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(71) Applicants:
- **Qingdao Haier Air-Conditioning Electronic Co., Ltd**
  Qingdao, Shandong 266101 (CN)
- **Haier Smart Home Co., Ltd.**
  Qingdao, Shandong 266101 (CN)

(72) Inventors:
- **CONG, Anping**
  Qingdao, Shandong 266101 (CN)
- **SHAO, Haizhu**
  Qingdao, Shandong 266101 (CN)
- **GENG, Yan**
  Qingdao, Shandong 266101 (CN)
- **SHI, Bin**
  Qingdao, Shandong 266101 (CN)
- **ZHANG, Bo**
  Qingdao, Shandong 266101 (CN)
- **HU, Xianghui**
  Qingdao, Shandong 266101 (CN)

(74) Representative: **dompatent von Kreisler Selting Werner -**
Partnerschaft von Patent- und Rechtsanwälten mbB
Deichmannhaus am Dom
Bahnhofsvorplatz 1
50667 Köln (DE)

(54) COMPRESSOR FLUX-WEAKENING CONTROL APPARATUS, AIR CONDITIONER, METHOD AND STORAGE MEDIUM

(57) The present disclosure relates to the field of compressor control, and discloses a device for field weakening control of a compressor. The device includes a main circuit unit and the compressor, wherein the main circuit unit provides power for the compressor, and the device further includes: a compressor rotational speed obtaining unit; and a control unit used to compare the rotational speed ω of the compressor with a rotational speed threshold $\omega 1$ of the compressor, and control the main circuit unit as follows according to comparison results: when the rotational speed ω of the compressor is less than $\omega 1$, an output voltage of the main circuit unit is controlled at a fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the main circuit unit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise. In this way, the time for the compressor to enter the field weakening control can be delayed to the greatest extent, the compressor is controlled not to enter the field weakening control to the greatest extent, and the stability of the system is improved. The present disclosure further discloses a method for field weakening control of a compressor, a storage medium and an air conditioner.

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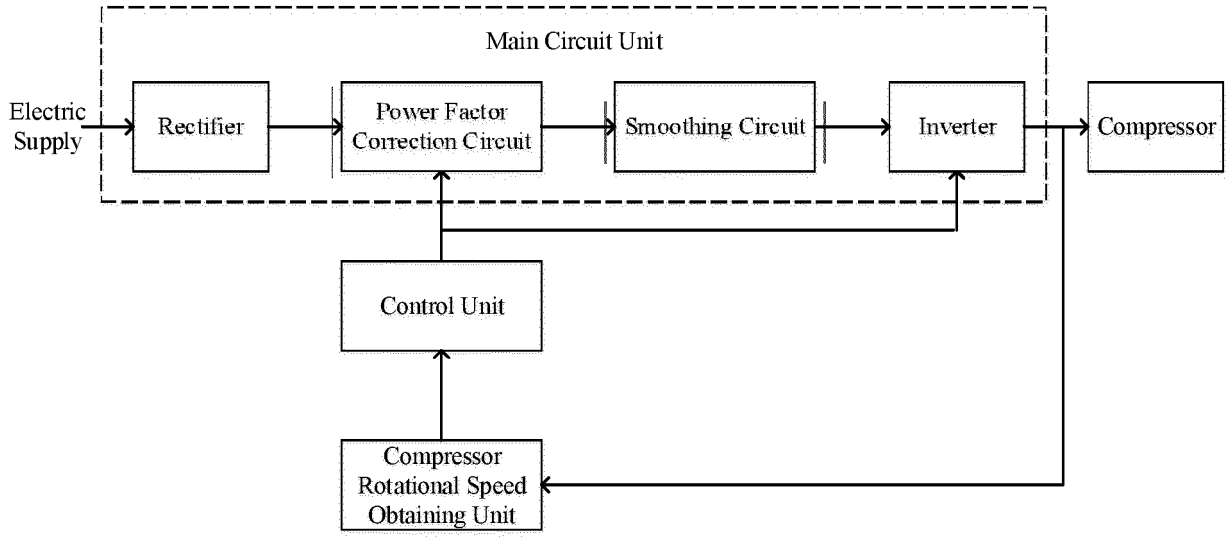
Main Circuit Unit
Electric Supply
Rectifier
Power Factor Correction Circuit
Smoothing Circuit
Inverter
Compressor
Control Unit
Compressor Rotational Speed Obtaining Unit

Fig. 1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The application is based upon and claims priority to Chinese Patent Application No. 201811469185.5, filed November 28, 2018, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of compressor control technologies, and more particularly, to a device and a method for field weakening control of a compressor, an air conditioner and a storage medium.

