(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 967 630 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.09.2008 Bulletin 2008/37

(51) Int Cl.:
D05B 65/06 *(2006.01)*

(21) Application number: **08004151.0**

(22) Date of filing: **06.03.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **06.03.2007 JP 2007055152**

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(54) Sewing machine with upper thread cutting and holding mechanisms

(57) A sewing machine includes an upper thread cutting mechanism (35) having an upper thread movable blade (40) cutting an upper thread (14) extending from workpiece cloth (W) through an eye (9a) of a needle (9) above a needle plate (5), an upper moving mechanism (36) reciprocally moving the upper thread movable blade (40) between an upper side thread take-up position and an upper side thread cutting position spaced away from the upper side thread take-up position by a predetermined distance, and an upper thread holding mechanism (31) holding an end (14a) of the upper thread (14) cut by the upper thread cutting mechanism (35) when the upper thread movable blade (40) is moved reciprocally by the upper moving mechanism (36). The predetermined distance is set so as to be longer than a distance from the eye (9a) of the needle (9) to the needle plate (5).

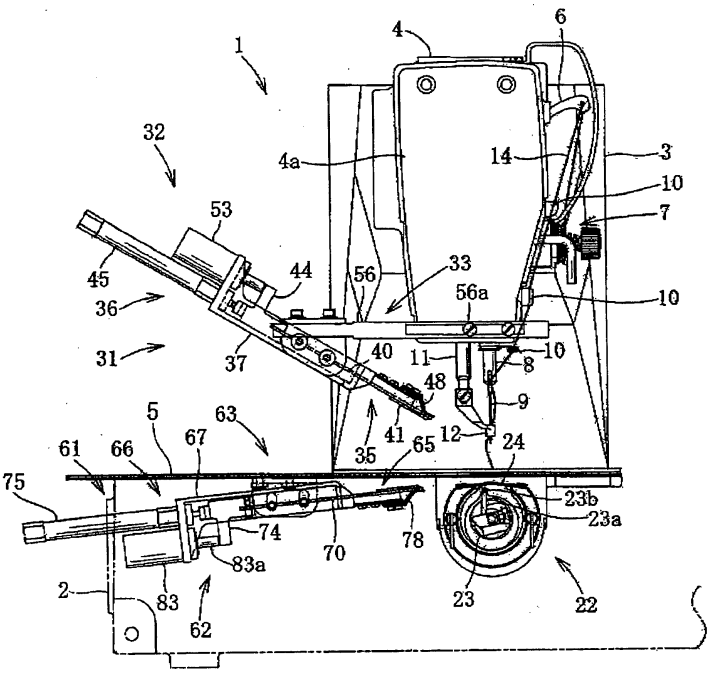

FIG. 3

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Description

[0001] The present invention relates to a sewing machine provided with an upper thread cutting mechanism which cuts an upper thread upon completion of sewing and an upper thread holding mechanism which holds an end of the upper thread cut by the upper thread cutting mechanism.

[0002] Some types of conventional sewing machines have been provided with a thread cutting device which cuts upper and lower threads both extending to workpiece cloth. Furthermore, the conventional sewing machines have also been provided with an upper thread holding device which holds ends of the upper and lower threads cut by the thread cutting device. The thread cutting device cuts the upper and lower threads over or below workpiece cloth automatically or in response to instructions to cut threads by an operator upon completion of sewing.

[0003] For example, JP-A-H04-26490 discloses an upper thread cutting device for a sewing machine, comprising an upper thread cutting device including an upper thread holding mechanism, a cutting member, a fixed plate and a cylinder. The upper thread cutting device is provided on an upper side of a sewing bed. Upon completion of sewing, the upper thread cutting mechanism causes the cutting member to generate heat which is used to cut an upper thread located between a cloth presser and workpiece cloth. Subsequently, the upper thread holding mechanism is returned to an original position while holding an end of the upper thread at the needle side. A sewing operation of the needle applies a drawing force to the upper thread end held by the upper thread holding mechanism. As a result, the upper thread end is drawn to the needle side thereby to drop out of the upper thread holding mechanism.

[0004] JP-A-H02-213385 discloses a thread cutting device for a sewing machine, comprising a pair of needle thread cutters and a holder each located above workpiece cloth, a fixed cutter, a movable-cutter pivoting arm and a bobbin-thread pulling plate each located below the workpiece cloth. Upon completion of sewing, the needle thread is cut by the paired needle thread cutters and thereafter, an end of the needle thread is held between one of the needle thread cutters and the holder. The movable-cutter pivoting arm and the bobbin-thread pulling plate are caused to pivot simultaneously so that the bobbin thread is cut by the fixed cutter. When the movable-cutter pivoting arm and the bobbin-thread pulling plate pivot to return to original positions after the bobbin thread has been cut, an end of the bobbin thread is held between the bobbin-thread pulling plate and a distal end of the movable cutter.

[0005] Various patterns are sometimes sewn onto leather goods such as belts or bags using a sewing machine. In this case, the operator uses a heated iron in order to melt down the last stitches of the upper and lower threads cut by the respective cutting mechanisms into a spherical shape after completion of the sewing. The last stitches of the upper and lower threads are rendered spherical in order that fray may be prevented. When melting down the stitches using the iron, the operator needs to pick the cut upper and lower threads with his or her fingers and to retain the threads in a stretched state.

[0006] In the above-described JP-A-H04-26990, a piston of a cylinder is moved forward when the upper thread is cut upon completion of the sewing. As the forward movement of the piston, the upper thread extending from the workpiece cloth to the needle eye is to be cut between a cloth presser and the workpiece cloth, namely, at the upper surface side of the workpiece cloth. As a result, the end of the upper thread is too short such that the operator has a difficulty in picking the end of the upper thread with his or her fingers.

[0007] In the above-described JP-A-H02-213385, too, the upper thread extending from the workpiece cloth is cut right over the workpiece cloth, and the lower thread extending from the workpiece cloth is cut right below the workpiece cloth. As a result, the operator also has a difficulty in picking the upper and lower threads with his or her fingers.

[0008] Therefore, an object of the present invention is to provide a sewing machine which can prevent the end of the upper thread cut by an upper thread cutting mechanism from being sewn at the time of start of the subsequent sewing.

[0009] The present invention provides a sewing machine which comprises a sewing machine frame, a needlebar on which a needle having an eye is mounted, a hook, an upper thread cutting mechanism having an upper thread movable blade cutting an upper thread extending from workpiece cloth through an eye of the needle above a needle plate, an upper moving mechanism which reciprocally moves the upper thread movable blade between an upper side thread take-up position where the upper thread is hooked beneath the needle and an upper side thread cutting position which is spaced away from the upper side thread take-up position by a predetermined distance, and an upper thread holding mechanism which holds an end of the upper thread cut by the upper thread cutting mechanism when the upper thread movable blade is moved reciprocally by the upper moving mechanism, characterized in that the predetermined distance is set so as to be longer than a distance from the eye of the needle to the needle plate.

[0010] According to the above-described construction, the upper thread movable blade is moved to the upper side thread take-up position by the upper moving mechanism and is then returned to the upper side thread cutting position with the upper thread being hooked thereon. On this occasion, the upper thread is cut by the upper thread cutting mechanism. The upper thread extending from the workpiece cloth is longer than the distance from the needle eye to the needle plate. Consequently, the fray preventing work can be carried out easily and quickly using an iron.

[0011] In a first preferred form, the sewing machine further comprises an upper thread releasing mechanism. In the sewing machine, the upper thread holding mechanism has an upper thread holding spring which cooperates with the upper thread movable blade to clamp the end of the upper thread therebetween, thereby holding the end. The upper thread releasing mechanism releases the upper thread held between the upper thread movable blade and the upper thread holding spring, the upper moving mechanism has a first air cylinder which reciprocally moves the upper thread movable blade, the upper thread releasing mechanism has a second air cylinder which reciprocally moves the upper thread movable blade, a range of movement of the upper thread movable blade by the second air cylinder is narrower than a range of movement of the upper thread movable blade by the first air cylinder, and the second air cylinder has a drive force which is set so as to be larger than a drive force of the first air cylinder.

[0012] According to the above-described construction, the upper thread movable blade is reciprocally moved between the upper side thread cutting position and the upper side thread take-up position by the first air cylinder. When having been moved to the upper side thread cutting position by the first air cylinder, the upper thread movable blade holds the upper thread in cooperation with the upper thread holding spring. When the second air cylinder with a larger drive force as compared with the first air cylinder is driven, the upper thread movable blade is moved to a position before the upper side thread take-up position (upper release position). The upper thread movable blade can be prevented from colliding against the needle even during sewing.

[0013] In a second preferred form, the sewing machine further comprises a control device which controls a sewing operation. In the sewing machine, the control device is provided with sewing data on which the workpiece cloth is sewn, and the sewing data includes a releasing command for the upper thread releasing mechanism.

[0014] According to the above-described arrangement, when stitches are sequentially formed based on the sewing data, the upper thread can be released from the held state when a predetermined number of stitches is formed.

[0015] In a third preferred form, the sewing machine further comprises a lower thread cutting mechanism having a lower thread movable blade cutting a lower thread extending from the workpiece cloth to the hook below the needle plate, a lower moving mechanism which reciprocally moves the lower thread movable blade between a lower side thread take-up position where the lower thread is hooked below the needle plate and a lower side thread cutting position which is spaced away from the lower side thread take-up position by a predetermined distance, and a lower thread holding mechanism which holds an end of the lower thread cut by the lower thread cutting mechanism when the lower thread movable blade is moved reciprocally by the lower moving mechanism.

[0016] According to the above-described construction, the lower thread movable blade is moved to the lower side thread take-up position by the lower moving mechanism and is then returned to the lower side thread cutting position with the lower thread being hooked thereon. On this occasion, the lower thread is cut by the lower thread cutting mechanism. The lower thread extending from the workpiece cloth is longer than the distance from the needle eye to the needle plate. Consequently, the fray preventing work can be carried out easily and quickly using an iron.

[0017] In a fourth preferred form, the sewing machine further comprises a lower thread releasing mechanism. In the sewing machine, the lower thread holding mechanism has a lower thread holding spring which cooperates with the lower thread movable blade to clamp the end of the lower thread therebetween, thereby holding the end, the lower thread releasing mechanism releases the lower thread held between the lower thread movable blade and the lower thread holding spring, the lower moving mechanism has a third air cylinder which reciprocally moves the lower thread movable blade, the lower thread releasing mechanism has a fourth air cylinder which reciprocally moves the lower thread movable blade, a range of movement of the lower thread movable blade by the fourth air cylinder is narrower than a range of movement of the upper thread movable blade by the third air cylinder, and the fourth air cylinder has a drive force which is set so as to be larger than a drive force of the third air cylinder.

[0018] According to the above-described construction, the lower thread movable blade is reciprocally moved from the lower side thread cutting position to the lower side thread take-up position by the third air cylinder. When the lower thread movable blade is moved to the lower side thread cutting position, the lower thread is held by the lower thread movable blade and the lower thread holding spring. When the fourth air cylinder having a larger drive force than the third air cylinder is driven, the lower thread movable blade is moved to a position before the lower side thread take-up position (lower releasing position). Consequently, the lower thread movable blade can be prevented from contact with the lower thread.

[0019] In a fifth preferred form, the sewing machine further comprises a lower thread release speed adjusting mechanism which adjusts a movement speed of the lower thread movable blade by the fourth air cylinder, and an upper thread release speed adjusting mechanism which adjusts a movement speed of the upper thread movable blade by the second air cylinder. In the sewing machine, the upper and lower thread release speed adjusting mechanisms adjust the movement speeds of the upper and lower thread movable blades so that a release speed at which the upper thread held by the upper thread holding mechanism is released by the upper thread releasing mechanism is lower than a release speed at which the lower thread held by the lower thread holding mechanism is released by the lower thread releasing

mechanism, respectively.

[0020] According to the above-described construction, the upper thread is held by the upper thread holding mechanism until stitches are formed by the upper thread. Consequently, the end of the upper thread can be prevented from being drawn to the back side of the workpiece cloth by the lower thread. Accordingly, the end of the upper thread can reliably be caused to remain at the surface side of the workpiece cloth.

[0021] In a sixth preferred form, the sewing machine comprises an upper movement speed adjusting mechanism which adjusts a movement speed at which the upper thread movable blade is moved by the first air cylinder. In the sewing machine, the upper movement speed adjusting mechanism sets a first movement speed at which the upper thread movable blade is moved from the upper side thread take-up position to the upper side thread cutting position so that the first movement speed is lower than a second movement speed at which the upper thread movable blade is moved from the upper side thread cutting position to the upper side thread take-up position.

[0022] According to the above-described construction, an amount of friction applied to the upper thread drawn can be reduced. Consequently, the stability of the upper thread can be improved to a marked extent and accordingly, good-looking stitches can be formed.

[0023] In a seventh preferred form, the sewing machine comprises a lower movement speed adjusting mechanism which adjusts a movement speed at which the lower thread movable blade is moved by the third air cylinder. In the sewing machine, the lower movement speed adjusting mechanism sets a third movement speed at which the lower thread movable blade is moved from the lower side thread take-up position to the lower side thread cutting position so that the third movement speed is lower than a fourth movement speed at which the lower thread movable blade is moved from the lower side thread cutting position to the lower side thread take-up position.

[0024] According to the above-described construction, an amount of friction applied to the lower thread drawn can be reduced. Consequently, the stability of the lower thread can be improved to a marked extent and accordingly, good-looking stitches can be formed.

[0025] In an eighth preferred form, the sewing machine further comprises a position changing mechanism which changes positions of the upper thread cutting mechanism and the upper moving mechanism to a direction in which the upper side thread cutting position and the upper side thread take-up position are connected to each other with an imaginary straight line.

[0026] According to the above-described construction, the position changing mechanism can arbitrarily change the distance from the thread take-up position to the thread cutting position. Consequently, the length of the upper thread end extending from the workpiece cloth can be changed to a desired value.

[0027] The invention will be described, merely by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of a sewing machine in accordance with one embodiment of the present invention;
FIG. 2 is a partially enlarged perspective view of the sewing machine;
FIG. 3 is a partial front view of the sewing machine;
FIG. 4 is a partial enlarged front of the sewing machine;
FIG. 5 is a plan view of an upper thread cutting mechanism, an upper thread holding mechanism and an upper thread releasing mechanism;
FIG. 6 is a partial front view of the upper thread holding mechanism;
FIG. 7 is a partial bottom view of a first body frame;
FIG. 8 is a partial plan view of a sewing bed of the sewing machine;
FIG. 9 is a front view of the sewing bed;
FIG. 10 is a bottom view of a needle plate of the sewing machine;
FIG. 11 is a partial front view of the lower thread holding mechanism;
FIG. 12 is a partial bottom view of a second body frame;
FIG. 13 is a block diagram showing a control system of the sewing machine;
FIG. 14 shows data formation of sewing data;
FIG. 15A is a schematic circuit diagram showing an air supply system for an upper thread cutting cylinder;
FIG. 15B is a schematic circuit diagram showing an air supply system for an upper releasing cylinder;
FIG. 15C is a schematic circuit diagram showing an air supply system for a lower thread cutting cylinder;
FIG. 16 is a time chart showing cutting and release of upper and lower threads;
FIG. 17 is a view similar to FIG. 4, showing a thread take-up operation by an upper thread cutting mechanism;
FIG. 18 is a view similar to FIG. 4, showing an upper thread releasing operation;
FIG. 19 is a view similar to FIG. 5, showing a condition where a drawing direction of the upper thread differs;
FIG. 20 is a view similar to FIG. 9 showing a thread take-up operation by a lower thread cutting mechanism;
FIG. 21 is a view similar to FIG. 9, showing a condition where the lower thread is released;
FIG. 22 is a view similar to FIG. 20, showing a condition where a drawing direction of the lower thread differs; and
FIG. 23 is a view similar to FIG. 4, showing a modified form.

[0028] One embodiment of the invention will be described with reference to the accompanying drawing. Referring to FIG. 1, an overall sewing machine 1 of the embodiment is shown. The sewing machine 1 includes a sewing bed 2 constituting a sewing machine body, a sewing pillar 3 continuous from the bed 2 and a sewing arm 4 extending from an upper part of the pillar 3 in parallel to the bed 2 all of which are mounted on a table 13. The bed 2 has a needle plate 5 and a cloth presser 15 on an upper surface thereof. The needle plate 5 has a needle hole 5a (see FIG. 5) through which a needle 9 is capable of passing. The bed 2, the pillar 3 and the arm 4 constitute a sewing machine frame. Further referring to FIG. 1, the side of the sewing machine where the pillar 3 is located will hereinafter be referred to as "the rear" of the sewing machine 1 and the side of the sewing machine 1 where a cloth presser plate 16 is located as will be described later will be referred to as "the front" of the sewing machine 1, as viewed in FIG. 1.

[0029] The arm 4 has a main shaft (not shown) extending in a front-back direction. The arm 4 is provided with a needle bar 8 reciprocated vertically and a thread take-up lever 6 (see FIG. 3). The needlebar 8 has a lower end to which the needle 9 is attached. A presser bar 11 is provided on the left of the needlebar 8 so as to be vertically moveable as viewed in FIG. 3. The presser bar 11 has a lower end to which a cylindrical cloth presser 12 is fixed. The needle 9 is inserted through the cloth presser 12. An upper thread 14 extending from a thread spool (not shown) serving as an upper thread supply passes through a thread tension disc assembly 7, the thread take-up lever 6 and a plurality of thread guides 10 sequentially, further extending through an eye 9a of the needle 9 (see FIG. 4).

