



Delegatura de Propiedad Industrial

División de Nuevas Creaciones

SOLICITUD

PATENTE DE INVENCION

03-29529

21. EXPEDIENTE No.

54. TÍTULO

Unidad de control de salida para
generador sincrónico

51. CLASIFICACIÓN INTERNACIONAL H02 P 9/48

71. SOLICITANTE HONDA GIKEN KOGYO KABUSHIKI KAISHA

DOMICILIO Tokio, Japón

74. APODERADO Humberto Rubio Camacho

22. BOGOTÁ, D. C., Abril 08 de 2003

202038



PETITORIO

FORMULARIO ÚNICO DE SOLICITUD DE PATENTE
PCT
ENTRADA EN FASE NACIONAL

① SOLICITUD DE:
☒ Patente de Invención ☐ Patente de Modelo de Utilidad

Capítulo I

☒ Capítulo II

② SOLICITANTE (71)
Nombre: HONDA GIKEN KOGYO KABUSHIKI KAISHA IDENTIFICACIÓN
Dirección: 1-1, Minamiaoyama 2-chome, Minato-ku C.C. NIT
Teléfono: 3132408 Fax: 3131647 C.E. OTRO
E-mail: Número
Domicilio: Tokio, Japón
Lugar de constitución: JAPÓN

③ REPRESENTANTE O APODERADO (74)
Nombre: HUMBERTO RUBIO CAMACHO IDENTIFICACIÓN
Dirección: Carrera 7 No. 74 - 64, Of. 506 C.C. ☒ NIT
Teléfono: 3132408 Fax: 3131647 C.E. OTRO
E-mail: No. 17'192.062 T.P. 50.007 CSJ

INVENTOR(ES) (72)
Nombre: Atsuo OTA IDENTIFICACIÓN
Satoshi HONDA C.C. NIT
Dirección: 4-1, Chuo 1-chome, Wako-shi C.E. OTRO
Teléfono: 3132408 Fax: 3131647 Número
E-mail:
Domicilio: SAITAMA, JAPÓN

PCT (86)
Solicitud Internacional No. 2000-310769 Fecha 11 DE OCTUBRE DE 2.000
Publicación Internacional No. WO 02/31960 A1 Fecha 18 DE ABRIL DE 2.002

⑥ TÍTULO (54) UNIDAD DE CONTROL DE SALIDA PARA GENERADOR
SÍNCRONO

⑦ Clasificación Internacional (51) H 02 P 5/20

⑧ Prioridad (33) País de origen (32) Fecha (31) Número de solicitud
SI ☒ NO
PCT 10 DE OCTUBRE DE 2.001 PCT/JP01/08873
JAPONESA 11 DE OCTUBRE DE 2.000 2000-310769

⑨ Comprobante de pago No. 16,842 Fecha: 11 DE MARZO DE 2.002
1,095 08 DE ENERO DE 2.003
23,297 01 DE ABRIL DE 2.003
23,298 01 DE ABRIL DE 2.003

- ☒ Comprobante de pago de la tasa de presentación de la solicitud.
- ☐ Comprobante de pago de la tasa por concepto de excedente de palabras en la publicación.
- ☒ Comprobante de pago por reivindicación de prioridad.
- ☐ Certificado de existencia y representación legal cuando el solicitante sea persona jurídica
- ☒ Poderes, si fuere el caso. *Protocolo No. 17334 de 20/03/1997.*
- ☐ Copia de la solicitud PCT
- ☒ Publicación de la solicitud ante OMPI
- ☒ Copia del reporte de la búsqueda internacional
- ☒ Copia certificada de la primera solicitud, si se reivindica prioridad.
- ☒ Traducción simple de la primera solicitud, si se reivindica prioridad.
- ☒ Documento de cesión del inventor al solicitante o a su causante.
- ☐ Descripción de la invención.
- ☐ Una o más reivindicaciones.
- ☒ Dibujos y/o planos necesarios.
- ☐ Texto completo al castellano, con las reivindicaciones modificadas según el artículo 19
- ☐ Texto al castellano de la solicitud PCT, tal y como fue presentada
- ☐ De ser el caso, copia del contrato de acceso.
- ☐ De ser del caso, documento que acredite la licencia o autorización de uso de conocimientos tradicionales de las comunidades indígenas.
- ☐ De ser el caso, certificado de depósito del material biológico.
- ☒ Arte final 12 x 12

(11) Figura característica:

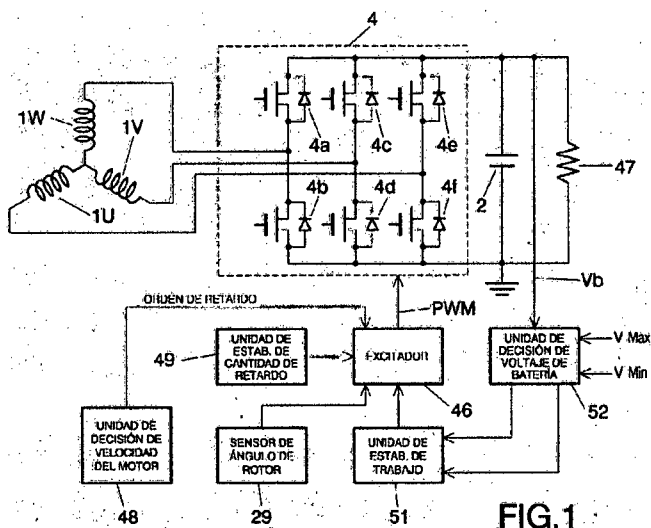


FIG. 1

(12)

HUMBERTO RUBIO CAMACHO

FIRMA

Brevi

C.C. 17'192.062 de Bogotá

T.P. 50.007 Consejo Superior de La Judicatura

PARA USO EXCLUSIVO DE
HUMBERTO RUBIO & CIA. LTDA

SUPERINDUSTRIA Y COMERCIO
Radicacion : 03029529 00000000 Folios: 168
Fecha (AMD): 2003-04-08 15:25:33
Tramite : 011 PCT-PATENT 379 FASE NACI 411 PRESENTAC
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

4
cio

CIA

**REGISTRO
PATENTE DE INVENCION: "UNIDAD
DE CONTROL DE SALIDA PARA
GENERADOR SINCRONO"**

NIT : 890176089-2

RECIBO OFICIAL DE CAJA : 02 - 16,842
FECHA : MARZO 11 DE 2002

***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	Nº. PAGO	FECHA PGO	Vr. PAGO
HUMBERTO RUBIO CAMACHO	CONSIGNACION	BANCO POPULAR	050-00110-6	2407614	11/03/2002	11.145.000.00

***** C O N C E P T O *****

CANT. REENTISTADO	CONCEPTO	TOTAL CONCEPTO
1 50005-01-01 SOLICITUDES	1 TRAMITES DE SOL. DE PATENTE DE IN	378.000.00
	TOTAL :	378.000.00

CON: CIENTOS SETENTA Y OCHO MIL PESOS

RESPONSABLE :

RECIBO DE CAJA APLICADO AL EXPEDIENTE N°.

Carrera 13 No. 27-00 Pisos 5, 7 y 10
Conmutador 382 0840
Fax 350 5220
E-mail: info@sic.gov.co
www.sic.gov.co
Bogotá, D.C., Colombia

NIT : 800175099-2

SUPERINDUSTRIA Y COMERCIO

Radicacion : 0302529 0000000

Folios: 168

Fecha (AMD): 2003-04-08 15:25:33

Tramite : 011 PCT-PATENT 379 FASE NACI 411 PRESENTAC

Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

CERTIFICACION DE EXCEDENTE : 03 - 1,095
FECHA : ENERO 8 DE 2003

PARA USO EXCLUSIVO DE
HUMBERTO RUBIO & CIA. LTDA

***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	Nº. PAGO	FECHA PGO	Vr. PAGO
HUMBERTO RUBIO CAMACHO	CONSIGNACION	BANCO POPULAR	050-00110-6			
HUMBERTO RUBIO CAMACHO	CONSIGNACION	BANCO POPULAR	050-00110-6			

REGISTRO
PATENTE DE INVENCION: "UNIDAD DE CONTROL DE SALIDA PARA GENERADOR SINCRONO"
31 DE 8706458 00.00 300.00

***** CONCEPTO *****

SANT. RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1 50005-01-09 OTROS SERVICIOS DE PROPIEDAD I	99 OTROS SERVICIOS ADMINISTRATIVOS	22,000.00
	TOTAL :	\$ 22,000.00

CON: VEINTIDOS MIL PESOS

RESPONSABLE :

RECIBO DE CAJA APLICADO AL EXPEDIENTE N°. _____

ESTA CERTIFICACION DE EXCEDENTE DE PAGO SOLO PODRA SER UTILIZADA
COMO PARTE DE LA CANCELACION DE UNA TARIFA VIDENTE Y NO PODRA SER
SUSTITUIDA POR NINGUN RECIBO.

Carrera 13 No. 27-00 Pisos 5 y 10
Conmutador: 334 12 21
Fax: 281 31 25
Santa Fe de Bogotá, D.C., Colombia

PARA USO EXCLUSIVO DE
HUMBERTO RUBIO & CIA. LTDA

6
SUPERINDUSTRIA Y COMERCIO
Radicacion : 03029529 00000000
Fecha (AMD): 2003-04-08 15:25:33
Folios: 168
Tramite : 011 PCT-PATENT 373 FASE NACI 411 PRESENTAC
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

**REGISTRO
PATENTE DE INVENCION: "UNIDAD
DE CONTROL DE SALIDA PARA
GENERADOR SINCRONO"**

NIT : 800176089-2

RECIBO OFICIAL DE CAJA : 03 - 23,297
FECHA : ABRIL 1 DE 2003

***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PAGO	Vr. PAGO
TINIKE STOL	CONSIGNACION	BANCO POPULAR	050-00110-6	3121561	01/04/2003	3,120,000.00

***** CONCEPTO *****

CANT.	RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1	50005-01-01 SOLICITUDES	82 INVOCACION DE UNA PRIORIDAD EN NU	112,000.00
		TOTAL :	\$ 112,000.00

SON: CIENTO DOCE MIL PESOS

RESPONSABLE :

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

1991,22 - 30 : ALAS 50 LAIDIRG 081355
1991 30 / JIRGA : ANGEL

0-10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

DEPOSIT DATE	1990	BANK	CURRENT	NO. PAGE	FECHA PAG	VOL. PAG
THIRTE STOL	CONDEMINACION	BANCO POPULAR	080-00110-8	3215781	01/03/9003	2,130,000.00

0793107

IT-30000 JATBT 07130400 BEITG17H36 17440

00.000.000 80 INNOVATION DE NOUVEAUX PRODUITS EN MO
113.000.000 TOTAL

2025 JAN 2004 01000

[illegible][illegible]

PARA USO EXCLUSIVO DE
HUMBERTO RUBIO & CIA. LTDA

7
SUPERINDUSTRIA Y COMERCIO
Radicacion : 03029529 00000000 Folios: 163
Fecha (AMD): 2003-04-01 15:25:33
Tramite : 011 PCT-PATENT 373 FASE NACI 411 PRESENTA
Dependencia: 2020 DIVISION DE NUEVAS CREACIONES

NIT : 800176089-2

**REGISTRO
PATENTE DE INVENCION: "UNIDAD
DE CONTROL DE SALIDA PARA
GENERADOR SINCRONO"**

RECIBO OFICIAL DE CAJA : 03 - 23,298
FECHA : ABRIL 1 DE 2003

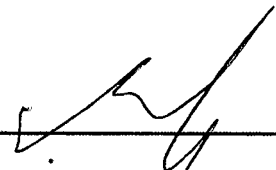
***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PGO	Vr. PAGO
TINIKE STOL	CONSIGNACION	BANCO POPULAR	050-00110-6	3121561	01/04/2003	3,120,000.00

***** CONCEPTO *****

CANT. RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1 50005-01-01 SOLICITUDES	82 INVOCACION DE UNA PRIORIDAD EN NI	112,000.00
	TOTAL :	\$ 112,000.00

SON: CIENTO DOCE MIL PESOS

RESPONSABLE : 

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

WIT : 800176029-2

RECIBO OFICIAL DE CAJA : 02 - 22, 1985
FECHA : ABRIL : 02 2002

***** COMISIONACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CHEQUE	Nº. PAGOS	FECHA PAGO	VAL. PAGO
THIKE STOP	COMISIONACION	BANCO POPULAR	020-00110-4	2157591	01/04/2002	2,150,000.00

***** COMISIONACION *****

CANT. REMITIDO	CONCEPTO	TOTAL CONCEPTO
----------------	----------	----------------

1 20002-01-01 SOLICITUDES 115,000.00
TOTAL : 115,000.00

RECIBO OFICIAL DE CAJA

RESPONSABLE :

RECIBO DE CASH APLICADO AL EXPEDIENTE Nº.

(12)特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局(43) 国際公開日
2002 年 4 月 18 日 (18.04.2002)

PCT

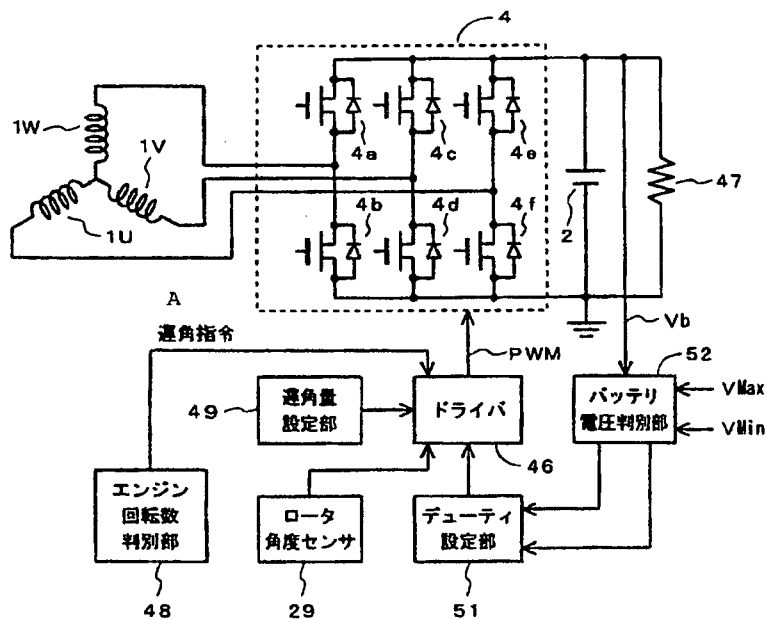
(10) 国際公開番号
WO 02/31960 A1

- (51) 国際特許分類: H02P 9/48 (71) 出願人: 本田技研工業株式会社 (HONDA GIKEN KOGYO KABUSHIKI KAISHA) [JP/JP]; 〒107-8556 東京都港区南青山二丁目1番1号 Tokyo (JP).
- (21) 国際出願番号: PCT/JP01/08873 ✓
- (22) 国際出願日: 2001 年 10 月 10 日 (10.10.2001) (72) 発明者: 大田淳朗 (OTA, Atsuo), 本田 聡 (HONDA, Satoshi); 〒351-0193 埼玉県和光市中央一丁目4番1号 株式会社 本田技術研究所内 Saitama (JP).
- (25) 国際出願の言語: 日本語
- (26) 国際公開の言語: 日本語 (74) 代理人: 田中香樹, 外 (TANAKA, Koji et al.); 〒160-0023 東京都新宿区西新宿三丁目3番23号 ファミール西新宿403号 Tokyo (JP).
- (30) 優先権データ:
特願 2000-310769
2000 年 10 月 11 日 (11.10.2000) JP (81) 指定国 (国内): BR, CO, ES, ID, IL, IN, KR, PH, TR, VN, ZA.

[続葉有]

(54) Title: OUTPUT CONTROL DEVICE OF SYNCHRONOUS GENERATOR

(54) 発明の名称: 同期発電機の出力制御装置



(57) Abstract: A generated energy is increased in a low-rotation region with an engine rotation kept stabilized. An engine rotating speed judging unit (48) detects the rotating speed of a rotor, and, when an engine's rotating speed is in a low-rotation region, a driver (46) subjects a rectifier (4) to delay angle energizing control to intensify a field magnetic flux and increase a generated energy. The driver (46) responds to a change in the polarity of a magnetic pole detected by a rotor angle sensor (29), and reads a delay amount stored in a delay angle amount setting unit (49) to subject a stator winding to delay angle energizing. The output voltage of the generator is so controlled as to converge to a value between voltage control values Vmax and Vmin lower than the regulated voltage of a regulator.

- A...DELAY ANGLE INSTRUCTION
49...DELAY ANGLE AMOUNT SETTING UNIT
46...DRIVER
52...BATTERY VOLTAGE JUDGING UNIT
48...ENGINE'S ROTATING SPEED JUDGING UNIT
29...ROTOR ANGLE SENSOR
51...DUTY SETTING UNIT

[続葉有]



添付公開書類:
— 国際調査報告書

2文字コード及び他の略語については、定期発行される各PCTガゼットの巻頭に掲載されている「コードと略語のガイダンスノート」を参照。

(57) 要約:

低回転域でエンジン回転の安定を保持しながら発電量を増大させること。エンジン回転数判別部(48)で回転子の回転数を検出し、エンジン回転数が低回転域にあったときに、ドライバ(46)で整流器(4)を遅角通電制御して界磁束を増加させ、発電量を増大させる。ドライバ(46)はロータ角度センサ(29)で検出された磁極の極性変化にตอบสนองし、遅角量設定部(49)に記憶された遅角量を読み出してステータ巻線に遅角通電する。発電機の実出力電圧はレギュレータのレギュレート電圧よりも低い電圧制御値 V_{MaxV} と V_{Min} との間に収斂するように制御される。

A



US005642021A

United States Patent [19]

Liang et al.

[11] Patent Number: 5,642,021

[45] Date of Patent: Jun. 24, 1997

[54] **METHOD AND SYSTEM FOR CONTROLLING AN ALTERNATOR TO OPTIMIZE DIRECT CURRENT OUTPUT**

[75] Inventors: Feng Liang, Canton; John Michael Miller, Saline; Xingyi Xu, Canton, all of Mich.

[73] Assignee: Ford Motor Company, Dearborn, Mich.

[21] Appl. No.: 566,749

[22] Filed: Dec. 4, 1995

[51] Int. Cl.⁶ H02P 5/20

[52] U.S. Cl. 318/146; 318/148; 318/154; 363/89

[58] Field of Search 318/146, 148, 318/154; 388/909; 307/10.1, 112, 120, 116, 139; 363/89, 52, 84; 322/59, 93

[56] References Cited

U.S. PATENT DOCUMENTS

3,984,750 10/1976 Pfeffer et al. 307/10.1 X
4,667,282 5/1987 Peterson 363/89

4,709,203 11/1987 Roux et al. 322/59 X
4,924,371 5/1990 Peterson 363/89
5,057,763 10/1991 Torii et al. 322/93 X
5,281,905 1/1994 Dhyanchand et al. 322/93 X
5,418,401 5/1995 Kaneyuki 307/10.1

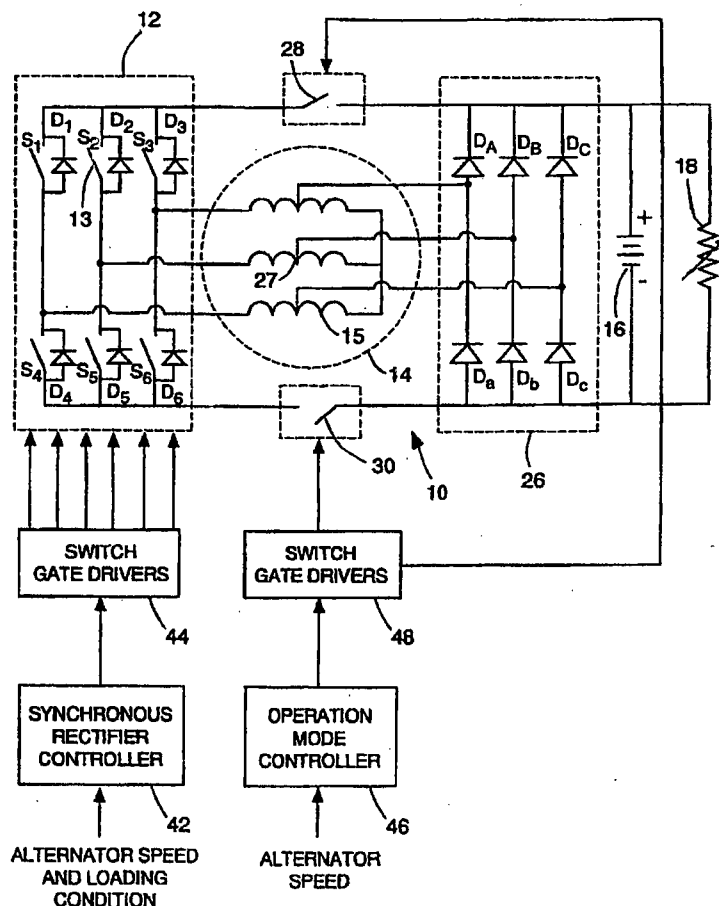
Primary Examiner—Karen Masih

Attorney, Agent, or Firm—Mark S. Sparschu; Roger L. May

[57] ABSTRACT

A method and system for maximizing the output of an alternator in an automotive vehicle. An alternator is provided having a first rectifier connectable to a first output of the alternator to form a first winding configuration and a second rectifier connectable to a second output of the alternator to form a second winding configuration. Based on the speed of the alternator, a controller operatively couples one of the first and second rectifiers to the first and second outputs, respectively, so as to maximize output current of the alternator. If the speed of the alternator is below a predetermined speed range, the controller couples the first output of the alternator to the first rectifier. Alternatively, if the speed of the alternator is above the predetermined speed range, the controller couples the second output of the alternator to the second rectifier.

16 Claims, 5 Drawing Sheets



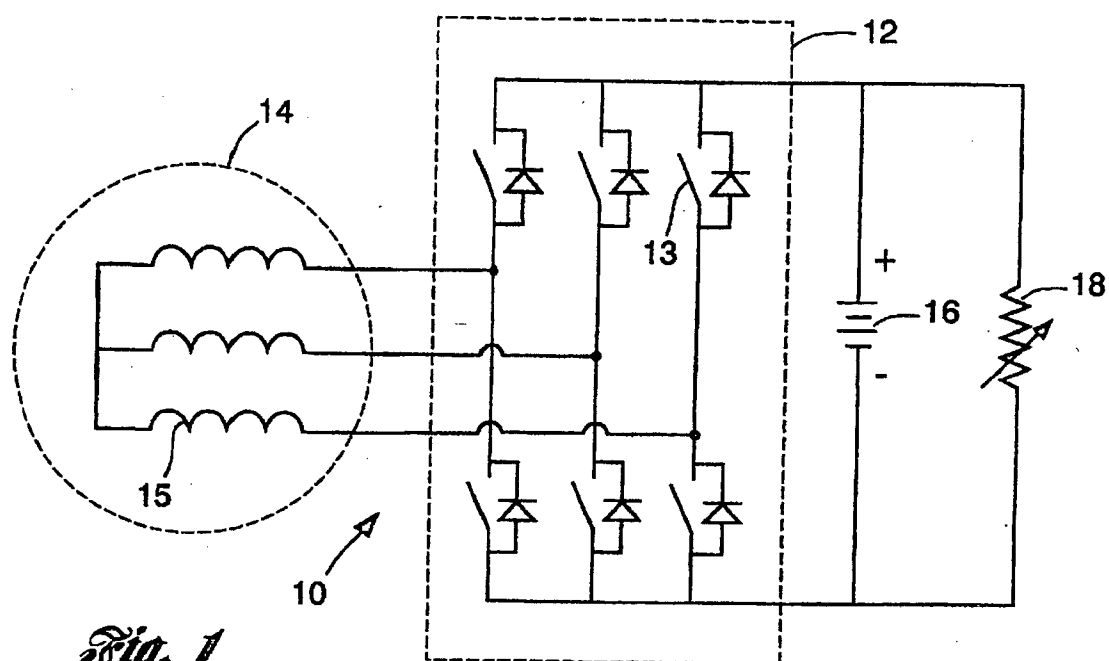


Fig. 1

OUTPUT CURRENT (A)

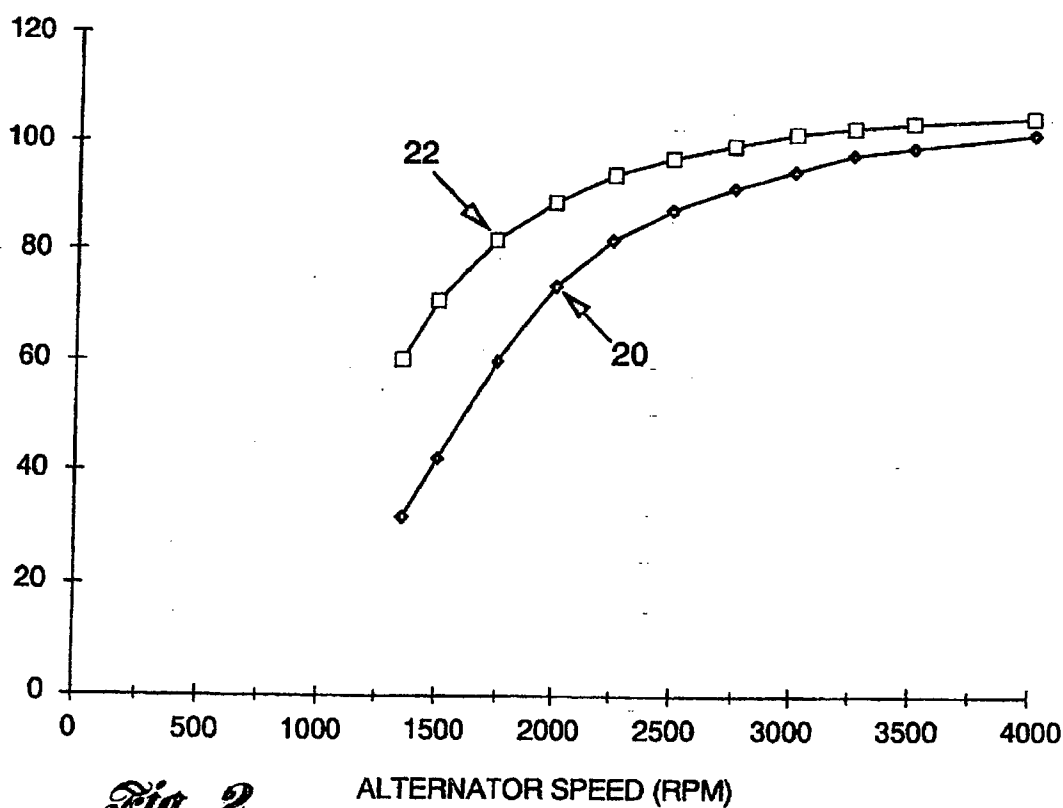


Fig. 2

ALTERNATOR SPEED (RPM)

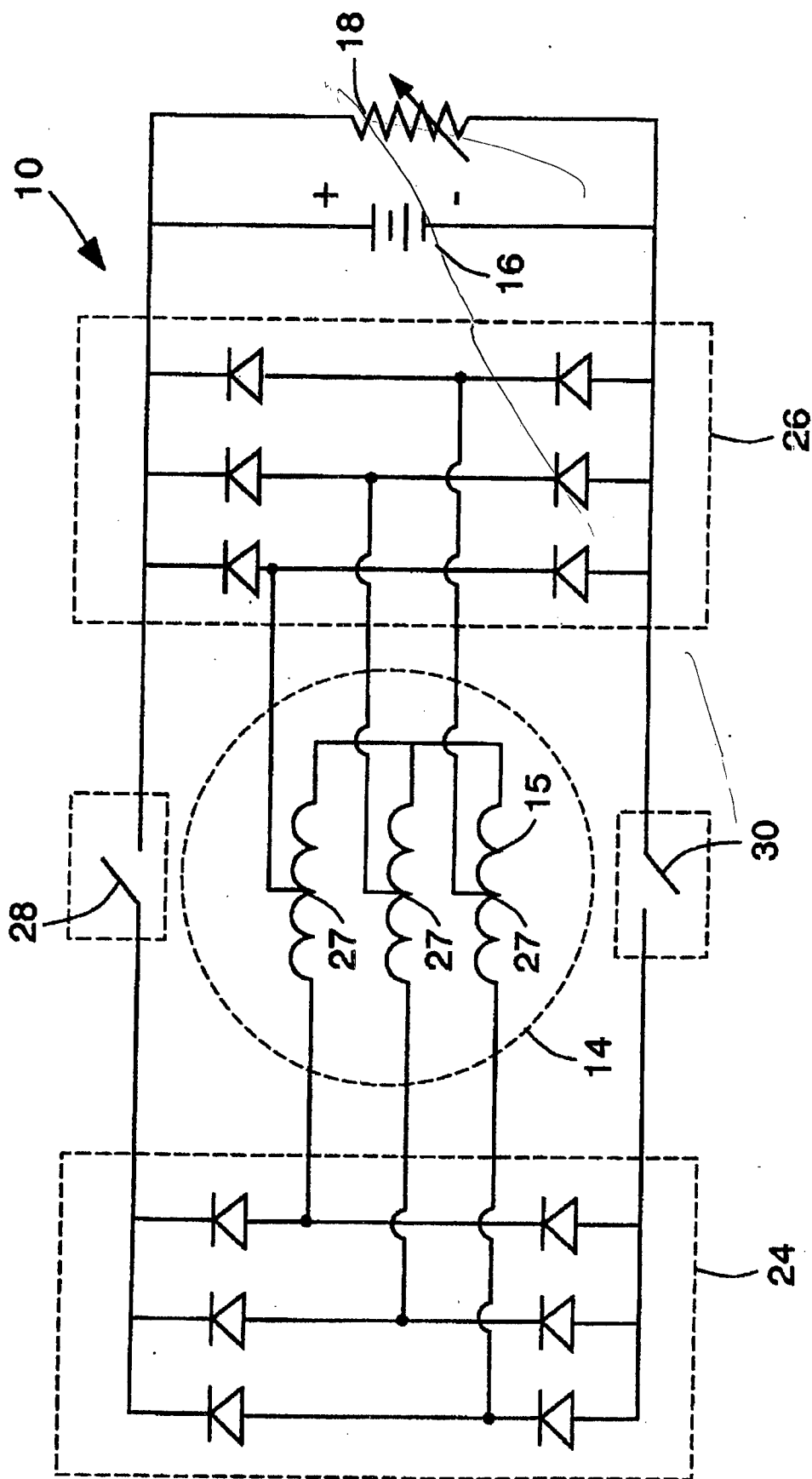
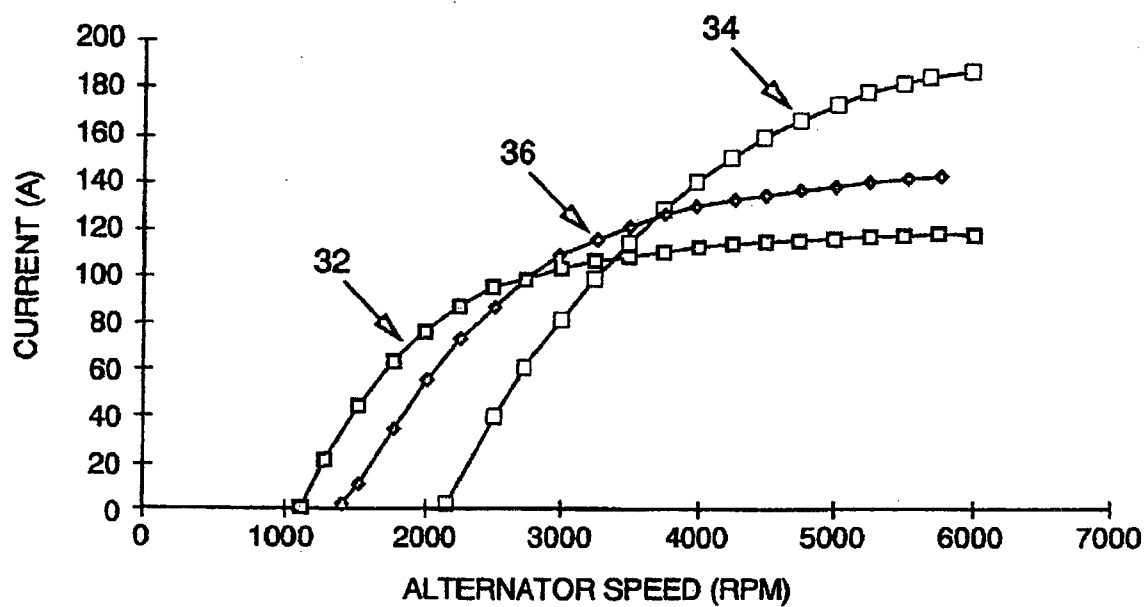


Fig. 3

*Fig. 4*

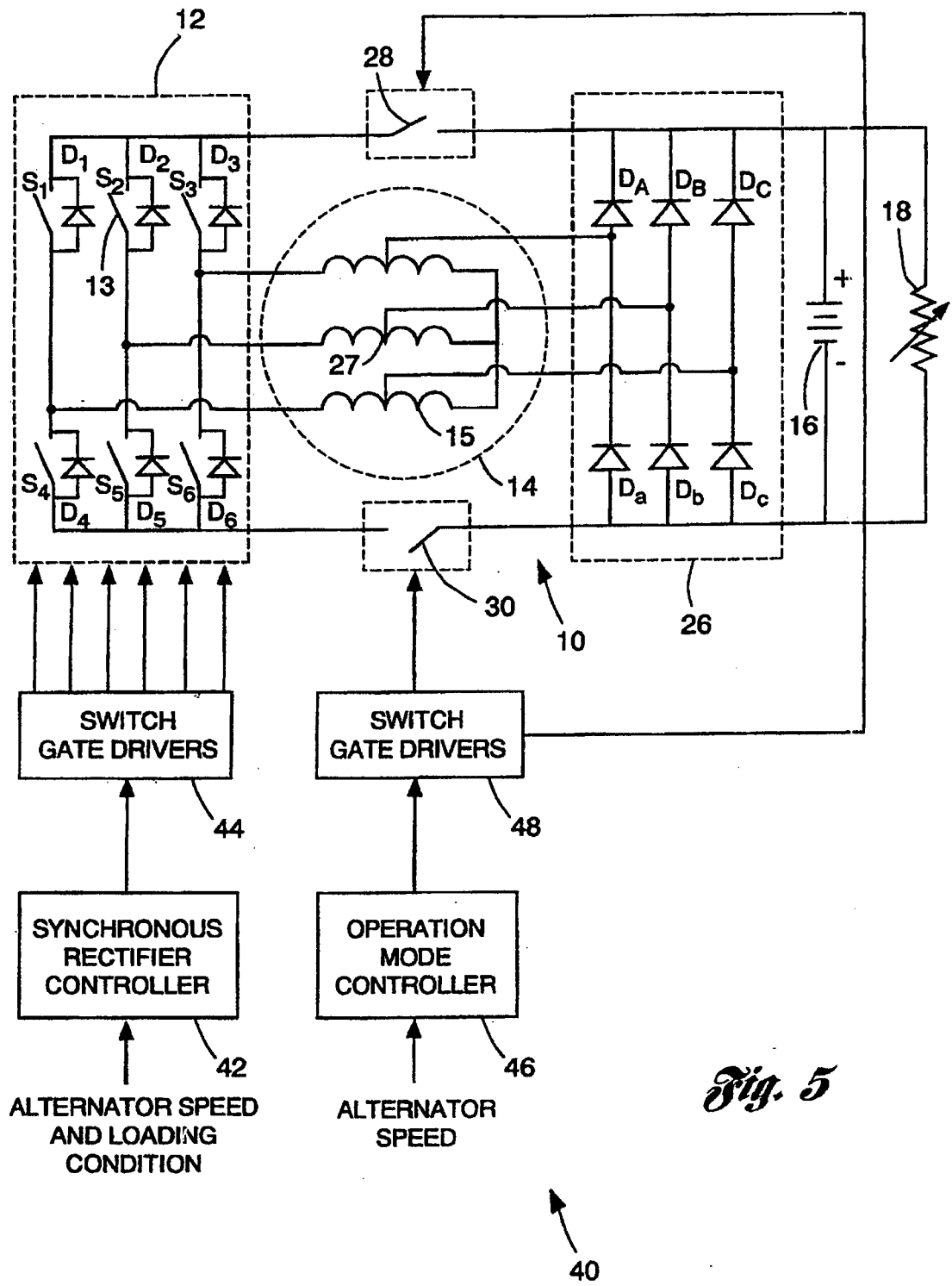


Fig. 5

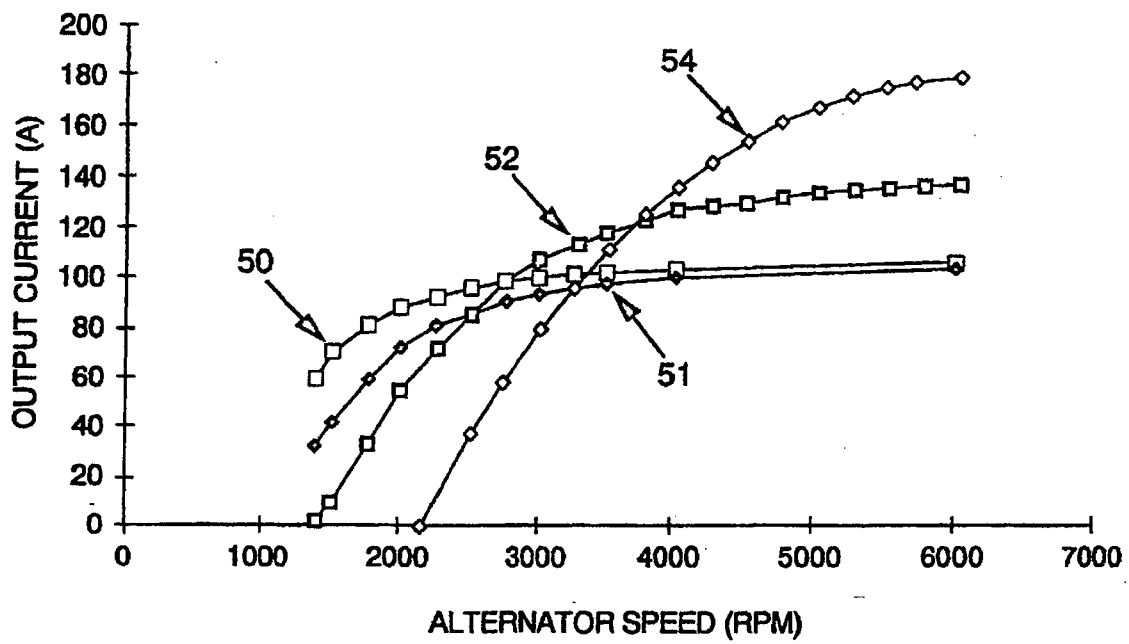


Fig. 6

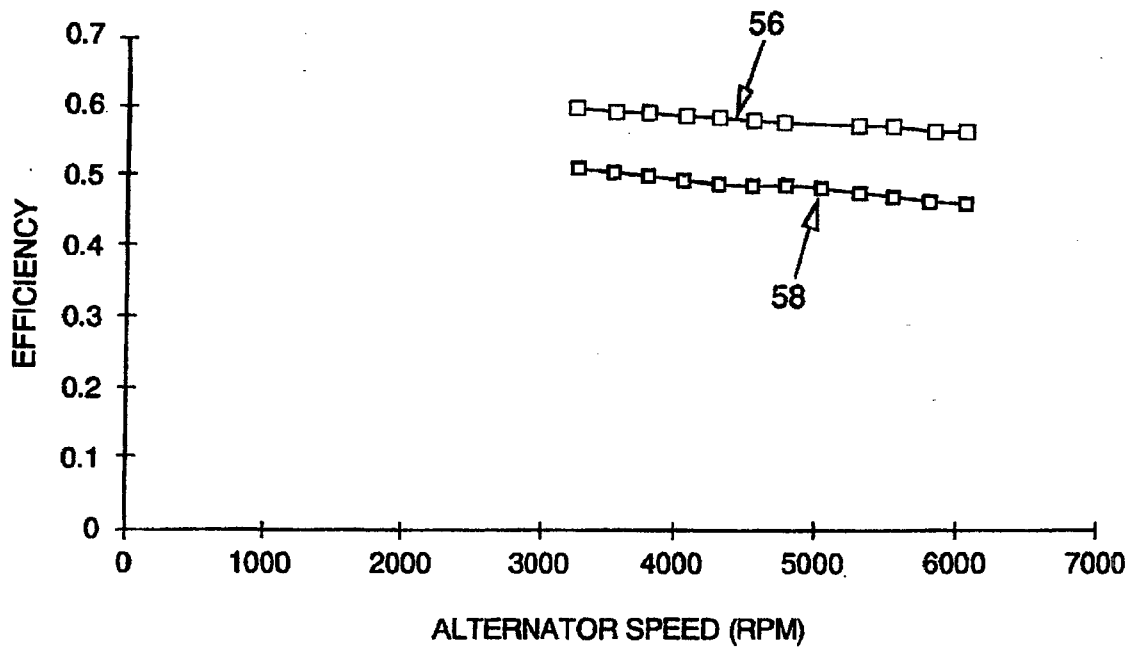


Fig. 7

METHOD AND SYSTEM FOR CONTROLLING AN ALTERNATOR TO OPTIMIZE DIRECT CURRENT OUTPUT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to co-pending application having Ser. No. 08/523,761, filed Sep. 5, 1995, and entitled "Motor Vehicle Alternator And Methods Of Operation".

TECHNICAL FIELD

This invention relates to methods and systems for controlling an alternator to optimize direct current output in an automotive vehicle.

BACKGROUND ART

An alternator is typically utilized to provide a direct current (DC) output and to maintain the electrical charge on a battery. A conventional motor vehicle alternator includes a three phase stator winding with a rotor magnetically coupled to the stator and driven by the vehicle's internal combustion engine. As the rotor is driven, three phase current generated at the output connections of the stator windings is rectified by a three phase diode rectifier. The output current and efficiency of the alternator vary with the speed of the engine which is controlled in accordance with the operational requirements of the vehicle. At low and high speeds, the alternator output may be insufficient to provide the power needed to operate some or all of the electrical equipment of the vehicle. Also at high speeds, the efficiency, or economy, of the alternator may not be maximized.

Accordingly, there is a need for increasing the output current and/or efficiency of the alternator without increasing the volume or weight of the alternator.

DISCLOSURE OF THE INVENTION

A general object of the present invention is to provide a method and system to maximize output current and/or efficiency of the alternator at various alternator speeds.

In carrying out the above object and other objects, features and advantages, of the present invention, a method is provided for controlling the electrical output of the alternator. An alternator, for example in a motor vehicle, is provided having a first rectifier connectable to a first output of the alternator to form a first winding configuration and a second rectifier connectable to a second output of the alternator to form a second winding configuration. A rotational speed of the alternator is determined and a corresponding speed signal is generated. One of the first and second rectifiers is then coupled to the first and second outputs respectively based on the speed signal so as to maximize current output of the alternator.

In further carrying out the above objects and other objects, features and advantages, of the present invention, a system is also provided for performing the method of operation of the present invention. The system includes an alternator having a first rectifier connectable to a first output of the alternator to form a first winding configuration and a second rectifier connectable to a second output of the alternator to form a second winding configuration. The system also includes a controller, operatively coupled to the alternator, for determining a speed of the alternator and generating a corresponding speed signal, and generating a control signal for operatively coupling one of the first and second rectifiers to the first and second outputs respectively based on the speed signal so as to maximize current output of the alternator.

The above object and other objects, features and advantages of the present invention are readily apparent from the following detailed description of the best mode for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram of an alternator having a synchronous rectifier;

FIG. 2 is a graphical representation of the performance of an alternator having a synchronous rectifier vs. a diode rectifier;

FIG. 3 is a schematic block diagram of an alternator having different winding configurations;

FIG. 4 is a graphical representation of the performance of the alternator illustrated in FIG. 3;

FIG. 5 is a schematic block diagram of a system including an alternator operable in accordance with the present invention;

FIG. 6 is a graphical representation of the improvement in alternator performance in accordance with the present invention; and

FIG. 7 is a graphical representation of the improvement in efficiency of the charging system of the present invention.

BEST MODES FOR CARRYING OUT THE INVENTION

A battery, for example in a motor vehicle, is charged via an alternator. The alternator is mechanically driven by an internal combustion engine to generate a direct current (DC) output, for example, to charge the battery of the motor vehicle and operate electrical equipment of the motor vehicle. The alternator typically comprises a three phase stator winding having three output connections. A rotor is typically magnetically coupled to the stator winding and mechanically driven to generate a back electromotive force in the stator winding and thereby generate three phase power at the three output connections of the stator winding. Since an alternator generates three phase alternating current, it is necessary to rectify the alternating current at the three output connections by means of rectifier diodes to provide DC output.

Turning now to FIG. 1, there is shown a typical alternator, denoted generally by reference numeral 10, wherein a conventional full wave diode rectifier of the alternator 10 is replaced with a synchronous, or full wave controlled, rectifier 12 having controlled switches 13 in place of diodes. The controlled switches 13 are preferably semiconductor switches. The alternator 10 further includes a three phase stator winding 14 having three windings 15 coupled to each other at one end and to the synchronous rectifier 12 at the other end. The output of the synchronous rectifier 12 is connected to a battery 16 and an electrical load 18, such as a radio, head lights or any other electrical equipment of the motor vehicle.

Phase control of the alternator 10 shown in FIG. 1 is performed by the switches 13 of the synchronous rectifier 12 to preempt natural commutation and shift the phase of the alternator phase voltages relative to the phase currents as disclosed in application having U.S. Ser. No. 08/523,761, filed Sep. 5, 1995, entitled "Motor Vehicle Alternator And Methods Of Operation", incorporated herein by reference. The phase angle control disrupts the normal unity power factor operation of the alternator and causes additional reactive current flow in the three phase stator winding of the alternator 10.

Turning now to FIG. 2, there is a graphical representation of the output of the alternator 10 having different rectifiers. Graph 20 represents the current output of the alternator 10 having a typical diode rectifier. Graph 22 represents the current output of the alternator 10 having the synchronous rectifier 12 shown in FIG. 1. The controlled switches 13 of the synchronous rectifier 12 boost output from the alternator by from 40% to 60% at low alternator speeds. The improvement, however, is not as significant for higher alternator speeds.

Turning now to FIG. 3, there is shown the alternator 10 in which the three phase stator winding 14 is adapted to have different winding configurations. A first diode rectifier 24 is connected to a first output of the windings 15. A second diode rectifier 26 is connected to a second output, or center tap 27, of the windings 15.

The alternator configuration further includes a first and second switch 28, 30. The first switch 28 is coupled between the first diode rectifier 24 and the positive terminal of the battery 16. The second switch 30 is coupled between the first diode rectifier 24 and the negative terminal of the battery 16. The first and second switches 28, 30 can be either semiconductor switches or relays and are utilized to change the winding configuration of the alternator 10.

Turning now to FIG. 4, there is shown a graphical representation of the output current of the alternator 10 in three different winding configurations. Graph 32 represents the output current of the alternator 10 when both the first switch 28 and the second switch 30 are turned on and all the windings 15 of the stator winding 14 are used.

Graph 34 represents the output current of the alternator 10 when both the first switch 28 and the second switch 30 are turned off and only a portion of the windings 15 of the stator winding 14 are used. Furthermore, Graph 36 represents the output current of the alternator 10 when the first switch 28 is turned off and the second switch 30 is turned on and a portion of the windings 15 is disabled. As can be seen in FIG. 4, the output current increases significantly after the winding configuration is changed at high alternator speeds.

The current output and/or efficiency of the alternator 10 increases significantly at both high and low alternator speeds if the alternator 10 includes both synchronous rectification and winding reconfiguration. Turning now to FIG. 5, there is shown a schematic block diagram of a charging system, denoted generally by reference numeral 40, including the alternator 10 operable in accordance with the present invention. The first diode rectifier 24 shown in FIG. 3 is replaced with the synchronous rectifier 12 of FIG. 1.

The synchronous rectifier 12 is controlled by a synchronous rectifier controller 42 via a plurality of switch gate drivers 44. The synchronous rectifier controller 42 determines and sets the switch conduction time for the controlled switches 13 based on the speed of the alternator 10 and loading conditions. The synchronous rectifier controller 42 thus controls the conduction state of the controlled switches 13 of the controlled rectifier 12. The controlled rectifier 12 is operated as described in co-pending application having U.S. Ser. No. 08/523,761, filed Sep. 5, 1995, entitled "Motor Vehicle Alternator And Methods Of Operation".

The charging system 40 further includes an operation mode controller 46 for controlling the first and second switches 28, 30 via a second set of switch gate drivers 48. The operation mode controller 46 controls the first and second switches 28, 30 based on the speed of the alternator 10. The speed of the alternator 10 may be sensed directly or, alternatively, determined from the speed of the engine (not shown).

The operation of the charging system 40 will now be described. In a first operating mode, first and second switches 28, 30 are turned on. The diode rectifier 26 has no effect on the output of the alternator 10 because the input AC voltage to the diode rectifier 26 is less than the input AC voltage to the synchronous rectifier 12. Therefore, in the first operating mode the synchronous rectifier 12 is utilized and all the turns of the windings 15 are also utilized. As shown in FIG. 6, the output performance of the alternator 10 during the first operating mode, as shown by graph 50, is maximized. The graph at 51 represents the output performance of a typical alternator having a typical diode rectifier.

In a second operating mode, the first switch 28 is turned off and the second switch 30 is turned on. Furthermore, all the controlled switches 13 in the synchronous rectifier 12 are turned off. In the second operating mode, only the three upper diodes D_A , D_B , and D_C in the diode rectifier 26 and the diodes of the three lower controlled switches 13 in the synchronous rectifier 12, i.e., D_4 , D_5 , and D_6 , can conduct. Consequently, part of the turns of the windings 15 is disabled. Referring again to FIG. 6, the performance of the alternator 10 has a maximum output current at intermediate alternator speeds, as shown by graph 52.

In a third operating mode, the first and second switches 28, 30 and all the controlled switches 13 in the synchronous rectifier 12 are turned off. Therefore, the synchronous rectifier 12 is totally disabled and only a part of the windings 15 is utilized. It can be seen in FIG. 6 that the third operating mode yields the highest output current at high alternator speeds, as shown by graph 54.

If the operating mode is changed based on the speed of the alternator 10, maximum output current can be obtained at all speeds. Thus, the operation mode controller 46 operates the alternator 10 based on the speed of the alternator 10. The speed of the alternator 10 is compared to a predetermined speed range. If the speed of the alternator 10 is less than the predetermined speed range, the operation mode controller 46 generates a control signal to turn on the first and second switches 28, 30 so that the synchronous rectifier 12 is enabled and the output current of the alternator 10 is maximized.

If the speed of the alternator 10 is greater than the predetermined speed range, the operation mode controller 46 generates a control signal to turn off the first and second switches 28, 30 so that only the diode rectifier 26 is enabled. Furthermore, If the speed of the alternator 10 is within the predetermined speed range, or intermediate alternator speed, the operation mode controller 46 generates a control signal to turn off the first switch 28 and turn on the second switch 30.

The efficiency of the charging system 40 will be significantly increased by changing the operating mode of the alternator 10 according to the alternator speed when the demanded current of the load 18 is less than the maximum output current of the charging system 40. The output current can be reduced to meet the current demand of the load 18 by reducing the field current of the alternator.

Turning now to FIG. 7, there is shown a graphical representation of the improvement in efficiency of the charging system 40 of the present invention. FIG. 7 illustrates that with the same output current the efficiency of charging system 40 of the present invention, as shown by graph 56, is significantly higher than that of an existing typical system, as shown by graph 58. As an example, consider a vehicle speed of 45 mph which corresponds to an alternator speed ranging from 3800 rpm to 5600 rpm, depending on the

5

powertrain and pulley ratios chosen. The efficiency of the alternator is improved considerably in the 3800 rpm to 5600 rpm speed range which results in a decrease in the engine power required to drive the alternator and, therefore, an increase in a fuel economy of the vehicle.

While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention as defined by the following claims.

What is claimed is:

1. For use with an alternator having a stator winding including a plurality of coils and a first output and a second output, the alternator further having a first rectifier connectable to the first output to form a first winding configuration enabling all of the plurality of coils and a second rectifier connectable to the second output to form a second winding configuration enabling a portion of the plurality of coils, a method for controlling the alternator to optimize DC output current comprising:

generating a speed signal corresponding to the rotational speed of the alternator; and

coupling one of the first and second rectifiers to one of the first and second outputs respectively in response to said speed signal so as to maximize the output current of the alternator and keep output voltage substantially constant.

2. The method as recited in claim 1 wherein coupling includes comparing the speed signal with a predetermined speed range.

3. The method as recited in claim 2 wherein coupling includes coupling the first rectifier to the first output in response to the speed signal being less than the predetermined speed range.

4. The method as recited in claim 2 wherein coupling includes coupling the second rectifier to the second output in response to the speed signal having a value exceeding the predetermined speed range.

5. The method as recited in claim 1 wherein the alternator includes at least one switch operatively coupled between the first and second rectifiers and wherein coupling includes switching the switch.

6. The method as recited in claim 2 wherein a combination of the first and second rectifiers with the first and second outputs form a third winding configuration enabling a second portion of the plurality of coils and wherein coupling includes coupling the first and second rectifiers to the first and second outputs to form the third winding configuration when the speed signal has a value within the predetermined speed range so as to maximize output current of the alternator at intermediate alternator speeds.

7. The method as recited in claim 1 further comprising coupling the alternator to a battery of a motor vehicle so that

6

the alternator charges the battery and operates equipment of the motor vehicle.

8. For use with an alternator having a stator winding including a plurality of coils and a first output and a second output, a system for maximizing the DC output current of the alternator comprising:

a first rectifier connectable to the first output of the alternator to form a first winding configuration enabling all of the plurality of coils;

a second rectifier connectable to the second output of the alternator to form a second winding configuration enabling a portion of the plurality of coils;

a sensor for sensing a rotational speed of the alternator and generating a corresponding speed signal; and

a controller, operatively coupled to the alternator, to couple one of the first and second outputs to one of the first and second rectifiers based on the speed signal so as to maximize output current of the alternator and keep output voltage substantially constant.

9. The system as recited in claim 8 wherein the controller further compares the speed signal with a predetermined speed range.

10. The system as recited in claim 9 wherein the control signal operatively couples the first output of the alternator to the first rectifier in response to the speed signal being less than the predetermined speed range.

11. The system as recited in claim 10 wherein the first rectifier is a synchronous rectifier having controlled switches.

12. The system as recited in claim 9 wherein the control signal operatively couples the second output of the alternator to the second rectifier in response to the speed signal having a value exceeding the predetermined speed range.

13. The system as recited in claim 12 wherein the second rectifier is a full wave diode rectifier.

14. The system as recited in claim 8 wherein the alternator includes at least one switch operatively coupled between the first and second rectifier and wherein the control signal is generated for switching the switch.

15. The system as recited in claim 9 wherein a combination of the first and second rectifiers with the first and second outputs form a third winding configuration enabling a second portion of the plurality of coils and wherein the controller further generates the control signal to couple the first and second rectifiers to the first and second outputs to form the third winding configuration when the speed signal has a value within the predetermined speed range so as to maximize output current of the alternator at intermediate alternator speeds.

16. The system as recited in claim 8 wherein the alternator is coupled to a battery of a motor vehicle to charge the battery and operate equipment of the motor vehicle.

* * * * *

日 本 国 特 許 庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office

出 願 年 月 日

Date of Application: 2000年10月11日

出 願 番 号

Application Number: 特願2000-310769

[ST.10/C]:

[JP2000-310769]

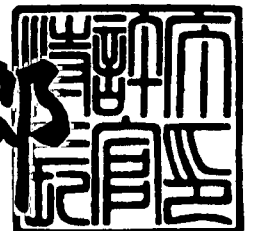
出 願 人

Applicant(s): 本田技研工業株式会社

2002年12月10日

特 許 庁 長 官
Commissioner,
Japan Patent Office

太田 信一郎



出証番号 出証特2002-3097783

【書類名】 特許願
【整理番号】 H100171901
【提出日】 平成12年10月11日
【あて先】 特許庁長官殿
【国際特許分類】 H02P 9/04
H02J 7/16

【発明者】

【住所又は居所】 埼玉県和光市中央一丁目4番1号 株式会社 本田技術
研究所内

【氏名】 大田 淳朗

【発明者】

【住所又は居所】 埼玉県和光市中央一丁目4番1号 株式会社 本田技術
研究所内

【氏名】 本田 聡

【特許出願人】

【識別番号】 000005326

【氏名又は名称】 本田技研工業株式会社

【代理人】

【識別番号】 100084870

【弁理士】

【氏名又は名称】 田中 香樹

【選任した代理人】

【識別番号】 100079289

【弁理士】

【氏名又は名称】 平木 道人

【手数料の表示】

【予納台帳番号】 058333

【納付金額】 21,000円

特2000-310769

【提出物件の目録】

【物件名】	明細書	1
【物件名】	図面	1
【物件名】	要約書	1
【プルーフの要否】	要	

【書類名】 明細書

【発明の名称】 同期発電機の出力制御装置

【特許請求の範囲】

【請求項 1】 界磁束発生用磁石手段を有する回転子、および発電出力発生用の固定子巻線が巻回された固定子を有する同期発電機の出力制御装置において

前記回転子の回転数を検出する検出手段と、

前記固定子巻線に遅角通電させて前記発電機の発電量を増大させる通電手段と

前記発電機の出力電圧を所定のレギュレート電圧に制限するレギュレータとを具備し、

前記遅角通電が、前記回転子の回転数が予定の低回転数域にあるときに行われるとともに、前記出力電圧を前記レギュレート電圧よりも低い、予定の電圧制御値に制御するよう通電制御されることを特徴とする同期発電機の出力制御装置。

【請求項 2】 前記遅角通電では、通電遅角量を予定値に維持したまま通電デューティを変化させることにより、前記出力電圧が前記予定の電圧制御値に制御されることを特徴とする請求項 1 記載の同期発電機の出力制御装置。

【請求項 3】 前記電圧制御値が予定の幅を有し、前記通電デューティを、前記出力電圧が該幅の最大値に達したときに微減させ、前記出力電圧が該幅の最小値に以下に下がったときに微増させることを特徴とする請求項 2 記載の同期発電機の出力制御装置。

【請求項 4】 前記通電デューティが、前記発電機の回転数に応じて決定されることを特徴とする請求項 2 または 3 記載の同期発電機の出力制御装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本発明は、同期発電機の出力制御装置に関し、特に、低回転域での発電量を増大させるのに好適な同期発電機の出力制御装置に関する。

【0002】

【従来技術】

車両用発電装置として三相同期発電機が用いられ、発電された交流を、三相全波整流器で整流してバッテリーの充電に使用している。特開平9-19194号公報に開示された三相同期発電機では、ステータコイルに進相電流を流して、この進相電流に起因する電機子反作用の増磁作用により界磁束を増加させて出力（発電電圧および出力電流）を増大させている。

【0003】

【発明が解決しようとする課題】

一般に発電機には発電電力が所定値を超えないように出力電圧を制限するレギュレータが設けられ、このレギュレータが機能することにより発電が停止される。発電が停止するとエンジンに負荷変動が起こるため、特に、低回転域ではエンジン回転が不安定になってしまう。また、発電電力が過大であると、低回転域ではそのためのフリクションの増大によるエンジン回転への影響が大きい。

【0004】

本発明は、低回転域においてエンジン回転を不安定にさせずに発電電力を増大させることができる同期発電機の出力制御装置を提供することを目的とする。

【0005】

【課題を解決するための手段】

前記目的を達成するために、本発明は、発電機の回転子の回転数を検出する検出手段と、固定子巻線に遅角通電させて前記発電機の発電量を増大させる通電手段と、前記発電機の出力電圧を所定のレギュレート電圧に制限するレギュレータとを具備し、前記遅角通電が、前記回転子の回転数が予定の低回転数域にあるときに行われるとともに、前記出力電圧を前記レギュレート電圧よりも低い予定の電圧制御値に制御するよう通電制御される点に第1の特徴がある。

【0006】

第1の特徴によれば、固定子巻線に遅角通電することにより発電出力が増大する。そして、この遅角通電が、出力電圧をレギュレータのレギュレート電圧より低く設定される電圧制御値に制御するように行われるので、低回転域でレギュレータを作動させずに安定的に発電量の増大を図ることができる。

【0007】

また、本発明は、前記遅角通電では、通電遅角量を予定値に維持したまま通電デューティを変化させることにより、前記出力電圧が前記予定の電圧制御値に制御される点に第2の特徴がある。

【0008】

さらに、本発明は、前記電圧制御値が予定の幅を有し、前記通電デューティを、前記出力電圧が該幅の最大値に達したときに微減させ、前記出力電圧が該幅の最小値に以下に下がったときに微増させる点に第3の特徴があり、前記通電デューティが、前記発電機の回転数に応じて決定される点に第4の特徴がある。

【0009】

第2～第4の特徴によれば、遅角のタイミングが固定されるので、発電量の調整が容易であり、調整の精度を上げることができる。

【0010】

【発明の実施の形態】

以下、図面を参照して本発明の一実施形態を説明する。図2は、本発明の一実施形態に係るスタータ兼発電機の断面図である。このスタータ兼発電機（以下、「ACG」という）1は、例えば、スクータ型自動二輪車エンジンに搭載される。ACG1は、三相巻線（ステータコイル）が巻回されたステータ50と、エンジンのクランク軸201の端部に結合されてステータ50の外周を回転するアウトロータ60とを有する。アウトロータ60はクランク軸201に連結されるカップ状のロータケース63と、ロータケース63の内周面に収容されるマグネット62とを有する。マグネット62はロータヨークに円周方向に沿って配置される。

【0011】

アウトロータ60は、ハブ部60aの内周をクランク軸201の先端テーパ部に嵌合させて取り付けられ、ハブ部60aの中心を貫通してクランク軸201の端部ネジに螺挿されるボルト253で固定される。アウトロータ60の内周側に配設されるステータ50はボルト279によってクランクケース202に固定される。アウトロータ60にはボルト246によって固定されたファン280が設

けられる。ファン280に隣接してラジエータ282が設けられ、ラジエータ282はファンカバー281によって覆われる。

【0012】

ステータ50の内周にはセンサケース28が嵌め込められ、このセンサケース28内にはアウトロータ60のボスの外周に沿って等間隔でロータ角度センサ（磁極センサ）29およびパルサセンサ（点火パルサ）30が設けられる。ロータ角度センサ29はACG1のステータコイルに対する通電制御を行うためのものであり、ACG1のU相、V相、W相のそれぞれに対応して1つずつ設けられる。一方、点火パルサ30はエンジンの点火制御のためのものであり、1つだけ設けられる。ロータ角度センサ29および点火パルサ30はいずれもホールICまたは磁気抵抗（MR）素子で構成することができる。

【0013】

ロータ角度センサ29および点火パルサ30のリード線は基板31に接続され、さらに基板31にはワイヤハーネス32が結合される。アウトロータ60のボス60aの外周には、ロータ角度センサ29および点火パルサ30のそれぞれに磁気作用を及ぼすよう2段着磁されたマグネットリング33が嵌め込まれる。

【0014】

ロータ角度センサ29に対応するマグネットリング33の一方の着磁帯には、ステータ50の磁極に対応して、円周方向に30°幅間隔で交互に配列されたN極とS極が形成され、点火パルサ30に対応するマグネットリング33の他方の着磁帯には、円周方向の1か所に15°ないし40°の範囲で着磁部が形成される。

【0015】

上記構成のACG1は、始動時には同期モータとして機能し、バッテリーから供給される電流で駆動されてクランク軸201を回動させてエンジンを始動させるとともに、始動後は同期発電機として機能し、発電した電流でバッテリーを充電し、かつ各電装部に電流を供給する。

【0016】

図3は、ACG1の出力制御装置を有する自動二輪車の要部電装系統図である

。同図において、ECU3にはACG1で発生した三相交流を整流する全波整流器4と、全波整流器4の出力を予定のレギュレート電圧（レギュレータ作動電圧：例えば、14.5V）に制限するためのレギュレータ5とが設けられる。さらに、ECU3は、エンジン回転数が予定の低回転域（以下、「発電制御領域」という）であるとき、発電量を増加させる制御を行う発電制御部6を有する。なお、発電制御部6はCPUの機能として実現される。前記ロータ角度センサ29および点火パルサ30もECU3に接続されて、その検出信号はECU3に入力される。

【0017】

ECU3には、点火コイル21が接続され、点火コイル21の二次側には点火プラグ22が接続される。また、ECU3にはスロットルセンサ23、フューエルセンサ24、シートスイッチ25、アイドルスイッチ26、冷却水温センサ27が接続され、各部から検出信号がECU3に入力される。

【0018】

さらに、ECU3には、スタータリレー34、スタータスイッチ35、ストップスイッチ36、37、スタンバイインジケータ38、フューエルインジケータ39、スピードセンサ40、オートバイスタ41、およびヘッドライト42が接続される。ヘッドライト42には、ディマースwitch43が設けられる。

【0019】

上記の各部にはメインヒューズ44およびメインスイッチ45を介してバッテリー2から電流が供給される。なお、バッテリー2は、スタータリレー34によってECU3に直接接続される一方、メインスイッチ45を介さず、メインヒューズ44だけを介してECU3に接続される回路を有する。

【0020】

上記発電制御部6は、通常に発電量（電圧）を制御する機能に加え、本発明に従って前記発電ACG1の各相のステータコイルに対してバッテリー2から遅角通電して発電量を増加させる（以下、「ACG 通電制御」という）機能を有する。ここで、遅角通電とは、前記ロータ角度センサ29で検出される前記着磁帯33の磁極の変化時の検出信号から予定の電気角相当分を遅延させてステータコイルに

通電することをいう。但し、低回転域で前記レギュレータ5が作動することによって生じるエンジン負荷の急変に起因するエンジン回転の不安定化を防止するため、全波整流器4の出力電圧（バッテリー電圧）が、レギュレート電圧以下の予定電圧範囲内に収まるよう制御される。

【0021】

図4はACG 通電制御をしたときのエンジン回転数と発電電流との関係を示す図である。同図において、エンジン回転数が1000rpm～3500rpmの領域が発電制御領域として設定されており、このような低回転領域では、従来の制御手法によるACG1の発電電流（ACG出力）は極めて小さい。そこで、発電制御領域においてACG 通電制御により発電電流を増加させる。増加分は「遅角通電時」として点線で示す。発電量が常用負荷電流に相当するように制御することにより、低回転領域においても、消費電流量に相当する発電量を確保できる。

【0022】

図5は、遅角発電領域におけるバッテリー電圧の変化を示す図である。同図において、レギュレート電圧（14.5V）以下に設定された制御電圧最大値VMaxおよび制御電圧最小値VMinで規定されるACG 制御電圧範囲でバッテリー電圧Vbが制御される。具体的には、ステータコイルに対する通電遅角量は固定値（例えば電気角60°）とし、全波整流器4の通電デューティを増減してバッテリー電圧VbをACG 制御電圧範囲に制御する。すなわち、バッテリー電圧Vbが制御電圧最大値VMaxに達したら通電デューティを予定の微小値（例えば1%）だけ低減させ、バッテリー電圧Vbが制御電圧最小値VMinに下がったら通電デューティを同微小値だけ増大させる。

【0023】

図1は、ACG 通電制御装置の要部機能を示すブロック図である。同図において、全波整流器4はACG1のステータコイル1U, 1V, 1Wに接続されたFET（一般的には固体スイッチング素子）4a, 4b, 4c, 4d, 4e, 4fを有し、エンジン始動時は、ドライバ46によりFET4a～4fをスイッチングし、ACG1を同期電動機として駆動し、前記クランク軸201を回転させる一方、エンジン始動後は、逆にアウトロータがエンジンによって駆動して同期発電

機として機能するので、F E T 4 a ~ 4 f で発電交流を整流してバッテリー 2 や電装負荷 4 7 に給電する。また、エンジン駆動による発電中においても、特に、エンジンの低回転時には本発明に従い、ステータコイルへの遅角通電が行われるようにドライバ 4 6 で F E T 4 a ~ 4 f を制御して発電量を増大させる。なお、遅角通電制御については図 7 を参照して後述する。

【 0 0 2 4 】

エンジン回転数判別部 4 8 は、例えば、点火パルサ 3 0 の検出信号や発電電圧の周波数信号などをもとにエンジン回転数を検出し、検出エンジン回転数が予定の発電制御領域にあれば遅角指令をドライバ 4 6 に供給する。ドライバ 4 6 は遅角指令に応答して遅角量設定部 4 9 から予め設定されている通電遅角量を読み出して遅角通電させる。通電デューティはデューティ設定部 5 1 から読み出してドライバ 4 6 に供給される。ドライバ 4 6 はロータ角度センサ 2 9 による磁極検出信号、すなわちアウトロータ 6 0 の磁極に対応して形成されているマグネトリング 3 3 の着磁帯をセンサ 2 9 が検出するたびにオンに立ち上がる信号を検出する。そして、その信号の立上がりから通電遅角量相当分を遅角させて F E T 4 a ~ 4 f に対する P W M 制御信号を出力する。

