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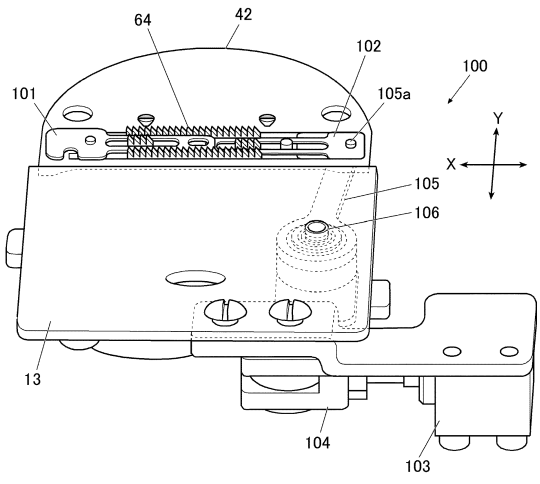
(54) Sewing machine

(57) A sewing machine (10) comprises a throat plate (40, 40A) formed with a needle hole (411, 421, 431A) through which a sewing needle (11) passes, a moving mechanism (60) configured to move a workpiece along an upper surface of the throat plate (40, 40A), a needle up-down moving mechanism (30) configured to move the sewing needle (11), a shuttle mechanism (50) configured to capture an upper thread (U) from the sewing needle (11) below the throat plate (40, 40A) and to interlace the upper thread (U) with a lower thread (D); a thread cutting device (80, 80A) provided between the throat plate (40, 40A) and the shuttle mechanism (50) to cut the upper and lower threads (U, D), a wiper mechanism (90) configured to pull out, upwardly from the workpiece, a sewing needle side portion of the upper thread (U) that has been cut by the thread cutting device (80, 80A), a control device (120), a remaining end cutoff mechanism (100, 100A) disposed below the upper surface of the throat plate (40, 40A) and above the thread cutting device (80, 80A). The remaining end cutoff mechanism (100, 100A) is configured to cut off, after the lower thread (D) and the upper thread (U) are cut by the thread cutting device (80, 80A), remaining end portions of the lower thread (D) and the upper thread (U) connected to the workpiece.

FIG. 10



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Description

[0001] The present invention relates to a sewing machine having a thread cutting device for cutting an upper thread and a lower thread.

[0002] A sewing machine that forms stitches by knotting an upper thread and a lower thread by cooperative operation of a needle up-down moving mechanism and a shuttle mechanism includes a thread cutting device to cut the threads after performing thread sorting for sorting the lower thread and the upper thread into a cloth-side portion and a sewing needle side portion below a throat plate. Most of such thread cutting devices are a turning type in which a knife turns around the shuttle and a horizontal type in which a knife moves along a horizontal plane.

[0003] The turning type thread cutting device includes a stationary thread cutting knife and a movable thread cutting knife that are supported turnably around a horizontal shuttle. When performing the cutting, the stationary thread cutting knife that is retreated from a stitch point during the sewing advances to a position just before the stitch point, and the movable thread cutting knife moves in a direction opposite to the advancing direction of the stationary thread cutting knife and reaches the advanced position of the movable thread cutting knife while performing the thread sorting at the stitch point and cuts the lower thread and the cloth-side portion of the upper thread (see, e.g., JPH07-155489A).

[0004] The horizontal type thread cutting device includes a movable thread cutting knife that turns back and forth in a reciprocating manner along a horizontal plane so as to pass through the stitch point, and a stationary thread cutting knife provided near the stitch point. The movable thread cutting knife performs the thread sorting when turning forward, and when turning backward, cuts the lower thread and the cloth-side portion of the upper thread in cooperation with the stationary thread cutting knife (see, e.g., JP2007-029437A).

[0005] However, each of the thread cutting devices described above performs the thread cutting below the throat plate. As a result, even if the thread cutting knife is disposed close to the throat plate to set the cutting position close to the stitch point, remaining end portions (remaining threads) of sewing threads longer than the thickness of the throat plate remain on the cloth after the thread cutting. Therefore, when it is desired to minimize the remaining end portions of the sewing threads, manual cutting is necessary.

[0006] Cloth feeding by using a feed dog that projects from and sinks below the throat plate has the following problem. That is, in the thread cutting device, cutting is performed when the sewing needle is positioned near the top dead point so as to prevent interference between the sewing needle and the thread cutting knife. On the other hand, the feed dog performs feeding when the sewing needle is higher than the throat plate, so that at the cutting timing described above, as shown in Fig. 14A, the feed dog maximally projects from the throat plate and pushes the cloth up from the throat plate. As a result, the distance from the cloth to the thread cutting knife is increased by the amount of pressing up by the feed dog from the throat plate, so that remaining end portions of the sewing threads become longer.

[0007] Further, when performing cloth feeding by using a feed dog, if thread cutting is performed near the top dead point of the sewing needle after the downward movement of the needle in the final stitch, the feed dog has already started cloth feeding, so that by the amount of feeding, the distance from the cloth to the thread cutting knife is increased, so that remaining end portions of the sewing threads become longer. Further, the upper thread that has been pulled down below the cloth at the time of the final stitch is cut, so that at the stitch point of the final stitch, no knot of the upper thread and the lower thread is formed, and a remaining end portion of the upper thread extends from the stitch point of the final stitch, and a remaining end portion of the lower thread extends from the stitch point of the stitch immediately before the final stitch. Therefore, as shown in Fig. 13B, remaining end portions extend from the two separate locations, which deteriorates the sewing quality.

[0008] It is an object of the present invention to make remaining end portions of upper and lower threads shorter.

[0009] According to an aspect of the present invention, a sewing machine comprises a throat plate through which a needle hole is formed to allow a sewing needle to pass through the needle hole, a moving mechanism configured to move a workpiece along an upper surface of the throat plate, a needle up-down moving mechanism configured to move the sewing needle up and down, a shuttle mechanism configured to capture an upper thread from the sewing needle below the throat plate and to interlace the upper thread with a lower thread, a thread cutting device provided between the throat plate and the shuttle mechanism and configured to cut the lower thread and the upper thread, a wiper mechanism configured to pull out, upwardly from the workpiece, a sewing needle side portion of the upper thread that has been cut by the thread cutting device, and a control device configured to control operations of the moving mechanism, the thread cutting device and the wiper mechanism. The sewing machine is characterized in that it further comprises a remaining end cutoff mechanism disposed below the upper surface of the throat plate and above the thread cutting device. The remaining end cutoff mechanism is configured to cut off, after the lower thread and the upper thread are cut by the thread cutting device, remaining end portions of the lower thread and the upper thread connected to the workpiece.

[0010] With this configuration, the remaining end cutoff mechanism is disposed below the upper surface of the throat plate and above the thread cutting device, and this remaining end cutoff mechanism cuts off the remaining end portions of the lower thread and the upper thread on

the workpiece side that has been cut by the thread cutting device. Therefore, the finally remaining end portions of the lower thread and the upper thread can be shortened.

[0011] The throat plate may have a double layer structure comprising an upper layer and a lower layer, and the remaining end cutoff mechanism may comprise a cutoff knife incorporated between the upper layer and the lower layer to cut off, after the lower thread and the upper thread are cut by the thread cutting device, the remaining end portions of the lower thread and the upper thread connected to the workpiece.

[0012] With this configuration, the cutoff knife of the remaining end cutoff mechanism is incorporated between the upper and lower layers of the throat plate to cut off the remaining end portions of the lower thread and the upper thread on the workpiece side that has been cut by the thread cutting device. Therefore, the length of the finally remaining end portions of the lower thread and the upper thread added due to the thickness of the throat plate can be reduced.

[0013] The control device may be configured to control a feeding amount of the moving mechanism such that the feeding amount from a stitch point of a stitch immediately before a final stitch, at which the threads are cut by the thread cutting device, to a stitch point of the final stitch is zero or smaller than an immediately previous feeding amount.

[0014] With this configuration, the stitch point of the final stitch becomes the same as or close to the stitch point of the stitch immediately before the final stitch. This prevents an increase in length of the remaining end portions of sewing threads due to the movement of the workpiece after the downward movement of the needle in the final stitch. In addition, it is possible to avoid a situation where the remaining end portion of the upper thread and the remaining end portion of the lower thread extend from separate locations. As a result, sewing quality can be improved.

[0015] The moving mechanism may comprise a feed dog configured to project from and to sink into an in-out hole of the throat plate to feed the workpiece, and after the lower thread and the upper thread are cut by the thread cutting device, the control device may rotate a sewing machine motor to reduce a projecting amount of the feed dog from the throat plate and then control the remaining end cutoff mechanism to cut off the remaining end portions of the lower thread and the upper thread.

[0016] With this configuration, the remaining end portions of the lower thread and the upper thread are cut off after the projecting amount of the feed dog is reduced. Therefore, the finally remaining end portions can be made even shorter.

[0017] The control device may control the feeding amount of the moving mechanism to form a given number of stitches at a preset condensed stitching pitch when an input of a thread cutting signal by a signal input means is detected. With this configuration, a condensed stitching can be performed.

[0018] The sewing machine may further comprise a suctioning mechanism configured to perform suctioning from below the needle hole of the throat plate. With this configuration, dust below the throat plate can be collected by the suctioning mechanism, so that operation failures caused by adhesion of the dust to the peripheral mechanisms, etc., can be reduced. In addition, the remaining end portions of the upper thread and the lower thread to be cut off by the remaining end cutoff mechanism can be stretched downward, so that the remaining end portions can be cut off more reliably.

[0019] The suctioning mechanism may comprise a suction nozzle configured to move toward and away from the needle hole of the throat plate, and a nozzle driving means for moving the suction nozzle toward and away from the needle hole. With this configuration, the suction nozzle can be moved toward and away from a position below the throat plate at which various components are disposed, so that interference between other components and the suction nozzle can be suppressed, and the respective operations can be stabilized.

[0020] The sewing machine may comprise a suction control device configured to control the suctioning mechanism to start the suctioning at the time when or before the suction nozzle reaches the needle hole of the throat plate. With this configuration, dust around the needle hole can also be collected by the suction nozzle, so that the region below the throat plate can be kept cleaner.

[0021] As described above, according to the present invention, the remaining end portions of the upper thread and the lower thread can be made shorter.

[0022] The following description of embodiments of the present invention describes the present invention in greater detail along with the drawings. The drawings include:

Fig. 1: a schematic configuration diagram of a sewing machine according to a first embodiment of the present invention;

Fig. 2: a block diagram of a control system of the sewing machine;

Fig. 3: a front view showing a configuration of a part of a feed adjusting mechanism;

Fig. 4: a perspective view showing a schematic configuration of a thread cutting device;

Fig. 5: a plan view showing a thread cutting state made by a movable thread cutting knife and a stationary thread cutting knife of the thread cutting device;

Fig. 6: a perspective view of a throat plate;

Fig. 7: a plan view of a lower plate of the throat plate and a remaining end cutoff mechanism;

Fig. 8: a bottom view (standby position state) of an upper plate of the throat plate and a remaining end cutoff mechanism;

Fig. 9: a bottom view (cutting-off position state) of the upper plate of the throat plate and a re-

maining end cutoff mechanism;

Fig. 10: a perspective view of the remaining end cutoff mechanism;

Fig. 11: a perspective view of the remaining end cutoff mechanism viewed from a direction different from in Fig. 10;

Fig. 12: a back view of a suctioning mechanism;

Fig. 13A: an explanatory view showing a state after sewing thread cutting where zero-pitch control is performed;

Fig. 13B: an explanatory view showing a state after sewing thread cutting where zero-pitch control is not performed;

Fig. 14A: an explanatory view showing lengths after cutting-off sewing thread remaining end portions when feed dog lowering control is not performed;

Fig. 14B: an explanatory view showing lengths after cutting-off sewing thread remaining end portions when feed dog lowering control is performed;

Fig. 15: a timing chart showing a flow of sewing control of the sewing machine;

Fig. 16: a bottom view showing another example of the thread cutting device;

Fig. 17: a perspective view showing another example of the remaining end cutoff mechanism;

Fig. 18A: an explanatory view showing a state of sewing threads before remaining end portions thereof are cut off by another remaining end cutoff mechanism;

Fig. 18B: an explanatory view showing a state of sewing threads after remaining end portions thereof are cut off by another remaining end cutoff mechanism;

Fig. 19: a plan view showing another example of the remaining end cutoff mechanism and the suctioning mechanism in which the throat plate is not shown in a state before cutting off the remaining end portions before starting suctioning;

Fig. 20: a plan view showing another example of the remaining end cutoff mechanism and the suctioning mechanism in which the throat plate is not shown in a state before cutting off the remaining end portions after starting suctioning;

Fig. 21: a plan view showing another example of the remaining end cutoff mechanism and the suctioning mechanism in which the throat plate is not shown in a state after cutting off the remaining end portions and after starting suctioning; and

Fig. 22: a flowchart showing operation control from sewing to thread cutting and remaining end cutting-off.

Overall Configuration of Sewing Machine

[0023] Hereinafter, an embodiment of the present invention is described in detail with reference to Fig. 1 to Fig. 15. Fig 1 is a schematic configuration diagram of a sewing machine 10 according to an embodiment of the present invention, and Fig. 2 is a block diagram of a control system.

[0024] The sewing machine 10 is a so-called lockstitch sewing machine, and includes a sewing machine frame 20, a needle up-down moving mechanism 30 configured to move a needle bar 12 holding a sewing needle 11 up and down, a throat plate 40 provided at a stitch point of a bed portion 21 of the sewing machine frame 20, a shuttle mechanism 50 configured to interlace an upper thread U of the sewing needle 11 with a lower thread D below the throat plate 40, a feeding mechanism 60 as an example of a moving mechanism configured to feed a workpiece on the upper surface of the throat plate 40 at a given feeding pitch, a feed adjusting mechanism 70 configured to change the feeding pitch, a thread cutting device 80 configured to cut the upper thread U and the lower thread D after the downward movement of the needle in the final stitch, a wiper mechanism 90 configured to pull out a sewing needle side portion U1 of the cut upper thread U upwardly from the workpiece, a remaining end cutoff mechanism 100 configured to cut off remaining end portions of the upper thread U and the lower thread D remaining on the workpiece after they are cut by the thread cutting device 80, a suctioning mechanism 110 configured to perform suctioning from below the needle holes 411, 421 of the throat plate 40, and a control device 120 configured to control operations of the structures described above.

[0025] As for a thread tensioner and a thread take-up lever, well known structures that are installed generally in sewing machines can be employed, so that they are omitted from the drawings and from the detailed description.

[0026] Hereinafter, configurations of the respective structures described above will be described.

Sewing Machine Frame

[0027] The sewing machine frame 20 includes a bed portion 21 positioned on the lower portion, a sewing machine vertical drum portion 22 erected upward from one end portion of the bed portion 21, and an arm portion 23 extended along the bed portion 21 from the upper portion of the sewing machine vertical drum portion 22.

[0028] Here, in description of the configuration of the sewing machine 10, the up-down moving direction of the needle bar 12 described later is defined as a Z-axis direction, a direction orthogonal to the Z-axis direction and parallel to the longitudinal direction of the bed portion 21 and the arm portion 23 is defined as a Y-axis direction, and a direction orthogonal to both of the Z-axis direction and the Y-axis direction is defined as an X-axis direction.

When the sewing machine 10 is set on a horizontal plane, the Z-axis direction is the vertical up-down direction, and the X-axis direction and the Y-axis direction are horizontal directions.

[0029] Inside the arm portion 23, a main shaft 32 directed to be parallel to the longitudinal direction (Y-axis direction) of the arm portion 23 is supported rotatably.

[0030] Inside the bed portion 21, an up-down feed shaft 61 directed to be parallel to the longitudinal direction (Y-axis direction) of the bed portion 21 is supported rotatably.

[0031] To the main shaft 32 and the up-down feed shaft 61, sprockets 33, 62 are fixedly provided, respectively, and a torque is transmitted from the main shaft 32 to the up-down feed shaft 61 via a toothed belt 63.

Needle Up-Down Moving Mechanism

[0032] The needle up-down moving mechanism 30 includes, as shown in Fig. 1, a sewing machine motor 31 consisting of a servo motor provided on the upper portion of the sewing machine vertical drum portion 22, a main shaft 32 that is connected to an output shaft of the sewing machine motor 31 and rotates, a needle bar crank 34 fixedly provided to the end portion on the sewing machine face side of the main shaft 32, a crank rod 35 one end portion of which is joined to a position eccentric from the center of rotation according to the main shaft 32 of the needle bar crank 34, and a needle bar 12 joined to the other end portion of the crank rod 35 via a needle bar connecting stud 36.

[0033] The needle bar 12 holds a sewing needle 11 on the lower end portion, and is supported by the arm portion 23 in a manner enabling the needle bar 11 to move up and down in a reciprocating manner along the Z-axis direction.

[0034] The sewing machine motor 31 is a servo motor, and includes an encoder 37 (see Fig. 2). The control device 120 detects a rotation speed of the sewing machine motor 31 and a main shaft angle, etc., from the encoder 37, and controls the operation of the sewing machine motor 31.

[0035] The basic configurations of the needle bar crank 34, the crank rod 35, and the needle bar connecting stud 36, etc., are basically the same as those widely known, so that detailed description thereof is omitted.

