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(54) **Sewing machine**

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Description

[0001] The invention relates to a sewing machine including an upper thread drawing mechanism.

[0002] A conventional buttonhole stitching machine has an upper thread path arranged such that, for example, as shown in Fig. 15, on an upper surface of the sewing machine head portion, an upper thread (sewing thread) is guided from an upper thread supply source to a needle bar 103 via a thread tensioner 101 which applies a thread tension and a thread take-up bar 102 which reciprocates forward and rearward, and passes through the inside of the needle bar 103 and reaches a needle.

[0003] Between the thread tensioner 101 and the thread take-up bar 102, an upper thread drawing mechanism 110 is provided. This upper thread drawing mechanism 110 includes, as shown in Fig. 16, an upper thread drawing member 111 which moves forward and rearward, a first air cylinder 112 which switches the position of the upper thread drawing member 111 between a most advanced position and a most retreated position, and a second air cylinder 113 which stops the upper thread drawing member 111 at an intermediate position between the most advanced position and the most retreated position by projection of a plunger (see, e.g., JP 4094867 B).

[0004] In the upper thread drawing mechanism 110, as shown in Fig. 16C, the upper thread drawing member 111 is separated maximally from both of the thread tensioner 101 and the thread take-up bar 102 and can lengthen the upper thread path when the upper thread drawing member 111 is at the most advanced position, and accordingly, the upper thread can be fed out from the thread supply source side or lifted up from the needle side.

[0005] At the intermediate position shown in Fig. 16B, the upper thread drawing member 111 comes closer to the thread tensioner 101 and the thread take-up bar 102 and the upper thread path becomes slightly shorter, and at the most retreated position shown in Fig. 16A, the upper thread drawing member 111 comes closest to the thread tensioner 101 and the thread take-up bar 102 and the upper thread path becomes shortest.

[0006] In the buttonhole stitching machine, after cutting an upper thread at the finish of the previous sewing, by switching the upper thread drawing member 111 to the most advanced position, the length of the upper thread end portion hung down from the eye of the needle is made shorter. Accordingly, the extra length of the upper thread which will jut out of a cloth at a first stitch point position in the next sewing can be shortened.

[0007] Then, by slacking the upper thread between the upper thread drawing member 111 and the needle bar 103 by switching the upper thread drawing member to the most retreated position before starting formation of a first stitch of the next sewing, the upper thread is prevented from coming out of the eye of the needle by being pulled by the thread take-up bar which has started oper-

ation.

[0008] Then, by switching the upper thread drawing member 111 to the intermediate position before cutting the upper thread after sewing is finished, a necessary amount of the upper thread is fed out from the thread supply source and then cut, and accordingly, a necessary extra length is secured. After the upper thread is cut, the upper thread drawing member 111 is switched again to the most advanced position.

[0009] Thus, before and after sewing, the upper thread drawing mechanism switches the upper thread drawing member 111 among three positions to properly adjust the upper thread path length.

[0010] For example, a buttonhole stitching machine which forms radial stitches at an end portion of a buttonhole like eyelet buttonhole stitching includes a needle up-down movement mechanism which moves the needle bar up and down while oscillating the needle by a predetermined width, a turning mechanism which turns the needle bar which oscillates the needle, and a cloth feed mechanism which arbitrarily moves a cloth along the horizontal (X-Y) plane.

[0011] Eyelet buttonhole stitching by such a buttonhole stitching machine will be described with reference to Fig. 17. Eyelet buttonhole stitching is performed for the right parallel section L1, an eyelet lower right section L2, an eyelet upper section L3, an eyelet lower left section L4, and a left parallel section L5 in order.

[0012] In the right parallel section L1, diagonal stitches are formed by feeding a cloth at predetermined pitches rearward in the Y axis direction by a cloth feed mechanism at timings at which the needle is oscillated from inner stitch points (black points in the figure that are close to a buttonhole) to outer stitch points (white points in the figure that are moved away from the buttonhole).

[0013] In the eyelet lower right section L2, in addition to the same movement as in the right parallel section L1, by also feeding the cloth inward in the X axis direction (leftward in Fig. 17) by the cloth feed mechanism at the timings at which the needle is oscillated from the inner stitch points to the outer stitch points, the stitch points are displaced outward and diagonal stitches are formed.

[0014] In the eyelet upper section L3, by turning the needle bar in increments of a predetermined angle in a direction opposite to the stitch forming direction by the turning mechanism at timings at which the needle is oscillated from the inner stitch points to the outer stitch points and oscillated from the outer stitch points to the inner stitch points, the needle oscillation direction is gradually switched to the Y direction, and accordingly, arc-like stitches are formed.

[0015] In the eyelet lower left section L4, at timings at which the needle is oscillated from the inner stitch points to the outer stitch points, the cloth is fed forward in the Y axis direction by the cloth feed mechanism and is also fed outward in the X axis direction (leftward in Fig. 17), and accordingly, inward diagonal stitches are formed.

[0016] In the left parallel section L5, by feeding the

cloth at predetermined pitches forward in the Y axis direction by the cloth feed mechanism at the timings at which the needle is oscillated from the inner stitch points to the outer stitch points, diagonal stitches are formed.

[0017] On the other hand, in the right and left parallel sections L1 and L5, the eyelet lower right section L2, and the eyelet lower left section L4, when the needle is oscillated from the outer stitch points to the inner stitch points, the cloth is not fed in the Y axis direction, such that stitches along the X axis direction are formed.

[0018] Thus, stitches formed diagonally and turningly and stitches straightly advanced by needle oscillation are different from each other in upper thread consumption.

[0019] As is clearly understood from Fig. 18 showing the upper thread consumptions in the sections L1 to L5, when the consumption in the parallel sections L1 and L5 is defined as a reference consumption, the consumption is larger in the eyelet lower right section L2, the consumption is slightly smaller in the eyelet upper portion L3, and the consumption is much smaller in the eyelet lower left section L4.

[0020] Specifically, in the eyelet lower right section L2, the cloth is fed to the side opposite to the needle oscillation direction by the cloth feed mechanism, such that the distance from the inner stitch point position to the outer stitch point position becomes longer, and as a result, the upper thread consumption increases.

[0021] In the eyelet upper section L3, stitches are formed radially, such that the interval between the inner stitch point position and the inner stitch point position becomes shorter, and as a result, the distance from the inner stitch point position to the outer stitch point position becomes substantially equal to the needle oscillation width, and as a result, the upper thread consumption is reduced.

[0022] In the eyelet lower left section L4, the cloth is fed in the same direction as the needle oscillation direction by the cloth feed mechanism, such that the distance from the inner stitch point position to the outer stitch point position becomes shorter, and as a result, the upper thread consumption is reduced.

[0023] Thus, when stitches are formed diagonally and turningly, the upper thread consumption becomes difficult individually as compared with stitches which are straightly advanced by needle oscillation. The upper thread consumption differences change according to cloth moving amounts in the X axis and Y axis directions and turning angle units when the needle advances diagonally.

[0024] However, in the above-described conventional buttonhole stitching machine, the position of the upper thread drawing member 111 can be switched among only three positions by the upper thread drawing mechanism 110 before and after sewing, and the above-described various upper thread consumption differences cannot be avoided.

[0025] As a result, stitch skipping caused by a failure of tying between the upper thread and the lower thread,

irregular stitch caused by irregular thread tightness, and sewing shrink of the cloth, etc., occur, and these deteriorate the sewing quality.

[0026] The above-described problem occurs not only in the case of eyelet buttonhole stitching but also in the cases of closed-eye buttonhole stitching for forming turning stitches L6 as shown in Fig. 19A, taper bar tack sewing for forming stitches L7 and L8 by gradually displacing the needle oscillation range in the X axis direction at the sewing start or sewing finish as shown in Fig. 19B, straight bar tack sewing for forming stitches L9 orthogonal to the parallel sections at the sewing finish as shown in Fig. 20A, and round bar tack sewing for forming turning stitches L10 at the sewing start or sewing finish as shown in Fig. 20B.

[0027] Not only in buttonhole stitching, upper thread consumption differences also occur according to workpiece moving amounts in sewing machines including a cloth feed mechanism which moves a workpiece by an optionally set amount with respect to the needle, such that stitch skipping, irregular stitch, and sewing shrink of cloth, etc., occur, and these deteriorate the sewing quality.

[0027a] A feed control device for an electronically controlled zigzag sewing machine is known from US 4,791,877. An automatic thread tensioning adjusting device for a sewing machine is disclosed in DE 30 21 450 A1. And US 4,215,641 relates to an electronic control of the needle thread in a sewing machine.

[0028] An object of the present invention is to solve the problem of sewing quality deterioration caused by thread consumption differences during sewing.

[0029] According to a first aspect of the invention, a sewing machine comprises: a needle up-down movement mechanism which moves a needle bar up and down, wherein the needle bar holds a needle; a thread take-up bar which reciprocates in synchronization with up and down movements of the needle bar to pull up an upper thread from the needle or to feed out the upper thread from a thread supply source; a thread tensioning device which gives a tension to the upper thread from the thread supply source; an upper thread drawing mechanism comprising an upper thread drawing member which is operable to engage with the upper thread positioned on an upper thread path between the thread tensioning device and the thread take-up bar and to move in a direction crossing the upper thread path; a cloth feed mechanism which moves a workpiece by using a cloth moving motor, in synchronization with the up and down movements of the needle bar, and by an optional moving amount along a plane crossing the needle bar; and an operation control means which controls the cloth moving motor during a sewing operation such that the workpiece is moved by a preset moving amount. The sewing machine is characterized in that it further comprises a data memory which stores sewing pattern data in which an upper thread drawing amount is set, and that the upper thread drawing mechanism further comprises an upper

thread drawing motor coupled to the upper thread drawing member so as to move the upper thread drawing member, wherein the operation control means controls the upper thread drawing motor based on the sewing pattern data such that the upper thread drawing member is moved by an optionally set amount for each stitch during the sewing operation.

[0030] According to a second aspect of the present invention, the operation control means controls the upper thread drawing motor such that, with reference to a thread consumption in parallel sections of eyelet buttonhole stitches, a thread consumption in an eyelet lower right section of the eyelet buttonhole stitches is increased and a thread consumption in an eyelet lower left section of the eyelet buttonhole stitches is reduced.

[0031] According to a third aspect of the present invention, in the sewing pattern data, the number of drive pulses of the upper thread drawing motor and the number of drive pulses of the cloth moving motor are set for each stitch.

[0032] According to a fourth aspect of the present invention, the sewing machine further comprises a data setting means which is operable to set, in the sewing pattern data, an upper thread drawing amount for each of parallel sections, an eyelet lower right section, an eyelet upper section, and an eyelet lower left section of eyelet buttonhole stitches.

[0033] According to a fifth aspect of the present invention, the data setting means is operable to set the upper thread drawing amount in the sewing pattern data, with reference to the parallel sections, and based on an input of correction values for the eyelet lower right section and the eyelet lower left section.

[0034] According to a sixth aspect of the present invention, the upper thread drawing mechanism further comprises a joint rod which couples the upper thread drawing member and the upper thread drawing motor. The thread tensioning device comprises a pair of thread tension discs, a thread tensioning solenoid, and a transmission rod which transmits a thrust of the thread tensioning solenoid to the pair of thread tension discs. In a direction from a vertical drum portion of the sewing machine toward the needle bar, the thread tension discs and the upper thread drawing member are disposed closer to the needle bar than from the thread tensioning solenoid and the upper thread drawing motor.

[0035] According to the first aspect of the present invention, during sewing, even when the upper thread consumption is changed by the cloth feed mechanism, the upper thread can be supplied by an optional thread drawing amount by control of the upper thread drawing motor. Specifically, the upper thread can be supplied according to upper thread consumption changes, such that stitch skipping, irregular stitch, and sewing shrink of cloth, etc., can be effectively suppressed, and the sewing quality can be improved.

[0036] Particularly, according to the second aspect of the present invention, in formation of eyelet buttonhole

stitches, it is possible to handle thread consumption differences in the respective sections in which stitches are formed, and the sewing quality of eyelet buttonhole stitching can be improved.

[0037] According to the third aspect of the present invention, the upper thread drawing amount can be adjusted for each stitch, and sewing which changes the thread consumption in the respective sections of stitches can be performed, and the sewing quality can be improved.

[0038] According to the fourth and fifth aspects of the present invention, setting can be made for each of the constituent sections of eyelet buttonhole stitches, such that sewing pattern data can be prepared quickly. In formation of eyelet buttonhole stitches, it is possible to handle thread consumption differences in the respective sections in which stitches are formed, and the sewing quality of eyelet buttonhole stitching can be improved.

[0039] According to the sixth aspect of the present invention, the upper thread drawing member is supplied with power by the joint rod and the thread tension discs are supplied with power by the transmission rod, such that even if a drive source is disposed close to the vertical drum portion where a disposition space is easily secured, the upper thread drawing member and the thread tension discs can be disposed close to the needle bar, and the thread path from the thread tension discs to the needle bar via the upper thread drawing member and the thread take-up bar is shortened, such that influence of thread expansion and contraction is reduced, and a thread consumption change and a thread tension change according to movement of the upper thread drawing member can be quickly transmitted to the needle side, and target stitches can be easily formed.

[0040] The following description of a preferred embodiment of the invention serves to explain the invention in greater detail in conjunction with the drawings. These show:

Fig. 1: a side view of a buttonhole stitching machine according to an embodiment of the present invention;

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

Fig. 3: a perspective view of various components provided on a sewing machine arm portion upper surface;

Fig. 4: a side view of various components provided on a sewing machine arm portion upper surface;

Fig. 5: an upper side perspective view of an upper thread drawing mechanism;

Fig. 6: a lower side perspective view of the upper thread drawing mechanism;

Fig. 7: a front view of an operation panel;

Fig. 8: an explanatory view showing a list of setting parameters set through the operation panel;

Fig. 9: an explanatory view showing a list of other setting parameters set through the operation panel;

Fig. 10: an explanatory view showing data content

of sewing pattern data in the form of a table;

Fig. 11: a flowchart showing general processing from the setting and inputting of setting parameters to a sewing operation of the buttonhole stitching machine;

Fig. 12: a flowchart of setting processing for setting parameters;

Fig. 13: a flowchart of operation control of the upper thread drawing mechanism during sewing;

Fig. 14: an explanatory view showing a list of other setting parameters set through the operation panel;

Fig. 15: a perspective view of the upper thread drawing mechanism of a conventional buttonhole stitching machine;

Fig. 16A: a plan view of the upper thread drawing mechanism of Fig. 15 when the upper thread drawing member is at a most retreated position;

Fig. 16B: a plan view of the upper thread drawing mechanism of Fig. 15 when the upper thread drawing member is at an intermediate position;

Fig. 16C: a plan view of the upper thread drawing mechanism of Fig. 15 when the upper thread drawing member is at a most advanced position;

Fig. 17: an explanatory view showing a right parallel section, an eyelet lower right section, an eyelet upper section, an eyelet lower left section, and a left parallel section constituting eyelet buttonhole stitching;

Fig. 18: a diagrammatic view showing upper thread consumptions in the respective sections of eyelet buttonhole stitching;

Fig. 19A: an explanatory view of closed-eye buttonhole stitching;

Fig. 19B: an explanatory view of taper bar tack sewing added to the buttonhole stitching;

Fig. 20A: an explanatory view of straight bar tack sewing added to the buttonhole stitching; and

Fig. 20B: an explanatory view of round bar tack sewing added to the buttonhole stitching.

