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(54) **Title:** LARVAE GRAFTING DEVICE AID METHOD

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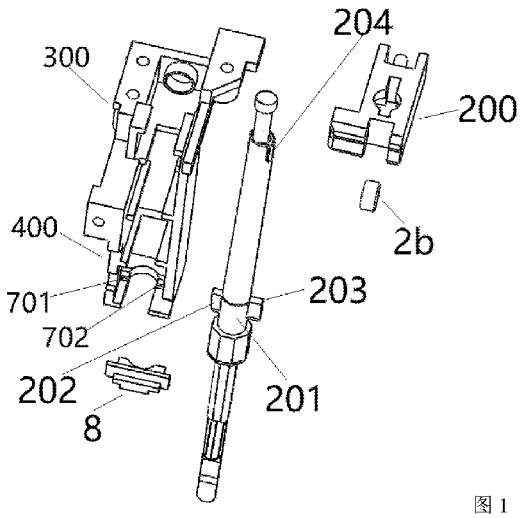

图 1

(57) **Abstract:** A larvae grafting device, comprising a supporting point structure for supporting a support point (201) on a larvae grafting needle (20), and a motion module structure for driving a movable point (202) on the larvae grafting needle (20) to move, wherein the support point (201) on the larvae grafting needle (20) can rotate around the supporting point structure, such that the larvae grafting needle can obliquely enter a cell, thereby preventing bee larvae from being grafted straight up and down in order to improve the larvae grafting success rate. A larvae grafting method uses the larvae grafting device, comprising the supporting point structure for supporting the support point (201) on the larvae grafting needle (20), the movable point (202) on the larvae grafting needle (20) moves to drive the support point (201) to move around the supporting point structure, such that the larvae grafting needle can obliquely enter a honeycomb, and a larvae grafting element is bent forwards during movement, which can effectively graft larvae and prevent the failure of larvae grafting due to the backward bending of the larvae grafting element when same comed into contact with the inner wall of the honeycomb.

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— 包括国际检索报告(条约第21条(3))。

(57) 摘要: 一种移虫装置，包括用于支撑移虫针（20）上的支点（201）的支撑点结构和用于带动移虫针（20）上动点（202）运动的运动模块结构；移虫针（20）上的支点（201）能够围绕支撑点结构转动，如此设置使得移虫针能倾斜着进入巢房，避免直上直下移取蜂虫，提高移虫成功率；一种移虫方法，使用该种移虫装置，包括用于支撑移虫针（20）上的支点（201）的支撑点结构，移虫针（20）上动点（202）运动带动支点（201）围绕支撑结构做运动，如此设置使移虫针倾斜着向下进入巢房，移动过程中移虫元件向前弯曲，可以有效移取蜂虫，避免移虫元件接触巢房内壁时向后弯曲导致移虫失败。

LARVAE GRAFTING DEVICE AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[1] This application claims the priorities to the Chinese Applications No. 2020105341830 filed on June 12, 2020 and No. 2020105341826 filed on June 12, 2020, the entire contents of which are incorporated by reference as a part of the present invention.

TECHNICAL FIELD

[2] The present invention specifically relates to a larvae grafting method, more particularly to a bee larvae moving or transferring device or transferring method.

BACKGROUND OF THE INVENTION

[3] Bees lay eggs in honeycomb cells. However, the size of the cells is so small that if the bee larvae are allowed to grow in the cells all the time, they will not grow into queen bees, but only into worker bees, and there will be no royal jelly produced. To breed queen bees and produce royal jelly, it is required to transfer bee larvae into culture cups or culture cavities on cell bars with larger space. This, on the one hand, gives the larvae enough space to grow, and on the other hand, may induce the worker bees to breed the larvae as queen bees, which may improve the output of royal jelly. The process of transferring bee larvae from cells into cell bars is called larvae grafting in the industry.

[4] After the eggs are hatched into larvae in the egg combs, it is required to scoop the larvae together with a small amount of royal jelly into the culture cups of the cell bar. When the worker bees in the colony see the larvae in the culture cups, they will secrete the royal jelly to feed the larvae until the larvae grow up to become queen bees.

[5] In traditional bee breeding enterprises, the larvae are grafted manually, which, however, is inefficient and wasteful of labor. This is mainly because the bee larvae are so small that they are almost invisible to the naked eye. Moreover, the cells are small in size, and not every cell has larvae. In addition, the cell has a certain depth, and manual larvae grafting may also hurt or even kill the larvae, resulting in low efficiency and even lower survival rate.

[6] Therefore, it is necessary to provide a device and method that can automatically graft larvae.

SUMMARY OF THE INVENTION

[7] In view of the above, in order to overcome the defects in the prior art, the present invention provides a larvae grafting method and device. The device can improve the larvae grafting efficiency and the survival rate of larvae, and realizes automatic larvae grafting.

[8] A first aspect of the present invention provides a larvae grafting mechanism or device, including a mounting mechanism configured to receive a larvae grafting needle movable around a support point on the mechanism.

[9] Alternatively, provided is a larvae grafting device, including a supporting point structure for supporting a support point on a larvae grafting needle, and a motion module structure for driving a movable point on the larvae grafting needle to move. In some implementations, the support point on the larvae grafting needle is rotatable around the supporting point structure.

[10] In some implementations, the mounting mechanism includes a first mounting mechanism. The first mounting mechanism includes a support point structure or a supporting point structure. The support point structure or the supporting point mechanism is used for fitting with the support point on the larvae grafting needle, such that the support point on the larvae grafting needle is rotatable around the support point structure or the supporting point structure.

[11] In some implementations, the supporting point structure on the first mounting mechanism includes a groove, a notch or a pin. Correspondingly, the support point on the larvae grafting needle is a protrusion or wing structure fitted with the groove, or a hole, etc.

[12] In some implementations, the larvae grafting mechanism further includes a motion module, and the motion module is capable of driving the movable point on the larvae grafting needle to move.

[13] In some implementations, alternatively, the device further includes a motion module, and the motion module is capable of driving the movable point on the larvae grafting needle to move. In some implementations, the movement of the movable point drives the rotation of the support point on the needle around a supporting point or the supporting point structure. The rotation is, relative to a vertical direction, clockwise or counterclockwise rotation, or reciprocating rotation between clockwise and counterclockwise by any angle.

[14] In some implementations, the mounting mechanism includes a second mounting mechanism used for mounting the motion module. In some implementations, the second mounting mechanism is slidably connected to the motion module. The movement of the motion module drives the movement of the movable point on the needle. In some implementations, the motion module makes a lateral movement relative to a longitudinal direction of the needle.

[15] With this movement of the movable point that drives the movement of the support point, it is finally expected that the larvae grafting element can enter the honeycomb cell at an angle with the cell

rather than vertically, and in particular, a head of the larvae grafting element forms an angle, for example, an acute angle, with the wall of the cell, so that it is expected that the larvae grafting needle can enter obliquely rather than vertically.

[16] In some implementations, the movement of the motion module may be implemented by a motor that is controlled by a computer program to push the motion module to move. Of course, the movement of the motion module may also be implemented by mechanical actions.

[17] It can be understood that when the larvae grafting element enters the honeycomb cell, it is expected to enter the cell at an angle with the cell rather than vertically. Generally, the cell has a wall and a bottom, and the larvae are typically located at the bottom of the cell. Therefore, it is expected that when the larvae grafting element enters the cell, the head of the larvae grafting element can form an angle, for example, an acute angle, with the wall of the cell, so that it is expected that the larvae grafting needle can enter obliquely rather than vertically. As a result, with the Y-axis as the ordinate and the X-axis as the abscissa, the larvae grafting needle may be located in quadrant I and quadrant III when it is inclined. At this time, the movable point may be located in quadrant I, and the larvae grafting element is located in quadrant III (assuming that the support point is the intersection between the X-axis and the Y-axis). Alternatively, the larvae grafting needle may also be located in quadrant II and quadrant IV. At this time, the movable point may be located in quadrant II, and the larvae grafting element is located in quadrant IV. The cell is generally vertical, and a central axis of the cell is parallel to the Y-axis or the Y-axis coincides with the central axis of the cell.

[18] In some implementations, the device includes an elastic element, and the elastic element is arranged on the motion module. For example, one end is arranged on the motion module, and the other end is arranged on the device. In this way, even in a case that the movement of the motion module is pushed by the motor, although it is required to overcome the elastic resistance to push the module to move, once the motor loses thrust or the thrust is removed, the motion module can be pushed to move reversely by the aid of the restoring force of the elastic element.

[19] Other functions of the elastic element are more obvious in the following implementations. In some implementations, the larvae grafting mechanism or device further includes a guide mechanism with a guide surface, and the guide surface is configured to guide the larvae grafting needle to move up and down and to adjust a movement locus of the movable point on the larvae grafting needle. In some implementations, the guide surface contacts the motion module and guides the movement of the motion module to adjust the movement locus of the movable point. In some implementations, the guide surface includes surfaces with different lateral heights. The lateral height here means that the guide surface, relative to the vertical direction, has different distances from the point in the vertical direction, like an undulating mountain. By adjusting the lateral height, the lateral movement distance of the motion module

can be adjusted. Relative to the vertical direction, the motion module may move leftwards or rightwards. This lateral movement distance may be adjusted or changed along with the movement of the motion module on the undulating guide surface.

[20] In some implementations, the device includes an elastic element, and the elastic element is arranged on the motion module. For example, one end is arranged on the motion module, and the other end is arranged on the device. In this way, when the motion module moves on the undulating guide surface, the movement locus of the motion module is controlled under the action of elasticity, compression or tension of the elastic element. In some implementations, in the process of driving, the motion module, the movable point to move, when the needle or the larvae grafting element is in a vertical position, the elastic element is compressed. When the elastic element is in a natural state, the motion module is away from a vertical direction (rightwards or leftwards relative to the lateral direction), and the larvae grafting element is inclined leftwards or rightwards. Therefore, under the fit between the elastic element and the motion module, the motion module can drive the movable point to move away from the Y-axis or close to the Y-axis, or to move leftwards close to the Y-axis or rightwards away from the Y-axis, so that the support point can rotate. Thereby, the end with the larvae grafting element is inclined, so that an included angle can be formed between the elastic element and the wall of the cell.

[21] The guide surface functions to limit the movement locus of the motion module by contacting the motion module under the mechanical actions. The movement locus of the motion module is mainly the distance of the lateral movement. It can be understood that the movement distance of the motion module in the X-axis direction relative to the Y-axis is adjusted to control the movement distance of the movable point in the X-axis direction relative to the Y-axis, so that the angle of rotation of the support point on the larvae grafting needle is finally controlled, thereby controlling the angle of the larvae grafting element. Usually, the larvae grafting needle is vertical, and of course it is not excluded that the larvae grafting needle is bent, but in any case, the movement of the movable point drives the movement of the support point so as to adjust the angle of the larvae grafting element with the wall of the cell. The larvae grafting element should form an angle with the wall of the cell, rather than being parallel to the wall of the cell.

[22] In some implementations, the guide surface includes a first guide surface, a second guide surface and a third guide surface. A lateral height of the first guide surface is greater than that of the second guide surface, and the lateral height of the second guide surface is greater than that of the third guide surface. In some implementations, when the motion module is in contact with the first guide surface of the guide surface, the motion module makes the movable point on the needle basically in the vertical direction, and at this time, the elastic element is compressed. When the motion module is on the second guide surface, a resilient force of the elastic element pushes the motion module to move away from the vertical direction so as to drive the movable point to be away from the vertical direction (leftwards or rightwards), so that

the movement of the movable point drives the rotation of the support point, and thereby, the end with the larvae grafting element is away from the vertical direction, for example, rightwards or leftwards. Like a seesaw, when the movable point moves leftwards, the end with the larvae grafting element moves rightwards; and when the movable point moves rightwards, the end with the larvae grafting element moves leftwards.

[23] The movement of the motion module along the guide surface may be a downward movement, or an upward movement, or an up-and-down reciprocating movement. This movement may be the up-and-down movement of the entire mechanism, for example, the up-and-down movement of the mounting structure driven by the motor. If the motion module is located on the mounting mechanism and the guide surface is relatively fixed, then the up-and-down sliding of the motion module on the guide surface can be realized, and the left-and-right movement and movement distance of the motion module can be adjusted, so that the left-and-right movement and movement distance of the movable point can be adjusted, thereby realizing the movement distance of the larvae grafting element in the opposite direction.

[24] In some implementations, the first surface may include a transition surface. The second surface may include a curved surface or/and an inclined surface.

[25] The third surface may include an additional inclined surface or curved surface. However, the first surface, the second surface and the third surface have different lateral distances.

[26] In some implementations, the guide mechanism is provided with a first mounting part used to be fixed to the device. In terms of the mounting mechanism of the larvae grafting needle, the mounting mechanism of the larvae grafting needle may make an up-and-down reciprocating movement relative to the fixed guide mechanism.

[27] In some implementations, the motion module is provided with a mounting hole used for mounting the movable point of the larvae grafting needle, and the larvae grafting needle can swing along with the movement of the motion module. In some implementations, the motion module includes a rolling element used for contacting the guide surface and making a rolling movement on the guide surface.

[28] In some implementations, the device further includes a control module. This module may be a motor or a mechanical mechanism controlled by the motor, that applies an instantaneous acting force to the motion module to complete the larvae digging action of the larvae grafting element. The larvae grafting element connected to the lower end of the support point of the larvae grafting needle is slightly bent in a natural state, and is typically made of a plastic material. The "slightly bent" means that relative to the honeycomb cell containing the larvae, when the larvae grafting element enters the cell, it is expected that the tip of the larvae grafting element is bent slightly towards the inside of the honeycomb cell. In this way, as the larvae grafting element continues to move downwards, when the flexible larvae grafting element comes into contact with the rigid honeycomb cell, the flexible larvae grafting element

becomes bent at the bottom of the cell, thereby scooping up and digging up the larvae at the bottom and making the larvae at the bottom attached to the larvae grafting element. However, this only happens in an ideal case. At this time, in order to improve the larvae grafting efficiency, it is expected that the larvae grafting element can quickly move down into the honeycomb cell and scoop up the larvae without hurting the larvae. The bee larvae are so small that they are almost invisible to the naked eye. Moreover, they are located at the bottom, and may be stretched or curled up. Usually, the larvae are in a small amount of honey or syrup. The larvae are so soft that they are easily hurt if they are moved by the mechanical mechanism and power without any protection. Therefore, through repeated experiments by the inventors, it is expected that: first, when the flexible larvae grafting element (or an elastic material, for example, TPEE) enters the cell, the larvae grafting element forms an included angle with the wall of the honeycomb cell; and then, the larvae grafting element moves to the bottom along the wall, so that the larvae grafting element gradually becomes bent under the acting force of the wall while clinging closely to the bottom of the cell. This puts forward a high requirement for the material of the flexible larvae grafting element. If the larvae grafting element is made of a common flexible material, when the larvae grafting element that has been stretched and bent repeatedly enters the cell, it may still be bent, and thus can hardly scoop up the larvae. Moreover, the cell has a small diameter of about 0.5-0.8 cm, so the bent element entering the cell may press directly against the larvae, thus making them die. In addition, after the larvae grafting element is stretched and bent repeatedly, it becomes bent to scoop up the larvae. When the larvae are to be released from the larvae grafting element, a sliding block is used to push the larvae away from the element. After the larvae grafting element releases the larvae, it is generally expected that the element is stretched or straight in the natural state, but this is not the case. Sometimes, the element is bent backwards. This element that is bent backwards can hardly form an angle of inclination when entering the honeycomb cell. In summary, these disadvantages of the element need to be further overcome, so as to prolong the service life of the element, improve the larvae grafting efficiency and reduce the death rate.

[29] As a result, it is expected that the larvae grafting element is stretched or straight when or before the larvae grafting element comes into contact with the wall of the honeycomb cell, and after that, the larvae grafting element is bent along the bottom of the cell. Therefore, in some implementations, when or before the elastic larvae grafting element enters the honeycomb cell, the larvae grafting element should be stretched or straight. In order to achieve this, a method is to make the sliding block for pushing larvae on the needle be in a "pushed out" state, so that the slightly bent larvae grafting element becomes stretched. Thereby, the larvae grafting element can form an angle with the wall of the honeycomb cell.

[30] In addition, the process of the larvae grafting element contacting the wall of the cell and becoming bent at the bottom to scoop up the larvae is completed within only about 0.1-0.3 second. Therefore, at this time, while the larvae grafting element is inclined (in the process of driving, by the

motion module, the movable point to move), an instantaneous opposite acting force is applied to the motion module, so that the inclined larvae grafting element can quickly move in the opposite direction, thereby completing the "scooping" action. In this way, the larvae can be "scooped" up effectively. For example, while moving quickly downward along the guide surface, the motion module drives the movable point to quickly move away from the Y-axis, for example, quickly move rightwards away from the Y-axis (for example, by a lateral distance of 0.5 cm). At this time, the larvae grafting element quickly moves downwards and quickly moves leftwards away from the Y-axis. At this time, the element forms an angle (for example, 30 degrees) with the wall of the cell. When the needle continues to move downwards, the element becomes bent and runs through, for example, syrup or honey, at the bottom of the cell, so as to scoop up the larvae by utilizing the viscosity of the syrup. At this time, if an opposite acting force, for example, a force towards the Y-axis, is quickly applied to the motion module within a very short time, just like a knock on the motion module, this instantaneous opposite acting force drives the motion module to move quickly. At this time, the element quickly moves towards the opposite direction, for example, towards the Y-axis, just like shaking, so that the "scooping" action is completed. The knock on the motion module may be completed by a rotor of the motor that is in direct contact with the motion module. Of course, the motor may be arranged near the motion module and move downward together with the motion module. Of course, the motor may also be arranged on the guide element. When the motion module moves to a proper position on the guide element, the rotor of the motor directly contacts the motion module to apply an opposite force to the module, for example, a force towards the Y-axis.

[31] A second aspect of the present invention provides a larvae grafting method, including:

[32] An elastic larvae grafting element is allowed to form an acute angle with a wall of a cell, and the elastic larvae grafting element is allowed to be straight. In some implementations, the elastic element is allowed to be straight by a sliding push block on a needle, for example, when the sliding push block retracts, the elastic element may be bent, and when the sliding push block is pushed to a tail end of the elastic element, the elastic element is pushed straight by the push block.

[33] In some implementations, the elastic larvae grafting element is allowed to contact the wall of the cell and form an acute angle with the wall of the cell. In this way, as the element continues to move downwards, the sliding push block is retracted, and the elastic element is bent, so that the larvae at the bottom of the cell are scooped up.

[34] In some implementations, the elastic element being bent means that the elastic element contacts the wall of the cell and moves downward such that the elastic element is made bent along the wall of the cell and the bottom of the cell. Usually, the bottom and wall of the cell are rigid, so that the elastic element can become bent when moving inside the cell. The "elastic" here can be understood as a flexible material. The larvae grafting element may be described as elastic, or flexible, or both elastic and flexible.

[35] Therefore, a third aspect of the present invention provides a larvae grafting method, including the following steps:

[36] Step 1: A larvae grafting needle is allowed to be in a second position. At this time, the larvae grafting element is in contact with an inner wall of a cell. The second position means: a movable point of the larvae grafting needle is inclined forwards, the larvae grafting element is inclined backwards, the larvae grafting element is inclined backwards at a certain angle relative to a vertical direction, and the larvae grafting element is straight instead of being bent.

[37] Step 2: The larvae grafting needle is allowed to be in a third position, thereby completing the larvae grafting operation in the process of changing the larvae grafting needle from the second position to the third position. The third position means: the movable point of the larvae grafting needle is inclined backwards, the larvae grafting element is inclined forwards, the larvae grafting element is inclined forwards at a certain angle relative to the vertical direction, and bee larvae or larvae are carried on or attached to the larvae grafting element.

[38] In some implementations, in steps (1) to (2), the certain angle is 5°-40°.

[39] In some implementations, in step (2), in the process of changing the larvae grafting needle from the second position to the third position, the larvae grafting element is bent, the movable point on the larvae grafting needle swings backwards, the larvae grafting element moves forwards, and the larvae grafting element stirs royal jelly containing the bee larvae, such that the royal jelly containing the bee larvae is attached to the larvae grafting element.

[40] In some implementations, in step (2), after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle is moved upwards and separated from the cell.

[41] In some implementations, in step (2), after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle is moved upwards and backwards and separated from the cell.

[42] In some implementations, after the larvae grafting needle is separated from the cell and located in the third position, the larvae grafting needle is moved forwards.

[43] In some implementations, after the larvae grafting needle is separated from the cell and located in the third position, the movable point on the larvae grafting needle is moved forwards, and at the same time, the larvae grafting needle is moved downwards to a target position.

[44] In some implementations, after the larvae grafting needle is separated from the cell and located in the third position, the movable point on the larvae grafting needle is moved forwards, and at the same time, the larvae grafting needle is moved downwards to a target position such that the larvae grafting needle enters a culture cup, and the bee larvae are pushed into the culture cup.

[45] In some implementations, before the larvae grafting needle comes into contact with the inner wall of the cell, the larvae grafting needle is located in the second position, or a first position, or any position in the process of changing from the first position to the second position.

[46] In some implementations, in the process of changing the larvae grafting needle from the first position to the second position, the larvae grafting needle is moved downwards until the larvae grafting element contacts the inner wall of the cell.

[47] A fourth aspect of the present invention provides a detection device for larvae grafting, including a sliding bracket, a collecting element for collecting information of bee larvae in a cell, and a detecting element for detecting the bee larvae in the cell. The collecting element is mounted on the sliding bracket. The sliding bracket includes a sliding member. The sliding member can slide along a slideway, and the collecting element can move along with the sliding member.

[48] In some implementations, the detection device for larvae grafting further includes a locating element for identifying a position of the larvae grafting needle or the cell.

[49] In some implementations, the sliding bracket includes a first mounting arm and a second mounting arm, and the collecting element is mounted on the first mounting arm.

[50] In some implementations, the locating element is mounted on the mounting arm and/or the first mounting arm.

[51] In some implementations, the first mounting arm is arranged opposite to the second mounting arm.

[52] In some implementations, the collecting element is an image pickup device configured to take photos of the inside of the cell.

[53] In some implementations, the locating element is a position sensor.

[54] In some implementations, the detection device further includes a clamping structure. The clamping structure includes a clamping part.

[55] In some implementations, the clamping part is a curved clamping part.

[56] In some implementations, the first mounting arm is connected with a clamping member.

[57] The present invention has the following beneficial effects:

[58] (1) According to the larvae grafting method of the present invention, the larvae grafting needle can enter the cell obliquely and downwards. Moreover, when the larvae grafting needle contacts the inner wall of the cell, the larvae grafting element is straight instead of being bent. During the upward movement of the push tongue, the larvae grafting element is bent forwards, which can effectively graft the bee larvae and prevent the failure of larvae grafting due to the backward bending of the larvae grafting element when the larvae grafting device comes into contact with the inner wall of the cell.