Feeding Mechanism

[0036] The feeding mechanism 60 has basically the same configuration as the one widely known, so that detailed description thereof is omitted. That is, the feeding mechanism 60 includes a feed dog 64 that projects and sinks the tooth tips from and into in-out holes 412, 422 formed in the throat plate 40 to feed a workpiece along the X-axis direction at a fixed feeding pitch (see Fig. 10), a feed base that supports the feed dog 64, an up-down feed shaft 61 that provides up-down reciprocating movement to the feed base, a horizontal feed shaft that provides horizontal reciprocating movement along the X-axis direction to the feed base, a cam crank mechanism that converts full rotation of the up-down feed shaft 61 into up-down reciprocating movement and transmits the movement to the feed base, another cam crank mechanism that converts full rotation of the up-down feed shaft 61 into reciprocating turning movement and transmits the movement to the horizontal feed shaft, and a horizontal feed arm that is fixedly provided to the horizontal feed shaft and provides horizontal reciprocating movement to the feed base.

[0037] To the feed base, up-down reciprocating movement is provided from one end portion thereof, and horizontal reciprocating movement is provided from the other end portion. Both of the up-down reciprocating movement and the horizontal reciprocating movement are provided in the same cycle as that of the rotation of the sewing machine motor 31, and accordingly, these are synthesized and the feed dog 64 positioned in the middle of the feed base orbits in a substantially oval orbit. When moving in the upper portion of this oval movement, the tooth tips of the feed dog 64 project from the in-out holes of the throat plate 40 to perform the movement of feeding the workpiece along the longitudinal direction of the oval.

Feed Adjusting Mechanism

[0038] The feed adjusting mechanism 70 includes, between the cam crank mechanism that transmits reciprocating turning movement to the horizontal feed shaft from the up-down feed shaft 61 and the horizontal feed shaft in the feeding mechanism 60, a feed adjuster not shown which switches an amplitude of the reciprocating turning angle and the phase between positive and negative which are transmitted to the horizontal feed shaft according to an inclination angle.

[0039] The inclination angle of the feed adjuster of the feed adjusting mechanism 70 at which the feeding pitch becomes zero is determined, and from this angle, as the inclination angle increases in a fixed direction, the feeding pitch in the forward feeding direction can be adjusted to be longer, and as the inclination angle increases in the opposite direction, the feeding pitch in the backward feeding direction can be adjusted to be longer.

[0040] As shown in Fig. 2 and Fig. 3, the feed adjusting mechanism 70 includes a dial (not shown) from which a feeding pitch is input to set the feeding pitch, a cam member 71 supported inside the sewing machine vertical drum portion 22 in a turnable manner and whose turning angle changes in accordance with to the dial setting, a feed adjusting shaft 77 one end of which is joined to the dial and the other end of which comes into contact with the cam member, a joint rod 72 that joins the cam member 71 and the feed adjuster, a feed adjusting spring (not shown) downwardly biasing the joint rod 72, a condensed stitching air cylinder 74 configured to adjust the angle of the feed adjuster so as to obtain a predetermined con-

densed stitching pitch smaller than the feeding pitch set by the dial via the joint rod 72 and a lever arm 73, a zero-pitch air cylinder 75 configured to switch the inclination angle of the feed adjuster so that the feeding pitch becomes zero, and a backward feed solenoid 76 configured to switch the inclination angle of the feed adjuster so that the feeding direction changes from the forward direction to the backward direction while maintaining the width of the feeding pitch set with the dial or the feeding pitch for condensed stitching.

[0041] In the case of the feed adjusting mechanism 70 shown in Fig. 3, by adjusting the contact position with the cam member 71 by advancing or retreating the adjusting shaft 77 (in the X-axis direction in Fig. 3) by the dial, the inclination angle of the feed adjuster is adjusted via the joint rod 72, and accordingly, the feeding pitch for normal sewing is adjusted.

[0042] The feed adjuster and the mechanism for adjusting the angle of the feed adjuster are widely known techniques, and for example, the feed adjustment mechanism disclosed in JP2007-202667A and JP2011-101719A, can be used.

[0043] Operations of both of the condensed stitching air cylinder 74 and the zero-pitch air cylinder 75 are controlled by the control device 120 via a solenoid valve not shown.

[0044] As shown in Fig. 3, by turning the lever arm 73 clockwise (in Fig. 3) by suctioning (moving rightward in Fig. 3) the plunger, the condensed stitching air cylinder 74 turns the joint rod 72 clockwise (in Fig. 3) against the feed adjusting spring to adjust the inclination angle of the feed adjuster so as to obtain the pitch for condensed stitching. By pushing back counterclockwise the lever arm 73 turned by the condensed stitching air cylinder 74 by advancing (moving leftward in Fig. 3) the plunger, the zero-pitch air cylinder 75 turns the joint rod 72 counterclockwise to adjust the inclination angle of the feed adjuster so as to obtain the zero pitch. Due to the structure described above, when setting the feeding pitch to the zero pitch, the suctioning operation of the condensed stitching air cylinder 74 and the advancing operation of the zero-pitch air cylinder 75 are always combined and performed.

[0045] In the case of the feed adjusting mechanism 70 shown in Fig. 3, by the suctioning operation of the condensed stitching air cylinder 74, the joint rod 72 is turned clockwise (in Fig. 3), and at the inclination angle of the feed adjuster at this time, sewing with backward feeding is performed at the pitch for condensed stitching.

Wiper Mechanism

[0046] The wiper mechanism 90 is the basically same as the one widely known, and detailed description of respective components thereof is omitted. This wiper mechanism 90 includes a wiper 91 that is supported turnably around the X-axis at a position adjacent to the needle bar 12 at the tip end lower portion of the arm portion 23, and a wiper solenoid 92 that provides turning movement to the wiper 91.

[0047] The wiper 91 has a lower end portion formed into a hook shape, and is provided so that when the wiper turns, its lower end portion passes through the lower side of the sewing needle 11 being at an upper stop position so as to slash the lower side. Accordingly, the sewing needle side portion U1 of the upper thread U that has been cut below the throat plate 40 by the thread cutting device 80 can be pulled out upwardly from the workpiece.

Shuttle Mechanism

[0048] The shuttle mechanism 50 is a widely known horizontal full rotary shuttle, and includes an inner shuttle inside which a bobbin with the lower thread D wound around is housed, an outer shuttle that rotates on the outer periphery of the inner shuttle to capture the upper thread U from the sewing needle 11, and a shuttle shaft 51 that provides a torque to the outer shuttle.

[0049] The shuttle shaft 51 is supported so as to be parallel to the up-down feed shaft 61 and rotatable inside the bed portion 21, and between the shuttle shaft 51 and the up-down feed shaft 61, rotation in the reverse direction at a double speed is transmitted via a gear. That is, the outer shuttle of the shuttle mechanism 50 rotates at a speed twice the speed of the main shaft 32.

[0050] The inner shuttle and the outer shuttle are disposed below the throat plate 40, and are designed so that the hook of the outer shuttle passes through a position perpendicularly below the needle holes 411, 421 formed through the throat plate 40.

Thread Cutting Device

[0051] The thread cutting device 80 includes, as shown in Fig. 4, a movable thread cutting knife 81 and a stationary thread cutting knife 82 that cut the upper thread U and the lower thread D in cooperation with each other, an actuation mechanism that moves the movable thread cutting knife 81 and the stationary thread cutting knife 82 in directions to make their blade portions 81a and 82a butt against each other along the outer periphery of the outer shuttle of the shuttle mechanism 50 by using the sewing machine motor 31 as a drive source, and a thread cutting solenoid 83 (see Fig. 2) that switches between connection and disconnection of power transmission between the actuation mechanism and the sewing machine motor 31.

[0052] The thread cutting device 80 can utilize a widely known configuration disclosed in, for example, JPH07-1455489A, so that description of a part of the thread cutting device 80 is omitted.

[0053] When the stationary thread cutting knife 82 performs a cutting operation, the blade portion 82a thereof is moved by the actuation mechanism to advance to a position near a needle passing-through position below the needle hole 421, and stands-by there.

[0054] On the other hand, the movable thread cutting knife 81 moves in a direction opposite to the advancing direction of the stationary thread cutting knife 82 from the side opposite to the stationary thread cutting knife 82 across the needle passing-through position below the needle hole 421 so that the blade portion 81a passes through the needle passing-through position below the needle hole 421. Accordingly, the upper thread U and the lower thread D are sandwiched by the blade portions 81a and 82a of the knives 81, 82, and cut at the needle passing-through position below the needle hole 421.

[0055] Fig. 5 shows a shape around the blade portion 81a of the movable thread cutting knife 81. As shown in the drawing, the movable thread cutting knife 81 includes a handling portion 81b shaped to become sharp in the direction of advancing for the cutting operation, and first and second concave portions 81c and 81d formed on both sides of the handling portion 81b.

[0056] The handling portion 81b enters the loop of the upper thread U pulled out to the position below the throat plate 40 by the outer shuttle when passing through the needle passing-through position below the needle hole 421, and sorts the upper thread U into a sewing needle side portion U1 and a workpiece side portion U2. As a result, the sewing needle side portion U1 of the upper thread is sorted to the first concave portion 81c, and the workpiece side portion U2 and the lower thread D are sorted to the second concave portion 81d.

[0057] On the edge portion on the inner side of the second concave portion 81d of the movable thread cutting knife 81, the blade portion 81a is formed, and the blade portion 82a of the stationary thread cutting knife 82 is formed to be opposed to only the second concave portion 81 d side of the movable thread cutting knife 81. Therefore, only the workpiece side portion U2 and the lower thread D sorted to the second concave portion 81d are cut.

[0058] The actuation mechanism includes individual support bodies that support the respective thread cutting knives 81, 82 individually, concentrically with the shuttle shaft 51, and turnably, a knife shaft to which reciprocating turning movement is transmitted from the sewing machine motor 31 via a clutch mechanism and a cam mechanism, and a plurality of link bodies that provide turning movement to the individual support bodies in directions opposite to each other from the knife shaft. Switching between power connection and disconnection to the knife shaft from the sewing machine motor 31 in the clutch mechanism is performed by the above-described thread cutting solenoid 83.

Throat Plate

[0059] The throat plate 40 is provided at a position that is an upper portion of the bed portion 21 and below the needle bar 12. This throat plate 40 has, as shown in Fig. 6, a vertically two-layer structure consisting of an upper plate 41 and a lower plate 42.

[0060] Both of the upper plate 41 and the lower plate 42 are plate bodies having semi-oval shapes, and the lower plate 42 fits and is integrated with a concave portion 413 formed on the lower surface side of the upper plate 41 by screwing.

[0061] In these upper plate 41 and lower plate 42, the needle holes 411, 421 and the in-out holes 412, 422 for the feed dog 64 (see Fig. 10) are formed at positions that become the same when the upper plate 41 and the lower plate 42 are integrated.

[0062] The needle holes 411, 421 are formed just below the sewing needle 11, and the in-out holes 412, 422 for the feed dog 64 are four in number two of which are formed on the front side and the rear side on the same line along the X-axis direction with respect to the needle holes 411, 421, and the other two of which are formed on both sides of the former two. The in-out holes 412, 422 are both formed into slits along the workpiece feeding direction, and are structured to allow the tooth tip of the feed dog 64 to move in the feeding direction inside.

Remaining End Cutoff mechanism

[0063] The remaining end cutoff mechanism 100 includes, as shown in Fig. 7 to Fig. 11, a stationary cutoff knife 101 and a movable cutoff knife 102 as an example of a cutoff knife incorporated between the upper plate 41 being an upper layer and the lower plate 42 being a lower layer of the throat plate 40, a thread cutoff air cylinder 103 configured to actuate the movable cutoff knife 102, and a knife actuation arm 105 having an end portion joined to the plunger of the thread cutoff air cylinder 103 via a knuckle 104.

[0064] Fig. 7 is a plan view of the lower plate 42, and Fig. 8 is a bottom view of the upper plate 41.

[0065] On the lower surface of the upper plate 41 and the upper surface of the lower plate 42, concave portions 414 and 424 are formed around the needle holes 411, 421 and the in-out holes 412, 422 for the feed dog 64 to enable interposition of the stationary cutoff knife 101 and the movable cutoff knife 102.

[0066] In the concave portion 414 of the upper plate 41, the stationary cutoff knife 101 is disposed so that its longitudinal direction is along the X-axis direction. Further, the base end portion of the stationary cutoff knife 101 is fixed and supported by screwing to the concave portion 414 formed on one end portion side of the in-out hole 412 in the lower surface of the upper plate 41, and from this base end portion, an extended portion extended toward the needle hole 411 side to a position farther than the needle hole 411 is formed. Further, in the extended portion tip end of the stationary cutoff knife 101, a through hole through which the sewing needle 11 is inserted is formed at a position corresponding to the needle hole 411, and the portion on the tip end side of the inner edge portion of the through hole is a blade portion 101a for thread cutting-off.

[0067] The stationary cutoff knife 101 is substantially

entirely formed to be narrow in width so as not to interfere with the feed dog 64 that projects from and sinks into the in-out holes 412, and a slot 101b is formed in the stationary cutoff knife 101.

[0068] The movable cutoff knife 102 is disposed so that its longitudinal direction is along the X-axis direction in the concave portion 424 of the lower plate 42. A slot 425 is formed to pierce vertically the concave portion 424 formed on the other end portion side of the in-out hole 422 of the lower plate 42, and into this slot 425, a pin 105a (see Fig. 10) of the knife actuation arm 105 is inserted from below.

[0069] In the base end portion of the movable cutoff knife 102, an insertion hole 102a into which the pin 105a of the knife actuation arm 105 is inserted is formed. From the base end portion of the movable cutoff knife 102, an extended portion extended toward the needle hole 421 side to a position farther than the needle hole 421 is formed. Further, in the movable cutoff knife 102, a slot 102b is formed across substantially the entire length from the base end portion to a position close to the tip end of the extended portion. Through the tip end side of this slot 102b, the sewing needle 11 that passes through the needle hole 421 can be inserted. Further, the portion on the tip end side of the inner edge portion of the slot 102b is a blade portion 102c for thread cutting-off.

[0070] A guide pin 415 projecting downward from the lower surface of the upper plate 41 is inserted in the slot 102b of the movable cutoff knife 102. In the case where the knife actuation arm 105 described later provides reciprocating movement in the X-axis direction to the movable cutoff knife 102, the guide pin 415 stabilizes the reciprocating movement of the movable cutoff knife 102.

[0071] The movable cutoff knife 102 is formed to be substantially entirely narrow in width so as not to interfere with the feed dog 64 that projects from and sinks into the in-out holes 412.

[0072] Further, the extended end portion of the stationary cutoff knife 101 overlaps the extended end portion of the movable cutoff knife 102 from above, and the blade portion 101a of the stationary cutoff knife 101 and the blade portion 102c of the movable cutoff knife 102 are disposed so as to be opposed to each other across the needle holes 411, 421.

[0073] The movable cutoff knife 102 is provided with movement so as to be pulled by the knife actuation arm 105 in a direction away from the stationary cutoff knife 101 as shown in Fig. 9 from the state where the blade portions 101a and 102c are opposed to each other, and accordingly, after cutting by the thread cutting device 80, remaining end portions of the upper thread U and the lower thread D inside the needle holes 411, 421 can be cut off.

[0074] The knife actuation arm 105 and the thread cut-off air cylinder 103 are supported by a slide plate 13 provided adjacent to the throat plate 40 in the bed portion 21 as shown in Fig. 10 and Fig. 11. In Fig. 10, the upper plate 41 of the throat plate 40 is not shown.

[0075] The knife actuation arm 105 is supported turnably at its middle portion in the longitudinal direction by a shoulder screw 106 attached to the lower surface side of the slide plate 13, and one end portion thereof is joined to the plunger of the thread cutoff air cylinder 103 via a knuckle 104.

[0076] The other end portion of the knife actuation arm 105 is provided with a pin 105a projecting upward, and this pin 105a is inserted in the insertion hole 102a of the movable cutoff knife 102 as described above.

[0077] The thread cutoff air cylinder 103 can provide turning movement to the knife actuation arm 105 by advancing and retreating movement of the plunger, and by advancing the plunger from the retreated state, cutting-off movement can be provided to the movable cutoff knife 102.

Suctioning mechanism

[0078] The suctioning mechanism 110 is disposed adjacent to the shuttle mechanism 50 inside the bed portion 21 as shown in Fig. 12. This suctioning mechanism 110 includes a suction nozzle 111 and a nozzle moving air cylinder 113 as a nozzle driving means that moves in a reciprocating manner a support body 112 supporting the suction nozzle 111 in a predetermined direction.

[0079] This suctioning mechanism 110 is provided for more reliably cutting-off remaining end portions of the upper thread U and the lower thread D by stretching the remaining end portions downward when cutting-off the remaining end portions, and for capturing the cut-off remaining end portions of the sewing threads by suctioning from below the needle hole 421.

[0080] The suction nozzle 111 has a suction port formed by opening the upper end portion, and the lower end portion is connected to a negative pressure generation source via a dust collecting trap not shown. Between the trap of the suction nozzle 111 and the negative pressure generation source, a suctioning solenoid valve 114 (see Fig. 2) is provided to enable switching between start and stop of suctioning.

[0081] The upper end portion of the suction nozzle 111 is formed to curve along the outer periphery of the outer shuttle so as to come close to the needle hole 421 of the throat plate 40 while avoiding the shuttle mechanism 50.