[0030] A vertical rotating hook 22 (see FIG. 3) is provided on the bed 2. The vertical rotating hook 22 forms stitches in cooperation with the needle 9. The vertical rotating hook 22 has a bobbin case 23 accommodating a lower thread bobbin (not shown). The bobbin case 23 has a horn portion 23a protruding to the needle plate 5 side. The horn portion 23a has an upper end having a thread guide hole 23b for guiding a lower thread 21. The lower thread 21 extending from the lower thread bobbin passes through the thread guide hole 23b, a thread guide plate 24 and the needle hole 5a of the needle plate 5 sequentially, further extending to an upper part of the bed 2. Thus, a sewing mechanism is comprised of the needlebar 8 with the needle 9 attached, the thread take-up lever 6 and the hook 22.

[0031] The cloth presser 15 holds workpiece cloth W to be sewn in cooperation with the cloth presser plate 16 and a feed plate 17. X and Y drive mechanisms (neither shown) move the cloth presser 15. The X drive mechanism includes an X-axis drive motor 98 (see FIG. 13) which moves the feed plate 17 in a horizontal direction (X direction) perpendicular to a main shaft (not shown). The Y drive mechanism includes a Y-axis drive motor 99 (see FIG. 13) which moves the feed plate 17 in the front-back direction (Y direction) parallel to the main shaft. The cloth presser 15 comprises the feed plate 17, a presser arm 18 and the cloth presser plate 16 as shown in FIG. 2. The feed plate 17 is moved on the needle plate 5 back and forth and right and left. The presser arm 18 is mounted on the Y drive mechanism. The cloth presser plate 16 is formed into a rectangular frame and mounted on a front end of the presser arm 18 so as to be movable upward and downward.

[0032] The cloth presser plate 16 is normally away from the feed plate 17 and is moved upward and downward via a connecting part (not shown) by a pressing solenoid 20 provided on the arm 4. During sewing, the cloth presser plate 16 is moved downward by the pressing solenoid 20 to a location where the cloth presser plate 16 is brought into contact with the feed plate 17, whereupon the workpiece cloth W is held between the cloth presser plate 16 and the feed plate 17. The cloth presser plate 16 and the feed plate 17 with the workpiece cloth W being held therebetween are moved in the X and Y directions synchronously.

[0033] A control box 26 is mounted under the table 13 as shown in FIG. 1. The control box 26 houses a control device 90 (see FIG. 13) which will be described later and a drive section of a pressurized air supply system. A pedal-type start/stop switch 27 is provided below the table 13. The operator operates the start/stop switch 27 to enter signals instructing start and stop of a sewing operation and signals instructing upward and downward movement of the cloth presser plate 16.

[0034] An upper thread path of the upper thread 14 starting from the thread spool and leading to the needle 9 is located on the right of the arm 4 as viewed in FIG. 3. Opposite the upper thread path are located an upper thread holding mechanism 31, an upper thread releasing mechanism 32, an upper thread direction adjusting mechanism 33, an upper thread cutting mechanism 35 and an upper moving mechanism 36 with the arm 4 being located between these mechanisms and the upper thread path. Consequently, when the operator threads the sewing machine 1 up to the needle 9, the threading work is not blocked by the upper thread cutting mechanism 35 etc., whereupon higher working efficiency can be achieved. The upper thread cutting mechanism 35 is operated to cut the upper thread 14 extending from the workpiece cloth W through the eye 9a of the needle 9. An end 14b of the upper thread 14 cut by the upper thread cutting mechanism 35 is held by the upper thread holding mechanism 31. The end 14a of the upper thread 14 is released from the held state by the upper thread releasing mechanism 32.

[0035] The upper thread cutting mechanism 35 comprises a first body frame 37 (upper guide member), a first movable blade 40 (upper thread movable blade) and a first fixed blade 41. The first movable blade 40 has a length corresponding at least to a distance from the upper side thread cutting position to the upper side thread take-up position as will be described later. The first body frame

37 includes a bottom wall 37a, a side wall 37b, a distal end wall 37c, a rear end wall 37e and a holding wall 37d, all of which are formed integrally as shown in FIGS. 4 to 7. The holding wall 37d has in a lower end thereof a guide groove 37f (see FIG. 7) which guides a lengthwise movement of the first movable blade 40.

[0036] The first movable blade 40 comprises a plate member with a predetermined width and is movable between an upper side thread take-up position (see FIG. 17) and an upper side thread cutting position (see FIGS. 3 and 4). The upper thread 14 is hooked beneath the needle 9 at the upper side thread take-up position. The upper side thread cutting position is spaced away by a predetermined distance from the upper side thread take-up position. A distance from the upper side thread take-up position to the upper side thread cutting position is longer than a distance from the eye 9a of the needle 9 to the needle plate 5. The first movable blade 40 has a blade portion 40b (see FIG. 7) formed on a distal hook portion 40a thereof. The first fixed blade 41 includes a fixed portion 41a and a blade portion 41b. The fixed portion 41a has a larger width than the blade portion 41b and is fixed to the underside of the holding wall 37d by fixing screws 42. The blade portion 41b is mounted at the distal end side of the fixed portion 41a so as to be inclined.

[0037] The upper moving mechanism 36 will be described. Referring to FIGS. 3 to 5, the upper moving mechanism 36 includes the first body frame 37, a first movement block 44 and an upper side thread cutting cylinder 45 (a first air cylinder). The first movement block 44 is connected to a rear end of the first movable blade 40. The first movable blade 40 is reciprocally moved via the first movement block 44 by the upper side thread cutting cylinder 45. The first movement block 44 has a body 44a and a connection 44b as shown in FIGS. 4 and 5. The body 44a is formed into the shape of an axially extending block. The connection 44b protrudes upward from the body 44a. The first movement block 44 is moved along an upper surface of the bottom wall 37a of the first body frame 37. The upper side thread cutting cylinder 45 includes a movable piston rod 45a. The piston rod 45a has a distal end connected to the rear end of the body 44a. The body 44a has a front end connected to the rear end of the first movable blade 40.

[0038] The upper thread holding mechanism 31 will be described. Referring to FIGS. 4 to 6, the upper thread holding mechanism 31 includes a first holding spring 47 (an upper thread holding spring), a first leaf spring 48 and an adjusting screw 49. The first holding spring 47 is located on an upper surface of the holding wall 37d, and the first leaf spring 48 is located on an upper surface of the first holding spring 47. The first holding spring 47 comprises a rectangular elastic plate-shaped member. The first leaf spring 48 also comprises a rectangular elastic plate-shaped member and has substantially the same shape as the first holding spring 47. Both springs 47 and 48 have respective rear ends fixed to an upper surface of the holding wall 37d by fixing screws 50. The first holding spring 47 has a downwardly bent front end which presses a front end of the first movable blade 40 from above. The adjusting screw 49 is threadingly engaged with the holding wall 37d through the springs 47 and 48. The adjusting screw 49 is operated to adjust a force pressing the first leaf spring 48 against the first holding spring 47, namely, a force holding the thread end 14b between the first movable blade 40 and the first holding spring 47.

[0039] The upper thread releasing mechanism 32 will be described. Referring to FIGS. 4 and 5, the upper thread releasing mechanism 32 includes an upper releasing cylinder 53 (a second air cylinder), the first movement block 44 and the first movable blade 40. The upper releasing cylinder 53 is fixed to an upper part of the rear end wall 37e and has a movable piston rod 53a. The movable piston rod 53a has a distal end which is connectable to the connection 44b of the first movement block 44. The piston rod 53a of the upper releasing cylinder 53 has a narrower range of movement than the piston rod 45a of the upper thread cutting cylinder 45. The upper releasing cylinder 53 has a larger inner diameter than the upper side thread cutting cylinder 45. When air pressurized by the same pressure is applied to the upper releasing cylinder 53 and the upper side thread cutting cylinder 45, a driving force of the upper releasing cylinder 53 is stronger than a driving force of the upper side thread cutting cylinder 45. As a result, the upper releasing cylinder 53 can be moved forward with the piston rod 45a of the upper side thread cutting cylinder 45 being stepped backward.

[0040] The piston rod 53a of the upper releasing cylinder 53 is moved forward when the end 14b of the upper thread 14 is held between the first movable blade 40 and the first holding spring 47. Consequently, the piston rod 45a of the upper side thread cutting cylinder 45 is also moved forward together with the first movement block 44. Upon forward movement of the first movement block 44, the first movable blade 40 is moved forward to the upper releasing position (see FIG. 18). The end 14b of the upper thread 14 is released from hold of the upper thread holding mechanism 31 by the movement of the first movable blade 40. Accordingly, the upper releasing position is located nearer to the upper side thread cutting position side than the upper side thread take-up position.

[0041] The following describes the upper thread direction adjusting mechanism 33 which adjusts a direction in which the upper thread 14 extending through the eye 9a of the needle 9 is drawn. Referring to FIGS. 4 to 7, the upper thread direction adjusting mechanism 33 includes the first body frame 37, a first overhang plate 55 (an upper overhang member) and a support member 56. The first overhang plate 55 is curved as viewed in FIG. 5 and has two curved or arc grooves 55a (upper arc grooves) formed with a predetermined distance. The first overhang plate 55 has a rear end having a downwardly bent fixing portion 55b formed integrally therewith. The fixing portion

55b is fixed to the side wall 37b of the first body frame 37 by a fixing bolt 57. The first body frame 37 is disposed so that the rear end wall 37e is located higher than the distal end wall 37c. The support member 56 extending in the right-left direction is fixed to the distal end of the arm 4 by a fixing bolt 56a. The first overhang plate 55 is fixed to the support member 56 by fixing bolts 58 extending through the arc groove 55a.

[0042] The first body frame 37 is located in the left rear of the needle hole 5a of the needle plate 5 as viewed in FIGS. 5 and 8. Furthermore, the first body frame 37 is located in front of the presser arm 18 of the cloth presser 15 as viewed in FIG. 8. Thus, the first body frame 37 is located so as not to interfere with the presser arm 18. The direction of the first body frame 37 (the direction in which the upper thread 14 is drawn) is adjustable from a rear limit position as shown in FIG. 8 to a forward limit position where the first body frame 37 is parallel to the support member 56, as shown in FIG. 19. The movement limit position of the first body frame 37 is set by the arc grooves 55a so as not to interfere with the cloth presser 15. When the direction of the first body frame 37 is adjusted by the upper thread direction adjusting mechanism 33, the fixing bolts 58 are loosened so that the first body frame 37 is moved to a desired position. Subsequently, the fixing bolts 58 are tightened up against the support member 56. Since the center of each arc groove 55a is on the axis line of the needle 9, the distal end of the first body frame 37 is necessarily directed to the needle 9 by the arc grooves 55a.

[0043] Referring to FIGS. 9 to 12, the sewing machine 1 further comprises a lower thread cutting mechanism 65, a lower moving mechanism 66, a lower thread holding mechanism 61, a lower thread releasing mechanism 62 and a lower thread direction adjusting mechanism 63. The mechanisms 65, 66, 61 and 62 are located on the left of the vertical rotating hook 22 below the needle plate 5 as viewed in FIG. 9. The lower thread 21 extending from the workpiece cloth W to the vertical rotating hook 22 is cut by the lower thread cutting mechanism 65. An end 21b of the lower thread 21 is held by the lower thread holding mechanism 61. The end 21b of the lower thread 21 is released from hold by the lower thread holding mechanism 61. The lower thread cutting mechanism 65 includes a second body frame 67 (a lower guide member), a second movable blade 70 (lower thread movable blade) and a second fixed blade 71. The second movable blade 70 has a length corresponding at least to a distance from the lower side thread cutting position to the lower side thread take-up position as will be described later. The second body frame 67 includes a bottom wall 67a, a side wall 67b, a distal end wall 67c, a rear end wall 67e and a holding wall 67d, all of which are formed integrally, as shown in FIGS. 9 to 12. The holding wall 67d has in an upper end thereof a guide groove 67f (see FIG. 12) which guides a lengthwise movement of the second movable blade 70.

[0044] The second movable blade 70 comprises a plate member with a predetermined width and is movable between the lower side thread take-up position (see FIG. 20) and the lower side thread cutting position (see FIGS. 3 and 9). The lower thread 21 is hooked beneath the needle plate 5 at the lower side thread take-up position. The lower side thread cutting position is spaced away by a predetermined distance from the lower side thread take-up position. A distance from the lower side thread take-up position to the lower side thread cutting position is longer than a distance from the eye 9a of the needle 9 to the needle plate 5. The second movable blade 70 has a blade portion 70b (see FIG. 12) formed on a distal hook portion 70a thereof. The second fixed blade 71 includes a fixed portion 71a and a blade portion 71b. The fixed portion 71a has a larger width than the blade portion 71b and is fixed to the upper surface of the holding wall 67d by fixing screws 72. The blade portion 71b is mounted at the distal end side of the fixed portion 71a so as to be inclined.

[0045] The lower moving mechanism 66 will be described. Referring to FIGS. 3, 9 and 10, the lower moving mechanism 66 includes a second movement block 74 and a lower side thread cutting cylinder 75 (a third air cylinder). The second movement block 74 is connected to a rear end of the second movable blade 70. The second movable blade 70 is reciprocally moved via the second movement block 74 by the lower side thread cutting cylinder 75. The second movement block 74 has a body 74a and a connection 74b as shown in FIGS. 9 and 10. The body 74a is formed into the shape of an axially extending block. The connection 74b protrudes downward from the body 74a. The second movement block 74 is moved along the bottom wall 67a of the second body frame 67. The lower side thread cutting cylinder 75 is fixed to the upper surface of the rear end wall 67e. The lower side thread cutting cylinder 75 includes a piston rod 75a which is movable forward. The piston rod 75a has a distal end connected to the rear end of the body 74a.

[0046] The lower thread holding mechanism 61 will be described. Referring to FIGS. 9 to 11, the lower thread holding mechanism 61 includes a second holding spring 77 (a lower thread holding spring), a second leaf spring 78 and an adjusting screw 79. The second holding spring 77 is located on an underside of the holding wall 67d, and the second leaf spring 78 is located on an underside of the second holding spring 77. The second holding spring 77 comprises a rectangular elastic plate-shaped member. The second leaf spring 78 also comprises a rectangular elastic plate-shaped member and has substantially the same shape as the second holding spring 77. Both springs 77 and 78 have respective rear ends fixed to an underside of the holding wall 67d by fixing screws 80. The second holding spring 77 has a bent front end which presses a front end of the second movable blade 70 from below. The adjusting screw 79 is threadingly engaged with the holding wall 67d through the springs 77 and 78. The adjusting screw 79 is operated

to adjust a force pressing the second leaf spring 78 against the second holding spring 77, namely, a force holding the thread end 21b of the lower thread 21 between the second movable blade 70 and the second holding spring 77.

[0047] The lower thread releasing mechanism 62 will be described. Referring to FIGS. 9 and 10, the lower thread releasing mechanism 62 includes a lower releasing cylinder 83 (a fourth air cylinder), the second movement block 74 and the second movable blade 70. The lower releasing cylinder 83 has a front end fixed to a lower part of the rear end wall 67e of the second body frame 67. The lower releasing cylinder 83 also has a movable piston rod 83a. The movable piston rod 83a has a distal end which is connectable to the connection 74b of the second movement block 74. The piston rod 83a of the lower releasing cylinder 83 has a narrower range of movement than the piston rod 75a of the lower side thread cutting cylinder 75. The lower releasing cylinder 83 has a larger inner diameter than the lower side thread cutting cylinder 75. When air pressurized by the same pressure is applied to the lower releasing cylinder 83 and the lower side thread cutting cylinder 75, a driving force of the lower releasing cylinder 83 is stronger than a driving force of the lower side thread cutting cylinder 75. As a result, the lower releasing cylinder 83 can be moved forward with the piston rod 75a of the lower side thread cutting cylinder 75 being stepped backward.

[0048] The piston rod 75a of the lower side thread cutting cylinder 75 is moved forward together with the second movement block 74 in the case where the lower releasing cylinder 83 is moved forward when the end 21b of the lower thread 21 is held between the second movable blade 70 and the second holding spring 77. Upon forward movement of the second movement block 74, the second movable blade 70 is moved forward to the lower releasing position (see FIG. 21). The end 21b of the lower thread 21 is released from hold of the lower thread holding mechanism 61. Accordingly, the lower releasing position is located nearer to the lower side thread cutting position side than the lower side thread take-up position.

[0049] The following describes the lower thread direction adjusting mechanism 63 which adjusts a direction in which the lower thread 21 extends from the thread guide hole 23b of the bobbin case 23 of the vertical rotating hook 22 to the lower thread holding mechanism 61. Referring to FIGS. 9 to 12, the lower thread direction adjusting mechanism 63 includes the second body frame 67, a second overhang plate 85 (a lower overhang member) and fixing bolts 86 (a fastening member). The second overhang plate 85 is curved as viewed in FIG. 10 and has two curved or arc grooves 85a (lower arc grooves) formed with a predetermined distance therebetween. The second overhang plate 85 has a front end having a downwardly bent fixing portion 85b formed integrally therewith. The fixing portion 85b is fixed to the side wall 67b of the second body frame 67 by fixing bolts 87. The second body frame 67 is inclined so that the distal end wall 67c side is higher (the needle 9 side is located higher). The second overhang plate 85 is fixed to the underside of the needle plate 5 by the fixing bolts 86 extending through the arc grooves 85a respectively.

