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(71) Applicant: **MURATA KIKAI KABUSHIKI KAISHA**
Minami-ku Kyoto-shi Kyoto 601 (JP)

(72) Inventor: **Kuroda, Keiji**
Gamou-gun, Shiga (JP)

(74) Representative: **Vogeser, Werner, Dipl.-Ing. et al**
Patent- und Rechtsanwälte
Hansmann, Vogeser, Dr. Boecker,
Alber, Dr. Strych, Liedl
Albert-Rosshaupter-Strasse 65
81369 München (DE)

Remarks:
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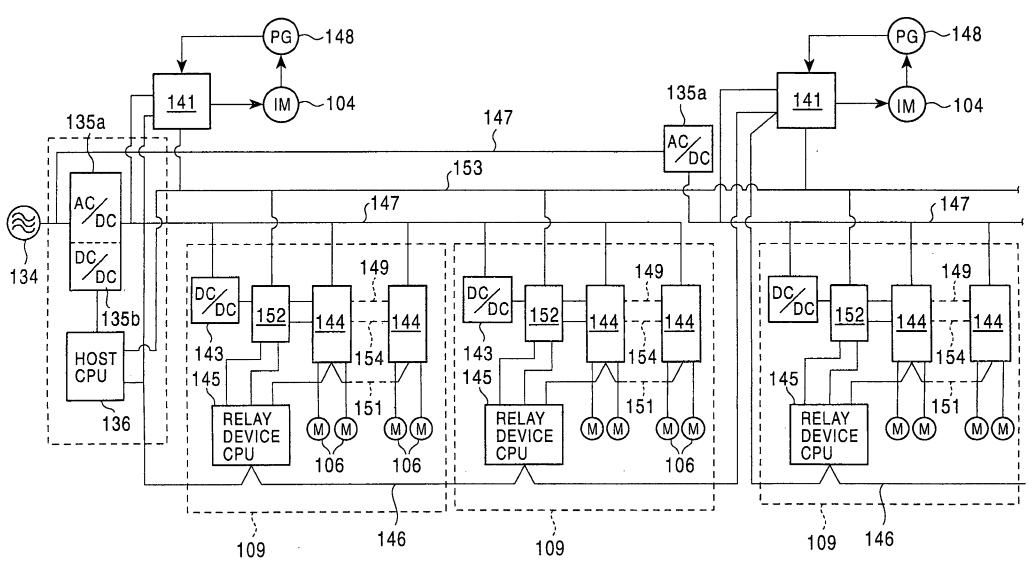
(54) Individual-spindle-drive type textile machine with a plurality of spindles divided into units

(57) The present invention provides an individual-spindle-drive type textile machine wherein a plurality of spindle units (U) are installed in a line, each spindle unit having a drive motor (104), the plurality of drive motors being driven by rotation speed control apparatuses (144). To prevent a voltage drop even if a large number of winding units are installed in a line the machine comprises a direct-current bus (147) having a first direct-current voltage for driving force and connecting to said rotation speed control apparatuses, and a direct-current voltage transforming means (143) for transforming said first direct-current voltage into a second direct-current voltage for control, and in that said plurality of rotation speed control apparatuses (144) are divided into a plurality of units, each of which includes a specified number of these apparatuses, with said direct-current voltage transforming means (143) provided for each of said units (Fig. 8).

FIG. 8



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Description

Field of the Invention

[0001] The present invention relates to an individual-spindle-drive type textile machine wherein a plurality spindle units are installed in a line, each spindle having a spindle drive motor, the plurality of drive motors being driven and controlled by rotation speed control apparatuses as disclosed in the parent patent EP 0 942 081 and according to the preamble of claim 1.

Background of the Invention

[0002] As shown in Figure 13, a conventional multi-twister comprises a plurality of multi-twisting units each having a spindle apparatus 301 a and a winding apparatus 301b. The multi-twisting unit has a driving mechanism 310 for driving a winding drum 306, a traverse guide 307, and a spindle 303. The spindle apparatus 301 a uses a belt 304 to transmit the driving force of a drive motor 313 to the spindle 303 in order to twist yarn. In addition, the winding apparatus 301 b winds a yarn twisted by the spindle apparatus 301 a around a winding package 305, while traversing the yarn via a feed roller 308 using the traverse guide 307.

[0003] The driving mechanism 310 mainly comprises a drive motor 313, a plurality of pulleys 311, 312, 315, 316, 317, and 319, two belts 304 and 318. A single drive motor 313 drives the winding drum 306, the traverse guide 307, and the spindle 303. The output of the drive motor 313 is transmitted through an output shaft 314, the third pulley 315, the belt 318, the fifth pulley 317, and the first pulley 311 to a running belt 304 to drive the spindle 303. In addition, the output of the drive motor 313 is transmitted through the output shaft 314, the fourth pulley 316, a belt 320, the sixth pulley 319, a speed changing belt apparatus 350, a speed reducing box 323, and a belt 330 to drive the winding drum 306. Moreover, the rotation of a support shaft 326 is transmitted via a belt 334 to a grooved drum 337, which then rotates to move a cam shoe 339 along a groove 338, thereby reciprocating the traverse guide 307.

[0004] When the single drive motor 313 drives the spindle apparatus 301 a and the winding apparatus 301 b as in the conventional multi-twister the belts 304 and 320 rotate the plurality of pulleys. This configuration may result in large mechanical losses and excessive power consumption and may prevent the spindle from being accurately kept at a predetermined rotation speed. Thus, individual-spindle-drive type multi-twisters have been developed in which different motors drive the spindle drive system and the winding drum drive system, respectively, and in which a spindle drive motor is provided for each spindle apparatus to drive it independently.

[0005] However, in such a multi-twister, when power stoppage causes each motor to be stopped (braked), due to the inertia moment of the spindle drive system, which is larger than that of the winding drum drive system, the motor for the spindle drive system rotates by inertia for a certain period of time after the winding drive system has stopped, resulting in twisting cuts caused by excessive twisting of yarn.

[0006] Accordingly, multi-twisters are being developed that can decelerate and stop the spindle drive system motor and the drum drive system motor synchronously upon power stoppage to prevent twisting cuts.

[0007] Since, however, these multi-twisters use different motors to drive the winding drum and the traverse apparatus, the winding drum, the traverse apparatus and the spindle drive system must all be operated in perfect synchronization in order to prevent a stitching (the yarn becomes separated from the package.) or a straight winding, thereby requiring sophisticated control.

[0008] In view of this problem, the parent patent provides an individual-spindle-drive type textile machine that upon power stoppage can synchronously decelerate and stop the spindle drive motor and the drum drive motors using control mechanisms.

[0009] Thus, after a power stoppage has been detected due to a power supply voltage drop lasting a predetermined period of time, feedback control is provided while the rotation speed of each motor is detected independently for each rotation speed control apparatus. This control is performed continuously until the motor stops. This configuration eliminates the need to transmit rotation speed signals between rotation speed control apparatuses and the need to provide an external rotation speed instruction means for each rotation speed control apparatus. Further, this configuration can decelerate and stop each motor while synchronizing them together using simple control operations.

[0010] Since an individual-spindle-drive type multi-twister has a spindle drive motor for each spindle, the voltage of a voltage supply bus may decrease when a large number of winding units are installed in a line. That is, in, for example, the conventional individual-spindle-drive type textile machine having a drive motor for each spindle for twisting yarns, a voltage drop may occur to preclude each spindle from being rotationally driven stably, thereby providing unstable twisting.

[0011] In view of this problem, the object of the present invention is to provide an individual-spindle-drive type textile machine that can prevent a voltage drop even if a large number of winding units are installed in a line.

[0012] To achieve this object, the present invention provides an individual-spindle-drive type textile machine as defined in the characterizing portion of claim 1.

[0013] Thus, voltage drops can be prevented, thus increasing the number of winding units that can be installed in a line in the individual-spindle-drive type textile machine.

[0014] Furthermore, it is proposed that the machine comprises a central control apparatus that includes a communication function and a relay device for unifying the rotation speed control apparatuses for the drive motor for each of said units, and in that said central control apparatus and each of said rotation speed control apparatuses are connected together via said relay device using a communication line.

[0015] Thus, the central control apparatus can set parameters to control each motor for a large number of rotation speed control apparatuses. Even if the number of spindle units is increased, each rotation speed control apparatus can control its motor reliably.

[0016] Each of said units may have an equal number of said rotation speed control apparatuses connected to a single direct-current voltage transforming means and a single relay device.

[0017] Thus, the wiring between the direct-current bus and communication line and each rotation speed control apparatus can be simplified.

[0018] According to another embodiment the spindle drive motor is a brushless motor having a built-in sensor for detecting the rotational position of the rotor, the sensor being incorporated in a stator section located around a rotor that is a permanent magnet.

[0019] Thus, since the sensor for detecting the rotational direction of the rotor is built into the motor, the rotation of the motor can be controlled while reliably preventing errors in detection caused by fiber dust. In addition, the use of the brushless motor can help make each motor compact and improve motor efficiency.

Brief Description of the Drawings

[0020] Figure 1 describes an individual-spindle-drive type multi-twister according to a first embodiment of the parent patent.

[0021] Figure 2 describes a winding apparatus and a spindle apparatus in an individual-spindle-drive type multi-twister in Figure 1.

[0022] Figure 3 is a block diagram describing power stoppage processing in an individual-spindle-drive type multi-twister in Figure 1.

[0023] Figure 4 is a flowchart describing the operation of the power stoppage processing in an individual-spindle-drive type multi-twister.

[0024] Figure 5 describes an individual-spindle-drive type multi-twister according to a second embodiment of the parent patent and the present invention.

[0025] Figure 6 describes a winding apparatus and a spindle apparatus in an individual-spindle-drive type multi-twister shown in Figure 5.

[0026] Figure 7 is a block diagram describing a control system in an individual-spindle-drive type multi-twister shown in Figure 5.

[0027] Figure 8 is a block diagram of a control system according to the present invention.

[0028] Figure 9 describes an individual-spindle-drive type multi-twister according to the present invention.

[0029] Figure 10 describes a winding apparatus and a spindle apparatus in an individual-spindle-drive-type multi-twister shown in Figure 9.

[0030] Figure 11 is a block diagram describing the control system in an individual-spindle-drive type multi-twister shown in Figure 9.

[0031] Figure 12 describes activation times for a spindle drive motor and a winding package in an individual-spindle-drive type multi-twister shown in Figure 9.

[0032] Figure 13 describes a conventional multi-twister.

Detailed Description of the preferred Embodiments

[0033] A first embodiment of the parent patent will be described with reference to Figures 1 to 4.

[0034] An individual-spindle-drive type multi-twister 1 is composed of 80 to 308 yarn winding units U for the corresponding spindle units installed in a line, as shown in Figure 1. A single yarn winding unit U for the corresponding spindle unit has a spindle apparatus 2 and a winding apparatus 3 connected to the spindle apparatus 2 so that yarn on a single supply package 8 is wound around a winding package P.

[0035] The spindle apparatus 2 has the supply package 8, a stationary plate 31, a tension apparatus 32, a rotating disc 33, and a spindle drive motor 6 that twists a yarn Y. The spindle drive motor 6 comprises a direct-current brushless motor BLM, and the rotating disc 33 is disposed on its output shaft. The stationary plate 31 is provided on the rotating disc 33 so that a single supply package 8 can be placed on the stationary plate 31. Furthermore, the tension apparatus 32 is provided on the supply package 8 to apply a predetermined tension to yarn Y released from the supply package 8.

[0036] Thus, the spindle apparatus 2 places the yarn Y unwound from the supply package 8 in the tension apparatus 32 to apply a tension to it while using the drive motor 6 to rotate the rotating disc 33 at a high speed to balloon the yarn Y to a balloon guide 37. In addition, the yarn Y is twisted once between the tension apparatus 32 and the rotating disc 33, and is twisted again between the rotating disc 33 and the balloon guide 37.

[0037] As shown in Figure 2. the winding apparatus 3 has a winding drum 21, the winding package P, a traverse guide 29, a feed roller 26, and a cradle 40 to wind the yarn Y twisted by the spindle apparatus 2 around the winding package P. The winding package P is rotatably supported by the cradle 40, and the winding drum 21 pressure-contacts the winding package P. Thus, after passing the yarn, which has been twisted twice as described above, from the balloon guide 37 through the guide rollers 38 and 39 and the feed roller 26, the winding apparatus 3 winds the yarn around the winding package P while traversing it using the traverse guide 29.

[0038] As shown in Figure 1, the multi-twister has not only the yarn winding unit U described above but also a drive system 5 for driving the winding apparatuses 3 concurrently and a control system 7 for controlling each spindle apparatus 2 and each winding apparatus 3. The drive system 5 has a winding drum drive motor 4, a first pulley 10, a belt 113, a second pulley 12, a speed reducing apparatus 11, a third pulley 16, a variable speed changer 17, a fourth pulley 19, a belt 20, a fifth pulley 22, a sixth pulley 24, and a cam box 27. The drive system 5 uses the driving force of the winding drum drive motor 4 to rotate the winding drum 21 and the feed roller 26 of each yarn winding unit U while the traverse guide 29 moves reciprocally.

