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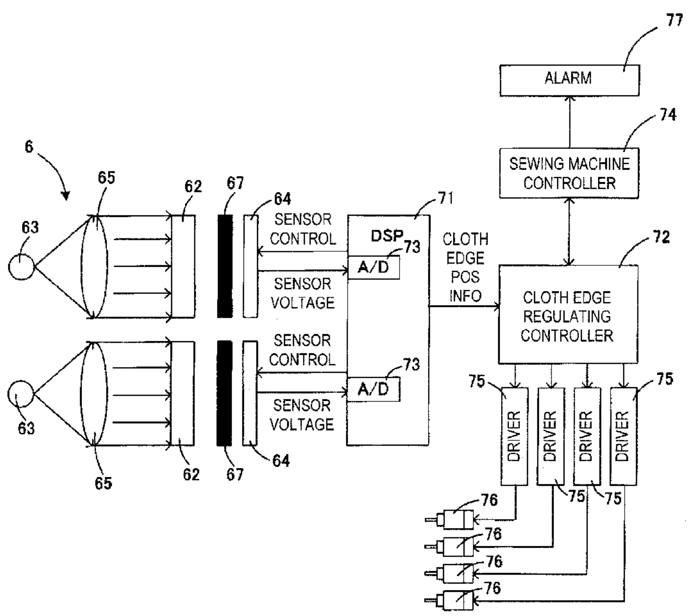
(54) **Cloth edge position detecting device and sewing machine**

(57) The present invention relates to a cloth edge position detecting device and a sewing machine. The cloth edge position detecting device includes a cloth edge sensor (6) configured to output a voltage corresponding to a cloth edge position and a control section (71, 72) configured to detect the cloth edge position based on the voltage output from the cloth edge sensor (6). The control section (71, 72) determines that a position (Pos) at which a voltage change exceeding a cloth edge determining threshold (Ve) appears first in the direction from the inner side to the outer side of the workpiece cloth (W) across the cloth edge is the cloth edge position.

FIG. 3



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Description

[0001] The present invention relates to a cloth edge position detecting device for a sewing machine configured to sew upper and lower workpiece cloths together and a sewing machine having the cloth edge position detecting device.

[0002] JP5-277273A discloses a cloth edge position detecting device of a sewing machine that detects a change in shape of a cloth edge. This cloth edge position detecting device is provided with a cloth edge sensor, a notch sensor, and a fluff sensor that are opposed to a workpiece cloth placed on a cloth table. The cloth edge sensor, the notch sensor, and the fluff sensor are arranged side by side in a lateral direction orthogonal to the cloth feeding direction, and with the cloth edge sensor in the middle, the notch sensor is disposed on the inner side of the workpiece cloth and the fluff sensor is disposed on the outer side of the workpiece cloth. Each of the sensors is configured to output a voltage corresponding to an area overlapping the workpiece cloth in a top view.

[0003] When there is no fluff or the like at the cloth edge, a voltage corresponding to an area of the workpiece cloth overlapping the cloth edge sensor is output, and an average displacement of the cloth edge position is calculated. On the other hand, when there is a fluff at the cloth edge, a voltage corresponding to a total area of the workpiece cloth and the fluff overlapping the cloth edge sensor is output. By subtracting the voltage corresponding to the area of the fluff overlapping the fluff sensor from the voltage of the cloth edge sensor, an average displacement of the cloth edge position that takes into account the fluff is calculated. In the cloth edge position detecting device described in Patent Document 1, the cloth edge position is adjusted in the lateral direction based on the average displacement of the cloth edge position, whereby sewing is carried out with a constant seam allowance.

[0004] However, in the cloth edge position detecting device described above, the fluff sensor and the notch sensor are required to be provided in addition to the cloth edge sensor, so that the device configuration is complicated. In addition, the cloth edge position is detected by applying arithmetic processing to the output voltages of the sensors, so that the detection processing is complicated.

[0005] The present invention has been made in view of these circumstances, and it is an object thereof to provide a cloth edge position detecting device and a sewing machine which can detect a cloth edge position by a simple configuration.

[0006] According to an aspect of the present invention, a cloth edge position detecting device includes a cloth edge sensor configured to output a voltage corresponding to a cloth edge position, the cloth edge position being a position of a cloth edge of a workpiece cloth to be fed in a cloth feeding direction such that the cloth edge is disposed along the cloth feeding direction, and a control section configured to detect the cloth edge position in a direction orthogonal to the cloth feeding direction based on the voltage output from the cloth edge sensor. The control section determines that a position at which a voltage change exceeding a cloth edge determining threshold appears first in the direction from the inner side to the outer side of the workpiece cloth across the cloth edge is the cloth edge position.

[0007] With this configuration, even when a voltage change exceeding the cloth edge determining threshold appears repeatedly due to several fluffs (simple fluffs), a cloth edge position is set at the position at which the voltage change exceeding the cloth edge determining threshold appeared first. Therefore, the cloth edge position of the workpiece cloth is detected irrespective of voltage changes caused by the fluffs. Accordingly, even when the fluffs project from the cloth edge, the cloth edge position of the workpiece cloth can be detected with a simple device configuration and detection processing, without need to separately provide a sensor for detecting the fluffs.

[0008] In the above-described cloth edge position detecting device, the control section may be configured to determine a cloth condition as a fluff when the position determined as the cloth edge position changes by a first threshold or more in a direction from the inner side to the outer side of the workpiece cloth within a first cloth feeding time or during feeding of the workpiece cloth by a first cloth feeding amount. With this configuration, for example, a comparatively large fluff like a complex fluff formed of many fluffs entwined with each other can be detected based on a sharp change in the cloth edge position.

[0009] In the above-described cloth edge position detecting device, the control section may be configured to determine the cloth condition as a notch when the position determined as the cloth edge position changes by the first threshold or more in the direction from the outer side to the inner side of the workpiece cloth within the first cloth feeding time or during the feeding of the workpiece cloth by the first cloth feeding amount. With this configuration, a notch provided in the workpiece cloth can be detected based on a sharp change in the cloth edge position.

[0010] In the above-described cloth edge position detecting device, the control section may be configured to determine the cloth condition as a stepped portion when the cloth condition is continuously determined as the fluff or the notch for a second cloth feeding time or more or for a period equal to or more than a time in which the workpiece cloth is fed by a second cloth feeding amount. With this configuration, based on whether a state after the position determined as the cloth edge position changed by the first threshold continues for a predetermined time, the fluff or notch and the stepped portion can be distinguished.

[0011] In the above-described cloth edge position detecting device, the cloth edge sensor may include an infrared LED configured to irradiate parallel light toward the surface of the workpiece cloth, a reflector disposed on the back surface of the workpiece cloth, and a CMOS linear sensor configured to receive the light reflected from the workpiece cloth. With this configuration, the cloth edge sensor can easily be configured by using reflection type optical sensors. The parallel light is not limited to perfect parallel light, and includes substantially parallel light.

[0012] According to an aspect of the present invention, a sewing machine includes the above-described cloth edge position detecting device, and a manipulator configured to adjust the position of the cloth edge in the direction orthogonal to the cloth feeding direction. The control section is configured to control the manipulator in proportion to a difference between the cloth edge position and a target position of the cloth edge when the fluff and the notch are not detected. With this configuration, the cloth edge position of the workpiece cloth can be adjusted by the manipulator based on a displacement of the cloth edge position.

[0013] In the above-described sewing machine, the control section may be configured to suspend the position adjustment by the manipulator when the fluff and the notch are not detected and when the difference between the cloth edge position and the target position of the cloth edge is within a predetermined allowable range. With this configuration, by providing an allowable range of the difference between the cloth edge position and the target position, stable position adjustment can be performed.

[0014] In the above-described sewing machine, the control section may be configured to suspend the position adjustment by the manipulator or to stop the entire sewing machine when the fluff or the notch is detected. With this configuration, the seam allowance does not follow the fluff and the notch.

[0015] In the above-described sewing machine, the manipulator may be configured to align the cloth edges of two workpiece cloths arranged on top of one another. With this configuration, in a top and bottom feed sewing machine configured to sew upper and lower workpiece cloths together, the cloth edge positions of the upper and lower workpiece cloths can be adjusted respectively.

[0016] In the above-described sewing machine, the cloth edge sensor and the stitch point may be arranged to be spaced away from each other so that the total time of the first cloth feeding time and the second cloth feeding time is equal to or less than a time in which the workpiece cloth is fed from the cloth edge sensor to the stitch point, or such that the total amount of the first cloth feeding amount and the second cloth feeding amount is equal to or less than a feeding amount by which the workpiece cloth is fed from the cloth edge sensor to the stitch point. With this configuration, the workpiece cloth is not fed to the stitch point before the total time of the cloth feeding time required for determining the stepped portion elapses or before the total amount of the cloth feeding amount required for determining the stepped portion is reached,.

[0017] The following description of preferred embodiments of the invention serves to explain the invention in greater detail in conjunction with the drawings. These show:

Fig. 1:	an enlarged view of a periphery of a stitch point of a sewing machine according to an embodiment;
Fig. 2:	a schematic view of a cloth edge sensor according to the embodiment;
Fig. 3:	a control block diagram of a cloth edge position detecting device according to the embodiment;
Figs. 4A to 4F:	diagrams illustrating examples of output characteristics of the cloth edge sensor according to the embodiment;
Figs. 5A to 5D:	diagrams illustrating a cloth edge determination according to the embodiment;
Fig. 6:	an example of a flowchart of the cloth edge determination according to the embodiment;
Fig. 7:	diagrams illustrating a cloth condition determination according to the embodiment;
Fig. 8:	an example of a flowchart of the cloth condition determination according to the embodiment;
Figs. 9A to 9D:	diagrams illustrating a cloth edge adjustment control according to the embodiment; and
Fig. 10:	an example of a flowchart of the cloth edge adjustment control according to the embodiment.

[0018] Hereinafter, an example in which a cloth edge position detecting device according to the present invention is applied to a top and bottom feed sewing machine will be described, however, the present invention is not limit to this example, changes may be made therein as appropriate. For example, the cloth edge position detecting device according to the present invention is applicable to other types of sewing machines such as a regular feed sewing machine.

[0019] A schematic configuration of a sewing machine according to the present embodiment will be described with reference to Fig. 1 and Fig. 2. Fig. 1 is an enlarged view of the periphery of the stitch point of the sewing machine according to the present embodiment. Fig. 2 is a schematic view of a cloth edge sensor according to the present embodiment. This sewing machine has the same configuration as that of a known sewing machine except for the principal portion around the stitch point, so that the main portions relating to the present invention will be described.