BACKGROUND

[0003] When operating in a high-speed area, a permanent magnet synchronous compressor is easy to enter a field weakening control area. During the field weakening control, the increase of Id current (Id: current that generates magnetic flux) is easy to cause the efficiency of a whole machine to become lower, meanwhile, the change of Id will cause problems such as position estimation, resulting in the unstable system. Therefore, if the time for the compressor to enter the field weakening control can be delayed, the efficiency of the compressor and the stability of the system will be improved.

SUMMARY

[0004] The present disclosure provides a device and a method for field weakening control of a compressor, an air conditioner and a storage medium, so as to solve the problem that the compressor is easy to enter a field weakening control area during high-speed operation. In order to have a basic understanding of some aspects of the disclosed embodiments, a brief summary is given below. This summary is not a general comment, nor is it intended to identify key/important constituent elements or describe the scope of protection of these embodiments. The sole purpose thereof is to present some concepts in a simplified form as a preface to the following detailed description.

[0005] According to a first aspect of the present disclosure, there is provided a device for field weakening control of a compressor.

[0006] In some embodiments, the device for field weakening control of the compressor includes a main circuit unit and the compressor, the main circuit unit provides power for the compressor, and the device further includes:

a compressor rotational speed obtaining unit used to obtain a current of the compressor, and calculate a rotational speed ω of the compressor; and

a control unit used to compare the rotational speed co of the compressor with a rotational speed threshold $\omega 1$ of the compressor, and control the main circuit unit as follows according to comparison results:

when the rotational speed co of the compressor is less than $\omega 1$, an output voltage of the main circuit unit is controlled at a fixed value V0; and when the rotational speed co of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the main circuit unit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

[0007] In some embodiments, the main circuit unit includes a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, the power factor correction circuit is connected to the inverter through the smoothing circuit, and an output end of the inverter is electrically connected to the compressor; when the rotational speed co of the compressor is less than $\omega 1$, an output voltage of the power factor correction circuit is controlled at the fixed value V0; and when the rotational speed co of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the power factor correction circuit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

[0008] In some embodiments, the smoothing circuit is a capacitor filter circuit.

[0009] According to a second aspect of the present disclosure, there is provided an air conditioner, including the aforementioned device for field weakening control of the compressor.

[0010] According to a third aspect of the present disclosure, there is provided a method for field weakening control of a compressor, including:

obtaining a current of the compressor and calculating a rotational speed ω of the compressor; and
setting a rotational speed threshold $\omega 1$ of the compressor, when the rotational speed co of the compressor is less than $\omega 1$, controlling an output voltage of a main circuit unit at a fixed value V0; and when the rotational speed co of the compressor is greater than or equal to $\omega 1$, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the main circuit unit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

[0011] In some embodiments, the main circuit unit includes a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, the power factor correction circuit is connected to the inverter through the smoothing circuit, and an output end of the inverter is electrically connected to the compressor; when the rotational speed co of the compressor is less than $\omega 1$, controlling an output voltage of the power factor correction circuit at the fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the power factor correction circuit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

[0012] In some embodiments, the smoothing circuit is a capacitor filter circuit.

[0013] According to a fourth aspect of the present disclosure, there is provided a computer readable storage medium having a computer program stored thereon, when the computer program is executed by a processor, when the computer program is executed by a processor, the aforementioned method for field weakening control of the compressor is implemented.