[59] (2) By simulating the manual larvae grafting technique, the larvae grafting method of the present invention can graft the bee larvae together with a small amount of the royal jelly and then place them into the culture cup. During the larvae grafting, the larvae grafting element is bent into a certain arc, and the larvae grafting element clings to the inner wall of the cell, which can avoid damaging the bee larvae and the larvae grafting element. Thereby, the larvae grafting method of the present invention has the advantages of high speed, high accuracy and high efficiency.

[60] (3) By using the larvae grafting method of the present invention, the larvae grafting success rate is up to 95% or above, and the final larvae grafting survival rate is also higher. Compared with the traditional method in which the larvae are grafted straight up and down, the larvae grafting method of the present invention can protect the larvae grafting needle, prolong the service life of the larvae grafting needle and avoid hurting the bee larvae.

[61] (4) An end of the motion module of the present invention is connected with a roller, and the roller can roll along the contact surface. Relatively speaking, the roller produces smaller friction with the contact surface, and will not wear the contact surface or damage other components. Moreover, under the same conditions, the roller can roll faster. The position of the larvae grafting needle may be adjusted by allowing the roller on the motion module to roll along the corresponding contact surface (for example, the guide surface).

[62] (5) In the present invention, the larvae grafting needle is mounted in the motion module, and the motion module can slide in the sliding chute. The motion module and the sliding chute are fitted with each other, so that the angle of forward or backward inclination (the amplitude of forward and backward swing) of the larvae grafting needle can be adjusted. Thereby, the larvae grafting needle can obliquely enter the cell, thereby preventing the bee larvae from being grafted straight up and down, leading to low larvae grafting success rate. Some bee breeding enterprises usually use the traditional larvae grafting method to automatically graft larvae with the larvae grafting needle, in which the larvae grafting needle enters the cell straight up and down to dig up the larvae (that is, the larvae grafting needle vertically enters the cell to graft the larvae, and then vertically leaves the cell). However, this method is low in success rate and may easily hurt the larvae, leading to a low larvae grafting survival rate. The traditional larvae grafting method may also easily damage the larvae grafting needle, which puts forward a high requirement for the quality of the larvae grafting needle. Sometimes, when the larvae grafting needle vertically enters the cell, the larvae grafting element of the larvae grafting needle may be bent backwards, which leads to failure of effective larvae grafting and damage to the larvae grafting element.

BRIEF DESCRIPTION OF DRAWINGS

[63] Figure 1 is a schematic structural view of a first mounting mechanism and a second mounting mechanism according to the present invention.

[64] Figure 2 a schematic structural side view of the first mounting mechanism according to the present invention.

[65] In Figure 3, (1) is a front view of the first mounting mechanism, and (2) is a schematic structural side view of the first mounting mechanism (the supporting point structure is shown).

[66] In Figure 4, (1) is a front view of the second mounting mechanism, and (2) is a schematic structural side view of the second mounting mechanism.

[67] In Figure 5, (1) is a schematic structural view of a motion module in a specific implementation, (2) is a schematic structural view of a motion module in another specific implementation, and (3) is a schematic structural view of a motion module in other specific implementations.

[68] In Figure 6, (1) is a schematic structural view of a larvae grafting needle and the motion module combined together, and (2) is a schematic structural view of the motion module and the second mounting mechanism combined together.

[69] In Figure 7, (1) is a schematic structural view of the second mounting mechanism and the first mounting mechanism combined together, and (2) is a schematic structural view of a stop block.

[70] In Figure 8, (1) is a schematic structural view of the second mounting mechanism and the first mounting mechanism combined together, (2) is a schematic structural view of the larvae grafting needle and the first mounting mechanism combined together, and (3) is an exploded view of the larvae grafting needle.

[71] Figure 9 is a schematic structural view of the motion module and the second mounting mechanism combined together.

[72] Figure 10 is a schematic diagram showing a process of the larvae grafting needle swinging forwards or backwards.

[73] In Figure 11, (1) is a schematic structural view of the larvae grafting needle being inclined backwards when an interference block presses a bump (the height adjustment mechanism is shown); and (2) is a schematic view of the back of the height adjustment mechanism (in order to show the fit between a first gear and a first rack, part of a support frame is omitted).

[74] In Figure 12, (1) is a schematic structural view of a timing kit in one specific implementation, and (2) is a schematic structural view of a timing kit in another specific implementation.

[75] In Figure 13, (1) is a schematic structural view of the interference block and the timing kit combined together, and (2) is a schematic structural view of the interference block.

[76] Figure 14 is a schematic diagram showing a process of grafting bee larvae with the larvae grafting needle (the relative position relationship between the larvae grafting needle and the cell with time is shown).

[77] Figure 15 is a schematic diagram showing the relative position relationship between the larvae grafting needle and the timing kit during bee larvae grafting.

[78] Figure 16 is a schematic structural view of a forward-backward position adjustment mechanism mounted on a larvae grafting machine (in order to show the forward-backward position adjustment mechanism, the structure of a part of the larvae grafting machine is omitted).

[79] Figure 17 is a schematic structural view of the forward-backward position adjustment mechanism.

[80] In Figure 18, (1) is a schematic view of a housing and a support frame combined together (in order to show the mounting part between the image pickup device and the position sensor, the structures of the first mounting mechanism and the motion module are omitted), and (2) is a schematic structural view of the housing.

[81] Figure 19 is an exploded view of a larvae grafting mechanism in a specific implementation.

[82] Figure 20 is a schematic structural view of the first mounting mechanism, the second mounting mechanism and the motion module in Figure 19.

[83] In Figure 21, (1) is a schematic structural view of a movable frame and a connecting frame in a separated state, (2) is a schematic view of the movable frame and the connecting frame combined together, and (3) is a back view of the structure in (2).

[84] In Figure 22, (1) is a schematic structural view of the movable frame (in order to show the structures of the first cavity and the second cavity, the structure of a part of the movable frame is omitted), and (2) is a schematic structural view of the connecting frame.

[85] In Figure 23, (1) is a schematic view of the movable frame, the connecting frame, the mounting mechanism and the motion module combined together, (2) is a schematic structural view of the height adjustment mechanism in a specific implementation, and (3) is a side view of the structure in (2) (the clamping structure is shown).

[86] In Figure 24, (1) is an exploded view of the larvae grafting mechanism in a specific implementation, (2) is a schematic structural view of the mounting mechanism, the larvae grafting needle, the motion module and the connecting frame in a separated state, and (3) is a schematic structural view of the mounting mechanism, the larvae grafting needle, the motion module and the connecting frame in a combined state.

[87] Figure 25 is a schematic structural view of a sliding bracket.

[88] Figure 26 is a photo taken by an image pickup device (bee larvae in the cell are shown).

[89] Figure 27 is a schematic diagram of a larvae grafting process in one implementation (the changes in relative position between the larvae grafting element, the push tongue and the cell during larvae grafting are shown), where the flat object at the bottom of the cell represents the bee larvae.

[90] Figure 28 is a schematic diagram of a larvae grafting process in one implementation (the changes in relative position between the larvae grafting element, the push tongue and the cell during larvae grafting are shown), where the flat object at the bottom of the cell represents the bee larvae.

[91] Figure 29 is a schematic diagram of a larvae releasing process in one implementation (the changes in relative position between the larvae grafting element, the push tongue and the culture cup during larvae releasing are shown), where the flat object at the bottom of the cell represents the bee larvae.

DETAILED DESCRIPTION OF THE INVENTION

[92] In order to make the objects, technical solutions and advantages of this application more clear, this application will be described and illustrated below with reference to the accompanying drawings and embodiments. It should be understood that the specific embodiments described herein are merely illustrative of this application and are not intended to limit this application. All other embodiments obtained by those of ordinary skill in the art based on the embodiments provided in this application without creative work shall fall within the protection scope of this application.

[93] In this application, a reference to "an embodiment" means that a specific feature, structure or characteristic described in connection with the embodiment can be included in at least one embodiment of this application. The appearance of this phrase in various places in the specification does not necessarily refer to the same embodiment, nor is it an independent or alternative embodiment mutually exclusive with other embodiments. It is explicitly and implicitly understood by those of ordinary skills in the art that the embodiments described in this application can be combined with other embodiments without conflict.

[94] Unless otherwise defined, the technical terms or scientific terms involved in this application shall have the ordinary meanings understood by those of ordinary skill in the art to which this application belongs. Words such as "a", "an", "the" and the like referred to in this application do not mean any limitation to quantity, but may mean its singular or plural form. The terms "comprise", "include", "have" and any derivatives thereof referred to in this application are intended to cover non-exclusive inclusion. Words such as "connect", "join", "couple" and the like referred to in this application are not limited to physical or mechanical connections, but may include electrical connections, whether direct or indirect. "A plurality of" referred to in this application refers to more than or equal to two. "And/or" describes the relationship of related objects, indicating that there may be three kinds of relationships. For example, "A and/or B" may indicate that there are three situations: A alone, A and B together, and B alone. The terms

"first", "second" and "third" referred to in this application are only used to distinguish similar objects, and do not represent the specific ordering of the objects.

[95] **Embodiment 1**

[96] The present invention provides a larvae grafting mechanism or device, as shown in Figures 1 to 2, including a mechanism (or mounting mechanism) configured to receive a larvae grafting needle. Thereby, the larvae grafting needle swings forwards and backwards around a support point in the mechanism.

[97] The "support point" means that a certain position on the larvae grafting needle is fitted with a certain position or structure on the mechanism such that the larvae grafting needle swings forwards and backwards around the support point, thereby controlling the angle of the larvae grafting needle relative to the vertical direction (that is, controlling the included angle between the straight line where the larvae grafting needle is located and the vertical line). The support point here can be understood as a relatively fixed point. The "fixed" here is not completely fixed, but means that a certain position or point on the larvae grafting needle is supported on a point or structure on the mounting mechanism as a support point so that the larvae grafting needle can rotate around the support point, and the position of the support point is basically unchanged on the larvae grafting needle.

[98] In some implementations, the movement of the support point changes as the position of another point relative to the support point changes. This another point may be defined as a movable point. The movable point drives the movement of another position or another point on the larvae grafting needle. Using the principle similar to a lever or a seesaw, the movement, for example, the forward and backward movement, of the movable point drives the support point to rotate, thereby driving the larvae grafting needle to swing.

[99] Of course, the support point here may be a certain point on the larvae grafting needle supported on a point or a structure on the mounting mechanism that serves as a supporting point or supporting point structure of the support point, so that the larvae grafting needle rotates or swings around the support point or supporting point structure. The movable point here may be another point on the larvae grafting needle that is driven to move. This movement includes the movement of the horizontal position or the movement of other positions, and can drive the support point on the larvae grafting needle to rotate around the supporting point structure or the supporting point.

[100] In some implementations, the present invention provides a specific structure. With this structure, the movement of the movable point on the larvae grafting needle drives the movement of the support point on the larvae grafting needle, so that the larvae grafting needle swings forwards and backwards. The details will be described below.

[101] For example, as shown in Figure 1, the structure includes a support point structure 7 or a supporting point structure. The larvae grafting needle includes a support point 201. The support point 201

is in a clearance fit with the support point structure or the supporting point structure, which may also be referred to as a supporting point, so that the support point 201 on the larvae grafting needle can rotate or swing around the supporting point on the supporting point structure by using the supporting point structure or the supporting point on a structure 700. For example, as shown in Figures 1 to 3, the supporting point structure may be a groove 7, and the support point 201 is a wing-like structure 202 or a protrusion structure including two extended wings 202 and 203 respectively located on two grooves 701 and 703, so that the swing structure can move like the support point in the groove. Of course, the support point and the supporting point here may be in other forms. For example, the supporting point structure may be a cylinder, the larvae grafting needle contains a lateral through hole, and the cylinder runs through the through hole, which may also realize the rotation of the support point around the supporting point. Any other forms or structures that can realize the rotation or swing of the support point 201 included on the larvae grafting needle relative to the supporting point by making the support point 201 included on the larvae grafting needle directly or directly contact the supporting point on the mechanism can be used in the specific implementations of the present invention.

[102] In some preferred implementations, the device includes a first mounting mechanism of the supporting point and a second mounting mechanism for mounting the motion module. The second mounting mechanism is located above the first mounting mechanism. The mounting here is only understood as the mechanism being used for mounting, accommodating and receiving the larvae grafting needle, rather than fixing the larvae grafting needle so that it cannot move.

[103] In some preferred implementations, as shown in Figures 2 to 3, the first mounting mechanism includes a fourth mounting plate 4 (i.e., bottom plate) whose left and right ends are respectively a groove 7. The grooves 7 can be fitted with the protrusions on the larvae grafting needle 20. The protrusions 203, 202 of the larvae grafting needle are mounted in the grooves 701, 703, so that the larvae grafting needle 20 will not fall down or come out of the mounting mechanism of the larvae grafting needle 20. In some preferred implementations, the groove is a curved groove (the supporting point or supporting point structure that supports the support point). With this curved groove, the support point 201 on the larvae grafting needle 20 can swing forwards and backwards around the supporting point set by the curved groove 7, so that the angle of forward or backward inclination of the larvae grafting needle 20 can be adjusted.

[104] In some preferred implementations, the first mounting mechanism further includes a first mounting plate 1 (i.e., right side plate) provided with an opening 5. Through this opening, the larvae grafting needle can be mounted conveniently, and the user can see whether the larvae grafting needle 20 is mounted in place inside the first mounting mechanism.

[105] In some preferred implementations, as shown in Figures 1 to 3, the first mounting mechanism includes the first mounting plate 1, a second mounting plate 2, a third mounting plate 3 and the fourth mounting plate 4, that are connected and fixed together in pairs or are integrally formed. In some preferred implementations, as shown in Figures 1 to 3, the first mounting plate 1 and the second mounting plate 2 are arranged opposite to each other. The first mounting plate 1 and the second mounting plate 2 serving as two opposite sides can protect the larvae grafting needle 20 and prevent the larvae grafting needle from being interfered with by other objects or mechanisms on the left and right sides during larvae grafting.

[106] In some preferred implementations, the third mounting plate 3 serving as a back side plate is respectively connected together with the first mounting plate 1, the second mounting plate 2 and the fourth mounting plate 4, and the fourth mounting plate 4 serving as the bottom plate is respectively connected and fixed with the first mounting plate 1, the second mounting plate 2 and the third mounting plate 3. In some preferred implementations, as shown in Figures 1 to 3, the fourth mounting plate 4 (i.e., the bottom plate) is provided with a through hole 6, so that the larvae grafting needle 20 can be just inserted into the through hole. An upper section 21 of the larvae grafting needle is located at an upper part of the through hole 6, a mounting combination part is combined with the through hole, and a middle section and a lower section of the larvae grafting needle are both located below the through hole.

[107] It can be understood that the first to fourth mounting plates are merely names for different parts of the structure, and they can be integrally formed, for example, from plastics, metals or the like. Of course, the first and third mounting plates here may be omitted, and only the fourth mounting plate 4 with the supporting point structure is retained.

[108] In some preferred implementations, as shown in Figure 1, the first mounting mechanism further includes a stop block 8. In some preferred implementations, the stop block 8 is arranged opposite to the third fixing plate 3, and detachably connected to the first fixing plate 1 and the second fixing plate 2. For example, in this embodiment, the stop block 8 is respectively clamped with the first fixing plate 1 and the second fixing plate 2. In some preferred implementations, as shown in Figure 7, the stop block 8 includes a clamping surface 70. In some preferred implementations, the clamping surface 70 is a curved clamping surface that can be combined with the mounting combination part 83 of the larvae grafting needle. In some preferred implementations, the stop block 8 further includes a first clamping part 71 and a second clamping part 72 that can be fitted with clamping grooves on the first mounting mechanism to realize connection. The stop block arranged can further fix the larvae grafting needle, so that the mounting combination part of the larvae grafting needle can be combined with the first mounting mechanism tightly. As shown in Figure 8, the mounting combination part 83 of the larvae grafting needle may serve as a support point. The larvae grafting needle here is kept still or can slightly swing forwards or

backwards. As shown in Figure 3, the larvae grafting needle 20 is mounted in the first mounting mechanism, and the fixed position (i.e., the mounting combination part 83 of the larvae grafting needle) serves as the support point. When the upper section 21 of the larvae grafting needle is stirred forwards by a hand or other manners, the upper section 21 of the larvae grafting needle can be inclined forwards or swing forwards, and at the same time, the lower section 23 of the larvae grafting needle can be inclined backwards or swing backwards, as shown in Figure 10. In some preferred implementations, the first fixing plate and the second fixing plate are provided with connecting components. In some preferred implementations, the connecting components include a first connecting component 10 and a second connecting component 11. The first connecting component 10 is connected and fixed with the second connecting component 11. In this embodiment, as shown in Figure 3, the first connecting component 10 is a connecting plate, and the second connecting component 11 is fixedly connected to the first fixing plate and the second fixing plate. The second connecting component 11 is provided with a connecting hole.

[109] In another implementation, the larvae grafting needle includes a movable point located at another position on the larvae grafting needle, for example, a movable point 202 at one end. The movable point can move to drive the support point to move. The description will be made below with reference to the specific structural views. The movable point 202 of the larvae grafting needle is arranged on a motion module 200. The movement of the motion module drives the movement of the movable point 204. For example, the forward and backward horizontal movement of the motion module necessarily drives the rotation of the support point 201 around the supporting point. For example, as shown in Figure 1, the horizontal movement of the movable point 204 drives the support point 201 to swing forwards and backwards around the supporting point.

[110] The larvae grafting needle here is generally a rigid structure, so that the movement of the movable point 204 can easily drive the movement of the support point 201, thereby producing a movement manner like a seesaw. Specifically, one end of the larvae grafting needle is provided with a larvae grafting element, which may be a flexible element, such as a brush, a flexible sheet, a flexible block, a flexible wire, etc. This flexible element may be inserted into the cell and become bent to dig up, bond or scoop up the bee larvae. The larvae grafting element is generally an elastic element that can be bent and deformed. In some preferred implementations, the larvae grafting mechanism in the present invention may include a larvae grafting needle. As shown in Figure 8, the larvae grafting needle includes an upper section 21, a mounting combination part, a middle section 22 and a lower section 23. The lower section 23 of the larvae grafting needle includes a larvae grafting element for grafting the bee larvae. The lower section of the larvae grafting needle further includes a push tongue 7m. The push tongue 7m is located on a side of the larvae grafting element 4f. The push tongue 7m is in contact with the larvae grafting element. The push tongue 7m can push out royal jelly and larvae on the surface of the larvae

grafting element and make them separated from the larvae grafting element. In the present invention, the larvae grafting needle may be a conventional larvae grafting needle in the prior art, for example, a larvae grafting needle in Chinese Application No. 201810974288.0 or 201810974335.1, and of course may be other forms of larvae grafting needle in the prior art. The present invention does not make improvements to the structure of the larvae grafting needle.

[111] Typically, the larvae grafting element is located at one end of the larvae grafting needle, for example, a lower end of the support point 201 (when the larvae grafting needle is in a vertical position), and the movable point 204 is located at an upper end of the support point.

[112] Therefore, the present invention provides a larvae grafting device, including a supporting point structure for supporting a support point on a larvae grafting needle, and a motion module for fixing a movable point on the larvae grafting needle. The movement of the motion module drives the support point on the larvae grafting needle to rotate around the supporting point, so that the larvae grafting element of the larvae grafting needle can swing. In some implementations, the forward and backward movement of the movable point drives the forward and backward movement or the forward and backward swing of the larvae grafting element. The forward and backward swing or the forward and backward movement here forms an included angle with the vertical direction (as shown Figure 10). It can also be understood that the movement of the movable point is used to adjust the angle of forward or backward swing of the larvae grafting needle. The angle here may also refer to the included angle between the larvae grafting needle and the vertical axis.

[113] In some implementations, the supporting point and the motion module are an integrated structure. For example, as shown in Figure 1, the motion module 200 includes a hole for fixing the movable point 204 on the larvae grafting needle. For example, the movable point may also be a wing-like structure fixed in the hole 3b (Figure 6). The "fixed" here means that: the larvae grafting needle 20 can be mounted, and after being mounted, the larvae grafting needle 20 cannot be separated from the motion module or sway left and right, but the movable point 204 on the larvae grafting needle 20 can be driven to move forwards and backwards by the motion module.

[114] The forward and backward movement of the motion module may be pushed by mechanical power, and of course, may also be driven by power of a motor. Even, during the up-and-down movement of the larvae grafting needle, the movable point of the larvae grafting needle is driven to move, so that the larvae grafting element swings forwards and backwards. This will be described in detail below.

[115] In some implementations, the motion module 200 is arranged in a fixing structure 300 (i.e., second mounting mechanism). For example, the motion module 200 has slide rails on two sides, and the fixing structure 300 has a slideway. The motion module can move forwards and backwards in the

slideway, thereby driving the movable point of the larvae grafting needle to move forwards and backwards.

[116] In some preferred implementations, the second mounting mechanism is configured to fit with the motion module 200, and used for adjusting an included angle between the larvae grafting needle 20 and the vertical axis. The included angle refers to an angle of forward or backward inclination of the larvae grafting needle 20 relative to the vertical axis, as shown in Figure 10. The second mounting mechanism may be directly or indirectly connected to the first mounting mechanism, or they may be integrally formed.

[117] In some preferred implementations, the second mounting mechanism is slidably connected to the motion module, as shown in Figure 6. The motion module can slide in the second mounting mechanism, so as to change the amplitude of the forward or backward swing of the larvae grafting needle and change the included angle between the larvae grafting needle and the vertical axis.

[118] Specifically, as shown in Figure 4, the second mounting mechanism includes a sliding chute 1c, configured to adjust the angle of forward or backward inclination of the larvae grafting needle 20 (the angle of swing). Since the larvae grafting needle 20 is mounted in the motion module and the motion module can slide in the sliding chute 1c, the larvae grafting needle 20 can move along with the motion module in the sliding chute 1c. As shown in Figure 6, the motion module and the sliding chute 1c are fitted with each other so as to adjust the angle of inclination of the larvae grafting needle 20, so that the larvae grafting needle 20 can obliquely enter the cell, thereby preventing the bee larvae from being grafted straight up and down, leading to low larvae grafting success rate.

[119] In some preferred implementations, the sliding chute has an elastic element therein. The elastic element may be a spring. The spring can be compressed or retracted, which makes the motion module move in the sliding chute. As shown in Figures 4 and 6, the sliding chute 1c has a spring 2c therein. The inside of the sliding chute 1c is provided with a spring mounting seat 3c for mounting the 2c. In some preferred implementations, the spring mounting seat 3c is a cylinder structure with an opening facing the outside, and the spring 2c can be fixedly mounted inside the cylinder. In this embodiment, as shown in Figure 6(2), one end of the spring 2c is located in the spring mounting seat 3c. In the process of sliding, by the motion module, from a head end to a tail end of the sliding chute 1c, the spring 2c can be compressed, and conversely, the spring 2c is retracted.

