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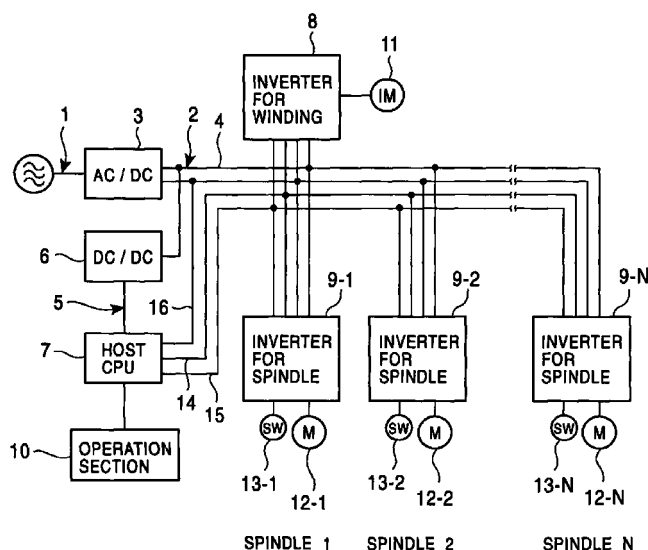
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(54) **Motor driving system**

(57) To provide a motor driving system that does not require a backup power supply apparatus. A motor driving system for converting an alternating current power supply (1) into a direct current power supply (2) and using the direct current power supply (2) to drive motors (11) and (12) by rotation-speed-controlling apparatuses

(8) and (9), wherein the direct current power supply (2) supplies controlling power via a DC/DC converter (6) to external equipment (7) different from the rotation-speed-controlling apparatus.

FIG. 1



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Description

Field of the Invention

[0001] The present invention relates to a computer-controlled motor driving system, and in particular, to a motor driving system that does not require a backup power supply apparatus.

Background of the Invention

[0002] To drive rotating systems in a machine such as a textile machine, a computerized motor driving system is used in which a switching regulator is connected to an alternating current power supply, and uses a direct current power supply by means of the switching regulator for a computer that provides control instructions to rotation-speed-controlling apparatuses for driving motor. If the power interruption occurs due to an instantaneous power stoppage or a power stoppage, the computer is stopped, and the rotation-speed-controlling apparatuses becomes uncontrollable, and the rotating systems rotate for a while due to inertia. In some cases, control may not be recovered despite the successful recovery of the power supply after the instantaneous power stoppage. In addition, in a machine in which several different rotation systems are employed together for operation, the rotation quantity after the power interruption varies due to the difference in inertia among the rotating systems, resulting in inconvenience. Thus, a computer-controlled motor driving system requires a means of compensation for an instantaneous power stoppage or a power stoppage.

[0003] In general, an instantaneous power stoppage is defined as a power interruption that lasts 0.5 to 1 cycle (10 to 20 millisecond), and a power stoppage is defined as a longer power interruption. Textile machines, however, require compensation for a power interruption that lasts 0.5 to 1 second. Therefore, such a relatively long power interruption is also hereafter referred to as an "instantaneous power stoppage", while a much longer power interruption is referred to as a "power stoppage".

[0004] An instantaneous power stoppage compensation in a conventional motor driving system is done by adding an uninterruptible power supply and a switching regulator to an alternating current power supply or by adding a battery to a direct current power supply side in order to back up the power supply of a computer and a motor during the instantaneous power stoppage. During this backup period, the computer judges the power stoppage in order to control and to decelerate the rotating systems or to synchronously decelerate the several rotating systems.

[0005] A conventional motor driving system requires a backup power supply apparatus such as an uninterruptible power supply or a battery for an instantaneous power stoppage compensation or a power stoppage

compensation. However, when the backup power supply is provided to compensate for the instantaneous power stoppage or the power stoppage, costs increase because the instantaneous power stoppage or the power stoppage does not occur frequently.

[0006] It is thus an object of the present invention to solve this problem in order to provide a motor driving system that does not require a backup power supply apparatus.

Summary of the Invention

[0007] To achieve this object, the present invention provides a motor driving system for converting an alternating current power supply into a direct current power supply and using the direct current power supply to drive a motor by a rotation-speed-controlling apparatus, wherein a power supply for control is supplied, via a direct current/direct current (DC/DC) converter, from the direct current power supply to an external equipment different from the rotation-speed-controlling apparatus.