[0041] Overall Configuration of Sewing Machine

[0042] A buttonhole stitching machine 1 according to an embodiment of the present invention will be described with reference to Fig. 1 to Fig. 13. Fig. 1 is a side view of the buttonhole stitching machine 1, and Fig. 2 is a block diagram showing a control system of the buttonhole stitching machine 1. This buttonhole stitching machine 1 is an eyelet buttonhole stitching machine enabling eyelet buttonhole stitching.

[0043] As shown in Fig. 1, the buttonhole stitching machine 1 includes a sewing machine frame 2 including a bed portion 2a which is positioned on a lower portion of the entire sewing machine and has a substantially rectangular box shape, a vertical drum portion 2b provided on one end portion of the bed portion 2a, and an arm portion 2c provided to extend in the same direction as that of the bed portion 2a from the vertical drum portion 2b. In the description given below, the direction of erection of the vertical drum portion 2b is defined as the Z

axis direction, the longitudinal direction of the bed portion 2a and the arm portion 2c, orthogonal to the Z axis direction, is defined as the Y axis direction, and the direction orthogonal to both of the Y axis direction and the Z axis direction is defined as the X axis direction.

[0044] The buttonhole stitching machine 1 includes, as shown in Fig. 1 and Fig. 2, a needle bar 12 holding a needle 11 through which an upper thread is inserted, a needle bar turning base 13 which supports the needle bar 12 so as to allow the needle bar 12 to oscillate, an up-down movement mechanism (not shown) which moves the needle bar 12 up and down and oscillates the needle bar 12, a looper mechanism 60 which forms stitches of buttonhole stitching, a turning mechanism 20 which turns a needle bar turning base 13 and a looper base 61 of the looper mechanism 60, a stitching motor 17 serving as a drive source of a sewing operation, an upper thread guide means 30 which guides the upper thread, a thread take-up bar 14 which lifts up the upper thread from the needle side or feeds out the upper thread from a thread supply source side, an upper thread drawing mechanism 40 having an upper thread drawing member 41 which the upper thread laid across the thread take-up bar 14 passes through and draws the upper thread, a thread tensioning device 35 which applies a tension to the upper thread, a cloth feed mechanism 50 which moves a workpiece by an optional moving amount along the X-Y plane and positions the workpiece, and a control means 70 (operation control means) which controls the respective components.

[0045] Needle Bar

[0046] The needle bar 12 has a tubular shape having a hollow interior, and has an upper end portion projecting to the outside from the upper surface of the arm portion 2c of the sewing machine frame 2, and an upper thread is inserted from the upper end opening and the needle bar 12 guides the upper thread to the needle 11 on the lower end portion through the hollow interior.

[0047] The needle up-down movement mechanism includes the needle bar 12 holding the needle 11, an upper shaft to which a torque for full rotation is applied by the stitching motor 17, a crank mechanism which extracts a reciprocatory up-down driving force from the upper shaft, a sleeve which supports the needle bar movably up and down, and a leaf spring which has a thin plate shape along the X-Y plane and supports the sleeve.

[0048] The needle up-down movement mechanism applies reciprocatory up-down movements to the needle bar 12 with a period synchronized with the rotation speed of the stitching motor 17 by the crank mechanism, and the sleeve supporting the needle bar 12 is supported by the leaf spring along the X-Y plane so as to oscillate, and accordingly, the needle 11 side of the lower end portion of the needle bar 12 is allowed to oscillate in both of the X and Y directions.

[0049] Further, the needle up-down movement mechanism includes a needle bar oscillating base which applies reciprocatory oscillating movements along the X ax-

is direction to the needle bar 12 while allowing up-down movements of the needle bar 12, and a transmission mechanism which applies reciprocatory up-down movements to the needle bar oscillating base by the stitching motor 17. On the needle bar oscillating base, a cam groove inclined in the synthetic direction of the X axis direction and the Z axis direction is formed, and the needle bar turning base 13 supports the needle bar oscillating base movably along the cam groove. When the needle bar oscillating base descends, the needle bar turning base 13 moves to one side in the X axis direction along the cam groove, and when the needle bar oscillating base ascends, the needle bar turning base 13 moves to the opposite side in the X axis direction. The transmission mechanism applies up-down movements with a period twice the up-down movement period of the needle bar 12, and accordingly, the needle bar 12 moves down each time it oscillates to one side or the other side of the X axis direction to oscillate the needle.

[0050] The needle up-down movement mechanism supports the needle bar 12 such that the needle bar 12 is along the Z axis direction (vertical direction) when the leaf spring does not bend, and in this reference posture, the needle moves down to an inner stitch point of a needle oscillation sewing stitch described later. An oscillating movement is applied from the reference posture and the needle bar 12 is inclined by a predetermined angle in the synthetic direction of the X axis direction and the Z axis direction, and in this inclined state, the needle moves down to an outer stitch point of the needle oscillation sewing stitch.

[0051] The needle bar turning base 13 is supported rotatably around the Z axis on the lower side of the arm portion 2c of the sewing machine frame 2, and has a pulley (not shown) which is fixed to the needle bar 12 and around which a timing belt 21 of the turning mechanism 20 is laid. Accordingly, when a turning movement is applied from the turning mechanism 20, this turning movement around the Z axis can be applied to the needle bar 12 via the needle bar oscillating base.

[0052] Looper Mechanism

[0053] The looper mechanism 60 is disposed in the upper portion of the sewing machine bed portion 2a and below a feed base 51 of the cloth feed mechanism 50 described later. This looper mechanism 60 includes a looper base 61 supported on the sewing machine bed portion 2a rotatably around the Z axis, a left looper and a left spreader which are mounted on an upper portion of the looper base 61 and entwine a lower thread with an upper thread to form a double chainstitch, a right looper and a right spreader which form a single-thread chainstitch by using an upper thread, and a drive mechanism which applies predetermined oscillating movements for sewing to the loopers and spreaders.

[0054] The looper base 61 is supported turnably concentrically with the turning axis of the needle bar turning base, and has a pulley which is fixed to the looper base 61 and around which a timing belt 23 of the turning mechanism 20 is laid.

anism 20 is laid.

[0055] The left looper and the left spreader and the right looper and the right spreader are disposed on both ends in the radial direction of a circle around the turning axis on the upper portion of the looper base 61. When sewing, the reference turning angle of the looper base 61 is set such that the left looper and the left spreader form a double chainstitch when the needle bar 12 moves down to the inner stitch point, and the right looper and the right spreader form a single-thread chainstitch when the needle bar 12 moves down to the outer stitch point.

[0056] The drive mechanism includes a circular-tube-like looper drive shaft 62 supported movably up and down at the central position of the looper base 61, a spreader drive shaft 63 inserted through the inside of the looper drive shaft 62, a transmission mechanism which oscillates the right and left loopers according to reciprocatory up-down movements of the looper drive shaft 62, a transmission mechanism which oscillates the right and left spreaders according to reciprocatory up-down movements of the spreader drive shaft 63, and cam mechanisms which move the drive shafts 62 and 63 up and down from the lower shaft driven to rotate by the stitching motor 17.

[0057] The drive mechanism applies up-down movements to the drive shafts 62 and 63 with a period twice the up-down movement period of the needle bar 12 (equal to the rotation period of the stitching motor 17), and accordingly, the right and left loopers and spreaders alternately capture the upper thread from the needle 11 each time the needle bar 12 moves down.

[0058] Turning Mechanism

[0059] The turning mechanism 20 includes a turning motor 24 disposed inside the sewing machine bed portion 2a, transmission pulleys 22 (the lower pulley is not shown) provided on the upper and lower sides of the same shaft for transmitting a torque of the turning motor 24 to the needle bar turning base 13 side, a timing belt 23 laid across a main driving pulley provided on the output shaft of the turning motor 24, the pulley provided on the looper base 61, and the lower transmission pulley, and a timing belt 21 laid across the upper transmission pulley 22 and the pulley provided on the needle bar turning base 13.

[0060] In the turning mechanism 20, the transmission ratio of the pulleys is set such that the looper base 61 and the needle bar turning base 13 rotate in the same phase by the rotation driving of the turning motor 24. Specifically, the turning mechanism 20 applies a turning movement such that the needle oscillation direction of the needle bar and the alignment direction of the right and left loopers and spreaders are always matched with each other during turning.

[0061] Cloth Feed Mechanism

[0062] The cloth feed mechanism 50 includes a feed base 51 having a workpiece placing surface parallel to the X-Y plane, an X axis motor 52 (a cloth moving motor) which moves the feed base 51 along the X axis direction,

a Y axis motor 53 (another cloth moving motor) which moves the feed base 51 along the Y axis direction, and a known power transmission mechanism which converts rotation driving forces of the motors 52 and 53 into direct driving forces along the X axis direction and the Y axis direction and applies these to the feed base 51.

[0063] Thread take-up bar, Thread Tensioning Device, and Thread Guide Means

[0064] Fig. 3 is a perspective view of the various components provided on the sewing machine arm portion upper surface, and Fig. 4 is a side view.

[0065] As shown in Fig. 3 and Fig. 4, the thread take-up bar 14 is disposed closer to the needle bar side (upper thread supply downstream side) than the thread tensioning device 35, axially supported by a pivot along the X axis direction so as to oscillate, and mounted such that the oscillating end portion projects upward from the upper surface of the sewing machine arm portion 2c, in the upper thread path. The thread take-up bar 14 is subjected to reciprocatory movements along the Y axis direction by the stitching motor 17 via the crank mechanism in synchronization with up and down movements of the needle bar 12, and retreats to separate from the needle bar 12 and feeds the upper thread out from the upper thread supply source side and lifts up the upper thread from the needle 11 side when the needle bar 12 moves up, and advances to the needle bar 12 side and supplies the upper thread to the needle 11 side when the needle bar 12 moves down.

[0066] As shown in Fig. 3 and Fig. 4, the thread tensioning device 35 is disposed on the upper thread supply path upstream side of the thread take-up bar 14, and includes two thread tension discs 36 and 37, a thread tensioning solenoid 38 which can arbitrarily control pressing forces of these thread tension discs, and a transmission rod 39 which applies a thrust of the thread tensioning solenoid 38 to the thread tension discs.

[0067] As shown in Fig. 3 and Fig. 4, the upper thread guide means 30 includes a first thread guide 31 disposed closest to the thread supply source side, a second thread guide 32 disposed before the thread tensioning device 35, a third thread guide 33 disposed on the immediately downstream side of the thread tensioning device 35, and a fourth thread guide 34 disposed between the thread take-up bar 14 and the needle bar 12.

[0068] Upper Thread Drawing Mechanism

[0069] Fig. 5 is a perspective view of the upper thread drawing mechanism 40 from the diagonally upper side, and Fig. 6 is a perspective view from the diagonally lower side.

[0070] As shown in Fig. 3 to Fig. 6, the upper thread drawing mechanism 40 includes an upper thread drawing member 41 disposed between the third thread guide 33 provided on the downstream side of the thread tensioning device 35 in the upper thread path and the thread take-up bar 14, a guide 42 which makes the upper thread drawing member 41 move along the Y axis direction, a support arm 43 which supports the upper thread drawing

member 41 by an oscillating end portion, an upper thread drawing motor 44 serving as a drive source of positioning movement of the upper thread drawing member 41 along the Y axis direction, a driven pulley 46 which is driven to rotate by the upper thread drawing motor 44 via the timing belt 45, a joint rod 47 which couples the outer peripheral portion of the driven pulley 46 and the support arm 43, a shielding plate 48 extended to the radially outer side of the driven pulley 46, and an origin sensor 49 which searches for an origin of the upper thread drawing motor 44 according to shielding and non-shielding states made by the shielding plate 48.

[0071] In the upper end portion of the upper thread drawing member 41, a thread insertion hole 41 is opened, and by inserting the upper thread through the thread insertion hole 41 a, the upper thread laid across the thread take-up bar 14 is made to pass through the upper thread drawing member 41. The upper thread drawing member 41 is disposed between the thread tensioning device 35 and the thread take-up bar 14, and can change the thread path length between the thread tensioning device 35 and the thread take-up bar 14 by approaching and separating from a straight line connecting the third thread guide 33 and the thread take-up bar 14. Accordingly, the thread pulling amount and the thread supply amount of the thread take-up bar 14 can be adjusted.

[0072] The support arm 43 supporting the upper thread drawing member 41 is disposed such that its longitudinal direction is substantially in the X axis direction, and holds the upper thread drawing member 41 while allowing it to move along the longitudinal direction. On the other hand, the guide 42 having a straight guide hole formed along the Y axis direction allows the upper thread drawing member 41 to move only along the guide hole. Specifically, by reciprocatory rotational movement of the support arm 43, its rotational movement end portion moves substantially along the Y axis direction, however, the movement locus of the rotational movement end portion becomes arced, such that it is also displaced in the X axis direction. However, the upper thread drawing member 41 is restricted from moving in the X axis direction and allowed to move in the longitudinal direction with respect to the support arm 43 by the guide 42, such that according to rotational movement of the support arm 43, only the straight movement along the Y axis direction is transmitted to the upper thread drawing member 41.

[0073] To the rotational movement end portion of the support arm 43, a tension is always applied by a tension spring 43a such that the upper thread drawing member 41 moves to the needle bar 12 side.

[0074] The upper thread drawing motor 44 applies a rotation movement to the driven pulley 46 by a timing belt 45 laid across the output shaft of the motor 44. The driven pulley 46 is structured to apply a displacement in the Y axis direction during rotation to the support arm 43 by the joint rod 47 which has one end portion coupled to the outer peripheral edge portion of the driven pulley 46 and the other end portion coupled to the rotational movement

end portion of the support arm 43. Accordingly, rotational movement can be applied to the support arm 43 by driving of the upper thread drawing motor 44.

[0075] To the driven pulley 46, the shielding plate 48 extended in the rotation radial direction of the driven pulley 46 is fixed. Within the movement range of this shielding plate 48, an optical origin sensor 49 is disposed, and for example, a point shielded during rotation in a predetermined direction is defined as an origin of the upper thread drawing motor 44.

[0076] The upper thread drawing motor 44 is a stepping motor, and its driving amount is controlled according to a number of pulses input as a drive command from a shaft angle of the origin determined by the origin sensor. Specifically, the position of the upper thread drawing member 41 can be arbitrarily adjusted along the Y axis direction according to the number of command pulses.

[0077] As shown in Fig. 3 to Fig. 6, the upper thread drawing mechanism 40 includes the joint rod 47 which couples the upper thread drawing member 41 and the upper thread drawing motor 44. The thread tensioning device 35 includes the transmission rod 39 which transmits a thrust of the thread tensioning solenoid 38 to the pair of thread tension discs 36 and 37.

[0078] Therefore, the upper thread drawing motor 44 as a drive source and the thread tensioning solenoid 38 can be disposed in a range YB (range close to the vertical drum portion) separated from the needle bar with reference to the thread take-up bar rearmost end position, and the pair of thread tension discs 36 and 37 and the upper thread drawing member 41 can be disposed in a range YA on the needle bar side of the rearmost end position of the thread take-up bar 14.

[0079] Therefore, the thread path from the thread tension discs 36 and 37 to the needle bar via the upper thread drawing member 41 and the thread take-up bar 14 is shortened, such that influence of thread expansion and contraction is reduced, and the thread consumption changes quickly according to movements of the upper thread drawing member 41, and target stitches can be easily formed.