[0020] As shown in Fig. 1, a sewing machine 1 according to the present embodiment is configured to sew upper and lower workpiece cloths W (see Fig. 2) placed on a cloth table 2 together while feeding these in the same direction, respectively. A sewing machine head 3 positioned above the cloth table 2 is provided with a needle bar 31 and a presser bar (not illustrated) movably up and down. To the lower end of the needle bar 31, a sewing needle 32 is attached, and to the lower end of the presser bar, a presser foot 33 that presses the vicinity of a sewing position of the workpiece cloths

W is attached. In Fig. 1, a feed foot that comes into contact with the upper workpiece cloth W from above and feeds it forward and a feed dog that comes into contact with the lower workpiece cloth W and feeds it forward are not illustrated.

[0021] On the upstream side of the cloth table 2 in the cloth feeding direction, a pair of upper and lower manipulators 4 are provided. The manipulators 4 have a mechanism that feeds the workpiece cloths W in the cloth feeding direction and aligns the cloth edges in the lateral direction orthogonal to the cloth feeding direction. The manipulators 4 include drive rollers 41 that feed the workpiece cloths W in the cloth feeding direction. On the outer peripheral surface of the drive roller 41, a plurality of groove portions 42 are formed at even intervals along the circumferential direction, and each groove portion 42 houses a gear 43 rotatable in the lateral direction. A part of each gear 43 projects from the outer peripheral surface of the drive roller 41, and is contactable with the workpiece cloth W.

[0022] The drive rollers 41 are fixed to hollow roller drive shafts 44, and when the roller drive shafts 44 are driven to rotate, the drive rollers 41 rotate in the cloth feeding direction. The plurality of gears 43 are joined to a gear drive shaft (not illustrated) housed inside the roller drive shaft 44, and rotate by using a shaft parallel to the cloth feeding direction as a rotary shaft in conjunction with the rotation of the gear drive shaft. Accordingly, the workpiece cloths W are fed in the cloth feeding direction by the drive rollers 41 according to sewing pitches, and simultaneously, by rotating the plurality of gears 43 forward and reverse by using the shafts parallel to the cloth feeding direction as rotary shafts, sewing with a constant seam allowance from the cloth edges to the sewing position (stitch point) is realized. Details of the alignment of the cloth edges of the workpiece cloths W will be described later.

[0023] Between the pair of upper and lower manipulators 4, a separating plate 5 that divides the space before the sewing position into upper and lower spaces is disposed. The separating plate 5 is positioned slightly higher than the cloth table 2, and forms feed paths for feeding the upper and lower workpiece cloths W to the cloth table 2. The upper workpiece cloth W is fed while being sandwiched between the upper surface of the separating plate 5 and the upper manipulator 4, and the lower workpiece cloth W is fed while being sandwiched between the lower surface of the separating plate 5 and the lower manipulator 4.

[0024] Between the sewing position and the manipulators 4, a cloth edge sensor 6 that detects the cloth edge positions of the workpiece cloths W is provided. The cloth edge sensor 6 has a sensor base 61 having a substantially U shape in a front view, and on the inner side of the sensor base, a reflector 62 (see Fig. 2) is supported horizontally. The reflector 62 is aligned in height with the separating plate 5, and forms portions of the feed paths of the upper and lower workpiece cloths W. On upper and lower opposed portions of the sensor base 61, reflection type optical sensors are disposed, respectively.

[0025] As shown in Fig. 2, each optical sensor includes an infrared light emitting diode 63 (infrared LED) as a light emitting element and a complementary metal oxide semiconductor linear sensor 64 (CMOS linear sensor) as a light receiving element. The infrared LED 63 is fixed to the sensor base 61 at a predetermined angle with respect to the reflector 62, and the CMOS linear sensor 64 is fixed to the sensor base 61 at an angle enabling the linear sensor to efficiently receive reflected light from the reflector 62. Diffused light from the infrared LED 63 is converted into parallel light by a lens portion 65, and becomes parallel light narrow and long in the lateral direction orthogonal to the cloth feeding direction via a slit 66. This parallel light is reflected by the reflector 62 via the workpiece cloth W, and received by the CMOS linear sensor 64 via an infrared filter 67.

[0026] In the CMOS linear sensor 64, by carrying out photoelectric conversion by a large number of sensor elements arranged in the lateral direction, a voltage change corresponding to the cloth edge position of the workpiece cloth W is detected. By outputting signals corresponding to the cloth edge positions of the workpiece cloths W from the cloth edge sensor 6, the workpiece cloths are aligned in the lateral direction by the manipulators 4. In the present embodiment, the infrared LED 63 is illustrated as a light emitting element, however, the light emitting element is not limited to this. The light emitting element may be a light source as long as the light source is capable of irradiating parallel light onto the workpiece cloth W. The parallel light does not need to be perfectly parallel to the lateral direction, and includes substantial parallel light.

[0027] The flow of signal processing in the cloth edge position detecting device will be described with reference to Fig. 3. Fig. 3 is a control block diagram of the cloth edge position detecting device according to the present embodiment.

[0028] As shown in Fig. 3, the cloth edge position detecting device includes a cloth edge sensor 6, a cloth edge sensor controller 71 (control section), and a cloth edge regulating controller 72 (control section). In the cloth edge sensor 6, parallel lights are received by the CMOS linear sensors 64 via the workpiece cloths W, and photoelectrically converted by the large number of sensor elements in the CMOS linear sensors 64. The sensor voltages output from the respective sensor elements are input into the cloth edge sensor controller 71 including such as a digital signal processor (DSP. In the cloth edge sensor controller 71, the sensor voltages are A/D conversion processed by A/D converters 73. In the cloth edge sensor controller 71, a cloth edge determination is performed according to the sensor voltages, and cloth edge position information showing the cloth edge positions of the workpiece cloths W is generated.

[0029] The cloth edge position information is input into the cloth edge regulating controller 72 including such as a microcomputer. In the cloth edge regulating controller 72, in response to a command from a higher-order sewing machine controller 74, cloth edge adjustment control based on the cloth edge position information is performed. The cloth edge regulating controller 72 controls drive motors 76 that drive the pair of upper and lower manipulators 4 via four drivers 75. In detail, the cloth edge regulating controller 72 controls cloth feeding of the workpiece cloths W with the upper and lower drive rollers 41 by two drive motors 76. By the remaining two drive motors 76, the gears 43 of the drive rollers 41 are rotated to adjust the positions in the lateral direction of the cloth edges of the workpiece cloths W.

[0030] In this case, in the cloth edge regulating controller 72, a cloth condition determination is performed based on cloth edge position information, and fluffs, notches, and stepped portions at the cloth edges are detected. The fluffs to be detected here are comparatively large fluffs such as complex fluffs formed of many fluffs entwined with each other. When a complex fluff or a notch is detected, the cloth edge regulating controller 72 aligns the cloth edges by the manipulators 4 to prevent the seam allowance from following the complex fluff or the notch. When a complex fluff or a notch is not detected, the cloth edge regulating controller 72 aligns the cloth edges so as to correct position displacements of the cloth edge positions.

[0031] The cloth edge regulating controller 72 may be configured to stop the entire sewing machine by outputting a stop signal to the sewing machine controller 74 when a complex fluff or a notch is detected. In this case, an alarm portion 77 may be made to indicate an alarm. In the present embodiment, the cloth edge determination is performed by the cloth edge sensor controller 71 and the cloth condition determination is performed by the cloth edge regulating controller 72, however, the configuration is not limited to this. It is also possible that the cloth edge determination and the cloth condition determination are performed by the cloth edge sensor controller 71. It is also possible that the cloth edge sensor controller 71 and the cloth edge regulating controller 72 are formed integrally.

[0032] Output characteristics of the cloth edge sensor are described with reference to Fig. 4A to Fig. 4F. Fig. 4A to Fig. 4F show examples of output characteristics of the cloth edge sensor according to the present embodiment.

[0033] As shown in Fig. 4A, when a workpiece cloth W does not pass through the cloth edge sensor 6, the voltage level of the output voltage waveform is constant in the sensing region of the CMOS linear sensor 64. As shown in Fig. 4B, when a workpiece cloth W without fluffs and the like passes through the cloth edge sensor 6, the voltage level of the output voltage waveform sharply changes from one point in the sensing region. In this case, the sharp voltage change point indicates the cloth edge of the workpiece cloth W, the side with the lower voltage level indicates the inner side of the workpiece cloth W, and the side with the higher voltage level indicates the outer side of the workpiece cloth W.

[0034] As shown in Fig. 4C, when a workpiece cloth W with several fluffs (simple fluffs) 91 passes through the cloth edge sensor 6, the voltage level of the output voltage waveform sharply changes at several points in the sensing region. In this case, the first sharp voltage change point in the direction from the inner side to the outer side of the workpiece cloth W in the sensing region indicates the cloth edge of the workpiece cloth W, and voltage fluctuations after the first voltage change point indicate the fluffs 91. Thus, when the workpiece cloth has the several fluffs 91, the cloth edge position can be identified by the position of the voltage change point.

[0035] As shown in Fig. 4D, when a workpiece cloth W with a comparatively large complex fluff 92 passes through the cloth edge sensor 6, the voltage level of the output voltage waveform sharply changes at several points in the sensing region. In this case, the complex fluff 92 is formed of uneven fluffs entangled with each other, so that it may cause the first voltage change point on the outer side of the workpiece cloth W relative to the cloth edge. Therefore, the cloth edge position cannot be identified according to the position of the voltage change point. This complex fluff 92 has a characteristic that it changes in shape in each cloth feeding, so that it changes the position of the sharp voltage change point in each cloth feeding.

[0036] As shown in Fig. 4E, when a workpiece cloth W with a notch 93 passes through the cloth edge sensor 6, the voltage level of the output voltage waveform sharply changes at one point in the sensing region. In this case, the notch 93 is cut inward of the workpiece cloth W, so that it causes a voltage change point on the inner side of the workpiece cloth W relative to the cloth edge (edge shift). Therefore, the cloth edge position cannot be identified according to the position of the voltage change point. The notch 93 has a characteristic that it temporarily changes the position of the sharp voltage change point.

[0037] As shown in Fig. 4F, when a workpiece cloth W with a stepped portion 94 passes through the cloth edge sensor 6, the voltage level of the output voltage waveform sharply changes at one point in the sensing region. In this case, the stepped portion 94 is a shift of the cloth edge position of the workpiece cloth W (edge shift), so that the sharp voltage change point indicates the cloth edge of the workpiece cloth W. The stepped portion 94 has a characteristic that it continues the shifted position of the sharp voltage change point.

[0038] In the present embodiment, the cloth edge determination and the cloth condition determination are performed based on the output voltage waveform described above. In the cloth edge determination, the cloth edge position is obtained, and in the cloth condition determination, the cloth condition, such as the complex fluff 92, the notch 93, the stepped portion 94, or the like, is determined based on the cloth edge position. Hereinafter, the cloth edge determination and the cloth condition determination are described with reference to Fig. 5A to Fig. 8.

