(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 November 2007 (08.11.2007)

PCT

(10) International Publication Number
WO 2007/126251 A1

(51) International Patent Classification:
H02K 17/30 (2006.01)

(21) International Application Number:
PCT/KR2007/002051

(22) International Filing Date: 26 April 2007 (26.04.2007)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
10-2006-0039678 2 May 2006 (02.05.2006) KR

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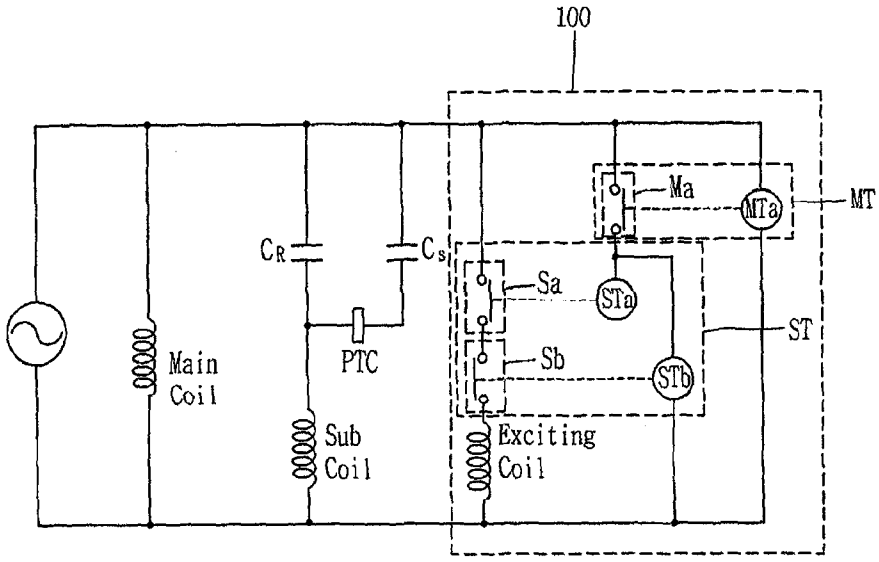
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** STARTING CONTROL APPARATUS AND METHOD FOR MOTOR



(57) **Abstract:** An exciting coil of a motor is formed to be controlled by using an analog timer to thus control an excitation control circuit of a motor control apparatus, whereby an excitation control circuit that excites an exciting coil of a motor control apparatus can be simplified and complexity can be reduced by simplifying a circuit construction of an excitation controller. The present invention includes: an auxiliary winding (sub-coil) and a main winding (main coil); and an exciting unit which is electrically connected with the auxiliary winding and the main winding, determines an excitation application time and an excitation time, and generates an excitation current according to the determined excitation application time and the excitation time.

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STARTING CONTROL APPARATUS AND METHOD FOR MOTOR

TECHNICAL FIELD

The present invention relates to a motor and, more particularly, to an apparatus and method for controlling starting of a motor capable of exciting an exciting coil by using an analog timer.

BACKGROUND ART

In general, in a motor used for a refrigerator, two exciter poles and an exciting coil are separately installed in a stator of a single-phase induction motor.

In the motor used for the refrigerator, two excitor polls and an exciting coil are separately installed at the stator in the single-phase induction motor including a core, a main winding (main coil) and an auxiliary winding (sub-coil).

A rotor of the motor used for the refrigerator includes a magnetic material that facilitates magnetizing and demagnetizing.

An excitation control circuit of the motor used for the refrigerator is a circuit that controls the exciting coil in order to magnetize the magnetic material.

The excitation control circuit includes a feedback coil, a capacitor, a speed response switch and an external controller.

FIG. 1 is schematic view showing the structure of the motor used for

the refrigerator according to the related art, which includes a stator 20 and a rotor 40 having a magnetic material.

Here, the operation of the apparatus for controlling the motor of the refrigerator according to the related art will now described.

First, the control apparatus controls such that power is applied to the main winding and the auxiliary winding of the stator 20 of the motor, according to which the rotor 40 is rotated by the power applied to the main winding and the auxiliary winding.

Next, when the rotor 40 reaches a certain speed (synchronous speed 75% to 80%), the exciting coil is excited to magnetize the magnetic material 30 to the rotor 40.

The apparatus for controlling the motor used for the refrigerator as described above is discriminated from an electronic control apparatus that controls an operation of the refrigerator.