[0014] Technical solutions provided by the present disclosure may include the following technical effects:
by setting the rotational speed threshold of the compressor, when the rotational speed of the compressor is greater than or equal to the threshold, the compressor is controlled not to enter the field weakening control temporarily and a drive voltage of the compressor is controlled to rise, and the compressor is controlled to enter the field weakening control until the drive voltage of the compressor cannot continue to rise. In this way, the time for the compressor to enter the field weakening control can be delayed to the greatest extent, the compressor is controlled not to enter the field weakening control to the greatest extent, and the stability of the system is improved.

[0015] It should be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not intended to limit the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are incorporated in and constitute a part of this description, illustrate embodiments consistent with the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

Fig. 1 is a circuit structural diagram illustrating a device for field weakening control of a compressor according to an exemplary embodiment.
Fig. 2 is a schematic circuit structural diagram illustrating a main circuit unit in a device for field weakening control of a compressor according to an exemplary embodiment.

DETAILED DESCRIPTION

[0017] The following description and accompanying drawings fully illustrate the specific implementation solutions of the present disclosure so that a person skilled in the art can practice them. Parts and characteristics of some implementation solutions may be included in or replace parts and characteristics of other implementation solutions. The scope of the implementation solutions of the present disclosure includes the whole scope of the claims and all available equivalents of the claims. As used herein, terms such as "first" and "second" are merely for distinguishing one element from another element and do not require or imply any actual relationship or sequence among these elements. In fact, the first element may also be called the second element, and vice versa. Moreover, terms such as "comprise" and "include" or any other variants indicate a non-exclusive inclusion, so that a structure, apparatus, or device including a series of elements not only include these elements, but also include other elements not explicitly listed or also include elements inherent to such a structure, apparatus, or device. Without further restrictions, the element defined by the statement "includes a/an..." does not exclude the existence of other identical elements in the structure, apparatus, or device that includes the element. As used herein, each embodiment is described progressively, and contents focally described in each embodiment are different from those in other embodiments. The same or similar parts among each of the embodiments may be referred to each other.

[0018] Orientations or positional relationships indicated by terms "longitudinal", "transverse", "upper", "lower", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", "outer" and the like as used herein are based on orientations or positional relationships shown in the drawings, merely for facilitating describing the present disclosure and simplifying the description, rather than indicating or implying that indicated devices or elements have to be in a specific orientation or configured and operated in a specific orientation, therefore, they should not be construed as limiting the present disclosure. In the description herein, terms "mount", "join" and "connect" shall be construed in a broad sense, unless otherwise indicated and limited. For example, the connection may be mechanical connection or electrical connection, also may be internal communication between two elements, the connection may be direct connection or indirect connection through an intermediate medium. For a person of ordinary skill in the art, specific meanings of the above terms may be understood according to specific circumstances.

[0019] Herein, a term "a plurality of' as used herein refers to two or more than two, unless otherwise indicated.

[0020] Herein, a character "/" indicates that front and back objects are in an "or" relationship. For example, A/B means A or B.

[0021] Herein, a term "and/or" is used to describe an association relation between objects, and indicates that there may be three relationships. For example, A and/or B means A or B, or, A and B.

[0022] As shown in Fig. 1, a device for field weakening control of a compressor includes a main circuit unit and the compressor, wherein the main circuit unit provides power for the compressor, and the device further includes:

a compressor rotational speed obtaining unit used to obtain a current of the compressor, and calculate a rotational speed ω of the compressor; and

a control unit used to compare the rotational speed ω of the compressor with a rotational speed threshold $\omega 1$ of the compressor, and control the main circuit unit as follows according to comparison results:

when the rotational speed ω of the compressor is less than $\omega 1$ ($\omega<\omega 1$), an output voltage of the main circuit unit is controlled at a fixed value V0, which is generally about 20V higher than an input peak value, and different manufacturers can select different values; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$ ($\omega\geq\omega 1$), the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the main circuit unit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

[0023] According to the present embodiment, by setting the rotational speed threshold of the compressor, when the rotational speed of the compressor is greater than or equal to the threshold, the compressor is controlled not to enter the field weakening control temporarily and a drive voltage of the compressor is controlled to rise, and the compressor is controlled to enter the field weakening control until the drive voltage of the compressor cannot continue to rise. In this way, the time for the compressor to enter the field weakening control can be delayed to the greatest extent, the compressor is controlled not to enter the field weakening control to the greatest extent, and the stability of the system is improved.