[0082] The support body 112 supporting the suction nozzle 111 is supported movably and horizontally inside the bed portion 21, and can move the upper end portion of the suction nozzle 111 from a position away from the needle hole 421 of the throat plate 40 to the vicinity of a position just below the needle hole 421.

[0083] The nozzle moving air cylinder 113 advances and retreats the suction nozzle 111 according to the moving range of the support body 112. Accordingly, the suction nozzle 111 can be moved in a reciprocating manner between a retreated position away from the needle hole 421 of the throat plate 40 and a suctioning position at which the upper end portion of the suction nozzle 111

approaches the vicinity of the position just below the needle hole 421.

Control System of Sewing Machine

[0084] As shown in Fig. 2, the control device 120 generally consists of a ROM 122 in which various programs for various processing of control and judgment, etc., are memorized and stored, a CPU 121 that performs various arithmetic processing according to the various programs, a RAM 123 to be used as a work memory for each processing, and an EEPROM 124 storing various sewing data and setting data.

[0085] To the control device 120, via a system bus and a drive circuit, etc., the sewing machine motor 31 and the encoder 37 of the needle up-down moving mechanism 30, the backward feed solenoid 76, the condensed stitching air cylinder 74, and the zero-pitch air cylinder 75 of the feed adjusting mechanism 70, the thread cutting solenoid 83 of the thread cutting device 80, the thread cutoff air cylinder 103 of the remaining end cutoff mechanism 100, the wiper solenoid 92 of the wiper mechanism 90, and the suctioning solenoid valve 114 and the nozzle moving air cylinder 113 of the suctioning mechanism 110, etc., are connected.

[0086] For controlling the condensed stitching air cylinder 74, the zero-pitch air cylinder 75, the thread cutoff air cylinder 103, and the nozzle moving air cylinder 113, the control device 120 controls the solenoid valves that actuate these in actuality, however, here, the respective solenoid valves are not shown.

[0087] The sewing machine motor 31 is controlled via a driver circuit, however, this is not shown, either.

[0088] To the control device 120, an operation input portion 125 for inputting various settings relating to sewing, and a pedal 126 as a signal input means for execution, etc., of sewing are connected.

[0089] In the operation input portion 125, for example, whether or not condensed stitching described later is to be performed, the condensed stitching pitch, the number of stitches, and the forward/backward sewing direction, etc., are set.

[0090] The pedal 126 commands and inputs to the control device 120 a sewing start signal in response to forward stepping on the pedal, a sewing stop signal in response to release of forward stepping, and a thread cutting signal in response to backward stepping. In the case where condensed stitching is set, when the pedal 126 is stepped backward, thread cutting is performed after condensed stitching is performed.

Zero-Pitch Control

[0091] Here, various controls to be performed by the control device 120 when sewing is stopped are described.

[0092] First, when a signal input in response to backward stepping on the pedal 126 is detected, the control device 120 performs a thread cutting operation. At this time, the control device 120 sets a feeding pitch of zero by controlling the feeding mechanism 60 such that the stitch point of the final stitch at which thread cutting is performed by the thread cutting device 80 becomes the same (or substantially the same) as the stitch point of the stitch immediately before the final stitch.

[0093] As in the conventional case, when thread cutting is performed by the thread cutting device after feeding is performed at the normal feeding pitch or condensed stitching pitch until the final stitch, as shown in Fig. 13B, no knot is formed by the downward movement of the needle in the final stitch, so that the remaining end portion of the upper thread U remaining on the workpiece hangs down from the stitch point of the final stitch, and the remaining end portion of the lower thread D remaining on the workpiece hangs down from the stitch point of one stitch before that is at a distance of one pitch from the stitch point of the final stitch.

[0094] On the other hand, when the above-described zero-pitch control is performed, as shown in Fig. 13A, no knot is formed for the final stitch, however, the upper thread U and the lower thread D hang down from the same stitch point, and the state where the remaining end portion of the lower thread D hangs down from the stitch point of one stitch before can be avoided. In addition, the remaining end portions of the upper thread and the lower thread can be prevented from being increased by the length fed by the feeding mechanism 60 of the workpiece during a period from the downward movement of the needle in one stitch before to the thread cutting.

Feed Dog Lowering Control

[0095] The control device 120 performs feed dog lowering control so that remaining end portions of the lower thread D and the upper thread U are cut off by the remaining end cutoff mechanism 100 after the projecting amount of the feed dog 64 from the upper surface of the throat plate 40 when the lower thread D and the upper thread U are cut by the thread cutting device 80 is reduced by rotation of the sewing machine motor 31.

[0096] In Figs. 14, the symbol h denotes a position of a cutting-off plane to be cut by the stationary cutoff knife 101 and the movable cutoff knife 102 inside the throat plate 40.

[0097] The thread cutting device 80 cuts the upper thread U and the lower thread D at a main shaft angle of 50 degrees (a so-called upper stop position, provided that the needle bar top dead point is 0 degrees). Fig. 14A shows a projecting state of the feed dog 64 at the main shaft angle of 50 degrees. In this state, when the remaining end cutoff mechanism 100 cuts off the remaining end portions of the upper thread U and the lower thread D, the final length L1 of the remaining end portions after being cut off becomes substantially equal to a sum of the projecting distance of the feed dog 64 from the upper surface of the throat plate and the distance from the upper

surface of the throat plate to the cutting-off plane of the respective cutoff knives 101, 102.

[0098] In the control device 120, during the period from cutting of the upper thread U and the lower thread D by the thread cutting device 80 to cutting-off of the remaining end portions of the sewing threads by the remaining end cutoff mechanism 100, the sewing machine motor 31 is driven to rotate the main shaft forward so that the main shaft angle changes from 50 degrees to 95 degrees.

[0099] Accordingly, as shown in Fig. 14B, the projecting amount of the feed dog 64 from the upper surface of the throat plate 40 can be set to substantially zero, and therefore, the final length L2 of the remaining end portions of the upper thread U and the lower thread D after being cut off can be shortened to be substantially equal to the distance from the upper surface of the throat plate to the cutting-off plane of the respective cutoff knives 101, 102.

Nozzle Drive Control

[0100] In addition, before the remaining end cutoff mechanism 100 starts cutting-off, the control device 120 performs nozzle drive control to make the upper end portion of the suction nozzle 111 complete the movement from the retreated position distant from the needle holes 411, 421 of the throat plate 40 to the position just below the needle holes 411, 421, and switch the suction nozzle 111 to a suctioning state during a period from the start of movement of the suction nozzle 111 to at least completion of cutting-off by the remaining end cutoff mechanism 100.

[0101] Accordingly, the suction nozzle 111 can collect not only the cut-off remaining end portions of the upper thread U and the lower thread D but also dust around the moving range of the suction nozzle 111, so that the region below the throat plate 40 can be cleaned up. The suctioning is started at the time when or before the suction nozzle 111 reaches the position directly below the needle holes 411, 421 of the throat plate 40, so that suctioning is started before the remaining end cutoff mechanism 100 cuts off the remaining end portions of the upper thread U and the lower thread D, and therefore, the cut-off remaining end portions of the upper thread U and the lower thread D can be collected without omission.

[0102] The remaining end portions of the upper thread U and the lower thread D can be stretched downward when they are cut off, so that the remaining end portions of the upper thread U and the lower thread D can be more reliably cut off by the remaining end cutoff mechanism 100.

Flow of Sewing Control of Sewing Machine

[0103] The flow of operation control from sewing to thread cutting and cutting-off of sewing thread remaining end portions in the sewing machine 10 is described with reference to the timing chart shown in Fig. 15 and the flowchart shown in Fig. 22. Here, it is assumed that setting is made so that condensed stitching is performed at the end of sewing. In Fig. 15, "(LO)" denotes a lower stop position of the main shaft angle, and "(UP)" denotes an upper stop position.

[0104] First, when a forward stepping signal of the pedal 126 is detected (Step S1), the control device 120 starts driving of the sewing machine motor 31 (Step S3). The feeding mechanism 60 operates at a feeding pitch set with the dial of the feed adjusting mechanism 70 as a feeding pitch during this normal sewing.

[0105] Then, when forward stepping on the pedal 126 is released and an input of a thread cutting signal in response to backward stepping is detected (Step S5), after waiting for detection of the main shaft angle of 220 degrees by the encoder 37 (Step S7), the control device 120 actuates the condensed stitching air cylinder 74 in a direction in which the plunger retreats (timing T1) (Step S9). Accordingly, the feed adjuster of the feed adjusting mechanism 70 is set to an inclination angle at which a set condensed stitching pitch is obtained.

[0106] Then, when the last downward movement of the needle in the given number of stitches of condensed stitching is performed (Step S11), after waiting for detection of the main shaft angle of 220 degrees again by the encoder 37 (Step S13), the control device 120 actuates the zero-pitch air cylinder 75 in a direction in which the plunger advances (timing T2) (Step S15).

[0107] Accordingly, the feed adjuster of the feed adjusting mechanism 70 is set to an inclination angle for zero pitch, and the next downward movement of the needle in the final stitch is performed at the same position as that of the last downward movement of the needle in the condensed stitching (Step S17).

[0108] Next, after downward movement of the needle in the final stitch, when the main shaft angle of 220 degrees is detected again by the encoder 37 (Step S19), the control device 120 actuates the thread cutting solenoid 83 of the thread cutting device 80 to switch power transmission between the actuation mechanism of the thread cutting device 80 and the sewing machine motor 31 to a connected state (timing T3) (Step S21).

[0109] Accordingly, by the movable thread cutting knife 81 of the thread cutting device 80, the upper thread U is sorted into a sewing needle side portion U1 and a workpiece side portion U2 based on the handling portion 81b, and further, by cooperative operation of the movable thread cutting knife 81 and the stationary thread cutting knife 82, the workpiece side portion U2 of the upper thread U and the lower thread D are cut (Step S23).

[0110] Thereafter, at the main shaft angle of 50 degrees, the sewing machine motor 31 stops driving (timing T4) (Steps S25 and S27), and after waiting for an elapse of 120 msec from the detection of the main shaft angle of 50 degrees by the encoder 37 (Step S29), the control device 120 stops the thread cutting solenoid 83 (Step S31) and switches the power transmission between the actuation mechanism of the thread cutting device 80 and the sewing machine motor 31 to a shut-off state (timing

T5).

[0111] At this timing T5, the control device 120 actuates the wiper solenoid 92 of the wiper mechanism 90 to turn the wiper 91 (Step S33). Accordingly, the sewing needle side portion U1 of the upper thread U extending from the sewing needle 11 to the workpiece can be pulled out upwardly from the workpiece.

[0112] Then, the control device 120 actuates the nozzle moving air cylinder 113 at the timing of completion of actuation of the wiper solenoid 92 to move the suction nozzle 111 from the standby position toward the position just below the needle holes 411, 421 (timing T6). At the same timing, the suctioning solenoid valve 114 is opened to start the movement and suctioning of the suction nozzle 111 (Step S35).

[0113] Then, after a prescribed time elapses, the suction nozzle 111 arrives at the position just below the needle hole 421, and at this timing, the control device 120 drives the sewing machine motor 31 (timing T7) (Step S37) and continues driving of the sewing machine motor 31 until the main shaft angle reaches 95 degrees (timing T8).

[0114] Accordingly, the tip end portion of the feed dog 64 projecting from the upper surface of the throat plate 40 lowers and substantially hides below the throat plate 40.

[0115] Then, when the main shaft angle of 95 degrees is detected (Step S39), the control device 120 stops driving of the sewing machine motor 31 (Step S41), and with almost no pause, actuates the thread cutoff air cylinder 103 of the remaining end cutoff mechanism 100 (Step S43) to start a cutting-off operation of the movable cutoff knife 102. Accordingly, remaining end portions of the upper thread U and the lower thread D are cut off, and the cut-off remaining end portions are suctioned by the suction nozzle 111 disposed below.

[0116] Then, after the thread cutoff air cylinder 103 is actuated for a prescribed time, the actuation is stopped and the movable cutoff knife 102 is retreated (timing T9).

[0117] Thereafter, the control device 120 closes the suctioning solenoid valve 114 to stop the suctioning state of the suction nozzle 111 (Step S45), and drives the sewing machine motor 31 reversely (timing T10) (Step S47).

[0118] Then, when the main shaft angle is returned to 50 degrees (Step S49), the control device 120 stops driving of the sewing machine motor 31 (timing T11) (Step S51). At the same timing, the control device 120 advances the plunger of the condensed stitching air cylinder 74 and retreats the plungers of the zero-pitch air cylinder 75 and the nozzle moving air cylinder 113 and returns these to the standby positions (Step S53).

[0119] Accordingly, sewing control of the sewing machine by the control device 120 is ended.

Advantageous Effects of Embodiment of the Invention

[0120] As described above, the sewing machine 10 includes the throat plate 40 through which the needle holes 411, 421 are formed to allow the sewing needle 11 to pass through the needle holes 411, 421, the feeding mechanism 60 as an example of a moving mechanism configured to move a workpiece along the upper surface of the throat plate 40, the needle up-down moving mechanism 30 configured move the sewing needle 11 up and down, the shuttle mechanism 50 configured to capture the upper thread U from the sewing needle 11 and to interlace the upper thread U with the lower thread D below the throat plate 40, the thread cutting device 80 provided between the throat plate 40 and the shuttle mechanism 50 and configured to cut the lower thread D and the workpiece side portion of the loop of the upper thread U, and the wiper mechanism 90 configured to pull out, upwardly from the workpiece, the sewing needle side portion U1 of the loop of the upper thread U that has been cut by the thread cutting device 80. The sewing machine 10 further includes a remaining end cutoff mechanism 100 disposed below the upper surface of the upper plate 41 of the throat plate 40 and above the thread cutting knives 81, 82 of the thread cutting device 80. After the thread cutting operation by the thread cutting device 80, remaining end portions of the lower thread D and the upper thread U connected to the workpiece are cut off by the remaining end cutoff mechanism 100.

[0121] Further, the throat plate 40 has a double layer structure having the upper plate 41 and the lower plate 42 as upper and lower layers, and between the upper plate 41 and the lower plate 42 of the throat plate 40, the stationary cutoff knife 101 and the movable cutoff knife 102 as cutoff knives of the remaining end cutoff mechanism 100 for cutting-off the remaining end portions of the lower thread D and the upper thread U on the workpiece side cut by the thread cutting device 80 are incorporated.

[0122] In the sewing machine 10, after cutting the lower thread D and the workpiece side portion of the upper thread U by the thread cutting device 80, remaining end portions of the lower thread D and the upper thread U on the workpiece side are cut off by the stationary cutoff knife 101 and the movable cutoff knife 102 of the remaining end cutoff mechanism 100 incorporated in the throat plate 40, so that remaining end portions of the lower thread D and the upper thread U after the cutting-off process can be made shorter than the length corresponding to the thickness of the throat plate 40.

[0123] In addition, the sewing machine 10 includes the control device 120 that performs zero-pitch control to control the feeding amount of the feeding mechanism 60 as a moving mechanism so that the stitch point of the final stitch at which thread cutting is performed by the thread cutting device 80 becomes the same as the stitch point of one stitch before.

[0124] Therefore, the state where the remaining end portions of the upper thread U and the lower thread D hang down from different positions can be avoided, and the sewing quality can be further improved. Further, the fed length of the workpiece fed by the feeding mechanism 60 until the thread cutting after the downward movement

of the needle in the final stitch can be prevented from being added to the lengths of the remaining end portions of the upper thread U and the lower thread D, so that the remaining end portions of the upper thread U and the lower thread D cut by the thread cutting device 80 can be shortened.

[0125] The remaining end portions of the upper thread U and the lower thread D cut by the thread cutting device 80 are cut off so as to become shorter by the remaining end cutoff mechanism 100, and by making shorter the remaining end portions of the upper thread U and the lower thread D in advance by the thread cutting device 80, the amount of waste to be produced by cutting off by the remaining end cutoff mechanism 100 can be reduced. The cut-off remaining end portions of the upper thread U and the lower thread D are short, so that they can be more reliably collected by the suctioning mechanism 110.

[0126] Further, the sewing machine 10 includes the suctioning mechanism 110 that suctions remaining end portions of the lower thread D and the upper thread U cut-off below the throat plate 40.

[0127] Therefore, the remaining end portions of the lower thread and the upper thread below the throat plate 40 can be collected by the suctioning mechanism 110, and occurrence of operation failures, etc., due to adhesion of the remaining end portions to the surrounding mechanisms, etc., can be reduced.

[0128] The remaining end portions of the upper thread U and the lower thread D to be cut off by the remaining end cutoff mechanism 100 can be suctioned and stretched downward, so that they can be more reliably cut off.

[0129] The suctioning mechanism 110 of the sewing machine 10 includes the suction nozzle 111 that can approach and separate from the needle hole 421 of the throat plate 40 and the nozzle moving air cylinder 113 as a nozzle driving means that provides the approaching and separating movement.

[0130] Therefore, during operation of the feed dog 64 or the shuttle mechanism 50, etc., the suction nozzle 111 can be retreated, and interference between these components and the suction nozzle 111 can be reduced and the mutual operations thereof can be stabilized.

[0131] The sewing machine 10 includes the control device 120 as a suction control device that controls the suctioning mechanism 110 to start suctioning before the suction nozzle 111 reaches the needle hole 421 of the throat plate 40.

[0132] Therefore, dust around the movement path of the suction nozzle 111 can also be collected, and the suctioning operation is started before the suction nozzle 111 arrives at the needle hole 421, so that the remaining end portions of the upper thread U and the lower thread D can be stretched downward and the cut-off remaining end portions can be captured more reliably.

