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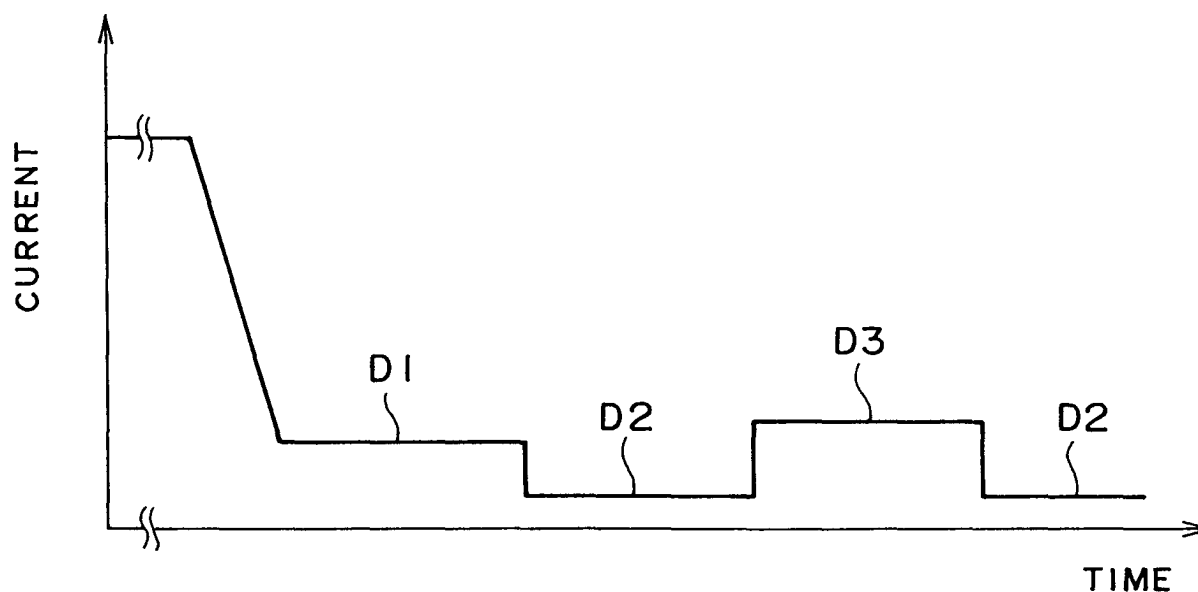
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(54) **Method of controlling single spindle driving motors of a spinning machine**

(57) In a spinning machine for independently driving each spindle (5) by an individual motor (6), a synchronization motor is used as the motor and is controlled

through an inverter (14). At least when a bobbin is pulled out after a doffing stop, each of the motors is supplied with a direct current (D3), and a holding force for holding the spindle in a stop state is increased.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of controlling single spindle driving motors of a spinning machine such as a ring spinner or a ring throwing machine, for independently driving the respective spindles by individual motors.

2. Description of the Related Art

[0002] A machine that has been proposed recently has, instead of only one motor for driving all spindles in a spinning frame, a plurality of spindle driving motors so that each spindle has its own motor. This has been proposed for the purpose of making it possible to set a large number of spindles in the spinning frame, or to increase the rotational speed of the spindles. In the case where the single spindle driving motor is provided in each of the spindles as described above, a problem of spindle rotation may occur in doffing differently from the case of a ring spinner of a belt driving method where a plurality of spindles are driven by one belt.

[0003] The reason for this is that when a thread ranging from a spindle to a full bobbin through a traveler is applied with tension in doffing, particularly, in pulling the full bobbin out of the spindle, the tension acts on a direction in which the spindle is rotated. In the belt driving method, a large braking force acts on the spindle by a belt in a stationary state. Thus, the spindle does not rotate with the tension caused due to strain of the thread in pulling out the bobbin, or the spindle rotates slightly even if it rotates. On the other hand, the spindle that is directly driven by the single spindle driving motor is rotated by the thread tension, and the thread ranging from the spindle to the full bobbin is difficult to be cut at a desired position. Besides, the position of the traveler is easy to change and the thread ranging to a draft part through the traveler is liable to break at the time of restarting of the frame after doffing.