[0039] The winding drum drive motor 4 is an induction motor 1M. The motor 4 has the first pulley 10 on its output shaft, and the second pulley 12 is provided for the motor 4 via the belt 13. The speed reducing apparatus 11 has a plurality of gears (not shown) and decelerates at a specified rate while changing its rotational direction when the driving force of the winding drum drive motor 4 is transmitted via the second pulley 12. In addition, the speed reducing apparatus 11 has two output shafts 14 and 15 so as to receive force through one shaft while outputting the force through two shafts. The third pulley 16 is fitted on the first output shaft 14, and the other output shaft 15 is connected to the variable speed changer 17 to change a winding angle.

[0040] The fourth pulley 19 fitted on the support shaft 18 is connected to the third pulley 16 via the belt 20, and the plurality of the winding drums 21 are provided on the support shaft 18 at a predetermined interval. In addition, the fifth pulley 22 is fitted on the support shaft 18 in a line to the fourth pulley 19. The sixth pulley 24 fitted on the support shaft 23 is connected to the fifth pulley 22, and the plurality of the feed rollers 26 are provided on the support shaft 23 at a predetermined interval. Thus, the drive system 5 transmits a driving force reduced by the speed reducing apparatus 11 to each winding drum 21 via the third pulley 16, the belt 20, and the fourth pulley 19. The drive system 5 also transmits a driving force to the feed roller 26 via the fifth pulley 22, the belt 25, and the sixth pulley 24.

[0041] The variable speed changer 17 is connected to the cam box 27, which transforms a rotational force into a reciprocating motion. The reciprocating rod 28 is connected to the cam box 27, and the traverse guides 29 are fitted on the reciprocating rod 28 at a predetermined interval. Thus, the drive system 5 causes the traverse guide 29 to reciprocate so as to traverse the yarn Y twisted by the spindle apparatus 2 while winding the yarn Y around the winding package P, which is rotated while pressure-contacting the winding drum 21.

[0042] As shown in Figure 3, the control system 7 not only controls the spindle apparatus 2 and the winding apparatus 3 but also acts as a power stoppage processing apparatus 7. The power stoppage processing apparatus 7 has a body controlling device 48 and a plurality of unit control sections 9 for controlling each spindle apparatus 2 to execute power stoppage processing if the drop in the voltage of an alternating current power supply 36 has lasted a predetermined period of time. The body controlling device 48 has a converter 41 that converts the voltage of the alternating current power supply 36, a host CPU 35 (a central processing apparatus) constituting a stop instruction means, a power stoppage detector 34 constituting a power stoppage detection means, and an inverter 42 constituting a means for stopping the winding drum drive motor. The body controlling device 48 outputs a stop instruction concurrently to each unit control section 9 and the inverter 42 for the winding drum drive motor constituting the stopping means.

[0043] The power stoppage detector 34 is connected to the host CPU 35 so that it can transmit a power stoppage signal to the CPU 35 upon detecting that the decrease in the voltage of the alternating current power supply 36 has lasted a predetermined period of time. Upon receiving the power stoppage signal, the host CPU 35 transmit a stop instruction directly and concurrently to each unit control section 9 and the winding drum drive motor inverter 42 via the control signal line 53. In addition, the converter 41 has an AC/DC conversion section 41a and a DC/DC conversion section 41 b, and the winding drum drive motor inverter 42 is connected to the AC/DC conversion section 41 a via the direct-current bus 47. The host CPU 35 is connected to the DC/DC conversion section 41 b, and the section 41 b transforms the direct-current voltage to 24 volts for use in control operations executed by the host CPU 35.

[0044] Each unit control section 9 has 32 inverters 45 for the spindle drive motor, a single relay device 44, and a single auxiliary power supply apparatus 43, and is connected to the body controlling apparatus 48 via a communication line 46. The 32 inverters 45 are connected to the relay device 44 via a communication line 51. The relay device 44 receives via the communication line 46 parameters output from the host CPU 35 and transmits them to each of the 32 inverters 45 via the communication line 51. Conversely, the relay device 44 receives the rotation speed of the spindle drive motor 6 output from each inverter 45 or an instruction value for the motor 6, and transmits the instruction value to the host CPU 35 via the communication line 46.

[0045] The 32 inverters 45 constituting each unit control section 9 are connected in series via a control power supply line 49, a control signal line 50, and a communication line 51. A relay connector board 52 is interposed between the group of 32 inverters and the auxiliary power supply apparatus 43, and the control power supply line 49 is connected from the auxiliary power supply apparatus 43 to the group of inverters and the relay device 44 via the relay connector board 52. In addition, the control signal line 50, disposed as the direct-current bus 47, along the machine body from the host CPU 35 is connected to the group of inverters and the relay device 44 via the relay connector board 52. In addition, the two spindle drive motors 2 are connected to each inverter 45. Each inverter 45 has a regenerative circuit. The circuit outputs regenerative power generated by rapidly decelerating the spindle drive motor 6 during power stoppage to the direct-current bus 47, which serves as a drive power supply line a predetermined stop time is set for each inverter beforehand.

[0046] The regenerative power is generated because, upon power stoppage, the spindle drive motor 6 provides a large moment of inertia and acts as a generator.

[0047] Auxiliary power supply apparatuses 43 are provided for each unit control section 9 and are connected via the direct-current bus 47. In addition, the auxiliary power supply apparatus 43 has a direct-current transformer 43a, and during normal operation and power stoppage, the apparatus 43 converts a direct-current voltage supplied via the direct-current bus 47 into the 24 volts control voltage required to control the spindle drive motor 6 so as to supply this voltage to the group of inverters. The apparatus 43 supplies the 24 volts control voltage to each of the 32 inverters 45 via the control power supply line 49. In addition, the auxiliary power supply apparatus 43 has a capacitor 43b constituting a storage means to store regenerative power so as to maintain the control voltage over a longer period of time.

[0048] After receiving the stop instruction via the control signal line 50, each inverter 45 uses the control voltage from the auxiliary power supply apparatus 43 to control each spindle drive motor 6 independently via feedback, thereby allowing the motor 6 to decelerate and stop within a preset stop time. In addition, after receiving the stop instruction via the control signal line 53, the inverter 42 for the winding drum drive motor uses a direct-current voltage on the direct-current bus 47 obtained from regenerative power from the motor 6 to control the winding drum drive motor 4 independently via feedback, thereby allowing the motor 4 to decelerate and stop within a preset stop time. That is, the inverters 42 and 45 individually decelerate and stops the motors 4 and 6, respectively. The inverter 42 for the winding drum drive motor has a direct-current transformer (not shown) for generating the control voltage inside the inverter 42.

[0049] As described above, in the power stoppage processing apparatus 7 according to this embodiment, the body controlling apparatus 48 individually controls the spindle drive motor 6 and the winding drum drive motor 4 instead of obtaining the rotation speeds of the motors 6 and 4 so as to control them synchronously. Thus, the power stoppage processing apparatus 7 does not need to receive the rotation speeds of the spindle drive motor 6 and the winding drum drive motor 4, thereby simplifying the wiring configuration and eliminating the need for advanced control.

[0050] The operation of the individual-spindle-drive type multi-twister, having the above configuration is described with reference to the drawings.

[0051] As shown in Figure 1, when power is supplied from the alternating current power supply 36 to the inverter 45 for the spindle drive motor via the converter 41 and the direct-current bus 47, the spindle drive motor 6 is driven to rotate each rotating disc 33 at the same rotation speed as that of each spindle drive motor 6. When each rotating disc 33 rotates, the yarn Y unwound from the supply package 8 enters the tension apparatus 32, which twists the yarn Y once while tensing it. The yarn Y is twisted again and ballooned to the balloon guide 37.

[0052] On the other hand, when power is supplied to the inverter 42 via the direct-current bus 47, the winding drum drive motor 4 is driven and its output is transmitted to the support shafts 18 and 23 and the reciprocating rod 18 via the pulleys 10, 12, 16, 19, 22, and 24, the belts 13, 20, and 25, the speed reducing apparatus 11, the variable speed changer 17, and the cam box 27. The winding drum 21 and the feed roller 26 for each spindle unit then rotate and the traverse guide 29 for each spindle unit reciprocates.

[0053] When this rotation and reciprocating motion occurs, the traverse guide 29 traverses the yarn Y, which has been twisted twice by the spindle apparatus 2. The yarn Y is then wound around the winding package P. During traversing, the variable speed changer 17 corrects the winding angle.

[0054] While the yarn Y is being wound around the winding package P in this manner and when the power stoppage detector 34 detects a decrease in power supply voltage (S1, YES), the host CPU 35 determines whether the decrease has lasted a predetermined period of time (for example, 1 msec.) (S2). If not (S2, NO), the power stoppage time is too short to affect the operation of the multi-twister 1, so the apparatuses 2 and 3 each resume normal operation (S3).

[0055] On the other hand, if at S2, the decrease has lasted the predetermined period of time (for example, over 1 msec.) (S2, YES), the host CPU 35 sends a stop instruction concurrently via the control signal line 53 to the inverter 42 for the winding drum drive motor and the relay connector board 52 provided for each unit control section 9. The stop instruction is then transmitted concurrently to each inverter 45 from each relay connector board 52 via the control signal line 50 (S4). After the inverters 42 and 45 each have received the stop instruction, the power supply from the alternating current power supply 36 to the spindle drive motor 6 and the winding drum drive motor 4 is terminated.

[0056] Since the spindle drive motor 6 provides a large inertia even after the power supply has stopped, it can be operated as a generator to generate regenerative power by rapidly decelerating and stopping it within the predetermined stop time. This regenerative power is output from a regenerative circuit for each inverter 45 to the direct-current bus 47, which serves as a drive power supply line, with part of the power supplied to each inverter 45 via the auxiliary power supply apparatus 43 and the control power supply line 49 used as a control voltage for the spindle drive motor 6. In addition, the other regenerative power is supplied from the direct-current bus 47 to the direct-current transformer (not shown) inside the inverter 42 for the winding drum drive motor as a control voltage.

[0057] Thus, based on a rotation speed detected by a built-in hall sensor incorporated in a stator located around a rotor to detect the rotational position of the rotor, each inverter 45 independently transmits and receives feedback control to and from the spindle drive motor 6 to decelerate and stop the motor 6 within the predetermined stop time. In addition, the inverter 42 for the winding drum drive motor obtains the rotation speed of the winding drum drive motor 4 from a pulse generator 30 provided separately from the motor 4 to independently transmit and receive feedback control to and from the motor 4 in order to decelerate and stop the motor 4 within the predetermine stop time (S5). The each spindle drive motor 6 and the winding drum drive motor 4 then synchronously decelerate and simultaneously stop after the predetermined stop time (S6).

[0058] The control power supply line 49 in the multi-twister 1 according to this embodiment supplies each inverter 45 with a control voltage (24 volts) to control the spindle drive motor 6. In addition, the control signal lines 50 and 53 transmit the stop instruction to all the inverters 42 and 45 upon the detection of a power stoppage, and send a normal concurrent start or stop signal to the body. Furthermore, the communication lines 46 and 51 allow the host CPU 35 to monitor the rotation speed of each motor 6 or an instruction value therefore or to set controlling parameters for each of the inverters 42 and 45.

[0059] In the multi-twister 1 the winding drum 21 and the traverse mechanisms 28 and 29 are mechanically connected together using the cam box 27 and are driven by a common winding drum drive motor 4.

[0060] Next, another embodiment of the parent patent and the present invention will be described with reference to Figures 5 to 7.

[0061] An individual-spindle-drive type multi-twister 101 is composed of 80 to 308 yarn winding units U for the corresponding spindle units installed in a line, as shown in Figure 5. A single yarn winding unit U for the corresponding spindle unit has a spindle apparatus 102 and a winding apparatus 103 connected to the spindle apparatus 102 so that yarn on a single supply package 108 is wound around a winding package P.

[0062] The spindle apparatus 102 has the supply package 108, a stationary plate 131, a tension apparatus 132, a rotating disc 133, and a spindle drive motor 106 that twists the yarn Y. The spindle drive motor 106 comprises a direct-current brushless motor BLM and has the rotating disc 133 on its output shaft. The stationary plate 131 is provided on the rotating disc 133 so that the single supply package 108 can be placed on the stationary plate 131. Furthermore, the tension apparatus 132 is provided on the supply package 108 to apply a predetermined tension to the yarn Y unwound from the supply package 108.

[0063] Thus, the spindle apparatus 102 places the yarn Y that is unwound from the supply package 108 in the tension apparatus 132 to tense it while using the drive motor 106 to rotate the rotating disc 133 at a high speed to balloon the yarn Y to a balloon guide 137. In addition, the yarn Y is twisted once between the tension apparatus 132 and the rotating disc 133, and is twisted again between the rotating disc 133 and the balloon guide 137.

[0064] As shown in Figure 6. the winding apparatus 103 has a winding drum 121, a winding package P, a traverse guide 129, a feed roller 126 and a cradle 140 to wind the yarn Y twisted by the spindle apparatus 102 around the winding package P. The winding package P is supported by the cradle 140 in a way that it is free to rotate, and the winding drum 121 pressure-contacts the winding package P. Thus, after passing the yarn twisted twice as described above, from the balloon guide 137 through guide rollers 138 and 139 and the feed roller 126, the winding apparatus 103 winds the yarn around the winding package P while traversing it using the traverse guide 129.

