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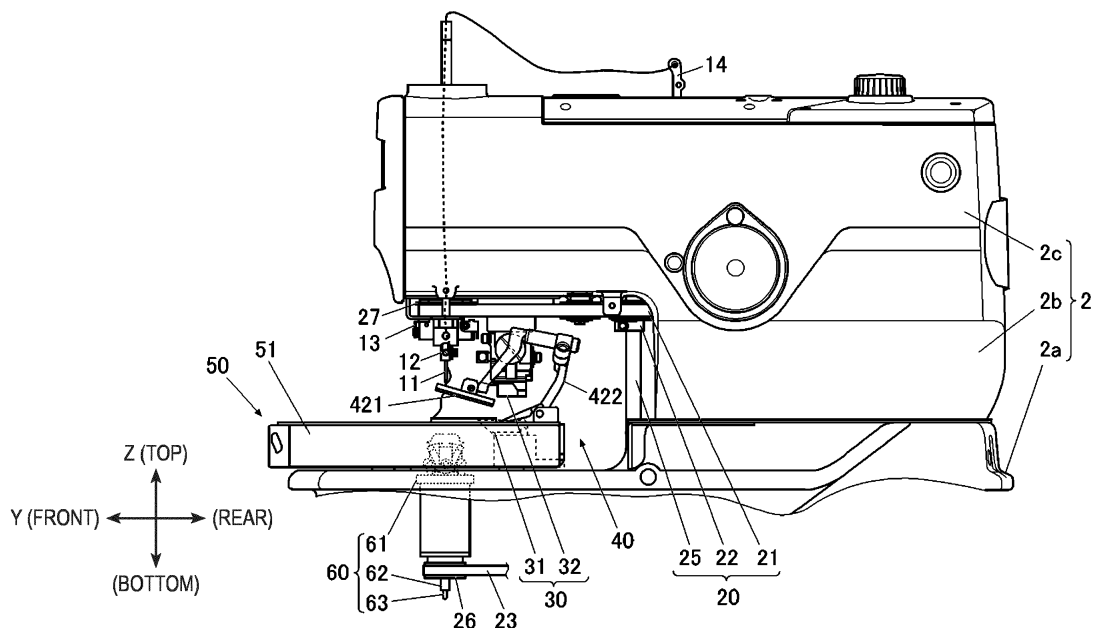
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(54) **BUTTONHOLING SEWING MACHINE**

(57) A buttonholing sewing machine (1) in which a buttonholing sewing control is performed for formation of buttonholing seam. In performing a buttonholing sewing control, a control device (70) causes formation of a double buttonholing seam around a buttonhole and causes a knife mechanism (30) to form a buttonhole before formation of a second buttonholing seam and performs an

opening width varying control of controlling a press mechanism (40) so that it makes the buttonhole opening width larger in forming the second buttonholing seam than in forming a first buttonholing seam. The thus-configured buttonholing sewing machine (1) can form a double buttonholing seam satisfactorily.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a buttonholing sewing machine.

BACKGROUND ART

[0002] Electronic buttonholing sewing machines are known which are to form an eyelet holing seam consisting of a straight portion and an eyelet hole portion in a sewing object that is set on a feed stage, and perform eyelet holing sewing through cooperation among a machine motor drive mechanism for driving a needle bar to which a needle is attached and a looper/spreader that is disposed under the needle bar, a turning mechanism for turning the needle bar and the looper/spreader to form stitches radially, an XY drive mechanism for driving the feed stage in the front-rear direction and the left-right direction, a press mechanism for pressing the sewing object on the feed stage from the left side and the right side, and other things. Also provided is a core thread supply mechanism for sewing a core thread into a holing seam to increase its volume (refer to JP-A-2013-252159).

[0003] In such electronic buttonholing sewing machines, an eyelet hole can be formed in a sewing object using a cloth-cutting mechanism and selection can be made between an advance cutting method in which a cloth-cutting knife operates before sewing and a post-cutting method in which the cloth-cutting knife operates after sewing.

[0004] Buttonholing sewing machines of another type are known in which sewing is done two times repeatedly using a sewing pattern for formation of one seam (refer to JP-A-11-333164).

[0005] In buttonholing sewing machines of still another type, a buttonholing seam is formed using an ordinary sewing pattern after reinforcement sewing was performed on left and right parallel sewing portions with a needle swing width that is smaller than usual (refer to JP-A-2009-006196).

[0006] In eyelet holing sewing machines of the above type, a sewing object is pressed by cloth pressers from the left side and the right side and stitches are formed between the left and right pressers. Therefore, to suppress a flutter of a cloth, stitches are formed while cloth opening is performed in which the cloth is pulled by the left and right cloth pressers so as to be expanded in the left-right direction.

[0007] In eyelet holing sewing machines of the above type, as mentioned above, selection can be made between the advance cutting method and the post-cutting method. In the post-cutting method, since stitches are formed in a cloth in which a buttonhole is not formed yet, it has an advantage that the stitches formed are not distorted. However, the needle needs to be dropped at po-

sitions that are distant from a buttonhole so that sewing threads will not be cut by a knife and it is difficult to hide portions, around the button hole, of the cloth behind the stitches.

[0008] In contrast, the advance cutting method is effective in a case that high quality sewing performance is demanded because cutting of sewing threads can be prevented and portions, around a buttonhole, of a cloth can be hidden behind stitches. However, in the advance cutting method, if the interval between parallel sets of stitches on the left side and the right side of a buttonhole is set small to increase the quality of sewing performance, the needle may be dropped in the adjacent parallel sewing section beyond the buttonhole to close the buttonhole. For this reason, in advance cutting type sewing, after formation of a buttonhole, stitches are formed while cloth opening is done in which a cloth is pulled by the left and right cloth pressers so as to be expanded in the left-right direction.

[0009] For eyelet holing sewing machines of the above type, it is being studied to increase the volume of stitches by performing double (i.e., superimposed) sewing as disclosed in Patent documents 2 and 3 instead of using a core thread.

[0010] Where double (i.e., superimposed) sewing is applied to an eyelet holing sewing machine, when sewing is performed in a state that a cloth is opened by the advance cutting method, stitches can be formed properly in first sewing because of cloth opening. However, when stitches are formed in second sewing, a problem arises that since the cloth has already been opened fully in the first sewing, the effect of the cloth opening and hence the effect of preventing the needle from being dropped in the adjacent sewing section beyond the buttonhole is insufficient.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide a buttonholing sewing machine capable of forming a good buttonholing seam at the time of superimposed sewing. The invention provides the following features that are set forth in the form of items (1)-(6):

(1) A buttonholing sewing machine having:

- a needle vertical movement mechanism which moves a needle bar vertically while swinging it;
- a looper mechanism provided with a looper, a spreader, and a looper base which supports the looper and the spreader;
- a turning mechanism which turns the needle bar and the looper base;
- a feed mechanism which moves a sewing object across a placement surface that is mounted with the sewing object;
- a knife mechanism which forms a buttonhole in the sewing object;

a press mechanism which can operate so as to widen the buttonhole of the sewing object while pressing the sewing object; and

a control device which performs a buttonholing sewing control for formation of a buttonholing seam around the buttonhole, characterized in that in performing the buttonholing sewing control,

the control device causes formation of a double buttonholing seam around a buttonhole and causes the knife mechanism to form the buttonhole before formation of a second buttonholing seam; and

the control device performs an opening width varying control of controlling the press mechanism so that it makes an opening width of the buttonhole larger in forming the second buttonholing seam than in forming a first buttonholing seam.

(2) The buttonholing sewing machine according to item (1), characterized in that in performing the buttonholing sewing control, the control device controls the knife mechanism so that it forms the buttonhole after formation of the first buttonholing seam and before formation of the second buttonholing seam.

(3) The buttonholing sewing machine according to item (1) or (2), characterized in:

that the buttonholing sewing machine further comprises an execution setting unit which sets whether the opening width varying control should be performed or not;

that if execution of the opening width varying control is set, the control device performs the opening width varying control in performing the buttonholing sewing control; and

that if execution of the opening width varying control is not set, the control device controls the press mechanism so that it maintains a constant opening width both during formation of the first buttonholing seam and during formation of the second buttonholing seam.

(4) The buttonholing sewing machine according to any one of items (1) to (3), characterized in:

that the buttonholing sewing machine further comprises:

a data storage unit which stores plural kinds of sewing pattern data for formation of a buttonholing seam; and

a data selection unit which selects sewing pattern data for formation of the first buttonholing seam and sewing pattern data for formation of the second buttonholing seam from the plural kinds of sewing pattern data

stored in the data storage unit; and

that in performing the buttonholing sewing control, the control device causes formation of the double buttonholing seam on the basis of the two kinds of sewing pattern data selected by the data selection unit.

(5) The buttonholing sewing machine according to any one of items (1) to (4), characterized in that the press mechanism varies the opening width in a direction of widening the buttonhole in the sewing object by a combination of operations of plural air cylinders.

(6) The buttonholing sewing machine according to any one of items (1) to (4), characterized in that the press mechanism varies the opening width in a direction of widening the buttonhole in the sewing object by varying an air supply rate of an air cylinder.

[Advantages of the invention]

[0012] In the buttonholing sewing machine according to the invention, in performing a buttonholing sewing control, the control device causes formation of a double buttonholing seam and performs the opening width varying control of controlling the press mechanism so that it makes an opening width of the buttonhole larger in forming a second buttonholing seam than in forming a first buttonholing seam.

[0013] Where a double buttonholing seam is formed in such a manner that a constant opening width is set in forming first and second buttonholing seams, the second buttonholing seam cannot be formed satisfactorily because at this time the buttonhole in a sewing object has already been opened fully. In contrast, where the opening width varying control is performed, since a buttonhole in a sewing object can be opened more in forming a second buttonholing seam than in forming a first buttonholing seam, the second buttonholing seam can also be formed satisfactorily. Furthermore, the opening width varying control makes it possible to suppress fluttering of the sewing object more properly also in forming the second buttonholing seam and to thereby increase the sewing quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a side view of a buttonholing sewing machine according to an embodiment of the present invention;

Fig. 2 is a front view of the buttonholing sewing machine shown in Fig. 1;

Fig. 3 is a block diagram of a control system of the buttonholing sewing machine shown in Fig. 1;

Fig. 4 is a plan view of a feed stage and a press

mechanism;

Fig. 5 is a front view of the manipulation panel;

Fig. 6 shows a list of various setting parameters of sewing pattern data to be set through the manipulation panel;

Figs. 7A schematically shows an overall shape of an eyelet holing seam, and Fig. 7B shows individual dimensional items of the eyelet holing seam;

Fig. 8A show a specific example of an eyelet hole which is a reference of the eyelet hole portion, and Fig. 8B shows sizes of respective eyelet hole shapes;

Figs. 9 and 10 are flowcharts of an overall process from setting/input of sewing pattern data for the buttonholing sewing machine to a buttonholing sewing control;

Fig. 11 is a flowchart of sewing pattern data setting process; and

Fig. 12 illustrates an example configuration in which the size of a cloth opening width is adjusted using only a first opening/closing air cylinder.

DETAILED DESCRIPTION

[Overall configuration of buttonholing sewing machine 1]

[0015] A buttonholing sewing machine 1 according to an embodiment of the present invention will be hereinafter described with reference to Figs. 1-11. Figs. 1 and 2 are a side view and a front view, respectively, of the buttonholing sewing machine 1. Fig. 3 is a block diagram of a control system of the buttonholing sewing machine 1. The buttonholing sewing machine 1 is an eyelet holing sewing machine capable of eyelet holing.

[0016] As shown in Fig. 1, the buttonholing sewing machine 1 has a machine frame 2 which is equipped with a box-shaped bed unit 2a as a bottom part of the machine 1, a vertical barrel unit 2b disposed on one end portion of the bed unit 2a, and an arm unit 2c which extends from the vertical barrel unit 2b parallel with the bed unit 2a.

[0017] In the following description, the Z-axis direction is defined as the vertical direction in which the vertical barrel unit 2b is erected from the bed unit 2a, the Y-axis direction is defined as the direction that is parallel with the longitudinal directions of the bed unit 2a and the arm unit 2c and is perpendicular to the Z-axis direction, and the X-axis direction is defined as the direction that is perpendicular to both of the Y-axis direction and the Z-axis direction. In the Y-axis direction, the side to which the arm unit 2c extends from the vertical barrel unit 2b will be referred as the left side and the side opposite to the left side will be referred to as the right side. In the X-axis direction, the sides that are located on the left of and on the right of the arm unit 2c when viewed from the side facing the front end of the arm unit 2c will be referred to as the left side and the right side, respectively.