[0133] In the sewing machine 10, the feeding mechanism 60 as a moving mechanism feeds a workpiece by the feed dog 64 that is supplied with power from the sewing machine motor 31 and projects from and sinks into the in-out holes 412, 422 of the throat plate 40, and the control device 120 performs feed dog lowering control by which remaining end portions of the lower thread D and the upper thread U are cut off by the remaining end cutoff mechanism 100 after the projecting amount of the feed dog 64 from the throat plate 40 when cutting the lower thread D and the workpiece side portion U2 of the loop of the upper thread U by the thread cutting device 80 is reduced by rotating the sewing machine motor 31.

[0134] Therefore, after the projecting amount of the feed dog 64 is reduced, remaining end portions of the lower thread D and the upper thread U are cut off, so that remaining end portions left even after cutting-off can be made shorter.

[0135] During the period from the start of cutting of the upper thread U and the lower thread D by the thread cutting device 80 to the start of suctioning by the suction nozzle, an upper thread clamping operation by the upper thread clamping device described in JP-A-2008-018282 may be added although this is not described in the present application.

Another Example of Thread Cutting Device

[0136] Fig. 16 is a bottom view of another thread cutting device 80A. The thread cutting device 80A having the movable thread cutting knife and the stationary thread cutting knife that are attached to a throat plate 40A as shown in Fig. 16 is preferably used for a sewing machine equipped with a moving mechanism other than the feeding mechanism 60 using the feed dog 64.

[0137] This thread cutting device 80A includes a movable thread cutting knife 81A that turns around the Z-axis, a stationary thread cutting knife 82A that cuts the upper thread U and the lower thread D in cooperation with the movable thread cutting knife 81A, and a plurality of link bodies 83A to 85A that transmit reciprocating turning to the movable thread cutting knife 81 A by using the sewing machine motor 31 or another actuator as a drive source.

[0138] The movable thread cutting knife 81A is disposed so as to pass through a position below a needle hole 441A when it turns, and has, on one side edge portion, a thread sorting portion 811A that sorts the threads into the sewing needle side portion U1 and the workpiece side portion U2 of the loop of the upper thread U and the lower thread D and an eyelet blade portion 812A, and the other side edge portion is a capturing portion 813A that captures the workpiece side portion U2 of the upper thread U and the lower thread D and delivers these to the stationary thread cutting knife 82A.

[0139] The stationary thread cutting knife 82A is provided in the turning range of the movable thread cutting knife 81A, and on one side edge portion thereof, a blade portion 821A is formed.

[0140] As reciprocating turning is provided to the movable thread cutting knife 81A from the drive source, when it passes through the position below the needle hole 441A

in the outward path of turning, the thread sorting portion 811A sorts the sewing needle side portion U1 of the loop of the upper thread U to the inner side in the turning radius and the workpiece side portion U2 and the lower thread D to the outer side in the turning radius.

[0141] Then, when the movable thread cutting knife 81A turns in the return path of turning, the workpiece side portion U2 and the lower thread D sorted to the outer side of the turning radius go around to the side of the other side edge portion of the movable thread cutting knife 81A, and are sandwiched and cut by the eyelet blade portion 812A of the movable thread cutting knife 81A and the blade portion 821A of the stationary thread cutting knife 82A.

[0142] This thread cutting device 80A can also be used in the same manner as the thread cutting device 80 described above.

[0143] Without limiting to the configuration in which the movable thread cutting knife 81A turns within a horizontal plane as in the case of the thread cutting device 80A, for example, a thread cutting device including a movable thread cutting knife that linearly moves in a reciprocating manner within a horizontal plane is also applicable.

Another Example of Remaining End Cutoff Mechanism and Suctioning mechanism

[0144] Another example of the remaining end cutoff mechanism and the suctioning mechanism are described with reference to Fig. 17 to Fig. 21.

[0145] A remaining end cutoff mechanism 100A as another example is preferably used for a sewing machine equipped with a moving mechanism other than the feeding mechanism 60 using the feed dog 64.

[0146] This remaining end cutoff mechanism 100A includes a stationary cutoff knife 101A and a movable cutoff knife 102A as cutoff knives incorporated between an upper plate 41A being the upper layer and a lower plate 42A being the lower layer of the throat plate 40A, a thread cutoff air cylinder 103A that actuates the movable cutoff knife 102A, and a knife actuation member 104A joined to the plunger of the thread cutoff air cylinder 103A.

[0147] The needle holes are not directly formed through the upper plate 41A and the lower plate 42A of the throat plate 40A, but at the stitch point, openings 411A, 421A larger than the needle holes are formed. To the opening 411A at the stitch point of the upper plate 41A, an needle hole formed plate 43A through which a needle hole 431A is formed is fixedly provided by screwing. To the opening 421A at the stitch point of the lower plate 42A, a needle hole guide 44A through which a needle hole 441A is formed (see Fig. 16) is fixedly provided by screwing although this is not shown in Fig. 17. This throat plate 40A has substantially the same functions as those of the throat plate 40 described above.

[0148] The stationary cutoff knife 101A is attached to the opening 411A of the upper plate 41A, and a through hole through which the sewing needle is inserted is formed at a position overlapping the needle hole 431A, and on the inner edge portion on one end side in the Y-axis direction of the through hole, a blade portion 101 Aa is formed.

[0149] The movable cutoff knife 102A is disposed so that its longitudinal direction is along the X-axis direction inside a concave portion 422A of the lower plate 42A. This movable cutoff knife 102A is supported turnably around the Z-axis with respect to the lower surface of the upper plate 41A by a shoulder screw 105A.

[0150] Further, the upper surface of one end portion of the movable cutoff knife 102A comes into sliding contact with the lower surface of the stationary cutoff knife 101A, and in one end portion of the movable cutoff knife 102A, a through hole through which the sewing needle is inserted is formed at a position overlapping the needle hole 431A, and on the inner edge portion on the other end side in the Y-axis direction of the through hole, a blade portion 102Aa is formed.

[0151] In the concave portion 422A of the lower plate 42A, a through hole 423A piercing vertically is formed, and under the through hole 423A, the knife actuation member 104A is disposed. This knife actuation member 104A has a boss 104Aa formed on the upper surface, and this boss 104Aa is inserted into a slot 102Ab of the movable cutoff knife 102A through the through hole 423A.

[0152] The thread cutoff air cylinder 103A is fixedly provided to the lower surface side of the lower plate 42A so that the advancing and retreating direction of the plunger of this air cylinder 103A is along the Y-axis direction, and this plunger is equipped with the knife actuation member 104A. Accordingly, the thread cutoff air cylinder 103A turns the movable cutoff knife 102A via the knife actuation member 104A, and accordingly, the end portion on which the blade portion 102Aa is formed can be advanced along the Y-axis direction.

[0153] The thread cutoff air cylinder 103A is normally in a state where the plunger thereof advances, and as shown in Fig. 18A, the blade portion 101Aa of the stationary cutoff knife 101A and the blade portion 102Aa of the movable cutoff knife 102A are opposed to each other while sandwiching the upper thread U and the lower thread D passing through the needle hole 431A. When the plunger of the thread cutoff air cylinder 103A is moved to retreat, as shown in Fig. 18B and Fig. 21, the movable cutoff knife 102A advances toward the blade portion 101Aa side of the stationary cutoff knife 101A, and the upper thread U and the lower thread D can be cut off by their blade portions 101Aa and 102Aa.

[0154] The suctioning mechanism 110A is disposed below the throat plate 40A inside the bed portion 21 as shown in Fig. 19 to Fig. 21. This suctioning mechanism 110A includes a suction nozzle 111 A and a nozzle moving air cylinder 113A as a nozzle driving means that turns a support arm 112A supporting the suction nozzle 111 A in a predetermined direction and in a reciprocating manner.

[0155] One end portion of the suction nozzle 111A opens and serves as a suction port, and the other end portion is connected to the negative pressure generation source via a dust collecting trap not shown. This suction nozzle 111A is supported by the support arm 112A while being inclined so that the suction port side becomes higher.

[0156] It is the same as in the suctioning mechanism 110 described above in that switching between start and stop of suctioning can be made by a suctioning solenoid valve not shown.

[0157] One end portion of the support arm 112A supports the suction nozzle 111A, and the other end portion is joined to the plunger of the nozzle moving air cylinder 113A via a knuckle 115A.

[0158] This support arm 112A is supported turnably around the Z-axis by the lower surface of the lower plate 42A of the throat plate 40A or the frame of the sewing machine, and according to this turning, the support arm 112A can switch the suction port of the suction nozzle 111A between a retreated position away from the needle hole 431A (position shown in Fig. 19) and a position near the position just below the needle hole 431A (position shown in Fig. 20 and Fig. 21).

[0159] The knuckle 115A and the other end portion of the support arm 112A are joined via a slot not shown formed in the other end portion of the support arm 112A.

[0160] Operations of the remaining end cutoff mechanism 100A and the suctioning mechanism 110A can be controlled in the same manner as of the remaining end cutoff mechanism 100 and the suctioning mechanism 110 described above.

[0161] That is, after the upper thread U and the lower thread D are cut by the thread cutting device, the sewing needle side portion U1 of the upper thread U is pulled out from the workpiece by the wiper mechanism 90, and then, the suction nozzle 111A is turned from the retreated position (state shown in Fig. 19) to the position near the position just below the needle hole (state shown in Fig. 20) while suctioning. Then, in the state where the remaining end portions of the upper thread U and the lower thread D are stretched downward by the suction nozzle 111A, the movable cutoff knife 102A of the remaining end cutoff mechanism 100A is turned to cut off the remaining end portions of the upper thread U and the lower thread D (state shown in Fig. 21). The cut-off remaining end portions of the upper thread U and the lower thread D are collected by the suction nozzle 111A.

[0162] Thus, the remaining end cutoff mechanism 100A and the suctioning mechanism 110A can also be used in the same manner as the remaining end cutoff mechanism 100 and the suctioning mechanism 110 described above.

[0163] Both of the thread cutting device 80A and the remaining end cutoff mechanism 100A described above are preferably used for a sewing machine using a moving mechanism that does not use a feed dog, however, the above-described suctioning mechanism 110A can be preferably used in both of a sewing machine equipped with a feeding mechanism 60 as a moving mechanism using the feed dog 64 and a sewing machine using a moving mechanism that does not use a feed dog.

Other Sewing Machines

[0164] The above-described sewing machine 10 is an exemplification of a lockstitch sewing machine, however, the thread cutting device 80, the remaining end cutoff mechanism 100, the suctioning mechanism 110 or 110A, and operation control of these can also be applied to other types of sewing machines each equipped with a feeding mechanism using a feed dog.

[0165] The above-described thread cutting devices 80 and 80A, remaining end cutoff mechanisms 100 and 100A, and suctioning mechanisms 110 and 110A, and operation control of these can be applied to other types of sewing machines each equipped with a moving mechanism other than a feeding mechanism using a feed dog.

[0166] Other types of sewing machines each equipped with a moving mechanism other than a feeding mechanism using a feed dog are, for example, sewing machines (for example, buttoning sewing machines, electronic cycle sewing machines, etc.) that arbitrarily move a workpiece in an X-Y plane (or R-θ plane) as a moving mechanism that moves the workpiece.

[0167] In these sewing machines each equipped with a moving mechanism, sewing is performed according to sewing data for forming a predetermined sewing pattern, so that when the zero-pitch control described above is performed, after the downward movement of the needle at a sewing end position determined according to the sewing data, the downward movement of the needle in the final stitch is performed at the same position, and thereafter, the upper thread U and the lower thread D are cut by the thread cutting device, and accordingly, preferable thread cutting can be performed.

[0168] In the case of a sewing machine that arbitrarily moves a workpiece within an X-Y plane (or R-θ plane), trouble with a feed dog does not occur, so that the feed dog lowering control is not performed.

Others

[0169] The thread cutting device is not limited to the above-described one in which a thread cutting knife turns around the Y-axis, and for example, a knife mechanism, etc., in which a movable thread cutting knife moves within a horizontal plane is also applicable.

[0170] As a shuttle of the shuttle mechanism 50, a horizontal full rotary shuttle is exemplified, however, without limiting to this, a horizontal shuttle or a semi-rotary shuttle can also be used. However, in the case of a horizontal shuttle, a knife mechanism in which a movable thread cutting knife moves within a horizontal plane is preferably used.

[0171] In the throat plate shown in Fig. 7 and Fig. 8,

both of the upper plate and the lower plate have semi-oval shapes, however, it is not necessary to form both of the upper plate and the lower plate into semi-oval shapes as long as the portion to be incorporated in the cutoff knife is formed to have a two-layer structure consisting of an upper plate and a lower plate.

[0172] In the present application, air cylinders are used as drive sources to adjust the angle of the feed adjuster so as to obtain a condensed stitching pitch and a zero pitch, however, solenoids can also be used. Similarly, air cylinders are used as drive sources of the remaining end cutoff mechanism and the nozzle approaching and separating movement, however, solenoids can also be used.

[0173] A solenoid is used as a drive source to switch the inclination angle of the feed adjuster so that the feeding direction switches from the forward direction to the backward direction, however, an air cylinder can also be used.

[0174] The zero-pitch air cylinder 75 of the feed adjusting mechanism 70 switches the inclination angle of the feed adjuster such that the feeding pitch becomes zero, however, the pitch does not necessarily have to become completely zero. For example, the inclination angle of the feed adjuster may be switched such that the feeding pitch becomes smaller than the immediately previous feeding pitch (for example, the condensed stitching pitch).

Claims

1. A sewing machine (10) comprising:

a throat plate (40, 40A) through which a needle hole (411, 421, 431A) is formed to allow a sewing needle (11) to pass through the needle hole (411, 421, 431A);
a moving mechanism (60) configured to move a workpiece along an upper surface of the throat plate (40, 40A);
a needle up-down moving mechanism (30) configured to move the sewing needle (11) up and down;
a shuttle mechanism (50) configured to capture an upper thread (U) from the sewing needle (11) below the throat plate (40, 40A) and to interlace the upper thread (U) with a lower thread (D);
a thread cutting device (80, 80A) provided between the throat plate (40, 40A) and the shuttle mechanism (50) and configured to cut the lower thread (D) and the upper thread (U);
a wiper mechanism (90) configured to pull out, upwardly from the workpiece, a sewing needle side portion of the upper thread (U) that has been cut by the thread cutting device (80, 80A); and
a control device (120) configured to control operations of the moving mechanism (60), the thread cutting device (80, 80A) and the wiper mechanism (90),
characterized in that the sewing machine (10) further comprises a remaining end cutoff mechanism (100, 100A) disposed below the upper surface of the throat plate (40, 40A) and above the thread cutting device (80, 80A),
wherein the remaining end cutoff mechanism (100, 100A) is configured to cut off, after the lower thread (D) and the upper thread (U) are cut by the thread cutting device (80, 80A), remaining end portions of the lower thread (D) and the upper thread (U) connected to the workpiece.

2. The sewing machine (10) according to claim 1, wherein the throat plate (40, 40A) has a double layer structure comprising an upper layer (41, 41A) and a lower layer (42, 42A), and
wherein the remaining end cutoff mechanism (100, 100A) comprises a cutoff knife (101, 101A, 102, 102A) incorporated between the upper layer (41, 41A) and the lower layer (42, 42A) to cut off, after the lower thread (D) and the upper thread (U) are cut by the thread cutting device (80, 80A), the remaining end portions of the lower thread (D) and the upper thread (U) connected to the workpiece.

3. The sewing machine (10) according to claim 1 or 2, wherein the control device (120) is configured to control a feeding amount of the moving mechanism (60) such that the feeding amount from a stitch point of a stitch immediately before a final stitch, at which the threads (U, D) are cut by the thread cutting device (80, 80A), to a stitch point of the final stitch is zero or smaller than an immediately previous feeding amount.

4. The sewing machine (10) according to any one of the preceding claims, wherein the moving mechanism (60) comprises a feed dog (64) configured to project from and to sink into an in-out hole (412, 422) of the throat plate (40) to feed the workpiece, and
wherein, after the lower thread (D) and the upper thread (U) are cut by the thread cutting device (80), the control device (120) rotates a sewing machine motor (31) to reduce a projecting amount of the feed dog (64) from the throat plate (40, 40A) and then controls the remaining end cutoff mechanism (100) to cut off the remaining end portions of the lower thread (D) and the upper thread (U).

5. The sewing machine (10) according to any one of the preceding claims, wherein the control device (120) controls the feeding amount of the moving mechanism (60) to form a given number of stitches at a preset condensed stitching pitch when an input of a thread cutting signal by a signal input means (126) is detected.

6. The sewing machine (10) according to any one of the preceding claims, further comprising a suctioning mechanism (110, 110A) configured to perform suctioning from below the needle hole (411, 421, 431A) of the throat plate (40, 40A).

7. The sewing machine (10) according to claim 6, wherein the suctioning mechanism (110, 110A) comprises a suction nozzle (111, 111A) configured to move toward and away from the needle hole (411, 421, 431A) of the throat plate (40, 40A), and a nozzle driving means (113, 113A) for moving the suction nozzle toward and away from the needle hole (411, 421, 431A).

8. The sewing machine (10) according to claim 7, comprising a suction control device (120) configured to control the suctioning mechanism (110, 110A) to start the suctioning at the time when or before the suction nozzle (111, 111A) reaches the needle hole (411, 421, 431A) of the throat plate (40, 40A).

