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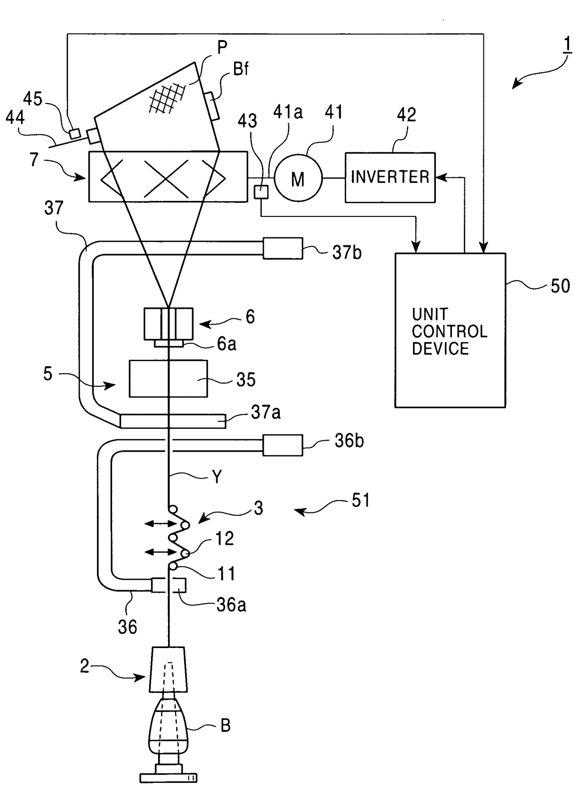
(54) **Method of predicting weight of package, method of manufacturing package, and yarn winder**

(57) The present invention improve productivity by quickly completing corrections of the amount of yarn rewound which corrections are required to obtain a desired package. The total number of package rotations are acquired for all winding units 1 when the total number of rotations of the winding drum 7 continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during rewinding. Then, on the basis of the total numbers of package rotations, the package weight obtained in each winding unit 1 after the completion of the rewinding is predicted. Then, the amount of yarn rewound is corrected so as to reduce a variation in package weight which may occur during the rewinding process and which may remain after the completion of the rewinding.

FIG. 4



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Description

Field of the Invention

[0001] The present invention relates to a yarn winder comprising a plurality of winding units each of which winds a yarn unwound from a yarn supplying bobbin, around a winding bobbin to obtain a package, as well as a method of predicting the weight of a package and a method of manufacturing a package.

Background of the Invention

[0002] A yarn winder such as an automatic winder comprises a plurality of winding units each of which splices a large number of yarns together which are wound around yarn supplying bobbins, while eliminating defects in the yarns, to rewind the spliced yarns around a cone-like winding bobbin. In each winding unit, when the yarn is rewound around the winding bobbin, the length of the yarn is measured. Then, once a package with a predetermined length of yarn is obtained, this package is cut off. Then, the package is weighed to determine whether or not it has a predetermined package weight. If, for example, the weight of the package is insufficient, a timer is used to increase (correct) the amount of yarn rewound so as to compensate for the insufficiency.

[0003] However, when the weight of the package is actually measured to correct the amount of yarn rewound after the package with the predetermined length of yarn has been obtained, various processes are required including the process of cutting off the package, the weighing process, and the attaching process. Accordingly, a long time is required to obtain the desired package. This disadvantageously results in a low productivity.

[0004] The above-mentioned method is disclosed in, for example, the Unexamined Japanese Utility Model Application Publication No. 5-5768

Summary of the Invention

[0005] It is an object of the present invention to improve productivity by quickly completing corrections of the amount of rewound which corrections are required to obtain the desired package.

[0006] An aspect of the present invention set forth in Claim 1 provides a method of predicting the weight of a package in an automatic wider having a large number of winding units arranged in line to execute a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package, characterized in that the weight of a full package in each winding unit is predicted on the basis of the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding.

[0007] In connection with the above configuration, in the prior art of yarn winders, which do not include the present invention, it has been considered that the total number of package rotations required to complete the rewinding and the weight of the package do not have an accurate proportional relationship even through they may have a certain degree of such a relationship. Thus, measures have been taken to execute, for example, a process of actually measuring the weight of the package after the rewinding has been completed and then to compensate for insufficiency by increasing the amount of yarn rewound. However, the results of the repetition of various tests or the like indicate that in a group composed of a plurality of winding units, the total number of package rotations during rewinding has a strong correlation with the package weight obtained after the rewinding has been completed. That is, it has been found out that the package weight obtained after the completion of the rewinding decreases consistently with the total number of package rotations during the rewinding and that the package weight obtained after the completion of the rewinding increases consistently with the total number of package rotations during the rewinding. A variation in package weight among the winding units is assumed to be a result of a mechanical error in each winding unit or the like, which causes a slip between the package and the winding drum driving the surface of the package to prevent the rotation of the winding drum and the rotation of the package from having a one-to-one correspondence. The present invention has been completed on the basis of such knowledge. Thus, by predicting the package weight obtained after the completion of the rewinding, it is possible to quickly complete corrections such as an increase in the amount of yarn rewound which corrections are carried out to obtain the desired package, compared to the prior art, in which the package weight is actually measured after the rewinding has been completed. This also improves productivity.

[0008] An aspect of the present invention set forth in Claim 2 provides a method of manufacturing a package in an automatic wider having a large number of winding units arranged in line to execute a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package, characterized by comprising, for all the winding units, acquiring the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding, and on the basis of the said total numbers of package rotations, correcting the amount of yarn rewound so as to reduce a variation in package weight among the winding unit when the packages are full.

[0009] The above configuration enables a reduction in a variation in weight among a plurality of packages produced in parallel. This makes it possible to prevent the package weight from being excessively large or small. Further, since the amount of yarn rewound is corrected during rewinding, the productivity is improved.

[0010] An aspect of the present invention set forth in Claim 3 is a method of manufacturing a package according to Claim 2, characterized in that the amount of yarn rewound is corrected on the basis of a standard deviation of the total number of package rotations during rewinding. This configuration enables a variation in package weight to be sufficiently reduced.

[0011] An aspect of the present invention set forth in Claim 4 provides a yarn winder having a plurality of winding units each of which executes a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package and a frame control device which can control and manage the rewinding process executed on each group of winding units, characterized in that the frame control device has package total rotation number acquiring means for acquiring, for all the winding units of each group, the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding, and variation determining means for determining a variation in package weight among the winding units in the group on the basis of the total numbers of package rotations.

[0012] With the above configuration, for each winding unit, the package weight obtained after the completion of the rewinding can be predicted on the basis of a variation in package weight during rewinding. Thus, by adjusting the amount of yarn rewound in each winding unit, it is possible to reduce a variation in package weight among the winding units in each group. Further, since the amount of yarn rewound is corrected during the rewinding, the productivity is improved.

[0013] An aspect of the present invention set forth in Claim 5 is a yarn winder according to Claim 4, characterized in that the variation determining means determines the variation from a standard deviation of the total number of package rotations. With this configuration, for each winding unit, the package weight obtained after the completion of rewinding can be relatively accurately predicted on the basis of a variation in package weight during the rewinding.

[0014] An aspect of the present invention set forth in Claim 6 is a yarn winder according to Claim 4, characterized in that the frame control device has rewinding amount correcting means for correcting the amount of yarn rewound for each winding unit on the basis of the variation in package weight determined by the variation determining means so as to reduce a variation in package weight which may remain after the rewinding has been completed. This configuration enables a variation in package weight among the winding units to be automatically reduced without the intervention of an operator. Further, since the amount of yarn rewound is corrected during the rewinding, the productivity is improved.

[0015] An aspect of the present invention set forth in Claim 7 is a yarn winder according to Claim 6, characterized in that the frame control device has variation coefficient determining means for determining a coefficient of variation among the winding units in the group on the basis of the total numbers of package rotations and if the coefficient of variation is less than a predetermined value, prohibiting the rewinding amount correcting means from correcting the amount of yarn rewound. This configuration enables the degree of deviation to be determined using the coefficient of variation. It is thus possible to prevent the correction of the amount of yarn rewound from being uselessly carried out even though they are actually not effective.

[0016] An aspect of the present invention set forth in Claim 8 is a yarn winder according to any one of Claims 4 to 7, characterized in that the frame control device has variation displaying means for directly and/or indirectly displaying, in a graph, the total number of package rotations for each of the winding units in the group. This configuration enables the operator to easily understand the degree of the deviation of the total number of package rotations in each winding unit.

[0017] An aspect of the present invention set forth in Claim 9 is a yarn winder according to Claim 8, characterized in that the frame control device has error notifying means for identifying a winding unit for which the total number of package rotations deviates, by at least a predetermined value, from an average of the total numbers of package rotations for all the winding units in the group and notifying an operator of this winding unit. This configuration enables early detection of a winding unit performing an erroneous rewinding operation. Consequently, adequate measures can subsequently be taken.

[0018] According to the present invention, the package weight obtained after the completion of rewinding can be predicted during the rewinding. It is thus possible to quickly complete corrections such as an increase in the amount of yarn rewound which corrections are carried out to obtain the desired package. This advantageously serves to improve productivity.

[0019] By determining a variation in the total number of package rotations during rewinding, the inventors have accomplished the object to quickly complete the correction of the amount of yarn rewound into a package in order to improve productivity.