[0050] The second body frame 67 is located obliquely in front of the needle hole 5a of the needle plate 5 to the left as viewed in FIG. 10. A direction in which the lower thread 21 is drawn can be set to the same direction in which the lower thread 21 extends form the needle hole 5a of the needle plate 5 to the thread guide hole 23b of the bobbin case 23. The direction of the second body frame 67 (the direction in which the lower thread 21 is drawn) is adjustable from a forward limit position as shown in FIG. 10 to a rear limit position where the second body frame 67 is parallel to the X axis as shown in FIG. 22. An adjusting manner is similar to the adjusting manner in the case of the upper thread direction adjusting mechanism 33 and accordingly the description of the adjusting manner will be eliminated.

[0051] The control system of the sewing machine 1 will now be described. Referring to FIG. 13, the control device 90 comprises a computer composed of a CPU 91, a ROM 92 and a RAM 93. A start/stop switch 94, a presser switch 95, a rotation angle sensor 96 and drive circuits 100 to 103 are connected to the control device 90. The presser switch 95 is operated to switch the cloth presser plate 16 between a press position and a release position. The rotation angle sensor 96 is provided for detecting a rotation angle of the main shaft. The drive circuit 100 controls drive of a sewing machine motor 97. The drive circuit 101 controls drive of the pressing solenoid 20 switching the cloth presser plate 16 to the press position. The drive circuit 102 controls drive of the X-axis drive motor 98. The drive circuit 103 controls drive of the Y-axis drive motor 99.

[0052] The ROM 92 stores various control programs for control of the sewing machine 1, a plurality of types of sewing data for execution of sewing and the like. The sewing data includes needle location data, a lower thread release command code and an upper thread release command code. The needle location data indicates needle locations of first to last n-th stitches as shown in FIG. 14. The lower thread release command code is provided for releasing the lower thread 21. The upper thread release command code is provided for releasing the upper thread 14. The sewing data includes, next to the needle location data of the n-th stitch, an upper thread cutting command code for cutting the upper thread 14 and a lower thread cutting command code for cutting the lower thread 21.

[0053] The RAM 93 temporarily stores the results of computing executed by the CPU 91. To the control device 90 are further connected drive circuits 110 to 113 which drive a first electromagnetic switching valve 104, a first release electromagnetic switching valve 105, a second electromagnetic switching valve 106 and a second release electromagnetic switching valve 107. The first and

second electromagnetic switching valves 104 and 105 and the first and second release electromagnetic switching valves 105 and 107 incorporate exhaust throttle valves 104A to 107A and 1048 to 107B respectively (see FIG. 15).

[0054] The following briefly describes a pressurized air supply system to the upper side thread cutting cylinder 45 and the lower side thread cutting cylinder 75. The upper and lower side thread cutting cylinders 45 and 75 comprise respective double-acting air cylinders as shown in FIGS. 15A and 15C. The upper side thread cutting cylinder 45 has a forward movement air feed port 45b and a rearward movement air feed port 45c. The lower side thread cutting cylinder 75 has a forward movement air feed port 75b and a rearward movement air feed port 75c. The first electromagnetic switching valve 104 switches a supply route of pressurized air to be supplied from an air source 115 to the upper side thread cutting cylinder 45. The second electromagnetic switching valve 106 switches a supply route of pressurized air to be supplied from the air source 115 to the lower side thread cutting cylinder 75. The piston rod 45a is moved forward when the first electromagnetic switching valve 104 is operated so that pressurized air is supplied to the forward movement air feed port 45b of the upper side thread cutting cylinder 45. The piston rod 75a is moved forward when the second electromagnetic switching valve 106 is operated so that pressurized air is side thread cutting cylinder 75. The piston rod 45a is moved rearward when the first electromagnetic switching valve 104 is operated so that pressurized air is supplied to the rearward movement air feed port 45c of the upper side thread cutting cylinder 45. The piston rod 75a is moved rearward when the second electromagnetic switching valve 106 is operated so that pressurized air is supplied to the rearward movement air feed port 75c of the lower side thread cutting cylinder 75.

[0055] The exhaust throttle valves 104A and 106A (upper and lower moving speed adjusting mechanisms) have respective larger air flow rates than the exhaust throttle valves 104B and 106B (upper and lower moving speed adjusting mechanisms) . As a result, the speed of the first movable blade 40 moving to the upper side thread cutting position is lower than the speed of the first movable blade 40 moving to the upper side thread take-up position. Furthermore, the speed of the second movable blade 70 moving to the lower side thread cutting position is lower than the speed of the second movable blade 70 moving to the lower side thread take-up position.

[0056] The upper and lower side releasing cylinders 53 and 83 comprise respective double-acting air cylinders as shown in FIGS. 15B and 15D. The upper releasing cylinder 53 has a forward movement air feed port 53b and a rearward movement air feed port 53c. The lower side releasing cylinder 83 has a forward movement air feed port 83b and a rearward movement air feed port 83c. The first release electromagnetic switching valve 105 switches supply of pressurized air to be supplied from the air source 115 to the upper releasing cylinder 53. The second release electromagnetic switching valve 107 switches supply of pressurized air to be supplied from the air source 115 to the lower releasing cylinder 83. The piston rod 53a is moved forward when the first release electromagnetic switching valve 105 is operated so that pressurized air is supplied to the forward movement air feed port 53b of the upper releasing cylinder 53. The piston rod 83a is moved forward when the second release electromagnetic switching valve 107 is operated so that pressurized air is supplied to the forward movement air feed port 83b of the lower releasing cylinder 83. The piston rod 53a is moved rearward when the first release electromagnetic switching valve 105 is operated so that pressurized air is supplied to the rearward movement air feed port 53c of the upper releasing cylinder 53. The piston rod 83a is moved rearward when the second release electromagnetic switching valve 107 is operated so that pressurized air is supplied to the rearward movement air feed port 83c of the lower releasing cylinder 83.

[0057] The exhaust throttle valves 105A and 107A (upper and lower release speed adjusting mechanisms) have respective smaller air flow rates than the exhaust throttle valves 105B and 107B (upper and lower release speed adjusting mechanisms). As a result, the speed of the first movable blade 40 moving toward the upper side thread cutting position is higher than the speed of the first movable blade 40 moving to the upper release position. Furthermore, the speed of the second movable blade 70 moving to the lower side thread cutting position is higher than the speed of the second movable blade 70 moving to the lower release position. In particular, the exhaust throttle valve 105A (upper thread release speed adjusting mechanism) has a smaller air flow rate than the exhaust throttle valve 107A (lower thread release speed adjusting mechanism). As a result, the upper thread 14 drops out of the upper thread holding mechanism 31 even when the speed of the upper thread 14 is lower than the speed of the lower thread 21.

[0058] Based on the upper thread release command code, the CPU 91 drives the first release electromagnetic switching valve 105 so that pressurized air is supplied to the forward movement air feed port 53b. Subsequently, upon lapse of a predetermined time (130 msec), the CPU 91 drives the first release electromagnetic switching valve 105 so that pressurized air is supplied to the rearward movement air feed port 53c. Since the foregoing is also applied to the lower thread release command code, the description thereof will be eliminated. Based on the upper thread cutting command code, the CPU 91 drives first electromagnetic switching valve 104 so that pressurized air is supplied to the forward movement air feed port 45b. Subsequently, upon lapse of a predetermined time (700 msec), the CPU 91 drives the first electromagnetic switching valve 104 so that pressurized air is supplied to the rearward movement air feed port 45c. When the sewing machine 1 is connected to the electric power supply, the CPU 91 delivers signals to the respective

drive circuits 110 to 113 so that all the piston rods 45a, 53a, 75a and 83a are moved rearward.

[0059] The operation and advantages of the sewing machine 1 will now be described with reference to FIGS. 14 and 16. At time T1 when the sewing based on the needle location data of the last or n-th stitch is completed, the upper thread 14 (as shown by a chain line in FIG. 16) is cut by the upper thread cutting mechanism 35 in conformity with the read upper thread cutting command code. The end 14b of the cut upper thread 14 is held by the upper thread holding mechanism 31. At time T2, the lower thread 21 (as shown by two-dot chain line in FIG. 16) is cut by the lower thread cutting mechanism 65 based on the read lower thread cutting command code. The end 21b of the lower thread 21 is held by the lower thread holding mechanism 61.

[0060] The cutting and holding of the upper thread 14 will be described. As described above with reference to FIG. 15A, the CPU 91 delivers a signal to the drive circuit 110 at time T1 so that pressurized air is supplied to the forward movement air feed port 45b by the first electromagnetic switching valve 104. The piston rod 45a of the upper side thread cutting cylinder 45 is moved to the needle 9 side. As the result of forward movement of the piston rod 45a, the first movable blade 40 is quickly moved from the upper side thread cutting position as shown in FIG. 4 to the upper side thread take-up position as shown in FIG. 17. The hook portion 40a of the first movable blade 40 is moved beneath the needle 9 to hook the upper thread 14 extending from the workpiece cloth W through the eye 9a.

[0061] Upon lapse of 700 msec after output of the signal to the drive circuit 110, the CPU 91 delivers a signal to the drive circuit 110 so that pressurized air is supplied to the rearward movement air feed port 45c by the first electromagnetic switching valve 104. When the piston rod 45a of the upper side thread cutting cylinder 45 is moved rearward, the first movable blade 40 is quickly moved rearward to the upper side thread cutting position in FIG. 4 at time T3. As the result of the rearward movement of the first movable blade 40, the upper thread 14 is cut by the cooperation of the blade portion 40b of the hook portion 40a and the first fixed blade 41. Simultaneously, the end 14b of the cut upper thread 14 continuous to the eye 9a of the needle 9 is held by the first movable blade 40 and the first holding spring 47. The upper thread 14 is drawn out of the thread spool by the first movable blade 40 and cut at the upper side thread cutting position spaced away by a predetermined distance from the upper side thread take-up position. The end 14a of the upper thread 14 extending from the workpiece cloth W has a length corresponding to the distance from the upper side thread take-up position to the upper side thread cutting position. Accordingly, the long end 14a of the upper thread 14 can easily be picked by fingers. The operator can easily carry out a ravel preventing work using a heated iron, for example.

[0062] The cutting and holding of the lower thread 21 will be described. As described above with reference to FIG. 15C, the CPU 91 delivers a signal to the drive circuit 112 at time T2 so that pressurized air is supplied to the forward movement air feed port 75b by the second electromagnetic switching valve 106. The piston rod 75a of the lower side thread cutting cylinder 75 is moved forward as the result of supply of pressurized air by the second electromagnetic switching valve 106. As the result of forward movement of the piston rod 75a, the second movable blade 70 is quickly moved from the lower side thread cutting position as shown in FIG. 9 to the lower side thread take-up position as shown in FIG. 20. The hook portion 70a of the second movable blade 70 is moved beneath the needle 9 to hook the lower thread 21 extending from the workpiece cloth W to the vertical rotating hook 22.

[0063] Upon lapse of 700 msec after output of the signal to the drive circuit 112, the CPU 91 delivers a signal to the drive circuit 112 so that pressurized air is supplied to the rearward movement air feed port 75c by the second electromagnetic switching valve 106. When the piston rod 75a of the lower side thread cutting cylinder 75 is moved rearward as the result of supply of pressurized air by the second electromagnetic switching valve 106, the second movable blade 70 is quickly moved rearward to the lower side thread cutting position in FIG. 9 at time T4. As the result of rearward movement of the second movable blade 70, the lower thread 21 is cut by the cooperation of the blade portion 70b of the hook portion 70a and the second fixed blade 71. Simultaneously, the end 21b of the cut lower thread 21 continuous to the vertical rotating hook 22 is held by the second movable blade 70 and the second holding spring 77. The lower thread 21 is drawn out by the second movable blade 70 and cut at the lower side thread cutting position spaced away by a predetermined distance from the lower side thread take-up position. The end 21a of the lower thread 21 extending from the workpiece cloth W has a length corresponding to the distance from the lower side thread take-up position to the lower side thread cutting position. Accordingly, the long end 21a of the lower thread 21 can easily be picked by fingers. The operator can easily carry out a ravel preventing work using a heated iron, for example.

[0064] The following describes, with reference to FIGS. 14 and 16, the operation and advantages of the sewing machine 1 in the case where upon start of sewing, the held upper thread 14 is released from the held state by the upper thread releasing mechanism 32 and simultaneously, the held lower thread 21 is released from the held state by the lower thread releasing mechanism 62. Shortly after the sewing is started based on the sewing data as shown in FIG. 14, the CPU 91 loads the lower thread release command code next to the needle location data for the first and second stitches. At time T11 in FIG. 16, the end 21b of the lower thread 21 is released from the held state by the lower thread releasing mechanism 62. The CPU 91 loads the upper thread release command code, and the end 14b of the upper thread 14 is released

from the held state by the lower thread releasing mechanism 32 at time T12.

[0065] The release of the lower thread 21 will now be described. As described above with reference to FIG. 15D, the CPU 91 delivers a signal to the drive circuit 113 at time T11 so that pressurized air is supplied to the forward movement air feed port 83b by the second release electromagnetic switching valve 107. As the result of the supply of pressurized air by the second release electromagnetic switching valve 107, the piston rod 83a of the lower releasing cylinder 83 is moved against the rearward drive force of the lower side thread cutting cylinder 75. As the result of movement of the piston rod 83a, the second movable blade 70 is quickly moved from the lower side thread cutting position as shown in FIG. 9 to the lower release position as shown in FIG. 21. The held end 21b of the lower thread 21 is released from the held state by the second movable blade 70 and the second holding spring 77. Upon lapse of 100 msec after output of the signal to the drive circuit 113, the CPU 91 delivers a signal to the drive circuit 113 so that pressurized air is supplied to the rearward movement air feed port 83c by the second release electromagnetic switching valve 107. As the result of supply of pressurized air by the second release electromagnetic switching valve 107, the piston rod 83a of the lower releasing cylinder 83 is moved rearward.

[0066] The release of the upper thread 14 will be described. As described above with reference to FIG. 15B, the CPU 91 delivers a signal to the drive circuit 111 at time T12 so that pressurized air is supplied to the forward movement air feed port 53b by the first release electromagnetic switching valve 105. As the result of the supply of pressurized air by the first release electromagnetic switching valve 105, the piston rod 53a of the upper release cylinder 53 is moved against the rearward drive force of the upper side thread cutting cylinder 45. As the result of forward movement of the piston rod 53a, the first movable blade 40 is quickly moved from the upper side thread cutting position as shown in FIG. 4 to the upper release position as shown in FIG. 18. The held end 14b of the upper thread 14 is released from the held state by the first movable blade 40 and the first holding spring 47. Upon lapse of 130 msec after output of the signal to the drive circuit 111, the CPU 91 delivers a signal to the drive circuit 111 so that pressurized air is supplied to the rearward movement air feed port 53c by the first release electromagnetic switching valve 105. As the result of supply of pressurized air by the first release electromagnetic switching valve 105, the piston rod 53a of the upper release cylinder 53 is moved rearward.

[0067] The sewing machine 1 is provided with the upper thread direction adjusting mechanism 33. When the direction of the first body frame 37 is adjusted, the drawing direction in which the upper thread 14 is to be drawn can be adjusted in a range from the rearward limit position as shown in FIG. 8 to the forward limit position as shown in FIG. 19. In execution of sewing, the drawing direction of the upper thread 14 is changed by the upper thread direction adjusting mechanism 33 so as to differ from the sewing direction at the sewing start time. Consequently, the end 14b of the upper thread 14 released from the held state by the upper thread releasing mechanism 32 can be prevented from being sewn.

[0068] The sewing machine 1 is provided with the lower thread direction adjusting mechanism 63. When the direction of the second body frame 67 is adjusted, the drawing direction in which the lower thread 21 is to be drawn can be adjusted in a range from the position as shown in FIG. 10 to the position as shown in FIG. 22. As shown in FIG. 10, the drawing direction of the lower thread 21 can be set so as to be the same as the direction in which the lower thread 21 extends from the needle hole 5a to the thread guide hole 23b of the bobbin case 23. Consequently, as compared with the case where the drawing direction of the lower thread 21 differs from the above-described direction, the sewing machine 1 of the embodiment can reduce the possibility that the machine 1 of the embodiment can reduce the possibility that the end 21b of the lower thread 21 released from the held state by the lower thread releasing mechanism 62 may be sewn.

[0069] The releasing command to be delivered to the upper thread releasing mechanism 32 is previously added to the sewing data on which the workpiece cloth W is sewn. Consequently, the cutting and holding of the upper thread 14 can be controlled by the control device 90 and accordingly, the release of the upper thread 14 can be executed when a predetermined number of stitches has been formed.

