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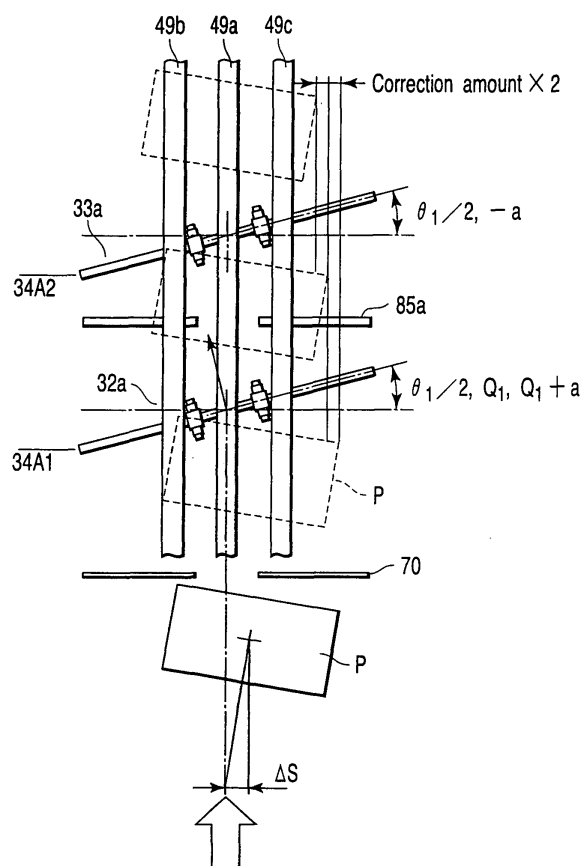
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(54) **Paper sheet positioning apparatus**

(57) A paper sheet positioning apparatus includes a pair of conveying belts (49a to 49c) which convey banknotes (P) along a conveyance path, an optical sensor array (70) which measures a shift amount of the banknotes (P) conveyed by the pair of conveying belts (49a to 49c) on the conveyance path, and two units of shift correction devices (32a, 32a) which correct the shift amount measured by the optical sensor array (70).



Position correction operation view

FIG. 7

Description

[0001] The present invention relates to a paper sheet positioning apparatus to be applied to a paper sheet processing apparatus that sorts and stacks banknotes according to their denominations, for example.

[0002] Paper sheets including banknotes, checks, and gift coupons functions as key media in social and economic activities, and are distributed. In the course of their distribution, these paper sheets are collected in bulk at a specific processing area and sorted according to their denominations or kinds.

[0003] For the purpose of automatic and energy-saving sorting work of these paper sheets, a paper sheet sorting apparatus has been employed conventionally. In the paper sheet sorting apparatus, scattered paper sheets are charged into a feeding unit in bulk, and the charged paper sheets are taken out one by one to be transferred to a determining unit. The determining unit reads various kinds of information from the surfaces of the paper sheets, and performs logical operation to the information to compare them with information serving as a reference. Then, the determining unit determines the presence or absence of dust or damage, kinds (denominations in the case of banknotes) of paper sheets, and further, their four directions of head and tail and front side and back side. On the basis of the determination result, the paper sheets are sorted and stacked to a plurality of stacking units for every kind, and bundled in a predetermined number of sheets (100 sheets).

[0004] Further, the paper sheet sorting apparatus includes an inversion unit. When the determining unit determines that the front side and the back side of a paper sheet are reversed, the paper sheet is inverted horizontally by 180 degrees with a twist belt at the inversion unit, the front side and the back side thereof are corrected to their right directions, and then, the paper sheet is stacked into the stacking unit of its kind.

[0005] Meanwhile, when the paper sheets are charged into the feeding unit, in particular, when paper sheets of different sizes are changed in bulk, or when they are taken out from the feeding unit, their positions may be displaced or become skewed.

[0006] When the paper sheets in displaced or skewed states are taken out and transferred to the determining unit, there is a fear that the information of the paper sheets cannot be read in the determining unit. In this case, the paper sheets cannot be read, and accordingly they are rejected, which has been a problem in the prior art.

[0007] Further, the paper sheet that is inverted in the inversion unit is rotated around the center point of the twist belt. For this reason, there occurs a horizontal displacement (referred to as shift) between the paper sheet that goes into the twist belt and that goes out from the twist belt, and preferable stacking or bundling thereof cannot be expected.

[0008] In order to solve these problems, it is required to provide a positioning apparatus that corrects the shift

or skewed state of the taken-out paper sheets to position the paper sheets correctly before they are transferred to the determining unit.

[0009] The positioning apparatus has, for example, a transmissive optical sensor array as a measuring device at the inlet side thereof, and the shift amount and the skew amount of paper sheets taken out from the feeding unit are measured by means of the optical sensor array.

[0010] A shift correction mechanism for correcting a shift amount of paper sheets, and a skew correction mechanism for correcting a skew amount are arranged on the base of the positioning apparatus. According to the measured shift amount and skew amount, the shift correction mechanism and the skew correction mechanism are operated to correct the shift and the skewed state (refer to, for example, Jpn. Pat. Appln. KOKAI Publication No. 2002-87647).

[0011] However, in the prior art, only one shift correction mechanism and one skew correction mechanism have been arranged in a positioning apparatus, and accordingly, the correction processing efficiency for paper sheets has not been preferable so far, which has been another problem in the prior art.

[0012] Although the correction processing efficiency may be improved by operating the shift correction mechanism and the skew correction mechanism at a high speed, the operation speed is determined by the driving force of a driving motor and the mass and moment of moving units. For this reason, there is a limitation in the high speed operation thereof at practical costs, and further, the high speed operation leads to vibration after stopping, shortened service life and other problems.

[0013] The present invention has been made in consideration of the above problems, and accordingly, an object of the present invention is to provide a paper sheet positioning apparatus for improving the correction processing efficiency without operating a shift correction device and a skew correction device at a high speed.

[0014] According to one aspect of the present invention, there is provided a paper sheet positioning apparatus comprising: a conveying device which conveys paper sheets along a conveyance path; a shift amount measuring device which measures a shift amount of the paper sheets conveyed by the conveying device on the conveyance path; and a plurality of shift correction devices which are arranged along the conveying direction of the paper sheets, and correct the shift amount measured by the shift amount measuring device.

[0015] According to another aspect of the present invention, there is provided a paper sheet positioning apparatus comprising: a conveying device which conveys paper sheets along a conveyance path; a skew amount measuring device which measures a skew amount of the paper sheets conveyed by the conveying device on the conveyance path; and a plurality of skew correction devices which are arranged along the conveying direction of the paper sheets, and correct the skew amount measured by the skew amount measuring device.

[0016] According to the present invention, it is possible to improve the correction processing efficiency for shifted and skewed paper sheets without operating a shift correction device and a skew correction device at high speed, and to reduce cots, and vibration after stopping can be prevented to attain a long service life of a paper sheet positioning apparatus.

[0017] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an internal structural view showing a banknote processing apparatus which is an embodiment of the present invention;

FIG. 2 is a front view showing a measuring device in the banknote processing apparatus in FIG. 1;

FIG. 3 is a bottom view showing the measuring device in FIG. 2;

FIG. 4 is a perspective view showing a shift correction mechanism in the banknote processing apparatus in FIG. 1;

FIG. 5 is a perspective view showing a skew correction mechanism in the banknote processing apparatus in FIG. 1;

FIG. 6 is a view showing a mechanism for driving the shift correction mechanism in FIG. 4 and the skew correction mechanism in FIG. 5;

FIG. 7 is a view showing a correction operation of the shift correction mechanism in FIG. 4;

FIG. 8 is a flowchart showing the correction operation of the shift correction mechanism in FIG. 4;

FIG. 9 is a view showing a correction operation of the skew correction mechanism in FIG. 5; and

FIG. 10 is a flowchart showing the correction operation of the skew correction mechanism in FIG. 5.

[0018] The present invention will be described in more details with reference to an embodiment shown in the accompanying drawings hereinafter.

[0019] FIG. 1 is a schematic structural view showing a banknote sorting apparatus as a paper sheet processing apparatus according to an embodiment of the present invention.

[0020] Reference numeral 1 in FIG. 1 denotes an apparatus main body, and a feeding unit 2 is provided at substantially the center portion of one side of the apparatus main body 1. In the feeding unit 2, banknotes P as paper sheets are contained in the upright position. The feeding unit 2 is provided with a backup plate 4 that is biased by a spring 3, and the banknotes P are fed out by the backup plate 4. A feeding roller 5 is arranged in the sending-out direction of the banknotes P. Under the feeding roller 5, a rubber roller 55 and a roller 56 that contacts the rubber roller 55 are provided. The roller 56 is biased by a spring material and clamps and conveys the paper sheets together by the roller 55.