Brief Description of the Drawings

[0020]

Figure 1 is a block diagram of a yarn winder.

Figures 2A and 2B are a flow chart of a frame control correcting process routine.

Figure 3 is a flow chart of a winding unit operation routine.

Figure 4 is a schematic diagram showing the configuration of a winding unit.

Figure 5 is a front view of the yarn winder.

Figure 6 is a table illustrating a correction value setting base table.

Figure 7 is a table illustrating a correction calculation table.

Figure 8 is a table illustrating a correction execution table.

Figure 9 is a diagram illustrating an automatic correction ON/OFF setting screen.

Figure 10 is a diagram illustrating a correction content setting screen.

Figure 11 is a diagram showing a total package rotation number graph window.

Detailed Description of the Preferred Embodiments

Embodiment 1

[0021] Embodiments of the present invention will be described below with reference to Figures 1 to 11.

[0022] As shown in Figure 5, a yarn winder according to the present embodiment comprises a one-line frame 61 including a plurality of winding units 1 provided in line and a frame control device 4 which can individually set operational conditions for the winding units 1 and which can monitor each winding unit 1 for its operations. The present embodiment will be described in connection with the one line of frame 61. However, plural lines of frames 61 and a higher control device such as a production management device may be connected together so that the control device can transmit and receive data to and from the frames 61. Thus, the higher control device can centrally manage the frames 61.

[0023] As shown in Figure 4, the winding unit 1 comprises an unwinding assisting device 2, a tensioning device 3 also used as a twist stopping device, a yarn splicing device 5, a slab catcher 6, and a winding drum 7 arranged in this order in a direction in which a yarn Y wound around a yarn supplying package B (yarn supplying body) such as a spinning bobbin is taken up. That is, the automatic winder is configured so that the winding drum 7 is rotated to unwind the yarn Y from the yarn supplying package B, while a package P wound around a bobbin Bf is rotated in contact with the winding drum 7 to wind the yarn Y into the package P.

[0024] The tensioning device 3 is placed above the yarn supplying package B via the unwinding assisting device 2. The tensioning device 3 is of a gate type in which fixed comb teeth 11 alternate with movable comb teeth 12. The yarn splicing device 5 executes a yarn splicing process of splicing the cut-off yarn Y on the yarn supplying package B to the yarn Y on the package P. The yarn splicing device 5 comprises a yarn splicing device main body 35, a lower yarn sucking and guiding member 36 that guides the yarn Y on the yarn supplying package B to the yarn splicing device main body 35, and an upper yarn sucking and guiding member 37 that guides the yarn Y on the package P to the yarn splicing device main body 35.

[0025] The lower yarn sucking and guiding member 36 has a suction port 36a that can be opened and closed. The lower yarn sucking and guiding member 36 can be pivoted around a shaft 36b. When the yarn Y is forcedly cut, the suction port 36a is opened. Then, the tensioning device 3 also used as the twist stopping device is also opened to suck a supplying-side yarn end into the suction port 36a. The suction port 36a holds the yarn end and the lower yarn sucking and guiding member 36 is pivoted from a lower yarn end catching position to an upper yarn end guiding position. Then, the lower end is guided into the yarn splicing main body 35 and into the tensioning device 3. When the suction port 36a lies between the yarn supplying package B and the tensioning device 3, the lower yarn sucking and guiding member 36 is in a standby position. Accordingly, after being activated, the lower yarn sucking and guiding member 36 can quickly catch the supplying-side yarn end.

[0026] The upper yarn sucking and guiding member 37 has a suction port 37a and can be pivoted around a shaft 37b. When the yarn Y is forcedly cut, the upper yarn sucking and guiding member 37 is pivoted to an upper yarn end catching position. The upper yarn sucking and guiding member 37 uses the suction port 37a to suck a yarn end rewound into the package P. Further, while catching the upper yarn, the upper yarn sucking and guiding member 37 is pivoted downward to guide the upper yarn to the yarn splicing main body 35. The yarn splicing device main body 35 then splices the upper yarn to the lower yarn.

[0027] The slab catcher 6 is, for example, a capacitance-type or optical-type yarn thickness detecting device. A signal from the slab catcher 6 is processed using an analyzer (not shown in the drawings) to detect a yarn defect such as a slab. When a yarn defect is detected, an attached cutter 6a cuts the yarn Y being taken up. Then, the yarn splicing device 5 removes the defective part during a yarn splicing process. The yarn splicing device 5 splices the yarn Y on the yarn supplying package B to the yarn Y on the package P.

[0028] The winding drum 7 is configured as a traversing drum comprising a traversing groove. The winding drum 7 contacts with the package P to rotate it and traverses the yarn Y being rewound into the package P. The winding drum 7 is rotatively driven by a motor 41. The motor 41 has its rotation speed controlled, via a drum rotation control device 42 (inverter), by a control signal outputted by a unit control device 50.

[0029] A drum rotation number measuring sensor 43 is provided near a rotating shaft 41a of the motor 41 to detect the number of rotations of the rotating shaft 41a. The drum rotation number measuring sensor 43 outputs a detection signal to the unit control device 50 for every rotation of the rotating shaft 41. The bobbin Bf, around which the package P is formed, is rotatably supported by a shaft member 44. A package rotation number measuring sensor 45 is provided near the shaft member 44 to detect the number of rotations of the shaft member 44. The package rotation number measuring sensor 45 outputs a detection signal to the unit control device 50 for every rotation of the rotating member 44.

[0030] As shown in Figure 1, the unit control device 50 comprises a communication section 52 connected to the frame control device 4 so as to enable data communications with the frame control device 4, as well as a total drum rotation number default value storage section 53, a correction value storage section 54, and a total drum rotation number final value storage section 55, and a package total rotation number output section 56 connected to the communication section 52. The total drum rotation speed default value storage section 53 is a storage area provided in a memory so as to store a total drum rotation number default value transmitted by the frame control device 4. Here, the "total drum rotation number default value" means the total number of drum rotations counted when the amount of yarn rewound (package weight) reaches, for example, 400g during while the yarn Y is rewound. The weight is not limited to 400g provided that a rewinding operation is being performed.

[0031] The correction value storage section 54 is a storage area provided in the memory so as to store a correction value transmitted by the frame control device 4. The total drum rotation number final value storage section 55 is a storage area provided in the memory so as to store a total drum rotation number full package value transmitted by the frame control device 4. If a correction value is stored in the correction value storage section 54, the total drum rotation number final value storage section 55 adds or subtracts the correction value to or from the total drum rotation number full package value and stores the result obtained. Here, the "correction value" means a value (the amount of yarn rewound) set to reduce a variation in package weight among the winding unit 1 in each group after rewinding has been completed. The "total drum number final value" is the total number of drum rotations required for the final weight of a full package (rewinding completion); with this value, the winding unit 1 is stopped. The total package rotation number output section 56 has a function to output the total number of package rotations to the frame control device 4 via the communication section 52 during rewinding and after the rewinding has been completed.

[0032] A total package rotation number counting section 57 is connected to the total package rotation number output section 56. The total package rotation number counting section 57 connects to an input and output section 58, a first total drum rotation number comparing section 59, and a second total drum rotation number comparing section 60. The input and output section 58 is connected to a total drum rotation number counting section 61. The total drum rotation number counting section 61 connects to the first total drum rotation number comparing section 59 and the second total drum rotation number comparing section 60. The second total drum rotation number comparing section 60 is connected to the total package rotation number counting section 57 and to the input and output section 58 via a stopping section 62.

[0033] The input and output section 58, having the above connection relationship, has a function to transmit and receive an output and input signals to and from the winding unit main body 51. Specifically, the input and output section 58 has, for example, a function to output a control signal to the drum rotation control device 42 of the winding unit main body 51 to rotate the motor 41 (winding drum 7), a function to receive an input signal from the package rotation number measuring sensor 45 to output the signal to the total package rotation number counting section 57, and a function to receive an input signal from the drum rotation number measuring sensor 43 to output the signal to the total drum rotation number counting section 61.

[0034] The total package rotation number counting section 57 has a function to increment its count every time the package rotation number measuring sensor 45 inputs a detection signal to the total package rotation number counting section 57 via the input and output section 58, to count the total number of rotations of the package P (the total number of package rotations) from start to completion of rewinding, and a function to output the total number of package rotations counted when the section is brought into the data output state, to the total package rotation number output section 56. The total drum rotation number counting section 61 has a function to increment its count every time the drum rotation number measuring sensor 43 inputs a detection signal to the total drum rotation number counting section 61 via the input and output section 58, to count the total number of rotations of the winding drum 7 (the total number of drum rotations) from start to completion of rewinding, and a function to output the total number of drum rotations to the first total drum rotation number comparing section 59 and the second total drum rotation number comparing section 60.

[0035] The first total drum rotation number comparing section 59 has a function to compare a total drum rotation number count in the total drum rotation number counting section 61 with a total drum rotation number default value in the total drum rotation number default value storage section 53, and when both values are equal, to set the operational state of the total package rotation number counting section 57 to the data output state. The second total drum rotation number comparing section 60 has a function to compare a total drum rotation number count in the total drum rotation number counting section 61 with a total drum rotation number final value in the total drum rotation number final value storage section 55, and when both values are equal, to set the operational state of the total package rotation number counting section 57 to the data output state, while bringing the stopping section 62 into an operative state.

