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(54) **AUTOMATIC CELL ISOLATION AND COLLECTION SYSTEM**

AUTOMATISCHES ZELLISOLIERUNGS- UND ZELLSAMMELSYSTEM

ISOLATION DE CELLULES AUTOMATIQUE ET SYSTÈME DE COLLECTE

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Description

[0001] The disclosure relates to an isolation and collection system, and more particularly to an automatic cell isolation and collection system.

[0002] For research purpose or medical procedure, oftentimes it is required to separate a specific type of cells from a tissue taken from a living body for further analysis or for performing a biopsy. Referring to Figure 1, a conventional cell isolation and collection method includes the follow steps: a sample preparing step 101 in which a tissue sample is prepared, a crushing step 102 in which the tissue sample is crushed, a centrifuging step 103 in which the crushed tissue sample is aliquoted into a number of centrifuge tubes and is centrifuged, a collecting step 104 in which pellet in each of the centrifuge tubes is collected, a first adding step 105 in which the pellet of each centrifuge tube is transferred into another centrifuge tube and a solution containing antibody-conjugated magnetic beads is added thereinto, a mixing step 106 in which the pellets and the solution are fully mixed so as to conjugate the target cells with the beads, a first magnetically attracting step 107 in which a magnetically attractive force is provided to move the beads conjugated with the target cells to bottom parts of the centrifuge tubes, a removing step 108 in which the supernatant is removed from each of the centrifuge tubes, a second adding step 109 in which an enzyme solution is added to break the conjugation between the beads and the target cells, a second magnetically attracting step 110 in which the magnetically attractive force is provided to magnetically attract the beads and the target cells are then moved into different centrifuge tubes, and a centrifuging and collecting step 111 in which a cycle of centrifuging the target cells, removing supernatants, and adding buffer for mixing is repeated for a number of times.

[0003] The above-mentioned cell isolation and collection method is relatively complicated, and at least part of the operation in each of the steps is performed by a human operator, which is attention demanding.

[0004] In addition, the purity of the target cells may be adversely affected by human operator error, and the efficiency of the entire operation is relatively low.

[0005] US2009/275073 A1 discloses a diagnosis device comprising a cutter for chopping tissue slices to suspend the tissue. The suspension is aspirated and discharged in a reservoir of a centrifugal separator through an aspiration line.

[0006] Therefore, an object of the disclosure is to provide an automatic cell isolation and collection system that can alleviate at least one of the drawbacks of the prior art.

[0007] According to the present invention, there is provided an automatic cell isolation and collection system according to claim 1.

[0008] According to the disclosure, the automatic cell isolation and collection system is adapted for sorting out target cells from a sample. The automatic cell isolation and collection system includes a crush module, a centrifuge module, a transport module, and a control unit.

[0009] The crush module includes a container that defines an accommodating space adapted for receiving the sample therein, and a crusher that is removably disposed in the accommodating space and that is for crushing the sample.

[0010] The centrifuge module is spaced apart from the crush module, and includes a centrifuge seat, a plurality of spaced-apart centrifuge tubes that are disposed on the centrifuge seat, and a magnetic mechanism that is spaced apart from the centrifuge seat, and that provides a magnetically attractive force to at least one of the centrifuge tubes.

[0011] The transport module is disposed along a path between the crush module and the centrifuge module, and includes a movable connecting seat, and a pipettor that is co-movably connected to the connecting seat and that is for transferring of the sample and for transferring of a reagent to the centrifuge tubes.

[0012] The control unit is in electrical communication with the crush module, the centrifuge module, and the transport module, and controls crushing operation of the crush module, transport of the sample via the transport module after the sample is crushed by the crush module, centrifugation of the centrifuge module, and operation of the magnetic mechanism for providing the magnetically attractive force.

[0013] Other features and advantages of the disclosure will become apparent in the following detailed description of the embodiment with reference to the accompanying drawings, of which:

Figure 1 is a flowchart illustrating a conventional method for cell isolation and collection;
Figure 2 is a perspective view illustrating an embodiment of an automatic cell isolation and collection system according to the disclosure;
Figure 3 is a schematic diagram illustrating relationship between components of the embodiment;
Figure 4 is an enlarged perspective view illustrating a crush module of the embodiment;
Figure 5 is an enlarged perspective view illustrating a centrifuge module of the embodiment;
Figure 6 is an enlarged perspective view illustrating a transport module and a consumable module of the embodiment;
Figure 7 is a flowchart illustrating steps of a cell isolation and collection process using the embodiment;
Figures 8 to 10 are fragmentary schematic views illustrating operation of the embodiment;
Figure 11 is a fragmentary schematic top view illustrating operations of the transport module and the centrifuge module of the embodiment; and
Figures 12 and 13 are schematic views illustrating operation of a magnetic mechanism of the centrifuge module of the embodiment.

[0014] Referring to Figures 2 to 4, an embodiment of

an automatic cell isolation and collection system according to the disclosure is adapted for sorting out target cells 92 (see Figures 12 and 13) from a sample. It should be noted that the sample exemplified in this embodiment is a tissue sample directly taken from a living body, and the target cells 92 exemplified in this embodiment are stem cells. However, the application of the automatic cell isolation and collection system of the disclosure is not limited thereto.

[0015] The automatic cell isolation and collection system includes a crush module 2, a centrifuge module 3, a transport module 4, a consumable module 5, a housing 6, an operating interface 7, and a control unit 8. The crush module 2 and the centrifuge module 3 are spaced apart from each other in a first direction (L1).

[0016] The crush module 2 includes a movable platform 21 that is operable to move in the first direction (L1), a container 22 that is disposed on the movable platform 21 and that defines an accommodating space 220 adapted for receiving the sample therein, and a crusher 23 that is removably disposed in the accommodating space 220 and that is for crushing the sample. The crusher 23 includes a rotor 231, a drive shaft 232 driven rotatably by the rotor 231, and a blade 233 disposed on the drive shaft 232 and configured to crush the sample when the drive shaft 232 is rotated.

[0017] Referring to Figures 2, 3, and 5, the centrifuge module 3 includes a centrifuge seat 31, a plurality of spaced-apart centrifuge tubes 32 that are symmetrically disposed on the centrifuge seat 31, a step motor 33 that is connected to the centrifuge seat 31 and that is in electrical communication with the control unit 8, and a magnetic mechanism 34 that is spaced apart from the centrifuge seat 31 and that provides a magnetically attractive force to at least one of the centrifuge tubes 32. In this embodiment, the magnetic mechanism 34 is a permanent magnet, and is operable by the control unit 8 to move between a magnetically attracted position, where the magnetic mechanism 34 is proximate to the at least one of the centrifuge tubes 32 so as to provide the magnetically attractive force to the at least one of the centrifuge tubes 32, and a magnetically non-attracted position, where the magnetic mechanism 34 is distal from the at least one of the centrifuge tubes 32. In other modification of this embodiment, the magnetic mechanism 34 may be an electromagnet that is operable by the control unit 8 to generate the magnetically attractive force.

[0018] Referring to Figures 2 and 6, the transport module 4 is disposed along a path in the first direction (L1) between the crush module 2 and the centrifuge module 3. The transport module 4 includes a linear rail 41 that extends in the first direction (L1) and that is located above the crush module 2 and the centrifuge module 3, a movable connecting seat 42 that is disposed on and slidable along the linear rail 41, and a pipettor 43 that is co-movably connected to the connecting seat 42 and that is for transferring of the sample and for transferring of a reagent to the centrifuge tubes 32. More specifically, the pipettor 43 is co-movable with the connecting seat 42 in the first direction (L1), and the pipettor 43 is movable reciprocately relative to the linear rail 41 in a second direction (L2) which is transverse to the first direction (L1).

[0019] The consumable module 5 is disposed between the crush module 2 and the centrifuge module 3, is located under the transport module 4, and includes a tip case 51 and a plurality of pipette tips 52. The tip case 51 is formed with a plurality of tip-receiving holes 511 facing upward, and a disposal space 512 spaced apart from the tip-receiving holes 511. Each of the pipette tips 52 is disposed in a corresponding one of the tip-receiving holes 511, and fits on the pipettor 43. In order to prevent cross contamination of the sample and reagents used during the isolation and collection process which may undesirably affect yield of the process, each of the pipette tips 52 is disposed in the disposal space 512 for disposal once it is used.

[0020] The housing 6 defines a closed space 600 in which the crush module 2, the transport module 4, the centrifuge module 3, and the consumable module 5 are disposed, so as to eliminate the introduction of microorganisms and other contaminants during a cell isolation and collection process. In actual practice, the housing 6 may be configured to be aseptic. It is worth mentioning that only a frame part of the housing 6 is shown in the figures for the sake of clarity. The automatic cell isolation and collection system is a closed system in this embodiment.

[0021] The operating interface 7 is disposed on the housing 6 and electrically communicates with the control unit 8.

[0022] The control unit 8 is in electrical communication with the crush module 2, the centrifuge module 3, and the transport module 4. The control unit 8 controls crushing operation of the crush module 2, transport of the sample via the transport module 4 after the sample is crushed by the crush module 2, centrifugation of the centrifuge module 3, and operation of the magnetic mechanism 34 for providing the magnetically attractive force.