[0008] The motor driving system may comprise a power interruption detection means for detecting that the alternating current power supply has been interrupted so that when a power interruption is detected, the motor is decelerated to regenerate electric power for the direct current power supply.

[0009] A plurality of rotation-speed-controlling apparatuses may be connected to a common direct current power supply bus that supplies the direct current power supply, and the external equipment may be a central controlling apparatus connected to a plurality of rotation-speed-controlling apparatuses via a communication bus to continually obtain and monitor the states of the motors from the rotation-speed-controlling apparatuses.

[0010] The external equipment may be an operation signal sending apparatus for continually sending out an operation signal to the rotation-speed-controlling apparatus while the motor is operating.

[0011] The external equipment may be a speed instruction signal sending apparatus for continually obtaining the detected rotation speed of the motor to calculate a speed instruction value and continually sending out a speed instruction signal to the rotation-speed-controlling apparatus.

Brief Description of the Drawing

[0012]

Figure 1 is a circuit diagram of a motor driving system applied to a double twister showing a first embodiment of the present invention.

Figure 2 is an internal configuration diagram of the rotation-speed-controlling apparatus in Figure 1.

Figure 3 is a temporal waveform diagram showing the operation of each section in Figure 1.

Figure 4 is a circuit diagram of a motor driving system applied to a take-up winding system with godet rollers showing a second embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0013] A first embodiment of the present invention will be described below with reference to the accompanying drawings.

[0014] A motor driving system according to the present invention is applied to a multiple twister such as a double twister. The double twister has a plurality of spindles, each of which rotates to twist a yarn on a yarn path while winding it. Each spindle that twists the yarn is rotationally driven by a separate brushless motor. A winding drum for winding a yarn is driven by an induction motor common to a plurality of spindles. A rotating system for the winding drum driven by the induction motor has a relatively low inertia, and a rotating system for the spindle driven by a brushless motor has a high rotation speed and a relatively high inertia.

[0015] As shown in Figure 1, a motor driving system in a double twister comprises an alternating current/direct current (AC/DC) converter 3 for converting a three-phase alternating current power supply 1 into a high-voltage direct current power supply for a motor, a direct current power supply bus 4 for distributing the high-voltage direct current power supply 2, a direct current/direct current (DC/DC) converter 6 for converting the high-voltage direct current power supply 2 from the direct current power supply bus 4 into a low-voltage direct current power supply 5 for an electronic circuit, a central controlling apparatus 7 composed of an electronic circuit, a winding rotation-speed controlling apparatus 8 connected to the direct current power supply bus 4, and spindle rotation-speed controlling apparatuses 9 (9-1, 9-2, ..., 9-N) connected to the direct current power supply bus 4. The rotation-speed-controlling apparatuses 8 and 9, which constitute a motor-driving-controlling apparatus, can convert a direct current power supply on the direct current power supply bus 4 into a motor driving signal of an appropriate frequency to drive the motor at a desired rotation speed. 10 is an operation section for setting parameters sent to each rotation-speed-controlling apparatus via a communication bus 14 described below. An induction motor 11 having its rotating shaft connected to winding drums of the plurality of spindles is connected to the winding rotation-speed-controlling apparatus 8, and a brushless motor 12 (12-1, 12-2, ..., 12-N) connecting the respective spindles is connected to the spindle rotation-speed-controlling apparatuses 9-1, 9-2, ..., 9-N. The brushless motor 12 comprises a sensor for a rotor and uses this sensor to detect or control the rotation speed. The spindle rotation-speed-controlling apparatus 9 has a manual switch SW 13 (13-1, 13-2, ..., 13-N) to enable arbitrary driving or stoppage during operation.

[0016] In addition, the central controlling apparatus 7 and the rotation-speed-controlling apparatuses 8 and 9 are connected together using the communication bus 14 and a control bus 15. The control bus 15 concurrently transmits an operation start or stop instruction from the central controlling apparatus 7 to each rotation-speed-controlling apparatus 8 and 9. The communication bus 14 transmits parameters such as the rotation speed and an acceleration time from the central controlling apparatus 7 to each rotation-speed-controlling apparatus 8 and 9 at the time of initial setting, and transmits state values such as a constant rotation speed and a motor current value from the each rotation-speed-controlling apparatus 8 and 9 to the central controlling apparatus 7.