[120] In some preferred implementations, as shown in Figure 4, an outer end of the sliding chute 1c is provided with a limit block 4c. The limit block 4c can limit the motion module and prevent the motion module from being separated or deviating from the sliding chute 1c. In some preferred implementations, the limit blocks 4c are arranged in pairs, which is beneficial to limit the motion module within the sliding chute 1c, so that the motion module can always move in the sliding chute 1c.

[121] In some preferred implementations, two sides and a bottom of the sliding chute 1c are respectively provided with a connecting section. Specifically, as shown in Figures 4 to 7, the two sides of the sliding chute are respectively provided with a first connecting section 5c and a second connecting section 6c, and the bottom of the sliding chute is provided with a third connecting section 7c. The first connecting section 5c and the second connecting section 6c can be used for connecting other components on an upper part of the sliding chute 1c, and the third connecting section 7c can be used for connecting other components on a lower part of the sliding chute. In this embodiment, as shown in Figure 7(1), the third connecting section 7c can be used for connecting the first mounting mechanism.

[122] In some preferred implementations, as shown in Figure 4, the first connecting section 5c, the second connecting section 6c and the third connecting section 7c are respectively provided with a first connecting hole 8c. In some preferred implementations, the first connecting hole 8c is a threaded hole, and the sliding chute 1c can be connected with the other components through a screw 10c or a bolt. As shown in Figure 7, the second mounting mechanism and the first mounting mechanism are combined together. In some embodiments, the second mounting mechanism and the first mounting mechanism may be two separate mechanisms that are connected together through connecting components, as shown in Figures 3 to 4 and 7. In others embodiments, the second mounting mechanism and the first mounting mechanism may be integrally formed, as shown in Figures 1 to 2 and 9.

[123] In some embodiments, as shown in Figure 4, left and right sides of the third connecting section 7c are provided with a pair of barrier strips 9c. The first connecting component 10 in the first mounting mechanism can be stuck between the two barrier strips 9c, which can reinforce the connection between the second mounting mechanism and the first mounting mechanism.

[124] In some preferred implementations, the larvae grafting mechanism further includes a height adjustment mechanism and a horizontal position adjustment mechanism. The mounting mechanism is connected to the height adjustment mechanism, so that the larvae grafting needle 20 can move up and down. The horizontal position adjustment mechanism is configured to allowe the larvae grafting needle 20 to make a horizontal movement. In some preferred implementations, the height adjustment mechanism and the horizontal position adjustment mechanism may be controlled respectively, so that the larvae grafting needle 20 can make an up-and-down movement or a horizontal movement separately, or the larvae grafting needle 20 can make the up-and-down movement and the horizontal movement at the same time.

[125] The height adjustment mechanism and the horizontal position adjustment mechanism can realize the movement of the larvae grafting needle by using sliding blocks and slide rails, or can realize the movement of the larvae grafting needle by using gears, racks and conveyor belts, which will be described

in detail below. The height adjustment mechanism and the horizontal position adjustment mechanism can also be realized by other devices or manners in the prior art.

[126] The present invention further provides a larvae grafting method, as shown in Figure 27, which simulates a manual larvae grafting operation and can use the larvae grafting mechanism or device described above. The larvae grafting method includes the following steps:

[127] (1) When or before a larvae grafting needle comes into contact with an inner wall of a cell, the larvae grafting needle 20 is allowed to be in a second position w2. The second position w2 means: the larvae grafting needle 20 is inclined forwards, a larvae grafting element 4f is inclined backwards, and the larvae grafting element 4f of the larvae grafting needle is inclined backwards at a certain angle relative to a vertical direction. The relative position relationship between the larvae grafting needle and the cell is shown in Figure 14, the relative position relationship between the larvae grafting element and the cell is shown in Figure 27, and the swing of the larvae grafting needle is shown in Figure 10. In Figure 14, the second position w2 may be the state indicated at d, or the second position is the state indicated at some point between c and d.

[128] The larvae grafting needle may be pushed to the second position by mechanical power, and of course, the larvae grafting needle may also be moved by power of a motor.

[129] (2) The larvae grafting needle 20 is allowed to be in a first position w1, thereby completing larvae digging in the process of changing the larvae grafting needle from the second position to the first position. The first position w1 means: the larvae grafting needle 20 is inclined backwards, and the larvae grafting element 4f of the larvae grafting needle 20 is inclined forwards at a certain angle relative to the vertical direction. The relative position relationship between the larvae grafting needle and the cell is shown in Figure 14, and the relative position relationship between the larvae grafting element and the cell is shown in Figure 27. In Figure 14, the first position w1 may be the state indicated at f, or the second position is the state indicated at some point before f.

[130] In some implementations, before the larvae grafting needle comes into contact with the inner wall of the cell, the larvae grafting needle may be located in the second position or the first position, or in any position in the process of changing from the first position to the second position, or other positions.

[131] In some preferred implementations, in steps (1) to (2), the certain angle is 5°-40°.

[132] In some preferred implementations, in step (2), in the process of changing the larvae grafting needle from the second position to the first position, after the larvae grafting element comes into contact with the inner wall of the cell, the larvae grafting needle is allowed to swing backwards (the larvae grafting needle may be pushed to swing by mechanical power or power of the motor), and the larvae grafting element moves forwards. The larvae grafting element is bent forwards while clinging to the inner

wall of the cell, and the larvae grafting element stirs royal jelly containing bee larvae, such that the royal jelly containing the bee larvae is attached to the larvae grafting element.

[133] Similarly, the larvae grafting needle may be pushed to move from the second position to the first position by mechanical power or power of the motor.

[134] In some preferred implementations, in step (2), after the bee larvae are carried onto or attached to the larvae grafting element, the larvae grafting needle is moved upwards and separated from the cell.

[135] In some preferred implementations, in step (2), after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle is moved upwards and backwards and separated from the cell.

[136] In some implementations, after the larvae grafting needle is separated from the cell, the larvae grafting needle is moved to a target position such that the larvae grafting needle obliquely enters a culture cup, and the bee larvae are pushed into the culture cup. The target position means: the larvae grafting needle is located at an upper part of the culture cup of a cell bar.

[137] In some preferred implementations, during larvae releasing, after the larvae grafting needle is moved downwards until the larvae grafting element contacts an inner wall of the culture cup, the bee larvae are pushed out, and then, the larvae grafting needle is moved upwards and backwards.

[138] By using the larvae grafting mechanism and larvae grafting method of the present invention, the larvae grafting success rate is up to 90% or above, and the final larvae grafting survival rate is also higher. Compared with the traditional larvae grafting method, the larvae grafting method of the present invention can protect the larvae grafting needle and prolong the service life of the larvae grafting needle.

[139] In other implementations, the present invention provides a larvae grafting method, as shown in Figure 28, which simulates a manual larvae grafting operation and can use the larvae grafting mechanism or device described above. The larvae grafting method specifically includes the following steps:

[140] (1) A larvae grafting needle 20 is allowed to be in a second position w22. The second position w22 means: the larvae grafting needle 20 is inclined forwards, the larvae grafting element 4f is inclined backwards, and the larvae grafting element 4f is inclined backwards at a certain angle relative to the vertical direction; and a push tongue 7m of the larvae grafting needle is pushed out downward, and the push tongue 7m clings to the larvae grafting element. In this way, the larvae grafting element has a certain rigidity and the larvae grafting element 4f is straight instead of being bent. In this way, when the larvae grafting element comes into contact with the inner wall of the cell, the larvae grafting element is straight and will not become bent. While the push tongue 7m moves upwards, the larvae grafting element is bent forwards, and thus can effectively dig up the bee larvae, which prevents the larvae grafting element from being bent backwards when coming into contact with the inner wall of the cell, leading to failure of digging up the bee larvae.

[141] The relative position relationship between the larvae grafting needle and the cell is similar to that in Figure 14, the relative position relationship between the larvae grafting element and the cell is shown in Figure 28, and the swing of the larvae grafting needle is shown in Figure 10. In Figure 28, the second position w22 may be the state indicated at (4), or the second position is the state indicated at some point between (3) and (4).

[142] (2) The larvae grafting needle 20 is allowed to be in a third position w33, thereby completing larvae grafting in the process of changing the larvae grafting needle from the second position to the third position. The third position w33 means: the larvae grafting needle 20 is inclined backwards, the larvae grafting element 4f of the larvae grafting needle 20 is inclined forwards at a certain angle relative to the vertical direction, and the bee larvae are carried on or attached to the larvae grafting element. The relative position relationship between the larvae grafting needle and the cell is similar to that in Figure 14, the relative position relationship between the larvae grafting element and the cell is shown in Figure 28, and the swing of the larvae grafting needle is shown in Figure 10. In Figure 28, the third position w33 may be the state indicated at (7), or the second position is the state indicated at some point between (6) and (7).

[143] In some preferred implementations, in steps (1) to (2), the certain angle is 5°-40°.

[144] In some preferred implementations, in step (2), in the process of changing the larvae grafting needle 20 from the second position w22 to the third position w33, after the larvae grafting element comes into contact with the inner wall of the cell, the push tongue 7m of the larvae grafting needle moves upwards, and the larvae grafting element is bent forwards while clinging to the inner wall of the cell; and the larvae grafting needle is allowed to swing backwards (the larvae grafting needle may be pushed to swing by mechanical power or power of the motor), and the larvae grafting element 4f moves forwards. The larvae grafting element 4f stirs royal jelly containing bee larvae, such that the royal jelly containing the bee larvae is attached to the larvae grafting element 4f.

[145] In some preferred implementations, in step (2), after the bee larvae are carried onto or attached to the larvae grafting element, the larvae grafting needle 20 is moved upwards such that the larvae grafting needle carrying the bee larvae and the royal jelly is separated from the cell.

[146] Further, in step (2), after the bee larvae are carried onto or attached to the larvae grafting element, the larvae grafting needle 20 is moved backwards horizontally and upwards such that the larvae grafting needle carrying the bee larvae and the royal jelly is separated from the cell.

[147] In some preferred implementations, after the larvae grafting needle is separated from the cell and located in the third position, the larvae grafting needle is moved forwards.

[148] In some preferred implementations, after the larvae grafting needle is separated from the cell and located in the third position, the larvae grafting needle is moved forwards, and at the same time, the larvae grafting needle is moved downwards to a target position such that the larvae grafting needle obliquely

enters a culture cup and contacts the inner wall of the culture cup, and then the bee larvae are pushed into the culture cup. The target position means: the larvae grafting needle is located at an upper part of the culture cup of a cell bar.

[149] In some preferred implementations, after the larvae grafting needle 20 is separated from the cell, the larvae grafting needle 20 is in the third position w33. During larvae releasing, the larvae grafting needle 20 is moved forwards to the cell bar and aligned with the culture cup; the larvae grafting needle is moved downwards and obliquely enters the culture cup; when the larvae grafting element comes into contact with the culture cup, the larvae grafting element is inclined forwards; and then, the larvae grafting needle is pressed, such that the push tongue 7m is moved downwards to push the bee larvae and the royal jelly on the surface of the larvae grafting element, and thereby, the bee larvae and the royal jelly are separated from the larvae grafting element 4f and enter the culture cup of the cell bar.

[150] Further, during the larvae releasing, after the larvae grafting element contacts the inner wall of the culture cup, the larvae grafting needle is pressed, such that the push tongue 7m is moved downwards to push the bee larvae and the royal jelly on the surface of the larvae grafting element; then the push tongue 7m is moved upwards, the larvae grafting needle is moved upwards and backwards, such that the royal jelly attached to the back of the larvae grafting element is scraped off by the edge of the culture cup; and after that, the larvae grafting needle continues to move upwards and backwards to leave the culture cup.

[151] In some implementations, before the larvae grafting needle comes into contact with the inner wall of the cell, the larvae grafting needle may be located in the second position or the third position, or in any position in the process of changing from the first position to the second position, or other positions.

[152] In some preferred implementations, before the larvae grafting needle 20 is in the second position w22, the larvae grafting needle 20 is in the first position w11. The first position w11 means: the larvae grafting needle is inclined backwards, the larvae grafting element is inclined forwards, the larvae grafting element is inclined forwards at a certain angle relative to the vertical direction, and the larvae grafting element is straight instead of being bent.

[153] In some preferred implementations, after the larvae grafting needle 20 is in the first position, the larvae grafting needle 20 is moved downwards.

[154] In some preferred implementations, the larvae grafting method in this embodiment is similar to that in Figure 23, except that when the larvae grafting needle is in the first position and the second position, the push tongue 7m of the larvae grafting needle is pushed out downwards. In some preferred implementations, in the process of changing the larvae grafting needle 20 from the first position w11 to the second position w22, the larvae grafting needle 20 is moved backwards horizontally and downwards.

[155] In some preferred implementations, in the process of changing the larvae grafting needle 20 from the first position w11 to the second position w22, the larvae grafting needle 20 is moved downwards, and

at the same time, the whole larvae grafting needle is moved backwards horizontally until the larvae grafting element 4f contacts the inner wall of the cell. At this time, the larvae grafting element 4f is inclined at a certain angle (the larvae grafting element is inclined relative to the inner wall of the cell), and the larvae grafting element is straight instead of being bent, which is different from the traditional larvae grafting method (in the traditional larvae grafting method, regardless of the shape of the cell, the larvae grafting needle vertically enters the cell from the middle of the cell).

[156] By using the larvae grafting method of the present invention, the larvae grafting success rate is up to 95% or above, and the final larvae grafting survival rate is also higher. Compared with the traditional larvae grafting method, the larvae grafting method of the present invention can protect the larvae grafting needle, prolong the service life of the larvae grafting needle and avoid hurting the bee larvae.

[157] **Embodiment 2**

[158] In some preferred implementations, the larvae grafting mechanism further includes a guide mechanism. The guide mechanism is configured to guide the larvae grafting needle 20 to move up and down, and can interact with the motion module so as to make the larvae grafting needle swing and change the included angle between the larvae grafting needle 20 and the vertical axis, thereby changing the larvae grafting locus.

[159] In some preferred implementations, the guide mechanism for larvae grafting, as shown in Figure 12, includes a timing kit. The timing kit has a guide surface 1a configured to guide the movement of the motion module. The movement here means: the motion module can move up and down along the guide surface; and during the upward or downward movement of the motion module, the guide surface can interact with the motion module to change the position of the motion module in the sliding chute, thereby changing the position of the larvae grafting needle in the sliding chute, i.e., changing the position of the larvae grafting needle in the forward-backward direction.

[160] As shown in Figure 11, during the upward or downward movement of the motion module along the guide surface, the position of the guide surface is fixed and does not change, and the position of the motion module changes with different shapes of the guide surface. Thereby, when the motion module moves in the sliding chute, the larvae grafting needle 20 can move upwards or downwards and forwards or backwards along with the motion module, thereby completing the larvae grafting operation. As shown in Figures 14 to 15, the bee larvae (usually with some royal jelly) are dug up from the cell.

[161] In some preferred implementations, as shown in Figure 12, the guide surface includes a transition surface. When the motion module moves up and down along the transition surface, the motion module can move in the sliding chute, the larvae grafting needle swings, and the forward-backward position of the larvae grafting needle changes from one position to another position. In some embodiments, the transition surface is only a curved surface. When moving up and down along the curved surface, the motion module

moves slowly in the sliding chute, the amplitude of swing of the larvae grafting needle in unit time is small, and the larvae grafting needle changes its position in the forward-backward direction slowly. In some embodiments, the transition surface is an inclined surface. When moving up and down along the inclined surface, the motion module moves quickly in the sliding chute, the amplitude of swing of the larvae grafting needle in unit time is large, and the larvae grafting needle can change its position in the forward-backward direction quickly. In some other implementations, the transition surface includes both an inclined surface and a curved surface. The sequence and the number of the inclined surfaces and the curved surfaces can be set according to specific conditions.

[162] In some embodiments, the guide surface includes a transition surface and/or a flat surface. When the motion module moves upwards or downwards along the flat surface, the horizontal distance between the motion module and the flat surface does not change, the position of the motion module in the sliding chute does not change, and the larvae grafting needle does not swing. That is, the height of the larvae grafting needle changes constantly, but the horizontal position (the forward-backward position) of the larvae grafting needle does not change. In specific implementations, different shapes of guide surfaces can be selected according to actual conditions. The shape of the guide surface is not specifically limited in the present invention.

[163] In a specific implementation, as shown in Figures 11 and 12(1), from top to bottom, the guide surface includes a plurality sections, namely a first flat surface 4a, a curved surface 5a, a first inclined surface 2a, a second flat surface 6a and a second inclined surface 7a in sequence. Since the timing kit is fixedly connected to the support frame 9 and the guide surface is fixed, the motion module can move upwards or downwards under the action of the height adjustment mechanism. The motion module interacts with the guide surface in different states (the motion module may be in either direct or indirect contact with the guide surface, but there is an interaction force therebetween), so that the included angle between the larvae grafting needle 20 and the vertical axis can be changed. When the larvae grafting needle is located on the second inclined surface 7a, the larvae grafting needle is in the process of digging up larvae at the bottom of the cell. As shown in Figure 14, the larvae grafting needle is in the state d, and at this time, the larvae grafting needle is in a certain position on the second inclined surface 7a. With the arrangement of the second inclined surface 7a, it is convenient to change the movement direction of the motion module, for example, it is beneficial to change the motion module from downward movement to upward movement.

[164] In some preferred implementations, the guide mechanism may be mounted in the larvae grafting device or the larvae grafting mechanism. In this embodiment, as shown in Figure 11, the guide mechanism can be fixedly mounted on the support frame 9. The motion module can move upwards or downwards along the guide surface 1a, thereby guiding the larvae grafting needle 20 to move upwards or

downwards. At the same time, the larvae grafting needle can swing, so that the larvae grafting needle 20 can smoothly enter the cell to dig up the bee larvae.

[165] In some preferred implementations, as shown in Figures 11 to 12, an upper end of the timing kit has a connector 3a that can be connected with other components. In some preferred implementations, the connector 3a may be fixedly connected to a larvae grafting machine or other devices through a bolt or a screw, so that the timing kit is mounted to the larvae grafting machine or other devices. In this embodiment, as shown in Figure 11, the connector 3a is fixedly connected to the support frame 9.

[166] In other implementations, as shown in Figure 12(2), from top to bottom, the guide surface includes a plurality of sections, namely a first flat surface 4a, a curved surface 5a, a first inclined surface 2a, a second flat surface 6a, a second inclined surface 7a and a third flat surface 88a in sequence. On the second inclined surface 7a, it is convenient change the motion module to move upwards. The third flat surface 88a, serving as a protective surface, prevents the motion module from moving to the bottom of the timing kit due to inertia.

[167] Other implementations in this embodiment may be the same as those in Embodiment 1 or similar to those in Embodiment 1.

[168] Other implementations in this embodiment may be the same as those in Embodiment 1 or similar to those in Embodiment 1.

[169] **Embodiment 3**

[170] In some preferred implementations, as shown in Figure 5, the motion module is provided with a mounting hole 1b. The upper section 21 of the larvae grafting needle can be fixedly mounted in the mounting hole 1b, so that the larvae grafting needle can swing as the motion module moves. In some preferred implementations, a diameter of the mounting hole 1b is matched with that of the upper section 21 of the larvae grafting needle. Specifically, the diameter of the mounting hole 1b is slightly greater than that of the upper section 21 of the larvae grafting needle, so that the upper section 21 of the larvae grafting needle can be just stably located in the mounting hole 1b. Since the larvae grafting needle is mounted in the first mounting mechanism, the mounting combination part 83 of the larvae grafting needle may serve as a support point. When the motion module moves forwards (or backwards) in the second mounting mechanism, the upper section 21 of the larvae grafting needle can swing forwards (or backwards) along with the motion module, and at the same time, the middle section 22 and the lower section 23 of the larvae grafting needle can swing backwards (or forwards), as shown in Figure 8.

[171] In some preferred implementations, an end of the motion module is connected with a rolling element. In some preferred implementations, the rolling element is a roller 2b. In some preferred implementations, as shown in Figure 5, an outer end of the motion module is connected with the roller 2b, and the roller 2b can roll along the contact surface. Relatively speaking, the roller 2b produces smaller

friction with the contact surface, and will not wear the contact surface or damage other components. Moreover, under the same conditions, the roller can roll faster.

[172] In some preferred implementations, as shown in Figures 5 to 6, the outer end of the motion module is provided with an opening 3b for containing the roller 2b. A lateral dimension of the opening 3b is slightly greater than that of the surface of the roller, so that the roller 2b can be just located at this opening 3b, and cannot move laterally or sway left and right. In some preferred implementations, the outer end of the motion module is provided with a shaft hole 4b for fixedly mounting a roller connecting shaft 41b, and the roller 2b can rotate around the roller connecting shaft 41b. In some preferred implementations, the surface of the roller protrudes from the outer end of the motion module, so that only the roller 2b contacts the contact surface. When the roller 2b rolls along the contact surface, the other components do not contact the contact surface, nor affect the rolling of the roller 2b. Moreover, when the roller 2b rollers, it will not damage or wear the other parts on the motion module.

[173] In some preferred implementations, the end of the motion module provided with the rolling element is provided with a bump. The bump is used for interfering with the other components (for example, a second interference part of the interference block) so as to change the position of the motion module in the forward-backward direction (as shown in Figure 6(1), the X-axis direction indicates the forward-backward direction), thereby changing the angle of forward or backward swing (or angle of inclination) of the larvae grafting needle 20, i.e., changing the included angle between the larvae grafting needle 20 and the vertical axis, as shown in Figure 10. In some preferred implementations, as shown in Figure 5, the end of the motion module provided with the rolling element is provided with a bump 5b. The arrangement of the bump 5b does not affect the rolling of the rolling element on the guide surface (or contact surface). In some embodiments, the protruding direction of the bump 5b is the same as the axial direction of the roller connecting shaft. In some other implementations, the protruding direction of the bump 5b is perpendicular to the axial direction of the roller connecting shaft, as shown in Figure 5(2). In some preferred implementations, the bump 5b is connected with a mounting component 5m. In some other preferred implementations, the other side of the bump 5b is connected with the mounting component 5m, as shown in Figure 5(3). In some preferred implementations, as shown in Figure 5(2), an end of the bump is connected with a roller. When contacting the other components, the roller do not wear the other components a lot.

[174] In some preferred implementations, the end of the motion module away from the rolling element is provided with a connecting element. In some preferred implementations, as shown in Figure 5, the connecting element is a connecting post 6b, and the connecting post 6b is used for connecting the other components.

[175] In some preferred implementations, the end of the motion module provided with the roller 2b has an inclined surface 7b, as shown in Figure 5. When the contact surface of the roller 2b is an inclined surface, the inclined surface 7b on the motion module can be matched with the contact surface. If the contact surface of the roller 2b is an inclined surface and the end of the motion module provided with the roller 2b is a flat surface, during the rolling of the roller 2b, the flat surface will interfere with the contact surface (i.e., inclined surface), which will affect the movement of the roller 2b and wear the contact surface and the motion module.