[0023] Referring to Figure 7, a cell isolation and collection process using the embodiment is described in detail in the following. The process includes a separating step 901, a collecting step 902, and a sorting step 903.

[0024] Referring to Figures 4, 7, and 8, in the separating step 901, first the sample is placed in the accommodating space 220 of the container 22, and the rotor 231 is actuated by the control unit 8 to drive rotation of the drive shaft 232 and the blade 233 to crush the sample. Subsequently, the pipettor 43 is moved along the linear rail 41 to a position directly above the consumable module 5 (see Figure 9), and then is moved downward so that one of the pipette tips 52 is fitted on the pipettor 43. Next, a buffer solution is added into the accommodating space 220 using the pipettor 43. Upon addition of the buffer solution, part of the crushed tissue sample attached to the blade 233 can be washed down for removal from the blade 233, and a sample solution containing the

crushed tissue sample and the buffer solution is obtained. At this time, the pipette tip 52 on the pipettor 43, which is used to transfer the buffer solution into the accommodating space 220, is disposed in the disposal space 512 of the tip case 51, and another one of the pipette tips 52 is fitted onto the pipettor 43 to transfer the sample solution to one of the centrifuge tubes 32 of the centrifuge module 3.

[0025] It is worth mentioning that in this embodiment, the buffer solution is normal saline, but is not limited thereto as long as the buffer solution can provide stability to the crushed sample and does not adversely affect the physical and chemical properties of the sample. In addition, a new pipette tip 52 of the consumable module 5 is used each time when adding a reagent or transferring the sample using the pipettor 43 so as to prevent cross contamination that may lead to unexpected result. In the following, the steps of disposing a used pipette tip 52 to the disposal space 512 and fitting the pipettor 43 with a new pipette tip 52 from the tip case 51 are not described in detail for the sake of clarity.

[0026] Referring to Figures 3, 7, and 10, in the collecting step 902, the centrifuge seat 31 is operated to rotate (i.e., centrifuging) to separate lipid in the sample solution. Since lipid has a lower density than the target cells 92, the target cells 92 form a pellet at a bottom of each of the centrifuge tubes 32 after centrifuging. The pellet in each centrifuge tube 32 is transferred to another centrifuge tube 32 by using the pipettor 43.

[0027] It should be noted that since the pipettor 43 can only be moved in the first direction (L1), whenever content in any one of the centrifuge tubes 32 is to be transferred using the pipettor 43, the control unit 8 controls the rotation of the step motor 33 so that the centrifuge tubes 32 are moved to positions that can be operated by the pipettor 43, as illustrated in Figure 11.

[0028] Referring to Figures 9 and 10, a hypotonic solution is added to the centrifuge tubes 32 containing the target cells 92 and then is mixed by pipetting action so that red blood cells in the sample are ruptured due to osmotic pressure. Afterwards, centrifugation is performed and the pellet containing the target cells 92 in each centrifuge tube 32 is transferred to another centrifuge tube 32 by using the pipettor 43 under the operation of the step motor 33.

[0029] At this time, each centrifuge tube 32 still contains cells other than the target cells 92. In order to isolate the target cells 92, a sorting step 903 is performed. First, a solution containing antibody-conjugated magnetic beads 91 is added into the centrifuge tubes 32 containing the target cells 92 by using the pipettor 43, and repeated pipetting action is performed for uniformly mixing the beads 91 and the target cells 92 so that the beads 91 can be conjugated to the target cells 92. Since the features of this disclosure does not reside in the conjugation of the magnetic beads 91 and the target cells 92, further details of the same are not provided herein for the sake of brevity.

[0030] Subsequently, the control unit 8 controls movement of the magnetic mechanism 34 from the magnetically non-attracted position to the magnetically attracted position, so as to provide the magnetically attractive force to the centrifuge tubes 32 containing the target cells 92. As shown in Figure 12, the target cells 92 move together with the beads 91 to a side of the centrifuge tubes 32 proximate to the magnetic mechanism 34 due to the magnetic attractive force. At this time, solution in the centrifuge tubes 32 can be removed using the pipettor 43 with the target cells 92 conjugated with the beads 91 being attracted to and staying at the side of the centrifuge tube 32. Subsequently, an enzyme solution for breaking the conjugation between the target cells 92 and the beads 91 is added to the centrifuge tubes 32 using the pipettor 43, and then the magnetic mechanism 34 is moved back to the magnetically non-attracted position before a repeated pipetting action is performed for mixing and breaking the conjugation between the target cells 92 and the beads 91. Afterwards, the magnetic mechanism 34 is moved to the magnetically attracted position again to magnetically attract the beads 91 to the side of the centrifuge tubes 32, and solution containing the target cells 92 in each centrifuge tube 32 can be transferred to a centrifuge tube 32 using the pipettor 43, which is then centrifuged. After centrifugation, the supernatant in the centrifuge tube 32 is removed, and the target cells 92 with a relative high purity are obtained.

[0031] The above-mentioned operation is an exemplified operation using the automatic cell isolation and collection system of this disclosure to demonstrate operations of the crush module 2, the centrifuge module 3, the transport module 4, the consumable module 5, and the control unit 8, and operation of the automatic cell isolation and collection system is not limited thereto. In addition to the control unit 8 automatically controlling the operation of each of the crush module 2, the centrifuge module 3, and the transport module 4 (i.e., controlling the entire isolation and collection process from start to finish), the operating interface 7 can be operated for setting the operating parameters, environment parameters (e.g., temperature in the housing 6), and even setting the sequence of detailed operations in each of the steps 901, 902, 903, so as to facilitate implementation of a fully automated and precisely-operated cell isolation and collection process in accordance with the requirements of a user.

[0032] In summary, by virtue of the control unit 8 controlling the operations of the crush module 2, the centrifuge module 3, and the transport module 4, the entire cell isolation and collection process is automated and can be carried out in a closed environment in the housing 6, thereby eliminating human operator error, effectively reducing operating time, and avoiding sample contamination due to human operation.

[0033] In the description above, for the purposes of explanation, numerous specific details have been set forth in order to provide a thorough understanding of the embodiment. It will be apparent, however, to one skilled

in the art, that one or more other embodiments may be practiced without some of these specific details. It should also be appreciated that reference throughout this specification to "one embodiment," "an embodiment," an embodiment with an indication of an ordinal number and so forth means that a particular feature, structure, or characteristic may be included in the practice of the disclosure. It should be further appreciated that in the description, various features are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of various inventive aspects.

Claims

1. An automatic cell isolation and collection system adapted for sorting out target cells from a sample, said automatic cell isolation and collection system comprising:

   a crush module (2) including a container (22) that defines an accommodating space (220) adapted for receiving the sample therein, and a crusher (23) that is removably disposed in said accommodating space (220) and that is for crushing the sample;
   a centrifuge module (3) spaced apart from said crush module (2), said centrifuge module (3) including a centrifuge seat (31), a plurality of spaced-apart centrifuge tubes (32) that are disposed on said centrifuge seat (31), and a magnetic mechanism (34) that is spaced apart from said centrifuge seat (31) and that provides a magnetically attractive force to at least one of said centrifuge tubes;
   a transport module (4) disposed along a path between said crush module (2) and said centrifuge module (3), said transport module (4) including a movable connecting seat (42) and a pipettor (43) that is co-movably connected to said connecting seat (42), wherein said pipettor (43) is for transferring of the sample from said container (22) to said centrifuge tubes (32), for transferring of a reagent to said centrifuge tubes (32), for transferring of antibody-conjugated magnetic beads (91) to said centrifuge tubes (32), and for uniformly mixing the beads (91) and the target cells in said centrifuge tubes (32) by repeated pipetting action for conjugating the beads (91) to the target cells; and
   a control unit (8) in electrical communication with said crush module (2), said centrifuge module (3), and said transport module (4), said control unit (8) controlling crushing operation of said crush module (2), transport of the sample to said centrifuge module (3) via said transport module (4) after the sample is crushed by said crush module (2), centrifugation of said centrifuge module (3), and operation of said magnetic mechanism (34) for providing a magnetically attractive force to the beads (91) in at least one of said centrifuge tubes (32) of said centrifuge module (3) to move the target cells together with the beads (91) in order to isolate the target cells conjugated with the beads (91) from the sample.

2. The automatic cell isolation and collection system as claimed in claim 1, wherein:

   said crush module (2) and said centrifuge module (3) are spaced apart from each other in a first direction (L1); and
   said crush module (2) further includes a movable platform (21) on which said container (22) is disposed, and which is operable to move said container (22) in the first direction (L1).

3. The automatic cell isolation and collection system as claimed in claim 2, wherein
   said transport module (4) further includes a linear rail (41) which extends in the first direction (L1), and which is located above said crush module (2) and said centrifuge module (3), said connecting seat (42) being disposed on and slidable along said linear rail (41) .

4. The automatic cell isolation and collection system as claimed in claim 3, wherein
   said pipettor (43) is co-movable with said connecting seat (42) in the first direction (L1), and is movable relative to said linear rail (41) in a second direction (L2) which is transverse to said first direction (L1).