[0039] First, the cloth edge determination will be described. Fig. 5A to Fig. 5D are diagrams illustrating the cloth edge determination according to the present embodiment. Fig. 6 is an example of a flowchart of the cloth edge determination according to the present invention. In the flowchart of Fig. 6, according to outputs from the upper and lower CMOS sensors, the upper and lower workpiece cloths are subjected to the cloth edge determination simultaneously.

[0040] As shown in Fig. 5A, the CMOS linear sensor 64 of the cloth edge sensor 6 includes 128-sectioned sensor elements arranged side by side in the lateral direction orthogonal to the cloth feeding direction. The voltage output from the CMOS linear sensor 64 is taken into the cloth edge sensor controller 71. In the cloth edge sensor controller 71, A/D conversion is performed as many times as the number of sensor elements. The A/D conversion is performed for the sensor elements from the 0-th sensor element to the 127-th sensor element in order. Specifically, in one cloth edge sensor 6, A/D conversion is repeated 128 times. This A/D conversion is performed in the upper and lower CMOS linear sensors 64 simultaneously.

[0041] As shown in Fig. 5B, from 128 pieces of data, a search is made for a point passing through the threshold Ve of a rise edge. Then, a voltage change point exceeding the threshold Ve first in the direction from the inner side to the outer side of the workpiece cloth W is recognized as a cloth edge position. Accordingly, as shown in Fig. 4C, even when a plurality of voltage change points are caused by several fluffs 91, a cloth edge position is detected irrespective of the fluffs. Thus, cloth edge positions not only of the workpiece cloths W shown in Fig. 4B and Fig. 4F but also of the workpiece cloth W shown in Fig. 4C are detected. The threshold Ve is a threshold enabling identification of a cloth edge even of the workpiece cloth W with the several fluffs 91, and is experimentally obtained.

[0042] Here, as shown in Fig. 4D and Fig. 4E, even if the voltage change point exceeding the threshold Ve first does not match the actual cloth edge position due to the complex fluff 92 or the notch 93, this voltage change point is assumed to be a cloth edge position. Cloth edge position information obtained through the cloth edge determination is used in the subsequent cloth condition determination.

[0043] As shown in Fig. 6, when a sensor process of the cloth edge sensor 6 is started, output voltages of the i-th (i = 0 to 127) sensor elements of the upper and lower CMOS linear sensors 64 are A/D converted (Step S01). Next, the A/D conversion result is stored in the sensor buffer variable BUF0 [i] for the upper linear sensor (Step S02). Then, the A/D conversion result is stored in the sensor buffer variable BUF1 [i] for the lower linear sensor (Step S03). Next, in a counter, the value i is incremented by 1 (Step S04), and it is determined whether the value i has exceeded 127 (Step S05).

[0044] When the value i does not exceed 127 (No in Step S05), the A/D conversion process from Step S01 to Step S05 is repeated. Thus, the A/D conversion process is repeated 128 times for the leading sensor element (i = 0) to the last sensor element (i = 127). When the A/D conversion process is repeated 128 times and the value i exceeds 127 (Yes in Step S05), the value i in the counter is reset (Step S06).

[0045] Next, it is determined whether the data stored in the i-th BUF0 [i] for the upper linear sensor has exceeded the threshold Ve (Step S07). When the data of BUF0 [i] exceeds the threshold Ve (Yes in Step S07), the position of the i-th sensor element is recognized as the voltage change point Edge0 (Step S10). On the other hand, when the data of BUF0 [i] does not exceed the threshold Ve (No in Step S07), the value i in the counter is incremented by 1 (Step S08), and it is determined whether the value i has exceeded 127 (Step S09). When the value i does not exceed 127 (No in Step S09), the voltage change point search process from Step S07 to Step S09 is repeated. Thus, the data of BUF0 are compared with the threshold Ve in ascending order.

[0046] Next, the value i in the counter is reset (Step S10), and in the lower linear sensor, the process of searching for the voltage change point Edge1 is performed in the same manner as in the upper linear sensor (Steps S11 to S14). Based on the voltage change points Edge 0 and 1 thus obtained, the cloth edge position information is calculated. In detail, when the sensing region of the CMOS linear sensors 64 is 8 mm, the cloth edge position information is calculated by the following formula (1).

$$\text{Cloth edge position information} = \text{Edge}/128 \times 8 \ldots (1)$$

For example, when Edges 0 and 1 are the results of the 30-th A/D conversion, the cloth edge position information is calculated as 1.875 mm.

[0047] As shown in Fig. 5C and Fig. 5D, when the workpiece cloths W are narrow and long in the cloth feeding direction, they may be disposed on the inner side of the cloth edge sensor 6 inversely with the case of Fig. 5A and Fig. 5B. In this case, the voltage change point search process is performed in descending order from the 127-th A/D conversion result.

[0048] Next, the cloth condition determination will be described. Fig. 7 are diagrams illustrating the cloth condition determination according to the present embodiment. Fig. 8 is an example of a flowchart of the cloth condition determination according to the present embodiment. In Fig. 8, only the process in the upper linear sensor is described, however, the process is also performed in the lower linear sensor simultaneously.

[0049] As described above, when the workpiece cloth has the complex fluff 92 and the notch 93, the voltage change point and the actual cloth edge position do not match each other, and in the cloth edge determination, the actual cloth edge position cannot be detected. Therefore, it is preferable that the alignment is stopped until the complex fluff 92 or the notch 93 passes through the cloth edge sensor 6, or the cloth edge is aligned based on cloth edge position information just before the complex fluff 92 or the notch 93. On the other hand, unlike the complex fluff 92 and the notch 93, the stepped portion 94 indicates the cloth edge of the workpiece cloth W changed in cloth width, and the actual cloth edge position can be detected at the cloth edge determination. Therefore, it is preferable that the cloth edge is aligned based on the cloth edge position information.

[0050] Therefore, in the present embodiment, based on cloth edge position information obtained through the cloth edge determination, the complex fluff 92, the notch 93, and the stepped portion 94 are detected by the cloth condition determination. As shown in Fig. 7A, in the cloth condition determination, when data is delivered from the cloth edge sensor controller 71 to the cloth edge regulating controller 72, coordinate conversion is performed for coordinates used in the cloth edge determination. Here, the coordinates [0 to 127] used in the cloth edge determination are converted into coordinates [-64 to 63], and the alignment target position is set to 0. Specifically, the cloth edge target position is set to the center of the sensing region of the CMOS linear sensor 64.

[0051] Fig. 7B shows a timing chart of the cloth condition determination. The vertical axis indicates the displacement of the cloth edge position position information with respect to the target position, and the horizontal axis indicates the time. In this cloth condition determination, the cloth condition is determined based on four thresholds of ON, START, T_s (first cloth feeding time), and T_{on} (second cloth feeding time). ON, START, and T_s are used for identifying a sharp change of the cloth edge position information. For example, when the cloth edge position information reaches +ON within the time T_s from the time point exceeding +START, it is determined as the complex fluff 92. This is because the cloth edge position is greatly separated from the target position toward the outer side of the workpiece cloth W in a short time. When the cloth edge position information reaches -ON within the time T_s after the time point at which the cloth edge information exceeds -START, it is determined as a notch 93. This is because the cloth edge position is greatly spaced away from the target position toward the inner side of the workpiece cloth W in a short time. Specifically, when the cloth edge position information changes by the absolute value |ON-START| (first threshold) or more of the difference between ON and START within the first cloth feeding time T_s, the cloth condition is determined as the complex fluff 92 or the notch 93.

[0052] When the $\pm$ON state continues for the time T_{on} or more, the cloth condition is determined as the stepped portion 94. This is because the state where the cloth edge position is spaced away from the target position continues. In this case, the cloth condition is determined as the complex fluff 92 or the notch 93 until the $\pm$ON state reaches the time T_{on}. However, the time T_{on} is very short in millisecond order, so that a small delay of the determination process for the stepped portion 94 does not affect the seam allowance. Further, when the cloth edge position information exceeds the time T_s and reaches $\pm$ON, it is determined as a cloth edge. This is because the cloth edge position gently changes. The thresholds ON and START are appropriately set according to, for example, the lengths of the fluffs of the complex fluff 92 and the cutting depth of the notch 93. The thresholds T_s and T_{on} are appropriately set according to, for example, a cloth feeding speed, etc.

[0053] As shown in Fig. 8, when the cloth edge determination is started, the cloth edge position information obtained through the cloth edge determination is subjected to coordinate conversion (Step S21). At this time, the cloth edge position information Edge is converted into Pos, and the cloth edge alignment target position is set to 0. Next, it is determined whether the cloth edge position information Pos has exceeded +START (Step S22). When the cloth edge position information Pos exceeds +START (Yes in Step S22), the variable Time indicating an elapsed time after START is exceeded is incremented in the counter (Step S23).

[0054] When the cloth edge position information Pos does not exceed +START (No in Step S22), it is determined whether the cloth edge position information Pos has exceeded -START (Step S24). When the cloth edge position information Pos exceeds -START (Yes in Step S24), the variable Time is decremented in the counter (Step S25). When the cloth edge position information Pos does not exceed -START (No in Step S24), the variable Time is reset in the counter (Step S26).

[0055] Next, a limiter process for the variable Time is performed. Specifically, it is determined whether the variable Time has exceeded a maximum value LIMIT of the counter (Step S27). When the variable Time exceeds the maximum value LIMIT of the counter (Yes in Step S27), the maximum value LIMIT is set in the variable TIME (Step S28). When the variable Time does not exceed the maximum value LIMIT of the counter (No in Step S27), it is determined whether the variable Time has exceeded the minimum value -LIMIT of the counter (Step S29).

[0056] When the variable Time exceeds the minimum value -LIMIT of the counter (Yes in Step S29), the minimum value -LIMIT of the counter is set in the variable Time (Step S30). When the variable Time does not exceed the minimum value -LIMIT of the counter (No in Step S29), the variable Time is not changed.

[0057] Next, complex fluff determination is performed (Step S31). In this determination, when the cloth edge position information Pos exceeds +ON, the variable Time is smaller than T_s, and the variable On Time indicating an elapsed time after ON is exceeded is smaller than T_{on}, it is determined as the complex fluff 92. When it is determined as the complex fluff 92 (Yes in Step S31), a flag 1 indicating the complex fluff 92 is set as notification information, and the variable On Time is incremented in the counter (Step S32). When it is not determined as the complex fluff 92 (No in Step S31), notch determination is performed (Step S33).

[0058] In this determination, when the cloth edge position information Pos exceeds -ON, the variable Time is larger than - T_s, and the variable On Time is smaller than T_{on}, it is determined as the notch 93. When it is determined as the notch 93 (Yes in Step S33), a flag -1 indicating the notch 93 is set as notification information, and the variable On Time is incremented in the counter (Step S34). When it is not determined as the notch 93 (No in Step S33), the cloth condition is determined as the stepped portion 94 and a normal cloth edge. Then, a flag 0 is set as notification information, and the variable On Time is reset (Step S35).