[0070] The lower thread 21 is released from the held state by the lower thread releasing mechanism 62 and thereafter, the upper thread 14 is released from the held state by the upper thread releasing mechanism 32. The end 14a of the upper thread 14 is held by the upper thread holding mechanism 31 until stitches are formed by the upper thread 14. Consequently, the end 14a of the upper thread 14 can be prevented from being drawn to the back side of the workpiece cloth by the lower thread 21. Accordingly, the end 14a of the upper thread 14 can reliably be caused to remain at the surface side of the workpiece cloth W as the thread end 14a as shown in FIG. 4.

[0071] The releasing speed at which the end 14a of the upper thread 14 is released from the held state by the upper thread releasing mechanism 32 is lower than the releasing speed at which the end 21b of the lower thread 21 is released from the held state by the lower thread releasing mechanism 62. Even when the release of the upper thread 14 is instructed simultaneously with the release of the lower thread 21, the releasing speed at which the the end 21b of the lower thread 21 can reliably be held before the end 14b of the upper thread 14 is held.

[0072] The speed at which the first movable blade 40 is moved forward to the upper side thread take-up position by the upper moving mechanism 36 is set so as to lower than the speed at which the first movable blade 40

is moved rearward to the upper side thread cutting position. Consequently, since an amount of friction applied to the upper thread 14 drawn is reduced, the stability of the upper thread 14 can be improved to a marked extent and accordingly, good-looking stitches can be formed.

[0073] The speed at which the second movable blade 70 is moved forward to the lower side thread take-up position by the lower moving mechanism 66 is set so as to lower than the speed at which the second movable blade 70 is moved rearward to the lower side thread cutting position. Consequently, since an amount of friction applied to the lower thread 21 drawn is reduced, the stability of the lower thread 21 can be improved to a marked extent and accordingly, good-looking stitches can be formed.

[0074] Modified forms of the foregoing embodiment will be described. As shown in FIG. 23, the upper thread cutting mechanism 35A and the upper moving mechanism 36A may be mounted to the upper thread direction adjusting mechanism 33A so that the positions of the mechanisms 35A and 36A are changeable to a direction in which the upper side thread cutting position and the upper side thread take-up position are connected to each other with an imaginary straight line. The fixing portion 55b of the first overhang plate 55A of the upper thread direction adjusting mechanism 33A is enlarged. A rack forming member 120 is secured to the enlarged fixing portion 55b. The rack forming member 120 has a lower end formed with a rack 120a.

[0075] A position changing motor 121 comprising a stepping motor is fixed to the underside of the first body frame 37A. A pinion 122 is mounted to a drive shaft of the position changing motor 121. The pinion 122 is brought into mesh engagement with the rack 120a. The fixing portion 55b has an elongate hole 55c parallel to the direction in which the first movable blade 40 is moved forward and rearward. The first body frame 37A is moved in the lengthwise direction of the elongate hole 55c, namely, in the direction of forward and rearward movement of the first movable blade 40 by a shoulder bolt 123 extending through the elongate hole 55c.

[0076] A switch for adjusting a length of thread end may be provided on an operation panel (not shown) mounted on the sewing machine 1. The position changing motor 121 is driven when the length adjusting switch is operated. The position changing motor 121 is driven so that the first body frame 37A is moved forward and rearward. In this modified form, the length of the end 14a of the upper thread 14 extending from the workpiece cloth W can be changed.

[0077] When the position of the first body frame 37A is changed as shown in FIG. 23, the position changing motor 121 may be eliminated and the position of the first body frame 37A may be changed manually by the operator. Regarding the lower thread cutting mechanism 60, too, the position of the second body frame may be changed electrically or manually.

Claims

1. A sewing machine which comprises:

a sewing machine frame;
a needlebar (8) on which a needle (9) having an eye (9a) is mounted;
a hook (22);
an upper thread cutting mechanism (35) having an upper thread movable blade (40) cutting an upper thread (14) extending from workpiece cloth W through an eye (9a) of the needle (9) above a needle plate (5);
an upper moving mechanism (36) which reciprocally moves the upper thread movable blade (40) between an upper side thread take-up position where the upper thread is hooked beneath the needle (9) and an upper side thread cutting position which is spaced away from the upper side thread take-up position by a predetermined distance; and
an upper thread holding mechanism (31) which holds an end (14a) of the upper thread (14) cut by the upper thread cutting mechanism (35) when the upper thread movable blade (40) is moved reciprocally by the upper moving mechanism (36), **characterized in that** the predetermined distance is set so as to be longer than a distance from the eye (9a) of the needle (9) to the needle plate (5).

2. The sewing machine according to claim 1, further comprising an upper thread releasing mechanism (32), wherein:

the upper thread holding mechanism (31) has an upper thread holding spring (47) which cooperates with the upper thread movable blade (40) to clamp the end (14a) of the upper thread (14) therebetween, thereby holding the end (14a);
the upper thread releasing mechanism (32) releases the upper thread (14) held between the upper thread movable blade (40) and the upper thread holding spring (47);
the upper moving mechanism (36) has a first air cylinder (45) which reciprocally moves the upper thread movable blade (40);
the upper thread releasing mechanism (32) has a second air cylinder (53) which reciprocally moves the upper thread movable blade (40);
a range of movement of the upper thread movable blade (40) by the second air cylinder (53) is narrower than a range of movement of the upper thread movable blade (40) by the first air cylinder (45); and
the second air cylinder (53) has a drive force which is set so as to be larger than a drive force

of the first air cylinder (45).

3. The sewing machine according to claim 2, comprising a control device (90) which controls a sewing operation, wherein the control device (90) is provided with sewing data on which the workpiece cloth (W) is sewn, and the sewing data includes a releasing command for the upper thread releasing mechanism (32).

4. The sewing machine according to any one of claims 1 to 3, comprising:

a lower thread cutting mechanism (66) having a lower thread movable blade (70) cutting a lower thread (21) extending from the workpiece cloth (W) to the hook (22) below the needle plate (5);
a lower moving mechanism (36) which reciprocally moves the lower thread movable blade (70) between a lower side thread take-up position where the lower thread is hooked below the needle plate (5) and a lower side thread cutting position which is spaced away from the lower side thread take-up position by a predetermined distance; and
a lower thread holding mechanism (61) which holds an end (21b) of the lower thread (21) cut by the lower thread cutting mechanism (65) when the lower thread movable blade (70) is moved reciprocally by the lower moving mechanism (66).

5. The sewing machine according to claim 4, comprising a lower thread releasing mechanism (62), wherein:

the lower thread holding mechanism (61) has a lower thread holding spring (77) which cooperates with the lower thread movable blade (70) to clamp the end (21a) of the lower thread (21) therebetween, thereby holding the end (21a);
the lower thread releasing mechanism (62) releases the lower thread (21) held between the lower thread movable blade (70) and the lower thread holding spring (77);
the lower moving mechanism (66) has a third air cylinder (75) which reciprocally moves the lower thread movable blade (70);
the lower thread releasing mechanism (62) has a fourth air cylinder (83) which reciprocally moves the lower thread movable blade (70);
a range of movement of the lower thread movable blade (70) by the fourth air cylinder (83) is narrower than a range of movement of the upper thread movable blade (70) by the third air cylinder (75); and
the fourth air cylinder (83) has a drive force which is set so as to be larger than a drive force of the third air cylinder (75).

6. The sewing machine according to claim 5, comprising:

a lower thread release speed adjusting mechanism (107B) which adjusts a movement speed of the lower thread movable blade (70) by the fourth air cylinder (83); and
an upper thread release speed adjusting mechanism (105A) which adjusts a movement speed of the upper thread movable blade (40) by the second air cylinder (53), wherein:

the upper and lower thread release speed adjusting mechanisms (105A, 107B) adjust the movement speeds of the upper and lower thread movable blades (40, 70) so that a release speed at which the upper thread (14) held by the upper thread holding mechanism (31) is released by the upper thread releasing mechanism (32) is lower than a release speed at which the lower thread (21) held by the lower thread holding mechanism (61) is released by the lower thread releasing mechanism (62), respectively.

7. The sewing machine according to one of claims 2 to 6, comprising an upper movement speed adjusting mechanism (104A) which adjusts a movement speed at which the upper thread movable blade (40) is moved by the first air cylinder (45), wherein the upper movement speed adjusting mechanism (104A) sets a first movement speed at which the upper thread movable blade (40) is moved from the upper side thread take-up position to the upper side thread cutting position so that the first movement speed is lower than a second movement speed at which the upper thread movable blade (40) is moved from the upper side thread cutting position to the upper side thread take-up position.

8. The sewing machine according to one of claims 5 to 7, comprising a lower movement speed adjusting mechanism (106B) which adjusts a movement speed at which the lower thread movable blade (70) is moved by the third air cylinder (75), wherein the lower movement speed adjusting mechanism (106B) sets a third movement speed at which the lower thread movable blade (70) is moved from the lower side thread take-up position to the lower side thread cutting position so that the third movement speed is lower than a fourth movement speed at which the lower thread movable blade (70) is moved from the lower side thread cutting position to the lower side thread take-up position.

9. The sewing machine according to one of claims 1 to

8, comprising a position changing mechanism which changes positions of the upper thread cutting mechanism and the upper moving mechanism to a direction in which the upper side thread cutting position and the upper side thread take-up position are connected to each other with an imaginary straight line.

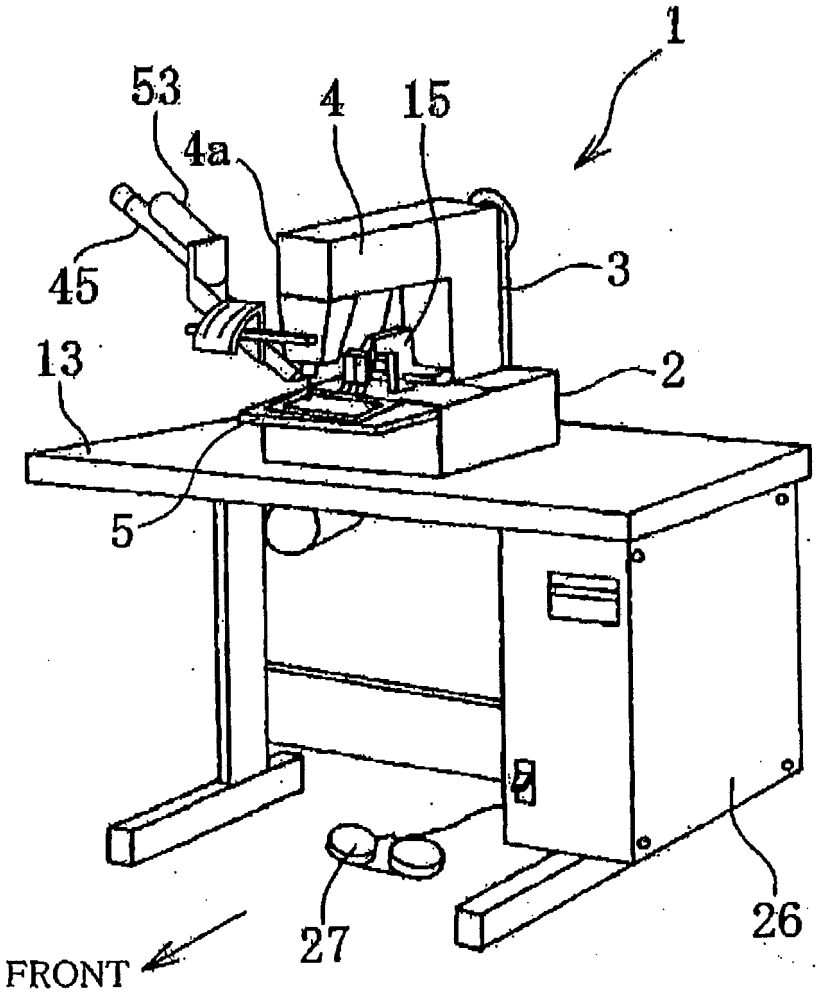


FIG. 1

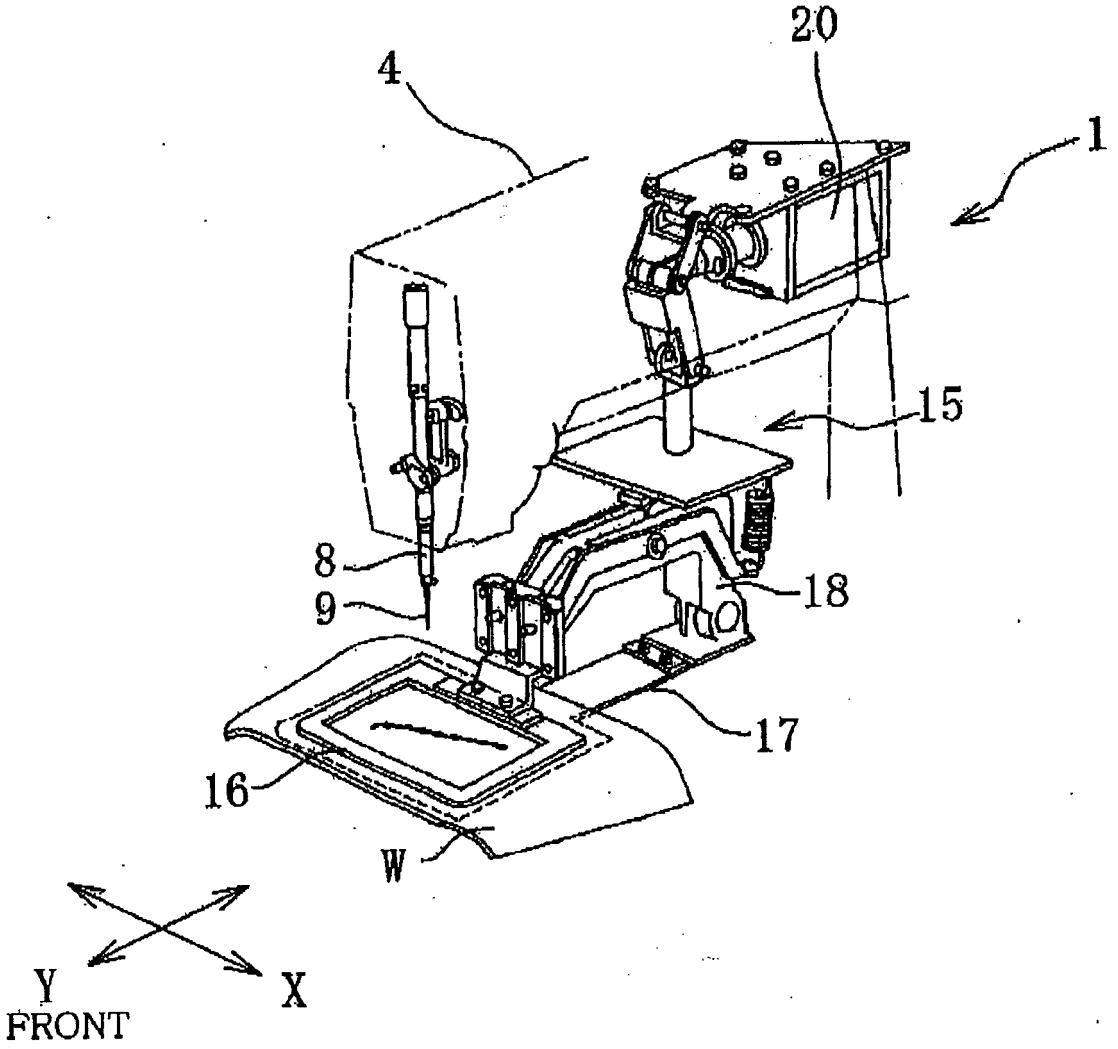
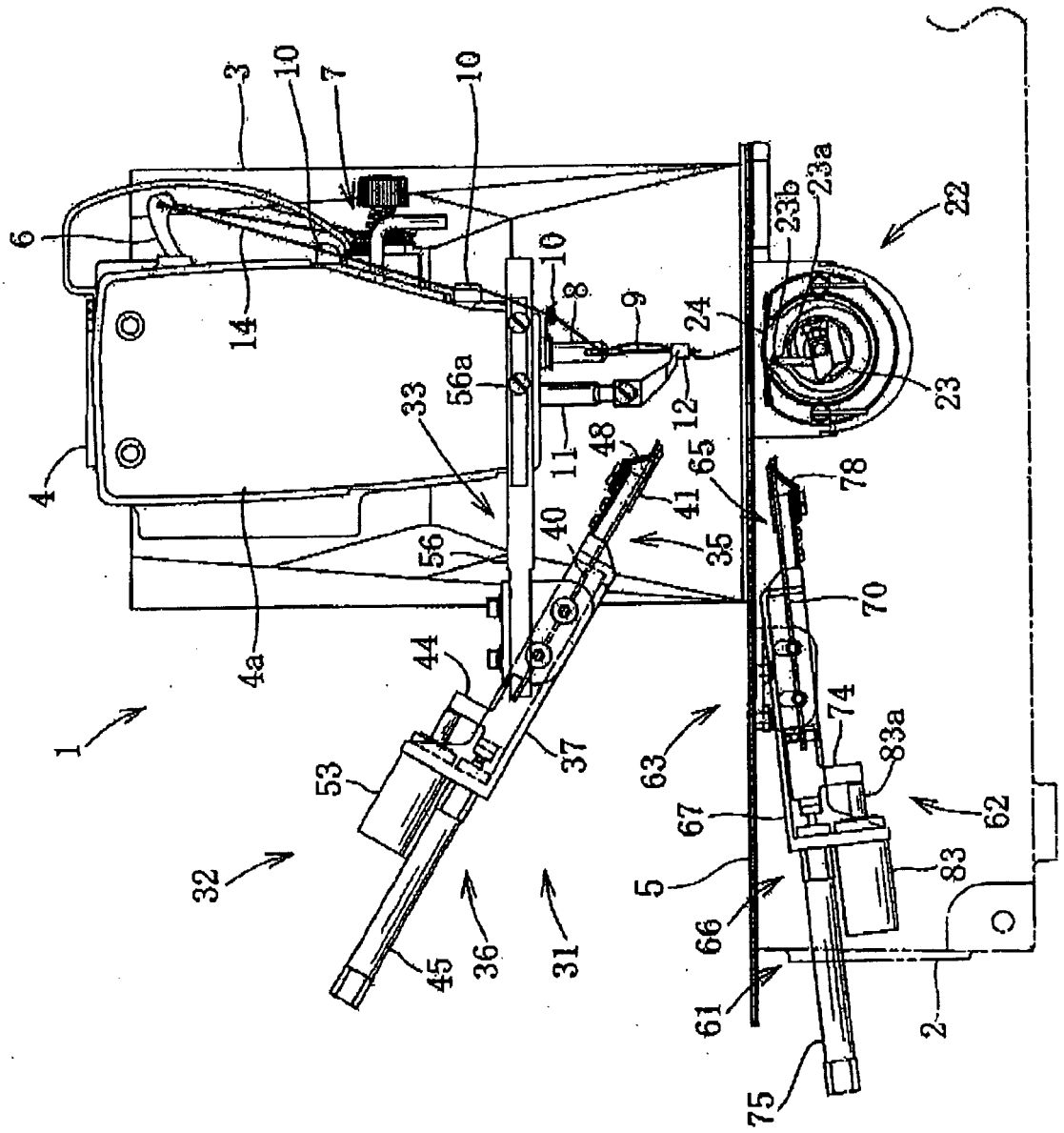