[0004] In order to solve such a defect, Japanese Patent Application Laid-open No. 1-306629 propose a braking device of a spinning machine using as a single spindle driving motor a polyphase AC motor, which comprises: a first power supply that supplies a driving current to the motor at the time of normal spinning; a second power supply that applies to the motor a rotational torque toward an opposite direction to that at the time of normal spinning; a changeover switch for changing the above two power supplies; and a brake control circuit for operating the changeover switch, is proposed in.

[0005] If the spinning frame is provided with the braking device disclosed in Japanese Patent Application Laid-open No. 1-306629 described above, the defect accompanied with the spindle rotation in doffing can be

eliminated. However, the device is provided with the two power supplies and therefore needs a changeover switch for the power supplies and a brake control circuit for operating the changeover switch. Thus, the structure becomes complicated, and the cost is increased.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in view of the above problems, and an object of the present invention is therefore to provide a method of controlling single spindle driving motors of a spinning machine that can prevent a spindle from being rotated to such an extent that a trouble occurs at the time of restarting due to tension of a thread in doffing by controlling a single spindle driving motor with one power supply and also without a changeover switch.

[0007] In order to achieve the above-described object, according to a first aspect of the present invention, in a spinning machine for independently driving each spindle by an individual motor, a synchronization motor is used as the motor, the synchronization motor is controlled through an inverter, and each of the motors is supplied with a direct current to hold the spindle in a state that a rotation is limited at least when a bobbin is pulled out of the spindle after a doffing stop.

[0008] In the present invention, after the doffing stop, a direct current is supplied to the synchronization motor for driving the spindle at the time of pulling the full bobbin out of the spindle. Therefore, an excitation state of a stator of the motor is held at a constant level, and a magnetic force for holding a rotator at a stop position acts on the rotator. As a result, even if the tension acting on a thread at the time of pulling out the full bobbin tries to rotate the spindle, the rotation of the spindle is limited. Thus, the spindle can be prevented from being rotated to such an extent that a trouble occurs at the time of restarting.

[0009] According to a second aspect of the present invention, in the first aspect of the invention, the inverter is mounted with each of the motors. Therefore, in the present invention, the motor of each of the spindles can be controlled with high precision.

[0010] According to a third aspect of the present invention, in the first or second aspect of the invention, the motor is supplied with a direct current smaller than that at the time of pulling out the bobbin during a stop of the motor except for the time of pulling out the bobbin. Therefore, in the present invention, during the stop, a holding force for suppressing the rotation of the rotator from the stop position by the action of an external force always acts while the action of the holding force is not limited to the time of pulling out the full bobbin.

[0011] According to a fourth aspect of the present invention, in a spinning machine for independently driving each spindle by an individual motor, a synchronization motor that enables a step operation is used as the motor, the synchronization motor is controlled through an in-

verter, and the motor is slightly rotated in an opposite direction to that in a spinning operation at least when a bobbin is pulled out of the spindle after a doffing stop.

[0012] In the present invention, the motor that enables the step operation, such as a switched reluctance motor, is used as the synchronization motor. When the full bobbin is pulled out of the spindle after the doffing stop, the motor is driven so as to slightly rotate the spindle in the opposite direction to that in the spinning operation (for example, 1/4 rotation or less) instead of holding the spindle at a stop position. Even with the same exciting current, the force against the torque for rotating the spindle by the thread tension is larger in the case where the motor is rotated in the opposite direction in comparison with the case where a stator is excited so as to stop the spindle at a predetermined position. Therefore, particularly in the case where a large force is required for cutting a thread as in the case of a thread with a thick count, the spindle is rotated in the opposite direction, whereby the action against the torque for rotating the spindle by the thread tension increases, and also cutting of the thread is smoothly carried out by a cutter equipped to the spindle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In the accompanying drawings:

- Fig. 1 is a graph showing a change of a supply current to a motor in accordance with one embodiment;
- Fig. 2 is a block circuit diagram showing an electrical structure of a spinning machine; and
- Fig. 3 is a schematic side view showing a state that a doffing device holds a full bobbin.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Hereinafter, one embodiment of a single spindle driving ring spinner according to the present invention is described with reference to Figs. 1-3.