FIG. 1

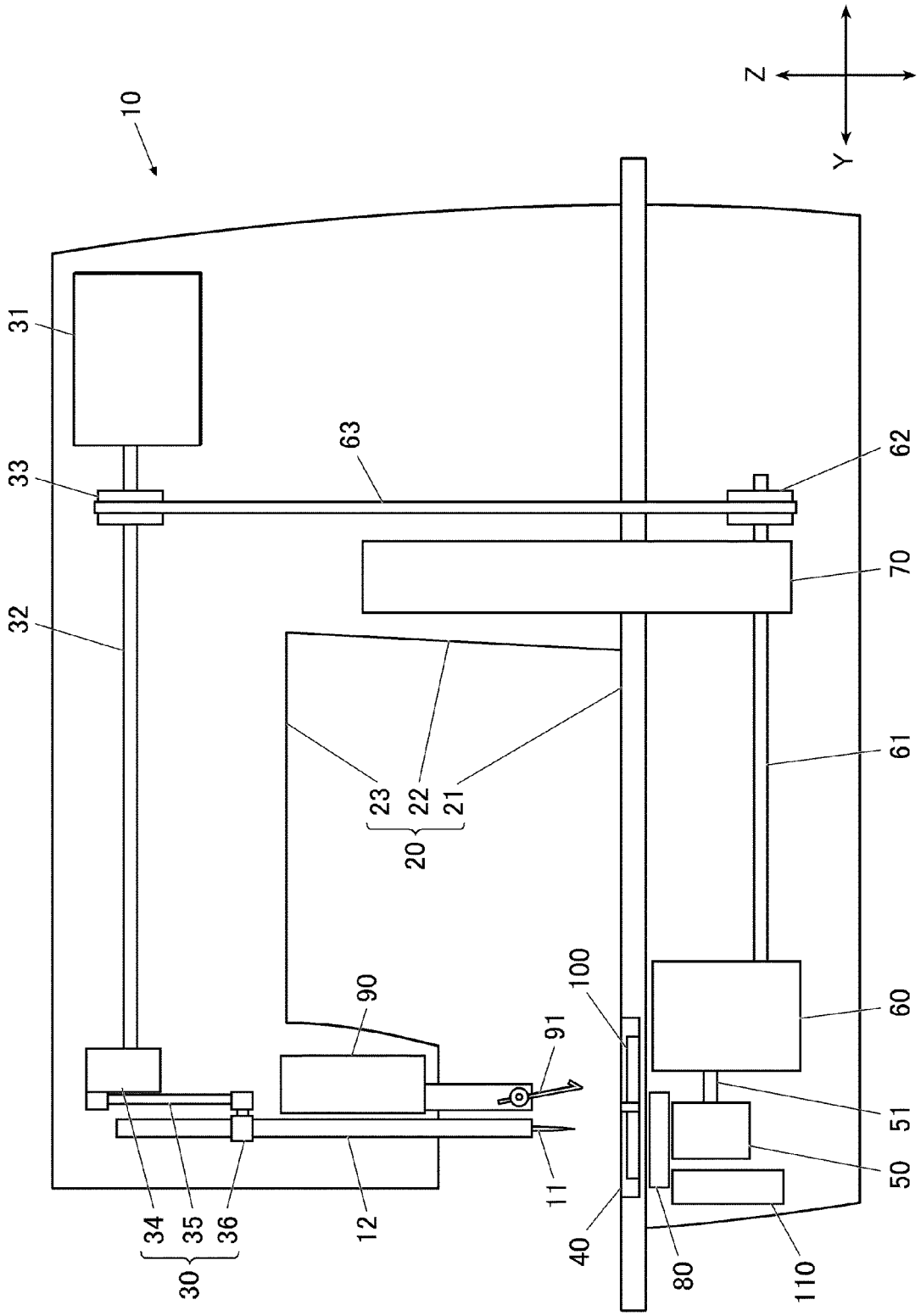

Z
Y
10
31
33
32
63
62
70
61
23
22
21
20
90
91
100
60
51
50
34
35
36
30
12
11
40
80
110

FIG. 2

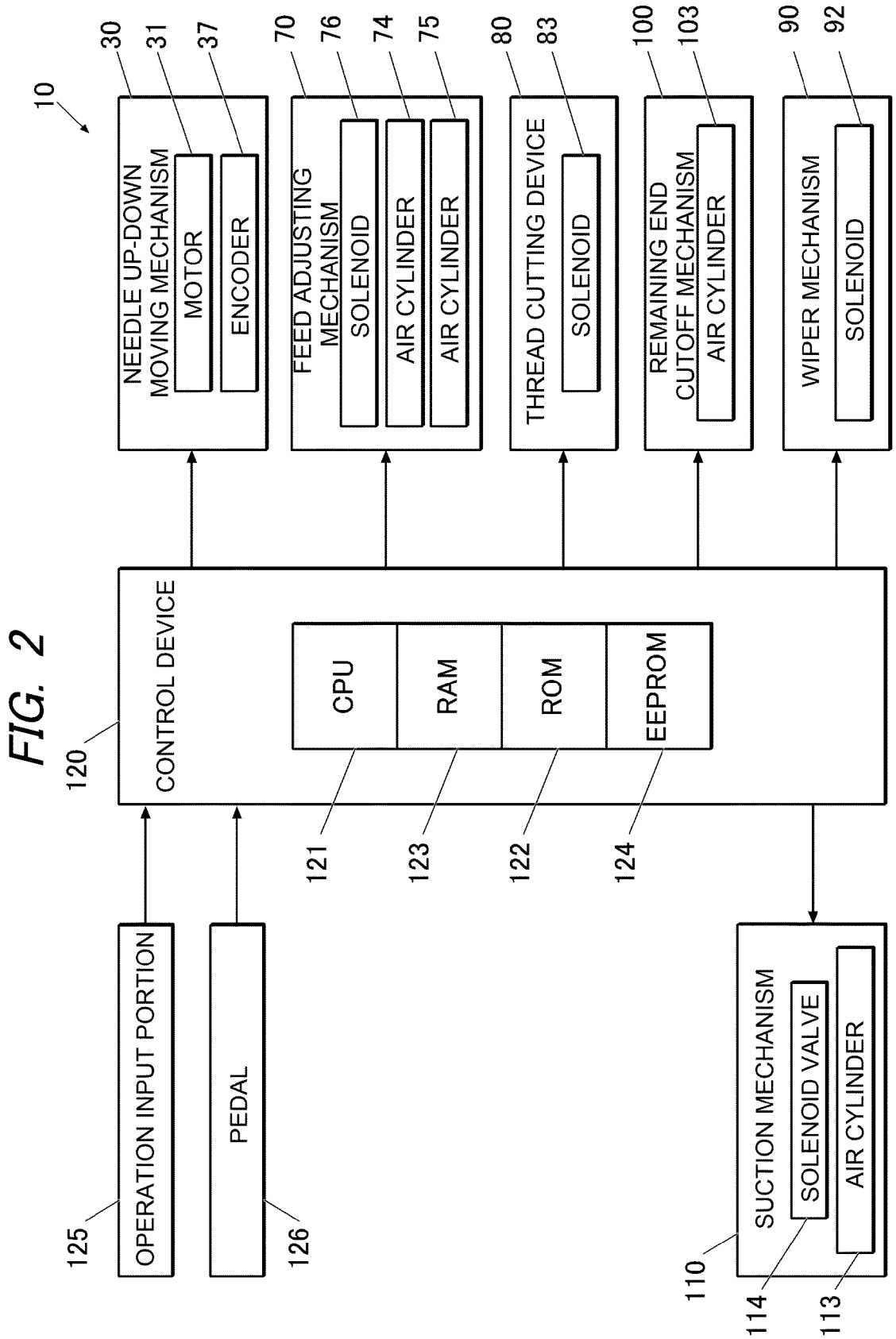

10
30
31
37
NEEDLE UP-DOWN MOVING MECHANISM
MOTOR
ENCODER
70
76
74
75
FEED ADJUSTING MECHANISM
SOLENOID
AIR CYLINDER
AIR CYLINDER
80
83
THREAD CUTTING DEVICE
SOLENOID
100
103
REMAINING END CUTOFF MECHANISM
AIR CYLINDER
90
92
WIPER MECHANISM
SOLENOID
120
CONTROL DEVICE
CPU
RAM
ROM
EEPROM
121
123
122
124
125
OPERATION INPUT PORTION
PEDAL
126
110
SUCTION MECHANISM
SOLENOID VALVE
AIR CYLINDER
114
113