[0065] As shown in Figure 4, the individual-spindle-drive type multi-twister 1 has not only the yarn winding unit U but also a drive system 105 for driving the winding apparatuses 103 concurrently and a control system 107 for controlling each spindle apparatus 102 and each winding apparatus 103. The drive system 105 has a winding drum drive motor 104, a first pulley 110, a belt 111, a second pulley 112, a speed reducing apparatus 117, a third pulley 116, a fourth pulley 119, a belt 120, a fifth pulley 122, a sixth pulley 124, a seventh pulley 113, a belt 114, an eighth pulley 115, and a cam box 127. The system 105 uses the driving force of the winding drum drive motor 104 to rotate the winding drum 121 and feed roller 126 of each yarn winding unit U while the traverse guide 129 moves reciprocally.

[0066] The winding drum drive motor 104 is an induction motor 1M. The motor 104 has the first pulley 110 on its output shaft, and the second pulley 112 is connected to the motor 104 via the belt 111. The speed reducing apparatus 117 has a plurality of gears (not shown) and decelerates at a specified rate while changing its rotational direction when the driving force of the winding drum drive motor 104 is transmitted via the second pulley 112. In addition, the speed reducing apparatus 117 has two output shafts so as to receive force through one shaft while outputting force through two shafts. The third pulley 116 is fitted on one of the output shafts, and the seventh pulley 113 is fitted on the other output shaft.

[0067] The fourth pulley 119 fitted on the support shaft 118 is connected to the third pulley 116 via the belt 120, and the plurality of winding drums 121 are provided on the support shaft 118 at a predetermined interval. In addition, the fifth pulley 122 is fitted on the support shaft 118 in a line to the fourth pulley 119. The sixth pulley 124 fitted on the support shaft 123 is connected to the fifth pulley 122, and the plurality of feed rollers 126 are provided on the support shaft 123 at a predetermined interval. Thus, the drive system 105 transmits a driving force reduced by the speed reducing apparatus 117 to each winding drum 121 via the third pulley 116, the belt 120, and the fourth pulley 119, and also transmits a driving force to the feed roller 126 via the fifth pulley 122, the belt 125, and the sixth pulley 124.

[0068] The speed reducing apparatus 117 is connected to the cam box 127 via the seventh pulley 113, the belt 114, and the eighth pulley 115. The reciprocating rod 128 is connected to the cam box 127 so as to convert rotational force into reciprocating motion. The traverse guides 129 are fitted on the reciprocating rod 28 at a predetermined interval. Thus, the drive system 105 causes the traverse guide 129 to reciprocate so as to traverse the yarn Y twisted by the spindle apparatus 102 while the yarn Y is wound around the winding package P, which is rotated while pressure-contacting the winding drum 121.

[0069] As shown in Figure 6, the control system 107 has a body controlling apparatus 142 and a plurality of unit control sections 109 for controlling each spindle apparatuses 102, and constitutes a control system for the individual-spindle-drive type multi-twister 101. The body controlling apparatus 142 has a converter 135 that converts the voltage of an alternating current power supply 134, a host CPU 136 constituting a central processing unit, and a rotation speed control apparatus 141 for the winding drum drive motor. The body controlling apparatus 142 outputs various control instructions concurrently to each unit control section 109 and the rotation speed control apparatus 141 for the winding drum drive motor.

[0070] The host CPU 136 transmits various parameters and control instructions concurrently to each unit control section 109 and the rotation speed control apparatus 141 for the winding drum drive motor via a communication line 146. The host CPU 136 also transmits activation and stop instructions concurrently to each unit control section 109 and the rotation speed control apparatus 141 for the winding drum drive motor via a control signal line 153. In addition, the converter 135 has an AC/DC conversion section 135a and a DC/DC conversion section 135b, and the rotation speed control apparatus 141 for the winding drum drive motor is connected to the AC/DC conversion section 135a via a direct-current bus line 147. The host CPU 136 is connected to the DC/DC conversion section 135b, and the DC/DC conversion section 135b converts 290 volts into 24 volts for use in control operations executed by the host CPU 136.

[0071] The rotation speed control apparatus 141 for the winding drum drive motor receives a supply of a first direct-current voltage of 290 volts via the direct-current bus line 147 and uses parameters and control instructions received via the communication line 146 to independently send feedback to the winding drum drive motor 104 based on the rotation speed measured by a pulse generator PG148.

[0072] Each unit control section 109 has 32 rotation speed control apparatuses 144 for the spindle drive motor, a single relay device 145, and a spindle direct-current transformer 143 constituting a single direct-current voltage transforming means, and is connected to the body controlling apparatus 142 via the communication line 146. The 32 rotation speed control apparatuses 144 are connected to the relay device 145 via the communication line 146. The relay device 145 relays a control instruction output from the host CPU 136 to transmit it to each of the 32 rotation speed control apparatuses 144.

[0073] The said spindle direct-current transformer 143 is connected to the direct-current bus line 147 and during normal operation, converts the first direct-current voltage of 290 volts supplied via the direct-current bus line 147 into a second direct-current voltage of 24 volts for use in controlling the spindle drive motor 106.

[0074] The each rotation speed control apparatuses 144 for the spindle drive motor are connected in series to the spindle direct-current transformer 143 via a control power supply line 149. A relay connector board 152 is interposed between the group of 32 rotation speed control apparatuses and the spindle direct-current transformer 143, and the control power supply line 149 is connected from the spindle direct-current transformer 143 to the group of rotation speed control apparatuses and the relay device 145 via the relay connector board 152. In addition, a control signal line 153 disposed along the body from the host CPU 136 is connected to the group of rotation speed control apparatuses and the relay device 145 via the relay connector board 152. In addition, the two spindle drive motors 102 are connected to each rotation speed control apparatus 144, and each rotation speed control apparatus 144 can receive a control instruction via the communication line 146, the relay device 145, and the communication line 151 to independently send feedback to control each spindle drive motor 106 based on the rotation speed as determined by the rotation speed detector 150. That is, a single rotation speed control apparatus 144 drives and stops two spindle drive motors 106. The rotation speed control apparatuses 141 and 144 individually drive and stop the motors 104 and 106, respectively.

[0075] The operation of the individual-spindle-drive type multi-twister 101 having the above configuration is described with reference to the drawings.

[0076] As shown in Figures 5 and 7, the alternating current power supply 134 supplies the second direct-current voltage of 24 volts to each rotation speed control apparatus 144 via the converter 135, the direct-current bus line 147, and the spindle direct-current transformer 143. In addition, the host CPU 136 transmits an activation instruction to the relay connector board 153 via the control signal line 153, and the instruction is then sent from the board 152 to the rotation speed control apparatus 144 via the control signal line 154. Each spindle drive motor 106 is concurrently driven based on the instruction from the rotation speed control apparatus 144 to rotate each rotating disc 133 at the same rotation speed as in each motor 106. When each rotating disc

133 rotates, the yarn Y unwound from the supply package 108 enters the tension apparatus 132, which twists the yarn Y once while tensing it. The yarn Y is twisted again and ballooned to the balloon guide 137.

[0077] On the other hand, the alternating current power supply 134 supplies the first direct-current voltage of 290 volts to the rotation speed control apparatus 141 via the converter 135 and the direct-current bus line 147, and the CPU 136 transmits the activation instruction to the apparatus 141 via the control signal line 153. The winding drum drive motor 104 is driven based on the instruction from the rotation speed control apparatus 141. The output of the motor 104 is transmitted to the support shafts 118 and 123 and the reciprocating rod 128 via the pulleys 110, 112, 116, 119, 122, and 124, the belts 111, 114, 120, and 125, the speed reducing apparatus 117, and the cam box 127 to rotate the winding drum 121 and feed roller 126 of each spindle unit while the traverse guide 129 of each spindle unit moves reciprocally.

[0078] When this rotation and reciprocal motion occurs, the yarn Y, which has been twisted twice by the spindle apparatus 102, is wound around the winding package P while traversing it using the traverse guide 129. During traversing, the speed reducing apparatus 117 corrects the winding angle.

[0079] During the above winding operation, the first direct-current voltage is supplied to each spindle direct-current transformer 143 via the direct-current bus 147 and each rotation speed control apparatus 144 can reliably receive the supply of the converted second direct-current voltage, thereby preventing a voltage drop. In addition, since the various parameters are transmitted to the plurality of rotation speed control apparatuses 144 via the relay device 145, the central control apparatus can set the parameters concurrently.

[0080] Next, the configuration of the control system according to the invention will be described with reference to Figure 8.

[0081] This control system differs from the above control system and has a plurality of winding drum drive motors 104. Thus, the AC/DC converter 135a is provided for each winding drum drive motor 104 and is directly connected to the alternating current power supply 134. The direct-current bus line 147 is connected to the each AC/DC converter 135a and the plurality of unit control sections 109 are connected to the body controlling apparatus 142.

[0082] Each rotation speed control apparatus 141 for the winding drum drive motor is connected to the host CPU 136 via the communication line 146 and the control signal line 153 to receive various parameters and activation and stop instructions. Even with a plurality of winding drum drive motors 104, this configuration has the advantage of enabling components corresponding to added winding spindle units to be added using the plurality of AC/DC converters 135a, the plurality of spindle direct-current transformers 143, and the relay device 145 and also using the direct-current bus line 147, the communication line 146, and the control signal line 153 for relaying. This configuration thus reduces the number of wiring steps required.

[0083] The control power supply line 149 in the individual-spindle-drive type multi-twister 201 according to this embodiment supplies each rotation speed control apparatus 144 with the control voltage (24 volts) for controlling the spindle drive motor 106. In addition, the control signal lines 153 and 154 transmit the activation or stop instruction to all the rotation speed control apparatuses 141 and 144, and sends a normal concurrent start or stop signal for the machine body. Furthermore, the communication lines 146 and 151 allow the host CPU 136 to monitor the rotation speed of each motor 106 or an instruction value therefore or to set controlling parameters for each of the rotation speed control apparatuses 141 and 144.

[0084] Although this embodiment has been described in conjunction with the 32 rotation speed control apparatuses 144 for the spindle drive motor constituting each unit control section 109, the number of controlling apparatuses 144 is not limited to 32.

[0085] In addition, although this embodiment has been described in conjunction with the two spindle drive motors 106 connected to the rotation speed control apparatus 144 for the spindle drive motor, the number of motors 106 is not limited to two.

[0086] Instead of the single supply package 108 provided for each yarn winding unit U a single supply package 108 and a plurality of supply packages 108 may be provided. The rotation speed detector 150 is built into the above direct-current brushless motor to detect the rotation speed of this motor.

[0087] Next, a second embodiment of the present invention will be described with reference to Figures 9 to 12.

[0088] An individual-spindle-drive type multi-twister 201 is composed of 80 to 308 yarn winding units U for the corresponding spindle units installed in a line, as shown in Figure 9. A yarn winding unit U for the corresponding spindle unit has a spindle apparatus 202 and a winding apparatus 203 connected to and installed on the spindle apparatus 202 so that yarn on a single supply package 208 is wound around a winding package P.

[0089] The above spindle apparatus 202 has the supply package 208, a stationary plate 231, a tension apparatus 232, a rotating disc 233, and a spindle drive motor 206 that twists yarn Y. The spindle drive motor 206 comprises a direct-current brushless motor BLM and has the rotating disc 233 on its output shaft. The stationary plate 231 is provided on the rotating disc 233 so that the single supply package 208 can be placed on the stationary plate 231. Furthermore, a tension apparatus 232 is provided on the supply package 208 to apply a predetermined tension to the yarn Y unwound from the supply package 208.

[0090] Thus, the spindle apparatus 202 places the yarn Y that is unwound from the supply package 208 in the tension apparatus 232 to tense it while using the spindle drive motor 206 to rotate the rotating disc 233 at a high speed so as to balloon the yarn Y to a balloon guide 237. In addition, the yarn Y is twisted once between the tension apparatus 232 and the rotating disc 233 and is twisted again between the rotating disc 233 and the balloon guide 237.

[0091] As shown in Figure 10. the above winding apparatus 203 has a winding drum 221, the winding package P, a traverse guide 229, a feed roller 226, a cradle 240, and a winding package brake 230 to wind around the winding package P the yarn Y twisted by the spindle apparatus 202. The winding package P is rotatably supported by the cradle 240, and the winding drum 221 pressure-contacts the winding package P. Thus, after passing the yarn twisted twice as described above, from the balloon guide 237 through the guide rollers 238 and 239 and the feed roller 226, the winding apparatus 203 winds the yarn Y around the winding package P while traversing it using the traverse guide 229.

[0092] The winding package brake 230 has a link arm 252 located between the winding package P and the winding drum 221, a cylinder 253 that rotates the link arm 252, and an electromagnetic valve SV248 that supplies and ejects air to and from the cylinder 253. The electromagnetic valve SV248 supplies air to the cylinder 253 to rotate the link arm 252 in order to allow the winding package P to contact or leave the winding drum 221. Thus, by allowing the winding package P and the winding drum 221 to separate, this configuration prevents the yarn Y from being wound to the winding package P despite the rotation of the winding drum 221.

[0093] As shown in Figure 9, this multi-twister has not only the above yarn winding unit U but also a drive system 205 for each driving the winding apparatus 203 concurrently and a control system 207 for controlling each spindle apparatus 202 and each winding apparatus 203. The drive system 205 has a winding drum drive motor 204, a first pulley 210, a belt 211, a second pulley 212, a speed reducing apparatus 217, a third pulley 216, a fourth pulley 219, a belt 220, a fifth pulley 222, a sixth pulley 224, a seventh pulley 213, a belt 214, an eighth pulley 215, and a cam box 227. The system 205 uses the driving force of the winding drum drive motor 204 to rotate the winding drum 221 and feed roller 226 of each yarn winding unit U while the traverse guide 229 moves reciprocally.