[0036] The stopping section 62 has a function to stop the winding unit main body 51 via the input and output section 58 when activated. The total package rotation number output section 56, the total package rotation number counting section 57, the first total drum rotation number comparing section 59, and the first total drum rotation number comparing section 60 may be composed of hardware or software. That is, these sections may be constructed using programs consisting of winding unit operation routines in Figure, so as to provide the same functions.

[0037] The unit control device 50 configured as described above is connected to the frame control section 4 so as to transmit and receive data to and from it. The frame control device 4 has a storage section and a central control section (not shown in the drawings). The storage section is composed of a mass storage device and has a correction value setting base table in Figure 6, a correction calculation table in Figure 7, and a correction execution table in Figure 8.

[0038] As shown in Figure 6, the correction value setting base table has a "total drum rotation number default value", a "total drum rotation number full package value", a "simple correction value", a " σ correction value", a "CV reference value", and a "warning value" for each yarn type. Data is pre-registered in the correction value setting base table so as to be rewritten as required. Here, the "total drum rotation number default value" indicates the total number of drum rotations during rewinding as described above. The "total drum rotation number full package value" is obtained when the package P regularly becomes full. The "simple correction value" indicates the amount of yarn rewound and is transmitted to the winding unit 1 as a correction value when the total number of package rotations during rewinding deviates from the appropriate value by at least $\pm$ 1.2 σ. For example, for the yarn type A (GT-30), if the total number of package rotations deviates from the appropriate value by at least + 1.2 σ, "-a3" is transmitted as a correction value and added to the total drum rotation number full package value "a2" to obtain a total drum rotation number final value of "a2-a3". "σ" is a standard deviation value. For the simple correction, the threshold is set at $\pm$ 1.2σ but is not limited to this value.

[0039] The "σ correctin value" indicates the amount of yarn rewound which is set on the basis of the relationship between each threshold ±0.8σ, ±1.2σ, ±1.6 σ and the total number of package rotations during rewinding. For example, for the yarn type A (GT-30), if the deviation of the total number of package rotation is between + 0.8 σ and + 1.2 σ , "-a4" is transmitted as a correction value. If the diviation of the total number of package rotations is between +1.2σ and +1.6 σ, "-a5" is transmitted as a correction value. If the total number of package rotations deviates from the appropriate value by at least + 1.6 σ, "-a6" is transmitted as a correction value.

[0040] Further, the "CV reference value" is a threshold compared with the coefficient of variation calculated from the total number of package rotations during rewinding to determined whether or not to carry out the above simple correction and σ correction.

[0041] The "warning value" is a threshold compared with the total number of package rotations in each winding unit 1 during rewinding to determine that a rewinding error is occurring in the winding unit 1 for which the total number of package rotations deviates from the average of the total number of package rotations by at least the warning value.

[0042] The correction calculation table is a data table provided for calculations. As shown in Figure 7, the correction calculation table has a "group", a "unit number", a "total number of drum rotations", an "average value", a "deviation", a "standard deviation", and a "coefficient of variation" so that all of these are rewritable. The "group" means an operation unit for a plurality of winding units 1 which is set so as to produce packages P for the same lot. The "unit number" is an identification number inherent in the winding unit 1. The "total number of package rotations" is the number of rotations of the package P during rewinding. The "average value", the "deviation, the "standard deviation", and the "coefficient of variation" are calculated on the basis of the total number of package rotations for each group.

[0043] The correction execution table is a data table provided in order to manage the operational status of each group. As shown in Figure 8, the correction execution table has a "group", a "yarn type", an "automatic correction", a "total number of drum rotations default value", a "correction method", a "simple correction value", a "σ correction value", a " σ reference value", and a "warning value". Here, the "automatic correction" is used to set whether or not to carry out automatic corrections. When this is set to "ON", the correction is permitted. When this is set to "OFF", the correction is prohibited. The "correction method" is used to set whether the simple correction or the σ correction is to be carried out. For example, for the "simple correction", the "simple correction value" corresponding to the "yarn type" is read from the correction value setting base table in Figure 8 for setting.

[0044] The central control section of the unit control device 50 is adapted to execute a frame control correcting process routine as shown in Figure 2. The frame control correcting process routine enables the package weight obtained in each winding unit 1 after the completion of rewinding to be predicted on the total numbers of package rotations in the group using the above described table. The frame control correcting process routine also corrects the amount of yarn rewound so as to reduce a variation in package weight among the winding units 1 which may remain after the completion of the rewinding. The central control section may comprise a function corresponding to the frame control correcting process routine, in hardware form.

[0045] For the above described configuration, operations of the yarn winder will be described below.

[0046] As shown in Figure 2, first, an operator operates the frame control device 4 to display an automatic correction ON/OFF setting screen in Figure 9. The automatic correction ON/OFF setting screen is formed on the basis of the data stored in the correction execution table in Figure 8. Specifically, groups (GR1, GR2, GR3, ...), yarn types produced by the groups (GT-30, GT-40, GT-12, ...), and an automatic correction setting status (ON, OFF) are displayed (S1) as shown in Figure 9.

[0047] Subsequently, it is determined whether or not the automatic correction has been switched on or off (S2). If the automatic correction has not switched on or off (S2, NO), it is subsequently determined whether or not to display a correction content setting screen (S6). On the other hand, if the automatic correction has been switched on or off (S2, YES), it is subsequently determined whether or not the automatic correction has been switched from ON state to OFF state (S3). If the automatic correction has been switched from ON state to OFF state (S3, YES), a switch target group is initialized. Specifically, as shown in Figure 8, given that the automatic correction for the group G2 has been switched off, the simple correction value and σ correction value corresponding to the group G2 are set at "0" to prohibit the correction duduring rewinding (S4).

[0048] On the other hand, as shown in Figure 2, if the automatic correction has been switched on (S3, N0), the switch target group is initialized. Specifically, as shown in Figure 8, given that the automatic correction for the group G1 hasa been switched on, the total drum rotation number default value, simple correction value, σ correction value, CV reference value, and warning value corresponding to the yarn type A (GT30) handled by the group G2 are read from the correction value base table in Figure 6. These values are then stored in the corresponding areas in the correction execution table (S5).

[0049] Then, it is determined whether or not to display a correction content setting screen (S6). If the operator performs an operation required to display the correction content setting screen (S3, YES), the correction content setting screen in Figure 10 is displayed. The correction content setting screen is desirably displayed on condition that a password is inputted. The contents of corrections in the correction content setting screen will be described in detail. In addition to the display items in the automatic correction ON/OFF setting screen in Figure 9, this screen displays the display items "monitor gram (g)", "automatic correction method", "correction value", and "monitor rpm-CV" in association with each group. Here, the "monitor gram (g)" indicates the amount of yarn rewound during rewinding from which the total number of package rotations is acquired. This value is normally set at 400g. Then, the total number of drum rotations corresponding to the monitor gram is set as a total drum rotation number default value. The "automatic correction method" indicates either the simple correction or the σ correction. Then, the contents of the "automatic correction method" and a correction value set on the basis of the ON/OFF of the automatic correction are displayed. The "monitor rpm-CV" displays the coefficient of variation calculated on the basis of the total number of package rotations corresponding to the package weight obtained during rewinding, for example, 400g (S7).

[0050] When the correction content setting screen is displayed as described above, changes to the correction contents are accepted (S8). Specifically, the numerical value for the "monitor gram (g)" and the "correction value" can be changed. The "automatic correction method" can be used to switch between the simple correction and the σ correction.

[0051] Then, it is determined whether or not all the desired changes to the correction contents have been finished (S9). The determination in S9 is also made if the correctin content setting screen is not displayed in the step S6, described above (S6, NO) and if the switch target group is initialized in the step S4. If not all the desired changes to the correction contents have been finished (S9, NO), the process returns to step S1 to display the automatic correction ON/OFF setting screen. On the other hand, if all the desired changes to the correction contents have been finished (S9, YES), correction content data containing correction contents such as the total drum rotation number default value and the total drum rotation number full package value is transmitted to the winding units 1 of each group (S10). Then, the process gets ready to receive a total package rotation number signal transmitted by the winding unit 1 (S11).

[0052] The winding units 1 of each group are executing the winding unit operation routine as shown in Figure 3. On receiving the correction content data, each of the winding units 1 stores the total drum rotation number default value contained in this signal, in the total drum rotation number default value storage section 53 in Figure 1 (G1). Subsequently, as shown in Figure 4, the operation of the winding unit main body 51 is started to rotate the winding drum 7. Thus, the yarn Y is wound around the bobbin Bf to obtain the package P (G2).

[0053] When the operation of the winding unit main body 51 is started, the winding detection signals are loaded from the drum rotation number measuring sensor 43 and package rotation number measuring sensor 45 as shown in Figure 1. Every time the detection signals are inputted, the total drum rotation number counting section 61 and the total package rotation number counting section 57 counts up the total number of drum rotations and the total number of package rotations, respectively. At this time, as also shown in Figure 3, it is determined whether or not the total drum rotation number count in the total drum rotation number counting section 61 equals the total drum rotation number default value in the total drum rotation number default value storage section 53 (G3). If the values are not equal (G3, NO), G3 is executed again. On the other hand, if the values are equal (G4), a total package rotation number signal containing the total package rotation number count is transmitted to the frame control device 4 (G4).