[0059] Next, it is determined whether the variable On Time has exceeded the maximum value On Time Limit of the counter (Step S36). When the variable On Time exceeds the maximum value On Time Limit of the counter (Yes in Step S36), the maximum value On Time Limit of the counter is set in the variable On Time (Step S37). On the other hand, when the variable On Time does not exceed the maximum value On Time Limit of the counter (No in Step S36), the variable On Time is not changed.

[0060] Thus, by each of the upper and lower linear sensors, the complex fluff 92, the notch 93, and the stepped portion 94 are distinguished by the cloth edge determination and the cloth condition determination. In the cloth condition determination, continuous cloth feeding is assumed, however, intermittent cloth feeding is also possible. In this case, when cloth feeding is stopped, the determination process is repeated at the same place, so that when cloth feeding is stopped, the increment and decrement processes in Steps S23, S25, S32, and S34 are omitted.

[0061] To determine the cloth condition as a stepped portion, a total time of T_s and T_{on} is necessary. Therefore, if the workpiece cloth W is fed to the stitch point from the cloth edge sensor 6 before the total time of the T_s and T_{on} elapses, cloth edge alignment according to the stepped portion 94 cannot be performed in time. In order to solve this problem, in the present embodiment, a sufficient distance is secured between the cloth edge sensor 6 and the stitch point. In the mechanism that feeds the cloth in the cloth feeding direction by one pitch for each 360-degree rotation of the main shaft motor, when Do [mm] is the distance between the cloth edge sensor 6 and the stitch point, P [mm] is the cloth feeding pitch, N [min^{-1}] is the rotation speed of the motor, and A is the safety factor, the relationship of the following formula (2) is established.

$$(T_s + T_{on})/A \leq D_0/P \times 60/N \ ... \ (2)$$

[0062] Thus, the total time of T_s and T_{on} required for determining the stepped portion 94 is set to be shorter than the time of feeding of the workpiece cloth W from the cloth edge sensor 6 to the stitch point. Therefore, the workpiece cloth W is not fed to the stitch point before the total time required for determining the stepped portion 94 elapses, and cloth edge can be aligned in accordance with the stepped portion 94.

[0063] T_s and T_{on} may be changed according to the rotation speed of the main shaft motor. In this case, T_s and T_{on} at a reference rotation speed No [min^{-1}] of the main shaft motor are experimentally obtained in advance. When No [min^{-1}] is the reference rotation speed of the main shaft motor and N [min^{-1}] is a changed set rotation speed, changed T_s and T_{on} can be obtained by the following formulas (3) and (4). T_s and T_{on} are not limited to those obtained by the following formulas, and may be set optionally.

$$T_s' = N_0/ \times T_s \ ... \ (3)$$

$$T_{on}' = N_0/N \times T_{on} \ ... \ (4)$$

[0064] Referring to Fig. 9A to Fig. 10, a cloth edge adjustment control will be described. Figs. 9A to 9D are diagrams illustrating the cloth edge adjustment control according to the present embodiment. Fig. 10 is an example of a flowchart of the cloth edge adjustment control according to the present embodiment.

[0065] In the system shown in Fig. 9A, full closed loop control using the cloth edge position information as feed-back information is performed. The motor system includes a motor driver B1 and a servo motor B2 with an encoder. In this motor system, by inputting a position command into the motor driver B1, the servo motor B2 is driven following the position command, and cloth edge position control is performed by the manipulator B3.

[0066] In the linear sensor process block B5, a voltage output from the CMOS linear sensor B4 according to the cloth edge position of the workpiece cloth W is detected. In the cloth edge determination block B6, cloth edge position information is calculated based on the output from the linear sensor process block B4. The cloth edge position information is input into the cloth condition determining block B7 and the summing point P2 via the drawing point P1. In the cloth condition determining block B7, the cloth condition (flag) is determined based on the cloth edge position information. The cloth condition is notified to the controller B8.

[0067] On the other hand, at the summing point P2, the cloth edge position information input via the drawing point P1 is subtracted from the position command θ_{CMD} indicating a cloth edge target position to obtain a deviation Err. In the controller B8, the deviation Err is multiplied by a position gain K_1 ($\theta = K_1$ x Err), and output as a position command θ to the motor driver B1. Here, on the assumption that K_1 is 1 and the target position is 0, the position command θ shown in Fig. 9B is output. When the deviation Err is within the allowable range from do to d_1 of the commanded position θ_{CMD}, a motor stop command is input from the controller B8 into the motor driver B1. Accordingly, stable alignment control can be performed. The position gain K_1 and the allowable range from do to d_1 are experimentally determined.

[0068] When the cloth condition is the complex fluff 92 and the notch 93, a motor stop command is input from the controller B8 into the motor driver B1. Accordingly, the seam allowance is prevented from following the complex fluff 92 and the notch 93. Instead of the input of the motor stop command, the process may be performed based on arbitrary cloth edge position information just before detecting the complex fluff 92 and the notch 93.

[0069] As shown in Fig. 10, first, cloth edge position information is detected by the cloth edge determination (Step S41). Next, the cloth condition is determined by the cloth condition determination (Step S42). Here, when the cloth condition is determined as the complex fluff 92 or the notch 93, i = 1 is set. When the cloth condition is determined as other than the complex fluff 92 and the notch 93, i = 0 is set. Next, it is determined whether the cloth condition is other than the complex fluff 92 and the notch 93 (Step S43).

[0070] When the cloth condition is determined as the complex fluff 92 or the notch 93 (No in Step S43), the drive motor 76 for the manipulator 4 is stopped (Step S44). In this case, it is possible that the sewing machine is stopped and an alarm is indicated. Instead of stopping the manipulator 4, the drive motor 76 for the manipulator 4 may be controlled according to the arbitrary cloth edge position information.

[0071] When the cloth condition is determined as other than the complex fluff 92 and the notch 93 (Yes in Step S43), a deviation Err between the position command θ_{CMD} indicating the target position and the cloth edge position information is calculated (Step S45). Next, it is determined whether the deviation Err is within the allowable range from do to d_1 (Step S46). When the deviation Err is out of the allowable range (No in Step S46), a position command calculation is performed (Step S47), and the drive motor 76 for the manipulator 4 is controlled (Step S48). On the other hand, when the deviation Err is within the allowable range (Yes in Step S46), the drive motor 76 for the manipulator 4 is stopped (Step S49).

[0072] The configuration in which the position command θ is input into the motor driver B 1 will be described, however, the configuration is not limited to this. As shown in Fig. 9C, a configuration in which a speed command V is input into the motor driver B1 is also possible. The speed command V is calculated by multiplying the deviation Err by the speed gain G in the controller B8 (V = GxErr). Here, on the assumption that G is 1 and the target position is 0, as shown in Fig. 9D, the speed command V is output. The larger the deviation of the cloth edge position information from the target position, the larger the speed command V, and the smaller the deviation of the cloth edge position from the target position, the smaller the speed command V.

[0073] In this case, to make the deviation Err fall within the allowable range from do to d_1 of the commanded position θ_{CMD}, a motor stop command is input from the controller B8 into the motor driver B1. Accordingly, stable alignment control can be performed. When there is a limit on the motor speed, a limiter may be provided such as $\pm V_{max}$. The speed gain G and the allowable range from do to d_1 are experimentally determined. In the flowchart in this case, the position command calculation in Step S47 in Fig. 10 is just replaced by a speed command calculation.

[0074] As described above, with the cloth edge position detecting device according to the present embodiment, even when a voltage change exceeding the cloth edge determining threshold Ve is repeated due to several fluffs 91, the cloth edge position is set to the position at which a voltage change exceeding the cloth edge determining threshold Ve appears first. Therefore, the cloth edge position of the workpiece cloth W can be detected irrespective of the voltage changes caused by the several fluffs 91. Further, with the cloth edge position detecting device according to the present embodiment, the complex fluff 92 and the notch 93 are determined by the cloth condition determination. When the complex fluff 92 and the notch 93 is detected, the cloth edge alignment process is performed by distinguishing the case where no fluff, etc., are detected and the case where the stepped portion 94 is detected. Therefore, the seam allowance does not follow the fluff and notch. There is no need to provide a sensor separately for detecting the complex fluff 92 and the notch 93, and the cloth edge position of the workpiece cloth W can be detected by the simple device configuration and detection process.

[0075] The present invention is not limited to the above-described embodiment, and can be variously changed and carried out. In the above-described embodiment, sizes and shapes are not limited to those illustrated in the accompanying drawings, and can be changed as appropriate in a scope in which the effect of the present invention is exerted.

[0076] For example, in the above-described embodiment, the cloth edge sensor is configured to detect a cloth edge by a reflection type optical sensor, however, the cloth edge sensor is not limited to this configuration. The cloth edge sensor may be configured to detect a cloth edge by a transmission type optical sensor. The cloth edge sensor may be configured to detect a cloth edge without using an optical sensor as long as it outputs a voltage corresponding to a cloth edge position of a workpiece cloth.

[0077] In the above-described embodiment, a complex fluff or a notch is detected by great shift of the cloth edge position within the time T_s as the first cloth feeding time, however, the configuration is not limited to this. It is also possible that a complex fluff or a notch is detected by great shift of the cloth edge position during feeding of the workpiece cloth by the first cloth feeding amount. In this case, the horizontal axis of the timing chart of Fig. 7B indicates the cloth feeding amount instead of time. The cloth feeding amount is set by an encoder pulse or a rotation angle (phase), etc., of the drive motor.

[0078] In the above-described embodiment, a stepped portion is detected based on continuation of a complex fluff or a notch for the time T_{on} or more as the second cloth feeding time, however, the configuration is not limited to this. It is also possible that a stepped portion is detected when a complex fluff or a notch continues even after the workpiece cloth is fed by the second feeding amount. In this case, the horizontal axis of the timing chart of Fig. 7B indicates the cloth feeding amount instead of time. The cloth feeding amount is set by an encoder pulse or a rotation angle (phase), etc., of the drive motor.

[0079] In the above-described embodiment, the workpiece cloth is fed in the cloth feeding direction by the manipulator, and the cloth edge is aligned in the lateral direction orthogonal to the cloth feeding direction, however, the configuration is not limited to this. The mechanism that feeds the workpiece cloth in the cloth feeding direction and the mechanism that aligns the cloth edge in the lateral direction may be provided separately.

[0080] In the above-described embodiment, T_s as the first cloth feeding time is measured from the position at which the cloth edge position exceeds START, however, the configuration is not limited to this. T_s may be measured from the state where the cloth edge position is 0.

[0081] As described above, the present invention has an effect of detecting a cloth edge position by a simple configuration, and is particularly useful for a cloth edge position detecting device for a top and bottom feed sewing machine configured to sew upper and lower workpiece cloths together.