5. The automatic cell isolation and collection system as claimed in any one of the preceding claims, further comprising a consumable module (5) disposed between said crush module (2) and said centrifuge module (3), located under said transport module (4), and including a tip case (51) that is formed with a plurality of tip-receiving holes (511) facing upward, and a plurality of pipette tips (52) that are disposed in said tip-receiving holes (511) and that fit on said pipettor (43).

6. The automatic cell isolation and collection system as claimed in claim 5, wherein said tip case (51) is further formed with a disposal space (512) spaced apart from said tip-receiving holes (511) and for disposal of said pipette tips (52) .

7. The automatic cell isolation and collection system as claimed in any one of the preceding claims, wherein said crusher (23) of said crush module (2) includes a rotor (231), a drive shaft (232) driven rotatably by said rotor (231), and a blade (233) dis-

posed on said drive shaft (232) and configured to crush the sample when said drive shaft (232) is rotated.

8. The automatic cell isolation and collection system as claimed in any one of the preceding claims, wherein said centrifuge module (3) further includes a step motor (33) that is connected to said centrifuge seat (31) and that is in electrical communication with said control unit (8).

9. The automatic cell isolation and collection system as claimed in any one of the preceding claims, wherein said magnetic mechanism (34) is a permanent magnet, and is operable by said control unit (8) to move between a magnetically attracted position, where said magnetic mechanism (34) is proximate to said at least one of said centrifuge tubes (32) so as to provide the magnetically attractive force to said at least one of said centrifuge tubes (32), and a magnetically non-attracted position, where said magnetic mechanism (34) is distal from said at least one of said centrifuge tubes (32).

10. The automatic cell isolation and collection system as claimed in any one of claims 1 to 8, wherein said magnetic mechanism (34) is an electromagnet, and is operable by said control unit (8) to generate the magnetically attractive force.

11. The automatic cell isolation and collection system as claimed in claim 5 or 6, further comprising a housing (6) defining a closed space (600) in which said crush module (2), said transport module (4), said centrifuge module (3), and said consumable module (5) are disposed.

12. The automatic cell isolation and collection system as claimed in claim 11, further comprising an operating interface (7) disposed on said housing (6) and electrically communicating with said control unit (8).

Patentansprüche

1. Automatisches Zellisolier- und Sammelsystem, das dafür geeignet ist, Zielzellen aus einer Probe auszusortieren, wobei das automatische Zellisolier- und Sammelsystem umfasst:

ein Zerkleinerungsmodul (2), das einen Behälter (22), der einen Aufnahmeraum (220) definiert, welcher dafür geeignet ist, die Probe in sich aufzunehmen, und einen Zerkleinerer (23) einschließt, der herausnehmbar im Aufnahmeraum (220) angeordnet ist und der dafür dient, die Probe zu zerkleinern;
ein vom Zerkleinerungsmodul (2) beabstandetes Zentrifugenmodul (3), wobei das Zentrifugenmodul (3) einen Zentrifugensitz (31), eine Vielzahl von beabstandeten Zentrifugenröhrchen (32), die am Zentrifugensitz (31) angeordnet sind, und einen Magnetmechanismus (34) einschließt, der vom Zentrifugensitz (31) beabstandet ist und der mindestens einem der Zentrifugenröhrchen eine magnetische Anziehungskraft bereitstellt;
ein Transportmodul (4), das entlang eines Pfades zwischen dem Zerkleinerungsmodul (2) und dem Zentrifugenmodul (3) angeordnet ist, wobei das Transportmodul (4) einen beweglichen Verbindungssitz (42) und einen Pipettierer (43) einschließt, der mitbeweglich mit dem Verbindungssitz (42) verbunden ist, wobei der Pipettierer (43) dafür dient, durch wiederholte Pipettieraktion die Probe aus dem Behälter (22) in die Zentrifugenröhrchen (32) zu transferieren, ein Reagens in die Zentrifugenröhrchen (32) zu transferieren, antikörperkonjugierte Magnetbeads (91) in die Zentrifugenröhrchen (32) zu transferieren, und die Beads (91) und die Zielzellen in den Zentrifugenröhrchen (32) gleichmäßig zu mischen, um die Beads (91) an die Zielzellen zu konjugieren; und
eine Steuerungseinheit (8), die mit dem Zerkleinerungsmodul (2), dem Zentrifugenmodul (3) und dem Transportmodul (4) in elektrischer Kommunikation steht, wobei die Steuerungseinheit (8) die Zerkleinerungsfunktion des Zerkleinerungsmoduls (2), den Transport der Probe, nachdem die Probe vom Zerkleinerungsmodul (2) zerkleinert wurde, über das Transportmodul (4) zum Zentrifugenmodul (3), das Zentrifugieren des Zentrifugenmoduls (3) und die Funktion des Magnetmechanismus (34), um den Beads (91) in mindestens einem der Zentrifugenröhrchen (32) des Zentrifugenmoduls (3) eine magnetische Anziehungskraft bereitzustellen, so steuert, dass die Zielzellen zusammen mit den Beads (91) bewegt werden, um die an die Beads (91) konjugierten Zielzellen aus der Probe zu isolieren.

2. Automatisches Zellisolier- und Sammelsystem nach Anspruch 1, wobei:

das Zerkleinerungsmodul (2) und das Zentrifugenmodul (3) in einer ersten Richtung (L1) voneinander beabstandet sind; und
das Zerkleinerungsmodul (2) weiter eine bewegliche Plattform (21) einschließt, auf der der Behälter (22) angeordnet ist, und die so betrieben werden kann, dass der Behälter (22) in der ersten Richtung (L1) bewegt wird.

3. Automatisches Zellisolier- und Sammelsystem nach

Anspruch 2, wobei das Transportmodul (4) weiter eine geradlinige Schiene (41) einschließt, die sich in der ersten Richtung (L1) erstreckt und die sich über dem Zerkleinerungsmodul (2) und dem Zentrifugenmodul (3) befindet, wobei der Verbindungssitz (42) an der geradlinigen Schiene (41) und entlang derselben verschiebbar angeordnet ist.

4. Automatisches Zellisolier- und Sammelsystem nach Anspruch 3, wobei der Pipettierer (43) in der ersten Richtung (L1) mit dem Verbindungssitz (42) mitbewegt werden kann, und in Bezug auf die geradlinige Schiene (41) in einer zweiten Richtung (L2) bewegt werden kann, die zur ersten Richtung (L1) quer verläuft.

5. Automatisches Zellisolier- und Sammelsystem nach einem der vorstehenden Ansprüche, weiter ein Verbrauchsmaterialienmodul (5) umfassend, das unter dem Transportmodul (4) befindlich zwischen dem Zerkleinerungsmodul (2) und dem Zentrifugenmodul (3) angeordnet ist und einen Spitzenkasten (51), der mit einer Vielzahl von nach oben gerichteten Spitzenaufnahmelöchern (511) ausgebildet ist, und eine Vielzahl von Pipettenspitzen (52) einschließt, die in den Spitzenaufnahmelöchern (511) angeordnet sind und die auf den Pipettierer (43) passen.

6. Automatisches Zellisolier- und Sammelsystem nach Anspruch 5, wobei der Spitzenkasten (51) weiter mit einem Entsorgungsraum (512) ausgebildet ist, der von den Spitzenaufnahmelöchern (511) beabstandet ist und zur Entsorgung der Pipettenspitzen (52) dient.

7. Automatisches Zellisolier- und Sammelsystem nach einem der vorstehenden Ansprüche, wobei der Zerkleinerer (23) des Zerkleinerungsmoduls (2) einen Rotor (231), eine vom Rotor (231) drehend angetriebene Antriebswelle (232) und eine Klinge (233) umfasst, die an der Antriebswelle (232) angeordnet und dazu ausgestaltet ist, die Probe zu zerkleinern, wenn die Antriebswelle (232) gedreht wird.

8. Automatisches Zellisolier- und Sammelsystem nach einem der vorstehenden Ansprüche, wobei das Zentrifugenmodul (3) weiter einen Schrittmotor (33) einschließt, der mit dem Zentrifugensitz (31) verbunden ist und der mit der Steuerungseinheit (8) in elektrischer Kommunikation steht.

9. Automatisches Zellisolier- und Sammelsystem nach einem der vorstehenden Ansprüche, wobei der Magnetmechanismus (34) ein Permanentmagnet ist und von der Steuerungseinheit (8) so betrieben werden kann, dass er sich zwischen einer magnetisch angezogenen Stellung, in der sich der Magnetmechanismus (34) nahe des mindestens einen der Zentrifugenröhrchen (32) befindet, um dem mindestens einen der Zentrifugenröhrchen (32) die magnetische Anziehungskraft bereitzustellen, und einer nicht magnetisch angezogenen Stellung bewegt, in der sich der Magnetmechanismus (34) fern des mindestens einen der Zentrifugenröhrchen (32) befindet.

10. Automatisches Zellisolier- und Sammelsystem nach einem der Ansprüche 1 bis 8, wobei der Magnetmechanismus (34) ein Elektromagnet ist und von der Steuerungseinheit (8) so betrieben werden kann, dass er die magnetische Anziehungskraft erzeugt.