FIG. 3

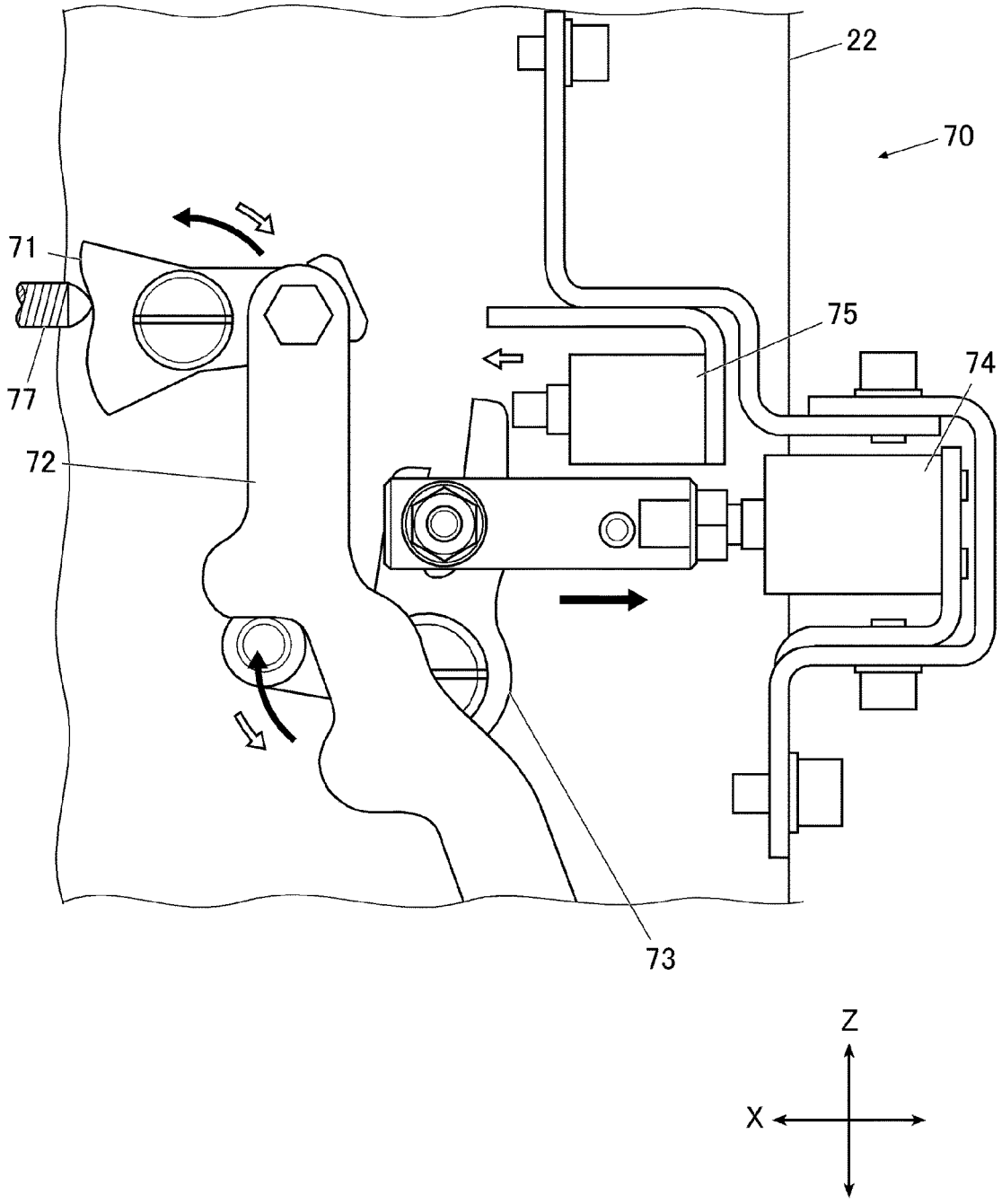


FIG. 4

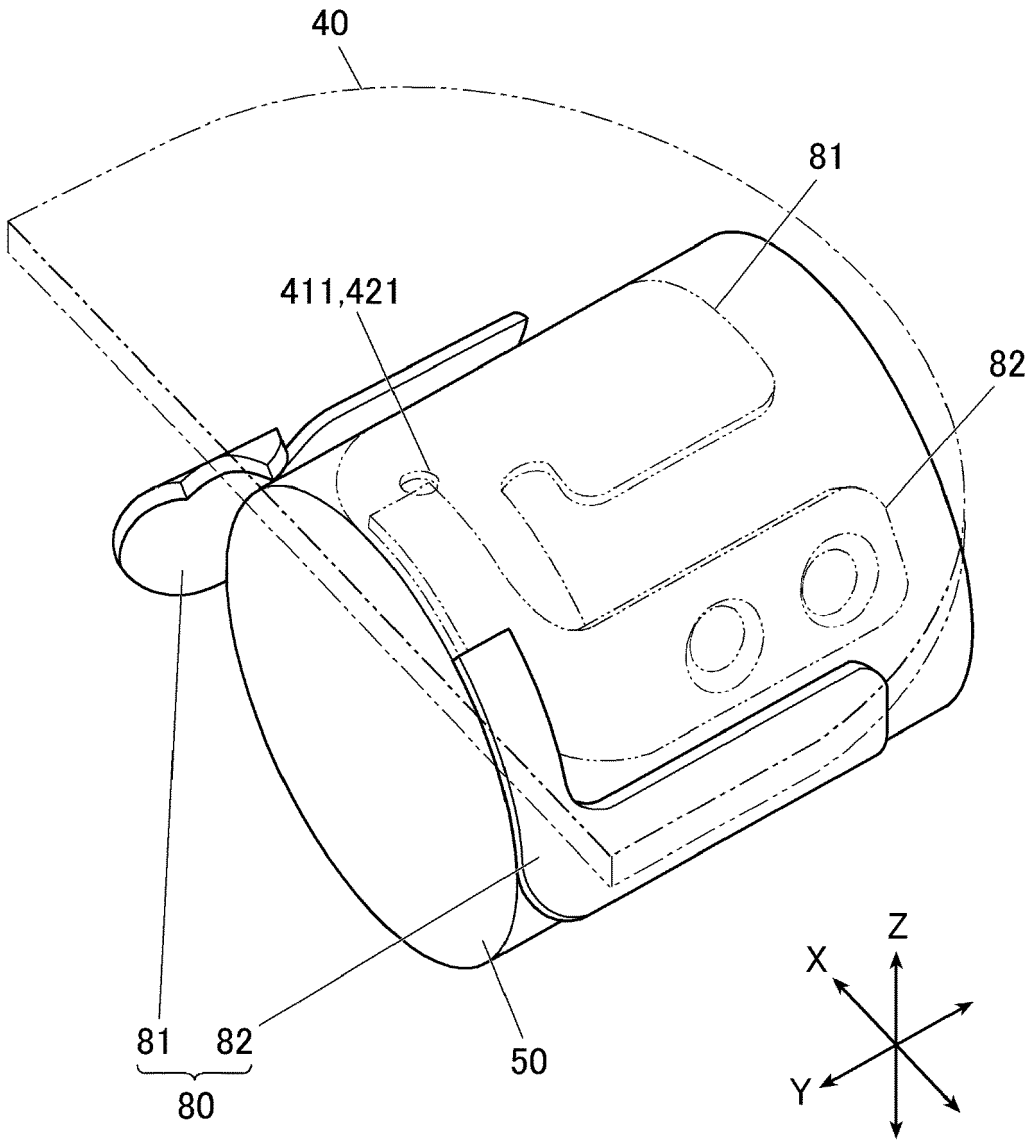


FIG. 5

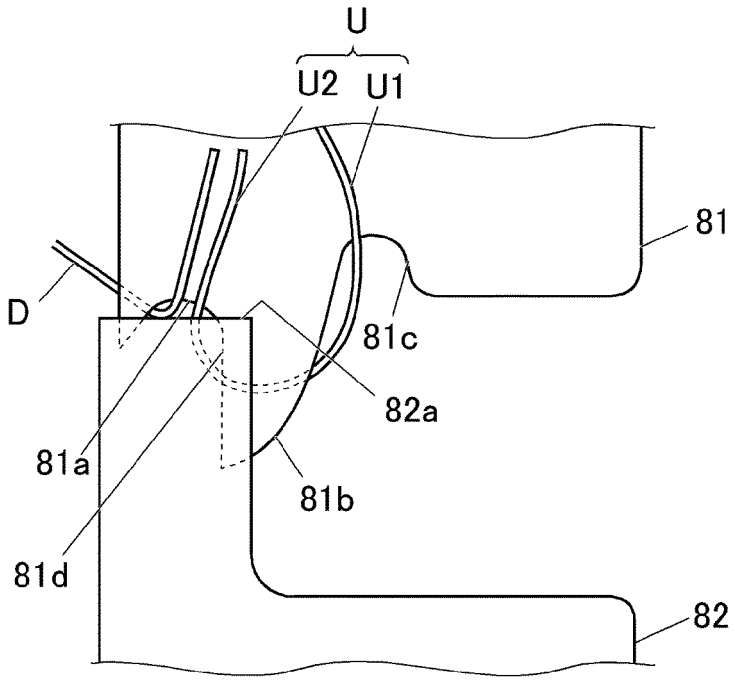


FIG. 6

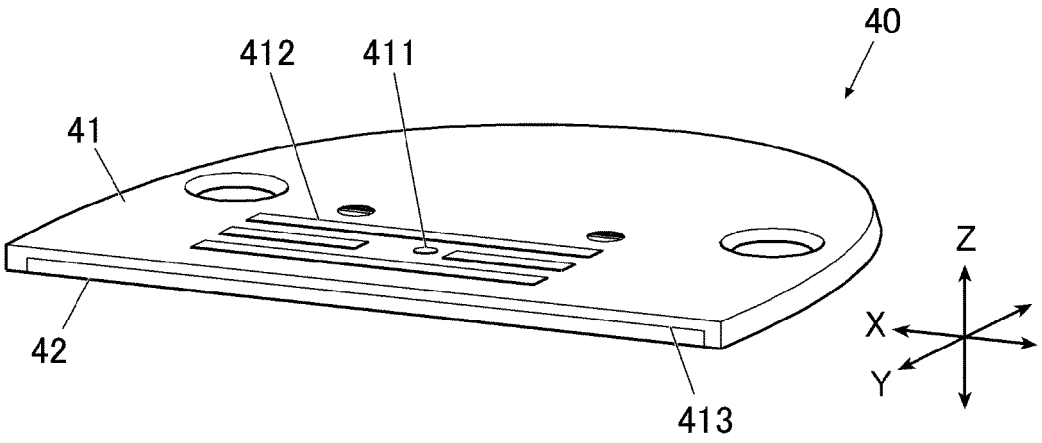


FIG. 7

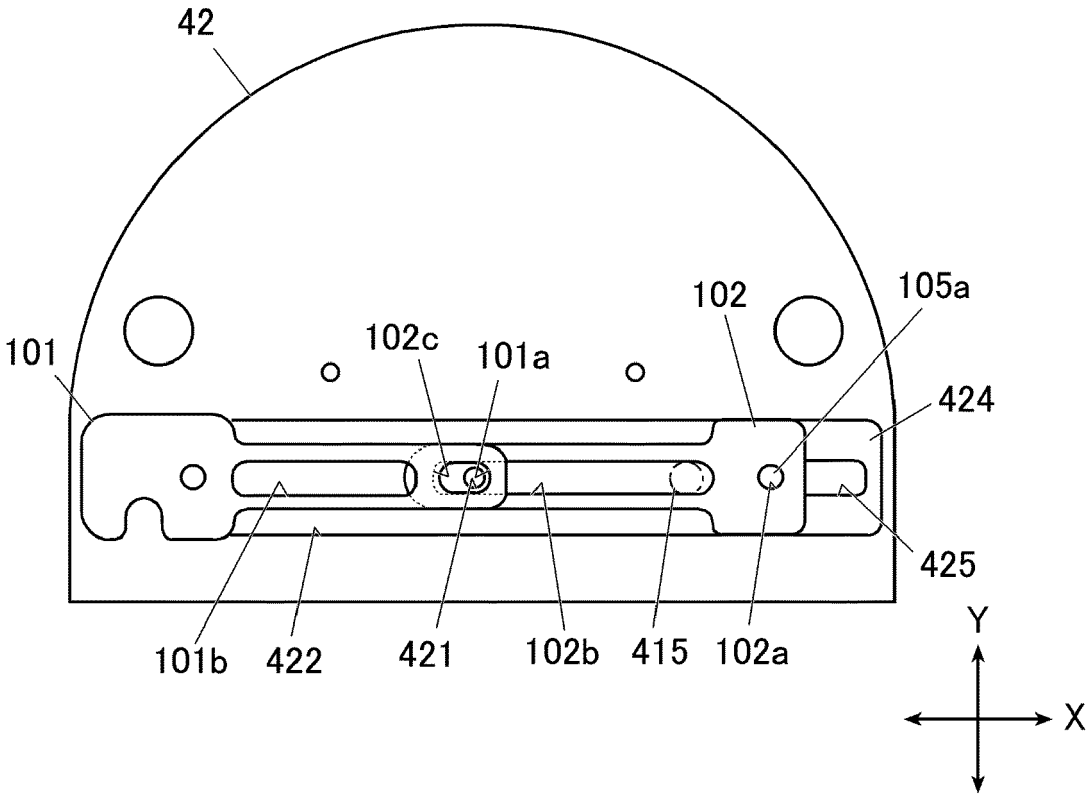


FIG. 8

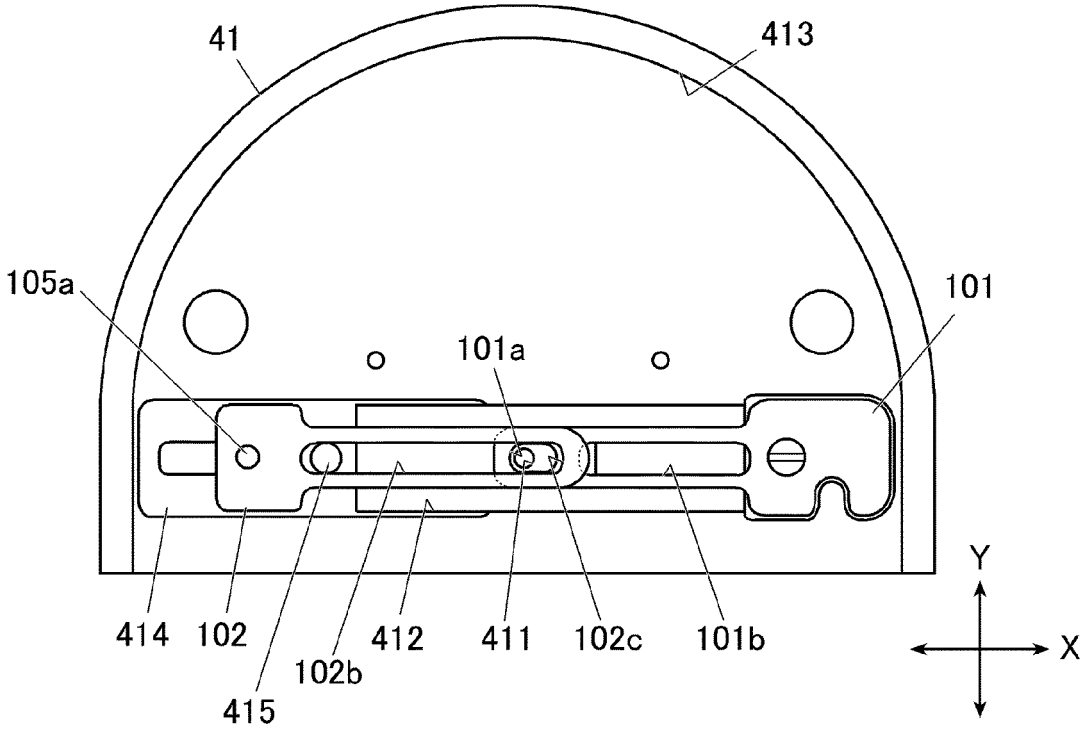

41
413
105a
101
101a
414
102
415
102b
412
411
102c
101b
Y
X

FIG. 9

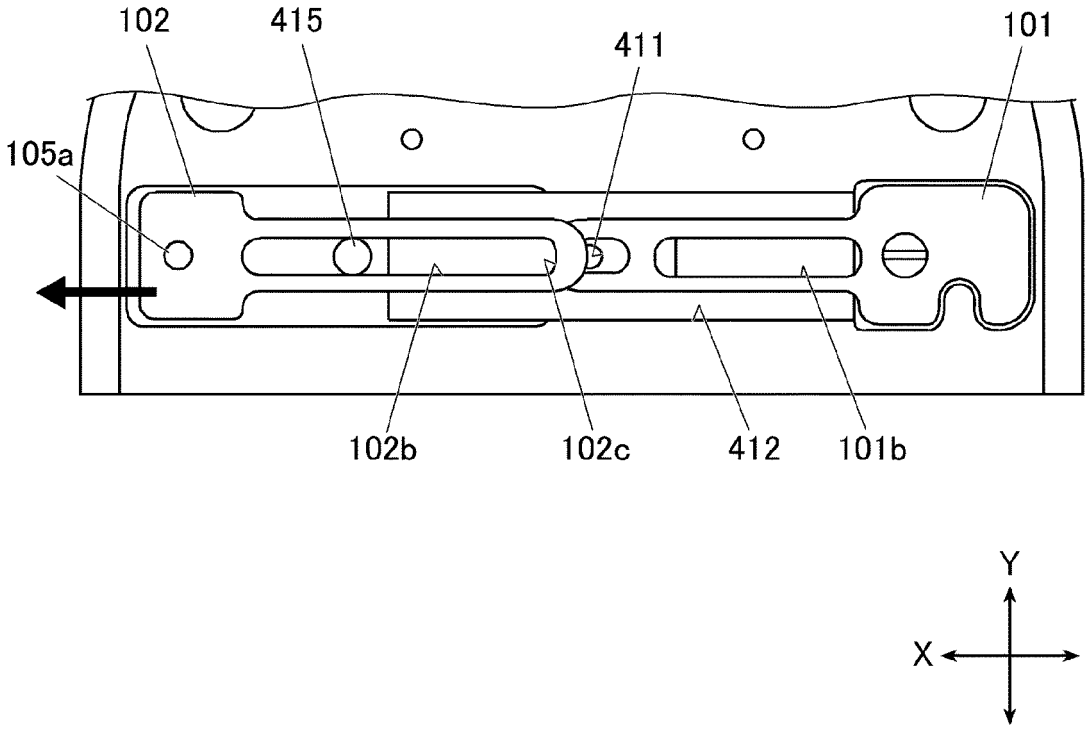

102
415
411
101
105a
102b
102c
412
101b
Y
X

FIG. 10

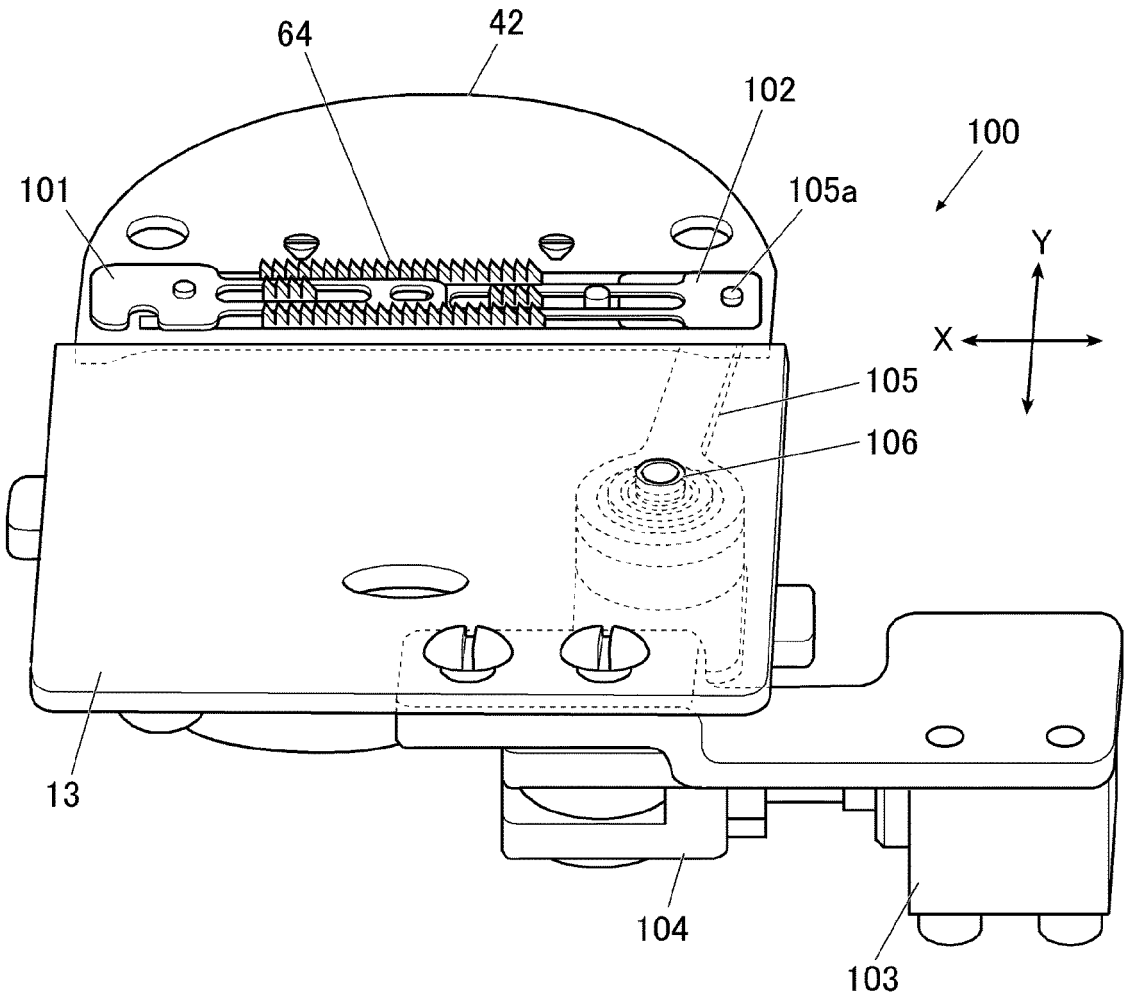


FIG. 11

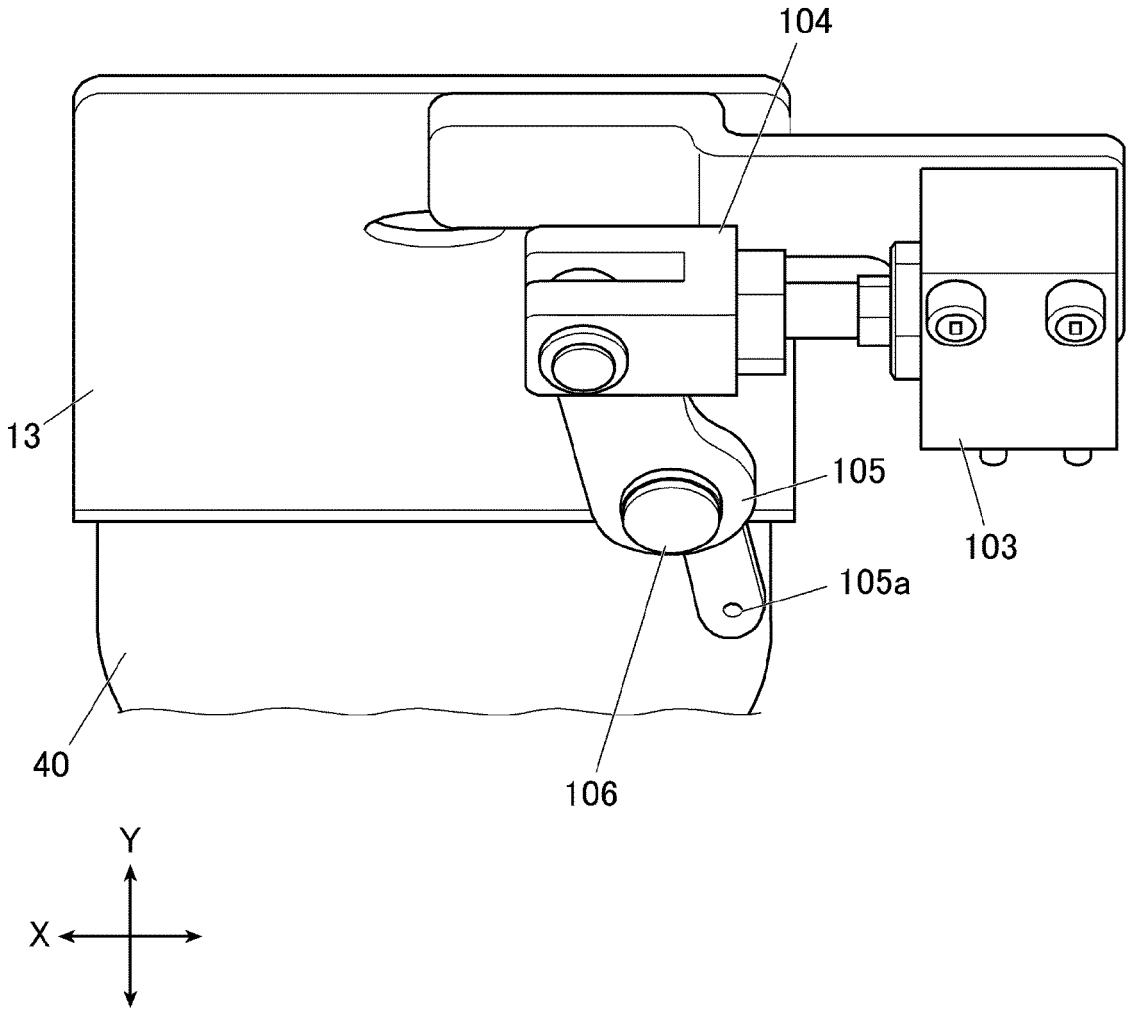


FIG. 12

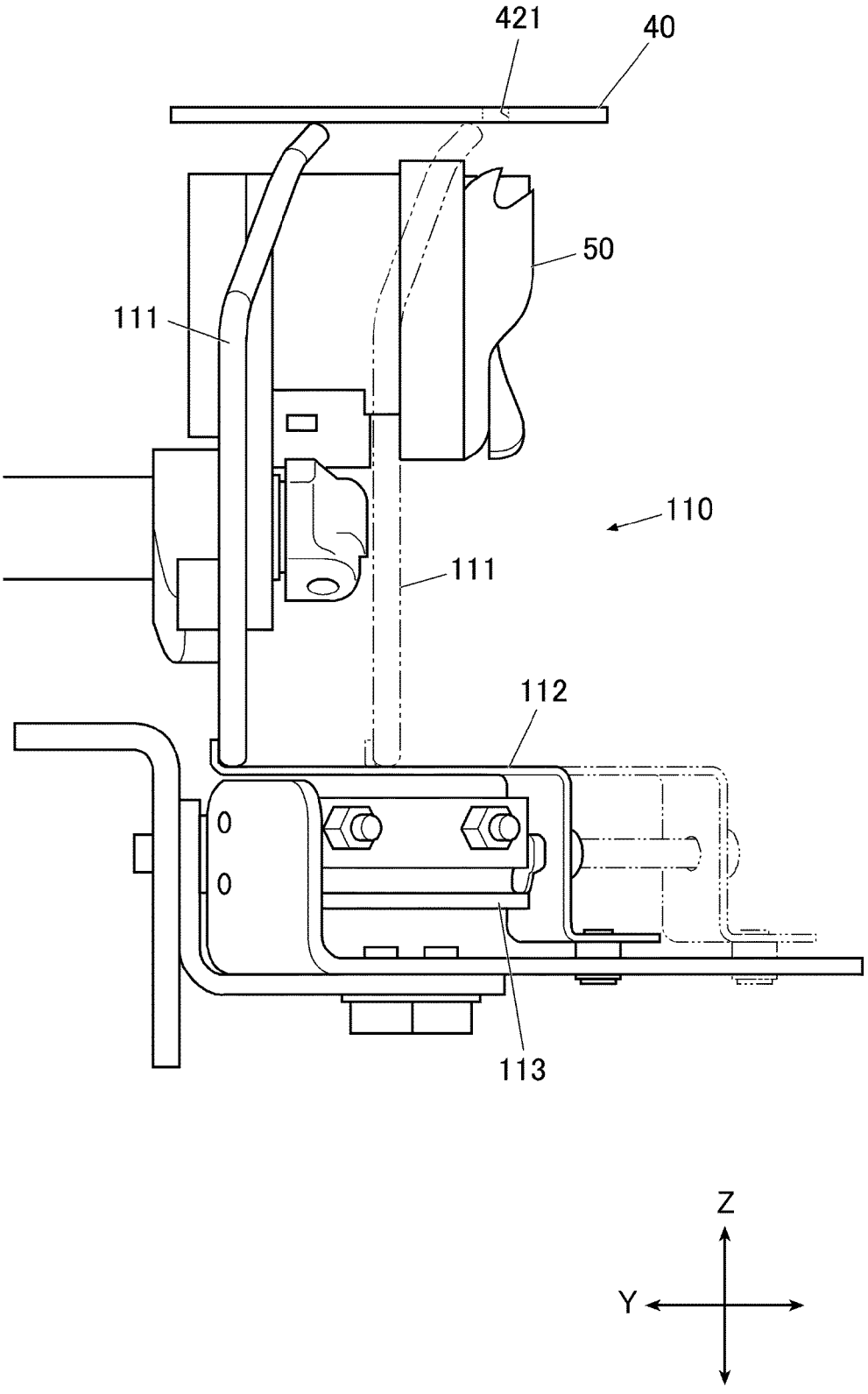


FIG. 13A

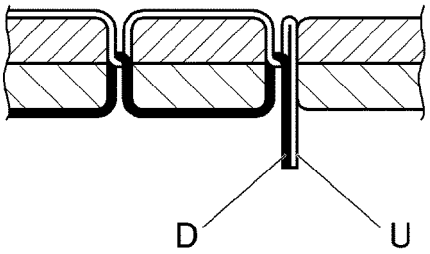