[0017] The AC/DC converter 3 has a built-in power interruption detection means for determining power interruption when the alternating current power supply 1 decreases to a predetermined voltage, and a power interruption detection signal line 16, which transmits a power interruption detection signal, is connected to the central controlling apparatus 7 and the rotation-speed-controlling apparatuses 8 and 9. Upon receiving the power interruption detection signal, the rotation-speed-controlling apparatus 8 and 9 controls the motor in order to decelerate it by a predetermined value.

[0018] Figure 2 shows the internal configuration of the rotation-speed-controlling apparatus. The rotation-speed-controlling apparatus controls the driving of a three-phase brushless motor 21, and comprises a stabilizing capacitor 22 provided between the input ends (a) and (b) of the direct current power supply, a transistor 23 that individually induces each phase coil of the motor 21 to a high electric potential or a low electric potential and applies a current, a flywheel diode 24 provided in parallel with the transistor 23 and in the opposite direction, a current sensor CT 25 for detecting the current value of the motor 21, a Hall sensor 26 for detecting the position of a rotor as a permanent-magnet of the motor 21, a central processing unit (CPU) 27 that controls the entire rotation-speed-controlling apparatus, and a non-volatile memory E²PROM 28 that stores various setting values. The CPU 27 has an input port that obtains data from the Hall sensor 26 and the current sensor 25, an output port that outputs a switching signal to each transistor 23, and a communication port connected to the power interruption detection signal line, the communication bus and the control bus. The CPU 27 and the memory 28 constitute a controlling circuit for switching the transistors 23 in order to supply a controlling voltage from the direct current power supply bus 4 via a DC/DC converter, which is not shown in this controlling circuit.

[0019] The operation of the motor driving system in Figure 1 will be described with reference to Figure 3.

[0020] While the alternating current power supply 1 is operating normally, the AC/DC converter 3 functions to correctly provide the high-voltage direct current power supply 2 to the direct current power supply bus 4. The

DC/DC converter 6 functions to correctly provide the low-voltage direct current power supply 5 to the central controlling apparatus 7 (Figure 3; normal operation 31). In this case, the winding rotation-speed-controlling apparatus 8 rotates the induction motor 11 at a predetermined rotation speed to rotate the plurality of winding drums connected to the rotating shaft. On the other hand, the rotation-speed-controlling apparatus 9-1, 9-2, ..., 9-N for each spindle rotates the brushless motor 12-1, 12-2, ..., 12-N at a required rotation speed to rotate each spindle. Thus, each spindle can twist a yarn on a yarn path while winding the yarn.

[0021] In addition, while the alternating current power supply 1 is operating normally, the central controlling apparatus 7 notifies the rotation-speed-controlling apparatuses 8 and 9 of the deceleration degree of the induction motor 11 and brushless motor 12 during a power interruption via the communication bus 14, and upon receiving this notification, the rotation-speed-controlling apparatuses 8 and 9 set rates of deceleration control.

[0022] When the alternating current power supply is interrupted or decreases to a predetermined voltage (Figure 3; power supply interruption 32), the power interruption detection means immediately outputs a power interruption detection signal 16. Upon receiving the power interruption detection signal 16, the spindle rotation-speed-controlling apparatus 9 immediately starts deceleration control at the set rate. This operation decelerates the brushless motor 12. This deceleration degree (Figure 3; 33) is larger than the deceleration degree caused by inertia rotations while the rotation-speed-controlling apparatuses are providing no control, so the spindle rotating systems are braked. This braking energy is converted into electric energy using the brushless motor 12 as a generator and this electric energy is regenerated as a high-voltage direct current power supply via the flywheel diode 24.

[0023] As shown in Figure 3, the high-voltage direct current power supply obtains the regenerated power from the spindle rotating system to maintain a voltage despite a decrease in the voltage of the alternating current power supply. The spindle rotating systems have a relatively large inertia and rotate at a high speed, for example, 20,000 rpm, and the number of spindle is large. Thus, the sufficient regenerated power can be obtained from the spindle rotating system. Accordingly, the voltage of the low-voltage direct current power supply for the electronic circuit is maintained in the DC/DC converter 6 to which high-voltage direct current power is supplied. Consequently, the central controlling apparatus 7 can continue operations such as the monitoring of the motor state.