[176] Other implementations in this embodiment may be the same as those in Embodiments 1 to 2 or similar to those in Embodiments 1 to 2.

[177] **Embodiment 4**

[178] In some embodiments, as shown in Figure 11, the timing kit is vertically mounted on the support frame 9. As shown in Figure 12, from top to bottom, the guide surface 1a includes a first flat surface 4a (i.e., first vertical surface), a curved surface 5a, a first inclined surface 2a, a second flat surface 6a (i.e., second vertical surface) and a second inclined surface 7a in sequence. The roller 2b can slide downward along the guide surface 1a, and during the sliding, the states of the spring and the larvae grafting needle 20 change constantly. During the sliding of the roller 2b along the first flat surface 4a, the roller 2b is in contact with the first flat surface 4a, the spring is compressed, the upper section 21 of the larvae grafting needle is inclined backwards, and the larvae grafting element 4f of the larvae grafting needle protrudes forwards. During the sliding of the roller 2b along the transition surface (i.e., the curved surface 5a and the first inclined surface 2a), the spring is gradually retracted, the upper section 21 of the larvae grafting needle gradually moves forwards until becoming vertical again, and then is inclined forwards, and the larvae grafting element 4f at the lower section of the larvae grafting needle protrudes backwards. During the sliding of the roller 2b along the second flat surface 6a (i.e., the second vertical surface), the roller 2b is in contact with the second flat surface 6a, the spring is slightly compressed, the larvae grafting needle 20 is inclined forwards, and the larvae grafting element 4f of the larvae grafting needle protrudes backwards. During the sliding of the roller 2b on the second inclined surface 7a, the roller 2b is in contact with the second inclined surface 7a, the spring is slightly compressed or the spring is in its free length, the larvae grafting needle 20 is inclined forwards, the angle of inclination increases, and the larvae grafting element 4f of the larvae grafting needle protrudes backwards.

[179] In some preferred implementations, as shown in Figure 13, the guide mechanism includes a fourth motor 8a. The fourth motor 8a is connected with a swing block 9a. The fourth motor 8a can control the swing block 9a to swing or stop. In some preferred implementations, as shown in Figure 12(1), the timing kit is provided with a first mounting part 10a for mounting the fourth motor 8a.

[180] In some preferred implementations, as shown in Figure 12, the timing kit is provided with a yielding structure 11a. In some preferred implementations, the timing kit is provided with a second mounting part. In some preferred implementations, the second mounting part includes a connecting shaft 12a.

[181] In some preferred implementations, the guide mechanism further includes an interference block 13a. The interference block 13a is connected to the timing kit. The interference block 13a can be mounted at the second mounting part. Specifically, as shown in Figure 13, a middle part of the interference block 13a is provided with a second connecting hole 14a. The connecting shaft 12a can run through the second connecting hole 14a to realize the connection between the interference block 13a and the timing kit. After the interference block and the timing kit are connected or combined, the interference block 13a can be in a certain position, such that the interference block 13a can swing around the connecting shaft 12a when an acting force is applied to the interference block 13a.

[182] In some preferred implementations, as shown in Figure 13, the upper end of the interference block 13a is partially located at the yielding structure 11a, which facilitates the swing of the interference block 13a and can limit the range of swing of the interference block 13a.

[183] In some preferred implementations, as shown in Figure 13, one end of the interference block 13a is provided with a first interference part 15a, and the other end is provided with a second interference part 16a. The first interference part 15a is configured to interfere with the swing block 9a on the fourth motor 8a. The second interference part 16a is configured to interfere with the bump 5b. As shown in Figure 18, when the motor 8a drives the swing block 9a to rotate, the swing block 9a stirs the first interference part 15a of the interference block 13a outwards, the interference block 13a rotates, and the second interference part 16a of the interference block 13a presses the bump 5b inwards. Thereby, the motion module slides towards the inside of the sliding chute, the upper section 21 of the larvae grafting needle swings backwards (i.e., is inclined backwards), and the larvae grafting element 4f of the larvae grafting needle protrudes forwards to dig up the bee larvae.

[184] In other implementations, as shown in Figure 12, the fourth motor is not arranged on the timing kit. The fourth motor is arranged on one side of the motion module, as shown in Figure 5(2). The fourth motor can move as the motion module moves. Therefore, the fourth motor may control the push tongue 7m of the larvae grafting needle to be in a pushed-out or normal state in real time.

[185] Other implementations in this embodiment may be the same as those in Embodiments 1 to 3 or similar to those in Embodiments 1 to 3.

[186] **Embodiment 5**

[187] In some preferred implementations, the larvae grafting mechanism further includes a height adjustment mechanism. The height adjustment mechanism can be used for adjusting the height of the

mounting mechanism, so that the larvae grafting needle is at different heights, thereby changing the vertical distance between the larvae grafting needle 20 and the cell. In this way, the larvae grafting needle 20 can conveniently enter the cell and then leave the cell after digging up the bee larvae.

[188] In some preferred implementations, the mounting mechanism is connected to the height adjustment mechanism, so that the larvae grafting needle 20 can move upwards or downwards to different heights.

[189] In some preferred implementations, as shown in Figure 18, the height adjustment mechanism includes a first gear 8e and a first rack 9e. The first gear 8e and the first rack 9e are fitted with each other to adjust the height of the mounting mechanism, thereby adjusting the height of the larvae grafting needle. In other implementations, the height may also be adjusted in other manners, for example, the height of the larvae grafting needle may be adjusted by a gear and a transmission belt.

[190] In some preferred implementations, the height adjustment mechanism further includes a first motor 7e for providing power that drives the first gear to rotate. In other implementations, the first gear may be driven to rotate not by the motor, but by other mechanical devices.

[191] In some preferred implementations, the height adjustment mechanism further includes a movable frame, a movable block 1e and a connecting member 6e. In some preferred implementations, the larvae grafting mechanism further includes a support frame 9, and the support frame 9 is connected with a column 2e.

[192] In some preferred implementations, as shown in Figure 11, the column 2e is fixedly connected to the support frame through a connecting component, a connecting rod or the like. The movable block 1e is connected and fixed to the movable frame. The movable block 1e is also slidably connected to the column 2e, so that the movable frame can move upwards or downwards relative to the column 2e. The first rack 9e and the connecting member 6e are respectively connected and fixed to the movable frame, and the movable frame is movable. The first motor 7e is fixedly connected to the support frame 9, and the first motor 7e is connected to the first gear 8e. The first motor 7e provides power that can drive the first gear 8e to rotate. The first gear 8e can contact and engage the first rack 9e. When the first motor 7e rotates, the first gear 8e rotates, and the first rack 9e can move upwards or downwards (when the first gear rotates clockwise or counterclockwise, the first rack can move downwards or upwards, and the movable frame can move downwards or upwards).

[193] In some preferred implementations, the second mounting mechanism is fixedly connected to the movable frame. In this embodiment, as shown in Figure 11, the mounting mechanism is connected and fixed to the connecting member 6e, and the connecting member 6e is connected and fixed to the movable frame. The second mounting mechanism can move as the movable frame move, so that the larvae grafting needle can move upwards or downwards along therewith.

[194] In some preferred implementations, an upper part of the support frame 9 is provided with a first limiting component, and a lower part is provided with a second limiting component. With the arrangement of the limiting components, the movable block 1e can move up and down within a certain range, and the larvae grafting needle 20 can move within a certain range, which can prevent the larvae grafting needle from moving beyond the appropriate range, leading damage to the larvae grafting needle 20.

[195] In some preferred implementations, the column 2e is fixedly connected to the support frame 9, and the movable block 1e is slidably connected to the column 2e and can slide up and down along the column 2e. In some preferred implementations, two sides of the column 2e are respectively provided with a sliding chute, the movable block 1e is provided with a protrusion matched therewith, and the protrusion is fitted with the sliding chute such that the movable block 1e can slide on the column 2e. In this embodiment, as shown in Figure 11, the height adjustment mechanism further includes two columns 2e, and in other implementations, one or two or more columns may be provided. In some embodiments, one or more movable block may be provided according to actual needs. In this embodiment, as shown in Figures 11 and 16, the height adjustment mechanism includes four movable block. Two of the movable blocks are located on one column (the two movable blocks are respectively in different positions of the column), and the other two movable blocks are located on another column (the two movable blocks are respectively in different positions of the column). In some preferred implementations, the column and the movable frame do not interfere with each other. In this embodiment, the body of the movable frame is located at a vacant position between the two columns, and the columns do not affect the upward or downward movement of the movable frame.

[196] In some preferred implementations, the movable block is fixedly connected to the movable frame. When the first motor 7e rotates, the first gear 8e rotates, the first rack 9e can move upwards or downwards, the movable frame can move upwards or downwards, the movable block can slide upwards or downwards on the column, and a fixing mechanism connected to the movable frame, the second mounting mechanism, can move upwards or downwards, thereby changing the vertical position of the larvae grafting needle (i.e., changing the height of the larvae grafting needle).

[197] In other implementations, as shown in Figure 23, the height adjustment mechanism includes a power transmission device and the movable frame. The power transmission device is connected to the movable frame. The larvae grafting needle is connected to the movable frame. A buffer element is arranged inside the movable frame. The buffer element may be an elastic member, or other structures or devices with a time buffering function.

[198] In some preferred implementations, the height adjustment mechanism includes a power device. The power device is connected to the power transmission device. The power device may be a motor. In

this embodiment, as shown in Figure 23, the power device is a first motor 7e. In other implementations, the power device may not be the motor, but other mechanical devices. The power device can transmit power to the power transmission device, the movable frame can be driven to move by the power device, and the larvae grafting needle can move upwards or downwards along the movable frame, thereby adjusting the larvae grafting needle to different heights.

[199] In some preferred implementations, the power transmission device includes a first gear 8e, a first rack 9e and a movable block 1e. In other implementations, the power may also be transmitted in other manners, for example, by a gear and a transmission belt.

[200] In this embodiment, as shown in Figure 23, the first gear 8e is connected to the first motor 7e, the first gear 8e is in contact and connected with the first rack 9e, the first rack 9e is connected to the movable frame 1h (the first rack 9e and the movable frame 1h are fixedly connected together, or may be integrally formed), the larvae grafting needle is directly or indirectly connected to the movable frame 1h, and the movable frame 1h is also connected to the movable block 1e. If the first motor 7e rotates, the first gear 8e can be driven to rotate, the first rack 9e can move upwards or downwards, the movable frame 1h can move upwards or downwards, and the larvae grafting needle can move upwards or downwards along with the movable frame.

[201] In some preferred implementations, the height adjustment mechanism further includes a column 2e. The movable block 1e is slidably connected to the column 2e, so that the movable frame 1h and the larvae grafting needle can move upwards or downwards relative to the column 2e.

[202] In some preferred implementations, as shown in Figure 23, the height adjustment mechanism further includes a connecting frame configured to connect the second mounting mechanism and the movable frame together, so that the larvae grafting needle can move as the movable frame moves.

[203] The movable frame 1h in this embodiment is different from the movable frame described above, and the connecting frame is also different from the connecting member described above.

[204] In some preferred implementations, as shown in Figure 22(1), the movable frame 1h includes a vertical bracket 2h. The vertical bracket 2h is provided with a first cavity 3h and a second cavity 4h. A bottom of the first cavity 3h is provided with a first connecting through hole 5h, and a bottom of the second cavity 4h is provided with a second connecting through hole 6h, which facilitates the connection with the other components.

[205] In some preferred implementations, as shown in Figure 22(2), the connecting frame includes a connecting piece 10h. Left and right sides of the connecting piece are provided with a movable block 1e connecting part for connection with the movable block 1e. The connecting piece is also connected with a support arm 7h that can be used for supporting the other components. In this embodiment, the fourth motor 8a is mounted at the support arm 7h. The support arm 7h can support the fourth motor 8a. The

fourth motor 8a is connected to a press block (or the interference block 13a) that can be used for pressing or hitting the bump 5b, so that the motion module moves backwards (i.e., moves to the inside of the sliding chute, and the spring inside the sliding chute is compressed). The larvae grafting needle swings, the upper section of the larvae grafting needle is inclined backwards, and the larvae grafting element is inclined forwards.

[206] In some preferred implementations, as shown in Figure 22(2), a back of the connecting piece is provided with a fitting member 8h. The fitting member 8h is also provided with a third connecting through hole 9h. In some preferred implementations, the fitting member 8h may be fitted and connected with the first cavity. For example, the fitting member 8h may be inserted into the first cavity, then the connecting post sequentially runs through the first connecting through hole 5h, the third connecting through hole 9h in the fitting member 8h and the second connecting through hole 6h in the second cavity 4h, and screw caps are screwed on the two ends of the connecting post to prevent the connecting post from falling down, so that the connecting post can perform the connecting function in deed to connect the fitting member 8h and the vertical bracket 2h together (to connect the connecting frame with the movable frame 1h). In some preferred implementations, the dimensions (length, width and height) of the fitting member 8h are respectively smaller than the dimensions (length, width and height) of the first cavity 3h, but the lateral dimension of the fitting member 8h is greater than the dimension of the first connecting through hole 5h, so that the fitting member 8h can be located inside the first cavity 3h without sliding out of the first connecting through hole 5h. In some preferred implementations, the height of the first cavity 3h is greater than that of the fitting member 8h. As shown in Figure 23, after the fitting member 8h is assembled in the first cavity 3h, the upper part inside the first cavity 3h has a remaining space 11h, such that the fitting member 8h can move upwards (downwards) along the connecting post inside the first cavity 3h.

[207] In some preferred implementations, an elastic member 8m is arranged inside the first cavity body 3h. The elastic member 8m serves as a buffer element. The elastic member 8m may be a spring (not shown). In some preferred implementations, the elastic member 8m is sleeved outside the connecting post. The elastic member 8m is located above the third connecting through hole 9h and below the second connecting through hole 6h. When the movable frame 1h moves upwards under the control of the first motor 7e, the fitting member 8h receives an upward acting force. The fitting member 8h moves upwards and thereby compresses the spring. After being compressed, the spring applies a downward acting force to the fitting member 8h, finally forming an equilibrium. The fitting member 8h moves upwards along with the movable frame 1h, and the larvae grafting needle moves upwards along with the movable frame 1h. Similarly, when the movable frame 1h moves downwards under the control of the first motor 7e, the spring is compressed, and the fitting member 8h receives a downward acting force, so that the fitting

member 8h and the larvae grafting needle can smoothly move downwards along with the movable frame 1h.

[208] With the arrangement of the elastic member 8m, the fitting member 8h and the larvae grafting needle do not move upwards along with the movable frame 1h immediately, but after a certain buffer time (or after a certain time delay). For example, when the larvae grafting needle is at position d, as shown in Figure 14, the larvae grafting element contacts the bottom of the culture cup, the fourth motor 8a is started, the interference block 13a connected with the fourth motor presses (or hits) the bump 5b, the motion module moves backwards, the larvae grafting needle swings, the upper section of the larvae grafting needle is inclined backwards, the larvae grafting element moves forwards to dig up the bee larvae, and then, the larvae grafting needle moves upwards. Theoretically, when the fourth motor 8a is started, the interference block should synchronously press the bump 5b to make the larvae grafting element dig up the bee larvae, and at the same time, the larvae grafting needle moves upwards. However, in practice, it takes time to start the fourth motor 8a, and it also takes some time for the interference block to press the bump 5b and make the larvae grafting element dig up the bee larvae. Therefore, there should be a certain time delay before the larvae grafting needle moves upwards at the very beginning, thereby preventing the larvae grafting element from moving upwards and leaving the cell before digging up the bee larvae. With the arrangement of the elastic member 8m, the larvae grafting element can effectively dig up the bee larvae, thereby preventing the larvae grafting element from leaving the cell before digging up the bee larvae.

[209] In some preferred implementations, the movable frame 1h is connected with a larvae releasing mechanism. The movable frame 1h is connected with a second motor 3e. The second motor 3e may be directly or indirectly connected to the vertical bracket 2h. The second motor 3e is also connected to a swing member. The swing member is connected with a press plate for pressing the upper end of the larvae grafting needle downwards, so that the push tongue 7m moves downwards and makes the bee larvae separated from the larvae grafting element.

[210] Other implementations in this embodiment may be the same as those in Embodiments 1 to 4 or similar to those in Embodiments 1 to 4.

[211] **Embodiment 6**

[212] In some preferred implementations, the larvae grafting mechanism includes a larvae releasing mechanism. The larvae releasing mechanism may realize the larvae releasing operation in the following way: a motor is used to control the push tongue to move downwards, so as to push the bee larvae out of the larvae grafting element. For example, the motor 3e, as shown in Figure 24(2), is used to hit the upper end of the larvae grafting needle, so that the push tongue moves downwards, and the bee larvae leaves the larvae grafting element. Of course, the larvae releasing may also be realized by other ways.

[213] In a specific implementation, as shown in Figure 11, the larvae releasing mechanism includes a second motor 3e, a second gear 4e and a second rack 5e that are fitted with each other, and can be used in the larvae releasing operation, i.e., to put the bee larvae on the larvae grafting element 4f into the culture cup of the cell bar.

[214] In some preferred implementations, the second motor 3e is fixedly connected to the movable frame. The second motor 3e is connected to the second gear. The second motor can drive the second gear to rotate, and the second gear 4e can engage the second rack 5e. In some preferred implementations, as shown in Figure 11, the connecting member 6e has a structure of a plurality of connecting sections. The connecting member 6e can be connected with the second mounting mechanism (i.e., the connecting member is connected with a first connecting section 5c and a second connecting section 6c in the second mounting mechanism through screws or bolts). At the same time, the connecting member 6e is connected with the movable block 1e, the connecting member 6e is connected with the movable frame, and the connecting member 6e is also connected with the second rack 5e. In some preferred implementations, two sides of the second rack are respectively provided with a clamping strip, the connecting member is provided with a slot, the second rack is clamped in a frame of the connecting member, and the second rack can slide upwards or downwards along the slot. When the second motor 3e is started, the second gear can rotate, and correspondingly, the second rack 5e can move upwards or downwards. A bottom of the second rack 5e is provided with a flat plate. After the second rack moves downward to above the larvae grafting needle, when the second rack continues to move downwards, the flat plate can abut against the upper end of the larvae grafting needle and press the larvae grafting needle, so that the push tongue 7m moves downwards to push the bee larvae and the royal jelly on the surface of the larvae grafting element to be separated from the larvae grafting element 4f and enter the culture cup of the cell bar. In some preferred implementations, the second rack is provided with a limit protrusion. This protrusion can interfere with the connecting member, thereby preventing the second rack from continuing to move upwards and being separated from the connecting member. In this embodiment, as shown in Figure 18, the limit protrusion is located at a lower part of the middle of the second rack, so that the second rack can move upwards a large distance. When the larvae releasing mechanism is idle, the flat plate at the bottom of the second rack is located at a certain distance from the upper end of the larvae grafting needle, and does not press the upper end of the larvae grafting needle, nor interfere with the upper end of the larvae grafting needle, so the larvae releasing mechanism does not affect the larvae grafting operation of the larvae grafting needle.

[215] Other implementations in this embodiment may be the same as those in Embodiments 1 to 5 or similar to those in Embodiments 1 to 5.

[216] **Embodiment 7**

[217] In some preferred implementations, the larvae grafting mechanism further includes a horizontal position adjustment mechanism. The horizontal position adjustment mechanism can be used for adjusting a horizontal position of the mounting mechanism, so that the larvae grafting needle 20 can be at different horizontal positions, thereby changing the horizontal distance between the larvae grafting element 4f of the larvae grafting needle and the cell. Thereby, the larvae grafting needle 20 can be moved in the horizontal direction and aligned with the target cell to dig up the bee larvae.

[218] In some preferred implementations, the horizontal position adjustment mechanism includes a forward-backward position adjustment mechanism and a left-right position adjustment mechanism. The forward-backward position refers the direction indicated by the X-axis in Figure 6. The left-right position refers to the direction indicated by the Y-axis in Figure 6.

[219] The target cell refers to a cell containing bee larvae. As shown in Figure 16, in the horizontal direction (i.e., the left-right direction), there are a plurality of rows of cells, and each row includes a plurality of cell. Some of these cells contain bee larvae, and some do not.

[220] In some preferred implementations, as shown in Figure 16, the horizontal position adjustment mechanism (the horizontal position adjustment mechanism here refers to the forward-backward position adjustment mechanism) can realize position adjustment by a gear and a rack, or by a gear and a transmission belt, or by a lead screw and a lead screw sleeve.

[221] In a specific implementation, the forward-backward position adjustment mechanism includes a third motor 1d, a third gear 2d, a third rack 3d and a translation plate 4d. The horizontal position adjustment mechanism is configured to adjust and change the position of the larvae grafting needle in the horizontal direction (i.e., the position in the forward-backward direction). In some preferred implementations, the third motor 1d is fixedly mounted on a support plate 5d of a frame. A height of the support plate 5d is smaller than that of the translation plate, so that a distance is left between the translation plate and the support plate. When the translation plate moves, the third rack does not interfere with the support plate, nor affect the movement of the translation plate.

[222] In some preferred implementations, as shown in Figures 16 to 17, the third gear 2d is connected to the third motor 1d, the third motor 1d can drive the third gear 2d to rotate, the third rack 3d contacts and engages the third gear 2d, and the rotation of the third gear 2d can drive the forward or backward movement of the third rack 3d relative to the third motor 1d. In some preferred implementations, as shown in Figure 17, the third rack 3d is connected and fixed to the translation plate 4d, and the translation plate 4d can move as the third rack 3d moves. In some preferred implementations, the translation plate 4d is directly or indirectly connected or fixed to the support frame 9. When the translation plate 4d moves forwards or backwards horizontally, the support frame 9 can be driven to move forwards or backwards, and then, components connected with the support frame 9 can also make a horizontal movement.

Therefore, the larvae grafting needle 20 can move forwards or backwards horizontally. During the larvae grafting, the larvae grafting needle 20 can make an upward or downward movement and a forward or backward translational movement, and can also swing forwards or backwards (i.e., move in the sliding chute along with the motion module).

[223] In some preferred implementations, the left-right position adjustment mechanism may be a conventional position adjustment mechanism in the prior art (not shown), mainly including a fifth motor, a fourth gear, a fifth gear, a conveyor belt, a slide rail, a sliding block, a connecting structure, etc. The fifth motor is connected to the fourth gear. The conveyor belt is connected to the fourth gear and the fifth gear respectively. The sliding block is slidably connected to the slide rail. The sliding block is also connected to the support frame. The connecting structure is connected to the conveyor belt. The connecting structure is connected to the support frame. The fifth motor can drive the fourth gear to rotate, and the conveyor belt moves along with the fourth gear. The fifth gear rotates, the connecting structure and the support frame connected with the conveyor belt move along therewith, and the sliding block slides along the slide rail along with the movement of the support frame, thereby adjusting the position of the larvae grafting needle in the left-right direction.