Thus, the motor control apparatus and the electronic control apparatus of the refrigerator, each including a complicated controller circuit, increase complexity in constructing a system of the refrigerator.

DISCLOSURE OF THE INVENTION

Therefore, an object of the present invention is to provide an apparatus and method for controlling starting of a motor capable of simplifying an excitation control circuit that excites an exciting coil of a motor control apparatus and reducing complexity by simplifying a circuit construction of an excitation controller such that the exciting coil is controlled by using an analog

timer to thus control the excitation control circuit.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided an apparatus for controlling starting of a motor including: an auxiliary winding (sub-coil) and a main winding (main coil); and an exciting unit which is electrically connected with the auxiliary winding and the main winding, determines an excitation application time and an excitation time, and generates an excitation current according to the determined excitation application time and the excitation time.

Here, the exciting unit includes: a main contact that allows power to be supplied to a timer; an auxiliary contact that allows power to be supplied to an exciting coil; and a timer that controls switching of the main contact and the auxiliary contact to allow power supply to the exciting coil to be cut off or to be supplied.

To achieve the above object, there is also provided a method for controlling starting of a motor including: a first step of turning on a timer of a main contact 'a' during a certain time period; and a second step of turning on a timer of an auxiliary contact 'a' and a timer of an auxiliary contact 'b', after the timer of the main contact 'a' is operated for a certain time period, in order to supply power to an exciting coil for a certain time period.

To achieve the above object, there is also provided a method for controlling starting of a motor including: a first step of operating a timer of a main contact 'a' during a pre-set operation time; and a second step of operating a timer of an auxiliary contact 'a' and a timer of an auxiliary contact

'b' during the pre-set time period to supply power to an exciting coil during a certain time period, after the timer of the main contact 'a' is operated during the pre-set operation time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing the structure of a motor of a refrigerator according to the related art;

FIG. 2 is a circuit diagram showing the construction of an apparatus for controlling starting of a motor according to an exemplary embodiment of the present invention;

FIG. 3 is a view showing a speed-torque curved line of the motor with respect to the apparatus for controlling starting of the motor according to the exemplary embodiment of the present invention; and

FIG. 4 is a graph showing operation timings of timers with respect to the apparatus for controlling starting of the motor according to the exemplary embodiment of the present invention.

MODES FOR CARRYING OUT THE PREFERRED EMBODIMENTS

An apparatus and method for controlling starting of a motor capable of simplifying an excitation control circuit that excites an exciting coil of a motor control apparatus and reducing complexity by simplifying a circuit construction of an excitation controller such that the exciting coil is controlled by using an analog timer to thus control the excitation control circuit, according to the exemplary embodiment of the present invention will now be described with

reference to FIGs. 2 to 4.

By including a magnetic material that can be magnetized in a rotor with a bar conductor, the motor can be operated as an inductor motor until speed of the rotor reaches a synchronous speed of a rotation magnetic field, and can be applicable to an excitation motor that magnetizes the magnetic material to reach the synchronous speed of the rotation magnetic field.

FIG. 2 is a circuit diagram showing the construction of an apparatus for controlling starting of a motor according to an exemplary embodiment of the present invention.

As shown in FIG. 2, it includes a main coil, a sub-coil, a starting capacitor Cs, an operation capacitor Cr, and an exciting unit 100.

In order to start the rotor of the self-magnetizing motor, the starting capacitor Cs applies a current with a fast phase to the sub-coil, and accordingly, the rotor is started by a magnetic field generated from the sub-coil and an induction current.

The operation capacitor Cr applies a current with a phase slower by 90° than the current flowing at the sub-coil, and accordingly, a rotation magnetic field is generated from the stator by the current flowing at the main coil, and thus, the rotor is rotated upon receiving power continuously.

The exciting unit 100 applies a strong current through the exciting coil only when it magnetizes the magnetic material.

Here, the exciting unit 100 includes a timer that cuts off power supply to the exciting coil or allows power to be provided to the exciting coil.

The timer includes a main timer (MT) that controls excitation

application time, and an auxiliary timer (sub-timer) (ST) that determines an excitation time for supplying power to the exciting coil.

The main timer MT includes a main contact 'a' (Ma) that supplies power to the auxiliary timer ST and a main timer 'a' (MTa) that controls an excitation application time by controlling ON/OFF of the main contact 'a' (Ma).