[0018] As shown in Figs. 1-3, the buttonholing sewing machine 1 is equipped with a needle bar 12 for holding

a sewing needle 11 through a needle thread is inserted, a needle bar turning stage 13 which supports the needle bar 12 swingably, a needle vertical movement mechanism (not shown) for moving the needle bar 12 vertically and swinging it, a looper mechanism 60 for forming a buttonholing seam, a turning mechanism 20 for turning the needle bar turning stage 13 and a looper base 61 of the looper mechanism 60, a machine motor 17 as a drive power source for a sewing operation, a balance 14 for pulling up a needle thread from the sewing needle side or paying out a needle thread from the thread supply source side, a thread tension applying device (not shown) for giving tension to a needle thread, a cloth feeding mechanism 50 as a feeding mechanism for positioning a cloth (sewing object) by moving it by a desired movement distance, a thread trimming device (not shown) for trimming a needle thread and a bobbin thread, a knife mechanism 30 for forming a buttonhole, a press mechanism 40 for pressing a cloth against the top surface of a feed stage 51 of the cloth feeding mechanism 50, and a control device 70 which is a control unit for controlling the individual units.

[Needle bar 12 and related structures]

[0019] As shown in Figs. 1 and 2, the needle bar 12 is shaped like a hollow pipe and its top portion projects outward from the top surface of the arm unit 2c of the machine frame 2. A needle thread is inserted into the needle bar 12 from its top opening and guided to the sewing needle 11 held at the bottom through its internal space.

[0020] As shown in Figs. 1 and 2, the needle vertical movement mechanism is equipped with the needle bar 12 which holds the sewing needle 11, an upper shaft which receives a full-rotation torque from the machine motor 17, a crank mechanism for extracting a vertical reciprocating drive force from the upper shaft, a swing arm having a front end portion that is linked to the needle bar 12 by the crank mechanism and swung vertically, a sleeve which supports the needle bar 12 so that it can be moved vertically, and a thin-plate-like leaf spring which extends parallel with the X-Y plane and supports the sleeve.

[0021] By means of the crank mechanism, the thus-configured needle vertical movement mechanism causes the needle bar 12 to make reciprocating vertical motion whose number of round trips (per unit time; this will also apply every time this expression appears in the following description) is proportional to a rotation speed of the machine motor 17. Supported swingably by the leaf spring which extends parallel with the X-Y plane, the sleeve supports the needle bar 12 so as to be able to swing a bottom end portion (i.e., a portion located on the side of the sewing needle 11) of the needle bar 12 in both of the X-axis direction and the Y-axis direction.

[0022] The needle vertical movement mechanism is also equipped with a needle bar swing stage for causing the needle bar 12 to perform a reciprocating swing op-

eration in the X-axis direction while allowing the needle bar 12 to move vertically, and a transmission mechanism for causing the needle bar swing stage to make reciprocating vertical motion using power produced by the machine motor 17. This needle bar swing stage is formed with a cam groove that is inclined so as to extend in a direction having X-axis and Z-axis components, and the needle bar turning stage 13 supports the needle bar swing stage so that the latter is movable in the direction of the cam groove.

[0023] When the needle bar swing stage is caused to lower by the transmission mechanism, the needle bar swing stage is moved obliquely, that is, down leftward, in the direction of the cam groove and the needle bar 12 is swung leftward. When the needle bar swing stage is caused to go up by the transmission mechanism, the needle bar swing stage is moved obliquely, that is, up rightward, in the direction of the cam groove and the needle bar 12 is swung rightward.

[0024] The transmission mechanism which functions in the above-described manners is configured so as to move the needle bar swing stage vertically by reciprocating half of a number of times the needle bar 12 is moved vertically. As a result, the needle bar 12 lowers every time it is swung leftward or rightward, whereby needle swinging is realized.

[0025] In the needle vertical movement mechanism, the needle bar 12 is supported so as to extend in the Z-axis direction (vertical direction) in a state that the above-mentioned leaf spring is not warped. Inside needle dropping is done for each needle-swung stitch (described later) in a state of this basic posture. When the needle bar 12 is swung from the state of the basic posture so as to be set in a state that it is inclined by a prescribed angle and extends in a direction having X-axis and Z-axis components. Outside needle dropping is done for each needle-swung stitch in this inclined state.

[0026] The needle bar turning stage 13 is supported under and in the vicinity of a front end portion of the arm unit 2c of the machine frame 2 so as to be rotatable about the Z axis, and is equipped fixedly with a pulley 131 on which a timing belt 21 of the turning mechanism 20 is wound. With this structure, the turning mechanism 20 can cause, via the above-mentioned needle bar swing stage, the needle bar 12 to turn about the Z axis.

[0027] Turning about the Z-axis direction while supporting the needle bar swing stage, the needle bar turning stage 13 can swing the needle bar 12 in any direction (i.e., not only in the left-right direction) with the Z axis as the swing center.

[Looper mechanism 60]

[0028] As shown in Fig. 1, the looper mechanism 60 is disposed in a top part of the machine bed unit 2a under the feed stage 51 of the cloth feeding mechanism 50 (described later). The looper mechanism 60 is equipped with the looper base 61 which is supported by the ma-

chine bed unit 2a so as to be rotatable about the Z axis, a left looper and a left spreader which are disposed in a top portion of the looper base 61 and perform double chain stitching by tying a bobbin thread to a needle thread, a right looper and a right spreader for performing single thread loop stitching using a needle thread, and a drive mechanism for swinging each looper and each spreader in prescribed manners to perform sewing.

[0029] The looper base 61 is supported so as to be able to turn coaxially with the turning axis of the needle bar turning stage 13, and is fixedly equipped with a pulley 26 on which a timing belt 23 of the turning mechanism 20 is wound.

[0030] The left looper/spreader and the right looper/spreader are disposed over the looper base 61 at two respective ends in a radial direction of a circle having the turning axis as the center. A basic turn angle of the looper base 61 is set so that during sewing the left looper and the left spreader perform double chain stitching for inside needle drops of the needle bar 12 and the right looper and the right spreader perform single thread loop stitching for outside needle drops of the needle bar 12.

[0031] The drive mechanism is equipped with a circular-pipe-shaped looper drive shaft 62 which is disposed at the center of the looper base 61 so as to be movable vertically, a spreader drive shaft 63 which is inserted in the looper drive shaft 62, a transmission mechanism for swinging the left and right loopers through reciprocating vertical motion of the looper drive shaft 62, a transmission mechanism for swinging the left and right spreaders through reciprocating vertical motion of the spreader drive shaft 63, and various cam mechanisms for causing the drive shafts 62 and 63 to move vertically through a lower shaft that is rotated by the machine motor 17.

[0032] The drive mechanism is configured so as to cause vertical movements by reciprocating half of a number of times the needle bar 12 is moved vertically (i.e., a number of times the machine motor 17 rotates). This allows the left looper/spreader and the right looper/spreader to catch a needle thread from the sewing needle 11 alternately every time the needle bar 12 is lowered.

[Turning mechanism 20]

[0033] As shown in Figs. 1-3, the turning mechanism 20 is equipped with a turning motor 24 which is disposed in the machine bed unit 2a, pulleys 22 (the bottom pulley 22 is not shown) which are provided at the top and bottom of a transmission shaft 25 for transmitting torque from the turning motor 24 to the needle bar turning stage 13 side, the timing belt 23 which is stretched among a primary pulley that is attached to the output shaft of the turning motor 24, the pulley 26 attached to the above-mentioned looper base 61, and the bottom pulley 22, and the timing belt 21 which is stretched between the top pulley 22 and the pulley 27 attached to the above-mentioned needle bar turning stage 13.

[0034] In the turning mechanism 20, the transmission ratios of the pulleys are set so that the looper base 61 and the needle bar turning stage 13 are rotated in phase when driven rotationally by the turning motor 24. That is, the turning mechanism 20 causes turns so that the swing direction of the needle bar 12 and the arrangement direction of the left looper/spreader and the right looper/spreader always coincide with each other.

[0035] As shown in Figs. 1-3, the cloth feeding mechanism 50 is composed of the feed stage 51 having a cloth placement surface that is parallel with the X-Y plane, an X-axis motor 52 as a cloth moving motor for moving the feed stage 51 in the X-axis direction, a Y-axis motor 53 as a cloth moving motor for moving the feed stage 51 in the Y-axis direction, and a power transmission mechanism of a known type for converting rotational drive power of each of the motors 52 and 53 into straight drive power in the X-axis or Y-axis direction and applies the latter to the feed stage 51.

[Knife mechanism 30]

[0036] As shown in Figs. 1-3, the knife mechanism 30 is disposed in the rear of the needle bar 12 to form buttonholes in a cloth.

[0037] The knife mechanism 30 is equipped with a knife receiver 32 which is disposed under the arm unit 2c and supported so as to go up and down, a cloth-cutting knife 31 which is disposed fixedly in a top part of the bed unit 2a so as to be opposed to the knife receiver 32, a knife motor 33 as a drive power source for elevating and lowering the knife receiver 32, and a pinion-rack mechanism (not shown) for converting torque of the knife motor 33 into elevation/lowering motion and transmitting the latter to the knife receiver 32.

[0038] Plural kinds of knife receivers 32 are prepared so as to correspond to respective shapes of buttonholes to be formed. The cloth-cutting knife 31 is disposed under an opening 511 that is formed through the feed stage 51 at the center in the X-axis direction and can be opened, in such a manner that formation of a buttonhole through a cloth is not obstructed as a result of the knife receiver 32's interfering with the cloth-cutting knife 31 when lowered.

[Press mechanism 40]

[0039] Fig. 4 is a plan view of the press mechanism 40 etc. The press mechanism 40 is equipped with a pair of cloth receiving plates 41 which are supported so as to be movable leftward and rightward with a cutting position S (located at the center, in the X-axis direction, of the opening 511 in the top surface of the feed stage 51) of the knife mechanism 30 as the center, a pair of cloth pressing elevation/lowering mechanisms 42 which are disposed on the top surfaces of rear end portions of the cloth receiving plates 41, respectively, and a pair of opening/closing mechanisms 43 for causing the cloth receiv-

ing plates 41 to move leftward and rightward, respectively.

[0040] Each of the pair of cloth receiving plates 41, the pair of cloth pressing elevation/lowering mechanisms 42, and the pair of opening/closing mechanisms 43 consists of the plates or mechanisms located on the left side and the right side so as to be symmetrical with each other in arrangement and structure with respect to the plane including the cutting position S of the knife mechanism 30. Therefore, only the left-hand cloth receiving plate 41 and cloth pressing elevation/lowering mechanism 42 and only the right-hand opening/closing mechanism 43 are shown in Fig. 4. Also in the following description, only the left-hand cloth pressing elevation/lowering mechanism 42 and only the right-hand opening/closing mechanism 43 will be described.

[0041] The pair of cloth receiving plates 41 are flat plates which are disposed horizontally on the left and right of the cutting position S of the knife mechanism 30 so as to close the opening 511 of the feed stage 51. The cloth receiving plates 41 are supported so as to extend horizontally and their top surfaces are placement surfaces on which a cloth is to be placed.

[0042] The cloth receiving plates 41 are supported so as to be movable in the left-right direction relative to the feed stage 51, and a gap is formed over the cutting position S of the knife mechanism 30 even when they come closest to each other. The cloth receiving plates 41 are moved away from each other from their closest positions. As the cloth receiving plates 41 come closer to or go away from each other, a buttonhole formed through a cloth placed on their top surfaces can be closed or opened in the direction perpendicular to its longitudinal direction after its formation or during stitching thereon.

[0043] The left-hand cloth pressing elevation/lowering mechanism 42 is attached to the top surface of a rear end portion of the left-hand cloth receiving plate 41. This cloth pressing elevation/lowering mechanism 42 is equipped with a cloth presser 421 having a smooth bottom surface, a support arm 422 which supports the cloth presser 421 by its front end portion, an attachment stage 424 which supports the support arm 422 swingably by means of a horizontal shaft 423, a cloth pressing air cylinder 425 as a drive power source for elevating and lowering the cloth presser 421, and a bell crank (not shown) for transmitting motive power from the cloth pressing air cylinder 425 to the support arm 422.

[0044] A side edge, located on the side of cutting position S, of the cloth presser 421 is cut into a shape as obtained by dividing an eyelet hole (buttonhole) in half. Therefore, cooperating with the right-hand cloth presser 421, this cloth presser 421 can press, from above, a portion, in the vicinity of its boundary, of an eyelet hole formed in a cloth.

[0045] The cloth presser 421 is supported by the front end portion of the support arm 422 via a horizontal shaft extending in the X-axis direction, whereby front and rear end portions of the cloth presser 421 can swing a little in

the vertical direction.