[224] Other implementations in this embodiment may be the same as those in Embodiments 1 to 6 or similar to those in Embodiments 1 to 6.

[225] **Embodiment 8**

[226] The present invention provides a larvae grafting method, which simulates the manual larvae grafting operation and may use the larvae grafting mechanism described above. The method specifically includes the following steps:

[227] (1) A larvae grafting needle 20 is allowed to be in a first position w1. The first position w1 means: the larvae grafting needle 20 is inclined backwards, and a larvae grafting element 4f is inclined forwards such that the larvae grafting element 4f of the larvae grafting needle 20 is inclined forwards at a certain angle relative to the vertical direction.

[228] (2) The larvae grafting needle 20 is allowed to be in a second position w2. The second position w2 means: the larvae grafting needle 20 is inclined forwards, and the larvae grafting element 4f is inclined backwards such that the larvae grafting element 4f of the larvae grafting needle is inclined backwards at a certain angle relative to the vertical direction.

[229] (3) The larvae grafting needle 20 is allowed to be in the first position w1 again, thereby completing larvae digging in the process of changing from the second position w2 to the first position. When the larvae grafting needle is located in the first position w1, the larvae grafting needle 20 is inclined backwards, such that the larvae grafting element 4f of the larvae grafting needle 20 is inclined forwards at a certain angle relative to the vertical direction, thereby digging up the bee larvae.

[230] In some preferred implementations, in steps (1) to (3), the certain angle is 5°-30°.

[231] In some preferred implementations, in step (1), the larvae grafting needle 20 is allowed to be in the first position w1, and then the larvae grafting needle 20 is moved downwards.

[232] In some preferred implementations, in step (2), as shown in Figures 14 to 15, in the process of changing the larvae grafting needle 20 from the first position w1 to the second position w2, the larvae grafting needle 20 is moved backwards horizontally, and at the same time, the larvae grafting needle is moved downwards.

[233] In some preferred implementations, in step (2), in the process of changing the larvae grafting needle 20 from the first position w1 to the second position w2, (Figure 10 is a schematic diagram showing the change of the angle of inclination when the larvae grafting needle 20 only swings forwards and backwards; in the figure, the larvae grafting needle 20 is inclined at an angle of 10°; as can be seen, the larvae grafting needle 20 swings from the first position w1 to the second position w2 through a middle position wg; since the support point is almost fixed, the inclination of the larvae grafting needle 20 becomes forwards from backwards, and the inclination of the larvae grafting element 4f below the support point becomes forwards from backwards), the larvae grafting needle 20 is moved downwards, and at the same time, the whole larvae grafting needle is moved backwards horizontally, as shown in Figure 14, and the larvae grafting element 4f enters the cell. The larvae grafting element 4f enters the cell at a certain angle of inclination while clinging to the inner wall of the cell, but not straight up and down from the middle of the cell. In Figure 14, the larvae grafting needle in the position w1 is not shown at the very beginning, but the larvae grafting needle may start from the position w1 and gradually move down, and also, the larvae grafting needle swings, such that the larvae grafting element 4f is inclined backwards to the position (a). Then the larvae grafting element 4f continues to move downwards and be inclined backwards to the position (d). The position w2 may be the position (d), or a certain position between the position (c) and the position (d). When the larvae grafting element 4f is in the position w2, the front end of the larvae grafting element is bent and attached to the bottom of the cell. The relative position relationship between the larvae grafting element and the cell is shown in Figure 27. In Figure 27, the second position w2 may be the state indicated at (3).

[234] In some preferred implementations, in step (3), as shown in Figures 14 to 15, in the process of changing the larvae grafting needle 20 from the second position w2 to the first position w1, the larvae grafting element is bent, the larvae grafting needle swings, the larvae grafting element 4f moves forwards, and the larvae grafting element 4f stirs royal jelly containing bee larvae such that the royal jelly containing the bee larvae is attached to the larvae grafting element 4f. Then, the larvae grafting needle 20 is moved backwards horizontally and upwards, such that the larvae grafting needle carrying the bee larvae and the royal jelly is separated from the cell.

[235] In some preferred implementations, after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle 20 moves upwards along the guide surface, the larvae grafting needle 20 is allowed to swing again, such that the larvae grafting element is inclined backwards, which is the same as the state when the larvae grafting needle 20 is in the first position w1 in step (1).

[236] In some preferred implementations, after the larvae grafting needle 20 is separated from the cell, the larvae grafting needle 20 is moved upwards to the first position w1 again. The larvae grafting needle 20 is moved forwards to the cell bar and aligned with the culture cup. At this time, the second motor 3e is started, and the second gear rotates. Correspondingly, the second rack 5e can move downwards, and the flat plate at the bottom of the second rack 5e abuts against the upper end of the larvae grafting needle and presses the larvae grafting needle, such that the push tongue 7m is moved downwards to push the bee larvae and the royal jelly on the surface of the larvae grafting element, and thereby the bee larvae and the royal jelly are separated from the larvae grafting element 4f and enter the culture cup of the cell bar.

[237] In some preferred implementations, during the larvae releasing, the larvae grafting needle moves downwards and obliquely enters the culture cup. In some preferred implementations, during the larvae releasing, after the larvae grafting element contacts the bottom of the culture cup, the bee larvae are pushed out, and the larvae grafting needle is moved upwards and backwards.

[238] The larvae grafting process performed by using the larvae grafting mechanism is shown in Figures14 and 27.

[239] The specific process of step (1) includes: after the larvae grafting needle 20 is in the first position w1, the first rack moves downwards, and correspondingly, the larvae grafting needle 20 is inclined backwards and moves downwards.

[240] Since the upper section 21 of the larvae grafting needle is mounted inside the motion module, the mounting combination part 83 of the larvae grafting needle is combined with the first mounting mechanism. The roller 2b on the motion module is in contact with the guide surface 1a of the timing kit, and the roller 2b slides downwards on the first flat surface 4a. In this process, the spring is compressed, and the larvae grafting needle 20 is in the first position w1: the larvae grafting needle 20 is inclined backwards, and the larvae grafting element 4f of the larvae grafting needle (i.e., the larvae digging part of the larvae grafting needle) protrudes forwards.

[241] The specific process of step (2) includes: the larvae grafting needle 20 moves downwards, and at the same time, the translation plate moves backwards (correspondingly, the larvae grafting needle moves backwards). In this process, the roller 2b slides along the transition surface (the curved surface 5a and the first inclined surface 2a) of the timing kit, slides along the second flat surface 6a of the timing kit (when the roller 2b slides along the second flat surface 6a, the larvae grafting element may be in the position (4) in Figure 27), and finally slides to the second inclined surface 7a of the timing kit. During this process,

the spring gradually retracts, the larvae grafting needle 20 swings, the upper section of the larvae grafting needle gradually swings forwards back to the vertical position (i.e., the middle position wg), then the upper section of the larvae grafting needle is inclined forwards, and the larvae grafting element 4f (i.e., the larvae digging part of the larvae grafting needle) protrudes backwards (i.e., the second position w2). The larvae grafting element 4f moves downwards to enter the cell. In Figure 14, the second position w2 may be the state indicated at d. In Figure 27, the second position w2 may be the state indicated at (3). When the larvae grafting needle is in the second position w2, the roller 2b is located at the second inclined surface 7a of the timing kit.

[242] The specific process of step (3) includes: As shown in Figure 11(1), the roller 2b is located at the second inclined surface 7a. At this time, the fourth motor 8a controls the interference block 13a to swing, the second interference part 16a of the interference block 13a presses the bump 5b, and the motion module slides towards the inside of the sliding chute. Correspondingly, the larvae grafting needle 20 swings, and the upper section of the larvae grafting needle is inclined backwards (the spring is compressed). As shown in Figures 14 and 27, the larvae grafting element 4f (i.e., the larvae digging part of the larvae grafting needle) tilts forwards, and at the same time, the translation plate moves forwards (correspondingly, the larvae grafting needle moves forwards), so that the larvae grafting needle moves upwards and digs up the bee larvae together with a small amount of royal jelly. In other implementations, as shown in Figure 24, the fourth motor 8a is started, and the fourth motor 8a rotates to hit or press the bump 5b, so that the motion module slides towards the inside of the sliding chute. Correspondingly, the larvae grafting needle 20 swings, and the larvae grafting needle changes from the second position w2 to the first position w1.

[243] After the bee larvae are carried onto the larvae grafting element, the larvae grafting needle 20 is moved backwards and moved upwards along the guide surface 1a and separated from the cell, and then moved to the first flat surface 4a of the timing kit. At this time, the state of the larvae grafting needle 20 is the same as that of the larvae grafting needle 20 in the first position in step (1).

[244] Further, during the larvae releasing, after the larvae grafting element contacts the inner wall of the culture cup, the larvae grafting needle is moved upwards and backwards, such that the royal jelly attached to the back of the larvae grafting element is scraped off by the edge of the culture cup at a certain point after (5), as shown in Figure 29, and then the larvae grafting needle continues to move upwards and backwards to leave the culture cup.

[245] By using the larvae grafting mechanism and larvae grafting method of the present invention, the larvae grafting success rate is up to 90% or above, and the final larvae grafting survival rate is also higher. Compared with the traditional method in the larvae are grafted straight up and down, the larvae grafting

method of the present invention can protect the larvae grafting needle and prolong the service life of the larvae grafting needle.

[246] **Embodiment 9**

[247] The present invention provides a larvae grafting method, which simulates the manual larvae grafting operation, as shown in Figure 28, and may use the larvae grafting mechanism described above. The method specifically includes the following steps:

[248] (1) A larvae grafting needle 20 is allowed to be in a first position w11. The first position w11 means: the larvae grafting needle 20 is inclined backwards, the larvae grafting element 4f is inclined forwards, and the larvae grafting element 4f is inclined forwards at a certain angle relative to the vertical direction; and a push tongue 7m of the larvae grafting needle is pushed out downward (i.e., in the state of larvae releasing), and the push tongue 7m clings to the larvae grafting element. In this way, the larvae grafting element has a certain rigidity and the larvae grafting element 4f is straight instead of being bent. In this way, when the larvae grafting element comes into contact with the inner wall of the cell, the larvae grafting element is straight and will not become bent. While the push tongue 7m moves upwards, the larvae grafting element is bent forwards, and thus can effectively dig up the bee larvae, which prevents the larvae grafting element from being bent backwards when coming into contact with the inner wall of the cell, leading to failure of digging up the bee larvae. Figure 26 is a photo taken by an image pickup device, in which the bee larvae are located in the cell.

[249] (2) The larvae grafting needle 20 is allowed to be in a second position w22. The second position w22 means: the larvae grafting needle 20 is inclined forwards, the larvae grafting element 4f is inclined backwards, and the larvae grafting element 4f is inclined backwards at a certain angle relative to the vertical direction; and the push tongue 7m of the larvae grafting needle is pushed out downward (i.e., in the state of larvae releasing), and the push tongue 7m clings to the larvae grafting element. In this way, the larvae grafting element has a certain rigidity and the larvae grafting element 4f is straight instead of being bent. In this way, when the larvae grafting element comes into contact with the inner wall of the cell, the larvae grafting element is straight and will not become bent. While the push tongue 7m moves upwards, the larvae grafting element is bent forwards, and thus can effectively dig up the bee larvae, which prevents the larvae grafting element from being bent backwards when coming into contact with the inner wall of the cell, leading to failure of digging up the bee larvae.

[250] (3) The larvae grafting needle 20 is allowed to be in a third position w33, thereby completing larvae grafting in the process of changing the larvae grafting needle from the second position to the third position. The third position w33 means: the larvae grafting needle 20 is inclined backwards, the larvae grafting element 4f of the larvae grafting needle 20 is inclined forwards at a certain angle relative to the vertical direction, and the bee larvae are carried on or attached to the larvae grafting element.

[251] In some preferred implementations, in steps (1) to (3), the certain angle is 5°-40°.

[252] In some preferred implementations, in step (1), the larvae grafting needle 20 is allowed to be in the first position w11, and then the larvae grafting needle 20 is moved downwards.

[253] In some preferred implementations, the larvae grafting method in this embodiment is similar to that in Figure 14, except that when the larvae grafting needle is in the first position and the second position, the push tongue 7m of the larvae grafting needle is pushed out downwards (i.e., in the state of larvae releasing), as shown in Figure 28. In step (2), in the process of changing the larvae grafting needle 20 from the first position w11 to the second position w22, the larvae grafting needle 20 is moved backwards horizontally and downwards.

[254] In some preferred implementations, in step (2), in the process of changing the larvae grafting needle 20 from the first position w11 to the second position w22, the larvae grafting needle 20 is moved downwards, and at the same time, the whole larvae grafting needle is moved backwards horizontally until the larvae grafting element 4f contacts the inner wall of the cell. At this time, the larvae grafting element 4f is inclined at a certain angle, and the larvae grafting element is straight instead of being bent, which is different from the traditional larvae grafting method (in the traditional larvae grafting method, the larvae grafting needle vertically enters the cell from the middle of the cell).

[255] Specifically, in the process of changing the larvae grafting needle 20 from the first position w11 to the second position w22,

[256] the roller 2b slides along the transition surface (the curved surface 5a and the first inclined surface 2a) of the timing kit, slides along the second flat surface 6a of the timing kit (when the roller 2b slides along the second flat surface 6a, the larvae grafting element may be in the position (4) in Figure 28), and finally slides to the second inclined surface 7a of the timing kit. During this process, the spring gradually retracts, the larvae grafting needle 20 swings, the upper section of the larvae grafting needle gradually swings forwards back to the vertical position (i.e., the middle position wg), then the upper section of the larvae grafting needle is inclined forwards, and the larvae grafting element 4f (i.e., the larvae digging part of the larvae grafting needle) protrudes backwards (i.e., the second position w22). The larvae grafting element 4f moves downwards to enter the cell. In Figure 28, the second position w22 may be the state indicated at (5), and when the larvae grafting needle is in the second position w2, the roller 2b is located at the second inclined surface 7a of the timing kit.

[257] In some preferred implementations, in step (3), as shown in Figure 28, in the process of changing the larvae grafting needle 20 from the second position w22 to the third position w33, after the larvae grafting element comes into contact with the inner wall of the cell, the push tongue 7m of the larvae grafting needle moves upwards, and the larvae grafting element is bent. At the same time, under the action of the fourth motor 8a, the interference block presses the bump 5b, the larvae grafting needle

swings, the larvae grafting element 4f moves forwards, and the larvae grafting element 4f stirs the royal jelly containing the bee larvae such that the royal jelly containing the bee larvae is attached to the larvae grafting element 4f. Then, the larvae grafting needle 20 is moved backwards horizontally and upwards, such that the larvae grafting needle carrying the bee larvae and the royal jelly is separated from the cell. In other implementations, as shown in Figure 24, the fourth motor 8a is started, and the fourth motor 8a rotates to hit or press the bump 5b, so that the motion module slides towards the inside of the sliding chute. Correspondingly, the larvae grafting needle 20 swings, and the larvae grafting needle changes from the second position w22 to the third position w33.

[258] In some preferred implementations, after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle 20 moves upwards along the guide surface and also moves backwards, and finally, the larvae grafting needle 20 is located in the third position w33, which is beneficial to the larvae releasing operation.

[259] In some preferred implementations, after the larvae grafting needle is separated from the cell and located in the third position, the larvae grafting needle is moved forwards.

[260] In some preferred implementations, after the larvae grafting needle is separated from the cell and located in the third position, the larvae grafting needle is moved forwards, and at the same time, the larvae grafting needle is moved downwards to a target position such that the larvae grafting needle obliquely enters a culture cup and contacts the inner wall of the culture cup, and then the bee larvae are pushed into the culture cup. The target position means: the larvae grafting needle is located at an upper part of the culture cup of a cell bar.

[261] In some preferred implementations, after the larvae grafting needle 20 is separated from the cell, the larvae grafting needle 20 is in the third position w33. As shown in Figure 29, during larvae releasing, the larvae grafting needle 20 is moved forwards to the cell bar and aligned with the culture cup; the larvae grafting needle is moved downwards and obliquely enters the culture cup; when the larvae grafting element comes into contact with the culture cup, the larvae grafting element is inclined forwards; then, the second motor 3e is started, and the second gear rotates; and correspondingly, the second rack 5e moves downwards, the flat plate at the bottom of the second rack 5e abuts against the upper end of the larvae grafting needle and presses the larvae grafting needle (the operation of pressing the larvae grafting needle may also be completed directly by the motor 3e, as shown in Figure 24), such that the push tongue 7m moves downwards to push the bee larvae and the royal jelly on the surface of the larvae grafting element, and thereby, the bee larvae and the royal jelly are separated from the larvae grafting element 4f and enter the culture cup of the cell bar.

[262] Further, during the larvae releasing, after the larvae grafting element contacts the inner wall of the culture cup, the larvae grafting needle is moved upwards and backwards, such that the royal jelly attached

to the back of the larvae grafting element is scraped off by the edge of the culture cup at a certain point after (5), as shown in Figure 29, and then the larvae grafting needle continues to move upwards and backwards to leave the culture cup.

[263] By using the larvae grafting method of the present invention, the larvae grafting success rate is up to 95% or above, and the final larvae grafting survival rate is also higher. Compared with the traditional method in which the larvae are grafted straight up and down, the larvae grafting method of the present invention can protect the larvae grafting needle, prolong the service life of the larvae grafting needle and avoid hurting the bee larvae.

[264] **Embodiment 10**

[265] The present invention provides a detection device for larvae grafting, including a collecting element for collecting information of bee larvae in a cell, and a detecting element for detecting the bee larvae in the cell. The collecting element can transmit the collected information to the detecting element, and the detecting element can analyze the received information to obtain a detection result.

[266] In some preferred implementations, the detection device for larvae grafting further includes a locating element for identifying a position of the larvae grafting needle or the cell. The locating element may be a position sensor or the like.

[267] In some preferred implementations, the collecting element is an image pickup device configured to take photos of the inside of the cell and transmit information of the photos to the detecting element, and the detecting element can analyze the photos to obtain the detection result, i.e., whether there are bee larvae in the cell. The image pickup device may be a camera or the like, and may also be a conventional device capable of taking photos in the prior art. In some embodiments, the detecting element includes an image analysis unit. The image analysis unit includes, but not limited to, a GPU server, and a detecting module running on the GPU server to detect the bee larvae. The detecting module can analyze image data, and train a high-accuracy model based on a large number of training data sets to detect the image data.

[268] The present invention does not improve the structures of the image pickup device, the detecting element and the position sensor, but only uses the existing devices and techniques to achieve the purpose of detecting bee larvae.

[269] In some specific implementations, as shown in Figure 18, the present invention provides a detection device for larvae grafting, including a collecting element, a position sensor and the like. The larvae grafting mechanism includes a housing 1f. The housing is connected to a support frame. Two sides of the housing are connected with a mounting structure. The mounting structure includes a first mounting structure 2f and a second mounting structure 5f. The first mounting structure 2f can be used for mounting the collecting element. The second mounting structure can be used for mounting the position sensor that

can be used for identifying a position of the larvae grafting needle or the cell, which facilitates the adjustment of the position of the larvae grafting needle and the larvae grafting operation.

[270] Other implementations in this embodiment may be the same as those in Embodiments 1 to 7 or similar to those in Embodiments 1 to 7.

[271] **Embodiment 11**

[272] In other implementations, the present invention provides a detection device for larvae grafting, as shown in Figure 25, including a sliding bracket, a collecting element for collecting information of bee larvae in a cell, and a detecting element for detecting the bee larvae in the cell. The collecting element is mounted on the sliding bracket. The sliding bracket includes a sliding member. The sliding member can slide along a slideway, and the collecting element can move along with the sliding member.

[273] In some preferred implementations, the detection device for larvae grafting further includes a locating element for identifying a position of the larvae grafting needle or the cell.

[274] In some implementations, the collecting element is an image pickup device configured to take photos of the inside of the cell, and the locating element is a position sensor. The detecting element includes an image analysis unit. The image analysis unit includes, but not limited to, a GPU server, and a detecting module running on the GPU server to detect the bee larvae. The detecting module analyzes image data, and trains a high-accuracy model based on a large number of training data sets and authentication data sets to detect the image data.

[275] The present invention does not improve the structures of the image pickup device, the detecting element and the position sensor, but only uses the existing devices and techniques to achieve the purpose of detecting bee larvae.

[276] In some preferred implementations, as shown in Figure 25, the sliding bracket includes a first mounting arm 6k and a second mounting arm 7k. The image pickup device is mounted on the first mounting arm, and the position sensor 2k is mounted on the second mounting arm and/or the first mounting arm. In some embodiments, there may be one or more position sensors. When the sliding member 5k slides along a slideway, the slideway is arranged in parallel to the slide rails in the left-right position adjustment mechanism. The image pickup device can move along with the position sensor 2k.

[277] In some preferred implementations, a side of the first mounting arm 6k is connected with a mounting member 4k, and the image pickup device can be mounted at an image pickup device mounting part of the mounting member 4k.

[278] In some preferred implementations, the first mounting arm 6k and the second mounting arm 7k are spaced by a certain distance and arranged in opposite to each other.

[279] In some preferred implementations, the detection device further includes a clamping structure. The clamping structure includes a clamping part.

[280] In some implementations, as shown in Figure 23, the clamping structure is fixedly connected to the support frame, and the clamping structure does not interfere with the height adjustment mechanism. In some preferred implementations, as shown in Figure 23, the clamping structure has a clamping part 1k configured to be clamped with other components. In some preferred implementations, the clamping part 1k is a curved clamping part 1k. The curved clamping part 1k is tightly combined with a component to be clamped, so as to connect the component to be clamped and the support frame together.

[281] In some preferred implementations, as shown in Figure 25, the first mounting arm 6k is connected with a clamping member 3k. The clamping member 3k can be fitted with the clamping part 1k to realize clamping connection. In some preferred implementations, the clamping piece 3k has a curved surface, and the curved surface can be combined with the curved clamping part 1k.

[282] After the clamping structure is combined with the clamping member 3k, when the larvae grafting needle is driven by the left-right position adjustment mechanism to move leftwards or rightwards, the image pickup device and the position sensor 2k can move leftwards or rightwards along with the larvae grafting needle. Since the image pickup device and the position sensor 2k are not fixedly connected to the support frame, when the larvae grafting needle moves up and down along the column 2e, the image pickup device and the position sensor 2k are not affected, and vibrations caused by the upward or downward movement of the larvae grafting needle have little influence on the image pickup device and the position sensor 2k, which can protect the image pickup device and the position sensor 2k, avoid affecting their operations and prolong their service life. In the prior art, in some larvae grafting mechanisms, the image pickup device, the position sensor 2k and the larvae grafting needle are all mounted in one mounting mechanism. This makes the image pickup device and the position sensor 2k move upward or downward along with the larvae grafting needle, so that the image pickup device and the position sensor 2k are susceptible to vibrations during the movement, and components connected with the image pickup device and the position sensor 2k are susceptible to vibrations or wear during the frequent upward or downward movement.