[0021] Further, in the feeding direction of the banknotes, a transmissive optical sensor array 70 is provided

which serves as a measuring device (shift amount measuring device, skew amount measuring device) that measures the shift amount and the skew amount of the taken-out banknote. The arrangement of the optical sensor array 70 is to be described later herein.

[0022] The banknote having passed through the optical sensor array 70 is sent to a clamp type conveying device 6 composed of a pair of belts 49a to 49c and a roller 7. The conveying device 6 is provided with a posture correction apparatus (positioning apparatus) 8 that automatically corrects the shift amount and the skew amount of the taken-out banknote. The posture correction apparatus 8 includes a shift correction mechanism 8a that corrects shift, and a skew correction mechanism 8b that corrects skew as described in detail later herein.

[0023] Meanwhile, portion where the banknote passes through the posture correction apparatus 8 of the conveying device 6 is made of a pair of belts and the banknote P is restrained thereby. However, the clamping force thereof is set weak, so that it should not become a load in correcting the banknote posture by the posture correction apparatus 8.

[0024] A determining unit 9 is provided above the conveying device 6. The determining unit 9 reads various kinds of information from the surface of the banknote P conveyed by a pair of rollers 10, and performs logical operation to the information to compare them with information serving as a reference. Consequently, the determining unit 9 determines the presence or absence of dust or damage, denominations (money amounts) of banknotes, and further, their four directions of head and tail and front side and back side.

[0025] A first branching unit 11 is provided above the determining unit 9, and the first branching unit 11 changes the conveying direction of the banknote P into the arrow "a" direction or the arrow b direction. More specifically, the conveying direction of the banknotes that are not determined as authentic bills by the determining unit 9 (for example, two banknotes taken together at one time, banknotes that are excessively skew, and the like) is changed to the arrow "a" direction, and they are guided to a reject box 12.

[0026] On the other hand, when the determining unit 9 determines that a banknote is an authentic bill and the front side thereof is upward, the conveying direction is changed to the arrow b direction. In the arrow b direction, a second branching unit 13 is arranged. This second branching unit 13 branches the conveying direction of the banknote P to first and second directions.

[0027] A horizontal flip path 14 is arranged in the first route, and a twist belt 15 that flips the banknote horizontally by 180 degrees is arranged in the horizontal flip path 14. In the second route, a normal conveying belt 16 is arranged, and the banknote is conveyed while the posture thereof is maintained as it is. The first and second routes merge at an interflow unit 17, and the route lengths of the first and second routes to the interflow unit 17 are made equal to each other, so that the intervals of ban-

knotes after the interflow should not go out of alignment.

[0028] A third branching unit 18 is provided below the interflow unit 17, and the conveying direction of the banknote is changed to third and fourth directions by the third branching unit 18. The third route is a switch back path 19, and the rear end of the banknote guided to an inversion box 20 is pushed to an inversion roller by a tap wheel 21, so that the head and tail thereof are inverted and the banknote is conveyed. The fourth route is a normal conveying belt 22, and the banknote is conveyed while the posture thereof is maintained as it is.

[0029] The third and fourth routes are merged at an interflow unit 23. The route lengths of the third and fourth routes to the interflow unit 23 are made equal to each other, so that the intervals of banknotes after interflow should not go out of alignment.

[0030] In the take-out direction of the above inversion unit, a horizontal conveyance path 24 is arranged. In the horizontal conveyance path 24, branching units 25a to 25d are arranged at predetermined intervals. Pocket units 26a to 26d that sort and stack banknotes according to their denominations are arranged below the branching units 25a to 25d.

[0031] A 100-note banding apparatus 27 is provided below the branching unit 25a. The 100-note banding apparatus 27 includes a stacking unit 28 that stacks banknotes in unit of 100 sheets, a transfer unit (not shown) that transfers the banknotes stacked in the stacking unit 28 to a binding position 29, and a banding unit 30 that binds the banknotes transferred to the binding position 29.

[0032] FIG. 2 is a front view showing the arrangement and structure of first to third pairs of conveying belts 49a to 49c of the conveying device 6, and the arrangement of the transmissive optical sensor array 70, and FIG. 3 is a bottom view thereof.

[0033] Among the first to third pairs of conveying belts 49a to 49c, the first pair of conveying belts 49a is positioned at the center of the conveyance path, and the second and third pairs of conveying belts 49b, 49c are arranged parallel with the first pair of conveying belts 49a with a predetermined distance.

[0034] Rubber roller 60, 60 are provided at the banknote introduction sides of the first to third pairs of conveying belts 49a to 49c, and rubber rollers 61, 61 that are biased by a spring (not shown) come in contact with the rubber rollers 60, 60. Further, rubber rollers 62, 62 are arranged between the rollers 60, 60 and the first to third pairs of conveying belts 49a to 49c, and rubber rollers 63, 63 that are biased by a spring (not shown) come in contact with the rubber rollers 62, 62.

[0035] At the banknote introduction sides of the first to third pairs of conveying belts 49a to 49c, the above-described optical sensor array 70 is arranged. The optical sensor array 70 is configured by a light receiving sensor 64 and an LED 65, and the light receiving sensor 64 and LED 65 are attached to the base via a plate (not shown). The light receiving sensor 64 and the LED 65 are each

contained in an airtight case 90. To the portion of the case 90 opposing the light receiving sensor 64 or the LED 65, a glass plate 91 is arranged so as to prevent dust from getting therein. The optical sensor array 70 is arranged in the direction perpendicular to the conveying direction of paper sheets.

[0036] FIG. 4 is a perspective view showing the shift correction mechanism 8a of the posture correction apparatus 8. FIG. 5 is a perspective view showing the skew correction mechanism 8b of the posture correction apparatus 8. FIG. 6 is a view showing a mechanism for driving the shift correction mechanism 8a and the skew correction mechanism 8b.

[0037] The shift correction mechanism 8a and the skew correction mechanism 8b are arranged in the conveying direction of paper sheets. Meanwhile, the shift correction mechanism 8a and the skew correction mechanism 8b are configured in the same manner, and therefore, the shift correction mechanism 8a is explained on behalf of these components.

[0038] The shift correction mechanism 8a has first and second shift correction units (shift correction devices) 32a, 32a. The first and second shift correction units 32a, 32a are configured in the same manner, and attached to a base 31. Since the first and second shift correction units 32a, 32a are configured in the same manner, the first shift correction unit 32a is explained on behalf of these components.

[0039] The first shift correction unit 32a has an inverted gate type frame (hereinafter, referred to as supporting frame) 34, which is configured by a frame base portion 34a that is longer than the banknotes are wide, and side plate portions 34b, 34b that are formed to be bent at both the sides of the frame base portion 34a. Herein, the supporting frame 34 of the first shift correction unit 32a may be referred to as a first shift correction arm 34A1, and the supporting frame 34 of the second shift correction unit 33a may be referred to as a second shift correction arm 34A2.

[0040] Further, the skew correction mechanism 8b has first and second skew correction units (skew correction devices) 32b, 33b that are configured in the same manner as the first and second shift correction units 32a, 33a. The supporting frame 34 of the first skew correction unit 32b may be referred to as a first skew correction arm 34B1, and the supporting frame 34 of the second skew correction unit 33b may be referred to as a second skew correction arm 34B2.

[0041] A driving shaft 35 is stretched via bearings 36, 36 over between the side plate portions 34b, 34b of the supporting frame 34, and a pair of rollers 37, 37 is attached to the driving shaft 35. The circumferential surface of the pair of rollers 37, 37 is made into a rubber portion for increasing a restriction force. A pair of rubber rollers 38, 38 comes in contact with the upper sides of the pair of rollers 37, 37. The pair of rubber rollers 38, 38 is attached to a shaft 40 via a bearing 39. Both the end portions of the shaft 40 are inserted into long holes 41 made

in the side plate portions 34b, 34b of the supporting frame 34, and are biased downward by springs 42. A pair of correction rollers is configured by the pair of rollers 37, 37 and the rubber rollers 38, 38.

[0042] The pairs of correction rollers 37, 38 are arranged between first and second pairs of conveying belts 49a, 49b passing through the posture correction apparatus 8, and between first and third pairs of conveying belts 49a, 49c, respectively. The pairs of correction rollers 37, 38 are arranged symmetrically around the first pair of conveying belts 49.

[0043] Further, a bevel gear 50 is attached fixedly to the driving shaft 35, and a bevel gear 51 is engaged to the bevel gear 50. The bevel gear 51 is, as shown in FIG. 6, fixed onto the upper end portion of a shaft 44 serving as a first driving shaft. The shaft 44 is arranged vertically, and the upper end portion thereof opposes the center portion of the driving shaft 35 of the roller 37. The shaft 44 is inserted into a cylindrical shaft 43 serving as a second driving shaft, and is held rotatably by bearings 52, 53 at the upper and lower portions. The bearing 53 at the lower side is attached to a pulley 45 fixed to the cylindrical shaft 43. A pulley 84 is attached to the lower end of the shaft 44 via a one-way clutch 55a. A stepping motor 54 is connected to the pulley 84 via a belt 82 and a pulley 83.