[0015] As shown in Fig. 2, an alternating-current power supply 1 is connected with an AC/DC converter 2. A draft motor 3 constituting a draft part drive system is connected with the AC/DC converter 2 through an inverter 4. The draft part drive system is connected with a lifting drive system (not shown) for raising or lowering a ring rail and a lappet angle through a rotation transmitting means (not shown) so as to be operatable with synchronization, and the draft motor 3 also drives the lifting drive system.

[0016] Respective spindles of a spinning machine are provided with single spindle driving motors 6, respectively, for independently driving each spindle 5 (shown in Fig. 3). Synchronization motors are used for the single spindle driving motors 6. In this embodiment, switched reluctance motors (SR motors) are used. The single spindle driving motors 6 are connected with the AC/DC

converter 2 through separate spindle control devices 7 and a chopper circuit 8. The chopper circuit 8 changes output of the AC/DC converter 2 to a voltage suitable for a driving power supply of each of the single spindle driving motors 6 to output the voltage.

[0017] The inverter 4 and the respective spindle control devices 7 are electrically connected with a frame control device 9. The frame control device 9 is provided with a CPU 10, a memory 11, and an input device 12. The CPU 10 is connected with the input device 12 through an input interface (not shown), is connected with the inverter 4 through an output interface (not shown), and is connected with the respective spindle control devices 7 through a serial interface (not shown).

[0018] The CPU 10 operates based on a predetermined program data stored in the memory 11. The memory 11 stores the program data and various data necessary for carrying out the program. The program data includes corresponding data on spinning conditions such as various fiber materials, spinning count and the number of twists, rotational speed of a spindle at the time of a steady operation, rotational speed of the draft motor 3, and the like. Further, the memory 11 stores a control program in a frame stop of the single spindle driving motor 6 until restarting of the frame after a stop of doffing.

[0019] The control program in a frame stop supplies the single spindle driving motor 6 with direct current for a predetermined time at least at the time of pulling a bobbin out of the spindle 5 in a doffing operation and supplies the single spindle driving motor 6 with direct current smaller than that at the time of pulling out the bobbin (for example, direct current approximately one third as large as that at the time of pulling out the bobbin) during the frame stop until the restarting of the frame after doffing except for the time of pulling out the bobbin. That is, during the frame stop, small direct current is supplied without stopping current supply to the single spindle driving motor 6, and larger direct current is supplied at the time of pulling out the bobbin. A time for changing the size of direct current to be supplied is set to a time after a predetermined time from a beginning of the operation of a doffing device (spool changing device) 13 (partially shown in Fig. 3).

[0020] Note that the small direct current is supplied to the single spindle driving motor 6 at the time of a stop for coupling thread accompanied with a broken-state of thread. That is, the same control of the single spindle driving motor 6 is conducted at the time of the thread coupling stop and at the time of the doffing stop except for the point that a supply current is made larger for a predetermined period of time at the time of pulling out the bobbin.

[0021] Each of the spindle control devices 7 is provided with an inverter 14 and a control circuit 15 provided with a CPU. The control circuit 15 is capable of communicating with the frame control device 9 through the serial interface (not shown), and can receive a command

signal from the frame control device 9 and also transmit data to the frame control device 9.

[0022] The action of the device structured as above will be described. Prior to the operation of the spinning machine, the spinning conditions such as the fiber material, the spinning count, and the number of twists are input to the frame control device 9 by the input device 12. Then, when the operation of the spinning machine is started, the CPU 10 of the frame control device 9 controls the draft motor 3 to a predetermined rotational speed through the inverter 4 based on the input spinning conditions, and also outputs a speed command signal to the respective spindle control devices 7. The spindle control devices 7 control the respective single spindle driving motors 6 to a predetermined rotational speed corresponding to the command signal from the frame control device 9.

[0023] When spinning is continued to reach the state of a full spool, a predetermined stop operation is performed. As shown in Fig. 3, a full bobbin (full spool of thread) F mounted onto the spindle 5 is formed with a sloping thread 16, a thread end Yb is wound around a thread end winding portion 17 with a predetermined number of times for winding, and the operation of the frame is stopped in a state that a traveler 19 on a ring rail 18 is positioned above the thread end winding portion 17.

