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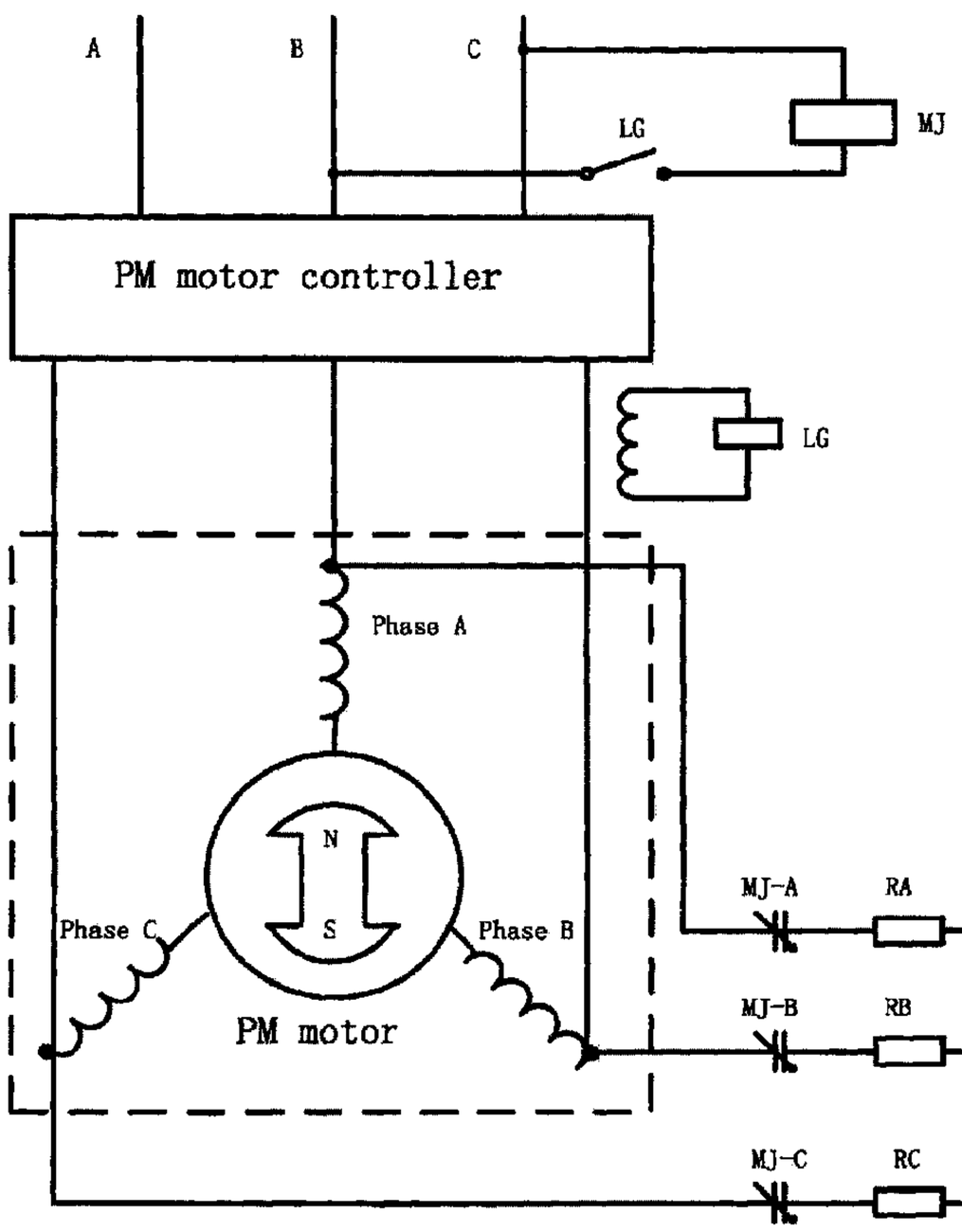
(54) **Titre : MODULE DE COMMANDE DE FREINAGE D'UN MOTEUR A COURANT CONTINU SANS BALAIS, A AIMANTS PERMANENTS ET A TROIS PHASES ENTRAINANT DIRECTEMENT UNE POMPE A VIS**