【 0 0 2 5 】

バッテリー電圧判別部 5 2 ではバッテリー電圧 V_b を、電圧制御範囲を規定する前記制御電圧最大値 V_{Max} および制御電圧最小値 V_{Min} と比較し、その比較結果に基づいて、デューティ設定部 5 1 に設定される通電デューティを増減し、バッテリー電圧 V_b が前記制御範囲に収まるようにする。

【 0 0 2 6 】

図 6 は、上記の出力制御装置の処理を示すフローチャートである。同図において、ステップ S 1 ではエンジン回転数が発電制御領域に存在しているか否かを判断する。発電制御領域は、上述のように、例えば 1 0 0 0 r p m 以上 3 5 0 0 r p m 以下に設定される。エンジン回転数が発電制御領域に存在していれば、ステップ S 2 に進み、エンジン回転数が発電制御領域に存在していることを示すフラグ F A C G がセットされている (= 1) か否かを判別する。フラグ F A C G がセットされていなければステップ S 3 に進んでフラグ F A C G をセットする (「1」にす

る)。フラグFACG をセットしたならば、ステップS4に進んで通電遅角量acgaglに予定値ACGAGLをセットする。予定値ACGAGLは、予め適当に設定しておくことができるが、本実施形態では、例えば、電気角 60° である。続くステップS5では通電デューティacdutyに初期値ACDUTYをセットする。前記初期値ACDUTYも予め適当に設定しておくことができるが、本実施形態では、例えば4.0%である。ステップS3～S5が終わったならばステップS7に進む。前記ステップS2が肯定ならばステップS3～S5はスキップしてステップS7に進む。また、エンジン回転数が前記発電制御領域に存在しないときは、ステップS6でフラグFACG をリセット(=0)した後、ステップS7に進む。

【0027】

ステップS7では、フラグFACG がセットされているか否かを判別する。フラグFACG がセットされていた(=1)ならば、ステップS8でバッテリー電圧Vb が制御電圧最大値VMax 以上か否かを判断する。制御電圧最大値VMax は、レギュレート電圧より低い値、例えば13.5ボルトに設定される。バッテリー電圧Vb が制御電圧最大値VMax 以上でないときは、ステップS9に進んでバッテリー電圧Vb が制御電圧最小値VMin 以下か否かを判断する。制御電圧最小値VMin は、例えば13.0ボルトに設定される。ステップS9でバッテリー電圧Vb が制御電圧最小値VMin 以下でないときは、レギュレータのレギュレート電圧よりも低い値に設定されたACG 通電電圧範囲に入っていると判断され、ステップS10に進んで、上記通電遅角量acgaglと通電デューティacdutyとに従ってACG 通電制御を行う。

【0028】

ステップS8でバッテリー電圧Vb が制御電圧最大値VMax 以上であると判断されたときは、ステップS11に進んで通電デューティacdutyを微小値DDUTY 低減する。微小値DDUTY は例えば1%である。また、ステップS9でバッテリー電圧Vb が制御電圧最小値VMin 以下であると判断されたときはステップS12に進んで通電デューティacdutyを微小値DDUTY 増大する。ステップS11, S12の処理後はステップS10に進む。なお、通電デューティacdutyを増大させる時と低減させるときの前記微小値DDUTY は必ずしも同一でなくてもよいし、制御電圧最

大値VMax または制御電圧最小値VMin と現在値との差に比例して微小値DDUTYを変化させてもよい。

【0029】

一方、ステップS7でフラグFACG がセットされていなかった(=0)ならば、発電制御領域でないのでステップS13に進んでACG 通電制御を停止する。

【0030】

図7は、ACG 通電制御時にステータコイルの各相に流れる電流(相電流)とロータ角度センサ29の出力とのタイミングを示す図である。図に示すように、遅角通電制御が行われ、通常の場合にはロータ角度センサ29の検出出力の正負(NS)の変化に応答してステータコイルのU, V, W各相に電流が供給される。一方、遅角通電制御を行った場合には、ロータ角度センサ29の検出出力の正負(NS)の変化時から予定の遅角量d(=60°)だけ遅れてステータコイルのU, V, W各相に電流が供給される。図7において、デューティチョッピングによる通電角Tは180°であるが、デューティ設定部51からドライバ46へ供給される通電デューティによって180°以内で決定することができる。

【0031】

図8はエンジン回転数つまり発電機の回転数をパラメータとして設定した通電デューティのテーブルである。エンジン回転数を検出し、図8を参照してエンジン回転数に応じた通電デューティを決定する。

【0032】

上記実施形態では、アウトロータ/インナロータ方式で、アウトロータに界磁束発生用磁石手段として永久磁石を配置した。しかし、本発明は、インナロータに界磁束発生用磁石手段を設けた発電機や、界磁束発生用磁石手段として電磁石を採用した発電機にも同様に適用できる。また、通電遅角量acgaglを、固定値とするのではなく、一般的な負帰還制御手法に従い、比例、微分、積分およびこれらの複合制御をすることができる。

【0033】

【発明の効果】

以上の説明から明らかなとおり、請求項1～請求項4の発明によれば、低回転

域で通常の電圧レギュレータを作動させずに安定的に発電量の増大を図ることができる。したがって、回転子がエンジンで駆動される車載の発電機に適用した場合、アイドル運転時などにエンジン負荷の変動を少なくしてエンジン回転の変動を極力小さくし、アイドル運転を安定にすることができる。また、請求項 2 ～ 4 の発明によれば、遅角のタイミングが予め設定した値に固定されるので、簡易な構成で容易に発電量の調整ができるとともに、調整の精度を上げることができる。

【図面の簡単な説明】

【図 1】 本発明の一実施形態に係る出力制御装置の要部機能を示すブロック図である。

【図 2】 本発明の一実施形態に係るスタータ兼発電機の断面図である。

【図 3】 本発明の出力制御装置を有する自動二輪車の要部電装系統図である。

【図 4】 ACG 通電制御時のエンジン回転数と発電電流との関係を示す図である。

【図 5】 遅角発電領域におけるバッテリー電圧の変化を示す図である。

【図 6】 出力制御装置の処理を示すフローチャートである。

【図 7】 ACG 通電制御時のステータコイルの相電流とロータ角度センサの出力とのタイミングを示す図である。

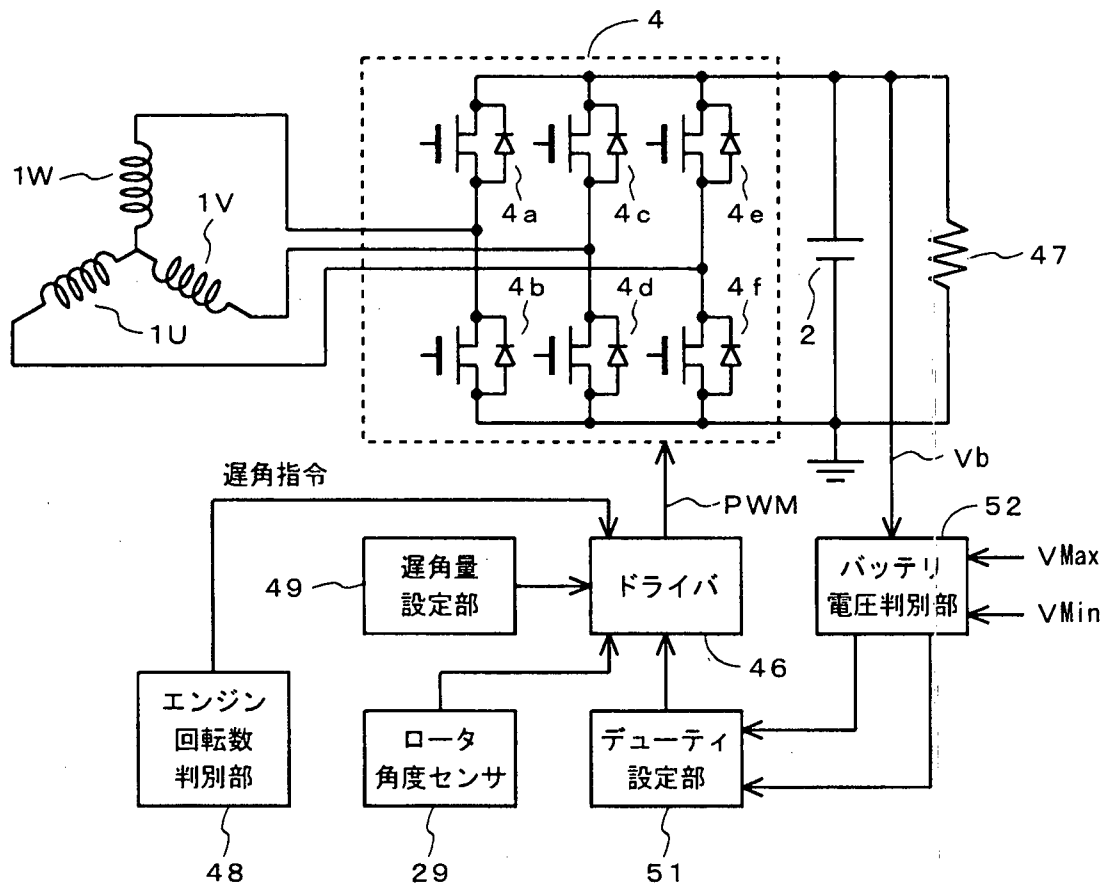
【図 8】 エンジン回転数をパラメータとする通電デューティのテーブルである。

【符号の説明】

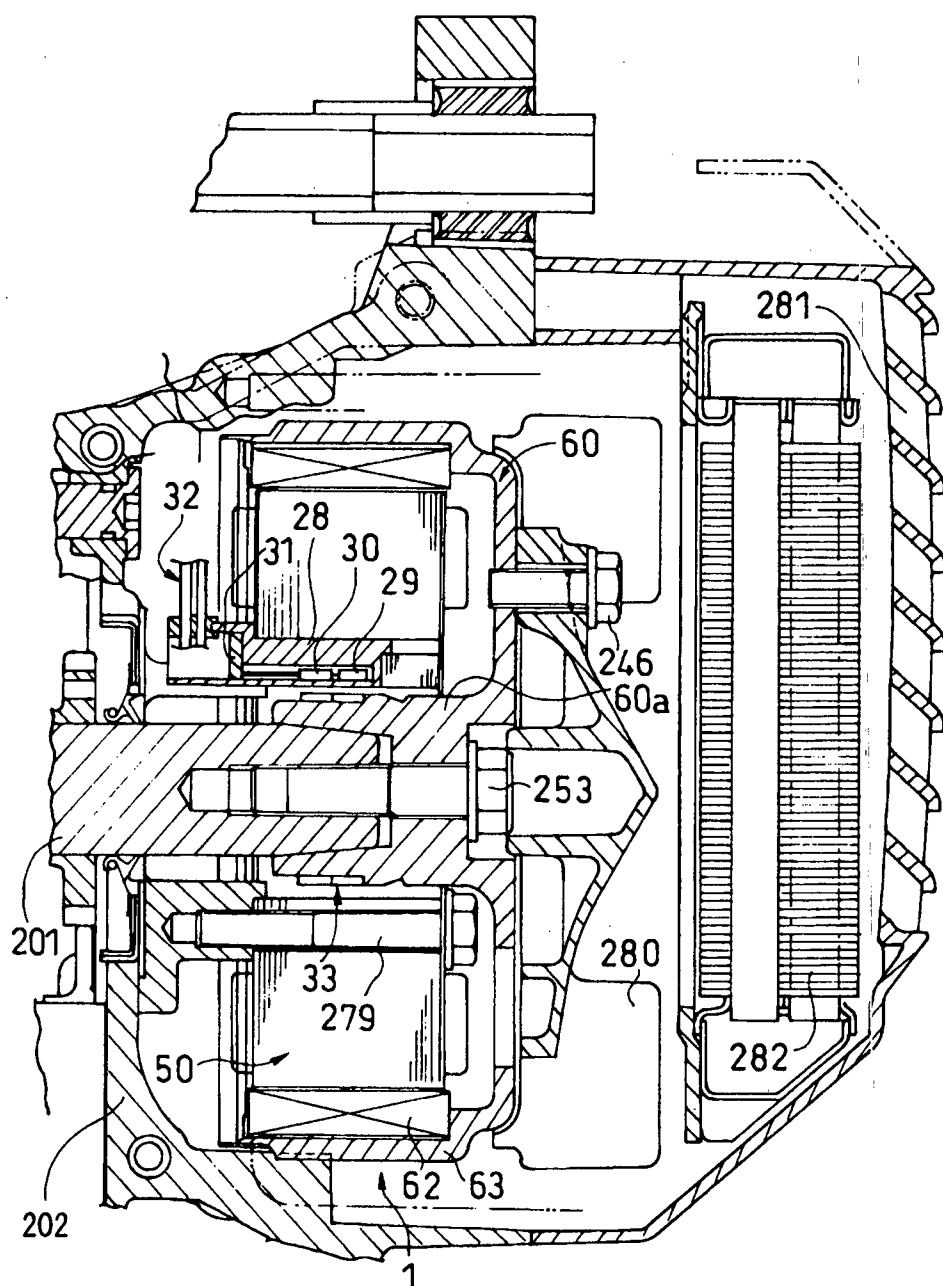
1 … スタータ兼発電機、 2 … バッテリー、 3 … ECU、 4 … 全波整流器、
5 … レギュレータ、 29 … ロータ角度センサ、 30 … 点火パルサ、 46 …
ドライバ、 48 … エンジン回転数判別部、 49 … 遅角量設定部、 50 … ステ
ータ、 51 … デューティ設定部、 60 … アウタロータ、 62 … マグネット
、 201 … クランク軸

【書類名】 図面

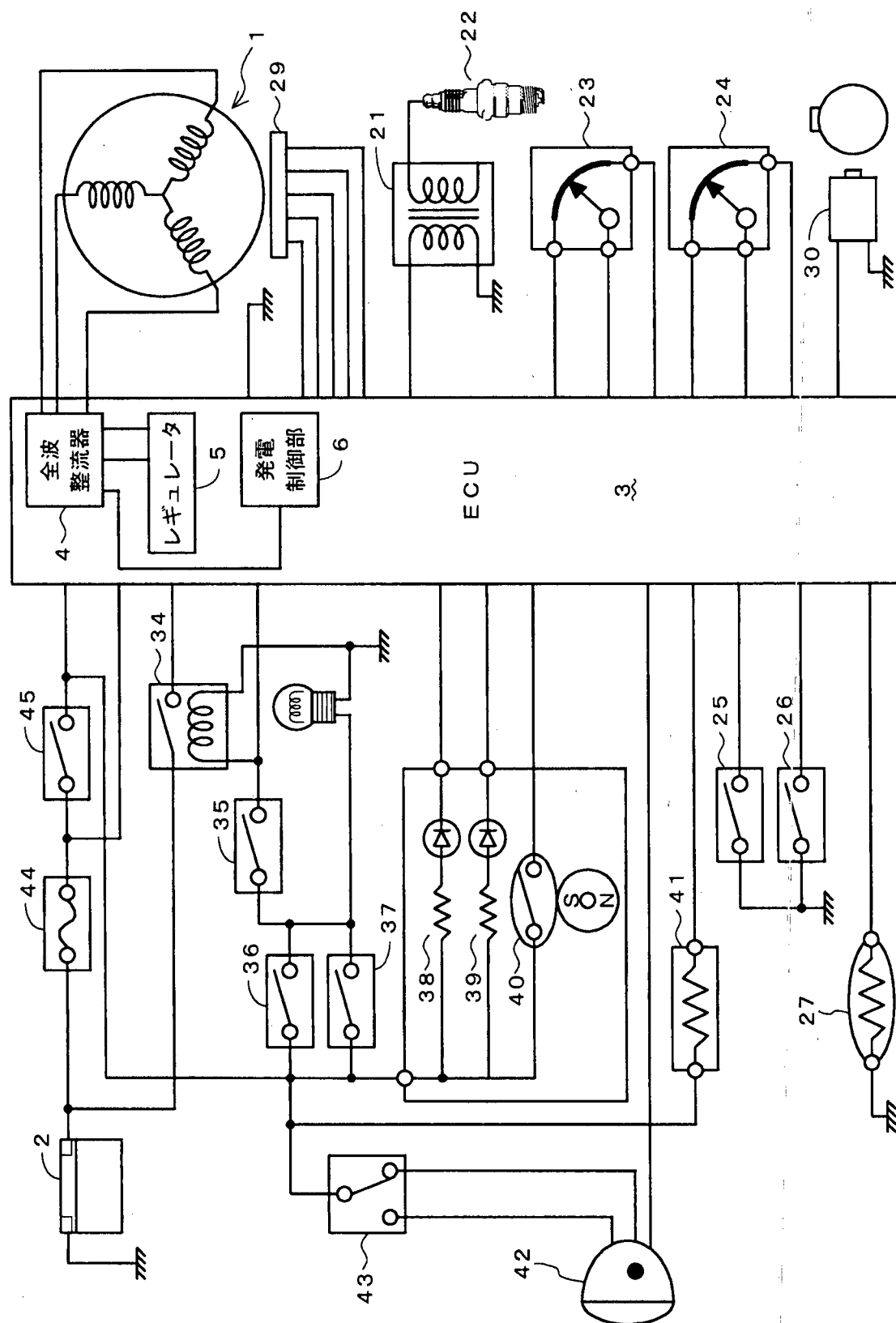
【図 1】



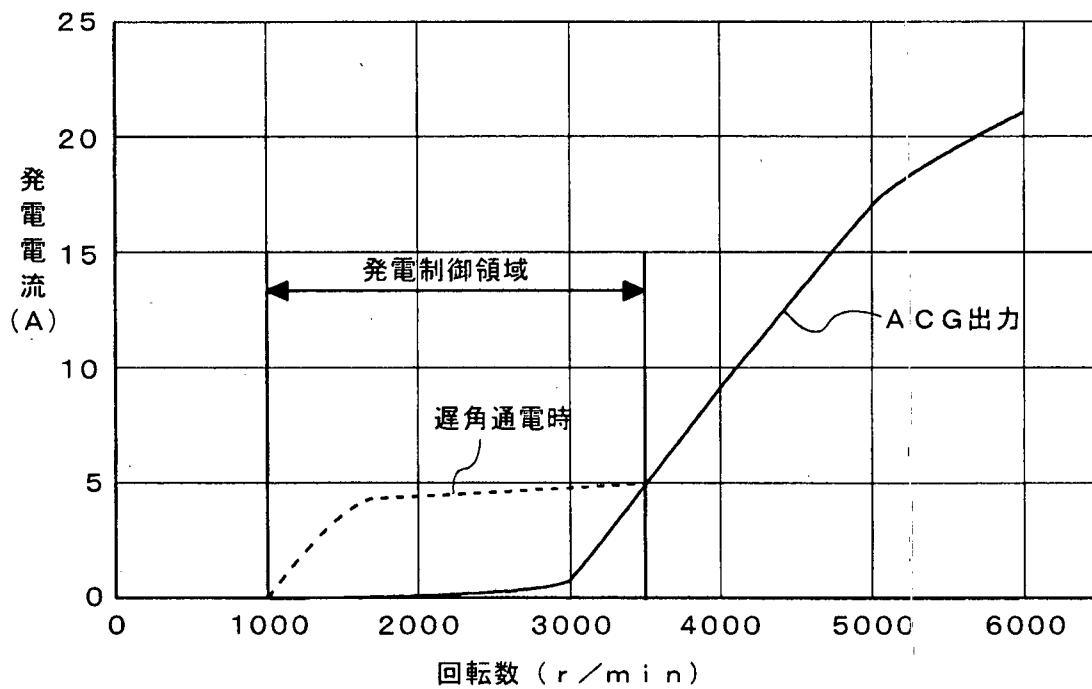
【図2】



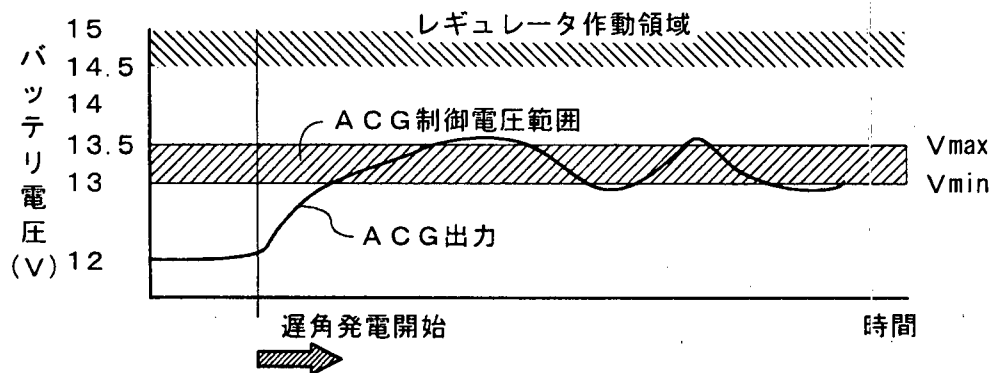
【図3】



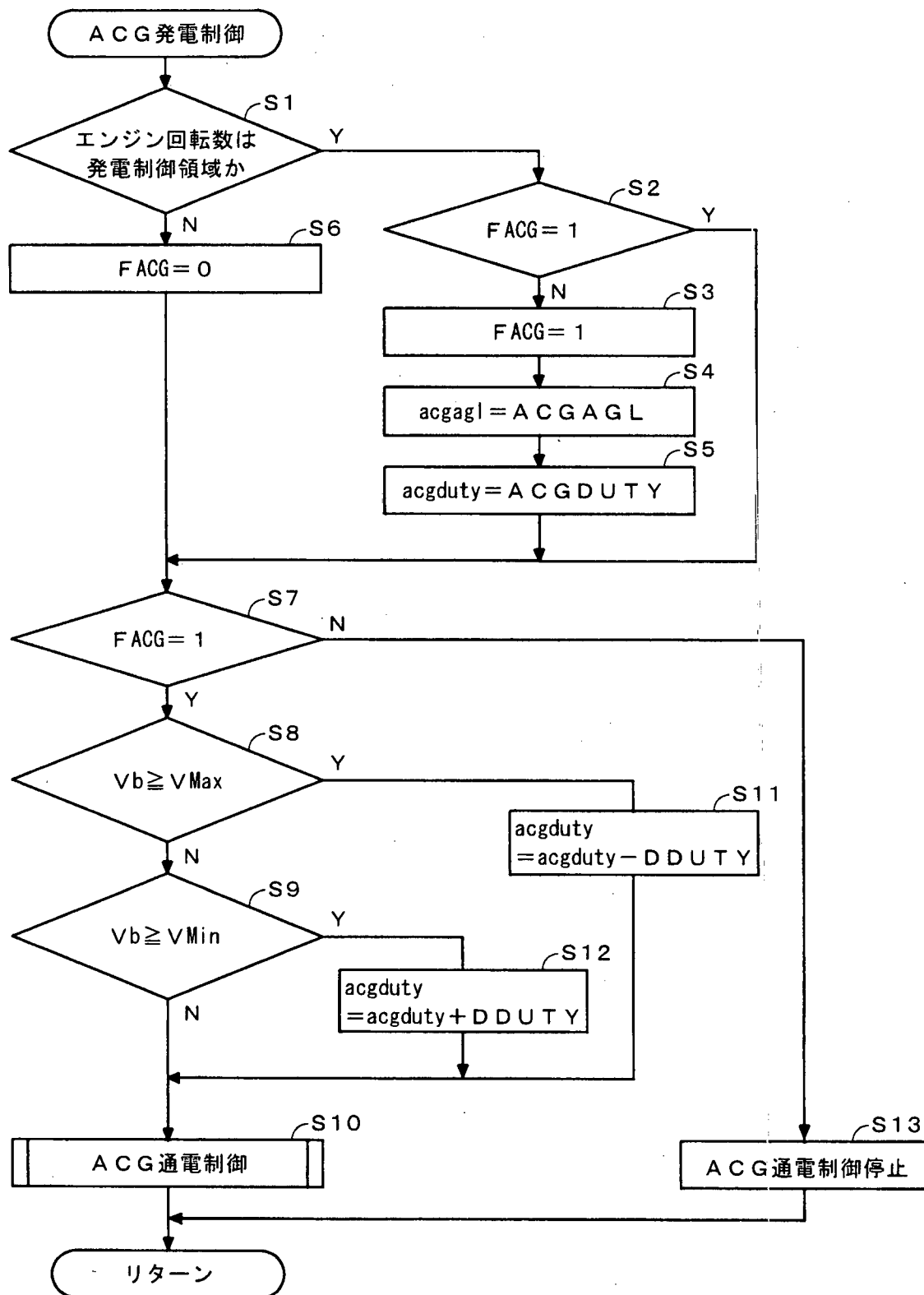
【図 4】



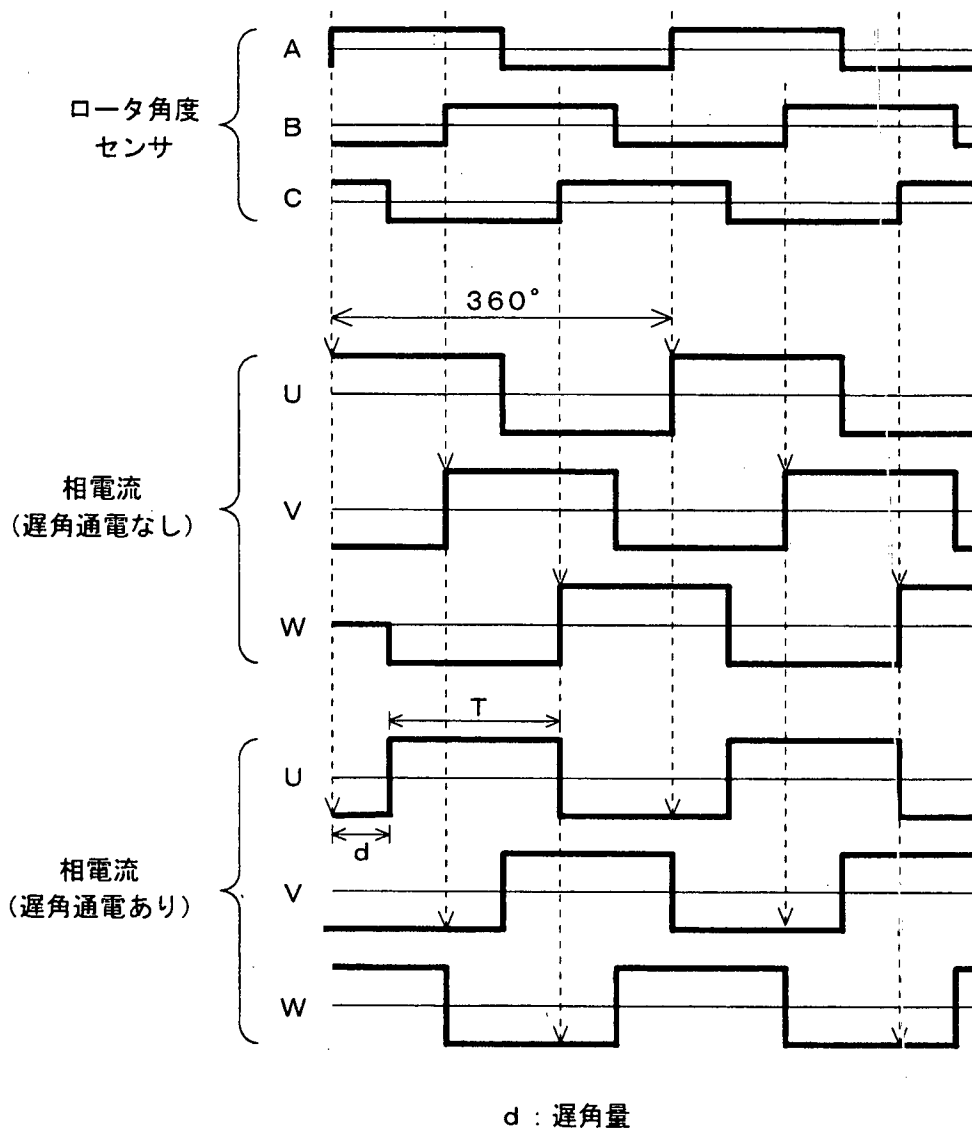
【図 5】



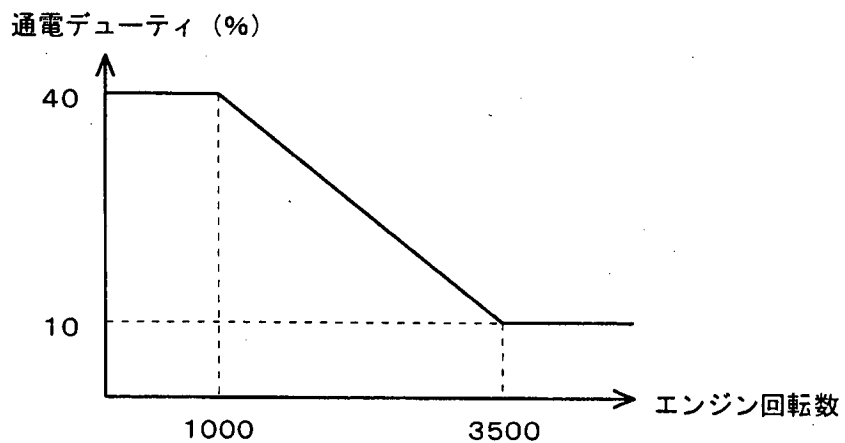
【図 6】



【図7】



【図8】



【書類名】 要約書

【要約】

【課題】 低回転域でエンジン回転の安定を保持しながら発電量を増大させること。

【解決手段】 エンジン回転数判別部48で回転子の回転数を検出し、エンジン回転数が低回転域にあったときに、ドライバ46で整流器4を遅角通電制御して界磁束を増加させ、発電量を増大させる。ドライバ46はロータ角度センサ29で検出された磁極の極性変化に応答し、遅角量設定部49に記憶された遅角量を読み出してステータ巻線に遅角通電する。発電機の実出力電圧はレギュレータのレギュレート電圧よりも低い電圧制御値 V_{MaxV} と V_{Min} との間に収斂するように制御される。

【選択図】 図1

出 願 人 履 歴 情 報

識別番号

[000005326]

1. 変更年月日 1990年 9月 6日

[変更理由] 新規登録

住 所 東京都港区南青山二丁目1番1号

氏 名 本田技研工業株式会社

CERTIFICATE

I, Akira KIMURA of 7-7-601, Minami Ohsawa 5-chome,
Hachioji-shi, Tokyo, Japan hereby declare that I am
the translator of the attached document and certify
that the following is a true translation of Japanese Patent
Application No. 2000-310769 to the best of my knowledge
and belief.

Dated this 22nd day of January, 2003

Akira Kimura
Akira KIMURA

Japanese Patent Application No. 2000-310769

(Translation)

Document ID: Application for Patent

Re. No. : H100 1719 01

Filing date: October 11, 2000

To: Commissioner of Patent Office

IPC: H02P 9/04

H02J 7/16

Inventors:

Address: c/o Kabushiki Kaisha Honda Gijutsu Kenkyusho,
4-1, Chuo 1-chome, Wako-shi, Saitama, Japan

Name: Atsuo OTA

Address: c/o Kabushiki Kaisha Honda Gijutsu Kenkyusho,
4-1, Chuo 1-chome, Wako-shi, Saitama, Japan

Name: Satoshi HONDA

Applicant:

Applicant ID No.: 000005326

Name: HONDA GIKEN KOGYO KABUSHIKI KAISHA

Agents:

Attorney ID No.: 100084870

Name: Koju TANAKA

Attorney ID No.: 100079289

Name: Michito HIRAKI

List of document attached:

Specification: 1

Drawing: 1

Abstract: 1

[Name of Document] Specification

[Title of the Invention] Output Control Unit for
Synchronous Generator

[Claims]

[Claim 1] An output control unit for a synchronous generator having a rotor provided with field flux generating magnet means and a stator with stator windings thereon for producing a generated output, comprising:

detector means for detecting the number of revolutions of said rotor;

energizing means for retard-energizing said stator windings to increase a generated energy of the generator; and

a regulator for restricting an output voltage of the generator to a regulating voltage,

wherein said retard-energizing is performed when the number of revolutions of said rotor lies in a low revolution region and it is performed so as to control said output voltage to a predetermined voltage control value lower than said regulating voltage.

[Claim 2] An output control unit for a synchronous generator according to claim 1, wherein, in said retard-energizing, said output voltage is controlled to said predetermined voltage control value by changing an

energizing duty while maintaining an energizing retard quantity at a predetermined value.

[Claim 3] An output control unit for a synchronous generator according to claim 2, wherein said voltage control value has a predetermined range and said energizing duty is slightly decreased upon arrival of said output voltage at a maximum value in said range and is slightly increased upon drop of said output voltage to a value of not larger than a minimum value in said range.

[Claim 4] An output control unit for a synchronous motor according to claim 2 or claim 3, wherein said energizing duty is determined in accordance with the number of revolutions of the generator.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an output control unit for a synchronous motor and more particularly to an output control unit for a synchronous motor suitable for increasing a generated energy in a low revolution region.

[0002]

[Prior Art]

As a vehicular generator there is used a three-phase synchronous generator and an alternating current

generated thereby is rectified by a three-phase full wave rectifier for use in charging a battery. In a three-phase synchronous generator disclosed in Japanese Patent Laid Open No. 19194/1997, a phase-advancing current is allowed to flow in stator coils and a field flux is increased to increase an output (generated voltage and output current) by virtue of magnetization based on armature reaction which is caused by the phase-advancing current.

[0003]

[Problem to be Solved by the Invention]

Generally, a generator is provided with a regulator which restricts an output voltage so as to prevent a generated output from exceeding a predetermined value. The generation of electric power is stopped by functioning of the regulator. When the power generation stops, there occurs a load variation in an engine, so that the engine revolution becomes unstable particularly in a low revolution region. Moreover, if the generated output is too large, the resulting increase of friction in a low revolution region greatly influences the engine revolution.

[0004]

It is an object of the present invention to provide an output control unit for a synchronous generator

40

capable of increasing a generated output without making the revolution of an engine unstable in a low revolution region.

[0005]

[Means for Solving the Problem]

For achieving the above-mentioned object, the present invention is firstly characterized by an output control unit for a synchronous generator, comprising detector means for detecting the number of revolutions of a rotor of the generator, energizing means for retard-energizing stator windings to increase a generated energy of the generator, and a regulator for restricting an output voltage of the generator to a regulating voltage, wherein the retard-energizing is performed when the number of revolutions of the rotor lies in a low revolution region and it is performed so as to control the output voltage to a predetermined voltage control value lower than the regulating voltage.

[0006]

According to this first feature, the generated output is increased by retard-energizing the stator windings. Since this retard-energizing is performed so as to control the output voltage to a voltage control value which is set lower than the regulating voltage of the

regulator, the generated energy can be increased stably without operating the regulator in a low revolution region.

[0007]

The present invention is secondly characterized in that, in the retard-energizing, the output voltage is controlled to the predetermined voltage control value by changing an energizing duty while maintaining an energizing retard quantity at a predetermined value.

[0008]

The present invention is thirdly characterized in that the voltage control value has a predetermined range and the energizing duty is slightly decreased upon arrival of the output voltage at a maximum in the range and is slightly increased upon drop of the output voltage to a value of not larger than a minimum value in the range. Further, the present invention is fourthly characterized in that the energizing duty is determined in accordance with the number of revolutions of the generator.

[0009]

According to the second to fourth features, since the retard timing is fixed, it is easy to adjust the generated energy and the adjustment accuracy can be

enhanced.

[0010]

[Mode for Carrying Out the Invention]

An embodiment of the present invention will now be described with reference to the drawings. Fig. 2 is a sectional view of a combined starter/generator related to an embodiment of the present invention. The combined starter/generator (hereinafter referred to as "ACG"), indicated at 1, is mounted, for example, on an engine of a scooter type two-wheeled motor vehicle. The ACG 1 has a stator 50 with three-phase windings (stator coils) thereon and an outer rotor 60 connected to an end portion of a crank shaft 201 of an engine and adapted to rotate along an outer periphery of the stator 50. The outer rotor 60 has a cup-shaped rotor case 63 connected to the crank shaft 201 and magnets 62 which are disposed on an inner periphery surface of the rotor case 63 in a circumferential direction of a rotor yoke.

[0011]

The outer rotor 60 is mounted by fitting an inner periphery of a hub portion 60a onto a tapered front end portion of the crank shaft 201 and is fixed with a bolt 253 which is inserted through the center of the hub portion 60a into a threaded hole in the end portion of

the crank shaft 201. The stator 50, which is disposed on an inner periphery side of the outer rotor 60, is fixed to a crank case 202 with bolts 279. Further, a fan 280 is fixed to the outer rotor 60 with bolts 246. Adjacent the fan 280 is a radiator 282, which is covered with a fan cover 281.

[0012]

A sensor case 28 is fitted in an inner periphery of the stator 50. Within the sensor case 28 are provided rotor angle sensors (magnetic pole sensors) 29 and a pulser sensor (ignition pulser) 30 at equal intervals along an outer periphery of a boss of the outer rotor 60. The rotor angle sensors 29 are for energizing-control for the stator coils of the ACG 1 and three such rotor angle sensor 29 are provided correspondingly to U, V, and W phases, respectively, of the ACG. On the other hand, the ignition pulser 30 is for ignition control for the engine and only one such ignition pulser 30 is provided. The rotor angle sensors 29 and the ignition pulser 30 can each be constituted by a Hall IC or a magnetic reluctance (MR) element.

[0013]

Lead wires of the rotor angle sensors 29 and the ignition pulser 30 are connected to a substrate 31 and a

44

wire harness 32 is connected to the substrate 31.

A magnet ring 33 is fitted on an outer periphery of the boss 60a of the outer rotor 60, the magnet ring 33 being magnetized in two stages so as to exert a magnetic action to each of the rotor angle sensors 29 and the ignition pulser 30.

[0014]

In one magnetized zone of the magnet ring 33 corresponding to the rotor angle sensors 29 are formed N and S poles alternately at 30° intervals in the circumferential direction correspondingly to the magnetic poles of the stator 50. In the other magnetized zone of the magnet ring 33 corresponding to the ignition pulser 30 there is formed one magnetized portion circumferentially in the range of 15° to 40° .

[0015]

The ACG 1 constructed as above functions as a synchronous motor at the time of starting and is driven with an electric current fed from a battery, causing the crank shaft 201 to rotate and thereby causing the engine to start. After start-up of the engine the ACG 1 functions as a synchronous generator, charges the battery with generated electric current and supplies the electric current to various electric appliances.

[0016]

Fig. 3 is a principal electric appliances system diagram in a two-wheeled motor vehicle having an output control unit for the ACG 1. In the same figure, an ECU (electric control unit) 3 is provided with a full wave rectifier 4 for rectifying a three-phase alternating current generated in the ACG 1 and a regulator 5 for restricting an output of the full wave rectifier 4 to a predetermined regulating voltage (regulator operating voltage: say 14.5V). The ECU 3 is further provided with a power generation controller 6 which makes control to increase the generated energy when the number of revolutions of the engine lies in a predetermined low revolution region ("power generation control region" hereinafter). The power generation controller 6 is implemented as the function of a CPU. The rotor angle sensors 29 and the ignition pulser 30 are also connected to the ECU 3 and their detected signals are inputted to the ECU 3.

[0017]

An ignition coil 21 is connected to the ECU 3 and a spark plug 22 is connected to a secondary side of the ignition coil 21. To the ECU 3 are also connected a throttle sensor 23, a fuel sensor 24, a seat switch 25,

an idle switch 26, and a cooling water temperature sensor 27, and their detected signals are inputted to the ECU 3.
[0018]

Further connected to the ECU 3 are a starter relay 34, a starter switch 35, stop switches 36 and 37, a stand-by indicator 38, a fuel indicator 39, a speed sensor 40, an auto-by starter 41, and a headlight 42. A dimmer switch 43 is provided in the headlight 42.
[0019]

An electric current is fed to the above various portions from a battery 2 through a main fuse 44 and a main switch 45. The battery 2 is directly connected to the ECU 3 through a starter relay 34 and has a circuit through which it is connected to the ECU 3 via the main fuse 44 alone without going through the main switch 45.
[0020]

The power generation controller 6 has, in addition to the ordinary function of controlling the generated energy (voltage), a function of retard-energizing the stator coils of the three phases in the ACG 1 from the battery 2 to increase the generated energy ("ACG energizing control" hereinafter). The "retard-energizing" means making a retard corresponding to a predetermined electrical angle from a detection signal obtained by any

of the rotor angle sensors 29 at the time of a pole change in one magnetized zone of the magnet ring 33 and energizing the stator coils. However, for preventing unstable rotation of the engine caused by a sudden change of the engine load which is induced by operation of the regulator 5 in a low revolution region, a control is made so that an output voltage (battery voltage) of the full wave rectifier 4 is within a predetermined voltage range which is not higher than the regulating voltage.

[0021]

Fig. 4 illustrates a relation between the engine speed and a generated electric current detected when the ACG energizing control is conducted. In the same figure, an engine speed range of 1000 to 3500 rpm is set as a power generation control range. In such a low revolution region, a generated electric current (ACG output) of the ACG 1 obtained by the conventional control method is very small. Therefore, the generated electric current is increased by the ACG energizing control in the power generation control range. The increment is designated "retard-energizing" and is indicated with a dotted line in the figure. By making control so that the generated energy corresponds to a normal load current, it is possible to ensure a generated energy corresponding to a

consumed current quantity also in the low revolution region.

[0022]

Fig. 5 illustrates how the battery voltage changes in a retard power generation region. In the same figure, the battery voltage V_b is controlled in an ACG control voltage range which is defined by both a maximum control voltage value V_{Max} set below the regulating voltage (14.5V) and a minimum control voltage value V_{Min} . More specifically, an energizing retard quantity for the stator coils is fixed (say 60° in terms of an electrical angle) and the energizing duty of the full wave rectifier 4 is increased or decreased to control the battery voltage V_b to a value falling under the ACG control voltage range. More particularly, upon arrival of the battery voltage V_b at the maximum control voltage value V_{Max} , the energizing duty is decreased by a predetermined very small value (say 1%), while upon drop of the battery voltage V_b to the minimum control voltage value V_{Min} , the energizing duty is increased by the same very small value as above.

[0023]

Fig. 1 is a block diagram showing functions of principal portions in the ACG energizing control unit.

In the same figure, the full wave rectifier 4 has FETs (generally solid switching elements) 4a, 4b, 4c, 4d, 4e, and 4f which are connected to the stator coils 1U, 1V, and 1W of the ACG 1. At the time of starting the engine, the FETs 4a to 4f are switched by a driver 46 to drive the ACG 1 as a synchronous motor, causing the crank shaft 201 to rotate, while after the start-up of the engine the outer rotor, conversely, is driven by the engine and functions as a synchronous motor, so that the generated alternating current is rectified by the FETs 4a to 4f and the resulting current is fed to the battery 2 and an electric appliance load 47. Also during power generation under operation of the engine, particularly in a low revolution of the engine, the FETs 4a to 4f are controlled by the driver 46 so that the retard energizing to the stator coils is performed in accordance with the present invention, thereby increasing the generated energy. As to the retard energizing control, it will be described later with reference to Fig. 7.

[0024]

An engine speed decision unit 48 detects an engine speed on the basis of, for example, a detection signal provided from the ignition pulser 30 or a frequency signal of a generated voltage and provides a retard

command to the driver 46 if the detected engine speed lies in a predetermined power generation control range. In response to the retard command the driver 46 reads out a preset energizing retard quantity from a retard quantity setting unit 49 and retard-energizes the stator coils. The energizing duty is read out from the duty setting unit 51 and is fed to the driver 46. The driver 46 detects a magnetic pole detection signal provided from each rotor angle sensor 29, i.e., a signal which rises ON every time the sensor 29 detects a portion of the magnetized zone in the magnet ring 33 formed correspondingly to the magnetic poles of the outer rotor 60. Then, the driver 46 makes a retard corresponding to the energizing retard quantity from the time when the signal rises and outputs a PWM control signal to the FETs 4a~4f.

[0025]

A battery voltage decision unit 52 compares the battery voltage V_b with the maximum control voltage value V_{Max} and the minimum control voltage value V_{Min} both of which define the voltage control range and, on the basis of the result of the comparison, increases or decreases the energizing duty set in the duty setting unit 51 so that the battery voltage V_b falls under the above control

range.

[0026]

Fig. 6 is a flow chart showing processings executed by the output control unit described above. In the same figure, it is judged in step S1 whether the engine speed lies in the power generation control region or not. As noted earlier, the power generation control region is set, for example, in the range from 1000 to 3500 rpm. If the engine speed lies in the power generation control region, the processing flow advances to step S2, in which a check is made to see if there is set (= 1) a flag FACG indicating that the engine speed lies in the power generation control region. If the answer is negative, the flow advances to step S3 to set the flag FACG (set to "1"). Once the flag FACG is set, the flow advances to step S4, in which an energizing retard value acgagl is set at a predetermined value ACGAGL. The predetermined value ACGAGL may be set to an appropriate value in advance, say, 60° in terms of an electrical angle in this embodiment. In step S5 which follows, an energizing duty acduty is set at an initial value ACDUTY. The initial value ACDUTY may also be set to an appropriate value in advance, say, 40% in this embodiment. If the processings of steps S3 to S5 are over, the flow advances to step S7.

Also, if the answer in step S2 is affirmative, steps S3 to S5 are skipped and the flow advances to step S7.

Further, if the engine speed does not lie in the power generation control region, the flag FACG is reset (= 0) in step S6 and thereafter the flow advances to step S7.

[0027]

In step S7, a check is made to see if the flag FACG is set or not. If the flag FACG is set (= 1), it is judged in step S8 whether the battery voltage Vb is not smaller than the maximum control voltage value VMax. The maximum control voltage value VMax is set to a value lower than the regulating voltage, say, 13.5V. If the answer in step S8 is negative, the flow advances to step S9, in which a check is made to see if the battery voltage Vb is not larger than the minimum control voltage value VMin, which value is set to say 13.0V. If the answer in step S9 is negative, it is judged that the battery voltage lies in the ACG energizing voltage range which is set lower than the regulating voltage of the regulator. Then, the flow advances to step S10, in which ACG energizing control is executed in accordance with the energizing retard quantity acgagl and the energizing duty acduty.

[0028]

If it is judged in step S8 that the battery voltage V_b is not smaller than the maximum control voltage value V_{Max} , the flow advances to step S11, in which the energizing duty $acduty$ is decreased by a very small value $DDUTY$, which value is say 1%. If it is judged in step S9 that the battery voltage V_b is not larger than the minimum control voltage value V_{Min} , the flow advances to step S12, in which the energizing duty $acduty$ is increased by the very small value $DDUTY$. After the processings of steps S11 and S12, the flow advances to step S10. The very small value $DDUTY$ used in increasing the energizing duty $acduty$ and that used in decreasing the $acduty$ need not always be equal to each other. The very small value $DDUTY$ may be changed in proportion to the difference between the maximum or minimum control voltage value V_{Max} or V_{Min} and the present value.

[0029]

On the other hand, if the flag FCG is not set ($= 0$) in step S7, since the engine speed is not in the power generation control region, the flow advances to step S13 to stop the ACG energizing control.

[0030]

Fig. 7 illustrates a timing between electric currents (phase currents) flowing in the three phases of

the stator coils in ACG energizing control and outputs of the rotor angle sensors 29. As shown in the same figure, in a normal condition wherein the retard energizing control is not performed, an electric current is fed to each of U, V, and W phases of the stator coils in response to positive-negative (NS) changes in detected outputs provided from the rotor angle sensors 29. On the other hand, in the case where the retard energizing control is performed, an electric current is fed to each of U, V, and W phases of the stator coils with a delay corresponding to a predetermined retard quantity, d ($= 60^\circ$), from the time when there occurs a positive-negative (NS) change in the detected output provided from each rotor angle sensor 29. In Fig. 7, a retard angle T resulting from duty chopping is 180° , but it may be determined inside of 180° by the energizing duty fed from the duty setting unit 51 to the driver 46.

[0031]

Fig. 8 is an energizing duty table in which the engine speed, i.e., the number of revolutions of the generator is set as a parameter. An energizing duty is determined in accordance with a detected engine speed and by reference to Fig. 8.

[0032]

55

In the above embodiment there is adopted an outer rotor/inner rotor system in which permanent magnets as field flux generating magnet means are disposed in the outer rotor. However, the present invention is also applicable to a generator in which field flux generating magnet means is provided in an inner rotor or a generator which adopts electromagnets as field flux generating magnet means. Further, without using a fixed value as the energizing retard quantity acgagl there may be adopted a proportional, differential, or integral control, or a combination thereof in accordance with a conventional negative feedback control method.

[0033]

[Effect of the Invention]

As will be apparent from the above description, according to the invention defined in claims 1 to 4, it is possible to increase the generated energy stably without operation of an ordinary type of a voltage regulator in a low revolution region. Consequently, when the invention is applied to a vehicular generator in which a rotor is driven by an engine, it is possible to diminish a variation of the engine load during idling for example, thereby minimize a variation of the engine revolution and stabilize the idling operation. According

to the invention defined in claims 2 to 4, since the retard timing is fixed to a preset value, the generated energy can be adjusted easily with a simple configuration and it is possible to improve the adjustment accuracy.

[Brief Description of the Drawings]

Fig. 1 is a block diagram showing functions of principal portions in an output control unit according to an embodiment of the present invention;

Fig. 2 is a sectional view of a combined starter/generator related to the embodiment;

Fig. 3 is a principal electric appliances system diagram of a two-wheeled motor vehicle having the output control unit embodying the present invention;

Fig. 4 illustrates a relation between the engine speed and a generated electric current in ACG energizing control;

Fig. 5 illustrates a change in battery voltage in a retard power generation region;

Fig. 6 is a flow chart showing processings executed by the output control unit;

Fig. 7 illustrates a timing between phase currents flowing in stator coils and outputs of rotor angle sensors in ACG energizing control; and

Fig. 8 is an energizing duty table using the engine

speed as a parameter.

[Explanation of Reference Numerals]

1 ... a combined starter/generator, 2 ... battery,
3 ... ECU, 4 ... full wave rectifier, 5 ... regulator,
29 ... rotor angle sensor, 30 ... ignition pulser,
46 ... driver, 48 ... engine speed decision unit, 49 ...
retard quantity setting unit, 50 ... stator, 51 ... duty
setting unit, 60 ... outer rotor, 62 ... magnet, 201 ...
crank shaft

[Name of Document] Abstract

[Abstract]

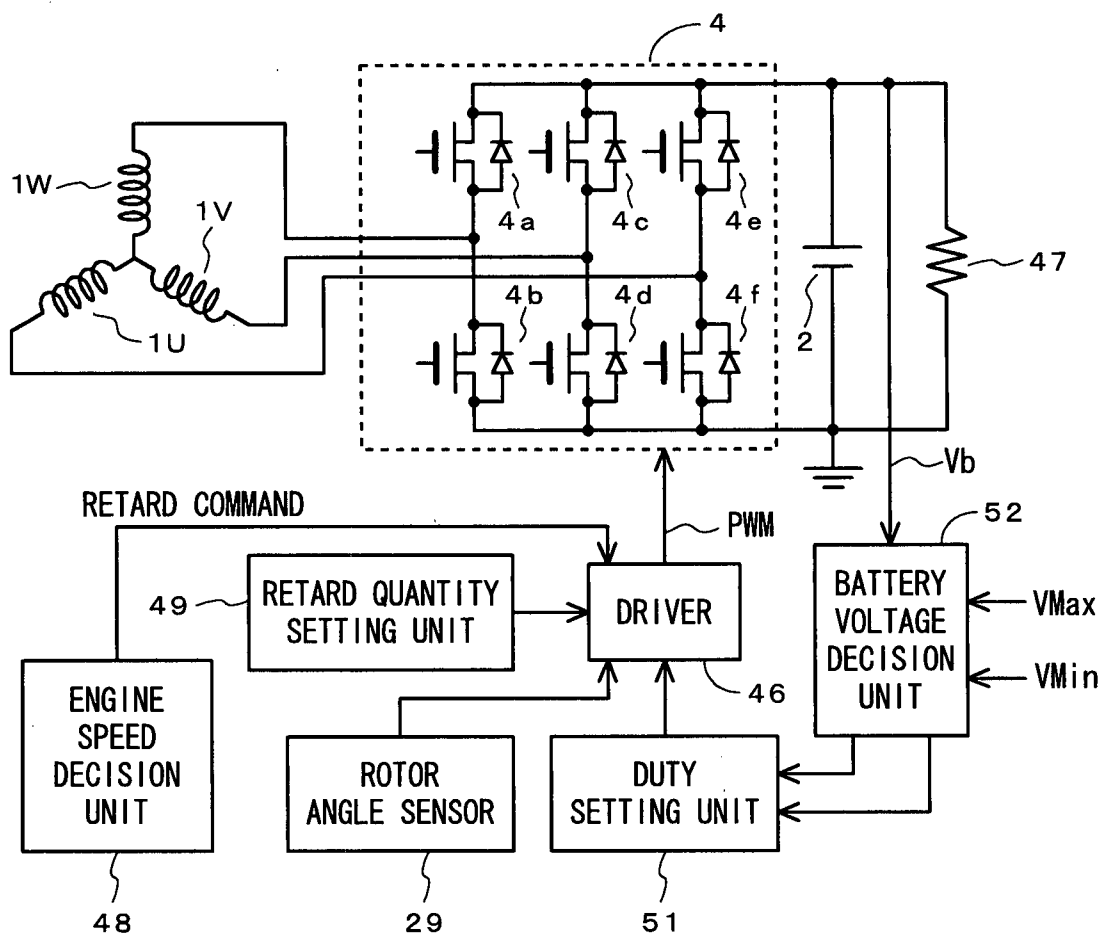
[Subject] Generated energy is to be increased while maintaining the engine revolution stable in a low revolution region.

[Solution] The number of revolutions of a rotor is detected by an engine speed decision unit 48, and when the engine speed is in a low revolution region, a retard energizing control is made for a rectifier 4 by a driver 46 to increase a field flux and thereby increase the generated energy. In response to a change in polarity in magnetic poles detected by rotor angle sensors 29 the driver 46 reads out a retard quantity stored in a retard quantity setting unit 49 and retard-energizes stator windings. A generator output voltage is controlled so as to be between a voltage control value V_{Max} which is lower than a regulating voltage of a regulator and a voltage control value V_{Min} .

[Selected Drawing] Fig. 1

1/6

Fig. 1



2/6
Fig. 2

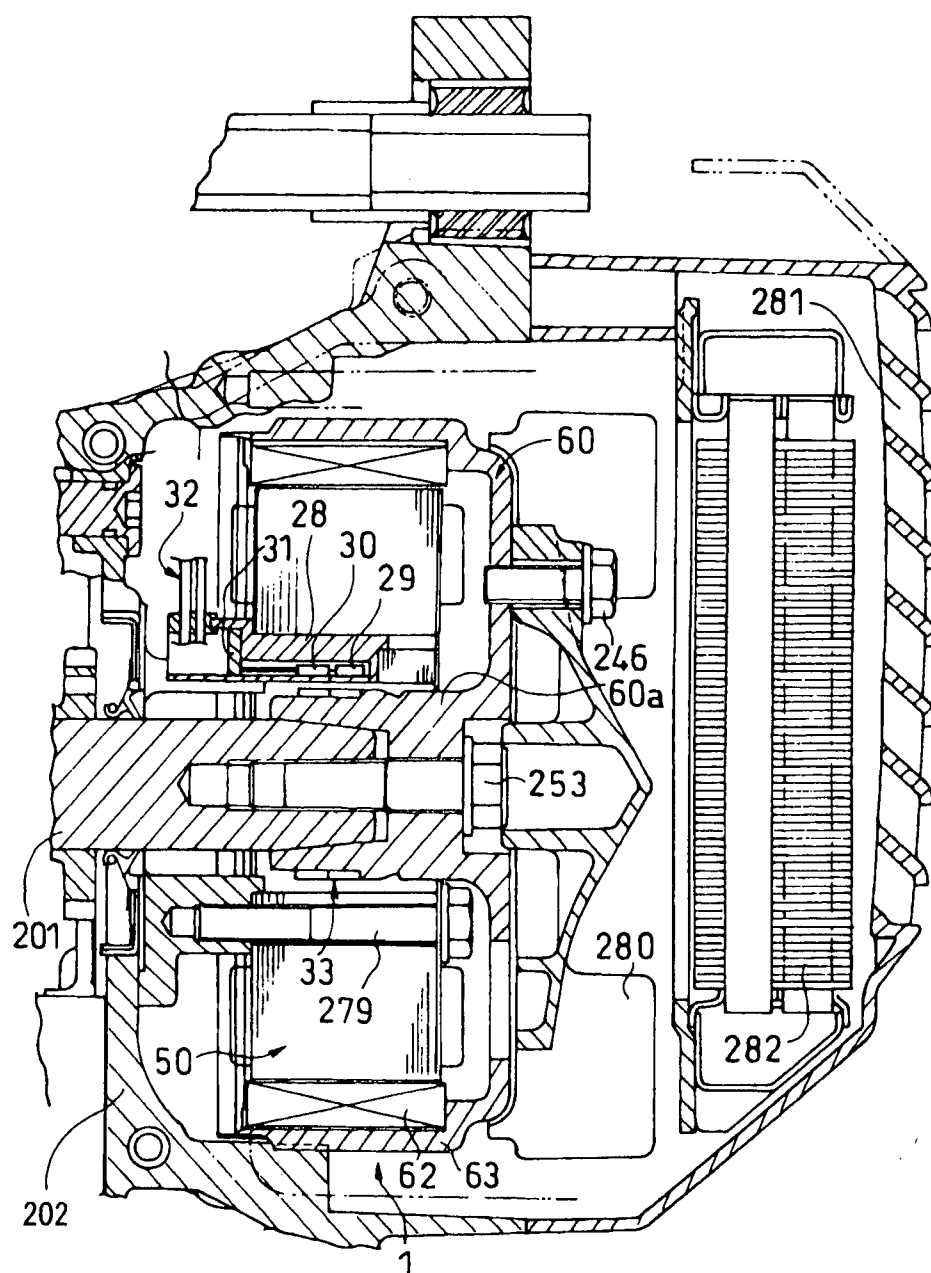
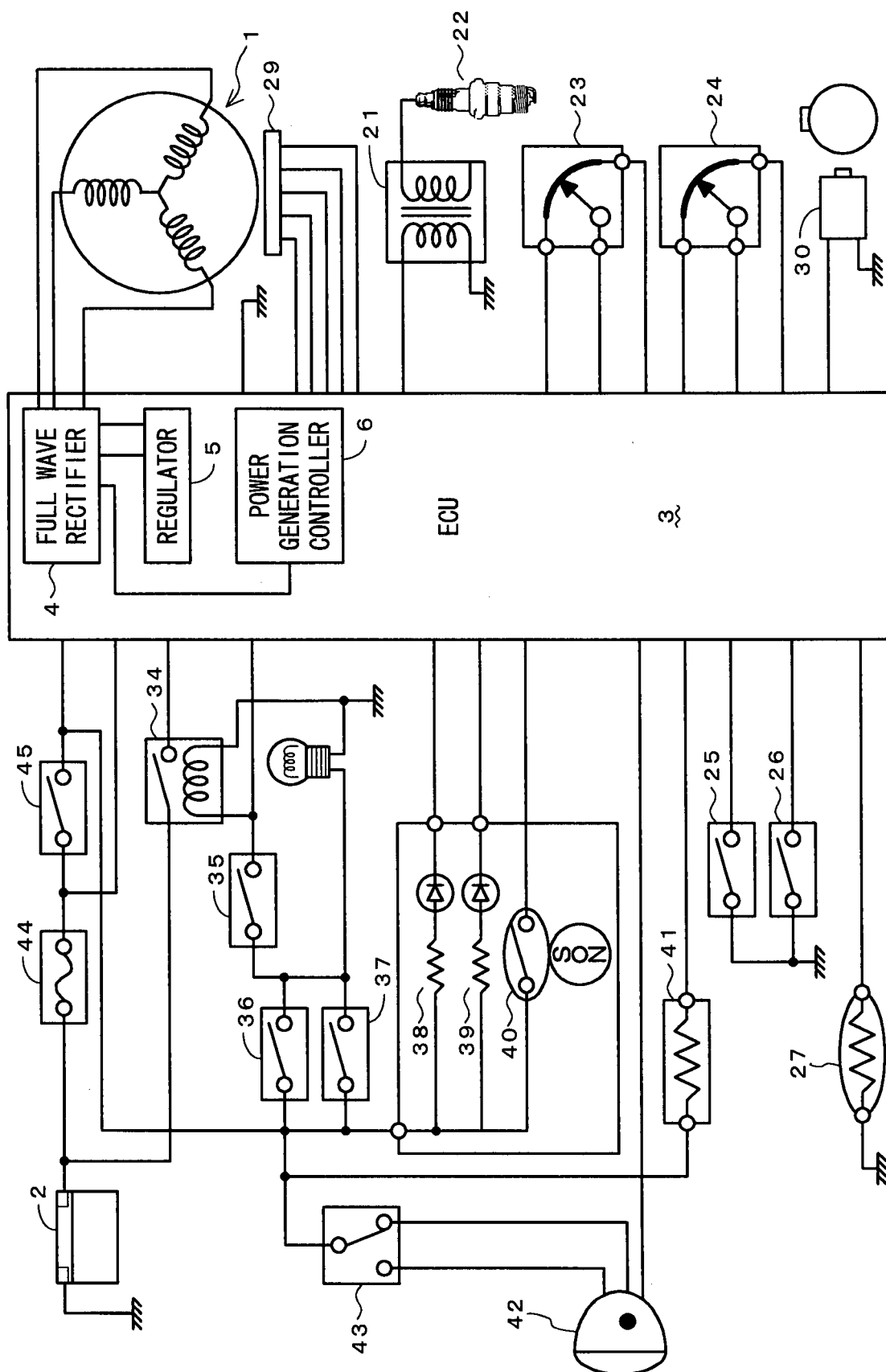
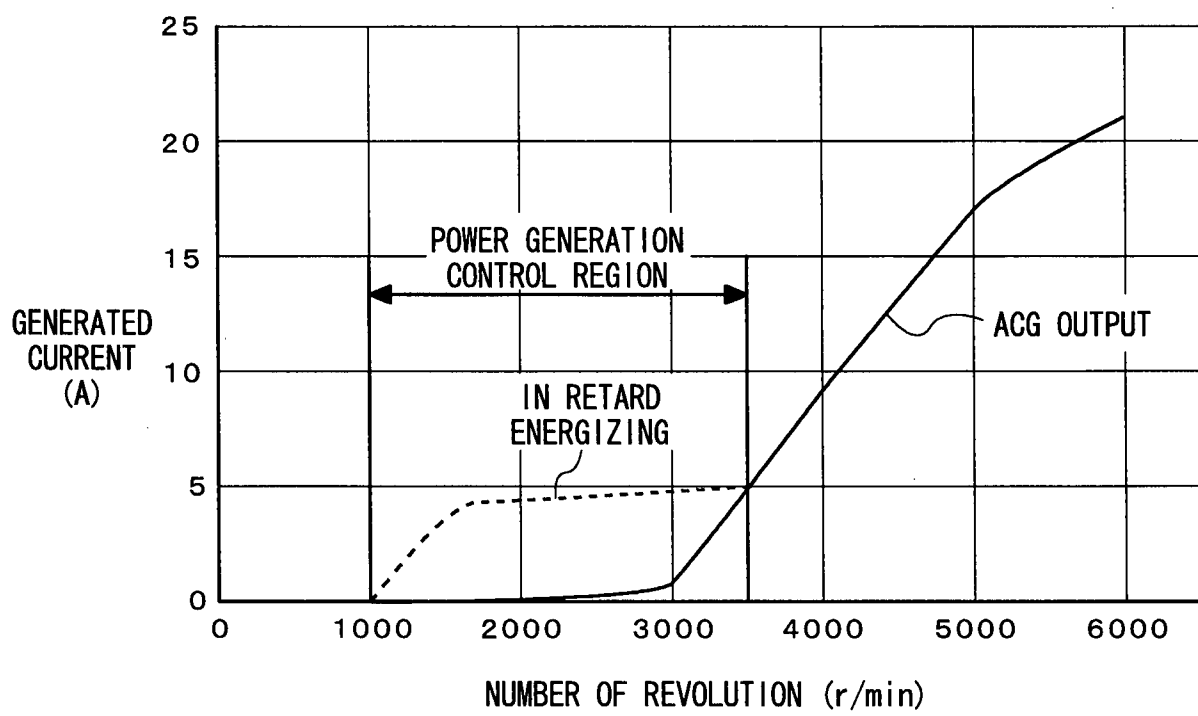


Fig. 3

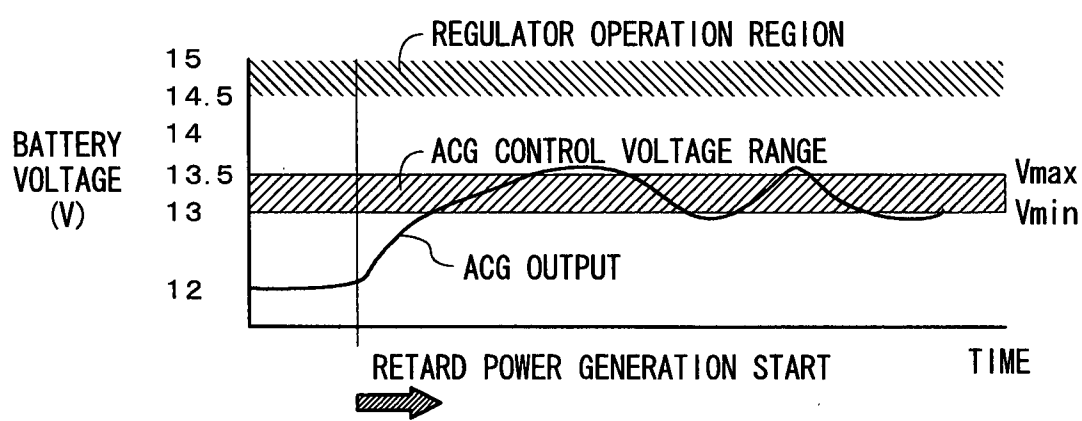


4 / 6

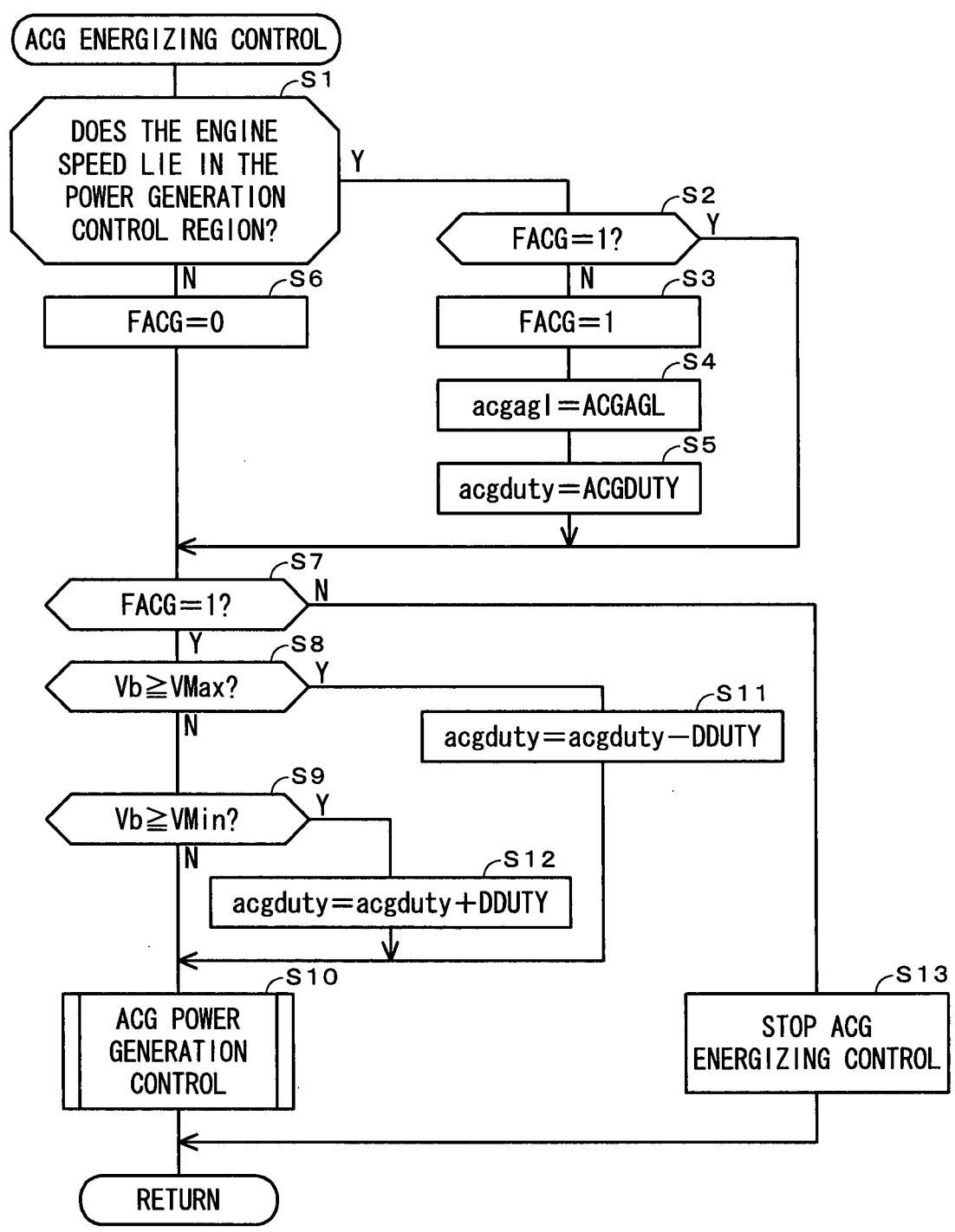
F i g . 4



F i g . 5



5 / 6
F i g . 6



6 / 6

Fig. 7

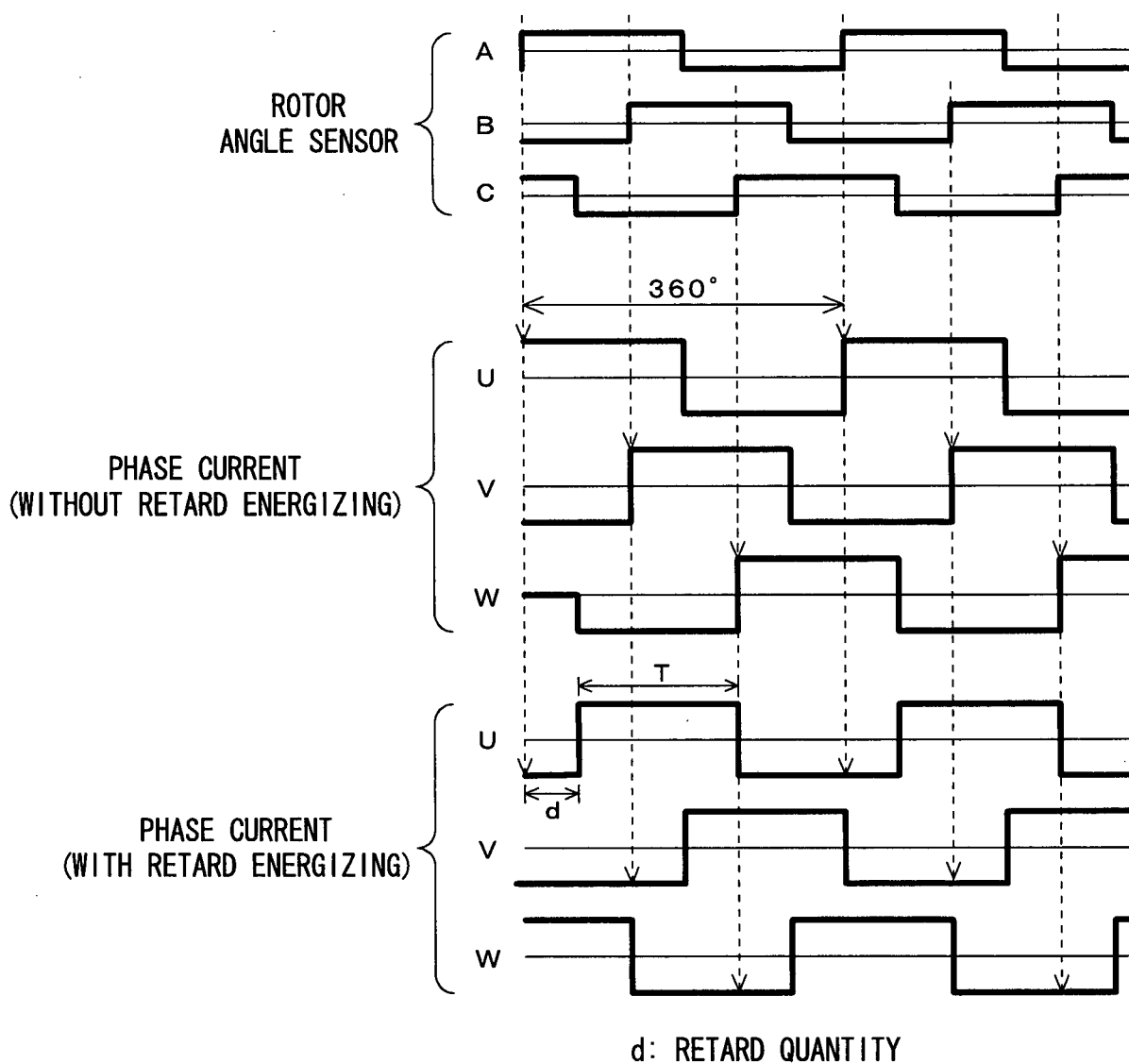
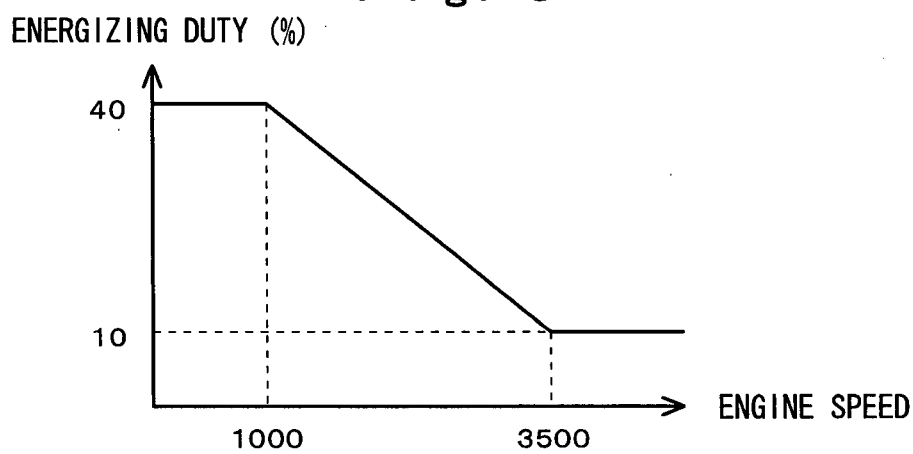


Fig. 8



CERTIFICADO

Yo, Akira KIMURA, de 7-7-601, Minami Ohsawa 5-chome, Hachioji-shi, Tokyo, Japón, declaro por la presente que soy el traductor del documento anexo y certifico que el documento siguiente es una traducción fiel de la Solicitud de Patente japonesa n° 2000-310769 según mi leal saber y entender.