Claims

1. A cloth edge position detecting device comprising:

   a cloth edge sensor (6) configured to output a voltage corresponding to a cloth edge position, the cloth edge position being a position of a cloth edge of a workpiece cloth (W) to be fed in a cloth feeding direction such that the cloth edge is disposed along the cloth feeding direction; and
   a control section (71, 72) configured to detect the cloth edge position in a direction orthogonal to the cloth feeding direction based on the voltage output from the cloth edge sensor (6),
   characterized in that the control section (71, 72) is configured to determine that a position (Pos) at which a voltage change exceeding a cloth edge determining threshold (Ve) appears first in the direction from the inner side to the outer side of the workpiece cloth (W) across the cloth edge is the cloth edge position.

2. The cloth edge position detecting device according to claim 1, wherein the control section (71, 72) is configured to determine a cloth condition as a fluff (92) when the position (Pos) determined as the cloth edge position changes by a first threshold (|ON-START|) or more in the direction from the inner side to the outer side of the workpiece cloth (W) within a first cloth feeding time (T_s) or during feeding of the workpiece cloth (W) by a first cloth feeding amount.

3. The cloth edge position detecting device according to claim 1, wherein the control section (71, 72) is configured to determine a cloth condition as a notch (93) when the position (Pos) determined as the cloth edge position changes by a first threshold (|ON-START|) or more in the direction from the outer side to the inner side of the workpiece cloth (W) within the first cloth feeding time (T_s) or during feeding of the workpiece cloth (W) by a first cloth feeding amount.

4. The cloth edge position detecting device according to claim 2, wherein the control section (71, 72) is configured to determine the cloth condition as a notch (93) when the position (Pos) determined as the cloth edge position changes by the first threshold (|ON-START|) or more in a direction from the outer side to the inner side of the workpiece cloth (W) within the first cloth feeding time (T_s) or during the feeding of the workpiece cloth (W) by the first cloth feeding amount.

5. The cloth edge position detecting device according to claim 2 or 3, wherein the control section (71, 72) is configured to determine the cloth condition as a stepped portion (94) when the cloth condition is continuously determined as the fluff (92) for a second cloth feeding time (T_{on}) or more or for a period equal to or more than a time in which the

workpiece cloth (W) is fed by a second cloth feeding amount.

6. The cloth edge position detecting device according to claim 3 or 4, wherein the control section (71, 72) is configured to determine the cloth condition as a stepped portion (94) when the cloth condition is continuously determined as the notch (93) for a second cloth feeding time (T_{on}) or more or for a period equal to or more than a time in which the workpiece cloth (W) is fed by a second cloth feeding amount.

7. The cloth edge position detecting device according to claim 1, wherein the cloth edge sensor (6) includes an infrared LED (63) configured to irradiate parallel light toward a surface of the workpiece cloth (W), a reflector (62) disposed on a back surface of the workpiece cloth (W), and a CMOS linear sensor (64) configured to receive the light reflected from the workpiece cloth (W).

8. A sewing machine (1) comprising:

the cloth edge position detecting device according to any one of claims 1 to 7; and
a manipulator (4) configured to adjust the position of the cloth edge in the direction orthogonal to the cloth feeding direction,
wherein the control section (71, 72) is configured to control the manipulator (4) in proportion to a difference (Err) between the cloth edge position and a target position of the cloth edge when the fluff (92) and the notch (93) are not detected.

9. The sewing machine (1) according to claim 8, wherein the control section (71, 72) is configured to suspend the position adjustment by the manipulator (4) when the fluff (92) and the notch (93) are not detected and when the difference (Err) between the cloth edge position and the target position of the cloth edge is within an allowable range (d_0-d_1).

10. The sewing machine (1) according to claim 8 or 9, wherein the control section (71, 72) is configured to suspend the position adjustment by the manipulator (4) or to stop the entire sewing machine (1) when the fluff (92) or the notch (93) is detected.

11. The sewing machine (1) according to claim 8 or 9, wherein the manipulator (4) is configured to align the cloth edges of two workpiece cloths (W) arranged on top of one another.

12. A sewing machine (1), comprising:

the cloth edge position detecting device according to claim 5 or 6; and
a manipulator (4) configured to adjust the position of the cloth edge in the direction orthogonal to the cloth feeding direction,
wherein the control section (71, 72) is configured to control the manipulator (4) in proportion to a difference (Err) between the cloth edge position and a target position of the cloth edge when the fluff (92) and the notch (93) are not detected, and
wherein the cloth edge sensor (6) and the stitch point are spaced away from each other such that the total time of the first cloth feeding time (T_s) and the second cloth feeding time (T_{on}) is equal to or less than a time in which the workpiece cloth is fed from the cloth edge sensor (6) to the stitch point, or such that the total amount of the first cloth feeding amount and the second cloth feeding amount is equal to or less than a feeding amount by which the workpiece cloth is fed from the cloth edge sensor to the stitch point.