11. Automatisches Zellisolier- und Sammelsystem nach Anspruch 5 oder 6, weiter ein Gehäuse (6) umfassend, das einen geschlossenen Raum (600) definiert, in dem das Zerkleinerungsmodul (2), das Transportmodul (4), das Zentrifugenmodul (3) und das Verbrauchsmaterialienmodul (5) angeordnet sind.

12. Automatisches Zellisolier- und Sammelsystem nach Anspruch 11, weiter eine Bedienschnittstelle (7) umfassend, die am Gehäuse (6) angeordnet ist und mit der Steuerungseinheit (8) in elektrischer Kommunikation steht.

Revendications

1. Système automatique d'isolement et de collecte de cellules adapté pour trier des cellules cibles d'un échantillon, ledit système automatique d'isolement et de collecte de cellules comprenant :

un module de broyage (2) comportant un récipient (22) qui définit un espace de réception (220) adapté pour y recevoir l'échantillon, et un broyeur (23) qui est disposé de manière amovible dans ledit espace de réception (220) et qui est destiné à broyer l'échantillon ;
un module de centrifugation (3) espacé dudit module de broyage (2), ledit module de centrifugation (3) comportant un siège de centrifugation (31), une pluralité de tubes de centrifugation espacés (32) qui sont disposés sur ledit siège de centrifugation (31), et un mécanisme magnétique (34) qui est espacé dudit siège de centrifugation (31) et qui fournit une force d'attraction magnétique à au moins l'un desdits tubes de centrifugation ;
un module de transport (4) disposé le long d'un chemin entre ledit module de broyage (2) et ledit module de centrifugation (3), ledit module de transport (4) comportant un siège de liaison mobile (42) et un pipetteur (43) qui est relié de manière co-mobile audit siège de liaison (42), dans lequel

ledit pipetteur (43) est destiné à transférer l'échantillon dudit récipient (22) auxdits tubes de centrifugation (32), à transférer un réactif auxdits tubes de centrifugation (32), à transférer des billes magnétiques conjuguées à des anticorps (91) auxdits tubes de centrifugation (32), et à mélanger uniformément les billes (91) et les cellules cibles dans lesdits tubes de centrifugation (32) par action de pipetage répétée pour conjuguer les billes (91) aux cellules cibles ; et une unité de commande (8) en communication électrique avec ledit module de broyage (2), ledit module de centrifugation (3) et ledit module de transport (4), ladite unité de commande (8) commandant l'opération de broyage dudit module de broyage (2), le transport de l'échantillon vers ledit module de centrifugation (3) par l'intermédiaire dudit module de transport (4) après que l'échantillon est broyé par ledit module de broyage (2), la centrifugation dudit module de centrifugation (3) et le fonctionnement dudit mécanisme magnétique (34) pour fournir une force d'attraction magnétique aux billes (91) dans au moins l'un desdits tubes de centrifugation (32) dudit module de centrifugation (3) pour déplacer les cellules cibles conjointement avec les billes (91) afin d'isoler les cellules cibles conjuguées avec les billes (91) de l'échantillon.

2. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 1, dans lequel :

ledit module de broyage (2) et ledit module de centrifugation (3) sont espacés l'un de l'autre dans une première direction (L1) ; et
ledit module de broyage (2) comporte en outre une plate-forme mobile (21) sur laquelle ledit récipient (22) est disposé, et qui peut fonctionner pour déplacer ledit récipient (22) dans la première direction (L1).

3. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 2, dans lequel
ledit module de transport (4) comporte en outre un rail linéaire (41) qui s'étend dans la première direction (L1), et qui est situé au-dessus dudit module de broyage (2) et dudit module de centrifugation (3), ledit siège de liaison (42) étant disposé sur et pouvant coulisser le long dudit rail linéaire (41).

4. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 3, dans lequel
ledit pipetteur (43) est co-mobile avec ledit siège de liaison (42) dans la première direction (L1), et est mobile par rapport audit rail linéaire (41) dans une deuxième direction (L2) qui est transversale à ladite première direction (L1).

5. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans l'une quelconque des revendications précédentes, comprenant en outre un module consommable (5) disposé entre ledit module de broyage (2) et ledit module de centrifugation (3), situé sous ledit module de transport (4), et comportant un boîtier de pointe (51) qui est formé avec une pluralité de trous de réception de pointe (511) orientés vers le haut, et une pluralité de pointes de pipette (52) qui sont disposées dans lesdits trous de réception de pointe (511) et qui s'ajustent sur ledit pipetteur (43).

6. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 5, dans lequel
ledit boîtier de pointe (51) est en outre formé avec un espace d'élimination (512) espacé desdits trous de réception de pointe (511) et destiné à éliminer lesdites pointes de pipette (52).

7. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel
ledit broyeur (23) dudit module de broyage (2) comporte un rotor (231), un arbre d'entraînement (232) entraîné en rotation par ledit rotor (231), et une lame (233) disposée sur ledit arbre d'entraînement (232) et configurée pour broyer l'échantillon lorsque ledit arbre d'entraînement (232) est mis en rotation.

8. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel
ledit module de centrifugation (3) comporte en outre un moteur pas à pas (33) qui est relié audit siège de centrifugation (31) et qui est en communication électrique avec ladite unité de commande (8).

9. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans l'une quelconque des revendications précédentes, dans lequel
ledit mécanisme magnétique (34) est un aimant permanent et peut être actionné par ladite unité de commande (8) pour se déplacer entre une position d'attraction magnétique, où ledit mécanisme magnétique (34) est à proximité dudit au moins l'un desdits tubes de centrifugation (32) de manière à fournir la force d'attraction magnétique audit au moins l'un desdits tubes de centrifugation (32), et une position de non attraction magnétique, où ledit mécanisme magnétique (34) est distal par rapport audit au moins l'un desdits tubes de centrifugation (32) .

10. Système automatique d'isolement et de collecte de

cellules tel que revendiqué dans l'une quelconque des revendications 1 à 8, dans lequel
ledit mécanisme magnétique (34) est un électroaimant, et peut être actionné par ladite unité de commande (8) pour générer la force d'attraction magnétique.

11. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 5 ou 6, comprenant en outre
un logement (6) définissant un espace fermé (600) dans lequel ledit module de broyage (2), ledit module de transport (4), ledit module de centrifugation (3) et ledit module consommable (5) sont disposés.

12. Système automatique d'isolement et de collecte de cellules tel que revendiqué dans la revendication 11, comprenant en outre
une interface de fonctionnement (7) disposée sur ledit logement (6) et communiquant électriquement avec ladite unité de commande (8).

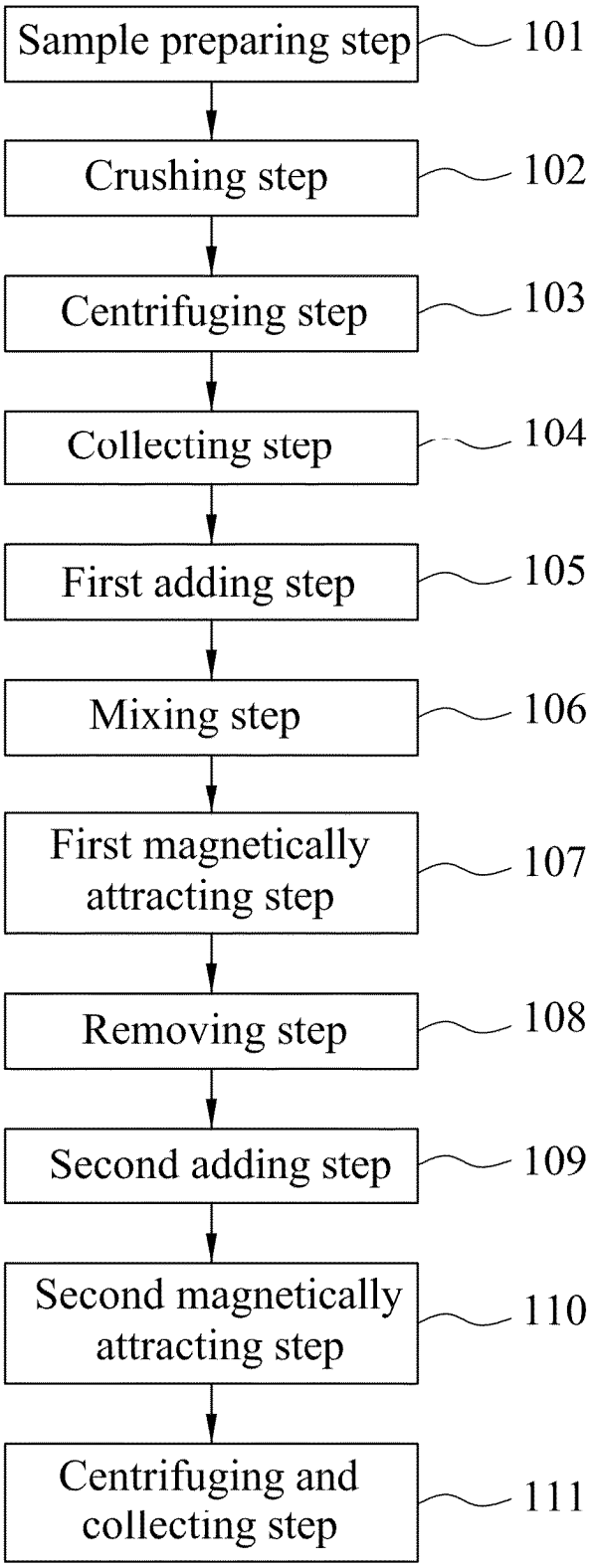
Sample preparing step
101
Crushing step
102
Centrifuging step
103
Collecting step
104
First adding step
105
Mixing step
106
First magnetically attracting step
107
Removing step
108
Second adding step
109
Second magnetically attracting step
110
Centrifuging and collecting step
111