[0046] The support arm 422 is supported by the attachment stage 424 via the horizontal shaft 423 extending in the X-axis direction, and can elevate and lower the cloth presser 421 which is supported by its front end portion. Rotational drive power is applied from the cloth pressing air cylinder 425 to an end portion, below the horizontal shaft 423, of the support arm 422 via the above-mentioned bell crank, whereby the cloth presser 421 is elevated or lowered.

[0047] The right-hand opening/closing mechanism 43 is equipped with a pair of rail plates 431 which are disposed under the cloth receiving plate 41 and supported by the feed stage 51 so as to advance in the X-axis direction, a triangular cloth opening plate 432 which is connected fixedly to the top surfaces of the pair of rail plates 431, a tension spring 433 for pulling the pair of rail plates 431 and the cloth opening plate 432 together toward the cutting position S side, a cam plate 434 which is disposed under the rail plates 431 and supported by the feed stage 51 so as to advance in the Y-axis direction, rollers 435 which are in contact with two respective cam portions of the cam plate 434, adjustment plates 436 which support the respective rollers 435 so that they can rotate about the Z-axis directions, and a drive link 437 which is disposed between the adjustment plates 436 and supported by the feed stage 51 so as to be rotatable about the Z-axis direction.

[0048] The opening/closing mechanism 43 is also equipped with a first opening/closing air cylinder 438 for causing the drive link 437 to rotate and a second opening/closing air cylinder 439 for stopping the drive link 437 at a halfway position in a range of rotation caused by the first opening/closing air cylinder 438.

[0049] Each rail plate 431 is a long flat plate extending in the X-axis direction, and is attached to the feed stage 51 with stepped screws that are inserted through holes that are long in the X-axis direction and formed at two respective end positions of the rail plate 431. This attachment structure allows each rail plate 431 to reciprocate in the X-axis direction over the length of the long holes.

[0050] A roller 435 is attached, via an adjustment plate 436, to the bottom surface of the associated rail plate 431 at a middle position in the X-axis direction. The adjustment plate 436 is fixed, by screwing, to the feed stage 51 through a through-hole (not shown) formed through the rail plate 431. The inner diameter of the through-hole of the rail plate 431 is sufficiently larger than the outer diameter of the screw, and hence the position of the roller 435 can be adjusted in a desired manner in the X-Y plane by loosening the screw.

[0051] The cloth opening plate 432 approximately assumes an isosceles triangle shape, and two end portions of a base portion are connected to left end portions of the rail plates 431, respectively, by screwing with such orientation that the base portion faces the cutting position S side. The cloth opening plate 432 has two bosses 432a that are convex upward at two respective end positions

of the base portion, and the cloth opening plate 432 is held being fitted in respective through-holes 411 which are formed in the associated cloth receiving plate 41. That is, the pair of rail plates 431, the cloth opening plate 432, and the cloth receiving plate 41 together move closer to and away from the cutting position S.

[0052] The cam plate 434 is a long flat plate extending in the Y-axis direction, and is attached to the feed stage 51 with stepped screws that are inserted through holes that are long in the Y-axis direction and formed at two respective end positions of the cam plate 434. This attachment structure allows the cam plate 434 to reciprocate in the Y-axis direction over the length of the long holes.

[0053] Edges, located on the side opposite to the cutting position S, of two end portions of the cam plate 434 are formed with cam portions 434a which are slant surfaces, respectively. In a top view, each cam portion 434a is inclined so as to come closer to the cutting position S as the position goes rearward.

[0054] Therefore, when the cam plate 434 is moved rearward in a state that the rollers 435 are in contact with the respective cam portions 434a from the side opposite to the cutting position S, the cloth receiving plate 41 can be moved away from the cutting position S via the rail plates 431 and the cloth opening plate 432. When the cam plate 434 is moved forward, the cloth receiving plate 41 can be moved closer to the cutting position S via the rail plates 431 and the cloth opening plate 432.

[0055] Since the cloth opening plate 432 is pulled by the tension spring 433 toward the cutting position S, the state that the rollers 435 are in contact with the respective cam portions 434a can be maintained.

[0056] The drive link 437 is a long link that is attached to the feed stage 51 with a stepped screw with such orientation as to extend approximately in the X-axis direction. The stepped screw, which is parallel with the Z-axis, supports a middle portion of the drive link 437 rotatably. As a result, both end portions of the drive link 437 can swing in the front-rear direction. An end portion, located on the side of the cutting position S, of the drive link 437 is connected rotatably to a middle portion, in its longitudinal direction, of the cam plate 434 by a stepped screw extending in the Z-axis direction.

[0057] The end portion, located on the side of the cutting position S, of the drive link 437 is connected to the cam plate 434 by the stepped screw that is inserted through a long hole extending in the X-axis direction, and a swing of the drive link 437 is not obstructed by this connection.

[0058] A portion in the vicinity of an end portion, opposite to the cutting position S, of the drive link 437 is linked to the plunger of the first opening/closing air cylinder 438 by a knuckle 440 so as to be rotatable about the Z-axis direction. The end portion, opposite to the cutting position S, of the drive link 437 extends beyond the position of linkage to the first opening/closing air cylinder 438, and the end portion (denoted by symbol 437a) thus extending

can come into contact with the plunger of the second opening/closing air cylinder 439.

[0059] The portion in the vicinity of the end portion 437a, opposite to the cutting position S, of the drive link 437 is connected to the knuckle 440 by a stepped screw that is inserted through a long hole extending in the X-axis direction, and a swing of the drive link 437 is not obstructed by this connection, either.

[0060] The first opening/closing air cylinder 438 is disposed in the rear of the drive link 437, and is fixed to the feed stage 51 in such a manner that the advancement/retract direction of its plunger is in the Y-axis direction. When the plunger retreats, the first opening/closing air cylinder 438 causes the extended end portion 437a of the drive link 437 to swing to position P1. When the plunger projects, the first opening/closing air cylinder 438 causes the extended end portion 437a of the drive link 437 to swing to position P3. The plunger of the first opening/closing air cylinder 438 has such a stroke as to be able to swing the extended end portion 437a of the drive link 437 in a wider range than the range of from position P1 to position P3. However, the stroke of the plunger of the first opening/closing air cylinder 438 is restricted by stoppers (not shown) so that the extended end portion 437a of the drive link 437 can swing only in the range of from position P1 to position P3.

[0061] When the extended end portion 437a of the drive link 437 is moved to position P1, the cam plate 434 is advanced and the cloth receiving plate 41 is thereby moved to a "proximate position" that is closest to the cutting position S. When the extended end portion 437a of the drive link 437 is moved to position P3, the cam plate 434 is retracted and the cloth receiving plate 41 is thereby moved to a "distant position" that is most distant from the cutting position S.

[0062] On the other hand, the second opening/closing air cylinder 439 is disposed in front of the drive link 437, and is fixed to the feed stage 51 in such a manner that the advancement/retract direction of its plunger is in the Y-axis direction. In a state that the plunger of the second opening/closing air cylinder 439 is retracted, the end of the plunger is located in front of the swing range P1-P3 of the extended end portion 437a of the drive link 437 and hence is not in contact with the latter.

[0063] When projected, the plunger can move the extended end portion 437a of the drive link 437 to position P2 that is located between positions P1 and P3. As the extended end portion 437a of the drive link 437 is moved to position P2, the cam plate 434 is moved to a middle position and the cloth receiving plate 41 is moved to a "middle position" which is located between the above-mentioned "proximate position" and "distant position."

[0064] Torque that is given to the drive link 437 from the second opening/closing air cylinder 439 is sufficiently stronger than torque that is given to the drive link 437 from the first opening/closing air cylinder 438. Thus, even in a state that the plunger of the first opening/closing air cylinder 438 is projected to push the extended end portion

437a of the drive link 437 forward, the extended end portion 437a of the drive link 437 can be pushed back to position P2 by causing the plunger of the second opening/closing air cylinder 439 to project.

[0065] In the above-described manner, the position of the cloth receiving plate 41 can be switched as follows:

- The cloth receiving plate 41 is set at the "proximate position" by making the plunger of the first opening/closing air cylinder 438 and the plunger of the second opening/closing air cylinder 439 in retracted states.
- The cloth receiving plate 41 is set at the "distant position" by making the plunger of the first opening/closing air cylinder 438 in a projected state and making the plunger of the second opening/closing air cylinder 439 in a retracted state.
- The cloth receiving plate 41 is set at the "middle position" by making the plunger of the first opening/closing air cylinder 438 and the plunger of the second opening/closing air cylinder 439 in projected states.

[Thread trimming device]

[0066] A thread trimming device for trimming a needle thread is equipped with a movable knife which is disposed on the looper base 61 and a needle thread trimming air cylinder 15 (see Fig. 3) for causing the movable knife to perform a trimming operation. The thread trimming device trims a needle thread using them.

[0067] A thread trimming device for trimming a bobbin thread is equipped with a movable knife and a fixed knife in the feed stage 51. The thread trimming device causes the movable knife to perform a trimming operation receiving drive power from a bobbin thread trimming air cylinder 16 (see Fig. 3). A bobbin thread is caught by the movable knife and is trimmed as the movable knife cooperates with the fixed knife.

[Control system of buttonholing sewing machine 1]

[0068] A control system of the buttonholing sewing machine 1 will be described with reference to Fig. 3. The control device 70 of the buttonholing sewing machine 1 is equipped with a machine motor drive circuit 17a for driving the machine motor 17, an interface (I/F) 17b which connects the drive circuit 17a to a CPU 71 of the control device 70, an X-axis motor drive circuit 52a for driving the X-axis motor 52 provided in the cloth feeding mechanism 50, an I/F 52b which connects 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 feeding mechanism 50, an I/F 53b which connects the drive circuit 53a to the CPU 71, a turning motor drive circuit 24a for driving the turning motor 24, an I/F 24b which connects the drive circuit 24a to the CPU 71, a knife motor drive circuit 33a for driving the knife motor 33, an I/F 33b which connects

the drive circuit 33a to the CPU 71, an encoder circuit 18a for counting output pulses of an encoder 18 which detects an output shaft angle of the machine motor 17, and an I/F 18b which connects the encoder circuit 18a to the CPU 71.

[0069] The control device 70 of the buttonholing sewing machine 1 is also equipped with an electromagnetic valve drive circuit 425a for driving an electromagnetic valve 425c which applies air pressure to the cloth pressing air cylinder 425, an I/F 425b which connects the drive circuit 425a to the CPU 71, an electromagnetic valve drive circuit 438a for driving an electromagnetic valve 438c which applies air pressure to the first opening/closing air cylinder 438, an I/F 438b which connects the drive circuit 438a to the CPU 71, an electromagnetic valve drive circuit 439a for driving an electromagnetic valve 439c which applies air pressure to the second opening/closing air cylinder 439, an I/F 439b which connects the drive circuit 439a to the CPU 71, an electromagnetic valve drive circuit 15a for driving an electromagnetic valve 15c which applies air pressure to the needle thread trimming air cylinder 15, an I/F 15b which connects the drive circuit 15a to the CPU 71, an electromagnetic valve drive circuit 16a for driving an electromagnetic valve 16c which applies air pressure to the bobbin thread trimming air cylinder 16, and an I/F 16b which connects the drive circuit 16a to the CPU 71.

[0070] Although actually the buttonholing sewing machine 1 is equipped with two sets of a cloth pressing air cylinder 425, a first opening/closing air cylinder 438, and a second opening/closing air cylinder 439 on the left side and the right side, respectively, only one of the two sets is shown in Fig. 3.

[0071] Each of the cloth pressing air cylinder 425, the first opening/closing air cylinder 438, the second opening/closing air cylinder 439, the needle thread trimming air cylinder 15, and the bobbin thread trimming air cylinder 16 is of a double-action air cylinder in which the plunger is projected or retracted by applying air pressure individually to air rooms located on the two respective sides of the piston in the cylinder.

[0072] All of the respective electromagnetic valves 425c, 438c, 439c, 15c, and 16c of the cloth pressing air cylinder 425, the first opening/closing air cylinder 438, and the second opening/closing air cylinder 439, the needle thread trimming air cylinder 15, and the bobbin thread trimming air cylinder 16 are of a 2-position, 5-port, single-action solenoid type (see the electromagnetic valve 439c shown in Fig. 4).

[0073] The control device 70 of the buttonholing sewing machine 1 is provided with a manipulation panel 75 through which to input various setting contents, an I/F 75i which connects the manipulation panel 75 to the CPU 71, a press switch 76 for lowering the cloth pressers 421, an I/F 76b which connects the press switch 76 to the CPU 71, a start switch 77 for starting a sewing operation, and an I/F 77b which connects the start switch 77 to the CPU 71.

