(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 734 178 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.11.2020 Bulletin 2020/45

(21) Application number: **18895635.3**

(22) Date of filing: **18.10.2018**

(51) Int Cl.:
F24F 11/86 *(2018.01)* ***F24F 11/41*** *(2018.01)*
F24F 140/20 *(2018.01)*

(86) International application number:
PCT/CN2018/110793

(87) International publication number:
WO 2019/128397 (04.07.2019 Gazette 2019/27)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **25.12.2017 CN 201711425104**

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

(72) Inventors:
- **AN, Chao**
  Qingdao City, Shandong 266101 (CN)
- **GU, Chao**
  Qingdao City, Shandong 266101 (CN)

(74) Representative: **Patentwerk B.V.**
P.O. Box 1514
5200 BN 's-Hertogenbosch (NL)

(54) **CONTROL METHOD FOR AIR CONDITIONER**

(57) The air conditioner comprises a compressor and an indoor unit. The method comprises: obtaining a coil temperature of the indoor unit; and selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit. According to the method, the operating frequency of the compressor is adjusted by determining a temperature interval in which the coil temperature of the indoor unit is, so as to avoid the icing of the indoor unit of the air conditioner, thereby effectively solving the icing problem of the indoor unit of the air conditioner, and also improving the operation stability and reliability of the air conditioner.

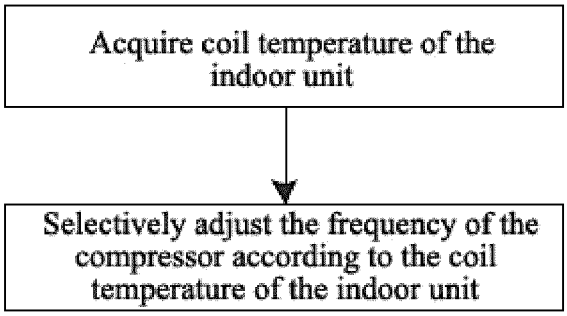

Fig. 1

EP 3 734 178 A1

Description

FIELD

[0001] The present disclosure belongs to the technical field of air conditioners, and in particular relates to a control method for an air conditioner.

BACKGROUND

[0002] An air conditioner is an apparatus that is capable of cooling or heating an indoor environment. During the cooling operation of the air conditioner, an indoor unit may freeze due to various reasons such as low indoor and outdoor ambient temperatures, long piping connection, and lack of freon, which in turn causes undesired phenomena such as poor cooling effect, water leakage, and pipe cracks, thus seriously affecting the user experience.

[0003] Therefore, there is a need in the art for a new control method for an air conditioner to solve the above problems.

SUMMARY

[0004] In order to solve the above problem in the related art, that is, to solve the problem that an indoor unit of the air conditioner may easily freeze to cause phenomena such as poor cooling effect of the air conditioner, water leakage of the air conditioner or pipe cracks, the present disclosure provides a control method for an air conditioner, wherein the air conditioner includes a compressor and an indoor unit, and the control method includes: acquiring a coil temperature of the indoor unit; and selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit.

[0005] In a preferred technical solution of the above control method, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" includes: operating the compressor at a decreased frequency, if the coil temperature of the indoor unit is lower than a first preset temperature.

[0006] In a preferred technical solution of the above control method, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" further includes: maintaining the operating frequency of the compressor unchanged, if the coil temperature of the indoor unit is higher than or equal to the first preset temperature and lower than or equal to a second preset temperature, the first preset temperature being lower than the second preset temperature.

[0007] In a preferred technical solution of the above control method, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" further includes: operating the compressor at an increased frequency, if the coil temperature of the indoor unit is higher than the second preset temperature and lower than or equal to a third preset temperature, the second preset temperature being lower than the third preset temperature.

[0008] In a preferred technical solution of the above control method, the control method further includes: after the compressor has been operated for a first preset duration, if the coil temperature of the indoor unit is lower than a fourth preset temperature for a second preset duration, stopping the operation of the compressor for a third preset duration.