[0024] On the other hand, due to the relatively low inertia of the winding-drum rotating systems, the rotation speed of the winding induction motor 11 rapidly decreases if the rotation-speed-controlling apparatuses stop providing control. This causes the spindle to exces-

sively twist the yarn that has not been wound around the winding drum, resulting in yarn breakage. However, as mentioned above, both the high-voltage direct current power supply and the low-voltage direct current power supply are maintained, so upon receiving a power interruption detection signal, the winding rotation-speed-controlling apparatus 8 starts to control deceleration at the set rate. This operation causes the induction motor 11 to decelerate in a controlled manner. This deceleration degree (Figure 3; 34) can be made lower than the deceleration caused by the inertia and, in this case, is synchronously set so as to match the twisting speed of the spindle and the yarn speed of the winding drum. Subsequently, the spindle rotating systems stop and after a while, the high-voltage direct current power supply stops. In the meantime, however, the spindle rotating system and the winding drum rotating system synchronously decelerate to avoid excessive twisting of the yarn in order to prevent yarn breakage.

[0025] If, for example, the power supply voltage is not recovered 1 second after the interruption, the system recognizes this situation as a complete power stoppage and stops, whereas if the power supply voltage is recovered within 1 second, normal motor driving is resumed. According to this embodiment, the controlling power supply for the central controlling apparatus 7 is supplied through the direct current power supply bus 4 via the DC/DC converter 6, thereby enabling the motor state value to be continuously monitored during an instantaneous power stoppage.

[0026] Even if an instantaneous power stoppage occurs, the present configuration can provide the controlling power supply for the external equipment, including not only the rotation-speed-controlling apparatus but also an apparatus for continually obtaining a motor state signal (a rotation-speed-signal and so on) from the rotation-speed-controlling apparatus for monitoring or continually sending out an operation signal or a speed instruction signal that is essential for normally operating the rotation-speed-controlling apparatus, without the use of a backup power supply. The rotation-speed-controlling apparatus includes at least an inverter section for converting direct current into alternating current, and a controlling circuit for switching a switching element in the inverter section.

[0027] In addition, since the motor is controlled to decelerate to regenerate power for the direct current power supply when a power interruption is detected, an instantaneous power stoppage lasting 0.5 to 1 second can be compensated for without the need to increase the size of the AC/DC converter.

[0028] Next, a second embodiment of the present invention will be described in detail with reference to the drawings.

[0029] In this case, the motor driving system according to the present invention is applied to a take-up winding system with godet rollers. This system has a plurality of spindles that each wind a yarn while godet

rollers each draw the yarn on a yarn path. Each godet roller applies a predetermined tension to the yarn based on the rotation speed ratio of the plurality of rollers around which the yarn is wound and feeds the yarn. A heater may be built into the godet roller to heat the wound yarn.

[0030] As shown in Figure 4, the motor driving system in the take-up winding system with godet rollers is provided for each of a godet roller (GR) control board 40 for controlling the godet rollers and a winder control board 50. The GR control board 40 has rotation-speed-controlling apparatuses 41 and 42 for controlling the driving of motors 45 and 46 for a first roller and a second roller using a three-phase alternating current power supply 60 as an input, a sequencer PLC (an operation signal sending apparatus) 43 that continually sends out an operation signal to each of the rotation-speed-controlling apparatuses 41 and 42 via an operation signal line 61, and a DC/DC converter 44 that converts a direct current power supply obtained from an AC/DC conversion section 42a in the rotation-speed-controlling apparatus 42 into a direct current power supply for an electronic circuit. An AC/DC conversion section 41a is provided in the rotation-speed-controlling apparatus 41.

[0031] The winder control board 50 has a rotation-speed-controlling apparatus 51 for individually controlling the driving of four motors using the three-phase alternating current power supply 60 as an input, a sequencer PLC 52 that executes alarm processing and that controls the driving of winders, a speed controlling apparatus (a speed instruction signal sending apparatus) 53 for continually sending out a speed instruction signal to the rotation-speed-controlling apparatus 51 via a speed instruction signal line 63, and a DC/DC converter 54 that converts a high-voltage direct current power supply obtained from an AC/DC conversion section 51a in the rotation-speed-controlling apparatus into a direct current power supply for electronic circuits of the sequencer PLC 52 and speed controlling apparatus 53. The four motors comprise a traverse motor 55, a touch roller driving motor 56, and spindle motors 57 and 58. Each motor has a rotation speed sensor 59, and a signal of the rotation speed sensor 59 is input to the speed controlling apparatus 53.