[0074] The X-axis motor 52, the Y-axis motor 53, and the turning motor 24 are pulse motors and are each equipped with an origin sensor (not shown) for origin search and an I/F (not shown) which connects the origin sensor for origin search to the CPU 71.

[0075] The control device 70 is further equipped with a ROM 72 which is stored with various control programs and data to be used by those programs, a RAM 73 to serve as a working area when the CPU 71 performs processing according to programs on the basis of data that are read out from the ROM 72, data that are input or set through the manipulation panel 75, and calculation result sewing stitch data, an EEPROM 74 for storage of sewing pattern data etc., and the CPU 71 for performing various kinds of processing according to the programs. The EEPROM 74 thus functions as a data storage unit.

[0076] Sewing pattern data are pattern data for formation of a single-fold buttonholing seam, and the EEPROM 74 is stored with plural kinds of sewing pattern data. Each kind of sewing pattern data is assigned a unique pattern number for identification.

[0077] The control device 70 controls respective actuators of the needle vertical movement mechanism, the turning mechanism 20, the knife mechanism 30, the press mechanism 40, and the cloth feeding mechanism 50 on the basis of selected sewing pattern data.

[Manipulation panel and sewing pattern data]

[0078] Fig. 5 is a front view of the manipulation panel 75. The manipulation panel 75 is equipped with a display box 75a for display of a sewing pattern data number and increment/decrement keys 75b for selecting a sewing pattern data number, a display box 75c for display of a setting value of each of various parameters of each kind of sewing pattern data and increment/decrement keys 75b for incrementing or decrementing a setting value, a display box 75e for display of an item number that identifies one of various parameters and increment/decrement keys 75b for selecting an item number of a setting item, a data enter key 75g for updating data, and a preparation key 75h for causing a transition to a sewing-possible state.

[0079] Various control values necessary for execution of sewing are calculated on the basis of setting values of various parameters of sewing pattern data that have been set or input through the manipulation panel 75. That is, the manipulation panel 75 is a pattern setting means for setting sewing pattern data for eyelet holing.

[0080] Next, various setting parameters of sewing pattern data to be set through the manipulation panel 75 will be described with reference to Fig. 6. Fig. 6 shows a contents list of various setting parameters of sewing pattern data of eyelet holing. Fig. 7A schematically shows an overall shape of an eyelet holing seam 100, and Fig. 7B shows individual dimensional items of the eyelet holing seam 100.

[0081] The eyelet holing seam 100 consists of an eye-

let hole portion 104 having an arc portion (turn portion) 101 and a pair of slant portions 102 and 103 which extend from the respective ends of the arc portion 101 so as to be inclined inward from the Y-axis direction, a pair of parallel portions 105 and 106 which extend from the respective slant portions 102 and 103 in the Y-axis direction, and a round bar tack portion 108 which is located on the side opposite to the arc portion 101.

[0082] In the following description, the right-hand slant portion will be referred to as an eyelet hole bottom-right portion 102 and the left-hand slant portion will be referred to as an eyelet hole bottom-left portion 103, and reference numerals 105 and 106 will denote a right-hand parallel portion and a left-hand parallel portion, respectively. Fig. 8A shows a specific example of an eyelet hole 107 which is a reference of the eyelet hole portion 104, and Fig. 8B shows sizes of respective eyelet hole shapes.

[0083] The round bar tack portion 108 is just an example. There are cases that other kinds of bar tacks such as a taper bar tack and a straight bar tack are formed and even no bar tack is formed.

[0084] First, settings of inputting sewing pattern data shown in Fig. 6 are made in the following manner through the manipulation panel 75:

(1) Eyelet hole shape: Select one of a sleeping eye hole and five stages of eyelet hole shapes having different sizes shown in Figs. 8A and 8B using numerical values "0" to "5."

(2) Holing length: Input a total length ml in the Y-axis direction of the hole of a holing seam to be formed.

(3) Cloth cutting knife operation: Make a selection as to execution/non-execution of cloth cutting and/or whether cloth cutting should be done before or after formation of a buttonholing seam using numerical values "0" to "2."

(4) The number of parallel stitches: Input, in the form of a numerical value, the number ln of stitches in the right-hand parallel portion 105 and the eyelet hole bottom-right portion 102 (the same numerical value is set for the left-hand parallel portion 106 and the eyelet hole bottom-left portion 103).

(5) The number of arc-forming stitches: Input, in the form of a numerical value, the number en of stitches in the arc portion 101.

(6) Parallel portion knife gap: Input, in the form of a numerical value, a gap ls between an inside needle drop position in each parallel portion 105 or 106 and the cloth-cutting knife 31.

(7) Arc portion knife gap: Input, in the form of a numerical value, a gap es between an inside needle drop position in the arc portion 101 and the cloth-cutting knife 31.

(8) Bar tacking type: Make a selection as to formation/non-formation of bar tack and/or a bar tacking type using numerical values "0" to "3."

(9) Taper bar tack stitch length: Input, in the form of a numerical value, a length of a taper bar tack stitch.

(15) The number of round bar tack stitches: Input, in the form of a numerical value, the number cn of round bar tack stitches if a round bar tacking was selected at step (8).

(20) Needle swing width: Input, in the form of a numerical value, a needle swing width ww.

(21) Double sewing pattern number: By selecting two sewing pattern data, double buttonholing can be performed in which a first buttonholing seam is formed on the basis of one sewing pattern data and a second buttonholing seam is formed on the basis of the other sewing pattern data so as to be superimposed on the first one. Whether to perform double sewing is set in the first sewing pattern data. If a double sewing pattern number "0" is set, a setting to the effect that double sewing should not be performed is made. If a numerical value other than "0" is set, sewing pattern data whose pattern number coincides with the numerical value will be used as data for formation of a second buttonholing seam.

This parameter is invalid when the sewing pattern data being discussed is used as second sewing pattern data for formation of a double buttonholing seam.

(22) First-sewing cloth opening width: Select one of numerical values "0" to "2" as a number indicating a cloth opening width attained by the press mechanism 40 in a case that the sewing pattern data being discussed is used as sewing pattern data for formation of a single buttonholing seam or first sewing pattern data for formation of a double buttonholing seam.

- Number "0" indicates no cloth opening, in which case the left and right cloth receiving plates 41 are placed at the "proximate positions."
- Number "1" indicates full cloth opening, in which case the left and right cloth receiving plates 41 are placed at the "distant positions."
- Number "2" indicates half cloth opening, in which case the left and right cloth receiving plates 41 are placed at the "middle positions."

[0085] This parameter is invalid when the sewing pattern data being discussed is used as second sewing pattern data for formation of a double buttonholing seam.

[Overall operation of control device 70 of buttonholing sewing machine 1]

[0086] Figs. 9 and 10 are flowcharts of an overall process from setting/input of sewing pattern data for the buttonholing sewing machine 1 to a buttonholing sewing control. Fig. 11 is a flowchart of sewing pattern data setting process. The overall process of the buttonholing sewing machine 1 will be described below with reference to Figs. 9-11.

[0087] First, at step S1, the CPU 71 judges whether the sewing pattern data number increment/decrement

keys 75b have been depressed or not. If neither of the increment/decrement keys 75b has been depressed, an initial value (pattern number "1"), for example, is maintained and displayed in the display box 75a. Then the process moves to step S5. If one of the increment/decrement keys 75b has been depressed, at step S3 the pattern number is incremented or decremented depending on whether the "+" key or the "-" has been depressed and the resulting pattern number is displayed in the display box 75a. Then the process moves to step S5.

[0088] At step S5, the CPU 71 judges whether the data enter key 75g has been depressed or not. If the data enter key 75g has not been depressed, the process moves to step S9. If the data enter key 75g has been depressed, at step S7 the CPU 71 starts the above-mentioned sewing pattern data setting process. After completion of the sewing pattern data setting process, the process moves to step S9.

[0089] Now, the sewing pattern data setting process (step S7) will be described with reference to the flowchart of Fig. 11. The following description will be directed to a case of setting of the sewing pattern data shown in Fig. 6.

[0090] When the data enter key 75g has been depressed, first, at step S61, the CPU 71 automatically selects "eyelet hole shape" having the item number (1) as a setting target data item and displays "1" in the display box 75e. At step S63, the CPU 71 judges whether one of the increment/decrement keys 75f has been depressed or not. If neither of the increment/decrement keys 75f has been depressed, the process moves to step S67. If one of the increment/decrement keys 75f has been depressed, at step S65 the CPU 71 changes the item number of the setting target data item. Then the process moves to step S67.

[0091] At step S67, the CPU 71 judges whether or not an input for incrementing or decrementing the setting numerical value of the currently selected setting parameter has been made by depressing the increment/decrement keys 75d. If no such input has been made, the process moves to step S71. If such an input has been made, at step S69 the CPU 71 changes the setting numerical value of the target setting parameter. That is, the CPU 71 changes the setting numerical value of the selected one of the parameters (1) eyelet hole shape, (2) holing length, (3) cloth cutting knife operation, (4) the number of parallel stitches, (5) the number of arc-forming stitches, (6) parallel portion knife gap, (7) arc-portion knife gap, (8) bar tacking type, (9) taper bar tack stitch length, (15) the number of round bar tack stitches, (20) needle swing width, (21) double sewing pattern number, and (22) first-sewing cloth opening width.

[0092] At step S71, the CPU 71 judges whether or not the data enter key 75g has been depressed. Upon completion of the setting of the above setting parameters (1)-(22), the data enter key 75g is depressed. At step S73, the CPU 71 updates the setting parameters. Then the process returns to step S9 shown in Fig. 9.

[0093] On the other hand, if the setting of the above

setting parameters (1)-(22) should be continued, the data enter key 75g is not depressed. The process returns to step S63 to execute steps S63-S71 again for a new setting parameter.

[0094] Upon completion of the sewing pattern data setting process, at step S9 shown in Fig. 9 the CPU 71 judges whether the preparation key 75h displayed on the manipulation panel 75 has been depressed or not. If the preparation key 75h has not been depressed, the process returns to step S1. If the preparation key 75h has been depressed, the CPU 71 executes a sewing stitch data generation process. More specifically, sewing stitch data are calculated on the basis of the setting contents of the sewing pattern data.

[0095] The sewing stitch data are data that are generated by calculating operation amounts of the above-described respective actuators of the buttonholing sewing machine 1 to form a sewing pattern on the basis of the setting contents of sewing pattern data.

[0096] At step S13, to start a buttonholing sewing operation, origin sensors of the feed stage 51 (X-axis motor 52 and the Y-axis motor 53), the needle bar turning stage 13 and the looper base 61 (turning motor 24), and the knife motor 33 perform origin searches.

[0097] Upon depression of the press switch 76 provided in the buttonholing sewing machine 1 at step S 15, the CPU 71 lowers the cloth pressers 421 to presses a cloth at step S 17. At this time, the left and right cloth receiving plates 41 of the press mechanism 40 are located at the initial positions, that is, "proximate positions."

[0098] At step A19, the CPU 71 waits for depression of the start switch 77. Upon depression of the start switch 77, the CPU 71 starts a buttonholing sewing operation.

[0099] First, at step S21, the CPU 71 judges whether advance cutting is set in the selected sewing pattern data. If it is not set, the process moves to step S25. If it is set, at step S23 the CPU 71 causes the cloth-cutting knife 31 to go up and down to form a hole in the cloth.

[0100] If the current sewing pattern data are for second sewing of double sewing, the CPU 71 judges, on the basis of first sewing pattern data, whether hole formation has already been completed. The CPU 71 causes hole formation only if hole formation has not been completed yet.

[0101] At step S25, the CPU 71 judges whether or not the buttonholing sewing being performed is first sewing of double sewing. For example, this judgment can be made on the basis of a history of setting values of (21) double sewing pattern numbers of sewing pattern data of past sewing operations. Alternatively, this judgment may be made using a flag that is set when second sewing of double sewing is performed.

[0102] If the current buttonholing sewing is first sewing of double sewing or single sewing, at step S29 the CPU 71 causes the plungers of only the left and right first opening/closing air cylinders 438 to be projected to place the left and right cloth receiving plates 41 at the "distant positions," that is, to establish a cloth full-open state.

[0103] If it is judged at step S25 that the current but-

tonholing sewing is first sewing of double sewing, at step S27 the CPU 71 judges whether or not the setting of (22) first-sewing cloth opening width of the current sewing pattern data is "full cloth opening."

[0104] If the setting of (22) first-sewing cloth opening width is "full cloth opening," at step S29 the CPU 71 causes the left and right cloth receiving pates 41 to be placed at the "distant positions," that is, establishes a cloth full-open state.

[0105] If it is judged at step S27 that the setting of (22) first-sewing cloth opening width of the current sewing pattern data is not "full cloth opening," at step S31 the CPU 71 judges the setting is "half cloth opening."