FIG.2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10
7
10
6
14
10
8
9
24
23a
23b
22
23
56a
33
12
48
11
65
41
78
4
40
35
56
70
4a
44
74
83a
1
53
37
63
62
67
32
5
83
66
36
31
45
61
2
75

FIG.3

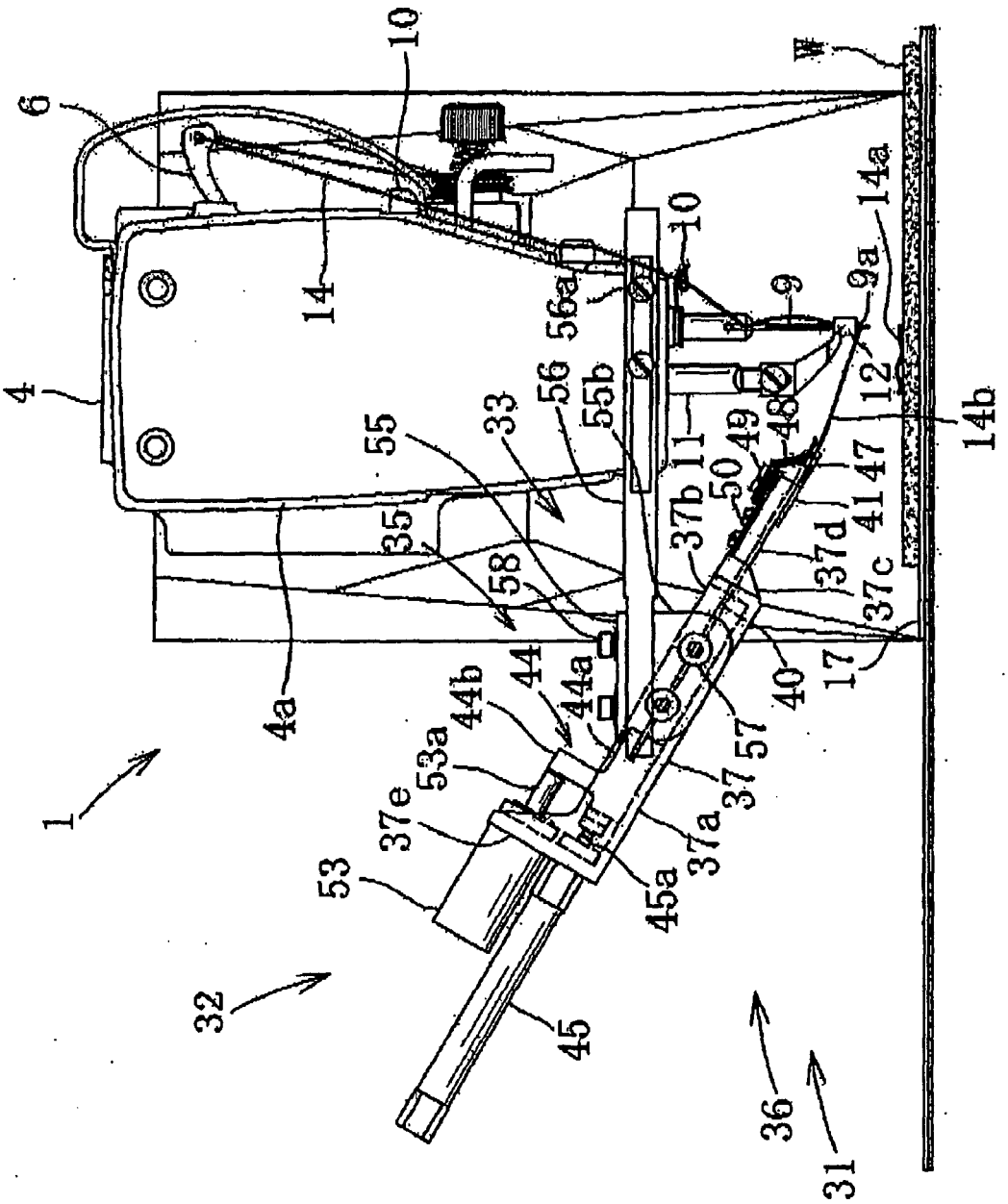

6
10
W
14a
14
56a
10
9
9a
4
56
55b
12
14b
55
33
48
49
11
50
37b
41
47
35
37d
37c
58
4a
44
44a
40
17
44b
57
53a
37
37e
37a
53
45a
32
45
36
31
1

FIG. 4

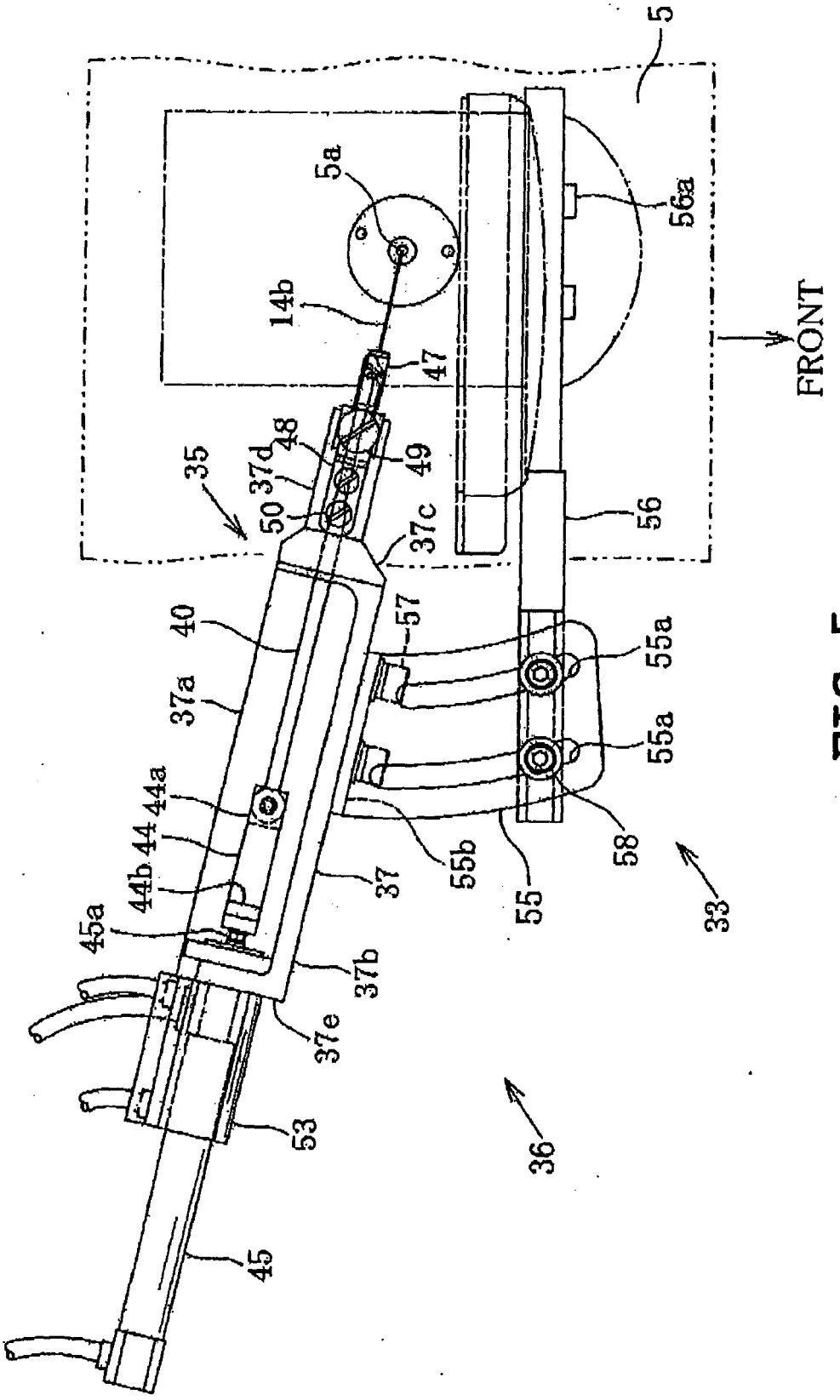

5
5a
56a
14b
47
FRONT
48
49
35
37d
50
37c
56
40
57
55a
37a
55a
44a
44
44b
58
55b
37
55
33
45a
37b
37e
53
36
45

FIG. 5

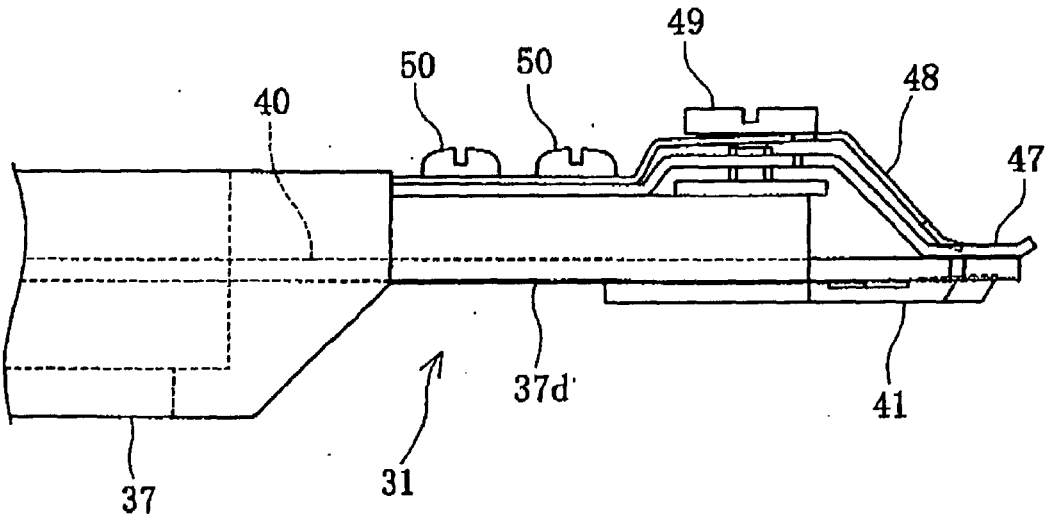
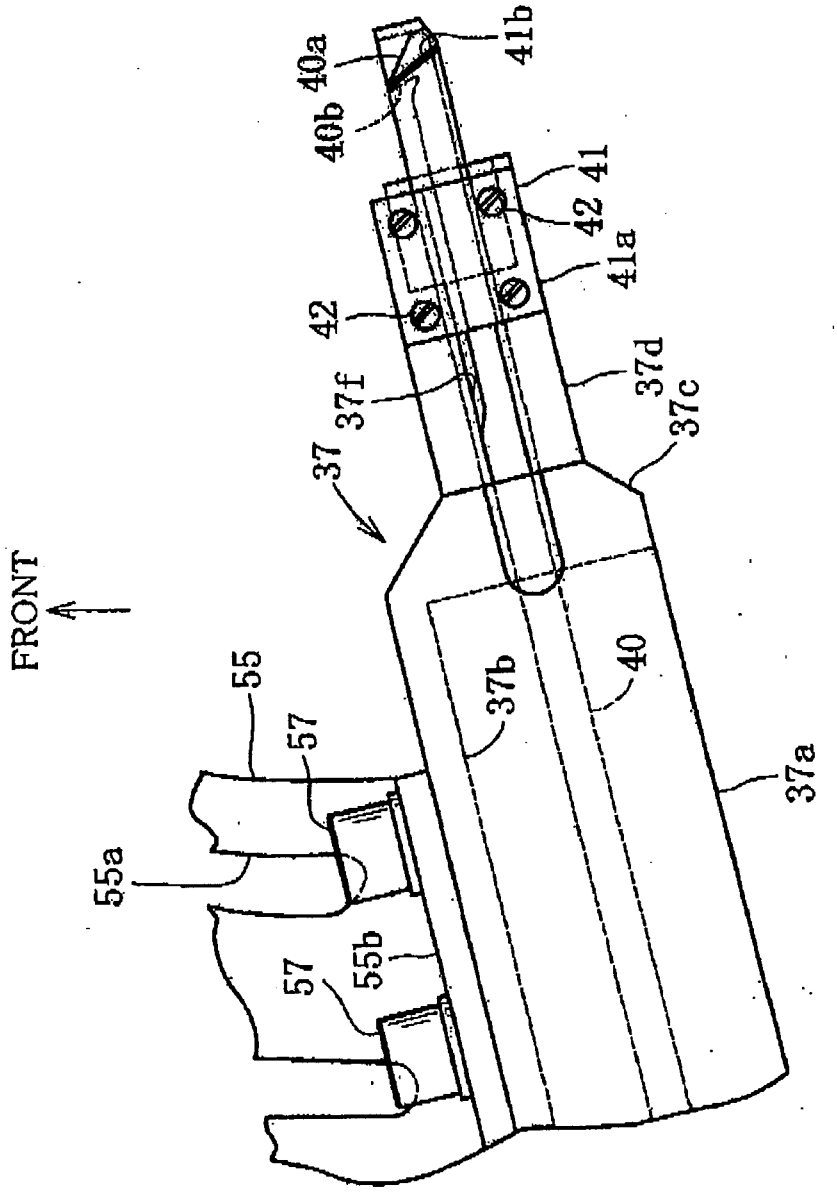


FIG. 6


FRONT
55
57
55a
57
55b
37b
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37a
37
37f
42
42
41
41a
40b
40a
41b
37d
37c