[283] Other implementations in this embodiment may be the same as those in Embodiments 1 to 7 or similar to those in Embodiments 1 to 7.

[284] It should be understood by those skilled in the art that the technical features of the above-mentioned embodiments can be arbitrarily combined. For the sake of concise description, all possible combinations of the technical features in the above-mentioned embodiments are not described. However, as long as there is no contradiction in the combination of these technical features, it should be considered as falling within the scope recorded in this specification.

[285] In the above-mentioned embodiments, only several implementations of this application are expressed, which are specifically described in detail, but this should not be understood as limiting the

scope of the invention patent. It should be noted that, for those of ordinary skills in the art, without departing from the concept of this application, several modifications and improvements can be made, all of which are within the scope of protection of this application.

Claims

1. A larvae grafting device, comprising a supporting point structure for supporting a support point on a larvae grafting needle, and a motion module structure for driving a movable point on the larvae grafting needle to move.

2. The device according to claim 1, wherein the support point on the larvae grafting needle is rotatable around the supporting point structure.

3. The device according to claim 1, wherein the device comprises a first mounting mechanism, the first mounting mechanism comprises a supporting point structure, and the support point structure is used for fitting with the support point on the larvae grafting needle, such that the support point on the larvae grafting needle is rotatable around the support point structure or the supporting point structure.

4. The device according to claim 1, wherein the supporting point structure comprises a groove, a notch or a pin.

5. The device according to claim 4, wherein the support point on the larvae grafting needle comprises a protrusion or wing structure fitted with the groove; or a hole fitted with the pin.

6. The device according to any of claims 1 to 5, wherein the device further comprises a motion module, and the motion module is capable of driving the movable point on the larvae grafting needle to move.

7. The device according to claim 6, wherein the movement of the movable point drives the rotation of the support point on the needle around a supporting point or the supporting point structure.

8. The device according to claim 7, wherein the rotation is, relative to a vertical direction, clockwise or counterclockwise rotation, or reciprocating rotation between clockwise and counterclockwise by any angle.

9. The device according to claim 6, wherein the device comprises a second mounting mechanism used for mounting the motion module.

10. The device according to claim 6, wherein the movement of the motion module is a lateral movement relative to a longitudinal direction of the needle.

11. The device according to claim 6, wherein the movement of the movable point drives the movement of the support point, so that a larvae grafting element enters a honeycomb cell at an angle with the cell.

12. The device according to claim 11, wherein a head of the larvae grafting element is allowed to form an angle, for example, an acute angle, with a wall of the cell.

13. The device according to claim 6, wherein the device comprises a motor, and the motor pushes the motion module to move.

14. The device according to claim 6, wherein with the Y-axis as the ordinate and the X-axis as the abscissa, the movable point on the larvae grafting needle is located in quadrant I, and the larvae grafting element is located in quadrant III; or the movable point is located in quadrant II, and the larvae grafting element is located in quadrant IV.

15. The device according to claim 14, wherein a central axis of the cell containing larvae is parallel to the Y-axis, or the Y-axis coincides with the central axis of the cell.

16. The device according to claim 6, wherein the device comprises an elastic element, and one end of the elastic element is arranged on the motion module.

17. The device according to any of claims 1 to 17, wherein the device comprises a guide mechanism containing a guide surface, and the guide surface is configured to guide the larvae grafting needle to move up and down and to adjust a movement locus of the movable point on the larvae grafting needle.

18. The device according to claim 17, wherein the guide surface contacts the motion module and guides the movement of the motion module to adjust the movement locus of the movable point.

19. The device according to claim 18, wherein the guide surface comprises surfaces with different lateral heights.

20. The device according to claim 19, wherein when the motion module moves on the undulating guide surface, the movement locus of the motion module is controlled under the action of elasticity, compression or tension of the elastic element.

21. The device according to claim 19, wherein in the process of driving, by the motion module, the movable point to move, when the needle or the larvae grafting element is in a vertical position, the elastic element is compressed; or when the elastic element is in a natural state, the motion module is away from a vertical direction (rightwards or leftwards relative to the lateral direction), and the larvae grafting element is inclined leftwards or rightwards.

22. The device according to claim 17, wherein the guide surface comprises a first guide surface and a second guide surface, a lateral height of the first guide surface being greater than that of the second guide surface.

23. The device according to claim 17, wherein the guide surface further comprises a third guide surface, a lateral height of the second guide surface being greater than that of the third guide surface.

24. The device according to claim 22, wherein when the motion module is in contact with the first guide surface of the guide surface, the motion module makes the movable point on the needle basically in the vertical direction, and at this time, the elastic element is compressed; or when the motion module is on the second guide surface, a resilient force of the elastic element pushes the motion module to move away from the vertical direction so as to drive the movable point to be away from the vertical direction, so that

the movement of the movable point drives the rotation of the support point, and thereby, an end with the larvae grafting element is away from the vertical direction.

25. The device according to claim 17, wherein a first mounting structure and a second mounting structure make an up-and-down movement relative to the guide mechanism.

26. The device according to claim 25, wherein the guide mechanism is fixed on the device, and the mounting structure with the needle makes the up-and-down movement along the guide surface.

27. The device according to claim 6, wherein the motion module is provided with a mounting hole used for mounting the movable point of the larvae grafting needle.

28. The device according to claim 17, wherein the motion module comprises a rolling element used for contacting the guide surface and making a rolling movement on the guide surface.

29. The device according to claim 1 to 29, wherein the device comprises a control mechanism used for applying a lateral opposite force to the motion module.

30. The device according to claim 29, wherein the opposite force is a force in an opposite direction to the lateral movement of the motion module.

31. A larvae grafting method, comprising: providing a device, wherein the device comprises a supporting point structure for supporting a support point on a larvae grafting needle; and allowing a movable point on the larvae grafting needle to move so as to drive the support point to move around the supporting point structure.

32. The method according to claim 31, wherein the support point on the larvae grafting needle is allowed to make a rotational movement around the supporting point structure.

33. The method according to claim 31, wherein the device comprises a motion module, and the motion module is allowed to drive the movable point on the needle to make a lateral movement.

34. The method according to claim 31, wherein the supporting point structure comprises a groove, a notch or a pin; and the support point is allowed to make a rotational movement around a groove, a notch or a pin.

35. The method according to claim 32, wherein the rotation of the support point around the supporting point structure is, for example, clockwise or counterclockwise rotation, or reciprocating rotation between clockwise and counterclockwise by any angle.

36. The method according to claim 32, wherein the rotation of the support point is allowed to drive the larvae grafting element on the needle to form an angle, for example, an acute angle, with a wall of a honeycomb.

37. The method according to claim 32, wherein the rotation of the support point is allowed to drive a larvae grafting element on the needle not to coincide with an axis of the honeycomb.

38. The method according to claim 36, wherein the movement of the movable point drives the movement of the support point, so that a larvae grafting element enters a honeycomb cell at an angle with a wall of the cell.

39. The method according to claim 36, wherein with the Y-axis as the ordinate and the X-axis as the abscissa, when the movable point on the larvae grafting needle is located in quadrant I, the larvae grafting element is located in quadrant III; or the movable point is located in quadrant II, and the larvae grafting element is located in quadrant IV.

40. The method according to claim 39, wherein a central axis of the cell is parallel to the Y-axis, or the Y-axis coincides with the central axis of the cell.

41. The method according to claim 33, wherein the motion module is allowed to make an up-and-down movement on a guide surface of a guide mechanism so as to adjust a lateral movement locus of the movable point on the needle, thereby adjusting an angle of rotation of the support point, and further adjusting an angle of inclination of the larvae grafting element or an included angle between the larvae grafting element and the cell.

42. The method according to claim 33, wherein the guide surface has one or more surfaces with different lateral heights.

43. The method according to claim 42, wherein the device further comprises an elastic element, and one end of the elastic element is connected to the motion module; and when the motion module moves on the undulating guide surface, the movement locus of the motion module is controlled under the action of elasticity, compression or tension of the elastic element.

44. The method according to claim 43, wherein in the process of driving, by the motion module, the movable point to move, when the needle or the larvae grafting element is in a vertical position, the elastic element is compressed; or when the elastic element is in a natural state, the motion module is away from a vertical direction (rightwards or leftwards relative to the lateral direction), and the larvae grafting element is inclined leftwards or rightwards.

45. The method according to claim 44, the guide surface comprises a first guide surface and a second guide surface, a lateral height of the first guide surface being greater than that of the second guide surface.

46. The method according to claim 44, wherein the guide surface further comprises a third guide surface, a lateral height of the second guide surface being greater than that of the third guide surface.

47. The method according to claim 45, wherein when the motion module is in contact with the first guide surface of the guide surface, the motion module makes the movable point on the needle basically in the vertical direction, and at this time, the elastic element is compressed; or when the motion module is on the second guide surface, a resilient force of the elastic element pushes the motion module to move away from the vertical direction so as to drive the movable point to be away from the vertical direction, so that

the movement of the movable point drives the rotation of the support point, and thereby, an end with the larvae grafting element is away from the vertical direction.

48. A larvae grafting method, comprising:

allowing an elastic larvae grafting element to form an acute angle with a wall of a cell, and allowing the elastic larvae grafting element to be straight.

49. The method according to claim 48, wherein the elastic element is allowed to be straight by a sliding push block on a needle, for example, when the sliding push block retracts, the elastic element is bent, and when the sliding push block is pushed to a tail end of the elastic element, the elastic element is pushed straight by the push block.

50. The method according to claim 48, wherein the elastic larvae grafting element is allowed to contact the wall of the cell and form an acute angle with the wall of the cell.

51. The method according to claim 50, wherein the elastic element being bent means that the elastic element contacts the wall of the cell and moves downward such that the elastic element is made bent along the wall of the cell and a bottom of the cell.

52. A larvae grafting method, comprising the following steps: step 1: allowing a larvae grafting needle to be in a second position, wherein at this time, the larvae grafting element is in contact with an inner wall of a cell, and the second position means: a movable point of the larvae grafting needle is inclined forwards, the larvae grafting element is inclined backwards, and the larvae grafting element is inclined backwards at a certain angle relative to a vertical direction, such that the larvae grafting element is straight instead of being bent; and

step 2: allowing the larvae grafting needle to be in a third position, thereby completing the larvae grafting operation in the process of changing the larvae grafting needle from the second position to the third position; wherein the third position means: the movable point of the larvae grafting needle is inclined backwards, the larvae grafting element is inclined forwards, the larvae grafting element is inclined forwards at a certain angle relative to the vertical direction, and bee larvae or larvae are carried on or attached to the larvae grafting element.

53. The method according to claim 52, wherein in steps (1) to (2), the certain angle is 5°-40°.

54. The method according to claim 53, wherein in step (2), in the process of changing the larvae grafting needle from the second position to the third position, the larvae grafting element is bent, the movable point on the larvae grafting needle swings backwards, the larvae grafting element moves forwards, and the larvae grafting element stirs royal jelly containing the bee larvae, such that the royal jelly containing the bee larvae is attached to the larvae grafting element.

55. The method according to claim 54, wherein in step (2), after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle is moved upwards and separated from the cell.

56. The method according to claim 54, wherein in step (2), after the bee larvae are carried onto the larvae grafting element, the larvae grafting needle is moved upwards and backwards and separated from the cell.