The auxiliary timer ST includes an auxiliary contact 'a' (Sa) and an auxiliary contact 'b' (Sb) that allow power to be supplied to the exciting coil, and includes an auxiliary timer 'a' (STa) and an auxiliary timer 'b' (STb) that determine an excitation time by using a time difference of when the auxiliary contact 'a' (Sa) and the auxiliary contact 'b' (Sb) respectively become conductive.

Here, when the main timer MT and the auxiliary timer ST are operated for a certain time, they automatically return to their original state.

Namely, the apparatus for controlling starting of the motor determines the excitation application time and the excitation time by using the analog timers MT and ST.

The operation of the present invention will now be described.

First, in order to start the rotor of the self-magnetizing motor, the starting capacitor Cs applies a current with a fast phase to the sub-coil, and accordingly, the rotor is started by the magnetic field and an induction current generated from the sub-coil.

Next, the operation capacitor Cr applies a current with a phase slower by 90° than that of the current flowing at the sub-coil to the main coil, and accordingly, the stator generates a rotation magnetic field by the current

flowing at the main coil, so the rotor can be rotated upon receiving power continuously.

In this case, because the rotor body is made of a ferromagnetic substance of high permeability, the magnetic field generated by the main coil and the sub-coil magnetizes the rotor, and accordingly, the rotor is rotated upon receiving a hysteresis torque (H) by a hysteresis effect as shown in FIG. 3.

Namely, as shown in FIG. 3, the rotor receives the hysteresis torque (H) and an induction torque (I) so as to be rotated.

If the speed of the rotor becomes the same as a synchronous speed (3,600rpm) of the rotation magnetic field, the rotor is always slower than the synchronous speed of the rotation magnetic field. Namely, a slip phenomenon occurs.

At this time, when a strong current is applied to the exciting coil, a strong magnetic flux generated by the exciting coil is transferred to a magnetic material surrounding an outer circumferential surface of the rotor to magnetize the magnetic material.

Then, the magnetic material is magnetized to become a permanent magnet which is rotated along the rotation magnetic field which has been already generated at the stator.

In this case, although the rotation speed of the rotor is gradually increased to be the same as the synchronous speed of the rotation magnetic field, the permanent magnet can be continuously rotated along the rotation magnetic field, so the rotary force of the rotor will not be reduced.

That is, the self-magnetizing motor according to the present invention undergoes two-stage rotation process: It is rotated by the induction torque (I) and the hysteresis torque (H) at the low speed stage, and then, when it enters the high speed stage (synchronous speed: 3,600 rpm), the exciting coil magnetizes the magnetic material so that the self-magnetizing motor can be rotated by the magnetization torque (P).

In this case, because the strong current needs to be applied through the exciting coil only at the instant the magnetic material is magnetized, a heat loss that may be possibly generated at the coil when the strong current is continuously applied can be reduced and thus the motor efficiency can be increased.

Here, in the present invention, the strong current is applied through the exciting coil only at the instant when the magnetic material is magnetized by using the exciting unit 100.

The operation of the exciting unit 100 will now be described with reference to FIG. 4.

First, when power is applied, the timer (MTa) of the main contact 'a' (Ma) is operated, and when a certain time (Ton) lapses after the main contact 'a' (Ma) is operated, the main contact 'a' (Ma) enters a closed state from an opened stated.

When the main contact 'a' (Ma) is in the closed state, the timer (STa) of the auxiliary contact 'a' (Sa) and the timer (STb) of the auxiliary contact 'b' (Sb) are operated.

When the operation time of the timer (STa) of the auxiliary contact 'a'

(Sa) reaches a certain time (Ta), the auxiliary contact 'a' (Sa) enters the closed state from the opened state.

Simultaneously when the timer (STb) of the auxiliary contact 'b' (Sb) is operated, the auxiliary contact 'b' (Sb) enters the closed state from the opened state, and when the operation time of the timer (STb) of the auxiliary contact 'b' (Sb) reaches a certain time (Tb), the auxiliary contact 'b' (Sb) enters the opened state from the closed state.

Accordingly, the excitation application time for applying power to the exciting coil is 'Ton', and the excitation time is Tex=Tb-Ta-1 Cycle'.

The excitation application time and the excitation time will be described in detail as follows.

First, when power is applied at steps 0 to 3 and the main timer (MT) is operated to be turned on, the main contact 'a' (Ma) is in the opened state during a certain time (Ton).