[0024] Subsequently, a doffing operation by the doffing device 13 is started. The doffing device 13 pulls the full bobbin F out of the spindle 5, and then, mounts the spindle 5 with an empty bobbin. When the full bobbin F is pulled out, the thread ranging from the thread end winding portion 17 to the full bobbin F is brought into a press-contact with a known cutter (not shown) mounted above the thread end winding portion 17 to be cut.

[0025] When the doffing operation is started, a signal notifying the start is output to the respective spindle control devices 7 from the frame control device 9, and the respective spindle control devices 7 confirm the start time of the doffing. The respective spindle control devices 7 count the lapse time from the start time of the doffing with a counter (not shown) and keeps the timing of pulling out the full bobbin F under control.

[0026] Fig. 1 is a graph showing a change in time of a volume of a current supplied to the single spindle driving motor 6 during the period of from the frame stop operation to the doffing operation. As shown in Fig. 1, during the frame stop operation, the supply current to the single spindle driving motor 6 is reduced to decelerate. After the speed reaches a predetermined low speed, a direct current D1 having a predetermined volume is supplied to the single spindle driving motor 6 for a predetermined period of time in order to conduct a braking operation. After the stop of the spindle 5, a direct current D2 smaller than the direct current D1 is supplied to the single spindle driving motor 6. Then, after the start of the doffing operation, before the doffing device 13 starts the operation of pulling out the full bobbin F, a direct cur-

rent D3 larger than both the direct current D1 and the direct current D2 is supplied to the single spindle driving motor 6 for a predetermined period of time. Thereafter, the small direct current D2 is supplied again, and this state is held until the time of restarting of the frame.

[0027] Since the full bobbin F is formed with the sloping thread 16 in pulling out of the full bobbin F as shown in Fig. 3, a torque for rotating in a rotational direction in spinning acts on the spindle 5 through the sloping thread 16. In a state that a current is not supplied to the single spindle driving motor 6, the spindle 5 is rotated by the torque described above, and a thread Y ranging through the traveler 19 to a draft part (not shown) is wound around the spindle 5. As a result, the position of the traveler 19 changes, or the tension of the thread Y increases. Thus, the broken-state of thread is easy to occur at the time of restarting of the frame. However, in this embodiment, when the full bobbin F is pulled out of the spindle 5, the single spindle driving motor 6 is supplied with the direct current D3 to stop the rotation of the spindle 5.

[0028] Note that, at the time of the stop for coupling thread accompanied with a broken-state of thread, after the direct current D1 is supplied for a braking operation and the spindle 5 is stopped, the small direct current D2 is supplied to the single spindle driving motor 6 during the stop.

[0029] This embodiment provides the following effects.

- (1) The synchronization motor is used as the single spindle driving motor 6 and is controlled through the inverter 14. When the full bobbin F is pulled out from the spindle 5 after the doffing stop, the direct current is supplied to the motor, whereby a rotor is held in a stop state. Therefore, even if the torque for rotating the spindle 5 acts on the spindle 5 by the thread Y ranging to the full bobbin F when the full bobbin F is pulled out, the rotation of the spindle 5 is limited. Thus, the spindle 5 is prevented from being rotated to such an extent that the trouble such as the broken-state of thread occurs at the time of restarting.
- (2) The large direct current D3 is not kept to be supplied during the doffing operation, but the large direct current D3 is supplied at the time of pulling out the full bobbin F and the small direct current D2 is made to flow for the other period. Therefore, the amount of consumption of current can be reduced, and also the generation of heat can be suppressed.
- (3) During the stop of the frame operation, the small direct current D2 is supplied to the single spindle driving motor 6 in the other period except for the doffing operation. Thus, the possibility that the spindle 5 rotates during the stop is further lowered, and the generation rate of the broken-state of thread at the time of restarting the frame is further reduced.
- (4) Since each of the single spindle driving motors 6 is mounted with the inverter 14, respectively, the

single spindle driving motors 6 can be controlled with high precision.