[0044] When the stepping motor 54 is driven to rotate, the shaft 44 is rotated via the pulley 83, the belt 82 and the pulley 84. By this rotation, the driving shaft 35 is rotated via the bevel gears 51, 50, and the pair of correction rollers 37, 38 is rotated. By the rotation of the pair of correction rollers 37, 38, banknotes are clamped and transferred.

[0045] Note that the clamping force of the pair of correction rollers 37, 38 of the posture correction unit 8 is set so as to be stronger than the pinching force of the conveying belts 49a to 49c.

[0046] On the other hand, the cylindrical shaft 43 is held rotatably by a housing 56a via a bearing 57, and the center portion of the frame base portion 34a of the supporting frame 34 is fixed to the upper end portion of the cylindrical shaft 43. To the pulley 45 fixed to the lower side of the cylindrical shaft 43, the stepping motor 48 is connected via the belt 46, and the pulley 47. The drive amount of the stepping motor 48 is controlled on the basis of a shift amount (or skew amount) of the banknote measured by the optical sensor array 70. The housing 56a is fixed onto the base 31 via a plate 58. A sensor 59 is attached to the base 31, and a material to be detected 34b that turns the sensor 59 on or off is attached to the supporting frame 34.

[0047] When the stepping motor 48 is driven to rotate, the cylindrical shaft 43 is rotated via the pulley 47, the belt 46 and the pulley 45. By this rotation, the supporting frame is rotated to change the direction of the pair of correction rollers 37, 38. The rotation amount of the supporting frame 34 is controlled in such a manner that the material to be detected 34b is detected by the sensor 59.

[0048] Meanwhile, in the case where the shift amount

or the skew amount of the banknote P measured by the optical sensor array 70 is small, the operation amounts (angles) of the shift correction arms 34A1, 34A2 and the skew correction arms 34B1, 34B2 become small. Accordingly, in some cases, the operation amount of the stepping motor 48 is so small that a preferable result cannot be attained. For example, in the case of the stepping motor 48, the minimum operation amount thereof is one step. For this reason, the minimum amount of the operations of the shift correction arms 34A1, 34A2 and the skew correction arms 34B1, 34B2 becomes one step, and a smaller angle than this cannot be corrected.

[0049] In order to avoid this, in the case of a shift amount or skew amount of a predetermined level or less, only one of the two shift correction arms 34A1, 34A2, or only one of the two skew correction arms 34B1, 34B2 is made to operate.

[0050] Further, in the case when the correction amount is one step or below of the stepping motor 48, the first shift correction arm 34A1 or first skew correction arm 34B1 is made to operate by one step plus the correction amount, and thereafter, the second shift correction arm 34A2 or second skew correction arm 34B2 is made to operate by one step in the reverse direction.

[0051] A measuring device 85a that optically measures the correction amount of the banknote whose shift has been corrected by the first shift correction unit 32a is provided between the first shift correction unit 32a and the second shift correction unit 33a. A measuring device 85b that optically measures the correction amount of the banknote whose skew has been corrected by the first skew correction unit 32b is provided between the first skew correction unit 32b and the second skew correction unit 33b.

[0052] On the basis of the correction amount measured by the measuring device 85a, the correction amount of the banknote by the second shift correction unit 33a is controlled to change. In addition, on the basis of the correction amount measured by the measuring device 85b, the correction amount of the banknote by the second skew correction unit 33b is controlled to change.

[0053] FIG. 7 shows the operation of correcting the shift of the banknote P, and FIG. 10 shows a flowchart thereof.

[0054] A shift amount ΔS of the banknote P is measured by the optical sensor array 70. When the total of the rotation angles of the first and second shift correction arms 34A1, 34A2 for correcting the measured shift amount ΔS is defined as θ_1 , it is determined whether or not $\theta_1 > 2a$ (wherein "a" is a minimum angle for shift correction of the first and second shift correction arms 34A1, 34A2), or, $a < \theta_1 \leq 2a$, or $\theta_1 \leq a$ (step ST1).

[0055] If it is determined that $\theta_1 > 2a$, the first shift correction arm 34A1 is rotated by the angle $\theta_1/2$ in the counterclock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the first shift correction arm 34A1 (step ST2). The banknote P passes through the first shift correction

arm 34A1 rotated thus, so that the first time shift correction is performed (step ST3). The corrected banknote P passes through the measuring device 85a, so that the correction amount thereof is measured, and it is determined whether or not the banknote has been corrected by a predetermined amount (half of the shift amount ΔS) (step ST4). If it is determined that the banknote has been corrected by the predetermined amount, the second shift correction arm 34A2 is rotated by the angle $\theta_1/2$ in the counterclock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the second shift correction arm 34A2 (step ST5). The banknote P passes through the second shift correction arm 34A2 rotated thus, so that the second time shift correction is performed (step ST6). By the first time and second time shift corrections described above, the shift amount ΔS is corrected to eliminate the shift of the banknote. Note that, if it is determined that the banknote has not been corrected by the predetermined amount in step ST4, the second shift correction arm 34A2 is controlled to rotate such that the rotation amount becomes more or less than $\theta_1/2$ (step ST7). The banknote P passes through the second shift correction arm 34A2 rotated under the control of the rotation amount as described above, so that the second time shift correction is performed (step ST6). As a result, it is possible to perform the shift correction for the banknote P more precisely.

[0056] Further, if it is determined that $a < \theta_1 \leq 2a$ in step ST1, the first shift correction arm 34A1 is rotated by the angle θ_1 in the counterclock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the first shift correction arm 34A1 (step ST8). The banknote P passes through the first shift correction arm 34A1 rotated thus, so that the shift amount ΔS is corrected (step ST9). Consequently, the banknote P is corrected into its shift-free state.

[0057] Furthermore, if it is determined that $\theta_1 \leq a$ in step ST1, the first shift correction arm 34A1 is rotated by the angle $(\theta_1 + a)$ in the counterclock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the first shift correction arm 34A1 (step ST10). The banknote P passes through the first shift correction arm 34A1 rotated thus, whereby the first time shift correction is performed (step ST11). The corrected banknote P passes through the measuring device 85a, so that the correction amount thereof is measured, and it is determined whether or not the banknote has been corrected by a predetermined amount (step ST12). If it is determined that the banknote has been corrected by the predetermined amount, the second shift correction arm 34A2 is rotated by the angle $-a$ from the state where it crosses the conveyance path at right angles before the banknote P reaches the second shift correction arm 34A2 (step ST13). The banknote P passes through the second shift correction arm 34A2 rotated thus, so that the second time shift correction is performed. As a result, the banknote P is corrected into its shift-free state.

[0058] If it is determined that the banknote has not been corrected by the predetermined amount in step ST12, the second shift correction arm 34A2 is controlled to rotate such that the rotation amount becomes more or less than the angle $-a$ (step ST15). The banknote P passes through the second shift correction arm 34A2 rotated under the control of the rotation amount as described above, whereby the second time shift correction is performed (step ST14). This makes it possible to perform the shift correction for the banknote P more precisely.

[0059] FIG. 9 shows the operation for correcting skew of the banknote P, and FIG. 10 shows a flowchart thereof.

[0060] A skew angle θ_2 of the banknote P is measured by the optical sensor array 70, and then it is determined whether or not $\theta_2 > 2a$ (wherein "a" is a minimum angle for skew correction), or, $a < \theta_2 \leq 2a$, or $\theta_2 \leq a$ (step ST11).

[0061] If it is determined that $\theta_2 > 2a$, the first skew correction arm 34B1 is rotated by the angle $\theta_2/2$ in the clock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the first skew correction arm 34B1 (step ST12). Then, while the banknote P passes through the first skew correction arm 34B1, the first skew correction arm is rotated by $-\theta_2/2$ to make it right back, and the first time skew correction is performed (step ST13). The corrected banknote P passes through the measuring device 85b, so that the correction amount thereof is measured, and it is determined whether or not the banknote has been corrected by a predetermined amount (half of the skew angle θ_2) (step ST14).

[0062] If it is determined that the skew angle θ_2 of the banknote P has been corrected by the predetermined amount (half correction of the skew angle θ_2), the second skew correction arm 34B2 is rotated by the angle $\theta_2/2$ before the banknote P reaches the second skew correction arm 34B2 (step ST15). While the banknote P passes through the second skew correction arm 34B2 rotated thus, the second skew correction arm is rotated by $-\theta_2/2$ to make it right back, and the second time skew correction is performed (step ST16). By the first time and second time skew corrections described above, the skew of the banknote is eliminated.