[0106] If the setting is "half cloth opening," at step S33 the CPU 71 causes the plungers of both of the left and right first opening/closing air cylinders 438 and the left and right second opening/closing air cylinders 439 to be projected to place the left and right cloth receiving pates 41 at the "middle positions," that is, to establish a cloth half-open state.

[0107] If it is judged at step S31 that the setting is not "half cloth opening," the CPU 71 recognizes that the setting of (22) first-sewing cloth opening width of the current sewing pattern data is "no cloth opening" and advances to step S35 while the plungers of both of the left and right first opening/closing air cylinders 438 and the left and right second opening/closing air cylinders 439 are kept retracted.

[0108] At step S35, the CPU 71 controls the X-axis motor 52 and the Y-axis motor 53 to move the feed stage 51 from the origin to the sewing start position.

[0109] At step S37, the CPU 71 drives the machine motor 71 to start an actual buttonholing sewing operation. In forming each stitch, the CPU 71 reads an "X feed distance," a "Y feed distance," and a "turn angle" and thereby controls the X-axis motor 52, the Y-axis motor 53, and the turning motor 24. In this manner, the CPU 71 forms stitches at respective positions of, for example, an eyelet holing seam (or sleeping eye holing seam) in order.

[0110] Upon completion of the buttonholing sewing operation using the sewing stitch data of all the stitches, at step S39 the CPU 71 returns the feed stage 51 (X-axis motor 52 and Y-axis motor 53) to the origin. At step S41, the CPU 71 activates the needle thread trimming air cylinder 15 and the bobbin thread trimming air cylinder 16 to trim the needle thread and the bobbin thread.

[0111] At step S43, the CPU 71 judges whether post-cutting is set in the sewing pattern data. If it is not set, the process moves to step S47. If it is set, at step S45 the CPU 71 causes the cloth-cutting knife 31 to go up and down to form a hole in the cloth.

[0112] If the current sewing pattern data are for second sewing of double sewing, the CPU 71 judges, on the basis of first sewing pattern data, whether hole formation has already been completed. The CPU 71 causes hole formation only if hole formation has not been completed yet.

[0113] At step S47, the CPU 71 reads the setting of (21) double sewing pattern number of the current sewing

pattern data and judges whether or not a pattern number of second sewing pattern data is set or not. If the setting is "0," the process moves to step S49. If a pattern number of second sewing pattern data is set, the process returns to step S21. Steps S21-S45 are executed on the basis of new, second sewing pattern data to form a second buttonholing seam.

[0114] Step S47 assumes that the current sewing pattern data are not for second sewing of double sewing. If the current sewing pattern data is for second sewing of double sewing, the process moves to step S49.

[0115] At step S49, the CPU 71 causes the cloth pressers 421 to be elevated to cancel the pressing against the cloth and causes the feed stage 51 and the needle bar turning stage 13 and the looper base 61 (turning motor 24) to the origins. If the left and right cloth receiving plates 41 are open, at step S51 the CPU 71 cause both of them to be placed at the "proximate positions." Then the process moves to step S15, that is, the buttonholing sewing machine 1 is rendered in a waiting state until the press switch 76 is depressed for the next sewing.

[Technical advantages of embodiment of the invention]

[0116] In the above-described buttonholing sewing machine 1, the control device 70 performs an opening width varying control (corresponding to the processing that the process moves to step S29 if the judgment result of step S25 shown in Fig. 10 is negative) for controlling the press mechanism 40 so that it makes the buttonhole opening width larger in forming a second buttonholing seam than in forming a first buttonholing seam if read-in sewing pattern data satisfy the following conditions (1)-(4):

- (1) The sewing pattern data are not second sewing pattern data of double sewing.
- (2) Advance cutting or post-cutting is set in the sewing pattern data, or no cloth cutting is set in the sewing pattern data and advance cutting is set in second sewing pattern data.
- (3) A pattern number of second sewing pattern data of double sewing is set in the sewing pattern data.
- (4) (22) first-sewing cloth opening width of the sewing pattern data is "no cloth opening" or "half cloth opening."

[0117] By making the buttonhole opening width larger in forming second sewing than in first sewing by the opening width varying control, sewing failures such as a failure that a buttonhole is closed due to needle dropping in the adjacent parallel sewing section of the buttonhole opening width is not changed in the second sewing can be suppressed effectively.

[0118] Furthermore, fluttering can be suppressed effectively by making a cloth tense by means of the cloth pressers 421 also at the time of second sewing.

[0119] In second sewing, a measure is frequently taken

that in a first sewing pattern the needle swing width is set small and the parallel portion knife gap is set large and in a second sewing pattern the needle swing width is set large and the parallel portion knife gap is set small, whereby first stitches are hidden behind first stitches to improve the appearance of a resulting double buttonholing seam.

[0120] In this case, (3) cloth cutting knife operation of each of first sewing pattern data and second sewing pattern data is set so that a buttonhole can be formed by the knife mechanism 30 after formation of a first buttonholing seam and before formation of a second buttonholing seam.

[0121] In this case, by performing the above-described opening width varying control, a buttonhole that was formed immediately before formation of a second buttonholing seam can be opened more effectively, whereby the probability of occurrence of sewing failures can be lowered and better double sewing can be realized.

[0122] In the buttonholing sewing machine 1, whether the opening width varying control should and should not be performed can be set substantially by setting, through the manipulation panel 75, (22) first-sewing cloth opening width of sewing pattern data to "full cloth opening" and to "no cloth opening" or "half cloth opening," respectively. More specifically, if setting is made to "full cloth opening," stitches are formed with full cloth opening also in second sewing, which means that no opening width varying control is performed. If setting is made to "no cloth opening" or "half cloth opening," stitches are formed with full cloth opening only in second sewing, which means that the opening width varying control is performed.

[0123] In this manner, the manipulation panel 75 can function as an execution setting unit and makes it possible to select, as desired, a setting that the opening width varying control should be performed.

[0124] In the buttonholing sewing machine 1, the EEPROM 74 functions as a data storage unit for storing plural sewing pattern data.

[0125] The manipulation panel 75 makes it possible to select any second sewing pattern data using (21) double sewing pattern number and to select first sewing pattern data at the time of sewing. Thus, the manipulation panel 75 functions as a data selection unit for selecting first and second sewing pattern data from plural kinds of sewing pattern data stored in the EEPROM 74.

[0126] With these units, when double sewing is performed, first-sewing pattern data and second-sewing sewing pattern data can be selected in a desired manner, whereby a wider variety of, proper forms of double sewing can be realized.

[0127] In the buttonholing sewing machine 1, switching can be made to a target opening width quickly because the opening width in the direction of widening a buttonhole in a cloth is varied by a combination of operations of the first opening/closing air cylinder 438 and the second opening/closing air cylinder 439.

[Others]

[0128] In the press mechanism 40, the opening width of the cloth receiving plates may be adjusted only by the first opening/closing air cylinder 438 without using the second opening/closing air cylinder 439.

[0129] For example, Fig. 12 shows a structure that speed controllers 438d and 438e are disposed on supply paths for supplying air to air rooms located on the two respective sides of the piston of the first opening/closing air cylinder 438, respectively. The opening width of the cloth receiving plates can be adjusted by controlling the plunger stroke in a desired manner by controlling the air supply time while making the air supply rate per unit time constant.

[0130] In this structure, it is desirable that the first opening/closing air cylinder 438 be provided with a 3-position, 5-port electromagnetic valve 438c and switching positions for establishing an air sealing state be provided in the air rooms located on the two respective sides of the piston. This makes it possible to keep the opening width of the cloth receiving plates 41 at an adjusted value.

[0131] With this measure, the manufacturing cost of the buttonholing sewing machine 1 can be reduced because of reduction in the number of air cylinders. And an existing sewing machine can be modified into a buttonholing sewing machine 1 capable of performing the opening width varying control by little time and labor and a small cost.

[0132] In the press mechanism 40, the opening width may be adjusted in more stages using three or more air cylinders. In this case, for example, third and further opening/closing air cylinders are disposed parallel with the second opening/closing air cylinder 439 in the same direction and the plunger projection positions of the second and further opening/closing air cylinders are set different from each other, whereby the extended end portion 437a of the drive link 437 is allowed to stop at any position between position P1 and position P3. The torque that is exerted on the drive link 437 from each of the second and further opening/closing air cylinders is set sufficiently stronger than that exerted on the drive link 437 from the first opening/closing air cylinder 438.

[0133] With this measure, by projecting the first opening/closing air cylinder 438 and a selected one of the second and further air cylinders, the associated cloth receiving plate 41 can be moved to any of plural positions between the "proximate position" and the "distant position."

[0134] The actuator for rotating each swing link 437 is not limited to air cylinders; each cloth receiving plate 41 may be made movable using a motor capable of position control.

[0135] Although in the above description the buttonholing sewing machine 1 has been described mainly for a case of performing eyelet holing sewing, it is also effective for a case of performing sleeping eye holing sewing.

Claims

1. A buttonholing sewing machine having:

a needle vertical movement mechanism which moves a needle bar vertically while swinging it; a looper mechanism provided with a looper, a spreader, and a looper base which supports the looper and the spreader; a turning mechanism which turns the needle bar and the looper base; a feed mechanism which moves a sewing object across a placement surface that is mounted with the sewing object; a knife mechanism which forms a buttonhole in the sewing object; a press mechanism which can operate so as to widen the buttonhole of the sewing object while pressing the sewing object; and a control device which performs a buttonholing sewing control for formation of a buttonholing seam around the buttonhole, **characterized in that** in performing the buttonholing sewing control, the control device causes formation of a double buttonholing seam around a buttonhole and causes the knife mechanism to form the buttonhole before formation of a second buttonholing seam; and the control device performs an opening width varying control of controlling the press mechanism so that it makes an opening width of the buttonhole larger in forming the second buttonholing seam than in forming a first buttonholing seam.

2. The buttonholing sewing machine according to claim 1, **characterized in that** in performing the buttonholing sewing control, the control device controls the knife mechanism so that it forms the buttonhole after formation of the first buttonholing seam and before formation of the second buttonholing seam.

3. The buttonholing sewing machine according to claim 1 or 2, **characterized in:**

that the buttonholing sewing machine further comprises an execution setting unit which sets whether the opening width varying control should be performed or not; **that** if execution of the opening width varying control is set, the control device performs the opening width varying control in performing the buttonholing sewing control; and **that** if execution of the opening width varying control is not set, the control device controls the press mechanism so that it maintains a constant opening width both during formation of the first

buttonholing seam and during formation of the second buttonholing seam.

4. The buttonholing sewing machine according to any one of claims 1 to 3, **characterized in:**

that the buttonholing sewing machine further comprises:

a data storage unit which stores plural kinds of sewing pattern data for formation of a buttonholing seam; and a data selection unit which selects sewing pattern data for formation of the first buttonholing seam and sewing pattern data for formation of the second buttonholing seam from the plural kinds of sewing pattern data stored in the data storage unit; and

that in performing the buttonholing sewing control, the control device causes formation of the double buttonholing seam on the basis of the two kinds of sewing pattern data selected by the data selection unit.

5. The buttonholing sewing machine according to any one of claims 1 to 4, **characterized in that** the press mechanism varies the opening width in a direction of widening the buttonhole in the sewing object by a combination of operations of plural air cylinders.

6. The buttonholing sewing machine according to any one of claims 1 to 4, **characterized in that** the press mechanism varies the opening width in a direction of widening the buttonhole in the sewing object by varying an air supply rate of an air cylinder.