[0009] In a preferred technical solution of the above control method, the control method further includes: after stopping the operation, if the coil temperature of the indoor unit becomes higher than or equal to a fifth preset temperature, resuming the operation of the compressor, the fourth preset temperature being lower than the fifth preset temperature.

[0010] It can be understood by those skilled in the art that in the preferred technical solutions of the present disclosure, the coil temperature of the indoor unit is acquired; that is, when the coil temperature of the indoor unit is lower than the first preset temperature, the compressor is operated at a decreased frequency; when the coil temperature of the indoor unit is higher than or equal to the first preset temperature and lower than or equal to the second preset temperature, the operating frequency of the compressor is maintained unchanged; and when the coil temperature of the indoor unit is higher than the second preset temperature and lower than or equal to the third preset temperature, the compressor is operated at an increased frequency. With these arrangements, that is, by setting values of the first preset temperature, the second preset temperature and the third preset temperature, the frequency of the compressor is adjusted for different temperature intervals. By adopting the above described control method of the present disclosure, the frequency of the compressor can be adjusted according to the coil temperature of the indoor unit in practical applications, thereby ensuring that the indoor unit does not freeze and further effectively realizing anti-freezing protection for the air conditioner during the cooling operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a schematic flowchart of a control method for an air conditioner of the present disclosure;

FIG. 2 is a schematic flowchart of a first embodiment of the control method for the air conditioner of the present disclosure; and

FIG. 3 is a schematic flowchart of a second embodiment of the control method for the air conditioner of the present disclosure.

DETAILED DESCRIPTION

[0012] Hereinafter, preferred embodiments of the present disclosure will be described with reference to the accompanying drawings. It should be understood by those skilled in the art that these embodiments are only used to explain the technical principles of the present disclosure, and are not intended to limit the scope of protection of the present disclosure.

[0013] It should be noted that in the description of the present disclosure, terms "first", "second", "third", "fourth" and "fifth" are used for descriptive purpose only, and should not be interpreted as indicating or implying relative importance.

[0014] In view of the problem pointed out in the "BACKGROUND OF THE INVENTION" that the indoor units of existing air conditioners may easily freeze to cause phenomena such as poor cooling effect of the air conditioner, water leakage of the air conditioner or pipe cracks, the present disclosure provides a control method for an air conditioner, which aims to avoid the freezing of the indoor unit of the air conditioner, and thus effectively solve the problem that the indoor unit is easy to freeze.

[0015] Specifically, reference is made to FIG. 1, which is a schematic flowchart of a control method for an air conditioner of the present disclosure. As shown in FIG. 1, the present disclosure provides a control method for an air conditioner, wherein the air conditioner includes a compressor and an indoor unit, and the control method includes: acquiring a coil temperature of the indoor unit; and selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit.

[0016] In the present disclosure, with the operation of the air conditioner, the coil temperature of the indoor unit will also change accordingly. According to the different coil temperatures of the indoor unit, the frequency of the compressor can be controlled differently. In practical applications, the coil temperature of the indoor unit can be detected in real time by an indoor unit coil sensor. Of course, the coil temperature of the indoor unit may also be an experimental value obtained by those skilled in the art based on experiments under specific working conditions, or an empirical value obtained from experience. That is, those skilled in the art can choose any method to obtain the coil temperature of the indoor unit according to the actual situation, as long as the operating frequency of the compressor can be adjusted according to the change of the coil temperature of the indoor unit. By adjusting the frequency of the compressor, the compressor can be always operated within a suitable frequency range, which not only can ensure the cooling effect, but also can prevent the indoor unit of the air conditioner from freezing.

[0017] Preferably, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" includes: operating the compressor at a decreased frequency, if the coil temperature of the indoor unit is lower than a first preset temperature. That is, according to the setting of the first preset temperature, an initial conclusion of operating the compressor at a decreased frequency can be given. Those skilled in the art can flexibly set the specific value of the first preset temperature in practical applications, as long as the boundary point determined by the first preset temperature can give the conclusion that the compressor needs to be operated at a decreased frequency, and the indoor unit of the air conditioner will not freeze after the adjustment of the operating frequency of the compressor.