[0063] If it is determined that the skew angle θ_2 of the banknote P has not been corrected by the predetermined amount (half correction of the skew angle θ_2) in step ST14, the second skew correction arm 34B2 is controlled to rotate such that the rotation amount becomes more or less than $\theta_2/2$ (step ST17). While the banknote P passes through the second skew correction arm, the second skew correction arm 34B2 is rotated by the angle of the rotation controlled in step ST17 to rotate it in the reverse direction (step ST18), whereby the second time skew correction is performed (step ST16). This makes it possible to perform the skew correction for the banknote P more precisely.

[0064] Further, if it is determined that $a < \theta_2 \leq 2a$ in step ST11, the first skew correction arm 34B1 is rotated by the angle θ_2 in the clock direction from the state where

it crosses the conveyance path at right angles before the banknote P reaches the first skew correction arm 34B1 (step ST19). Then, while the banknote P passes through the first skew correction arm 34B1, the first skew correction arm is rotated by $-\theta_2$ to make it right back, and thereby the skew angle is corrected (step ST20). The first time skew correction is performed (step ST13). As a result, the banknote P is corrected into its skew-free state.

[0065] Furthermore, if it is determined that $\theta_2 \leq a$ in step ST11, the first skew correction arm 34B1 is rotated by the angle $(\theta_2 + a)$ in the clock direction from the state where it crosses the conveyance path at right angles before the banknote P reaches the first skew correction arm 34B1 (step ST21). Then, while the banknote P passes through the first skew correction arm 34B1, the first skew correction arm is rotated

by $-(\theta_2 + a)$ to make it right back (step ST22). Thereby, the banknote P is corrected by the angle "a" in the counterclock direction. The banknote P passes through the measuring device 85b, so that the correction amount thereof is measured, and it is determined whether the banknote has been corrected by the predetermined amount (step ST23). If it is determined that the banknote has been corrected by the predetermined amount, the second skew correction arm 34B2 is rotated by the angle $-a$ from the state where it crosses the conveyance path at right angles before the banknote P reaches the second skew correction arm 34B2 (step ST24). Subsequently, while the banknote P passes through the second skew correction arm 34B2, the second skew correction arm is rotated by the angle a to make it right back, and thereby the skew angle is corrected (step ST25). Consequently, the banknote P is corrected into its skew-free state.

[0066] If it is determined that the skew of the banknote P has not been corrected by the predetermined amount in step ST23, the second skew correction arm 34B2 is controlled to rotate such that the rotation amount becomes more or less than the angle $-a$ (step ST26). While the banknote P passes through the second skew correction arm 34B2 rotated as described above, the second skew correction arm is rotated by the angle of the rotation controlled in step ST24 to rotate it in the reverse direction, so that the second time skew correction is performed (step ST27). This makes it possible to perform the skew correction for the banknote P more precisely.

[0067] As described above, according to the present embodiment, two shift correction units 32a, 32a and two skew correction units 32b, 33b are arranged, and the shift amount and the skew amount of banknotes P are corrected by the two shift correction units 32a, 32a and two skew correction units 32b, 33b. Accordingly, it is possible to improve the correction processing efficiency without performing a high-speed operation.

[0068] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications

may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

Claims

1. A paper sheet positioning apparatus **characterized by** comprising:

a conveying device (6) which conveys paper sheets (P) along a conveyance path;
a shift amount measuring device (70) which measures a shift amount of the paper sheets (P) conveyed by the conveying device (6) on the conveyance path; and
a plurality of shift correction devices (32a, 33a) which are arranged along the conveying direction of the paper sheets (P), and correct the shift amount measured by the shift amount measuring device (70).

2. A paper sheet positioning apparatus according to claim 1, **characterized in that** two units of the shift correction devices (32a, 33a) are arranged.

3. A paper sheet positioning apparatus according to claim 2, **characterized in that** the two units of the shift correction devices (32a, 33a) correct, at a time, half of the shift amount measured by the shift amount measuring device (70).

4. A paper sheet positioning apparatus according to claim 2, **characterized in that**, when the shift amount measured by the shift amount measuring device (70) is below twice a minimum value which is correctable by the shift correction devices (32a, 33a), only the first shift correction device (32a) corrects the shift amount.

5. A paper sheet positioning apparatus according to claim 2, **characterized in that**, when the shift amount measured by the shift amount measuring device (70) is below a minimum value which is correctable by the shift correction devices (32a, 33a), the first shift correction device (32a) corrects a sum shift amount obtained by adding the correctable minimum value to the shift amount, and thereafter, the second shift correction device (33a) corrects the correctable minimum value in the reverse direction.

6. A paper sheet positioning apparatus according to claim 2, **characterized by** further comprising: a measuring device (85a) which measures a correction amount of the paper sheets (P) whose shift is corrected by the shift correction device (32a) located at the upstream side in the conveying direction of the paper sheets (P), wherein, on the basis of the

correction value measured by the measuring device (85a), the shift correction amount by the shift correction device (33a) located at the downstream side in the conveying direction of the paper sheets (P) is controlled.

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7. A paper sheet positioning apparatus **characterized by** comprising:

a conveying device (6) which conveys paper sheets (P) along a conveyance path;
a skew amount measuring device (70) which measures a skew amount of the paper sheets (P) conveyed by the conveying device (6) on the conveyance path; and
a plurality of skew correction devices (32b, 33b) which are arranged along the conveying direction of the paper sheets (P), and correct the skew amount measured by the skew amount measuring device (70).

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8. A paper sheet positioning apparatus according to claim 7, **characterized in that** two units of the skew correction devices (32b, 33b) are arranged.

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9. A paper sheet positioning apparatus according to claim 8, **characterized in that** the two units of the skew correction devices (32b, 33b) correct, at a time, half of the skew amount measured by the skew amount measuring device (70).

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10. A paper sheet positioning apparatus according to claim 8, **characterized in that**, when the skew amount measured by the skew amount measuring device (70) is below twice a minimum value which is correctable by the skew correction devices (32b, 33b), only the first skew correction device (32b) corrects the skew amount.

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11. A paper sheet positioning apparatus according to claim 8, **characterized in that**, when the skew amount measured by the skew amount measuring device (70) is below a minimum value which is correctable by the skew correction devices (32b, 33b), the first skew correction device (32b) makes a correction of an angle obtained by adding the correctable minimum value to the skew amount, and thereafter, the second skew correction device (33b) corrects the correctable minimum value in the reverse direction.

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12. A paper sheet positioning apparatus according to claim 8, **characterized by** further comprising: a measuring device (85b) which measures a correction amount of the paper sheets (P) whose skew is corrected by the skew correction device (32b) located at the upstream side in the conveying direction of the paper sheets (P), wherein, on the basis of the

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correction value measured by the measuring device (85b), the skew correction amount by the skew correction device (33b) located at the downstream side in the conveying direction of the paper sheets (P) is controlled.

13. A paper sheet positioning apparatus **characterized by** comprising:

a conveying device (6) which conveys paper sheets (P) along a conveyance path;
a measuring device (70) which measures a shift amount and a skew amount of the paper sheets (P) conveyed by the conveying device (6) on the conveyance path;
a plurality of shift correction devices (32a, 33a) which are arranged along the conveying direction of the paper sheets (P), and correct the shift amount measured by the measuring device (70); and
a plurality of skew correction devices (32b, 33b) which are arranged along the conveying direction of the paper sheets (P), and correct the skew amount measured by the measuring device (70).

14. A paper sheet positioning apparatus according to claim 13, **characterized in that** two units of the shift correction devices (32a, 33a) and two units of the skew correction devices (32b, 33b) are arranged.

15. A paper sheet positioning apparatus according to claim 13, **characterized in that** the two units of the shift correction devices (32a, 33a) correct, at a time, half of the shift amount measured by the measuring device (70), and the two units of the skew correction devices (32b, 33b) correct, at a time, half of the skew amount measured by the measuring device (70).

16. A paper sheet positioning apparatus according to claim 14, **characterized in that**, when the shift amount measured by the measuring device (70) is below twice a minimum value which is correctable by the shift correction devices (32a, 33a), only the first shift correction device (32a) corrects the shift amount, and when the skew amount measured by the measuring device (70) is below twice a minimum value which is correctable by the skew correction devices (32b, 33b), only the first skew correction device (32b) corrects the skew amount.

17. A paper sheet positioning apparatus according to claim 14, **characterized in that**, when the shift amount measured by the measuring device (70) is below a minimum value which is correctable by the shift correction devices (32a, 33a), the first shift correction device (32a) corrects a sum shift amount obtained by adding the correctable minimum value to

the shift amount, and thereafter, the second shift correction device (33a) corrects the correctable minimum value in the reverse direction, and when the skew amount measured by the measuring device (70) is below a minimum value which is correctable by the skew correction devices (32b, 33b), the first skew correction device (32b) makes a correction of an angle obtained by adding the correctable minimum value to the skew amount, and thereafter, the second skew correction device (33b) corrects the correctable minimum value in the reverse direction.