[0054] As shown in Figure 2, the frame control device 4 is ready to receive the total package rotation number signal from each winding unit 1 (S11). On receiving the total package rotation number signal from each winding unit 1, the frame control device 4 extracts the total package rotation number count contained in the signal as the total number of package rotations. Then, the frame control device 4 stores the total number of package rotations in the correction calculation table in Figure 7 in the storage area for the total number of package rotations corresponding to the unit number of the winding unit 1. Then, it is determined whether or not the total numbers of package rotations have been obtained from all the winding units 1 of the group (S12). If the total numbers of package rotations have not been obtained from all the winding units 1 of the group (S12, NO), the process returns to the step S11 to continue to store the total numbers of package rotations. In the step S12, it is determined whether or not the total numbers of package rotations have been obtained from all the winding units 1 of the group. However, the present invention is not limited to this aspect. It may be determined whether or not the total numbers of package rotations have been obtained from a certain span or from a certain number, for example, about two winding units 1 within the group.

[0055] On the other hand, if the total numbers of package rotations have been obtained from all the winding units 1 of the group (S12, YES), it is subsequently determined whether or not the group correction mode, that is, the automatic correction has been turned on (S13). If the automatic correction has been turned on (S13, YES), then as shown in Figure 7, the average, deviation, standard deviation, and coefficient of variation of the total numbers of package rotations in the group are calculated (S14). Subsequently, it is determined whether or not the coefficient of variation is smaller than the CV reference value of 2% or the like (S15). If the coefficient of variation is not smaller than the CV reference value (S15, NO), the correction is determined to be effective in suppressing a variation. Then, the correction value corresponding to the correction method is transmitted to each of the winding units 1 in the group (S16). If the group correction mode has not been turned on (S13, NO) and the coefficient of variation is smaller than the CV reference value (S15, YES), the correction value of "0" is transmitted to all the winding units 1 in the group so as to avoid carrying out the correction.

[0056] When the correction value if transmitted to each winding unit 1 as described above, a total package rotation number graph window is subsequently displayed all over or in a part of the display screen. As shown in Figure 11, the window directly and indirectly shows, in a graph, the total number of package rotations in each of the winding units 1 in the group. The window screen is separated into an upper display area and a lower display area. In the upper display area, a bar graph shows the relationship between the unit number of the winding unit 1 and the total number of package rotations. In the lower display area, a bar graph shows the relationship between the unit number of the winding unit 1 and the average value. The graph display may be direct or indirect (S18). Then, by viewing the total package rotation number graph window, the operator can predict the weight of the full package obtained after rewinding has been completed, on the basis of the strong correlation between the total number of package rotations during the rewinding and the weight of the full package.

[0057] Subsequently, the frame control device determines the absolute value of the difference between the total number of package rotations for each winding unit 1 and the average of the total numbers of package rotations for all the winding units 1 in the group. Then, winding units 1 are identified for which the absolute value of the difference is larger than the warning value. The graph for each of the identified winding units 1 is then provided with a warning display having a particular color or particular characters. The operator can thus easily identify winding units 1 for which the total number of package rotations deviates from the average total package rotation number by at least a predetermined value. The operator can then recognize that these winding units 1 are performing an erroneous rewinding operation (S19).

[0058] Subsequently, it is determined whether or not all the groups have undergone the correction process (S20). If not all the groups have undergone the correction process, the process returns to the step S11 to execute the correction process on the remaining groups. On the other hand, if all the groups have undergone the correction process (S20), the present routine is ended. Alternatively, instead of ending the present routine, the correction value may be calculated every time package data on a certain number of winding units is updated.

[0059] On the other hand, as shown in Figure 3, when the winding unit 1 receives the correction value from the frame control device 4, the value is stored in the correction value storage section 54 in Figure 1. The value is then added to the total drum rotation number full package value in the total drum rotation number final value storage section 55 (G6). It is then determined whether or not the total drum rotation number count equals the total drum rotation number full package value (G7). If the values are not equal (G7, NO), G7 is repeated until the values become equal. On the other hand, if the values are equal (G7, YES), the rewinding process in the winding unit main body 51 is stopped.

[0060] As described above, in the present embodiment, as shown in Figures 1 to 3, the weight of a full package in each winding unit 1 can be predicted using a method of predicting the weight of a package in an automatic wider having a large number of winding units 1 arranged in line to execute a rewinding process of rotating the winding drum 7 to rewind a yarn from the yarn supplying package B (yarn supplying bobbin B) to obtain the package P, wherein the weight of the full package in each winding unit 1 can be predicted on the basis of the total number of package rotations when the total number of rotations of the winding drum 7 continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding.

[0061] With the above configuration, the package weight obtained after the completion of rewinding can be predicted during the rewinding. This makes it possible to quickly complete corrections such as an increase in the amount of yarn rewound which corrections are carried out to obtain the desired package, compared to the prior art, in which the package weight is actually measured after the rewinding has been completed. Further, by reducing a variation in weight among the packages in each lot, it is possible to control the rewinding so as to reduce differences from the average of the package weights within the lot. Specifically, in Figure 5, if one winder (having, for example, 60 winding units) performs a rewinding operation on a lot for a yarn type A, control can be provided so as to reduce differences from the average value for the 60 winding units. Further, if one winder performs a rewinding operation on two yarn types A and B, that is, winding units 1 Nos. 1 to 30 perform a rewinding operation on the yarn type A, while winding units 1 Nos. 31 to 60 perform a rewinding operation on the yarn type B, then the winding units 1 Nos. 1 to 30 use the average value for these units, while the winding units 1 Nos. 31 to 60 use the average value for these units. Then, the rewinding can be controlled so as to reduce the differences from each average value.

[0062] Furthermore, in the present embodiment, as shown in Figures 1 to 3, the package P can be produced using a method of manufacturing a package in an automatic wider having a large number of winding units 1 arranged in line to execute a rewinding process of rotating the winding drum 7 to rewind a yarn from the yarn supplying package B (yarn supplying bobbin) to obtain the winding package P, the method comprising, for all the winding units 1, acquiring the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding, and on the basis of the total numbers of package rotations, correcting the amount of yarn rewound so as to reduce a variation in package weight among the winding unit 1 when the packages are full.

[0063] It is thus possible to reduce a variation in weight among a plurality of packages P produced in parallel. This makes it possible to prevent the package weight from being excessively large or small. Further, since the amount of yarn rewound is corrected during rewinding, the productivity is improved.

[0064] Further, the present embodiment discloses the configuration below as a form of yarn winder that can realize the method of predicting the weight of the package P. The yarn winder has a plurality of winding units 1 each of which executes a rewinding process of rotating the winding drum 7 to rewind the yarn Y around the bobbin Bf to obtain the package P and the frame control device 4 which can control and manage the rewinding process executed on each group of winding units 1. The frame control device 4 has package total rotation number acquiring means (S11 and S12 in Figure 2) for acquiring, for all the winding units 1, the total number of package rotations when the total number of rotations of the winding drum 7 continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding, and variation determining means (S14 in Figure 2) for determining a variation in package weight among the winding units 1 in the group on the basis of the total numbers of package rotations.

[0065] Furthermore, the present embodiment discloses the configuration below as a form of yarn winder that can realize the method of manufacturing the weight of the package P. In addition to the above arrangements, the yarn winder has rewinding amount correcting means (S16 in Figure 2) for correcting the amount of yarn rewound for each winding unit 1 on the basis of the variation in package weight determined by the variation determining means so as to reduce a variation in package weight which may remain after the rewinding has been completed.

[0066] The yarn winder according to the present embodiment further has variation coefficient determining means (S17) for determining a coefficient of variation among the winding units 1 in the group on the basis of the total numbers of package rotations and if the coefficient of variation is less than a predetermined value, prohibiting the rewinding amount correcting means from correcting the amount of yarn rewound. It is thus possible to determine the degree of deviation using the coefficient of variation to prevent the correction of the amount of yarn rewound from being uselessly carried out even though they are actually not effective.

[0067] The yarn winder according to the present embodiment further has variation displaying means (S18 in Figure 2) for directly and/or indirectly displaying, in a graph (the total package rotation number graph window in Figure 11), the total number of package rotations for each of the winding units 1 in the group. This configuration enables the operator to easily understand the degree of the deviation of the total number of package rotations in each winding unit 1. It is thus possible to facilitate the prediction of the weight of the full package described above. Additionally, in the present embodiment, as shown in Figure 11, the total number of package rotations is displayed in a graph so that the operator can visually determine the deviation to accomplish the prediction. However, the present invention is not limited to this aspect. A variation in the total number of package rotations may be expressed as numeral values and a predicted value for the weight of the full package may be displayed.

[0068] The yarn winder according to the present embodiment further has error notifying means (19 in Figure 2) for identifying a winding unit 1 for which the total number of package rotations deviates, by at least a predetermined value, from an average of the total numbers of package rotations for all the winding units 1 in the group and notifying an operator of this winding unit 1. This enables early detection of a winding unit 1 performing an erroneous rewinding operation. Consequently, adequate measures can subsequently be taken.

[0069] The program composed of the routines according to the present embodiment may be pre-written in a ROM in the storage section so as to be only readable. Alternatively, the program may be recorded in a recording medium such as a CD and may be read and written in the storage section as required. Alternatively, the program may be written in the storage section by being transmitted via an electric communication line such as the Internet.