(54) **Title: BRAKING CONTROLLER OF A THREE-PHASE PERMANENT MAGNETIC BRUSHLESS DC MOTOR FOR DIRECTLY DRIVING A SCREW PUMP**



(57) **Abrégé/Abstract:**
A braking controller of a three-phase permanent magnetic brushless DC motor for directly driving a screw pump includes a detection circuit for detecting power supply states of the three-phase permanent magnetic brushless DC motor and a braking

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(57) **Abrégé(suite)/Abstract(continued):**
circuit for controlling the braking startup according to the power supply states of the three-phase permanent magnetic brushless DC motor. When the motor is supplied with power, the braking circuit is cut off. When the motor is not supplied with power and the screw pump drives the motor to reverse, the braking circuit starts up.

Abstract

A braking controller of a three-phase permanent magnetic brushless DC motor for directly driving a screw pump includes a detection circuit for detecting power supply states of the three-phase permanent magnetic brushless DC motor and a braking circuit for controlling the braking startup according to the power supply states of the three-phase permanent magnetic brushless DC motor. When the motor is supplied with power, the braking circuit is cut off. When the motor is not supplied with power and the screw pump drive the motor to reverse, the braking circuit starts up.

TITLE

[0001] Braking controller of a three-phase permanent magnetic brushless DC motor for directly driving a screw pump

TECHNICAL FIELD

[0002] The present invention pertains to a braking controller for a direct drive motor for an oil-extracting screw pump; in particular, to a braking controller that inhibits the reverse rotation of a three phase permanent magnet brushless direct current motor used to drive a direct drive screw pump.

BACKGROUND

[0003] Screw pumps are high efficiency oil-extracting apparatuses. There are two main causes of the shutdown and reversal of the screw pump motor:

1. When the rotor is rotated by the drive device of the rod pump, elastic deformation will be produced in the long polished rod. The downhole rotor starts to rotate after the the polished rod rotates for tens of cycles. The elastic energy of these tens of cycles will then be released when the motor is shutdown, thus the parts of the polished rod close to ground will reversely rotate back with high speed if not inhibited. The high speed reverse rotation will lead to reversal tripping accident of polished rod because the polished rod is formed by many nodes connected to each other (except continuous rod). To ensure the safety of the polished rod, braking means must be employed.

2. When shut down, the backflow of produced liquid will result in liquid pressure and pipeline pressure in the tubing and will drive the rotor of screw pump in revers with high speed like a hydro-generator. This will occur in both ground drive rod pumps and rodless pumps submerged in the oil downhole. When liquid flows in reverse, the part of the transmission shaft connected to the rotor will disconnect or break by the drastic liquid backflow (especially for submerged rodless pump).

[0004] At present, there are two main braking means employed on screw pumps: the first one is to stop reverse rotation using a ratchet. This is a mechanical solution that results in an absolute stop and does not allow the polished rod rotate in revers. This approach has a simple structure but the reliability is poor andalso has problems such as: the initial torque is too great and may cause a starting impact when restarted, the elastic transformation must be released in

workover operation, and mechanical damage or human injury accidents may be caused when not employed correctly. The second approach is to stop reverse rotation by hydraulic pressure. This has a high reliability, however the cost is high and the structure is complex.

SUMMARY

[0005] The purpose of the invention is to provide a braking controller that inhibits the reverse rotation of a motor for a direct drive screw pump, to overcome the disadvantages of mechanical braking of screw pump.

[0006] According to an aspect, the present invention relates to a braking controller for a three phase permanent magnet brushless direct current motor for a direct drive screw pump, which comprises: a detecting circuit for detecting the state of a power supply of the three phase permanent magnet brushless direct current motor; a braking circuit for engaging the brake according to the state of the power supply of the permanent magnet synchronous motor, where the brake is not engaged when working power is supplied to the motor and the brake is engaged when no power is supplied to the motor and the motor rotates in reverse as driven by the screw pump.

[0007] According to an aspect, the present invention installs a braking circuit on the three phase permanent magnet brushless direct current motor for the direct drive screw pump, through which soft braking is applied to the three phase permanent magnet brushless direct current motor for the direct drive screw pump, and the elastic force of the polished rod of the screw pump can be released at a sufficiently slow rate, thus overcome the disadvantage of mechanical braking.