18. A paper sheet positioning apparatus according to claim 14, **characterized by** further comprising:

a measuring device (85a) which measures a correction amount of the paper sheets (P) whose shift is corrected by the shift correction device (32a) located at the upstream side in the conveying direction of the paper sheets (P), wherein, on the basis of the correction value measured by the measuring device (85a), the shift correction amount by the shift correction device (33a) located at the downstream side in the conveying direction of the paper sheets (P) is controlled; and
a measuring device (85b) which measures a correction amount of the paper sheets (P) whose skew is corrected by the skew correction device (32b) located at the upstream side in the conveying direction of the paper sheets (P), wherein, on the basis of the correction value measured by the measuring device (85b), the skew correction amount by the skew correction device (33b) located at the downstream side in the conveying direction of the paper sheets (P) is controlled.

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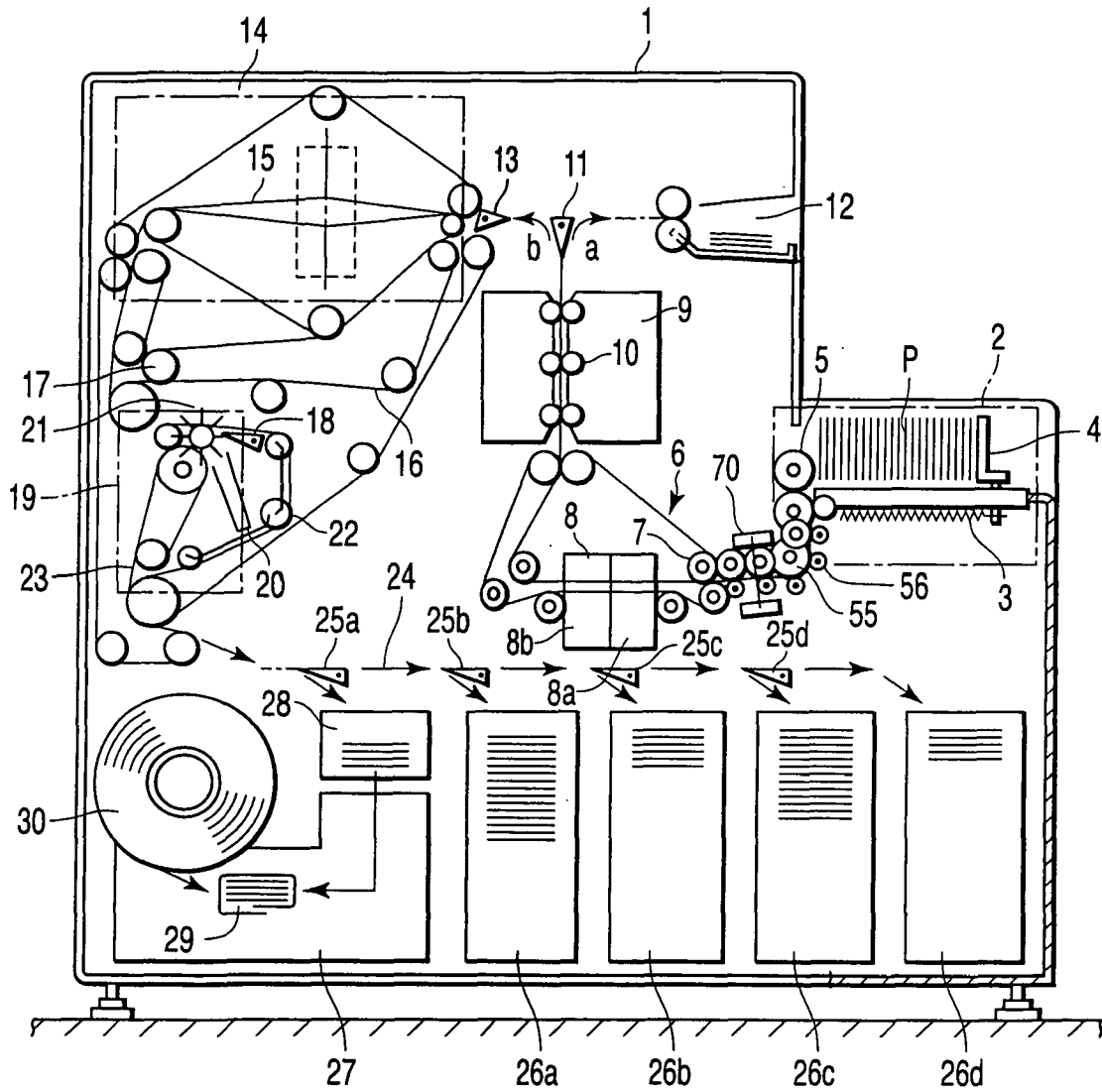


