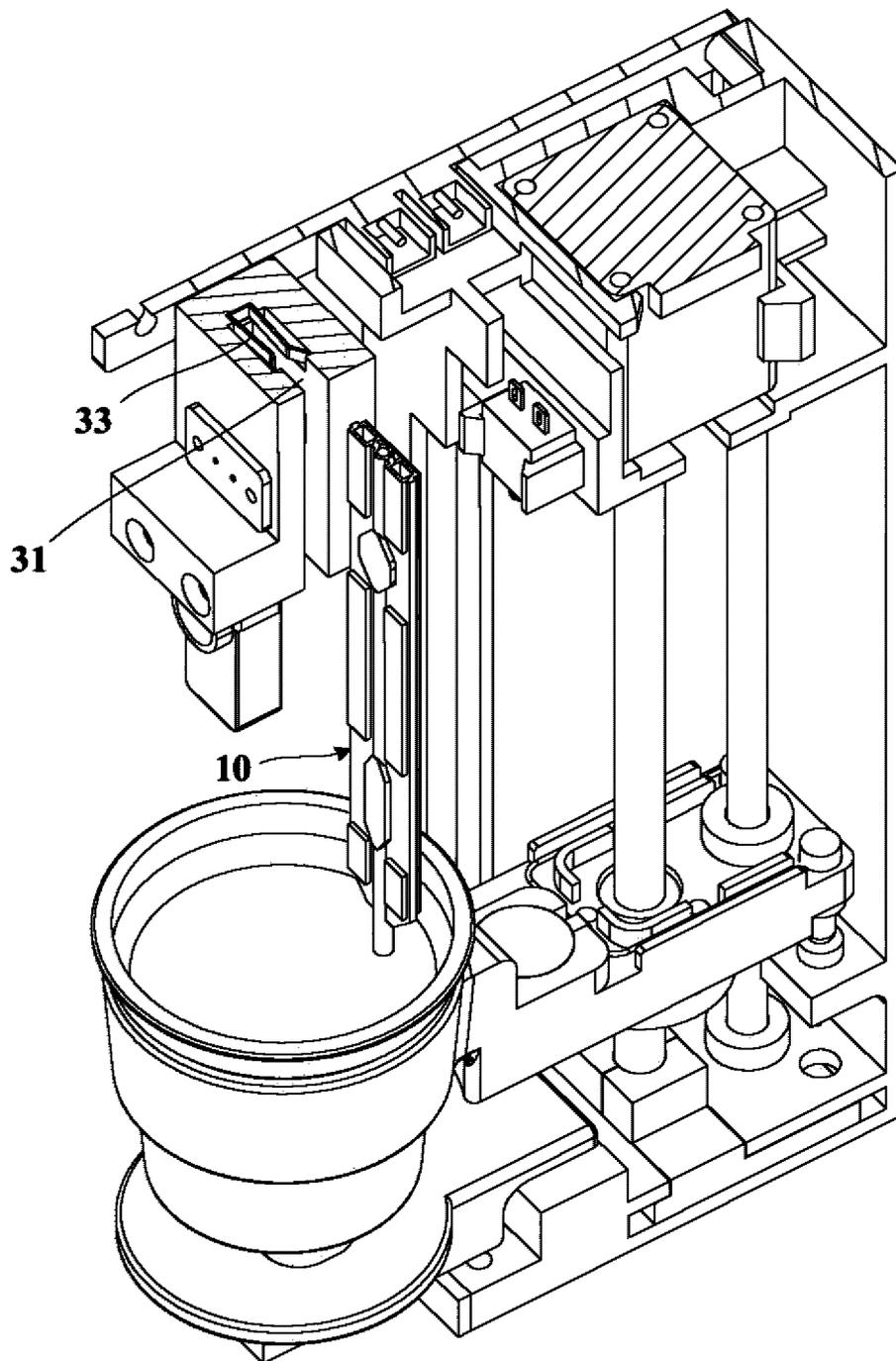


FIG. 6

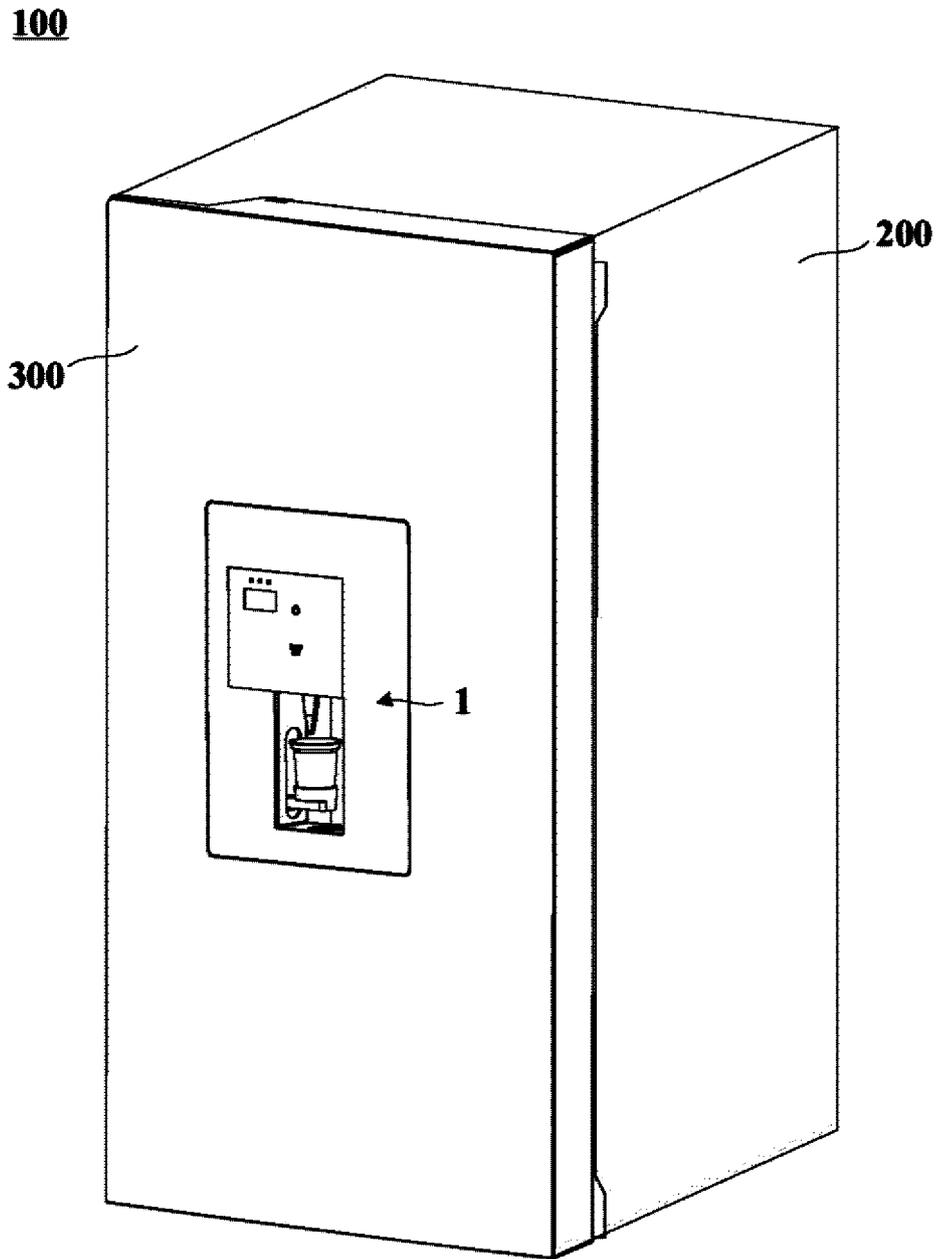


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/126154

5	A. CLASSIFICATION OF SUBJECT MATTER	
	B01L 3/00(2006.01)i; G01N 35/10(2006.01)i; F25D 23/12(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
10	B. FIELDS SEARCHED	
	Minimum documentation searched (classification system followed by classification symbols) B01L3, G01N35, F25D23	
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI; SIPOABS; CNABS; CNTXT; CNKI: 微流体, 微流控, 气囊, 球囊, 弹性, 球, 挤压, 按压, microfluidic, air bag, ball, elastic, press, force	
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT	
	Category*	Citation of document, with indication, where appropriate, of the relevant passages
		Relevant to claim No.
	Y	CN 214041434 U (QINGDAO HAIER REFRIGERATOR CO., LTD. et al.) 24 August 2021 (2021-08-24) description, paragraphs 54-55 and 77, and figures 3-5
25	Y	CN 102671729 A (CAPITALBIO CORPORATION et al.) 19 September 2012 (2012-09-19) description, paragraphs 38-40, and figure 3
	Y	CN 214039171 U (QINGDAO HAIER REFRIGERATOR CO., LTD. et al.) 24 August 2021 (2021-08-24) description, paragraphs 56-57 and 80, and figures 3-5
30	Y	CN 205731290 U (HANGZHOU TINKER BIOTECHNOLOGY CO., LTD.) 30 November 2016 (2016-11-30) description, abstract, claim 1, and figure 1
	A	CN 204514801 U (HANGZHOU TINKER BIOTECHNOLOGY CO., LTD.) 29 July 2015 (2015-07-29) entire document
35	A	CA 3017978 A1 (MESA BIOTECH, INC.) 27 October 2016 (2016-10-27) entire document
	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
40	* 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
45	Date of the actual completion of the international search 20 December 2022	Date of mailing of the international search report 16 January 2023
50	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China Facsimile No. (86-10)62019451	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/126154

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REFERENCES CITED IN THE DESCRIPTION

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