[0032] The PLCs 43 and 52 are connected together using an alarm signal/driving stop signal line 62.

[0033] The normal operation of the motor driving system will be described. A voltage from the three-phase alternating current power supply 60 is supplied to each of the rotation-speed-controlling apparatuses 41, 42 and 51. The rotation-speed-controlling apparatuses 41, 42 and 51 have built-in AC/DC conversion sections 41a, 42a and 51a, respectively, and also have built-in DC/DC converters that convert an AC/DC-converted high-voltage direct current power supply into a controlling low-voltage direct current power supply. The controlling low-voltage direct current power supply drives internal control circuits (used for switching). Based on a signal from

the rotation speed sensor 59 provided for each motor, the speed controlling apparatus 53 detects the rotation speed of each motor and compares it with a predetermined target value to calculate a speed instruction value. The speed controlling apparatus 53 continually sends out a speed instruction signal to the rotation-speed-controlling apparatus 51 via the speed instruction signal line 63. Although in the example in Figure 4, the rotation-speed-controlling apparatuses 41, 42 and 51 have the built-in AC/DC conversion sections 41a, 42a and 51a, all of the rotation-speed-controlling apparatuses 41, 42 and 51 may be connected to a direct current bus of the single AC/DC conversion section.

[0034] On the other hand, the rotation-speed-controlling apparatuses 41, 42 and 51 each have a built-in power interruption detection means to continually monitor for power interruption. Alternatively, power interruption may be detected at one of the power interruption means so that the power interruption detection signal is transmitted to each of the rotation-speed-controlling apparatuses 41, 42 and 51. Next, the operation performed when a power interruption is detected will be explained.

[0035] The motor driving system continues the winding operation in the event of an instantaneous power stoppage, and stops the operation in the event of a power stoppage. First, in the case of an instantaneous power stoppage, when the alternating current power supply is interrupted or decreases to a predetermined voltage, a power interruption detection means built into each of the rotation-speed-controlling apparatuses 41, 42 and 51 detects this condition in order to decelerate each motor to a rotation speed lower than the normal value and continues the operation. If the alternating current power supply is recovered within 1 second of example, the motor driving system makes the rotation speed return to the normal value and continues the operation. If the power is not recovered, the entire system remains stopped. Since each motor is decelerated to regenerate power for the direct current power supply when a power interruption is detected as described above, a power stoppage compensation for 0.5 to 1 second can be done without the need to increase the size of the AC/DC conversion section. Since the GR control board 40 and the winder control board 50 cause the motors to synchronously decelerate, the tension applied to the yarn is maintained at an appropriate value even during an instantaneous power stoppage. In addition, each motor is decelerated to regenerate energy for the AC/DC conversion sections 42a and 51a in the rotation-speed-controlling apparatuses. Thus, the sequencers 43 and 52 obtain sufficient electric power to continue operations.

[0036] According to this embodiment, even in the event of an instantaneous power stoppage, the speed controlling apparatus 53 can continue to calculate a speed instruction value and to send the speed instruction signal to the rotation-speed-controlling apparatus 51. The sequencer 52 can also continue the alarm

processing or the control of winder operations.

[0037] The present invention provides the following beneficial effects.

[0038] An instantaneous power stoppage compensation or a power stoppage compensation can be done 5 without the use of a backup power supply apparatus.

[0039] The textile machine can decelerate the rotating systems in a controlled manner after a power interruption, thereby preventing yarn breakage.