[0094] The above winding drum drive motor 204 is an induction motor IM. The motor 4 has the first pulley 210 on its output shaft, and the second pulley 212 is provided for the motor 4 via the belt 211. The above speed reducing apparatus 217 has a plurality of gears (not shown) and decelerates at a specified rate while changing its rotational direction, when the driving force of the winding drum drive motor 204 is transmitted via the second pulley 212. In addition, the speed reducing apparatus 217 has two output shafts so as to receive force through one shaft while outputting force through two shafts. The third pulley 216 is fitted on one of the output shafts, and the seventh pulley 213 is fitted on the other output shaft.

[0095] The fourth pulley 219 fitted on the support shaft 218 is connected to the third pulley 216 via the belt 220, and the plurality of winding drums 221 are provided on the support shaft 218 at a predetermined interval. In addition, the fifth pulley 222 is fitted on the support shaft 218 in a line to the fourth pulley 119. The sixth pulley 224 fitted on the support shaft 223 is connected to the fifth pulley 222, and the plurality of feed rollers 226 are provided on the support shaft 223 at a predetermined interval. Thus, the drive system 205 transmits a driving force reduced by the speed reducing apparatus 211 to each winding drum 221 via the third pulley 216, the belt 220, and the fourth pulley 219, and also transmits a driving force to the feed roller 226 via the fifth pulley 222, the belt 225, and the sixth pulley 224.

[0096] The speed reducing apparatus 217 is connected to the cam box 227 via the seventh pulley 213, the belt 214, and the eighth pulley 215. The reciprocating rod 228 is connected to the cam box 227 so as to convert a rotational force into reciprocating motion. The traverse guides 229 are fitted on the reciprocating rod 228 at a predetermined interval. Thus, using a motion reciprocal to that of the traverse guide 229, the drive system 205 traverses the yarn Y, which is twisted by the spindle apparatus 202 while winding the yarn Y around the winding package P, which is rotated while pressure-contacting the winding drum 221.

[0097] As shown in Figure 11, the control system 207 has a body controlling apparatus 242 and a plurality of unit control sections 209 for controlling each spindle apparatus 202, and constitutes a control system for the individual-spindle-drive type multi-twister 201. The body controlling apparatus 242 has a converter 235 that converts the voltage of an alternating current power supply 234, a host CPU 236 constituting a central processing unit, and an inverter (a rotation speed control apparatus) 241 for the winding drum drive motor. The body controlling apparatus 242 outputs various control instructions concurrently to each unit control section 209 and the inverter 241 for the winding drum drive motor.

[0098] The host CPU 236 transmits various parameters and control instructions concurrently to each unit control section 209 and the inverter 241 for the winding drum drive motor via a communication line 246. The host CPU 136 also transmits activation and stop instructions concurrently to each control section 209 and the inverter 241 for the winding drum drive motor via a control signal line 257. In addition, the converter 235 has an AC/DC conversion section 235a and a DC/DC conversion section 235b, and the inverter 241 for the winding drum drive motor is connected to the AC/DC conversion section 235a via a direct current bus line 247. The host CPU 236 is connected to the DC/DC conversion section 235b, and the section 235b converts 290 volts into 24 volts for use in control operations executed by the host CPU 236.

[0099] The inverter 241 for the winding drum drive motor receives a supply of a first direct-current voltage of 290 volts via the direct-current bus line 247 and uses parameters and control instructions received via the communication line 246 to independently send feedback to control the winding drum drive motor 204 based on the rotation speed measured by a pulse generator PG254.

[0100] Each unit control section 209 has 32 inverters (rotation speed control apparatuses) 244 for the spindle drive motor, a single relay device 245, and a spindle apparatus direct-current transformer 243, and is connected to the body controlling apparatus 242 via the communication line 246. The 32 inverters 244 are connected to the relay device 245 via the communication line 251. The relay device 245 relays a control instruction output from the host CPU 236 to transmit it to each of the 32 inverters 244.

[0101] Each spindle apparatus direct-current transformer 243 is connected to the direct-current bus line 247, and during normal operation, converts the first direct-current voltage of 290 volts supplied via the direct-current bus line 247 into a second direct-current voltage of 24 volts for use for the controlling of the spindle drive motor 206.

[0102] The 32 inverters 244 for the spindle drive motor are connected in series to the direct-current transformer 243 via a control power supply line 249. A relay connector board 256 is interposed between the group of 32 inverters and the spindle apparatus direct-current transformer 243, and the control power supply line 249 is connected from the spindle apparatus direct-current transformer 243 to the group of inverters and the relay device 245 via the relay connector board 256. In addition, a control signal line 257 disposed along the body from the host CPU 236 is connected to the group of inverters and the relay device 245 via the relay connector board 256. In addition, the two spindle drive motors 202 are connected to each inverter 244, and each inverter 244 can receive a control instruction via the communication line 246, the relay device 245, and the communication line 251 to independently send feedback to control each spindle drive motor 206 based on a rotation speed measured by the rotation speed detector 255. That is, the single inverter 244 drives and stops the two spindle drive motors 206. The inverter 241 and 244 individually drive and stop the motors 204 and 206, respectively.

[0103] Next, the integral part of the individual-spindle drive type multi-twister 201 according to this embodiment is described.

[0104] As shown in Figures 9 and 11, the inverter 244 for spindle drive motor has an activation controlling section 244a and a clearing control section 244b to control the activation of the spindle drive motor 206 and the opening and closing of the electromagnetic valve SV248. To start up each spindle drive motor 206 concurrently, the activation controlling section 244a controls each spindle drive motor 206 so as to be activated slowly in about 15 to 20 seconds. To start up any spindle drive motor 206 during the winding of other spindle units, the section 244a controls the motor 206 so as to be activated rapidly in about 10 seconds.

[0105] In addition, to start up any spindle drive motor 206 during the winding of other spindle units, the clearing control section 244b controls the electromagnetic valve SV248 so that after the activation of this spindle drive motor 206, the winding package brake 230 is cleared after a predetermined period of time (2 seconds).

[0106] In addition, an activation switch 250 constituting an operation means is connected to each inverter 244 for spindle drive motor so that to start up any spindle drive motor 206 during the winding of other spindle units, this switch 250 can be turned on to activate the spindle drive motor 206.

[0107] The operation of the individual-spindle-drive type multi-twister 201 of the above configuration is described with reference to the drawings.

[0108] As shown in Figures 9 and 11, the alternating current power supply 234 supplies 24 volts to each inverter 244 via the converter 235, the direct-current bus 247, and the spindle apparatus direct-current transformer 243. In addition, the host CPU 236 transmits an activation instruction to each relay connector board 256 via the control signal line 257, and the instructions for the spindle drive motor is then sent from the relay connector board 256 to the inverter 244 via the control signal line 258. Each spindle drive motor 206 is concurrently driven based on instructions from the activation controlling section 244a in the rotation speed control apparatus 244 to rotate each rotating disc 233 at the same rotation speed as that of each motor 206. And each spindle drive motor 206 reaches to the predetermined speed of rotation about 15 seconds after rotation begins while each rotating disc 233 rotates, the yarn Y unwound from the supply package 208 enters the tension apparatus 232, which twists the yarn Y once while tensing it. The yarn Y is twisted again and ballooned to the balloon guide 237.

[0109] On the other hand, the alternating current power supply 234 supplies 290 volts to the inverter 241 for the winding drum drive motor via the converter 235 and the direct-current bus line 247, and the CPU 236 transmits the activation instruction to the inverter 241 via the control signal line 257. The winding drum drive motor 204 is driven based on the instruction from the inverter 241. The output of the motor 204 is transmitted to the support shafts 218 and 223 and the reciprocating rod 228 via the pulleys 210, 212, 216, 219, 222, and 224, the belts 211, 214, 220, and 225, the speed reducing apparatus 217, and the cam box 227 to rotate the winding drum 221 and feed roller 226 of each spindle unit while the traverse guide 229 of each spindle unit moves reciprocally.

[0110] When this rotation and reciprocal motion occurs, the yarn Y, which has been twisted twice by the spindle apparatus 202, is wound around the winding package P while traversing it using the traverse guide 229. During the traversing, the speed reducing apparatus 217 corrects the winding angle.

[0111] As described above, when the yarn Y is cut while being wound around the package P, a yarn cut sensor (not shown) sends a motor stop signal to the inverter 244. Upon receiving this signal, the inverter 244 stops the spindle drive motor 206 while transmitting an opening or closing signal to the electromagnetic valve SV248. The valve SV248 is opened to feed air to the cylinder 253 to rotate the link arm 252. Then, the link arm 252 enters the area between the winding package P and the winding drum 221 to brake the package P. At this point, the winding drum 221, which is common to all spindle units, continues rotating at the normal winding speed.

[0112] Then, a piecing apparatus (not shown) pieces the yarn, and when the yarn is ready for winding, the operator turns on the activation switch 250 to cause the spindle drive motor 206, which has been stopped, to rotate again,(see Figure 11). Turning the switch 250 on causes the activation control section 244a to activate the motor 206 rapidly in about 10 seconds. Thus, the winding package P stops to allow the yarn Y to be twisted during the time it doesn't travel, thereby preventing incompletely twisted twist yarn Y from being wound around package P.

[0113] The clearing control section 244b transmits the opening or closing signal to the electromagnetic valve SV248 about two minutes after the activation of the spindle drive motor 206. The electromagnetic valve SV248 is closed to reduce the pressure on the cylinder 253 to rotate the link arm 252. Thus, the arm 252 leaves the winding package P and winding drum 221 about two seconds after the activation of the spindle drive motor 206, thereby clearing the braked condition of the package P.

[0114] Clearing the braked condition causes the winding package P to contact the winding drum 221, which is rotating at the normal winding speed, so the package P starts to rotate. About eight seconds after the start of the rotation of the winding package P, the package P reaches its rotation speed for normal operation. On the other hand, the spindle drive motor 206 reaches the rotation speed for normal operation about 10 seconds after rotation begins. In this manner, about 10 seconds after the activation switch 250 is turned on, the motor 206 and the package P return to their normal rotation speeds.

[0115] The control power supply line 249 in the multi-twister 201 according to this embodiment supplies each inverter 244 with the control voltage (24 volts) for controlling the spindle drive motor 206. In addition, the control signal lines 257 and 258 transmit the activation or stop instruction to all the inverters 241 and 244 upon the detection of a power stoppage, and send a normal concurrent start or stop signal for the machine body. Furthermore, the communication lines 246 and 251 allow the host CPU 236 to monitor the rotation speed of each motor 206 or an instruction value therefore or to set controlling parameters for each of the inverters 241 and 244.

[0116] To activate each spindle drive motor 206 concurrently, the individual-spindle-drive type multi-twister 201 according to the invention simultaneously starts activating the winding drum 221 common to all spindle units and motors 206 and gradually accelerates them at the same rate. This prevents the slippage between the drum 221 and the winding package P, and thus the yarn Y is cut upon activation. With respect to the operation during the concurrent activation, when the power is turned on, the package brake 230 is cleared to allow the package P to contact the winding drum 221. Subsequently, both the winding drum 221 and the spindle apparatus 202 begin to rotate.

[0117] Although this embodiment has been described in conjunction with the clearing control section 244b that clears the winding package brake 230 for predetermined period of time (two seconds) after activation, it is not limited in this respect. Based on the rotation speed detected by the rotation speed detector 255 (Figure 11), the clearing control section 244b may control the winding package brake 230 so as to be cleared when the spindle drive motor 206 reaches a predetermined rotation speed.

[0118] In addition, according to this embodiment, about 15 to 20 seconds are required to activate the spindle drive motors 206 concurrently, but the activation time is not limited to these values. In addition, according to this embodiment, about 10 seconds are required to activate any spindle drive motor 206, but this activation time is not limited to these values.

[0119] Although this embodiment has been described in conjunction with 32 inverters 244 for the spindle drive motor for consisting each unit control section 209, the number of inverters 244 is not limited to 32.

[0120] In addition, although this embodiment has been described in conjunction with the two spindle drive motors 206 connected to the inverter 244, the number of motors 206 is not limited to two.

[0121] Instead of the single supply package 208 provided for each yam winding unit U a plurality of supply packages 208 may be provided. A rotation speed detector 255 is built into the direct-current brushless motor to detect the rotation speed of this motor.

[0122] The invention provides an individual-spindle-drive type textile machine wherein a plurality of spindle units are installed in a line, each spindle unit having a drive motor, the plurality of drive motors being driven by rotation speed control apparatuses. The machine also comprises a direct-current bus having a first direct-current voltage for driving force and connecting the direct-current bus to said rotation speed control apparatuses, and direct-current voltage transforming means for transforming the first direct-current voltage into a second direct-current voltage for control, the machine being configured so that said plurality of rotation speed control apparatuses are divided into a plurality of units each including a specified number of these apparatuses, with said direct-current voltage transforming means provided for each of said units.

[0123] Thus, the voltage drop can be prevented to increase the number of winding units that can be installed in a line in the individual-spindle-drive type textile machine.

[0124] The invention is configured so that the machine comprises a central control apparatus that includes a communication function and a relay device for unifying the rotation speed control apparatuses for the drive motors of each of said units. Moreover, said central control apparatus and each of said rotation speed control apparatuses are connected together via said relay device using a communication line.