[0080] Control System of Sewing Machine

[0081] With reference to Fig. 2, a control system of the buttonhole stitching machine 1 will be described. The control means 70 of the buttonhole stitching machine 1 includes a stitching motor drive circuit 17a for driving the stitching motor 17, an I/F 17b for connecting the drive circuit 17a to a CPU 71 of the control means 70, an X axis motor drive circuit 52a for driving the X axis motor 52 provided in the cloth feed mechanism 50, an I/F 52b for connecting the drive circuit 52a to the CPU 71, a Y axis motor drive circuit 53a for driving the Y axis motor 53 provided in the cloth feed mechanism 50, an I/F 53b for connecting the drive circuit 53a to the CPU 71, a turning motor drive circuit 24a for driving the turning motor 24, an I/F 24b for connecting the drive circuit 24a to the CPU 71, an upper thread drawing motor drive circuit 44a for driving the upper thread drawing motor 44, an I/F 44b

for connecting the drive circuit 44a to the CPU 71, an I/F 49b for connecting the origin sensor 49 which searches for the origin of the upper thread drawing motor 44 to the CPU 71, a thread tensioning solenoid drive circuit 38a for driving the thread tensioning solenoid 38 of the thread tensioning device 35, an I/F 38b for connecting the drive circuit 38a to the CPU 71, an operation panel 75 into which various settings are input, an I/F 75b for connecting the operation panel 75 to the CPU 71, an encoder circuit 18a for counting the output pulses of the encoder 18 which detects an output shaft angle of the stitching motor 17, and an I/F 18b for connecting the encoder circuit 18a to the CPU 71.

[0082] The X axis motor 52, the Y axis motor 53, and the turning motor 24 are also pulse motors and have origin sensors for searching for origins, however, they are not shown.

[0083] The control means 70 includes a ROM 72 storing various control programs and data to be used in the programs, data read out from the ROM 72, data input or set through the operation panel 75, a RAM 73 which serves as a work area to be used by the CPU 71 to perform processing based on the programs, an EEPROM 74 for storing input data and arithmetic operation result data, etc., and a CPU 71 which performs various processings based on the programs.

[0084] Operation Panel and Setting Parameters

[0085] Fig. 7 is a front view of the operation panel 75. The operation panel 75 includes a display section 75a for displaying a number of sewing pattern data and an increment/decrement key 75b for selecting the number, a display section 75c for displaying set values of various parameters of various sewing pattern data and an increment/decrement key 75d for incrementing and decrementing the set values, a display section 75e for displaying item numbers for identifying the various parameters and an increment/decrement key 75f for selecting the item number of a setting item, a data set key 75g for inputting setting start, and a preparation key 75h for inputting setting completion.

[0086] According to set values of various parameters of sewing pattern data set and input through the operation panel 75, various control values necessary for performing sewing are calculated to generate sewing pattern data.

[0087] Next, various setting parameters set through the operation panel 75 will be described with reference to Fig. 8 and Fig. 9. Fig. 8 shows a case where values of upper thread drawing amounts for the respective sections (see L1 to L8 of Fig. 17 and Fig. 19) of buttonhole stitching are set as various setting parameters of buttonhole stitching, and Fig. 9 shows a case where ratios by which the thread consumption is multiplied for the respective sections of buttonhole stitching, calculated by the CPU 71 as various setting parameters of buttonhole stitching, are set. In the case of Fig. 9, the CPU 71 automatically calculates the upper thread drawing amounts from the set ratios.

[0088] Description is given in order from the case of

Fig. 8, and the following are set as setting parameters to be input through the operation panel 75.

(1) Eyelet Form: Closed-eye buttonhole stitching or eyelet buttonhole stitching is selectable by number. The number "0" is selected for closed-eye buttonhole stitching, and for eyelet buttonhole stitching, five sewing patterns with different sizes are selected from the numbers "1" to "5."

(2) Stitching Length: An entire length in the Y axis direction of buttonhole stitching to be formed is numerically input.

(3) Number of Parallel Section Stitches: The number of stitches for the right parallel section L1 + the eyelet lower right section L2 is numerically input (the same number is set for the left parallel section L5 + the eyelet lower left section L4).

(4) Number of Eyelet Stitches: The number of stitches for the eyelet upper section L3 (or the closed-eye section L6) is numerically input.

(5) Bar Tacking Type: It is selected whether bar tack sewing is performed, and a type of bar tack is input by number. Performing no bar tacking is set by "0," taper bar tack is set by "1," straight bar tack is set by "2," and round bar tack is set by "3."

(6) Eyelet Lower Right Section - Upper Thread Drawing Amount: An upper thread drawing amount which is the total number of all stitches belonging to the eyelet lower right section L2 is numerically input. The input total upper thread drawing amount is divided by the number of stitches for the eyelet lower right section by the CPU 71 and converted into a value per stitch. The number of stitches for the eyelet lower right section is automatically determined according to the size of eyelet buttonhole stitching.

(7) Eyelet Upper Section - Upper Thread Drawing Amount: An upper thread drawing amount which is the total number of all stitches belonging to the eyelet upper section L3 (or closed-eye section L6) is numerically input. It is converted into a value per stitch in the same manner as described above.

(8) Eyelet Lower Left Section - Upper Thread Drawing Amount: An upper thread drawing amount which is the total number of all stitches belonging to the eyelet lower left section L4 is numerically input. It is converted into a value per stitch in the same manner as described above. The number of stitches for the eyelet lower left section is also automatically determined according to the size of eyelet buttonhole stitching.

(9) Right Taper bar tack Section - Upper Thread Drawing Amount: When "taper bar tack" is selected in (5), an upper thread drawing amount which is the total number of all stitches belonging to the right taper bar tack section is numerically input. It is converted into a value per stitch in the same manner as described above.

(10) Left Taper bar tack Section - Upper Thread

Drawing Amount: When "taper bar tack" is selected in (5), an upper thread drawing amount which is the total number of all stitches belonging to the left taper bar tack section is numerically input. It is converted into a value per stitch in the same manner as described above.

[0089] As the upper thread drawing amounts for the right and left parallel sections L1 and L5, prescribed values are used, such that setting is not performed.

[0090] For (6) to (10), it is also possible that an upper thread drawing amount per stitch is set.

[0091] In the case of Fig. 9, the following are set as setting parameters to be input through the operation panel 75. (1) to (5) are the same as above. (6) Upper thread drawing correction: Concerning the distance between stitch point positions (thread consumption) when the needle is oscillated from an inner stitch point to an outer stitch point, when the distance in the parallel sections L1 and L5 is defined as a reference value, correction values by which the distance change amounts in other sections are multiplied are numerically input. "0" is set when no correction is performed, and correction values of "1" to "10" can be set. The distance between the stitch point positions is calculated according to arithmetic operation by the CPU 71.

[0092] The operation panel 75 serves as data setting means for setting and inputting these setting parameters.

[0093] Processing of Control Means: Generation of Sewing Pattern Data

[0094] When setting parameters of Fig. 8 or Fig. 9 are set and input, the CPU 71 generates sewing pattern data. Fig. 10 is an explanatory view showing data content of sewing pattern data in the form of a table.

[0095] In the sewing pattern data, "stitch point" indicates a stitch point of each of the inner stitch points and outer stitch points when sewing one buttonhole, and concerning the number of stitches, one stitch is counted per two stitch points of an inner stitch point and an outer stitch point. "Section" indicates each of the sections L1 to L8 of buttonhole stitching to which the numbers of stitches belong.

[0096] "Feed base XY coordinates" indicates a target position on the X-Y coordinates of the feed base 51 for each stitch. As the origin and the sewing start position of the feed base 51, prescribed values are determined in advance, and "feed base X coordinate" for each stitch point is determined for each section. For example, in the parallel sections L1 and L5, the feed base 51 does not move in the X axis direction, and in the eyelet lower sections L2 and L4, the needle oscillation stitching advances diagonally, such that the feed base XY coordinates change gradually for each stitch, and in the eyelet upper section L3, the feed base XY coordinates change such that the inner stitch points form an arc locus.

[0097] As the "feed base Y coordinate" for each stitch point, a prescribed value is determined depending on the section, or calculated from setting parameters depending

on the section. For example, in the parallel sections L1 and L5, the CPU 71 calculates "feed base Y coordinate" from a value obtained by subtracting the length of the eyelet upper section L3 from the "stitching length" of the setting parameter, and dividing it by "number of parallel section stitches".

[0098] "Turning position" indicates the rotation angle of the turning motor 24 per stitch. The CPU 71 calculates a turning angle in the eyelet upper section L3 (or closed-eye section L6) by dividing 180° by the "number of eyelet stitches" of the setting parameter.

[0099] The "stitch point position" is calculated by summing "feed base XY coordinates" and a position change amount of the needle according to needle oscillation.

[0100] ΔX of "distance between stitch points" is a change amount of the stitch point position X from the previous stitch point, and ΔY is a change amount of the stitch point position Y from the previous stitch point. Further, L is a change amount synthesizing the change amounts in the X axis and Y axis directions from the previous stitch point. This L is the distance between stitch point positions from the inner stitch point to the outer stitch point.

[0101] "Change amount ΔL from inner stitch point to outer stitch point" is a change amount with reference to the distance L between stitch point positions in the parallel sections L1 and L5. Specifically, ΔL in the parallel sections L1 and L5 is a reference value and all ΔL are zero, and ΔL in other sections are calculated from (distance L between stitch points in each section) - (distance L between stitch points in parallel section).

[0102] "Feed base XY moving amounts" are drive pulse numbers of the X axis motor 52 and the Y axis motor 53 per stitch. The CPU 71 calculates the "feed base XY moving amounts" from the differences in "feed base XY coordinates" from the values of the previous stitch point.

[0103] "Turning moving amount" is a drive pulse number of the turning motor 24 per stitch. The CPU 71 calculates the "turning moving amount" from the difference in "turning position" from the value of the previous stitch point.

[0104] "Upper thread drawing amount A" is a drive pulse number of the upper thread drawing motor 44 per stitch, and is calculated when the setting parameters of Fig. 8 are input. Specifically, the CPU 71 calculates the upper thread drawing amounts per stitch by dividing the total upper thread drawing amounts set in (6) to (10) of Fig. 8 by the numbers of inner stitch points (or the numbers of outer stitch points) of the respective sections, and calculates the drive pulse numbers of the upper thread drawing motor according to the upper thread drawing amounts.

[0105] On the other hand, "upper thread drawing amount B" is also a drive pulse number of the upper thread drawing motor 44 per stitch as the "upper thread drawing amount A," and it is calculated when the setting parameters of Fig. 9 are input. Specifically, the CPU 71

calculates the upper thread drawing amount per stitch by multiplying "change amount ΔL from inner stitch point to outer stitch point" by the upper thread drawing correction value set in (6) of Fig. 9, and calculates a drive pulse number of the upper thread drawing motor according to the upper thread drawing amount.

[0106] The resolutions per pulse of the X axis motor 52 and the Y axis motor 53 are set to 0.1mm, the resolution per pulse of the turning motor 24 is set to 1° , and the resolution per pulse of the upper thread drawing motor 14 is set to 0.1 mm.

[0107] The sewing pattern data generated by the processing described above is stored in the EEPROM 74. That is, the EEPROM 74 serves as a data memory.

[0108] The CPU 71 which generates the sewing pattern data through the processing described above serves as data generation means.

[0109] Processings and Operations of Buttonhole Stitching Machine

[0110] Fig. 11 is a flowchart showing general processing from the setting and inputting of setting parameters to the sewing operation of the buttonhole stitching machine 1, Fig. 12 is a flowchart of setting processing for setting parameters, and Fig. 13 is a flowchart of operation control of the upper thread drawing mechanism 40 during sewing.

[0111] Based on these, general processing of the buttonhole stitching machine 1 will be described.

[0112] First, the CPU 71 determines whether the number increment/decrement key 75b for sewing pattern data on the operation panel 75 has been depressed (Step S1), and when it is not depressed, the CPU 71 keeps, for example, the initial value (pattern number 1 is selected) and displays the pattern number on the display section 75a, and advances the process to Step S3. When the number increment/decrement key 75b is depressed, according to + or - of the key, the CPU 71 increments or decrements the pattern number and displays it on the display section 75a (Step S2), and advances the process to Step S3.

[0113] In Step S3, the CPU 71 determines whether the set key 75g has been depressed, and when it is not depressed, the CPU 71 advances the process to Step S5. When the set key 75g is depressed, the CPU 71 starts the setting parameter setting processing (Step S4), and after setting processing, advances to the process to Step S5.

[0114] Here, the setting parameter setting processing of Step S4 will be described in detail with reference to the flowchart of Fig. 12. Here, description is given by using the settings of setting parameters of Fig. 8 by way of example.

[0115] When the set key 75g is depressed, first, the CPU 71 automatically selects "eyelet form" of the item number (1) as a setting parameter as a setting object, and displays "1" on the display section 75e (Step S31). Then, the CPU 71 determines whether an input has been made with the increment/decrement key 75f (Step S32),

and when no input is made, the CPU 71 advances the process to Step S34, and when an input is made, the CPU 71 changes the item number of the setting parameter as a setting object (Step S33) and then advances the process to Step S34.

[0116] In Step S34, the CPU 71 determines whether an increment or a decrement of the set value of the setting parameter currently selected has been input by depressing the increment/decrement key 75d. When no input is made, the CPU 71 advances the process to Step S36, and when an input is made, the CPU 71 changes the set value of the setting parameter as a setting object. That is, the set value of the parameter selected among (1) eyelet form, (2) stitching length, (3) number of parallel section stitches, (4) number of eyelet stitches, (5) tacking type, (6) eyelet lower right section - upper thread drawing amount, (7) eyelet upper section - upper thread drawing amount, (8) eyelet lower left section - upper thread drawing amount, (9) right taper bar tack section - upper thread drawing amount, and (10) left taper bar tack section - upper thread drawing amount, is changed (Step S35).

[0117] In Step S36, it is determined whether an input has been made with the data set key 75g. When the setting parameters (1) to (10) are all completely set, the data set key 75g is depressed, and after the setting parameters are updated (Step S37), the process is advanced to Step S5 of Fig. 11.

[0118] When the setting of the setting parameters (1) to (10) is continued, an input with the data set key 75g is not made, and the process is returned to Step S32, and the processes of S32 to S35 are repeated for all setting parameters to be changed.

[0119] When setting processing of the setting parameters is completed, as shown in Step S5 of Fig. 11, the CPU 71 determines whether the preparation key 75h of the operation panel 75 has been depressed, and when the preparation key 75h is not depressed, the CPU 71 returns the process to Step S1, and when the preparation key 75h is depressed, the CPU 71 performs sewing pattern data generation processing (Step S6). That is, as described above, data computation is performed according to the setting content of the setting parameters and sewing pattern data of Fig. 10 is generated.

[0120] Then, to start the buttonhole stitching operation, origin search is performed by origin sensors of the feed base 51 (the X axis motor 52 and the Y axis motor 53), the needle bar turning base 13 and the looper base 61 (turning motor 24), and the upper thread drawing motor 44 (Step S7).

[0121] The origin position of the upper thread drawing motor 44 is set such that the upper thread drawing member 41 comes to a position at which the thread drawing amount becomes largest (most advanced position, most distant from the thread take-up bar 14).

[0122] Accordingly, the extra end portion of the upper thread inserted through the eye of the needle 11 can be adjusted to be shorter.

[0123] Thereafter, when the start switch not shown

provided on the buttonhole stitching machine 1 is depressed, the CPU 71 starts control of the buttonhole stitching operation (Step S8).

[0124] First, by controlling the X axis and Y axis motors 52 and 53, the feed base 51 at the origin position is moved to a sewing start position (Step S9).