[0070] When the package weight obtained after the completion of rewinding can be predicted for each rewinding process on the basis of the total number of package rotations during the rewinding, the present invention is applicable to applications in which packages involving significant errors in the weight of the full package are manufactured.

Claims

1. A method of predicting the weight of a package in an automatic wider having a large number of winding units arranged in line to execute a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package, **characterized in that**:

   the weight of a full package in each winding unit is predicted on the basis of the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding.

2. A method of manufacturing a package in an automatic wider having a large number of winding units arranged in line to execute a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package, **characterized by** comprising:

   for all the winding units, acquiring the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding; and
   on the basis of the said total numbers of package rotations, correcting the amount of yarn rewound so as to reduce a variation in package weight among the winding unit when the packages are full.

3. A method of manufacturing a package according to Claim 2, **characterized in that** the amount of yarn rewound is corrected on the basis of a standard deviation of the total number of package rotations during rewinding.

4. A yarn winder having a plurality of winding units each of which executes a rewinding process of rotating a winding drum to rewind a yarn from a yarn supplying bobbin to obtain a package and a frame control device which can control and manage the rewinding process executed on each group of winding units, **characterized in that** said frame control device has:

   package total rotation number acquiring means for acquiring, for all the winding units of each group, the total number of package rotations when the total number of rotations of the winding drum continuously counted from the start of winding reaches a value corresponding to a predetermined package weight during the rewinding; and
   variation determining means for determining a variation in package weight among the winding units in said group on the basis of the total numbers of package rotations.

5. A yarn winder according to Claim 4, **characterized in that** said variation determining means determines the variation from a standard deviation of the total number of package rotations.

6. A yarn winder according to Claim 4, **characterized in that** said frame control device has:

   rewinding amount correcting means for correcting the amount of yarn rewound for each winding unit on the basis of the variation in package weight determined by said variation determining means so as to reduce a variation in package weight which may remain after the rewinding has been completed.

7. A yarn winder according to Claim 6, **characterized in that** said frame control device has:

variation coefficient determining means for determining a coefficient of variation among the winding units in said group on the basis of the total numbers of package rotations and if the coefficient of variation is less than a predetermined value, prohibiting said rewinding amount correcting means from correcting the amount of yarn rewound.

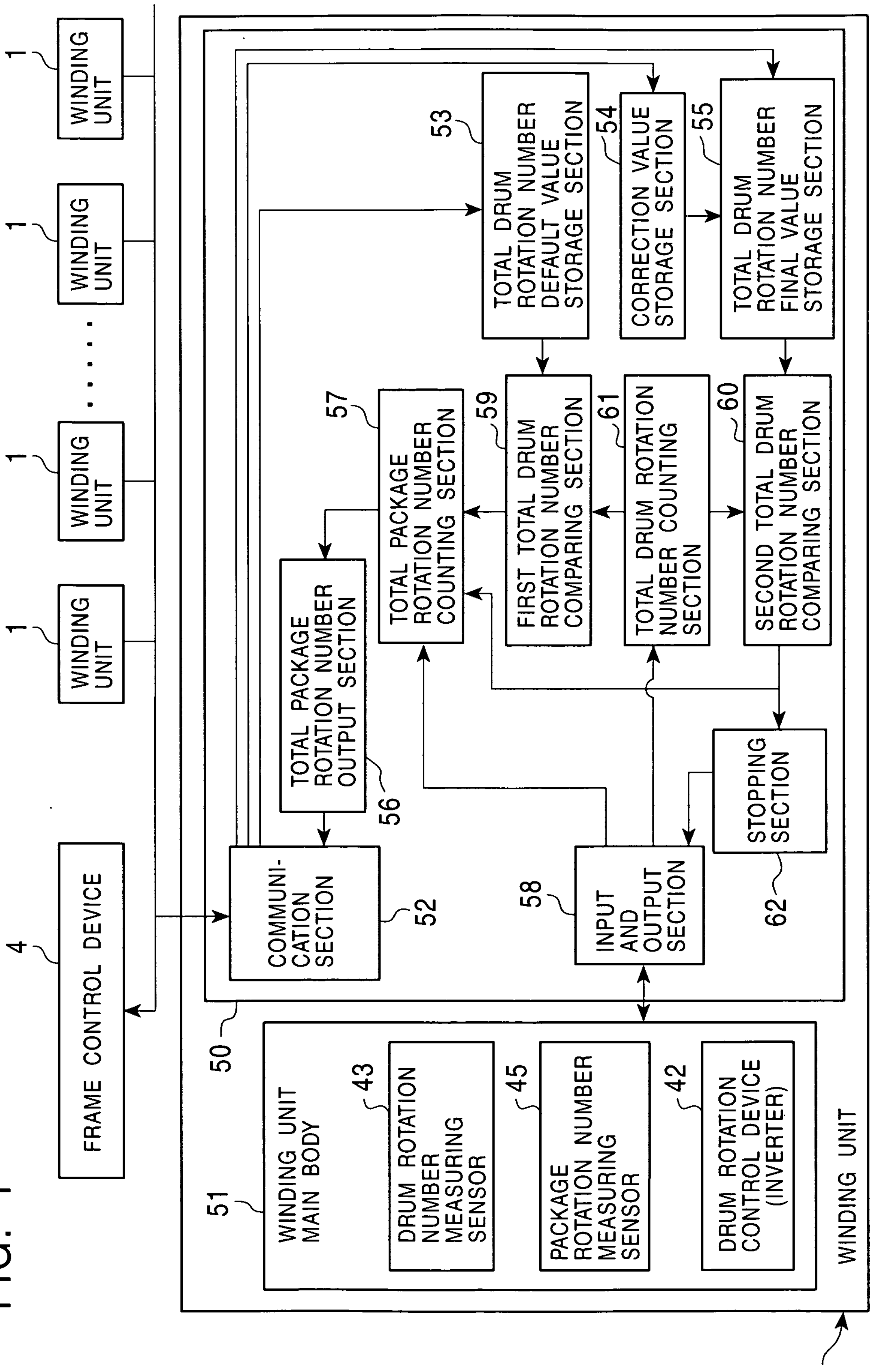
8. A yarn winder according to any one of Claims 4 to 7, **characterized in that** said frame control device has:

variation displaying means for directly and/or indirectly displaying, in a graph, the total number of package rotations for each of the winding units in said group.

9. A yarn winder according to Claim 8, **characterized in that** said frame control device has:

error notifying means for identifying a winding unit for which the total number of package rotations deviates, by at least a predetermined value, from an average of the total numbers of package rotations for all the winding units in said group and notifying an operator of this winding unit.

FIG. 1



1 WINDING UNIT
4 FRAME CONTROL DEVICE
52 COMMUNICATION SECTION
53 TOTAL DRUM ROTATION NUMBER DEFAULT VALUE STORAGE SECTION
54 CORRECTION VALUE STORAGE SECTION
55 TOTAL DRUM ROTATION NUMBER FINAL VALUE STORAGE SECTION
56 TOTAL PACKAGE ROTATION NUMBER OUTPUT SECTION
57 TOTAL PACKAGE ROTATION NUMBER COUNTING SECTION
59 FIRST TOTAL DRUM ROTATION NUMBER COMPARING SECTION
61 TOTAL DRUM ROTATION NUMBER COUNTING SECTION
60 SECOND TOTAL DRUM ROTATION NUMBER COMPARING SECTION
58 INPUT AND OUTPUT SECTION
62 STOPPING SECTION
50
51 WINDING UNIT MAIN BODY
43 DRUM ROTATION NUMBER MEASURING SENSOR
45 PACKAGE ROTATION NUMBER MEASURING SENSOR
42 DRUM ROTATION CONTROL DEVICE (INVERTER)
WINDING UNIT
1