[0018] Further, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" further includes: maintaining the operating frequency of the compressor unchanged, if the coil temperature of the indoor unit is higher than or equal to the first preset temperature and lower than or equal to a second preset temperature, the first preset temperature being lower than the second preset temperature. Similar to the first preset temperature, those skilled in the art can flexibly set the specific value of the second preset temperature in practical applications, as long as the boundary points determined by the first preset temperature and the second preset temperature can give the conclusion that the current operating frequency of the compressor needs to be maintained unchanged, and the indoor unit of the air conditioner will not freeze.

[0019] Still further, the step of "selectively adjusting the frequency of the compressor according to the coil temperature of the indoor unit" further includes: operating the compressor at an increased frequency, if the coil temperature of the indoor unit is higher than the second preset temperature and lower than or equal to a third preset temperature, the second preset temperature being lower than the third preset temperature. Similar to the first preset temperature and the second preset temperature, those skilled in the art can flexibly set the specific value of the third preset temperature in practical applications, as long as the boundary point determined by the third preset temperature can give the conclusion that the compressor needs to be operated at an increased frequency, and the indoor unit of the air conditioner will not freeze after the adjustment of the operating frequency of the compressor.

[0020] By setting the first preset temperature, the second preset temperature and the third preset temperature as described above, the coil temperature of the indoor unit can be divided into different temperature intervals, and the compressor can be adjusted accordingly within each temperature interval and the compressor can be operated at the most suitable frequency. This method is more advantageous for the adjustment of the compressor frequency. At the same time, by detecting the coil temperature of the indoor unit in real time and adjusting the compressor frequency in real time, a situation that the operating frequency of the compressor is too high or too low can be effectively avoided, thereby preventing the indoor unit of the air conditioner from freezing.

[0021] It should be noted that in the above technical

solution of the present disclosure, the temperature intervals divided according to the first preset temperature, the second preset temperature and the third preset temperature may be further divided. For example, when the coil temperature of the indoor unit is higher than the first preset temperature and lower than or equal to the second preset temperature, the temperature interval between the first preset temperature and the second preset temperature may be re-divided into multiple temperature sub-intervals, and different adjustment strategies for the compressor frequency are set within the temperature sub-intervals. Those skilled in the art may set the same or different ways of adjusting the compressor frequency according to different temperature intervals in practical applications, so that the air conditioner can be operated stably in different environments and the indoor unit can be effectively prevented from freezing.

[0022] In addition, it should also be noted that when controlling the compressor frequency to increase/decrease, the compressor frequency may be controlled to increase/decrease slowly, or the compressor frequency may be controlled to increase/decrease fast. In practice, those skilled in the art may flexibly set the adjustment speed of increasing/decreasing the compressor frequency, as long as the speed setting enables the compressor frequency to smoothly increase/decrease.

[0023] In a preferred embodiment, after the compressor has been operated for a first preset duration, if the coil temperature of the indoor unit is lower than a fourth preset temperature for a second preset duration, the operation of the compressor is stopped for a third preset duration. In practical applications, the fourth preset temperature may be set to be lower than the above first preset temperature. The fourth preset temperature may be an experimental temperature value obtained by those skilled in the art based on experiments under specific working conditions, or may be an empirical temperature value obtained from experience. Those skilled in the art can flexibly set the specific temperature value of the fourth preset temperature in practical applications, as long as the boundary point determined by the fourth preset temperature can give the conclusion that the operation of the compressor needs to be stopped, and the operating mode of the compressor and the anti-freezing function of the air conditioner can be optimized. In addition, the first preset duration, the second preset duration and the third preset duration can be flexibly adjusted and set according to actual conditions, as long as the boundary points determined by the above-mentioned first preset duration, the second preset duration, and the third preset duration can optimize the anti-freezing function of the air conditioner.