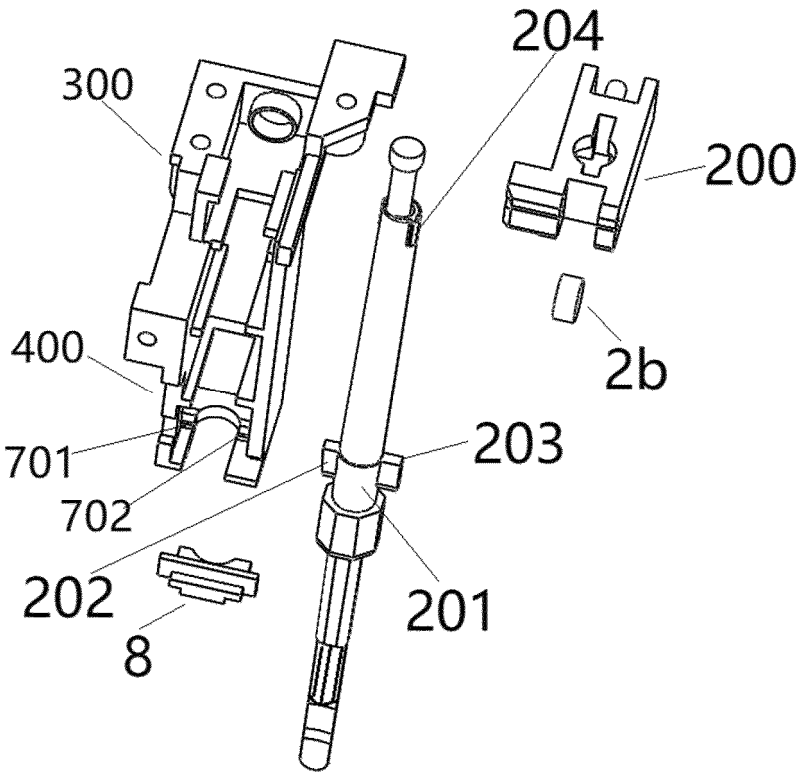


Figure 1

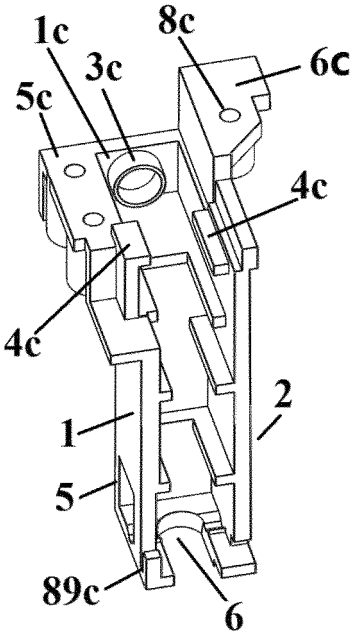


Figure 2

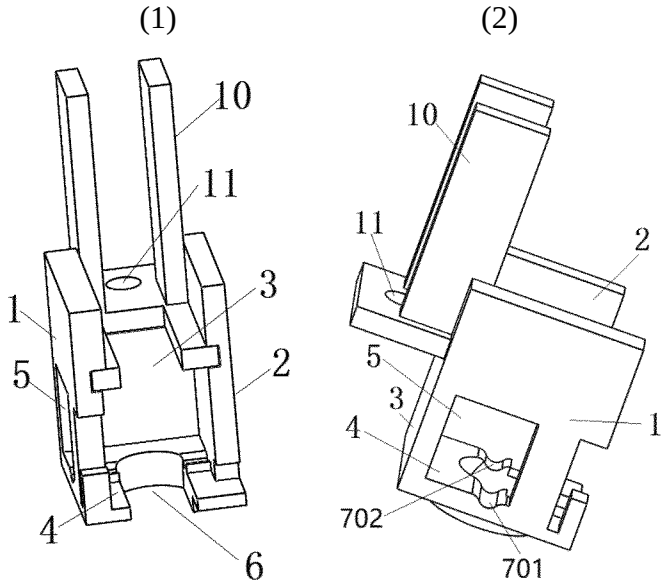


Figure 3

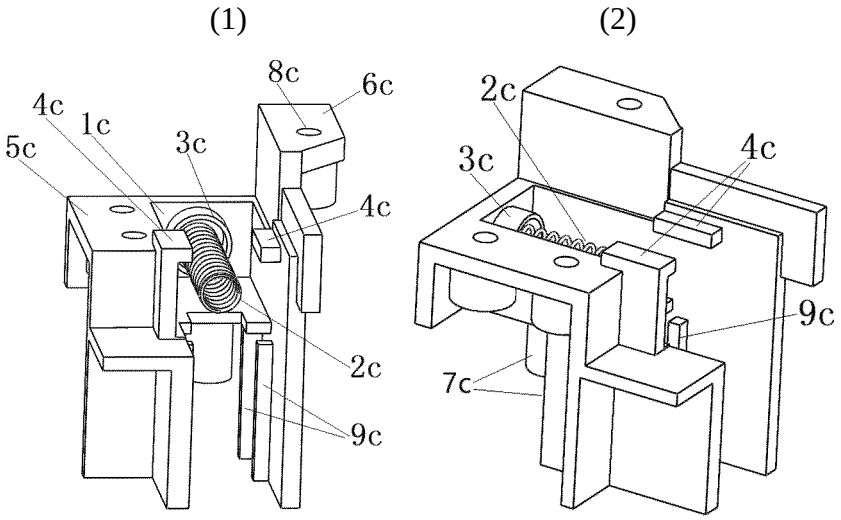


Figure 4

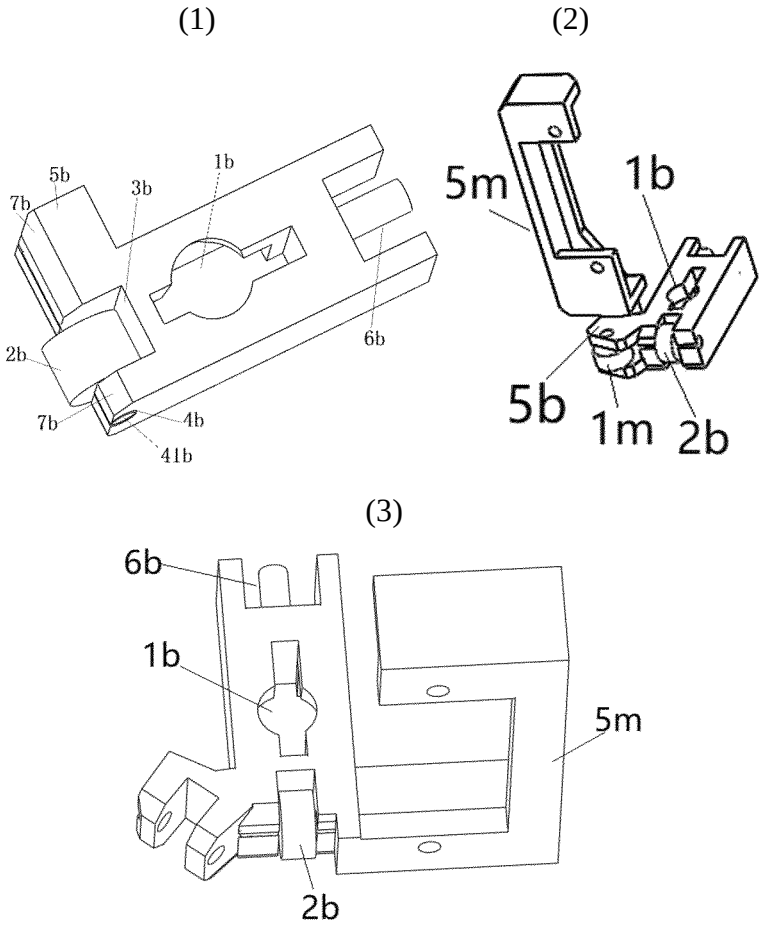


Figure 5

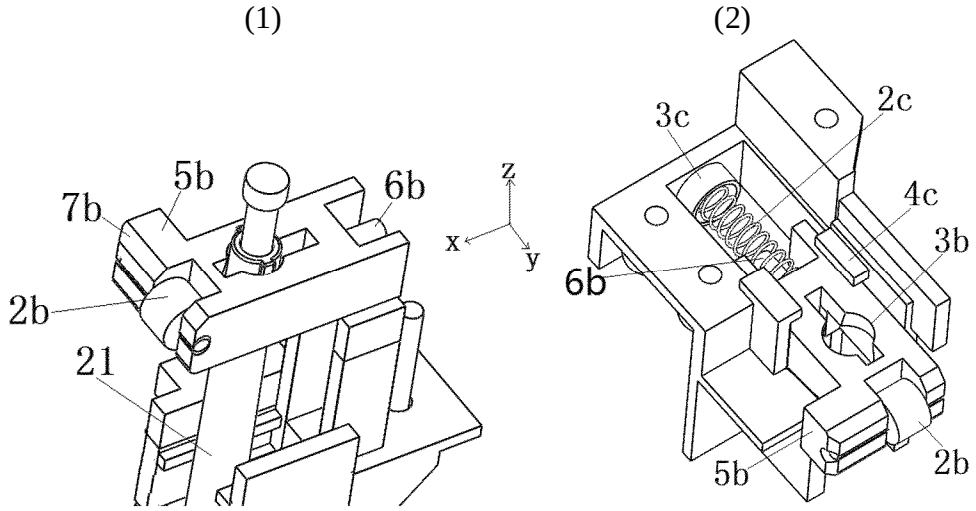


Figure 6

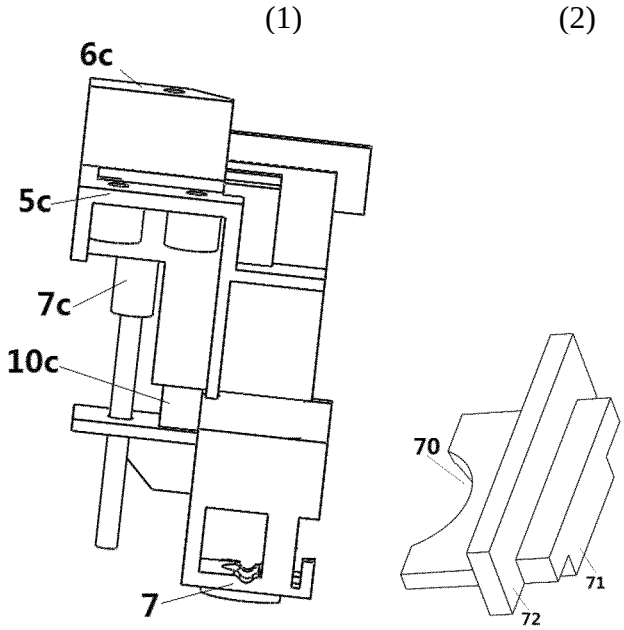


Figure 7

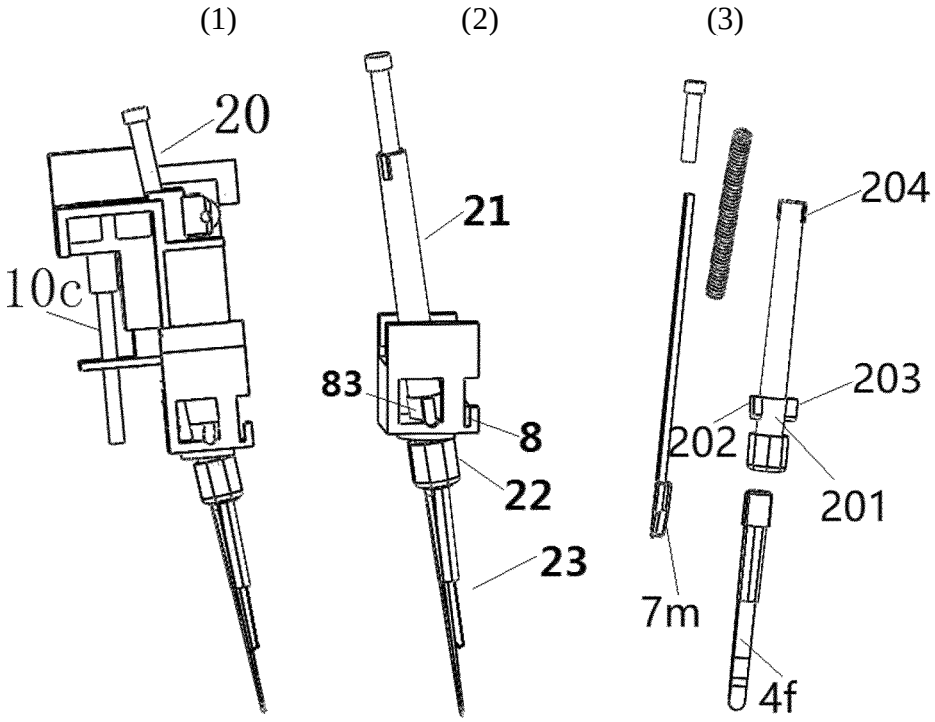


Figure 8

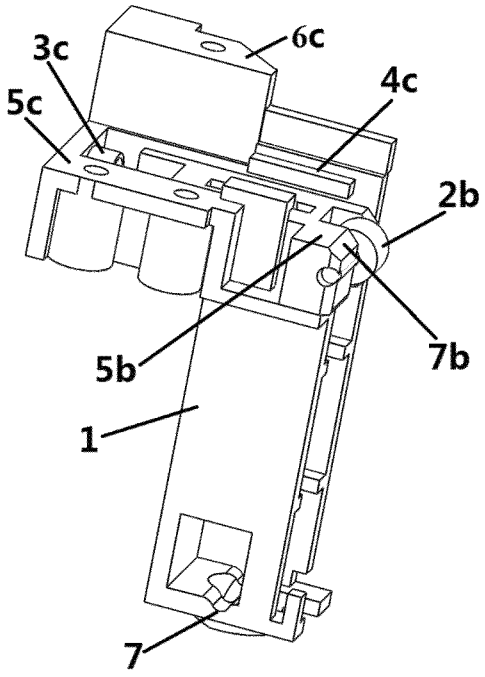


Figure 9

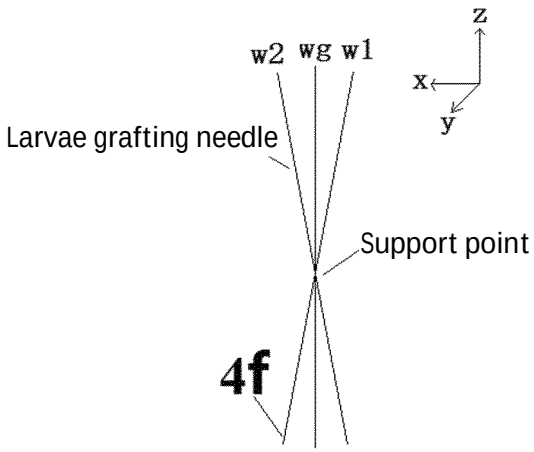
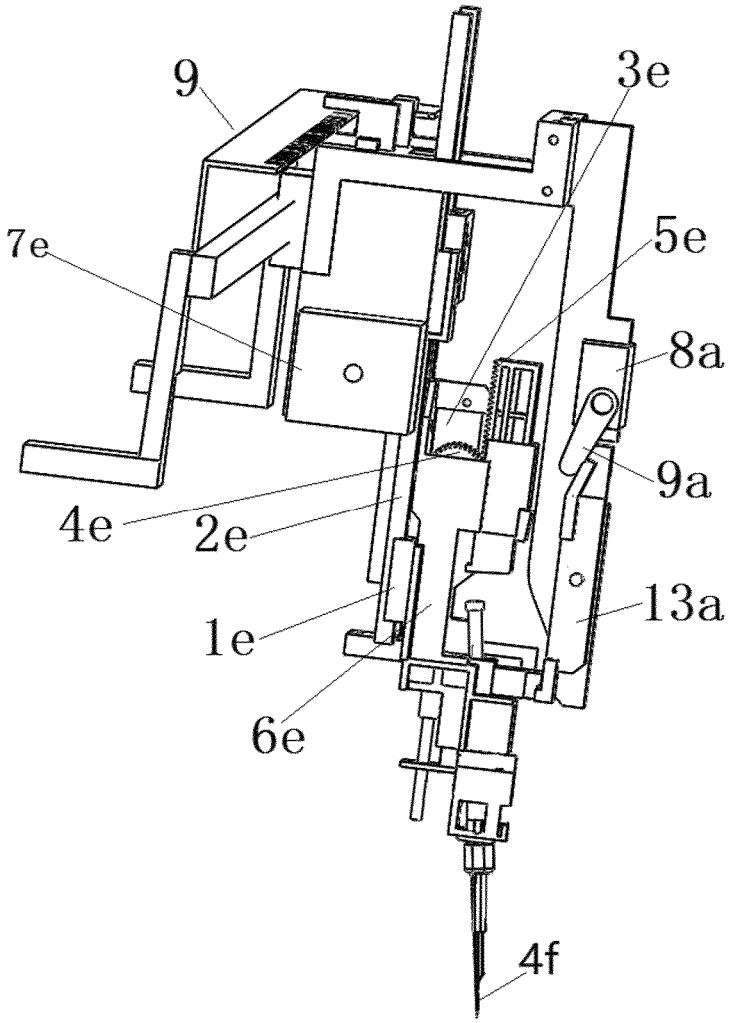

w2 wg w1
z
x
y
Larvae grafting needle
Support point
4f

Figure 10

(1)