FIG. 7

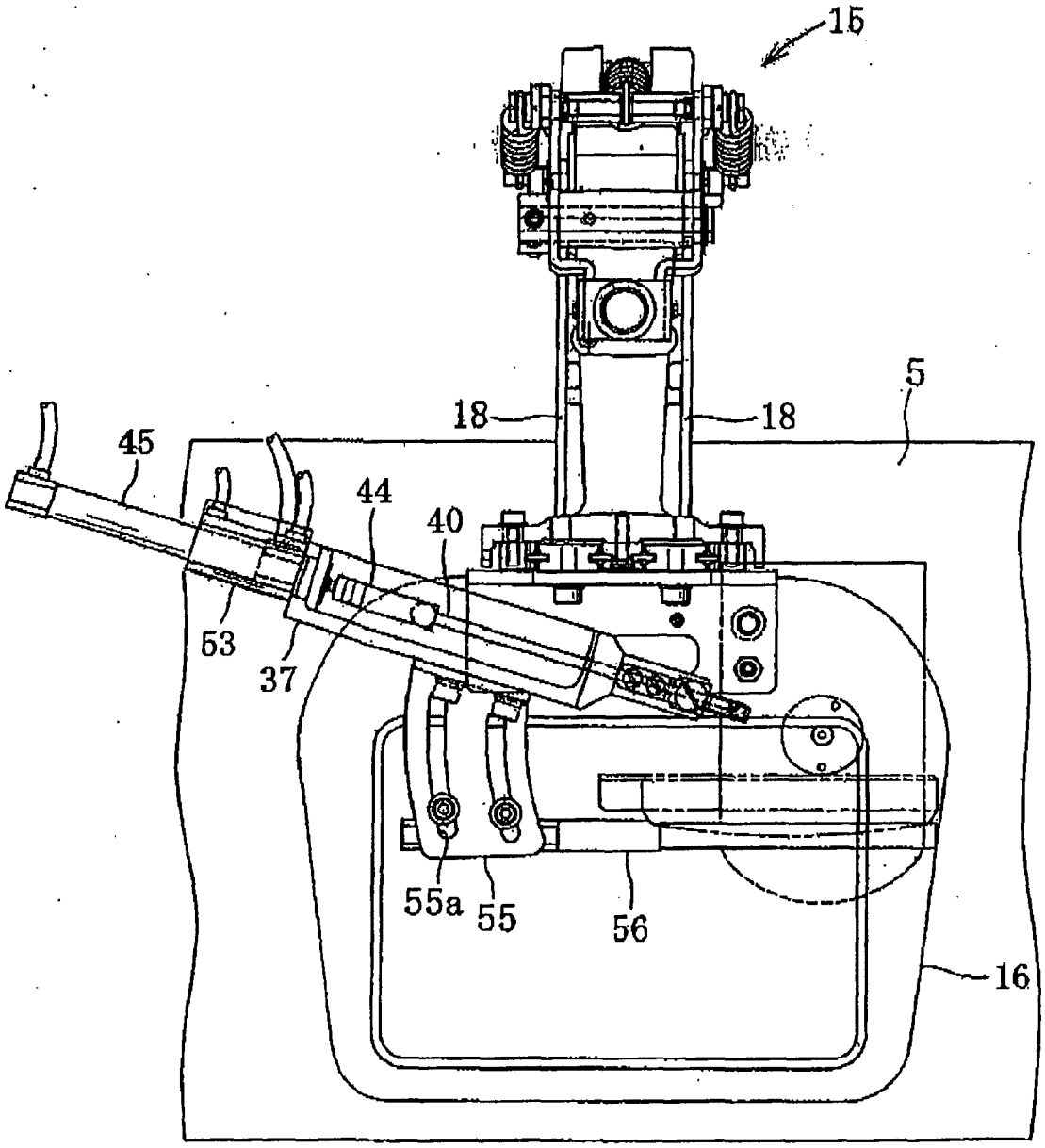


FIG. 8

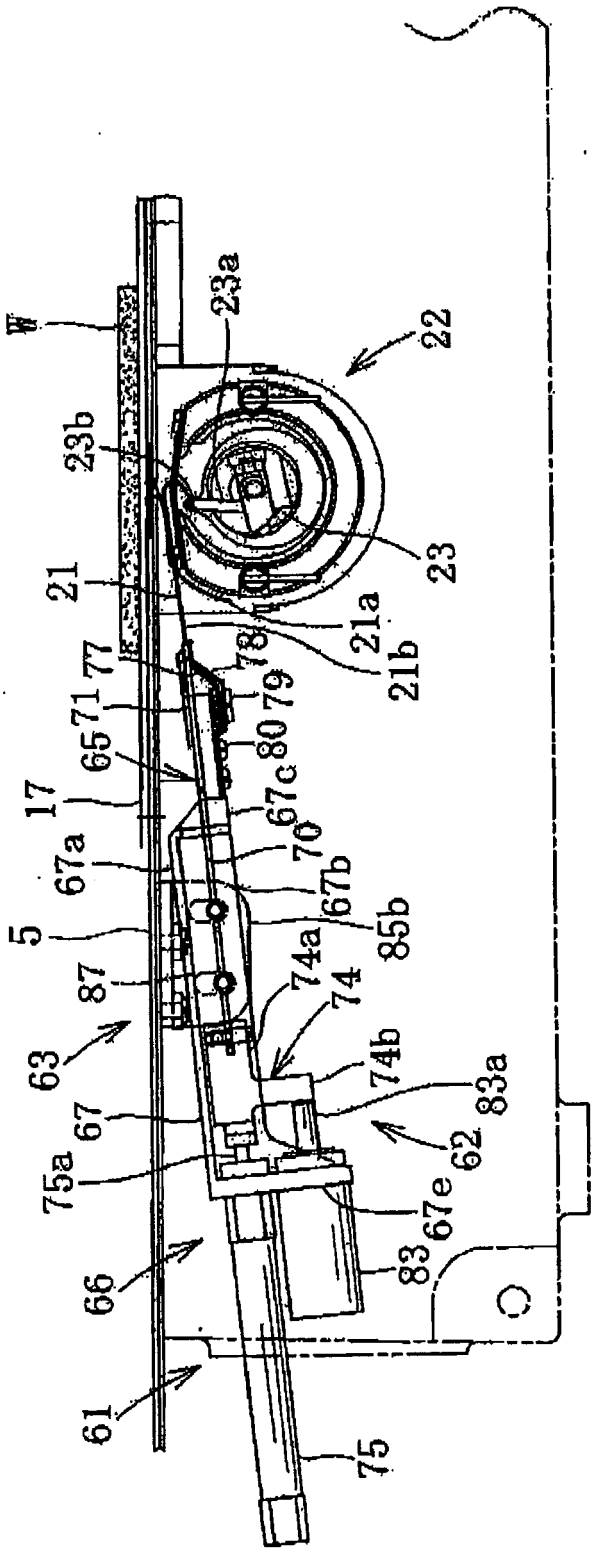

W
23a
22
23b
23
21
21a
21b
78
77
79
71
65
80
17
67c
70
67a
67b
5
85b
87
74a
74
63
74b
83a
67
62
75a
67e
83
66
61
75

FIG. 9

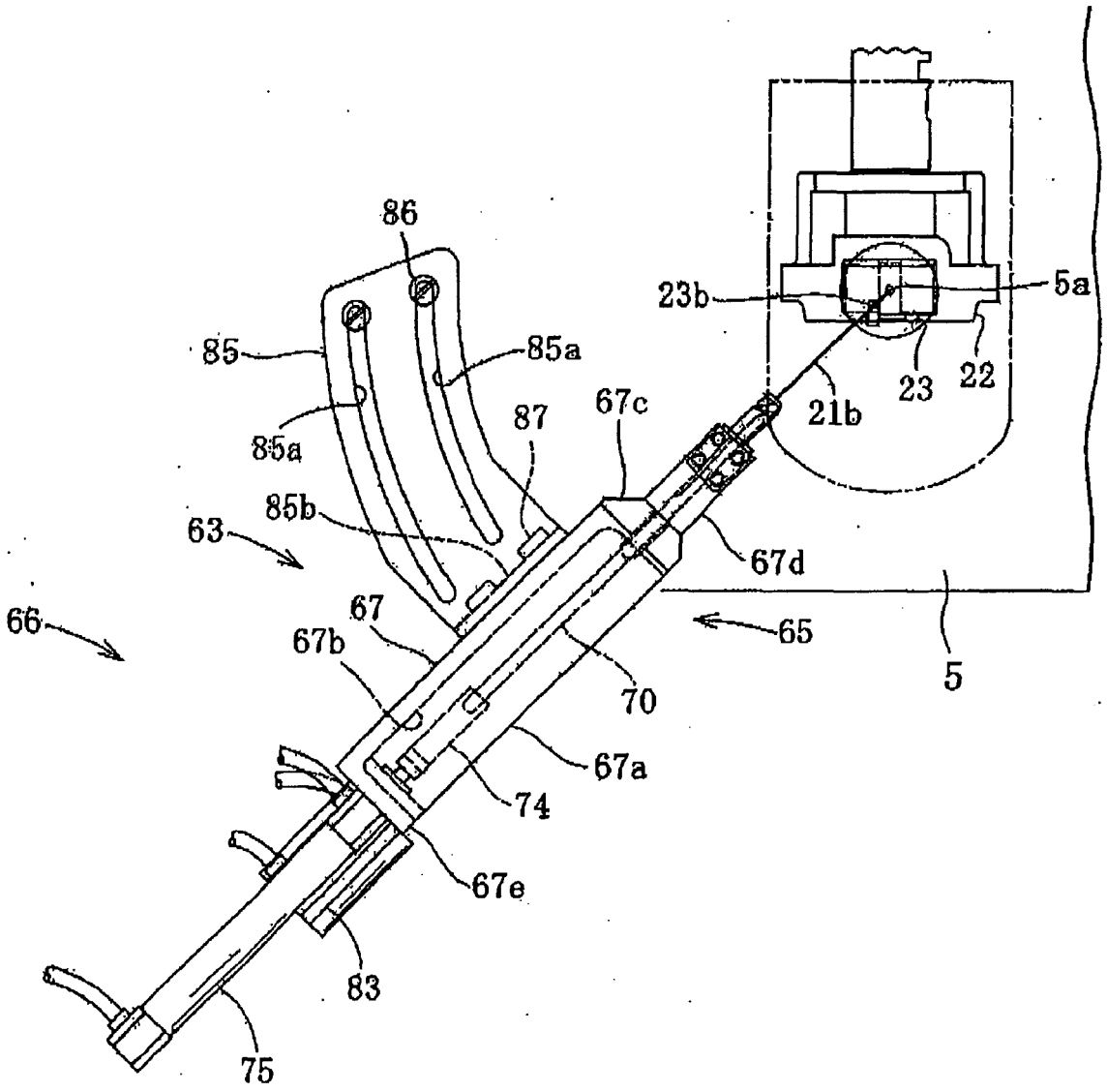

86
85
85a
85a
87
67c
23b
5a
23
22
21b
85b
63
67d
66
67
67b
65
5
70
67a
74
67e
83
75

FIG.10

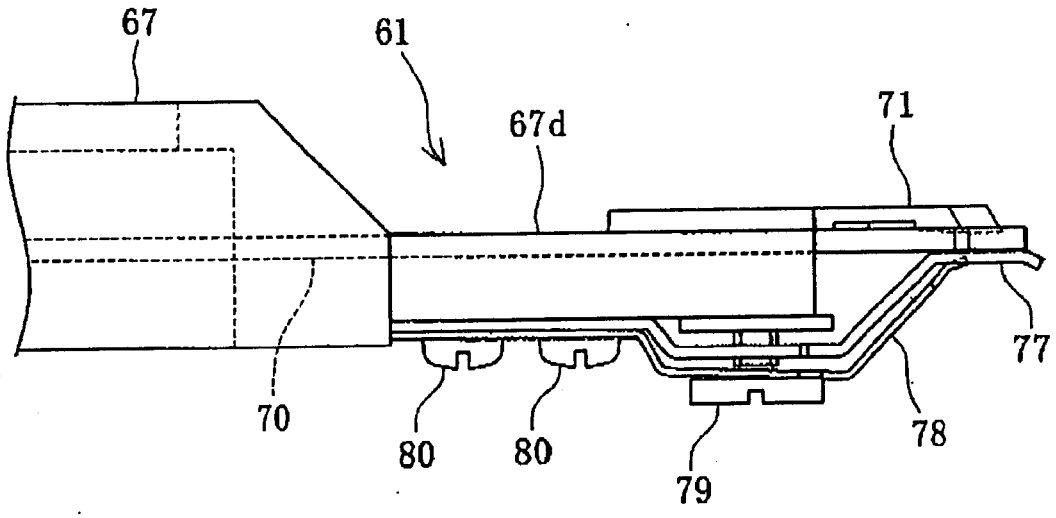


FIG. 11

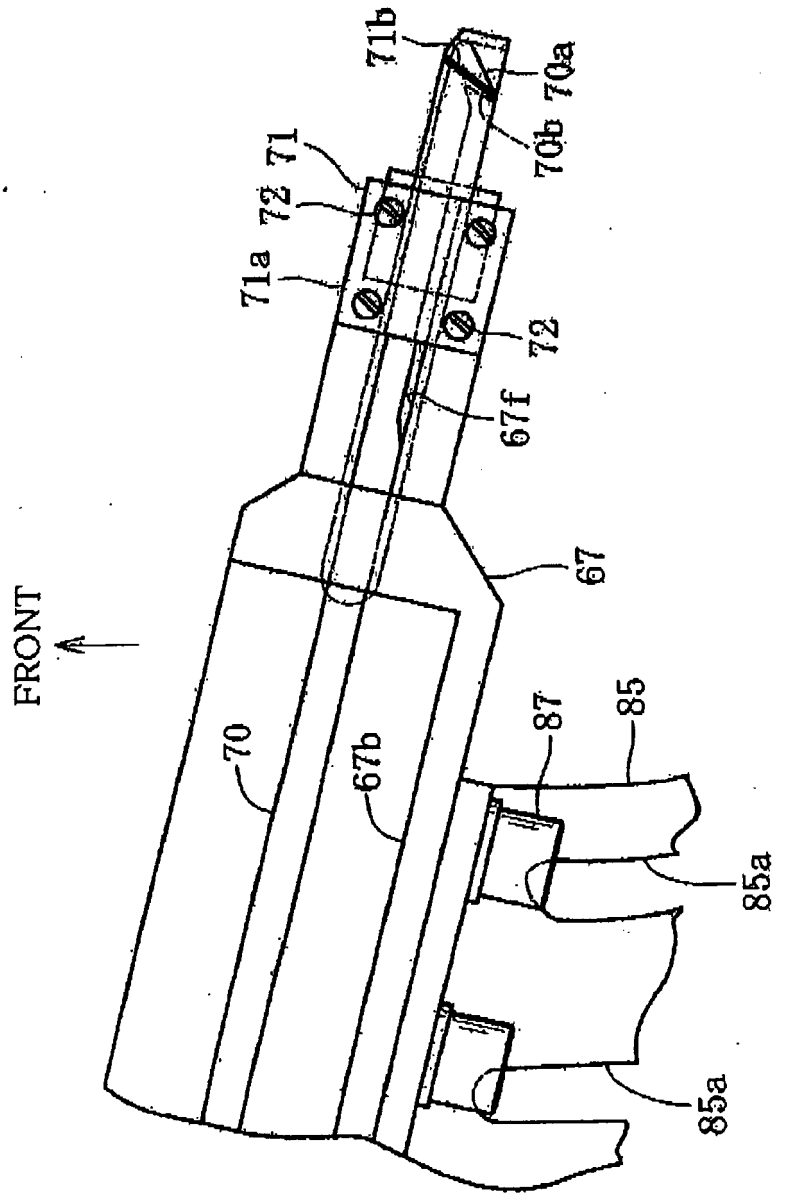


FIG. 12

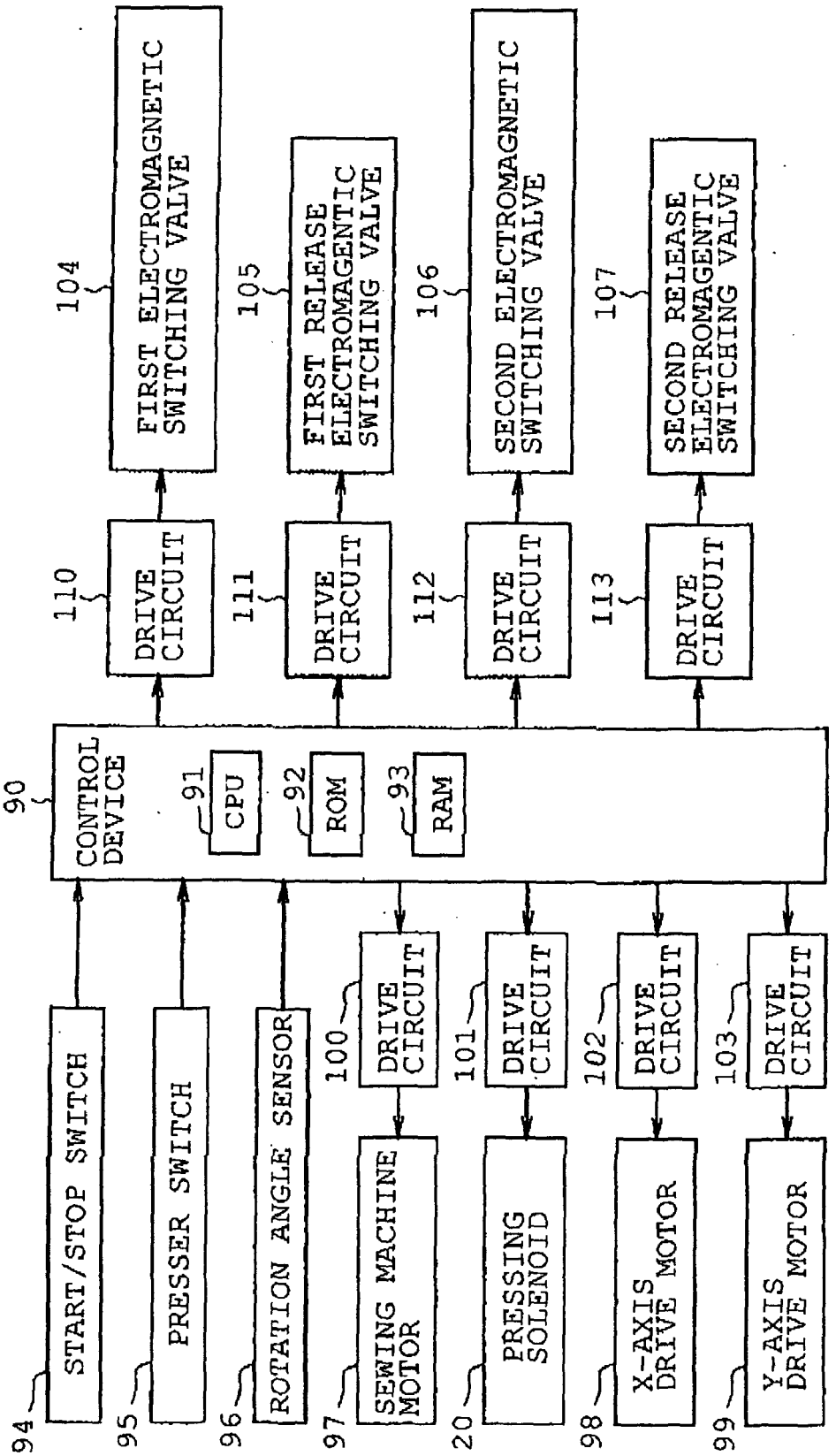

90
CONTROL DEVICE
91
CPU
92
ROM
93
RAM
94
START/STOP SWITCH
95
PRESSER SWITCH
96
ROTATION ANGLE SENSOR
97
SEWING MACHINE MOTOR
20
PRESSING SOLENOID
98
X-AXIS DRIVE MOTOR
99
Y-AXIS DRIVE MOTOR
100
DRIVE CIRCUIT
101
DRIVE CIRCUIT
102
DRIVE CIRCUIT
103
DRIVE CIRCUIT
104
FIRST ELECTROMAGNETIC SWITCHING VALVE
105
FIRST RELEASE ELECTROMAGENTIC SWITCHING VALVE
106
SECOND ELECTROMAGNETIC SWITCHING VALVE
107
SECOND RELEASE ELECTROMAGENTIC SWITCHING VALVE
110
DRIVE CIRCUIT
111
DRIVE CIRCUIT
112
DRIVE CIRCUIT
113
DRIVE CIRCUIT