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Claims

1. A motor driving system for converting an alternating current power supply into a direct current power supply and using the direct current power supply to drive a motor by a rotation-speed-controlling apparatus, characterized in that a power supply for control is supplied, via a DC/DC converter, from said direct current power supply to an external equipment different from said rotation-speed-controlling apparatus. 15 20
2. A motor driving system according to Claim 1 characterized in that the system comprises a power interruption detection means for detecting that said alternating current power supply has been interrupted so that when a power interruption is detected, said motors are decelerated to regenerate electric power for said direct current power supply. 25 30
3. A motor driving system according to Claim 1 characterized in that a plurality of rotation-speed-controlling apparatuses are connected to a common direct current power supply bus that supplies said direct current power supply, and in that said external equipment is a central controlling apparatus connected to a plurality of rotation-speed-controlling apparatuses via a communication bus to continually obtain and monitor the states of the motors from the rotation-speed-controlling apparatuses. 35 40
4. A motor driving system according to Claim 1 characterized in that said external equipment is an operation signal sending apparatus for continually sending an operation signal to said rotation-speed-controlling apparatuses while the motor is operating. 45
5. A motor driving system according to Claim 1 characterized in that said external equipment is a speed instruction signal sending apparatus for continually obtaining the detected rotation speed of the motor to calculate a speed instruction value and continually sending a speed instruction signal to said rotation-speed-controlling apparatus. 50 55