Next, when the certain time (Ton) lapses at steps 3 to 5, the main contact 'a' (Ma) is closed.

In addition, the auxiliary contacts 'a' and 'b' (Sa and Sb) are operated so that the auxiliary timer 'a' (STa) is turned on and the auxiliary contact 'a' (Sa) is maintained to be in the opened state while the auxiliary timer 'b' (STb) is turned on and the auxiliary contact 'b' (Sb) is maintained to be in the closed state.

Thereafter, when the auxiliary timer 'a' (STa) is turned on and the auxiliary contact 'a' (Sa) is closed at steps 5 and 6, an excitation current is applied to the exciting coil through the auxiliary contact 'b' (Sb) during one

cycle.

And then, when the auxiliary timer 'b' (STb) is turned on at steps 6 to 8, the auxiliary contact 'b' (Sb) is changed from the closed state to the opened state, and accordingly, the excitation current applied to the exciting coil is cut off.

Here, the main contact 'a' (Ma), the auxiliary contact 'a' (Sa) and the auxiliary contact 'b' (Sb) are formed of a relay(s) or bi-directionally conductive power semiconductor.

Namely, in the present invention, without having to a high-priced electronic control device, the excitation application time and the excitation time for supplying power to the exciting coil can be determined by using the analog timer.

As so far described, the apparatus and method for controlling starting of the motor according to the present invention has such an advantage that because exciting coil of the motor is controlled by using the analog timer to control the excitation control circuit of the motor controlling apparatus, the excitation control circuit for exciting the exciting coil can be simplified, and in addition, because the excitation control circuit for exciting the exciting coil and the component construction of the excitation controller are simplified, the complexity can be reduced.

CLAIMS

1. An apparatus for controlling starting of a motor comprising:

a sub-coil and a main coil; and

an exciting unit which is electrically connected with the sub-coil and the main coil, determines an excitation application time and an excitation time, and generates an excitation current according to the determined excitation application time and the excitation time.

2. The apparatus of claim 1, wherein the exciting unit comprises:

a main contact that allows power to be supplied to a timer;

an auxiliary contact that allows power to be supplied an exciting coil; and

a timer that controls switching of the main contact and the auxiliary contact to allow power supply to the exciting coil to be cut off or to be supplied.

3. The apparatus of claim 2, wherein the timer comprises:

a main timer that controls the excitation application time; and

an auxiliary timer that determines an excitation time for supplying power to the exciting coil.

4. The apparatus of claim 3, wherein the main timer comprises:

a main contact 'a' that allows power to be supplied to the auxiliary

timer; and

a main timer 'a' that controls the excitation application time by controlling ON/OFF of the main contact 'a'.

5. The apparatus of claim 3, wherein the auxiliary timer comprises:

auxiliary contacts 'a' and 'b' that allow power to be supplied to the exciting coil; and

auxiliary timers 'a' and 'b' that determine the excitation time by using a time difference of when the auxiliary contact 'a' and the auxiliary contact 'b' respectively become conductive.

6. The apparatus of claim 3, wherein when the main timer is operated for a certain time period, it automatically returns to its original state.

7. The apparatus of claim 3, wherein when the auxiliary timer is operated for a certain time period, it automatically returns to its original state.

8. The apparatus of claim 1, wherein the timer comprises:

a main contact 'a' that allows power to be supplied to the auxiliary timer;

a main timer that controls an excitation application time for controlling conducting of the main contact 'a';

auxiliary contacts 'a' and 'b' that allow power to be supplied to the exciting coil; and

an auxiliary timer that determines the excitation time by using a time difference between the auxiliary contacts 'a' and 'b'.

9. The apparatus of claim 8, wherein the contact 'a' is formed of a relay or a bi-directionally conductive power semiconductor.

10. The apparatus of claim 8, wherein the auxiliary contact 'a' is formed of a relay or a bi-directionally conductive power semiconductor.

11. The apparatus of claim 8, wherein the auxiliary contact 'b' is formed of a relay or a bi-directionally conductive power semiconductor.

12. A method for controlling starting of a motor comprising:

a first step of turning on a timer of a main contact 'a' during a certain time period; and

a second step of turning on a timer of an auxiliary contact 'a' and a timer of an auxiliary contact 'b', after the timer of the main contact 'a' is operated for a certain time period, in order to supply power to an exciting coil for a certain time period.