FIG.13

NEEDLE LOCATION DATA OF FIRST STITCH
NEEDLE LOCATION DATA OF SECOND STITCH
LOWER THREAD RELEASE COMMAND CODE
UPPER THREAD RELEASE COMMAND CODE
NEEDLE LOCATION DATA OF THIRD STITCH
NEEDLE LOCATION DATA OF FOURTH STITCH
⋮
NEEDLE LOCATION DATA OF n-TH STITCH
UPPER THREAD CUTTING COMMAND CODE
LOWER THREAD CUTTING COMMAND CODE

FIG.14

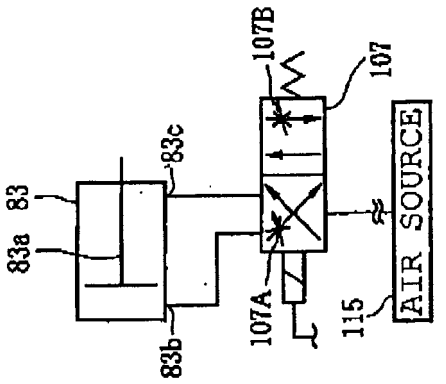


FIG.15D

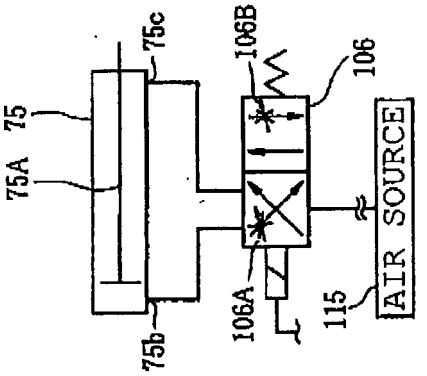


FIG.15C

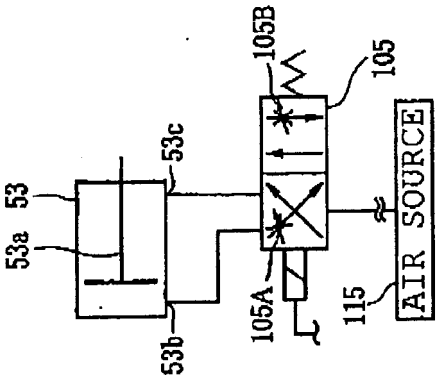


FIG.15B

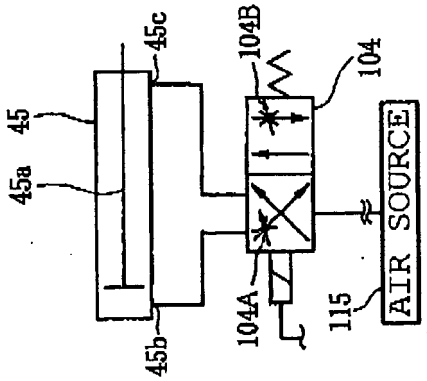


FIG.15A

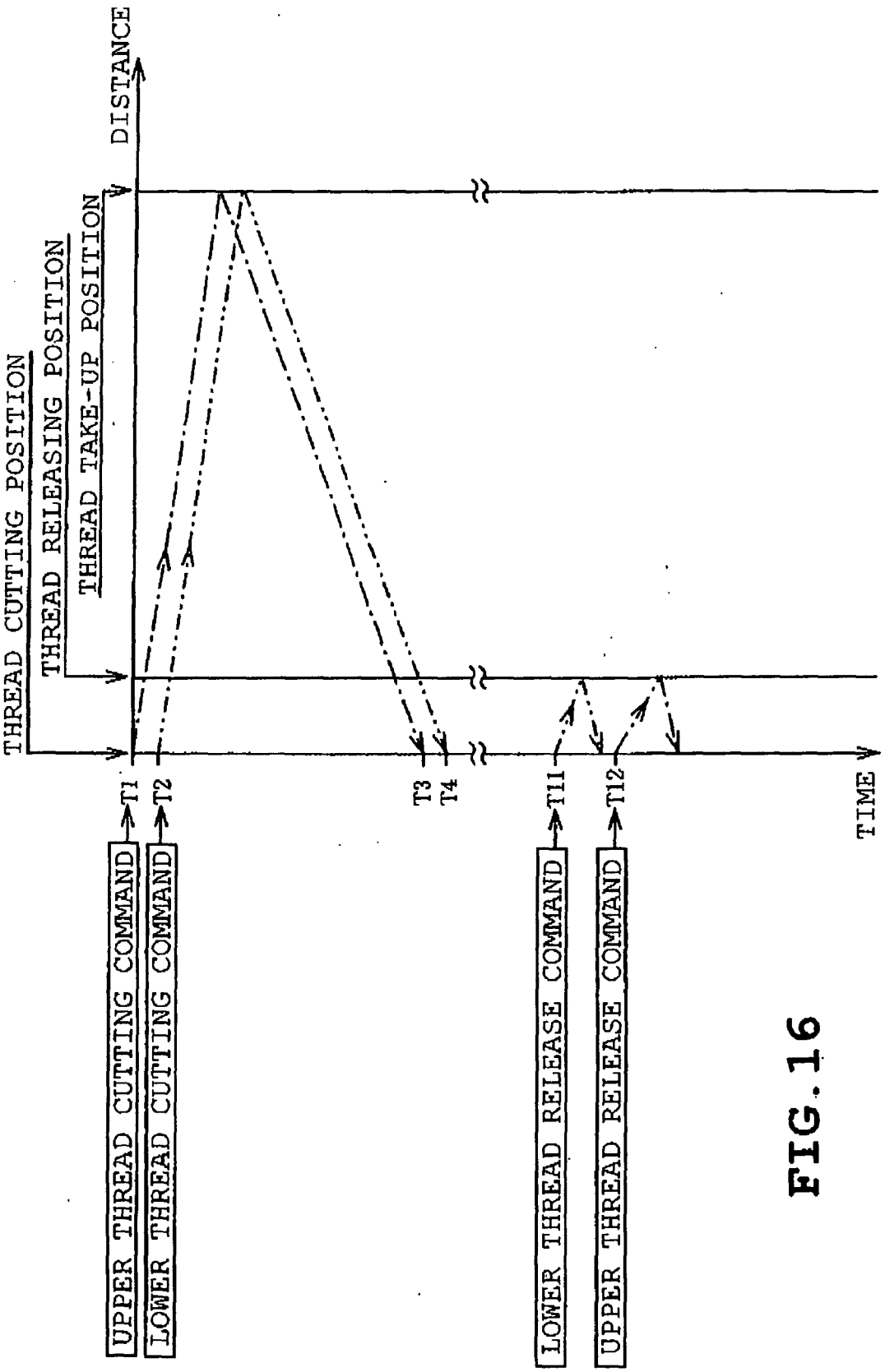

DISTANCE
THREAD CUTTING POSITION
THREAD RELEASING POSITION
THREAD TAKE-UP POSITION
T1
T2
T3
T4
T11
T12
TIME
UPPER THREAD CUTTING COMMAND
LOWER THREAD CUTTING COMMAND
LOWER THREAD RELEASE COMMAND
UPPER THREAD RELEASE COMMAND

FIG.16

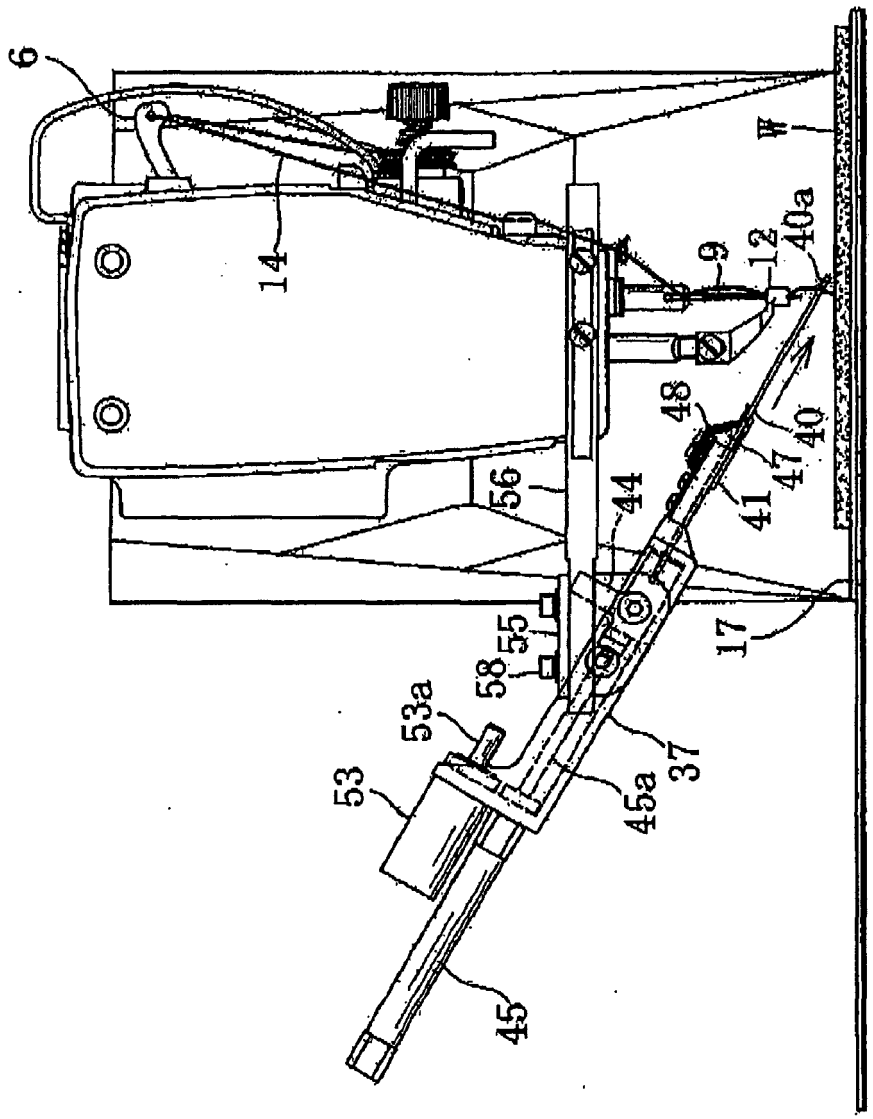


FIG. 17

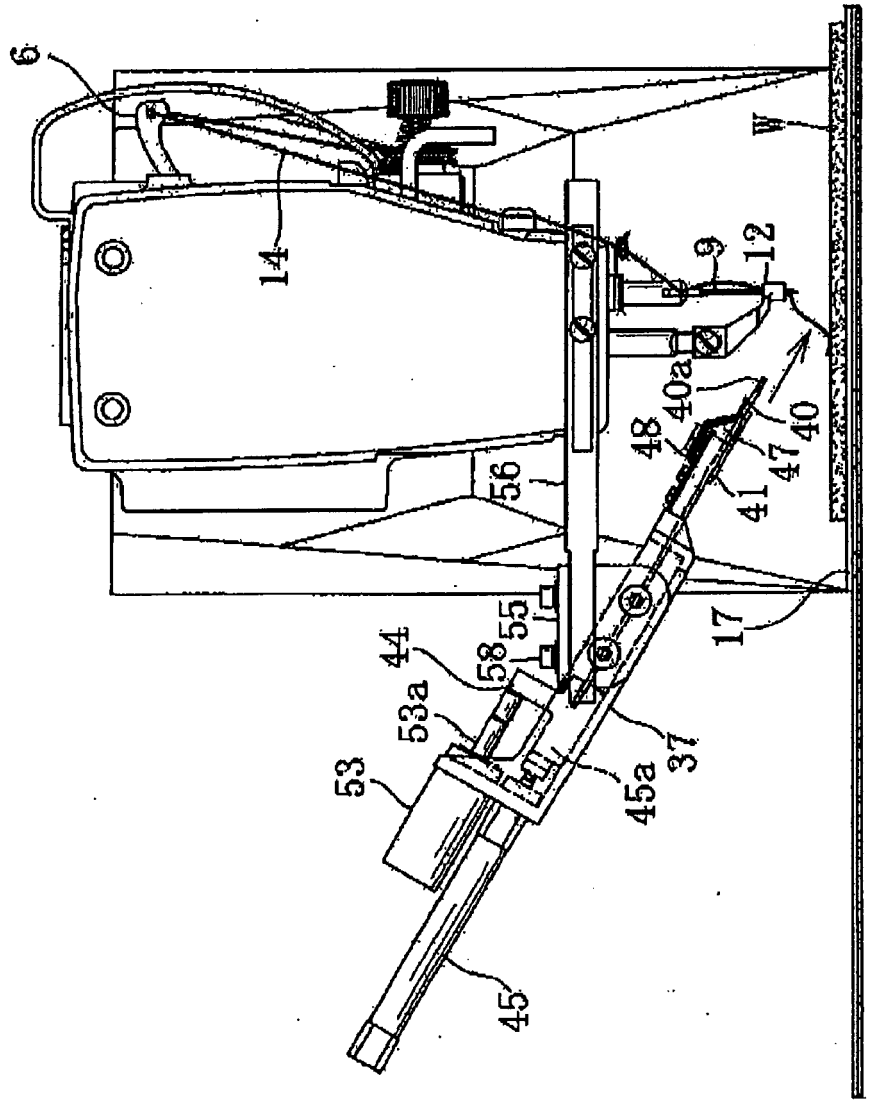
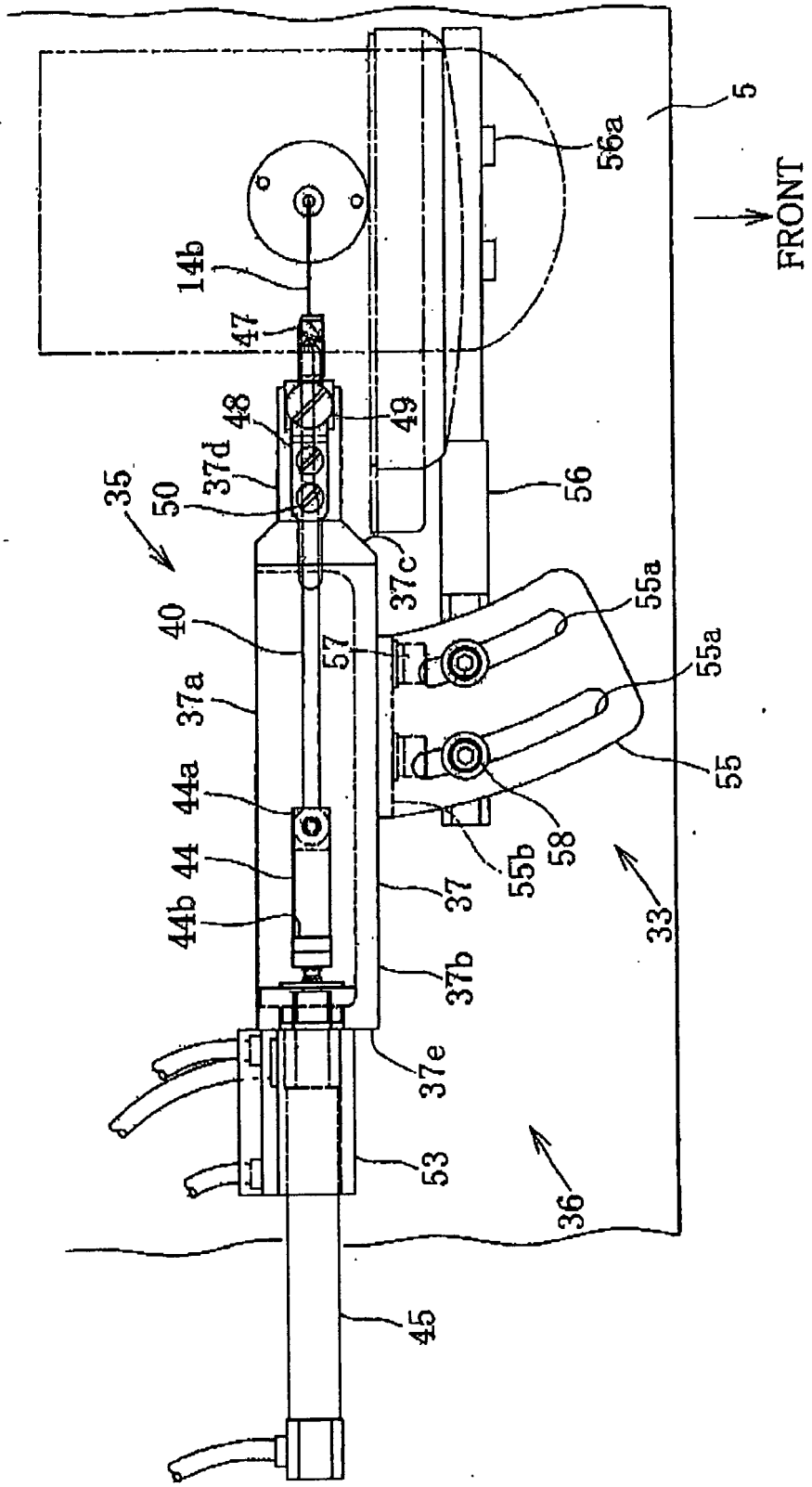