FIG. 1

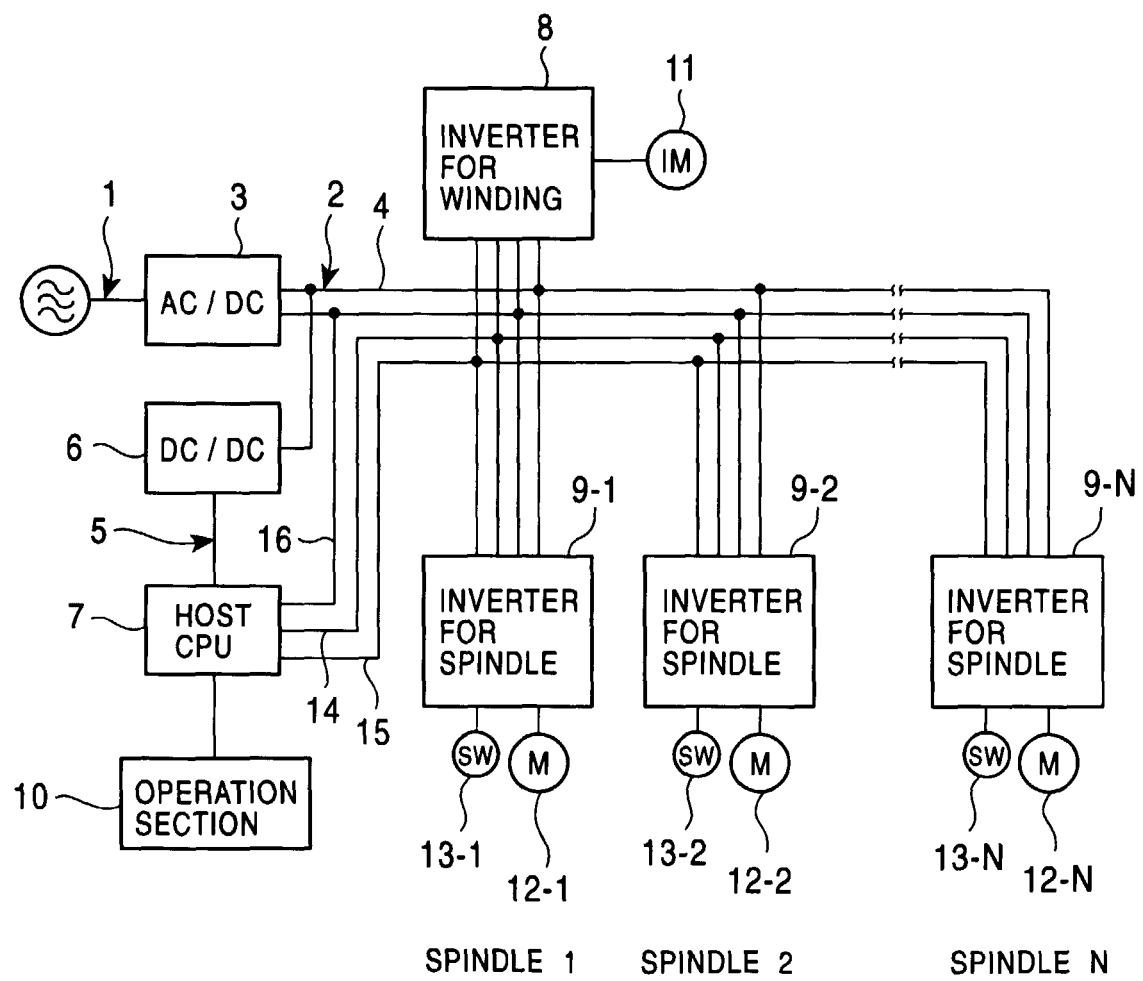


FIG. 2

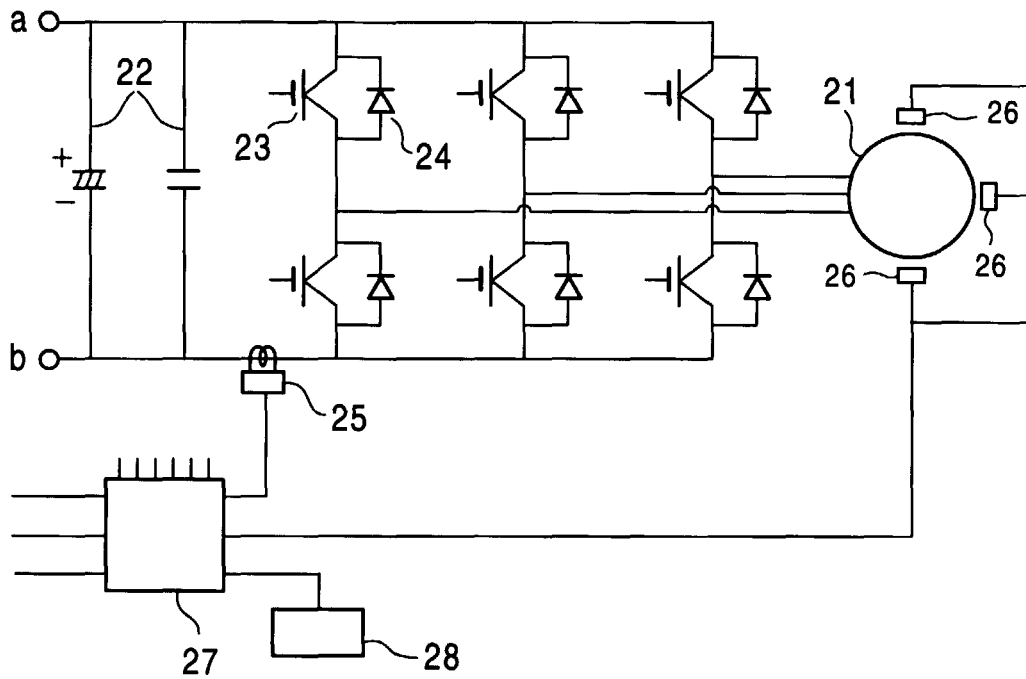


FIG. 3

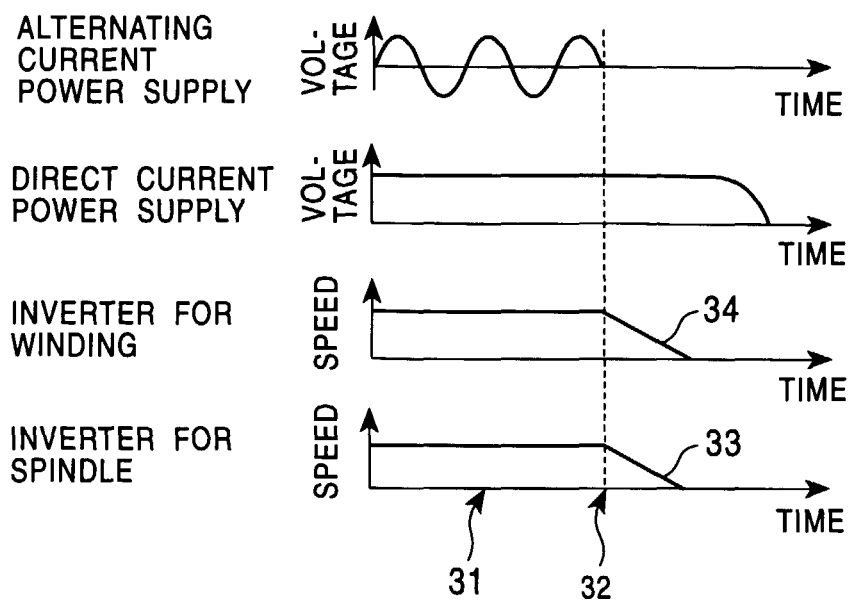
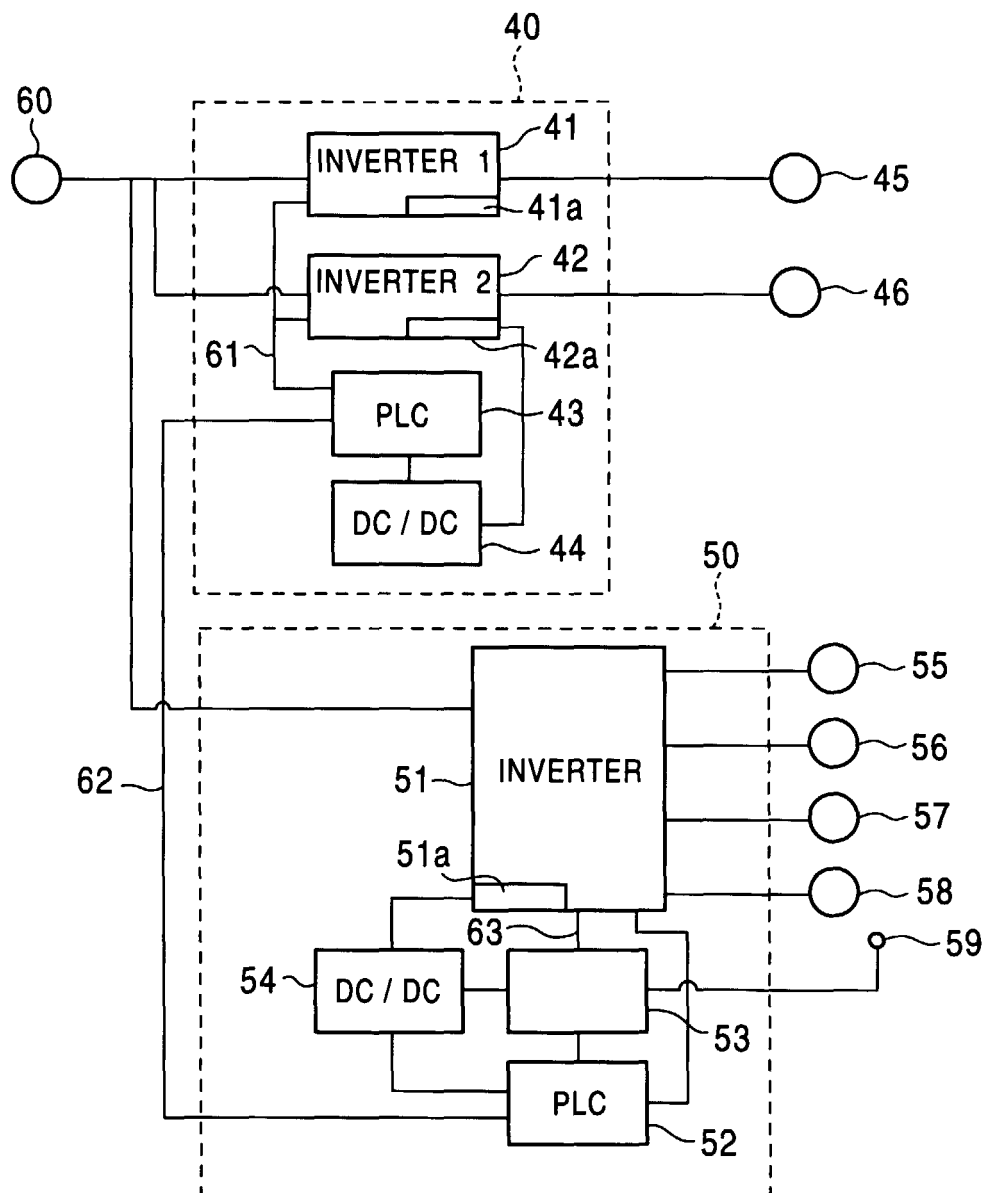


FIG. 4





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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 November 1999	Examiner Henningsen, O
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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