(5) At the time of the stop for coupling thread accompanied with the broken-state of thread, the direct current D1 having the predetermined volume is supplied for braking as in the doffing stop. After the stop, the direct current D2 smaller than the direct current D1 is supplied. Therefore, a part of the control program at the time of the stop of the single spindle driving motor 6 is shared, and an interrupt program for supplying the direct current D3 at the time of pulling out the full bobbin F is provided. Thus, the control can be made simpler.

[0030] The present invention is not limited to the embodiment described above. For example, the following embodiment may be adopted.

[0031] The period in which the large direct current D3 is supplied to the single spindle driving motor 6 may be set as the period from the start of the doffing operation to the completion of the doffing operation in order to give a large holding force at the time of pulling out the full bobbin F. In this case, the supply of the direct current D3 is started by a doffing start signal, and the supply of the direct current D3 is stopped by a doffing completion signal. Thus, the counter is unnecessary, which leads to the simple structure.

[0032] The direct current D3 may be supplied in accordance with the timing that the doffing device 13 pulls out the full bobbin F. For example, the structure in which the direct current D3 is supplied to the single spindle driving motor 6 by a command from the doffing device 13 for the operation of pulling out the full bobbin F.

[0033] During the stop of the frame operation, electric power may not be supplied to the single spindle driving motor 6 except for when the direct current D3 is supplied.

[0034] At least when the full bobbin F is pulled out of the spindle 5 after the doffing stop, the single spindle driving motor 6 may be slightly rotated in an opposite direction to that in the spinning operation instead of supplying the single spindle driving motor 6 with the direct current D3 to hold the spindle 5 in the stop state. Specifically, for example, a step operation is conducted by the single spindle driving motor 6 in accordance with the command from the doffing device 13 for the operation of pulling out the full bobbin to slightly rotate the spindle 5 (for example, approximately 30 to 60°). The SR motor can be easily controlled so as to conduct the step operation. In this case, even with the same exciting current, the force against the torque for rotating the spindle 5 by the thread tension is larger in the case where the single spindle driving motor 6 is rotated in the opposite direction in comparison with the case where a stator is excited so as to stop the spindle 5 at a predetermined position. Therefore, particularly in the case where a large force is required for cutting the thread Y as in the case of a thread with a thick count, the action against the

torque for rotating the spindle 5 by the thread tension increases, and also the spindle 5 rotates in a state that the cutter equipped to the spindle 5 abuts against the thread Y. Thus, cutting of the thread Y is smoothly carried out.

[0035] When the full bobbin is pulled out, the case where the spindle 5 is slightly rotated or the case where the direct current D3 is supplied to hold the spindle 5 in the stop state may be selected in accordance with a thickness of a spinning thread. For example, on the basis of the spinning conditions input to the frame control device 9, inversion control is conducted when the spinning thread has a predetermined thickness or more, and control is conducted so as to supply the direct current D3 when the spinning thread has a thickness thinner than the predetermined thickness. In this case, the inversion control is conducted only in case of the thread with a thick count, in which cutting of the thread is difficult to be smoothly carried out.

[0036] Instead of providing the inverter 14 in each spindle, the structure in which all the single spindle driving motors 6 are driven and controlled by one inverter or the structure in which the single spindle driving motors 6 are divided into a plurality of groups and one inverter is provided in each of the groups may be adopted. In this case, the number of inverters is reduced, and the manufacturing cost is reduced.

[0037] As the single spindle driving motor 6, a synchronous reactance motor, a permanent-magnet synchronization motor, a step motor or the like may be used instead of the SR motor. Further, the chopper circuit 8 may be omitted.

[0038] The present invention is not limited to the ring spinner and may be applied to a ring throwing machine for driving a single spindle, and the like.

[0039] Technical ideas (invention) except for those in accordance with claims, which can be grasped according to the above embodiments will be described below.

(1) In the present invention of claim 4, the motor is rotated in the opposite direction at the time of pulling out the bobbin after the doffing stop when the spinning thread has a predetermined thickness or more, and the motor is not rotated and is supplied with the direct current to hold the spindle in the stop state when the spinning thread has a thickness thinner than the predetermined thickness.

(2) A control device of a single spindle driving motor of a spinning machine for independently driving each spindle by an individual synchronization motor, the spinning machine comprising: an inverter for controlling the motor; and the control device for outputting a control command signal for supplying a direct current to each of the motors at least at the time of pulling a bobbin out of the spindle after a doffing stop, which is provided in the inverter.