[0024] Specifically, as shown in Fig. 2, the main circuit unit includes a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, which performs full-wave rectification on an alternating current power; an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, and the power factor correction circuit is used to control a duty ratio of PWM (Pulse Width Modulation), so as to improve the output voltage; the power factor correction circuit is connected to the inverter through the smoothing circuit, and the inverter is used to invert a direct current into the alternating current, so as to control the rotational speed of the compressor. As shown in Fig. 2, the smoothing circuit is a capacitor filter circuit.

[0025] When the rotational speed ω of the compressor is less than $\omega 1$, an output voltage of the power factor correction circuit is controlled at the fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the power factor correction circuit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

[0026] Calculating the rotational speed of the compressor based on the current of the compressor belongs to the prior art. For example, the compressor rotational speed obtaining unit obtains currents Iu, Iv, Iw of the compressor (Iu, Iv, Iw respectively represent U, V, W phase currents of the compressor), and then converts coordinates into i_α and i_β; through the following formulas:

$$u_\alpha = R_s \times i_\alpha + L_s \times \frac{di_\alpha}{dt} + e_\alpha ,$$

$$u_\beta = R_s \times i_\beta + L_s \times \frac{di_\beta}{dt} + e_\beta,$$

the following formula is obtained:

$$\frac{i_\alpha(n+1) - i_\alpha(n)}{T_s} = (-\frac{R_s}{L_s}) i_\alpha(n) + \frac{1}{L_s}[u_\alpha(n) - e_\alpha(n)],$$

and the rotational speed of the compressor can be calculated according to the rotational speed calculation formula:

$$\theta(n) = \arctan \frac{-e_\alpha(n)}{e_\beta(n)},$$

$$w_r = \sum_{n=1}^{m} [\theta(n) - \theta(n-1)] \times K,$$

where u_α is a α-axis voltage in a rotating coordinate system, u_β is a β-axis voltage in the rotating coordinate system, i_α is a α-axis current in the rotating coordinate system, i_β is a β-axis current in the rotating coordinate system, R_S is a phase resistance of the compressor, L_S is a phase inductance of the compressor, e_α is a back potential of the α-axis in the rotating coordinate system, e_β is a back potential of the β-axis in the rotating coordinate system, T_S is a switching period of PWM, $\theta(n)$ is an angle between a rotor flux direction and the α-axis, and K is a speed constant.

[0027] According to a second aspect of the present disclosure, there is provided an air conditioner, including the aforementioned device for field weakening control of the compressor.

[0028] According to a third aspect of the present disclosure, there is provided a method for field weakening control of a compressor, including:

obtaining a current of the compressor and calculating a rotational speed ω of the compressor; and
setting a rotational speed threshold ω1 of the compressor, when the rotational speed ω of the compressor is less than ω1, controlling an output voltage of a main circuit unit at a fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to ω1, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the main circuit unit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

[0029] In some embodiments, the main circuit unit includes a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, the power factor correction circuit is connected to the inverter through the smoothing circuit, and an output end of the inverter is electrically connected to the compressor; when the rotational speed ω of the compressor is less than ω1, controlling an output voltage of the power factor correction circuit at the fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to ω1, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the power factor correction circuit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

[0030] In some embodiments, the smoothing circuit is a capacitor filter circuit.

[0031] According to a fourth aspect of the present disclosure, there is provided a computer readable storage medium having a computer program stored thereon, when the computer program is executed by a processor, when the computer program is executed by a processor, the aforementioned method for field weakening control of the compressor is implemented.

[0032] In some embodiments, the computer readable storage medium stores the computer program, and when the computer program is executed by the processor, the aforementioned method for field weakening control of the compressor is implemented. The above computer readable storage medium includes ROM (Read Only Memory), RAM (Random Access Memory), magnetic tape, optical storage device, and the like.