13. The method of claim 12, wherein the second step of supplying power to the exciting coil for a certain time period comprises:

simultaneously operating the timers of the auxiliary contacts 'a' and 'b' for a certain time period.

14. The method of claim 12, further comprising:

previously setting the operation time of the timer of the main contact 'a' and the timer of the auxiliary contact 'b'.

15. The method of claim 12, wherein the contact 'a' is formed of a relay or a bi-directionally conductive power semiconductor.

16. The method of claim 12, wherein the auxiliary contact 'a' is formed of a relay or a bi-directionally conductive power semiconductor.

17. A method for controlling starting of a motor comprising:

a first step of operating a timer of a main contact 'a' during a pre-set operation time; and

a second step of operating a timer of an auxiliary contact 'a' and a timer of an auxiliary contact 'b' during the pre-set time period to supply power to an exciting coil during a certain time period, after the timer of the main contact 'a' is operated during the pre-set operation time.

18. The method of claim 17, wherein the second step of supplying power to the exciting coil for a certain time period comprises:

simultaneously operating the timers of the auxiliary contacts 'a' and 'b' for a certain time period.

19. The method of claim 17, wherein the main contact 'a' is formed of a

relay or a bi-directionally conductive power semiconductor.

20. The method of claim 17, wherein the auxiliary contact 'a' is formed of a relay or a bi-directionally conductive power semiconductor.

FIG. 1

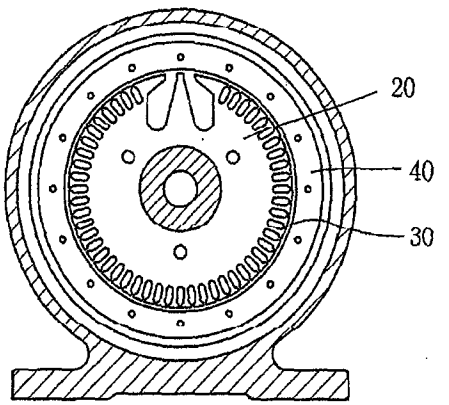
20
40
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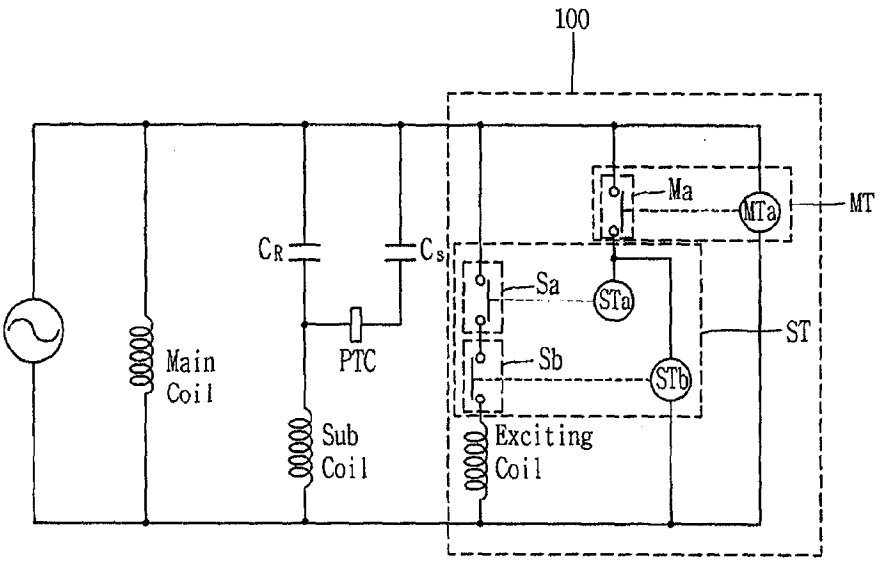
FIG. 2


100
Ma
MTa
MT
CR
Cs
Sa
STa
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PTC
Sb
STb
Sub
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Exciting
Coil