[0024] Further, the control method further includes: after stopping the operation of the compressor, if the coil temperature of the indoor unit becomes higher than or equal to a fifth preset temperature, resuming the operation of the compressor, the fourth preset temperature being lower than the fifth preset temperature. That is, after the operation of the compressor has been stopped for the third preset duration, if the coil temperature of the indoor unit rises to or above the fifth preset temperature, the operation of the compressor needs to be resumed. In practical applications, the fifth preset temperature may be set to be equal to the above-mentioned third preset temperature. Of course, this is not limiting, and the fifth preset temperature may also be other temperature values. In practical applications, those skilled in the art may flexibly set the specific temperature value of the fifth preset temperature, as long as the boundary point determined by the fifth preset temperature can give the conclusion that the operation of the compressor needs to be resumed, and the operating mode of the compressor and the anti-freezing function of the air conditioner can be optimized.

[0025] In a preferred embodiment, as shown in FIG. 2, the above control method includes the following steps s1 to s4.

Step s1, operating the air conditioner in a cooling mode at the maximum capacity.

Step s2: acquiring the coil temperature of the indoor unit.
wherein the coil temperature of the indoor unit may be directly detected by the temperature sensor, or it may be an experimental temperature value obtained by those skilled in the art based on experiments under specific working conditions, or an empirical temperature value obtained from experience.

Step s3, dividing the temperature interval of the value of the coil temperature of the indoor unit.
wherein the temperature interval of the coil temperature of the indoor unit may be divided according to the indoor temperature, or may be divided according to the outdoor ambient temperature, as long as the range determined by the temperature interval enables the operating frequency of the compressor to be adjusted and can prevent the air conditioner from freezing.

Step s4: selectively adjusting the frequency of the compressor according to the temperature interval of the coil temperature of the indoor unit.

[0026] In the above method, steps s1 and s2 may be executed sequentially or simultaneously. Those skilled in the art may flexibly set the execution of steps s1 and s2 in practical applications, as long as the coil temperature of the indoor unit can be acquired through the setting.

[0027] The technical solution of the present disclosure is further explained below in combination with specific embodiments:

[0028] In a possible situation, as shown in FIG. 3, after the air conditioner is started, or while the air conditioner is started, the coil temperature TM of the indoor unit is

detected by the indoor unit coil temperature sensor disposed on the air conditioner. The first preset temperature is set to 6°C, the second preset temperature is set to 8°C, and the third preset temperature is set to 10°C. The operating frequency of the compressor is adjusted by judging the temperature interval of the indoor unit coil temperature TM. If TM<6°C, the frequency of the compressor is decreased at a constant rate of 1Hz/10s; if 6°C≤TM≤8°C, the frequency of the compressor is maintained unchanged; and if 8°C<TM≤10°C, the frequency of the compressor is increased at a constant rate of 1Hz/10s.

[0029] During the operation of the compressor, the operation duration thereof is recorded. After the compressor has been operated for 6 minutes, if TM<2°C for 10 seconds, the operation of the compressor is stopped for a minimum duration of 5 minutes and a maximum duration of 9 minutes; when TM rises above 10°C, the normal operation of the compressor is resumed.

[0030] It should be understood that the specific values of the above parameters do not serve as limitations, but are only used to help understand the solutions.

[0031] Hitherto, the technical solutions of the present disclosure have been described in conjunction with the preferred embodiments shown in the accompanying drawings, but it is easily understood by those skilled in the art that the scope of protection of the present disclosure is obviously not limited to these specific embodiments. Without departing from the principle of the present disclosure, those skilled in the art can make equivalent changes or replacements to relevant technical features, and the technical solutions after these changes or replacements will fall within the scope of protection of the present disclosure.

Claims

1. A control method for an air conditioner, the air conditioner comprising a compressor and an indoor unit, wherein the control method comprises:

   acquiring coil temperature of the indoor unit; and
   selectively adjusting frequency of the compressor according to the coil temperature of the indoor unit.

2. The control method according to claim 1, wherein the step of "selectively adjusting frequency of the compressor according to the coil temperature of the indoor unit" comprises:
   operating the compressor at a decreased frequency, if the coil temperature of the indoor unit is lower than a first preset temperature.