[0033] The present disclosure is not limited to the structures already described above and shown in the accompanying drawings, and various modifications and changes may be made without departing from the scope. The scope of the present disclosure is limited only by the appended claims.

Claims

1. A device for field weakening control of a compressor, comprising the compressor and a main circuit unit providing power for the compressor, wherein the device further comprises:

   a compressor rotational speed obtaining unit used to obtain a current of the compressor, and calculate a rotational speed ω of the compressor; and
   a control unit used to compare the rotational speed ω of the compressor with a rotational speed threshold $\omega 1$ of the compressor, and control the main circuit unit as follows according to comparison results:
   when the rotational speed ω of the compressor is less than $\omega 1$, an output voltage of the main circuit unit is controlled at a fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the main circuit unit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

2. The device for field weakening control of the compressor according to claim 1, wherein the main circuit unit comprises a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, the power factor correction circuit is connected to the inverter through the smoothing circuit, and an output end of the inverter is electrically connected to the compressor;
   when the rotational speed ω of the compressor is less than $\omega 1$, an output voltage of the power factor correction circuit is controlled at the fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, the compressor is controlled not to enter the field weakening control temporarily and the output voltage of the power factor correction circuit is controlled to rise, and the compressor is controlled to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

3. The device for field weakening control of the compressor according to claim 2, wherein the smoothing circuit is a capacitor filter circuit.

4. An air conditioner, comprising the device for field weakening control of the compressor.

5. A method for field weakening control of a compressor, comprising:

   obtaining a current of the compressor and calculating a rotational speed ω of the compressor; and
   setting a rotational speed threshold $\omega 1$ of the compressor, when the rotational speed ω of the compressor is less than $\omega 1$, controlling an output voltage of a main circuit unit at a fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the main circuit unit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the main circuit unit cannot continue to rise.

6. The method for field weakening control of the compressor according to claim 5, wherein the main circuit unit comprises a rectifier, a power factor correction circuit, a smoothing circuit and an inverter, wherein an input end of the rectifier is an alternating current, an output end of the rectifier is electrically connected to an input end of the power factor correction circuit, the power factor correction circuit is connected to the inverter through the smoothing circuit, and an output end of the inverter is electrically connected to the compressor;
   when the rotational speed ω of the compressor is less than $\omega 1$, controlling an output voltage of the power factor correction circuit at the fixed value V0; and when the rotational speed ω of the compressor is greater than or equal to $\omega 1$, controlling the compressor not to enter the field weakening control temporarily and controlling the output voltage of the power factor correction circuit to rise, and controlling the compressor to enter the field weakening control when the output voltage of the power factor correction circuit cannot continue to rise.

7. The method for field weakening control of the compressor according to claim 6, wherein the smoothing circuit is a capacitor filter circuit.

8. A computer readable storage medium having a computer program stored thereon, wherein, when the computer program is executed by a processor, the method for field weakening control of the compressor according to any one of claims 5 to 7 is implemented.