A 22 de enero de 2003

(firma)

Akira KIMURA

(Nombre del documento)	Solicitud de Patente
(N° de referencia)	H100171901
(Fecha de presentación)	11 octubre 2000
(Destinatario)	Comisario, Oficina de Patentes
(Clasificación Internacional de Patentes)	H02P 9/04 H02J 7/16
(Inventor)	
(Dirección)	c/o: KABUSHIKI KAISHA HONDA GIJUTSU KENKYUSHO 4-1, Chuo 1-chome, Wako-shi, Saitama, Japón
(Nombre)	Atsuo OTA
(Inventor)	
(Dirección)	c/o: KABUSHIKI KAISHA HONDA GIJUTSU KENKYUSHO 4-1, Chuo 1-chome, Wako-shi, Saitama, Japón
(Nombre)	Satoshi HONDA
(Solicitante)	
(N° de identificación)	000005326
(Nombre)	HONDA GIKEN KOGYO KABUSHIKI KAISHA
(Agente)	
(N° de identificación)	100084870
(Abogado de patentes)	
(Nombre)	Koju TANAKA
(Agente)	
(N° de identificación)	100070289
(Abogado de patentes)	
(Nombre)	Michito HIRAKI
(Indicación de cargo)	
(Resguardo de pago n°)	058333
(Importe)	21.000 yen

(Lista de documentos presentados)

(Nombre del documento)	Memoria descriptiva	1
(Nombre del documento)	Dibujos	1
(Nombre del documento)	Resumen	1
(Necesidad de confirmación)		Necesaria

-1-

[Nombre del documento] Memoria descriptiva

[Título de la invención] Unidad de control de salida para generador síncrono

[Reivindicaciones]

5 [Reivindicación 1] Una unidad de control de salida para un generador síncrono que tiene un rotor provisto de medios de imán generadores de flujo de campo y un estator con devanados de estator para producir una salida generada, incluyendo:

10 medios detectores para detectar el número de revoluciones de dicho rotor;

 medios energizadores para energizar con retardo dichos devanados de estator para aumentar la energía generada del generador; y

15 un regulador para restringir un voltaje de salida del generador a un voltaje regulador,

 donde dicha energización con retardo se lleva a cabo cuando el número de revoluciones de dicho rotor está en una región de revolución baja y se lleva a cabo para controlar dicho voltaje de salida a un valor predeterminado de control de voltaje menor que dicho voltaje regulador.

20 [Reivindicación 2] Una unidad de control de salida para un generador síncrono según la reivindicación 1, donde, en dicha energización con retardo, dicho voltaje de salida se controla a dicho valor predeterminado de control de voltaje cambiando un trabajo de energización a la vez que se mantiene una cantidad de retardo de energización a un valor predeterminado.

25 [Reivindicación 3] Una unidad de control de salida para un generador síncrono según la reivindicación 2, donde dicho valor de control de voltaje tiene un rango predeterminado y dicho trabajo de energización se disminuye ligeramente a la llegada de dicho voltaje de salida a un valor máximo en dicho rango y se incrementa ligeramente a la caída de dicho voltaje de salida a un valor no

30

35

superior a un valor mínimo en dicho rango.

[Reivindicación 4] Una unidad de control de salida para un motor síncrono según la reivindicación 2 o la reivindicación 3, donde dicho trabajo de energización se
5 determina según el número de revoluciones del generador.

[Descripción detallada de la invención]

[0001]

[Campo técnico de la invención]

La presente invención se refiere a una unidad de control de salida para un motor síncrono y más en parti-
10 cular a una unidad de control de salida para un motor síncrono adecuada para incrementar la energía generada en una región de revolución baja.

[0002]

15 [Técnica anterior]

Como un generador de vehículo se usa un generador síncrono trifásico y la corriente alterna generada es rectificada por lo tanto por un rectificador trifásico de onda completa para uso al cargar una batería. En un gene-
20 rador síncrono trifásico descrito en La Publicación de Patente japonesa número 19194/1997, una corriente de avance de fase puede fluir en bobinas de estator y un flujo de campo se incrementa para aumentar una salida (voltaje generado y corriente de salida) en virtud de la
25 magnetización basada en la reacción de inducido que se produce por la corriente de avance de fase.

[0003]

[Problema a resolver con la invención]

En general, un generador está provisto de un regula-
30 dor que restringe un voltaje de salida para evitar que la salida generada exceda de un valor predeterminado. La generación de potencia eléctrica se detiene haciendo funcionar el regulador. Cuando la generación de potencia se para, se produce una variación de carga en un motor, de
35 manera que la revolución del motor resulta inestable en

particular en una región de revolución baja. Además, si la salida generada es demasiado grande, el incremento resultante del rozamiento en una región de revolución baja influye en gran medida en la revolución del motor.

5 [0004]

Un objeto de la presente invención es proporcionar una unidad de control de salida para un generador síncrono capaz de aumentar una salida generada sin hacer inestable la revolución de un motor en una región de revolución baja.

10

[0005]

[Medios para resolver el problema]

Para lograr el objeto antes indicado, la presente invención se caracteriza en primer lugar por una unidad de control de salida para un generador síncrono, incluyendo medios detectores para detectar el número de revoluciones de un rotor del generador, medios energizadores para energizar con retardo devanados de estator para aumentar la energía generada del generador, y un regulador para restringir el voltaje de salida del generador a un voltaje regulador, donde la energización con retardo se lleva a cabo cuando el número de revoluciones del rotor está en una región de revolución baja y se lleva a cabo para controlar el voltaje de salida a un valor predeterminado de control de voltaje menor que el voltaje regulador.

15

20

25

[0006]

Según esta primera característica, la salida generada se incrementa energizando con retardo los devanados de estator. Dado que esta energización con retardo se lleva a cabo para controlar el voltaje de salida a un valor de control de voltaje que se establece menor que el voltaje regulador del regulador, la energía generada se puede incrementar establemente sin poner en funcionamiento el regulador en una región de revolución baja.

30

35

[0007]

La presente invención se caracteriza en segundo lugar porque, en la energización con retardo, el voltaje de salida se controla al valor predeterminado de control de
5 voltaje cambiando un trabajo de energización a la vez que se mantiene la cantidad de retardo de energización a un valor predeterminado.

[0008]

La presente invención se caracteriza en tercer lugar
10 porque el valor de control de voltaje tiene un rango predeterminado y el trabajo de energización se disminuye ligeramente a la llegada del voltaje de salida a un máximo en el rango y se incrementa ligeramente a la caída del voltaje de salida a un valor no superior a un valor mínimo
15 en el rango. Además, la presente invención se caracteriza en cuarto lugar porque el trabajo de energización se determina según el número de revoluciones del generador.

[0009]

Según las características segunda a cuarta, dado que
20 la temporización de retardo es fija, es fácil ajustar la energía generada y se puede mejorar la exactitud del ajuste.

[0010]

[Modo de llevar a la práctica la invención]

25 Ahora se describirá una realización de la presente invención con referencia a los dibujos. La figura 2 es una vista en sección de un dispositivo de arranque/generador combinado relacionado con una realización de la presente invención. El dispositivo de arranque/generador combinado (que en adelante se denomina
30 "ACG"), indicado en 1, está montado, por ejemplo, en un motor de un vehículo de motor de dos ruedas de tipo scooter. El ACG 1 tiene un estator 50 con devanados trifásicos (bobinas de estator) y un rotor exterior 60 conectado
35 a una porción de extremo de un cigüeñal 201 de un motor y

-5-

adaptado para girar a lo largo de una periferia externa del estator 50. El rotor exterior 60 tiene una carcasa de rotor en forma de copa 63 conectada al cigüeñal 201 e imanes 62 que están dispuestos en una superficie perifé-
rica interior de la carcasa de rotor 63 en una dirección
5 circunferencial de un yugo de rotor.

[0011]

El rotor exterior 60 se monta encajando una periferia interna de una porción de cubo 60a sobre una porción
10 de extremo delantero ahusado del cigüeñal 201 y se fija con un perno 253 que se introduce a través del centro de la porción de cubo 60a en un agujero roscado en la porción de extremo del cigüeñal 201. El estator 50, que está
dispuesto en un lado de periferia interior del rotor exterior 60, está fijado a un cárter 202 con pernos 279.
15 Además, un ventilador 280 está fijado al rotor exterior 60 con pernos 246. Junto al ventilador 280 hay un radiador 282, que se cubre con una cubierta de ventilador 281.

[0012]

Una carcasa de sensor 28 está encajada en una periferia interna del estator 50. Dentro de la carcasa de sensor 28 se ha dispuesto sensores de ángulo de rotor (sensores de polo magnético) 29 y un sensor de pulsador (pulsador de encendido) 30 a intervalos iguales a lo lar-
20 go de una periferia externa de un saliente del rotor exterior 60. Los sensores de ángulo de rotor 29 son para controlar la energización de las bobinas de estator del ACG 1 y se ha dispuesto tres sensores de ángulo de rotor 29 correspondientes a las fases U, V, y W, respectivamen-
25 te, del ACG. Por otra parte, el pulsador de encendido 30 es para controlar el encendido del motor y solamente se ha previsto dicho pulsador de encendido 30. Cada uno de los sensores de ángulo de rotor 29 y el pulsador de encendido 30 puede estar constituido por un CI Hall o un
30 elemento de reluctancia magnética (RM).
35

[0013]

Hilos conductores de los sensores de ángulo de rotor 29 y el pulsador de encendido 30 están conectados a un sustrato 31 y un mazo de cables 32 está conectado al sustrato 31. Un aro magnético 33 está encajado en una periferia externa del saliente 60a del rotor exterior 60, magnetizándose el aro magnético 33 en dos etapas para ejercer una acción magnética en cada uno de los sensores de ángulo de rotor 29 y el pulsador de encendido 30.

10 [0014]

En una zona magnetizada del aro magnético 33 correspondiente a los sensores de ángulo de rotor 29 se forman polos N y S alternativamente a intervalos de 30° en la dirección circunferencial correspondientemente a los polos magnéticos del estator 50. En la otra zona magnetizada del aro magnético 33 correspondiente al pulsador de encendido 30 se ha formado una porción magnetizada circunferencialmente en el rango de 15° a 40° .

[0015]

20 El ACG 1 construido como antes funciona como un motor síncrono al tiempo de arrancar y es excitado con una corriente eléctrica alimentada desde una batería, haciendo que el cigüeñal 201 gire y haciendo por lo tanto que el motor arranque. Después del arranque del motor, el ACG
25 1 funciona como un generador síncrono, carga la batería con corriente eléctrica generada y suministra la corriente eléctrica a varios aparatos eléctricos.

[0016]

La figura 3 es un diagrama del sistema principal de
30 aparatos eléctricos en un vehículo de motor de dos ruedas que tiene una unidad de control de salida para el ACG 1. En la misma figura, una UCE (unidad de control eléctrico) 3 está provista de un rectificador de onda completa 4 para rectificar una corriente trifásica alterna generada en
35 el ACG 1 y un regulador 5 para restringir la salida del

-7-

rectificador de onda completa 4 a un voltaje regulador predeterminado (voltaje operativo del regulador, por ejemplo, 14,5 V). La UCE 3 está provista además de un controlador de generación de potencia 6 que realiza el control para aumentar la energía generada cuando el número de revoluciones del motor está en una región de revolución baja predeterminada (en adelante "región de control de generación de potencia"). El controlador de generación de potencia 6 se implementa como la función de una CPU. Los sensores de ángulo de rotor 29 y el pulsador de encendido 30 también están conectados a la UCE 3 y sus señales detectadas se introducen en la UCE 3.

[0017]

Una bobina de encendido 21 está conectada a la UCE 3 y una bujía 22 está conectada a un lado secundario de la bobina de encendido 21. A la UCE 3 también están conectados un sensor de regulador 23, un sensor de combustible 24, un interruptor de asiento 25, un interruptor de marcha en vacío 26, y un sensor de temperatura del agua refrigerante 27, y sus señales detectadas se introducen en la UCE 3.

[0018]

También están conectados a la UCE 3 un relé de dispositivo de arranque 34, un interruptor de dispositivo de arranque 35, interruptores de parada 36 y 37, un indicador de espera 38, un indicador de combustible 39, un sensor de velocidad 40, un dispositivo secundario de arranque automático 41, y un faro 42. Se ha dispuesto un interruptor regulador 43 en el faro 42.

[0019]

Se alimenta corriente eléctrica a las varias porciones anteriores desde una batería 2 a través de un fusible principal 44 y un interruptor principal 45. La batería 2 está conectada directamente a la UCE 3 mediante un relé de dispositivo de arranque 34 y tiene un circuito median-

-8-

te el que está conectada a la UCE 3 mediante el fusible principal 44 solo sin pasar por el interruptor principal 45.

[0020]

5 El controlador de generación de potencia 6 tiene, además de la función ordinaria de controlar la energía generada (voltaje), una función de energizar con retardo las bobinas de estator de las tres fases en el ACG 1 desde la batería 2 para aumentar la energía generada
10 ("control de energización de ACG" en adelante). "Energización con retardo" significa realizar un retardo correspondiente a un ángulo eléctrico predeterminado a partir de una señal de detección obtenida por cualquiera de los sensores de ángulo de rotor 29 al tiempo de un
15 cambio de polo en una zona magnetizada del aro magnético 33 y energizar las bobinas de estator. Sin embargo, para evitar la rotación inestable del motor producida por un cambio brusco de la carga del motor inducida por la operación del regulador 5 en una región de revolución baja,
20 el control se hace de manera que un voltaje de salida (voltaje de batería) del rectificador de onda completa 4 esté dentro de un rango predeterminado de voltaje que no es más alto que el voltaje regulador.

[0021]

25 La figura 4 ilustra una relación entre la velocidad del motor y una corriente eléctrica generada detectada cuando se realiza el control de energización de ACG. En la misma figura, un rango de velocidades del motor de 1000 a 3500 rpm se establece como un rango de control de
30 generación de potencia. En tal región de revolución baja, una corriente eléctrica generada (salida de ACG) del ACG 1 obtenida por el método de control convencional es muy pequeña. Por lo tanto, la corriente eléctrica generada se incrementa por el control de energización de ACG en el
35 rango del control de generación de potencia. El incremen-

to se designa "energización con retardo" y se indica con una línea de trazos en la figura. Efectuando el control de manera que la energía generada corresponda a una corriente de carga normal, es posible garantizar una energía generada correspondiente a una cantidad de corriente consumida también en la región de revolución baja.

[0022]

La figura 5 ilustra cómo el voltaje de batería cambia en una región de generación de potencia de retardo. En la misma figura, el voltaje de batería V_b se controla en un rango de voltaje de control de ACG que se define tanto por un valor máximo de voltaje de control V_{Max} establecido por debajo del voltaje regulador (14,5 V) como un valor mínimo de voltaje de control V_{Min} . Más específicamente, se fija una cantidad de retardo de energización para las bobinas de estator (por ejemplo 60° en términos de un ángulo eléctrico) y el trabajo de energización del rectificador de onda completa 4 se incrementa o disminuye para controlar el voltaje de batería V_b a un valor que cae por debajo del rango de voltaje de control de ACG. Más en particular, a la llegada del voltaje de batería V_b al valor máximo de voltaje de control V_{Max} , el trabajo de energización se disminuye un valor predeterminado muy pequeño (por ejemplo, 1%), mientras que a la caída del voltaje de batería V_b al valor mínimo de voltaje de control V_{Min} , el trabajo de energización se incrementa el mismo valor muy pequeño como antes.

[0023]

La figura 1 es un diagrama de bloques que muestra funciones de porciones principales en la unidad de control de energización de ACG. En la misma figura, el rectificador de onda completa 4 tiene FETs (elementos conmutadores generalmente sólidos) 4a, 4b, 4c, 4d, 4e, y 4f que están conectados a las bobinas de estator 1U, 1V, y 1W del ACG 1. al tiempo de arrancar el motor, los FETs 4a

-10-

a 4f son conmutados por un excitador 46 para mover el ACG 1 como un motor síncrono, haciendo que el cigüeñal 201 gire, mientras que después del arranque del motor el rotor exterior, a la inversa, es excitado por el motor y
5 funciona como un motor síncrono, de manera que la corriente alterna generada sea rectificada por los FETs 4a a 4f y la corriente resultante se alimenta a la batería 2 y una carga de aparatos eléctricos 47. También durante la generación de potencia a la operación del motor, en particular en una revolución baja del motor, los FETs 4a a
10 4f son controlados por el excitador 46 de manera que la energización con retardo a las bobinas de estator se lleve a cabo según la presente invención, aumentando por lo tanto la energía generada. En cuanto al control de la energización de retardo, se describirá más tarde con referencia a la figura 7.

[0024]

Una unidad de decisión de velocidad de motor 48 detecta la velocidad del motor, por ejemplo, en base a una
20 señal de detección proporcionada por el pulsador de encendido 30 o una señal de frecuencia de un voltaje generado y da una orden de retardo al excitador 46 si la velocidad detectada del motor está en un rango de control de generación de potencia predeterminado. En respuesta a
25 la orden de retardo el excitador 46 lee una cantidad predeterminada de retardo de energización en una unidad de establecimiento de cantidad de retardo 49 y energiza con retardo las bobinas de estator. El trabajo de energización se lee en la unidad de establecimiento de trabajo 51
30 y se alimenta al excitador 46. El excitador 46 detecta una señal de detección de polo magnético proporcionada por cada sensor de ángulo de rotor 29, es decir, una señal sube cada vez que el sensor 29 detecta una porción de la zona magnetizada en el aro magnético 33 formado correspondientemente a los polos magnéticos del rotor exte-
35

-11-

rior 60. Después, el excitador 46 hace un retardo correspondiente a la cantidad de retardo de energización desde el tiempo en la señal sube y envía una señal de control PWM a los FETs 4a-4f.

5 [0025]

Una unidad de decisión de voltaje de batería 52 compara el voltaje de batería Vb con el valor máximo de voltaje de control VMax y el valor mínimo de voltaje de control VMin que definen el rango de control de voltaje y, en base al resultado de la comparación, aumenta o disminuye el trabajo de energización establecido en la unidad de establecimiento de trabajo 51 de manera que el voltaje de batería Vb caiga por debajo del rango de control anterior.

15 [0026]

La figura 6 es un diagrama de flujo que muestra los procesos ejecutados por la unidad de control de salida descrita anteriormente. En la misma figura, se determina en el paso S1 si la velocidad del motor está en la región de control de generación de potencia o no. Como se ha indicado anteriormente, la región de control de generación de potencia se establece, por ejemplo, en el rango de 1000 a 3500 rpm. Si la velocidad del motor está en la región de control de generación de potencia, el flujo de procesamiento avanza al paso S2, en el que se comprueba si está puesto (=1) un señalizador FACG que indica que la velocidad del motor está en la región de control de generación de potencia. Si la respuesta es negativa, el flujo avanza al paso S3 para poner el señalizador FACG (ponerlo a "1"). Una vez puesto el señalizador FACG, el flujo avanza al paso S4, en el que un valor de retardo de energización acgagl se establece a un valor predeterminado ACGAGL. El valor predeterminado ACGAGL se puede establecer a un valor apropiado con anterioridad, por ejemplo, 60° en términos de un ángulo eléctrico en esta realiza-

-12-

ción. En el paso S5 siguiente, se pone un trabajo de energización acduty a un valor inicial ACDUTY. El valor inicial ACDUTY también se puede poner a un valor apropiado con anterioridad, por ejemplo, 40% en esta realización. Si los procesados de los pasos S3 a S5 han terminado, el flujo avanza al paso S7. Además, si la respuesta en el paso S2 es afirmativa, se saltan los pasos S3 a S5 y el flujo avanza al paso S7. Además, si la velocidad del motor no está en la región de control de generación de potencia, se reposiciona (=0) el señalizador FACG en el paso S6 y después el flujo avanza al paso S7.

[0027]

En el paso S7, se comprueba si el señalizador FACG está puesto o no. Si el señalizador FACG está puesto (=1), se determina en el paso S8 si el voltaje de batería Vb no es más pequeño que el valor máximo de voltaje de control VMax. El valor máximo de voltaje de control VMax se pone a un valor menor que el voltaje regulador, por ejemplo, 13,5 V. Si la respuesta en el paso S8 es negativa, el flujo avanza al paso S9, en el que se comprueba si el voltaje de batería Vb no es más grande que el valor mínimo de voltaje de control VMin, valor que se establece por ejemplo a 13,0 V. Si la respuesta en el paso S9 es negativa, se determina que el voltaje de batería está en el rango de voltaje de energización de ACG que es menor que el voltaje regulador del regulador. Después, el flujo avanza al paso S10, en el que el control de energización de ACG se ejecuta según la cantidad de retardo de energización acgagl y el trabajo de energización acduty.

[0028]

Si se determina en el paso S8 que el voltaje de batería Vb no es más pequeño que el valor máximo de voltaje de control VMax, el flujo avanza al paso S11, en el que el trabajo de energización acduty se disminuye un valor muy pequeño DDUTY, valor que es por ejemplo 1%. Si se de-

-13-

termina en el paso S9 que el voltaje de batería Vb no es más grande que el valor mínimo de voltaje de control VMin, el flujo avanza al paso S12, en el que el trabajo de energización acduty se incrementa el valor muy pequeño DDUTY. Después de los procesados de los pasos S11 y S12, el flujo avanza al paso S10. El valor muy pequeño DDUTY usado al aumentar el trabajo de energización acduty y el usado al disminuir el acduty no tienen que ser siempre iguales entre sí. El valor muy pequeño DDUTY se puede cambiar en proporción a la diferencia entre el valor máximo o mínimo del voltaje de control VMax o VMin y el valor presente.

[0029]

Por otra parte, si el señalizador FCG no está puesto (=0) en el paso S7, dado que la velocidad del motor no está en la región de control de generación de potencia, el flujo avanza al paso S13 para detener el control de energización de ACG.

[0030]

La figura 7 ilustra una temporización entre corrientes eléctricas (corrientes de fase) que fluyen en las tres fases de las bobinas de estator en el control de energización de ACG y las salidas de los sensores de ángulo de rotor 29. Como se muestra en la misma figura, en una condición normal donde el control de energización de retardo no se lleva a cabo, se alimenta una corriente eléctrica a cada una de las fases U, V, y W de las bobinas de estator en respuesta a cambios positivo-negativo (NS) de las salidas detectadas obtenidas de los sensores de ángulo de rotor 29. Por otra parte, en el caso en el que el control de energización de retardo se lleva a cabo, se alimenta una corriente eléctrica a cada una de las fases U, V, y W de las bobinas de estator con un retardo correspondiente a una cantidad predeterminada de retardo, d ($=60^\circ$), a partir del tiempo en que se produce un cambio

positivo-negativo (NS) en la salida detectada obtenida de cada sensor de ángulo de rotor 29. En la figura 7, un ángulo de retardo T resultante de troceado de trabajo es 180°, pero se puede determinar dentro de 180° por el trabajo de energización alimentado desde la unidad de establecimiento de trabajo 51 al excitador 46.

[0031]

La figura 8 es una tabla de trabajos de energización en la que la velocidad del motor, es decir, el número de revoluciones del generador se establece como un parámetro. Un trabajo de energización se determina según una velocidad detectada del motor y por referencia a la figura 8.

[0032]

En la realización anterior se adopta un sistema de rotor exterior/rotor interior en el que imanes permanentes como medios de imán generadores de flujo de campo están dispuestos en el rotor exterior. Sin embargo, la presente invención también es aplicable a un generador en el que se ha dispuesto medios de imán generadores de flujo de campo en un rotor interior o un generador que adopta electroimanes como medios de imán generadores de flujo de campo. Además, sin usar un valor fijo como la cantidad de retardo de energización acagl se puede adoptar un control proporcional, diferencial, o integral, o su combinación según un método de control de realimentación negativa convencional.

[0033]

[Efecto de la invención]

Como será evidente por la descripción anterior, según la invención definida en las reivindicaciones 1 a 4, es posible aumentar la energía generada establemente sin la operación de tipo ordinario de un regulador de voltaje en una región de revolución baja. En consecuencia, cuando la invención se aplica a un generador de vehículo en el

que un rotor es movido por un motor, es posible disminuir la variación de la carga del motor durante la marcha en vacío por ejemplo, minimizando por lo tanto la variación de la revolución del motor y estabilizando la operación de marcha en vacío. Según la invención definida en las reivindicaciones 2 a 4, dado que la temporización de retardo se fija a un valor preestablecido, la energía generada se puede ajustar fácilmente con una configuración simple y es posible mejorar la exactitud del ajuste.

10 [Breve descripción de los dibujos]

La figura 1 es un diagrama de bloques que muestra funciones de porciones principales en una unidad de control de salida según una realización de la presente invención.

15 La figura 2 es una vista en sección de un dispositivo de arranque/generador combinado relacionado con la realización.

La figura 3 es un diagrama del sistema principal de aparatos eléctricos de un vehículo de motor de dos ruedas que tiene la unidad de control de salida que realiza la presente invención.

La figura 4 ilustra una relación entre la velocidad del motor y una corriente eléctrica generada en el control de energización de ACG.

25 La figura 5 ilustra un cambio en voltaje de batería en una región de generación de potencia de retardo.

La figura 6 es un diagrama de flujo que muestra los procesos ejecutados por la unidad de control de salida.

La figura 7 ilustra una temporización entre corrientes de fase que fluyen en bobinas de estator y salidas de sensores de ángulo de rotor en el control de energización de ACG.

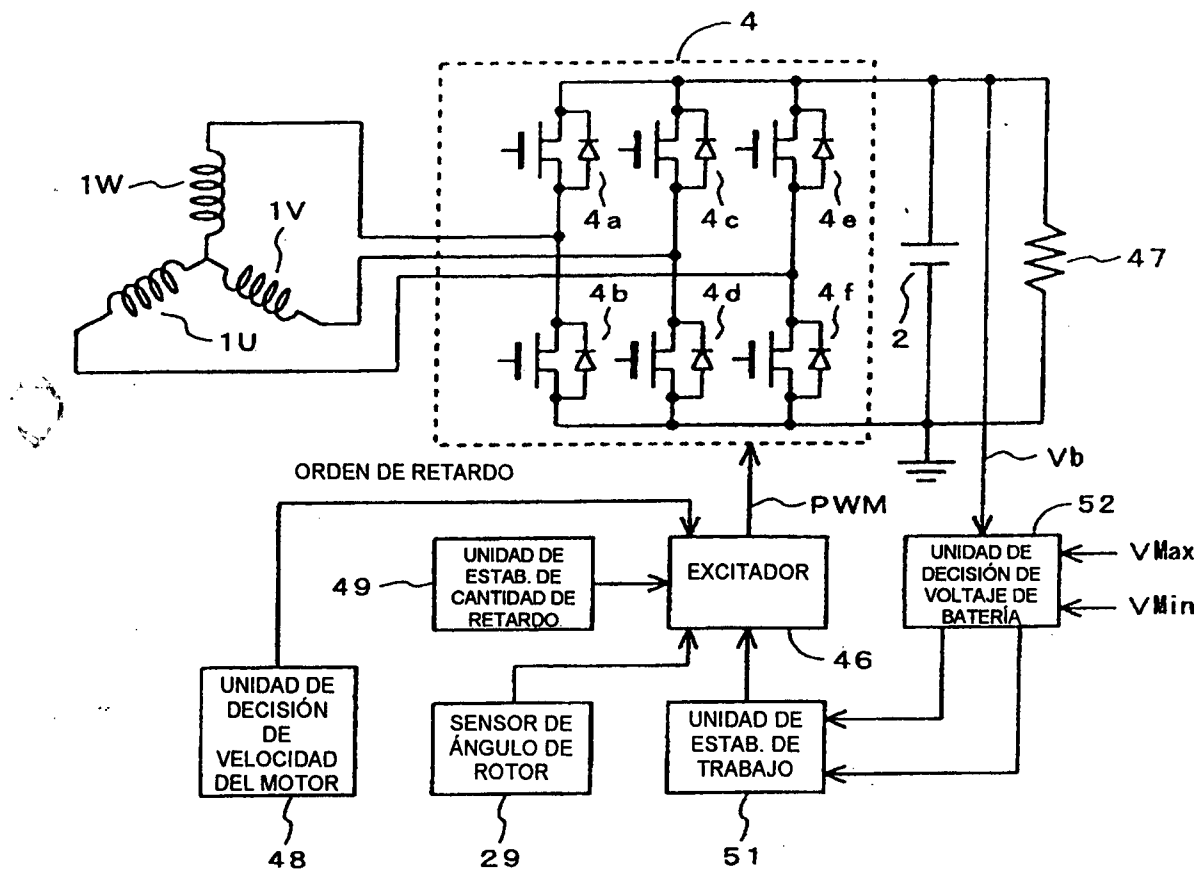
Y la figura 8 es una tabla de trabajos de energización usando la velocidad del motor como un parámetro.

35 [Explicación de los números de referencia]

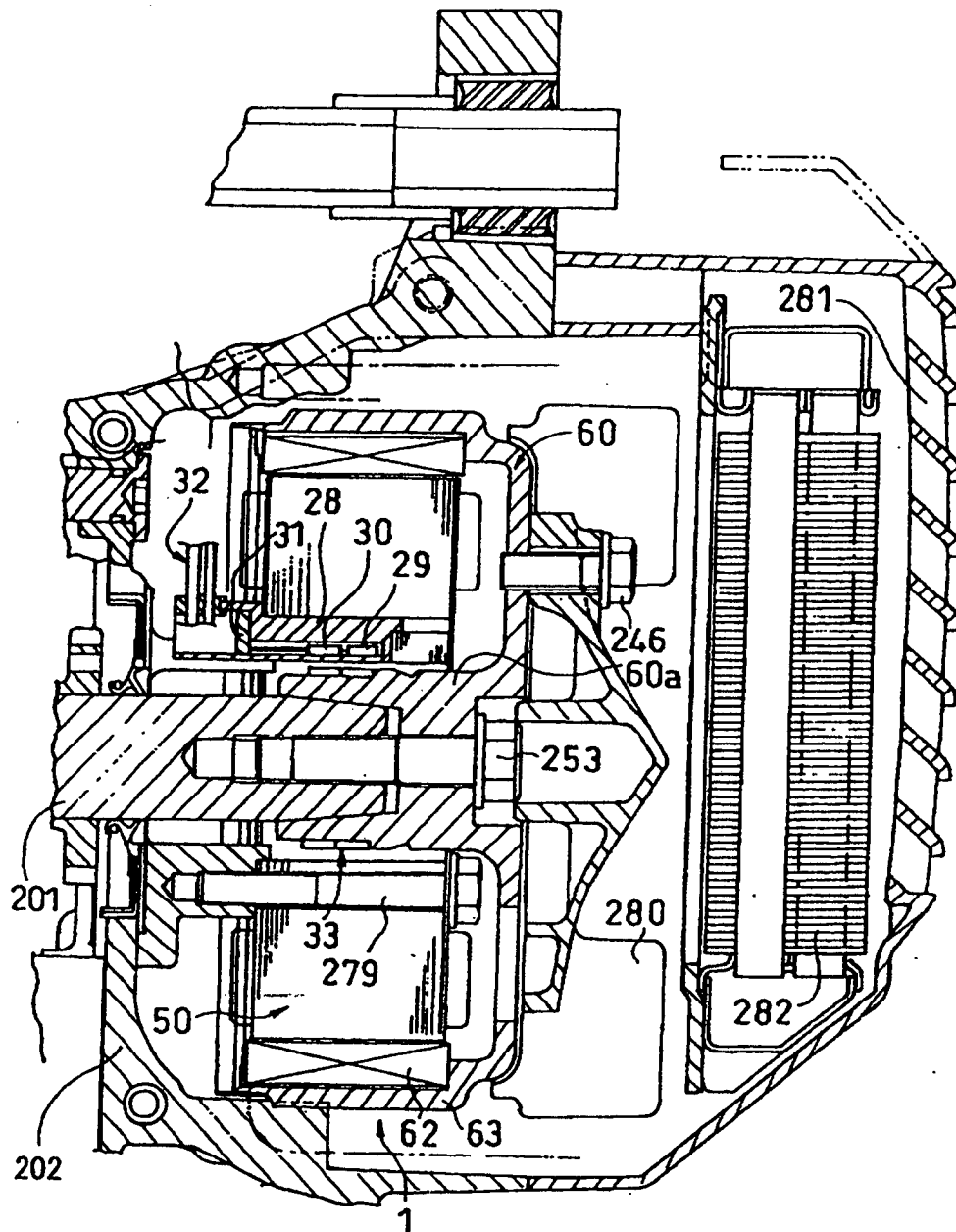
-16-

1: dispositivo de arranque/generador combinado, 2: batería, 3: UCE, 4: rectificador de onda completa, 5: regulador, 29: sensor de ángulo de rotor, 30: pulsador de encendido, 46: excitador, 48: unidad de decisión de velocidad del motor, 49: unidad de establecimiento de cantidad de retardo, 50: estator, 51: unidad de establecimiento de trabajo, 60: rotor exterior, 62: imán, 201: cigüeñal.

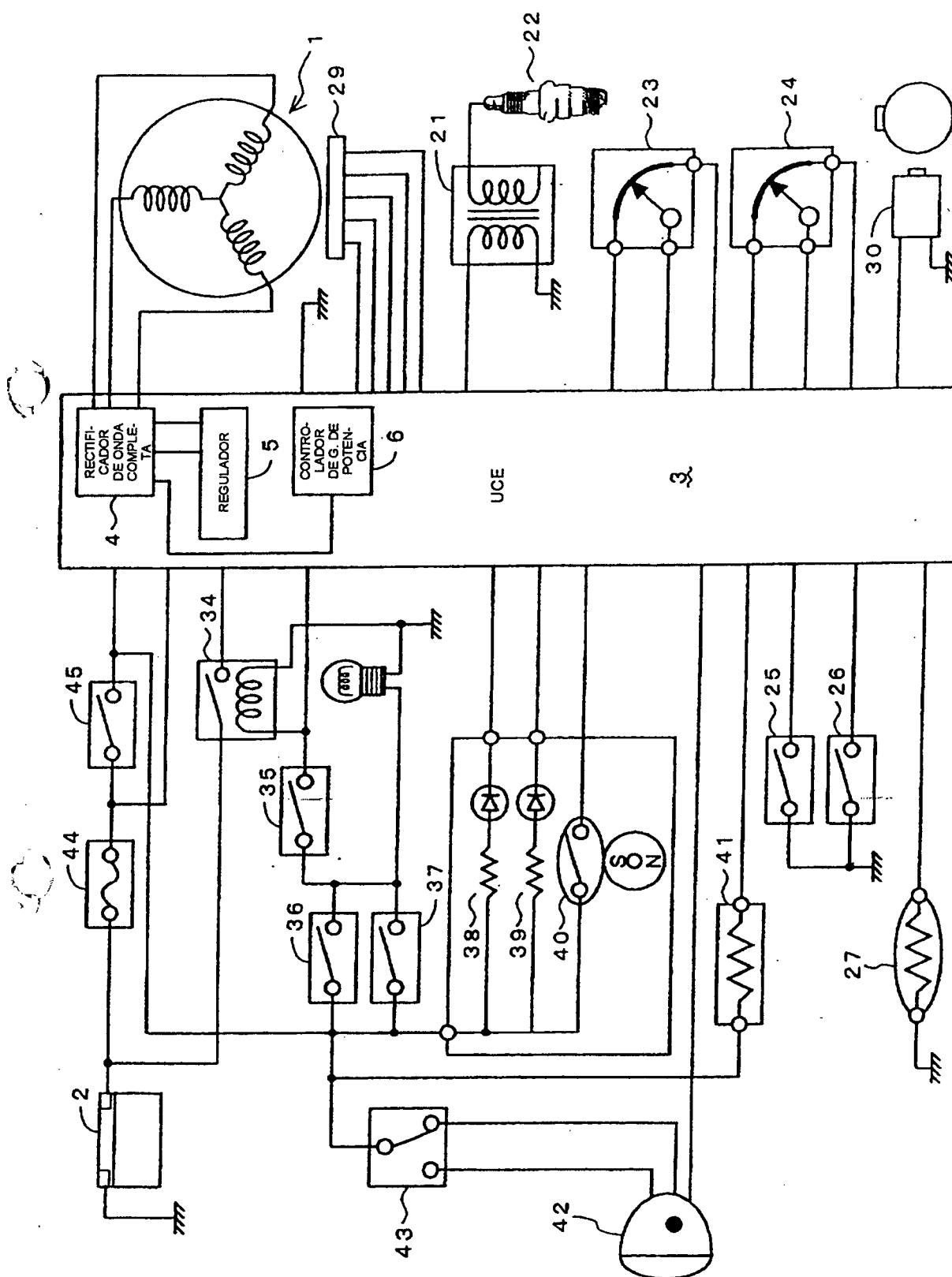
[FIG. 1]



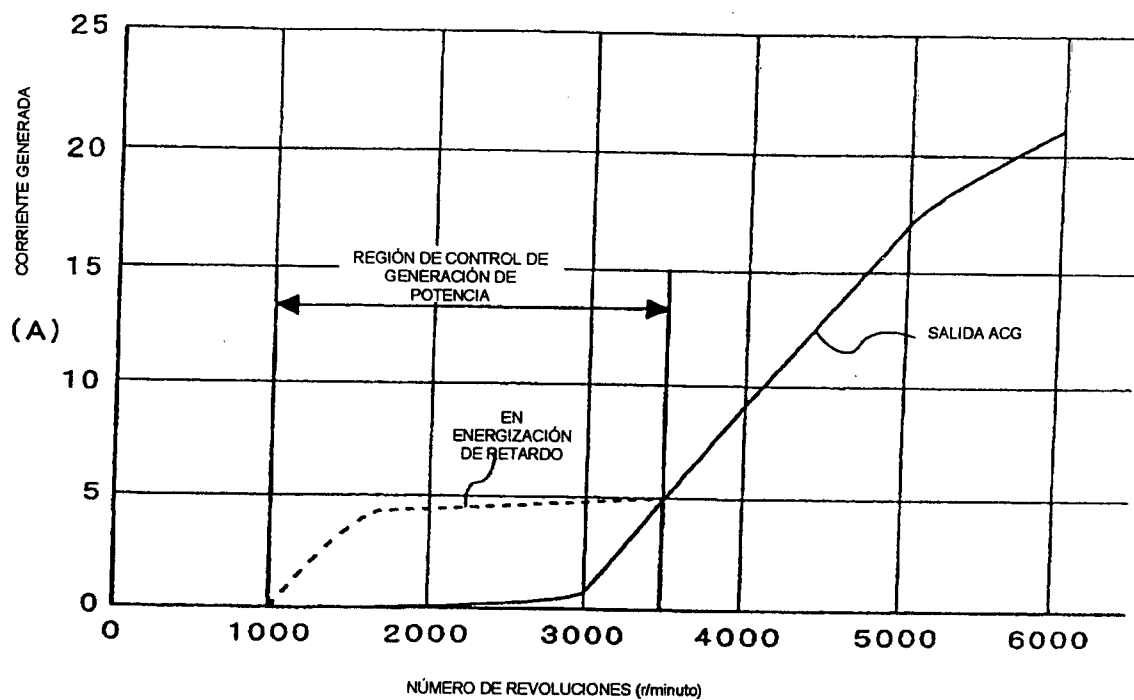
[FIG. 2]



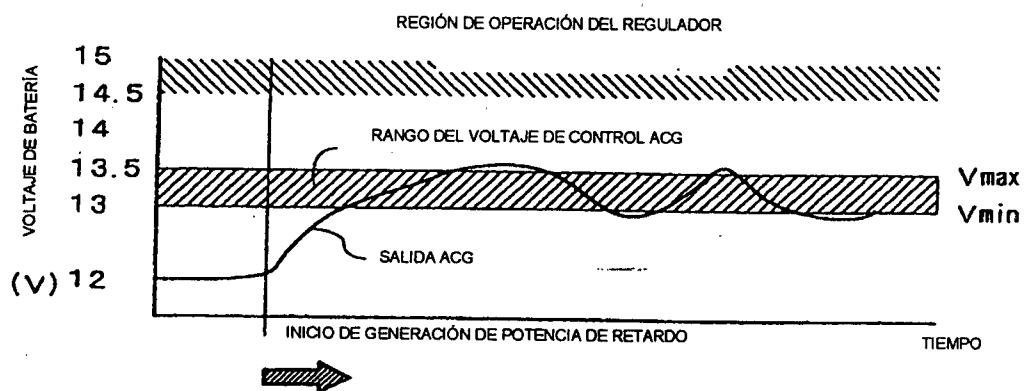
[FIG. 3]



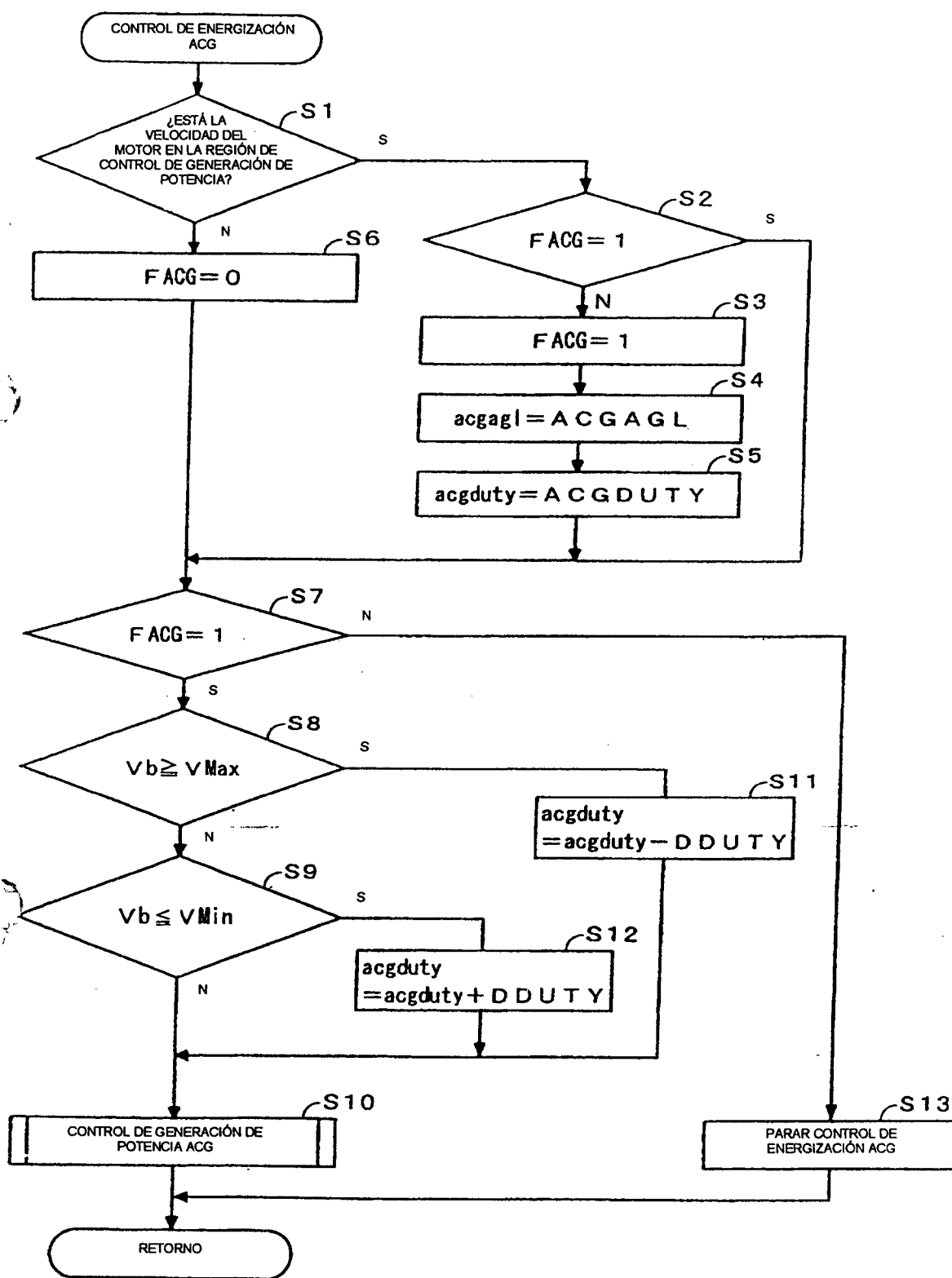
[FIG. 4]



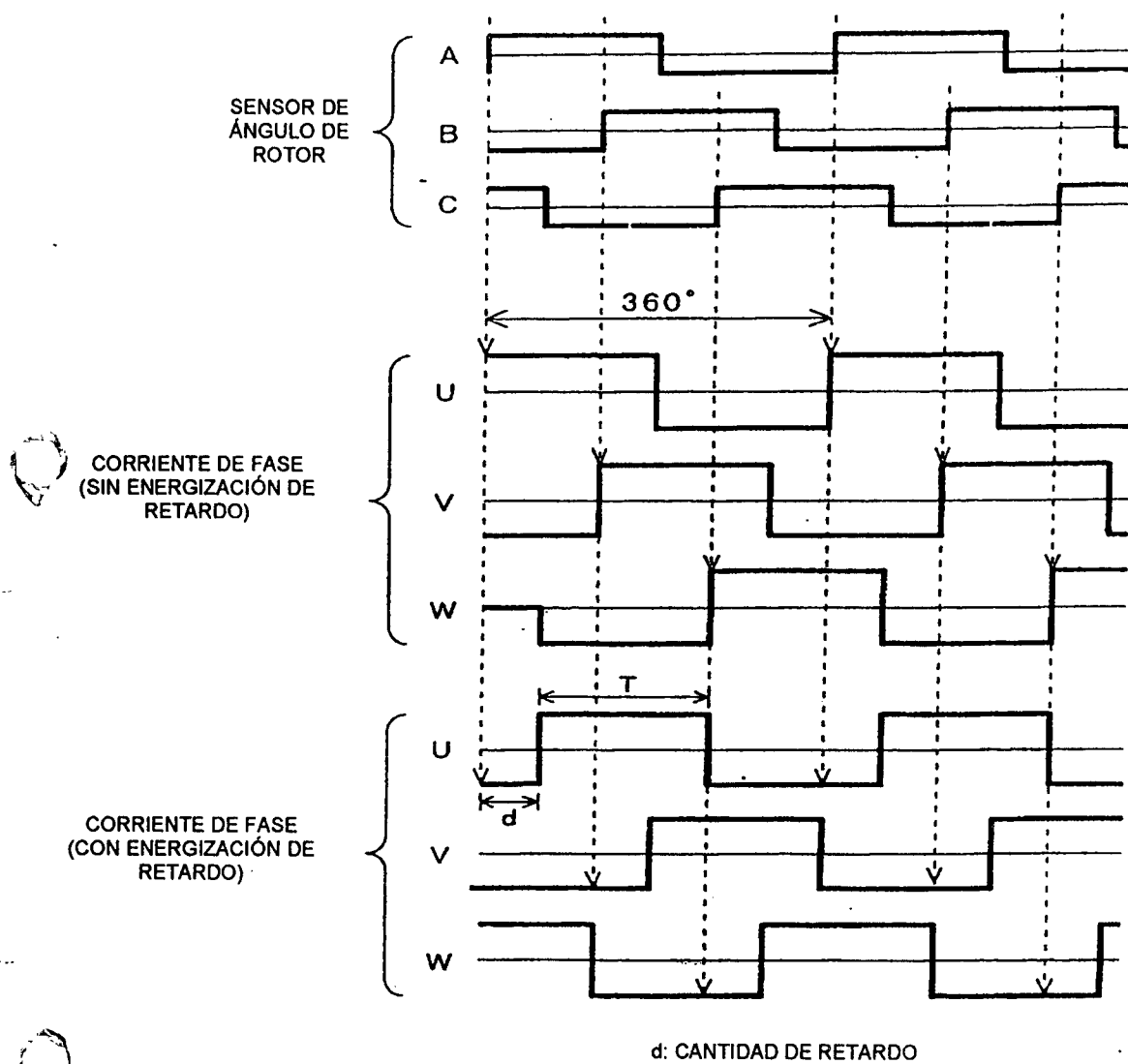
[FIG. 5]



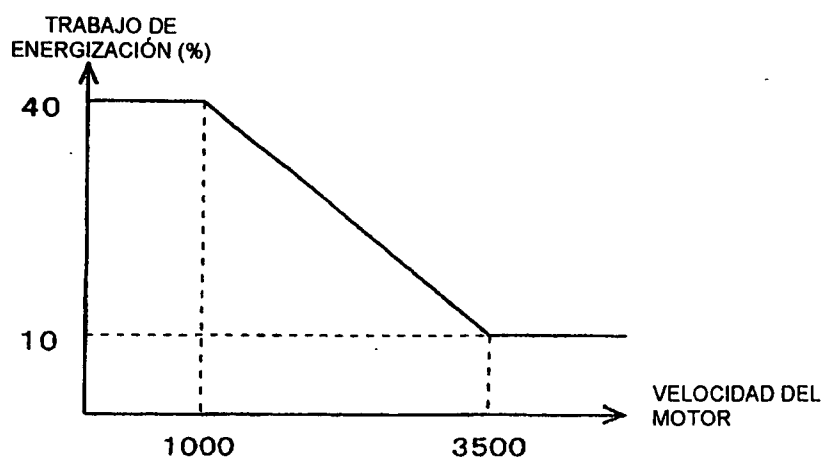
[FIG. 6]



[FIG. 7]



[FIG. 8]



-17-

[Nombre del documento] Resumen

[Resumen]

5 [Objeto] Se ha de incrementar la energía generada a la vez que se mantiene estable la revolución del motor en una región de revolución baja.

10 [Solución] El número de revoluciones de un rotor es detectado por una unidad de decisión de velocidad de motor 48, y cuando la velocidad del motor está en una región de revolución baja, se realiza un control de energización de retardo para un rectificador 4 por un excitador 46 para aumentar un flujo de campo y aumentar por lo tanto la energía generada. En respuesta a un cambio de polaridad en los polos magnéticos detectado por sensores de ángulo de rotor 29, el excitador 46 lee una cantidad de
15 retardo almacenada en una unidad de establecimiento de cantidad de retardo 49 y energiza con retardo devanados de estator. Un voltaje de salida del generador se controla de manera que esté entre un valor de control de voltaje VMax que es menor que un voltaje regulador de un regulador y un valor de control de voltaje VMin.
20

[Dibujos seleccionado] Figura 1.

Información histórica del Solicitante

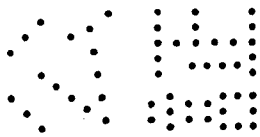
(N° de identificación) (000005326)

1. Fecha de registro 6 septiembre 1990

(Razón de registro) Nueva

Dirección 1-1, Minamiaoyama 2-chome, Minato-
ku, Tokyo, Japón

Nombre HONDA GIKEN KOGYO KABUSHIKI KAISHA



ASSIGNMENT

The undersigned
(1) Atsuo OTA
(2) Satoshi HONDA

Domiciled in
(1) - (2)
C/o Kabushiki Kaisha Honda Gijutsu
Kenkyusho, 4-1, Chuo 1-chome,
Wako-shi, Saitama, Japan

State under oath to be the sole and
true inventor of the Patent

"OUTPUT CONTROL UNIT FOR
SYNCHRONOUS GENERATOR"

State as well, that assigns, without
reservations or limitations, in favor
of
HONDA GIKEN KOGYO KABUSHIKI
KAISHA

Domicile in
1-1, Minamiaoyama 2-chome,
Minato-ku, Tokyo, Japan

All rights inherent to said invention
and that the above mentioned
company hereby is enable to apply,
in its name, for the corresponding
patent in the Republic of Colombia

This document must be notarized and
legalized by Apostille.

CESION

El abajo firmante
(1) Atsuo OTA
(2) Satoshi HONDA

Domiciliado en
(1) - (2)
C/o Kabushiki Kaisha Honda Gijutsu
Kenkyusho, 4-1, Chuo 1-chome,
Wako-shi, Saitama, Japón

Declara bajo juramento ser único y
verdadero inventor de la Patente

UNIDAD DE CONTROL DE SALIDA
PARA GENERADOR SINCRONO

Declara así mismo que cede y
transfiere, sin limitaciones, a favor
de
HONDA GIKEN KOGYO KABUSHIKI
KAISHA

Domiciliada en
1-1, Minamiaoyama 2-chome,
Minato-ku, Tokyo, Japón

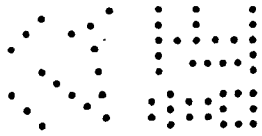
Todos los derechos inherentes a
dicha invención y que la citada
sociedad queda facultada para
solicitar en su nombre la patente
correspondiente en la República de
Colombia

Este documento debe ser legalizado ante
Notario y Apostilla.

February 10, 2003

(1) Atsuo Ota
Atsuo OTA

(2) Satoshi Honda
Satoshi HONDA



Registration No. 308

2003.

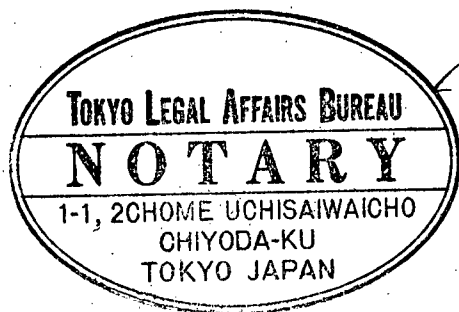
NOTARIAL CERTIFICATE

I, the undersigned Notary, do hereby certify that
Daisuke ANDO , an agent of Atsuo OTA and Satoshi HONDA

who have been authorized to sign the attached document, has
stated in my very presence that said Atsuo OTA and Satoshi
HONDA

acknowledged themselves to have signed to the attached document
and that their signatures are true and genuine.

Dated: on this 18th day of February , 2003



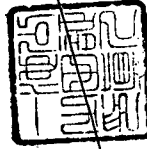
Makazu Ikeda
MAKAZU IKEDA
NOTARY



平成15年登録第 308 号

認 証

嘱託人大田淳朗及び本田聡の代理人安藤大輔は、本公証人に
対し、嘱託人が別添文書に署名したことを自認している旨陳
述した。



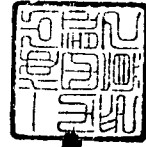
よって、これを認証する。

平成 15 年 2 月 / 8 日、本公証人役場において
東京都千代田区内幸町2丁目1番1号 霞ヶ関公証役場

東京法務局所属

公証人

池田真一



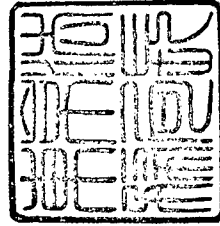
証 明

上記署名は、東京法務局所属公証人の署名に相違ないものであ
り、かつ、その押印は、真実のものであることを証明する。

平成 15 年 2 月 / 8 日

東京法務局長

寶 金 敏 明



CERTIFICATE

This is to certify that the signature affixed above has been provided
by Notary, duly authorized by the Tokyo Legal Affairs Bureau and that
the Official Seal appearing on the same is genuine.

Date FEB 18 2003

Toshiaki HOUKIN
Director of the Tokyo Legal Affairs Bureau

APOSTILLE

(Convention de La Haye du 5 octobre 1961)

1. Country: JAPAN

This public document

2. has been signed by Toshiaki HOUKIN

3. acting in the capacity of Director of the Tokyo Legal Affairs Bureau

4. bears the seal/stamp of

Certified

5. at Tokyo

6. FEB 18 2003

7. by the Ministry of Foreign Affairs

8. 03 - N 000464

9. Seal/stamp:

10. Signature:

S. Hagiwara

Shinichi HAGIWARA

For the Minister for Foreign Affairs



95

TRADUCCIÓN OFICIAL No. 049-03, DE UN DOCUMENTO ESCRITO EN INGLÉS, SELLADO CON EL SELLO DEL SUSCRITO TRADUCTOR OFICIAL HOY ABRIL 8 DEL 2003, EN LA CIUDAD DE BOGOTÁ D.C., REPÚBLICA DE COLOMBIA.

Registro No. 308

2003

CERTIFICADO NOTARIAL

Yo, el Notario Suscrito, por medio del presente certifico que Daisuke ANDO, un agente de Atsuo OTA y Satoshi HONDA.

Quien ha sido autorizado para firmar el documento adjunto, ha declarado en mi presencia que Atsuo OTA Y Satoshi HONDA

Reconoció que habían firmado el documento adjunto y que sus firmas son verdaderas y auténticas.

Fecha: este día 18 de Febrero del 2003.

Firma y sello de

MAKAZU IKEDA
NOTARIO

NOTARIO
DEPARTAMENTO DE ASUNTOS LEGALES DE TOKIO
TOKIO- JAPÓN

CERTIFICADO

Por medio del presente se certifica que la firma adjunta ha sido entregada por el Notario, debidamente autorizado por el Departamento de Asuntos Legales de Tokio y que el sello Oficial que aparece en el mismo es genuino.

Fecha: Febrero 18, 2003.

Firmado
Toshiaki HOUKIN
Director del Departamento de Asuntos Legales de Tokio.


SERGIO ELEUTERIO LATORRE MENDOZA
Traductor e Intérprete Oficial
Resol. No. 2839 Minjusticia 1.991

96

ADJUNTO AL DOCUMENTO SE ENCUENTRA LO SIGUIENTE.

APOSTILLE
(CONVENCION DE LA HAYE DE 5 OCTOBRE 1961)

1. PAIS: JAPON
ESTE DOCUMENTO PUBLICO
2. HA SIDO FIRMADO POR: TOSHIAKI HOUKIN
3. ACTUANDO EN CAPACIDAD DE: DIRECTOR DEL DEPARTAMENTO DE
ASUNTOS LEGALES DE TOKIO
4. LLEVA EL SELLO/ESTAMPILLA DE.

CERTIFICADO

5. EN: TOKIO
6. FEBRERO 18 DEL 2003
7. POR: EL MINISTRO DE RELACIONES EXTERIORES
8. 03 No.000464
9. SELLO/ESTAMPILLA
10. FIRMA

FIRMADO POR: SHINICHI HAGIWARA

Para el Ministerio de Relaciones Exteriores

Sello
Ministerio Relaciones Exteriores


SERGIO ELEUTERIO LATORRE MENDOZA
Traductor e Intérprete Oficial
Resol. No. 2839 Minjusticia 1.991

UNIDAD DE CONTROL DE SALIDA PARA GENERADOR SÍNCRONO

CAMPO TÉCNICO DE LA INVENCION

La presente invención se refiere a una unidad de control de salida para un motor síncrono y más en particular a una unidad de control de salida para un motor síncrono adecuada para incrementar la energía generada en una región de revolución baja.

ANTECEDENTES DE LA INVENCION

Como un generador de vehículo se usa un generador síncrono trifásico y la corriente alterna generada es rectificada por lo tanto por un rectificador trifásico de onda completa para uso al cargar una batería. En un generador síncrono trifásico descrito en La Publicación de Patente japonesa número 19194/1997, una corriente de avance de fase puede fluir en bobinas de estator y un flujo de campo se incrementa para aumentar una salida (voltaje generado y corriente de salida) en virtud de la magnetización basada en la reacción de inducido que se produce por la corriente de avance de fase.

En general, un generador está provisto de un regulador que restringe un voltaje de salida para evitar que la salida generada exceda de un valor predeterminado. La generación de potencia eléctrica se detiene haciendo funcionar el regulador. Cuando la generación de potencia se para, se produce una variación de carga en un motor, de manera que la revolución del motor resulta inestable en particular en una región de revolución baja. Además, si la salida generada es demasiado grande, el incremento resultante del rozamiento en una región de revolución baja influye en gran medida en la revolución del motor.

Un objeto de la presente invención es proporcionar una unidad de control de salida para un generador síncrono capaz de aumentar una salida generada sin hacer inestable la revolución de un motor en una región de revolución baja.

DESCRIPCIÓN DE LA INVENCION

Para lograr el objeto antes indicado, la presente

invención se caracteriza en primer lugar por una unidad de control de salida para un generador síncrono, incluyendo medios detectores para detectar el número de revoluciones de un rotor del generador, medios energizadores para energizar con retardo devanados de estator para aumentar la energía generada del generador, y un regulador para restringir el voltaje de salida del generador a un voltaje regulador, donde la energización con retardo se lleva a cabo cuando el número de revoluciones del rotor está en una
10 región de revolución baja y se lleva a cabo para controlar el voltaje de salida a un valor predeterminado de control de voltaje menor que el voltaje regulador.

Según esta primera característica, la salida generada se incrementa energizando con retardo los devanados de estator. Dado que esta energización con retardo se lleva a cabo para controlar el voltaje de salida a un valor de control de voltaje que se establece menor que el voltaje regulador del regulador, la energía generada se puede incrementar establemente sin poner en funcionamiento el regulador en una región de revolución baja.
20

La presente invención se caracteriza en segundo lugar porque, en la energización con retardo, el voltaje de salida se controla al valor predeterminado de control de voltaje cambiando un trabajo de energización a la vez que se mantiene la cantidad de retardo de energización a un valor predeterminado.
25

La presente invención se caracteriza en tercer lugar porque el valor de control de voltaje tiene un rango predeterminado y el trabajo de energización se disminuye ligeramente a la llegada del voltaje de salida a un máximo en el rango y se incrementa ligeramente a la caída del voltaje de salida a un valor no superior a un valor mínimo en el rango. Además, la presente invención se caracteriza en cuarto lugar porque el trabajo de energización se determina según el número de revoluciones del generador.
30
35

Según las características segunda a cuarta, dado que

la temporización de retardo es fija, es fácil ajustar la energía generada y se puede mejorar la exactitud del ajuste.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

5 La figura 1 es un diagrama de bloques que muestra funciones de porciones principales en una unidad de control de salida según una realización de la presente invención.

La figura 2 es una vista en sección de un dispositivo de arranque/generador combinado relacionado con la
10 realización.

La figura 3 es un diagrama del sistema principal de aparatos eléctricos de un vehículo de motor de dos ruedas que tiene la unidad de control de salida que realiza la presente invención.

15 La figura 4 ilustra una relación entre la velocidad del motor y una corriente eléctrica generada en el control de energización de ACG.

La figura 5 ilustra un cambio en voltaje de batería en una región de generación de potencia de retardo.

20 La figura 6 es un diagrama de flujo que muestra los procesos ejecutados por la unidad de control de salida.

La figura 7 ilustra una temporización entre corrientes de fase que fluyen en bobinas de estator y salidas de sensores de ángulo de rotor en el control de energización
25 de ACG.

Y la figura 8 es una tabla de trabajos de energización usando la velocidad del motor como un parámetro.