FIG. 1

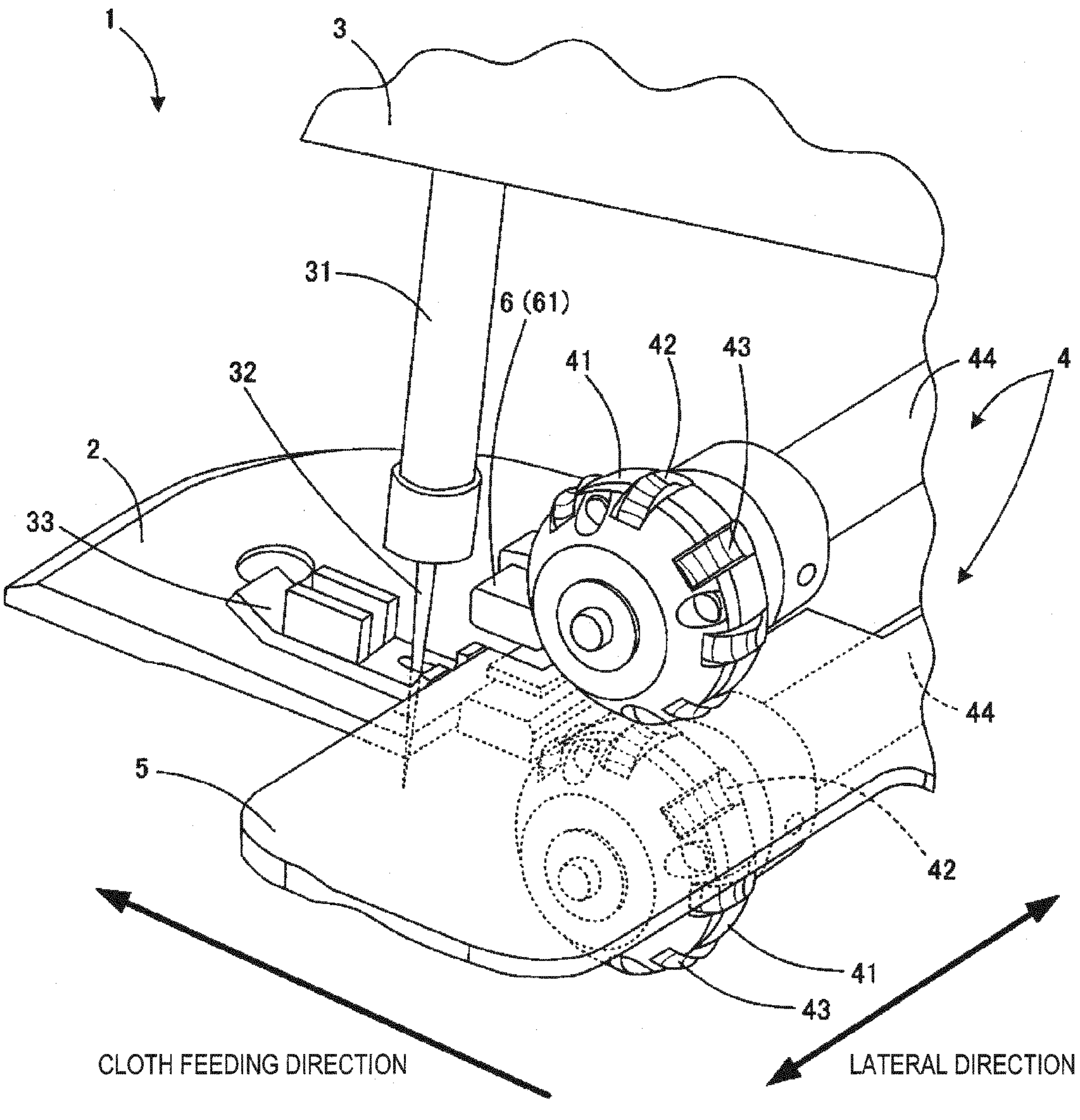

1
3
31
6 (61)
41
42
43
44
4
32
2
33
44
5
42
41
43
CLOTH FEEDING DIRECTION
LATERAL DIRECTION

FIG. 2

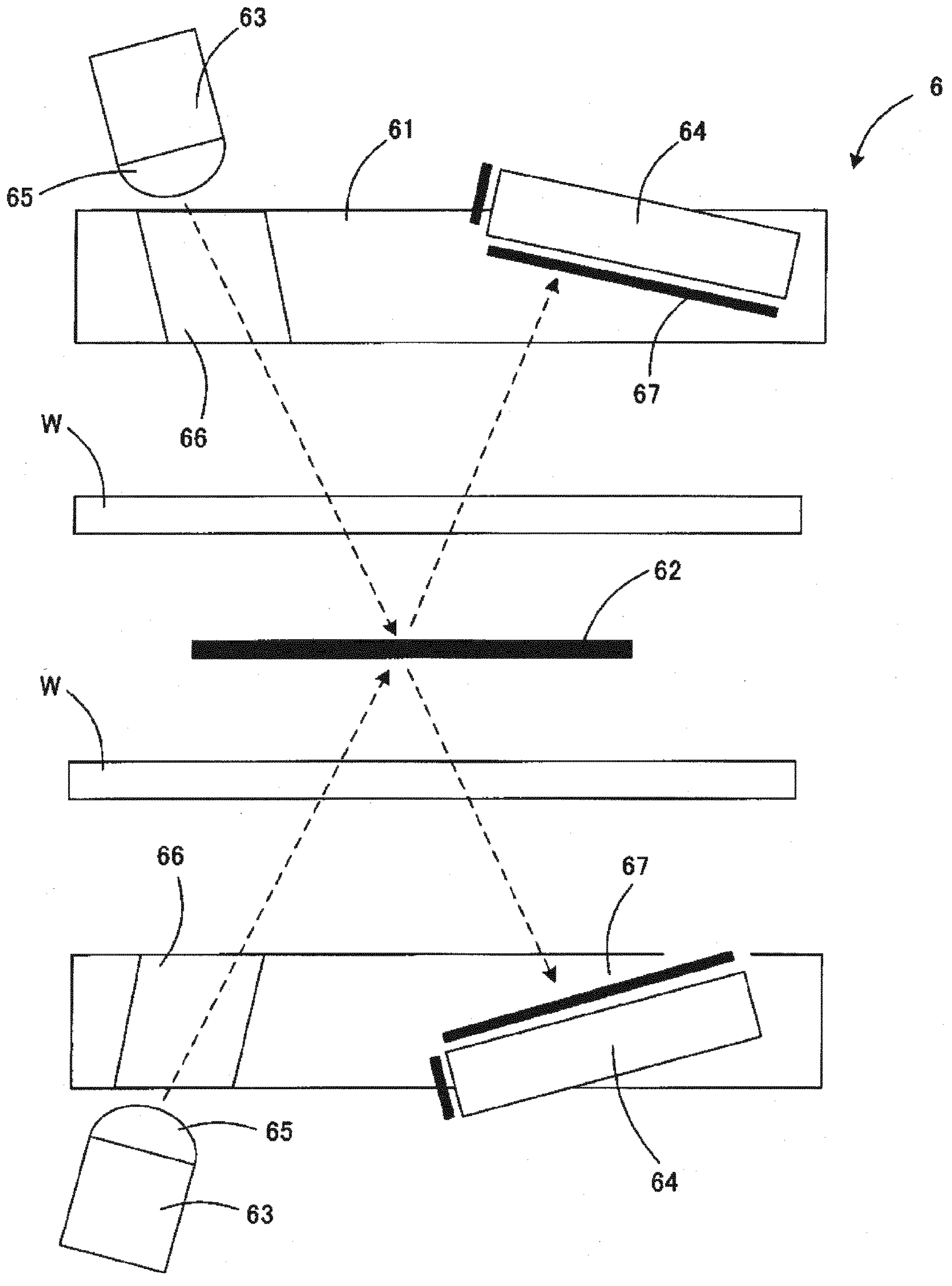


FIG. 3

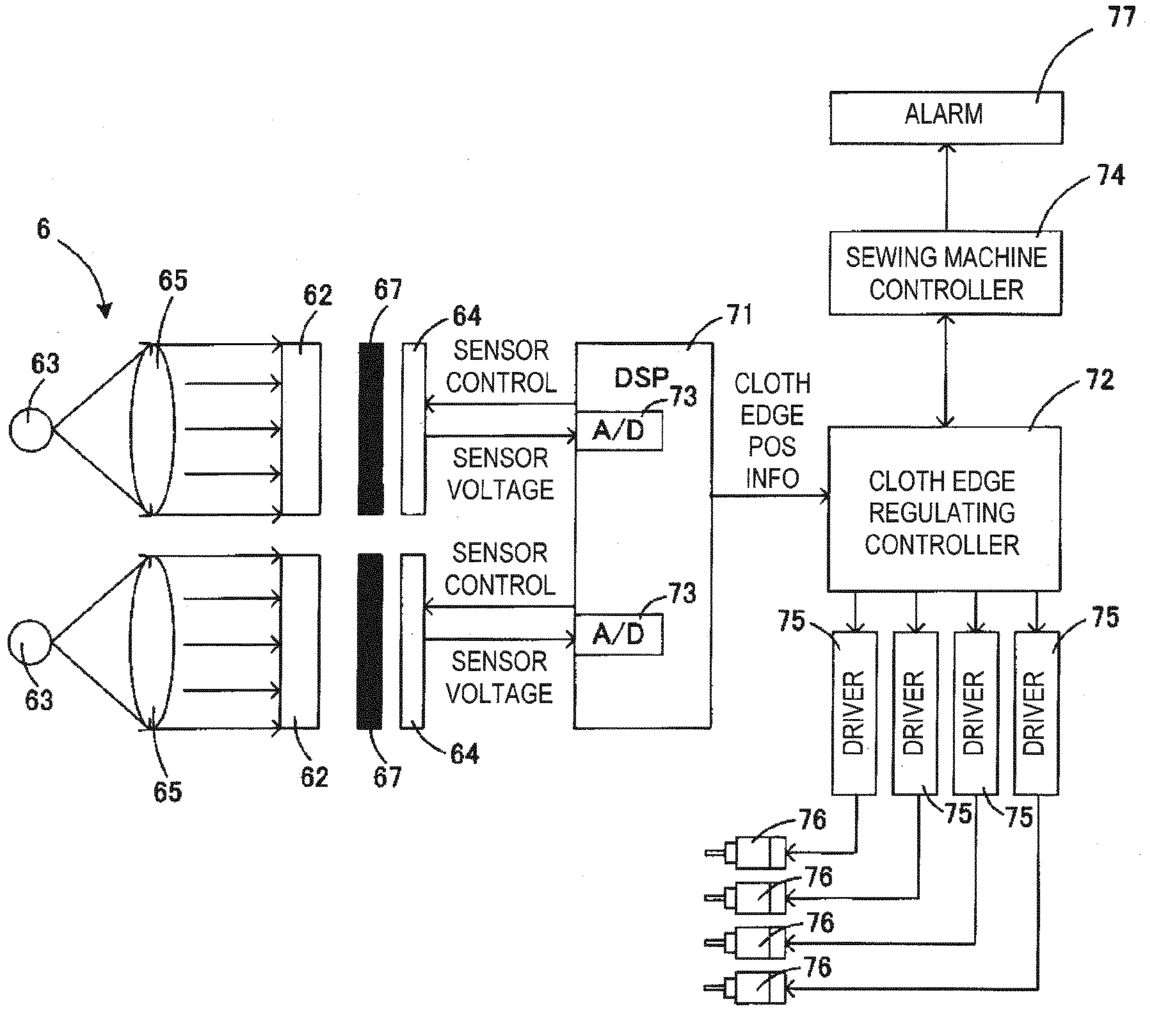

6
65
62
67
64
63
SENSOR
CONTROL
SENSOR
VOLTAGE
DSP
71
73
A/D
CLOTH
EDGE
POS
INFO
77
ALARM
74
SEWING MACHINE
CONTROLLER
72
CLOTH EDGE
REGULATING
CONTROLLER
75
DRIVER
DRIVER
DRIVER
DRIVER
76