FIG. 1

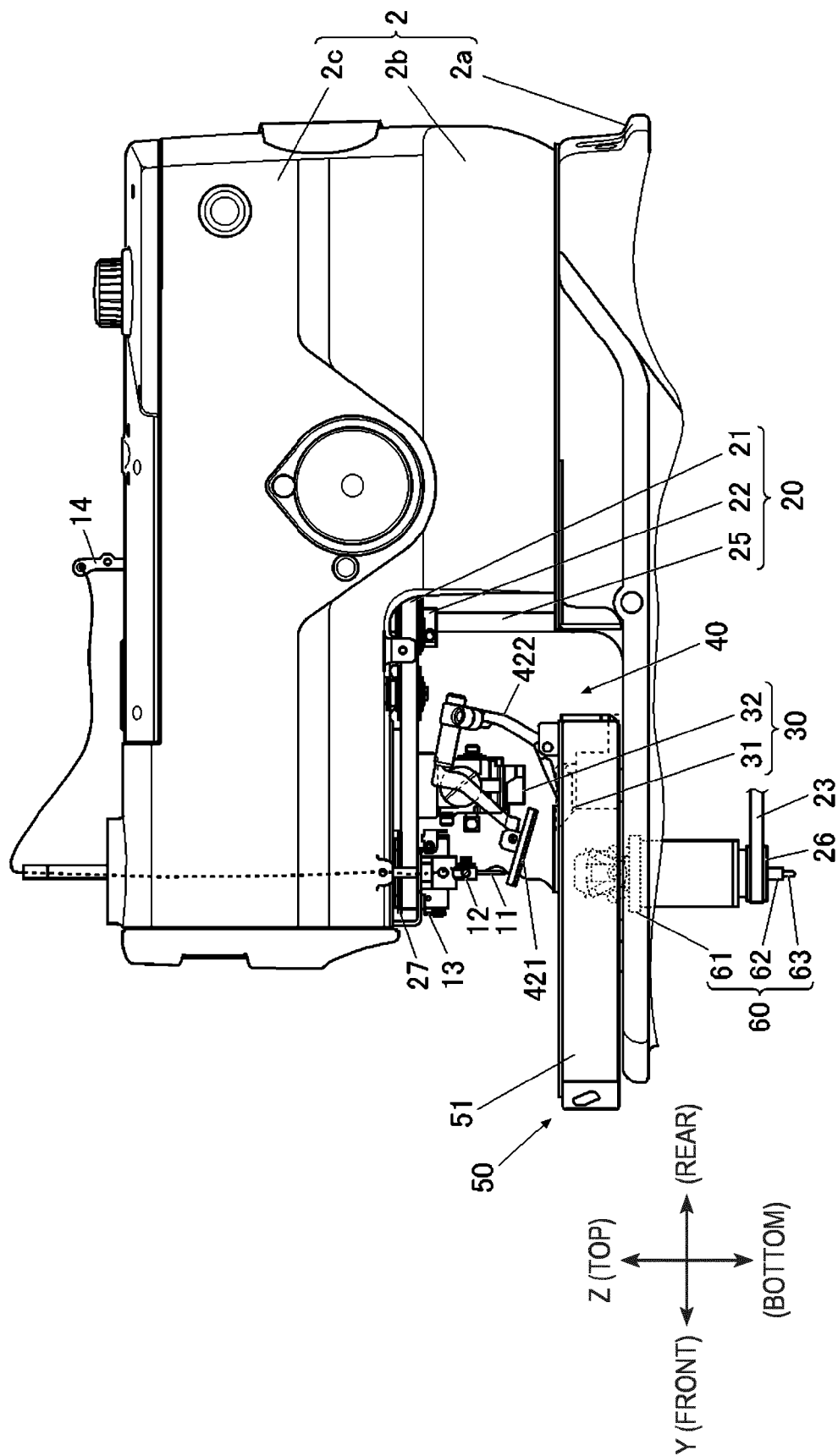


FIG. 2

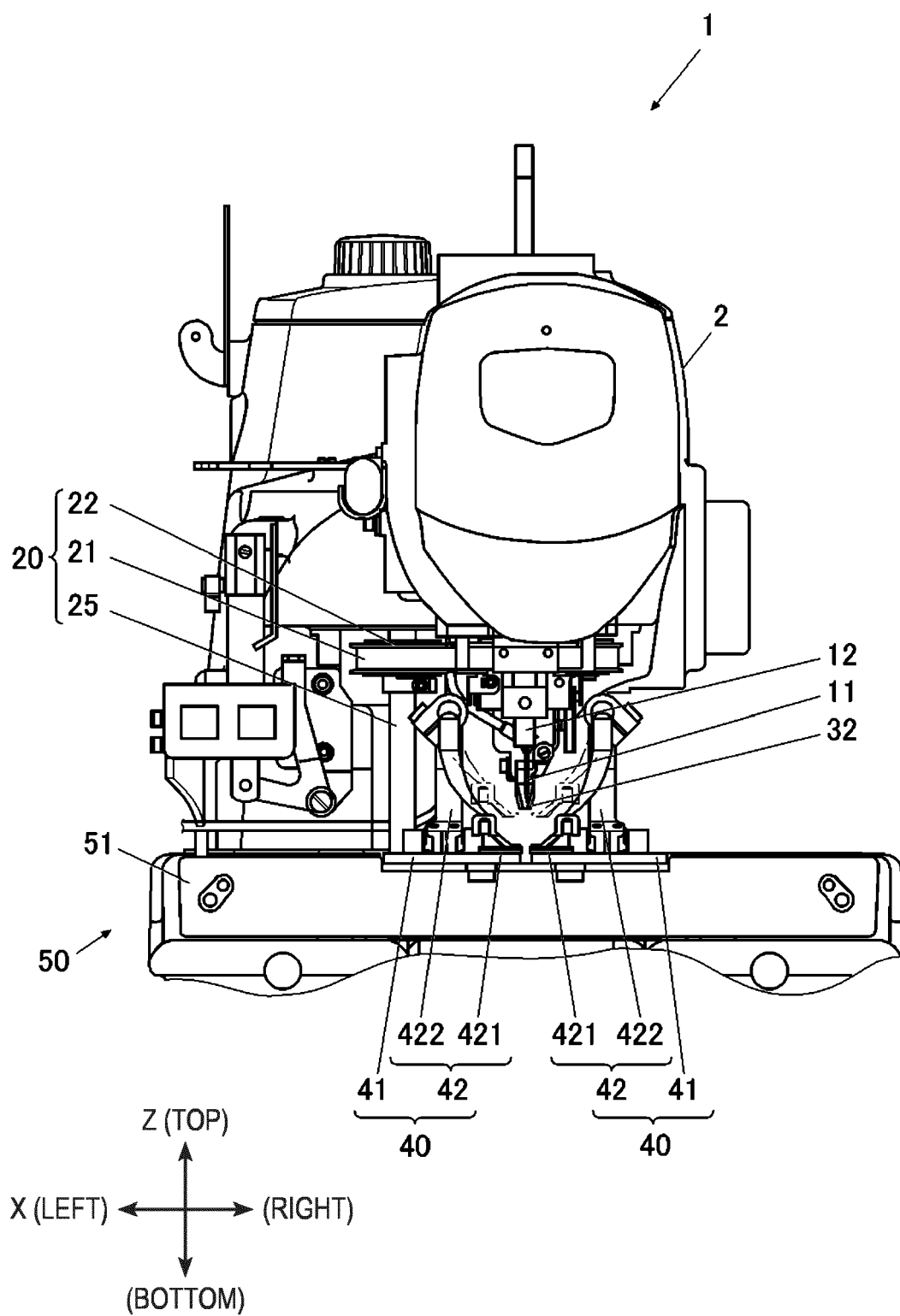
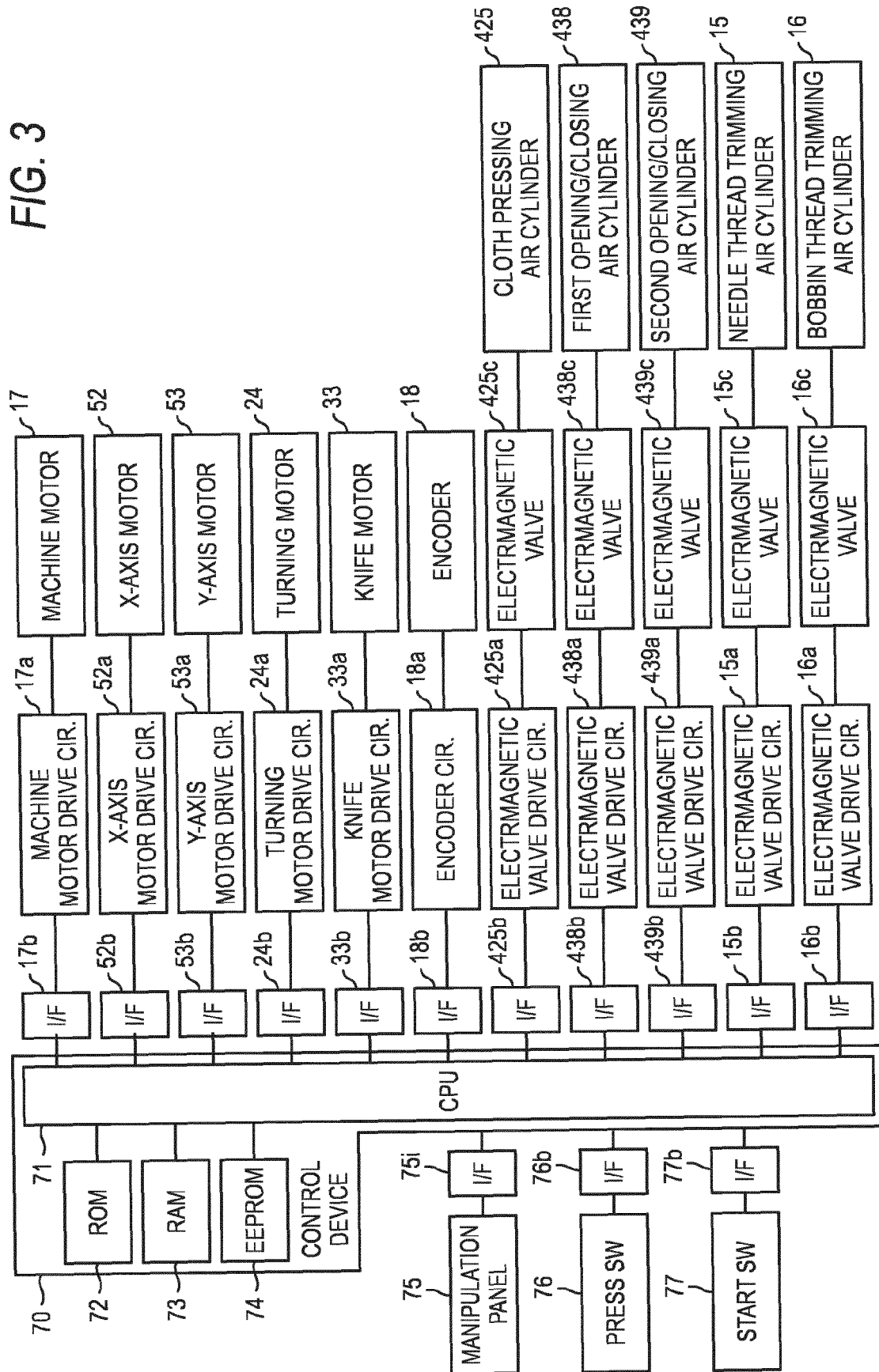