DESCRIPCIÓN DE UNA REALIZACIÓN DE LA INVENCION

Ahora se describirá una realización de la presente
30 invención con referencia a los dibujos. La figura 2 es una vista en sección de un dispositivo de arranque/generador combinado relacionado con una realización de la presente invención. El dispositivo de arranque/generador combinado (que en adelante se denomina "ACG"), indicado en 1, está
35 montado, por ejemplo, en un motor de un vehículo de motor de dos ruedas de tipo scooter. El ACG 1 tiene un estator 50

con devanados trifásicos (bobinas de estator) y un rotor exterior 60 conectado a una porción de extremo de un cigüeñal 201 de un motor y adaptado para girar a lo largo de una periferia externa del estator 50. El rotor exterior 5 60 tiene una carcasa de rotor en forma de copa 63 conectada al cigüeñal 201 e imanes 62 que están dispuestos en una superficie periférica interior de la carcasa de rotor 63 en una dirección circunferencial de un yugo de rotor.

El rotor exterior 60 se monta encajando una periferia interna de una porción de cubo 60a sobre una porción de extremo delantero ahusado del cigüeñal 201 y se fija con un perno 253 que se introduce a través del centro de la porción de cubo 60a en un agujero roscado en la porción de extremo del cigüeñal 201. El estator 50, que está dispuesto 15 en un lado de periferia interior del rotor exterior 60, está fijado a un cárter 202 con pernos 279. Además, un ventilador 280 está fijado al rotor exterior 60 con pernos 246. Junto al ventilador 280 hay un radiador 282, que se cubre con una cubierta de ventilador 281.

20 Una carcasa de sensor 28 está encajada en una periferia interna del estator 50. Dentro de la carcasa de sensor 28 se ha dispuesto sensores de ángulo de rotor (sensores de polo magnético) 29 y un sensor de pulsador (pulsador de encendido) 30 a intervalos iguales a lo largo 25 de una periferia externa de un saliente del rotor exterior 60. Los sensores de ángulo de rotor 29 son para controlar la energización de las bobinas de estator del ACG 1 y se ha dispuesto tres sensores de ángulo de rotor 29 correspondientes a las fases U, V, y W, respectivamente, 30 del ACG. Por otra parte, el pulsador de encendido 30 es para controlar el encendido del motor y solamente se ha previsto dicho pulsador de encendido 30. Cada uno de los sensores de ángulo de rotor 29 y el pulsador de encendido 30 puede estar constituido por un CI Hall o un elemento de 35 reluctancia magnética (RM).

Hilos conductores de los sensores de ángulo de rotor

29 y el pulsador de encendido 30 están conectados a un sustrato 31 y un mazo de cables 32 está conectado al sustrato 31. Un aro magnético 33 está encajado en una periferia externa del saliente 60a del rotor exterior 60, magnetizándose el aro magnético 33 en dos etapas para ejercer una acción magnética en cada uno de los sensores de ángulo de rotor 29 y el pulsador de encendido 30.

En una zona magnetizada del aro magnético 33 correspondiente a los sensores de ángulo de rotor 29 se forman polos N y S alternativamente a intervalos de 30° en la dirección circunferencial correspondientemente a los polos magnéticos del estator 50. En la otra zona magnetizada del aro magnético 33 correspondiente al pulsador de encendido 30 se ha formado una porción magnetizada circunferencialmente en el rango de 15° a 40°.

El ACG 1 construido como antes funciona como un motor síncrono al tiempo de arrancar y es excitado con una corriente eléctrica alimentada desde una batería, haciendo que el cigüeñal 201 gire y haciendo por lo tanto que el motor arranque. Después del arranque del motor, el ACG 1 funciona como un generador síncrono, carga la batería con corriente eléctrica generada y suministra la corriente eléctrica a varios aparatos eléctricos.

La figura 3 es un diagrama del sistema principal de aparatos eléctricos en un vehículo de motor de dos ruedas que tiene una unidad de control de salida para el ACG 1. En la misma figura, una UCE (unidad de control eléctrico) 3 está provista de un rectificador de onda completa 4 para rectificar una corriente trifásica alterna generada en el ACG 1 y un regulador 5 para restringir la salida del rectificador de onda completa 4 a un voltaje regulador predeterminado (voltaje operativo del regulador, por ejemplo, 14,5 V). La UCE 3 está provista además de un controlador de generación de potencia 6 que realiza el control para aumentar la energía generada cuando el número de revoluciones del motor está en una región de revolución

Q baja predeterminada (en adelante "región de control de generación de potencia"). El controlador de generación de potencia 6 se implementa como la función de una CPU. Los sensores de ángulo de rotor 29 y el pulsador de encendido 30 también están conectados a la UCE 3 y sus señales detectadas se introducen en la UCE 3.

Una bobina de encendido 21 está conectada a la UCE 3 y una bujía 22 está conectada a un lado secundario de la bobina de encendido 21. A la UCE 3 también están conectados un sensor de regulador 23, un sensor de combustible 24, un interruptor de asiento 25, un interruptor de marcha en vacío 26, y un sensor de temperatura del agua refrigerante 27, y sus señales detectadas se introducen en la UCE 3.

También están conectados a la UCE 3 un relé de dispositivo de arranque 34, un interruptor de dispositivo de arranque 35, interruptores de parada 36 y 37, un indicador de espera 38, un indicador de combustible 39, un sensor de velocidad 40, un dispositivo secundario de arranque automático 41, y un faro 42. Se ha dispuesto un interruptor regulador 43 en el faro 42.

Se alimenta corriente eléctrica a las varias porciones anteriores desde una batería 2 (a través de un fusible principal 44 y un interruptor principal 45. La batería 2 está conectada directamente a la UCE 3 mediante un relé de dispositivo de arranque 34 y tiene un circuito mediante el que está conectada a la UCE 3 mediante el fusible principal 44 solo sin pasar por el interruptor principal 45.

El controlador de generación de potencia 6 tiene, además de la función ordinaria de controlar la energía generada (voltaje), una función de energizar con retardo las bobinas de estator de las tres fases en el ACG 1 desde la batería 2 para aumentar la energía generada ("control de energización de ACG" en adelante). "Energización con retardo" significa realizar un retardo correspondiente a un ángulo eléctrico predeterminado a partir de una señal de detección obtenida por cualquiera de los sensores de ángulo

de rotor 29 al tiempo de un cambio de polo en una zona magnetizada del aro magnético 33 y energizar las bobinas de estator. Sin embargo, para evitar la rotación inestable del motor producida por un cambio brusco de la carga del motor inducida por la operación del regulador 5 en una región de revolución baja, el control se hace de manera que un voltaje de salida (voltaje de batería) del rectificador de onda completa 4 esté dentro de un rango predeterminado de voltaje que no es más alto que el voltaje regulador.

La figura 4 ilustra una relación entre la velocidad del motor y una corriente eléctrica generada detectada cuando se realiza el control de energización de ACG. En la misma figura, un rango de velocidades del motor de 1000 a 3500 rpm se establece como un rango de control de generación de potencia. En tal región de revolución baja, una corriente eléctrica generada (salida de ACG) del ACG 1 obtenida por el método de control convencional es muy pequeña. Por lo tanto, la corriente eléctrica generada se incrementa por el control de energización de ACG en el rango del control de generación de potencia. El incremento se designa "energización con retardo" y se indica con una línea de trazos en la figura. Efectuando el control de manera que la energía generada corresponda a una corriente de carga normal, es posible garantizar una energía generada correspondiente a una cantidad de corriente consumida también en la región de revolución baja.

La figura 5 ilustra cómo el voltaje de batería cambia en una región de generación de potencia de retardo. En la misma figura, el voltaje de batería V_b se controla en un rango de voltaje de control de ACG que se define tanto por un valor máximo de voltaje de control V_{Max} establecido por debajo del voltaje regulador (14,5 V) como un valor mínimo de voltaje de control V_{Min} . Más específicamente, se fija una cantidad de retardo de energización para las bobinas de estator (por ejemplo 60° en términos de un ángulo eléctrico) y el trabajo de energización del rectificador de

onda completa 4 se incrementa o disminuye para controlar el
voltaje de batería Vb a un valor que cae por debajo del
rango de voltaje de control de ACG. Más en particular, a la
llegada del voltaje de batería Vb al valor máximo de
5 voltaje de control VMax, el trabajo de energización se
disminuye un valor predeterminado muy pequeño (por ejemplo,
1%), mientras que a la caída del voltaje de batería Vb al
valor mínimo de voltaje de control VMin, el trabajo de
energización se incrementa el mismo valor muy pequeño como
10 antes.

La figura 1 es un diagrama de bloques que muestra
funciones de porciones principales en la unidad de control
de energización de ACG. En la misma figura, el rectificador
de onda completa 4 tiene FETs (elementos conmutadores
15 generalmente sólidos) 4a, 4b, 4c, 4d, 4e, y 4f que están
conectados a las bobinas de estator 1U, 1V, y 1W del ACG 1.
al tiempo de arrancar el motor, los FETs 4a a 4f son
conmutados por un excitador 46 para mover el ACG 1 como un
motor síncrono, haciendo que el cigüeñal 201 gire, mientras
20 que después del arranque del motor el rotor exterior, a la
inversa, es excitado por el motor y funciona como un motor
síncrono, de manera que la corriente alterna generada sea
rectificada por los FETs 4a a 4f y la corriente resultante
se alimenta a la batería 2 y una carga de aparatos
25 eléctricos 47. También durante la generación de potencia a
la operación del motor, en particular en una revolución
baja del motor, los FETs 4a a 4f son controlados por el
excitador 46 de manera que la energización con retardo a
las bobinas de estator se lleve a cabo según la presente
30 invención, aumentando por lo tanto la energía generada. En
cuanto al control de la energización de retardo, se
describirá más tarde con referencia a la figura 7.

Una unidad de decisión de velocidad de motor 48
detecta la velocidad del motor, por ejemplo, en base a una
35 señal de detección proporcionada por el pulsador de
encendido 30 o una señal de frecuencia de un voltaje

el
proceso
de
señal

generado y da una orden de retardo al excitador 46 si la
velocidad detectada del motor está en un rango de control
de generación de potencia predeterminado. En respuesta a la
orden de retardo el excitador 46 lee una cantidad
5 predeterminada de retardo de energización en una unidad de
establecimiento de cantidad de retardo 49 y energiza con
retardo las bobinas de estator. El trabajo de energización
se lee en la unidad de establecimiento de trabajo 51 y se
alimenta al excitador 46. El excitador 46 detecta una señal
10 de detección de polo magnético proporcionada por cada
sensor de ángulo de rotor 29, es decir, una señal sube cada
vez que el sensor 29 detecta una porción de la zona
magnetizada en el aro magnético 33 formado
correspondientemente a los polos magnéticos del rotor
15 exterior 60. Después, el excitador 46 hace un retardo
correspondiente a la cantidad de retardo de energización
desde el tiempo en la señal sube y envía una señal de
control PWM a los FETs 4a-4f.

Una unidad de decisión de voltaje de batería 52
20 compara el voltaje de batería Vb con el valor máximo de
voltaje de control VMax y el valor mínimo de voltaje de
control VMin que definen el rango de control de voltaje y,
en base al resultado de la comparación, aumenta o disminuye
el trabajo de energización establecido en la unidad de
25 establecimiento de trabajo 51 de manera que el voltaje de
batería Vb caiga por debajo del rango de control anterior.

La figura 6 es un diagrama de flujo que muestra los
procesos ejecutados por la unidad de control de salida
descrita anteriormente. En la misma figura, se determina en
30 el paso S1 si la velocidad del motor está en la región de
control de generación de potencia o no. Como se ha indicado
anteriormente, la región de control de generación de
potencia se establece, por ejemplo, en el rango de 1000 a
3500 rpm. Si la velocidad del motor está en la región de
35 control de generación de potencia, el flujo de procesado
avanza al paso S2, en el que se comprueba si está puesto

(=1) un señalizador FACG que indica que la velocidad del motor está en la región de control de generación de potencia. Si la respuesta es negativa, el flujo avanza al paso S3 para poner el señalizador FACG (ponerlo a "1"). Una vez puesto el señalizador FACG, el flujo avanza al paso S4, en el que un valor de retardo de energización ACGAGL se establece a un valor predeterminado ACGAGL. El valor predeterminado ACGAGL se puede establecer a un valor apropiado con anterioridad, por ejemplo, 60° en términos de un ángulo eléctrico en esta realización. En el paso S5 siguiente, se pone un trabajo de energización acduty a un valor inicial ACDUTY. El valor inicial ACDUTY también se puede poner a un valor apropiado con anterioridad, por ejemplo, 40% en esta realización. Si los procesados de los pasos S3 a S5 han terminado, el flujo avanza al paso S7. Además, si la respuesta en el paso S2 es afirmativa, se saltan los pasos S3 a S5 y el flujo avanza al paso S7. Además, si la velocidad del motor no está en la región de control de generación de potencia, se reposiciona (=0) el señalizador FACG en el paso S6 y después el flujo avanza al paso S7.

En el paso S7, se comprueba si el señalizador FACG está puesto o no. Si el señalizador FACG está puesto (=1), se determina en el paso S8 si el voltaje de batería Vb no es más pequeño que el valor máximo de voltaje de control VMax. El valor máximo de voltaje de control VMax se pone a un valor menor que el voltaje regulador, por ejemplo, 13,5 V. Si la respuesta en el paso S8 es negativa, el flujo avanza al paso S9, en el que se comprueba si el voltaje de batería Vb no es más grande que el valor mínimo de voltaje de control VMin, valor que se establece por ejemplo a 13,0 V. Si la respuesta en el paso S9 es negativa, se determina que el voltaje de batería está en el rango de voltaje de energización de ACG que es menor que el voltaje regulador del regulador. Después, el flujo avanza al paso S10, en el que el control de energización de ACG se ejecuta según la

cantidad de retardo de energización acgagl y el trabajo de energización acduty.

Si se determina en el paso S8 que el voltaje de batería Vb no es más pequeño que el valor máximo de voltaje de control VMax, el flujo avanza al paso S11, en el que el trabajo de energización acduty se disminuye un valor muy pequeño DDUTY, valor que es por ejemplo 1%. Si se determina en el paso S9 que el voltaje de batería Vb no es más grande que el valor mínimo de voltaje de control VMin, el flujo avanza al paso S12, en el que el trabajo de energización acduty se incrementa el valor muy pequeño DDUTY. Después de los procesados de los pasos S11 y S12, el flujo avanza al paso S10. El valor muy pequeño DDUTY usado al aumentar el trabajo de energización acduty y el usado al disminuir el ACDUTY no tienen que ser siempre iguales entre sí. El valor muy pequeño DDUTY se puede cambiar en proporción a la diferencia entre el valor máximo o mínimo del voltaje de control VMax o VMin y el valor presente.

Por otra parte, si el señalizador FCG no está puesto (=0) en el paso S7, dado que la velocidad del motor no está en la región de control de generación de potencia, el flujo avanza al paso S13 para detener el control de energización de ACG.

La figura 7 ilustra una temporización entre corrientes eléctricas (corrientes de fase) que fluyen en las tres fases de las bobinas de estator en el control de energización de ACG y las salidas de los sensores de ángulo de rotor 29. Como se muestra en la misma figura, en una condición normal donde el control de energización de retardo no se lleva a cabo, se alimenta una corriente eléctrica a cada una de las fases U, V, y W de las bobinas de estator en respuesta a cambios positivo-negativo (NS) de las salidas detectadas obtenidas de los sensores de ángulo de rotor 29. Por otra parte, en el caso en el que el control de energización de retardo se lleva a cabo, se alimenta una corriente eléctrica a cada una de las fases U,

V, y W de las bobinas de estator con un retardo correspondiente a una cantidad predeterminada de retardo, d ($=60^\circ$), a partir del tiempo en que se produce un cambio positivo-negativo (NS) en la salida detectada obtenida de cada sensor de ángulo de rotor 29. En la figura 7, un ángulo de retardo T resultante de troceado de trabajo es 180° , pero se puede determinar dentro de 180° por el trabajo de energización alimentado desde la unidad de establecimiento de trabajo 51 al excitador 46.

La figura 8 es una tabla de trabajos de energización en la que la velocidad del motor, es decir, el número de revoluciones del generador se establece como un parámetro. Un trabajo de energización se determina según una velocidad detectada del motor y por referencia a la figura 8.

En la realización anterior se adopta un sistema de rotor exterior/rotor interior en el que imanes permanentes como medios de imán generadores de flujo de campo están dispuestos en el rotor exterior. Sin embargo, la presente invención también es aplicable a un generador en el que se ha dispuesto medios de imán generadores de flujo de campo en un rotor interior o un generador que adopta electroimanes como medios de imán generadores de flujo de campo. Además, sin usar un valor fijo como la cantidad de retardo de energización acaggl se puede adoptar un control proporcional, diferencial, o integral, o su combinación según un método de control de realimentación negativa convencional.

Aplicabilidad Industrial

Como será evidente por la descripción anterior, según la invención definida en las reivindicaciones 1 a 4, es posible aumentar la energía generada establemente sin la operación de tipo ordinario de un regulador de voltaje en una región de revolución baja. En consecuencia, cuando la invención se aplica a un generador de vehículo en el que un rotor es movido por un motor, es posible disminuir la variación de la carga del motor durante la marcha en vacío

por ejemplo, minimizando por lo tanto la variación de la revolución del motor y estabilizando la operación de marcha en vacío. Según la invención definida en las reivindicaciones 2 a 4, dado que la temporización de
5 retardo se fija a un valor preestablecido, la energía generada se puede ajustar fácilmente con una configuración simple y es posible mejorar la exactitud del ajuste.

10

15

20

25

30

35

REIVINDICACIONES

1. Unidad de control de salida para un generador síncrono (1) que tiene un rotor (60) provisto de medios de imán generadores de flujo de campo (62) y un estator (50) con devanados de estator para producir una salida generada, comprendiendo:

medios detectores (30) para detectar un número de revoluciones de dicho rotor (60);

medios energizadores (46) para energizar con retardo dichos devanados de estator para aumentar la energía generada del generador; y

un regulador (5) para restringir un voltaje de salida del generador a un voltaje de regulación,

caracterizado porque dicha energización con retardo se lleva a cabo cuando el número de revoluciones de dicho rotor (60) está en una región de revolución baja y se lleva a cabo para controlar dicho voltaje de salida a un valor predeterminado de voltaje de control menor que dicho voltaje de regulación.

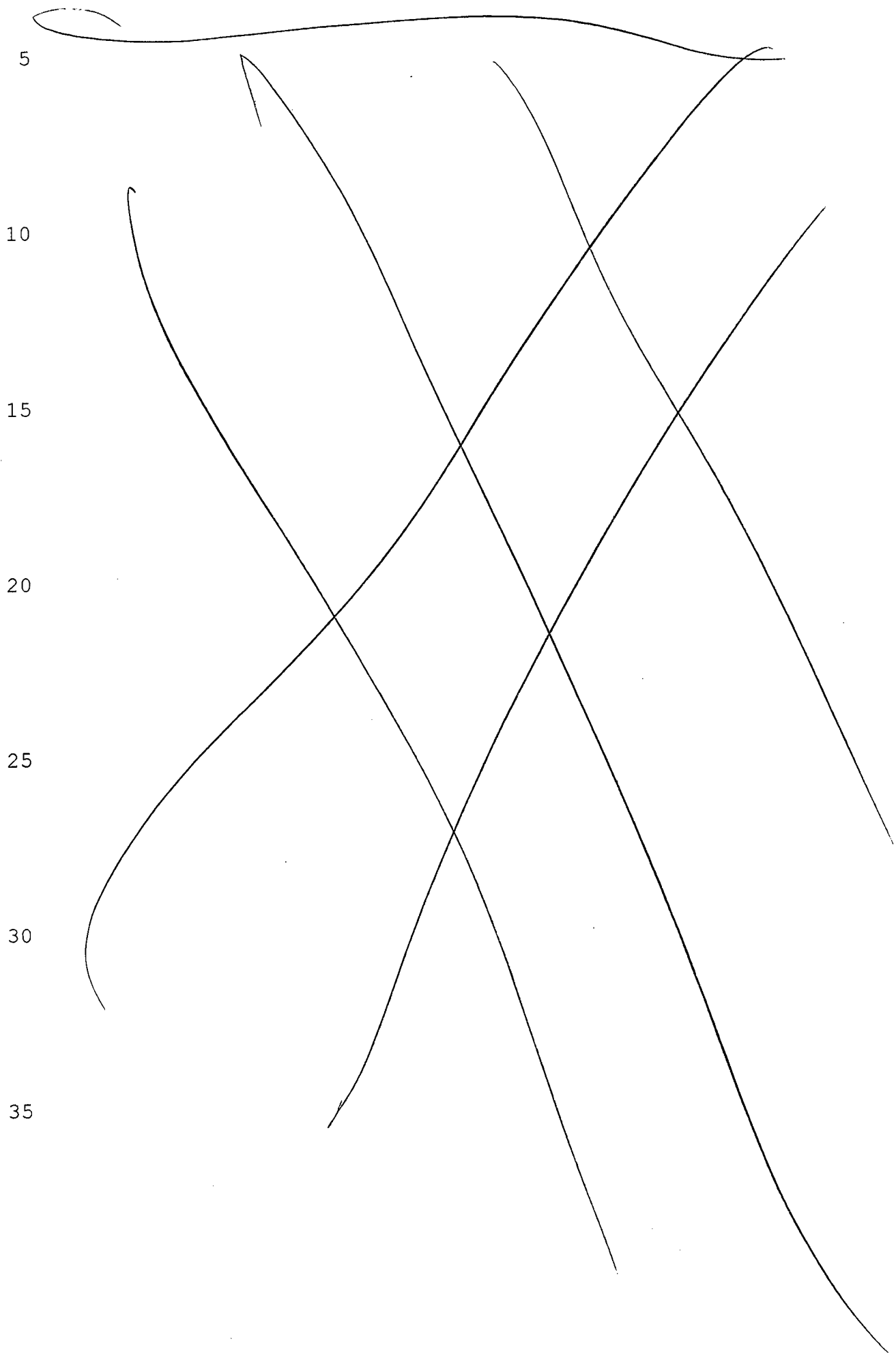
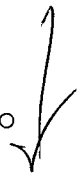
2. Unidad de control de salida para un generador síncrono (1) según la reivindicación 1, caracterizado porque en dicha energización con retardo, dicho voltaje de salida se controla a dicho valor predeterminado de voltaje de control, cambiando un trabajo de energización a la vez que se mantiene una cantidad de retardo de energización a un valor predeterminado.

3. Unidad de control de salida para un generador síncrono (1) según la reivindicación 2, caracterizado porque dicho valor de voltaje de control tiene un rango predeterminado y dicho trabajo de energización se disminuye ligeramente a la llegada de dicho voltaje de salida a un valor máximo en dicho rango y se incrementa ligeramente a la caída de dicho voltaje de salida a un valor no superior a un valor mínimo en dicho rango.

4. Unidad de control de salida para un motor síncrono (1) según la reivindicación 2 ó 3, caracterizado porque

reducidos en
terminos
de potencia
de salida

dicho trabajo de energización se determina según el número de revoluciones del generador (1).



RESUMEN

UNIDAD DE CONTROL DE SALIDA PARA GENERADOR SÍNCRONO

Se pretende incrementar la energía generada a la vez que se mantiene estable la revolución del motor en una
5 región de revolución baja.

El número de revoluciones de un rotor es detectado por una unidad de decisión de velocidad de motor (48), y cuando la velocidad del motor está en una región de revolución baja, se realiza un control de energización de retardo para
10 un rectificador (4) por un excitador (46) para aumentar un flujo de campo y aumentar por lo tanto la energía generada. En respuesta a un cambio de polaridad en los polos magnéticos detectado por sensores de ángulo de rotor (29), el excitador (46) lee una cantidad de retardo almacenada en
15 una unidad de establecimiento de cantidad de retardo (49) y energiza con retardo devanados de estator. Un voltaje de salida del generador se controla de manera que esté entre un valor de control de voltaje V_{Max} que es menor que un voltaje regulador de un regulador y un valor de control de
20 voltaje V_{Min} .

25

30

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-102279

(43)Date of publication of application : 07.04.2000

(51)Int.Cl.

H02P 6/06

F02N 11/04

H02P 9/04

(21)Application number : 10-270059

(71)Applicant : KOKUSAN DENKI CO LTD

(22)Date of filing : 24.09.1998

(72)Inventor : INABA YUTAKA

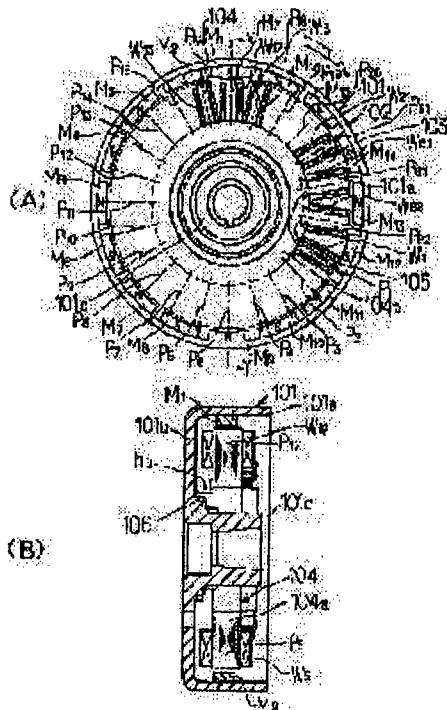
NAKAGAWA MASANORI

(54) GENERATOR FUNCTIONING AS MOTOR IN COMBINATION FOR STARTING INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a generator functioning as a motor in combination for starting an internal combustion engine, capable of being applied also to the internal combustion engine ignited by an ignition device driven at a single-phase AC voltage.

SOLUTION: The main body of this generator is composed of a magnet rotor 102 installed to the output shaft of the internal combustion engine, and a stator 103 on which three-phase connected armature coils W1-W18 and ignition-device drive coils We1, We2 which drive an ignition device for the internal combustion engine are mounted. The generator is operated as a motor by flowing a drive current through the three-phase armature coils through an inverter circuit from a DC power supply at the time of the starting of the internal combustion engine, and the internal combustion engine is started. The places for the changeover of the excitation phase of the armature coils, when the generator is worked as the motor, are set so as to maximize voltage induced in the ignition-device drive coils at the time of the starting of the internal combustion engine.



LEGAL STATUS

[Date of request for examination] 29.03.2001

[Date of sending the examiner's decision of rejection] 22.10.2002

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Publication No. 2000-102279

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim 1] The magnet rotator which has a multipolar magnet field, So that it may be wound around the tooth part of the armature core which has the tooth part of a large number on a par with a hoop direction, and this armature core and n phase circuit (n is two or more integers) may be constituted The stator which the magnetic pole section which has the armature coil of n phase which consists of a connected coil group, and was formed at the nose of cam of the tooth part of the aforementioned armature core is made to counter by the magnet field of the aforementioned magnet rotator, $2n$ on-off control by which the antiparallel connection was carried out to each and n phase bridge connection was carried out to the diode-bridge full wave rectifier circuit and the aforementioned $2n$ piece diode which consist of $2n$ diode by which n phase bridge connection was carried out, and rectify the output of the aforementioned armature coil The inverter circuit equipped with the switching circuit which consists of a possible switching device, The position where the physical relationship between the center position of the magnetic pole section at the nose of cam of the tooth part of an armature core around which the armature coil of each aforementioned phase is wound, and the center position of each magnetic pole of the aforementioned magnet field turns into a relation set up beforehand is detected as a criteria excitation phase change position of each phase. The position detection equipment which generates a signal including the information on this criteria excitation phase change position as a position detecting signal of each phase, The aforementioned magnet rotator in the direction which starts the aforementioned internal combustion engine to a rotation **** sake To pass required polar drive current from DC power supply to the aforementioned armature coil through the predetermined switching device of the aforementioned inverter circuit by the position detecting signal of each aforementioned phase It has the switch control unit which gives a driving signal to the predetermined switching device of the aforementioned inverter circuit in the excitation phase change position which has predetermined angle of advance to the criteria excitation phase change position or this criteria excitation phase change position detected. The aforementioned magnet rotator is rotated in the direction

which starts the aforementioned internal combustion engine by passing the drive current commutated to the armature coil of the aforementioned n phase by predetermined phase sequence from the aforementioned DC power supply at the time of starting of the aforementioned internal combustion engine. In the motor combination generator for internal combustion engine starting which takes out the output of the armature coil of the aforementioned n phase outside through the aforementioned diode-bridge full wave rectifier circuit, and drives an electric load after an internal combustion engine starts. The motor combination generator for internal combustion engine starting characterized by winding the single phase magneto coil which outputs single-phase alternative current voltage to some of tooth parts and tooth part groups of the aforementioned armature core.

[Claim 2] The motor combination generator for internal combustion engine starting according to claim 1 characterized by setting up the aforementioned angle of advance so that voltage which carries out induction to the aforementioned single phase magneto coil at the time of starting of the aforementioned internal combustion engine may be made into the maximum.

[Claim 3] The magnet rotator which has a multipolar magnet field, So that it may be wound around the tooth part of the armature core which has the tooth part of a large number on a par with a hoop direction, and this armature core and n phase circuit (n is two or more integers) may be constituted. The stator which the magnetic pole section which has the armature coil of n phase which consists of a connected coil group, and was formed at the nose of cam of the tooth part of the aforementioned armature core is made to counter by the magnet field of the aforementioned magnet rotator, $2n$ on-off control by which the antiparallel connection was carried out to each and n phase bridge connection was carried out to the diode-bridge full wave rectifier circuit and the aforementioned $2n$ piece diode which consist of $2n$ diode by which n phase bridge connection was carried out, and rectify the output of the aforementioned armature coil. The inverter circuit equipped with the switching circuit which consists of a possible switching device, The position where the physical relationship between the center position of the magnetic pole section at the nose of cam of the tooth part of an armature core around which the armature coil of each aforementioned phase is wound, and the center position of each magnetic pole of the aforementioned magnet field turns into a relation set up beforehand is detected as a criteria excitation phase change position of each phase. The position detection equipment which generates a signal including the information on this criteria excitation phase change position as a position detecting signal of each phase. The aforementioned magnet rotator in the direction which starts the aforementioned internal combustion engine to a rotation **** sake To pass required polar drive current from DC power supply to the aforementioned armature coil through the predetermined switching device of the

aforementioned inverter circuit by the position detecting signal of each aforementioned phase. It has the switch control unit which gives a driving signal to the predetermined switching device of the aforementioned inverter circuit in the excitation phase change position which has predetermined angle of advance to the criteria excitation phase change position or this criteria excitation phase change position detected. The aforementioned magnet rotator is rotated in the direction which starts the aforementioned internal combustion engine by passing the drive current commutated to the armature coil of the aforementioned n phase by predetermined phase sequence from the aforementioned DC power supply at the time of starting of the aforementioned internal combustion engine. In the motor combination generator for internal combustion engine starting which takes out the output of the armature coil of the aforementioned n phase outside through the aforementioned diode-bridge full wave rectifier circuit, and drives an electric load after an internal combustion engine starts. The ignition drive coil which outputs the single-phase alternative current voltage for driving the ignition for internal combustion engines to some of tooth parts and tooth part groups of the aforementioned armature core is wound. The motor combination generator for internal combustion engine starting characterized by setting up the aforementioned angle of advance so that voltage which carries out induction to the aforementioned ignition drive coil at the time of starting of the aforementioned internal combustion engine may be made into the maximum.

[Claim 4] The magnet rotator which has a multipolar magnet field, so that it may be wound around the tooth part of the armature core which has the tooth part of a large number on a par with a hoop direction, and this armature core and n phase circuit (n is two or more integers) may be constituted. The stator which the magnetic pole section which has the armature coil of n phase which consists of a connected coil group, and was formed at the nose of cam of the tooth part of the aforementioned armature core is made to counter by the magnet field of the aforementioned magnet rotator, $2n$ on-off control by which the antiparallel connection was carried out to each and n phase bridge connection was carried out to the diode-bridge full wave rectifier circuit and the aforementioned $2n$ piece diode which consist of $2n$ diode by which n phase bridge connection was carried out, and rectify the output of the aforementioned armature coil. The inverter circuit equipped with the switching circuit which consists of a possible switching device, The position where the physical relationship between the center position of the magnetic pole section at the nose of cam of the tooth part of an armature core around which the armature coil of each aforementioned phase is wound, and the center position of each magnetic pole of the aforementioned magnet field turns into a relation set up beforehand is detected as a criteria excitation phase change position of each phase. The position detection equipment which generates a

signal including the information on this criteria excitation phase change position as a position detecting signal of each phase, The aforementioned magnet rotator in the direction which starts the aforementioned internal combustion engine to a rotation **** sake To pass required polar drive current from DC power supply to the aforementioned armature coil through the predetermined switching device of the aforementioned inverter circuit by the position detecting signal of each aforementioned phase It has the switch control unit which gives a driving signal to the predetermined switching device of the aforementioned inverter circuit in the excitation phase change position which has predetermined angle of advance to the criteria excitation phase change position or this criteria excitation phase change position detected. The aforementioned magnet rotator is rotated in the direction which starts the aforementioned internal combustion engine by passing the drive current commutated to the armature coil of the aforementioned n phase by predetermined phase sequence from the aforementioned DC power supply at the time of starting of the aforementioned internal combustion engine. In the motor combination generator for internal combustion engine starting which takes out the output of the armature coil of the aforementioned n phase outside through the aforementioned diode-bridge full wave rectifier circuit, and drives an electric load after an internal combustion engine starts The injector drive coil which outputs the single-phase alternative current voltage inputted into the power supply section of the injector of a motor-spirit fuel injection equipment is wound around some of tooth parts or tooth part groups of the aforementioned armature core. ***** to which the aforementioned angle of advance is set so that voltage which carries out induction to the aforementioned magneto coil for a fuel-injection-equipment drive at the time of starting of the aforementioned internal combustion engine may be made into the maximum -- the motor combination generator for internal combustion engine starting characterized by things

[Claim 5] The magnet rotator which has a multipolar magnet field, So that it may be wound around the tooth part of the armature core which has the tooth part of a large number on a par with a hoop direction, and this armature core and n phase circuit (n is two or more integers) may be constituted The stator which the magnetic pole section which has the armature coil of n phase which consists of a connected coil group, and was formed at the nose of cam of the tooth part of the aforementioned armature core is made to counter by the magnet field of the aforementioned magnet rotator, $2n$ on-off control by which the antiparallel connection was carried out to each and n phase bridge connection was carried out to the diode-bridge full wave rectifier circuit and the aforementioned $2n$ piece diode which consist of $2n$ diode by which n phase bridge connection was carried out, and rectify the output of the aforementioned armature coil The inverter circuit equipped with the switching circuit which consists

of a possible switching device, The position where the physical relationship between the center position of the magnetic pole section at the nose of cam of the tooth part of an armature core around which the armature coil of each aforementioned phase is wound, and the center position of each magnetic pole of the aforementioned magnet field turns into a relation set up beforehand is detected as a criteria excitation phase change position of each phase. The position detection equipment which generates a signal including the information on this criteria excitation phase change position as a position detecting signal of each phase, The aforementioned magnet rotator in the direction which starts the aforementioned internal combustion engine to a rotation **** sake To pass required polar drive current from DC power supply to the aforementioned armature coil through the predetermined switching device of the aforementioned inverter circuit by the position detecting signal of each aforementioned phase It has the switch control unit which gives a driving signal to the predetermined switching device of the aforementioned inverter circuit in the excitation phase change position which has predetermined angle of advance to the criteria excitation phase change position or this criteria excitation phase change position detected. The aforementioned magnet rotator is rotated in the direction which starts the aforementioned internal combustion engine by passing the drive current commutated to the armature coil of the aforementioned n phase by predetermined phase sequence from the aforementioned DC power supply at the time of starting of the aforementioned internal combustion engine. In the motor combination generator for internal combustion engine starting which takes out the output of the armature coil of the aforementioned n phase outside through the aforementioned diode-bridge full wave rectifier circuit, and drives an electric load after an internal combustion engine starts The ignition drive coil which outputs the single-phase alternative current voltage for driving the ignition for internal combustion engines to some of tooth parts or tooth part groups of the aforementioned armature core is wound. The injector drive coil which outputs the single-phase alternative current voltage for inputting into the power supply section of the injector of a motor-spirit fuel injection equipment to some of other tooth parts or tooth part groups of the aforementioned armature core is wound. The motor combination generator for internal combustion engine starting characterized by setting up the aforementioned angle of advance so that voltage which carries out induction to the aforementioned ignition drive coil and the aforementioned injector drive coil, respectively at the time of starting of the aforementioned internal combustion engine may be made into the maximum.

(19)日本国特許庁 (J P)

(12) 公 開 特 許 公 報 (A)

(11)特許出願公開番号

特開2000-102279

(P2000-102279A)

(43)公開日 平成12年4月7日(2000.4.7)

(51)Int.Cl.⁷

識別記号

F I

サーポート* (参考)

H 0 2 P 6/06

H 0 2 P 6/00

3 2 1 B 5 H 5 6 0

F 0 2 N 11/04

F 0 2 N 11/04

A 5 H 5 9 0

H 0 2 P 9/04

H 0 2 P 9/04

L

文献 2

審査請求 未請求 請求項の数5 O L (全 17 頁)

(21)出願番号

特願平10-270059

(22)出願日

平成10年9月24日(1998.9.24)

(71)出願人 000001340

国産電機株式会社

静岡県沼津市大岡3744番地

(72)発明者 稲葉 豊

静岡県沼津市大岡3744番地 国産電機株式

会社内

(72)発明者 中川 昌紀

静岡県沼津市大岡3744番地 国産電機株式

会社内

(74)代理人 100073450

弁理士 松本 英俊 (外1名)

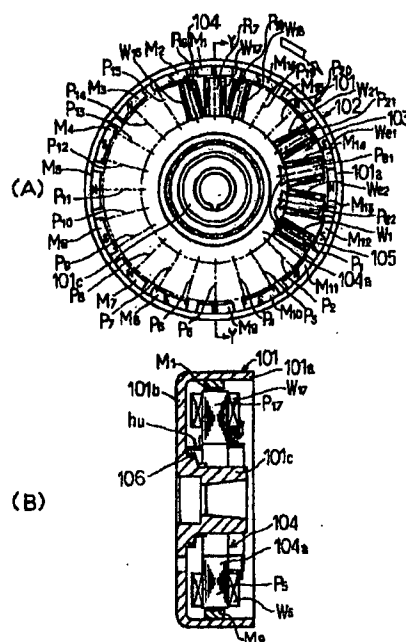
最終頁に続く

(54)【発明の名称】 内燃機関始動用電動機兼用発電機

(57)【要約】

【課題】 単相交流電圧により駆動される点火装置により点火される内燃機関にも適用できる内燃機関始動用電動機兼用発電機を提供する。

【解決手段】 内燃機関の出力軸に取り付けられた磁石回転子102と、3相結線された電機子コイルW1～W18及び内燃機関用点火装置を駆動する点火装置駆動コイルWe1, We2を設けた固定子103とにより発電機の本体を構成する。内燃機関の始動時に直流電源からインバータ回路を通して3相電機子コイルに駆動電流を流すことにより発電機を電動機として動作させて内燃機関を始動させる。内燃機関の始動時に点火装置駆動コイルに誘起する電圧を最大にするように、発電機を電動機として動作させる際の電機子コイルの励磁相の切替位置を設定する。



【特許請求の範囲】

【請求項1】 多極の磁石界磁を有する磁石回転子と、周方向に並ぶ多数の歯部を有する電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路（ n は2以上の整数）を構成するように結線されたコイル群からなる n 相の電機子コイルとを有して前記電機子鉄心の歯部の先端に形成された磁極部が前記磁石回転子の磁石界磁に対向せられる固定子と、 n 相ブリッジ接続された $2n$ 個のダイオードからなっていて前記電機子コイルの出力を整流するダイオードブリッジ全波整流回路と前記 $2n$ 個のダイオードにそれぞれに逆並列接続されて n 相ブリッジ接続された $2n$ 個のオンオフ制御が可能なスイッチ素子からなるスイッチ回路とを備えたインバータ回路と、前記各相の電機子コイルが巻回されている電機子鉄心の歯部の先端の磁極部の中心位置と前記磁石界磁の各磁極の中心位置との間の位置関係が予め設定された関係になる位置を各相の基準励磁相切替位置として検出して、該基準励磁相切替位置の情報を含む信号を各相の位置検出信号として発生する位置検出装置と、前記内燃機関を始動させる方向に前記磁石回転子を回転させるために必要な極性の駆動電流を直流電源から前記インバータ回路の所定のスイッチ素子を通して前記電機子コイルに流すべく前記各相の位置検出信号により検出される基準励磁相切替位置または該基準励磁相切替位置に対して所定の制御進み角を有する励磁相切替位置で前記インバータ回路の所定のスイッチ素子に駆動信号を与えるスイッチ制御装置とを備えて、前記内燃機関の始動時には前記直流電源から前記 n 相の電機子コイルに所定の相順で転流する駆動電流を流すことにより前記内燃機関を始動させる方向に前記磁石回転子を回転させ、内燃機関が始動した後は前記 n 相の電機子コイルの出力を前記ダイオードブリッジ全波整流回路を通して外部に取り出して電気負荷を駆動する内燃機関始動用電動機兼用発電機において、前記電機子鉄心の一部の歯部また歯部群に、単相交流電圧を出力する単相発電コイルが巻回されていることを特徴とする内燃機関始動用電動機兼用発電機。

【請求項2】 前記内燃機関の始動時に前記単相発電コイルに誘起する電圧を最大にするように前記制御進み角が設定されていることを特徴とする請求項1に記載の内燃機関始動用電動機兼用発電機。

【請求項3】 多極の磁石界磁を有する磁石回転子と、周方向に並ぶ多数の歯部を有する電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路（ n は2以上の整数）を構成するように結線されたコイル群からなる n 相の電機子コイルとを有して前記電機子鉄心の歯部の先端に形成された磁極部が前記磁石回転子の磁石界磁に対向せられる固定子と、 n 相ブリッジ接続された $2n$ 個のダイオードからなっていて前記電機子コイルの出力を整流するダイオードブリッジ全波整流回路と前記 $2n$ 個のダイオードにそれぞれに逆並列接続されて n 相ブリッジ接続

された $2n$ 個のオンオフ制御が可能なスイッチ素子からなるスイッチ回路とを備えたインバータ回路と、前記各相の電機子コイルが巻回されている電機子鉄心の歯部の先端の磁極部の中心位置と前記磁石界磁の各磁極の中心位置との間の位置関係が予め設定された関係になる位置を各相の基準励磁相切替位置として検出して、該基準励磁相切替位置の情報を含む信号を各相の位置検出信号として発生する位置検出装置と、前記磁石回転子を前記内燃機関を始動させる方向に回転させるために必要な極性の駆動電流を直流電源から前記インバータ回路の所定のスイッチ素子を通して前記電機子コイルに流すべく前記各相の位置検出信号により検出される基準励磁相切替位置または該基準励磁相切替位置に対して所定の制御進み角を有する励磁相切替位置で前記インバータ回路の所定のスイッチ素子に駆動信号を与えるスイッチ制御装置とを備えて、前記内燃機関の始動時には前記直流電源から前記 n 相の電機子コイルに所定の相順で転流する駆動電流を流すことにより前記内燃機関を始動させる方向に前記磁石回転子を回転させ、内燃機関が始動した後は前記 n 相の電機子コイルの出力を前記ダイオードブリッジ全波整流回路を通して外部に取り出して電気負荷を駆動する内燃機関始動用電動機兼用発電機において、前記電機子鉄心の一部の歯部また歯部群に、内燃機関用点火装置を駆動するための単相交流電圧を出力する点火装置駆動コイルが巻回され、前記内燃機関の始動時に前記点火装置駆動コイルに誘起する電圧を最大にするように前記制御進み角が設定されていることを特徴とする内燃機関始動用電動機兼用発電機。

【請求項4】 多極の磁石界磁を有する磁石回転子と、周方向に並ぶ多数の歯部を有する電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路（ n は2以上の整数）を構成するように結線されたコイル群からなる n 相の電機子コイルとを有して前記電機子鉄心の歯部の先端に形成された磁極部が前記磁石回転子の磁石界磁に対向せられる固定子と、 n 相ブリッジ接続された $2n$ 個のダイオードからなっていて前記電機子コイルの出力を整流するダイオードブリッジ全波整流回路と前記 $2n$ 個のダイオードにそれぞれに逆並列接続されて n 相ブリッジ接続された $2n$ 個のオンオフ制御が可能なスイッチ素子からなるスイッチ回路とを備えたインバータ回路と、前記各相の電機子コイルが巻回されている電機子鉄心の歯部の先端の磁極部の中心位置と前記磁石界磁の各磁極の中心位置との間の位置関係が予め設定された関係になる位置を各相の基準励磁相切替位置として検出して、該基準励磁相切替位置の情報を含む信号を各相の位置検出信号として発生する位置検出装置と、前記磁石回転子を前記内燃機関を始動させる方向に回転させるために必要な極性の駆動電流を直流電源から前記インバータ回路の所定のスイッチ素子を通して前記電機子コイルに流すべく前記各

相の位置検出信号により検出される基準励磁相切替位置または該基準励磁相切替位置に対して所定の制御進み角を有する励磁相切替位置で前記インバータ回路の所定のスイッチ素子に駆動信号を与えるスイッチ制御装置とを備えて、前記内燃機関の始動時には前記直流電源から前記 n 相の電機子コイルに所定の相順で転流する駆動電流を流すことにより前記内燃機関を始動させる方向に前記磁石回転子を回転させ、内燃機関が始動した後は前記 n 相の電機子コイルの出力を前記ダイオードブリッジ全波整流回路を通して外部に取り出して電気負荷を駆動する内燃機関始動用電動機兼用発電機において、

前記電機子鉄心の一部の歯部または歯部群に、内燃機関用燃料噴射装置のインジェクタの電源部に入力される単相交流電圧を出力するインジェクタ駆動コイルが巻回され、

前記内燃機関の始動時に前記燃料噴射装置駆動用発電コイルに誘起する電圧を最大にするように前記制御進み角が設定されていることを特徴とする内燃機関始動用電動機兼用発電機。

【請求項5】 多極の磁石界磁を有する磁石回転子と、周方向に並ぶ多数の歯部を有する電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路（ n は2以上の整数）を構成するように結線されたコイル群からなる n 相の電機子コイルとを有して前記電機子鉄心の歯部の先端に形成された磁極部が前記磁石回転子の磁石界磁に対向させられる固定子と、 n 相ブリッジ接続された $2n$ 個のダイオードからなっていて前記電機子コイルの出力を整流するダイオードブリッジ全波整流回路と前記 $2n$ 個のダイオードにそれぞれに逆並列接続されて n 相ブリッジ接続された $2n$ 個のオンオフ制御が可能なスイッチ素子からなるスイッチ回路とを備えたインバータ回路と、前記各相の電機子コイルが巻回されている電機子鉄心の歯部の先端の磁極部の中心位置と前記磁石界磁の各磁極の中心位置との間の位置関係が予め設定された関係になる位置を各相の基準励磁相切替位置として検出して、該基準励磁相切替位置の情報を含む信号を各相の位置検出信号として発生する位置検出装置と、前記磁石回転子を前記内燃機関を始動させる方向に回転させるために必要な極性の駆動電流を直流電源から前記インバータ回路の所定のスイッチ素子を通して前記電機子コイルに流すべく前記各相の位置検出信号により検出される基準励磁相切替位置または該基準励磁相切替位置に対して所定の制御進み角を有する励磁相切替位置で前記インバータ回路の所定のスイッチ素子に駆動信号を与えるスイッチ制御装置とを備えて、前記内燃機関の始動時には前記直流電源から前記 n 相の電機子コイルに所定の相順で転流する駆動電流を流すことにより前記内燃機関を始動させる方向に前記磁石回転子を回転させ、内燃機関が始動した後は前記 n 相の電機子コイルの出力を前記ダイオードブリッジ全波整流回路を通して外部に取り出して電気負荷を駆動する

内燃機関始動用電動機兼用発電機において、前記電機子鉄心の一部の歯部または歯部群に、内燃機関用点火装置を駆動するための単相交流電圧を出力する点火装置駆動コイルが巻回され、

前記電機子鉄心の他の一部の歯部または歯部群に、内燃機関用燃料噴射装置のインジェクタの電源部に入力するための単相交流電圧を出力するインジェクタ駆動コイルが巻回され、

前記内燃機関の始動時に前記点火装置駆動コイル及び前記インジェクタ駆動コイルにそれぞれ誘起する電圧を最大にするように前記制御進み角が設定されていることを特徴とする内燃機関始動用電動機兼用発電機。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、内燃機関の始動時には始動用電動機及び発電機として働き、内燃機関の始動後は発電機として働く内燃機関始動用電動機兼用発電機（内燃機関用スタータ・ジェネレータ）に関するものである。

【0002】

【従来の技術】内燃機関には、内燃機関用点火装置のような機関を運転するために必須の電装品を駆動したり、ランプ負荷やバッテリーなどに電力を供給したりするために磁石発電機が取り付けられる。

【0003】図9（A）は磁石発電機を備えた従来の汎用の内燃機関1の要部を示したもので、同図において2は内燃機関のケース、3は内燃機関1のケース2に軸受4を介して支持された機関の出力軸（通常はクランク軸）である。出力軸3の先端にはカップ状に形成されたフライホイール5が取り付けられ、該フライホイール5の周壁部の内周に永久磁石6が取り付けられて多極の磁石界磁が構成されている。フライホイール5と永久磁石6とにより磁石回転子7が構成されている。磁石回転子7の内側には、環状の継鉄部から多数の歯部を放射状に突出した構造を有する多極星形電機子鉄心8と該電機子鉄心の歯部に巻回された発電コイル9とからなる固定子10が配置され、該固定子は、機関のケース2に固定された台板11に取り付けられている。磁石回転子7と固定子10とにより磁石式発電機が構成されている。

【0004】フライホイール5の周壁部の外周にはリングギア12が固定され、機関のケース2には機関始動用電動機13が取り付けられている。電動機13の出力軸13aにはピニオンギア14が取り付けられ、電動機13が駆動されたときにピニオンギア14が前方に飛び出して図9（B）に示すようにリングギア12に噛み合うようになっている。

【0005】固定子10に設けられた発電コイルは、内燃機関用の点火装置を駆動するための電圧を発生する点火装置駆動コイルを含んでいて、電動機13が駆動されたときにピニオンギア14がリングギア12に噛み合っ

て磁石回転子7を回転させることにより機関のクランク軸を回転させるとともに、磁石回転子7の回転に伴って固定子10に設けられた点火装置駆動コイルに誘起する電圧で点火装置を動作させることにより内燃機関を始動させる。

【0006】

【発明が解決しようとする課題】上記のように、従来の内燃機関では、機関を始動するためにフライホイール5の外周にリングギア12を取り付けるとともに、始動用電動機13を設ける必要があったため、機関の構造が複雑になるのを避けられなかった。

【0007】そこで、機関の出力軸に始動用電動機兼用の磁石発電機を取り付けて、機関の始動時に該磁石発電機をブラシレス直流電動機として動作させることにより、始動用電動機を省略することが提案されている。

【0008】図8は、既提案のこの種の発電機の構成と、該発電機の負荷回路とを示したもので、同図においてRTは内燃機関の出力軸に取り付けられたフライホイールFの周壁部の内周に円弧状の永久磁石M1及びM2を取り付けて磁石界磁を構成してなる回転子、STは3極の電機子鉄心Aの歯部Au～Awにそれぞれ3相の電機子コイルLu～Lwを巻回してなる固定子である。永久磁石M1及びM2はそれぞれの内周側にN極及びS極が現れるようにそれぞれの磁化の方向を異ならせて回転子の径方向に着磁されている。

【0009】電機子コイルLu～Lwは3相星形結線されて、ブリッジ接続されたダイオードD1～D6からなる3相ダイオードブリッジ全波整流回路RECの入力端子に接続され、該整流回路の出力端子間にバッテリーBが接続されている。

【0010】図8には示していないが、回転子RTの磁石界磁の回転角度位置に応じて、バッテリーBから電機子コイルLu～Lwに所定の相順で転流する駆動電流を流す駆動回路が設けられていて、機関の始動時には該駆動回路から電機子コイルに駆動電流を流すことにより発電機をブラシレス直流電動機として動作させて機関を始動させるようになっている。

【0011】図8に示すように、既提案の始動用電動機兼用発電機では、発電機内に3相結線された電機子コイルLu～Lwのみが設けられていたため、発電機から電力を供給できる電装品負荷は整流回路RECを通して直流電流が供給される直流負荷（図示の例ではバッテリーB）に限られ、単相交流電圧を必要とする負荷を駆動することができなかった。

【0012】例えば、内燃機関用点火装置として、広く用いられているコンデンサ放電式の点火装置では、機関に取り付けた磁石発電機内に設けられた点火装置駆動コイル（一般にはエキサイタコイルと呼ばれる。）が機関の回転に同期して発生する単相交流電圧の一方の半サイクルの電圧で点火用コンデンサを充電し、該コンデンサ

の電荷を点火コイルの一次コイルを通して放電させることにより点火動作を行わせるようにしている。この点火装置を満足に動作させるためには、機関の始動時から200[V]以上の高い電圧を誘起するように十分多くの巻数をもって巻回された点火装置駆動コイルを発電機内に設ける必要がある。また、機関の低速時に高い電圧を得るために点火装置駆動コイルの巻数を多くすると、電機子反作用により、機関の高速時に該点火装置駆動コイルの出力電圧が低下してしまうため、高速時に高い電圧を誘起する高速用の点火装置駆動コイルを別個に設けることが必要になることがある。

【0013】点火コイルの一次コイルを兼ねるように点火装置駆動コイルを設けて、該点火装置駆動コイルを短絡することにより流した電流を機関の点火位置で遮断することにより点火用の高電圧を得るようにした電流遮断形の点火装置が用いられる場合には、点火装置駆動コイルの巻数をそれ程多くする必要はないが、この電流遮断形の点火装置の場合には、点火装置駆動コイル（点火コイルの一次コイル）のコイル導体の断面積を大きくする必要がある上に、該点火装置駆動コイルの外側に点火コイルの二次コイルを巻回する必要があるため、やはり点火装置駆動コイルを設けるために大きなスペースが必要になるのを避けることはできない。

【0014】上記の理由で、発電機内に点火装置駆動コイルを設けるためには、該駆動コイルを配置するために発電機内に相当のスペースを確保することが必要になる。

【0015】ところが、機関の始動時に必要なトルクを得ることを優先する必要がある始動用電動機兼用発電機では、始動用電動機の電機子コイルとして機能するコイルを犠牲にすることができず、該電機子コイルが発電機内で占めるスペースが大きくなるのを避けられないため、大形になる上に、低速用コイルと高速用コイルとの2つのコイルが必要になることもある点火装置駆動コイルを発電機内に設けることは行われていなかった。

【0016】なお大形の永久磁石を用いて電機子鉄心に流れる磁束の量を増加させるとともに、電機子鉄心を大形にすることにより、始動用電動機の電機子コイルを犠牲にすることなく、点火装置駆動コイルを巻回するためのスペースを確保することも考えられるが、このように構成した場合には、発電機が大形になるため、機関が大形化する上にその重量が増加し、好ましくない。

【0017】また燃料噴射装置により燃料を供給するようにした内燃機関では、インジェクタ（電磁式燃料噴射弁）を駆動するための電源を必要とするが、この電源としてバッテリーを用いると、機関の始動時に始動用電動機を駆動した際に生じるバッテリー電圧の低下により、燃料噴射装置の動作開始が遅れ、機関の始動性が悪くなる。このような問題を解消するためには、機関に取り付けた発電機内に単相交流電圧を誘起するインジェクタ駆動コ

イルを設けて、該駆動コイルからインジェクタに電源電圧を与えるようにするのが好ましい。このように機関により駆動される発電機内にインジェクタ駆動コイルを設けておくと、機関の始動操作を開始した直後に該インジェクタ駆動コイルから高い電圧を発生させてインジェクタの電源電圧を立ち上げることができるため、機関の始動性を良好にすることができる。

【0018】このように、燃料噴射装置により燃料が供給される内燃機関の場合には、機関に取り付けられる発電機内に単相交流電圧を発生するインジェクタ駆動コイルを設けることが望ましいが、従来の内燃機関始動用電動機兼用発電機では、このようなコイルを設けることは行われていなかった。

【0019】本発明の目的は、始動用電動機と発電機とに兼用する多相の電機子コイルとともに、点火装置駆動コイルや、インジェクタ駆動コイルなどの単相発電コイルを設けて、内燃機関用点火装置や燃料噴射装置をも駆動できるようにした内燃機関始動用電動機兼用発電機を提供することにある。

【0020】本発明の他の目的は、発電機を特に大形にすることなく、単相発電コイルから十分な出力を得ることができるようにした内燃機関始動用電動機兼用発電機を提供することにある。

【0021】

【課題を解決するための手段】本発明が対象とする内燃機関駆動用電動機兼用発電機は、多極の(2極以上の)磁石界磁を有する磁石回転子と、周方向に並ぶ多数の歯部を有する電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路(n は2以上の整数)を構成するように結線されたコイル群からなる n 相の電機子コイルとを有して電機子鉄心の歯部の先端に形成された磁極部が磁石回転子の磁石界磁に対向させられる固定子と、 n 相ブリッジ接続された $2n$ 個のダイオードからなっていて電機子コイルの出力を整流するダイオードブリッジ全波整流回路と $2n$ 個のダイオードにそれぞれ逆並列接続されて n 相ブリッジ接続された $2n$ 個のオンオフ制御が可能なスイッチ素子からなるスイッチ回路とを備えたインバータ回路と、各相の電機子コイルが巻回されている電機子鉄心の歯部の先端の磁極部の中心位置と磁石界磁の各磁極の中心位置との間の位置関係が予め設定された関係になる位置を各相の基準励磁相切替位置として検出して、該基準励磁相切替位置の情報を含む信号を各相の位置検出信号として発生する位置検出装置と、内燃機関を始動させる方向に磁石回転子を回転させるために必要な極性の駆動電流を直流電源からインバータ回路の所定のスイッチ素子を通して電機子コイルに流すべく各相の位置検出信号により検出される基準励磁相切替位置または該基準励磁相切替位置に対して所定の制御進み角を有する励磁相切替位置でインバータ回路の所定のスイッチ素子に駆動信号を与えるスイッチ制御装置とを備えて、内燃機関の始

動時には直流電源から n 相の電機子コイルに所定の相順で転流する駆動電流を流すことによりブラシレス直流電動機として機能させて内燃機関を始動させる方向に磁石回転子を回転させ、機関が始動した後は磁石発電機として機能させて n 相の電機子コイルの出力をダイオードブリッジ全波整流回路を通して外部に取り出して電気負荷を駆動するものである。

【0022】本発明が適用される発電機は、固定子の外側を磁石回転子が回転する回転子外転形(アウトロータ形)に構成されたものでもよく、固定子の内側を磁石回転子が回転する回転子内転形(インナロータ形)に構成されたものでもよい。

【0023】内燃機関には、一般にフライホイールが取り付けられるため、該フライホイールを利用して磁石回転子を構成すると機関をコンパクトに構成できる。この場合、磁石回転子は、周壁部と該周壁部の軸線方向の一端を閉じる底壁部と該底壁部の中央に設けられたボス部とを有するほぼカップ状の形状に形成されてボス部が内燃機関の出力軸に取り付けられるカップ状のフライホイールと、該フライホイールの周壁部の内周に取り付けられて磁石界磁を構成する永久磁石とにより構成される。また固定子は、環状の継鉄部から多数の歯部が放射状に突出した構造を有する多極星形電機子鉄心と該電機子鉄心の歯部に巻回されて n 相回路(n は2以上の整数)を構成するように結線されたコイル群からなる n 相の電機子コイルとにより構成されて磁石回転子の内側に配置される。

【0024】本発明は、上記のような始動用電動機兼用発電機(スタータ・ジェネレータ)において、電機子鉄心の一部の歯部また歯部群に、単相交流電圧を出力する単相発電コイルを巻回したことを特徴とする。

【0025】このように始動用電動機及び発電機に兼用する電機子コイルの他に単相発電コイルを設けておくと、単相発電コイルにより駆動される点火装置により点火される内燃機関にも始動用電動機兼用発電機を用いて、従来必要とした始動用電動機を省略し、その構造の簡素化を図ることができる。

【0026】本発明の好ましい態様では、内燃機関の始動時に単相発電コイルに誘起する電圧を最大にするように制御進み角を設定する。即ち、内燃機関の始動時に電機子コイルの励磁相を切り替える励磁相切替位置と、位置検出装置により検出される基準励磁相切替位置との間の関係を、単相発電コイルに誘起する電圧を最大にするように設定する。

【0027】なお「制御進み角」は、前述のように、位置検出装置により検出される基準励磁相切替位置と、実際の励磁相切替位置(駆動電流を流す電機子コイルの相を切り替える際の回転子の回転角度位置)との位相差であるが、本発明においては、この制御進み角が正負の値をとり得るものとする。即ち、実際の励磁相切替位置が

10

20

30

40

50

基準励磁相切替位置に対して遅れ側の位置となる場合も、励磁相切替位置と基準励磁相切替位置との間の位相差を「制御進み角」と呼ぶことにする。

【0028】なお3相以上のブラシレス直流電動機では、一度に2以上の相の電機子コイルを励磁して、回転子の位置に応じて、励磁相の組み合わせを順次切り替えていく。したがって、3相以上のブラシレス直流電動機の励磁相切替位置は、電機子コイルの励磁相の組み合わせを切り替える位置である。

【0029】上記基準励磁相切替位置は、ブラシレス直流電動機の機械的構造により一義的に決まるものではなく、位置検出装置を構成する位置検出器の取付け位置により決まるものである。通常のブラシレス直流電動機では、各相の電機子コイルに流す駆動電流の通電角（電気角）に応じて、位置検出器の取付け位置を適当な位置に設定している。例えば、磁石回転子の回転に伴って電機子コイルに誘起する無負荷誘起電圧がピークに達する位置（磁石界磁から各相の電機子コイルが巻回された歯部を通して流れる磁束が零点を通過する位置）の前後90度（電気角）の区間各相の電機子コイルに電流を流す180度スイッチング制御を行って電動機を回転させる場合には、各相の電機子コイルが巻回されている歯部の先端の磁極部の中心位置（周方向の中心）が回転子の磁石界磁の各磁極の中心位置に一致した時の回転子の回転角度位置を検出するように各相の位置検出信号を得るための位置検出器を取り付ける。例えば、図2に示したように、U相ないしW相の電機子コイル L_u ないし L_w が3つの歯部 $P_u \sim P_w$ に巻回されている場合に、ホールICからなる位置検出器 h_u ないし h_w を用いて磁石回転子の磁極を検出することにより、U相ないしW相の位置検出信号を得る場合には、図示のように歯部 P_u ないし P_w の磁極部の中心位置からそれぞれ電気角で90度位相が進んだ位置に位置検出器 $h_u \sim h_w$ を配置して磁石界磁の磁極を検出することにより、歯部 $P_u \sim P_w$ の先端の磁極部の中心位置に磁石界磁の各磁極の中心位置が一致する毎にレベルが変化する矩形波状のU相ないしW相の位置検出信号を得るようにするのが普通である。この場合、歯部 $P_u \sim P_w$ の先端の磁極部の中心位置に磁石界磁の各磁極の中心位置が一致する位置がそれぞれU相ないしW相の基準励磁相切替位置となり、各相の基準励磁相切替位置は、各相の位置検出器から得られる矩形波状の位置検出信号のレベルが変化する位置（矩形波信号の立上り位置及び立下がり位置）となる。

【0030】また磁石回転子の回転に伴って電機子コイルに誘起する無負荷誘起電圧がピークに達する位置の前後60度の区間各相の電機子コイルに電流を流す120度スイッチング制御を行って電動機を回転させる場合には、歯部 P_u ないし P_w の磁極部の中心位置からそれぞれ60度位相が進んだ位置にU相ないしW相の位置検出器 $h_u \sim h_w$ を配置して磁石界磁の磁極を検出すること

により、歯部 $P_u \sim P_w$ の先端の磁極部の中心位置よりも電気角で30度遅れた位置に磁石界磁の各磁極の中心位置が一致する毎にレベルが変化する矩形波状のU相ないしW相の位置検出信号を得るようにするのが普通である。この場合、歯部 $P_u \sim P_w$ の先端の磁極部の中心位置よりも電気角で30度遅れた位置に磁石界磁の各磁極の中心位置が一致した状態になったときの位置が基準励磁相切替位置となり、各相の基準励磁相切替位置は、各相の位置検出器から得られる位置検出信号のレベルが変化する位置となる。

【0031】180度スイッチング制御または120度スイッチング制御を行ってブラシレス直流電動機を回転させる場合に上記のように位置検出器を配置して、各相の位置検出信号を得るようにした場合には、制御進み角を零とした場合、即ち、各相の位置検出信号のレベルが変化する基準励磁相切替位置（位置検出信号の立上り位置及び立下がり位置）で励磁される電機子コイルの相の組み合わせを所定の組み合わせに切り替えるようにインバータのスイッチ素子を制御することにより、起動時のトルクを最大にすることができる。しかしながら、常に上記のように位置センサの取り付け位置を設定しなければならないわけではなく、基準励磁相切替位置をインバータ回路の制御にとって都合がよいで位置に設定して、該基準励磁相切替位置で検出信号を発生させるように位置センサを取り付けるようにすることもできる。

【0032】本発明に係わる始動用電動機兼用発電機において、制御進み角を適当に設定すると、機関の始動時に電機子コイルに流す駆動電流により電機子コイルから生じる磁束の一部を単相発電コイルが巻かれた歯部に流して、該単相発電コイルに鎖交する磁束の量を増加させることができるため、機関の始動時に単相発電コイルに誘起する電圧を高くすることができる。従って、内燃機関の始動時に単相発電コイルに誘起する電圧を最大にするように制御進み角（基準励磁相切替位置と実際の励磁相切替位置との関係）を設定しておく、単相発電コイルを配置するスペースを十分に確保することができないために、該発電コイルの巻数を十分に多くすることができない場合でも、機関の始動時に該単相発電コイルに誘起する電圧を高くすることができる。

【0033】機関の始動時に単相発電コイルの出力電圧を最大にする制御進み角の大きさは、基準励磁相切替位置の設定の仕方（位置検出器の取り付け位置）に応じて相違する。

【0034】上記の単相発電コイルは、内燃機関用点火装置を駆動するための電圧を発生する点火装置駆動コイルでもよく、内燃機関用燃料噴射装置のインジェクタの電源部に電圧を与えるインジェクタ駆動コイルであってもよい。

【0035】また内燃機関用点火装置と燃料噴射装置との双方を駆動するために単相交流電圧が必要になる場合

には、電機子鉄心の一部の歯部または歯部群に、点火装置駆動コイルを巻回し、該電機子鉄心の他の一部の歯部または歯部群に、インジェクタ駆動コイルを巻回するようによればよい。

【0036】この場合、内燃機関の始動時に点火装置駆動コイル及び前記インジェクタ駆動コイルにそれぞれ誘起する電圧を最大にするように制御進み角を設定する。

【0037】上記点火装置駆動コイルは、電機子鉄心の異なる歯部に巻回された低速用コイル及び高速用コイルにより構成するのが好ましい。この場合、低速用コイルは機関の低速時に高い電圧を誘起するように巻回し、高速用コイルは機関の高速時に高い電圧を誘起するように巻回する。

【0038】1つのコイルにより点火装置駆動コイルを構成した場合には、機関の低速時に高い電圧を誘起するようにその巻数を多く設定すると機関の高速時に電機子反作用により高い電圧を得ることができなくなり、また機関の高速時に点火装置駆動コイルに高い電圧を誘起させるようにその巻数を少なくしておく、機関の低速時に高い電圧を得ることができないため、機関の低速時から高速時まで十分に高い電圧を点火装置駆動コイルから得るのが難しいが、上記のように低速用コイルと高速用コイルとを設けておけば、機関の低速時から高速時まで点火装置駆動コイルから十分に高い電圧を得て点火装置を満足に動作させることができる。

【0039】同様に、インジェクタ駆動コイルも電機子鉄心の異なる歯部に巻回された低速用コイルと高速用コイルとにより構成するのが好ましい。

【0040】また、上記単相発電コイルが駆動する負荷は、点火装置や燃料噴射装置に限られるものではなく、他の適宜の負荷であってもよい。

【0041】

【発明の実施の形態】図1(A)及び(B)は本発明に係る始動用電動機兼用発電機の構成を示したもので、これらの図において101は周壁部101aと該周壁部の軸線方向の一端を閉じる底壁部101bと該底壁部の中央に設けられたボス部101cとを有するカップ状のフライホイールである。フライホイール101の周壁部101aの内周には、等角度間隔で配置された16個の円弧状の永久磁石M1～M16が接着などにより固定され、フライホイール101と永久磁石M1～M16とにより16極の磁石回転子102が構成されている。磁石M1～M16はそれぞれの内周側に現れる磁極が交互にN極とS極となるように磁化の方向を交互に異ならせてフライホイールの径方向に着磁され、ヨークを構成するフライホイール101の周壁部101aと磁石M1～M16とにより16極の磁石界磁が構成されている。磁石回転子102は、フライホイール101のボス部101cを図示しない機関の出力軸（通常はクランク軸）に嵌着することにより機関に取り付けられる。