FIG. 3

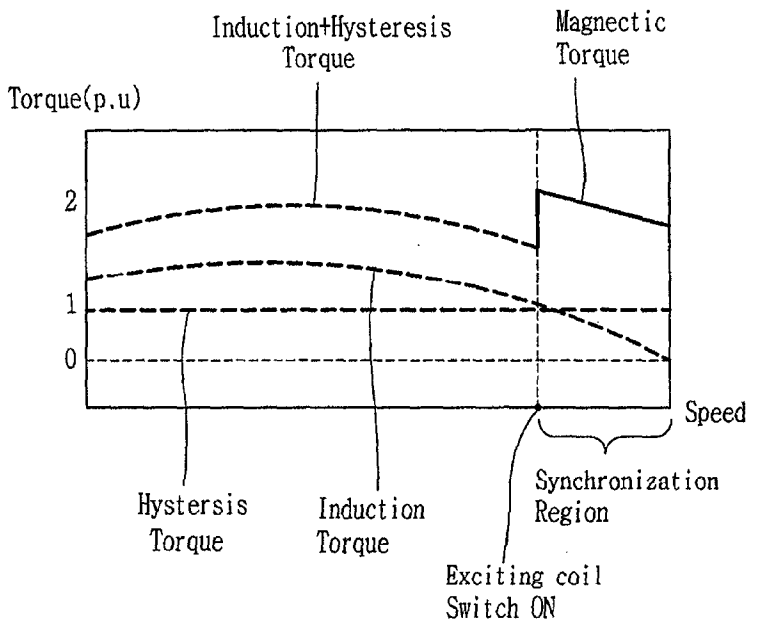
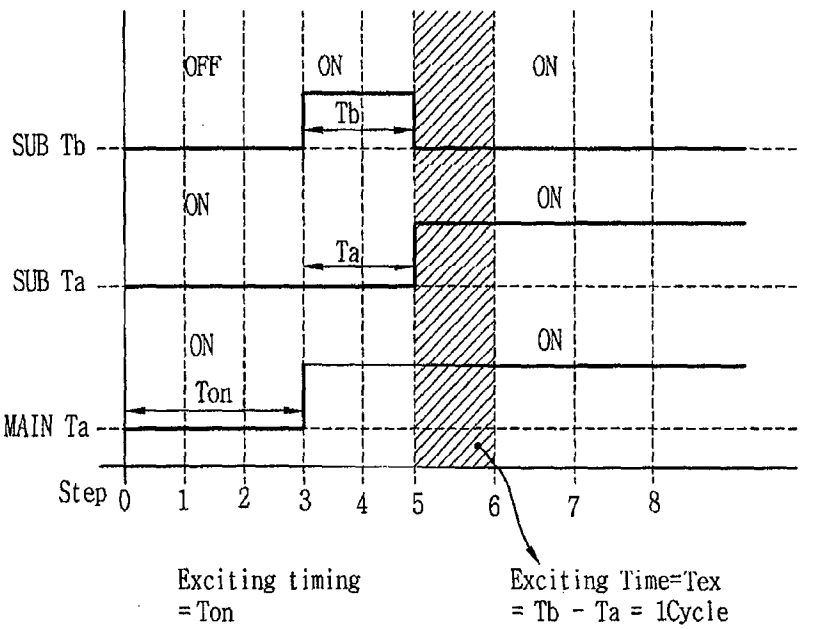

Induction+Hysteresis Torque
Magnectic Torque
Torque(p.u)
2
1
0
Speed
Hystersis Torque
Induction Torque
Synchronization Region
Exciting coil Switch ON

FIG. 4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ON
ON
Tb
SUB Tb
ON
ON
Ta
SUB Ta
ON
ON
Ton
MAIN Ta
Step 0 1 2 3 4 5 6 7 8
Exciting timing = Ton
Exciting Time=Tex = Tb - Ta = 1Cycle

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/002051

A. CLASSIFICATION OF SUBJECT MATTER

H02K 17/30(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: H02K 17/30, 29/03, 29/08, H02P 1/24, 1/42, 3/18, 5/28, 6/10, 6/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility Models since 1975

Japanese Utility models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) "motor", "control", "start", "main coil", "sub coil"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2006-0024970 A (LG ELECTRONICS INC.) 20 March 2006 See the abstract; figure 3	1-20
A	US 5574342 A (OKAMOTO, KENJIRO) 12 November 1996 See the abstract; figures 2, 4	1-20
A	US 6841967 B2 (LG ELECTRONICS INC.) 11 January 2005 See the abstract; figures 2, 3	1-20
A	JP 07-322676 A (NIPPON DENSAN CORP.) 08 December 1995 See the abstract; figures 1, 3	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search	Date of mailing of the international search report
20 AUGUST 2007 (20.08.2007)	**20 AUGUST 2007 (20.08.2007)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/002051

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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