[0008] According to an aspect, there is provided a braking controller for a three phase permanent magnet brushless direct current motor for direct drive screw pump of the present invention having a detecting circuit, in which the detecting circuit comprises: a motor controller, current transformer L, a normally-closed relay MJ, in which the detecting circuit connects between two phases of the three phase current input terminal of motor controller, the current transformer connects to the three phase current output terminal of the motor

controller, the current transformer connects to the normally-closed relay in series, the braking controller having a braking circuit that comprises: three high power resistors RA, RB and RC connected in series on the three phase current output circuit of the motor controller, in which each high power resistor connects to the contacts MJ-A, MJ-B or MJ-C of the normal-closed relay in series.

[0009] According to an aspect, a braking controller for a three phase permanent magnet brushless direct current motor for a direct drive screw pump, comprises a detecting circuit comprising: a motor controller, a current transformer L, a normal-closed relay MJ, rectifier diodes Q1 and Q2, rectifier triodes V and a current limiting impedance element Z1, in which the detecting circuit connects between any two phases of the three phase current input terminal of motor controller, the current transformer L connects to the three phase current output terminal of the motor controller, the current transformer L and normal-closed relay, rectifier diodes Q1 and Q2, rectifier triodes V and current limiting impedance element Z1 connect in series, the braking controller further comprises a braking circuit comprising: three high power resistors connected in series on the three phase current output circuit of the motor controller, in which each high power resistor RA, RB and RC connects to one of the high power bidirectional triode thyristor MC-A, MC-B or MC-A in series, wherein the the high power bidirectional triode thyristor is turned on and off by the normally-closed relay.

[0010] When power is supplied to the motor, the screw pump is driven to rotate forward, causing an induction current to be generated by the current transformer, such that two terminals of the normally-closed relay are charged and the contact of the normally-closed relay disconnects, that is the braking circuit does not start and the high power resistor is not connected. When the power supplied to the motor is turned off, no induction current exists in the current transformer, the two terminals of the normally-closed relay are not charged, the contact of the normally-closed relay MC-A, MC-B and MC-C connects, the braking circuit starts and the energy consumption resistance RA, RB and RC connect. At this time, the rotor of the screw pump will begin to rotate in reverse and drive the motor in reverse. The state of the permanent magnet motor will then change to the working state of a generator. Since the high power resistances have a fixed resistance, the braking torque of the generator is higher

when the speed of reverse rotation is higher, thus inhibiting the speed of the reverse rotation and causing a soft braking of the motor.

[0011] Advantages:

[0012] The braking controller of the present invention has a simple structure, convenient operation and good braking properties. The mechanical braking apparatus of screw pump is omitted and the disadvantage of mechanical braking is overcome. When used on rod driven direct drive screw pump, the braking controller can release the elastic force of the polished rod sufficiently slow. When used on submerged rodless pump, the braking controller can prevent the break of the transmission shaft due to the reverse flow of liquid. After shutdown is stabilized, the initial torque to restart is very small and the engine is relatively easy to start. This also prevents reverse rotation in workover operations and accidents can be reduced.

[0013] The braking controller of the present invention can reduce energy consumption. Since the braking is due to the electric power generated by the reverse rotation of the motor, acting as a generator, a higher rate of reverse rotation will lead to a higher rate of electric braking, until the elastic energy in the polished rod and the liquid pressure in the produced fluid is slowly released back to the initial state, thus causing a soft braking of the motor. Therefore, no external energy is required for braking.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other features will become more apparent from the following description in which reference is made to the appended drawings, the drawings are for the purpose of illustration only and are not intended to be in any way limiting, wherein:

FIG. 1 is the circuit block diagram of the braking controller of motor direct drive oil-extracting screw pump according to the present invention.

FIG. 2 is the circuit principle diagram of the braking controller of motor direct drive oil-extracting screw pump according to the present invention.

FIG. 3 is the circuit principle diagram of the braking controller of the motor direct drive oil-extracting screw pump according to the preferred embodiment of the

present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1 (see FIG. 2)

[0015] The braking controller of the three phase permanent magnet brushless direct current motor for driving a direct drive screw pump as shown has a detecting circuit with a motor controller, a current transformer L, and a normally-closed relay MJ. The detecting circuit connects between any two phases of the three phase current input terminal of motor controller. The current transformer L connects to the three phase current output terminal of the motor controller and is connected to the normally-closed relay MJ in series. The braking controller also has a braking circuit that has three high power resistors RA, RB, RC connected in series on the three phase current output circuit of the motor controller, in which each high power resistor connects to the contacts of the normally-closed relay MJ in series.