【0042】磁石回転子102の内側には固定子103が配置されている。固定子103は、環状の継鉄部104aから21個の電機子コイル巻回用の歯部P1～P21と、2個の点火装置駆動コイル巻回用の歯部Pe1及びPe2とが放射状に突出した構造を有する多極星形電機子鉄心104と、該電機子鉄心の歯部P1～P21にそれぞれ巻回された電機子コイルW1～W21と、歯部Pe1及びPe2にそれぞれ巻回されたコイルWe1及びWe2とからなっていて、電機子鉄心104を内燃機関のケースなどに設けられた固定子取付け部に適宜の手段により固定することにより機関に取り付けられる。

【0043】歯部P1～P21は、通常の24極の星形電機子鉄心の極間隔に相当する角度間隔（ $360/24$ 度）をもって配置され、歯部Pe1及びPe2は、歯部P21と歯部P1との間に形成された星形鉄心の歯部3個分の（歯部を3つ配置し得る）スペースに配置されている。歯部Pe1及びPe2は、それぞれの後端部に鳩尾状の突起（蟻）105を備えていて、該突起105を継鉄部104aに形成された蟻溝に嵌合させることにより継鉄部104aに固定される。

【0044】歯部P1～P21にそれぞれ巻回された電機子コイルW1～W21は、始動用電動機及び発電機に兼用するコイルで、同位相の電圧を誘起する2つ置きと同相の電機子コイル同士が直列または並列に接続されて各相の電機子コイルが構成されるとともに、3相の電機子コイルが星形結線されている。

【0045】また歯部Pe1及びPe2にそれぞれ巻回されたコイルWe1及びWe2は、コンデンサ放電式点火装置の点火用コンデンサを充電するために用いられる点火装置駆動コイルを構成する低速用コイル及び高速用コイルで、これらのコイルは、180度位相が異なる電圧を誘起する。低速用コイルWe1及び高速用コイルWe2は、電機子コイルを構成するコイルW1～W21を構成するコイル導体よりも線径が小さいコイル導体を用いて巻回されている。低速用コイルWe1は機関の低速時に十分に高い電圧を発生し得るように十分多くの巻数をもって巻回され、高速用コイルWe2は機関の高速時に十分に高い電圧を発生するように比較的少ない巻数をもって巻回されている。低速用コイルWe1及びWe2は、コイルW1～W21を巻回する工程とは別の工程で継鉄部104aから外された歯部Pe1及びPe2にそれぞれ巻回され、これらのコイルが巻回された後に歯部Pe1及びPe2が継鉄部104aに取り付けられる。

【0046】一般に3相のブラシレス直流電動機においては、固定子側が2m極（mは1以上の整数）に構成され、回転子の磁石界磁が3m極に構成される。図示の例は、 $m=8$ とした場合で、固定子103が電機子コイルW1～W21に対して24極に構成され、回転子102が16極に構成されている。

【0047】フライホイール101のボス部101cの

基部外周には、永久磁石M1～M16の磁極にそれぞれ対応した磁極を有するように16極に着磁されたリング状磁石106が取り付けられ、リング状磁石106の16個の磁極はそれぞれ磁石界磁の16個の磁極に同じ周方向位置で1対1で対応するようになっている。電機子鉄心104の継鉄部の内周には、3相の電機子コイルのそれぞれに対応する位置検出器hu～hw（図1においては、U相の位置検出器huのみが示されている。）が120度の角度間隔をもって取り付けられている。各相の位置検出器はホールICからなっていて、検出している磁極の極性に依じて異なるレベルの電圧信号を出力する。この例では、内燃機関の始動時に、バッテリーBからインバータ回路200のスイッチ素子を通して3相の電機子コイルに駆動電流を流して発電機をブラシレス直流電動機として動作させる際に、各相の電機子コイルに流す駆動電流の通電角を電気角で180度とする180度スイッチング制御を行うものとする。そのため、図示の例では、180度スイッチング制御を行う場合の位置検出器の普通の配置の仕方に倣って、各相の位置検出器は、対応する相の電機子コイルが巻回された電機子鉄心の複数の歯部のうちのいずれか1つの歯部の先端の磁極の中心位置よりも電気角で90度位相が進んだ位置に配置されて、リング状磁石106の磁極の極性を検出することにより、各相の電機子コイルが巻かれた歯部の磁極部の中心位置に磁石界磁の各磁極の中心位置が一致した状態になる位置を各相の基準励磁相切替位置として検出する。

【0048】位置検出器hu～hwが発生する位置検出信号は、基準励磁相切替位置の情報を含む波形の信号であればよいが、位置検出器としてホールICを用いた場合、該ホールICは、検出している磁極の極性がN極のときとS極のときとで異なるレベルの信号を発生するので、位置検出信号の波形は矩形波状の波形になり、該矩形波状の位置検出信号の立上り位置及び立下り位置がそれぞれ基準励磁相切替位置になる。

【0049】図2（A）は、電機子鉄心104の歯部P1～P21にそれぞれ巻回されて3相に結線された電機子コイルに接続される電気回路の構成を示したものである。図2（A）においては、理解を容易にするために、3相の電機子コイルW1～W21を3相星形結線して構成した3相の電機子コイルを符号Lu～Lwで表し、m=1として、3相の電機子コイルLu～Lwが120度間隔で配置された電機子鉄心104の3つの歯部Pu～Pwに集中巻されているとしている。また磁石回転子102の磁石界磁は永久磁石M1及びM2により2極に構成されているとしている。

【0050】また図2（A）においては、位置検出器hu～hwをそれぞれ構成するホールICが回転子の磁石界磁の位置を検出するために設けられたリング磁石でなく、磁石界磁の磁極を直接検出するように図示されてい

る。位置検出器hu～hwはそれぞれU相ないしW相の電機子コイルが巻回された歯部Pu～Pwの磁極の中心位置に対して電気角で90度進んだ位置に配置されて、磁石界磁の磁極の極性を検出する。即ち、この例では、各相の電機子コイルに流す駆動電流の通電角を電気角で180度とすることを想定している。

【0051】図2（A）において200は、3相のブラシレス直流電動機を駆動するために用いられるインバータ回路と同じ構成を有するインバータ回路で、このインバータ回路は、3相ブリッジ接続された6個のダイオードDu～Dw及びDx～Dzからなっていて電機子コイルLu～Lwの出力を整流するダイオードブリッジ全波整流回路と、6個のダイオードDu～Dw及びDx～Dzのそれぞれに逆並列接続されて3相ブリッジ接続された6個のオンオフ制御が可能なスイッチ素子（図示の例ではMOSFET）Fu～Fw及びFx～Fzとからなっている。

【0052】このインバータ回路200においては、スイッチ回路のブリッジの上辺のスイッチ素子Fu～Fwを構成するMOSFETのドレインの共通接続点（整流回路のブリッジの上辺を構成するダイオードDu～Dwのカソードの共通接続点）及びスイッチ回路のブリッジの下辺のスイッチ素子Fx～Fzを構成するMOSFETのソースの共通接続点（整流回路のブリッジの下辺を構成するダイオードDx～Dzのアノードの共通接続点）からそれぞれ導出された端子ta及びtbがスイッチ回路の直流入力端子及び整流回路の直流出力端子となっていて、これらの端子ta、tb間に直流電源300を構成するバッテリーBが接続されている。またスイッチ素子Fu～Fwをそれぞれ構成するMOSFETのソースとスイッチ素子Fx～Fzをそれぞれ構成するMOSFETのドレインとの接続点から引き出された端子tu～twがスイッチ回路の交流出力端子及び整流回路の交流入力端子となっていて、これらの端子tu～twがそれぞれ電機子コイルLu～Lwの中性点と反対側の端子に接続されている。

【0053】直流電源300を構成するバッテリーBの両端には平滑用コンデンサC1が接続されている。

【0054】400はマイクロコンピュータや論理回路などを用いて構成されるスイッチ制御装置で、このスイッチ制御装置は、位置検出器hu～hwがそれぞれ出力する位置検出信号Hu～Hwが入力される入力端子とスイッチ素子Fu～Fw及びFx～Fzのそれぞれの制御端子（図示の例ではMOSFETのゲート）に与える駆動信号Su～Sw及びSx～Szを出力する出力端子とを有していて、内燃機関の始動時に磁石回転子101を内燃機関を始動させる方向に回転させるために必要な極性の駆動電流を直流電源300からインバータ回路200のスイッチ回路部を通して電機子コイルLu～Lwに流すべく、位置検出器hu～hwにより3相の電機子コイ

ルに対して検出された基準励磁相切替位置を基にして決定した励磁相切替位置でスイッチ回路の所定のMOSFET（スイッチ素子）に駆動信号を与える。

【0055】上記スイッチ制御装置400の構成例を図3に示した。図3において401はマイクロコンピュータのCPUで、CPU401には、位置検出器 $h_u \sim h_w$ がそれぞれ出力する位置検出信号 $H_u \sim H_w$ と、内燃機関の始動時に始動スイッチ402を閉じることにより与えられる始動指令信号とが入力されている。

【0056】CPU401はスイッチ回路を構成するスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ にそれぞれ対応する出力端子を有して、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ にそれぞれ対応する出力端子からバッファ回路403を通してスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ をそれぞれ導通させることを指令する駆動指令信号 $s_u \sim s_w$ 及び $s_x \sim s_z$ を出力する。これらの駆動指令信号 $s_u \sim s_w$ 及び $s_x \sim s_z$ は駆動信号出力回路404に与えられる。駆動信号出力回路404は、駆動指令信号 $s_u \sim s_w$ 及び $s_x \sim s_z$ がそれぞれ入力される入力端子と、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ のそれぞれの制御端子（図示の例ではMOSFETのゲート）に接続された出力端子とを有して、駆動指令信号 $s_u \sim s_w$ 及び $s_x \sim s_z$ がそれぞれ発生したときにスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の制御端子に駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ を与える。

【0057】本発明においては、これらの駆動信号をスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ に与えることにより、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ を所定のタイミングでオンオフさせて、バッテリーBから電機子コイル $L_u \sim L_w$ に所定の相順で転流する駆動電流を流す。

【0058】バッテリーBからスイッチ回路を通して電機子コイル $L_u \sim L_w$ に流れる電流を検出するため、端子 t_b と接地間に電流検出用抵抗 R_1 が接続され、該抵抗 R_1 の両端に現れる電流検出信号 V_i が比較器CP1の非反転入力端子に与えられている。

【0059】また図示しない直流定電圧電源回路の出力電圧を抵抗 R_2 及び R_3 の直列回路からなる分圧回路により分圧して、抵抗 R_3 の両端に基準電圧 V_r を発生する基準電圧発生回路405が設けられ、基準電圧 V_r が比較器CP1の反転入力端子に入力されている。

【0060】バッファ回路403の出力端子（駆動信号出力回路404の入力端子）のうち、スイッチ回路のブリッジの下辺のスイッチ素子 $F_x \sim F_z$ をオン状態にすることを指令する駆動指令信号 s_x 、 s_y 、 s_z をそれぞれ出力する端子にカソードが共通接続されたダイオード D_1 、 D_2 及び D_3 のアノードが接続されている。ダイオード D_1 、 D_2 及び D_3 のカソードの共通接続点はエミッタが接地されたNPNトランジスタTR1のコレクタに接続され、トランジスタTR1がオン状態になっている間、駆動指令信号 s_x 、 s_y 及び s_z が該トラン

ジスタTR1を通して駆動信号出力回路404から側路されてスイッチ回路のブリッジの下辺のスイッチ素子 $F_x \sim F_z$ に駆動信号 $S_x \sim S_z$ が与えられるのが阻止されるようになっている。

【0061】トランジスタTR1のベースには、CPU401から与えられるPWM信号 S_{pwm} と、比較器CP1の出力とがオア回路406を通して与えられている。PWM信号は、スイッチ素子 $F_x \sim F_z$ をオン状態にする期間低レベルの状態（「0」の状態）を保持し、スイッチ素子 $F_x \sim F_z$ をオフ状態にする期間高レベルの状態（「1」の状態）を保持するパルス波形の信号である。

【0062】スイッチ回路を構成するスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ を通して流れる電流が設定値よりも小さく、比較器CP1の出力が低レベルの状態（「0」の状態）にあるときには、PWM信号 S_{pwm} が高レベルの状態にある期間トランジスタTR1がオン状態になって駆動指令信号 $s_x \sim s_z$ が駆動信号出力回路404に与えられるのを阻止し、PWM信号が低レベルの状態にある期間トランジスタTR1がオフ状態になって、駆動信号出力回路404に駆動指令信号 $s_x \sim s_z$ が与えられるのを許容する。これにより、バッテリーBから電機子コイル $L_u \sim L_w$ に駆動電流を流すスイッチ素子 $F_x \sim F_z$ が所定のデューティ比でオンオフ制御される。

【0063】バッテリーBからスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ を通して流れる電流が制限値を超えると、電流検出信号 V_i が基準電圧信号 V_r を超えて比較器CP1の出力が高レベルの状態に反転し、トランジスタTR1がオン状態に保持される。これによりスイッチ素子 $F_x \sim F_z$ に駆動信号 $S_x \sim S_z$ が与えられなくなり、これらのスイッチ素子 $F_x \sim F_z$ がオフ状態に保持される。この状態では、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ からなるスイッチ回路に電流が流れなくなるため、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ が過電流により破損するのが防止される。

【0064】図3に示した例では、バッファ回路403と駆動信号出力回路404とによりスイッチ駆動回路が、ダイオード $D_1 \sim D_3$ とトランジスタTR1とオア回路406とにより駆動電流のデューティ比を制御するデューティ制御回路がそれぞれ構成されている。また電流検出用抵抗 R_1 と比較器CP1と抵抗 R_2 及び R_3 とによりスイッチ素子を過電流から保護する過電流保護回路が構成され、これらスイッチ駆動回路、デューティ制御回路及び過電流保護回路と、CPU401及び始動スイッチ402とにより、スイッチ制御装置400が構成されている。

【0065】CPU401は位置検出器 $h_u \sim h_w$ が出力する位置検出信号 $H_u \sim H_w$ を入力として、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ をそれぞれ所定のタイミ

ングでオン状態にするための駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ を発生する。

【0066】図2のように3相の位置検出器 $h_u \sim h_w$ がそれぞれU相ないしW相の電機子コイルが巻回された歯部 $P_u \sim P_w$ の磁極部の中心位置に対して電気角で90度進んだ位置に取り付けられている場合、位置検出器がN極を検出したときに高レベルの信号を出力するものとする、位置検出器 $h_u \sim h_w$ がそれぞれ発生する位置検出信号 $H_u \sim H_w$ の波形は、図4の(A)～(C)のように電気角で120度の位相差をもって順次発生する矩形波状の波形になる。位置検出信号 $H_u \sim H_w$ のそれぞれの立上り位置及び立下がり位置がそれぞれU相ないしW相の基準励磁相切替位置となる。

【0067】図示の例では、磁石回転子が2極に構成されているため、電機子コイルに鎖交する磁束及び電機子コイルの誘起電圧の電気角(磁束波形及び誘起電圧波形上の位相角)は機械角(回転子の回転角度で表した位相角)に一致している。

【0068】また図示の例では、位置検出器 $h_u \sim h_w$ がそれぞれ固定子のU相ないしW相の磁極の中心に対して90度位相が進んだ位置に配置されているため、位置検出信号 $H_u \sim H_w$ が低レベルになっている期間及び高レベルになっている期間がそれぞれ磁石回転子が機関により駆動されて発電機として動作するときにU相ないしW相の電機子コイル $L_u \sim L_w$ に誘起する誘起電圧の一方の半サイクルの期間及び他方の半サイクルの期間に一致している。例えば位置検出信号 H_u が低レベルになっている期間がU相の電機子コイル L_u の誘起電圧の正の半サイクルの期間に一致し、 H_u が高レベルになっている期間がU相の電機子コイル L_u の誘起電圧の負の半サイクルの期間に一致している。

【0069】この例では、スイッチ回路を構成する各スイッチ素子を電気角で180度の期間オン状態にし、残りの180度の期間をオフ状態にするように各スイッチ素子のオンオフ制御(180度スイッチング制御)を行わせる。この場合、例えば図4(D)ないし(I)のように、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の基準のスイッチングパターンを定める。

【0070】図4(D)ないし(I)はスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の基準スイッチパターンをそれぞれのスイッチ素子に与えられる駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ の波形で示したもので、図4(D)ないし(I)にそれぞれ示された高レベルの矩形波信号が駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ である。これらの駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ が発生している期間がスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の駆動期間であり、駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ が発生していない期間がスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の非駆動期間である。

【0071】図4に示した180度スイッチング制御の

基準スイッチパターンにおいては、U相ないしW相の電機子コイル L_u ないし L_w に対してそれぞれ磁石回転子の回転角度位置を検出する位置検出器 h_u ないし h_w から得られる位置検出信号 H_u ないし H_w がそれぞれ高レベルになっている期間(それぞれの位置検出器が磁石界磁の一方の磁極を検出している期間)をブリッジの上辺の対応するスイッチ素子 F_u ないし F_w の非駆動期間とし、位置検出信号 H_u ないし H_w がそれぞれ低レベルになっている期間をブリッジの上辺の対応するスイッチ素子 F_u ないし F_w の駆動期間とする。またスイッチ回路のブリッジの上辺のスイッチ素子 F_u ないし F_w のそれぞれの非駆動期間(位置検出器 h_u ないし h_w がそれぞれ磁石界磁の他方の磁極を検出している期間)をブリッジの下辺の対応するスイッチ素子 F_x ないし F_z の駆動期間とし、ブリッジの上辺のスイッチ素子 F_u ないし F_w の駆動期間をそれぞれブリッジの下辺の対応するスイッチ素子 F_x ないし F_z の非駆動期間とする。

【0072】図4(D)ないし(I)に示したような基準スイッチパターンでスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ をオンオフさせると、磁石回転子の回転により電機子コイル $L_u \sim L_w$ に誘起させられる電圧(発電機としての誘起電圧)と同位相の交流電圧がバッテリーBからスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ により構成されたスイッチ回路を通して電機子コイル $L_u \sim L_w$ に印加される。

【0073】図1に示した発電機では、バッテリーB側から電機子コイル $L_u \sim L_w$ に駆動電流を流す際に、図4に示した基準スイッチパターンを基準にして、スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の実際のスイッチパターンの位相を変化させると、電機子コイル $L_u \sim L_w$ に鎖交する磁束の量を増加または減少させて、発電機としての出力特性を変化させることができる。スイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ の実際のスイッチパターンの位相と基準スイッチパターンとの位相差 γ を制御進み角と呼ぶ。

【0074】図1の始動用電動機兼用発電機では、内燃機関の始動時に、スイッチ制御装置400が、所定の基準励磁相切替位置または該基準励磁相切替位置に対して制御進み角 γ を有する所定の励磁相切替位置でインバータ回路200のスイッチ素子 $F_u \sim F_w$ 及び $F_x \sim F_z$ にそれぞれ駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ を与えて、電機子コイル $L_u \sim L_w$ に所定の相順で転流する駆動電流を流す。これにより磁石発電機をブラシレス直流電動機として動作させて磁石回転子102を回転させ、機関の出力軸を始動方向に回転させる。磁石回転子102が回転させられると、該磁石回転子の回転により電機子コイルに鎖交する磁束が変化させられるため、電機子コイル $L_u \sim L_w$ 及び点火装置駆動コイルを構成する低速用コイル $We1$ 及び高速用コイル $We2$ に電圧が誘起する。低速用コイル $We1$ 及び高速用コイル $We2$ の出力によ

り後記する点火装置が駆動されて機関が点火され、機関が始動させられる。

【0075】機関が始動した後は、駆動信号 $S_u \sim S_w$ 及び $S_x \sim S_z$ の出力を停止して、電機子コイル $L_u \sim L_w$ をもっぱら発電コイルとして用い、磁石回転子の回転に伴って電機子コイル $L_u \sim L_w$ に誘起する3相の電圧 V_u, V_v 及び V_w をインバータ回路200のダイオード $D_u \sim D_w$ 及び $D_x \sim D_z$ により構成された全波整流回路により整流してバッテリーBに充電電圧として印加する。

【0076】図1に示した始動用電動機兼用発電機により駆動されるコンデンサ放電式の点火装置は、一般に、点火コイルと、該点火コイルの一次側に設けられてエキサイタコイルの一方の半サイクルの電圧により一方の極性に充電される点火用コンデンサと、内燃機関の点火時期に点火信号が与えられたときに導通して点火用コンデンサに蓄積された電荷を点火コイルの一次コイルを通して放電させる放電用スイッチとを備えることにより構成される。

【0077】図2(B)はコンデンサ放電式の点火装置500の構成の一例を示したもので、この点火装置は、一次コイル及び二次コイルの一端が接地された点火コイルIGと、点火コイルIGの一次コイルの非接地側端子に一端が接続された点火用コンデンサCiと、コンデンサCiの他端と接地間にカソードを接地側に向けて接続された放電用スイッチとしてのサイリスタThiと、点火用コンデンサCiの他端にカソードが接続されたダイオードDi1と、点火コイルIGの一次コイルの両端にカソードを接地側に向けて接続されたダイオードDi2と、図示しない内燃機関の気筒に取り付けられて非接地側の端子が点火コイルの二次コイルの非接地側端子に接続された点火プラグPLとからなっている。

【0078】点火装置駆動コイルWeを構成する低速用コイルWe1及び高速用コイルWe2はそれぞれに誘起する電圧の極性を合わせた状態で直列に接続され、高速用コイルWe2の低速用コイルと反対側の端子がダイオードDi1のアノードに接続されている。また低速用コイルWe1の高速用コイルWe2と反対側の端子と接地間にアノードを接地側に向けたダイオードDaが接続され、低速用コイルWe1と高速用コイルWe2との接続点と接地間にアノードを接地側に向けたダイオードDbが接続されている。

【0079】図2(B)の点火装置において、点火装置駆動コイルWeに正の半サイクルの電圧が誘起すると、該点火装置駆動コイルの誘起電圧によりダイオードDi1とダイオードDi2及び点火コイルの一次コイルとを通して点火用コンデンサCiが図示の極性に充電される。内燃機関の点火時期にサイリスタThiのゲートに点火信号Viが与えられると、該サイリスタThiが導通するため点火用コンデンサCiの電荷がサイリスタThiと点火コ

イルIGの一次コイルとを通して放電する。この放電により点火コイルの一次コイルに誘起する高い電圧が更に昇圧されて点火コイルの二次コイルに点火用の高電圧が誘起させられる。点火コイルIGの二次コイルに誘起した高電圧は点火プラグPLに印加されるため、該点火プラグに火花放電が生じ、機関が点火される。

【0080】点火用コンデンサCiの充電は、機関の低速時にはダイオードDaを通して低速用コイルWe1の出力電圧と高速用コイルWe2の出力電圧との和の電圧により行われ、機関の高速時にはダイオードDbを通して主として高速用コイルWe2の出力により行われる。機関の高速時には、低速用コイルWe1のインピーダンスが高くなるが、図2(B)に示した回路では、高速時に高インピーダンスの低速用コイルWe1が高速用コイルWe2の負荷にならないようになっている。

【0081】図1の始動用電動機兼用発電機において、内燃機関の始動時にバッテリーBからスイッチ回路を通して電機子コイル $L_u \sim L_w$ に駆動電流を流すと、該駆動電流が流れることにより電機子コイル $L_u \sim L_w$ から生じる磁束の一部が点火装置駆動コイル(低速用コイルWe1及び高速用コイルWe2)が巻回された歯部Pe1, Pe2に流れる現象(電機子反作用)が生じるため、点火装置駆動コイルに鎖交する磁束が変化してその誘起電圧が変化する。バッテリーから電機子コイル $L_u \sim L_w$ に駆動電流を流した際に点火装置駆動コイルに鎖交する磁束の量は、図4に示した制御進み角 γ (位置検出器 $h_u \sim h_w$ により検出される基準励磁相切替位置と電機子コイル $L_u \sim L_w$ の励磁を切り替える励磁相切替位置との関係)により変化する。

【0082】図10は、電機子反作用により点火装置駆動コイルに鎖交する磁束が変化する様子と、点火装置駆動コイルの誘起電圧が電機子反作用の影響を受けて変化する様子を模式的に示したもので、同図において横軸は電気角 θ を示している。図10に示したaの波形は電機子コイルに電流を流さない場合に点火装置駆動コイルに鎖交する磁束の波形を示し、bの波形はブラシレス直流電動機として動作させるために前記制御進み角 γ を0度として電機子コイルに電流を流した場合に点火装置駆動コイルに鎖交する磁束の波形を示している。またcの波形は、aの波形の磁束変化により点火装置駆動コイルに誘起する無負荷電圧の波形であり、dの波形はbの波形の磁束変化により点火装置駆動コイルに誘起する無負荷電圧波形である。これより、電機子コイルWeに駆動電流を流すと、電機子コイルから生じる磁束の影響を受けて点火装置駆動コイルに鎖交する磁束の量が変化し、点火装置駆動コイルの無負荷誘起電圧が変化することが分かる。

【0083】本発明においては、内燃機関の始動時に点火装置駆動コイルに鎖交する磁束を最大にして該点火装置駆動コイルに誘起する電圧を最大にするように、制御

進み角 γ を設定する。

【0084】図5 (A) ないし (C) はバッテリーBから電機子コイルに駆動電流を流さずに磁石回転子を外力により回転させた場合、及びバッテリーから電機子コイルに駆動電流を流す際の制御進み角 γ を変化させた場合に点火装置駆動コイルWe (低速用コイルWe1及び高速用コイルWe2を直列に接続したもの) に誘起する電圧の波形を実測した結果を示したもので、同図 (A) はバッテリーB側から駆動電流を流さずに磁石回転子を外力により回転駆動した場合に点火装置駆動コイルに誘起する電圧の波形を示している。また図5 (B) は制御進み角 γ を0度として、バッテリーBからスイッチ回路を通して電機子コイルLu~Lwに駆動電流を供給した場合 (図4に実線で示したように、位置検出器により検出された基準励磁相切替位置と励磁相切替位置とを一致させた場合) に点火装置駆動コイルWeに誘起する電圧の波形を示し、図5 (C) は、制御進み角 γ を電気角で48度とした場合に点火装置駆動コイルWeに誘起する電圧の波形を示している。なお実験では回転数を始動時における通常の回転数である200 [rpm]とした。

【0085】この実験から、180度スイッチング制御を行わせる場合、内燃機関の始動時の回転数では、制御進み角 γ を0度としてバッテリーから電機子コイルLu~Lwに駆動電流を流した場合 (各相の電機子コイルが巻回された各歯部の磁極部の中心位置に磁石界磁の磁極の中心位置が一致する位置を各相の電機子コイルに駆動電流を流し始める位置または該駆動電流を遮断する位置として励磁相を切り替えるようにした場合) に、点火装置駆動コイルWeに誘起する電圧が最大になることが明らかになった。

【0086】このように、機関の始動時に電機子コイルに流す駆動電流により電機子コイルから生じる磁束の一部を点火装置駆動コイルが巻かれた歯部に流すことにより該点火装置駆動コイルに鎖交する磁束の量を増加させる増磁効果を生じさせて、点火装置駆動コイルに誘起する電圧を最大にするように制御進み角 (実際の励磁相切替位置と基準励磁相切替位置との位相関係) を設定しておく、機関の始動時に点火装置駆動コイルに誘起する電圧を高くすることができる。従って、内燃機関の始動時に点火装置駆動コイルに誘起する電圧を最大にするように励磁相切替位置と基準励磁相切替位置との関係を設定しておく、機関の始動時に点火装置駆動コイルに誘起する電圧を高くして点火性能を向上させ、機関の始動性を良好にすることができる。

【0087】上記の例では、固定子側に発電機を始動用電動機として動作させる際に用いる電機子コイルとともに点火装置駆動コイルを設けたが、電機子コイルとともに他の単相発電コイルを設けることもできる。例えば、内燃機関に燃料を供給する手段として燃料噴射装置が用

源部に入力される単相交流電圧を出力するインジェクタ駆動コイルを電機子コイルとともに固定子側に設けるようにしてもよい。機関の低速時から高速時までインジェクタを確実に駆動し得るようにするため、インジェクタ駆動コイルも低速用コイルと高速用コイルとにより構成するのが好ましい。

【0088】燃料噴射装置が用いられる場合に、点火装置としてバッテリーを電源としたものが用いられる場合には、図1に示した発電機の低速用コイルWe1及び高速用コイルWe2をそれぞれインジェクタ駆動コイルの低速用コイル及び高速用コイルにより置き換えればよいが、コンデンサ放電式の点火装置と燃料噴射装置との双方が用いられる場合には、点火装置駆動コイルを設けた上で更にインジェクタ駆動コイルを設ける必要がある。

【0089】図6 (A) 及び (B) は、固定子側に点火装置駆動コイルとインジェクタ駆動コイルとを設けた例を示したもので、この例では、電機子鉄心104が、24極の電機子鉄心の極間隔をもって配置された歯部P1~P9及びP10~P18と、歯部P9とP10との間に形成された3極分のスペースに取り付けられた2個の歯部Pi1及びPi2と、歯部P18とP1との間の3極分のスペースに取り付けられた2個の歯部Pe1及びPe2とを有している。

【0090】歯部Pe1及びPe2は図1の例で用いられたものと同様のものであり、これらの歯部には点火装置駆動コイルを構成する低速用コイルWe1及び高速用コイルWe2が巻回されている。

【0091】また歯部Pi1及びPi2は、歯部Pe1及びPe2と対称な位置に設けられていて、これらの歯部Pi1及びPi2には内燃機関用燃料噴射装置のインジェクタの電源部に印加する電圧を発生するインジェクタ駆動コイルを構成する低速用コイルWi1及び高速用コイルWi2が巻回されている。低速用コイルWi1は機関の始動時にインジェクタを駆動するために必要な十分に高い電圧を発生するように多くの巻数をもって巻回され、高速用コイルWi2は機関の高速時に高い電圧を発生するように比較的少ない巻数をもって巻回されている。

【0092】歯部Pe1、Pe2及びPi1、Pi2は図1に示した例と同様に、それぞれの後端部に鳩尾状の突起 (蟻) 105を有していて、それぞれにコイルが巻回された後に、それぞれの後端部の突起が電機子鉄心104の継鉄部に設けられた蟻溝に嵌合されて機関に取り付けられる。

【0093】電機子コイルW1~W9及びW10~W18は3相回路を構成するように星形結線され、低速用コイルWe1及びWe2は、図2 (B) にその一例を示したようにコンデンサ放電式の点火装置に接続される。

【0094】またインジェクタ駆動コイルを構成する低速用コイルWi1及び高速用コイルWi2は燃料噴射装置のインジェクタの電源部に接続される。図7は燃料噴射装

置600の要部の構成例を示したもので、同図において601は駆動コイルLiを有して該駆動コイルLiが励磁されたときに弁を開いて燃料を噴射するインジェクタ、602は駆動コイルLiに流す励磁電流をオンオフするスイッチ回路、603はインジェクタの電源部、604はインジェクタ制御装置、605はインジェクタ制御装置604に電源電圧を与える定電圧電源回路である。

【0095】インジェクタの駆動コイルLiの両端にはフライホイールダイオードD10が接続されている。スイッチ回路602は、エミッタが接地されたNPNトランジスタTR2からなっていて、該トランジスタのコレクタが駆動コイルLiの一端に接続されている。

【0096】電源部603は、ブリッジ接続されたダイオードD11～D16からなる3相全波整流回路603aと、該整流回路の出力電圧を一定値以下に保つように制御する電圧制限回路603bと、整流回路603aの直流出力端子間に接続された平滑用コンデンサC2とを備えている。インジェクタ駆動コイルを構成する低速用コイルWi1及び高速用コイルWi2は、それぞれの一端が共通接続されてその共通接続点が整流回路603aの1つの交流入力端子に接続され、両コイルWi1及びWi2の他端が整流回路603aの他の異なる交流入力端子に接続されている。

【0097】低速用コイルWi1及び高速用コイルWi2のそれぞれの他端と接地間に、カソードを接地側に向けたサイリスタTh1及びTh2が接続され、サイリスタTh1及びTh2のゲートカソード間にはそれぞれコンデンサC3及びC4が接続されている。サイリスタTh1及びTh2のゲートにはそれぞれ抵抗R5及びR6の一端が接続され、抵抗R5及びR6の他端は、カソードが整流回路603aの正極性側の直流出力端子に接続されたツェナーダイオードZD1のアノードに接続されている。サイリスタTh1及びTh2と、コンデンサC3及びC4と、抵抗R5及びR6と、ツェナーダイオードZD1とにより電圧制限回路603bが構成されている。

【0098】この電圧制限回路603bにおいては、コンデンサC2の両端の電圧（電源部603の出力電圧）が設定値を超えてツェナーダイオードZD1が導通したときにサイリスタTh1及びTh2にトリガ信号が与えられてこれらのサイリスタが導通し、サイリスタTh1及びTh2の導通により、駆動コイルWi1及びWi2の出力が整流回路603aに入力されるのが阻止される。これらの動作により、電源部603の出力電圧が設定値以下に制限される。

【0099】図示の電源部603においては、低速用コイルWi1及び高速用コイルWi2のうち、高い電圧を発生している方のコイルから整流回路603aのダイオードを通して電流が流れてコンデンサC2を充電する。即ち、低速用コイルWi1の誘起電圧が高速用コイルWi2の

誘起電圧よりも高くなる機関の低速時には、低速用コイルWi1-ダイオードD13-コンデンサC2-ダイオードD14-低速用コイルWi1の回路または低速用コイルWi1-ダイオードD11-コンデンサC2-ダイオードD16-低速用コイルWi1の回路を通して電流が流れ、低速用コイルWi1よりも高速用コイルWi2の誘起電圧が高くなる機関の高速時には、高速用コイルWi2-ダイオードD11-コンデンサC2-ダイオードD15-高速用コイルWi2の回路または高速用コイルWi2-ダイオードD12-コンデンサC2-ダイオードD14の回路を通して電流が流れてコンデンサC2が図示の極性に充電される。

【0100】電源部603の出力電圧は、インジェクタの駆動コイルLiとスイッチ回路602との直列回路の両端に印加されている。定電圧電源回路605は他の発電コイル、例えば点火装置駆動コイルの半波の出力電圧を入力としてインジェクタ制御装置604の電源端子に印加するのに適した一定の直流電圧を出力するように構成される。

【0101】インジェクタ制御装置604はマイクロコンピュータなどにより構成されていて、燃料噴射開始位置でスイッチ回路602のトランジスタTR2のベースに矩形波状の噴射指令信号Vjを与える。トランジスタTR2は噴射指令信号Vjが与えられている間だけオン状態になってコンデンサC2に蓄積されている電荷をインジェクタの駆動コイルLiを通して放電させることにより該駆動コイルLiに駆動電流を流す。インジェクタ601は、駆動コイルLiに所定のレベル以上の駆動電流が流れたときにその弁を開いて、機関の吸気通路内やシリンダ内（燃焼室内）などの機関の燃料噴射空間（燃料が噴射される空間）に燃料を噴射する。

【0102】バッテリーの出力電圧により燃料噴射装置を駆動するようにした場合には、内燃機関の始動時に始動用電動機を駆動した際に生じるバッテリーの電圧の低下により、燃料噴射装置の動作開始が遅れ、機関の始動性が悪くなるおそれがあるが、上記のように、機関により駆動される発電機にインジェクタ駆動コイルを設けて、該駆動コイルの出力でインジェクタに電源電圧を与えるようにすると、機関の始動操作を開始した直後に該インジェクタ駆動コイルに高い電圧を誘起させて、インジェクタの電源を立ち上げることができ、始動操作開始後燃料噴射装置の噴射動作を遅滞なく開始させて、機関の始動性を良好にすることができる。

【0103】上記のように、固定子側に電機子コイルとともに点火装置駆動コイル及びインジェクタ駆動コイルを設ける場合には、内燃機関の始動時に点火装置駆動コイル及びインジェクタ駆動コイルにそれぞれ誘起する電圧を最大にするように、前記制御進み角 γ （励磁相切替位置と基準励磁相切替位置との関係）を設定するのが好ましい。

【0104】上記の例では、電機子コイルが3相回路を

構成するように結線されているが、本発明は、一般に電機子コイルを n 相(n は2以上の整数)の回路を構成するように結線する場合に適用することができる。電機子コイルを n 相に結線する場合には、電機子鉄心の歯部の数を $n \times m$ とし、磁石回転子の磁石界磁の極数は $2 \times m$ とする。

【0105】上記の例では、インバータ回路200の整流回路部分を構成するためにダイオード $D_u \sim D_w$ 及び $D_x \sim D_z$ を設けているが、これらのダイオードとしては、MOSFETの構造上そのドレインソース間に形成される寄生ダイオードを用いることもできる。

【0106】またインバータ回路200のスイッチ回路を構成するスイッチ素子はMOSFETに限られるものではなく、トランジスタやIGBT(絶縁ゲート型バイポーラトランジスタ)などのオンオフ制御が可能な他のスイッチ素子を用いることもできる。

【0107】図1及び図6に示した例では、磁石回転子の回転角度位置を検出するためにフライホイールのボス部に磁石回転子の磁石界磁と同じように着磁されたリング磁石106を取り付けて、該リング磁石の磁極を位置検出器 $h_u \sim h_w$ により検出することにより、間接的に磁石界磁の磁極の位置を検出するようにしているが、位置検出器 $h_u \sim h_w$ により磁石回転子の磁石界磁の磁極を直接検出するようにしてもよい。

【0108】また磁石回転子が微小角度回転する毎にパルスを発生するロータリエンコーダを発電機に取り付けて、該ロータリエンコーダの出力パルスを計数することにより磁石回転子の回転角度位置(基準励磁相切替位置)を検出するようにしてもよい。

【0109】図6に示した例では、点火装置駆動コイルとインジェクタ駆動用コイルとを180度離れた対称位置に配置しているが、これらのコイルは、バッテリー側から電機子コイルに駆動電流が与えられた際に、電機子コイルから生じる磁束の影響を受けて誘起電圧が増大する効果が得られる位置に配置すればよく、必ずしも対称位置に配置する必要はない。

【0110】上記の例では、点火装置駆動コイル及びインジェクタ駆動コイル(単相発電コイル)のそれぞれが低速用コイルと高速用コイルとからなっているが、これらの駆動コイルを単一のコイルにより構成する場合にも本発明を適用することができる。

【0111】上記の例では、内燃機関用点火装置としてコンデンサ放電式の点火装置を用いる場合を例にとったが、点火コイルの一次コイルを兼ねるように設けられた点火装置駆動コイルを電源とする電流遮断形の点火装置が用いられる場合にも本発明を適用することができる。この種の点火装置では、点火装置駆動コイル(点火コイルの一次コイル)が発生する正負の半サイクルのうちの一方の半サイクルの電圧をトランジスタ等の半導体スイッチを通して短絡することにより該駆動コイルに短絡電

流を流した後該短絡電流を点火位置で遮断することにより該点火装置駆動コイルに電圧を誘起させ、この誘起電圧を点火コイルにより昇圧することによって点火用の高電圧を得るようにしている。

【0112】

【発明の効果】以上のように、本発明によれば、固定子側に始動用電動機及び発電機に兼用する電機子コイルの他に単相発電コイルを設けたので、駆動するために単相交流電圧を必要とする内燃機関用点火装置や燃料噴射装置などの電装品が用いられる内燃機関にも始動用電動機兼用発電機を適用して、従来必要とした始動用電動機を省略し、内燃機関の構造の簡素化を図ることができる利点がある。

【0113】また本発明において、内燃機関の始動時に単相発電コイルに誘起する電圧を最大にするように制御進み角を設定した場合には、単相発電コイルを配置するスペースが制限されているために、該発電コイルの巻数を十分に多くすることができない場合でも、機関の始動時にこれらのコイルに誘起する電圧を高くして、点火装置や燃料噴射装置などの電装品を動作させることができる。従って、磁石発電機を特に大形にしくなくても機関の始動時に点火装置や燃料噴射装置等の電装品を確実に動作させることができる。

【図面の簡単な説明】

【図1】本発明に係わる始動用電動機兼用発電機の構成例を示したもので、(A)は正面図、(B)は(A)のY-Y線断面図である。

【図2】(A)は図1の発電機の電機子コイルに接続される回路の構成例を示した回路図である。(B)は図1の発電機に設けられる点火装置駆動コイルに接続される点火装置の構成例を示した回路図である。

【図3】図2(A)に示したスイッチ制御回路の構成例をインバータ回路の構成とともに示した回路図である。

【図4】図1の発電機の各部の信号波形を示した波形図である。

【図5】図1の発電機の点火装置駆動コイルの誘起電圧を種々の条件に対して示した波形図である。

【図6】本発明に係わる始動用電動機兼用発電機の他の構成例を示したもので、(A)は正面図、(B)は(A)のY-Y線断面図である。

【図7】燃料噴射装置の電氣的構成例を示した回路図である。

【図8】従来の内燃機関始動用電動機兼用発電機と該発電機に接続されるバッテリー充電回路とを示した回路図である。

【図9】(A)は従来の磁石発電機を取り付けた内燃機関の要部の構成を示した断面図、(B)は(A)の要部の左側面図である。

【図10】本発明に係わる発電機において、電機子反作用により点火装置駆動コイルに鎖交する磁束が変化する

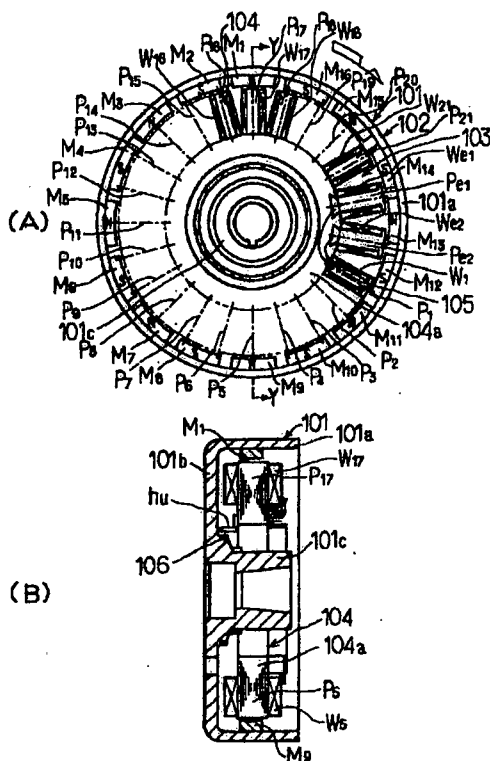
27

様子と、点火装置駆動コイルの誘起電圧が電機子反作用の影響を受けて変化する様子とを模式的に示した波形図である。

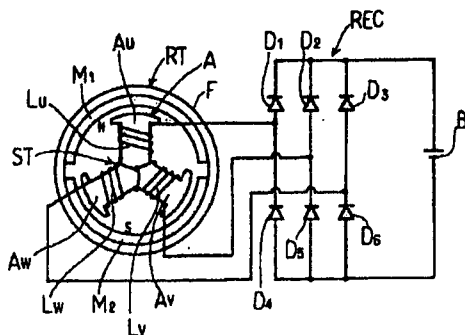
【符号の説明】

101…フライホイール、102…磁石回転子、103…固定子、104…電機子鉄心、106…リング磁石、

【図1】



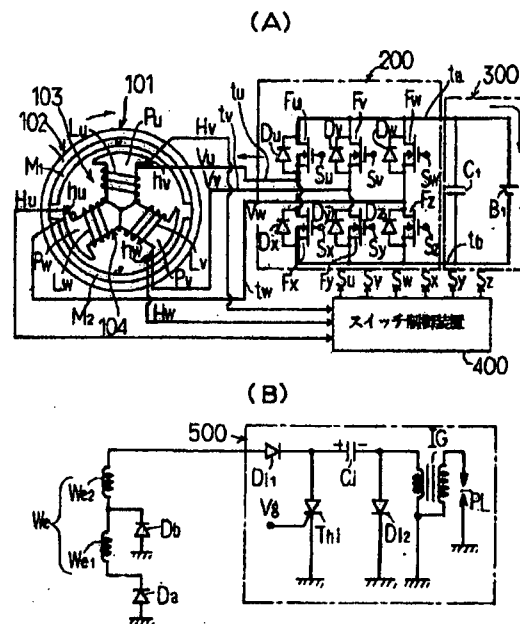
【図8】



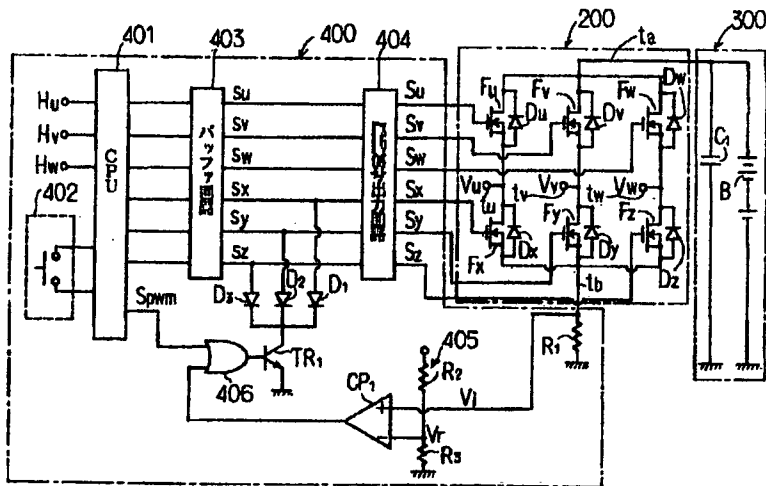
28

P1 ~ P21…電機子鉄心の歯部、M1 ~ M16…永久磁石、W1 ~ W21…電機子コイル、We1及びWe2 …点火装置駆動コイルを構成する低速コイル及び高速コイル、Wi1及びWi2…インジェクタ駆動コイルを構成する低速用コイル及び高速用コイル、hu ~ hw…位置検出器。

【図2】

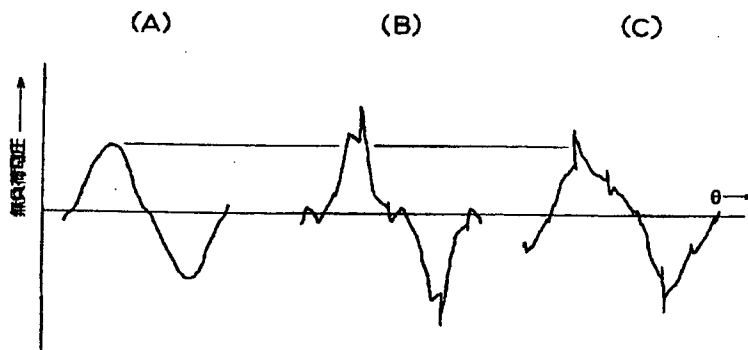


【図3】

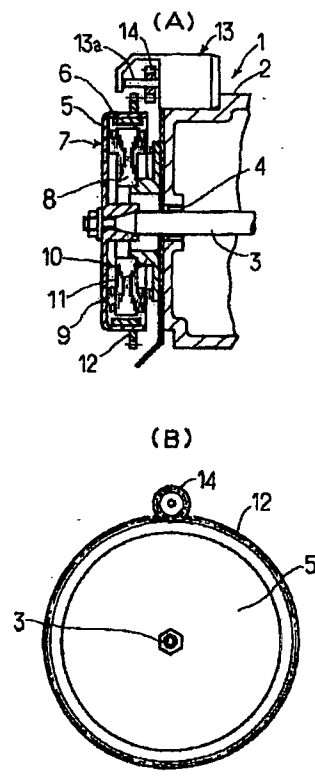
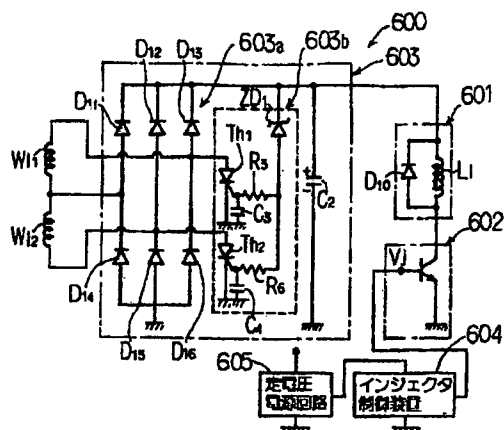


【図5】

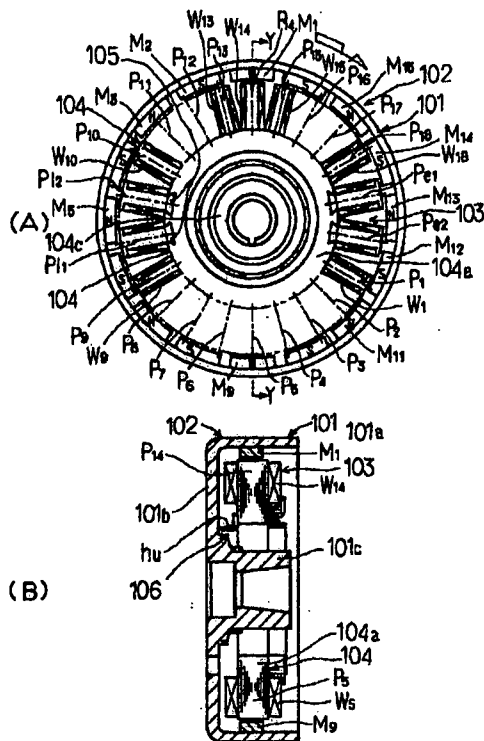
【図9】



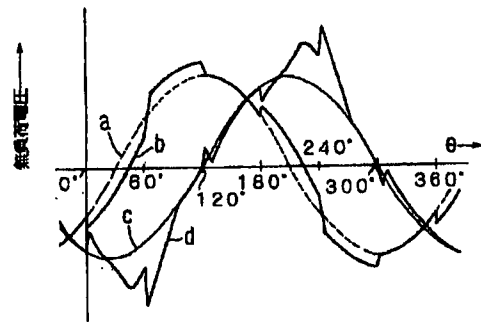
【図7】



【図6】



【図10】



フロントページの続き

Fターム(参考) 5H560 AA10 BB04 BB07 BB12 DA03
EB01 EC02 SS02 UA05 XA05
XA06
5H590 AA03 AA10 CA07 CA23 CB01
CC02 CC05 CC18 CC25 CC31
CD03 CE05 DD25 DD62 EA01
EA10 EB21 FA08 FC14 HA10
HB12 JB06 JB09

Description

CROSS-REFERENCE TO RELATED APPLICATION

The present application is related to and claims priority from Japanese Patent Application No. Hei. 7-98980, incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle power generating system having a vehicle AC power generator, and particularly to a vehicle power generating system capable of controlling the supply of a leading phase current.

2. Description of Related Art

Japanese Patent Laid-Open No. 4-138030 discloses a vehicle power generating system for rectifying a current generated from a vehicle synchronous generator by a three-phase rectifying bridge circuit comprising semiconductor switching devices, each composed of a MOSFET, thereby charging a battery.

According to the above disclosure, the respective MOSFETs, which constitute the three-phase rectifying bridge circuit, are on-off controlled as follows: each of voltages (also called "phase voltages") applied to armature windings for respective phases is first compared with a battery voltage. Next, a high side switch of the phase for generating a potential higher than the battery voltage VB is turned on and a low side switch of the lower potential generating phase of the remaining two phases is turned on, whereby a battery charging current is drawn out.

It is known that output terminals of respective armature windings employed in a normal three-phase AC power generator are electrically connected to one another by leading-phase capacitors to supply leading phase currents to their corresponding armature windings, whereby lags produced in the armature currents are reduced to increase the output of the generator.

However, the vehicle power generating system according to the aforementioned disclosure has problems in terms of output, efficiency, vibrations, etc. Further, the aforementioned leading-phase current supplying system using the conventional leading-phase capacitors has a problem in that since the inductance of the power generator is large, the size of each capacitor is excessively increased due to the need for the increase in capacity of each leading-phase capacitor.

SUMMARY OF THE INVENTION

With the foregoing problems in mind, it is therefore an object of the present invention to provide a vehicle power generating system capable of supplying a lead-

ing phase current while preventing the system from increasing in size and complexity.

To solve the above problem, the present inventors have found that it is particularly advantageous when a switch is brought into conduction only during a predetermined period (also hereinafter called a "phase period") in one cycle or period so that a leading phase current is supplied to its corresponding armature winding, thereby making it possible to improve the state of power generation, e.g., the output, the efficiency, the vibrations, etc. However, the present inventors have also found that the rate of change in output current, i.e., the ripple, is greatly increased in the case of the supply of the leading phase current to its corresponding armature winding during such a specific phase period under the switch control.

It is another object of the present invention to improve the state of power generation by the supply of a leading phase current while suppressing a variation in output current.

The above objects are achieved in a first preferred embodiment of the present invention by providing a vehicle power generating system including an AC power generator having a field winding for generating field magnetic flux and armature windings for producing power-generating outputs and being drivable by an engine, an AC-DC power converting unit for rectifying a voltage outputted from each armature winding and supplying the rectified voltage to an electrical load, a field current control unit for controlling a field current supplied to the field winding, a voltage control unit for controlling the field current control unit to control each of the outputs produced from the AC power generator to a predetermined value, a state-of-power generation detecting unit for detecting a predetermined quantity of state of power generation related to a state of power generation of the AC power generator, a determining unit for determining, based on the detected quantity of state of power generation, whether the supply of a leading phase current to each armature winding is necessary, and a leading-phase current control unit for starting the supply of the leading phase current to each armature winding or increasing the leading phase current when the determining unit determines the leading-phase current supply as being necessary and stopping the supply of the leading phase current thereto or decreasing the leading phase current when the determining unit determines the leading-phase current supply to be unnecessary.

The supply of the leading phase current to each armature winding will mean an increase in the amount of supply of the leading phase current thereto. Further, the stop of the supply of the leading phase current thereto will mean a decrease in the amount of supply of the leading phase current thereto.

Preferably, when the quantity of state of power generation exceeds a predetermined first threshold value in the direction in which the supply of the leading phase current to each armature winding is necessary, the

determining unit determines the supply of the leading phase current to each armature winding as being necessary. In either case, the quantity of state of power generation, which is related to the state of power generation of the power generator and varies according to the supply of the leading phase current to the power generator, is detected. When the passage of the leading phase current through each armature winding is determined as being necessary based on the detected status quantity, the leading phase current is supplied to each armature winding (the increase in the amount of supply of the leading phase current thereto is included). If determined as being unnecessary, then the supply of the leading phase current to each armature winding is stopped (the decrease in the leading phase current is included).

If so, then a change in the state of power generation such as an increase in output or the like due to the above supply can be achieved by supplying the leading phase current to each armature winding when its change is required. When the above change is unnecessary, the supply of the leading phase current thereto can be stopped to suppress a defective condition incident to the supply of the leading phase current thereto, particularly, the rate of change in output current, i.e., an increase in ripple. Namely, when the state of power generation is improved by the supply of the leading phase current to the armature winding while suppressing the change in output current, for example, the quantity of state of power generation is a physical quantity related to the capacity of the battery, and the capacity of the battery can be increased under the leading-phase current control if necessary.

Further, according to the present invention, the increase in ripple can be suppressed when the increase in output is unnecessary. On the other hand, when the increase in output is necessary, the output can be increased by supplying the leading phase current to the corresponding armature winding. Further, the body structure of the system having constant rated power can be reduced in size. Namely, since the leading phase current is supplied to the corresponding armature winding without a leading-phase capacitor, it is unnecessary to provide a large leading-phase capacitor. Therefore, the body structure of the system can be reduced in size. The body of the system can be made even smaller due to the following reasons.

Namely, since an output current greatly increases in a high-rpm region, the rating of the vehicle power generating system is defined based on a body structure for insuring a constant output current value in an idling speed region (low-rpm region) for providing the minimum generated voltage and output current. The leading-phase current supply according to the present invention can determine the following. Since the generated voltage is low in the idling speed region (low-rpm region) in the conventional power generator of non-leading phase system, the proportion of an output current carrying period per period or cycle is small. There-

fore, the effect of extending the output current carrying period by the leading-phase current supply is found to be high in the idling speed region (low-rpm region). Namely, the effect of supplying the leading phase current during a period other than the output current carrying period through a semiconductor switching device to extend the output current carrying period and supplying the leading phase current to increase the output current during the output current carrying period is excellent in the low-rpm region. It is thus apparent that the body structure for obtaining a constant rated current by the supply of the leading phase current to each armature winding can be greatly reduced in size.

The leading-phase current supply and its control will be described below.

The leading phase current mentioned in the present invention shows an armature current that flows in the direction opposite to the direction of an armature voltage. By bringing a switch into conduction only during a predetermined period (also hereinafter called merely a "phase period") in one period of the armature current indicative of alternating current (AC), the corresponding armature winding is energized.

The leading phase current is supplied in the direction of flow into the armature winding during a predetermined period after an output current that flows out from the armature winding has been brought to 0. Further, the leading phase current is supplied in the direction of flow out from the armature winding during a predetermined period after a generated current that flows into the armature winding has been brought to 0. Incidentally, the predetermined period shows a period (phase period) from a first predetermined phase angular position to a second predetermined phase angular position in one period corresponding to an electrical angle of 2π of an antiphase armature current of an arbitrary phase.

When an AC voltage is supplied to the AC-DC power converting unit, a voltage obtained by rectifying the AC voltage becomes a certain value. Therefore, phase periods during which the potential at the high-potential DC power terminal of the AC-DC power converting unit exceeds the armature voltage and a phase period during which the potential at the low-potential DC power terminal of the AC-DC power converting unit falls below the armature voltage inevitably exist. Conventionally, these periods are those during which the armature current is not supplied.

The supply of the leading phase current to each armature winding during the aforementioned phase period unit that the current is supplied to precede or lead in phase the armature voltage during the above armature current non-carrying period that has inevitably occurred in the conventional AC-DC power converting unit (e.g. a three-phase full-wave rectifier). Therefore, field magnetic flux is increased because the leading phase current precedes in phase the armature voltage, thus resulting in an increase in generated voltage (armature voltage) and an increase in output.

A further description will be made of the case where the leading phase current is supplied through a three-phase inverter circuit corresponding to the AC-DC power converting means in the appended claims. The three-phase inverter circuit includes high side switches for respective phases, which connect output terminals for the respective phases and a high-potential DC power terminal, and low side switches for the respective phases, which connect the output terminals for the respective phases and a low-potential DC power terminal.

First, a phase current indicative of an antiphase current flows in the direction of flow into its corresponding armature winding only during the above predetermined time (T_2 shown in FIG. 5, for example).

When the antiphase current is not supplied, a phase voltage is normally a value larger than the voltage (0V in FIG. 1) at the low-potential DC power terminal at a time t_1' when the predetermined time T_2 has elapsed. Thus, when the antiphase current is not supplied, the phase current (antiphase current) does not flow into the armature winding from the low-potential DC power terminal after the time t_1' .

However, when the antiphase current is caused to flow into its corresponding armature winding through the high side switch during the predetermined time T_2 , a counterelectromotive force developed in each armature winding upon turning off the high side switch at the time t_1' is produced in the direction of lowering the potential at the output terminal of the armature winding relative to the corresponding phase, i.e., the phase voltage relative to the corresponding phase. Thus, the phase voltage is reduced by the counterelectromotive force so that the phase voltage V_a becomes lower than the potential at the low-potential DC power terminal. As a result, the antiphase current flows from the low-potential DC power terminal to the armature winding of the corresponding phase through a turned-on low side switch or a low side diode parallel-connected to the low side switch.

In other words, electromagnetic energy is stored in the armature winding by the antiphase current that does not flow upon non-supply of the antiphase current during the predetermined time T_2 and the electromagnetic energy is discharged after the time t_1' . The antiphase current that flows after the time t_1' is actually recovered from the high-potential DC power terminal.

Further, the low side switch is cut off after a predetermined time delay since the time when the current flowing through the low side switch changes from the direction of flow into its corresponding armature winding to the direction of flow out therefrom. In doing so, the capability of power generation can be enhanced owing to the same operations and effects as those described above.

An experimental fact that the rate of change in output current, i.e., a ripple, increases due to the supply of the leading phase current will next be analyzed where the leading phase current is supplied by the three-

phase inverter circuit corresponding to the AC-DC power converting means.

As described above, the leading phase current flows out from the armature winding of the given phase to the low-potential DC power terminal of the AC-DC power converting unit immediately before the current flows out from the output terminal (phase output terminal) of the armature winding of the phase to the outside through the high-potential DC power terminal of the AC-DC power converting unit. When the leading phase current is cut off by a semiconductor switching device (i.e., a low side switch) of the AC-DC power converting unit, an induced voltage ($L di/dt$) is produced in the armature winding so that the leading phase current is intended to abruptly flow out (rise) through a semiconductor switching device (high side switch) of the AC-DC power converting unit, which is turned on at this time. Namely, when the voltage produced in the armature winding is high, the rising edge of the output current that flows from the high side switch to the outside is rendered steep by the leading phase current pre-supplied to its corresponding armature winding. Similarly, when the voltage produced in the armature winding is low, the rising edge of the output current that flows into the corresponding armature winding through the low side switch, is rendered steep by the leading phase current pre-supplied to the armature winding, with the result that the aforementioned ripple is increased by the supply of the leading phase current to the corresponding armature winding.

Also, when the quantity of state of power generation further exceeds a second threshold value exceeding the first threshold value in the direction opposite to the direction in which the supply of the leading phase current to each armature winding is necessary, the determining unit determines the supply of the leading phase current to each armature winding as being unnecessary, and the leading phase current may be supplied when the quantity of state of power generation exceeds the predetermined first threshold value in the direction in which the supply of the leading phase current is necessary. In doing so, the control is simplified because so-called binary control based on the threshold value is executed. In doing so, hunting can be reduced because so-called binary control with hysteresis is executed.

Moreover, it is possible that the quantity of state of power generation includes an electrical status quantity composed of at least one of a battery voltage, a field current, the rate of power generation, a generated voltage, a load voltage, a generated current and a ripple ratio. In this way, the state of power generation of the power generator can be detected and controlled with ease and reliability.

It is possible that the quantity of state of power generation includes a velocity status quantity composed of at least one of the rotational speed of the power generator, the rotational speed of the engine and a vehicle speed. In this way, the state of power generation can be detected and controlled with ease and reliability.

Only when the supply of the leading phase current is determined as necessary from the result of decision based on the velocity status quantity and the supply of the leading phase current is determined as necessary from the result of decision based on the electrical status quantity, the leading phase current may be supplied. Thus, a problem can be avoided that when the state of rotation of the power generator is improper for the supply of the leading phase current, a leading-phase current carrying command is simply issued based on the electrical status quantity alone.

Further, when the rotational speed of the engine is determined as being less than a predetermined rotational speed, the determining unit may determine the engine as being in an idle state based on the quantity of state of power generation and when the engine is determined as being in an idle state, the determining unit determines the supply of the leading phase current to each armature winding as necessary. In this way, the state of power generation of the power generator can be detected and controlled with ease and reliability.

It is possible that only when the supply of the leading phase current is determined as necessary from the result of idle decision and the supply of the leading phase current is determined as necessary from the result of decision based on the electrical status quantity, the leading phase current may be supplied. Thus, the supply of the leading phase current at the time except when the power generator is at idle can be stopped.

Incidentally, the effect of increasing an output by the supply of the leading phase current is particularly excellent at low-rpms such as during idling. This is because since, at low-rpms such as at idling, the proportion of the phase period during which the armature voltage exceeds the potential at the high-potential DC power terminal is reduced within one period and the proportion of the leading-phase current carrying enable period other than the above is increased, and the generated voltage is low and the output (current) is small, the output increasing effect according to the present invention by the supply of the leading phase current is enhanced. Namely, the output increasing effect according to the present invention significantly appears at low-rpms such as at idling, that the generated voltage is raised by the supply of the leading phase current over the above period; particularly, the period prior to the above period, the period during which DC is outputted from an armature winding through the AD-DC power converting unit, is extended and the output current itself is also increased.

Thus, shortages in the output can be avoided by supplying the leading phase current at idle in which the output is originally low. Further, a variation in output current can be reduced at high-rpm in which the output is usually sufficient.

Moreover, it is possible that the system includes a detecting unit for detecting a physical quantity related to the rotational speed of the power generator, and the leading-phase current control unit determines a timing

for supplying the leading phase current to each armature winding according to the rotational speed of the power generator detected based on the physical quantity.

Thus, the AC power generator for outputting DC through the AC-DC power converting unit has, in each phase, a period during which the armature voltage (phase voltage) becomes a potential lower than that at the high-potential DC power terminal of the AC-DC power converting unit and the period during which the armature voltage becomes the potential higher than that at the low-potential DC power terminal thereof and no current is outputted from each armature winding. Owing to the turning on of the switch selected for the need for the leading-phase current control, the leading phase current is caused to flow through the corresponding armature winding during these leading-phase current carrying enable periods. Since the time varies according to the rotational speed during these periods, a problem that the leading phase current is supplied during an unnecessary period can be solved by adjusting the current-carrying periods based on the quantity of state related to the rotational speed.

As an alternative to basing the decision of the current-carrying period on the rotational speed, the maximum value of the current-carrying period may be decided.

Further, it is possible that the leading-phase current control unit starts the supply of the leading phase current to each armature winding in leading-phase current carrying timing in which one of the efficiency and output of the power generator at the time that the rotational speed of the engine is a predetermined value becomes greater than or equal to a predetermined value. In this way, improvements in output and efficiency can be achieved and control can be simplified.

Incidentally, the leading-phase current carrying condition (e.g., the current-carrying timing) for maximizing the effect of improving the output by the supply of the leading phase current differs from the leading-phase current carrying condition for maximizing the effect of enhancing the efficiency by the supply of the leading phase current. The leading-phase current carrying period during which an increase in efficiency becomes highest is normally shorter than the leading-phase current carrying period during which an increase in output is maximized.

Moreover, it is possible that the leading-phase current control unit starts the supply of the leading phase current to each armature winding at a leading-phase current carrying timing in which one of the efficiency and output of the power generator at the time that the rotational speed of the engine is a predetermined idling engine speed (e.g., 500 - 1000 rpm) becomes greater than or equal to the predetermined value.

Further, the leading-phase current control unit may have a high-efficiency power generation mode indicative of a leading-phase current control mode under a leading-phase current carrying condition in which the

efficiency of the power generator becomes greater than or equal to the predetermined value, and a high-output power generation mode indicative of the leading-phase current control mode under a leading-phase current carrying condition in which the output of the power generator becomes greater than or equal to the predetermined value, where the determining unit selects one of both modes based on the quantity of state of power generation when the supply of the leading phase current to each armature winding is determined as being necessary. In this way, high output can be obtained when high output is needed. When high output is unnecessary, high efficiency can be obtained.

As described above, the leading-phase current carrying condition (e.g., the current-carrying timing) for maximizing the effect of improving the output by the supply of the leading phase current is different from the leading-phase current carrying condition for maximizing the effect of enhancing the efficiency by the supply of the leading phase current. In general, the leading-phase current carrying period during which the increase in efficiency is rendered highest is shorter than the leading-phase current carrying period during which the increase in output is brought to the maximum.

It is thus determined based on the quantity of state of power generation whether the output leaves a margin of safety. If it is determined that the output leaves such a margin, then the leading-phase current carrying condition is shifted from the high-output side to the high-efficiency side. If it is determined that the output lacks such a margin, then the leading-phase current carrying condition is shifted from the high-efficiency side to the high-output side. As a result, the aforementioned operations and effects can be achieved.

It is also possible that the quantity of state of power generation includes a battery voltage and the determining unit determines the supply of the leading phase current to each armature winding as being necessary when the battery voltage is lower than a predetermined first voltage value and determines the leading-phase current supply as being unnecessary when the battery voltage is higher than a predetermined second voltage value including the predetermined first voltage value. In this way, the battery voltage can be controlled to a desired level under the leading-phase current control. This can bring about an advantage that the above control can be quickly done owing to the control of the field current. The range of output control can be also increased in combination with the field current control.

The leading-phase current control unit may limit the maximum value of the rate of change in leading phase current so as to gradually change the leading phase current; limit the maximum value of the rate of change in at least one of a leading-phase current carrying period, the phase of the carrying leading-phase current relative to each phase voltage and the average of the leading phase currents supplied to the armature windings thereby to gradually change the leading phase current; or restrict the maximum value of the rate of change in

proportion of a leading-phase current carrying period per predetermined period in which the armature currents are continuous relative to each other thereby to gradually change the leading phase current.

Still further, the leading phase current may be gradually varied, i.e., the leading phase current may be varied at the predetermined maximum rate of increase in current or the predetermined maximum rate of decrease in current or less.

In this way, the load torque of the power generator can be prevented from suddenly increasing according to the supply or non-supply of the leading phase current. Further, a mechanical shock applied to the engine can be reduced and a change and increase in the rotational speed of the engine can be suppressed.

It is possible that the quantity of state of power generation includes a physical quantity related to at least one of an output voltage drop at the time of an increase in the electrical load supplied with power from the power generator and a reduction in the rotational speed of the power generator and that the determining unit determines the gradual change in and supply of the leading phase current as being necessary when at least one of the output voltage drop and the reduction in the rotational speed of the power generator is determined as larger than the other based on the physical quantity. In this way, the leading-phase current carrying control can be rapidly performed without the gradual change when the change in load torque is small.