[0125] Next, the upper thread drawing motor 44 is controlled such that the upper thread drawing member 41 is moved to a position at which the thread drawing amount becomes smallest (most retreated position, closest to the thread take-up bar 14) (Step S10). Accordingly, the upper thread drawing member 41 at the position of making the thread drawing amount largest in Step S7 retreats and shortens the upper thread path, and the upper thread is slackened or turned into a low-tension state. Accordingly, when the needle bar 12 moves down for the first stitch, the end portion of the upper thread can be prevented from coming out from the eye of the needle 11.

[0126] Then, the stitching motor 17 is driven to start buttonhole stitching (Step S11). The CPU 71 reads the "feed base XY moving amounts," "turning moving amount," and "upper thread drawing amount" set in the sewing pattern data for each stitch and controls the X axis motor 52, the Y axis motor 53, and the turning motor 24, and the upper thread drawing motor 44, and, for example, forms stitches of the sections L1 to L8 of eyelet buttonhole stitching in this order.

[0127] Here, upper thread drawing operation control during the buttonhole stitching will be described with reference to the flowchart of Fig. 13.

[0128] The CPU 71 determines whether the next needle movement is toward the inner stitch point during sewing (Step S51). This determination is performed based on, for example, whether the next stitch number is an odd number in the sewing pattern data. In this determination, when the next needle movement is not toward the inner stitch point, the process is ended.

[0129] On the other hand, when the next needle movement is toward the inner stitch point, the shaft angle of the stitching motor 17 is detected by the encoder 18, and the CPU 71 determines whether the shaft angle is a predetermined shaft angle for performing upper thread drawing (Step S52). In this determination, when the shaft angle is not the predetermined shaft angle for performing upper thread drawing, the process is ended.

[0130] On the other hand, when the shaft angle is the shaft angle for performing upper thread drawing, the set value of the upper thread drawing amount in the sewing pattern data is read out, and it is determined whether the set value is 0 (Step S53). In this determination, when the set value of the upper thread drawing amount is 0, the process is ended.

[0131] Then, when the set value of the upper thread drawing amount is not 0, the upper thread drawing motor 44 is driven according to the set value to perform upper thread drawing (Step S54), and then, the process shifts to a sewing operation for the next stitch number.

[0132] This upper thread drawing operation control is

interrupt processing to be repeated at small time intervals (e.g., period causing minute angle changes of the shaft angle of the stitching motor 17) during sewing.

[0133] When the buttonhole stitching operation based on the total number of stitches of the sewing pattern data is completed, the process returns to the process of Fig. 11, the stitching motor 17 is stopped, and then the upper thread drawing motor 44 is controlled such that the upper thread drawing member 41 comes to the position at which the upper thread drawing amount becomes largest. Accordingly, the extra end portion of the upper thread inserted through the eye of the needle 11 can be adjusted to be shorter, and preparation for the next sewing can be made (Step S12).

[0134] Then, the feed base 51 (the X axis motor 52 and the Y axis motor 53), the needle bar turning base 13 and the looper base 61 (turning motor 24) are all returned to the origin positions (Step S13), and the process is returned to Step S8. That is, a standby state is kept until the start switch is depressed for the next sewing.

[0135] Advantageous Effects of Embodiment

[0136] According to the buttonhole stitching machine 1, even when upper thread consumption changes according to cloth movement by the cloth feed mechanism 50 for forming the respective sections of buttonhole stitching, specifically, the eyelet lower right section L2, the eyelet upper section L3, the eyelet lower left section L4, the closed-eye section L6, and the taper bar tack sections L7 and L8 in eyelet buttonhole stitching, the upper thread drawing motor 44 is controlled according to upper thread drawing amount set values for the respective sections, such that the upper thread can be supplied by proper thread drawing amounts. That is, the upper thread can be supplied according to upper thread consumption changes, such that stitch skipping, irregular stitch, and sewing shrink of cloth, etc., can be effectively suppressed, and the sewing quality can be improved.

[0137] An upper thread drawing correction ratio can be set as a setting parameter, and in the sewing pattern data generation processing, the CPU 71 calculates the "change amount ΔL from inner stitch point to outer stitch point" of each needle oscillation, and automatically calculates a proper upper thread drawing amount from the upper thread drawing correction ratio, such that the setting operation burden can be dramatically reduced.

[0138] Other Examples

[0139] Another example of setting parameters in buttonhole stitching is shown in Fig. 14.

[0140] In this example, while a setting item of "upper thread drawing correction" is provided as (6) and the upper thread drawing amount (a ratio by which the "change amount ΔL from inner stitch point to outer stitch point" is multiplied) is determined for all stitches as in the case of Fig. 9 described above, the upper thread drawing amount may be further determined individually for specific sections as shown in (7) to (11) as in the example of Fig. 8. Specifically, in the sewing pattern data, for a stitch with the change amount ΔL from inner stitch point

to outer stitch point which is not 0, the change amount is multiplied by the set value of the "upper thread drawing correction" to calculate the upper thread drawing amount, however, for a section for which the upper thread drawing amount is individually determined as a set value, sewing control is performed such that the set upper thread drawing amount of the individual section is preferentially adopted.

[0141] In the embodiment described above, a buttonhole stitching machine is described by way of example, however, the present invention is not limited to buttonhole stitching, and, for example, even in a sewing machine such as an electronic cycle sewing machine which performs sewing while moving a cloth according to sewing pattern data and moving the needle down to stitch point positions on a workpiece optionally set for the respective stitches, it is also possible that the same upper thread drawing mechanism 40 is provided and the same upper thread drawing operation control is performed.

[0142] In the embodiment described above, a plurality of sections for which parameters can be set are described by setting taper bar tack sewing by way of example, however, it is easily conceivable that straight bar tack sewing or round bar tack sewing are set in the sections.

Claims

1. A sewing machine (1) comprising:

a needle up-down movement mechanism which moves a needle bar (12) up and down, wherein the needle bar (12) holds a needle (11);
a thread take-up bar (14) which reciprocates in synchronization with up and down movements of the needle bar (12) to pull up an upper thread from the needle (11) or to feed out the upper thread from a thread supply source;
a thread tensioning device (35) which gives a tension to the upper thread from the thread supply source;
an upper thread drawing mechanism (40) comprising an upper thread drawing member (41) which is operable to engage with the upper thread positioned on an upper thread path between the thread tensioning device (35) and the thread take-up bar (14) and to move in a direction crossing the upper thread path;
a cloth feed mechanism (50) which moves a workpiece by using a cloth moving motor (52, 53), in synchronization with the up and down movements of the needle bar (12), and by an optional moving amount along a plane crossing the needle bar (12); and
an operation control means (70) which controls the cloth moving motor (52, 53) during a sewing operation such that the workpiece is moved by a preset moving amount,

- characterized in that** the sewing machine (1) further comprises a data memory (74) which stores sewing pattern data in which an upper thread drawing amount is set, and the upper thread drawing mechanism (40) further comprises an upper thread drawing motor (44) coupled to the upper thread drawing member (41) so as to move the upper thread drawing member (41), wherein the operation control means (70) controls the upper thread drawing motor (44) based on the sewing pattern data such that the upper thread drawing member (41) is moved by an optionally set amount for each stitch during the sewing operation.
2. The sewing machine (1) according to claim 1, wherein the operation control means (70) controls the upper thread drawing motor (44) such that, with reference to a thread consumption in parallel sections (L1, L5) of eyelet buttonhole stitches, a thread consumption in an eyelet lower right section (L2) of the eyelet buttonhole stitches is increased and a thread consumption in an eyelet lower left section (L4) of the eyelet buttonhole stitches is reduced.
 3. The sewing machine (1) according to claim 1, wherein, in the sewing pattern data, the number of drive pulses of the upper thread drawing motor (44) and the number of drive pulses of the cloth moving motor (52, 53) are set for each stitch.
 4. The sewing machine (1) according to claim 1, wherein the sewing machine (1) further comprises a data setting means (75) which is operable to set, in the sewing pattern data, an upper thread drawing amount for each of parallel sections (L1, L5), an eyelet lower right section (L2), an eyelet upper section (L3), and an eyelet lower left section (L4) of eyelet buttonhole stitches.
 5. The sewing machine (1) according to claim 4, wherein the data setting means (75) is operable to set the upper thread drawing amount in the sewing pattern data, with reference to the parallel sections (L1, L5), and based on an input of correction values for the eyelet lower right section (L2) and the eyelet lower left section (L4).
 6. The sewing machine (1) according to claim 1, wherein the upper thread drawing mechanism (40) further comprises a joint rod (47) which couples the upper thread drawing member (41) and the upper thread drawing motor (44), the thread tensioning device (35) comprises a pair of thread tension discs (36, 37), a thread tensioning solenoid (38), and a transmission rod (39) which transmits a thrust of the thread tensioning solenoid

(38) to the pair of thread tension discs (36, 37), and in a direction from a vertical drum portion (2b) of the sewing machine (1) toward the needle bar (12), the thread tension discs (36, 37) and the upper thread drawing member (41) are disposed closer to the needle bar (12) than from the thread tensioning solenoid and the upper thread drawing motor (44).

10 Patentansprüche

1. Nähmaschine (1), umfassend:

einen Nadel-Auf-/Ab-Bewegungsmechanismus, der eine Nadelstange (12) auf und ab bewegt, wobei die Nadelstange (12) eine Nadel (11) hält;
 eine Fadenaufnahmestange (14), welche sich synchron mit Auf- und Abbewegungen der Nadelstange (12) hin- und herbewegt, um einen Oberfaden von der Nadel (11) hochzuziehen oder um den Oberfaden von einer Fadenlieferquelle abzuziehen;
 eine Fadenspannungsvorrichtung (35), welche dem Oberfaden von der Fadenlieferquelle eine Spannung verleiht;
 einen Oberfadenziehmechanismus (40), umfassend ein Oberfadenziehglied (41), welches mit dem an einem Oberfadenpfad zwischen der Fadenspannungsvorrichtung (35) und der Fadenaufnahmestange (14) positionierten Oberfaden in Eingriff bringbar und in eine den Oberfadenpfad kreuzende Richtung bewegbar ist;
 einen Nähgutvorschubmechanismus (50), welcher ein Werkstück unter Einsatz eines Nähgutbewegungsmotors (52, 53) synchron mit den Auf- und Abbewegungen der Nadelstange (12) und um ein optionales Bewegungsausmaß entlang einer die Nadelstange (12) kreuzenden Ebene bewegt; und
 ein Betriebssteuermittel (70), welches den Nähgutbewegungsmotor (52, 53) während einer Nähoperation so steuert, dass das Werkstück um ein voreingestelltes Bewegungsausmaß bewegt wird,
dadurch gekennzeichnet, dass die Nähmaschine (1) ferner einen Datenspeicher (74) umfasst, der Nähmusterdaten speichert, in welchen ein Oberfadenziehausmaß eingestellt ist, und dass
 der Oberfadenziehmechanismus (40) ferner einen an das Oberfadenziehglied (41) gekoppelten Oberfadenziehmotor (44) umfasst, um das Oberfadenziehglied (41) zu bewegen, wobei das Betriebssteuermittel (70) den Oberfadenziehmotor (44) auf Basis der Nähmusterdaten so steuert, dass das Oberfadenziehglied (41) um ein optional eingestelltes Ausmaß für

jeden Stich während der Nähoperation bewegt wird.

2. Nähmaschine (1) nach Anspruch 1, wobei das Betriebssteuermittel (70) den Oberfadenziehmotor (44) so steuert, dass - mit Bezug auf einen Fadenverbrauch in parallelen Abschnitten (L1, L5) von Augenknopflochstichen - ein Fadenverbrauch in einem unteren rechten Augenabschnitt (L2) der Augenknopflochstiche erhöht ist und ein Fadenverbrauch in einem unteren linken Augenabschnitt (L4) der Augenknopflochstiche vermindert ist. 5 10
3. Nähmaschine (1) nach Anspruch 1, wobei in den Nähmusterdaten die Anzahl von Antriebspulsen des Oberfadenziehmotors (44) und die Anzahl von Antriebspulsen des Nähgutbewegungsmotors (52, 53) für jeden Stich eingestellt ist. 15
4. Nähmaschine (1) nach Anspruch 1, wobei die Nähmaschine (1) ferner ein Dateneinstellmittel (75) umfasst, mit welchem in den Nähmusterdaten ein Oberfadenziehausmaß für jeden der Abschnitte, welche sind: parallele Abschnitte (L1, L5), ein unterer rechter Augenabschnitt (L2), ein oberer Augenabschnitt (L3) und ein unterer linker Augenabschnitt (L4) von Augenknopflochstichen, einstellbar ist. 20 25
5. Nähmaschine (1) nach Anspruch 4, wobei mit dem Dateneinstellmittel (75) das Oberfadenziehausmaß in den Nähmusterdaten mit Bezug auf die parallelen Abschnitte (L1, L5) und auf Basis einer Eingabe von Korrekturwerten für den unteren rechten Augenabschnitt (L2) und den unteren linken Augenabschnitt (L4) einstellbar ist. 30 35
6. Nähmaschine (1) nach Anspruch 1, wobei der Oberfadenziehmechanismus (40) ferner eine Gelenkstange (47) umfasst, welche das Oberfadenziehglied (41) und den Oberfadenziehmotor (44) koppelt, wobei die Fadenspannungsvorrichtung (35) umfasst: ein Paar von Fadenspannungsscheiben (36, 37), ein Fadenspannungssolenoid (38) und eine Transmissionsstange (39), welche eine Druckkraft des Fadenspannungssolenoids (38) auf das Paar von Fadenspannungsscheiben (36, 37) überträgt, und wobei 40 45
in einer Richtung von einem vertikalen Ständerbereich (2b) der Nähmaschine (1) zu der Nadelstange (12) hin die Fadenspannungsscheiben (36, 37) und das Oberfadenziehglied (41) näher zu der Nadelstange (12) als zu dem Fadenspannungssolenoid und dem Oberfadenziehmotor (44) angeordnet sind. 50

Revendications

1. Machine à coudre (1) comprenant :

un mécanisme de mouvement haut-bas de l'aiguille qui déplace une barre à aiguille (12) vers le haut et vers le bas, dans lequel la barre à aiguille (12) maintient une aiguille (11) ;
une barre de prise de fil (14) qui va et vient en synchronisation avec les mouvements vers le haut et vers le bas de la barre à aiguille (12), afin de tirer vers le haut un fil supérieur depuis l'aiguille (11) ou pour faire sortir le fil supérieur d'une source d'alimentation du fil ;
un dispositif de tension de fil (35) qui provoque une tension sur le fil supérieur depuis la source d'alimentation en fil ;
un mécanisme de traction de fil supérieur (40) comprenant un élément de traction de fil supérieur (41) qui peut être actionné pour se mettre en prise avec le fil supérieur, positionné sur un chemin de fil supérieur entre le dispositif de tension de fil (35) et la barre de prise dudit fil (14) et pour se déplacer dans une direction croisant le chemin de fil supérieur ;
un mécanisme d'alimentation de tissu (50) qui déplace une pièce à travailler en utilisant un moteur de déplacement de tissu (52, 53), en synchronisation avec les mouvements vers le haut et vers le bas de la barre à aiguille (12) et sur une distance de déplacement éventuelle, le long d'un plan croisant la barre à aiguille (12) ; et
un système de contrôle du fonctionnement (70) qui contrôle le moteur de déplacement de tissu (52, 53) pendant une opération de couture, de sorte que la pièce à travailler soit déplacée sur une distance de déplacement préétablie,
caractérisé en ce que la machine à coudre (1) comprend en outre une mémoire de données (74) qui stocke des données de modèle de couture, dans lesquelles une distance de traction de fil supérieur est établie et
le mécanisme de traction de fil supérieur (40) comprend en outre un moteur de traction de fil supérieur (44) raccordé à l'élément de traction de fil supérieur (41), de façon à déplacer l'élément de traction de fil supérieur (41),
dans laquelle le système de contrôle du fonctionnement (70) contrôle le moteur de traction de fil supérieur (44) sur la base des données de modèle de couture, de sorte que l'élément de traction de fil supérieur (41) soit déplacé sur une distance éventuellement établie pour chaque point pendant l'opération de couture.