FIG. 1

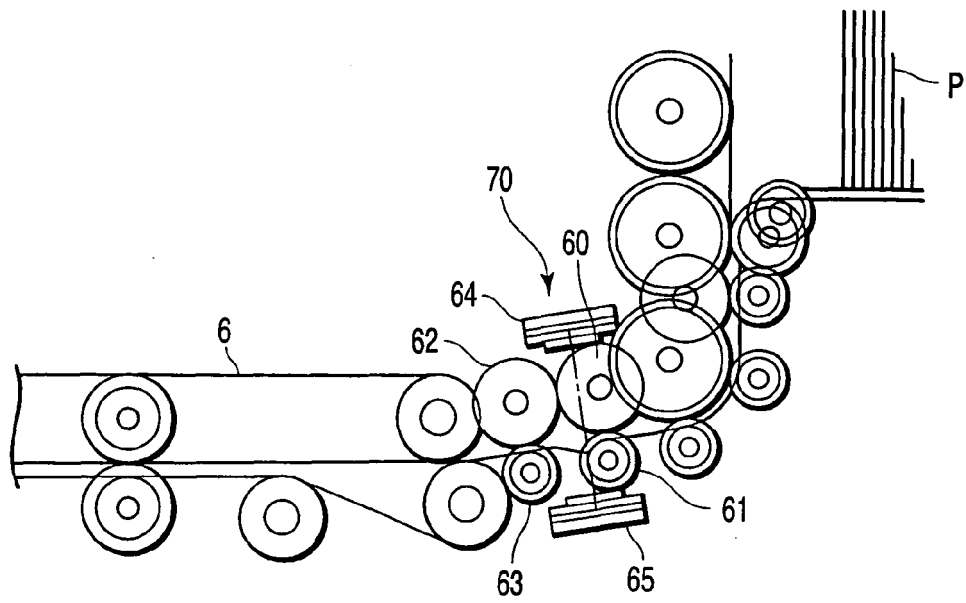


FIG. 2

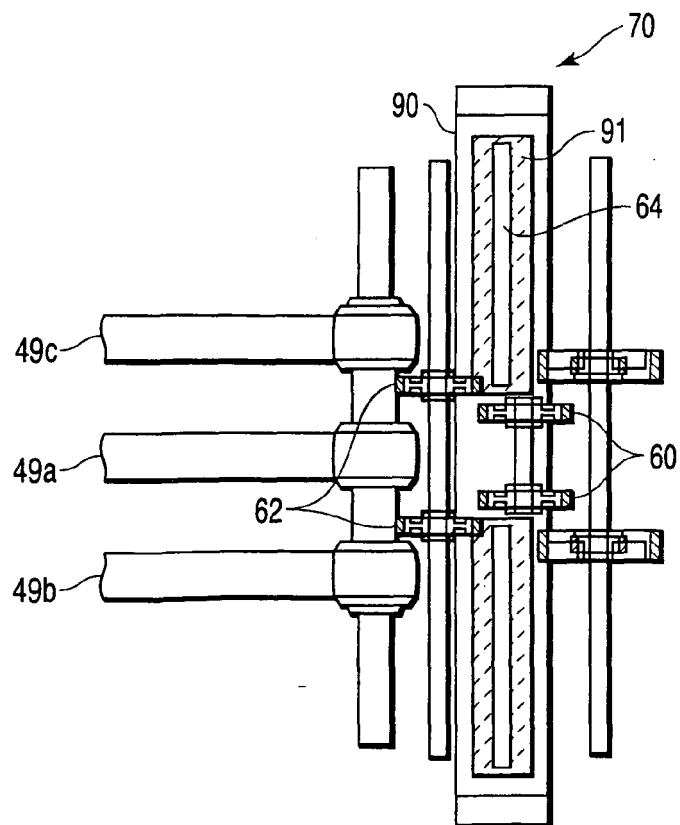


FIG. 3

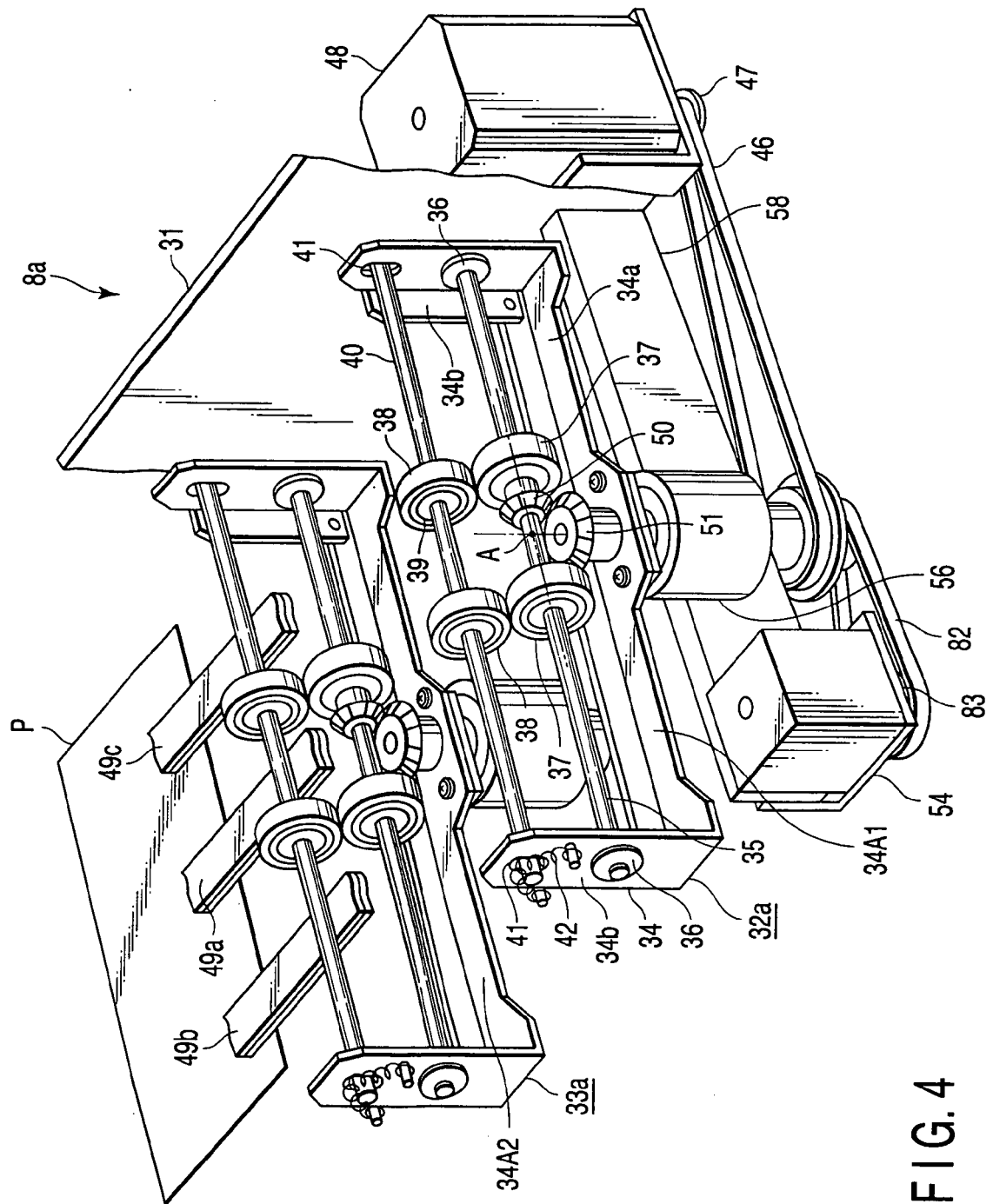