It is also possible that the quantity of state of power generation includes a physical quantity related to a variation in the rotational speed of the engine, and that the determining unit determines the leading-phase current supply as necessary when the variation is determined as large based on the physical quantity and the leading-phase current control unit suppresses the variation in the rotational speed of the engine under the control for the supply of the leading phase current when the leading-phase current supply is determined as necessary.

Thus, a change in the rotational speed of the engine is suppressed under the leading-phase current control in a physical condition (e.g., at idle) under which the rotational speed of the engine is determined as being high.

Namely, when the rotational speed of the engine is high, the leading phase current is supplied to increase the engine load, whereas when the rotational speed of the engine is low, the supply of the leading phase current is stopped to reduce the engine load. It is therefore possible to easily and quickly suppress the change in the rotational speed.

It is still further possible that the quantity of state of power generation includes a physical quantity related to vibrations created by the engine, that the determining unit determines the leading-phase current supply as being necessary when the vibrations are determined as large based on the physical quantity, and that the leading-phase current control unit suppresses the engine vibrations under the control for the supply of the leading

phase current when the leading-phase current supply is determined as necessary.

Thus, the vibrations created by the engine can be suppressed under the leading-phase current control in a physical condition (e.g., at idle) under which it is determined that the engine greatly vibrates.

Namely, the leading-phase current control is executed in the direction of suppressing the vibrations at a frequency the same as the waveform (whose fundamental frequency in particular) of the engine vibrations. Incidentally, the engine vibrations include rotational vibrations, reciprocating vibrations and vibrations obtained by combining these vibrations. However, any of the vibrations may be controlled.

It is also possible that the quantity of state of power generation includes a physical quantity related to the temperature of a predetermined portion of the power generator, that the determining unit determines based on the physical quantity whether the power generator has a low temperature, and that the leading-phase current control unit stops the supply of the leading phase current to each armature winding and reduces the leading phase current when the power generator is determined to be low in temperature and starts the supply of the leading phase current to each armature winding and increases the leading phase current when the power generator is determined to be in a non-low temperature state.

Thus, when the power generator is low in temperature, the supply of the leading phase current is stopped. Namely, when the power generator is at a low temperature, the resistance of each winding employed in the power generator is low and the output is increased under the same physical conditions as compared with the generator at a high temperature. It is thus possible to prevent the output current from flowing beyond expectations or need and prevent the engine load from becoming heavy.

It is possible that the leading-phase current control unit includes a normal/reverse energization opening/closing circuit having high side switches respectively composed of semiconductor switching devices for individually connecting a high-potential DC power terminal and output terminals of the armature windings for respective phases and low side switches respectively composed of semiconductor switching devices for individually connecting a low-potential DC power terminal set to a potential lower than that at the high-potential DC power terminal and the output terminals of the armature windings, and a controller for controlling the normal/reverse energization opening/closing circuit.

In this way, the leading-phase current control unit can be simply constructed. Particularly, when the normal/reverse energization opening/closing circuit doubles as the AC-DC power converting unit, the circuit configuration can be further simplified.

Also, it is possible that the leading-phase current control unit includes a short-circuiting circuit composed of a plurality of semiconductor switching devices for

short-circuiting between the output terminals of the armature windings for the respective phases and a controller for controlling the opening and closing of each semiconductor switching device. In this way, the leading-phase current control unit can be simply constructed.

It is further possible that the detecting unit for detecting a difference in potential between at least one of the high-potential DC power terminal and the low-potential DC power terminal of the AC-DC power converting unit and the output terminal of each armature winding and at least one of the armature currents is provided and the leading-phase current control unit sets a timing for opening and closing each semiconductor switching device based on at least one of the potential difference and at least one armature current. In this way, it is then unnecessary to provide a turning-angle sensor, i.e., an absolute type rotary encoder. As a result, the system structure can be simplified.

It is possible that each semiconductor switching device incorporates therein a current detection resistive element for detecting the armature current; for example, the current detection resistive element for detecting each armature current may be integrated into an IC chip with the semiconductor switching devices integrated therein to simplify the system structure.

It is also possible that the controller turns off each high side switch after a predetermined period has elapsed since a potential at the output terminal of each armature winding has become less than a potential at the high-potential DC power terminal and turns off each low side switch after a predetermined period has elapsed since the potential at the output terminal of each armature winding has become greater than a potential at the low-potential DC power terminal. Thus, the leading phase current can be cut off at an optimum timing with ease and reliability.

It is further possible that the controller turns on each high side switch after a predetermined period has elapsed since the potential at the output terminal of each armature winding has become greater than the potential at the low-potential DC power terminal and turns on each low side switch after a predetermined period has elapsed since the potential at the output terminal of each armature winding has become less than the potential at the high-potential DC power terminal.

Moreover, it is possible that each low side switch is turned on after the predetermined period has elapsed since the potential at the output terminal of each armature winding has become less than the potential at the high-potential DC power terminal (i.e., after the armature current has been inverted) and each high side switch is turned on after the predetermined period has elapsed since the potential at the output terminal of each armature winding has become greater than the potential at the low-potential DC power terminal (i.e., after the armature current has been reversed). The leading phase current can be supplied in optimum timing with ease and reliability if done in this way.

Particularly, when the high side switch and the low side switch identical in phase to each other are reverse-operated, the armature winding for each phase is always electrically connected to either the high side switch or the low side switch. Thus, a large counterelectromotive force at the time of cutoff of either the high side switch or the low side switch can be prevented from being applied to the corresponding semiconductor switching device as a surge voltage.

It is also possible that the controller turns on the semiconductor switching devices of the short-circuiting circuit for allowing the leading phase current to flow in each armature winding after the potential at the output terminal of each armature winding has become less than the potential at the high-potential DC power terminal, turns on the semiconductor switching devices of the short-circuiting circuit for allowing the leading phase current to flow out from each armature winding after the potential at the output terminal of each armature winding has become greater than the potential at the low-potential DC power terminal and turns off the semiconductor switching devices of the short-circuiting circuit after a predetermined time has elapsed since the turning-on.

Thus, the leading phase current can be turned on and off in optimum timing with ease and reliability.

The system may also include a phase angle detecting unit for detecting a rotational phase angle of a rotor of the AC power generator, where the leading-phase current control unit controls the opening and closing timing of each semiconductor switching device based on the rotational phase angle. In this way, the leading phase current can be turned on and off at an optimum timing with reliability.

Each semiconductor switching device may include a MOSFET. Since the MOSFET is able to provide bidirectional energization, the semiconductor switching device can be constructed of a single element. Since the MOSFET incorporates a pair of parasitic junction diodes between one of the source and drain thereof and a well region in particular, an advantage occurs in that if one of the pair of junction diodes is short-circuited upon application to each high side switch or each low side switch of the normal/reverse energization opening/closing circuit, then an excessive current can be shunted by the other diode.

The MOSFET may include SiC as a material. Since SiC has a high withstand voltage and a low on-resistance, a reduction in loss and an increase in voltage can be achieved.

The above objects are achieved according to another aspect of the invention by providing a vehicle power generating system including an AC power generator having a field winding for generating field magnetic flux and armature windings for producing power-generating outputs and driven by an engine, a field current control unit for controlling a field current supplied to the field winding, a voltage control unit for controlling the field current control unit to control each of the outputs

from the AC power generator to a predetermined value, and a leading-phase current control unit for controlling the supply of a leading phase current to each armature winding, where the leading-phase current control unit limits the maximum value of the rate of change in leading phase current to gradually change the leading phase current.

In this way, it is possible to prevent an abrupt change in load torque of the power generator incident to the supply or non-supply of the leading phase current, reduce a mechanical shock applied to the engine and suppress an increase in variations in the rotational speed of the engine.

The above objects are achieved according to a further aspect of the invention by providing a vehicle power generating system including an AC power generator having a field winding for generating field magnetic flux and armature windings for producing power-generating outputs and driven by an engine, a field current control unit for controlling a field current supplied to the field winding, a voltage control unit for controlling the field current control unit to control each of outputs produced from the AC power generator to a predetermined value, a detecting unit for detecting a physical quantity related to a variation in the rotational speed of the engine, a leading-phase current control unit for controlling the supply of a leading phase current to each armature winding, and a determining unit for determining the magnitude of the variation in the rotational speed of the engine based on the physical quantity, whereby the leading-phase current control unit supplies the leading phase current to each armature winding when the variation is determined to be large.

Thus, a change in the rotational speed of the engine is reduced under the control of the leading phase current. Namely, when the rotational speed of the engine is high, the leading phase current is supplied to increase the engine load. On the other hand, when the rotational speed of the engine is low, the supply of the leading phase current is stopped to lighten the engine load. As a result, the rotational speed of the engine can be easily and quickly prevented from varying.

The above objects are achieved according to still another aspect of the invention by providing a vehicle power generating system including an AC power generator having a field winding for generating field magnetic flux and armature windings for producing power-generating outputs and driven by an engine, a field current control unit for controlling a field current supplied to the field winding, a voltage control unit for controlling the field current control unit to control each of outputs produced from the AC power generator to a predetermined value, a detecting unit for detecting a physical quantity related to vibrations created by the engine, a leading-phase current control unit for controlling the supply of a leading phase current to each armature winding, and a determining unit for determining the magnitude of the engine variations based on the physical quantity, whereby the leading-phase current control unit supplies

the leading phase current to each armature winding when the vibrations are determined as large.

In this way, vibrations created by the engine are reduced under the control of the leading phase current. Namely, the leading phase current is controlled in the direction of suppressing the vibrations at the same frequency as that (particularly, fundamental frequency) of a detected and estimated engine vibrating waveform. Incidentally, the engine vibrations include rotational vibrations, reciprocating vibrations and vibrations obtained by combining them. However, any of them may be controlled.

The above objects are achieved according to yet another aspect of the present invention by providing a vehicle power generating system including an AC power generator having a field winding for generating field magnetic flux and armature windings for producing power-generating outputs and driven by an engine, a field current control unit for controlling a field current supplied to the field winding, a voltage control unit for controlling the field current control unit to control each of outputs produced from the AC power generator to a predetermined value, a detecting unit for detecting a physical quantity related to the temperature of a predetermined portion of the AC power generator, a leading-phase current control unit for controlling the supply of a leading phase current to each armature winding, and a determining unit for determining based on the physical quantity whether the AC power generator is at a low temperature, whereby the leading-phase current control unit stops the supply of the leading phase current to each armature winding and reduces the leading phase current when the AC power generator is determined as low in temperature and starts the supply of the leading phase current to each armature winding and increases the leading phase current when the AC power generator is determined as being at a non-low temperature.

Thus, an output excessively-producing phenomenon at a low temperature is suppressed under the control of the leading phase current in the vehicle power generating system having the AC power generator.

Namely, when the power generator is at a low temperature, the resistance of each winding employed in the power generator is low and the output is increased under the same physical condition as compared with at a high temperature. It is thus possible to prevent the output current from flowing beyond expectations or need due to the stop of the supply of the leading phase current at the low temperature and prevent the engine load from becoming heavy.

The above and other objects, features and advantages of the present invention will become apparent from the following description and the appended claims, taken in conjunction with the accompanying drawings in which preferred embodiments of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments thereof when taken together with the accompanying drawings in which:

FIG. 1 is a circuit diagram for explaining an overall configuration of a system according to the present invention;

FIG. 2 is a single-phase circuit diagram of a three-phase full-wave rectifier 11 shown in FIG. 1;

FIGS. 3A - 3D are timing charts for describing the waveforms of a phase current and a phase voltage and opening/closing timings of MOSFETs 11a and 11d at the time of control of a non-leading phase current by the vehicle power generating system shown in FIG. 1;

FIGS. 4A - 4F are timing charts for describing the waveforms of a phase current and a phase voltage and opening/closing timings of the MOSFETs 11a and 11d at the time of control of a leading phase current by the vehicle power generating system shown in FIG. 1;

FIG. 5 is a flowchart for describing the control operation of a controller 7 shown in FIG. 1 at the time of control of the non-leading phase current;

FIGS. 6 and 7 are a flowchart for describing another control operation of the controller 7 shown in FIG. 1 at the time of the control of the leading phase current;

FIG. 8 is a circuit diagram for explaining a second embodiment of the vehicle power generating system shown in FIG. 1;

FIGS. 9A - 9O are timing charts for describing the relationship between phase angles and the phases of gate signals at the time of control of non-leading phase and leading phase currents by the vehicle power generating system shown in FIG. 8;

FIG. 10 is a circuit diagram for explaining a third embodiment of the vehicle power generating system shown in FIG. 1;

FIG. 11 is a circuit diagram for explaining a fourth embodiment of the vehicle power generating system shown in FIG. 1;

FIGS. 12 and 13 are a flowchart for describing the control operation of a controller shown in FIG. 12 at the time of control of a non-leading phase current;

FIG. 14 is a flowchart for describing the control operation of the first embodiment of a vehicle power generating system of the present invention;

FIG. 15 is a characteristic diagram illustrating the relationship between the delay phase-angle value δ and efficiency and the output all obtained in the first embodiment at the time of control of a leading phase current;

FIG. 16 is a timing chart for describing variations in output current obtained in the first embodiment at

the time of control of the leading and non-leading phase currents;

FIG. 17 is a characteristic diagram showing the relationship between the output current and the rotational speed of a generator both obtained in the first embodiment at the time of control of the leading and non-leading phase currents;

FIG. 18 is a flowchart for describing the control operation of the second embodiment;

FIG. 19 is a flowchart for describing the control operation of the third embodiment;

FIG. 20 is a flowchart for describing the control operation of the fourth embodiment;

FIGS. 21A - 21C are timing charts for explaining effects obtained in the fourth embodiment;

FIG. 22 is a flowchart for describing the control operation of the fourth embodiment;

FIG. 23 is a timing chart for describing effects obtained in a fifth embodiment according to the present invention;

FIG. 24 is a flowchart for describing a modification of the fifth embodiment;

FIG. 25 is a flowchart for describing the control operation of a sixth embodiment according to the present invention;

FIG. 26 is a flowchart for describing the control operation of a seventh embodiment according to the present invention; and

FIG. 27 is a flowchart for describing the control operation of an eighth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

An overall configuration of a vehicle power generating system according to the present invention will hereinafter be described with reference to the block diagram shown in FIG. 1.

As shown in the block diagram of FIG. 1, the vehicle power generating system includes a three-phase synchronous generator (e.g., an AC power generator) 100, a three-phase full-wave rectifier (corresponding to the AC-DC power converting means and normal/reverse energization opening/closing circuit as recited in the appended claims) 11 for rectifying AC current generated by the three-phase synchronous generator 100, and a controller 7. The three-phase full-wave rectifier 11 and the controller 7 constitute a determining means and a leading phase current supplying means as recited in the appended claims.

A current generated in each of armature coils 5a through 5c is rectified by the three-phase full-wave rectifier 11. A field current passing through a field coil 4c is controlled by the controller 7. When the field coil 4c through which the field current is passed is rotated, a three-phase AC voltage is induced in the armature coils 5a through 5c.

The three-phase full-wave rectifier 11 comprises an inverter circuit of a type wherein MOSFETs 11a through 11f each composed of SiC are provided in the form of a three-phase bridge connection. A high-potential DC output terminal of the three-phase full-wave rectifier 11 is electrically connected to a high-potential terminal of a battery 9 and one terminal of an electrical load 10, and a low-potential DC output terminal thereof is electrically grounded together with a low-potential terminal of the battery 9 and the other end of the electrical load 10.

The controller 7 is implemented using a microprocessor and controls the conductivity of a field current by using pulse width modulation (PWM) techniques so that a battery voltage V_B matches a predetermined generated voltage. Further, the controller 7 generates gate voltage signals G_a through G_f based on voltage drop signals P_a through P_f to be described later, which are individually inputted from their corresponding Si-MOSFETs 11a through 11f and applies the produced gate voltage signals G_a through G_f to their corresponding gate electrodes of the Si-MOSFETs 11a through 11f. Incidentally, reference numeral 70 indicates a field temperature detector, which is attached to the generator and generates a temperature signal corresponding to the temperature of a field winding.

An a-phase inverter of the three-phase full-wave rectifier 11 will now be described with reference to FIG. 2.

The Si-MOSFET 11a which serves as a high side switch and the Si-MOSFET 11d which serves as a low side switch are each N-channel type devices and are connected in series with one another. The Si-MOSFET 11a has an N-type region on the armature coil side, which serves as a drain region during power generation, an N-type region on the battery side, which serves as a source region during power generation, and a P-well region provided directly under the gate electrode 114a thereof. A PN junction between these N-type regions and the P-well region forms a parasitic diode.

In the Si-MOSFET 11a serving as the high side switch, the P-well region and the N-type region on the armature coil side are short-circuit connected to one another. Further, the N-type region on the armature coil side and an output terminal of the armature coil 5a are electrically connected to each other through a small resistance used for the detection of a current, such as a small resistance 113a formed on a chip with an insulating film interposed therebetween by patterning a semiconductor or a metallic trace or the like having a predetermined resistivity. Thus, the current can be detected by detecting a voltage drop developed across the low resistor 113a.

In the Si-MOSFET 11d, similarly to the above, a P-well region and an N-type region on the side opposite the armature coil side are short-circuit connected to each other. Further, the N-type region on the side opposite the armature coil side and a ground terminal are electrically connected to each other through a small resistance 113d for the detection of a current. Thus, the

current can be detected by detecting a voltage drop developed across the resistor 113d. The remaining other Si-MOSFETs 11b, 11e, 11c and 11f respectively have resistors similar to the above resistors and include terminals Pb through Pf electrically connected to their corresponding points where N-type regions and the resistors are electrically connected to one another. Incidentally, the parasitic diodes 112a and 112d of the Si-MOSFETs 11a and 11d serve as current paths or channels used for supplying the generated current to the battery 9.

Thus, a current that flows when the Si-MOSFET 11a is turned on can be detected from the difference between a phase voltage Va and a potential applied to a connecting terminal Pa. Similarly, channel currents that flow in the Si-MOSFETs 11b through 11f can be detected.

Incidentally, the respective gate voltages are sufficiently high and each of the Si-MOSFETs 11a through 11f is used in a non-saturation active region (i.e., in an operating mode in which a channel is not pinched off in a depletion layer).

The opening/closing timing of each of the Si-MOSFETs 11a through 11f of the three-phase full-wave rectifier 11 will next be described.

(Where no leading phase current is supplied):

One example of the control for performing the non-supply of the leading phase current will first be described. FIG. 3B is a timing chart of the phase voltage Va developed in the armature coil 5a.

The control of the Si-MOSFET 11d, which serves as the a-phase low side switch, is performed as follows. It is checked whether the phase voltage Va of the armature coil 5a is lower than the ground voltage VE = 0V and other phase voltages Vb and Vc. If the phase voltage Va is found to be lower than these voltages, then the Si-MOSFET 11d is turned on. The turning-off of the Si-MOSFET 11d is carried out at the time when the phase voltage Va has become higher than the ground voltage. The control of opening and closing of each of the Si-MOSFETs 11e and 11f which serve as the low side switches of other phases is performed in the same manner as described above.

One example of a subroutine for executing a non-leading phase mode will be described in accordance with a flowchart shown in FIG. 5. The subroutine shown in the flowchart will be executed while interrupting an unillustrated main routine at regular time intervals.

It is first checked whether a phase voltage Va of an x-phase exceeds the battery voltage VB (Step 200). If the answer is YES, then the high side switch 11a is turned on (Step 202). If the answer is NO, then the high side switch 11a is turned off (Step 204). A check is next made as to whether the phase voltage Va is smaller than 0V corresponding to a potential at the low-potential terminal of the battery (Step 206). If the answer is YES, then the low side switch 11d is turned on (Step 208). If

the answer is NO, then the low side switch 11d is turned off (Step 210).

It is next checked whether a phase voltage Vb of a y-phase exceeds the battery voltage VB (Step 212). If the answer is found to be YES, then the high side switch 11b is turned on (Step 214). If the answer is found to be NO, then the high side switch 11b is turned off (Step 216). A check is next made as to whether the phase voltage Vb is lower than 0V corresponding to the potential at the low-potential terminal of the battery (Step 218). If the answer is found to be YES, then the low side switch 11e is turned on (Step 220). If the answer is found to be NO, then the low side switch 11e is turned off (Step 222).

It is next checked whether a phase voltage Vc of a z-phase exceeds the battery voltage VB (Step 224). If the answer is found to be YES, then the high side switch 11c is turned on (Step 226). If the answer is found to be NO, then the high side switch 11c is turned off (Step 228). A check is next made as to whether the phase voltage Vc is lower than 0V corresponding to the potential at the low-potential terminal of the battery (Step 230). If the answer is found to be YES, then the low side switch 11f is turned on (Step 232). If the answer is found to be NO, then the low side switch 11f is turned off (Step 234). Thereafter, execution returns to the main routine.

(Where the leading phase current is supplied):

One example of control for performing the supply of the leading phase current will now be described. FIG. 4B is a timing chart of the phase voltage Va developed in the armature coil 5a.

In the present embodiment, the turning-on timing of the Si-MOSFET 11a, which serves as the high side switch, is provided at the time when a phase current flowing therein changes from negative to positive, i.e., a time $t_2' (= t_0)$ delayed by $T_4 (= T_2)$ from a time t_2 when a voltage drop Vpsd developed across the low resistor 113d changes from negative to positive. The turning-on timing of each of the other Si-MOSFETs 11b and 11c, which serve as the high side switches, is provided in the same manner as described above. Further, the turning-on timing of the Si-MOSFET 11d, which serves as the low side switch, is provided at the time when a phase current flowing therein changes from positive to negative, i.e., a time t_1' delayed by T_2 from a time t_1 when a voltage drop Vpsa developed across the low resistor 113a changes from positive to negative. The turning-on timing of each of other Si-MOSFETs 11e and 11f, which serve as the low side switches, is provided in the same manner as described above.

On the other hand, the turning-on timing of each of the Si-MOSFETs 11a through 11f is extended up to the timing after a phase period of about 180° from the turning-on timing in the present embodiment. Namely, the Si-MOSFET 11a is turned off simultaneously with or immediately before the turning on of the Si-MOSFET 11d, whereas the Si-MOSFET 11d is turned off simulta-

neously with or immediately before the turning on of the Si-MOSFET 11a.

One example of a subroutine for executing a leading phase control mode will be described in accordance with flowcharts shown in FIGS. 6 and 7.

It is first checked whether a flag F2 for making a decision as to whether the execution of the subroutine is regarded as the first execution or not is 1 (Step 290). If the execution of the subroutine is found to be other than the first execution ($F2 = 1$), then execution jumps to Step 300. If the execution of the subroutine is found to be the first execution ($F2 = 0$), then only the operation for bringing the MOSFETs 11a through 11f into conduction (i.e., turning them on) is performed using the non-leading phase control routine shown in FIG. 5 (Step 292). Further, the flag F2 is set to 1 and execution proceeds to Step 300 (Step 294). Incidentally, the flag F2 will be reset to 0 upon power-up.

It is first checked at Step 300 whether the current or armature current i_x flowing in the low side switch 11d changes from negative to positive, i.e., from the direction in which the current flows into the stator winding 5a to the direction in which the current flows out into the low-potential DC power terminal (0V) during a turning-on period of the low side switch 11d. If the answer is found to be YES, then an internal timer d is started (Step 302). If the answer is found to be NO, it is then checked whether the current or armature current i_x flowing in the high side switch 11a changes from positive to negative, i.e., from the direction in which the current flows out from the stator winding 5a to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5a during a turning-on period of the high side switch 11a (Step 304). If the answer is found to be YES, then an internal timer a is started (Step 306). If the answer is found to be NO, then execution proceeds to Step 308.

It is first checked at Step 308 whether the current or armature current i_y flowing in the low side switch 11e changes from negative to positive i.e., from the direction in which the current flows into the stator winding 5b to the direction in which the current flows out into the low-potential DC power terminal (0V) during a turning-on period of the low side switch 11e. If the answer is found to be YES, then an internal timer e is started (Step 310). If the answer is found to be NO, it is then checked whether the current or armature current i_y flowing in the high side switch 11b changes from positive to negative, i.e., from the direction in which the current flows out from the stator winding 5b to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5b during a turning-on period of the high side switch 11e (Step 312). If the answer is found to be YES, then an internal timer b is started (Step 314). If the answer is found to be NO, then execution proceeds to Step 316.

It is first checked in Step 316 whether the current or armature current i_z flowing in the low side switch 11f changes from negative to positive i.e., from the direction

in which the current flows into the stator winding 5c to the direction in which the current flows out into the low-potential DC power terminal (0V) during a turning-on period of the low side switch 11f. If the answer is found to be YES, then an internal timer f is started (Step 318). If the answer is found to be NO, it is then checked whether the current or armature current i_z flowing in the high side switch 11c changes from positive to negative, i.e., from the direction in which the current flows out from the stator winding 5c to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5c during a turning-on period of the high side switch 11c (Step 320). If the answer is found to be YES, then an internal timer c is started (Step 322). If the answer is found to be NO, then execution proceeds to Step 400.

At Step 400, a check is made as to whether the time measured by timer d is over, i.e., only a predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If it is determined at Step 400 that the time period measured by timer d is not over, then execution proceeds directly to Step 404. If it is determined at Step 400 that the timer d is over, then the low side switch 11d is turned off and the high side switch 11a is turned on. Further, the timer d is reset to 0 and thereafter execution proceeds to Step 404.

It is checked at Step 404 whether the time period measured by timer a is over, i.e., only the predetermined delay time (leading-phase current carrying or energizing time) $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 404, then execution proceeds directly to Step 408. If the answer is found to be YES at Step 404, then the low side switch 11d is turned on and the high side switch 11a is turned off. Further, the timer a is reset to 0 and thereafter execution proceeds to Step 408.

It is checked at Step 408 whether the time period measured by timer e is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 408, then execution proceeds directly to Step 412. If the answer is found to be YES at Step 408, then the low side switch 11e is turned off and the high side switch 11b is turned on. Further, the timer e is reset to 0 and thereafter execution proceeds to Step 412.

It is checked at Step 412 whether the time period measured by timer b is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 412, then execution proceeds directly to Step 416. If the answer is found to be YES at Step 412, then the low side switch 11e is turned on and the high side switch 11b is turned off. Further, the timer b is reset to 0 and thereafter execution proceeds to Step 416.

It is checked at Step 416 whether the time period measured by timer f is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 416, then execution proceeds directly to Step 420. If the answer is found to be YES at

Step 416, then the low side switch 11f is turned off and the high side switch 11c is turned on. Further, the timer f is reset to 0 and thereafter execution proceeds to Step 420.

It is checked at Step 420 whether the time period measured by timer c is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 420, then execution proceeds directly to Step 102. If the answer is found to be YES at Step 420, then the low side switch 11f is turned on and the high side switch 11c is turned off. Further, the timer c is reset to 0 and thereafter execution proceeds to Step 102.

In doing so, the paths or channels through which leading phase components are supplied to their armature coils 5a, 5b and 5c can be formed due to delays at the time of the turning off referred to above, thus resulting in the increase in the field. Even if the Si-MOSFET 11a has reached the time t_1 , for example, the Si-MOSFET 11a is not turned OFF. Therefore, the turning off thereof is delayed by the time interval $\Delta T = T_2 = T_4$. Similarly, the turning off of the Si-MOSFET 11d is also made at the time t_2 delayed by $\Delta T = T_2 = T_4$ from the time t_2 . Thus, the current can be provided to each of the armature coils 5a through 5c. As a result, the current whose phase leads the phase voltage by α (see FIGS. 4A-4F) for producing a field increasing action is supplied to the stator coil 5a. It is now necessary to set the sum of a charging interval or period $T_1 (= T_3)$ and the delay time $\Delta T = T_2 = T_4$ to an electrical angle of 180° or less. Even if the phases are controlled in a state in which the b phase is allowed to lag the a phase by an electrical angle of 120° and the c phase is allowed to lead the a phase by an electrical angle of 120° , the leading phase control over the three phases can be performed.

In the aforementioned control example, each of the switches 11a through 11f is turned on only during an interval of 180° . However, the turning-on period may be less than 180° . Since the period in which both the high side switch and the low side switch are turned off is produced in each phase inverter circuit in this case, the following control may be performed.

A description will be made of the a phase, for example. If the phase voltage V_a of the stator winding 5a relative to the a phase becomes higher than the battery voltage V_B during the period in which the high side switch 11a and the low side switch 11d are being turned off, then the high side switch 11a is turned on. On the other hand, the turning off of the turned-on high side switch 11a may be performed after the predetermined delay time ΔT has elapsed since the phase voltage V_a has become lower than the battery voltage V_B in the same manner as described above.

Similarly, if the phase voltage V_a becomes lower than the ground potential during the period in which the high side switch 11a and the low side switch 11d are being turned off, then the low side switch 11d is turned on. On the other hand, the turning off of the turned-on

low side switch 11d may be carried out after the predetermined delay time ΔT has elapsed since the phase voltage V_a has become lower than the ground voltage 0V in the same manner as described above. The control on the b and c phases is also performed in the same manner as described above. Incidentally, the aforementioned device opening/closing control is made to the a phase alone. The control of the b and c phases over the switches 11b, 11c, 11e and 11f may be performed with the a-phase switching timing shifted by 120° .

FIG. 8 is a block circuit diagram of a vehicle AC power generator illustrating a modification 1 of the embodiment shown in FIG. 1. The present block circuit diagram showing the vehicle AC power generator is the same as the block circuit diagram of FIG. 1 except that the present vehicle AC power generator includes a magnetic pole position detector (corresponding to a phase angle detecting means in the appended claims) 16 for detecting the position of each magnetic pole of a rotor and a small resistive element r used for the detection of a field current. Incidentally, the resistive element r is electrically series-connected to a field coil 4c. A controller 7 detects the field current from a voltage drop developed across the resistive element r and reads engine information from an ECU 2 for controlling an engine 1. In the present embodiment, MOSFETs 17a through 17f of a three-phase full-wave rectifier 11 are different from the MOSFETs 11a through 11f in that they do not have such resistors for current detection.

The control for opening and closing the MOSFETs 17a through 17f constructed in the above-described manner will next be described below with reference to timing charts shown in FIGS. 9A-9O.

In the present embodiment, the position of each magnetic pole of the rotor is detected by the magnetic pole position detector 16. The magnetic pole position detector 16 is composed of an absolute position-type rotary encoder. Further, the magnetic pole position detector 16 outputs a reference pulse signal at a reference angular position and outputs a pulse signal at each predetermined incremental angle. The controller 7 counts a pulse signal from the read reference pulse signal and outputs phase angle signals S_a , S_b and S_c to control the MOSFETs 17a through 17f. The controller 7 outputs a high level at a phase angle δ_1 at which a phase voltage V_a corresponding to an output voltage from an armature coil (armature winding) 5a of an X phase changes from negative to positive and outputs a low level at a phase angle δ_2 at which the phase voltage V_a changes from positive to negative. Further, the controller 7 outputs a high level at a phase angle δ_3 at which a phase voltage V_b corresponding to an output voltage from an armature coil (armature winding) 5b of a Y phase changes from negative to positive and outputs a low level at a phase angle δ_4 at which the phase voltage V_b changes from positive to negative. Furthermore, the controller 7 outputs a high level at a phase angle δ_5 at which a phase voltage V_c corresponding to an output voltage from an armature coil (armature wind-

ing) 5c of a Z phase and outputs a low level at a phase angle $\delta 6$ at which the phase voltage V_c changes from positive to negative.

Since a non-leading phase control mode itself can be set equal to that shown in FIG. 5, a leading phase control mode will be described below. The leading phase control mode made under the present embodiment is as follows. As shown in FIGS. 9A-9O, the MOSFET 17a and the MOSFET 17d are respectively turned on and off at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 1$ by a phase angle equivalent to a predetermined delay or lag angle δ . The MOSFET 17a and the MOSFET 17d are respectively turned off and on at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 2$ by the phase angle equivalent to the predetermined lag angle δ . The MOSFET 17b and the MOSFET 17e are respectively turned on and off at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 3$ by the phase angle equivalent to the predetermined lag angle δ . The MOSFET 17b and the MOSFET 17e are respectively turned off and on at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 4$ by the phase angle equivalent to the predetermined lag angle δ . The MOSFET 17c and the MOSFET 17f are respectively turned on and off at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 5$ by the phase angle equivalent to the predetermined lag angle δ . Further, the MOSFET 17c and the MOSFET 17f are respectively turned off and on at the time when the phase angle for the leading phase control lags behind the phase angle $\delta 6$ by the phase angle equivalent to the predetermined lag angle δ .

The same leading phase control as that shown in FIG. 1 can be achieved if the above construction is made. A method of setting a leading-phase current carrying or energizing time comprised of the delay time ΔT employed in the vehicle power generating system shown in FIG. 1 and the lag angle δ employed in the vehicle AC power generator shown in FIG. 8 will be described in greater detail below.

A power generating system illustrating a second embodiment of the present invention will now be described with reference to FIG. 10. The power generating system shown in FIG. 10 is one of a type wherein the MOSFETs 11a through 11f of the three-phase full-wave rectifier 11 shown in FIG. 1 are respectively replaced by MOSFETs 17a through 17f excluding small resistive elements for current detection in a manner similar to FIG. 2.

Since the non-leading phase control itself can adopt the control mode shown in FIG. 5, a leading-phase current control mode of the second embodiment will be described below with reference to the flowcharts shown in FIGS. 6 and 7. The present modification is different from the embodiment shown in FIG. 1 in that the opening/closing timing of each of the MOSFETs 17a through 17f is decided based on the difference in poten-

tial between the source and drain of each of the MOSFETs 17a through 17f. FIG. 6 shows a routine for making a decision about a zero-crossing point of each armature current, and FIG. 7 shows a routine for controlling the opening/closing of each of the MOSFETs 17a through 17f. The present embodiment is different from the first embodiment in which the zero-crossing point is detected based on the voltage drop developed across each resistor, only in that the zero-crossing point of each armature current is determined based on the difference in potential between the source and drain of each of the MOSFETs 17a through 17f.

It is first checked whether a flag F2 for making a decision as to whether the execution of the routine is the first execution or not is 1 (Step 290). If the execution of the routine is found to be other than the first execution ($F2 = 1$), then execution jumps to Step 300. If the execution of the routine is found to be the first execution ($F2 = 0$), then only the operation for bringing the MOSFETs 17a through 17f into conduction (i.e., turning them on) is performed using the routine shown in FIG. 8 (Step 292). Further, the flag F2 is set to 1 and execution proceeds to Step 300 (Step 294). Incidentally, the flag F2 will be reset to 0 upon power-up.

It is first checked at Step 300 whether the current or armature current i_x flowing in the low side switch 17d changes from negative to positive, i.e., from the direction in which the current flows into the stator winding 5a to the direction in which the current flows out into the low-potential DC power terminal (0V), depending on whether V_a has become greater than or equal to 0V during a turning-on period of the low side switch 17d. If the answer is found to be YES at Step 300, then the internal timer d is started (Step 302). If the answer is found to be NO at Step 300, it is then checked whether the current or armature current i_x flowing in the high side switch 17a changes from positive to negative, i.e., from the direction in which the current flows out from the stator winding 5a to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5a, depending on whether V_a has become smaller than or equal to V_b during a turning-on period of the high side switch 17a (Step 304). If the answer is found to be YES at Step 304, then the internal timer a is started (Step 306). If the answer is found to be NO at Step 304, then execution proceeds to Step 308.

It is first checked at Step 308 whether the current or armature current i_y flowing in the low side switch 17e changes from negative to positive, i.e., from the direction in which the current flows into the stator winding 5b to the direction in which the current flows out into the low-potential DC power terminal (0V), depending on whether V_b has become greater than or equal to 0V during a turning-on period of the low side switch 17e. If the answer is found to be YES at Step 308, then the internal timer e is started (Step 310). If the answer is found to be NO at Step 308, it is then checked whether the current or armature current i_y flowing in the high side switch 17b changes from positive to negative, i.e.,

from the direction in which the current flows out from the stator winding 5b to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5b, depending on whether Vb has become less than or equal to VB during a turning-on period of the high side switch 17b (Step 312). If the answer is found to be YES at Step 312, then the internal timer b is started (Step 314). If the answer is found to be NO at Step 312, then execution proceeds to Step 316.

It is first checked at Step 316 whether the current or armature current i_z flowing in the low side switch 17f changes from negative to positive, i.e., from the direction in which the current flows into the stator winding 5c to the direction in which the current flows out into the low-potential DC power terminal (0V), depending on whether Vc has become greater than or equal to 0V during a turning-on period of the low side switch 17f. If the answer is found to be YES at Step 316, then the internal timer f is started (Step 318). If the answer is found to be NO at Step 316, it is then checked whether the current or armature current i_z flowing in the high side switch 17c changes from positive to negative, i.e., from the direction in which the current flows out from the stator winding 5c to the high-potential DC power terminal to the direction in which the current flows into the stator winding 5c, depending on whether Vc has become less than or equal to VB during a turning-on period of the high side switch 17c (Step 320). If the answer is found to be YES at Step 316, then the internal timer c is started (Step 322). If the answer is found to be NO at Step 316, then execution proceeds to Step 400.

At Step 400, a check is made as to whether the time period measured by timer d is over, i.e., only a predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If it is determined at Step 400 that the time period measured by timer d is not over, then execution proceeds directly to Step 404. If it is determined at Step 400 that the time period measured by timer d is over, then the low side switch 17d is turned off and the high side switch 17a is turned on. Further, the timer d is reset to 0 and thereafter execution proceeds to Step 404.

It is checked at Step 404 whether the time period measured by timer a is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 404, then execution proceeds directly to Step 408. If the answer is found to be YES at Step 404, then the low side switch 17d is turned on and the high side switch 17a is turned off. Further, the timer a is reset to 0 and thereafter execution proceeds to Step 408.

It is checked at Step 408 whether the time period measured by timer e is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 408, then execution proceeds directly to Step 412. If the answer is found to be YES at Step 408, then the low side switch 17e is turned off and the high side switch 17b is turned on. Further, the timer e is reset to 0 and thereafter execution proceeds to Step 412.

It is checked at Step 412 whether the time period measured by timer b is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 412, then execution proceeds directly to Step 416. If the answer is found to be YES at Step 412, then the low side switch 17e is turned on and the high side switch 17b is turned off. Further, the timer b is reset to 0 and thereafter execution proceeds to Step 416.

It is checked at Step 416 whether the time period measured by timer f is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 416, then execution proceeds directly to Step 420. If the answer is found to be YES at Step 416, then the low side switch 17f is turned off and the high side switch 17c is turned on. Further, the timer f is reset to 0 and thereafter execution proceeds to Step 420.

It is checked at Step 420 whether the time period measured by timer c is over, i.e., only the predetermined delay time $\Delta T = T_2 = T_4$ has elapsed. If the answer is found to be NO at Step 420, then execution proceeds directly to Step 102. If the answer is found to be YES at Step 420, then the low side switch 17f is turned on and the high side switch 17c is turned off. Further, the timer c is reset to 0 and thereafter execution returns to the main routine.

A third embodiment of the present invention will now be described with reference to FIG. 11.

The vehicle power generating system according to the third embodiment comprises a vehicle three-phase synchronous generator (corresponding to an alternator in the appended claims) 100 having Lundell-Rice type field poles, a three-phase full-wave rectifier (corresponding to an AC-DC power converting means in the appended claims) 3 for rectifying an AC current generated from the vehicle three-phase synchronous generator 100, a short-circuiting circuit 4, a controller 7a for controlling the short-circuiting circuit 4 and a regulator 8 for the control of a field current. The short-circuiting circuit 4 and the controller 7a constitute a leading-phase current control means in the appended claims.

The three-phase synchronous generator 100 includes three-phase armature windings 5a, 5b and 5c each wound on a stator core and a field winding 4c wound on a rotor core. The three-phase synchronous generator 100 is a so-called alternator driven by an engine. As is well known, three-phase AC voltages Va, Vb and Vc are respectively induced in the armature windings 5a, 5b and 5c by supplying a necessary field current from the regulator 8 to the field winding 4c and rotating the rotor core by the engine.

The controller 7a has a microprocessor incorporated therein. The controller 7a serves as a circuit for controlling respective short-circuit switches 41 through 43 of the short-circuiting circuit 4 based on output voltages (phase voltages) from the armature windings 5a, 5b and 5c and supplying a predetermined amount of

leading phase current to each of the armature windings 5a, 5b and 5c at a predetermined timing.

The regulator 8 has a conductivity or conduction-rate determining circuit 81 for comparing the battery voltage VB with a predetermined reference voltage to keep the battery voltage VB constant, determining the conductivity of a field current If from the result of comparison and controlling a switching transistor 82 based on the determined conductivity. The switching transistor 82 intermittently controls the field current supplied to the field winding 4c.

The three-phase full-wave rectifier 3 is a conventional one. Further, the three-phase full-wave rectifier 3 rectifies the output generated from the vehicle three-phase synchronous generator 100 and supplies the rectified output to the battery 9 and an electrical load 10.

The short-circuiting circuit 4 comprises the short-circuit switches 41 through 43 each composed of a power MOSFET made up of SiC, which are provided in the form of a delta connection (or star connection). Points where the short-circuit switches 41 through 43 are respectively connected to one another are electrically connected to their corresponding output terminals of the armature windings 5a, 5b and 5c.

Since the phase voltages Va through Vc may be rectified by the three-phase full-wave rectifier 3 without bringing the short-circuit switches 41 through 43 into conduction, non-leading phase control of the third embodiment will not be described in detail. In the present embodiment, the phase voltage Va will lead the phase voltage Vb by 120° and the phase voltage Vb will lead the phase voltage Vc by 120°. For simplicity of illustration, forward voltage drops developed across diodes 31 through 36 of the three-phase full-wave rectifier 3 will be neglected.

The leading-phase current control of the third embodiment will be described below with reference to flowcharts shown in FIGS. 12 and 13. A subroutine shown in FIGS. 12 and 13 is an interrupt routine preferably executed periodically at a predetermined time interval.

It is first checked whether a flag F for instructing the execution of the short-circuit control is 1 (Step 500). If the flag F is found to be 0 at Step 500, execution returns to a main routine (not shown) as the presence of the instruction for the execution of the short-circuit control. If the flag F is found to be 1 at Step 500, then execution proceeds to Step 501.

At Step 501, the phase voltages Va through Vc are read. A check is next made as to whether the read phase voltage Va is less than the battery voltage VB (Step 502). If the answer is found to be NO at Step 502, then execution proceeds to Step 503. If the answer is found to be YES at Step 502, then execution proceeds to Step 512. It is checked at Step 503 whether the phase voltage Va is greater than a ground voltage VE (= 0V). If the answer is found to be NO at Step 503, then execution proceeds to Step 504. If the answer is found to be YES at Step 503, then execution proceeds to Step

512. At Step 512, a timer a for setting a conduction time of the short-circuit switch 41 is started to immediately turn on the short-circuit switch 41 (Step 514). Thereafter, execution proceeds to Step 600.

It is checked at Step 504 whether the phase voltage Vb is smaller than the battery voltage VB. If the answer is found to be NO at Step 504, then execution proceeds to Step 506. If the answer is found to be YES at Step 504, then execution proceeds to Step 516. It is next checked at Step 506 whether the phase voltage Vb is greater than the ground voltage VE (= 0V). If the answer is found to be NO at Step 506, then execution proceeds to Step 508. If the answer is found to be YES at Step 506, then execution proceeds to Step 516. At Step 516, a timer b for setting a conduction time of the short-circuit switch 42 is started to immediately turn on the short-circuit switch 42 (Step 518). Thereafter, execution proceeds to Step 600.

It is checked at Step 508 whether the phase voltage Vc is smaller than the battery voltage VB. If the answer is found to be NO at Step 508, then execution proceeds to Step 510. If the answer is found to be YES at Step 508, then execution proceeds to Step 520. It is next checked at Step 510 whether the phase voltage Vc is greater than the ground voltage VE (= 0). If the answer is found to be NO at Step 510, then execution proceeds to Step 600. If the answer is found to be YES at Step 510, then execution proceeds to Step 520. At Step 520, a timer c for setting a conduction time of the short-circuit switch 43 is started to immediately turn on the short-circuit switch 43 (Step 522). Thereafter, execution proceeds to Step 600.

Incidentally, the reason why execution jumps over to Step 600 immediately after completion of Steps 514 and 518 is that the routine shown in FIGS. 12 and 13 is regularly and frequently executed and the short-circuit switches 41 through 43 are not turned on together due to the differences in phase between the short-circuit switches 41 through 43 within a one routine cyclic time. Further, a predetermined delay time ΔT calculated or preset by an embodiment to be described later will be set in each of the timers a, b and c.

It is checked at the following Step 600 whether a time measured by the timer a has reached the delay time ΔT set in the timer a. If the answer is found to be NO at Step 600, then execution proceeds to Step 604. If the answer is found to be YES at Step 600, then the short-circuit switch 41 is turned off and the timer a is reset (Step 602). Thereafter, execution proceeds to Step 604.

It is checked at the following Step 604 whether a time measured by the timer b has reached the delay time ΔT set in the timer b. If the answer is found to be NO at Step 604, then execution proceeds to Step 608. If the answer is found to be YES at Step 604, then the short-circuit switch 42 is turned off and the timer b is reset (Step 606). Thereafter, execution proceeds to Step 604.

It is next checked at Step 608 whether a tee measured by the timer c has reached the delay time ΔT set in the timer c. If the answer is found to be NO at Step 608, then execution returns to the main routine (not shown). If the answer is found to be YES at Step 608, then the short-circuit switch 43 is turned off and the timer c is reset (Step 610). Thereafter, execution returns to the main routine.

If the discharged or outflow currents are brought to zero, then the leading phase currents (short-circuit currents) flow into their corresponding armature windings 5a, 5b and 5c through the short-circuit switches 41 through 43 due to the above operation, whereas if the inflow currents are brought to zero, then the leading phase currents (short-circuit currents) flow out through the short-circuit switches 41 through 43, whereby the supply of the leading phase currents can be achieved.

An electromagnetic phenomenon produced by the conduction control of the short-circuit switch 41 will now be described below with reference to FIGS. 4A-4F.

In the third embodiment, the passage of the short-circuit current through its corresponding armature winding is started at a time t_1 and completed at a time (hereinafter called " t_1' ") when a short-circuit time is brought to an end. When no short-circuit current is supplied, the phase voltage V_a is normally smaller than V_B but has a value greater than a voltage (0V) at a low-potential DC power terminal. When the short-circuit current is not supplied, the phase current V_a does not flow in the stator winding 5a from the low-potential DC power terminal after the elapse of the time t_1' . However, when the short-circuit phase current is caused to flow in the stator winding 5a of the stator windings during a period from the time t_1 to the time t_1' , a counterelectromotive force developed in the stator winding 5a upon the turning off of the short-circuit switch 41 at the time t_1' is produced in the direction of reducing the potential or the phase voltage V_a at an output terminal of the stator winding 5a. Therefore, the phase voltage V_a is reduced by the produced counterelectromotive force and hence the phase voltage V_a becomes lower than the potential (0V) at the low-potential DC power terminal. As a result, the current is able to flow from the low-potential DC power terminal to the stator winding 5a through the diode 34.

In other words, it is considered that electromagnetic energy is stored in the stator winding 5a owing to the passage of the short-circuit current through the stator winding 5a and the electromagnetic energy is released after the time t_1' . The current that flows subsequent to the time t_1' is recovered by a battery 9 through a high-potential DC power terminal. For similar reasons, it is considered that when the short-circuit current flows out from the stator winding 5a during a period from a time t_2 to a time t_2' , electromagnetic energy is stored in the stator winding 5a owing to the passage of the short-circuit current therethrough and the electromagnetic energy is released after the time t_2' . The current that flows subsequent to the time t_2' is recovered by the battery 9 through the high-potential DC power terminal.

The third embodiment can bring about an excellent advantageous effect in that since the phase current is supplied to each of the short-circuit switches 41 through 43 referred to above, the battery 9 is not discharged even in the event that these switches are brought into cut-off disable states, whereby safety is ensured.

A fourth embodiment of the present invention in which the above-described passage of the phase current through each stator winding is applied to the control of operation of the vehicle power generating system will be described below. However, a mode using the turning-angle sensor (i.e., an absolute position-type rotary encoder) 16 shown in FIG. 7 will be described as the leading-phase current control mode by way of example for simplicity of illustration. It is, however, needless to say that other modes referred to above may be adopted.

The fourth embodiment of the present invention, which performs the leading-phase current control based on the rate of generation of power by the power generator 100, will be described with reference to a flowchart shown in FIG. 14 as one example for describing the state of generation of power by the power generator 100.

The controller 7 first waits until the rate of generation of power by the power generator 100 is greater than or equal to a predetermined threshold value A (e.g., 100%) (Step 1000). Then, it is then determined that a heavy-load state or power insufficient state has occurred. Further, the rotational speed is detected from a turning-angle signal detected by the turning-angle sensor 16 shown in FIG. 8 (Step 1010). In the present embodiment, the rate of power generation will be defined as a conduction rate or conductivity of a control voltage applied to a base electrode of a switching transistor (not shown) which is incorporated in the controller 7 shown in FIG. 8 and controls the field current supplied to the field winding 4c. The conduction rate is assumed to be achieved by the controller 7 under the known control of the switching transistor so that the battery voltage V_B coincides or matches with a predetermined target voltage.

At the next Step 1020, a lag angular value δa indicative of the maximum efficiency at the detected rotational speed n is read from a map stored in a memory (not shown) included in the controller 7 and in which the relationship between n and δa has been stored in advance. The read lag angular value δa is stored in a register (not shown) of a CPU (not shown) in the controller 7. As indicated by the timing charts of FIGS. 9A-9O, although not shown in a flowchart, the controller 7 executes a subroutine for opening and closing each of the MOSFETs 17a through 17f at a timing in which the phase angles for the leading phase control respectively lag the phase angles s_1 through s_6 by the lag angular value δa , at regular time intervals or at regular angles independent of the main routine shown in FIG. 14. Incidentally, the relationship between the lag angular value δa at which the power generator 100 can produce the maximum efficiency when the rate of power generation

is greater than or equal to A and the rotational speed n is measured in advance and stored in the memory.

It is next checked whether a predetermined time has elapsed since the time when the passage of the leading phase current through the armature winding has started at the lag angular value δa for providing the maximum efficiency of the power generator 100 (Step 1025). If the answer is found to be NO at Step 1025, then execution returns to Step 1010. If the answer is found to be YES at Step 1025, it is then checked whether the rate of power generation is greater than or equal to A in order to check whether the capacity of the battery 9 is in a recovered state according to the passage of the leading phase current therethrough at the maximum efficiency, i.e., the power shortage has been resolved (Step 1030). If the rate of power generation is found to be less than A, it is then determined that the battery 9 is being charged due to the passage of the leading phase current therethrough at maximum efficiency and hence the power shortage is being resolved. Thereafter, execution proceeds to Step 1040. If the rate of power generation still remains greater than or equal to A, it is then determined that the passage of the leading phase current therethrough under the condition of the maximum efficiency does not resolve the power shortage. Thus, the rotational speed n is detected again (Step 1060). A lag angular value δb for providing the maximum output of the power generator 100 at the detected rotational speed n is read from the map stored in the memory (not shown) included in the controller 7 and in which the relationship between n and s has been stored in advance. The read lag angular value δb is stored in the register (not shown) of the CPU (not shown) in the controller 7. The controller 7 executes the subroutine for opening and closing each of the MOSFETs 17a through 17f at a timing at which the phase angles for the leading phase control respectively lag the phase angles s1 through s6 by the lag angular value δb , at regular time intervals or at regular angles independent of the main routine shown in FIG. 14. Incidentally, the relationship between the lag angular value δb at which the power generator 100 can produce the maximum efficiency when the rate of power generation is greater than or equal to A and the rotational speed n is measured in advance and stored in the memory.

If the rate of power generation is found to be less than A at Step 1030, it is determined whether the rate of power generation is smaller than or equal to a second threshold value B (e.g., 50%) (Step 1040). If the answer is found to be NO at Step 1040, then execution returns to Step 1010. If the answer is found to be YES at Step 1040, it is determined that it is unnecessary to pass the leading phase current through the armature winding and a command for executing the control of setting the lag angular value δ to 0, i.e., the non-leading phase current control (see FIG. 5) under interrupt control is issued (Step 1050).

Thus, when the amount of power to be generated is slightly low according to the rate of power generation

indicative of a status quantity of power generation, the leading phase current can be controlled in a mode in which the power generator 100 generates power with high efficiency. When the amount of power to be generated still is low, the non-leading-phase current control can be executed in a high-output power generation mode.

As shown in FIG. 15, the amount of leading phase current (lag angular value δa in the present embodiment) corresponding to the maximum efficiency, which is obtained at an arbitrary rotational speed, is commonly smaller than the amount of leading phase current (lag angular value δb in the present embodiment) corresponding to the maximum output.

The aforementioned embodiment shows the case where the rate of power generation has been adopted as the quantity of state of power generation indicative of the state of power generation. However, other electrical quantities of states such as a field current, a battery voltage, a generated voltage, a load voltage, a generated current, a ripple ratio, etc. may be used as an alternative to the above. Namely, if the field current and the generated current exceed a first threshold value in their increasing directions, then the state of power shortage or the state of need for an increase in power generated can be determined. If the battery voltage, the generated voltage and the load voltage exceed the first threshold value in their decreasing directions, then the state of power shortage or the state of need for the increase in power generated can be determined. If the ripple ratio, i.e., the rate of change in the output current or output voltage of the power generator 100, exceeds the first threshold value in its increasing direction, then the state of power shortage or the state of need for the increase in power generated can be determined.

Further, if the field current and the generated current exceed a second threshold value smaller than the first threshold value in their decreasing directions, then the state of power shortage is resolved and the passage of leading phase current through the armature winding is allowed to stop without hunting. If the battery voltage, the generated voltage and the load voltage exceed a second threshold value larger than the first threshold value in their increasing directions, it is then possible to resolve the state of power shortage and stop the passage of leading phase current therethrough without hunting. If the ripple ratio, i.e., the change in output current or output voltage of the power generator 100 exceeds the second threshold value which is smaller than the first threshold value in its decreasing direction, it is then possible to resolve the state of high ripple and stop the passage of leading phase current therethrough without hunting.

Velocity status quantities related to the rotational speed of the power generator 100 such as the rotational speed of the power generator 100 or the engine 1, a vehicle speed, etc., which are used in place of the electrical status quantities described above, may be used as the quantity of state of power generation in place of the

rate of power generation to execute the aforementioned leading-phase current control.

Namely, since the voltage generated from and current outputted from the generator 100 greatly increase as the rotational speed thereof increases, no problem occurs even if there is no power shortage if the rotational speed n of the power generator, the engine speed and the vehicle speed exceed the second threshold value in their increasing directions. It is therefore possible to stop the passage of leading phase current through the armature winding. On the other hand, when the rotational speed n of the power generator, the engine speed and the vehicle speed exceed the first threshold value which is smaller than the second threshold value in their decreasing directions, the possibility of a power shortage is determined and a command for passing the leading phase current through the armature winding is issued.

Thus, no leading phase current is supplied to its corresponding armature winding in a high rotational range in which the passage of leading phase current therethrough is unnecessary. The ripple ratio of the output current in the high rotational range can be reduced and the shortage of output can be resolved in a low rotational range. A comparison between the rate of change in output current (ripple) at the time that the lag angular value δ is 0 (at the time of the non-leading phase control) and the rate of change in output current (ripple) at the time of the leading phase control will be shown in FIG. 16. A problem arises that the ripple increases upon passage of the leading phase current through the armature winding.

Incidentally, the leading phase current may flow through the armature winding only when both the velocity status quantities and the electrical status quantities require the passage of leading phase current therethrough. Alternatively, the leading phase current may be supplied to the armature winding unconditionally at low rpm and the leading phase current may be supplied thereto at high rpm only when the electrical status quantities require the passage of leading phase current therethrough. For example, detection is made as to whether the rotational speed n of the power generator is less than or equal to 2000 rpm. Based on the result of detection, the control for generating the leading phase current is performed. Further, the leading phase current can be supplied at 2000 - 5000 rpm only when the electrical status quantities require an increase in output. Furthermore, the leading phase current can be caused to stop flowing at 5000 rpm or more.

FIG. 17 shows the relationship between the output currents at the time of the supply of the leading phase current and the non-leading phase current and the rotational speed n of the power generator. The effect of increasing the output according to the passage of the leading phase current through the corresponding armature winding is particularly significant at low rpm but is low at high rpm.

In the aforementioned embodiment, the binary control of the supply of the leading phase current has been executed. It is, however, needless to say that the amount of passage of the leading phase current through the corresponding armature winding may be increased in place of the supply of the leading phase current and the amount of passage of the leading phase current therethrough may be reduced in place of non-supply of the leading phase current.

Owing to the construction and operation described above, the above control on normal use can provide an improvement in gas mileage for the vehicle and prevention of the charging of the battery from shortage by holding the generated output as a power source in high quality in a reduced state of the ripple of the generated output and generating high-efficiency and high output power when the output of the power generator is low.

Since the output at low rpm under which the output is apt to be low can be increased owing to the supply of the leading phase current, the power generator can be reduced in size and weight correspondingly. The effect of reducing idle speed and thereby improving the gas mileage can be also achieved in the same structure.

One example for performing the control for the passage of leading phase current through its corresponding armature winding at idle speed in a fifth embodiment will now be described with reference to FIG. 18.

In the present embodiment, Step 2020 is executed as an alternative to Steps 1010 and 1020 in the flow-chart of FIG. 14 illustrative of the fourth embodiment. Further, Step 2070 is executed as an alternative to Steps 1060 and 1070.

Namely, at Step 2020, a lag angular value δ is fixed to a lag angular value δ_c equivalent to the amount of passage of leading phase current through its corresponding armature winding, which provides the maximum efficiency of the power generator 100 at a predetermined idle speed regardless of an actual rotational speed. At Step 2070, the lag angular value δ is fixed to a lag angular value δ_d equivalent to the amount of passage of leading phase current through its corresponding armature winding, which provides the maximum output of the power generator 100 at the predetermined idle speed regardless of the actual rotational speed.

Thus, the leading phase current for providing the maximum output can be supplied when an increase in output is strongly required at idle speed under which the most need of the supply of the leading phase current occurs. Further, the leading phase current can be supplied with high efficiency when a slight increase in output is required but the supply of the maximum output is not required at idle speed under which the greatest need of the supply of the leading phase current occurs. Furthermore, when the increase in output according to the supply of the leading phase current is not required, its supply can be canceled. Since the effect of increasing the output owing to the supply of the leading phase current at non-idle is small, a great advantageous effect

can be ensured by doing so even though the control is simple.

Similarly, a lag angular value δ at a vehicle normal rotational speed can be set to the best efficiency value or the maximum output value as an alternative to the lag angular value δ at idle speed. In doing so, the efficiency of the power generator can be improved relative to the rotational speed most used while the vehicle is running, thereby making it possible to bring about the effect of improving gas mileage of the vehicle.

Another example for performing the control for the supply of the leading phase current at idle speed in a sixth embodiment will now be described with reference to FIG. 19.

In the present embodiment, Step 990 for making a decision as to whether the vehicle is at idle is provided before Step 1000 in the flowchart shown in FIG. 18 illustrative of the embodiment 2. Incidentally, the idling is determined by an ECU 2 based on the degree of opening of a throttle, the rotational speed and a vehicle speed.

In the present embodiment, the supply of the leading phase current is intermittently controlled based on the result of decision with both the rotational speed of the engine corresponding to the velocity status quantity and the rate of power generation corresponding to the electrical status quantity as the quantities of state of power generation. The supply of the leading phase current is controlled according to the rate of power generation particularly only when the rotational speed of the engine is determined as the idle speed. If so, then the leading phase current can be provided only when the rate of power generation is high at idle speed under which the most need of the supply of the leading phase current takes place, i.e., the power to be generated is low. Further, the leading phase current for providing the maximum output can be supplied when an increase in output is strongly required. Furthermore, the leading phase current can be supplied with the maximum efficiency when a slight increase in output is required but the supply of the maximum output is not required at idle speed under which the greatest need of the supply of the leading phase current occurs.

The rotational speed of the engine is detected based on a pulse signal outputted from the turning-angle sensor 16. If the detected rotational speed falls within a predetermined range of low rotational speed, then the rotational speed may be determined as being indicative of idle in the present embodiment. As an alternative to the rotational speed n of the power generator referred to above, the vehicle speed, the rotational speed of the engine, etc. may be used as the velocity status quantities. If a vehicle speed sensor outputs a vehicle speed 0, for example, then the engine can be determined as idle. When the rotational speed of the engine is below 800 rpm, the engine is determined to be at idle and execution proceeds to Step 1000. When the rotational speed of the engine increases above 2000 rpm, the supply of the leading phase current may be

stopped. Further, the control for supplying the leading phase current can be executed regarding the rotational speed of the power generator as low and the output generated therefrom as small when the vehicle speed is below 5 km/hour. If the vehicle speed is above 20 km/hour, then the control for the supply of the leading phase current can be stopped with the rotational speed n of the power generator regarded as high and the output generated therefrom regarded as sufficiently large.

In the aforementioned embodiments, the controller 7 includes a microprocessor. In this condition, each individual flowchart has been executed. It is however needless to say that the aforementioned flowcharts can be carried out by the ECU 2.

A seventh embodiment for performing control over a leading phase current with a battery voltage equivalent to an electrical status quantity as the quantity of state of power generation will be described with reference to a flowchart shown in FIG. 20.

The controller first waits until the rate of power generation reaches a predetermined value (95% or more in the present embodiment) (Step 700). If the answer is found to be YES at Step 700, it is then checked whether a battery voltage VB is less than a predetermined adjusted voltage V_{ref} (Step 702). If the answer is found to be NO at Step 702, it is then checked whether a lag angular value δ is equal to the minimum value δ_{min} (corresponding to a value near 0 in the present embodiment) (Step 706). If the answer is found to be YES at Step 706, then the lag angular value δ is set to 0 determining the supply of the leading phase current as unnecessary (Step 712). Thereafter, execution returns to Step 700. If the answer is found to be NO at Step 706, then a value obtained by subtracting only a predetermined small value from the previous value of the lag angular value δ is set as the present value of the lag angular value δ (Step 710). After a predetermined time has been delayed (Step 711), execution returns to Step 700. On the other hand, if the battery voltage VB is greater than the predetermined adjusted voltage V_{ref} at Step 702, it is then checked whether the lag angular value δ is the maximum value δ_{max} . If the answer is found to be YES at Step 704, then execution returns to Step 700. If the answer is found to be NO at Step 704, then a value obtained by adding a predetermined small value to the previous value of the lag angular value δ is set as the present value of the lag angular value δ (Step 708). After a predetermined time has been delayed (Step 711), execution returns to Step 700. The delay of the predetermined time at Step 711 is made for suppressing a routine cyclic speed thereby to prevent the rate of increase in the lag angular value δ at Step 708 and the rate of decrease in the lag angular value δ at Step 710 from excessively speeding up.

In the present embodiment, if the value stored in the register of CPU provided in the controller 7 for storing the lag angular value δ is 0, then the control for the supply of a non-leading phase current is executed in accordance with an interrupt routine executed at prede-

terminated time intervals. If the value stored in the register is not 0, then the control for the supply of the leading phase current is executed in accordance with the interrupt routine executed at predetermined time intervals.

Namely, in the present embodiment, the leading phase current is controlled to cause the battery voltage VB to coincide with the adjusted voltage Vref where there is a possibility that the rate of power generation becomes greater than a predetermined value and the shortage of power generation occurs in the case of simple control on a field current.

In the aforementioned embodiment, the maximum value $\delta_{\max}$ of the lag angular value δ is set to the lag angular value δ_2 for generating the maximum output shown in FIG. 15. The minimum value $\delta_{\min}$ of the lag angular value δ is set to the lag angular value δ_0 shown in FIG. 15.

Since the maximum value of the rate of change in the lag angular value δ is controlled to be the predetermined value or less at Steps 708, 710 and 711 in the present embodiment (i.e., the lag angular value gradually varies), a sudden shock to the engine load by the supply of the leading phase current can be lightened.

The effect of gradually changing the lag angular value will be described with reference to FIGS. 21A-21C. If the load for the power generator suddenly increases and the battery voltage is lowered, then the engine load is simply increased gradually owing to the effect of gradually increasing the lag angular value δ at Steps 708 and 711 under the leading-phase current control when the rate of power generation suddenly increases due to the conventional field current control or the lag angular value δ suddenly increases upon control of the leading phase current. It is therefore possible to prevent the rotational speed of the engine from suddenly decreasing. Since the leading phase current gradually increases even when the rate of power generation is 100%, the rotational speed of the engine can be prevented from suddenly decreasing. In the present embodiment, a predetermined initial value is set to the above register for storing the lag angular value δ therein at the time of initial reset after power-on. Incidentally, as an alternative to the reduction in the battery voltage, a reduction in the rotational speed of the power generator from a predetermined value may be detected to gradually change the lag angular value and supply the current. The aforementioned gradual change is made to control the maximum value (variation speed) of the rate of change in the lag angular value δ to the predetermined value or less. The lag angular value δ shows a leading-phase current supplying or carrying period. A description for gradually changing the lag angular value δ based on the turning-angle sensor has been made for simplicity as the leading-phase current control system. As a result, the leading phase current that leads the phase voltage by the lag angular value δ in phase is supplied. Thus, even if the phase period of each of the phase voltage and the phase current is detected and the control for the supply of the leading phase current is

performed so that the maximum value of the rate of change in the detected phase period is constrained to a predetermined value or less, the same advantageous effect as described above can be obtained by additionally providing the decision on the zero-crossing point of the phase voltage in addition to the decision on the zero-crossing point of the armature current as in the fifth embodiment of the present invention.

Even if the values of leading phase currents that flow during the leading-phase current carrying period are detected to calculate the average value of the detected values and the maximum value of the rate of change in the calculated average value is controlled to be a predetermined value or less, the same advantageous effect as described above can be obtained. Further, even if the period or cycle of the armature current is detected so that the maximum value of a leading-phase current carrying period (i.e., the period for supplying the leading phase current) is decided from the detected period and each of the constants and variables related to the angles employed in the present embodiment (Steps 704, 746, 708, 710 and 712) is used by being replaced with the leading-phase current carrying period, the same advantageous effect as described above can be obtained. Namely, the above effect of gradually changing the lag angular value can be obtained by adding or subtracting a predetermined small proportion to or from an initial value (e.g., 1%) of a proportion of the leading-phase current carrying period per period of the armature current according to the battery voltage and controlling the maximum value of the rate of change in that proportion to a predetermined value or less.

The operation for reducing a periodic variation (i.e., ripple) in the rotational speed of the engine under the aforementioned leading-phase current control in an eighth preferred embodiment of the present invention will now be described with reference to a flowchart shown in FIG. 22.

Since the aforementioned ripple is sensitive at idle in particular, it is first checked based on a system or mode the same as that at Step 990 in FIG. 19 whether the engine is at idle (Step 800). If the answer is found to be NO at Step 800, then execution returns to Step 800. If the answer is found to be YES at Step 800, then the rotational speed of the engine is detected (Step 804). It is next checked whether the detected rotational speed of the engine is smaller than a predetermined rotational speed N1 (Step 804). If the answer is found to be YES at Step 804, then a leading-phase current carrying or supplying mode (see FIGS. 6A and 7, for example) is selected to increase an engine load (Step 806). If the answer is found to be NO at Step 804, then a non-leading phase current supplying mode (see FIG. 5, for example) is selected to decrease the engine load (Step 808).

In doing so, the periodic variation (i.e., ripple) in the rotational speed of the engine can be reduced. FIG. 23 is a timing chart for describing the effect of reducing the

periodic variations (i.e., ripples) in the rotational speed of the engine at the time of the supply (indicated by the solid line) of the leading phase current and the non-supply (indicated by the broken line) of the leading phase current. If the average rotational speed of the engine at idle is regarded as N_m (600 rpm in the present embodiment), it is then preferable that the aforementioned predetermined rotational speed N_1 is N_m , preferably, a value (e.g., 590 rpm) slightly smaller than N_m . In the present embodiment, the lag angular value δ is kept constant.

Incidentally, the predetermined rotational speed N_1 can be corrected according to the magnitude of the variation (ripple) in the rotational speed of the engine. Namely, when the variation in the rotational speed of the engine is large, the predetermined rotational speed N_1 is set to a value substantially equal to the average rotational speed N_m (600 rpm in the present embodiment) to increase engine load torque in the form of the phase opposite to that of the variation in the rotational speed of the engine. On the other hand, when the rotational speed of the engine is low, the predetermined rotational speed N_1 is set to a value sufficiently smaller than the average rotational speed N_m (600 rpm in the present embodiment) so that the amount of increase in the engine load torque having the phase opposite to that of the variation in the rotational speed of the engine is reduced. One example of this processing will be shown in a flowchart of FIG. 24. This flowchart is equivalent to one in which Step 803 is additionally provided between Steps 802 and 804 in FIG. 21. The present Step 803 corresponds to a step for reading a predetermined rotational speed N_1 corresponding to the detected rotational speed of the engine from the memory in the controller 7 based on the detected rotational speed of the engine. Incidentally, the relationship between the two has been stored in the memory in advance. In doing so, the amount of the supply of the leading phase current can be adjusted according to the ripple. Thus, when the ripple is small, it is possible to prevent the risk of increasing the ripple by the supply of a leading phase current having an opposite phase.