FIG. 3



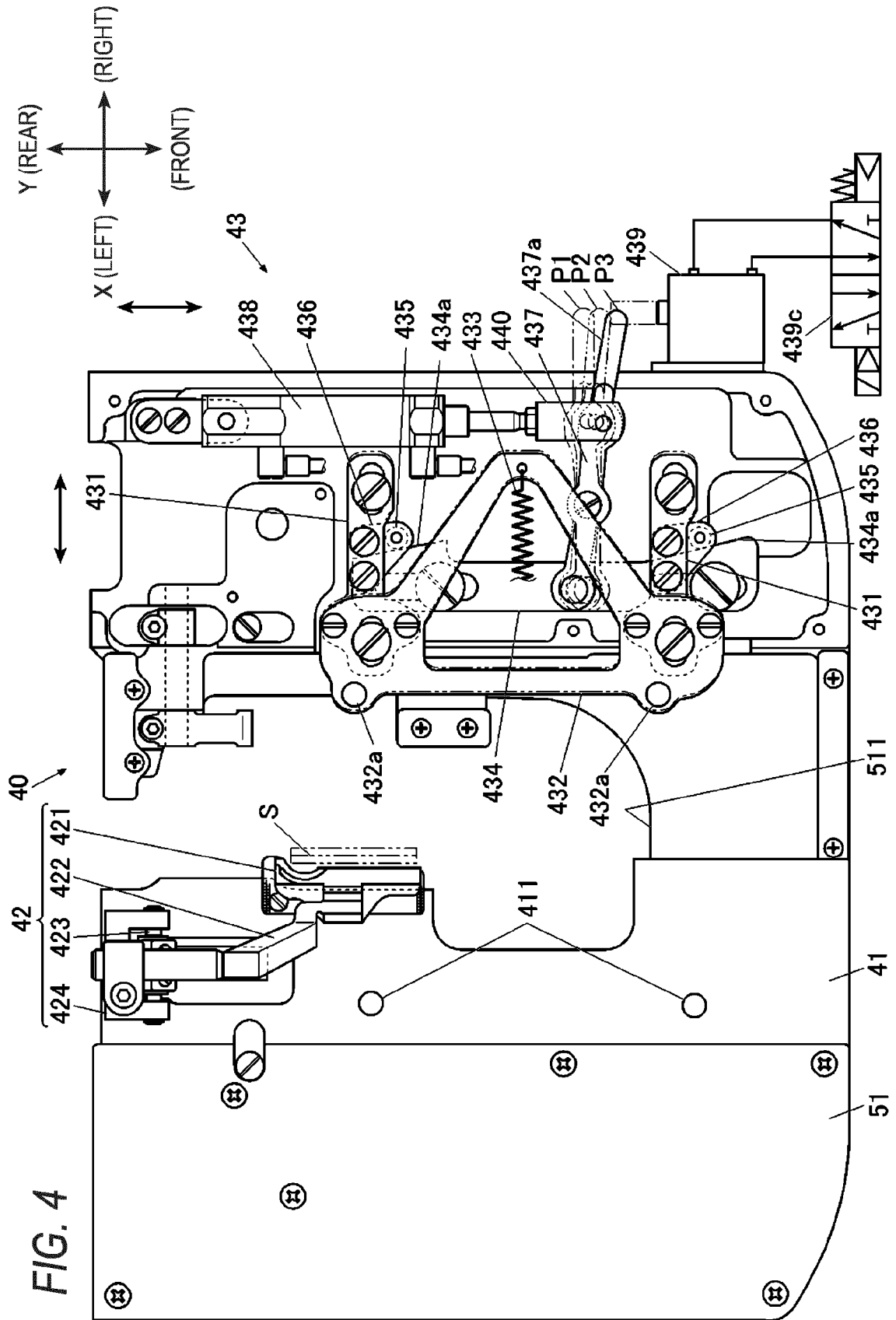


FIG. 5

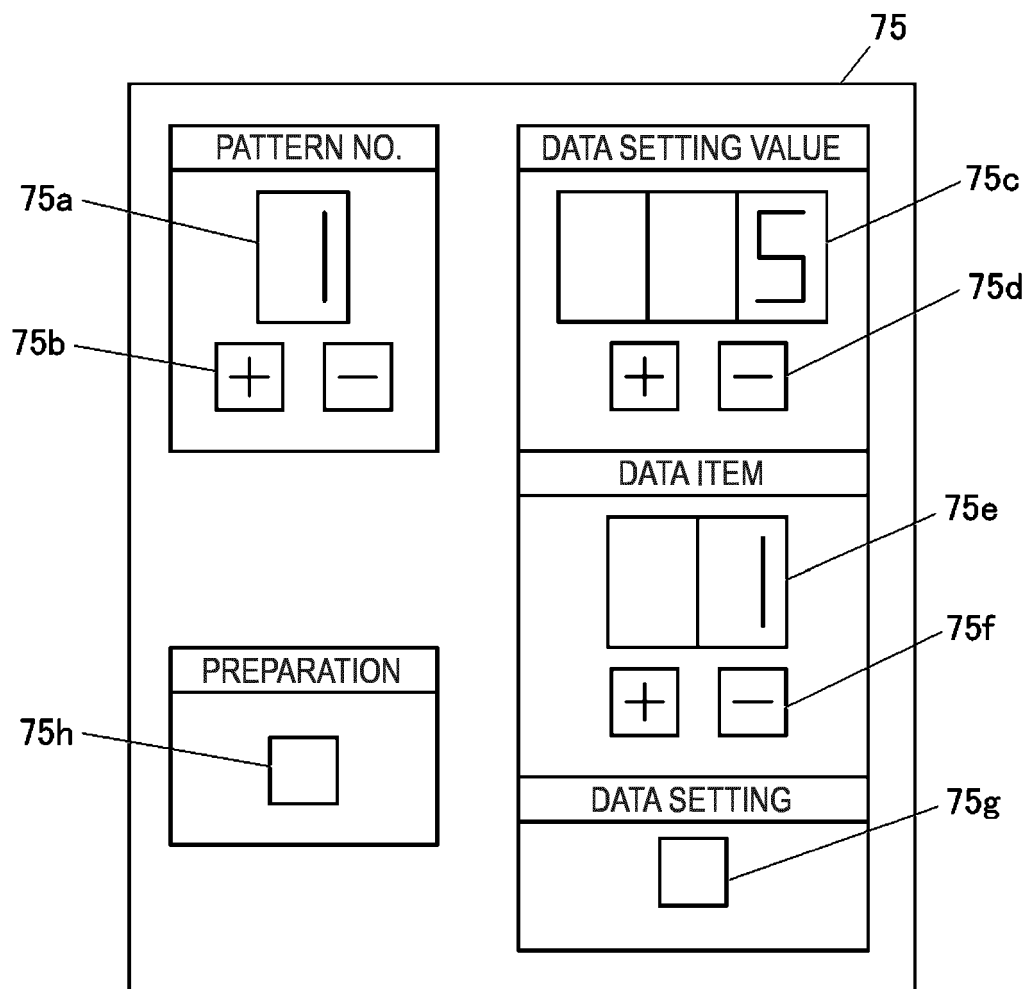


FIG. 6

No.	DATA ITEM	DETAILS OF DATA
1	EYELET HOLE SHAPE	0: SLEEPING EYE HOLE; 1-5: EYELET HOLE SHSHAPE
2	HOLING LENGTH	TOTAL LENGTH OF HOLE OH HOLING SEAM
3	CLOTH CUTTING KNIFE OPERATION	0: NONE; 1: ADVANCE CUTTING; 2: POST-CUTTING
4	NUMBER OF PARALLEL STITCHES	NUMBER OF STITCHES IN PARALLEL PORTION AND SLANT PORTION
5	NUMBER OF ARC PORTION STITCHES	NUMBER OF STITCHES IN ARC PORTION
6	PARALLEL PORTION KNIFE GAP	GAP BETWEEN INSIDE NEEDLE DROP POSITION IN PARALLEL PORTION AND CLOTH-CUTTING KNIFE
7	ARC PORTION KNIFE GAP	GAP BETWEEN INSIDE NEEDLE DROP POSITION IN ARC PORTION AND CLOTH-CUTTING KNIFE
8	BAR TACKING TYPE	0: NONE; 1: TAPER BAR TACKING; 2: STRAIGHT BAR TACKING; 3: ROUND BAR TACKING
9	TAPER BAR TACK STITCH LENGTH	LENGTH OF TAPER BAR TACK STITCH
↓	↓	↓
15	NUMBER OF ROUND BAR TACK STITCHES	NUMBER OF ROUND BAR TACK STITCHES
↓	↓	↓
20	NEEDLE SWING WIDTH	NEEDLE SWING WIDTH
21	DOUBLE SEWING PATTERN NUMBER	0: DOUBLE SEWING NOT PERFORMED; NUMBER OTHER THAN "0": PATTERN NUMBER OF SECOND SEWING PATTERN DATA
22	FIRST-SEWING CLOTH OPENING WIDTH	0: NO CLOTH OPENING; 1: FULL CLOTH OPENING; 2: HALF CLOTH OPENING

PATTERN DATA 1
PATTERN DATA 2
PATTERN DATA 3
PATTERN DATA 4
PATTERN DATA 5
↓

FIG. 7A

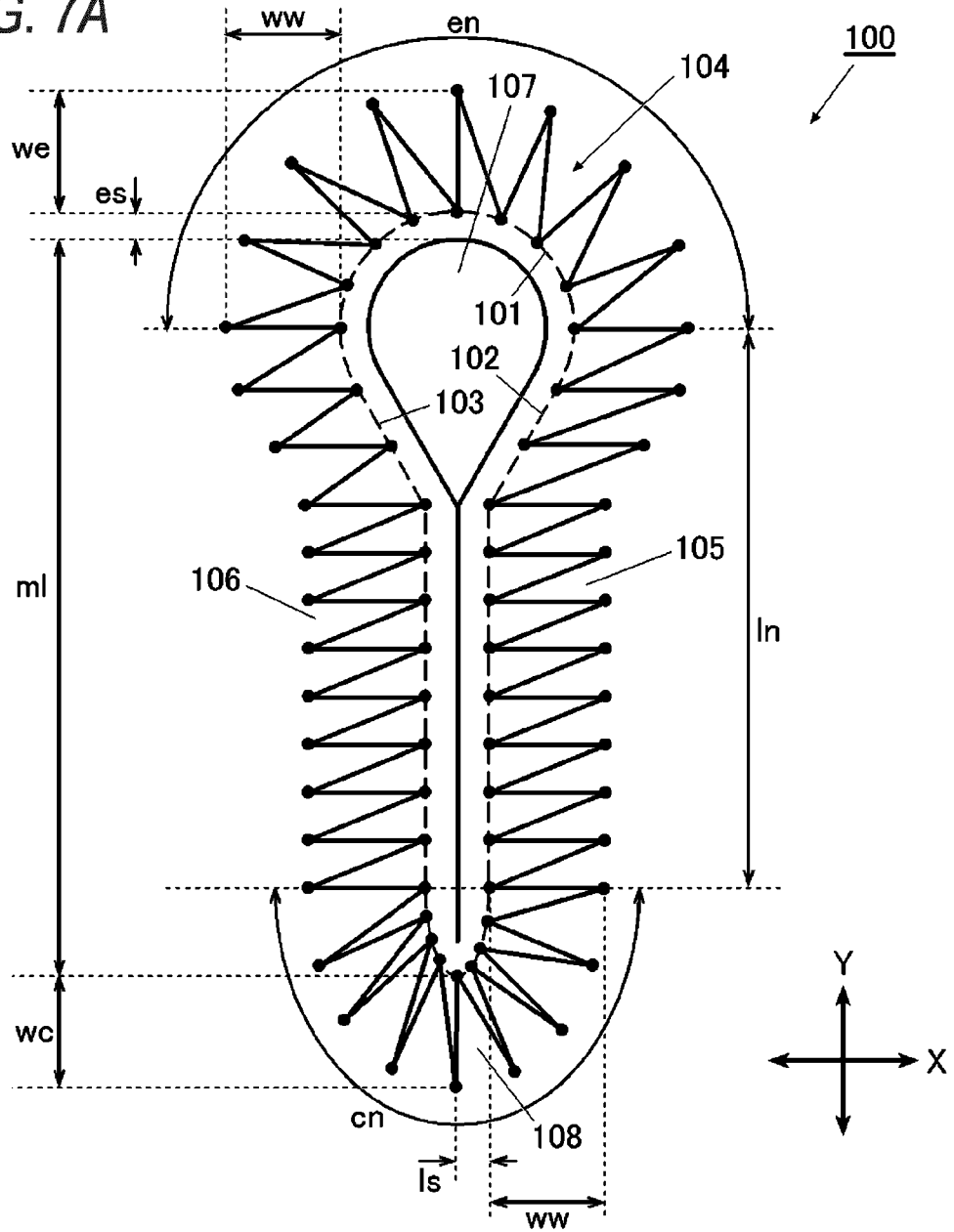


FIG. 7B

ml	HOLING LENGTH
ln	NUMBER OF PARALLEL STITCHES
en	NUMBER OF ARC PORTION STITCHES
ls	PARALLEL PORTION KNIFE GAP
es	ARC PORTION KNIFE GAP
cn	NUMBER OF ROUND BAR TACK STITCHES
ww	NEEDLE SWING WIDTH

FIG. 8A

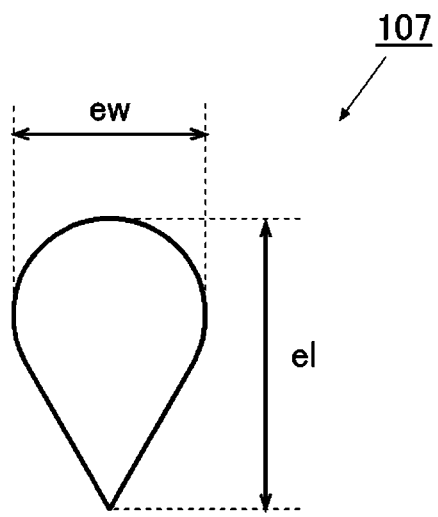


FIG. 8B

EYELET HOLE SHAPE	$ew \times el$
0	SLEEPING EYE HOLE
1	2.1×3.2
2	2.5×3.8
3	2.9×4.4
4	3.0×4.6
5	3.2×5.4