[0125] Thus, the central control apparatus can set parameters to control each motor for a large number of rotation speed control apparatuses. Even if the number of spindle units is increased, each rotation speed control apparatus can control its motor reliably.

[0126] The invention is configured so that each of said units has an equal number of said rotation speed control apparatuses connected to a single direct-current voltage transforming means and a single relay device.

[0127] The wiring between the direct-current bus and communication line and each rotation speed control apparatus can thus be simplified.

[0128] The present invention is configured so that the spindle drive motor is a brushless motor having a built-in sensor for detecting the rotational position of the rotor, the sensor being incorporated in a stator section located around a rotor that is a permanent magnet.

[0129] Thus, since the sensor for detecting the rotational direction of the rotor is built into the motor, the rotation of the motor can be controlled while reliably preventing errors in detection caused by fiber dust. In addition, the use of the brushless motor can make each motor more compact and improve its efficiency.

Claims

1. An individual-spindle-drive type textile machine wherein a plurality of spindle units are installed in a line, each spindle unit having a drive motor, the plurality of drive motors being driven by rotation speed control apparatuses,
characterized in that
the machine comprises a direct-current bus having a first direct-current voltage for driving force and connecting to said rotation speed control apparatuses, and a direct-current voltage transforming means for transforming said first direct-current voltage into a second direct-current voltage for control, and **in that** said plurality of rotation speed control apparatuses are divided into a plurality of units, each of which includes a specified number of these apparatuses, with said direct-current voltage transforming means provided for each of said units.

2. An individual-spindle-drive type textile machine according to Claim 1
characterized in that
the machine comprises a central control apparatus that includes a communication function and a relay device for unifying the rotation speed control apparatuses for said drive motor for each of the units, and **in that** said central control apparatus and each of said rotation speed control apparatuses are connected together via said relay device using a communication line.

3. An individual-spindle-drive type textile machine according to Claim 1 or Claim 2
characterized in that
each of said units has an equal number of said rotation speed control apparatuses connected to a single direct-current voltage transforming means and a single relay device.

4. An individual-spindle-drive type textile machine according to any one of Claims 1 to 3
characterized in that
said spindle drive motor is a brushless motor having a built-in sensor for detecting the rotational position of the rotor, the sensor being incorporated in a stator section located around a rotor that is a permanent magnet.

FIG. 1

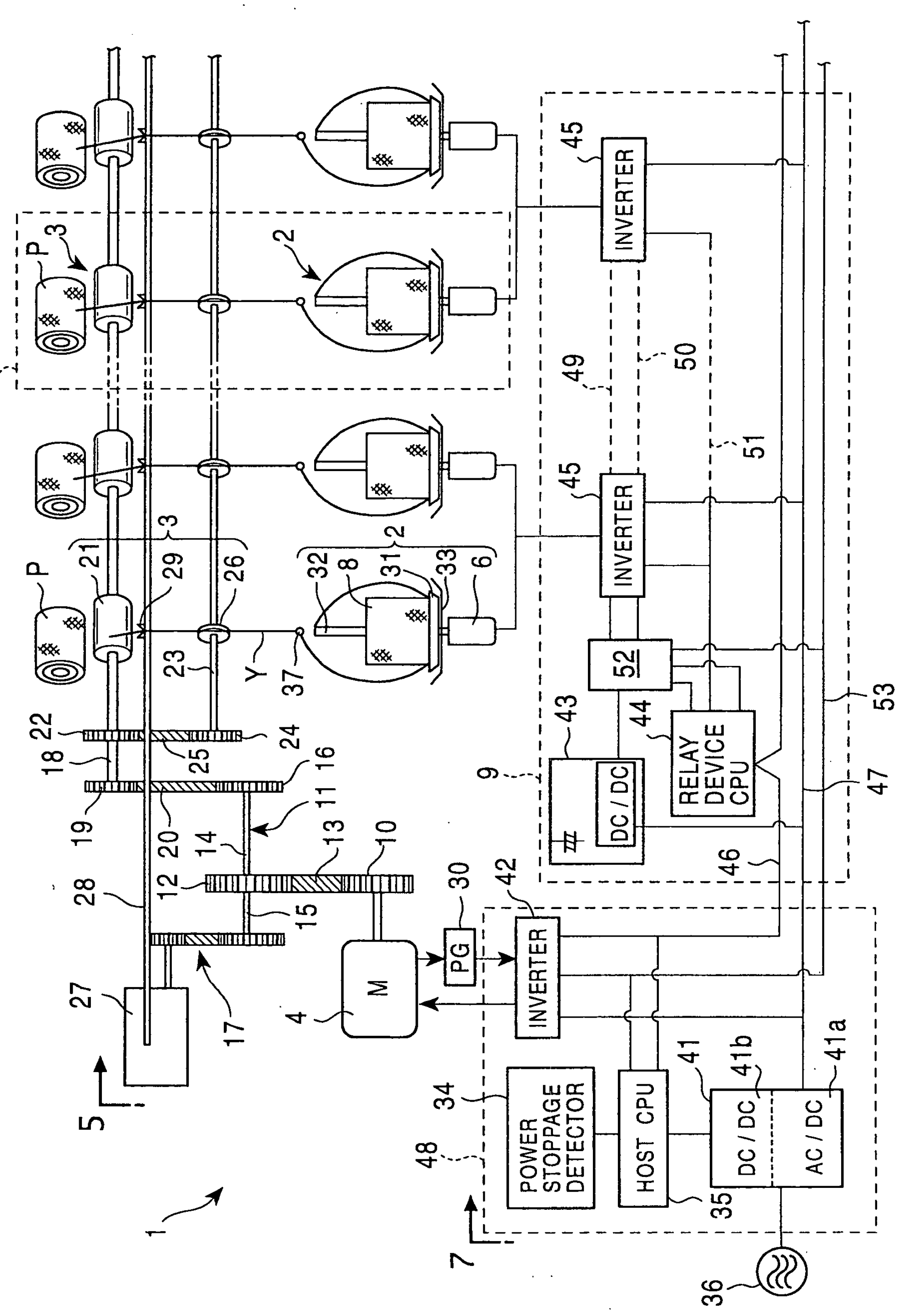

INVERTER
INVERTER
INVERTER
RELAY DEVICE CPU
DC / DC
HOST CPU
POWER STOPPAGE DETECTOR
DC / DC
AC / DC
PG
M

FIG. 2

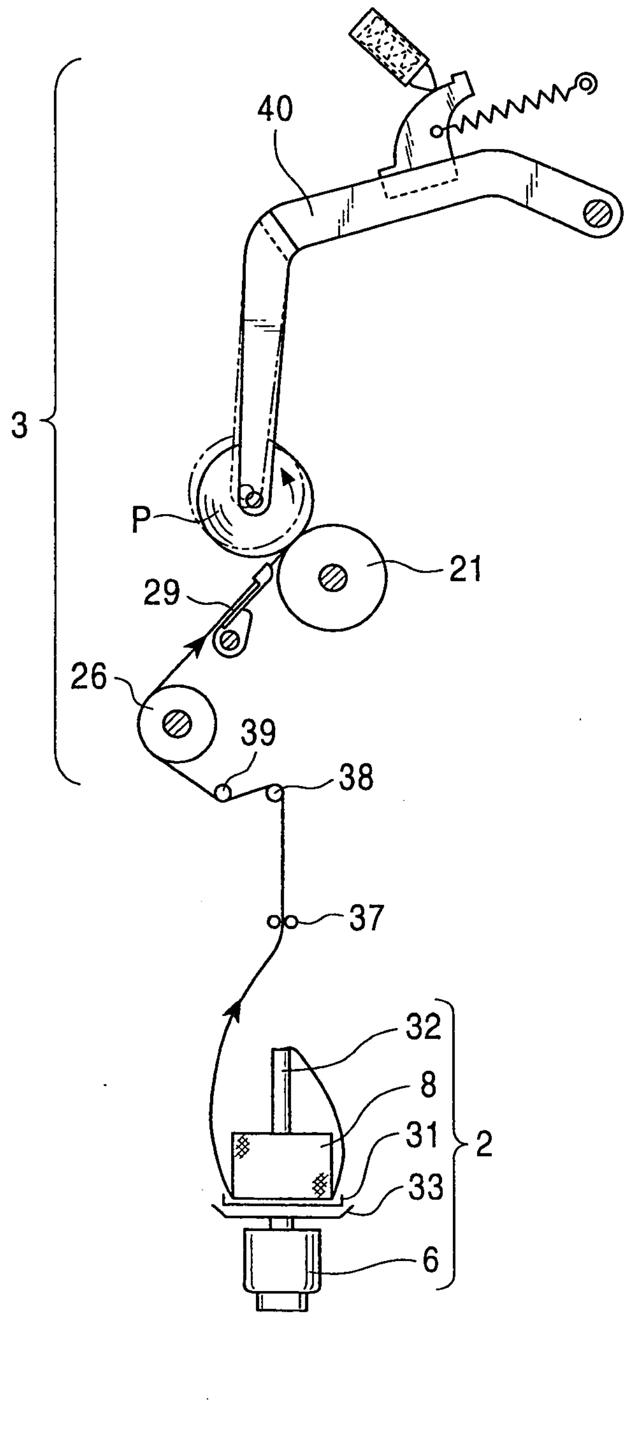


FIG. 3

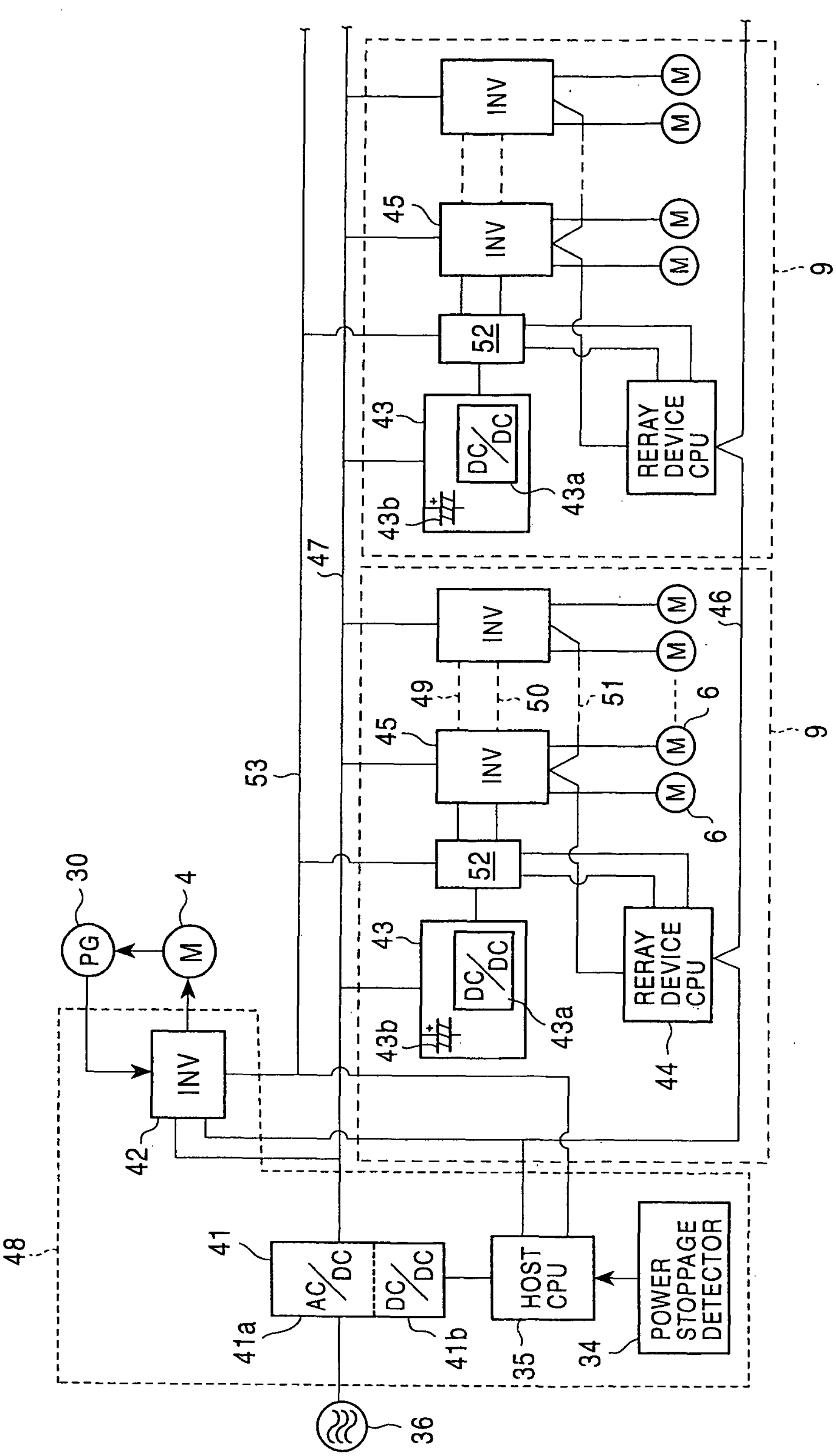

INV
M
PG
AC/DC
DC/DC
HOST CPU
POWER STOPPAGE DETECTOR
RERAY DEVICE CPU
52
30
4
42
48
41
41a
41b
35
34
36
43
43a
43b
44
45
46
47
49
50
51
53
6
9