2. Machine à coudre (1) selon la revendication 1, dans laquelle le système de contrôle du fonctionnement (70) contrôle le moteur de traction du fil supérieur (44), de sorte qu'en se référant à une consommation de fil dans des sections parallèles (L1, L5) de points de boutonnière à oeillet, une consommation de fil dans une section inférieure droite d'oeillet (L2) des

points de boutonnière à oeillet est accrue et une consommation de fil dans une section inférieure gauche d'oeillet (L4) des points de boutonnière à oeillet est réduite.

5

3. Machine à coudre (1) selon la revendication 1, dans laquelle, dans les données de modèle de couture, le nombre d'impulsions de commande du moteur de traction de fil supérieur (44) et le nombre d'impulsions de commande du moteur de déplacement de tissu (52, 53) sont établis pour chaque point. 10

4. Machine à coudre (1) selon la revendication 1, dans laquelle la machine à coudre (1) comprend en outre un système de paramétrage de données (75) qui peut être actionné pour établir, dans les données de modèle de couture, une distance de traction de fil supérieur pour chacune des sections parallèles (L1, L5), une section inférieure droite d'oeillet (L2), une section supérieure d'oeillet (L3), et une section inférieure gauche d'oeillet (L4) des points de boutonnière à oeillet. 15 20

5. Machine à coudre (1) selon la revendication 4, dans lequel le système de paramétrage des données (75) peut être actionné pour établir la distance de traction de fil supérieur dans les données de modèle de couture, en se référant aux sections parallèles (L1, L5) et sur la base d'une entrée de valeurs de correction pour la section inférieure droite d'oeillet (L2) et la section inférieure gauche d'oeillet (L4). 25 30

6. Machine à coudre (1) selon la revendication 1, dans laquelle le mécanisme de traction de fil supérieur (40) comprend en outre une tige jointe (47) qui raccorde l'élément de traction de fil supérieur (41) et le moteur de traction de fil supérieur (44), le dispositif de tension de fil (35) comprend une paire de disques de tension de fil (36, 37) ; une solénoïde de tension de fil (38) et une tige de transmission (39) qui transmet la poussée de la solénoïde de tension de fil (38) à la paire de disques de tension de fil (36, 37) et 35 40
dans une direction depuis une position de tambour verticale (2b) de la machine à coudre (1) vers la barre d'aiguille (12), les disques de tension de fil (36, 37) et l'élément de traction de fil supérieur (41) sont disposés plus près de la barre d'aiguille (12) que par rapport à la solénoïde de tension de fil et au moteur de traction de fil supérieur (44). 45 50