FIG. 4

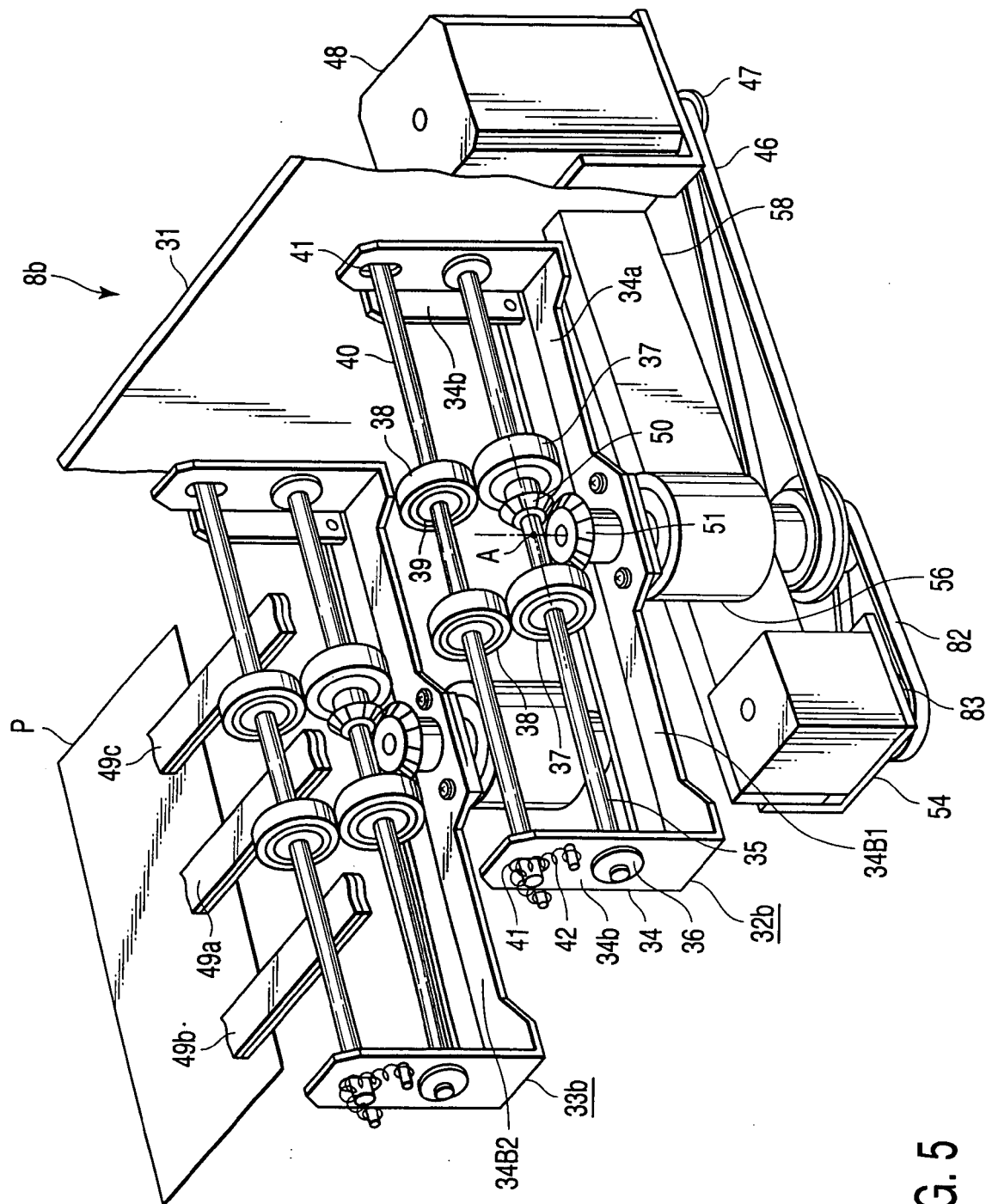


FIG. 5

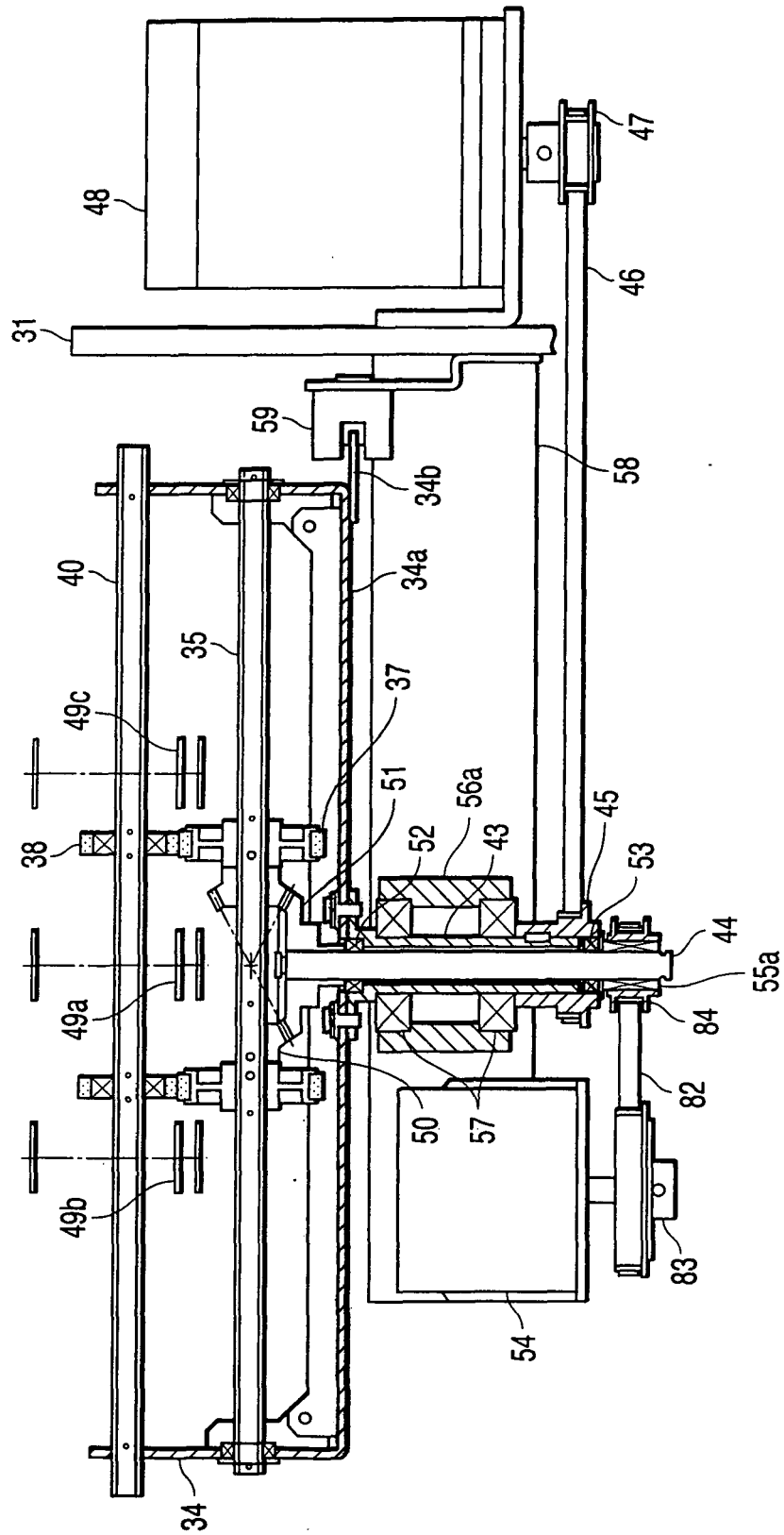
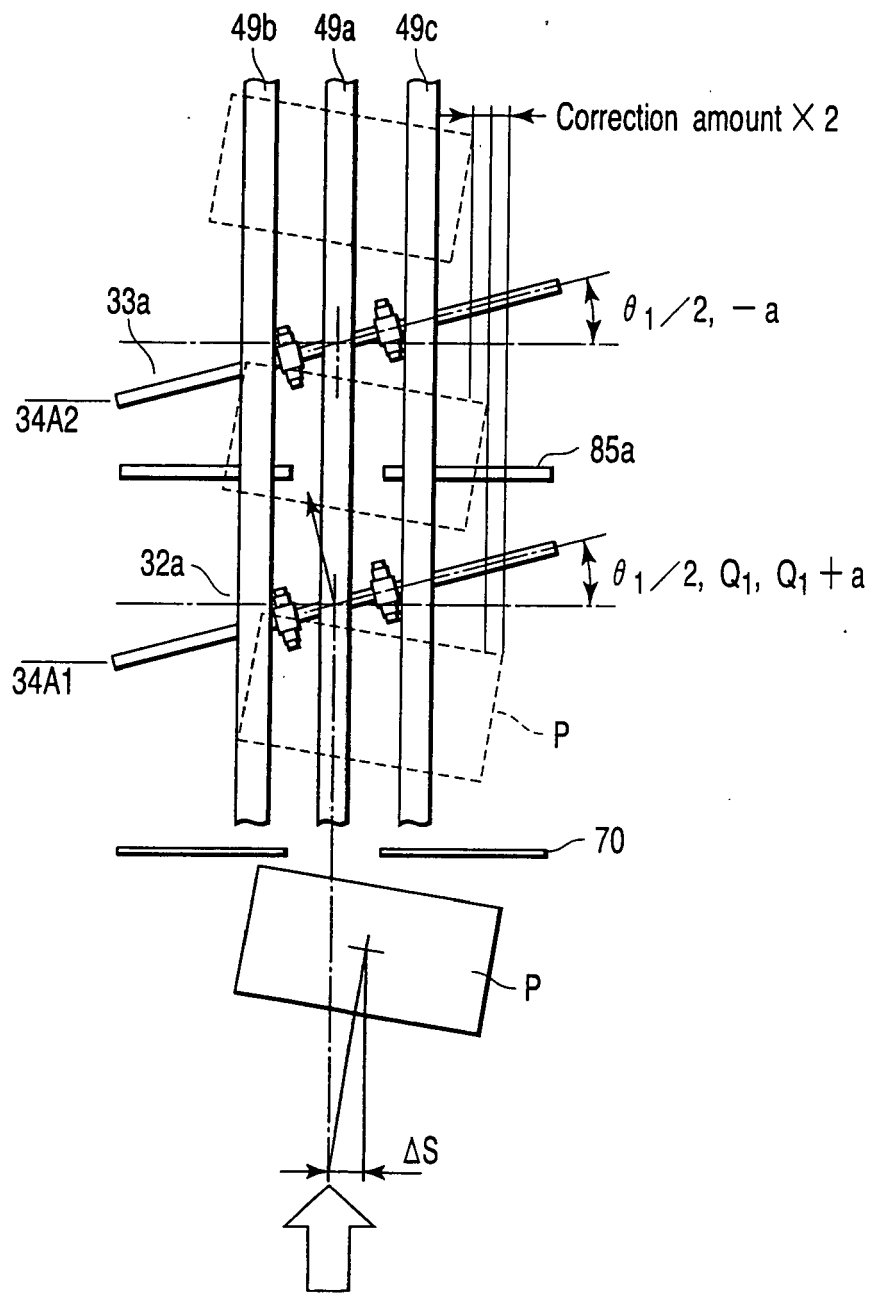