FIG. 13B

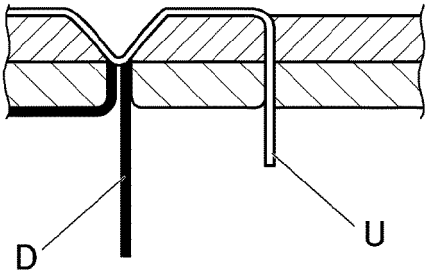


FIG. 14A

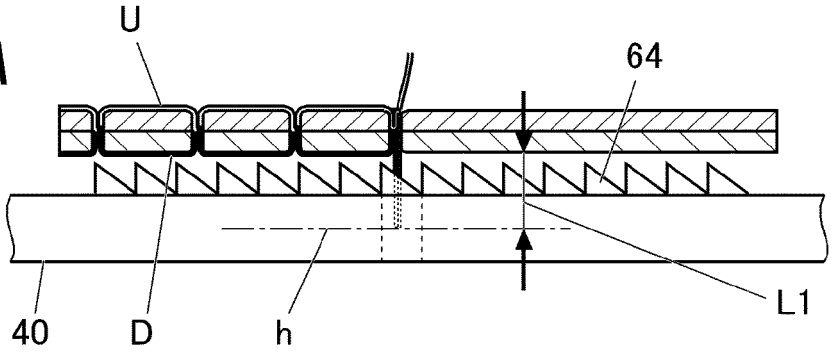


FIG. 14B

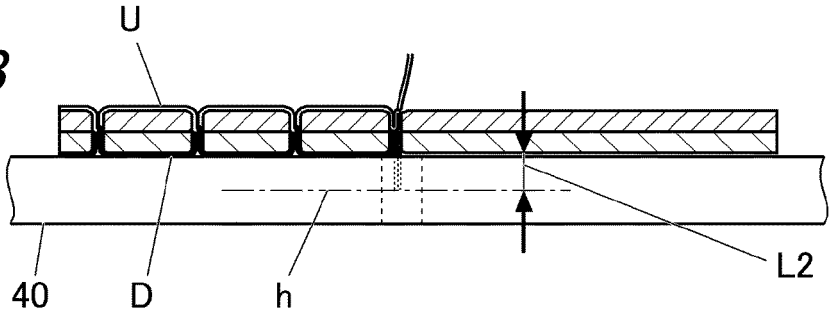


FIG. 15

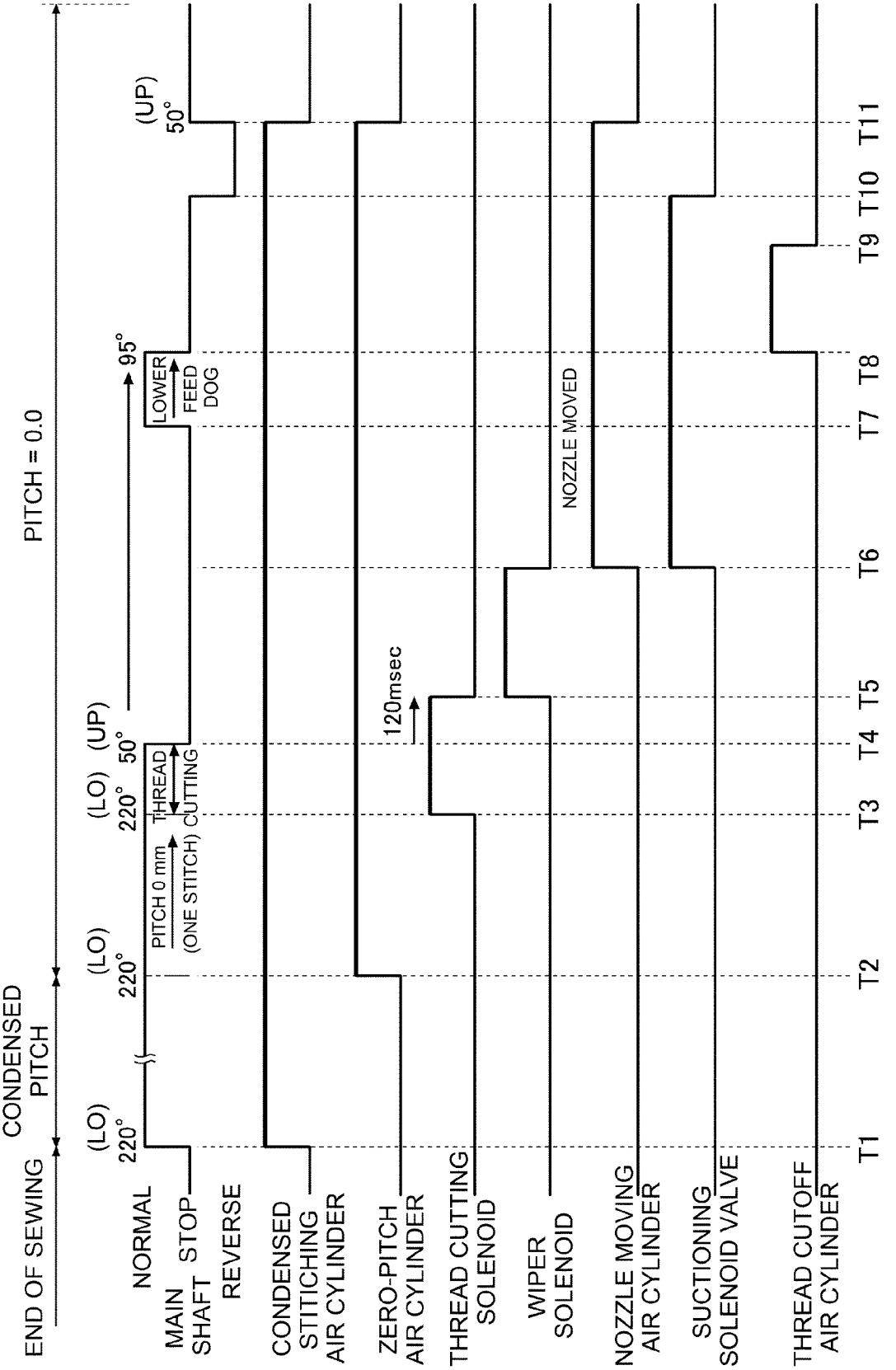

END OF SEWING
CONDENSED PITCH
PITCH = 0.0
(LO) 220°
(LO) 220°
(LO) 220°
(UP) 50°
(UP) 50°
95°
PITCH 0 mm (ONE STITCH)
THREAD CUTTING
LOWER FEED DOG
120msec
NOZZLE MOVED
NORMAL MAIN SHAFT STOP
REVERSE
CONDENSED STITICHING AIR CYLINDER
ZERO-PITCH AIR CYLINDER
THREAD CUTTING SOLENOID
WIPER SOLENOID
NOZZLE MOVING AIR CYLINDER
SUCTIONING SOLENOID VALVE
THREAD CUTOFF AIR CYLINDER
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11