55

FIG. 1

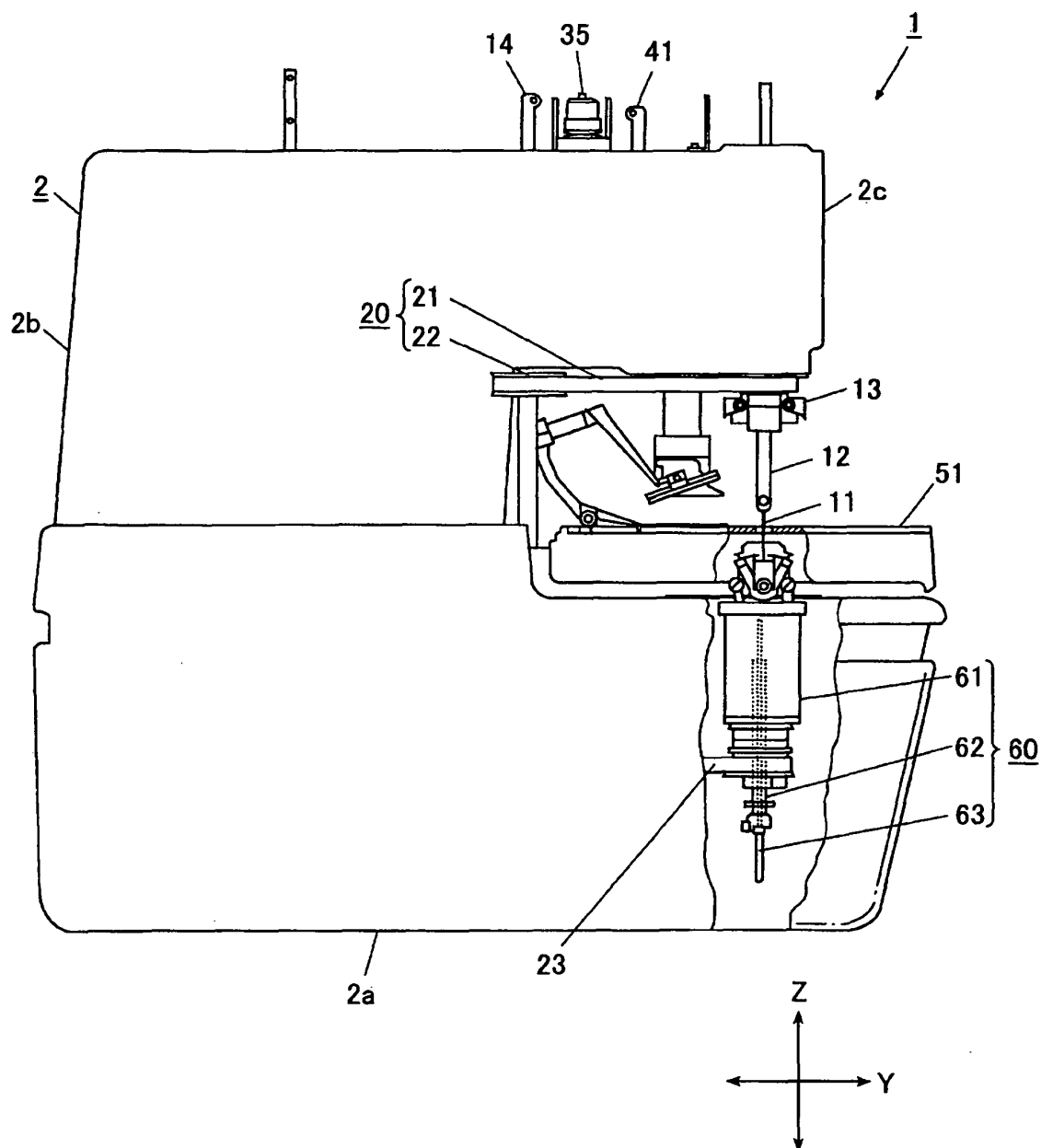


FIG. 2

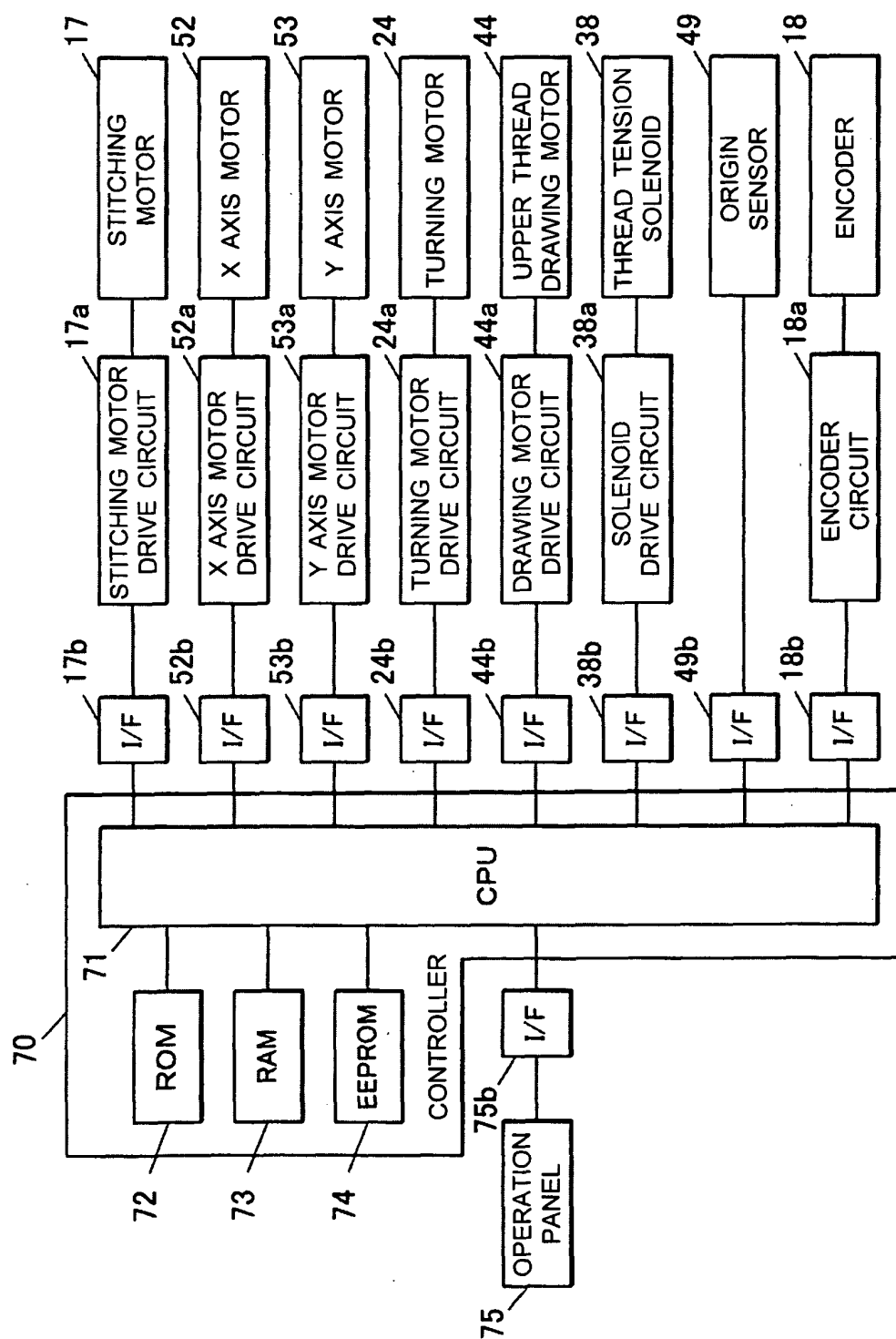


FIG. 3

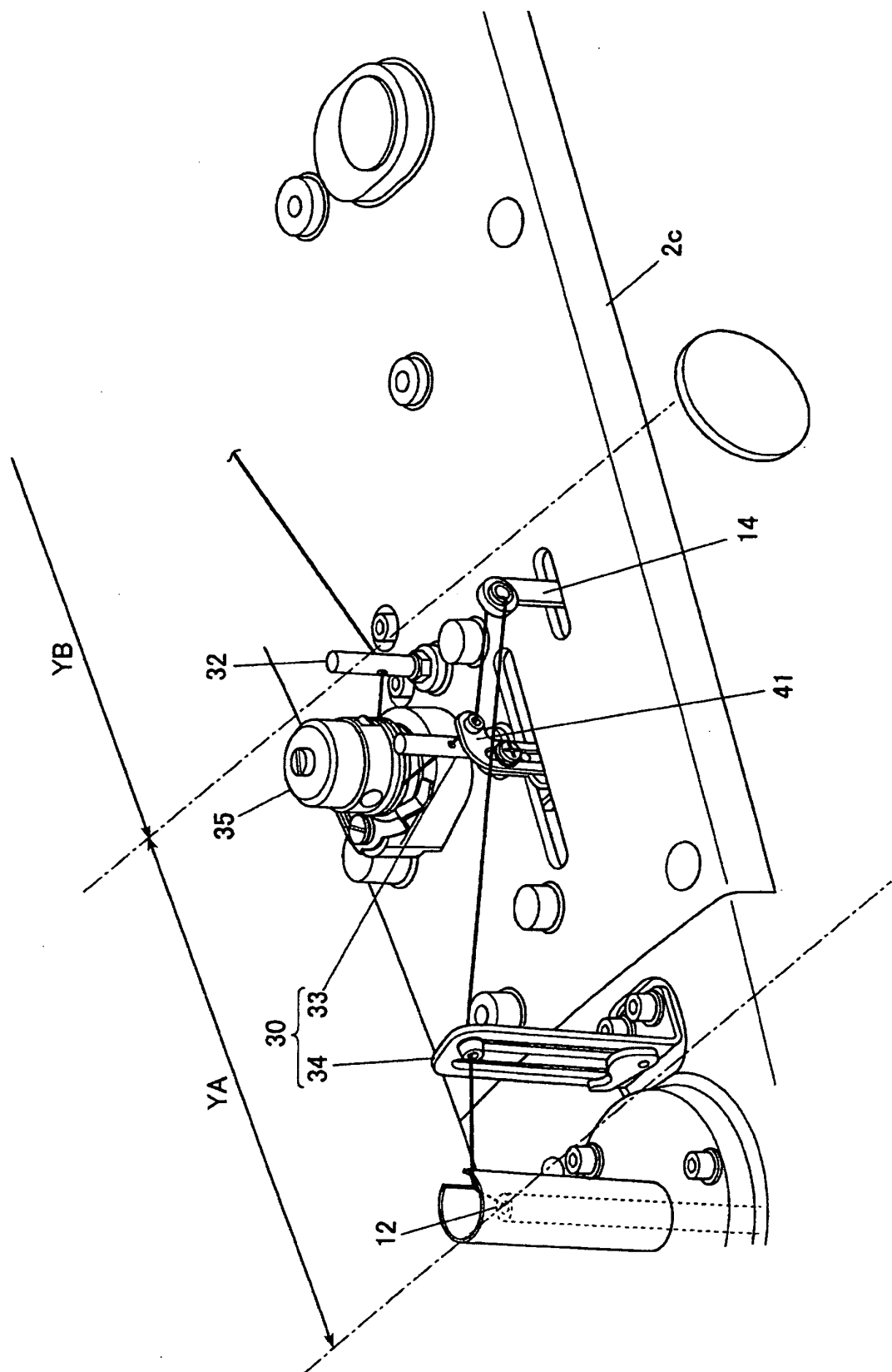


FIG. 4

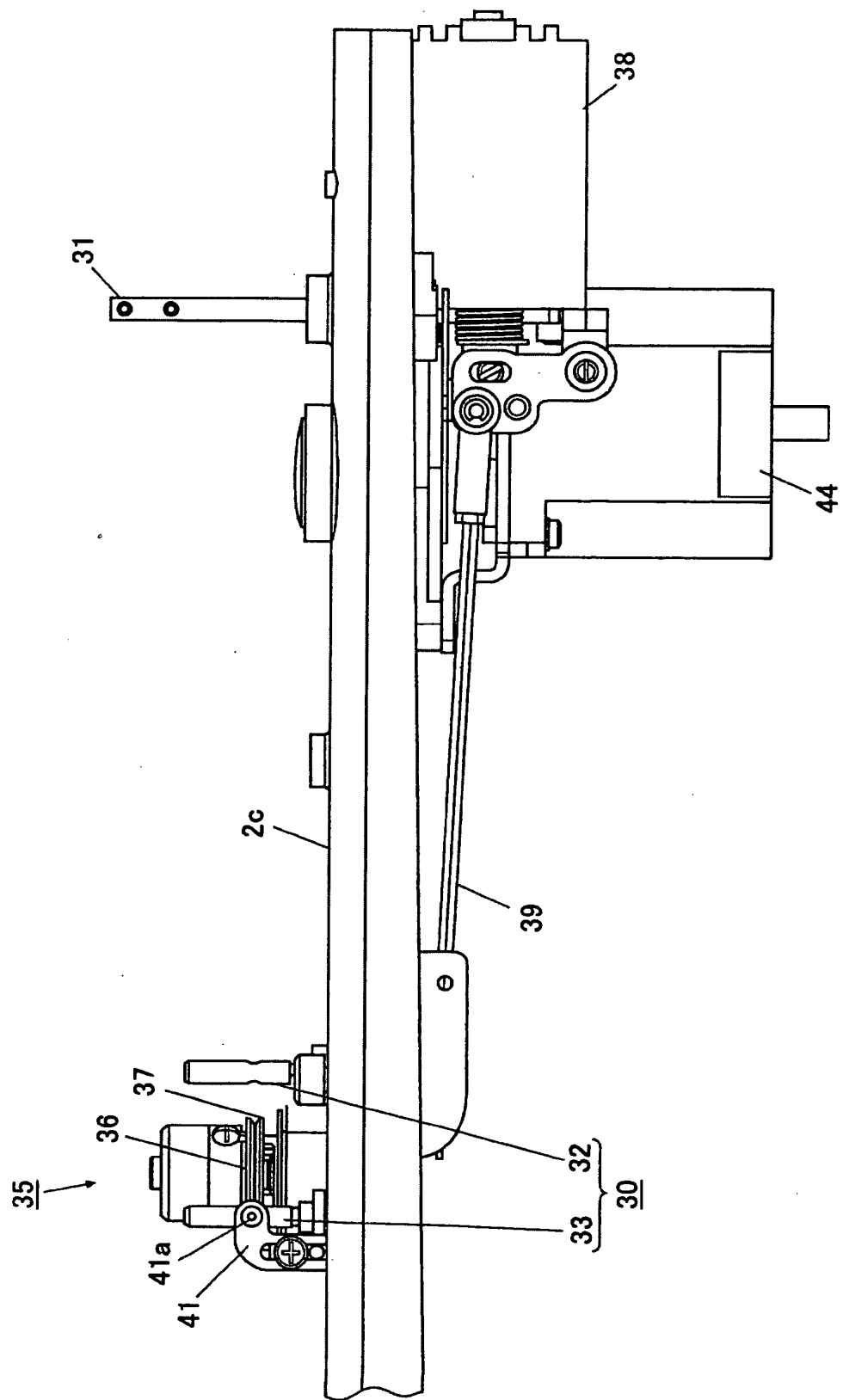


FIG. 5

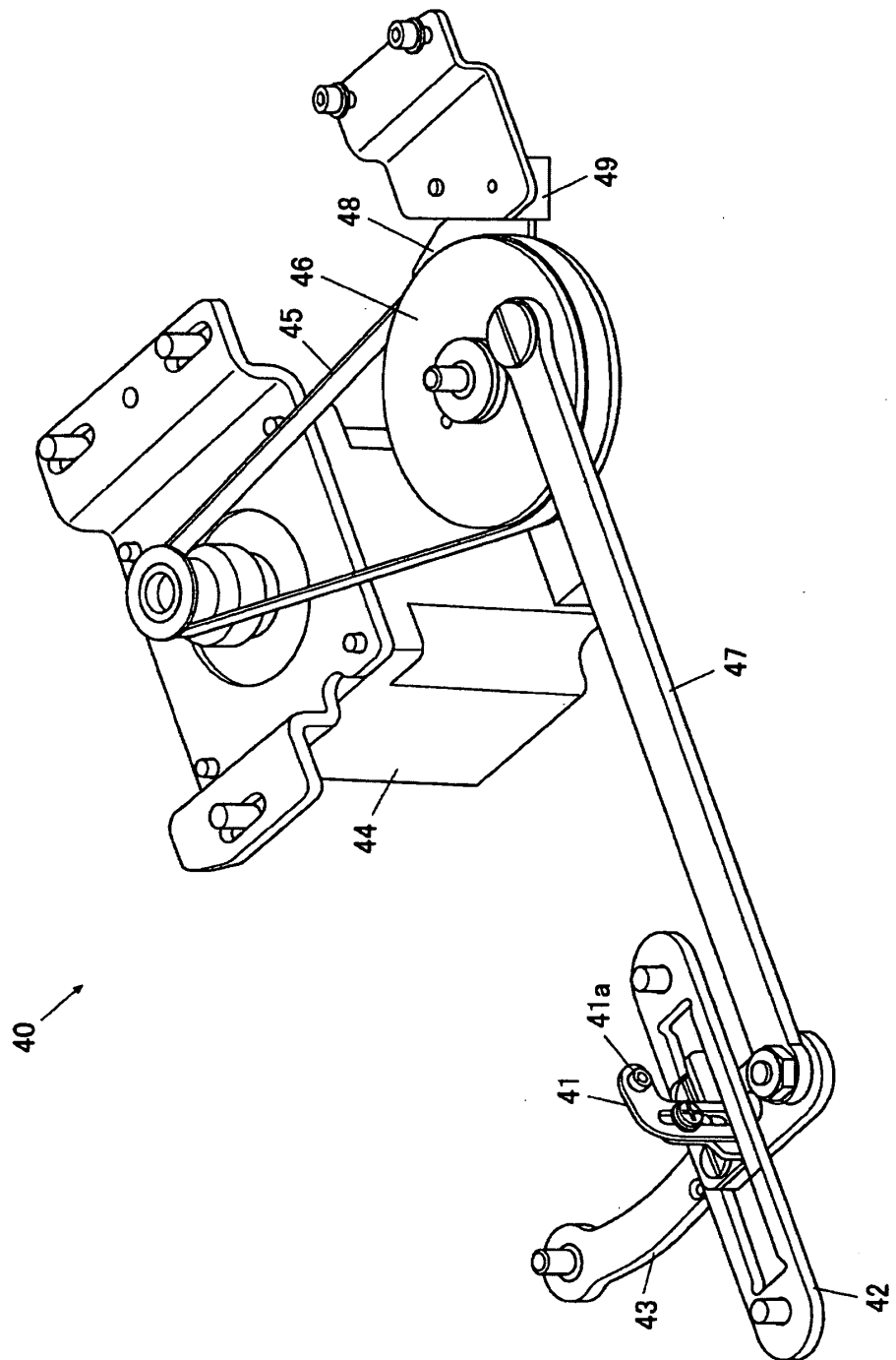


FIG. 6

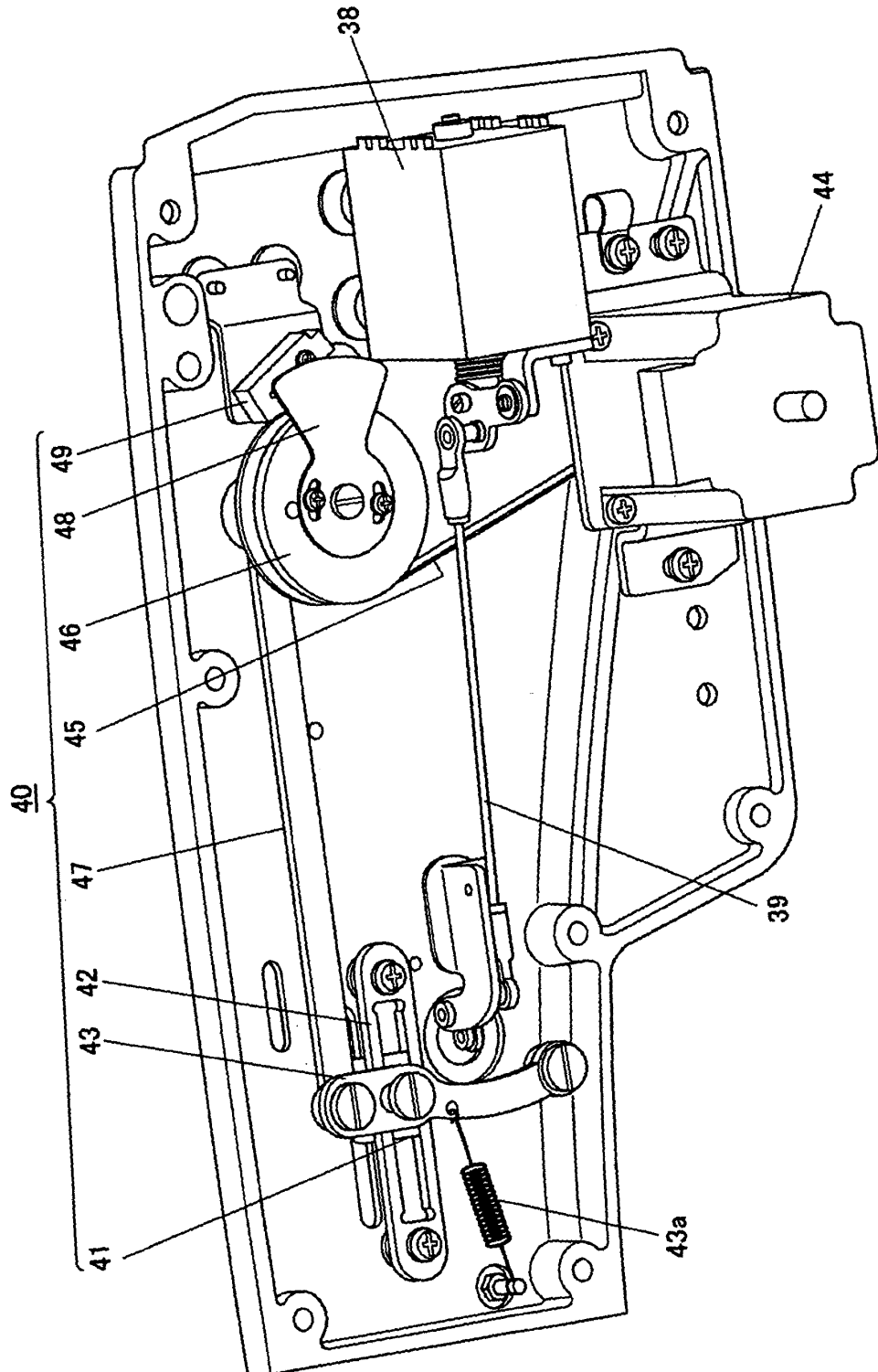


FIG. 7

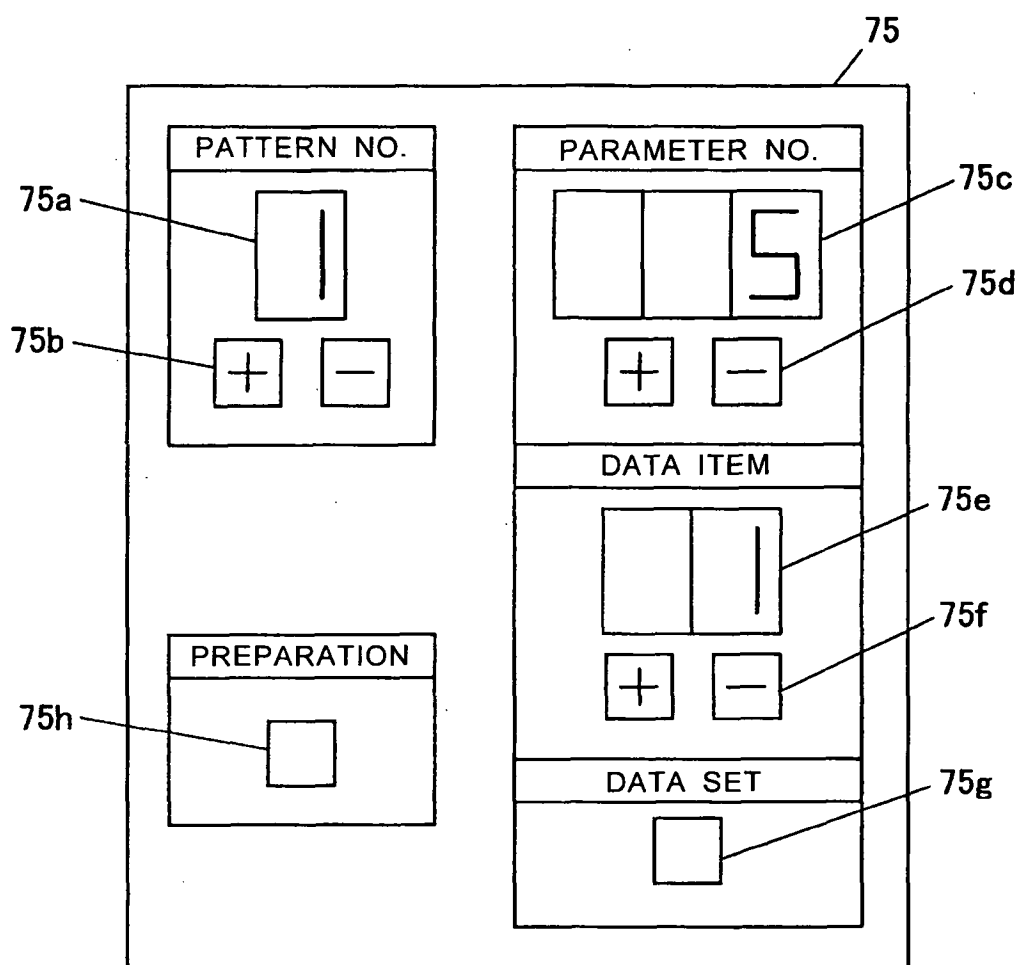


FIG. 8

No.	Data Item	Data Content
1	Eyelet Form	0: Closed-Eye, 1-5: Eyelet
2	Stitching Length	Entire Stitching Length
3	Number of Parallel Section Stitches	Total Number of Stitches in Parallel Section and Eyelet Lower Section on Right/Left Side
4	Number of Eyelet Stitches	Number of Stitches in Eyelet Upper Section or in Closed-Eye Section
5	Tacking Type	0: None, 1: Taper Bar Tack, 2: Straight Bar Tack, 3: Round Bar Tack
6	Eyelet Right Lower Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Right Lower Section
7	Eyelet Upper Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Upper Section or in Closed-Eye Section
8	Eyelet Left Lower Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Left Lower Section
9	Right Taper Bar Tack Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Right Taper Bar Tack Section
10	Left Taper Bar Tack Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Left Taper Bar Tack Section
11	:	:

FIG. 9

No.	Data Item	Data Content
1	Eyelet Form	0: Closed-Eye, 1-5: Eyelet
2	Stitching Length	Entire Stitching Length
3	Number of Parallel Section Stitches	Total Number of Stitches in Parallel Section and Eyelet Lower Section on Right/Left Side
4	Number of Eyelet Stitches	Number of Stitches in Eyelet Upper Section or in Closed-Eye Section
5	Tacking Type	0: None, 1: Taper Bar Tack, 2: Straight Bar Tack, 3: Round Bar Tack
6	Upper Thread Drawing Correction	0: None, 1-10
7	:	:

FIG. 10

SECTION	STITCH NO.	FEED BASE X-Y COORDS (0.1 mm)		TURN POS (1°)	STITCH POINT		DISTANCE TO STITCH POINT		INNER-OUTER CHANGE	FEED BASE X-Y MOV (PULSE NUM)		TURN MOV (PULSE NUM)	DRAWING AMOUNT A (PULSE NUM)	DRAWING AMOUNT B (PULSE NUM)
		X	Y		X	Y	ΔX	ΔY		X	Y			
PARALLEL	1	0.3	46.0	0	0.3	46.0						Z	H	
	2	0.3	47.2	0	2.8	47.2	2.5	1.1	2.7	0.0	0	11	0	0
	3	0.3	47.2	0	0.3	47.2	-2.5	0.0	2.5		0	0	0	0
	4	0.3	48.3	0	2.8	48.3	2.5	1.1	2.7	0.0	0	11	0	0
RIGHT PARALLEL	23	0.3	58.1	0	0.3	58.1	-2.5	0.0	2.5		0	0	0	0
	24	0.3	59.2	0	2.8	59.2	2.5	1.1	2.7	0.0	0	11	0	0
	25	0.3	59.2	0	0.3	59.2	-2.5	0.0	2.5		0	0	0	0
	26	0.7	60.3	0	3.2	60.3	2.9	1.1	3.1	-0.4	4	11	0	-4
L-RIGHT	27	0.7	60.3	0	0.7	60.3	-2.5	0.0	2.5		0	0	0	0
	28	1.4	61.4	0	3.9	61.4	3.2	1.1	3.4	-0.7	7	11	0	-7
	29	1.4	61.4	0	1.4	61.4	-2.5	0.0	2.5		0	0	0	0
	30	1.8	62.6	0	4.3	62.6	2.9	1.2	3.1	-0.4	4	12	0	-4
UPPER	31	1.8	62.6	9	1.8	62.6	-2.5	0.0	2.5		0	0	9	0
	32	1.8	63.1	18	4.2	63.1	2.4	1.3	2.7	0.0	0	5	9	0
	33	1.8	63.1	27	1.8	63.1	-2.4	-0.8	2.5		0	0	9	0
	34	1.5	63.6	36	2.5	63.1	1.7	2.0	2.6	0.1	3	5	9	1
EYELET UPPER	49	-1.8	63.1	171	-1.8	63.1	2.4	-0.8	2.5		0	0	9	0
	50	-1.8	62.6	180	-4.3	62.6	-2.5	-0.5	2.6	0.2	0	-5	9	1
	51	-1.8	62.6	180	-1.8	62.6	2.5	0.0	2.5		0	0	0	0
	52	-1.4	61.4	180	-3.9	61.4	-2.1	-1.2	2.4	0.3	4	-12	0	5
L-LEFT	53	-1.4	61.4	180	-1.4	61.4	2.5	0.0	2.5		0	0	0	0
	54	-0.7	60.3	180	-3.2	60.3	-1.8	-1.1	2.1	0.6	7	-11	0	5
	55	-0.7	60.3	180	-0.7	60.3	2.5	0.0	2.5		0	0	0	0
	56	-0.3	59.2	180	-2.8	59.2	-2.1	-1.1	2.4	0.4	4	-11	0	5
PARALLEL	57	-0.3	59.2	180	-0.3	59.2	2.5	0.0	2.5		0	0	0	0
	58	-0.3	58.1	180	-2.8	58.1	-2.5	-1.1	2.7	0.0	0	-11	0	0
	59	-0.3	58.1	180	-0.3	58.1	2.5	0.0	2.5		0	0	0	0
	60	-0.3	57.0	180	-2.8	57.0	-2.5	-1.1	2.7	0.0	0	-11	0	0
LEFT PARALLEL	79	-0.3	47.2	180	-0.3	47.2	2.5	0.0	2.5		0	0	0	0
	80	-0.3	46.0	180	-2.8	46.0	-2.5	-1.1	2.7	0.0	0	-11	0	0

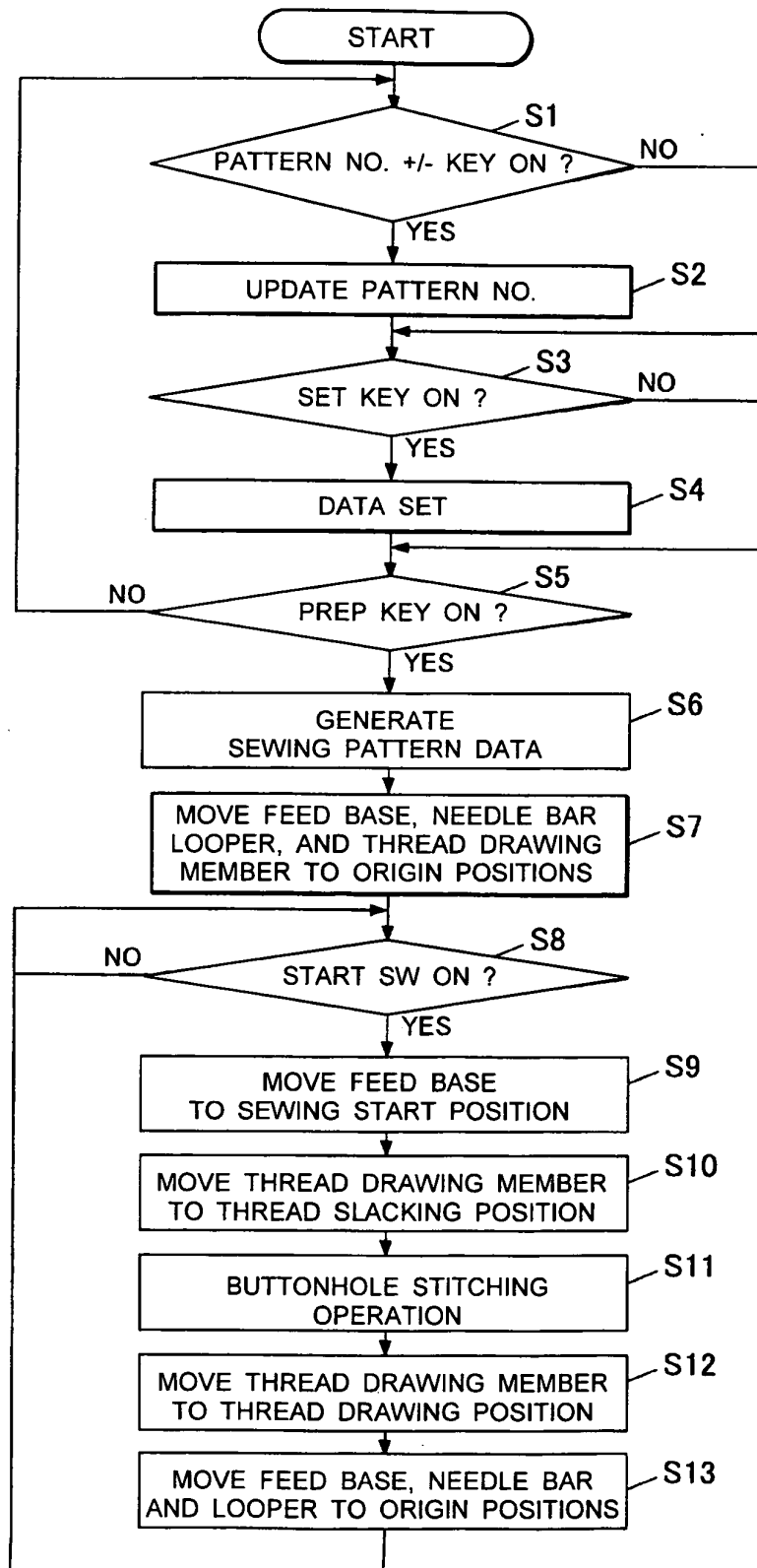
FIG. 11

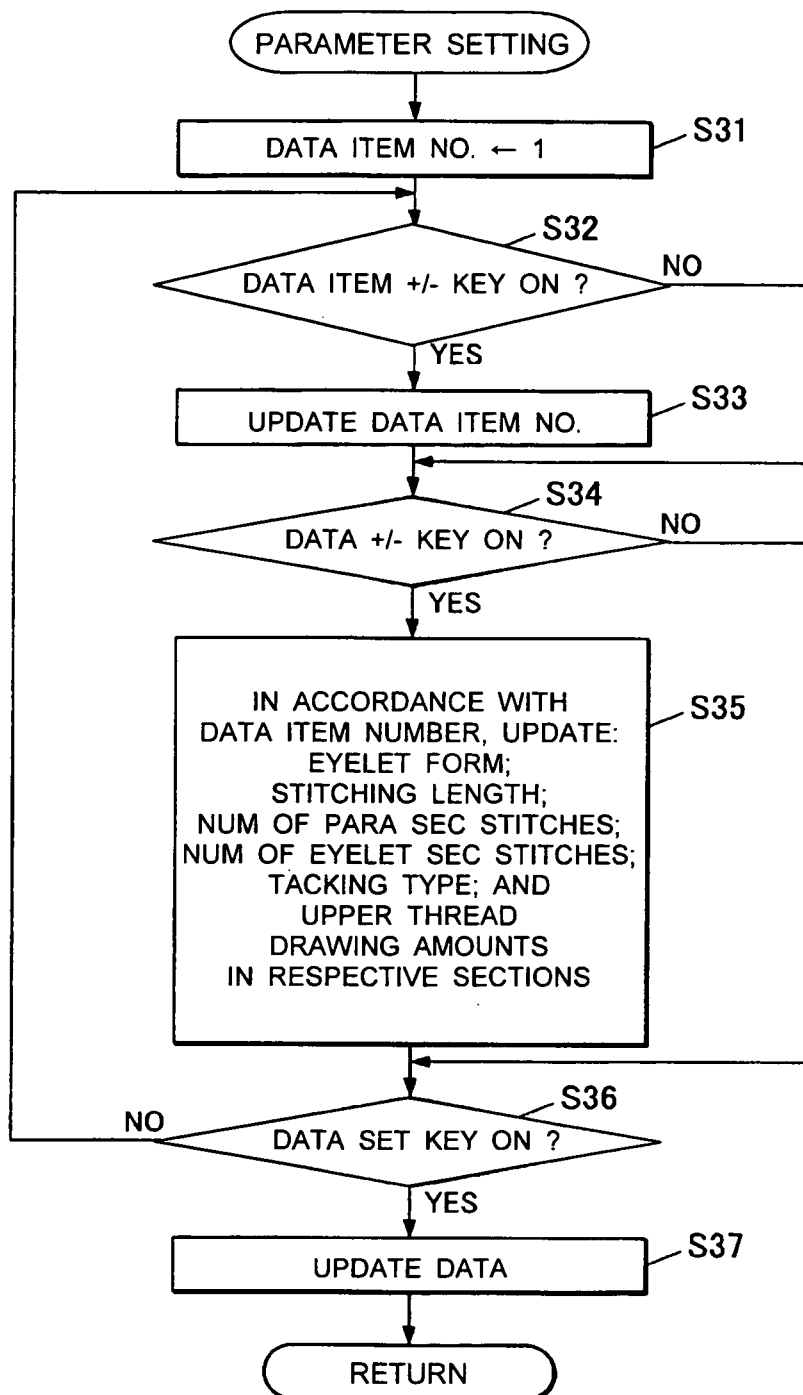
FIG. 12

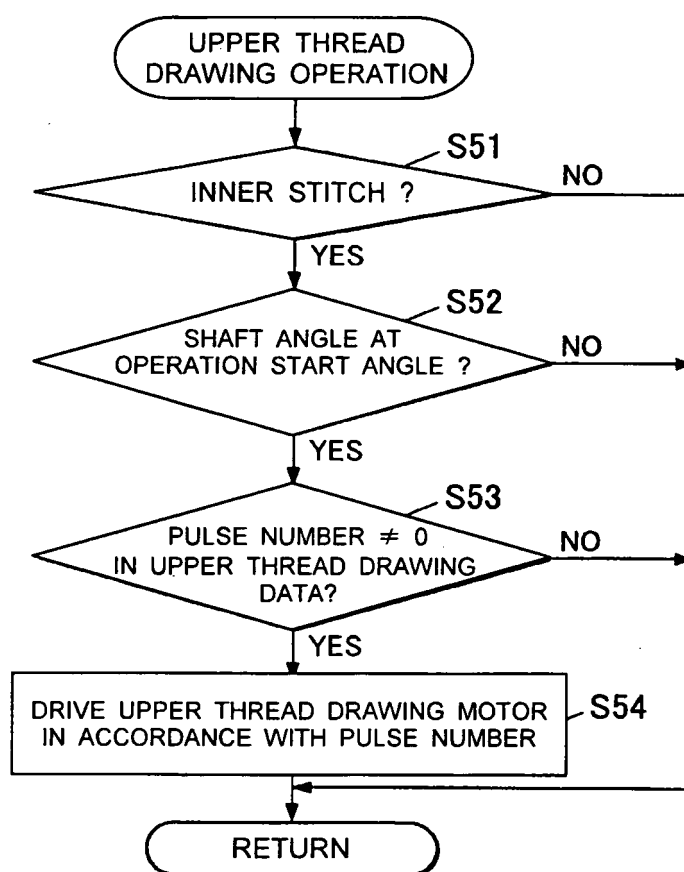
FIG. 13

FIG. 14

No.	Data Item	Data Content
1	Eyelet Form	0: Closed-Eye, 1-5: Eyelet
2	Stitching Length	Entire Stitching Length
3	Number of Parallel Section Stitches	Total Number of Stitches in Parallel Section and Eyelet Lower Section on Right/Left Side
4	Number of Eyelet Stitches	Number of Stitches in Eyelet Upper Section or in Closed-Eye Section
5	Tacking Type	0: None, 1: Taper Bar Tack, 2: Straight Bar Tack, 3: Round Bar Tack
6	Upper Thread Drawing Correction	0: None, 1-10
7	Eyelet Right Lower Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Right Lower Section
8	Eyelet Upper Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Upper Section or in Closed-Eye Section
9	Eyelet Left Lower Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Eyelet Left Lower Section
10	Right Taper Bar Tack Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Right Taper Bar Tack Section
11	Left Taper Bar Tack Section - Upper Thread Drawing Amount	Upper Thread Drawing Amount in Left Taper Bar Tack Section
12	:	:

FIG. 15

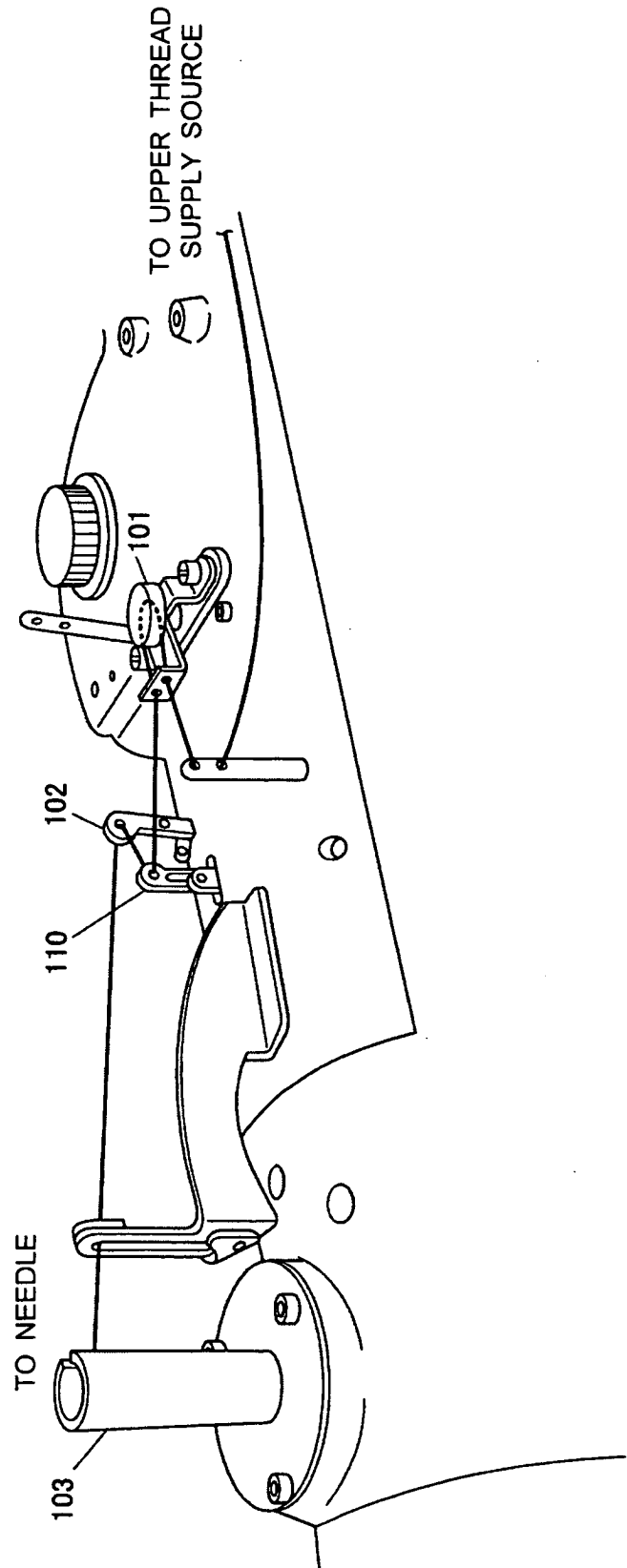


FIG. 16A

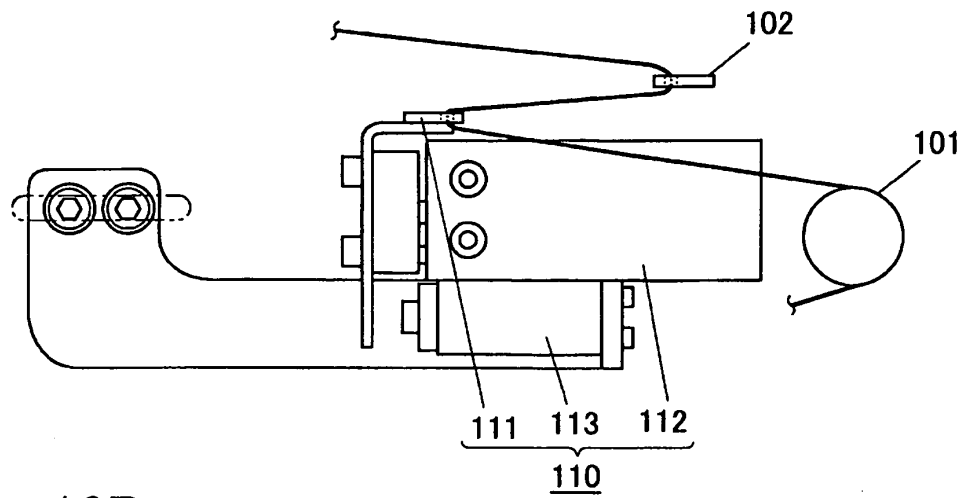


FIG. 16B

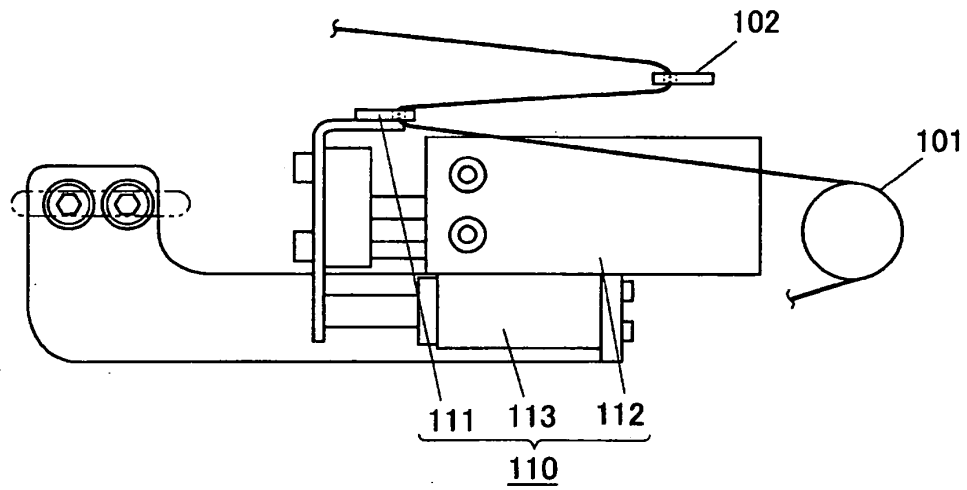


FIG. 16C

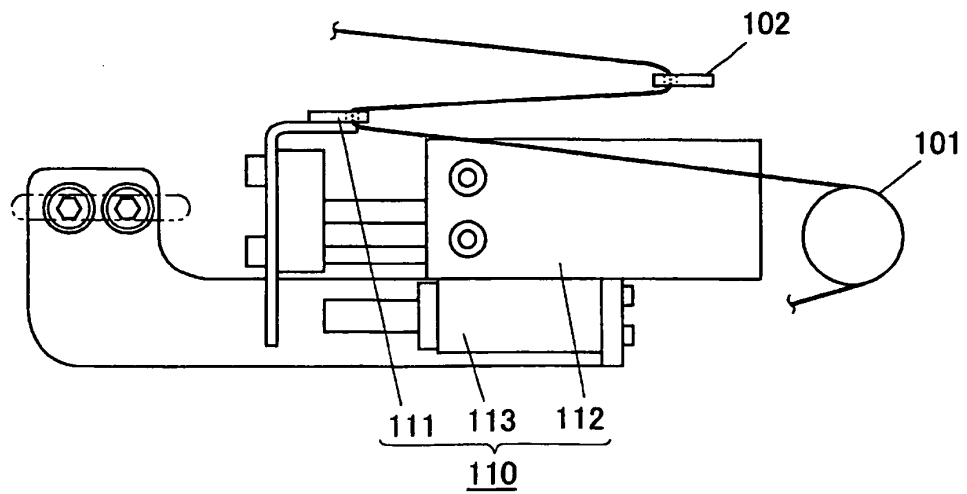


FIG. 17

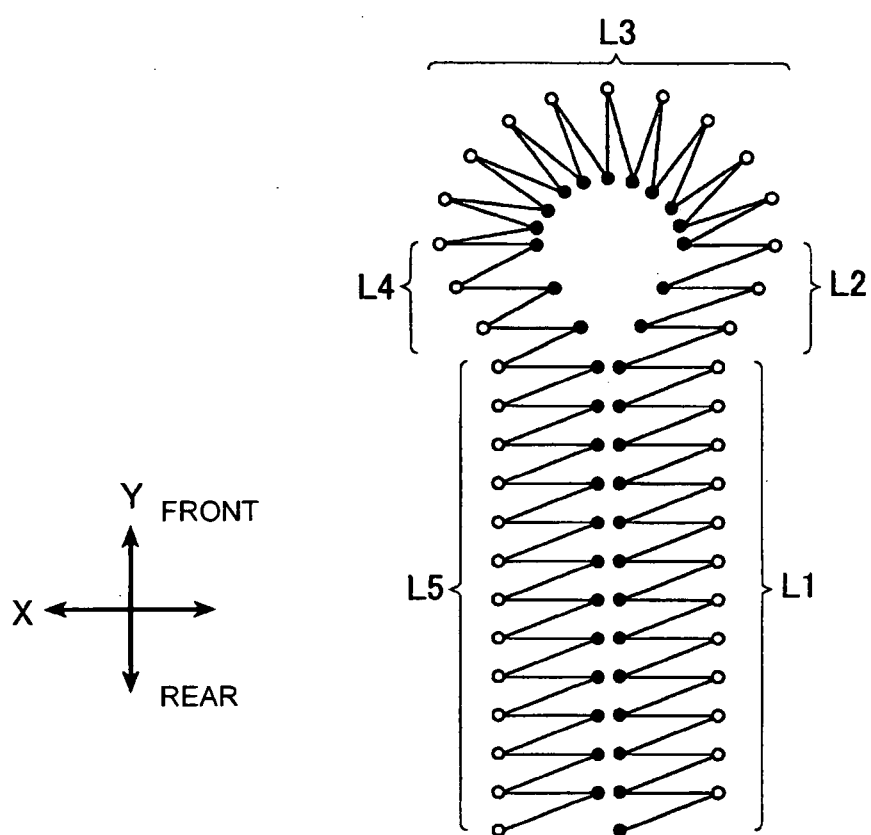


FIG. 18

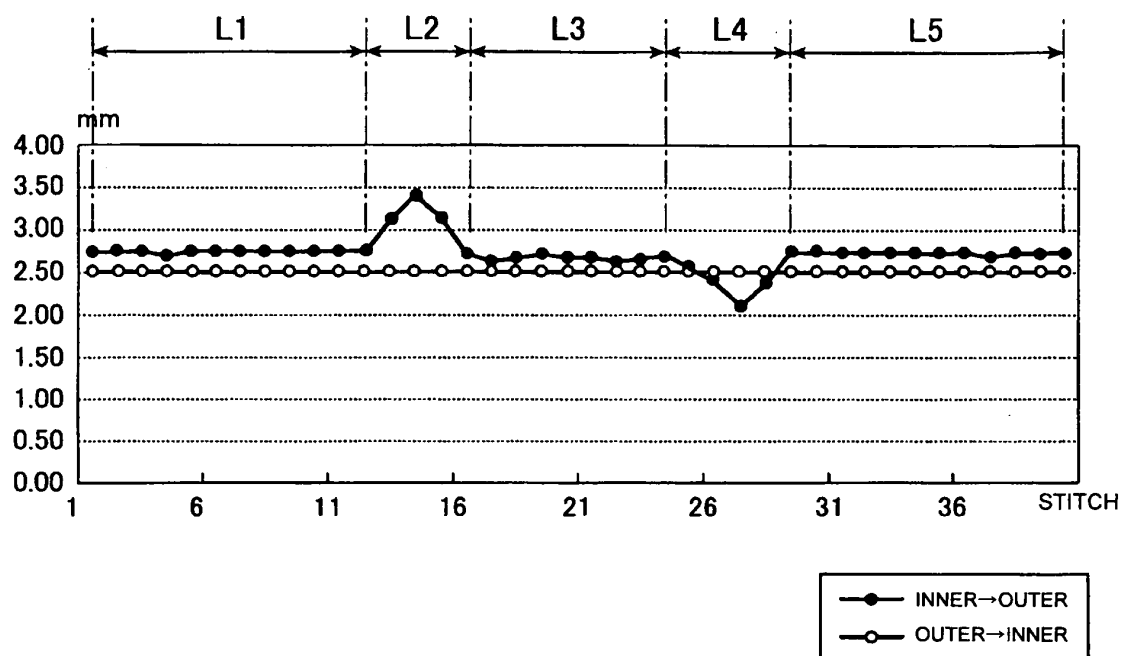


FIG. 19A

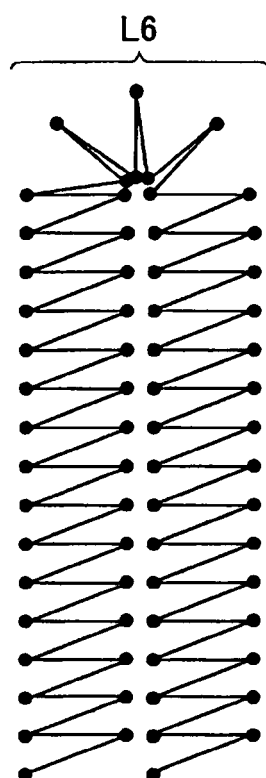


FIG. 19B

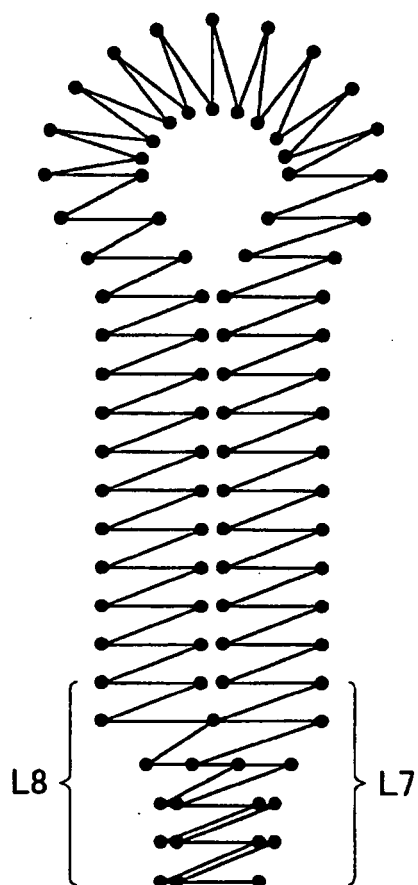


FIG. 20A

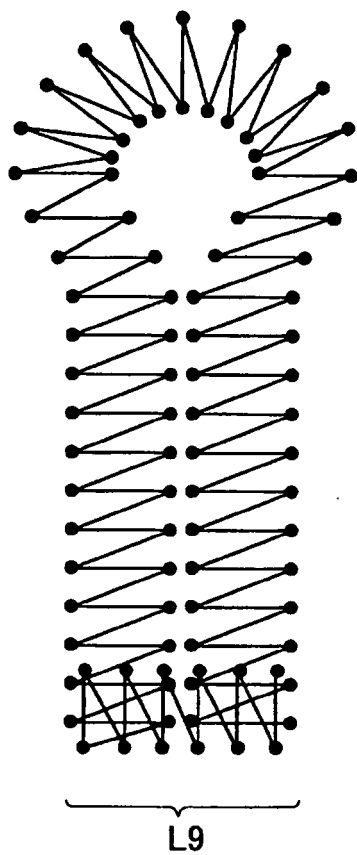
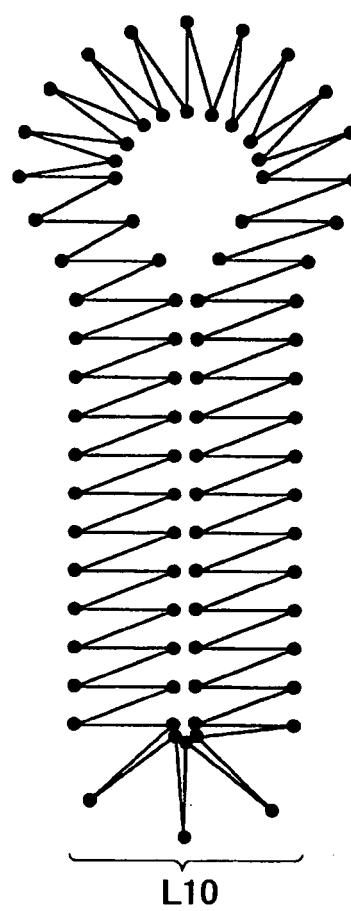


FIG. 20B



REFERENCES CITED IN THE DESCRIPTION

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