FIG. 4A

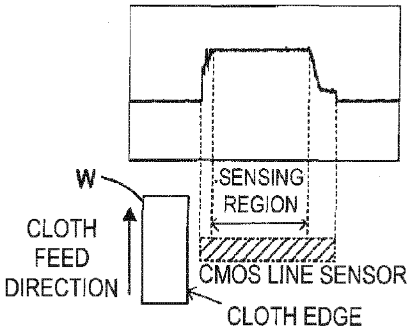


FIG. 4B

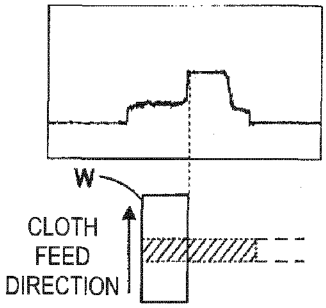


FIG. 4C

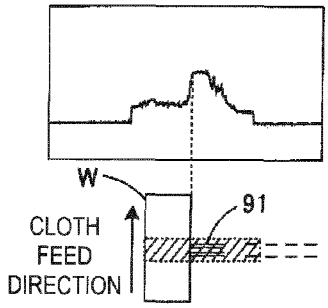


FIG. 4D

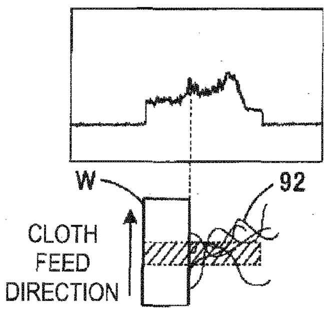


FIG. 4E

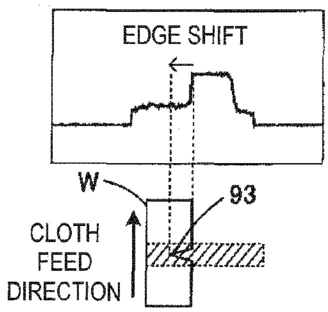


FIG. 4F

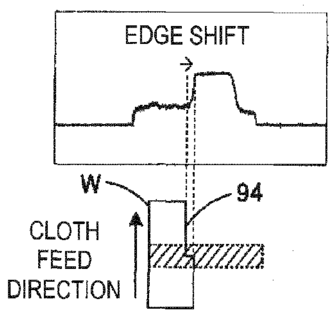


FIG. 5A

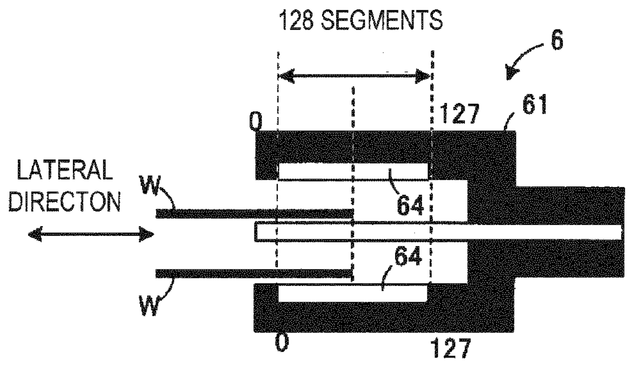


FIG. 5B

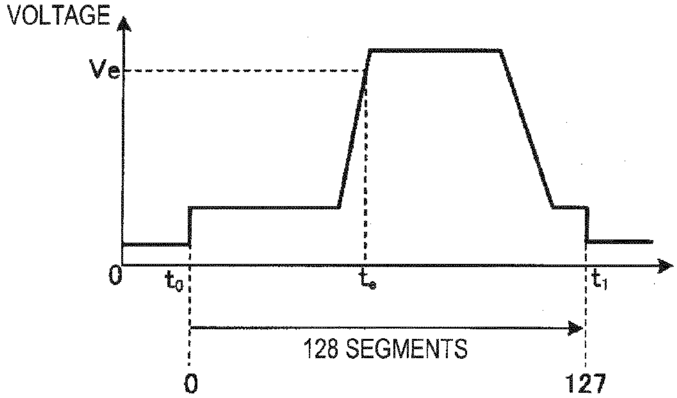


FIG. 5C

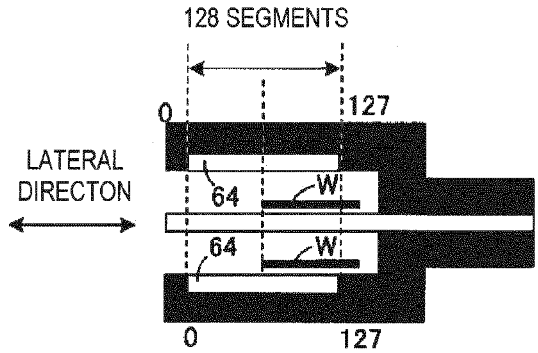


FIG. 5D

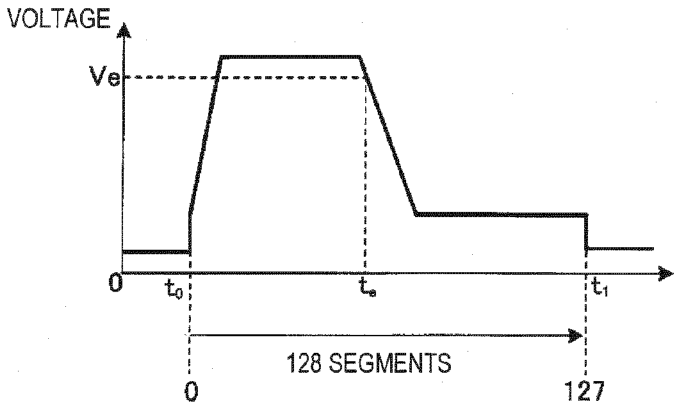


FIG. 6

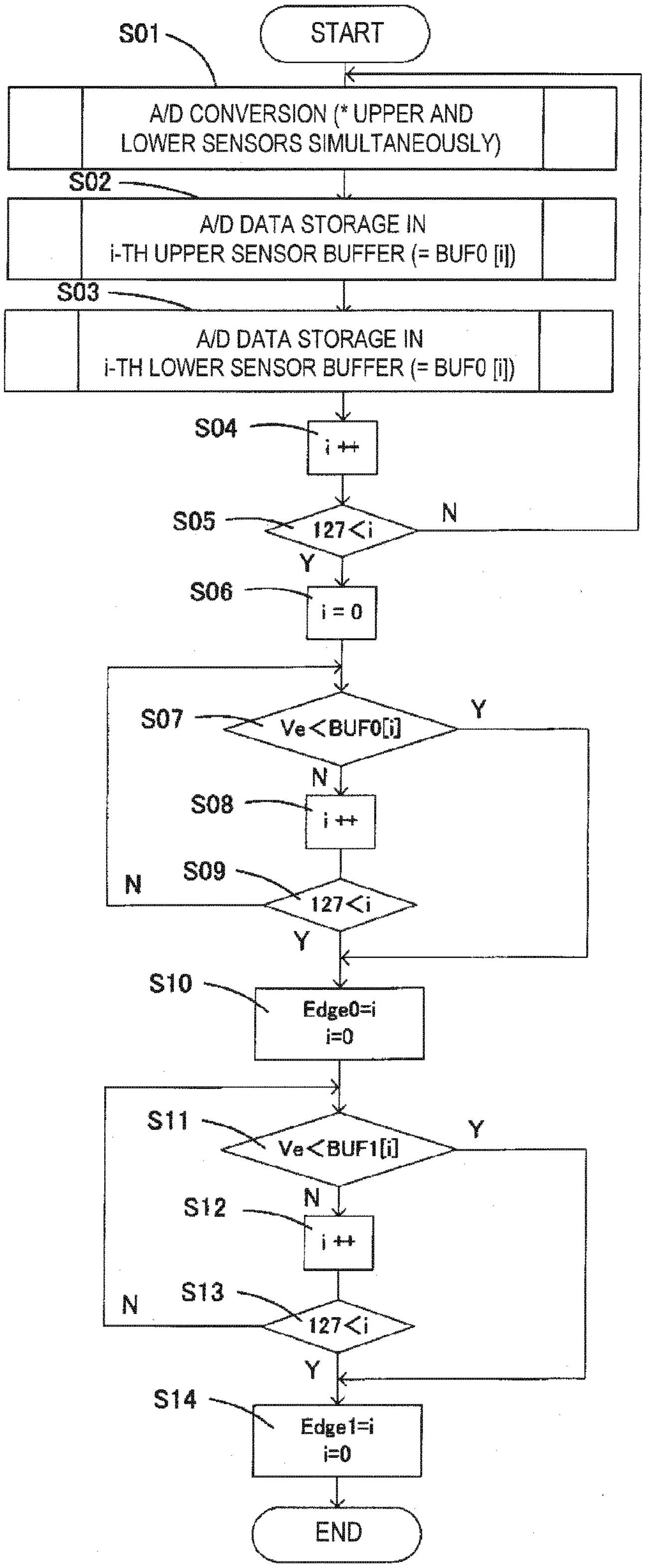

START
S01
A/D CONVERSION (* UPPER AND LOWER SENSORS SIMULTANEOUSLY)
S02
A/D DATA STORAGE IN i-TH UPPER SENSOR BUFFER (= BUF0 [i])
S03
A/D DATA STORAGE IN i-TH LOWER SENSOR BUFFER (= BUF0 [i])
S04
i ++
S05
127<i
N
Y
S06
i = 0
S07
Ve<BUF0[i]
Y
N
S08
i ++
S09
127<i
N
Y
S10
Edge0=i
i=0
S11
Ve<BUF1[i]
Y
N
S12
i ++
S13
127<i
N
Y
S14
Edge1=i
i=0
END

FIG. 7A

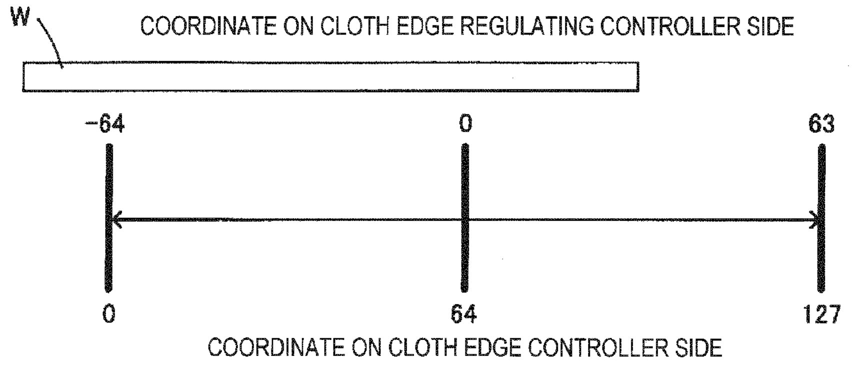

W
COORDINATE ON CLOTH EDGE REGULATING CONTROLLER SIDE
-64
0
63
0
64
127
COORDINATE ON CLOTH EDGE CONTROLLER SIDE

FIG. 7B

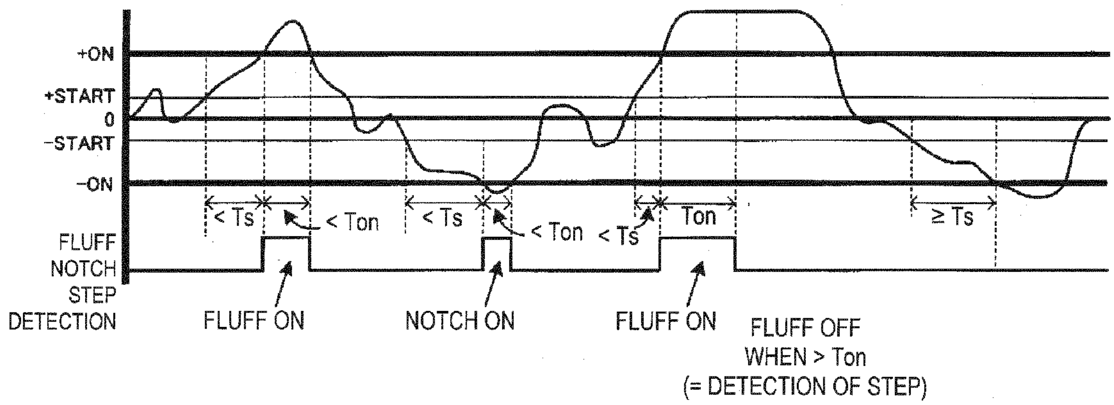

+ON
+START
0
-START
-ON
< Ts
< Ton
< Ts
< Ton
< Ts
Ton
≥ Ts
FLUFF
NOTCH
STEP
DETECTION
FLUFF ON
NOTCH ON
FLUFF ON
FLUFF OFF
WHEN > Ton
(= DETECTION OF STEP)