FIG. 6



Position correction operation view

FIG. 7

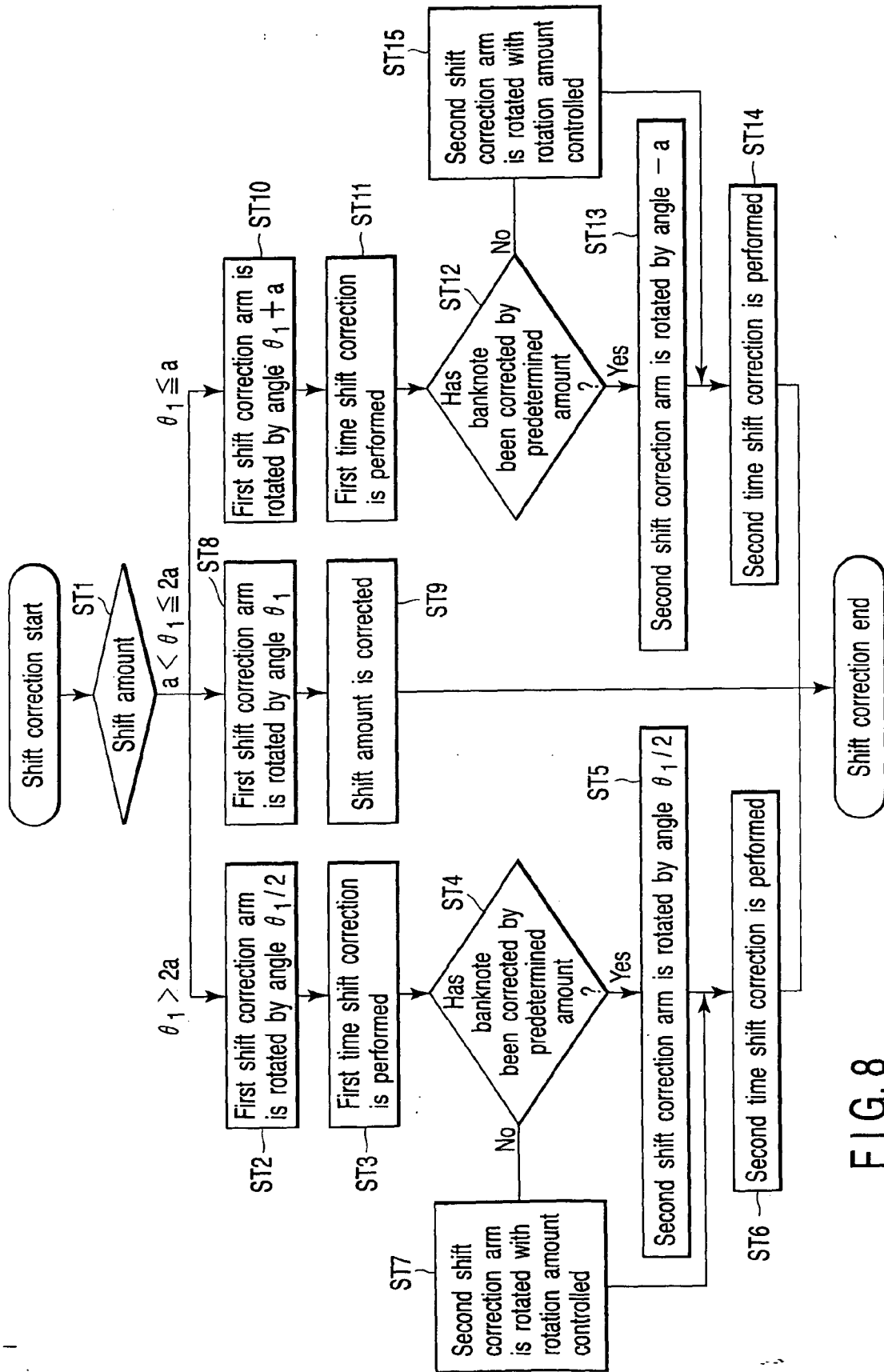
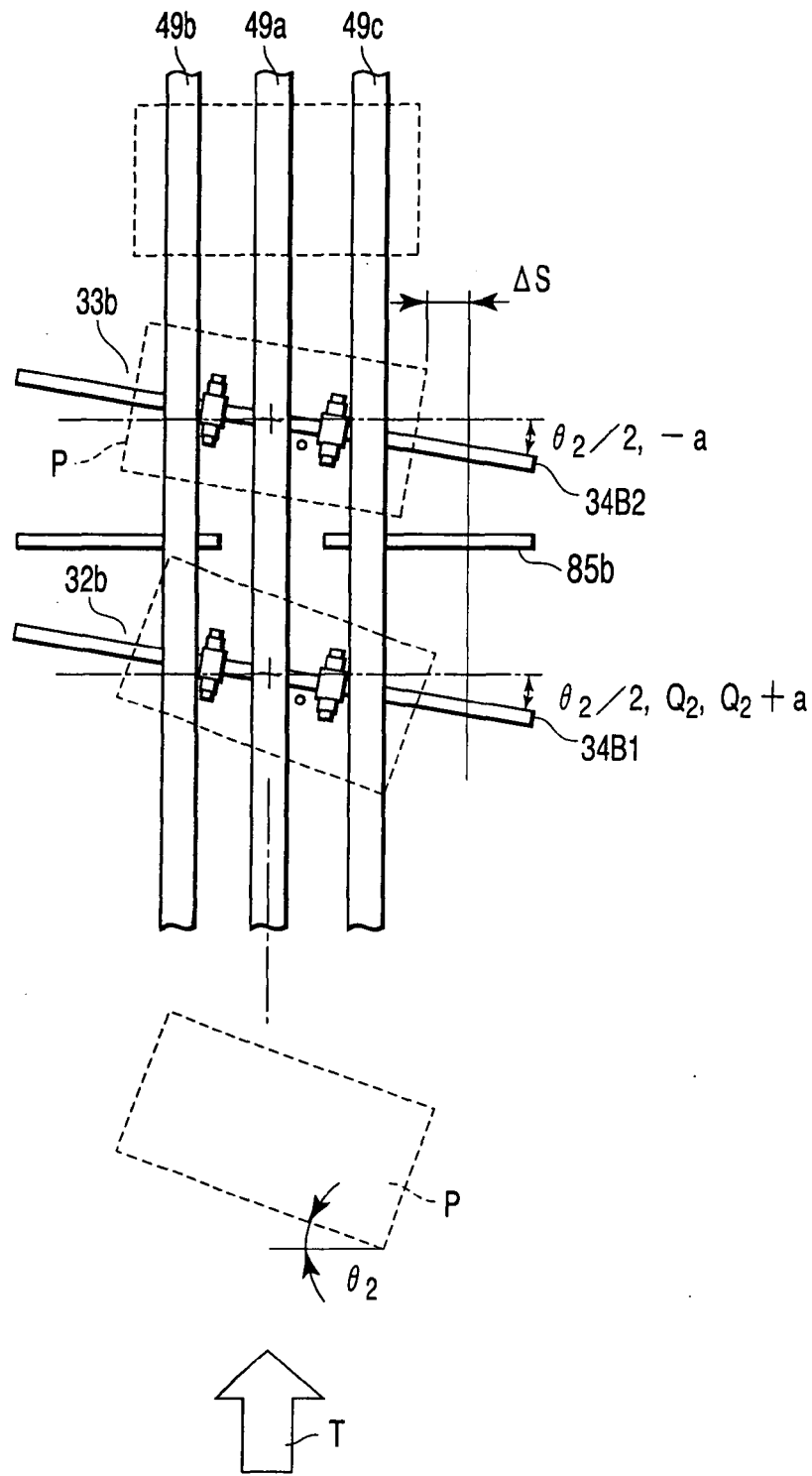


FIG. 8



Skew correction operation view

FIG. 9

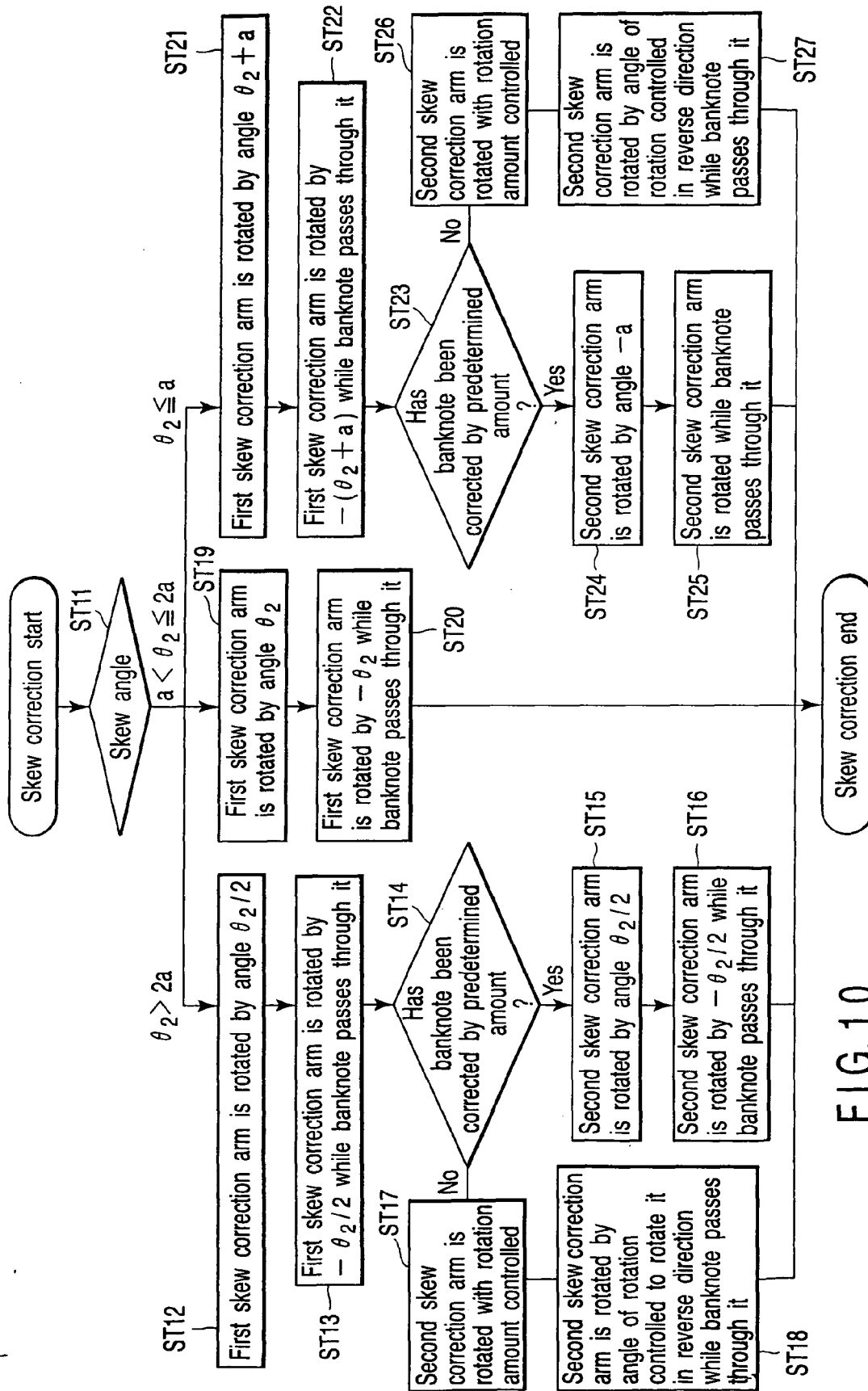


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002087647 A [0010]