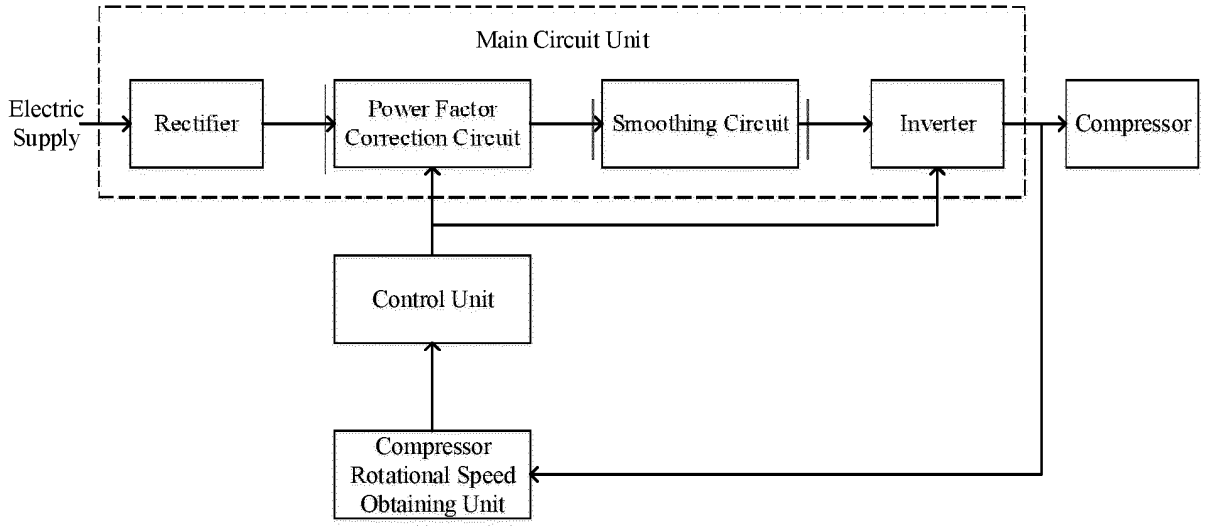
Main Circuit Unit
Electric Supply
Rectifier
Power Factor Correction Circuit
Smoothing Circuit
Inverter
Compressor
Control Unit
Compressor Rotational Speed Obtaining Unit

Fig. 1

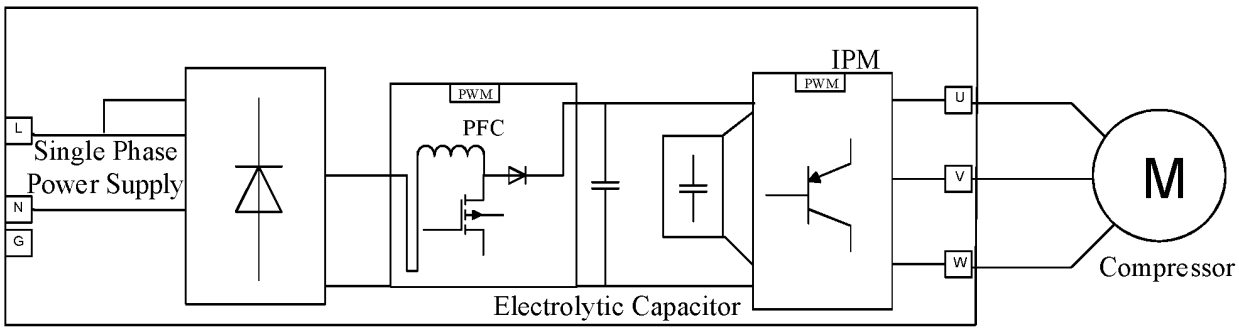
L
N
G
Single Phase Power Supply
PWM
PFC
IPM
PWM
U
V
W
M
Compressor
Electrolytic Capacitor

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/076423

A. CLASSIFICATION OF SUBJECT MATTER

H02P 25/18(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H02P

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

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

DWPI, CNABS, CNTXT, CNKI: 压缩机, 转速, 电压, 弱磁, compressor, rotate speed, revolving speed, voltage, flux weaken+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2018078845 A1 (MITSUBISHI ELECTRIC CORPORATION) 03 May 2018 (2018-05-03) description, paragraphs [0124]-[0137], and figures 5-7 and 16	1-8
A	CN 106817055 A (BYD COMPANY LIMITED) 09 June 2017 (2017-06-09) entire document	1-8
A	CN 108336941 A (GUANGDONG MEIZHI REFRIGERATION EQUIPMENT CO., LTD.) 27 July 2018 (2018-07-27) entire document	1-8

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 2019	**04 September 2019**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China**	
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/076423

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2018078845 A1	03 May 2018	CN 109863690 A	07 June 2019
		AU 2016428287 A1	20 June 2019
		KR 20190040296 A	17 April 2019
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		IN 201947014216 A	17 May 2019
		JP WO2018078845S X	14 March 2019
CN 106817055 A	09 June 2017	CN 106817055 B	13 March 2018
CN 108336941 A	27 July 2018	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201811469185 **[0001]**