FIG. 2A

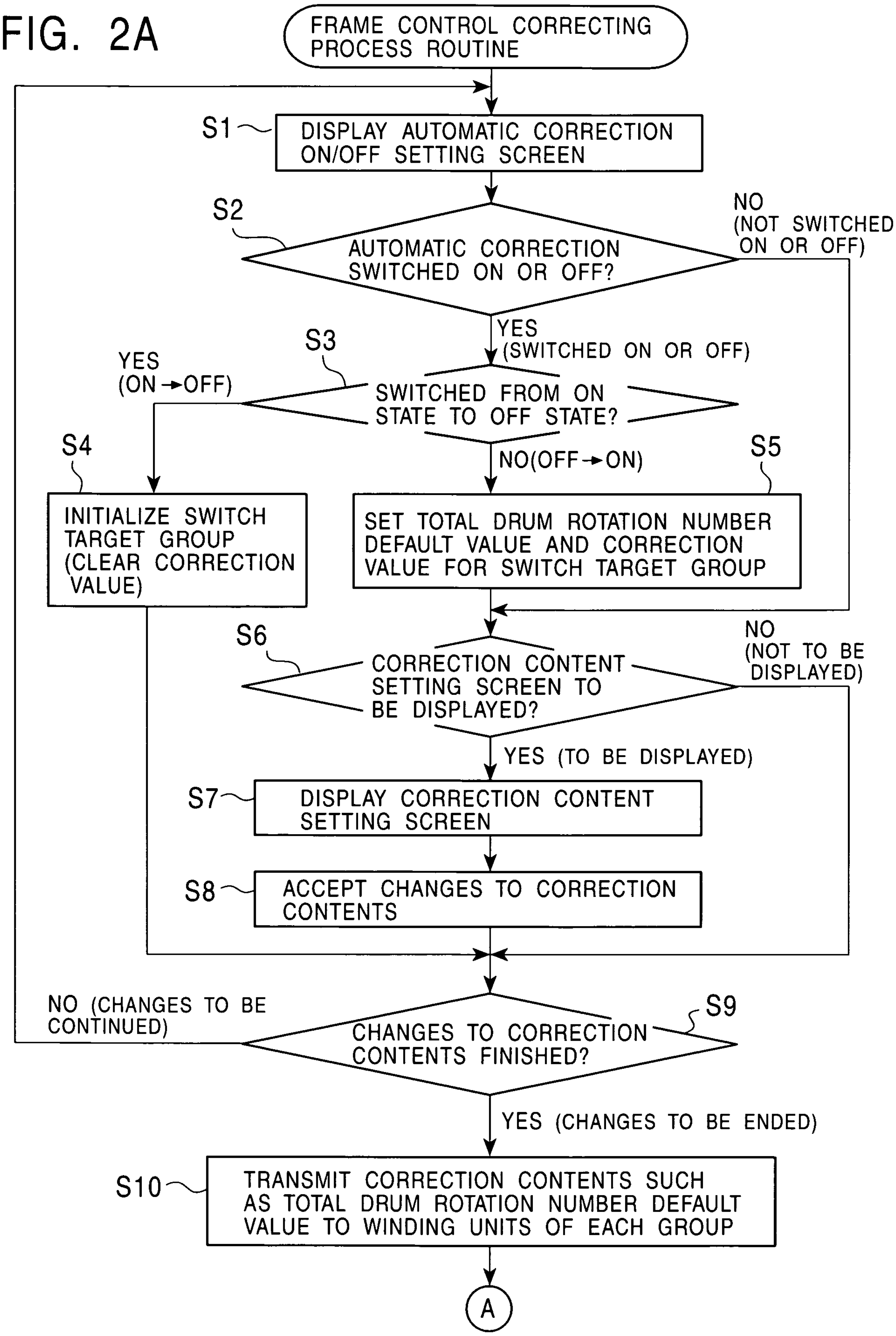

FRAME CONTROL CORRECTING PROCESS ROUTINE
S1
DISPLAY AUTOMATIC CORRECTION ON/OFF SETTING SCREEN
S2
AUTOMATIC CORRECTION SWITCHED ON OR OFF?
NO (NOT SWITCHED ON OR OFF)
YES (SWITCHED ON OR OFF)
S3
SWITCHED FROM ON STATE TO OFF STATE?
YES (ON→OFF)
NO(OFF→ON)
S4
INITIALIZE SWITCH TARGET GROUP (CLEAR CORRECTION VALUE)
S5
SET TOTAL DRUM ROTATION NUMBER DEFAULT VALUE AND CORRECTION VALUE FOR SWITCH TARGET GROUP
S6
CORRECTION CONTENT SETTING SCREEN TO BE DISPLAYED?
NO (NOT TO BE DISPLAYED)
YES (TO BE DISPLAYED)
S7
DISPLAY CORRECTION CONTENT SETTING SCREEN
S8
ACCEPT CHANGES TO CORRECTION CONTENTS
S9
CHANGES TO CORRECTION CONTENTS FINISHED?
NO (CHANGES TO BE CONTINUED)
YES (CHANGES TO BE ENDED)
S10
TRANSMIT CORRECTION CONTENTS SUCH AS TOTAL DRUM ROTATION NUMBER DEFAULT VALUE TO WINDING UNITS OF EACH GROUP
A

FIG. 2B

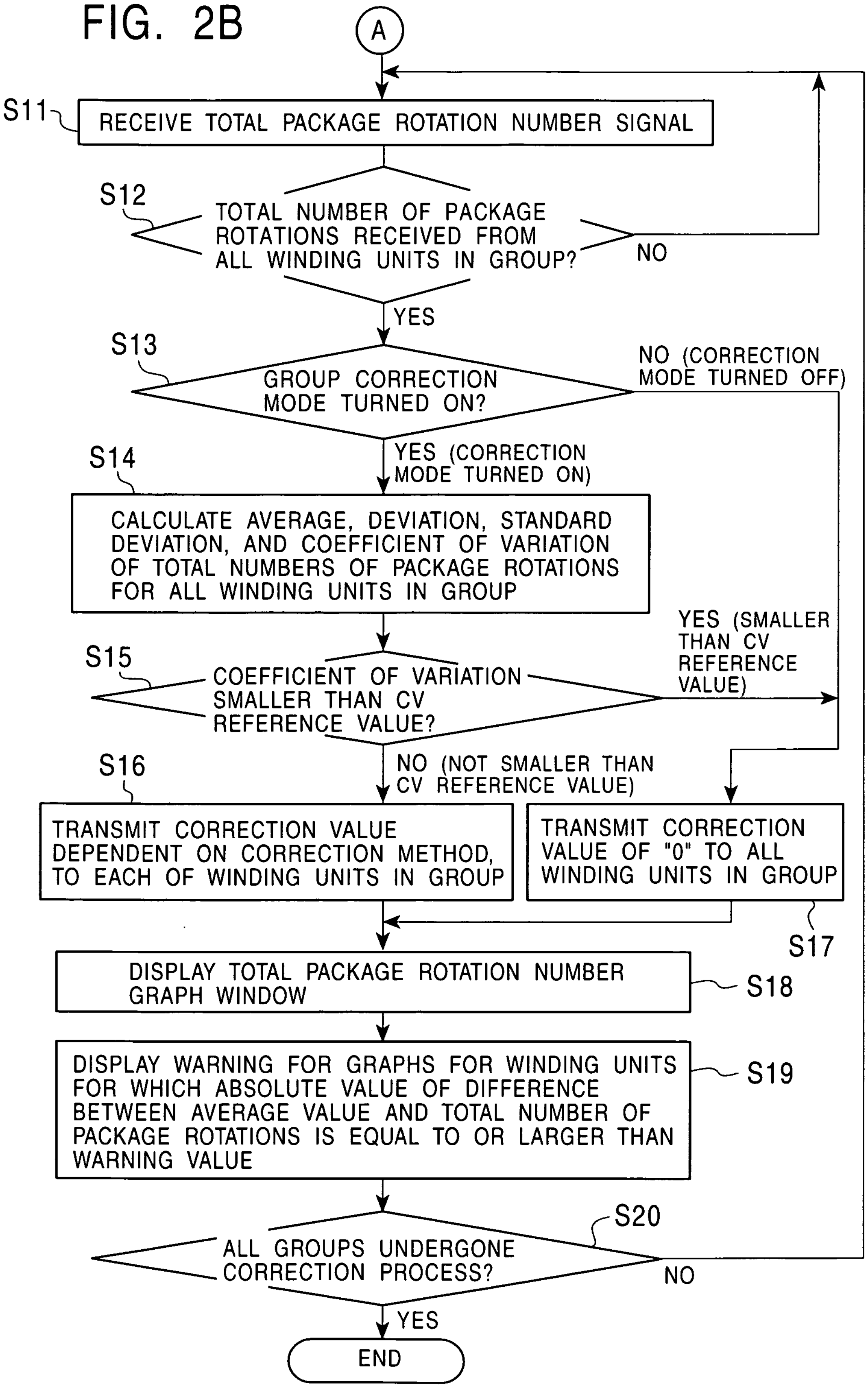

A
S11
RECEIVE TOTAL PACKAGE ROTATION NUMBER SIGNAL
S12
TOTAL NUMBER OF PACKAGE ROTATIONS RECEIVED FROM ALL WINDING UNITS IN GROUP?
NO
YES
S13
GROUP CORRECTION MODE TURNED ON?
NO (CORRECTION MODE TURNED OFF)
YES (CORRECTION MODE TURNED ON)
S14
CALCULATE AVERAGE, DEVIATION, STANDARD DEVIATION, AND COEFFICIENT OF VARIATION OF TOTAL NUMBERS OF PACKAGE ROTATIONS FOR ALL WINDING UNITS IN GROUP
S15
COEFFICIENT OF VARIATION SMALLER THAN CV REFERENCE VALUE?
YES (SMALLER THAN CV REFERENCE VALUE)
NO (NOT SMALLER THAN CV REFERENCE VALUE)
S16
TRANSMIT CORRECTION VALUE DEPENDENT ON CORRECTION METHOD, TO EACH OF WINDING UNITS IN GROUP
TRANSMIT CORRECTION VALUE OF "0" TO ALL WINDING UNITS IN GROUP
S17
DISPLAY TOTAL PACKAGE ROTATION NUMBER GRAPH WINDOW
S18
DISPLAY WARNING FOR GRAPHS FOR WINDING UNITS FOR WHICH ABSOLUTE VALUE OF DIFFERENCE BETWEEN AVERAGE VALUE AND TOTAL NUMBER OF PACKAGE ROTATIONS IS EQUAL TO OR LARGER THAN WARNING VALUE
S19
S20
ALL GROUPS UNDERGONE CORRECTION PROCESS?
NO
YES
END