(3) A control device of a single spindle driving motor of a spinning machine for independently driving

each spindle by an individual synchronization motor, the spinning machine including: an inverter for controlling the motor; and a control device for outputting either a control command signal for supplying a direct current to each of the respective motors or a control command signal for slightly rotating the motor in an opposite direction to that in a spinning operation and for carrying out the selection of the control command signals on the basis of the thickness of a spinning thread, which is provided in the inverter.

after the doffing stop when a spinning thread has a predetermined thickness or more, and the motor is not rotated and is supplied with a direct current to hold the spindle in a stop state when the spinning thread has a thickness thinner than the predetermined thickness.

[0040] As described in detail, according to the present invention, the single spindle driving motor is controlled with one power supply without providing the changeover switch, whereby the spindle can be prevented from being rotated to such an extent that the trouble occurs at the time of restarting due to the thread tension in doffing.

Claims

1. A method of controlling single spindle driving motors of a spinning machine for independently driving each spindle by an individual motor, **characterized in that:** a synchronization motor is used as the motor; the synchronization motor is controlled through an inverter; and each of the motors is supplied with a direct current to hold the spindle in a state that a rotation is limited at least when a bobbin is pulled out of the spindle after a doffing stop.
2. A method of controlling single spindle driving motors of a spinning machine according to claim 1, **characterized in that** the inverter is mounted with each of the motors.
3. A method of controlling single spindle driving motors of a spinning machine according to claim 1, **characterized in that** the motor is supplied with a direct current smaller than that at the time of pulling out the bobbin during a stop of the motor except for the time of pulling out the bobbin.
4. A method of controlling single spindle driving motors of a spinning machine for independently driving each spindle by an individual motor, **characterized in that:** a synchronization motor that enables a step operation is used as the motor; the synchronization motor is controlled through an inverter; and the motor is slightly rotated in an opposite direction to that in a spinning operation at least when a bobbin is pulled out of the spindle after a doffing stop.
5. A method of controlling single spindle driving motors of a spinning machine according to claim 4, **characterized in that** the motor is rotated in the opposite direction at the time of pulling out the bobbin