FIG.1

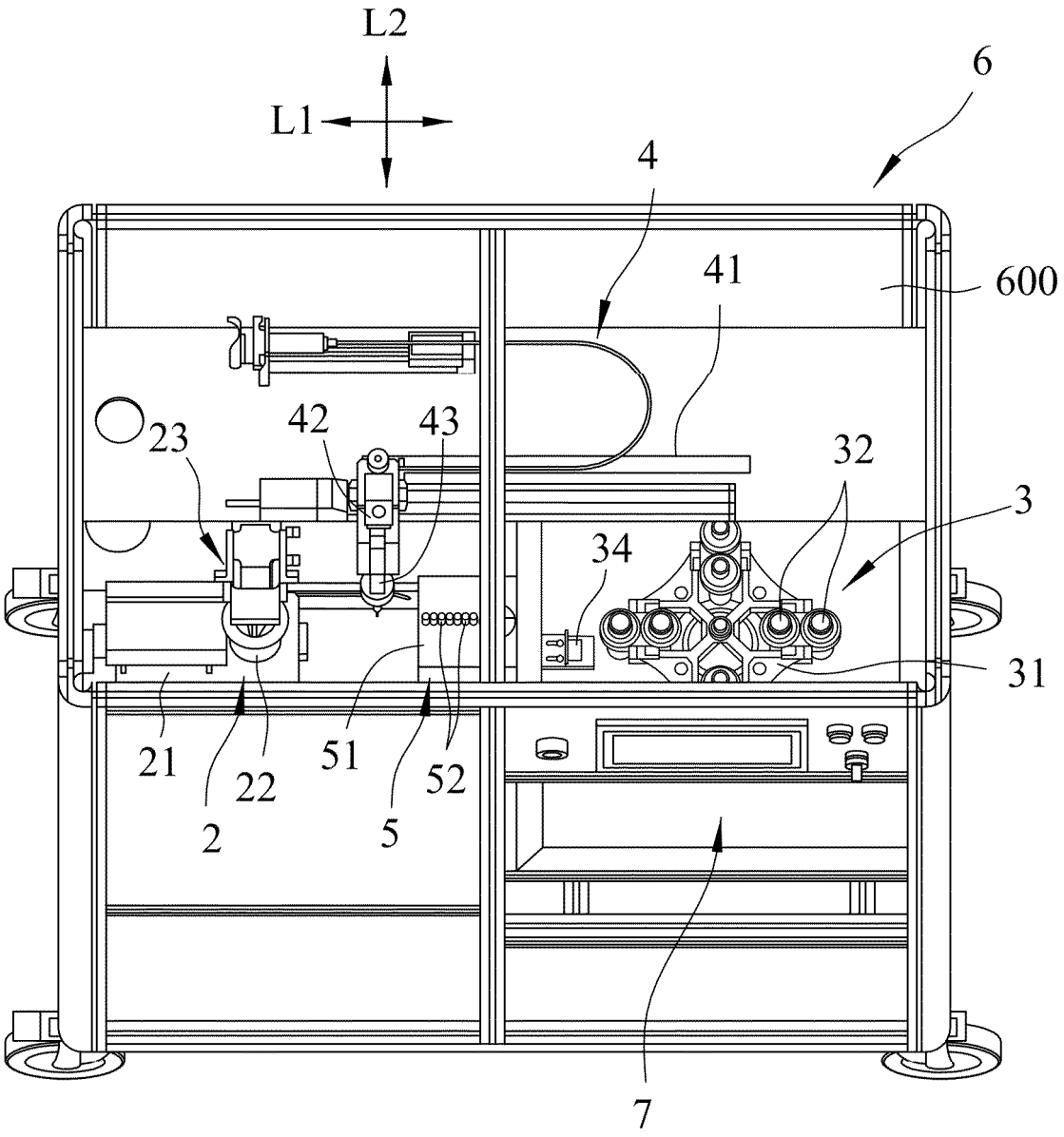

FIG.2

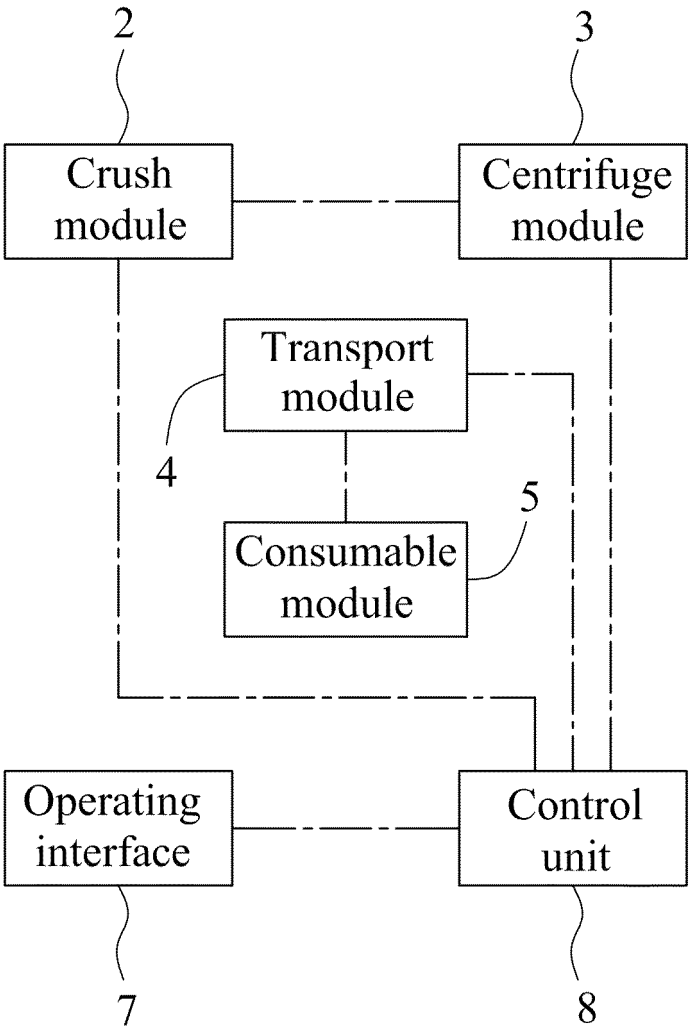
2
3
Crush module
Centrifuge module
Transport module
4
5
Consumable module
Operating interface
Control unit
7
8