FIG. 9

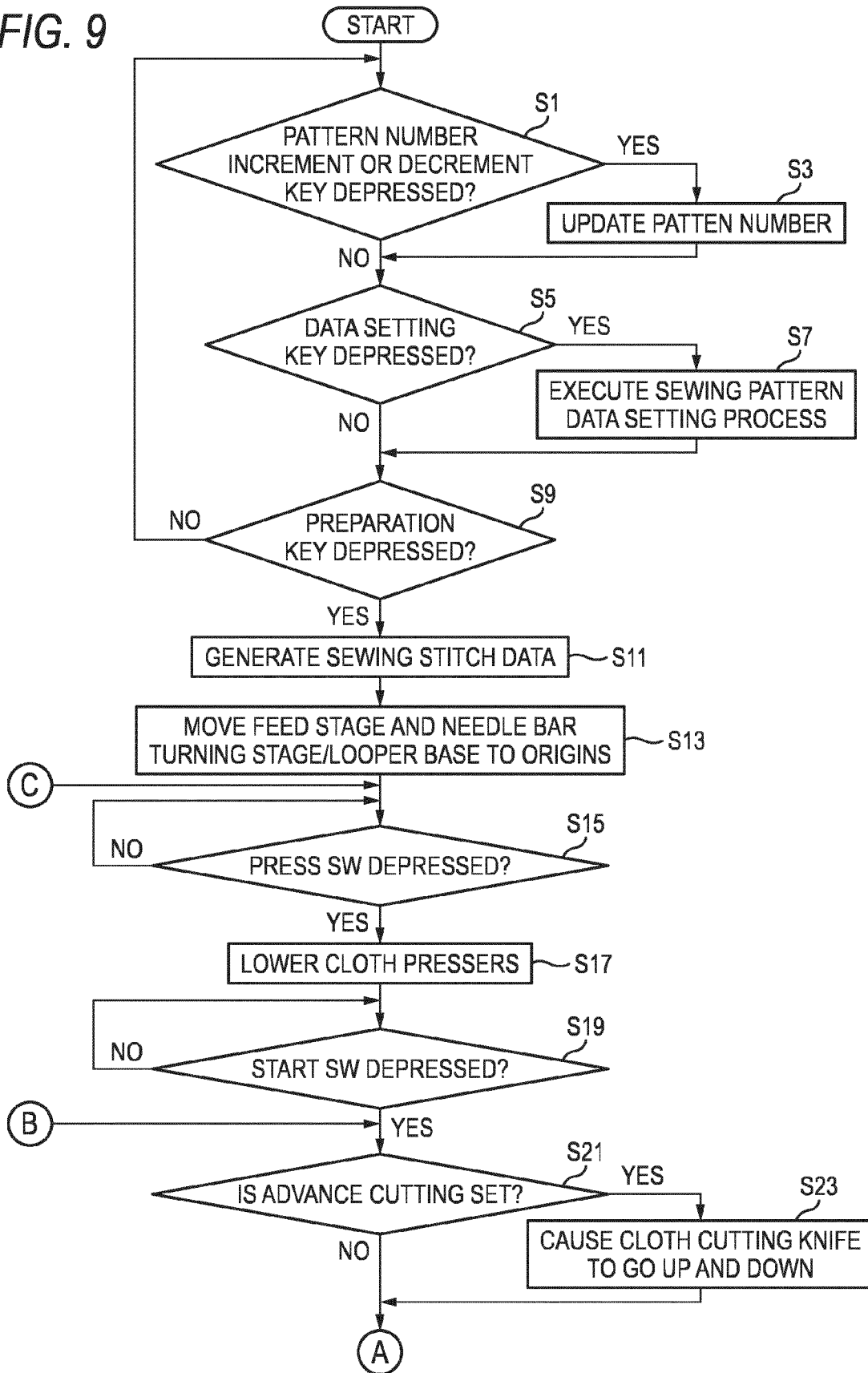


FIG. 10

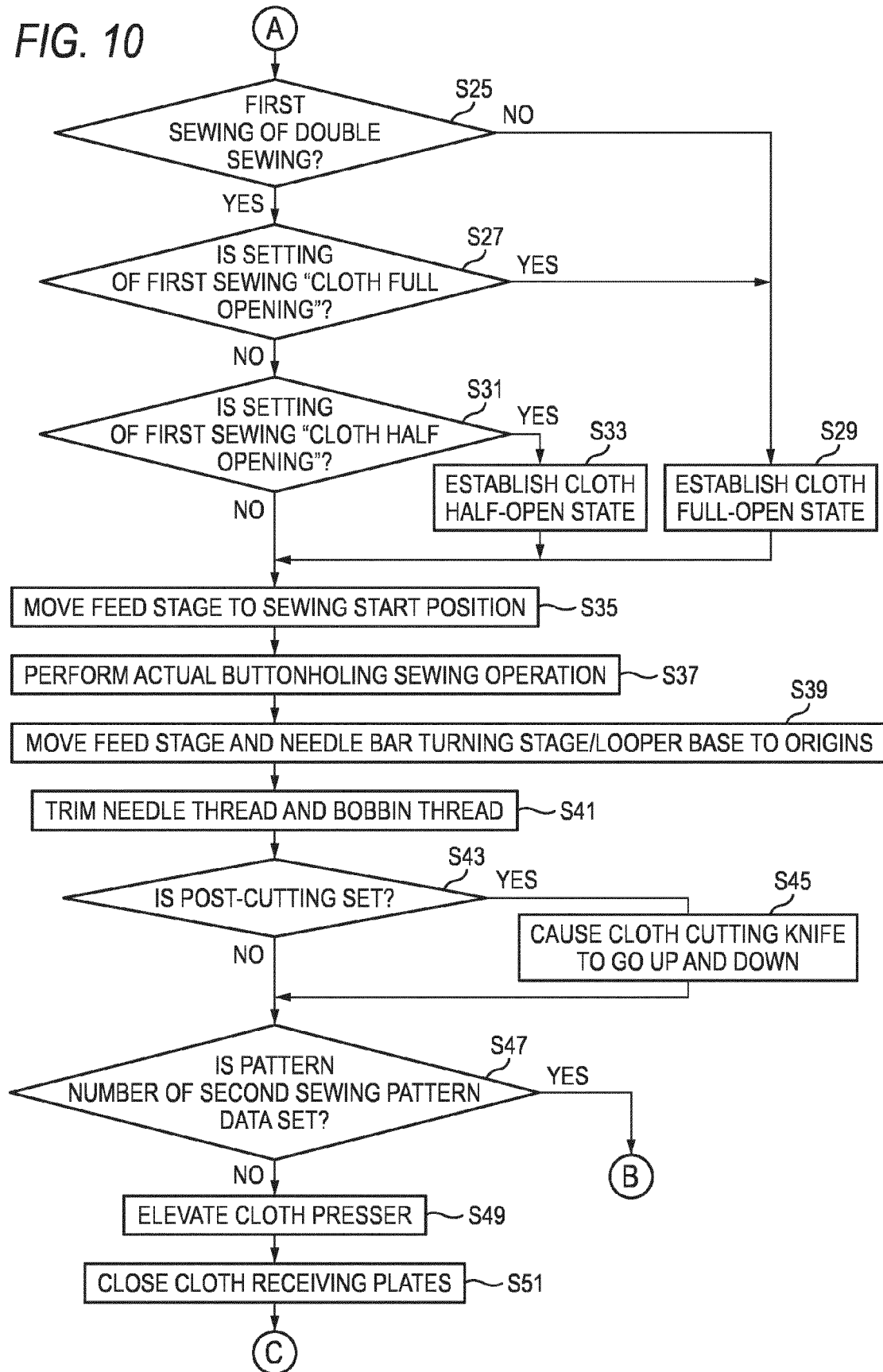


FIG. 11

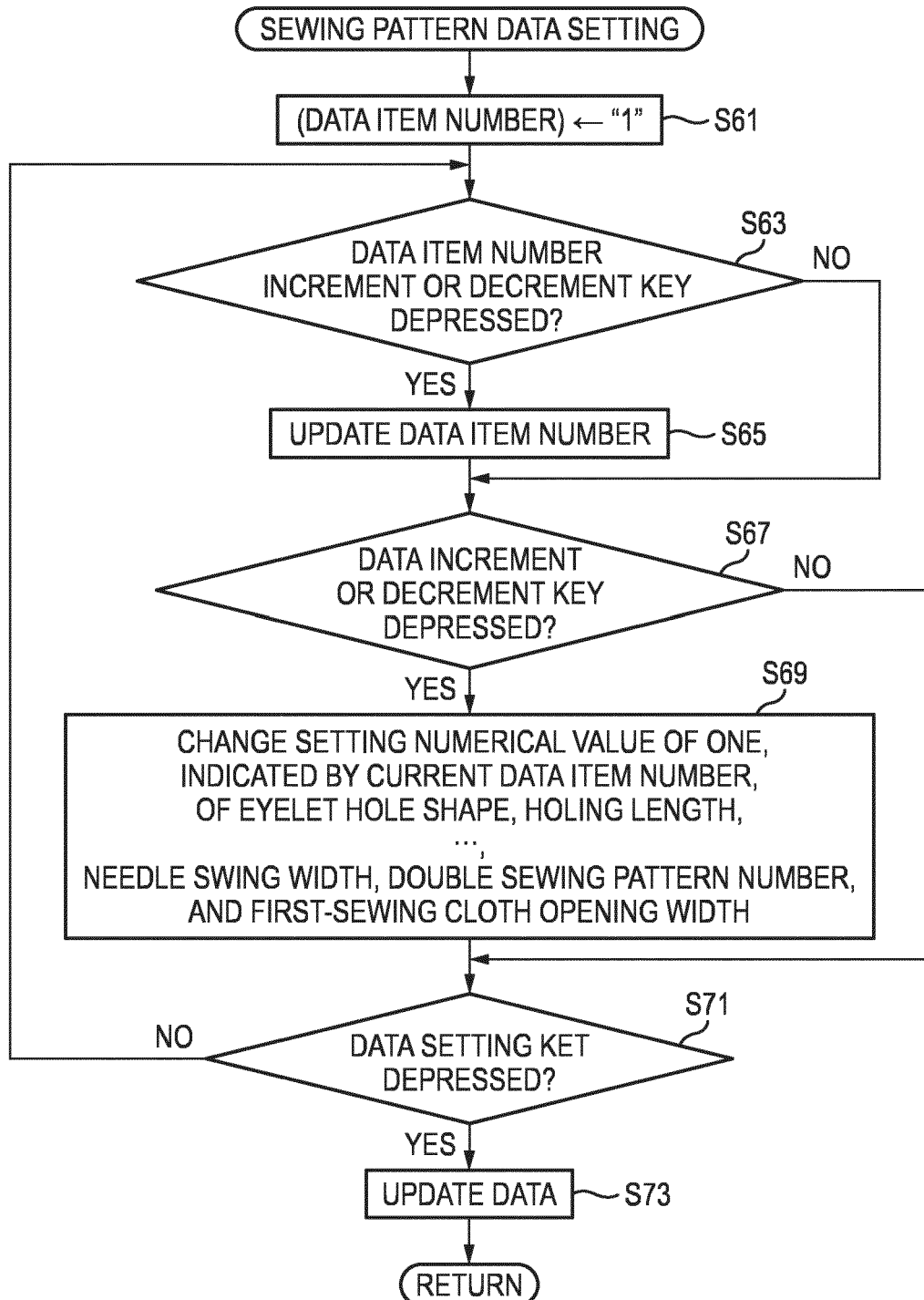
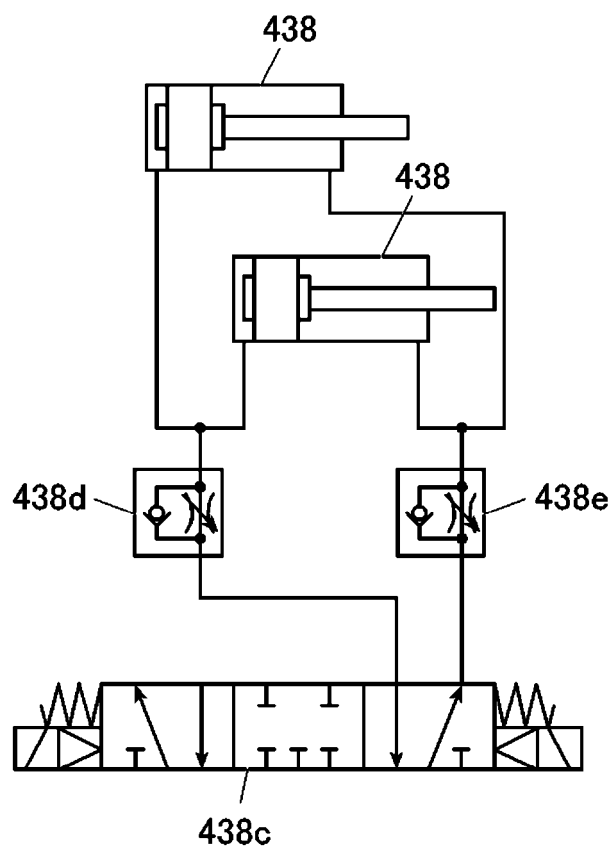


FIG. 12





EUROPEAN SEARCH REPORT

Application Number
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Place of search Munich		Date of completion of the search 24 August 2016	Examiner Herry-Martin, D
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