[0016] When power is supplied to the motor, the screw pump is driven to rotate and an induction current is generated by current transformer. Two terminals of normally-closed relay MJ are charged and the contact of the normally-closed relay MC-A, MC-B and MC-C disconnects. When the power supplied for the motor is interrupted, no induction current is generated by the current transformer, the two terminals of normally-closed relay are not charged, and the connection between the normally-closed relay MC-A, MC-B and MC-C is closed, connecting the high energy resistances RA, RB and RC into the circuit, which activates the braking circuit. When the permanent magnet motor is turned off, the rotor of screw pump rotates in reverse and drives the motor in reverse. The state of permanent magnet motor changes from a motor to a generator., Because the resitance value of the resistors are fixed, the dynamic torque of the generator is higher when the speed of reverse rotation is higher, thus inhibiting the reverse speed of the motor.

Embodiment 2 (see FIG. 3)

[0017] The depicted braking controller of the three phase permanent magnet brushless direct current motor for driving a direct drive screw pump has a detecting circuit with a motor

controller, current transformer L, a normally-closed relay MJ, rectifier diodes Q1 and Q2, rectifier triodes V and a current limiting impedance element Z1. The detecting circuit connects between any two phases of the three phase current input terminal of motor controller. Current transformer L connects to the three phase current output terminal of the motor controller, with the current transformer L and normally-closed relay MJ, rectifier diodes Q1 and Q2, rectifier triodes V and current limiting impedance element Z1 connected in series. The braking controller also hasa braking circuit with three high power resistors connected in series on the three phase current output circuit of the motor controller, in which each high power resistor RA, RB, RC connects to one of the high power bidirectional triode thyristor MC-A, MC-B and MC-C in series. The state of the high power bidirectional triode thyristor MC-A, MC-B and MC-C is controlled by the normally-closed relay.

[0018] When power is supplied to the motor, the screw pump is driven to rotate and an induction current is generated by current transformer. Two terminals of the normally-closed relay are charged, the contact of the normally-closed relay MC-A, MC-B and MC-C disconnects, and the high power bidirectional triode thyristor MC-A, MC-B and MC-C disconnects. When the power supplied for the motor is stopped, no induction current exists in the current transformer, two terminals of the normally-closed relay are not charged, the contact of the normally-closed relay MC-A, MC-B and MC-C connects, the high power bidirectional triode thyristor MC-A, MC-B and MC-C connect, and the high power resistances RA, RB and RC are connected into the circuit, which activates the braking circuit. When the permanent magnet motor stops working, the rotor of the screw pump will rotate in reverse and drive the motor in reverse, changing the state of the permanent magnet motor from a motor to a generator. Since the resistances have a fixed value, the dynamic torque of the generator is higher when the speed of reverse rotation is higher, thus inhibiting the speed of the motor.

[0019] In this patent document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that

there be one and only one of the elements.

[0020] The scope of the following claims should not be limited by the preferred embodiments set forth in the examples above and in the drawings, but should be given the broadest interpretation consistent with the description as a whole.

What is Claimed is:

1. A braking controller of a three phase permanent magnet brushless direct current motor for a direct drive screw pump comprises:

a detecting circuit for detecting the state of the power supply of a three phase permanent magnet brushless direct current motor; and

a braking circuit for controlling the brake engagement according to the state of the power supply of the permanent magnet synchronous motor, characterized in that the braking circuit starts when no power is supplied to the motor and the motor is driven in reverse by the screw pump.

2. The braking controller according to claim 1, characterized in that the detecting circuit comprises:

a motor controller, a current transformer, a normally-closed relay, wherein the detecting circuit connects between any two phases of the three phase current input terminal of motor controller, and current transformer connects to the three phase current output terminal of the motor controller, the current transformer and the normally-closed relay in series;

the braking circuit comprising high power resistors connected in parallel on the three phase current output circuit of the motor controller, in which each high power resistor connects with the contacts of the normally-closed relay in series.