FIG. 18


5
56a
FRONT
14b
47
48
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37d
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50
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37c
55a
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55a
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44a
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55b
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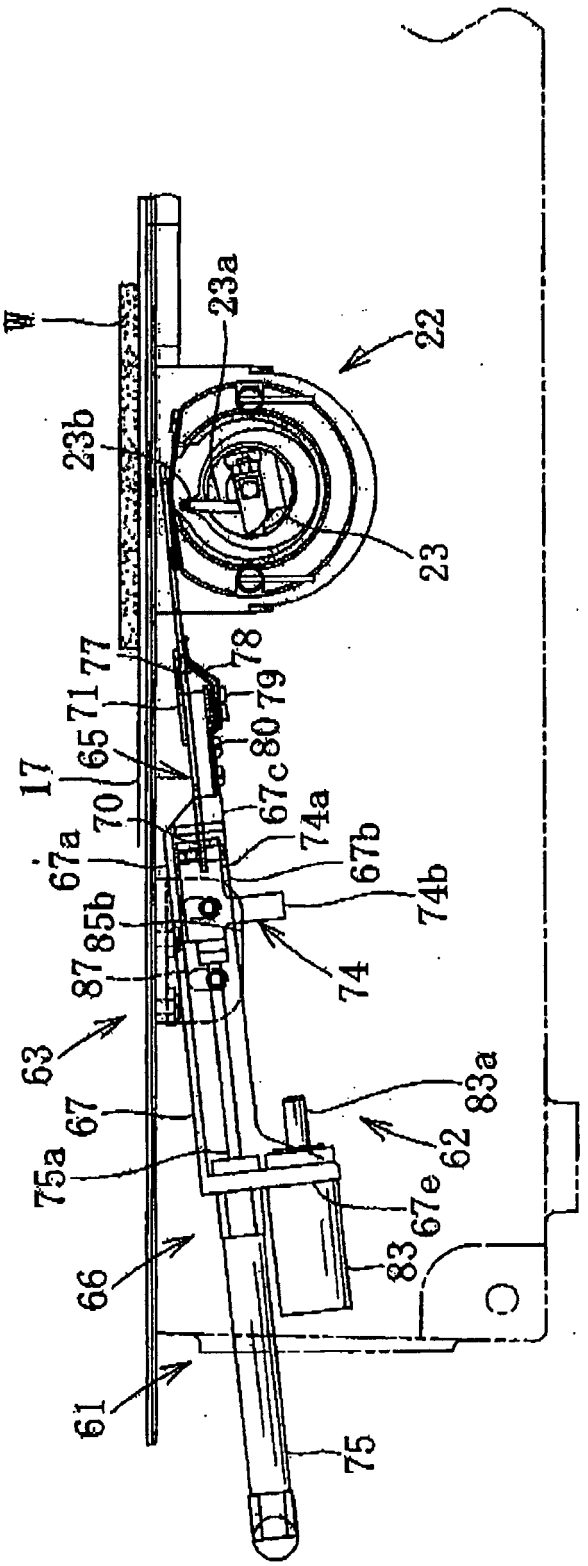
44b
37b
37e
53
36
45

FIG.19


W
23a
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23b
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74a
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83a
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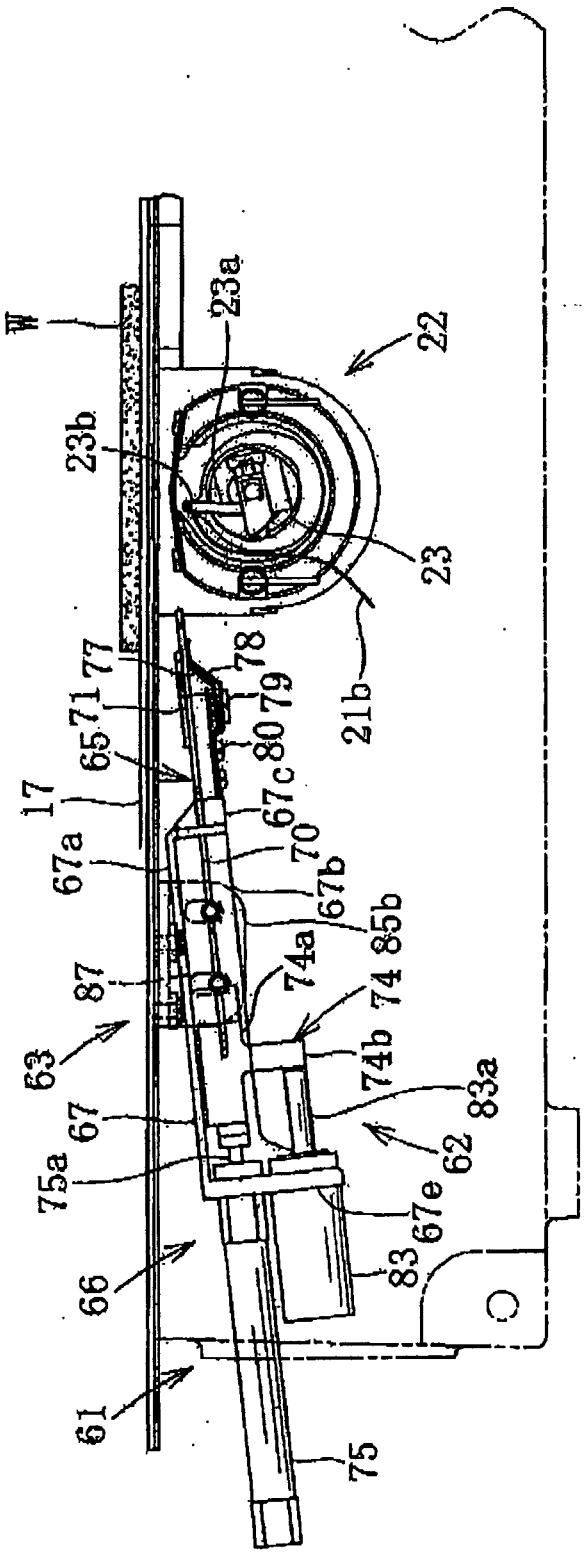
75a
67e
83
66
61
75

FIG.20


W
23a
22
23b
23
21b
77
78
79
80
71
65
17
67c
70
67a
67b
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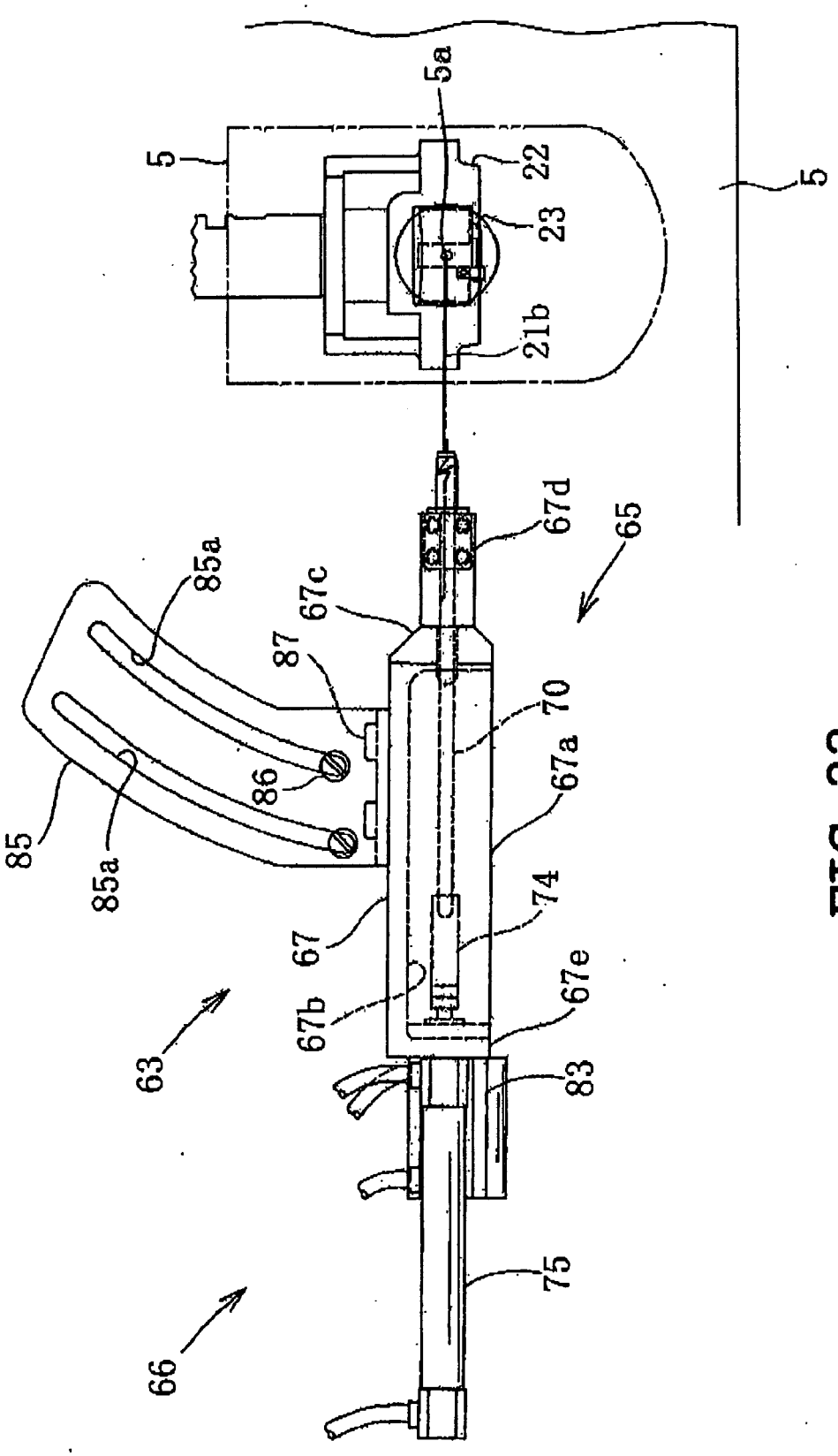
83a
62
75a
67e
83
66
61
75

FIG.21


5a
5
22
23
21b
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67d
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85a
67c
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86
67a
85
85a
74
67
67e
67b
63
83
75
66

FIG. 22

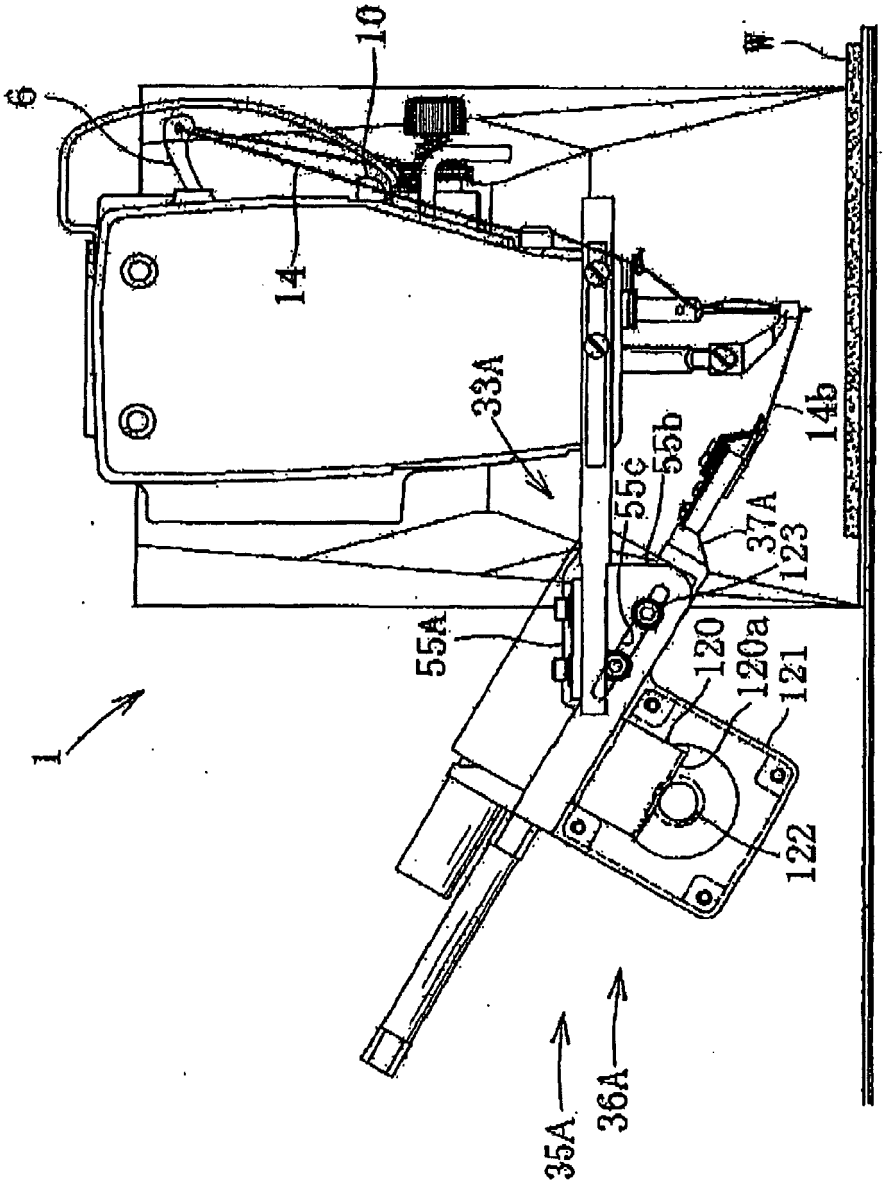

FIG. 23

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 00 4151

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2004/154507 A1 (NOGUCHI YASUKAZU [JP] ET AL) 12 August 2004 (2004-08-12) * paragraph [0027] - paragraph [0076]; figures 1-11 *	1,3,4	INV. D05B65/06
A	US 2003/183146 A1 (USA SHUICHIRO [JP]) 2 October 2003 (2003-10-02) * paragraph [0052] - paragraph [0096]; figures 1-42 *	4	
A	US 2002/035956 A1 (HORI MASAYUKI [JP]) 28 March 2002 (2002-03-28) * paragraph [0065] - paragraph [0107]; figures 1-13 *	1	
A	US 5 088 426 A (OGAWA MASAO [JP]) 18 February 1992 (1992-02-18) * column 3, line 32 - column 13, line 29; figures 1-20 *	1-3	
A	DE 28 15 297 A1 (DUERKOPPWERKE) 11 October 1979 (1979-10-11) * page 7, line 1 - page 10, line 23; figures 1,2 *	1,4	TECHNICAL FIELDS SEARCHED (IPC) D05B
A	JP 2001 218992 A (JUKI KK) 14 August 2001 (2001-08-14) * abstract; figures 1-5 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 June 2008	Herry-Martin, D

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4

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26-06-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004154507 A1	12-08-2004	CN 1523156 A	25-08-2004
		JP 3821098 B2	13-09-2006
		JP 2004222919 A	12-08-2004
US 2003183146 A1	02-10-2003	CN 1448564 A	15-10-2003
		JP 3981972 B2	26-09-2007
		JP 2003284878 A	07-10-2003
US 2002035956 A1	28-03-2002	JP 2002095882 A	02-04-2002
US 5088426 A	18-02-1992	JP 2969685 B2	02-11-1999
		JP 3126484 A	29-05-1991
DE 2815297 A1	11-10-1979	JP 1256078 C	12-03-1985
		JP 55010980 A	25-01-1980
		JP 59030117 B	25-07-1984
		US 4364319 A	21-12-1982
JP 2001218992 A	14-08-2001	CN 1308158 A	15-08-2001
		TW 509735 B	11-11-2002

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Patent documents cited in the description

- JP H0426490 A **[0003]**
- JP H02213385 A **[0004] [0007]**
- JP H0426990 A **[0006]**