FIG.3

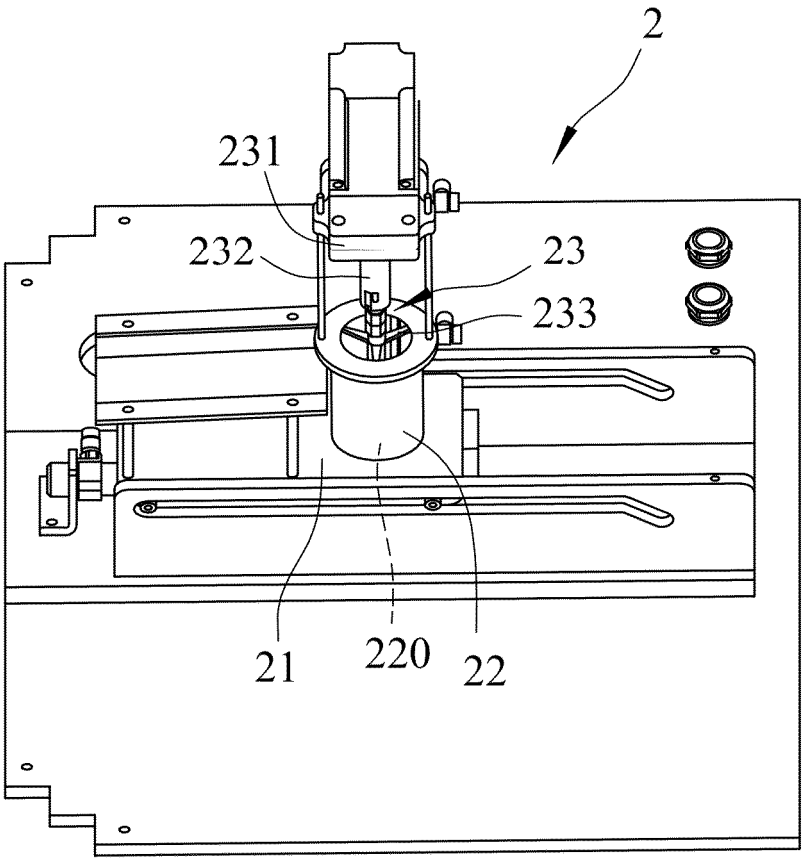

FIG.4

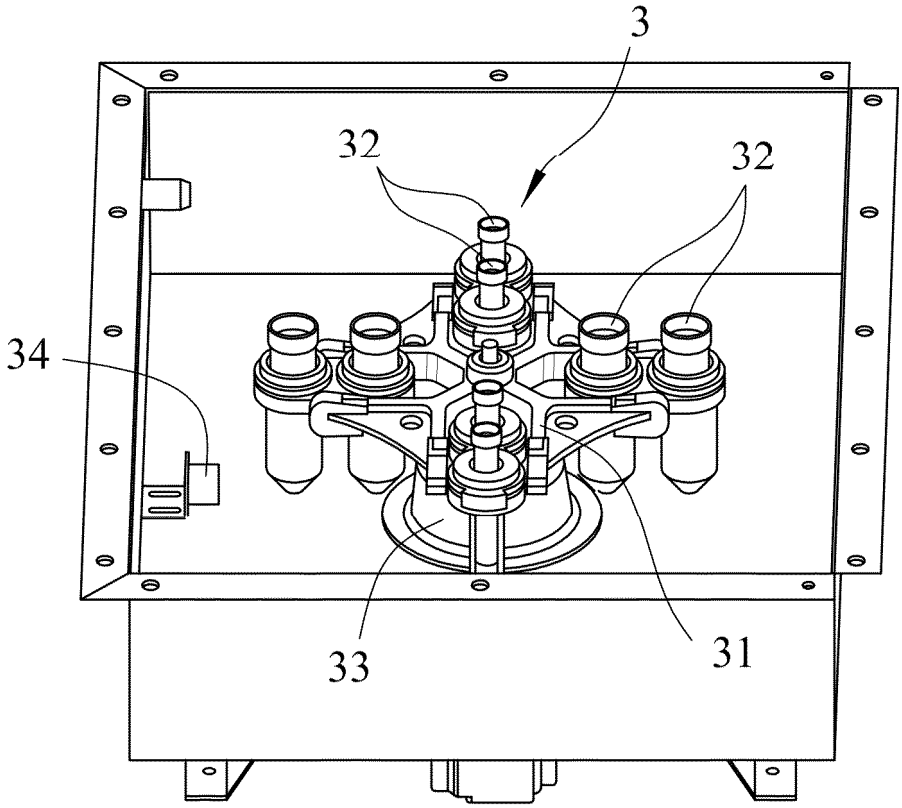

FIG.5

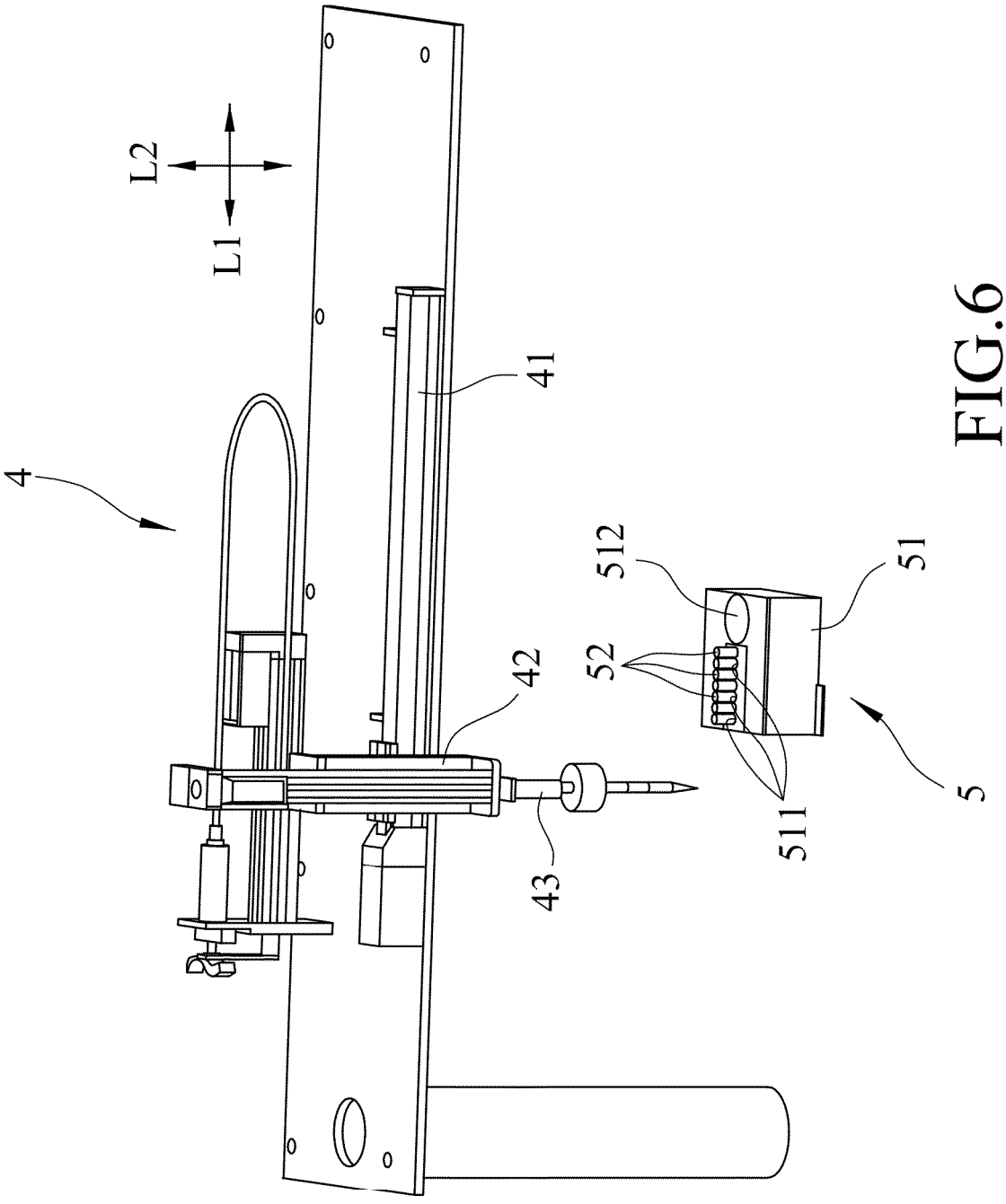

FIG.6

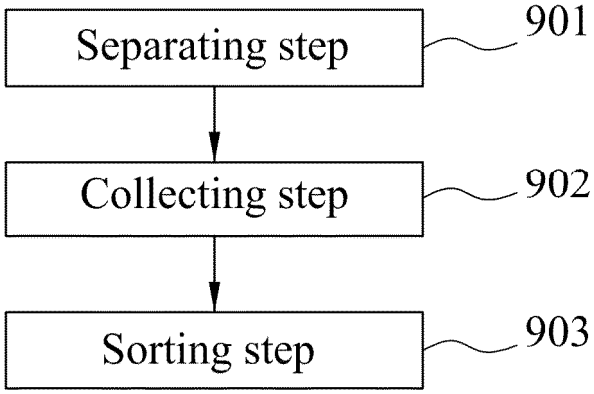

FIG.7