3. The braking controller according to claim 1, characterized in that the detecting circuit comprises:

a motor controller, a current transformer, a normal-closed relay, rectifier diodes, rectifier triodes and a current limiting impedance element, wherein the detecting circuit connects between any two phases of the three phase current input terminal of the motor controller, the current transformer connects to the three phase current output terminal of the motor controller, the current transformer, normally-closed relay, rectifier diodes, rectifier triodes and current limiting impedance element in series;

the braking circuit comprising high power resistors connected in parallel on the three phase current output circuit of the motor controller, in which each high power resistor

connects in series to a high power bidirectional triode thyristor in series, wherein the state of the high power bidirectional triode thyristor is controlled by the normally-closed relay.

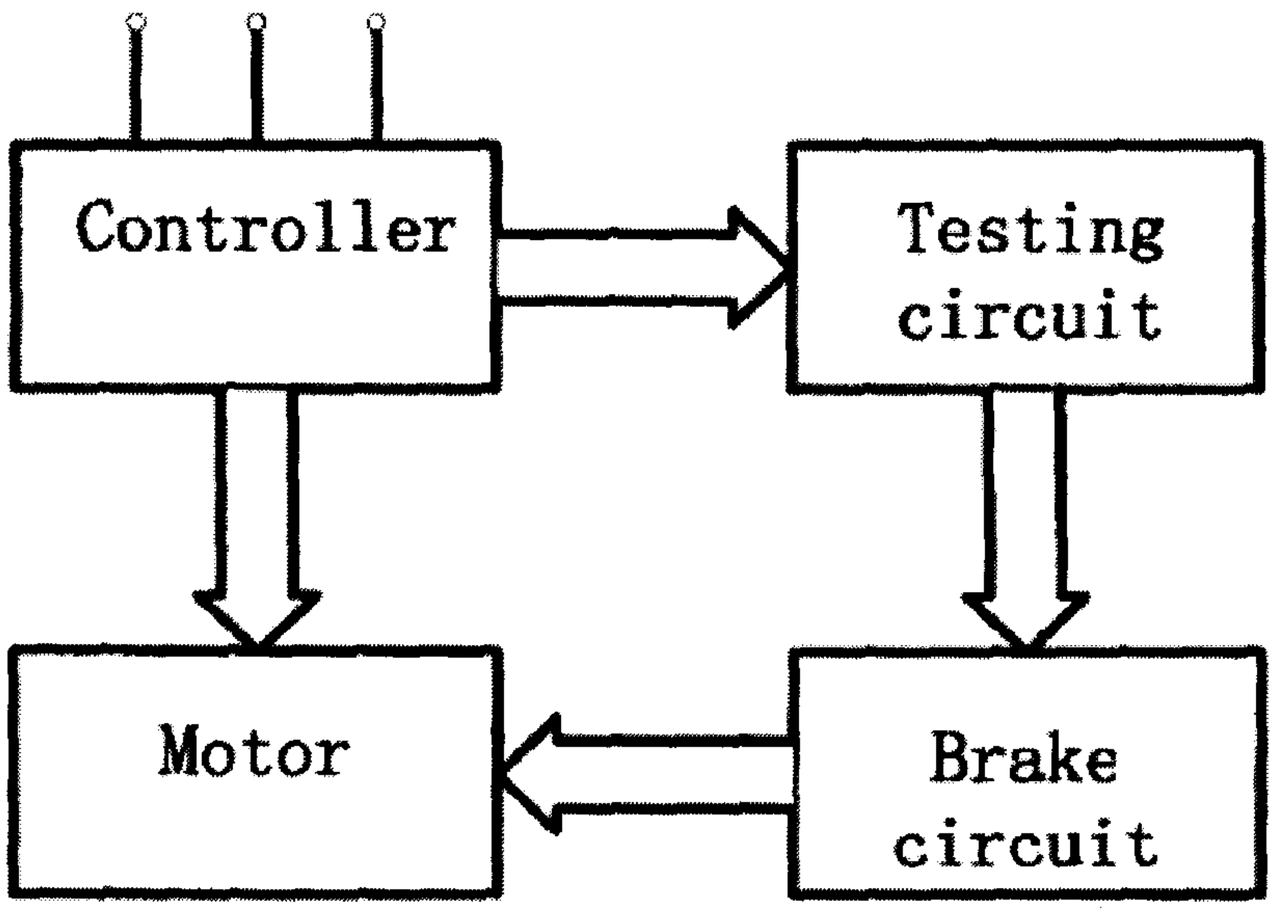


Fig.1

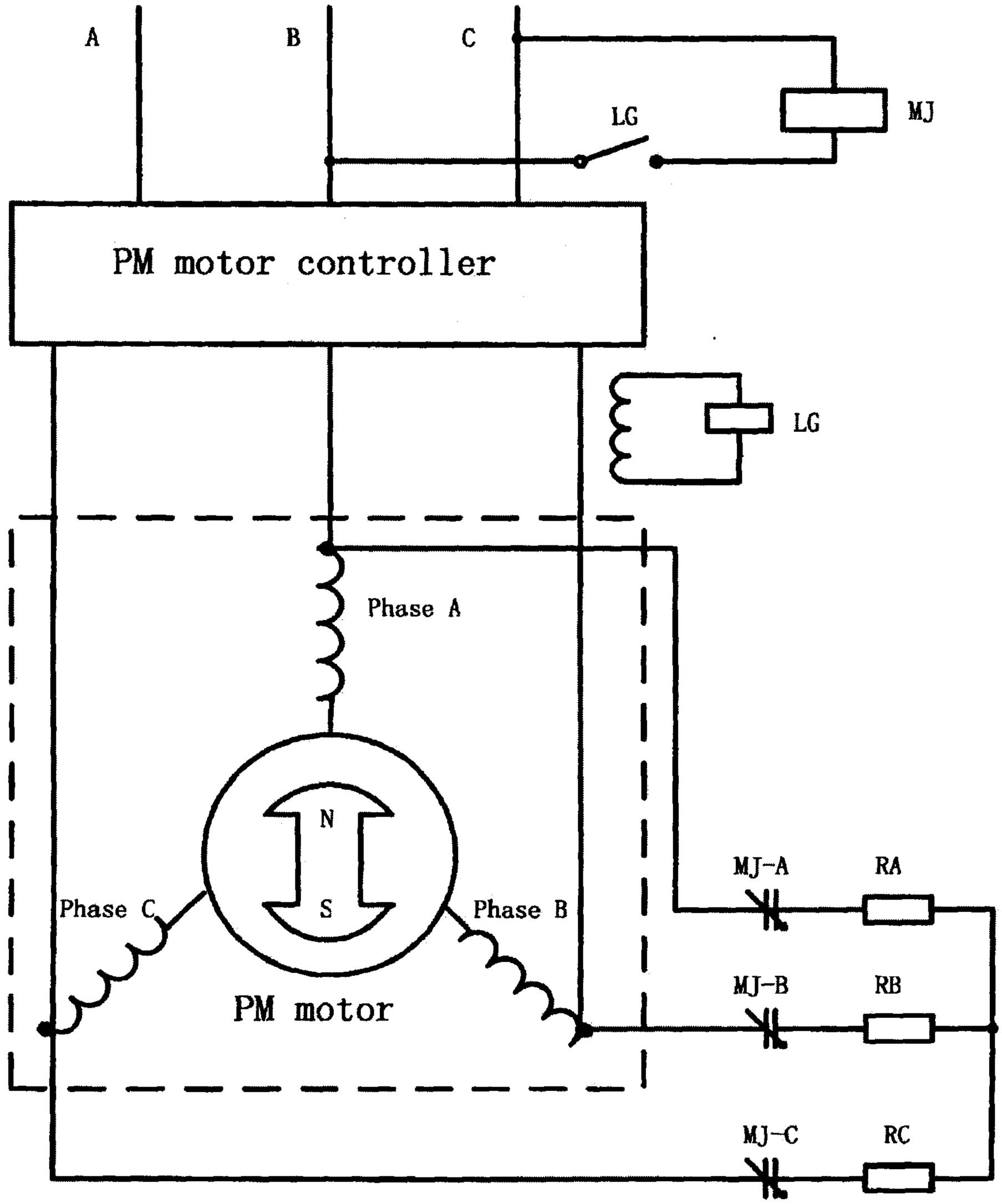
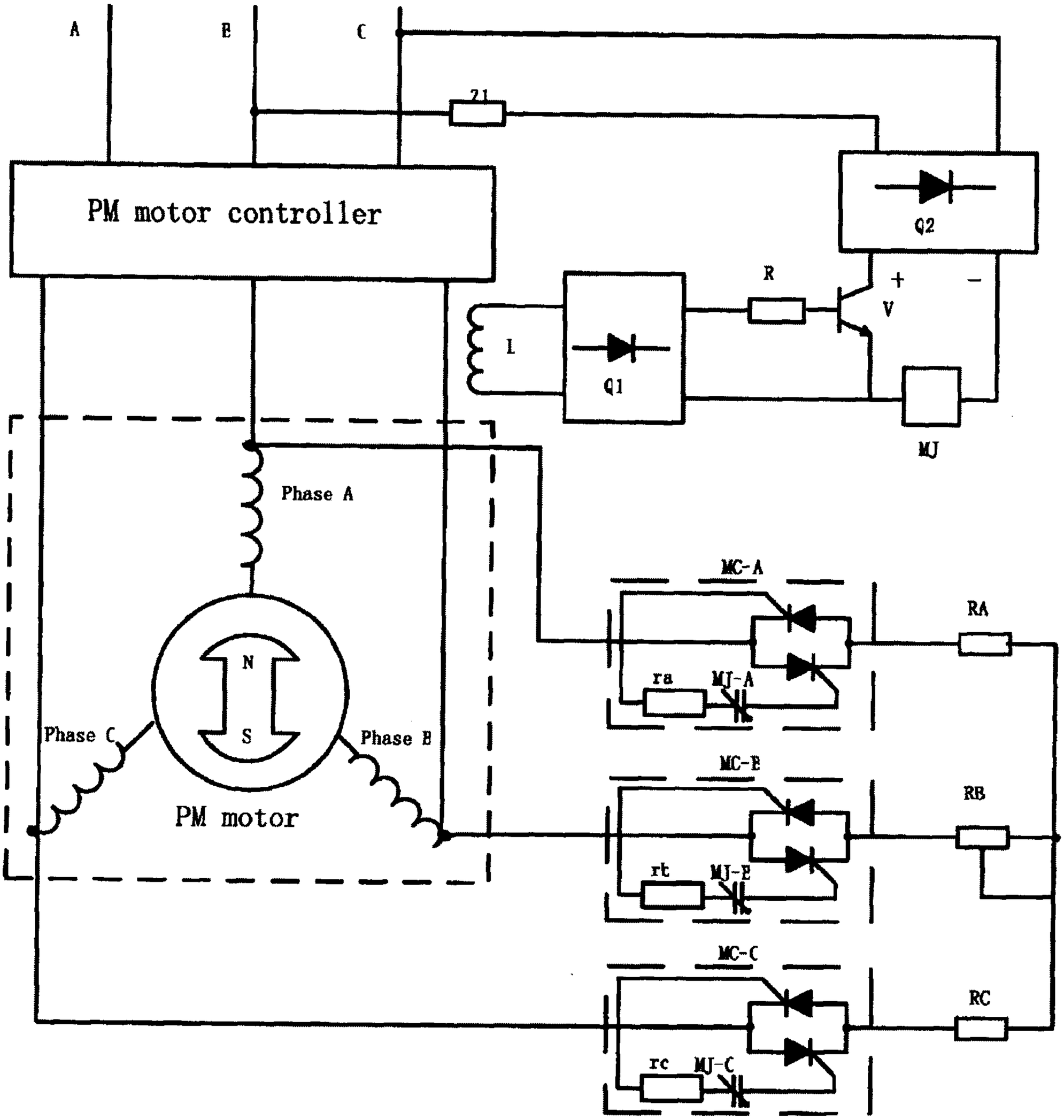

A
B
C
LG
MJ
PM motor controller
LG
Phase A
N
S
Phase C
Phase B
PM motor
MJ-A
RA
MJ-B
RB
MJ-C
RC