FIG. 3

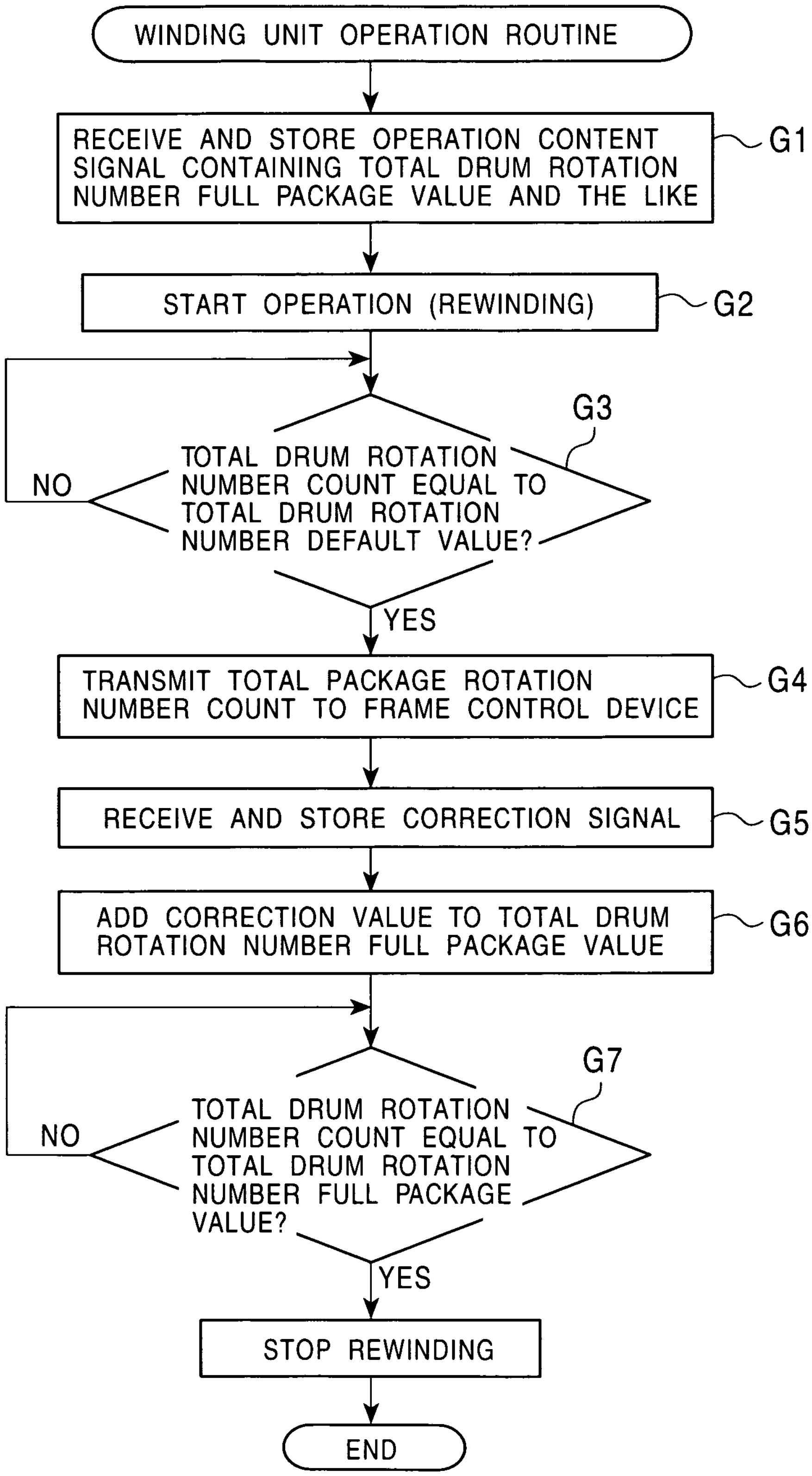

WINDING UNIT OPERATION ROUTINE
RECEIVE AND STORE OPERATION CONTENT SIGNAL CONTAINING TOTAL DRUM ROTATION NUMBER FULL PACKAGE VALUE AND THE LIKE
G1
START OPERATION (REWINDING)
G2
G3
TOTAL DRUM ROTATION NUMBER COUNT EQUAL TO TOTAL DRUM ROTATION NUMBER DEFAULT VALUE?
NO
YES
TRANSMIT TOTAL PACKAGE ROTATION NUMBER COUNT TO FRAME CONTROL DEVICE
G4
RECEIVE AND STORE CORRECTION SIGNAL
G5
ADD CORRECTION VALUE TO TOTAL DRUM ROTATION NUMBER FULL PACKAGE VALUE
G6
G7
TOTAL DRUM ROTATION NUMBER COUNT EQUAL TO TOTAL DRUM ROTATION NUMBER FULL PACKAGE VALUE?
NO
YES
STOP REWINDING
END