FIG. 4

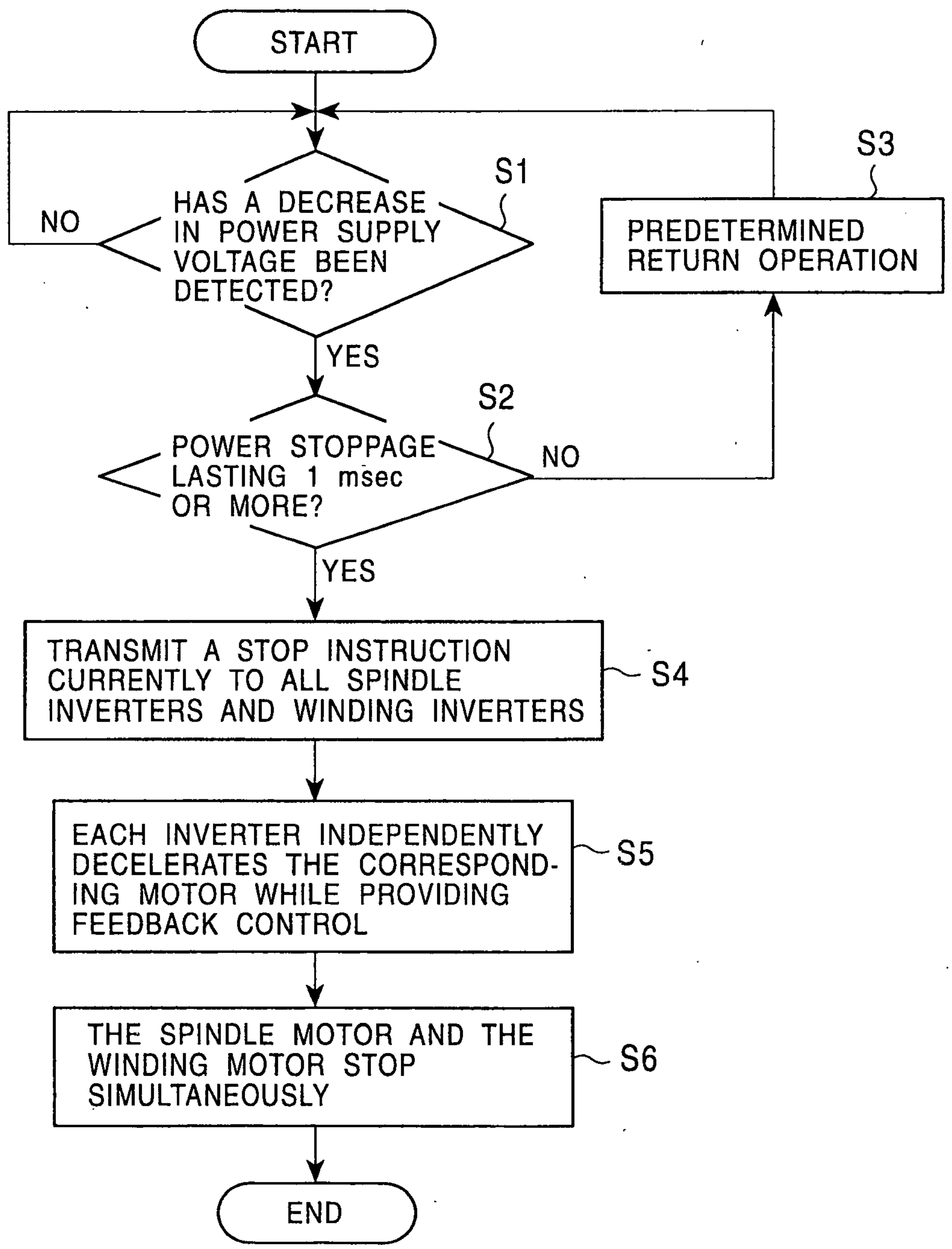
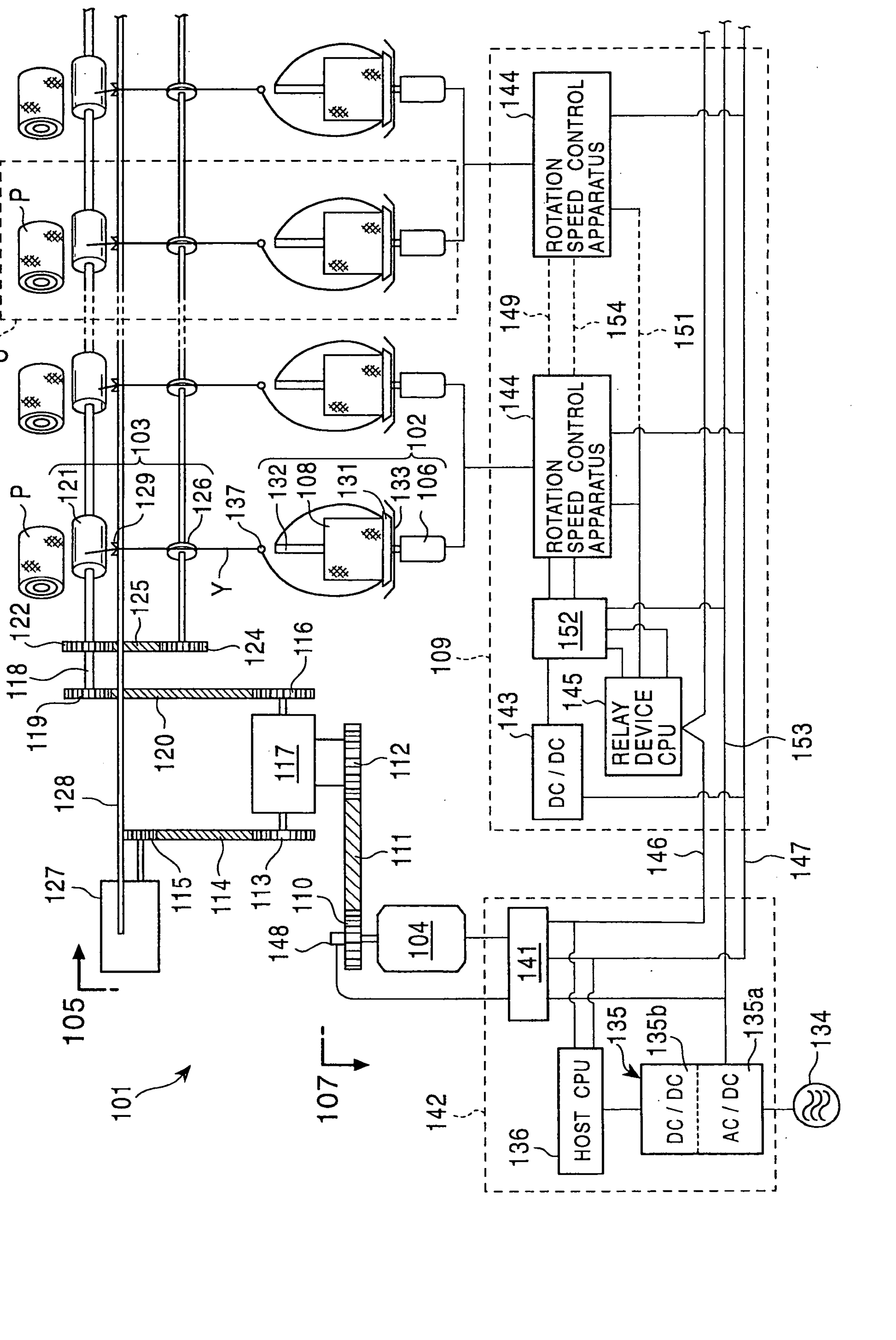

START
HAS A DECREASE IN POWER SUPPLY VOLTAGE BEEN DETECTED?
S1
NO
YES
POWER STOPPAGE LASTING 1 msec OR MORE?
S2
NO
YES
PREDETERMINED RETURN OPERATION
S3
TRANSMIT A STOP INSTRUCTION CURRENTLY TO ALL SPINDLE INVERTERS AND WINDING INVERTERS
S4
EACH INVERTER INDEPENDENTLY DECELERATES THE CORRESPONDING MOTOR WHILE PROVIDING FEEDBACK CONTROL
S5
THE SPINDLE MOTOR AND THE WINDING MOTOR STOP SIMULTANEOUSLY
S6
END

FIG. 5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ROTATION SPEED CONTROL APPARATUS
DC / DC
RELAY DEVICE CPU
HOST CPU
DC / DC
AC / DC
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102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
124
125
126
127
128
129
131
132
133
134
135
135a
135b
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FIG. 6