9
3e
7e
5e
8a
9a
4e
2e
13a
1e
6e
4f

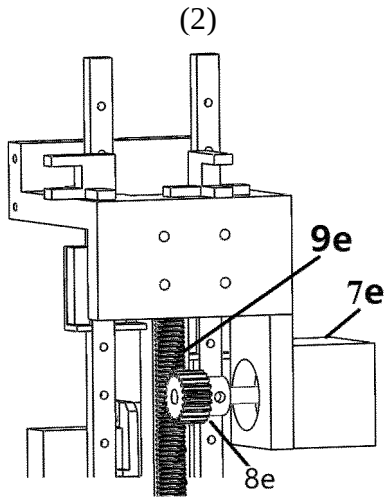


Figure 11

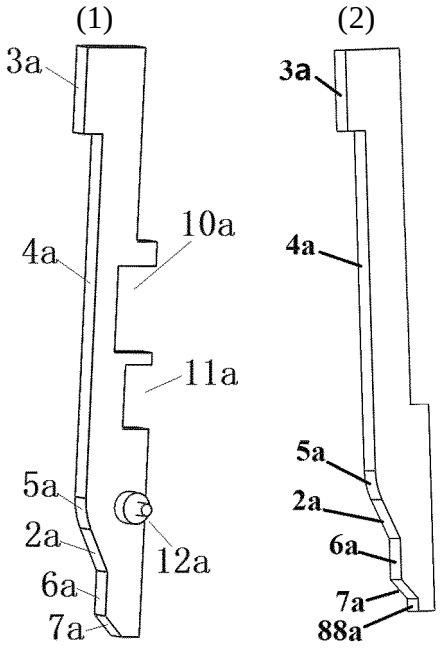


Figure 12

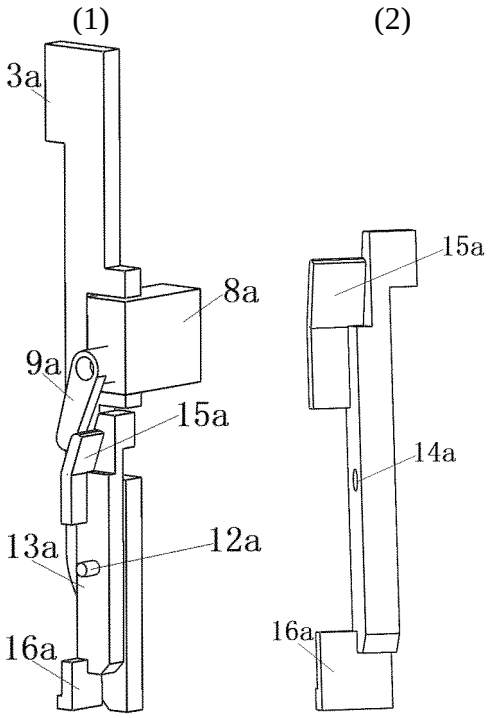


Figure 13

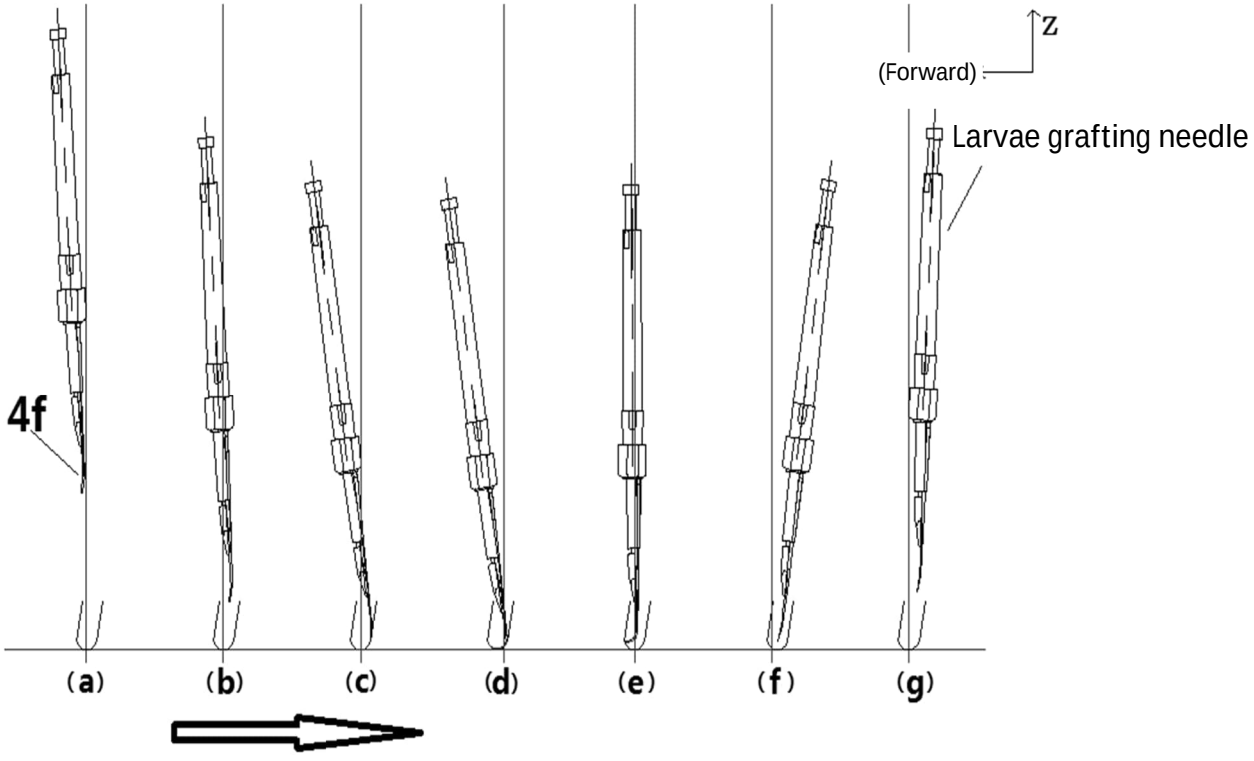


Figure 14

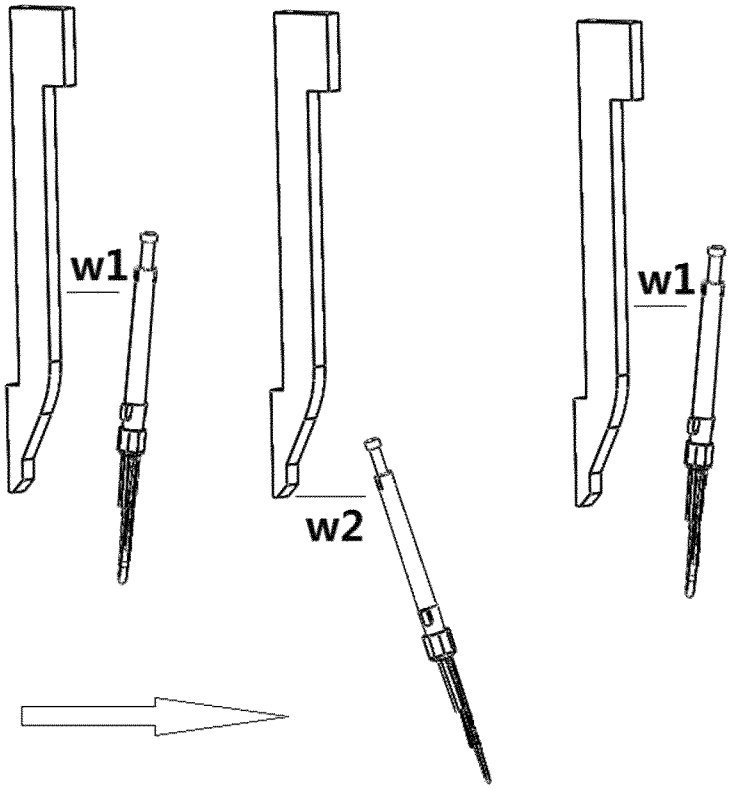


Figure 15

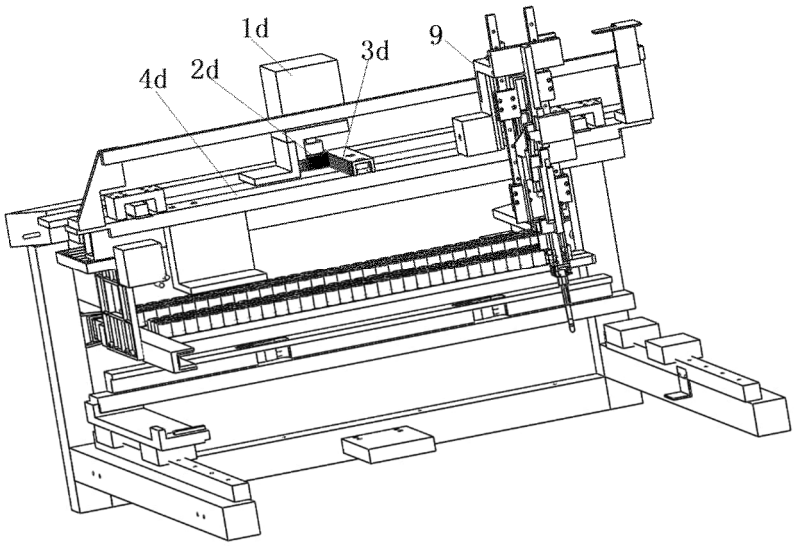


Figure 16

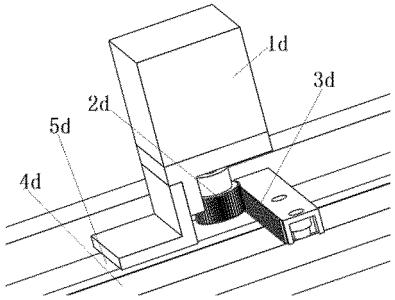


Figure 17

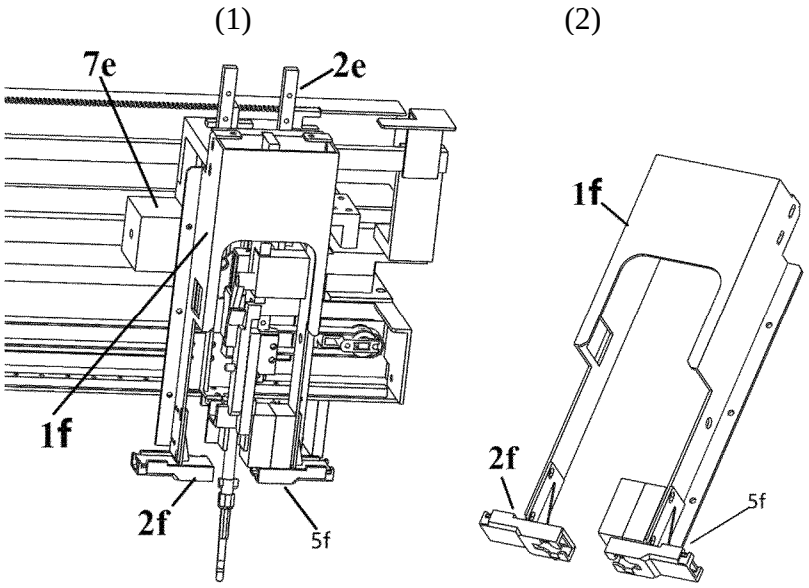


Figure 18

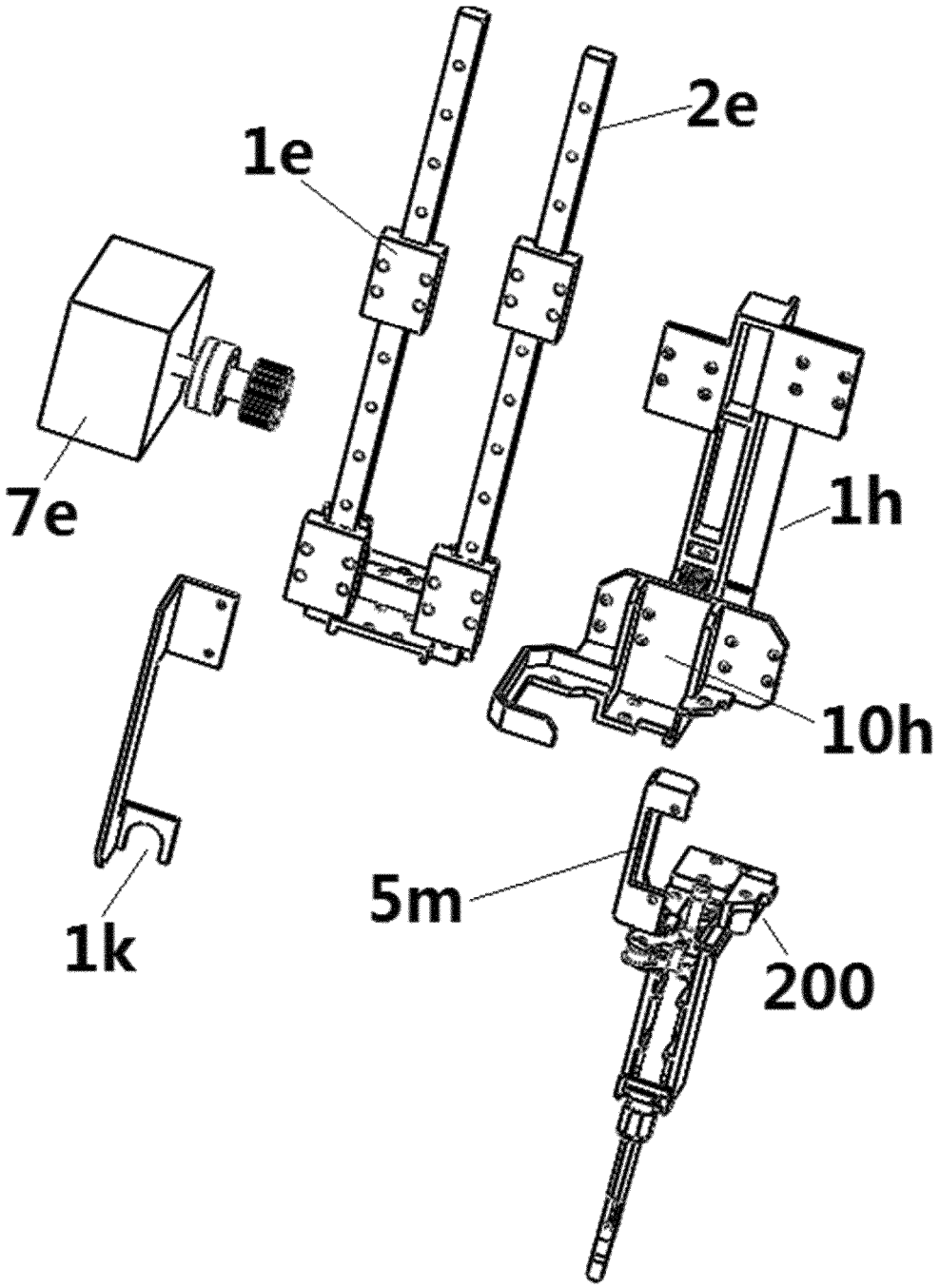


Figure 19

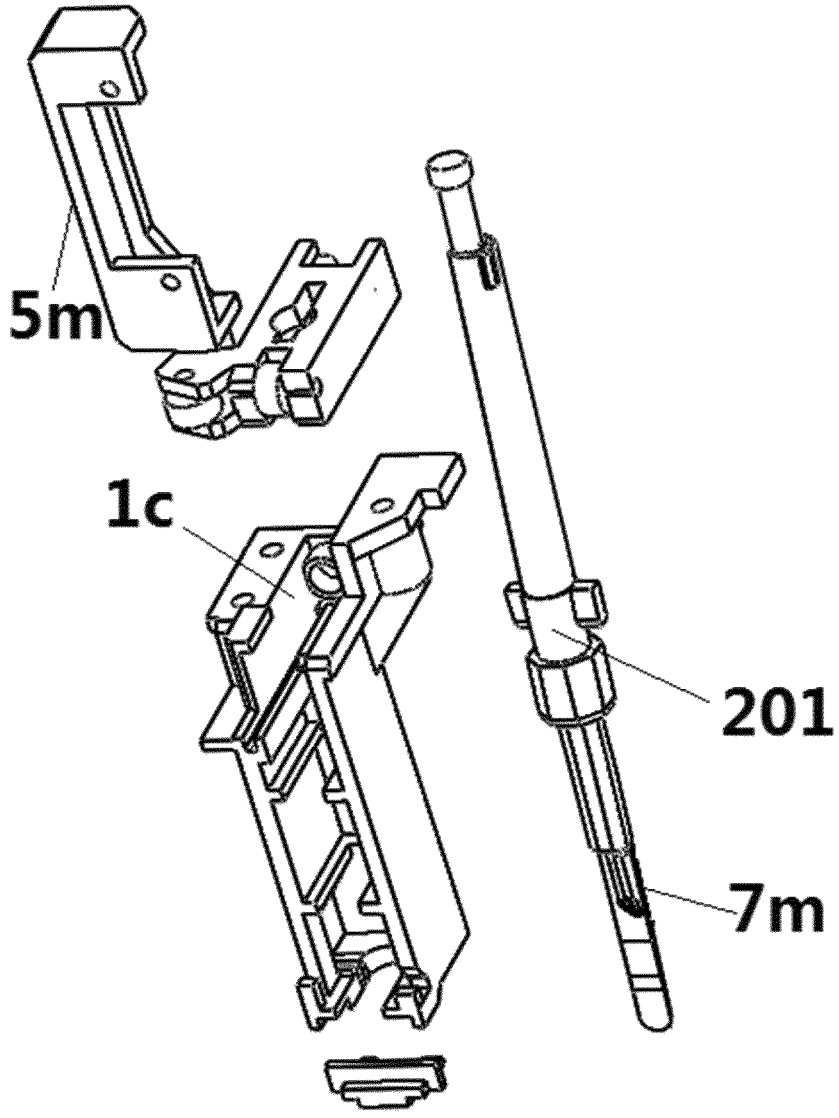


Figure 20

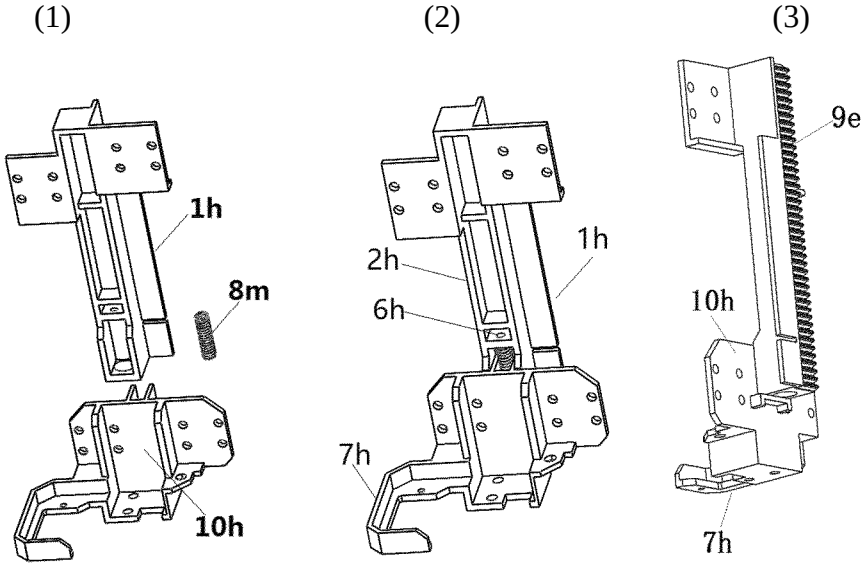


Figure 21

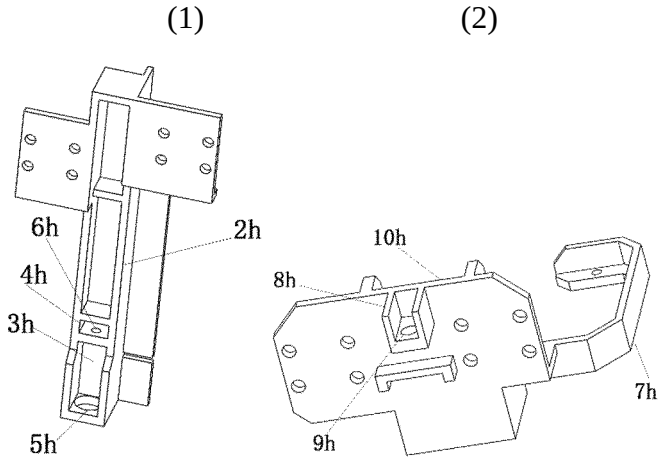


Figure 22

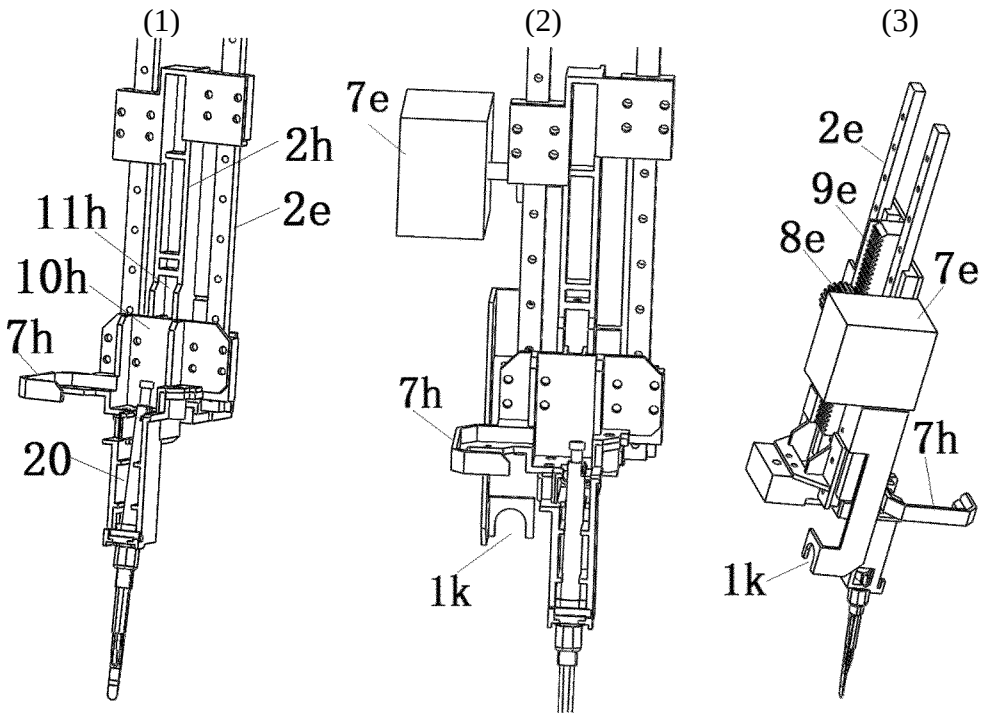
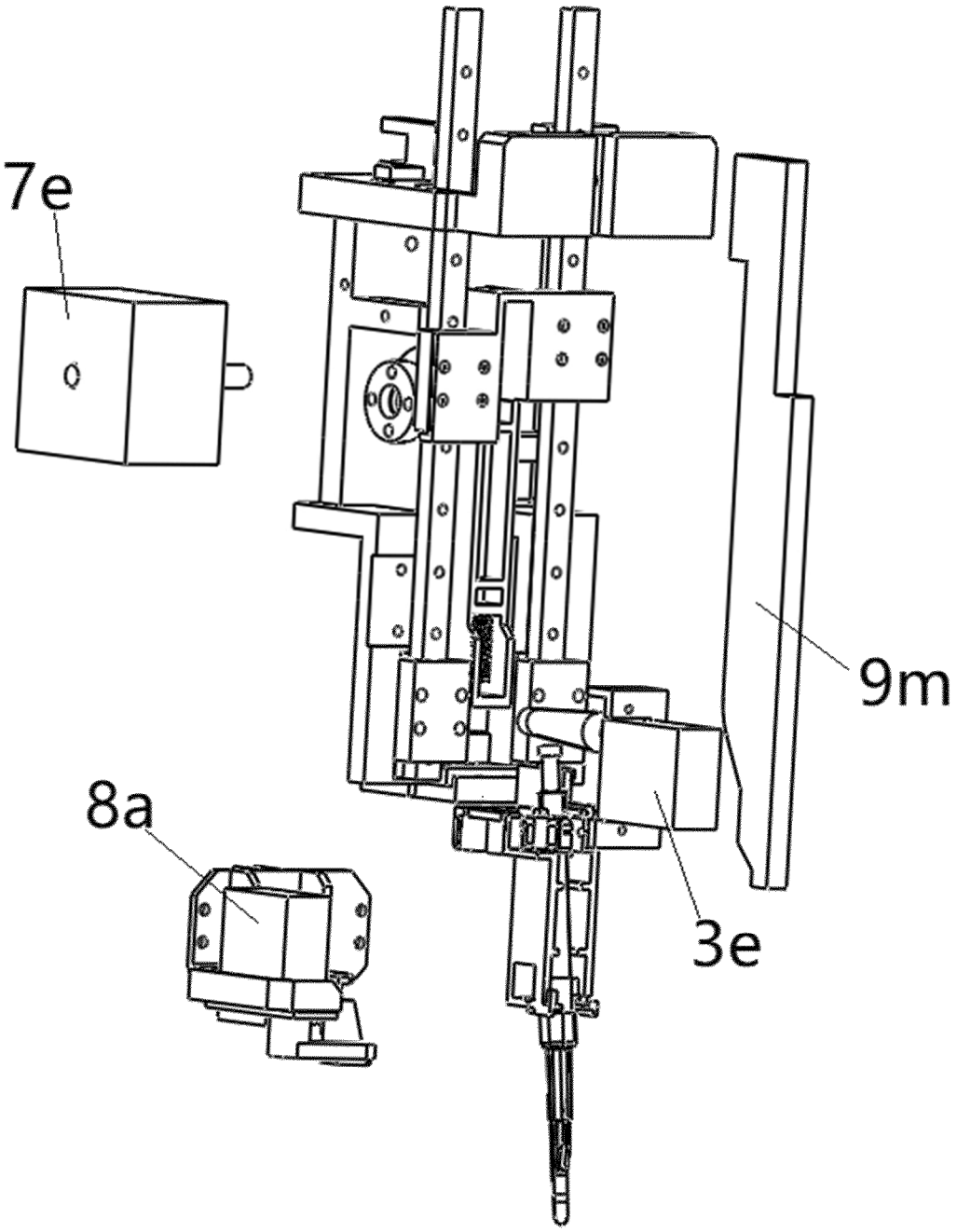
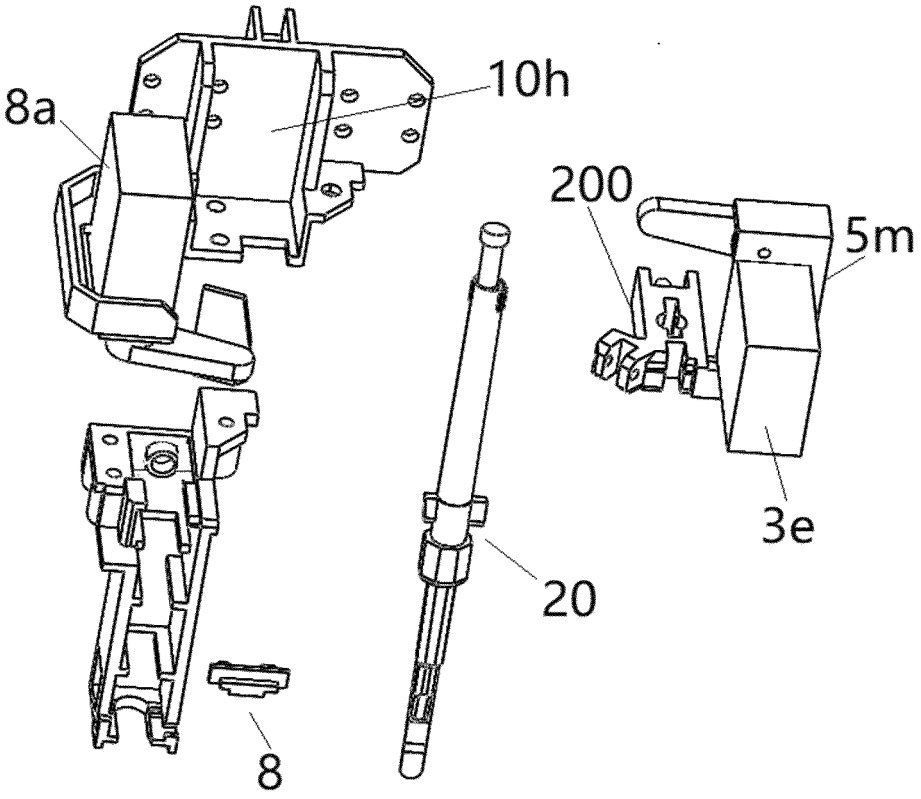


Figure 23

(1)



(2)



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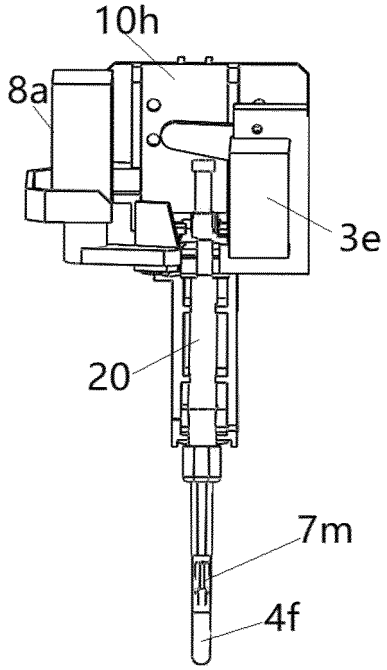

Figure 24

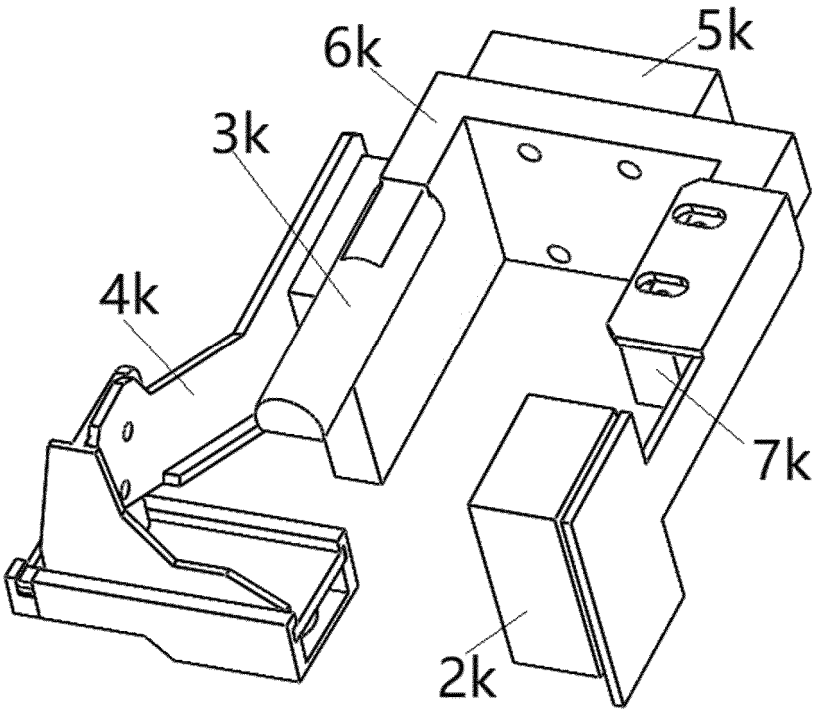

Figure 25

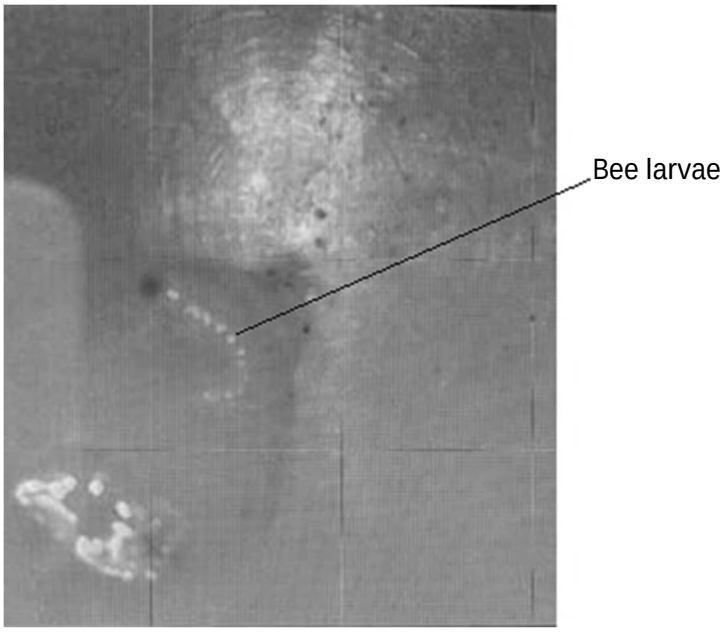

Figure 26

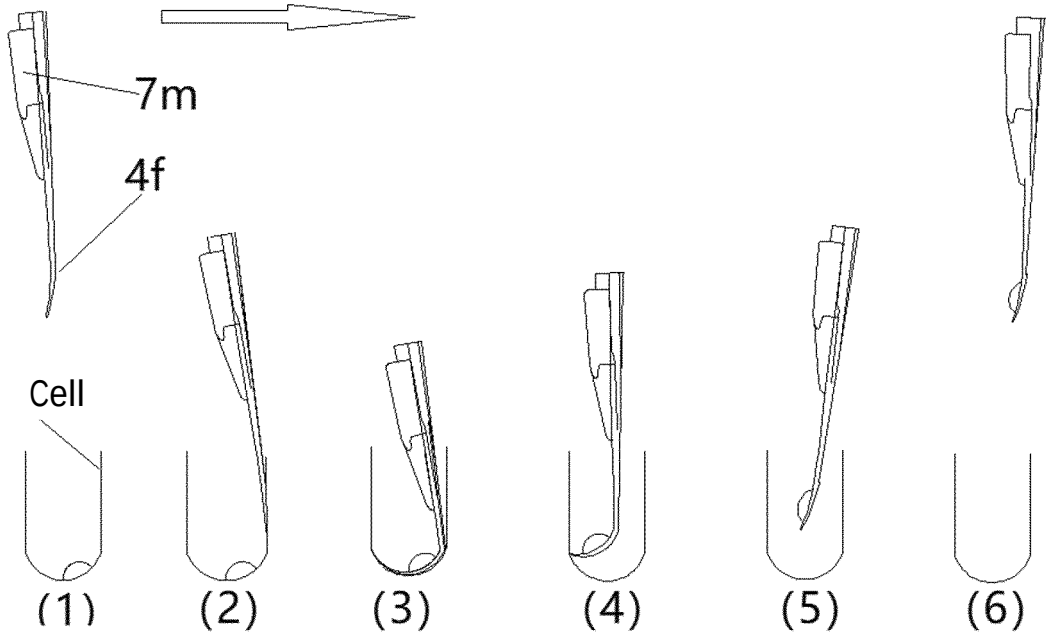

Figure 27

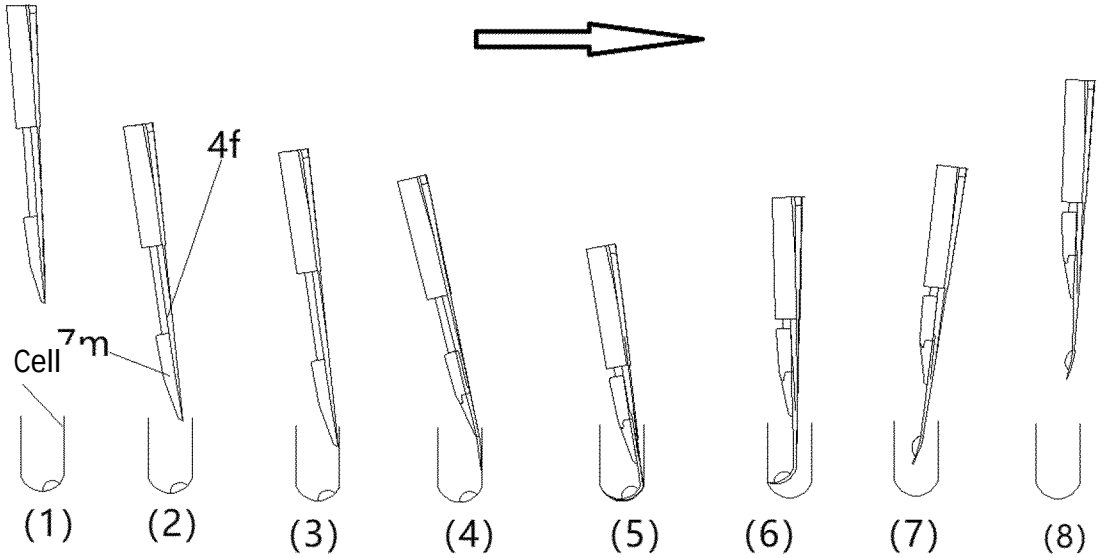

Figure 28

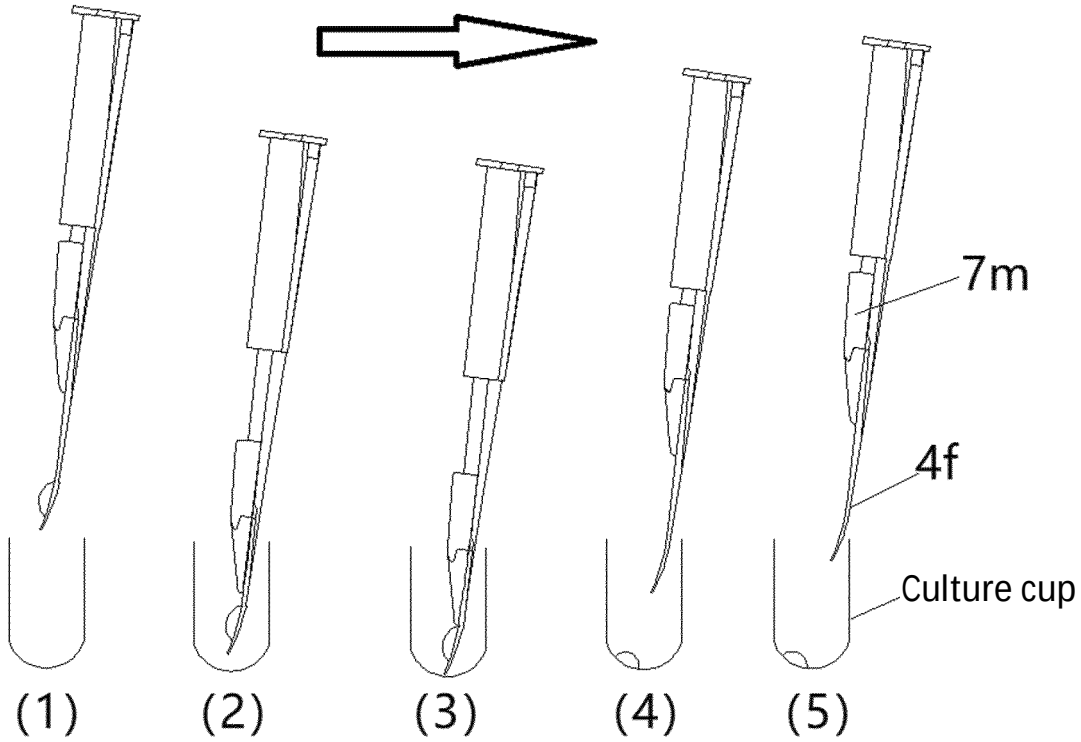

Figure 29