FIG. 16

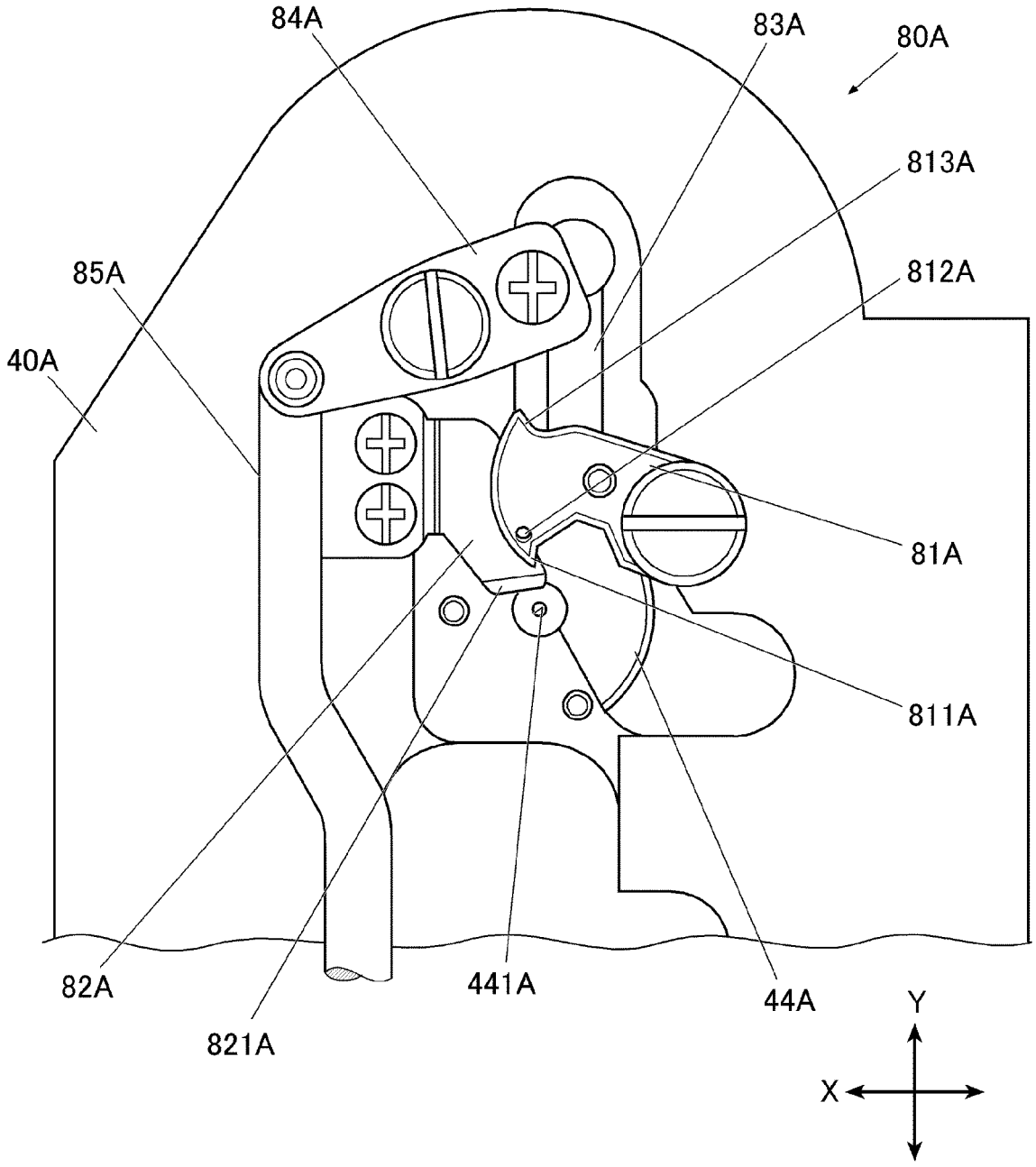


FIG. 17

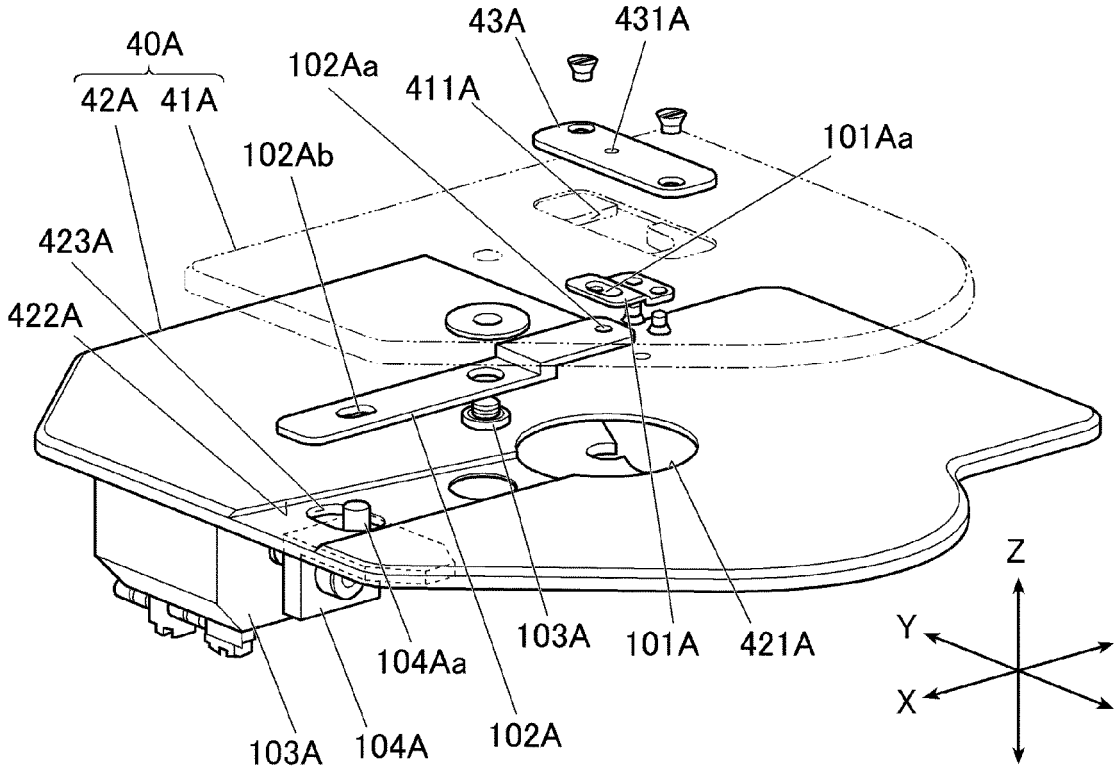


FIG. 18A

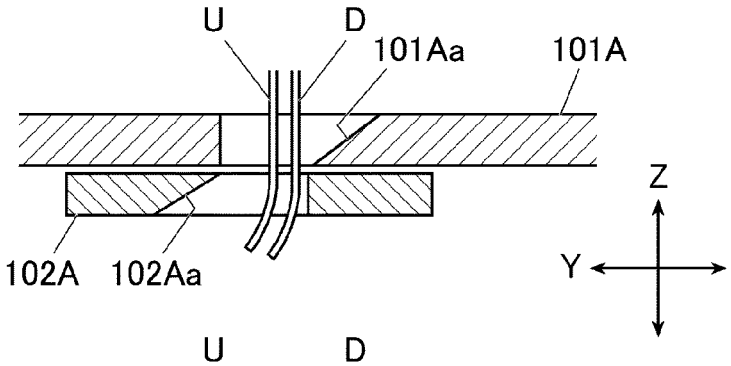


FIG. 18B

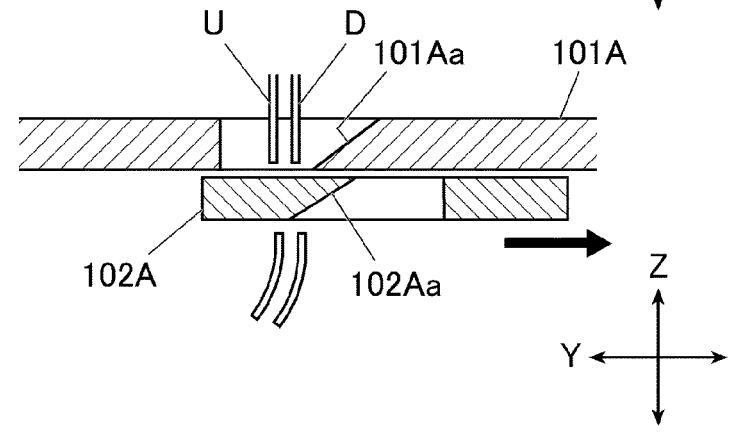


FIG. 19

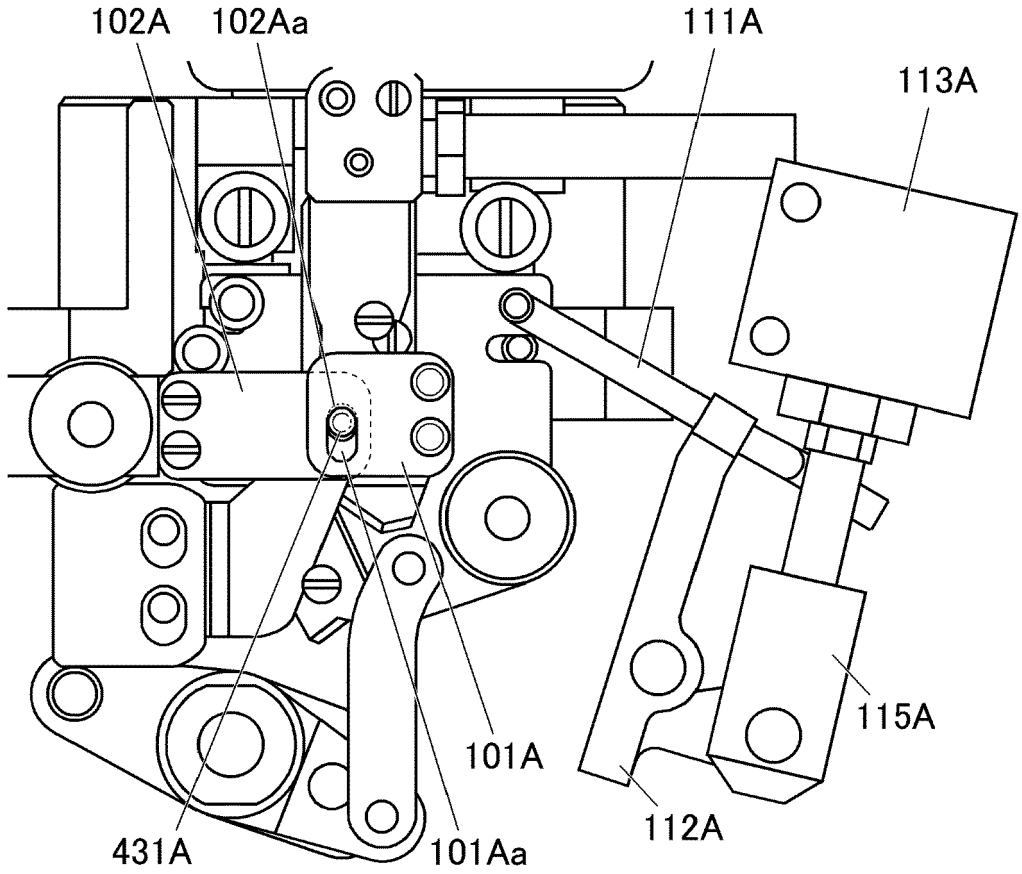


FIG. 20

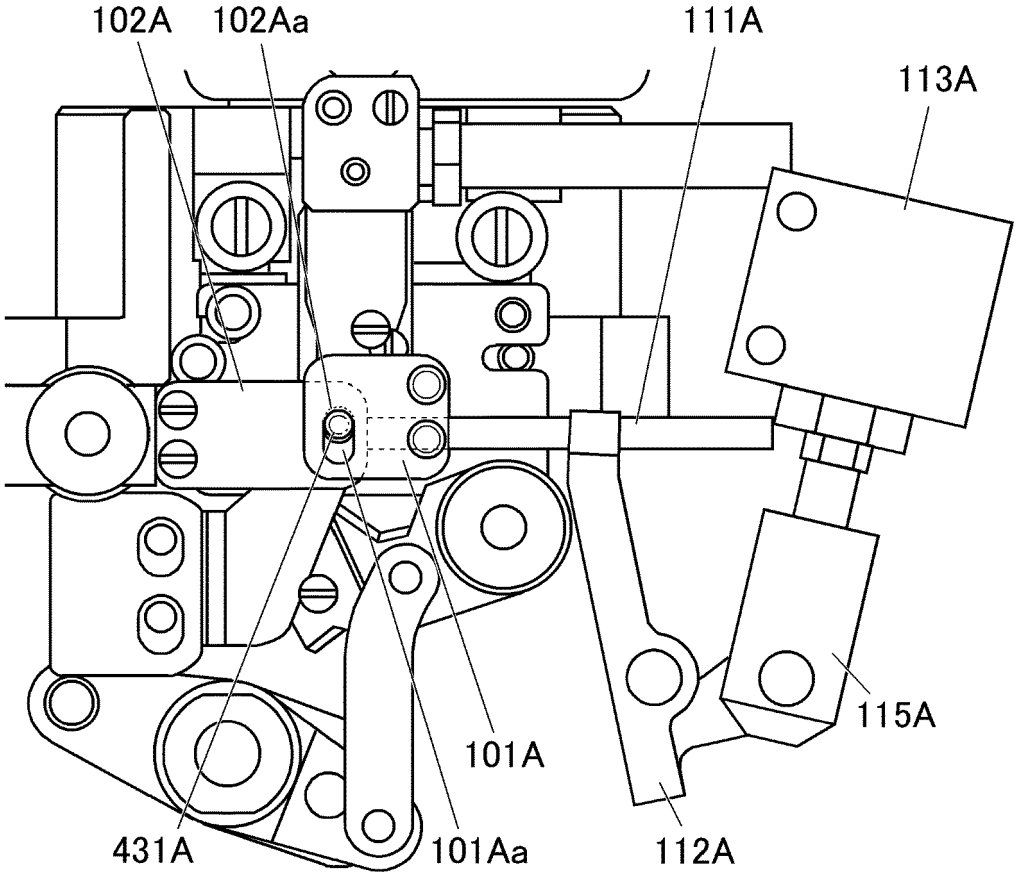


FIG. 21

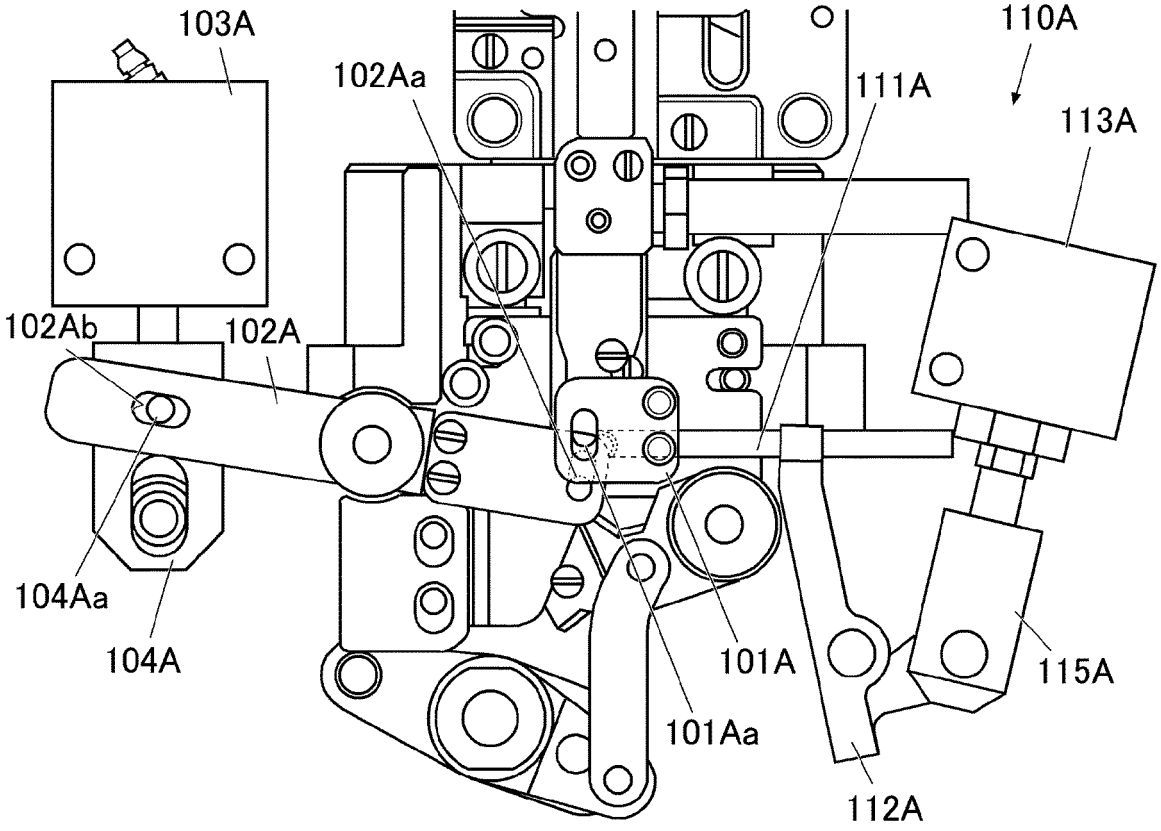
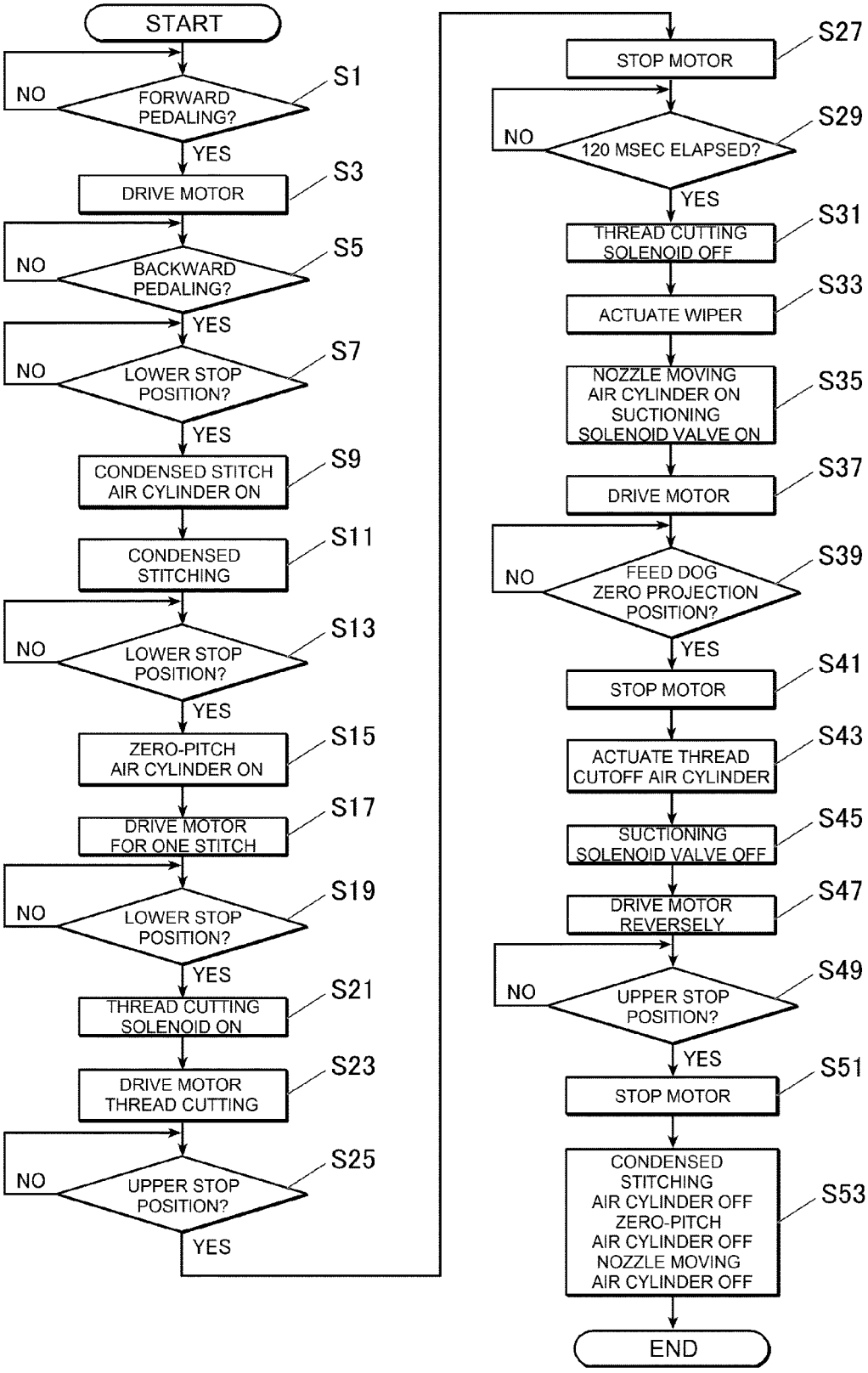

103A
102Aa
110A
111A
113A
102Ab
102A
104Aa
104A
101A
115A
101Aa
112A

FIG. 22


START
FORWARD PEDALING?
NO
YES
S1
DRIVE MOTOR
S3
BACKWARD PEDALING?
NO
YES
S5
LOWER STOP POSITION?
NO
YES
S7
CONDENSED STITCH AIR CYLINDER ON
S9
CONDENSED STITCHING
S11
LOWER STOP POSITION?
NO
YES
S13
ZERO-PITCH AIR CYLINDER ON
S15
DRIVE MOTOR FOR ONE STITCH
S17
LOWER STOP POSITION?
NO
YES
S19
THREAD CUTTING SOLENOID ON
S21
DRIVE MOTOR THREAD CUTTING
S23
UPPER STOP POSITION?
NO
YES
S25
STOP MOTOR
S27
120 MSEC ELAPSED?
NO
YES
S29
THREAD CUTTING SOLENOID OFF
S31
ACTUATE WIPER
S33
NOZZLE MOVING AIR CYLINDER ON SUCTIONING SOLENOID VALVE ON
S35
DRIVE MOTOR
S37
FEED DOG ZERO PROJECTION POSITION?
NO
YES
S39
STOP MOTOR
S41
ACTUATE THREAD CUTOFF AIR CYLINDER
S43
SUCTIONING SOLENOID VALVE OFF
S45
DRIVE MOTOR REVERSELY
S47
UPPER STOP POSITION?
NO
YES
S49
STOP MOTOR
S51
CONDENSED STITCHING AIR CYLINDER OFF ZERO-PITCH AIR CYLINDER OFF NOZZLE MOVING AIR CYLINDER OFF
S53
END

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3631

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DE 10 2007 017235 A1 (JUKI KK [JP]) 15 November 2007 (2007-11-15) * paragraph [0026] - paragraph [0085]; figures 1-11 *	1-8	INV. D05B65/06
Y	US 2003/196579 A1 (NAKATA MASAHIRO [JP]) 23 October 2003 (2003-10-23) * paragraph [0035] - paragraph [0049]; figures 1-10 *	1-8	
A	JP 2001 353392 A (JUKI KK) 25 December 2001 (2001-12-25) * abstract; figures 1-14 *	1-8	
A	JP 2003 150729 A (TSUBASA SYSTEM CO LTD) 23 May 2003 (2003-05-23) * the whole document *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC) D05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 January 2015	Herry-Martin, D

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21-01-2015

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- JP 2008018282 A **[0135]**