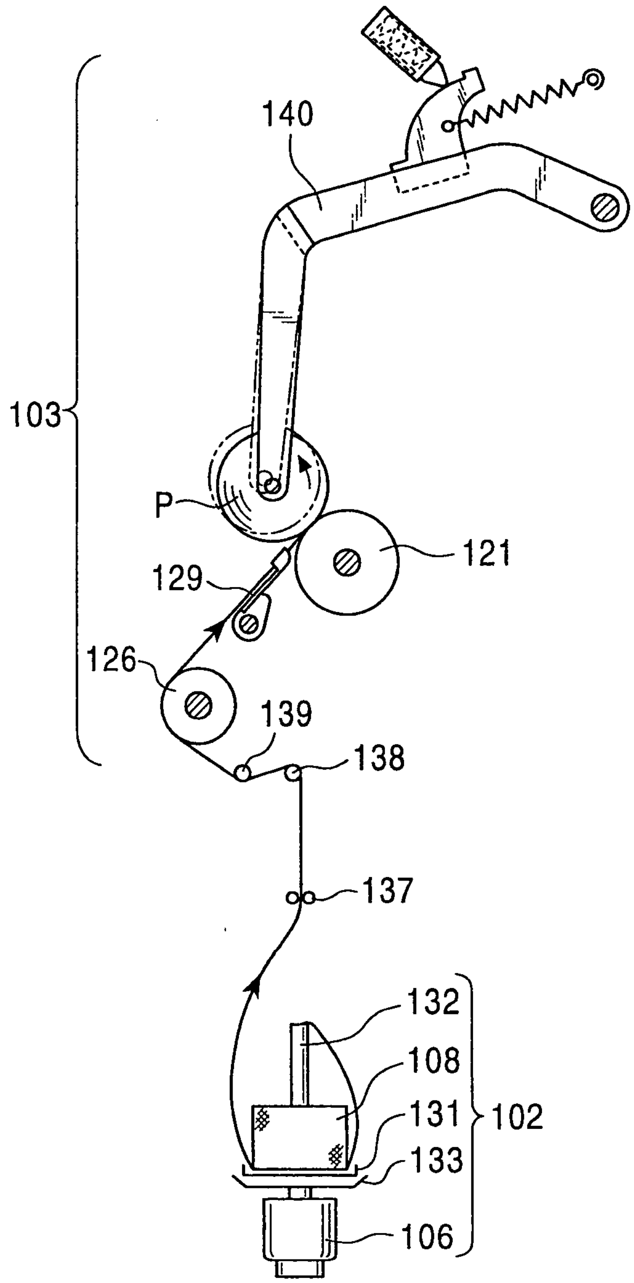


FIG. 7

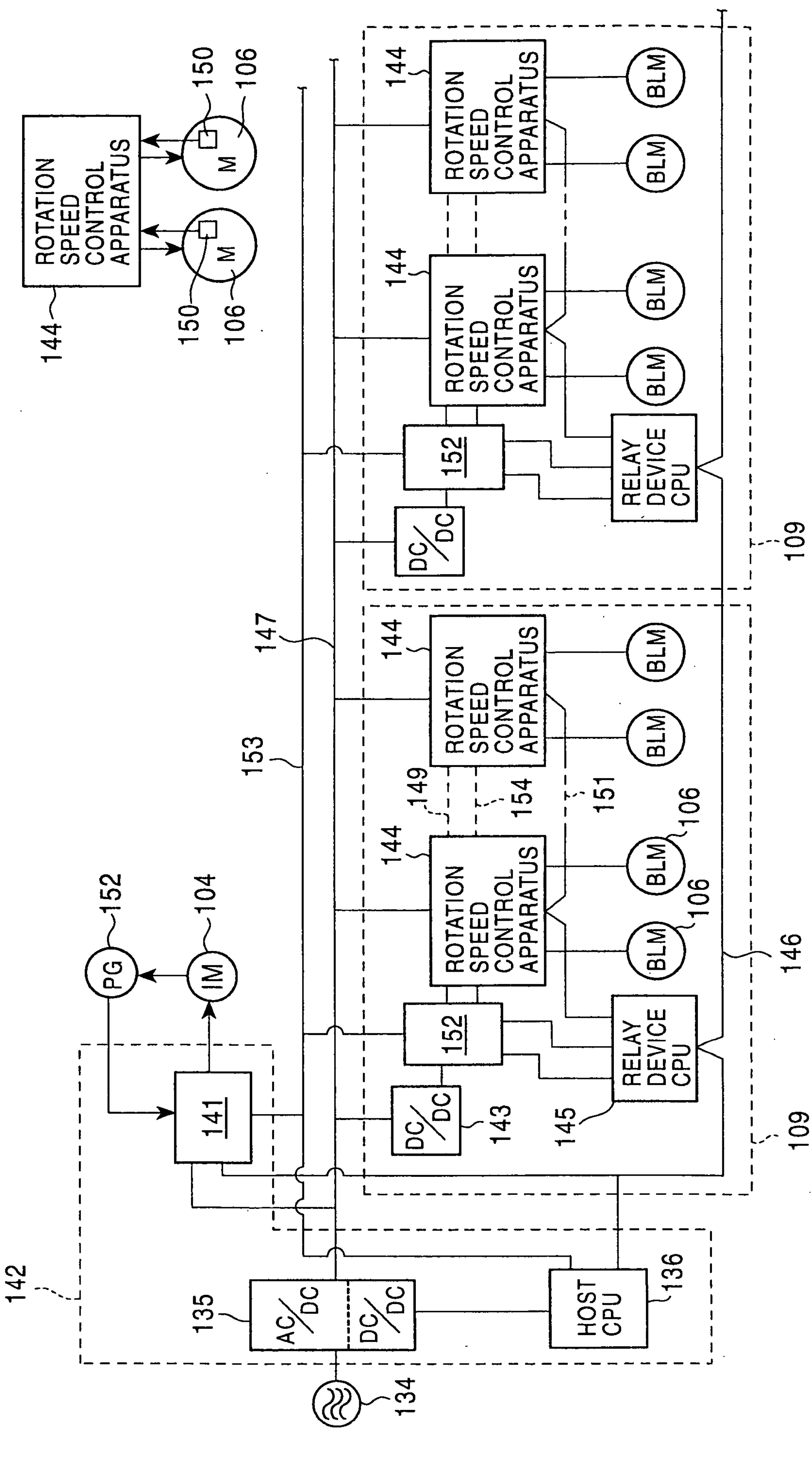
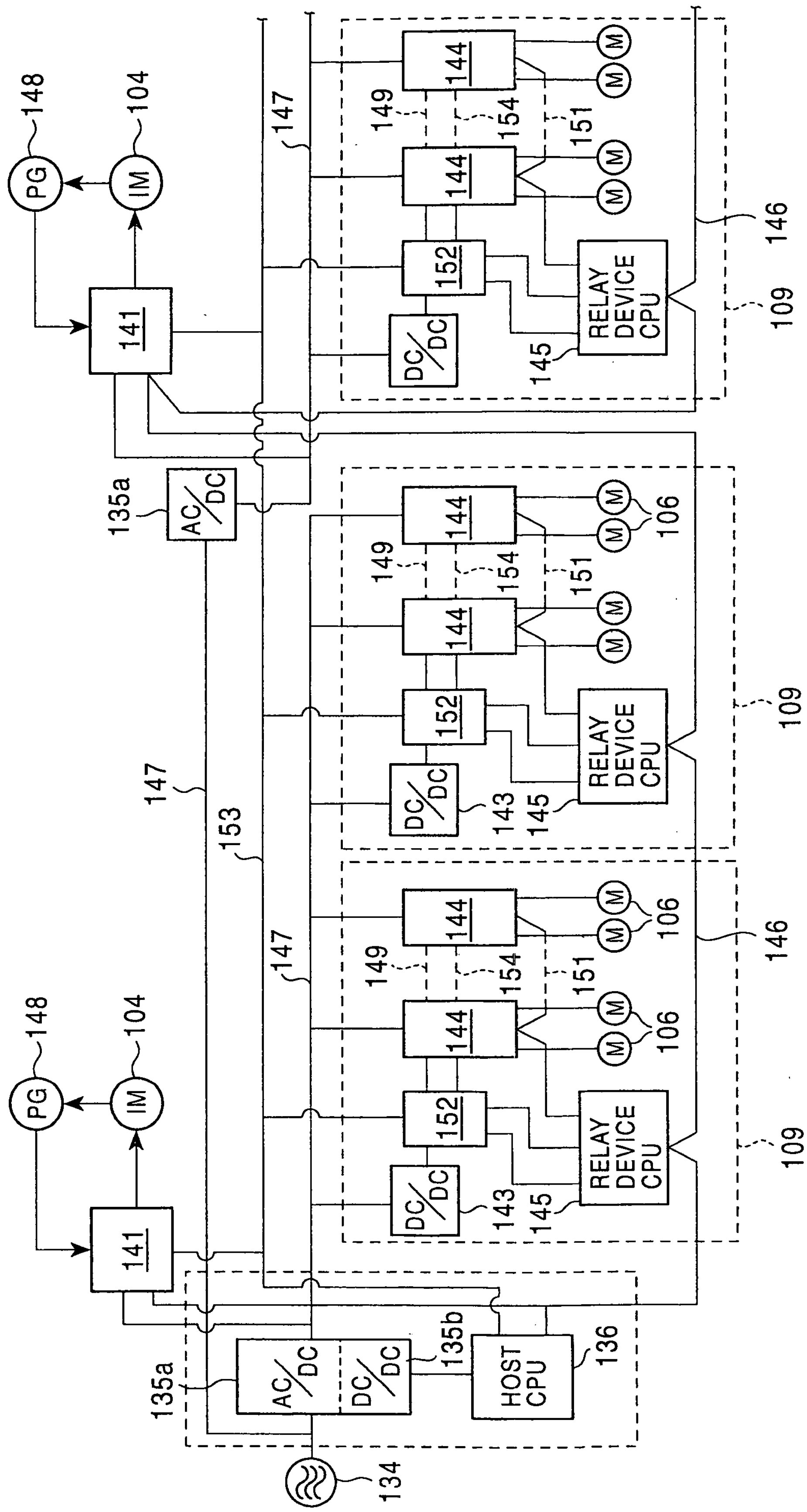

ROTATION SPEED CONTROL APPARATUS
144
150
106
M
152
PG
IM
104
141
142
147
153
152
DC/DC
143
RELAY DEVICE CPU
145
BLM
149
154
151
146
109
AC/DC
DC/DC
135
HOST CPU
136
134

FIG. 8


PG
IM
148
104
141
135a
AC/DC
DC/DC
135b
HOST CPU
136
134
147
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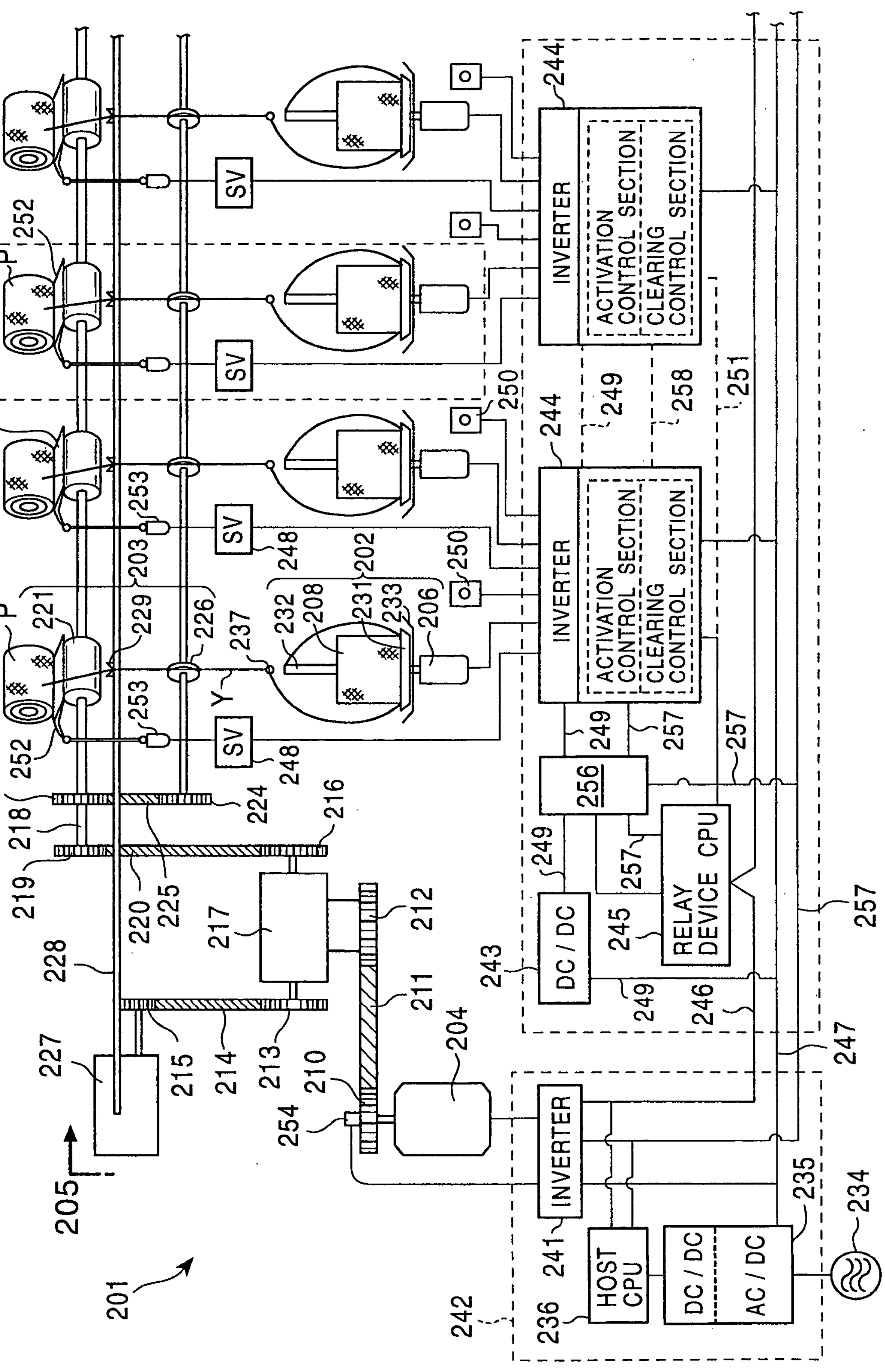
DC/DC
152
144
RELAY DEVICE CPU
143
145
149
154
151
106
146
109
M

FIG. 9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CLEARING CONTROL SECTION
INVERTER
ACTIVATION CONTROL SECTION
CLEARING CONTROL SECTION
SV
SV
SV
SV
DC / DC
256
RELAY DEVICE CPU
INVERTER
HOST CPU
DC / DC
AC / DC
P
P
U
Y
201
205
242
236
241
235
234