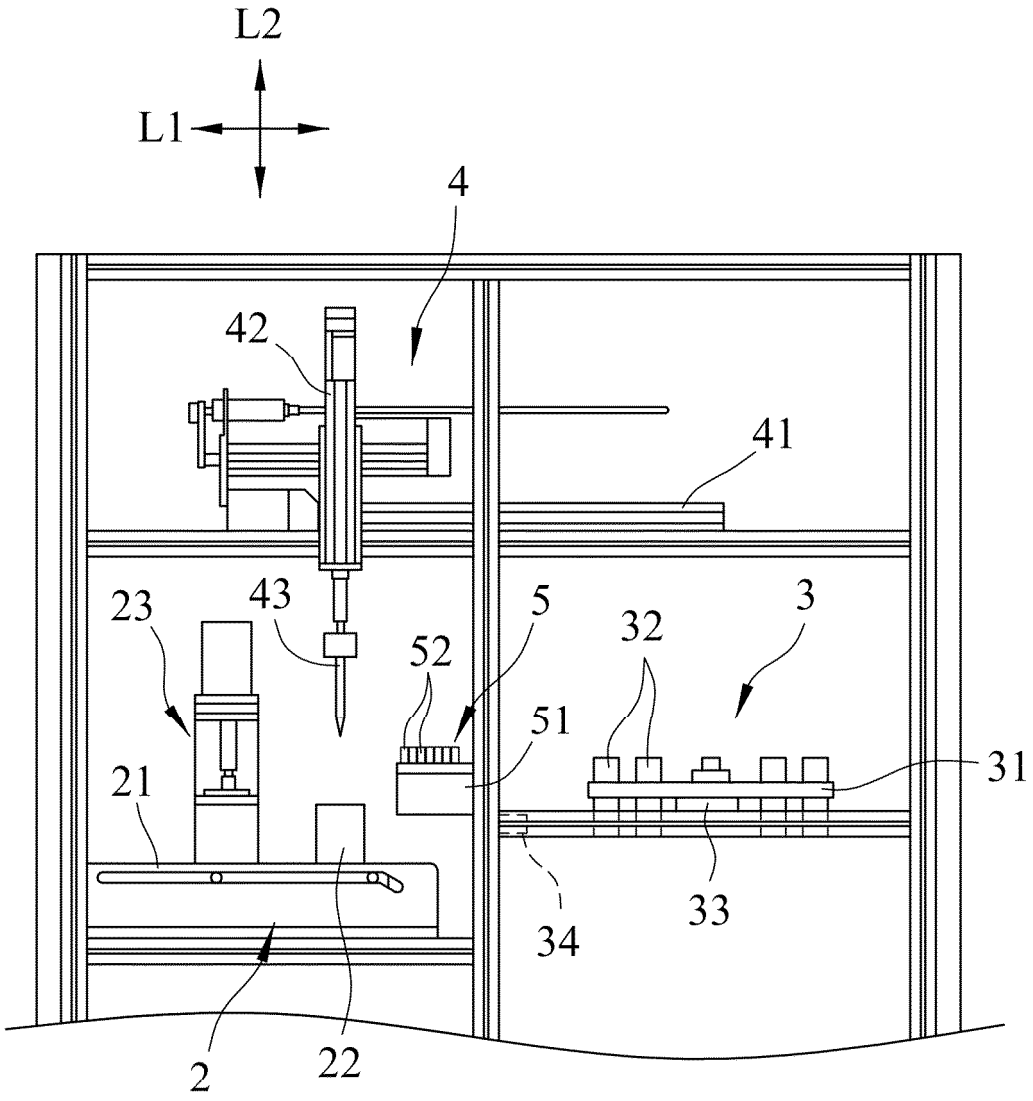

FIG.8

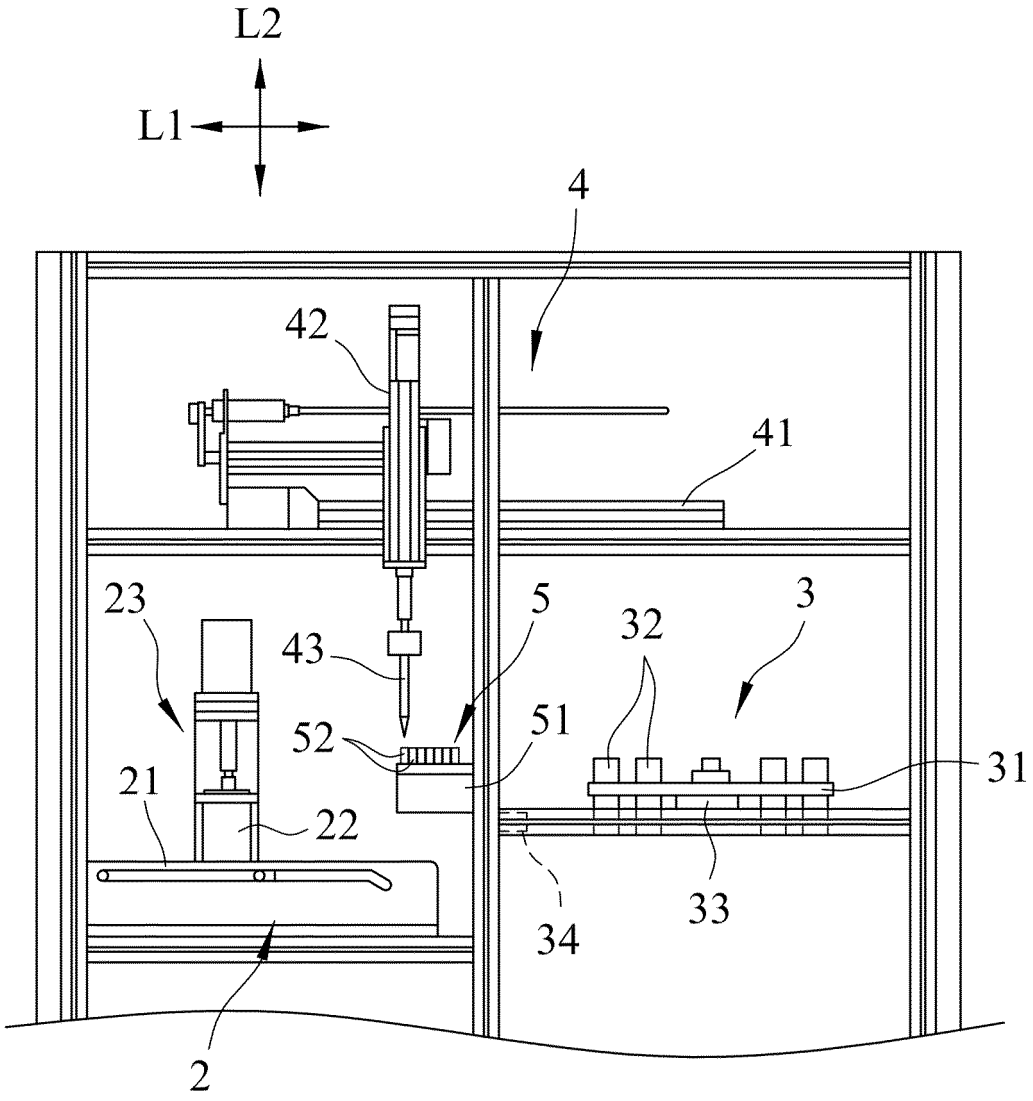

FIG.9

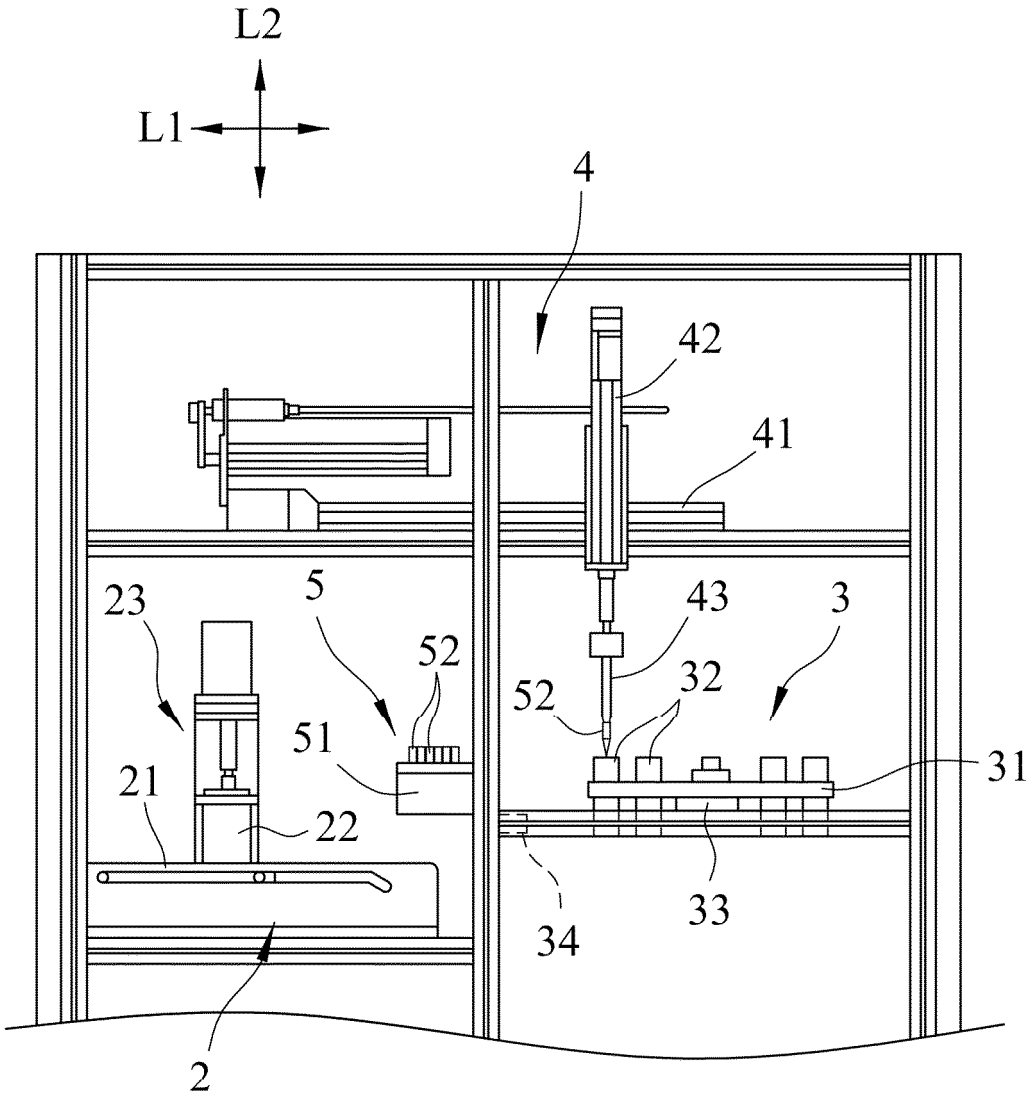

FIG.10

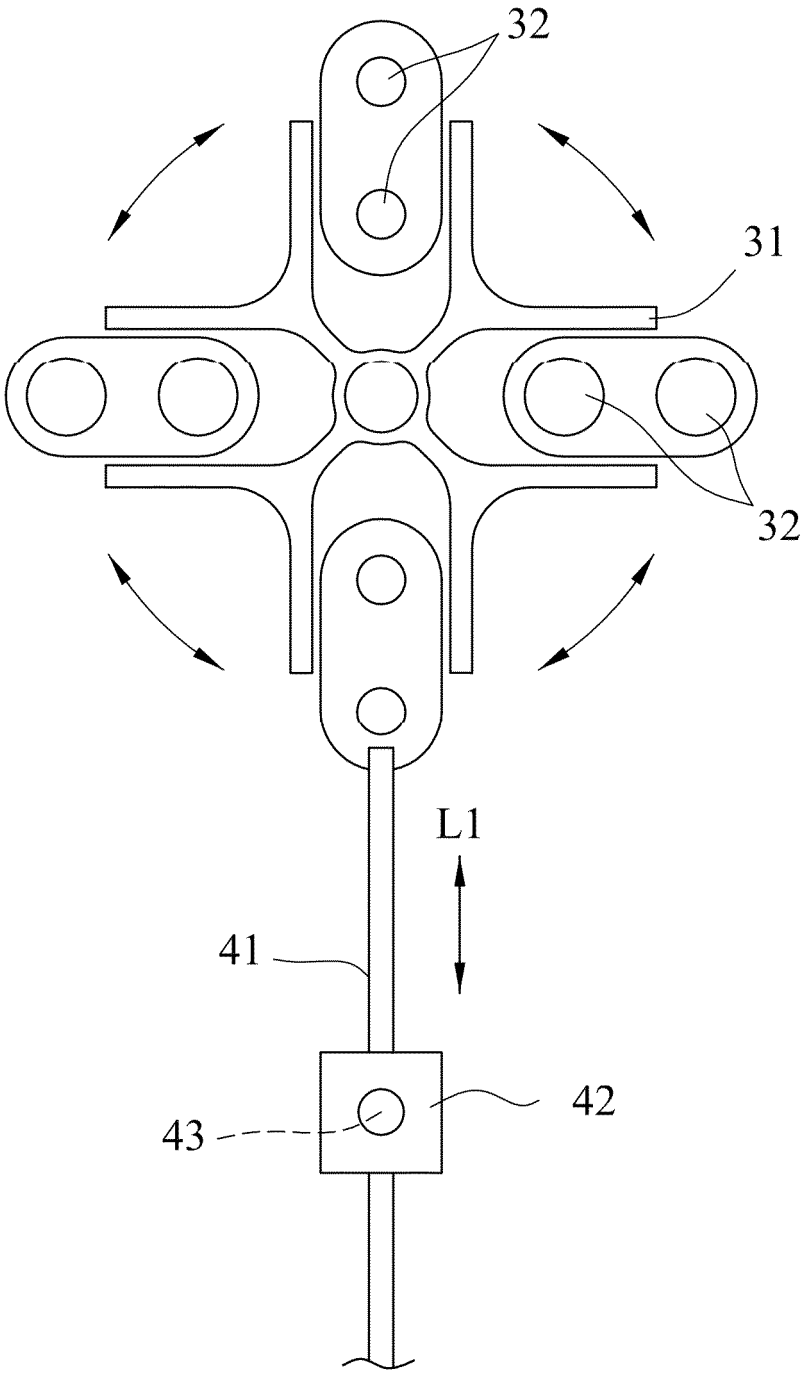

FIG.11