3. The control method according to claim 2, wherein the step of "selectively adjusting frequency of the compressor according to the coil temperature of the indoor unit" further comprises:

   maintaining the operating frequency of the compressor unchanged, if the coil temperature of the indoor unit is higher than or equal to the first preset temperature and lower than or equal to a second preset temperature, and
   wherein the first preset temperature is lower than the second preset temperature.

4. The control method according to claim 3, wherein the step of "selectively adjusting frequency of the compressor according to the coil temperature of the indoor unit" further comprises:

   operating the compressor at an increased frequency, if the coil temperature of the indoor unit is higher than the second preset temperature and lower than or equal to a third preset temperature, and
   wherein the second preset temperature is lower than the third preset temperature.

5. The control method according to claim 1, further comprising:
   after the compressor has been operated for a first preset duration, if the coil temperature of the indoor unit is lower than a fourth preset temperature for a second preset duration, stopping operation of the compressor for a third preset duration.

6. The control method according to claim 5, further comprising:

   after stopping the operation, if the coil temperature of the indoor unit becomes higher than or equal to a fifth preset temperature, resuming the operation of the compressor,
   wherein the fourth preset temperature is lower than the fifth preset temperature.

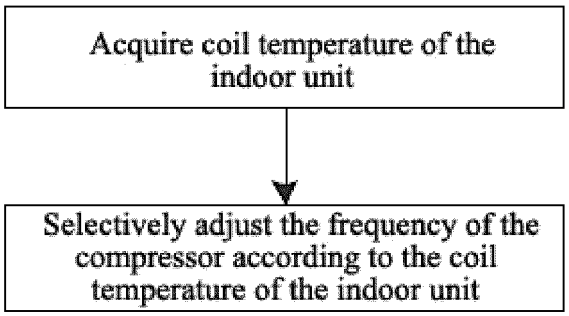
Acquire coil temperature of the indoor unit
Selectively adjust the frequency of the compressor according to the coil temperature of the indoor unit

Fig. 1

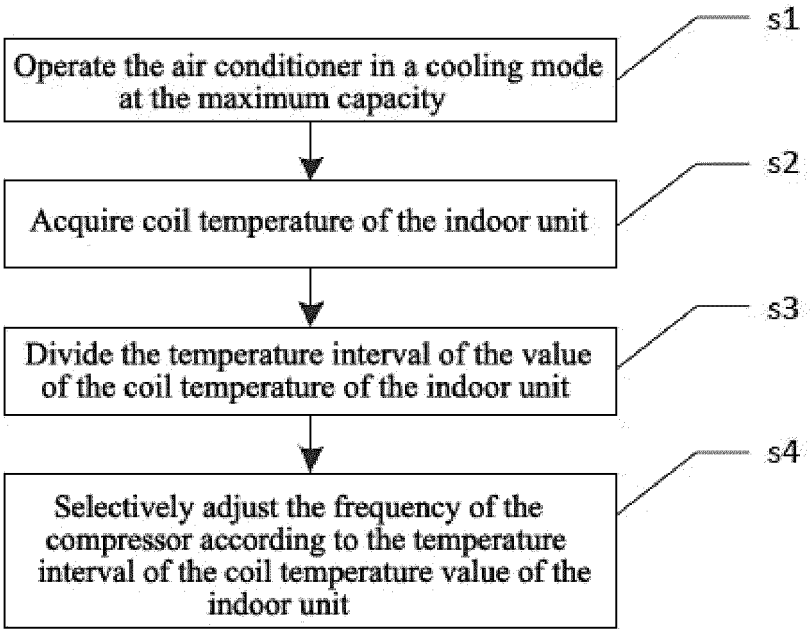
s1
Operate the air conditioner in a cooling mode at the maximum capacity
s2
Acquire coil temperature of the indoor unit
s3
Divide the temperature interval of the value of the coil temperature of the indoor unit
s4
Selectively adjust the frequency of the compressor according to the temperature interval of the coil temperature value of the indoor unit