FIG. 8

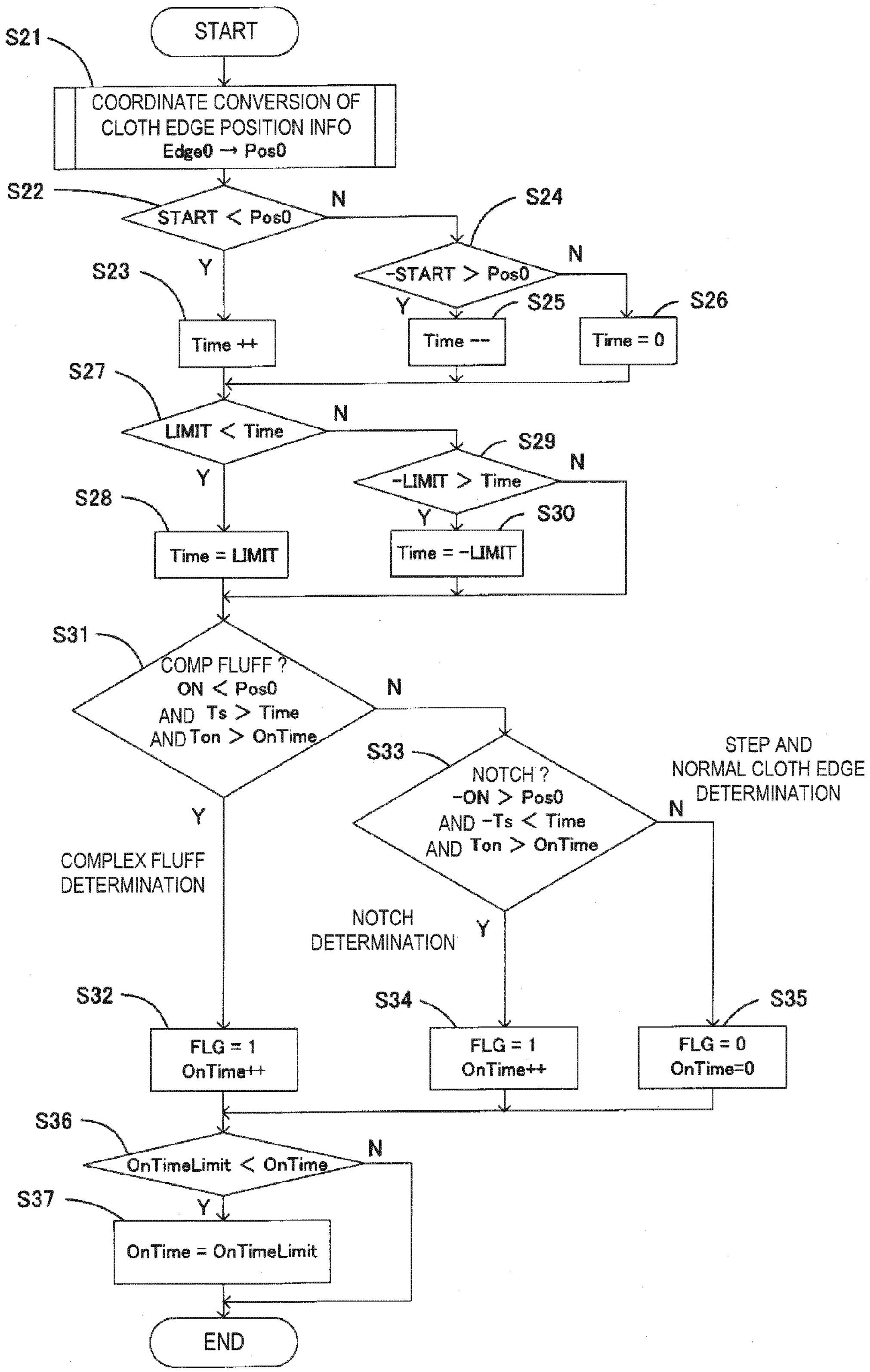

START
S21
COORDINATE CONVERSION OF CLOTH EDGE POSITION INFO
Edge0 → Pos0
S22
START < Pos0
N
S24
-START > Pos0
N
Y
S23
Time ++
S25
Time --
S26
Time = 0
S27
LIMIT < Time
N
S29
-LIMIT > Time
N
Y
S28
Time = LIMIT
S30
Time = -LIMIT
S31
COMP FLUFF ?
ON < Pos0
AND Ts > Time
AND Ton > OnTime
N
S33
NOTCH ?
-ON > Pos0
AND -Ts < Time
AND Ton > OnTime
STEP AND
NORMAL CLOTH EDGE
DETERMINATION
N
Y
COMPLEX FLUFF
DETERMINATION
NOTCH
DETERMINATION
Y
S32
FLG = 1
OnTime++
S34
FLG = 1
OnTime++
S35
FLG = 0
OnTime=0
S36
OnTimeLimit < OnTime
N
S37
Y
OnTime = OnTimeLimit
END

FIG. 9A

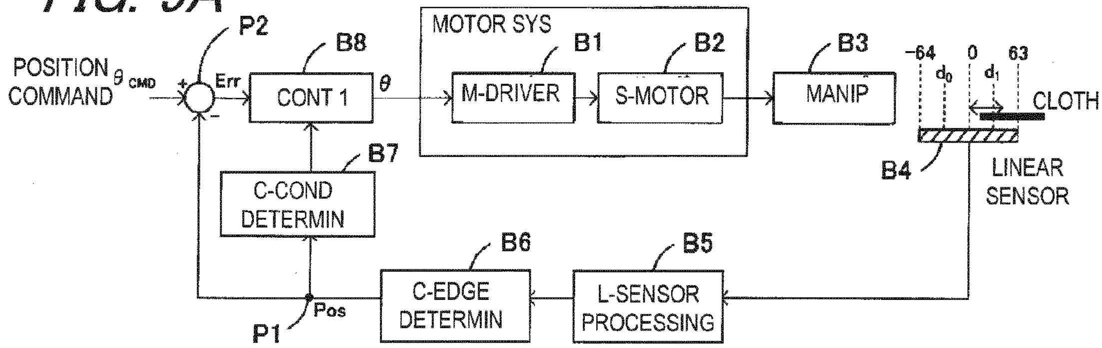


FIG. 9B

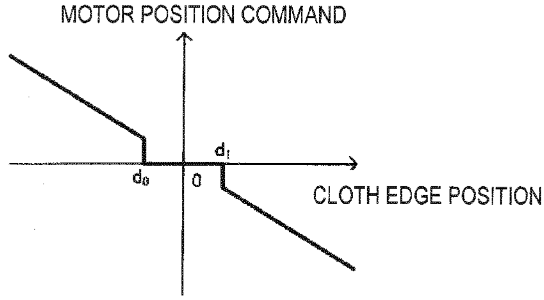


FIG. 9C

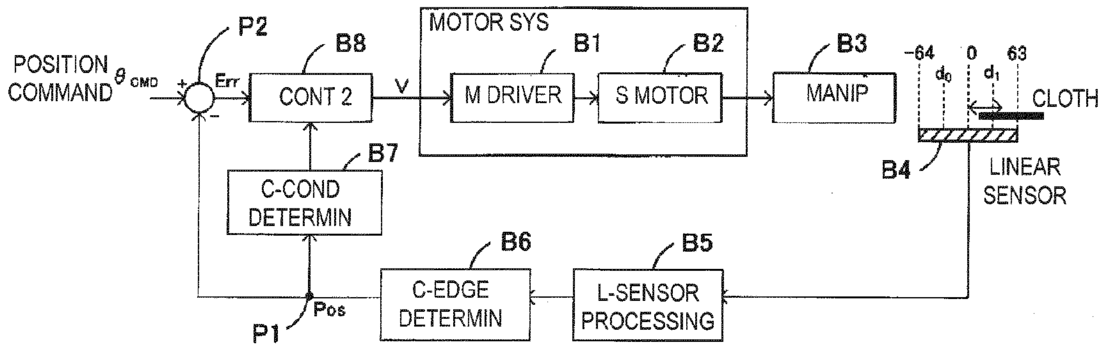


FIG. 9D

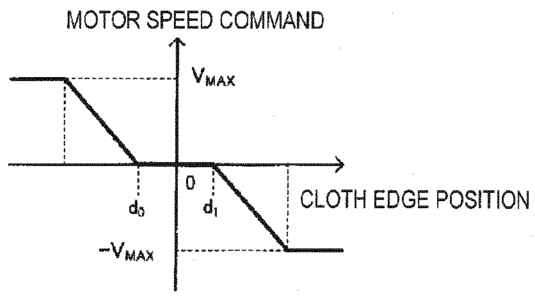
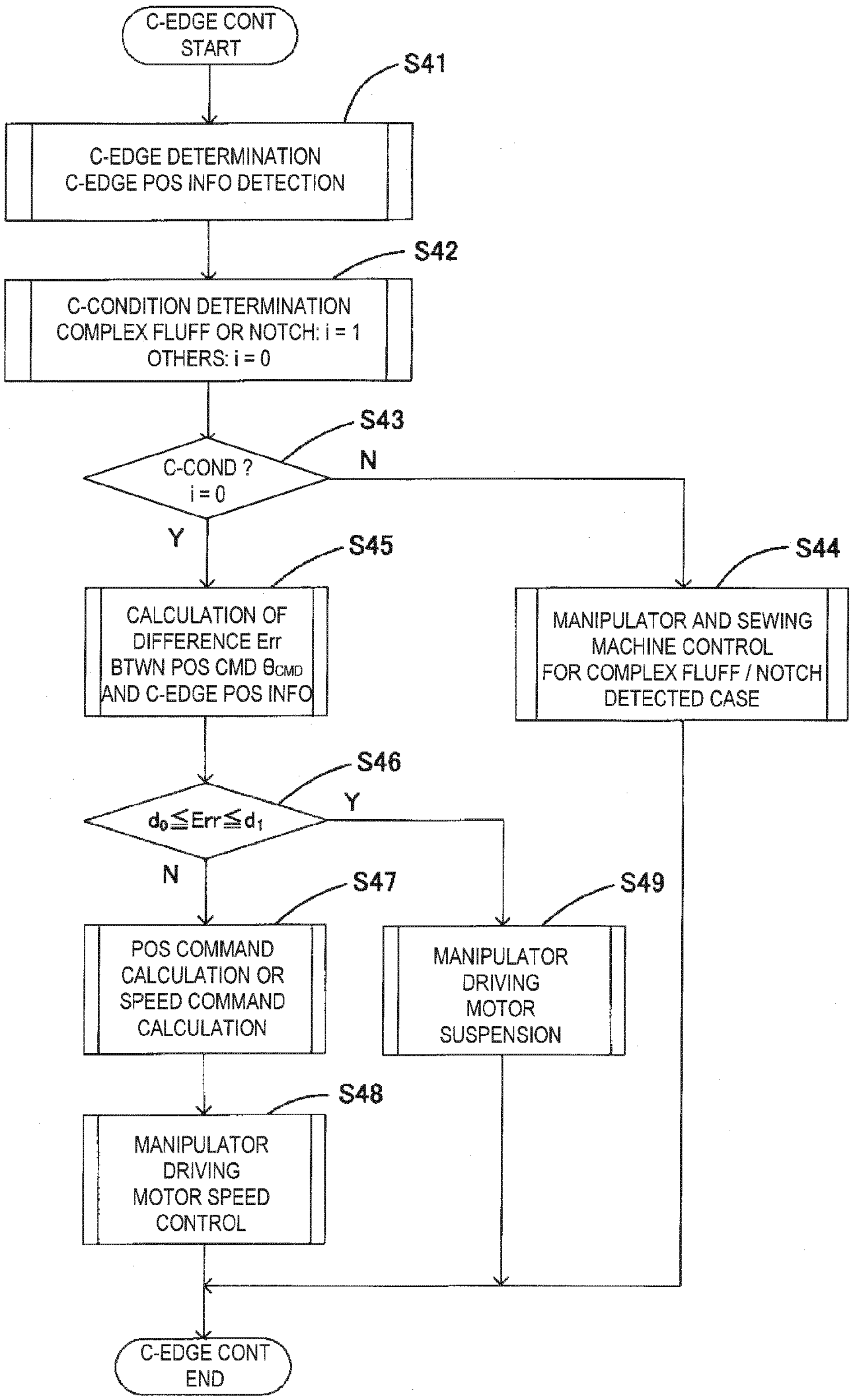


FIG. 10


C-EDGE CONT START
S41
C-EDGE DETERMINATION
C-EDGE POS INFO DETECTION
S42
C-CONDITION DETERMINATION
COMPLEX FLUFF OR NOTCH: i = 1
OTHERS: i = 0
S43
C-COND ?
i = 0
N
Y
S45
CALCULATION OF DIFFERENCE Err BTWN POS CMD θ_{CMD} AND C-EDGE POS INFO
S44
MANIPULATOR AND SEWING MACHINE CONTROL FOR COMPLEX FLUFF / NOTCH DETECTED CASE
S46
$d_0 \leqq Err \leqq d_1$
Y
N
S47
POS COMMAND CALCULATION OR SPEED COMMAND CALCULATION
S49
MANIPULATOR DRIVING MOTOR SUSPENSION
S48
MANIPULATOR DRIVING MOTOR SPEED CONTROL
C-EDGE CONT END

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EUROPEAN SEARCH REPORT

Application Number
EP 12 18 8075

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X : particularly relevant if taken alone
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