FIG. 4

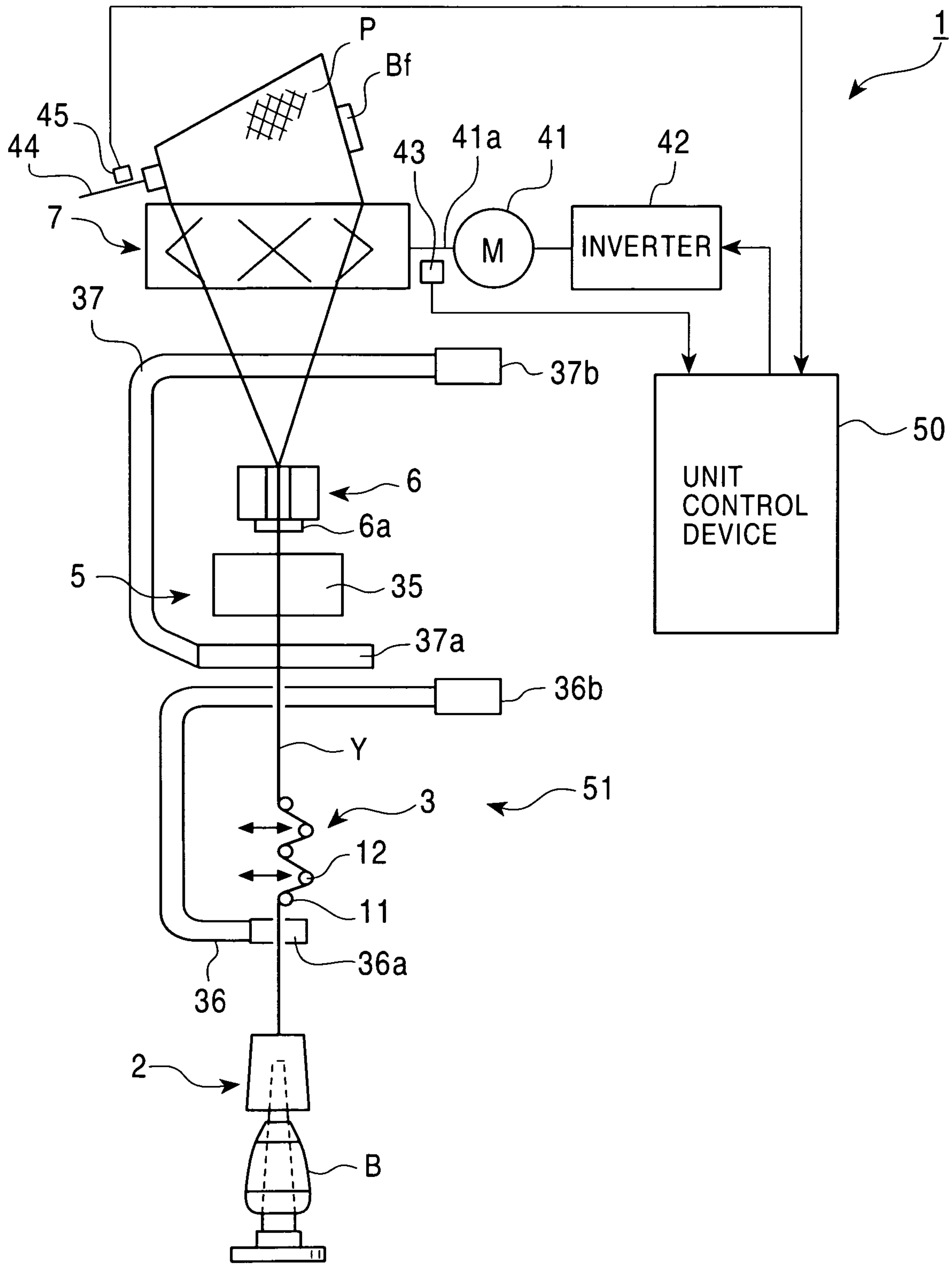

1
P
Bf
45
44
7
43
41a
41
42
M
INVERTER
37
37b
50
UNIT
CONTROL
DEVICE
6
6a
5
35
37a
36b
Y
51
3
12
11
36a
36
2
B

FIG. 5

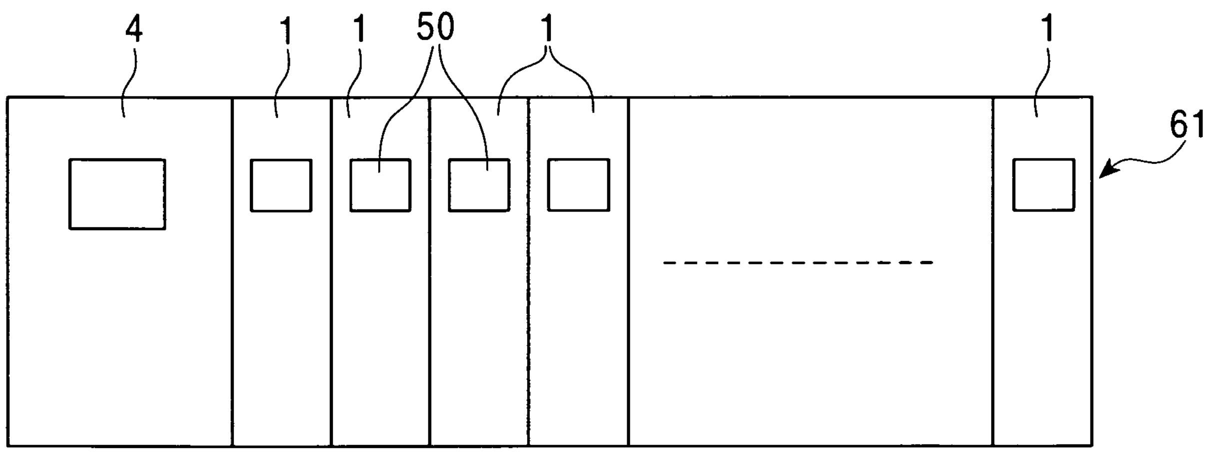


FIG. 6

CORRECTION VALUE SETTING TABLE

YARN TYPE	TOTAL DRUM ROTATION NUMBER DEFAULT VALUE	TOTAL DRUM ROTATION NUMBER FULL PACKAGE VALUE	SIMPLE CORRECTION VALUE	σ CORRECTION VALUE			CV REFERENCE VALUE	WARNING VALUE
			$\pm1.2\sigma$	$\pm0.8\sigma$	$\pm1.2\sigma$	$\pm1.6\sigma$		
A (GT-30)	a1	a2	a3	a4	a5	a6	a7	a8
B (GT-40)	b1	b2	b3	b4	b5	b6	b7	b8
C (GT-12)	c1	c2	c3	c4	c5	c6	c7	c8
D	d1	d2	d3	d4	d5	d6	d7	d8
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
Y	y1	y2	y3	y4	y5	y6	y7	y8
Z	z1	z2	z3	z4	z5	z6	z7	z8

FIG. 7

CORRECTION CALCULATION TABLE

GROUP	UNIT NUMBER	TOTAL PACKAGE ROTATION NUMBER	AVERAGE VALUE	DEVIATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
G1	1 2 3 ⋮ 23 24	x1 x2 x3 ⋮ x23 x24	Xav1	x1−Xav1 x2−Xav1 x3−Xav1 ⋮ x23−Xav1 x24−Xav1	σ1	CV1 (σ1/Xav1)
G2	25 ⋮ 48	x25 ⋮ x48	Xav2	x25−Xav2 ⋮ x48−Xav2	σ2	CV2 (σ2/Xav2)
G3	49 ⋮ 60	x49 ⋮ x60	Xav3	x49−Xav3 ⋮ x60−Xav3	σ3	CV3 (σ3/Xav3)
⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG. 8

CORRECTION EXECUTION TABLE

GROUP	YARN TYPE	AUTOMATIC CORREC-TION	TOTAL DRUM ROTATION NUMBER DEFAULT VALUE	CORRECTION METHOD	SIMPLE CORREC-TION VALUE	σ CORRECTION VALUE			CV REFERENCE VALUE	WARNING VALUE
					±1.2σ	±0.8σ	±1.2σ	±1.6σ		
G1	A (GT-30)	ON	a1	σ CORRECTION	±a3	±a4	±a5	±a6	a7	a8
G2	B (GT-40)	OFF	b2	σ CORRECTION	0	0	0	0	b7	b8
G3	C (GT-12)	ON	c2	SIMPLE CORRECTION	±c3	±c4	±c5	±c6	c7	c8
G4	A (GT-30)	ON	a1	σ CORRECTION	±a3	±a4	±a5	±a6	a7	a8
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG. 9

VOS (Visual ON-demand System)

F***

	GT-30	GT-40	GT-12
	GR1(1-24)	GR2(25-48)	G3(49-60)
AUTOMATIC CORRECTION OF PACKAGE WEIGHT	ON	OFF	ON

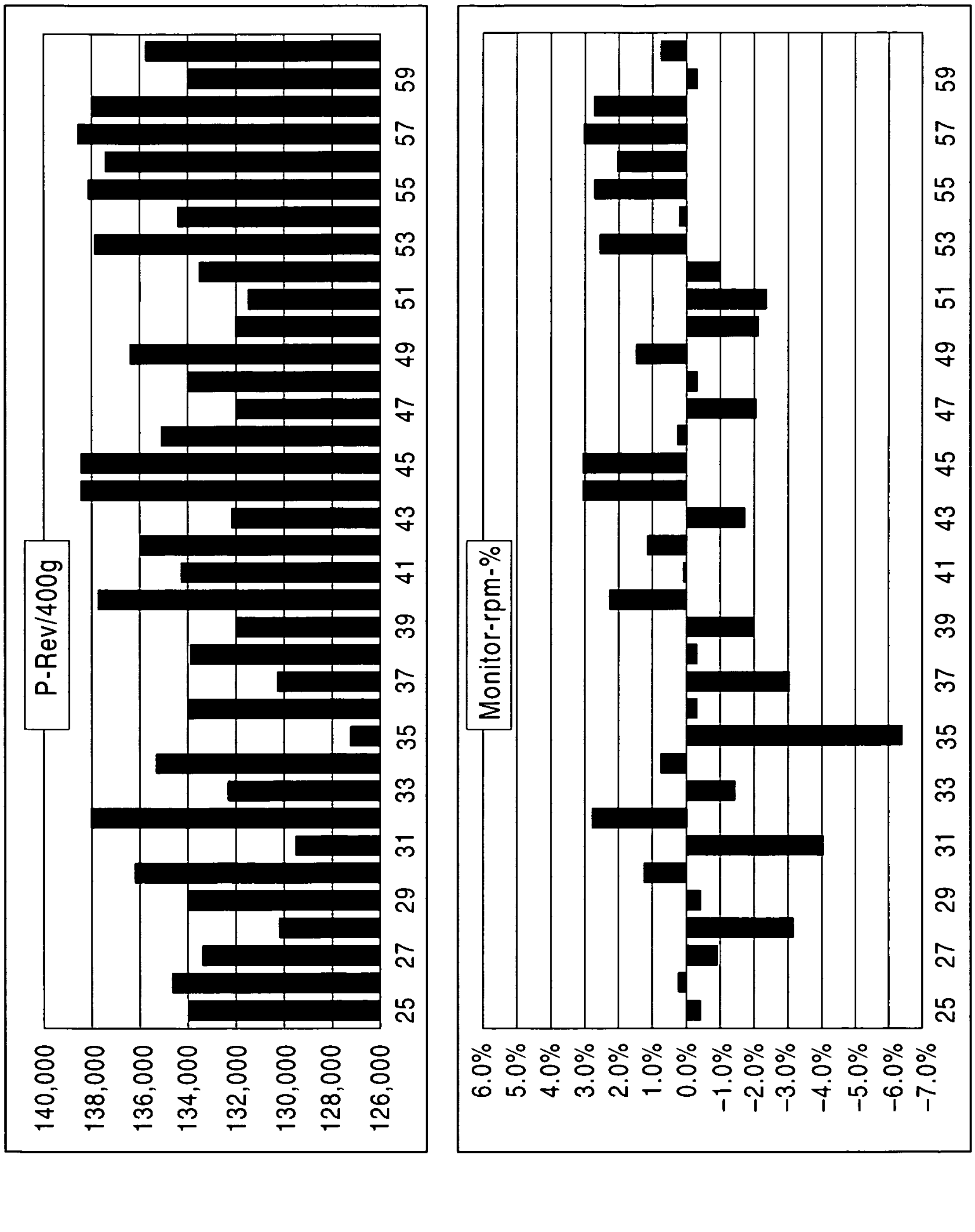
FIG. 10

VOS (Visual ON-demand System)

F ***

	GT-30	GT-40	GT-12
	GR1(1-24)	GR2(25-48)	GR3(49-60)
AUTOMATIC CORRECTION OF PACKAGE WEIGHT	ON	OFF	ON
MONITOR GRAM g	400	400	400
AUTOMATIC CORRECTION METHOD CORRECTION	σ CORRECTION	σ CORRECTION	SIMPLE CORRECTION
AT LEAST ±0.8σ	5	0	0
AT LEAST ±1.2σ	8	0	10
AT LEAST ±1.6σ	10	0	10
MONITOR rpm-CV%	3.50%	1.40%	6.50%

FIG. 11


P-Rev/400g
140,000
138,000
136,000
134,000
132,000
130,000
128,000
126,000
Monitor-rpm-%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
−1.0%
−2.0%
−3.0%
−4.0%
−5.0%
−6.0%
−7.0%
25
27
29
31
33
35
37
39
41
43
45
47
49
51
53
55
57
59