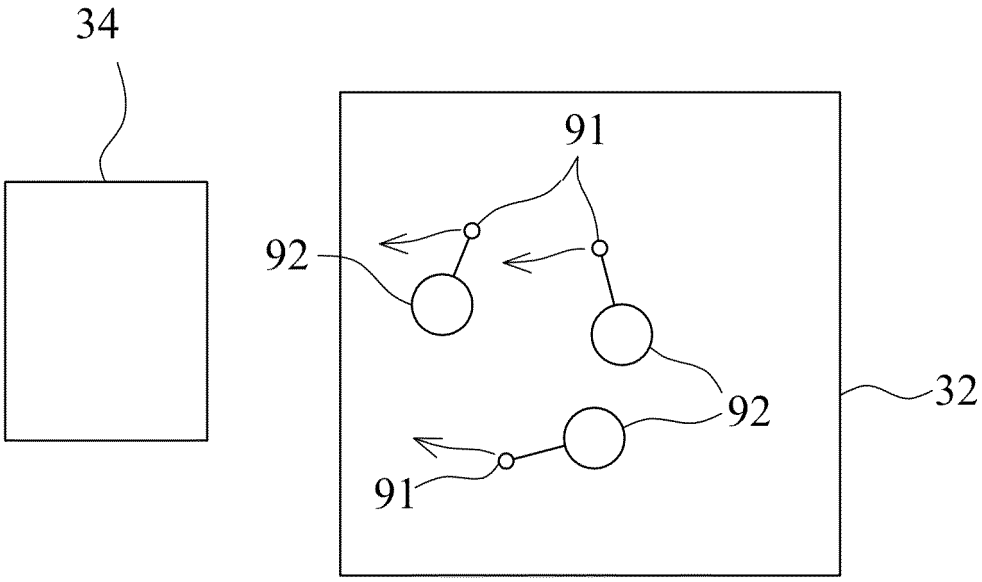

FIG.12

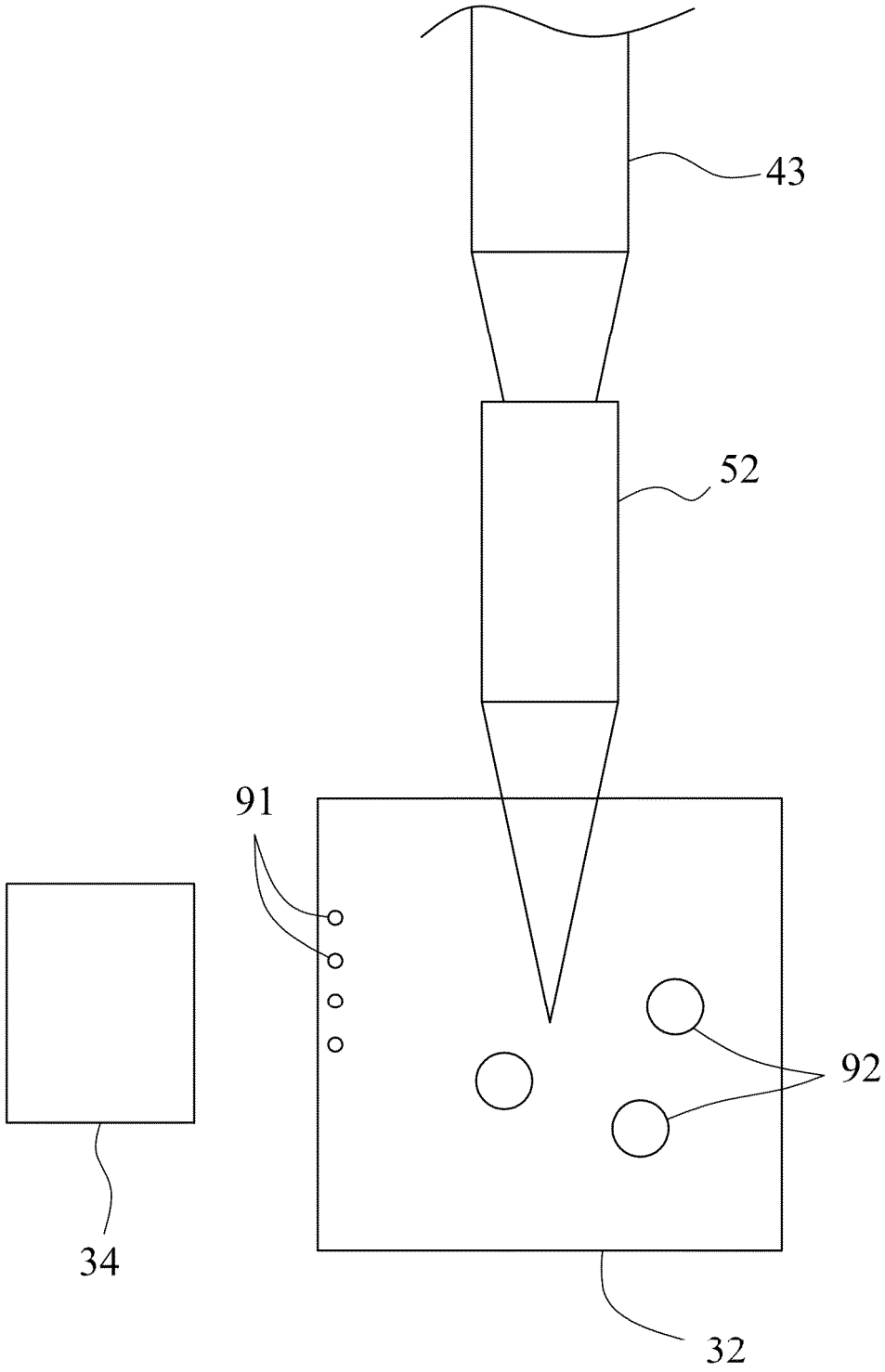

FIG.13

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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