FIG. 1

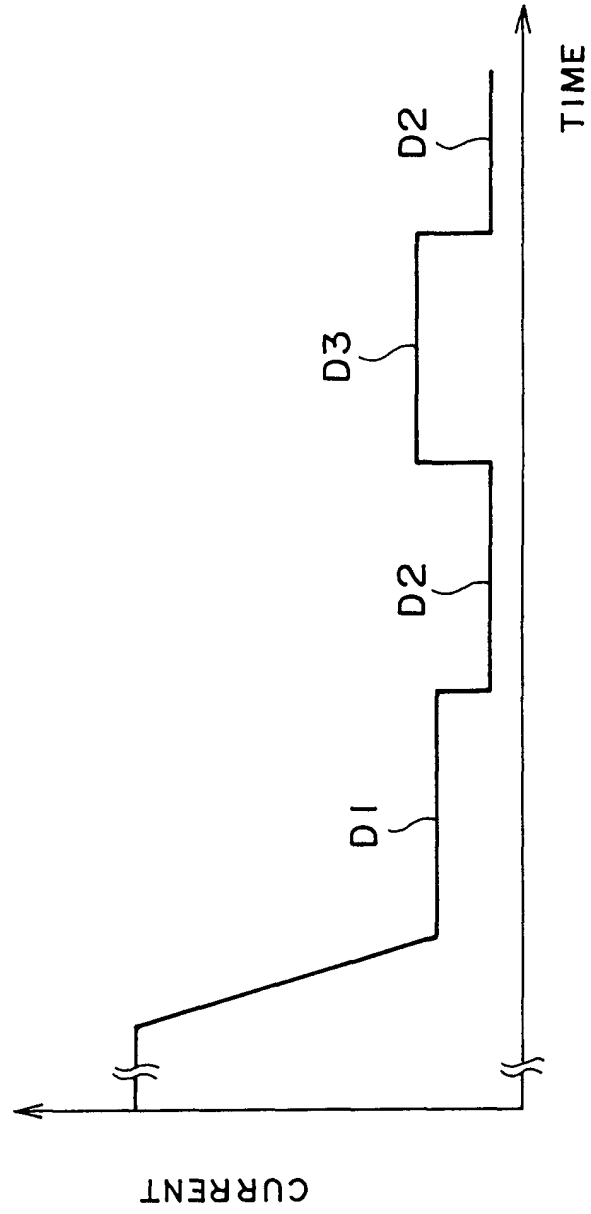


FIG. 2

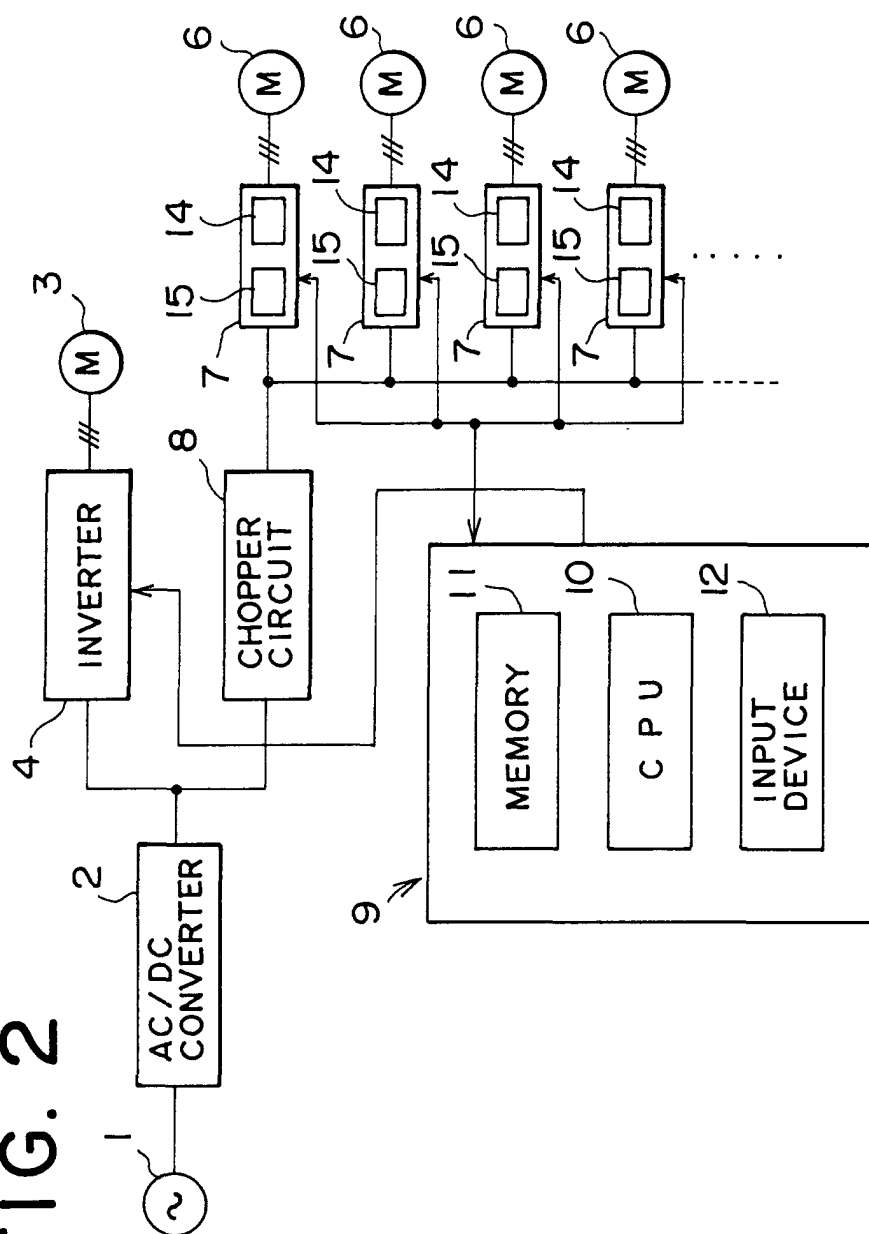


FIG. 3