Fig.2


A
B
C
21
PM motor controller
Q2
R
+
V
−
L
Q1
MJ
Phase A
Phase C
Phase B
N
S
PM motor
MC-A
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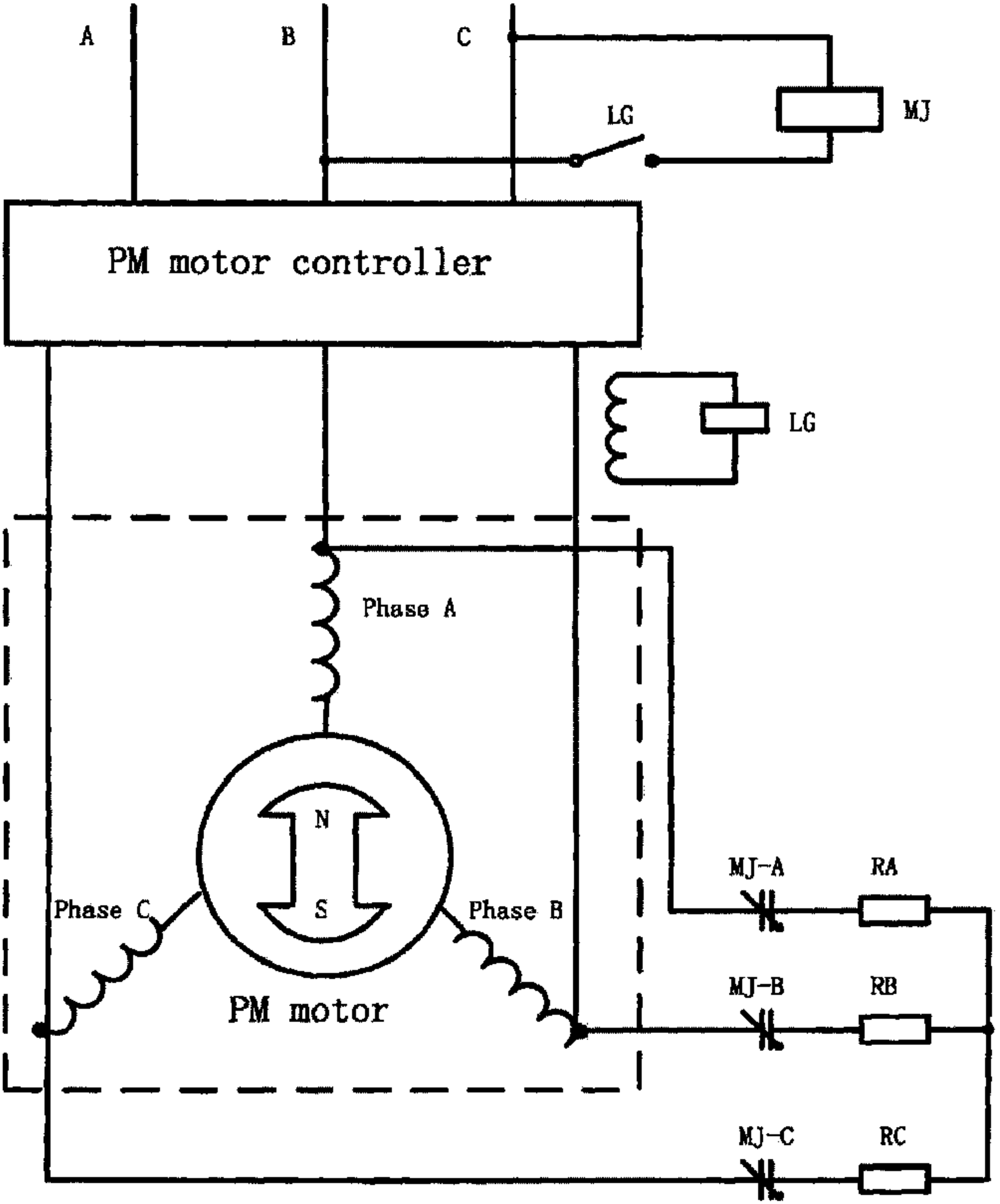
MJ-A
MC-B
RB
rb
MJ-B
MC-C
RC
rc
MJ-C

Fig.3


A
B
C
LG
MJ
PM motor controller
LG
Phase A
N
S
Phase C
Phase B
PM motor
MJ-A
RA
MJ-B
RB
MJ-C
RC