FIG. 10

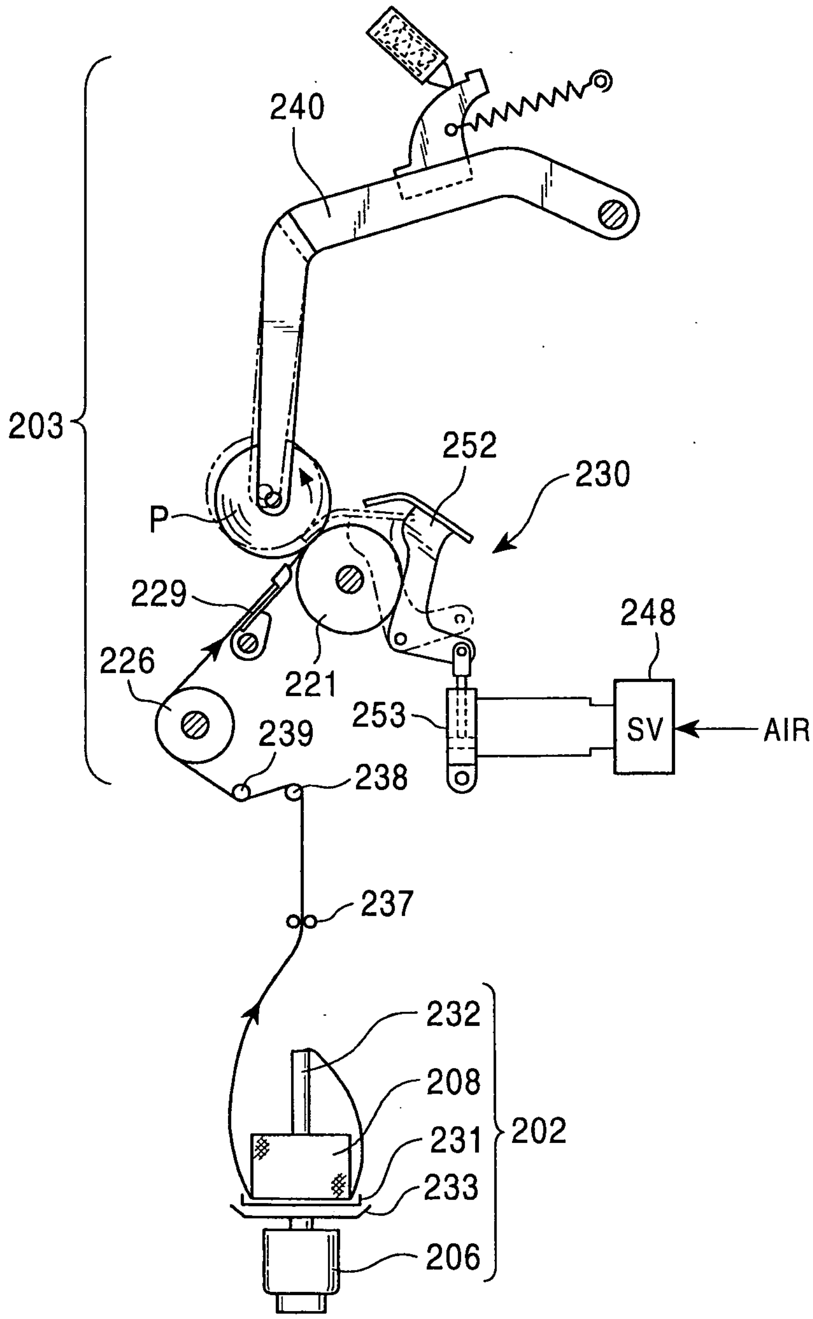

240
203
252
230
P
229
248
226
221
253
SV
AIR
239
238
237
232
208
231
202
233
206

FIG. 11

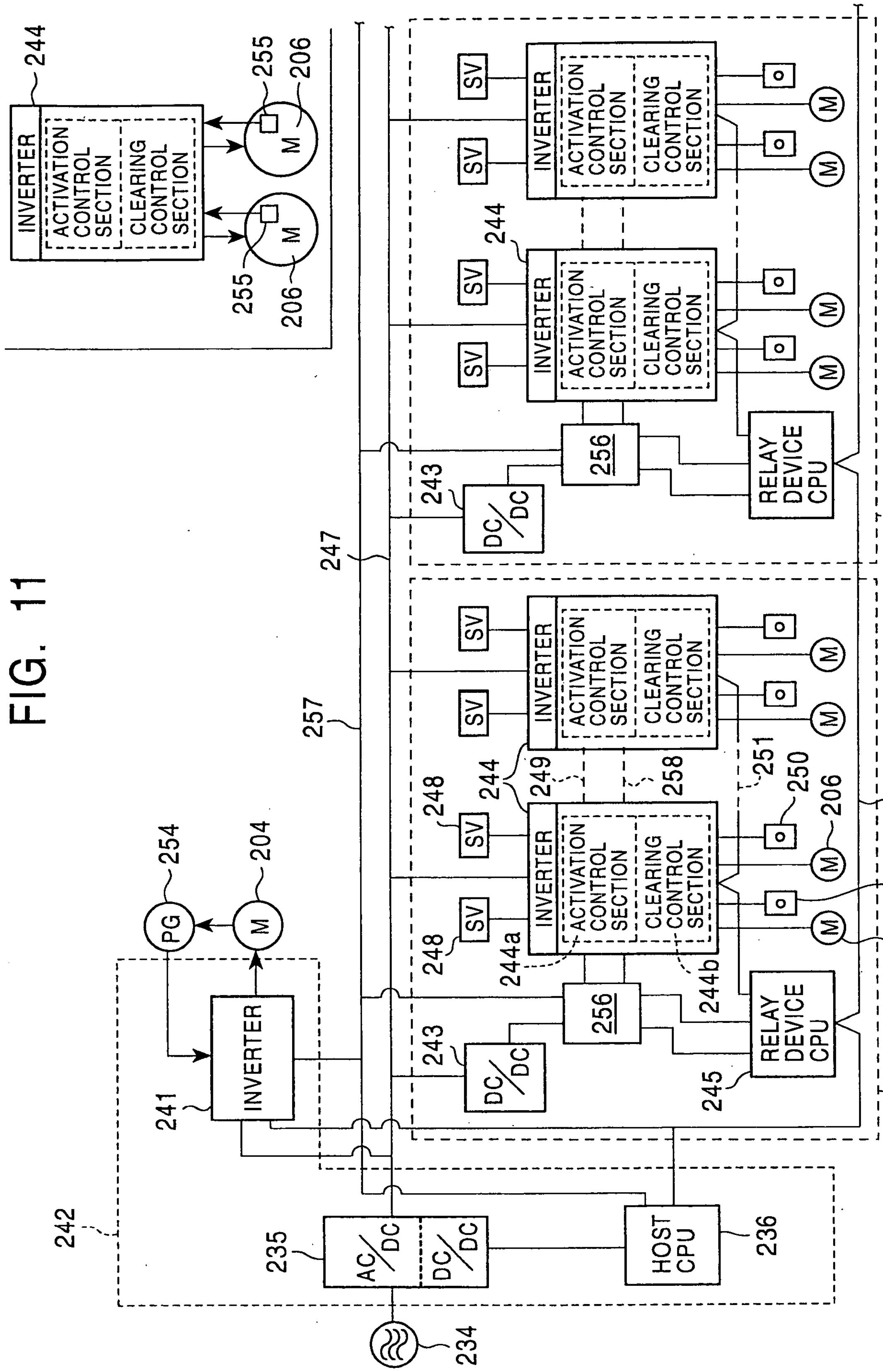

INVERTER
ACTIVATION CONTROL SECTION
CLEARING CONTROL SECTION
244
255
206
M
SV
PG
254
204
241
242
AC/DC
DC/DC
235
234
HOST CPU
236
243
256
RELAY DEVICE CPU
245
209
246
247
257
248
244a
244b
249
258
251
250

FIG. 12

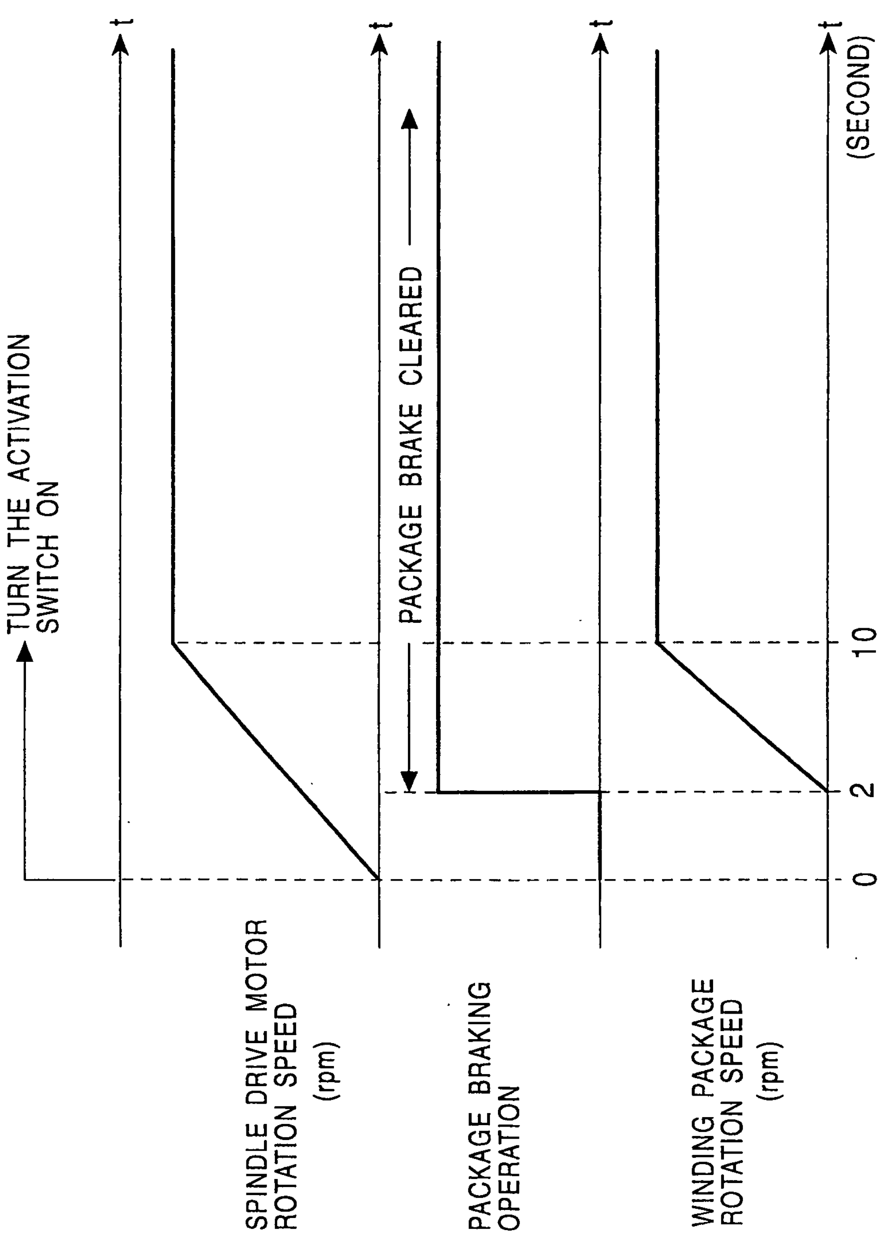
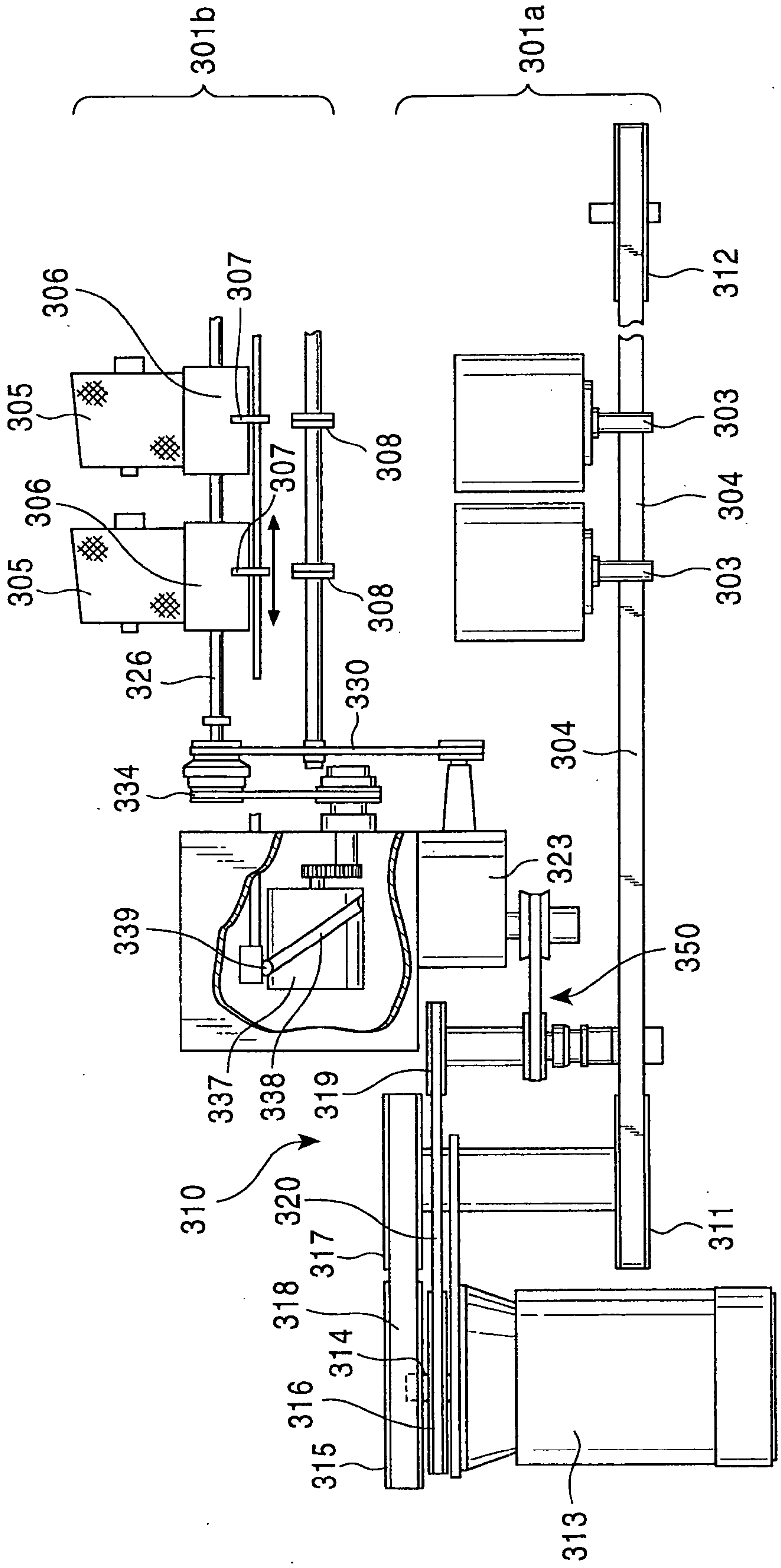

TURN THE ACTIVATION SWITCH ON
SPINDLE DRIVE MOTOR ROTATION SPEED (rpm)
PACKAGE BRAKING OPERATION
PACKAGE BRAKE CLEARED
WINDING PACKAGE ROTATION SPEED (rpm)
t
t
t
t
0
2
10
(SECOND)

FIG. 13


301b
301a
306
307
305
306
307
305
308
308
326
330
334
339
337
338
319
310
320
317
318
314
316
315
312
303
304
303
304
323
350
311
313

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 01 2083

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 97/05310 A (REEL SRL ; BERTOTTO EZIO (IT)) 13 February 1997 (1997-02-13) * page 3, line 27 - page 7, line 19; figures 1,2 * -----	1-4	D01H1/32
A	US 5 113 123 A (ERNI MARKUS ET AL) 12 May 1992 (1992-05-12) * column 4, line 67 - column 5, line 60; figure 1 * -----	1-4	
A	DE 195 09 658 A (LENZE GMBH & CO KG AERZEN) 26 September 1996 (1996-09-26) * column 3, line 4 - page 1, line 36 * -----	1-4	
A	US 5 224 331 A (STRAUB ALBERT ET AL) 6 July 1993 (1993-07-06) * column 5, line 4 - line 62; figure 3 * -----	1-4	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 July 2004	Henningsen, O

CATEGORY OF CITED DOCUMENTS

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