Fig. 2

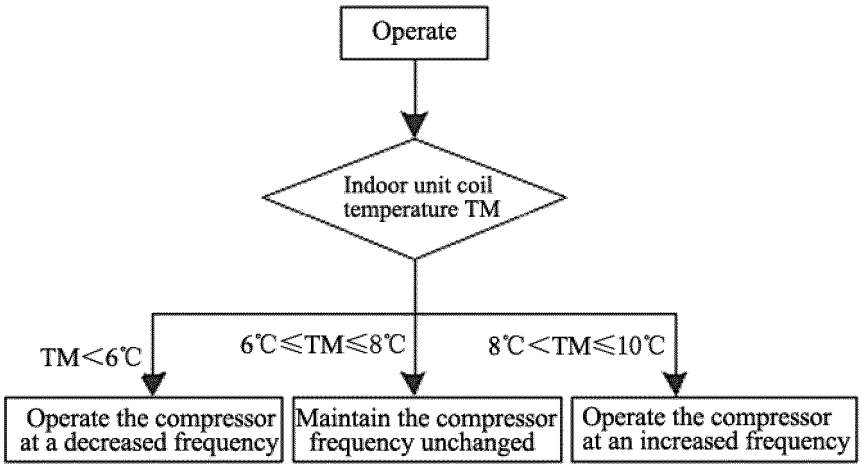
Operate
Indoor unit coil temperature TM
TM<6℃
6℃≤TM≤8℃
8℃<TM≤10℃
Operate the compressor at a decreased frequency
Maintain the compressor frequency unchanged
Operate the compressor at an increased frequency

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/110793

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/86(2018.01)i; F24F 11/41(2018.01)i; F24F 140/20(2018.01)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)

F24F 11/-

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)

CNABS, CNTXT, CNKI, DWPI, PATENTICS: 海尔, 空调, 安超, 顾超, 室内机, 室外机, 压缩机, 热交换热器, 制冷, 低温, 蒸发器, 盘管, 冰, 霜, 冻, 频, 升, 降, 恒定, 停止, 重新启动, 重启, 恢复, 回复, 调整, 预设, 温度, air, conditioner?, indoor?, machine?, coil+, pipe?, tube?, evaporator?, exchang+, frequenc+, compressor?, icing?, freez+, unit?, frozen, restart?, adjust+, operat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 108224704 A (QINGDAO HAIER AIR CONDITIONER ELECTRIC CO., LTD.) 29 June 2018 (2018-06-29) claims 1-6, description, paragraphs [0017]-[0037], and figures 1-3	1-6
X	CN 103115417 A (HAIER GROUP CO., LTD. ET AL.) 22 May 2013 (2013-05-22) description, paragraphs [0004]-[0019], and figure 1	1-6
X	CN 105157172 A (TCL AIR CONDITIONER (ZHONGSHAN) CO., LTD.) 16 December 2015 (2015-12-16) description, paragraphs [0055]-[0062], and figure 1	1
X	CN 104697118 A (GUANGDONG MIDEA REFRIGERATION EQUIPMENT CO., LTD. ET AL.) 10 June 2015 (2015-06-10) description, paragraphs [0039]-[0057], and figure 1	1, 2
X	CN 1991264 A (SAMSUNG ELECTRONICS CO., LTD.) 04 July 2007 (2007-07-04) description, page 6, paragraph 8 to page 7, paragraph 2, and figures 2-5	1, 2
A	JP 08338672 A (FUJITSU GENERAL LTD.) 24 December 1996 (1996-12-24) entire document	1-6

☐ 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

"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)

"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

"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
03 January 2019	**21 January 2019**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC (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/CN2018/110793

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 103115417 A	22 May 2013	CN 103115417 B	01 April 2015
CN 105157172 A	16 December 2015	CN 105157172 B	30 March 2018
CN 104697118 A	10 June 2015	CN 104697118 B	05 June 2018
CN 1991264 A	04 July 2007	CN 1991264 B	16 June 2010
		KR 20070071091 A	04 July 2007
		KR 101253568 B1	11 April 2013
JP 08338672 A	24 December 1996	JP 3348758 B2	20 November 2002

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