Incidentally, the control for the amount of supply of the leading phase current permits an adjustment to the lag angular value δ even if the proportion of the leading-phase current carrying period per each period of the phase current is changed, as well as an adjustment to the leading-phase current carrying period at each period of the phase current, i.e., the lag angular value δ .

In the aforementioned embodiment, the variation in the rotational speed due to the supply of the leading phase current has been suppressed depending on whether the rotational speed of the engine is greater than the predetermined rotational speed N_1 . However, the rotational speed of the engine may be suppressed when the rate (the amount of change in the rotational speed / the average rotational speed) of change in the rotational speed of the engine during a predetermined period exceeds a predetermined level. Further, if the

leading phase current is being supplied when the rotational speed of the engine falls into the idling engine speed range, then the supply of the leading phase current may be stopped to suppress the stoppage of the engine.

Another control example for preventing the rotational speed of the engine from suddenly decreasing under the control of the leading phase current in a ninth preferred embodiment of the present invention will now be described with reference to FIG. 25.

A quantity of state, which varies in relation to a sudden change in engine load is first inputted (Step 900). It is checked whether the engine load abruptly increases based on the variation in the quantity of state (Step 902). If the answer is found to be YES at Step 902, it is then checked whether the control is in a leading-phase current carrying mode (Step 904). If the answer is found to NO at Step 904, it is then checked whether the engine load is abruptly reduced (Step 906).

For the quantity of state which varies in relation to the sudden change in engine load, a load current, a battery voltage, the rate of power generation, the state of opening and closing of a switch for controlling the application of power to an electrical load, the state of opening and closing of a switch for applying power to a mechanical load such as a compressor or the like can be adopted. It is apparent that these status quantities can be detected by the controller 7 or the ECU 2.

If the answer is found to be NO at Step 906, then execution returns to Step 900. If the answer is found to be YES at Step 906, then a command for supplying the leading phase current is issued (Step 910). Thereafter, execution returns to Step 900. If the answer is found to be NO at Step 904, then execution returns to Step 900. If the answer is found to be YES at Step 904, then a check is made to see if the battery voltage is greater than a predetermined minimum value and the allowance for the capacity of the battery is provided (Step 908). If the battery voltage is low and no allowance for the capacity of the battery is given, then execution returns to Step 900. If the battery voltage is high and its allowance is given, then the leading-phase current carrying mode is stopped (Step 912) and execution returns to Step 900.

It is thus possible to prevent the rotational speed of the engine from suddenly changing due to the sudden change in the load of the power generator as shown in FIGS. 21A-21C.

Incidentally, the leading-phase current control has a fast response compared to the field current control. Accordingly, the leading-phase current control is suitable for the control in the present embodiment.

An embodiment for performing leading-phase current control based on the temperature of the field winding 4c, each of the stator windings 5a through 5c or a predetermined portion of the power generator 100 in a tenth preferred embodiment of the present invention will now be described with reference to a flowchart shown in FIG. 26.

The present flowchart is one in which Steps 1002, 1004 and 1006 are added to the flowchart shown in FIG. 14. Only these steps will be described below. At Step 1000, the rate of power generation is compared with a predetermined value A (e.g., 95%). If the answer is found to be YES at Step 1000, then the leading-phase current control is executed since the output is potentially low. Before its control, however, the temperature of the power generator 100 is detected based on a signal produced from a temperature sensor 70 shown in FIG. 8 (Step 1002). It is already known that when the temperature of the power generator 100 is low, a field current increases.

If the detected temperature is now found to be higher than or equal to a predetermined value T (100°C, for example), then execution proceeds to Step 1010 regarding an increase in field current at the low temperature referred to above as negligible. If the detected temperature is less than or equal to T, then a lag angular value δg corresponding to the temperature is searched from a stored map and the searched lag angular value δg is set to the aforementioned register for storing the s therein (Step 1006). Thereafter, execution proceeds to Step 1040.

The above map stored in a memory shows the relationship between the pre-checked temperature and the most suitable lag angular value δg (which no produces magnetic saturation at that temperature). Namely, the lag angular value δg becomes smaller as the temperature becomes higher.

Incidentally, the temperature of the power generator 100 may be searched from a map showing the relationship between the resistance and temperature based on an electrically-detected resistance value of a connected current detection resistor for detecting the field current flowing through the field winding 4c. Since the temperature sensor 70 is unnecessary in this case, the structure can be simplified.

In doing so, the leading phase current can be reduced by the increase in field current at the low temperature even when the rate of power generation is large, i.e., the load is large. It is therefore possible to suppress an output increase and magnetic saturation beyond conventional expectations. Particularly when the engine is started or immediately after the engine has started up at a low temperature, the engine load can be prevented from being uselessly increased by the power generator 100.

In the present embodiment, the leading phase current is increased and reduced relative to the temperature. However, the startability of the engine at the low temperature can be further improved by controlling the field current to a predetermined limiting value at the low temperature and suppressing the torque of the power generator.

A vibration control operation for reducing the vibrations created by the engine under the control of a leading phase current in an eleventh preferred embodiment of the present invention will now be described with refer-

ence to a flowchart shown in FIG. 27. Other embodiments show applications in which the output control based on the leading-phase current control according to the present invention is high-speed as compared with the conventional output control based on the field current.

Since the vibrations created by the engine are easily sensitive at idle in particular, it is first determined based on a system or mode similar to that at Step 990 in FIG. 19 whether the engine is at idle (Step 2000). If the answer is found to be NO at Step 2000, then execution returns to Step 2000. If the answer is found to be YES at Step 2000, then a crank angle is read from an unillustrated crank angle sensor attached to the engine 1 through the ECU 2 (Step 2002).

It is next checked whether the read crank angle is a half period controllable under the supply of the leading phase current or a reverse half period (Step 2004). If the answer is found to be YES at Step 2004, then a leading-phase current supplying or carrying mode (see FIGS. 6 and 7) is selected (Step 2006). If the answer is found to be NO at Step 2004, then a leading-phase current non-carrying mode (see FIG. 5) is selected (Step 2008).

Incidentally, the engine vibrations (whose fundamental frequency components in particular) are represented in the form of a waveform obtained by combining rotational vibrations and reciprocating vibrations. However, the composite waveform has one cycle or period related to a predetermined crank angle. The rotational speed of the engine increases during a phase period (hereinafter called "speed-increasing phase period") from a predetermined crank angle $\theta 1$ to a predetermined crank angle $\theta 2$. Thus, if the engine load is rendered heavy by supplying the leading phase current during the speed-increasing phase period (which may be a half period with the speed-increasing phase period as the center), then the rotational speed of a crankshaft can be prevented from increasing and the engine vibrations related to the speed increase in the crankshaft can be suppressed.

When the power generator 100 and the engine 1 are coupled to each other by a belt, there may be a case where a torque transfer time between the two is delayed somewhat. In this case, the timing for selecting the leading-phase current carrying mode may be made fast by using the delay time.

Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of the present invention as defined by the appended claims.

In a vehicle power generating system having an AC power generator (100), a quantity which is related to the state of power generation of the power generator (100) and varies according to the supply of a leading phase current (ix-iz) to the power generator (100), is detected.

When the passage of the leading phase current (ix-iz) through each armature winding (5a-5c) is determined as necessary based on the detected status quantity, the leading phase current (ix-iz) is supplied to each armature winding (5a-5c) (an increase in the amount of supply of the leading phase current (ix-iz) is included). If passage is determined as unnecessary, then the supply of the leading phase current (ix-iz) to each armature winding (5a-5c) is stopped (a decrease in the leading phase current (ix-iz) is included). If so, then a change (improvement) in the state of power generation such as an increase in output or the like due to the above supply can be achieved by supplying the leading phase current (ix-iz) thereto when its change is required. When the above change is unnecessary, the supply of the leading phase current (ix-iz) thereto can be stopped to suppress a defective condition incident to the supply of the leading phase current (ix-iz) thereto, particularly, the rate of change in output current, i.e., an increase in ripple. Owing to the above construction, the supply of the leading phase current (ix-iz) to the power generator (100) can be achieved by a simple circuit configuration and the state of power generation and the condition of a vehicle can be improved.

Claims

1. A vehicle power generating system comprising:

a power generator (100) having a field winding (4c) for generating field magnetic flux and armature winding (5a-5c) driven by an engine (1) for producing power-generating outputs (Va-Vc), said power generator (100) for being AC-DC power converting means (11) for rectifying a voltage (Va-Vc) outputted from each armature winding (5a-5c) and supplying said rectified voltage to an electrical load (10); field current control means (7) for controlling a field current (If) supplied to said field winding (4c); voltage control means (7) for controlling said field current control means (7) to control each of outputs (Va-Vc) produced from said power generator (100) to be a predetermined value; state-of-power generation detecting means (113a-113f) for detecting a predetermined quantity of state of power generation related to a state of power generation of said power generator (100); determining means (7, 290, 300, 304, 308, 312, 216, 320) for determining based on said detected quantity of state of power generation whether supply of a leading phase current (ix-iz) to each armature winding (5a-5c) is necessary; and leading-phase current control means (7, 11, 292-422) for starting said supply of said leading phase current (ix-iz) to each armature wind-

ing (5a-5c) or increasing said supply when said determining means (7, 290, 300, 304, 308, 312, 216, 320) determines said leading-phase current supply as necessary and stopping said supply of said leading phase current (ix-iz) thereto or decreasing said leading phase current (ix-iz) when said determining means (7, 290, 300, 304, 308, 312, 216, 320) determines said leading-phase current supply as being unnecessary.

2. A vehicle power generating system according to claim 1, further comprising a battery (9) supplied with power from said AC-DC power converting means (11).

3. A vehicle power generating system according to claim 1 or 2, wherein when said quantity of state of power generation exceeds a predetermined first threshold value in a direction in which said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) is necessary, said determining means (7, 290, 300, 304, 308, 312, 216, 320) is for determining said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) as being necessary.

4. A vehicle power generating system according to claim 3, wherein when said quantity of state of power generation further exceeds a second threshold value exceeding said first threshold value in a direction opposite to said direction in which said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) is necessary, said determining means (7, 290, 300, 304, 308, 312, 216, 320) is for determining said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) as unnecessary.

5. A vehicle power generating system according to any of claims 1 to 4, wherein said quantity of state of power generation includes an electrical status quantity composed of at least one of a battery voltage (VB), a field current (If), a rate of power generation, a generated voltage, a load voltage, a generated current and a ripple ratio.

6. A vehicle power generating system according to claims 1 to 5, wherein said quantity of state of power generation includes a velocity status quantity composed of at least one of said rotational speed (n) of said power generator (100), said rotational speed of said engine (1) and a vehicle speed.

7. A vehicle power generating system according to claims 1 to 6, wherein when said rotational speed of said engine (1) is determined as less than a predetermined rotational speed, said determining means (7, 990) is for determining said engine (1) to be at

- idle based on said quantity of state of power generation and when said engine (1) is determined to be at idle, said determining means (7, 1000-1070) is for determining said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) as being necessary.
8. A vehicle power generating system according to any of claims 1 to 7, further comprising detecting means (16) for detecting a physical quantity related to said rotational speed (n) of said power generator (100) and wherein said leading-phase current control means (7, 242-422) determines timing for supplying said leading phase current (ix-iz) to each armature winding (5a-5c) according to said rotational speed (n) of said power generator (100) detected based on said physical quantity.
9. A vehicle power generating system according to any of claims 1 to 7, wherein said leading-phase current control means (7, 242-422) supplies said leading phase current (ix-iz) to each armature winding (5a-5c) at a leading-phase current carrying timing in which one of efficiency and output of said power generator (100) at a time that said rotational speed of said engine (1) is a predetermined value, is greater than or equal to a predetermined value.
10. A vehicle power generating system according to claim 9, wherein said leading-phase current control means (7, 242-422) supplies said leading phase current (ix-iz) to each armature winding (5a-5c) at a leading-phase current carrying timing in which one of efficiency and output of said power generator (100) at a time that said rotational speed of said engine (1) is a predetermined idling engine (1) speed, is greater than or equal to said predetermined value.
11. A vehicle power generating system according to any of claims 1 to 10, wherein said leading-phase current control means (7, 242-422) has a high-efficiency power generation mode indicative of a leading-phase current control mode under a leading-phase current carrying condition in which efficiency of said power generator (100) becomes greater than or equal to a predetermined value, and a high-output power generation mode indicative of said leading-phase current control mode under a leading-phase current carrying condition in which an output (Va-Vc) of said power generator (100) becomes greater than or equal to said predetermined value, and said determining means (7, 1000-1070) selects one of said modes based on said quantity of state of power generation when said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) is determined as being necessary.
12. A vehicle power generating system according to any of claims 1 to 11, wherein said quantity of state of power generation includes a battery voltage (VB) and said determining means (7, 500-522) determines said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) as being necessary when said battery voltage (VB) is lower than a predetermined first voltage value and determines said leading-phase current supply as being unnecessary when said battery voltage (VB) is higher than a predetermined second voltage value including said predetermined first voltage value.
13. A vehicle power generating system according to any of claims 1 to 12, wherein said leading-phase current control means (7, 700-712) limits a maximum value of a rate of change in leading phase current (ix-iz) to gradually change said leading phase current.
14. A vehicle power generating system according to claims 1 to 13, wherein said leading-phase current control means (7, 700-712) limits a maximum value of a rate of change in at least one of a leading-phase current carrying period, a phase of said carrying leading-phase current relative to each phase voltage and an average of said leading phase currents (ix-iz) supplied to said armature windings (5a-5c) thereby to gradually change said leading phase current.
15. A vehicle power generating system according to claim 14, wherein said leading-phase current control means (7, 700-712) restricts a maximum value of a rate of change in proportion of a leading-phase current carrying period per predetermined period in which armature currents (ix-iz) are continuous relative to each other thereby to gradually change said leading phase current.
16. A vehicle power generating system according to any of claims 13 to 15, wherein said quantity of state of power generation includes a physical quantity related to at least one of an output voltage drop at a time of an increase in a electrical load (10) supplied with power from said power generator (100) and a reduction in said rotational speed (n) of said power generator (100) and said determining means determines said gradual change in and supply of said leading phase current (ix-iz) as being necessary when at least one of said output voltage drop and said reduction in said rotational speed (n) of said power generator (100) is determined as being larger than the other based on said physical quantity.
17. A vehicle power generating system according to claim 1, wherein said quantity of state of power generation includes a physical quantity related to a

variation in said rotational speed of said engine (1), said determining means (7, 902) determines said leading-phase current supply as being necessary when said variation is determined as being large based on said physical quantity and said leading-phase current control means (7, 904-412) suppresses said variation in said rotational speed of said engine (1) for said supply of said leading phase current (ix-iz) when said leading-phase current supply is determined as being necessary.

18. A vehicle power generating system according to claim 1, wherein said quantity of state of power generation includes a physical quantity related to vibrations created by said engine (1), said determining means (7, 2004) determines said leading-phase current supply as necessary when said vibrations are determined as large based on said physical quantity and said leading-phase current control means (7, 2006) suppresses said engine vibrations for said supply of said leading phase current (ix-iz) when said leading-phase current supply is determined as being necessary.
19. A vehicle power generating system according to claim 1, wherein said quantity of state of power generation includes a physical quantity related to a temperature of a predetermined portion of said power generator (100), said determining means (7, 1004) determines based on said physical quantity whether said power generator (100) has a low temperature and said leading-phase current control means (7, 1006, 1030-1050) stops said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) and reduces said leading phase current (ix-iz) when said power generator (100) is determined as being low in temperature and starts said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) and increases said leading phase current (ix-iz) when said power generator (100) is determined as being in a non-low temperature state.
20. A vehicle power generating system according to any of claims 1 to 19, wherein said leading-phase current control means (7, 11, 244-422) includes a normal/reverse energization opening/closing circuit (11) having high side switches (11a-11c) respectively composed of semiconductor switching devices (111a-111c) for individually connecting a high-potential DC power terminal and output terminals of said armature windings (5a-5c) for respective phases and low side switches (11d-11f) respectively composed of semiconductor switching devices (111d-111f) for individually connecting a low-potential DC power terminal set to a potential lower than that at said high-potential DC power terminal and said output terminals of said armature windings (5a-5c), and a controller (7) for controlling

said normal/reverse energization opening/closing circuit (11).

21. A vehicle power generating system according to any of claims 1 to 19, wherein said leading-phase current control means (7, 11, 244-422) includes a short-circuiting circuit (11) composed of a plurality of semiconductor switches (111a-111f) for short-circuiting between output terminals of said armature windings (5a-5c) for respective phases and a controller (7) for controlling opening and closing of each semiconductor switching device (11a-11f).
22. A vehicle power generating system according to claim 20, further including detecting means (113a-113f) for detecting a difference in potential between at least one of said high-potential DC power terminal and said low-potential DC power terminal of said AC-DC power converting means (11) and said output terminal of each armature winding (5a-5c) and at least one of said armature currents (ix-iz) and wherein said leading-phase current control means (7, 400-422) sets timing for opening and closing each semiconductor switch (11a-11f) based on at least one of said potential difference and said at least one armature current (ix-iz).
23. A vehicle power generating system according to claim 22, wherein each semiconductor switching device (11a-11f) incorporates therein a current detection resistive element (113a-113f) for detecting said armature current (ix-iz).
24. A vehicle power generating system according to claim 20, wherein said controller turns off (7, 206, 414, 422) each high side switch (11a-11c) after a predetermined period has elapsed since a potential at said output terminal of each armature winding (5a-5c) has become less than a potential at said high-potential DC power terminal and turns off (7, 402, 410, 418) each low side switch (11d-11f) after a predetermined period has elapsed since said potential at said output terminal of each armature winding (5a-5c) has become greater than a potential at said low-potential DC power terminal.
25. A vehicle power generating system according to claim 20, wherein said controller turns on (7, 402, 410, 418) each high side switch (11a-11c) after a predetermined period has elapsed since said potential at said output terminal of each armature winding (5a-5c) has become greater than said potential at said low-potential DC power terminal and turns on (7, 406, 414, 422) each low side switch (11d-11f) after a predetermined period has elapsed since said potential at said output terminal of each armature winding (5a-5c) has become less than said potential at said high-potential DC power terminal.

26. A vehicle power generating system according to claim 21, wherein said controller (7) turns on said semiconductor switches (11a-11f) of said short-circuiting circuit (11) for allowing said leading phase current (ix-iz) to flow in each armature winding (5a-5c) after said potential at said output terminal of each armature winding (5a-5c) has become less than said potential at said high-potential DC power terminal, turns on said semiconductor switches (11a-11f) of said short-circuiting circuit (11) for allowing said leading phase current (ix-iz) to flow out from each armature winding (5a-5c) after said potential at said output terminal of each armature winding (5a-5c) has become greater than said potential at said low-potential DC power terminal and turns off said semiconductor switches (11a-11f) of said short-circuiting circuit (11) after a predetermined time has elapsed since said turning-on.

27. A vehicle power generating system according to either of claims 20 and 21, further including phase angle detecting means (16) for detecting a rotational phase angle of a rotor of said power generator (100) and wherein said leading-phase current control means (7, 242-422) controls opening/closing timing at said time of opening/closing of each semiconductor switch (11a-11f) based on said rotational phase angle.

28. A vehicle power generating system according to any of claims 20 to 27, wherein each semiconductor switching device (111a-111f) comprises a MOSFET (111a-111f).

29. A vehicle power generating system according to claim 28, wherein said MOSFET (111a-111f) is composed of SiC.

30. A vehicle power generating system comprising:

a power generator (100) having a field winding (4c) for generating field magnetic flux and armature windings (5a-5c) for producing power-generating outputs (Va-Vc), said power generator (100) for being driven by an engine (1);
field current control means (7) for controlling a field current (If) supplied to said field winding (4c);
voltage control means (7) for controlling said field current control means (7) to control each of outputs (Va-Vc) produced from said power generator (100) to a predetermined value; and
leading-phase current control means (7, 700-712) for controlling supply of a leading phase current (ix-iz) to each armature winding (5a-5c), said leading-phase current control means (7, 700-712) limiting a maximum value of a rate

of change in leading phase current (ix-iz) to gradually change said leading phase current.

31. A vehicle power generating system comprising:

a power generator (100) having a field winding (4c) for generating field magnetic flux and armature windings (5a-5c) for producing power-generating outputs (Va-Vc), said power generator (100) for being driven by an engine (1);
field current control means (7) for controlling a field current (If) supplied to said field winding (4c);
voltage control means (7) for controlling said field current control means (7) to control each of outputs (Va-Vc) produced from said power generator (100) to be a predetermined value;
detecting means (16) for detecting a physical quantity related to a variation in said rotational speed of said engine (1);
leading-phase current control means (7, 806) for controlling a supply of a leading phase current (ix-iz) to each armature winding (5a-5c); and
determining means (7, 804) for determining a magnitude of a variation in said rotational speed of said engine (1) based on said physical quantity;
whereby said leading-phase current control means (7, 806) supplies said leading phase current (ix-iz) to each armature winding (5a-5c) when said variation is determined as being larger than a predetermined value.

32. A vehicle power generating system comprising:

a power generator (100) having a field winding (4c) for generating field magnetic flux and armature windings (5a-5c) for producing power-generating outputs (Va-Vc), said power generator (100) for being driven by an engine (1);
field current control means (7) for controlling a field current (If) supplied to said field winding (4c);
voltage control means (7) for controlling said field current control means (7) to control each of outputs (Va-Vc) produced from said power generator (100) to a predetermined value;
detecting means (16) for detecting a physical quantity related to vibrations created by said engine (1);
leading-phase current control means (7, 2006) for controlling supply of a leading phase current (ix-iz) to each armature winding (5a-5c); and
determining means (7, 2000-2008) for determining a magnitude of said engine variations based on said physical quantity;

whereby said leading-phase current control means (7, 2006) supplies said leading phase current (ix-iz) to each armature winding (5a-5c) when said vibrations are determined as being larger than a predetermined value.

5

33. A vehicle power generating system comprising:

a power generator (100) having a field winding (4c) for generating field magnetic flux and armature windings (5a-5c) for producing power-generating outputs (Va-Vc), said power generator (100) for being driven by an engine (1);
 field current control means (7) for controlling a field current (If) supplied to said field winding (4c);
 voltage control means (7) for controlling said field current control means (7) to control each of outputs (Va-Vc) produced from said power generator (100) to be a predetermined value;
 detecting means (70) for detecting a physical quantity related to a temperature of a predetermined portion of said power generator (100);
 leading-phase current control means (7, 1006, 1030-1070) for controlling a supply of a leading phase current (ix-iz) to each armature winding (5a-5c); and
 determining means (7, 1009) for determining based on said physical quantity whether said power generator (100) is at a low temperature; whereby said leading-phase current control means stops (7, 1006, 1030-1050) said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) and reduces said leading phase current (ix-iz) when said power generator (100) is determined as low in temperature and starts (7, 1010, 1020, 1025-1070) said supply of said leading phase current (ix-iz) to each armature winding (5a-5c) and increases said leading phase current (ix-iz) when said power generator (100) is determined as being at a non-low temperature.

45

50

55

FIG. 1

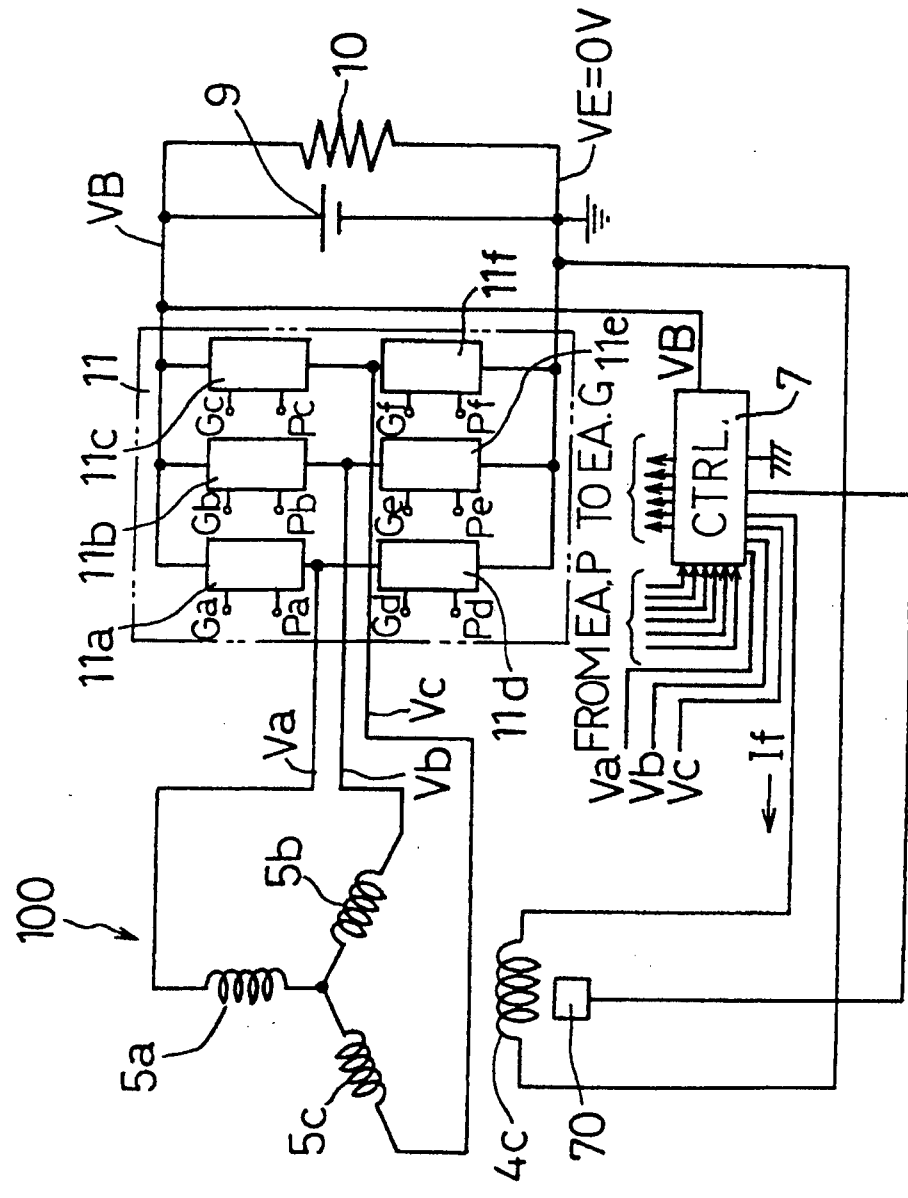
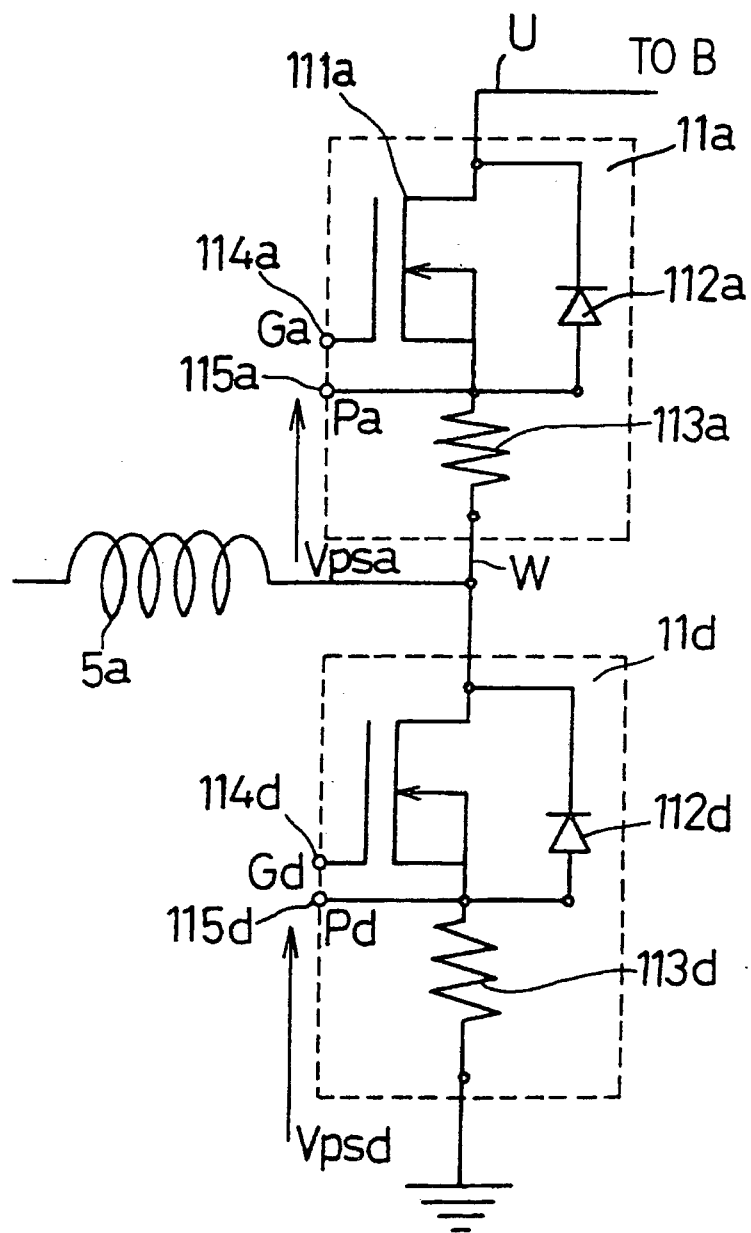
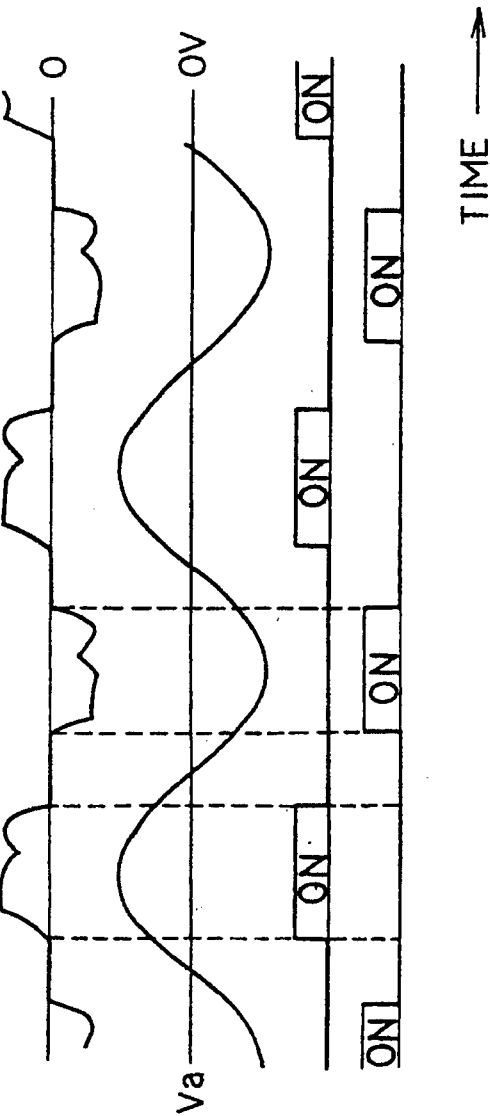


FIG. 2





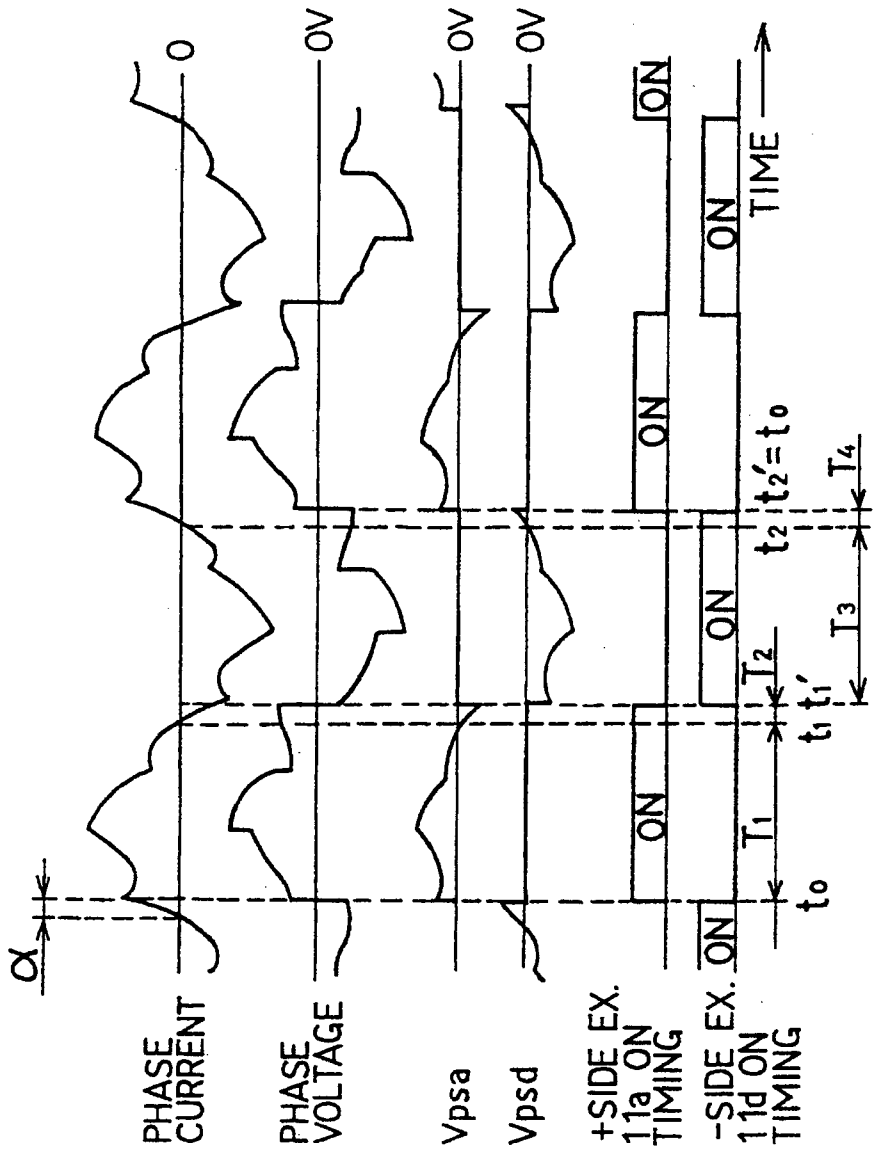
NON-LEADING PHASE CTRL. MODE

FIG. 3A
PHASE
CURRENT

FIG. 3B
PHASE
VOLTAGE

FIG. 3C
11a ON
TIMING

FIG. 3D
11d ON
TIMING



LEADING PHASE CTRL. MODE

FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

FIG. 4E

FIG. 4F

FIG. 5

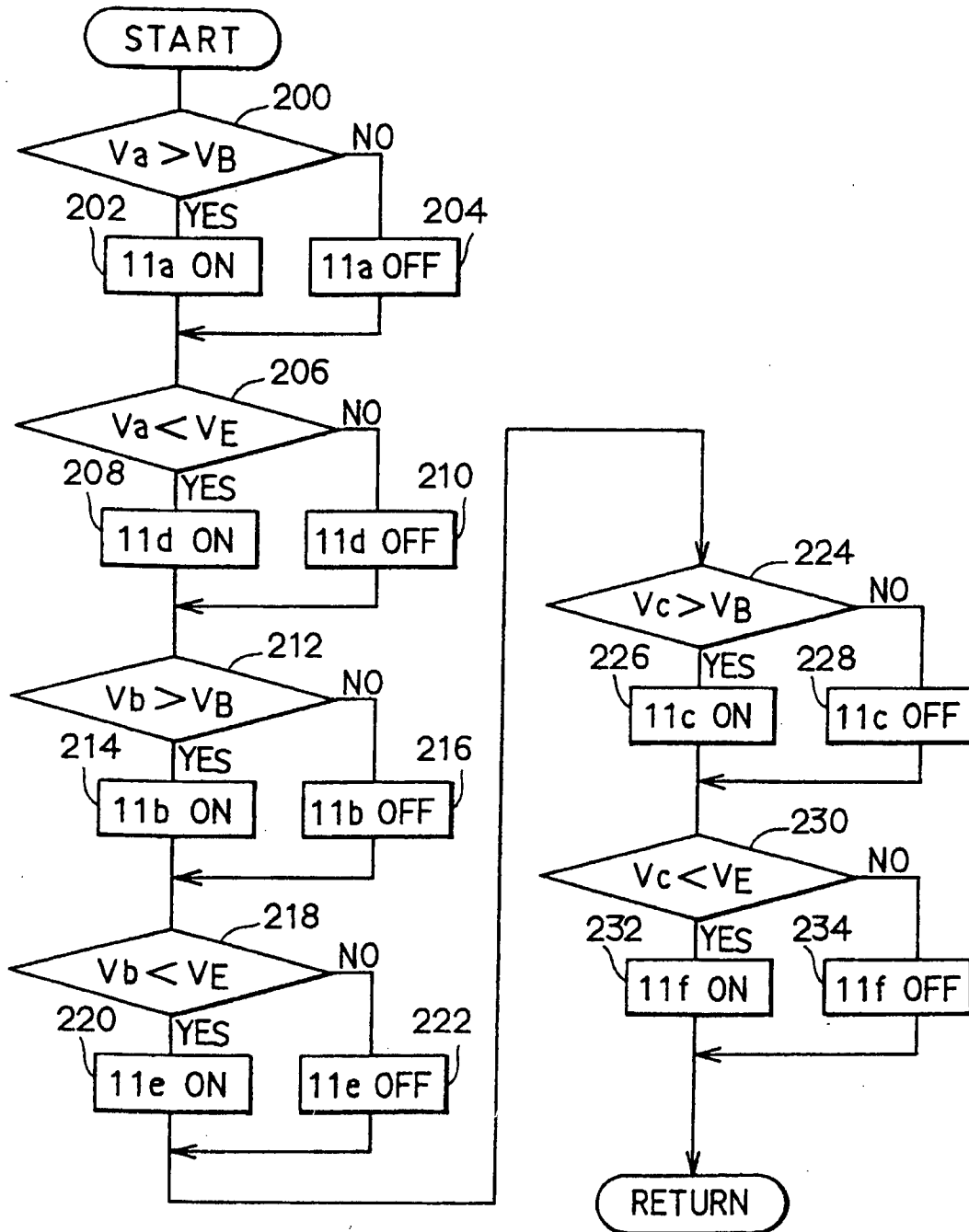


FIG. 6

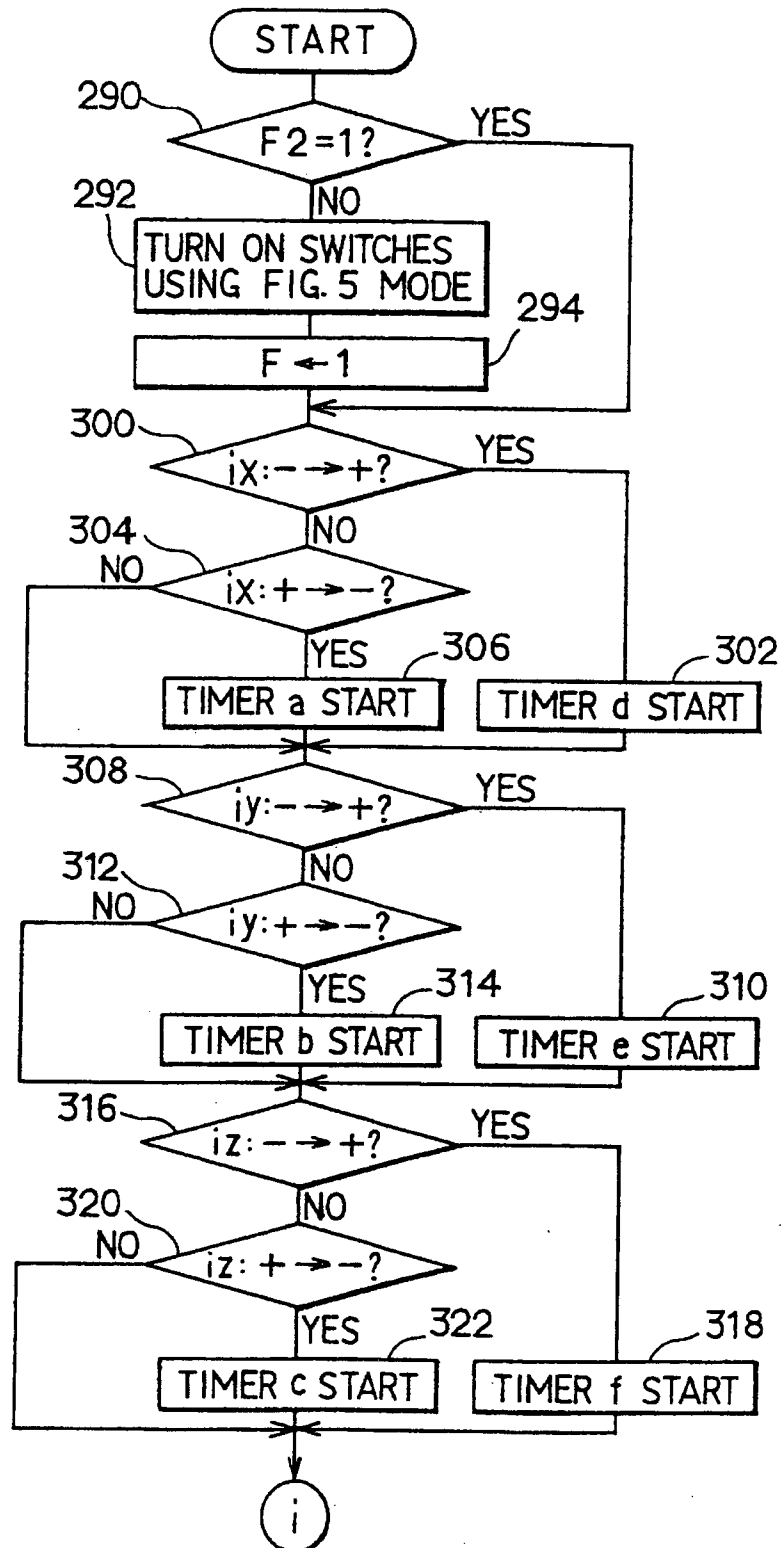


FIG. 7

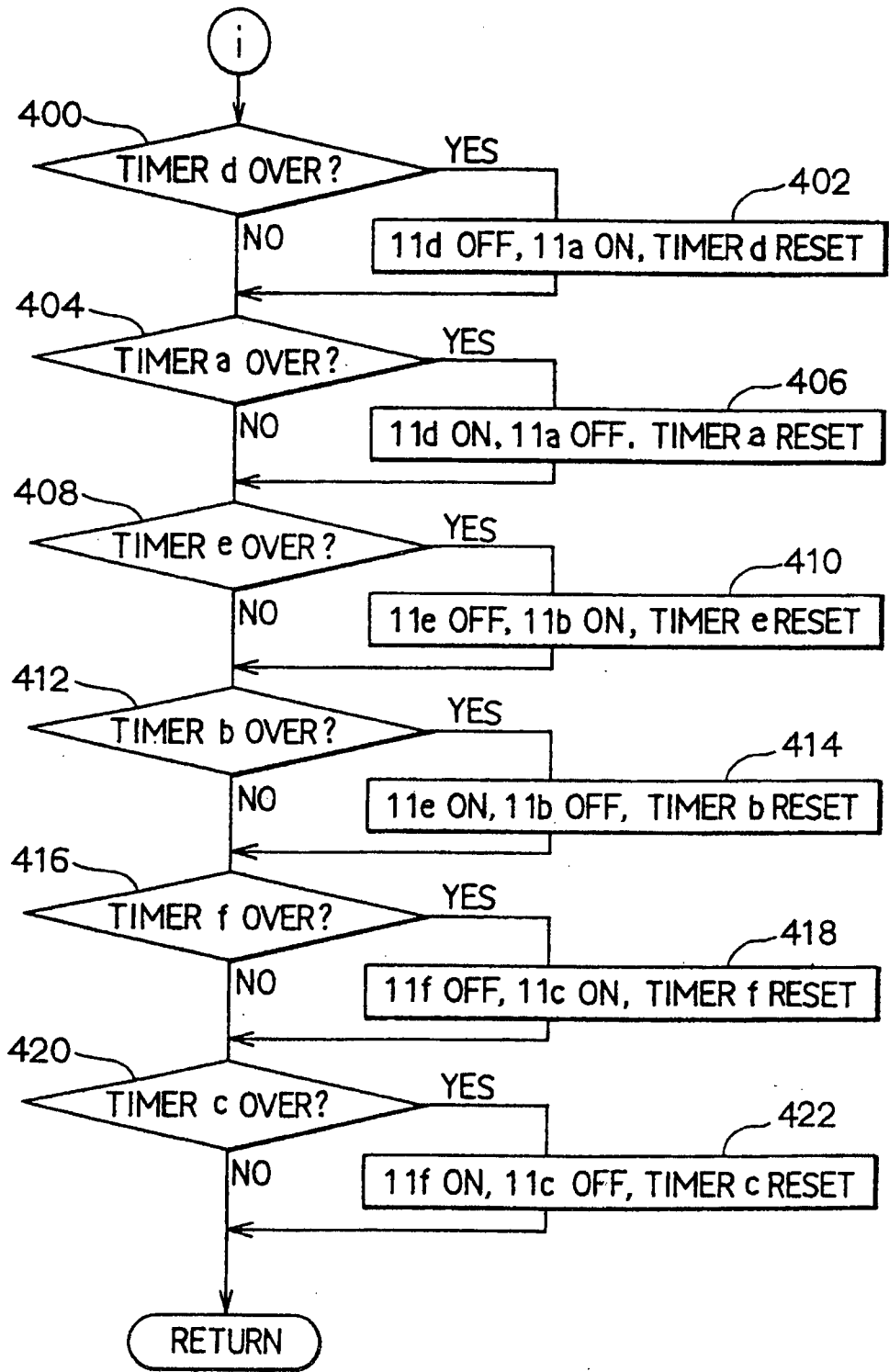


FIG. 8

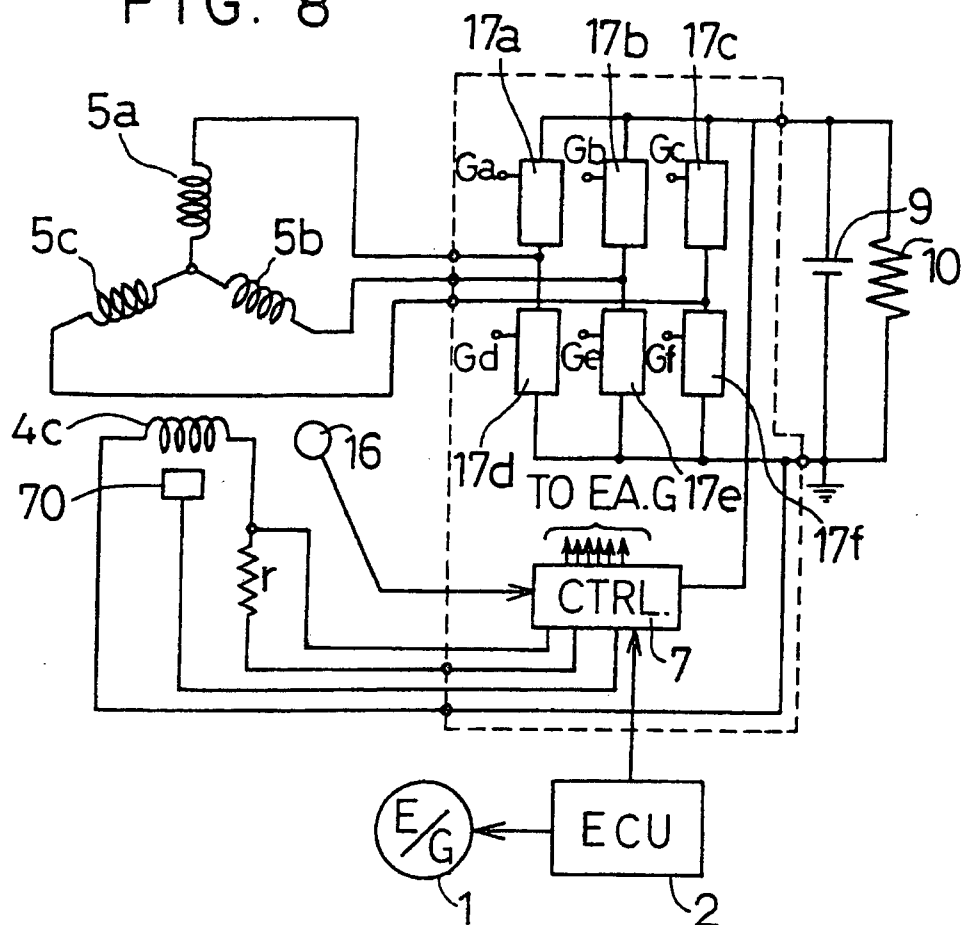
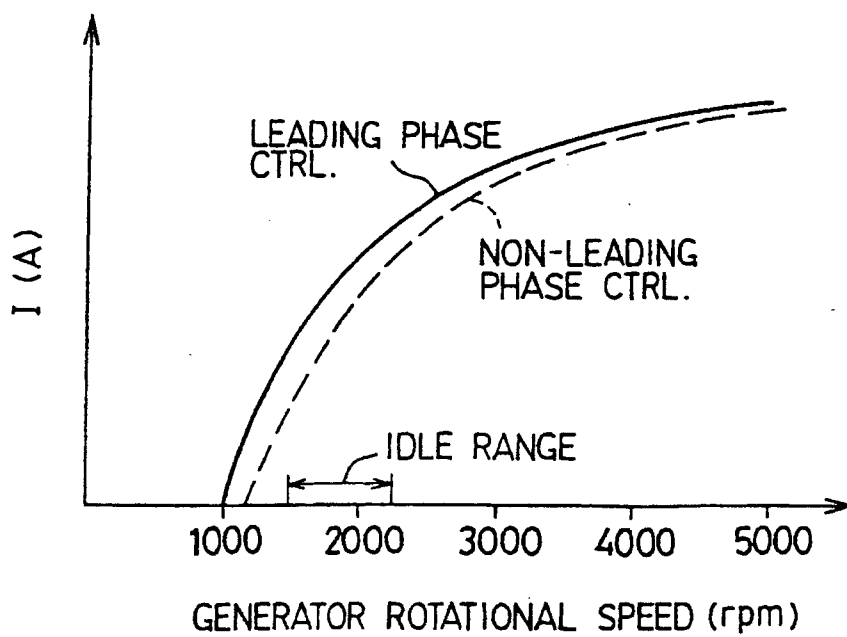


FIG. 17



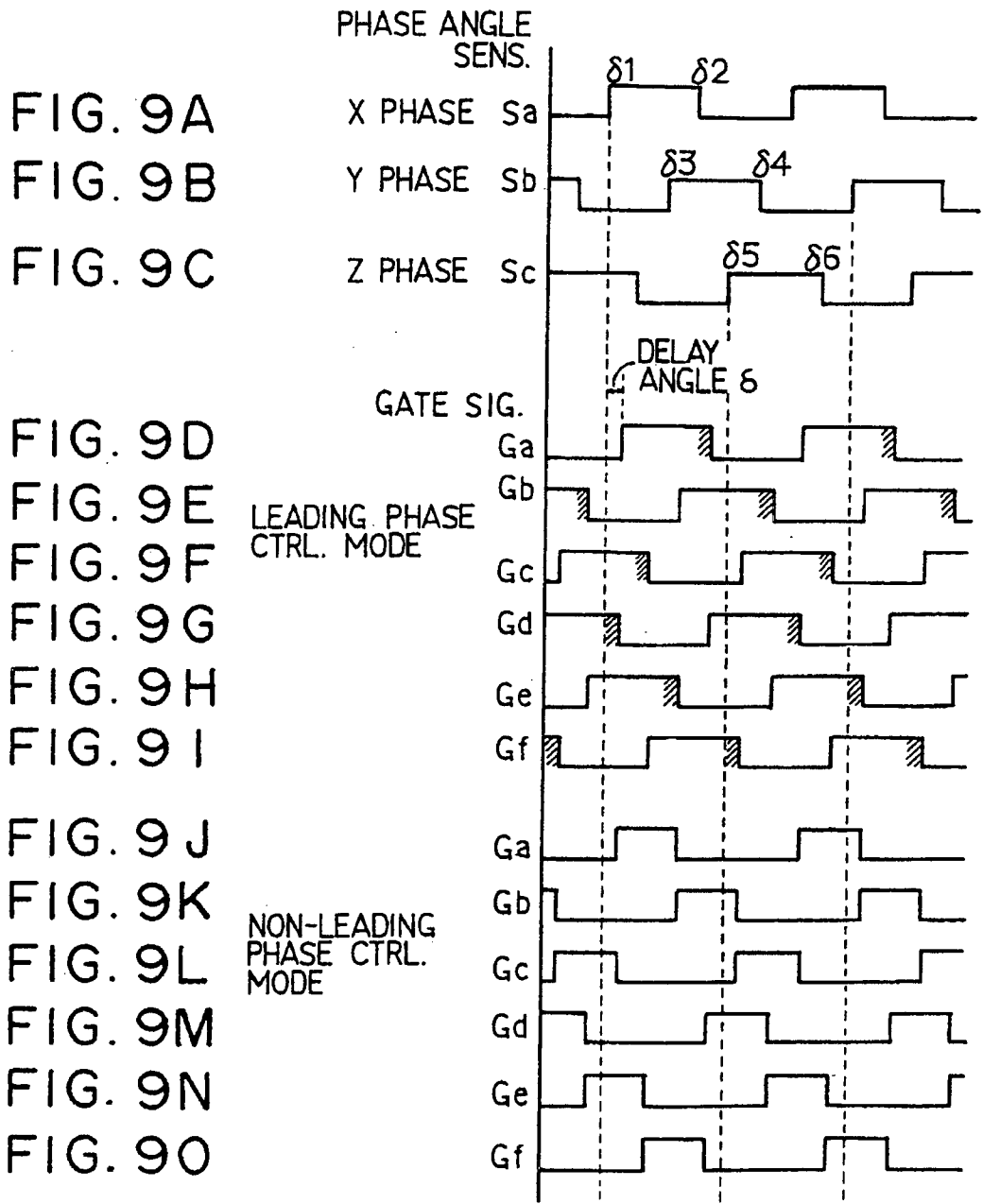


FIG. 10

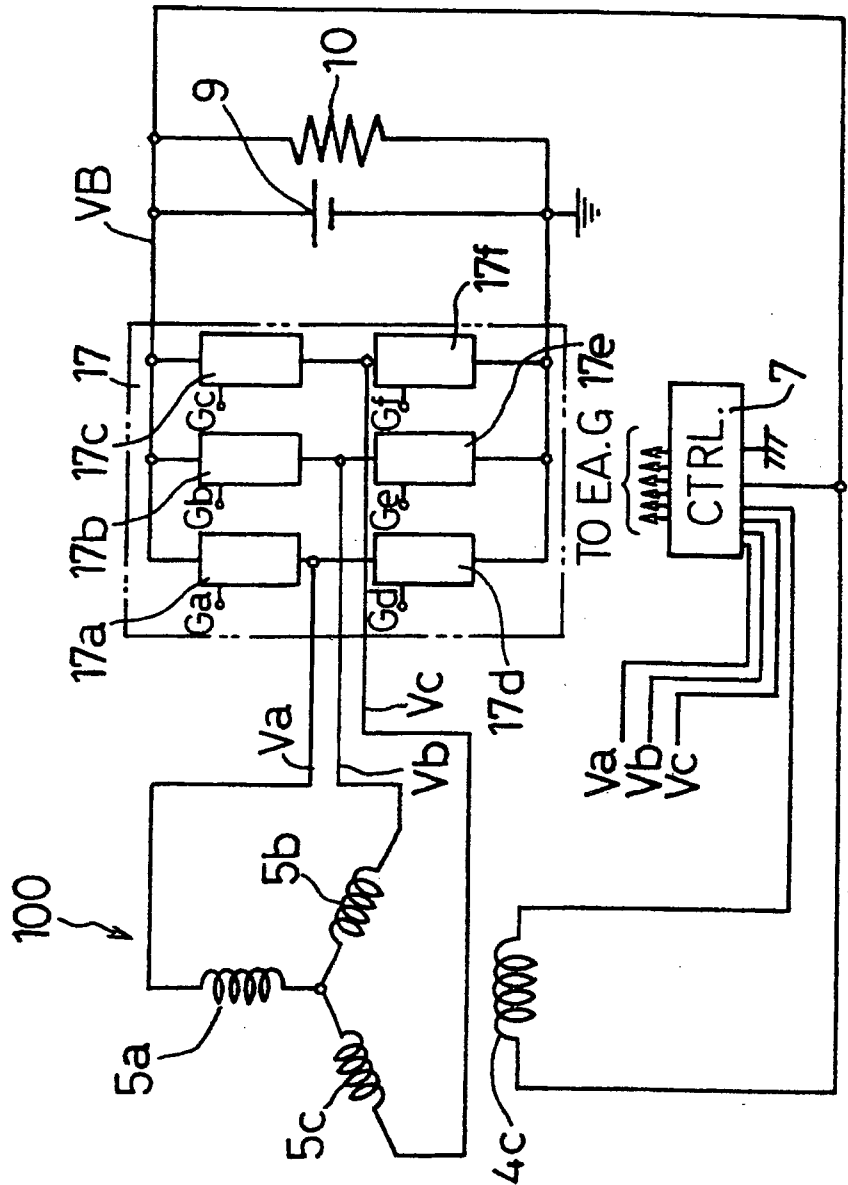


FIG. 11

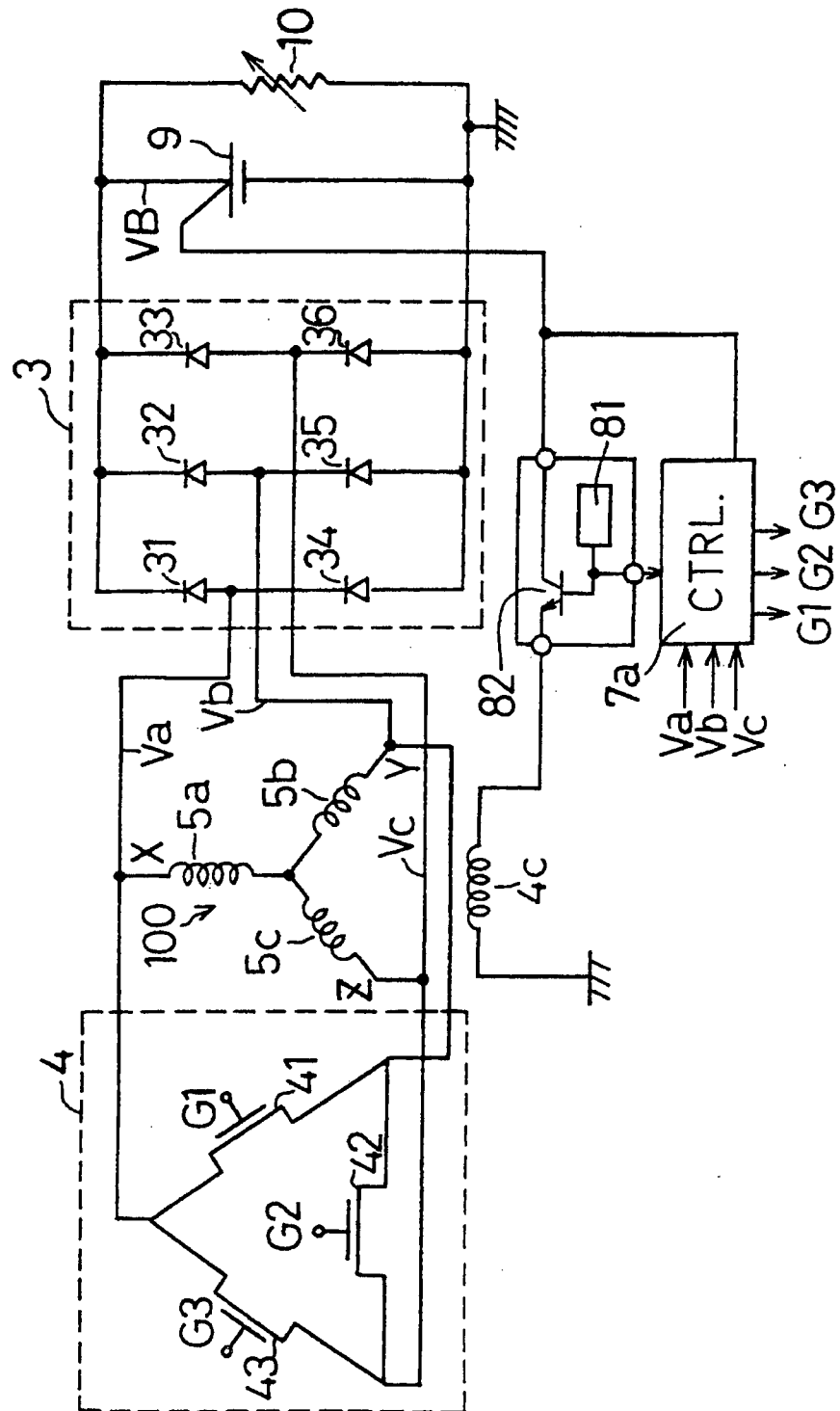


FIG. 12

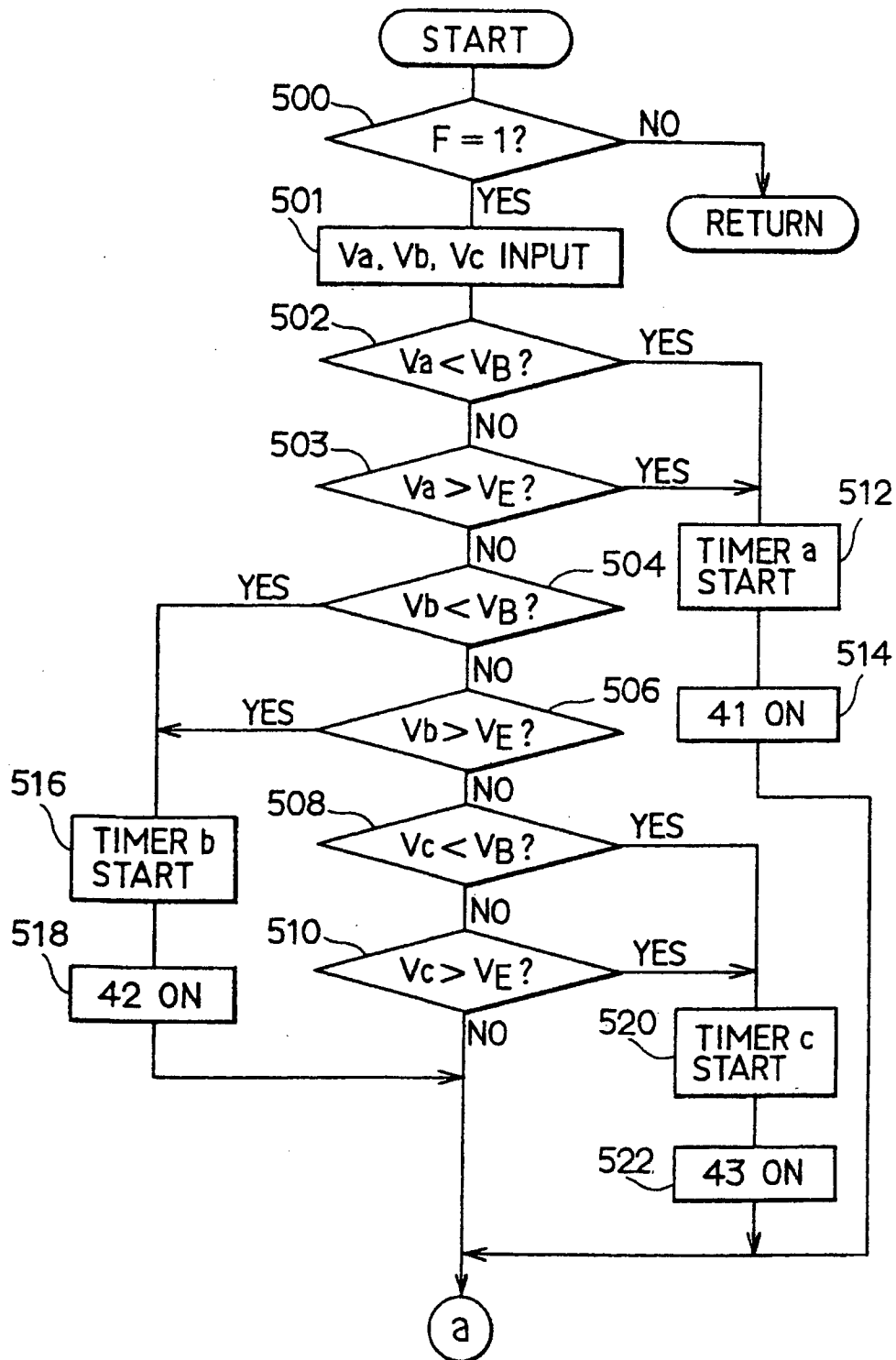


FIG. 13

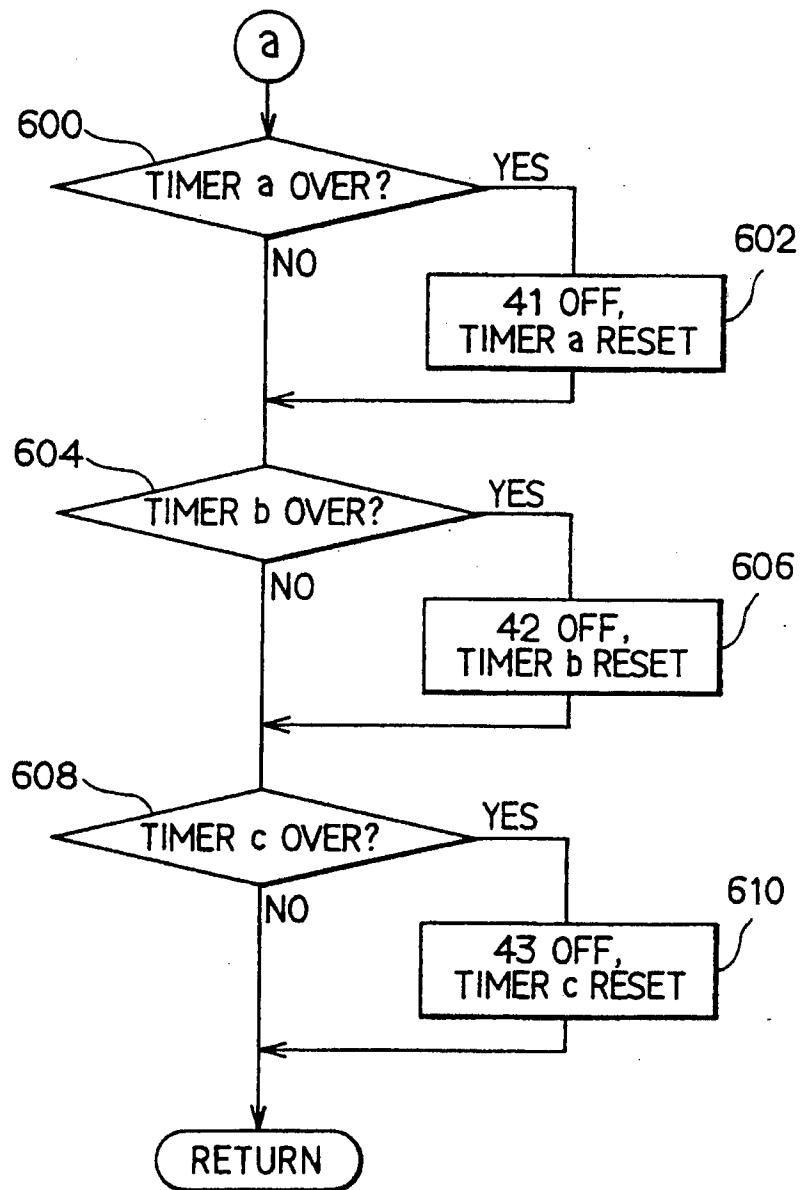


FIG. 14

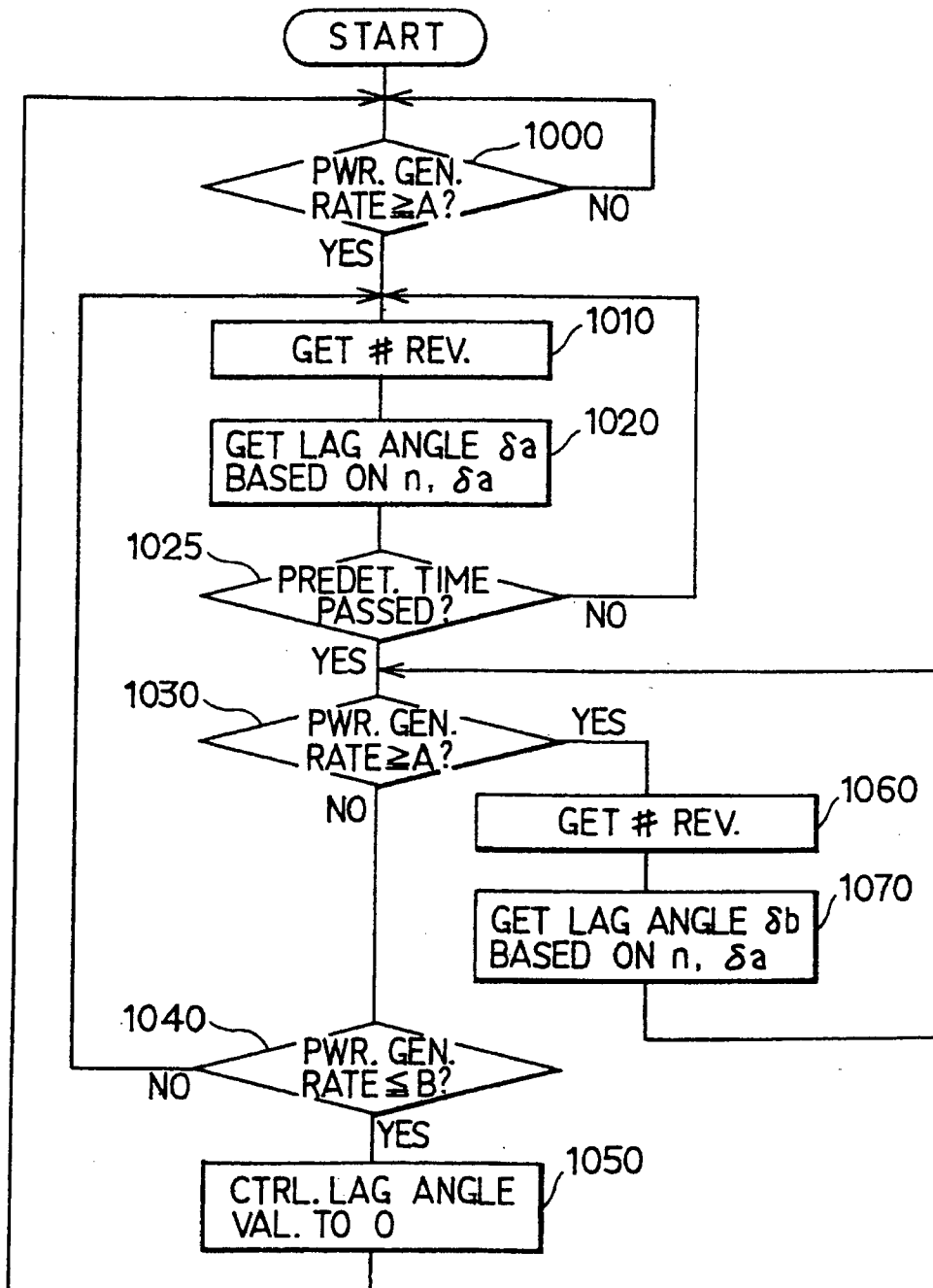


FIG. 15

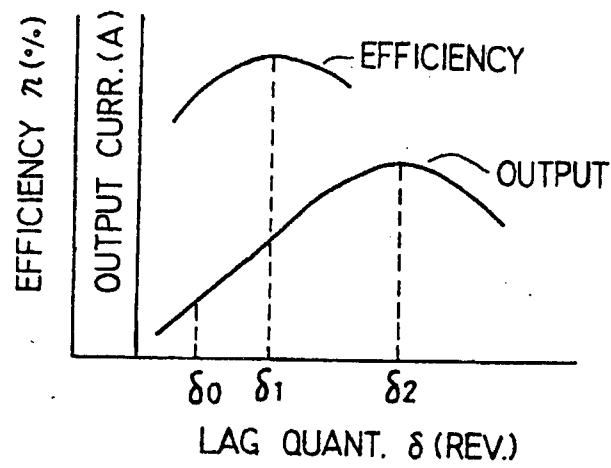


FIG. 16

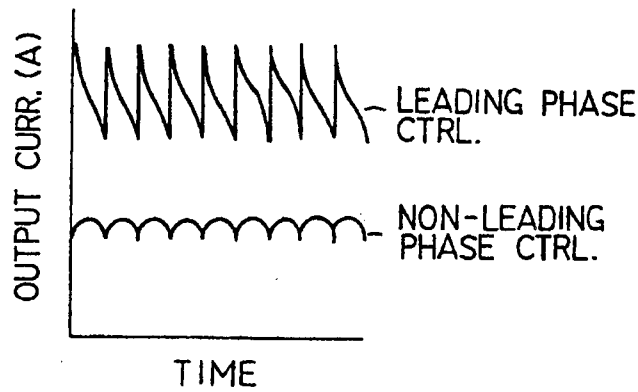


FIG. 21A

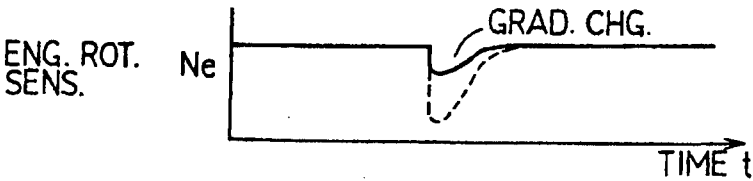


FIG. 21B

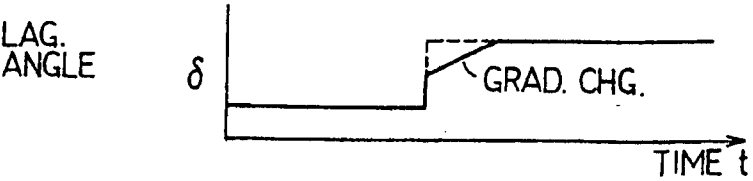


FIG. 21C

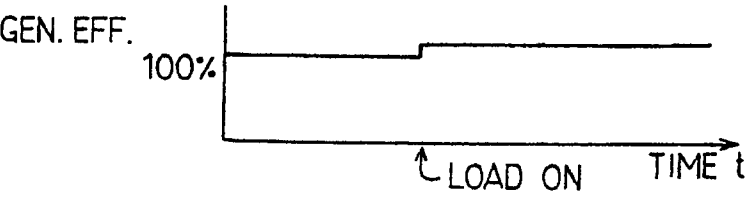


FIG. 18

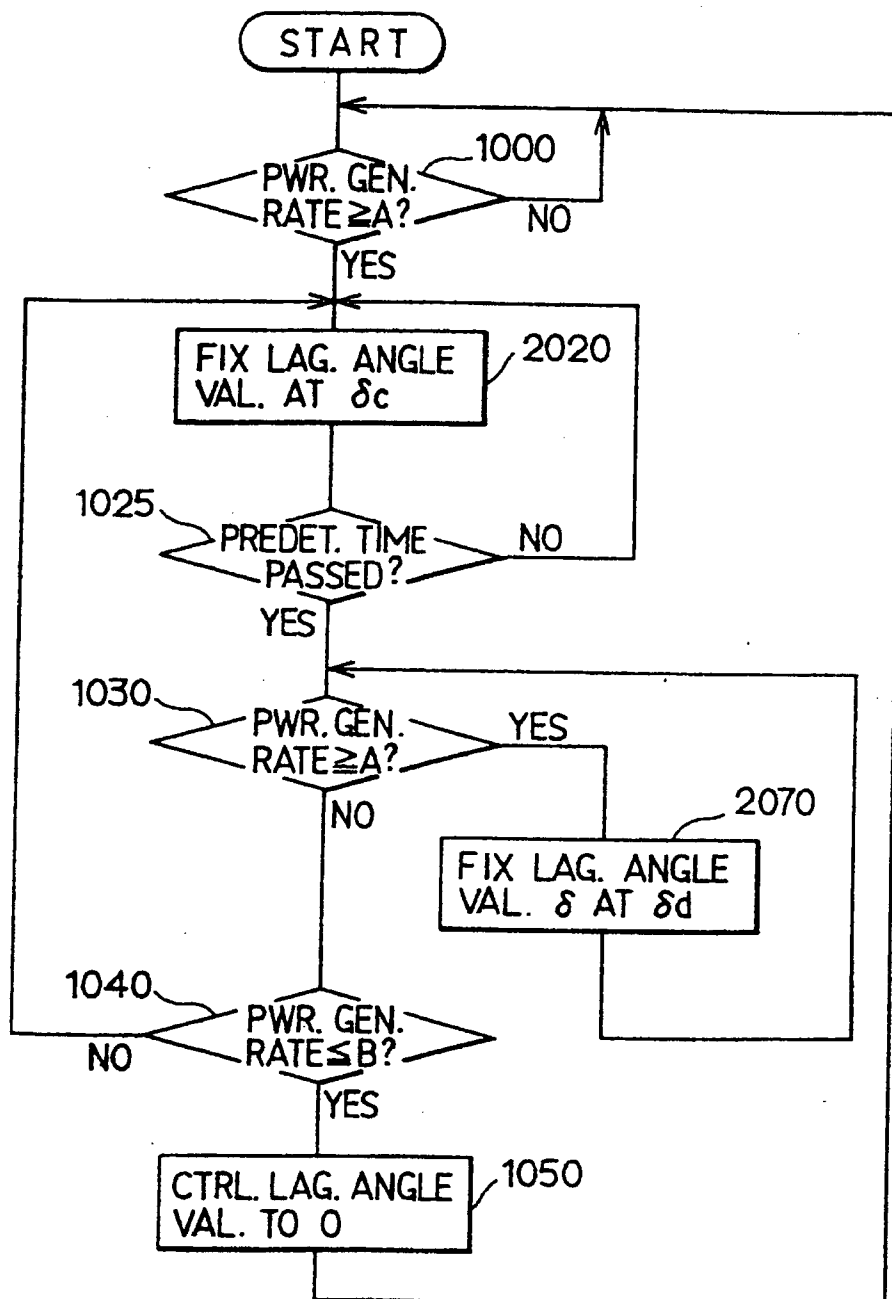


FIG. 19

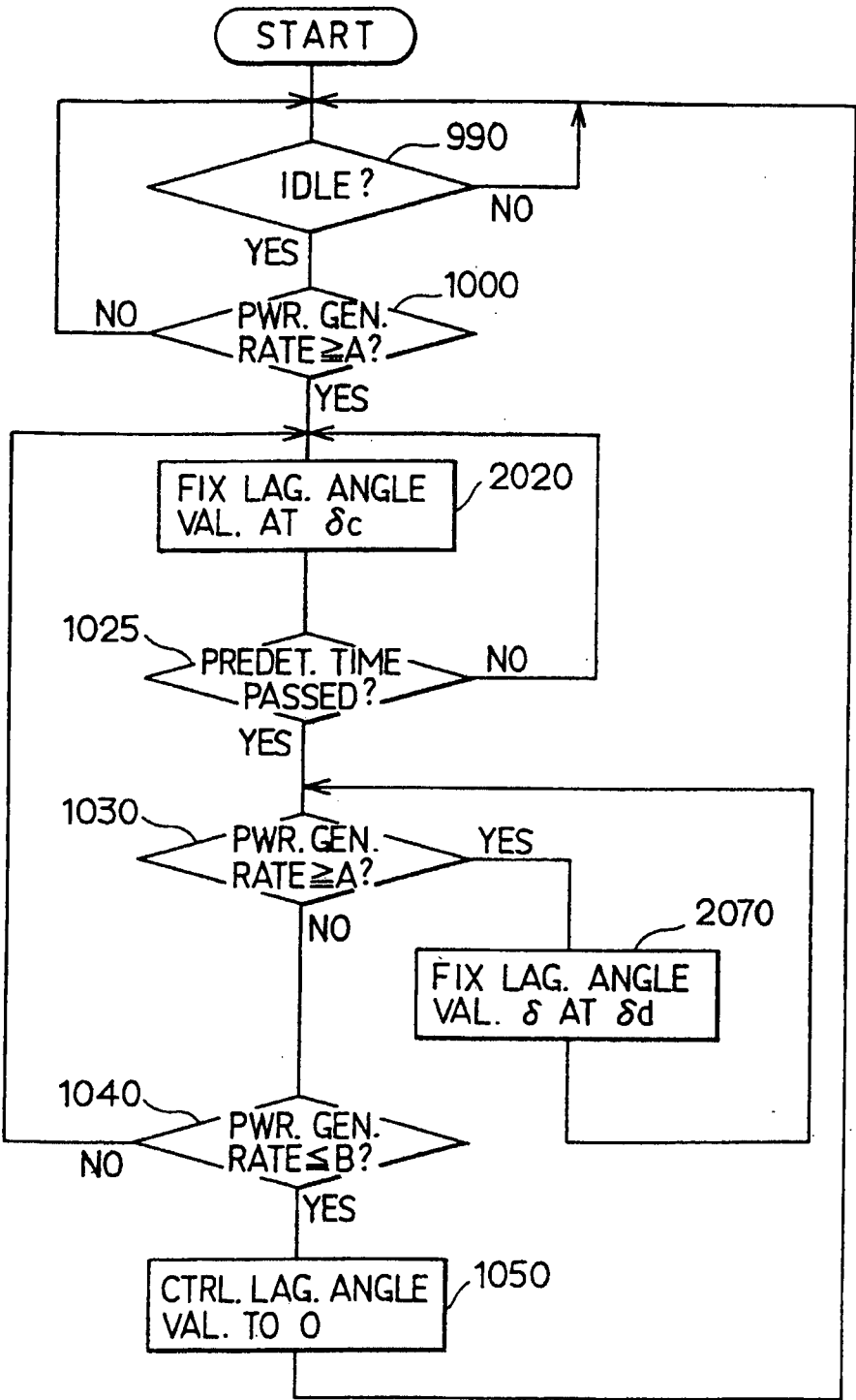


FIG. 20

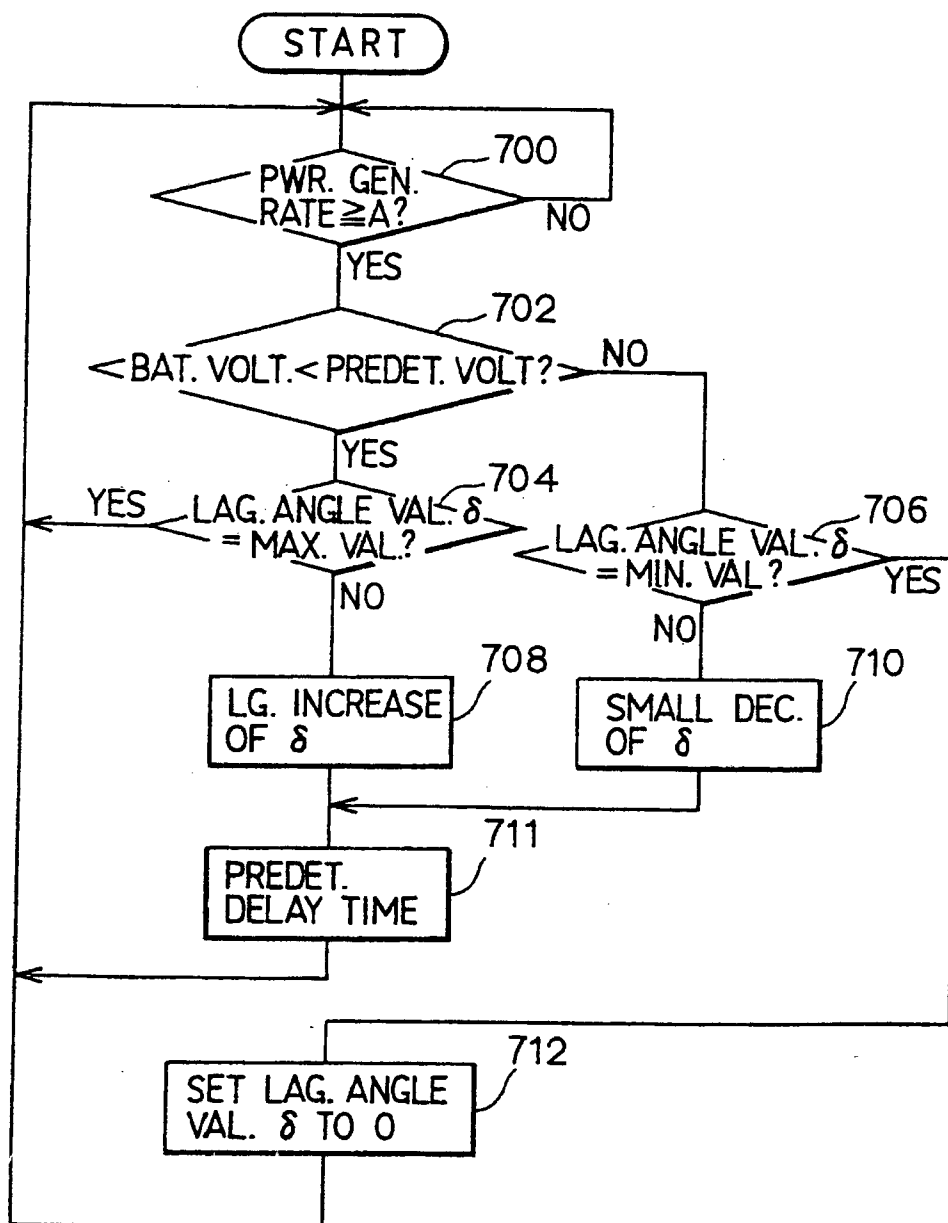


FIG. 22

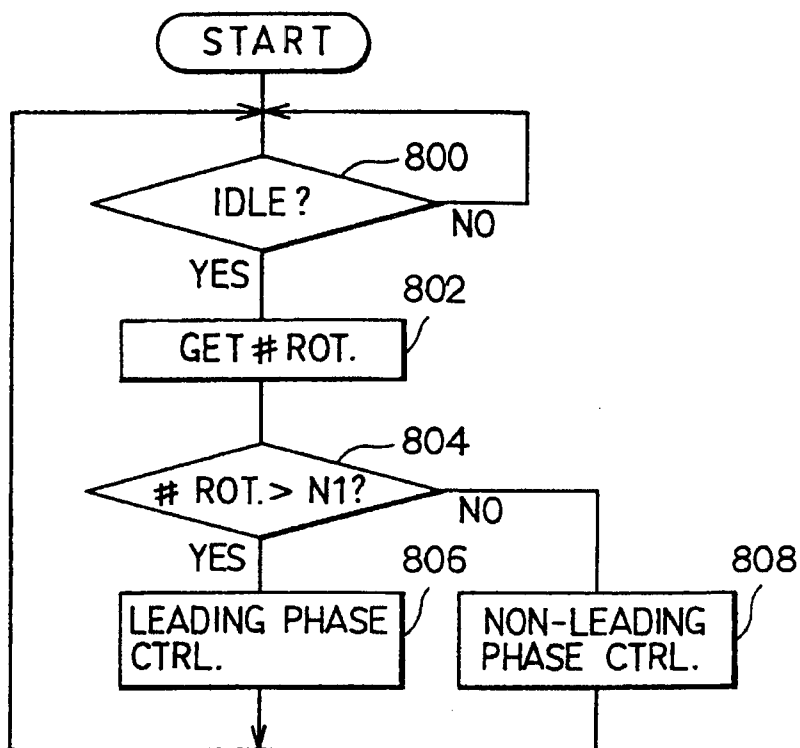


FIG. 23

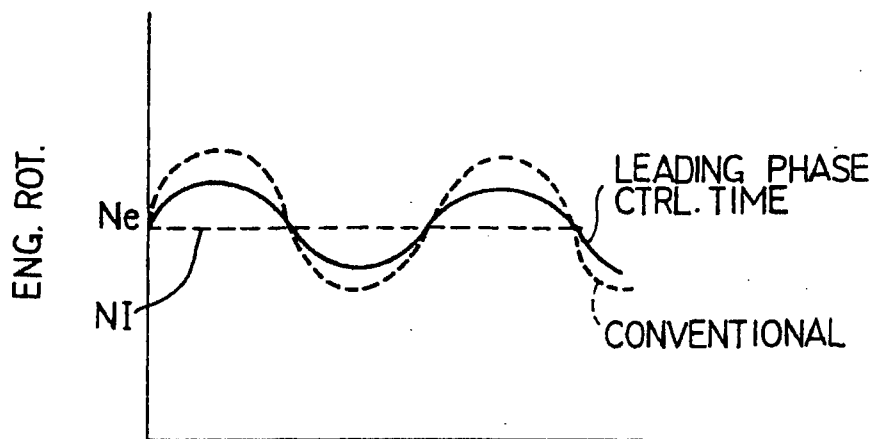


FIG. 24

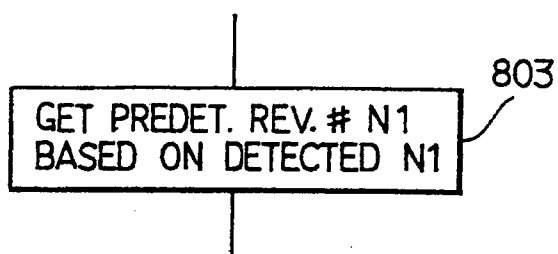


FIG. 25

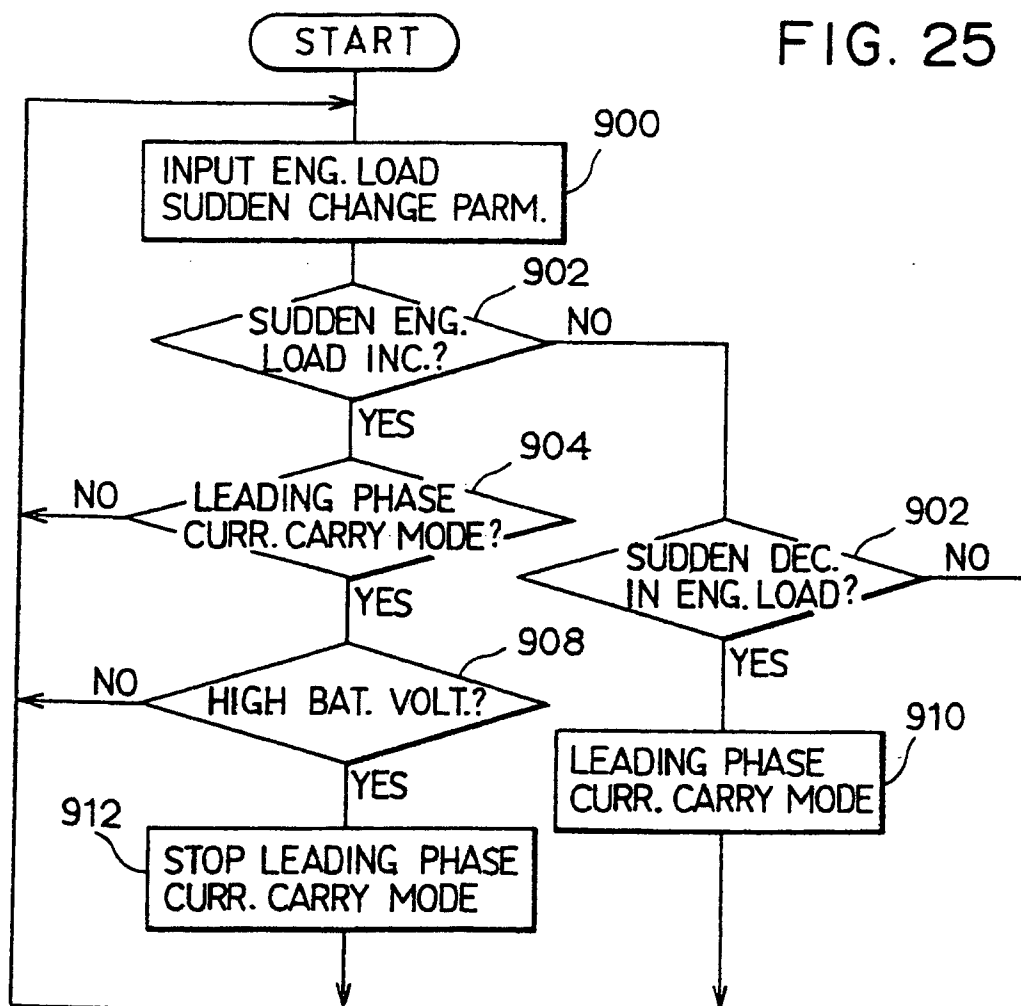


FIG. 26

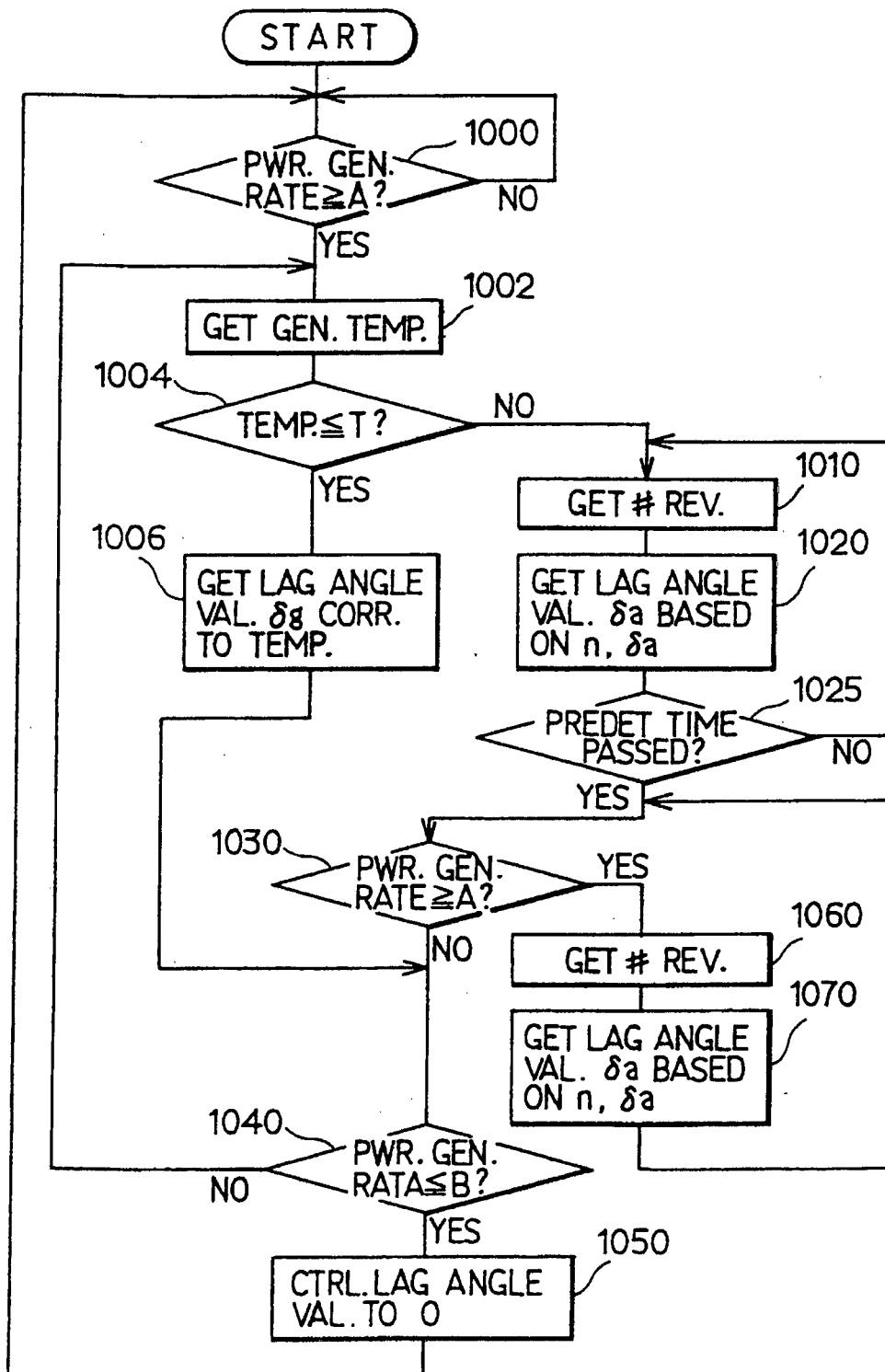
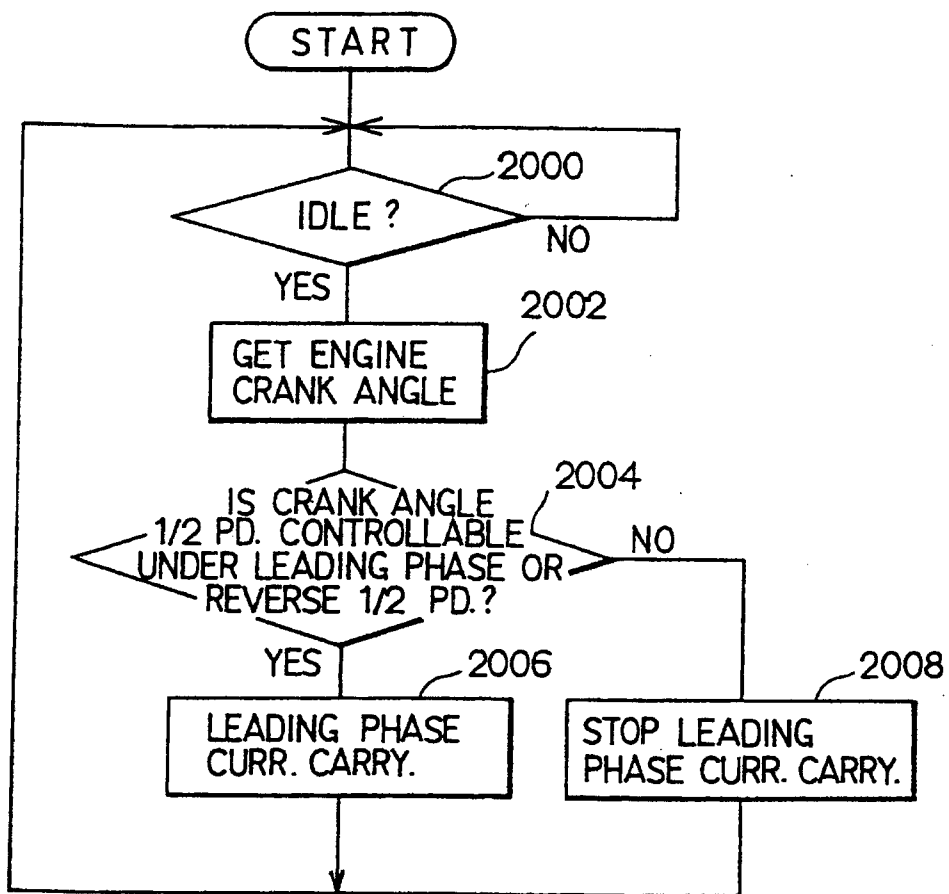


FIG. 27





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 6384

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
E	EP 0 717 490 A (GENERAL MOTORS) * the whole document *	1-3,5, 12,16,30	H02J7/14
P,A	EP 0 665 637 A (NIPPONDENSO) * the whole document *	1,30	
A	US 5 255 175 A (UCHINO) * the whole document *	1,30	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H02J H02P
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 December 1997	Examiner Calarasanu, P
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

English translation of the Request Form

1/4

PCT REQUEST

PCT01X

0	For receiving Office use only	
0-1	International Application No.	PCT/JP01/08873
0-2	International Filing Date	10 OCT 2001
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.92 (updated 01.03.2001)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Japan Patent Office (RO/JP)
0-7	Applicant's or agent's file reference	PCT01X
I	Title of invention	OUTPUT CONTROL UNIT FOR SYNCHRONOUS GENERATOR
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States
II-4	Name	HONDA GIKEN KOGYO KABUSHIKI KAISHA
II-5	Address:	1-1, Minamiaoyama 2-chome Minato-ku, Tokyo 107-8556 Japan
II-6	State of nationality	JP
II-7	State of residence	JP
II-8	Telephone No.	03-5412-1114
II-9	Facsimile No.	03-5412-1524
III-1	Applicant and/or inventor	
III-1-1	This person is:	inventor only
III-1-4	Name (LAST, First)	OTA, Atsuo
III-1-5	Address:	c/o Kabushiki Kaisha Honda Gijutsu Kenkyusho 4-1, Chuo 1-chome Wako-shi, Saitama 351-0193 Japan

III-2	Applicant and/or inventor	
III-2-1	This person is:	inventor only
III-2-4	Name (LAST, First)	HONDA, Satoshi
III-2-5	Address:	c/o Kabushiki Kaisha Honda Gijutsu Kenkyusho 4-1, Chuo 1-chome Wako-shi, Saitama 351-0193 Japan
IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	TANAKA, Koju
IV-1-2	Address:	Room 403, Famiil-Nishishinjuku, 3-23, Nishishinjuku 3-chome Shinjuku-ku, Tokyo 160-0023 Japan
IV-1-3	Telephone No.	03-3342-3380
IV-1-4	Facsimile No.	03-3342-3379
IV-1-5	e-mail	nissinpo@blue.ocn.ne.jp
IV-2	Additional agent(s)	additional agent(s) with same address as first named agent
IV-2-1	Name(s)	HIRAKI, Michito
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	---
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	BR CO ES ID IL IN KR PH TR VN ZA
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE

154

PCT REQUEST

PCT01X

VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	11 October 2000 (11.10.2000)	
VI-1-2	Number	P2000-310769	
VI-1-3	Country	JP	
VII-1	International Searching Authority Chosen	Japan Patent Office (JPO) (ISA/JP)	
VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	Check list	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	4	-
IX-2	Description	10	-
IX-3	Claims	1	-
IX-4	Abstract	1	-
IX-5	Drawings	6	-
IX-7	TOTAL	22	
	Accompanying items	paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-9	Original separate power of attorney	✓	-
IX-13	Priority document(s)	Item(s) VI-1	-
IX-17	PCT-EASY diskette	-	Diskette
IX-18	Other (specified):	Revenue stamps of transmittal fee and search fee for receiving office	-
IX-18	Other (specified):	Submission of certificate of payment for international fee	-
IX-19	Figure of the drawings which should accompany the abstract	1	
IX-20	Language of filing of the international application	Japanese	
X-1	Signature of applicant, agent or common representative		
X-1-1	Name (LAST, First)	TANAKA, Koju	

155

PCT REQUEST

PCT01X

X-2	Signature of applicant, agent or common representative	
X-2-1	Name (LAST, First)	HIRAKI, Michito

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/JP
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
------	--	--

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:

TANAKA, Koju
Room 403, Famiil-Nishishinjuku, 3-
23, Nishishinjuku 3-chome
Shinjuku-ku, Tokyo 160-0023
JAPON

Date of mailing (day/month/year) 18 April 2002 (18.04.02)		IMPORTANT NOTICE	
Applicant's or agent's file reference PCT01X			
International application No. PCT/JP01/08873	International filing date (day/month/year) 10 October 2001 (10.10.01)	Priority date (day/month/year) 11 October 2000 (11.10.00)	
Applicant HONDA GIKEN KOGYO KABUSHIKI KAISHA			

1. Notice is hereby given that the International Bureau has **communicated**, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this notice:

KR

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

BR,CO,ES,ID,IL,IN,PH,TR,VN,ZA

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this notice is a copy of the international application as published by the International Bureau on 18 April 2002 (18.04.02) under No. WO 02/31960

4. **TIME LIMITS for filing a demand for international preliminary examination and for entry into national phase**

The applicable time limit for entering the national phase will, **subject to what is said in the following paragraph be 30 MONTHS** from the priority date, not only in respect of any elected Office if a demand for international preliminary examination is filed before the expiration of **19 months** from the priority date, but also in respect of any designated Office, in the absence of filing of such demand, where Article 22(1) as modified with effect from 1 April 2002 applies in respect of the designated Office. For further details, see PCT Gazette No.44/2001 of 1 November 2001, pages 19926, 19932 and 19934, as well as the PCT Newsletter, October and November 2001 and February 2002 issues.

In practice, **time limits other than the 30-month time limit** will continue to apply, for various periods of time, in respect of certain designated or elected Offices. For **regular updates on the applicable time limits** (20,21,30 or 31 months, or other time limit), Office by Office, refer to the PCT Gazette, the PCT Newsletter and the PCT Applicant's Guide, Volume II, National Chapters, all available from WIPO's Internet site, at <http://www.wipo.int/pct/en/index.html>.

For filing a **demand for international preliminary examination**, see the PCT Applicant's Guide, Volume I/A, Chapter IX. Only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination (at present, all PCT Contracting States are bound by Chapter II.)

It is the applicant's **sole responsibility** to monitor all these limits.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. (41-22) 740.14.35	Authorized officer J. Zahra Telephone No. (41-22) 338.91.11
--	---

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP01/08873

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.⁷ H02P 9/48

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)
Int. Cl.⁷ H02P 9/00-9/48

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	EP 0740394 A2 (NIPPONDENSO CO., LTD.), 30 October, 1996 (30.10.1996), Column 17, line 33 to Column 45, line 24; Figs. 1 to 27 & JP 8-298731 A Par. Nos. [0030] to [0163]; Figs. 1 to 27	1 2-4
Y A	US 5648705 A (Ford Motor Company), 15 July, 1997 (15.07.1997), Column 3, line 1 to Column 8, line 11; Figs. 1 to 9 & US 5793167 A	1 2-4
Y A	JP 2000-102279 A (Kokusan Denki Co., Ltd.), 07 April, 2000 (07.04.2000), Par. Nos. [0041] to [0052]; Figs. 2, 3 (Family: none)	1 2-4
A	US 5642021 A (Ford Motor Company), 24 July, 1997 (24.07.1997), Column 2, line 27 to Column 5, line 5 (Family: none)	2-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 08 January, 2002 (08.01.02)	Date of mailing of the international search report 22 January, 2002 (22.01.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

PATENT COOPERATION TREATY

158

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

To:

TANAKA, Koju
Room 403, Famiil-Nishishinjuku, 3-
23, Nishishinjuku 3-chome
Shinjuku-ku, Tokyo 160-0023
JAPON

Date of mailing (day/month/year) 09 November 2001 (09.11.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference PCT01X	International application No. PCT/JP01/08873

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

HONDA GIKEN KOGYO KABUSHIKI KAISHA (all designated States)

International filing date : 10 October 2001 (10.10.01)

Priority date(s) claimed : 11 October 2000 (11.10.00)

Date of receipt of the record copy
by the International Bureau : 26 October 2001 (26.10.01)

List of designated Offices :

National : BR, CO, ES, ID, IL, IN, KR, PH, TR, VN, ZA

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

☒ time limits for entry into the national phase

☒ confirmation of precautionary designations

☐ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer: Shinji IGABASHI
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

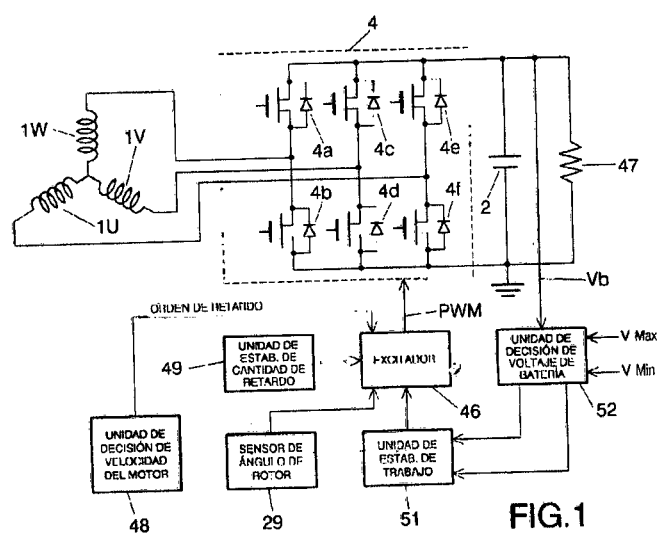


FIG.1

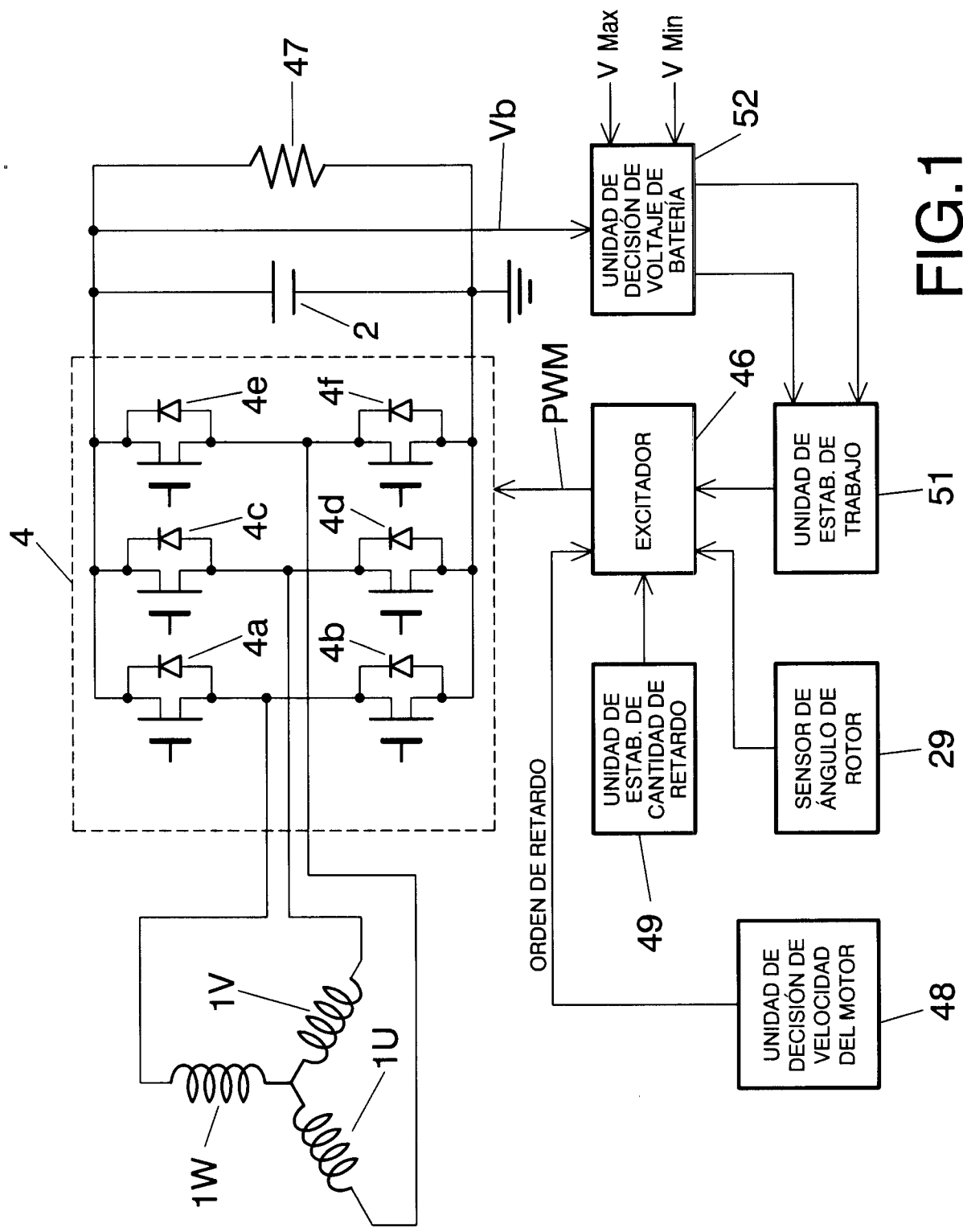


FIG.1

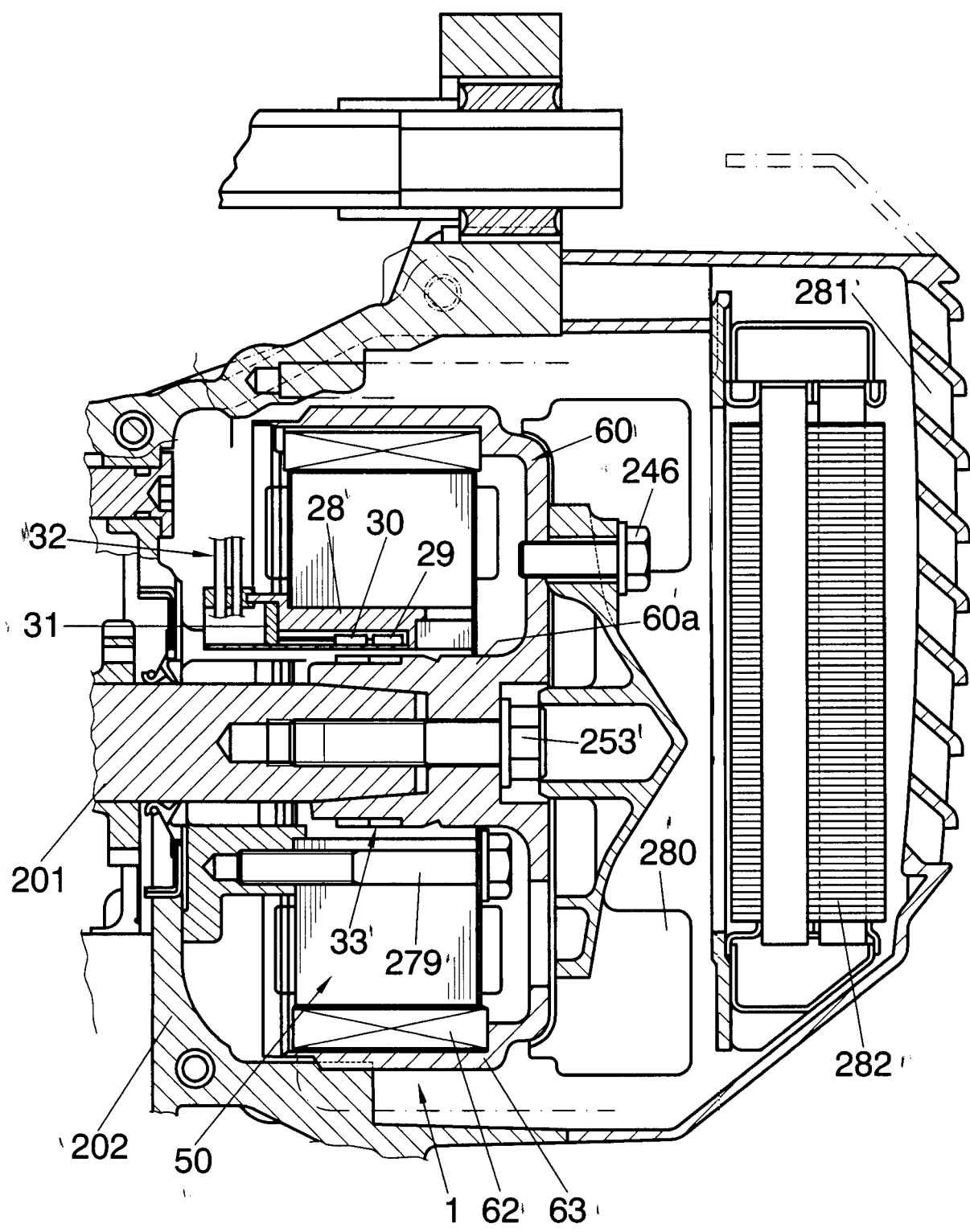


FIG.2

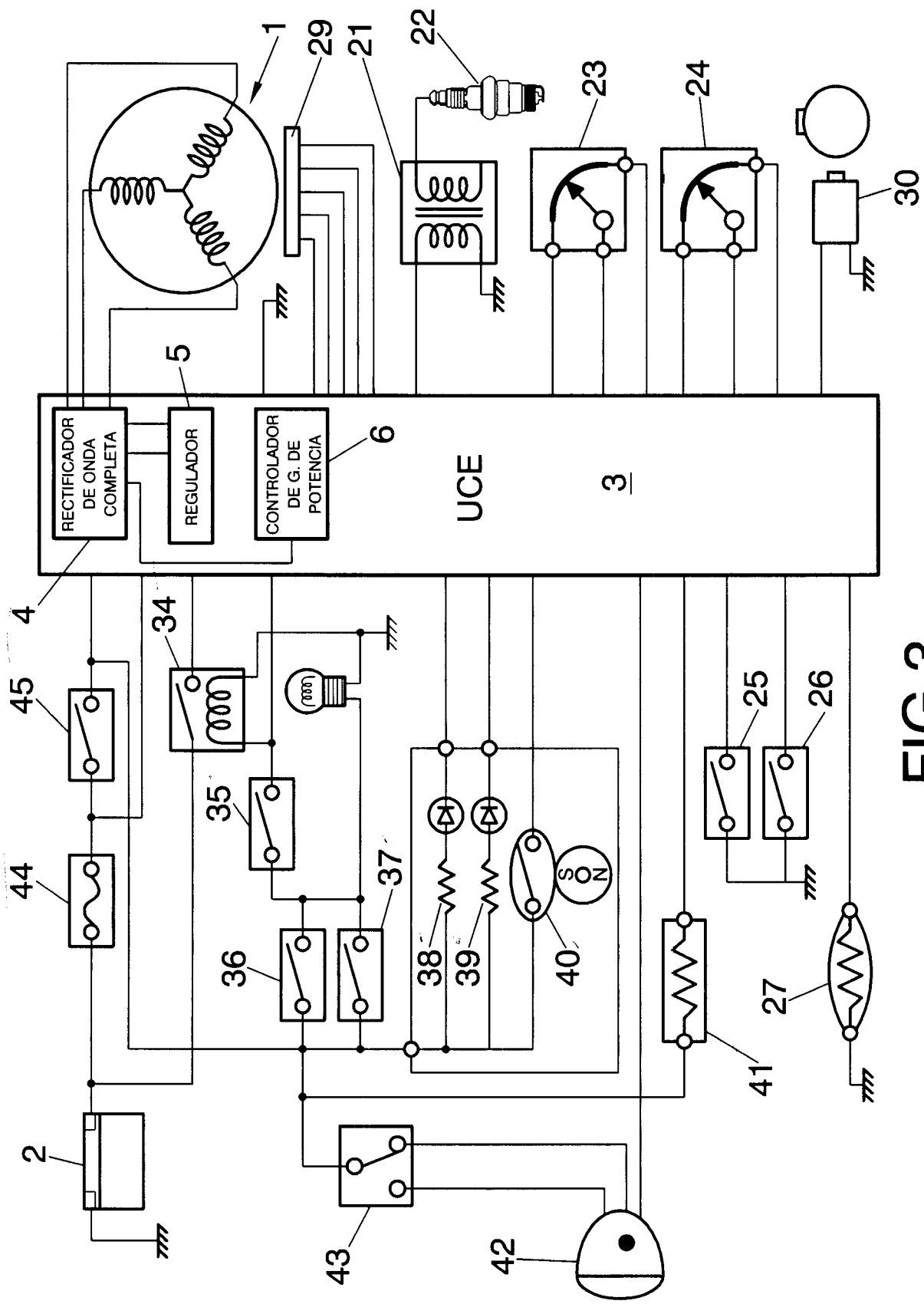


FIG.3

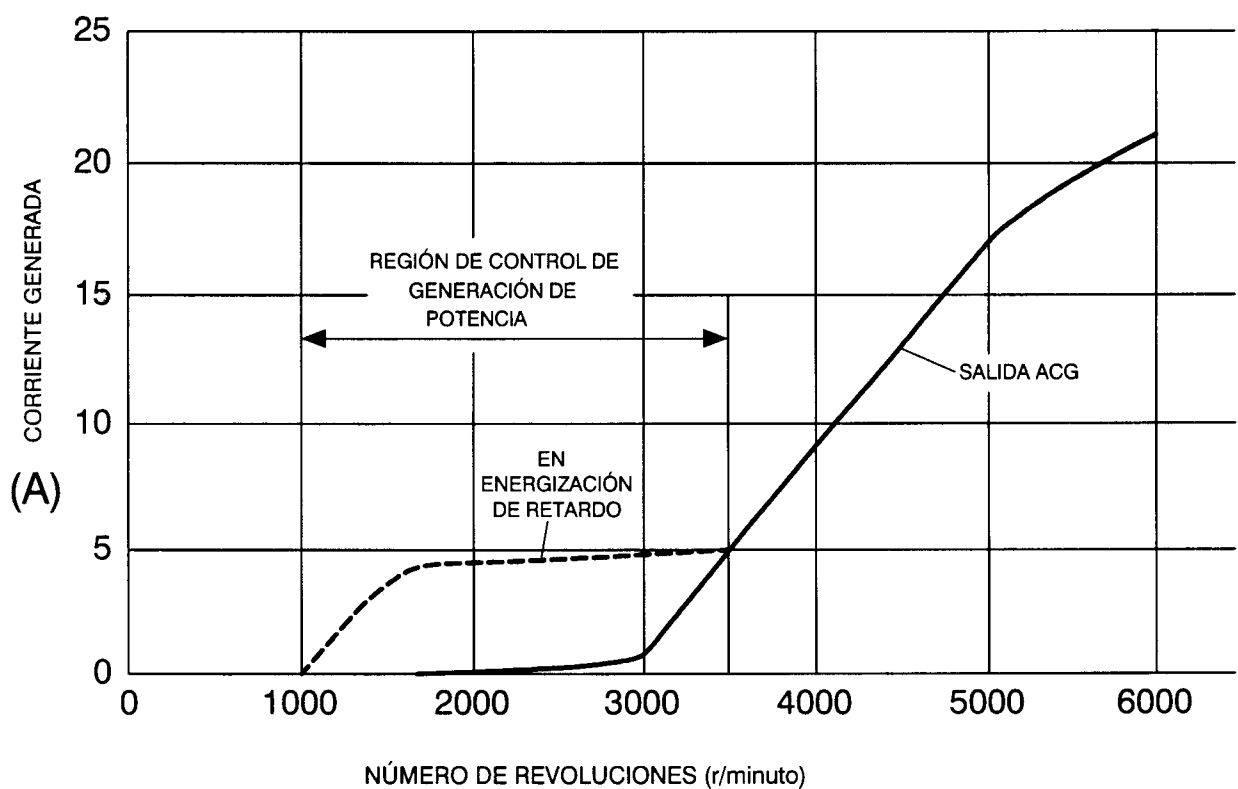


FIG.4

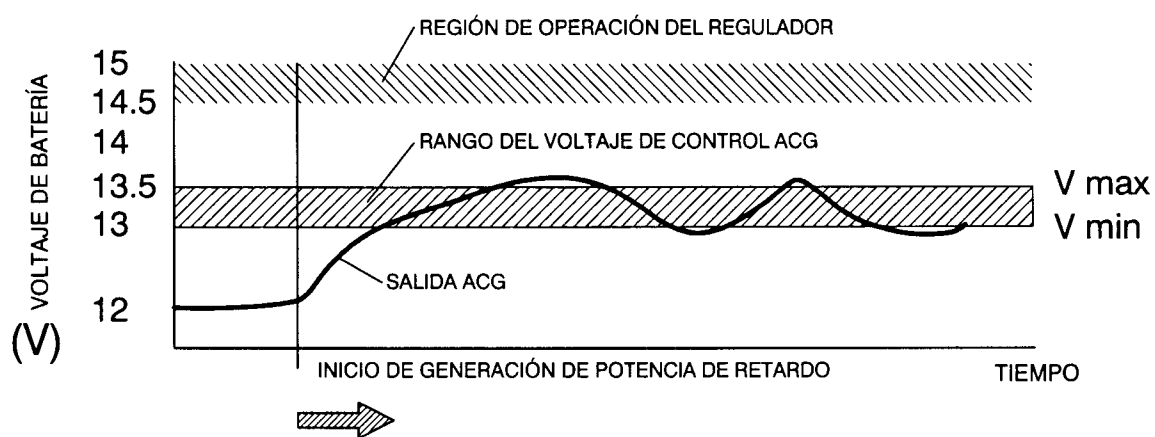


FIG.5

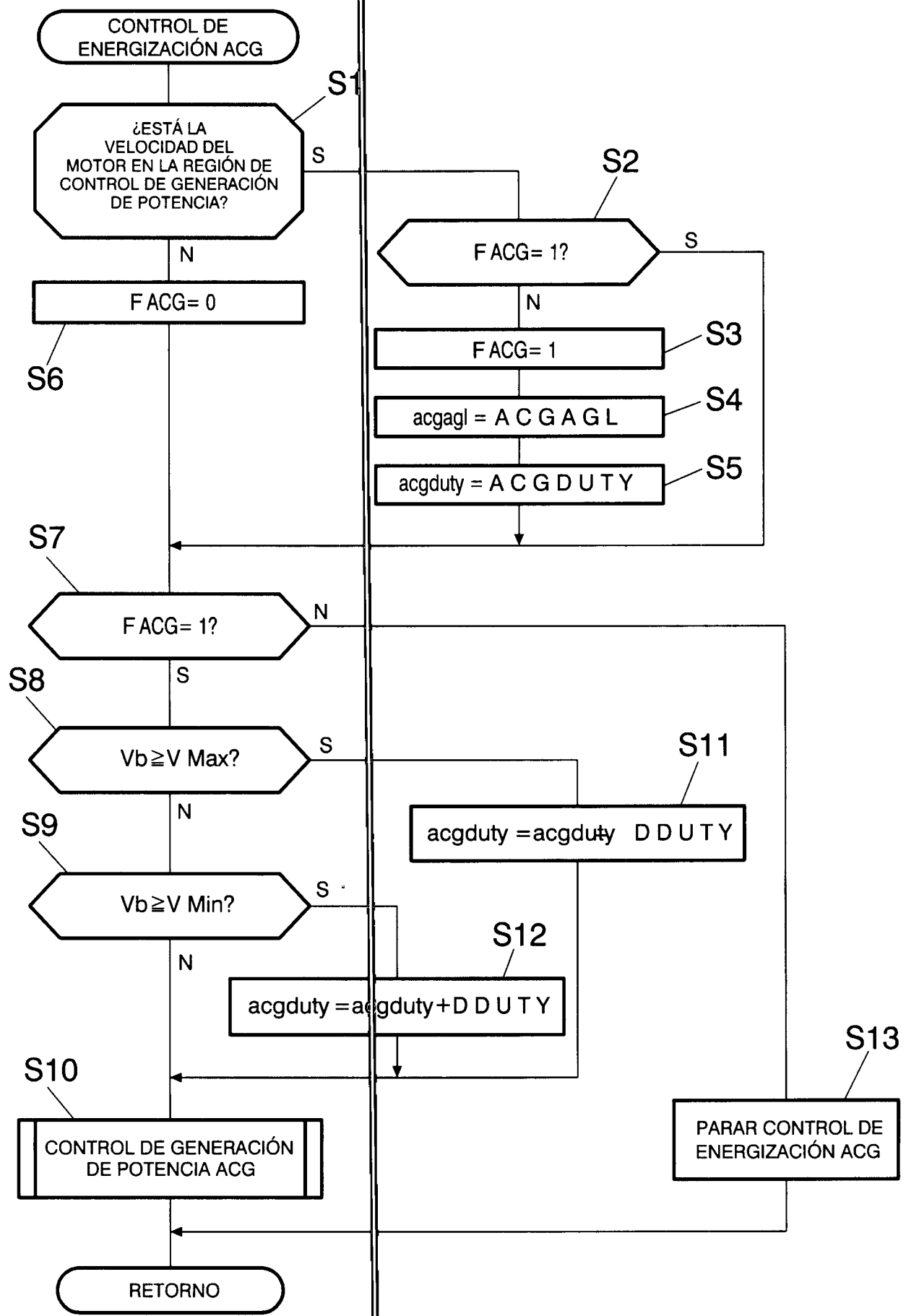


FIG.6

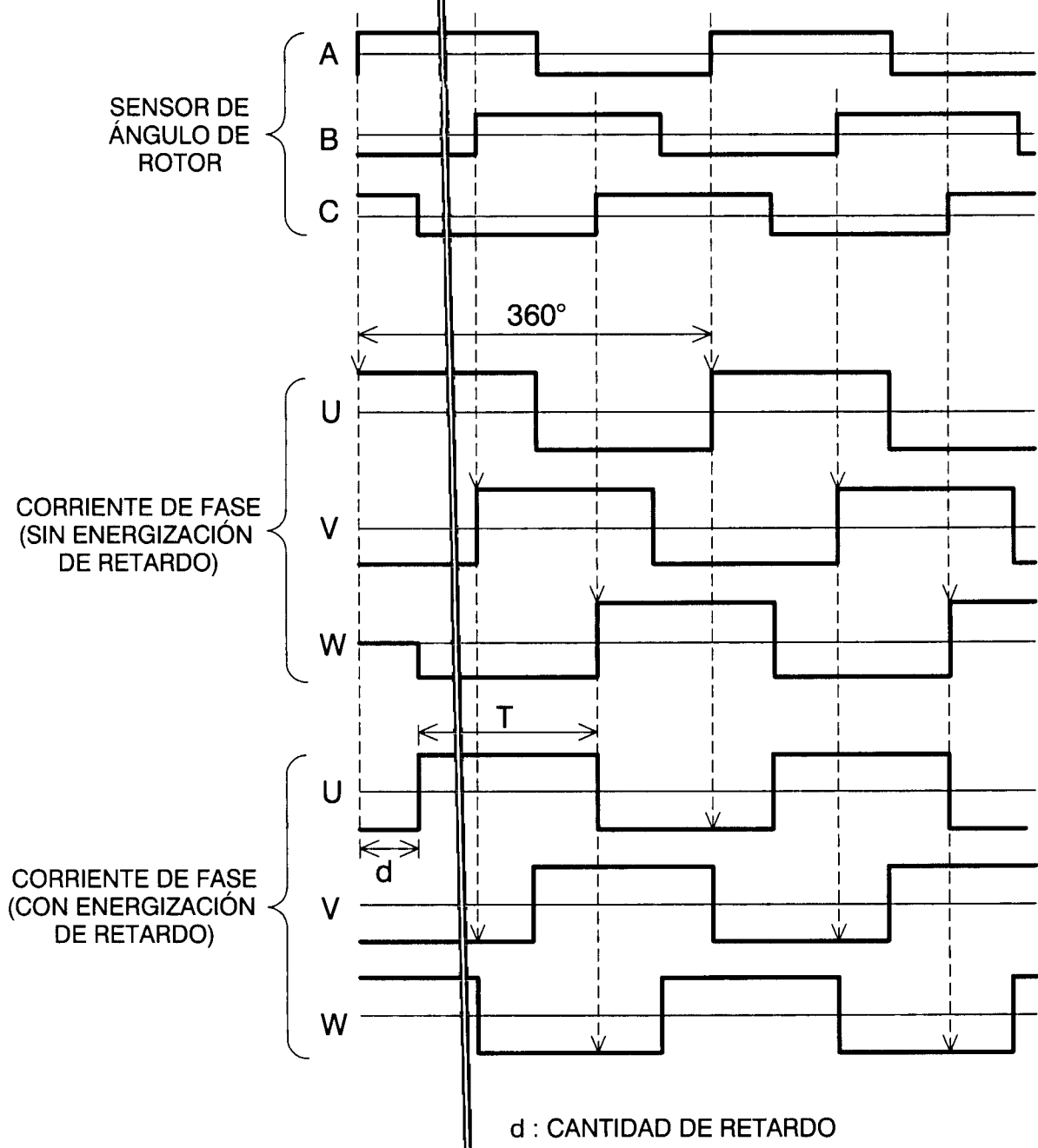


FIG.7

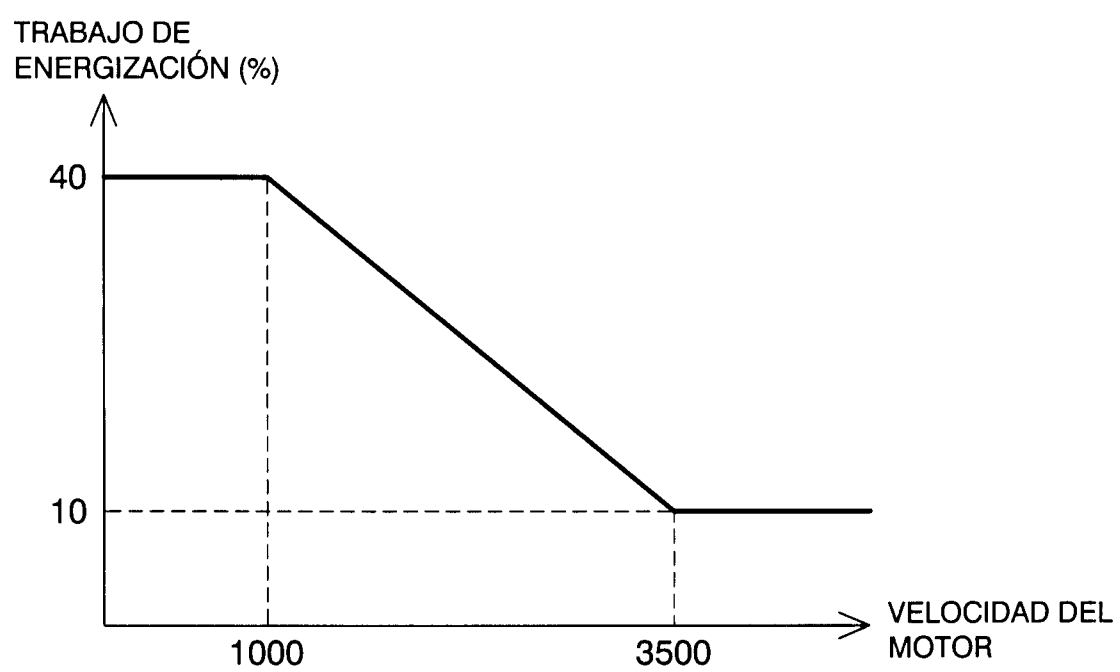


FIG.8

REQUISITOS NECESARIOS PARA PRESENTACION Y AGILIZACION DEL TRAMITE

	USUARIO	RADIADOR
PATENTE DE INVENCION 	()	()
- Indicación de que se solicita la concesión de una patente.		()
- Datos de identificación del solicitante o de la persona que se presenta la solicitud.		()
- Descripción de la invención.		()
- Dibujos de ser estos pertinentes.		()
- Comprobante de Pago de las tasas establecidas.		()

COMPLETA () INCOMPLETA ()

DISEÑO INDUSTRIAL ()

- Indicación de que se solicita el registro de Diseño Industrial	()	()
- Datos de identificación del solicitante o de la persona que presenta la solicitud.	()	()
- Representación gráfica y fotográfica del Diseño Industrial o muestra del Material que incorpora el diseño.	()	()
- Comprobante de pago de las tasas establecidas	()	()

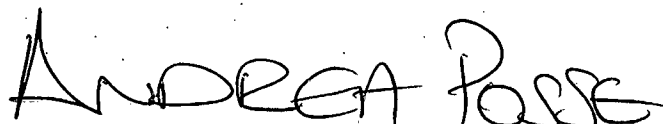
COMPLETA () INCOMPLETA ()

ESQUEMA DE TRAZADO ()

- Indicación de que solicita el registro de un Esquema de trazado.	()	()
- Datos de identificación del solicitante o de la persona que presenta La solicitud.	()	()
- Representación gráfica del esquema de trazado	()	()
- Comprobante de pago de las tasas establecidas.	()	()

COMPLETA () INCOMPLETA ()

Firma Responsable:



Fecha:

| MANTENIMIENTO DE PROTOCOLOS

|Numero : 17334

|Fecha : 20/03/1997

|Conferido: HONDA GIKEN KOGYO KABUSHIKI KAISHA

|

|Pais : JP JAPON

|Ciudad : 1 TOKYO

|Represent: S Sustituir : S Desistir : S

|No. Radicacion : Clase: 0 Seev: 0 Seac: 0

|-----

|scencia Codigo Ctr

Nombre

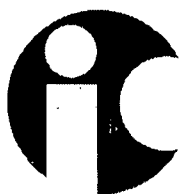
| 1 4134 RUBIO CAMACHO HUMBERTO

| 2 3116 REINA ROMERO GABRIEL

| 3 6230 STOL TINEKE

| Encontrados (1/1) registro(s)

|-----+



Folio 170

2020
Bogotá DC

Doctor(a)
HUMBERTO RUBIO CAMACHO
Apoderado(a)

REFERENCIA:	Radicación No.	03-29529
	Solicitud Internacional	PCT/JP2001/08873
	Fecha inicio fase nacional	11/05/2003
	Trámite	011
	Evento	379
	Actuación	416
	Oficio No.	1210
	Folios	001

Teniendo en cuenta que la solicitud de privilegio de patente que se tramita bajo el expediente indicado en la referencia, reúne los requisitos de forma establecidos en la Decisión 486 de la Comisión de la Comunidad Andina, el Tratado de Cooperación en Materia de Patentes (PCT), el Reglamento y la Circular Unica de la Superintendencia de Industria y Comercio, se envía el extracto de la solicitud a la Oficina de Comunicaciones para efecto de su publicación en la Gaceta de Propiedad Industrial.

Cúmplase
Dado en Bogotá DC,

01 OCT. 2003


ALIX CARMENZA CÉSPEDES DE VERGEL
Jefe de la División de Nuevas Creaciones

202051