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(54) **AUTOMATIC DRYING JUDGEMENT METHOD FOR CLOTHES DRYER AND CLOTHES DRYER**

(57) An automatic drying judgment method for a clothes dryer and a clothes dryer, comprises, setting up a corresponding relationship between a time t and a temperature T_1 of all loads in a drying state in the clothes dryer; in a drying process, the clothes dryer detecting a temperature T_2 in a drum in real time, and comparing with the temperature T_1 corresponding to the time; and when the temperature T_2 detected in real time is greater than or equal to the temperature T_1 corresponding to the time, clothes in the drum being judged to be dried. This judgment method realizes quantitative judgment of continuous loads, and can accurately judge the drying state of all the loads, thereby ensuring the drying effect of any load of the clothes dryer.

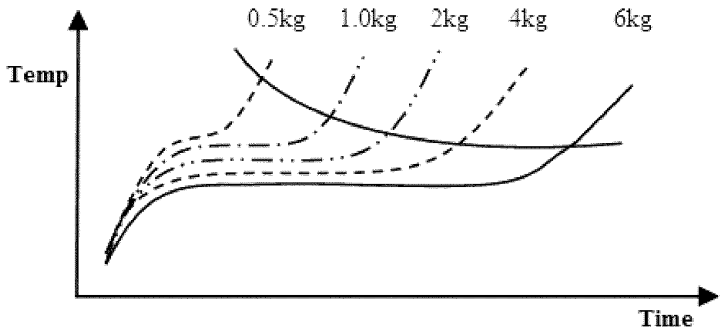

Fig. 2

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of clothes drying, and in particular to an automatic drying judgment method for a clothes dryer and a clothes dryer.

BACKGROUND ART

[0002] A NTC (thermistor) is commonly installed at an air outlet of a drum of clothes dryers, and it is an important branch of automatic drying control of the existing clothes dryer to perform automatic drying judgment by utilizing an NTC. Along with the process of drying, the NTC possesses as the curve characteristics shown in Fig. 1, stage 1 is a stage in which heating begins, and discharge temperature rises dramatically; stage 2 is a stage of stable drying, and the discharge temperature is stable; and stage 3 is a stage in which drying will be finished, and the discharge temperature rises dramatically.

[0003] In ordinary methods, the temperature value in stage 2 is taken as the stable temperature value T_2, while the temperature value in stage 3 is T_3, and let $\delta T=T_3-T_2$. The clothes drying degrees under different δT can be tested through tests with specific models of dryers and specific loads, thereby realizing automatic drying control. The method has the following shortcomings: the quantity of clothes have a great influence on the drying effect, when the clothes are more and a full load is approached, the drying effect is better, while when the clothes are fewer, the drying effect is poor and the clothes often cannot be completely dried. Clothes with different quantities can also be subjected to drying test to obtain several ranges corresponding to different clothes quantities, a corresponding range is selected based on the quantity of the dried clothes to determine the drying state. However, only a range is taken, and only discrete points can be detected and not all the loads can be included.

[0004] In view of this, the present disclosure is hereby proposed.

SUMMARY

[0005] The objective of the present disclosure is to overcome the shortcomings of the prior art and provide an automatic drying judgment method for a clothes dryer.

[0006] In order to realize the objective, the present disclosure adopts the following technical solution: an automatic drying judgment method for a clothes dryer is provided. The clothes dryer is set up with the corresponding relationship between time t and temperature T_1 of all the loads in a drying state. In the drying process, the clothes dryer detects the temperature T_2 in the drum in real time, and compares with the set temperature T_1 corresponding to the time; and when the temperature T_2 detected in real time is greater than or equal to the set temperature T_1 corresponding to the time, the clothes in the drum are judged to be dried.

[0007] The corresponding relationship of the time t and temperature T_1 of all the loads in a drying state is a quadratic function relationship.

[0008] The quadratic function is a quadratic function with its graphic concave up, and the corresponding relationship curve of the time t and temperature T_1 of all the loads in a drying state is the left part of the vertex of the quadratic function.

[0009] Through experimental tests, the clothes dryer obtains the curve formula of the quadratic function, stores the curve formula in a main control board of the clothes dryer, and directly calls the curve formula in the drying process.

[0010] The time t and temperature T_1 are got for multiple loads in the drum during the drying process through experiments by the clothes dryer, and connects the multiple groups of time t and temperature T_1 in the drum into a smooth curve, wherein the smooth curve is a quadratic function curve, and the formula of the quadratic function curve is determined.

[0011] The time t and temperature T_1 are get for at least three loads in the drum during drying process through experiments, and determines the formula of the quadratic function curve based on the three groups of time t and the temperature T_1 in the drum.

[0012] A temperature sensor is arranged at an air outlet of a drum of the clothes dryer and is used for detecting the temperature in the drum in real time.

[0013] The corresponding relationship between time t and temperature T_1 of all the loads in a drying state is as follows: $T_1=at^2+bt+c$, wherein a, b and c are constants, and the constant is related to the maximum load, heating power, wind speed and temperature control system of the clothes dryer.

[0014] The value of c is amended along with the difference of the ambient temperature, when drying begins, the ambient temperature is measured and is recorded as T_3, then $c=72-T_3*0.9$.

[0015] The present disclosure further provides a clothes dryer having the above method.

[0016] After the technical solution in the present disclosure is adopted, the following beneficial effects are brought about:

In the judgment method of the present disclosure, the quadratic function curve contains the corresponding relationship of the time and temperature of all the loads in a drying state. As long as the temperature curve of the clothes drying process is intersected with the quadratic function, the clothes are dried, that is to say, when the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum can be judged to be dried. This judgment method realizes quantitative judgment of continuous loads, and can judge the accurate drying state of all the loads, thereby ensuring

the drying effect of any load of the clothes dryer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a drying curve chart in the prior art;

Fig. 2 is a drying curve chart in the judgement method of the present disclosure;

Fig. 3 is a flow chart of the judgement method in the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENT

[0018] The specific implementation of the present disclosure will be described in detail below in combination with the accompanying drawings.

[0019] The present disclosure provides an automatic drying judgment method for a clothes dryer, wherein the clothes dryer is internally provided with the corresponding relationship between time t and temperature T_1 of all the loads in a drying state. In the drying process, the clothes dryer detects the temperature T_2 in the drum in real time, and compares with the set temperature T_1 corresponding to the time; and when the temperature T_2 detected in real time is greater than or equal to the set temperature T_1 corresponding to the time, the clothes in the drum are judged to be dried. By adopting such a judgment method, the accurate drying state of all the loads can be judged, thereby ensuring the drying effect of the clothes dryer at any load.

[0020] The corresponding relationship between time t and temperature T_1 of all the loads in a drying state is a quadratic function relationship and satisfies the following formula: $T_1=at^2+bt+c$, wherein a, b and c are constants. The constants a, b and c are corresponding to the maximum load or capacity, heating power, wind speed and temperature control system of the clothes dryer. That is, each model corresponds to a group of a, b and c, and each model is provided with a corresponding relationship of a quadratic function.

[0021] Through numerous researches and experiments, clothes of different weights (such as clothes of 0.5kg, 1kg, 2kg, 4kg and 6kg) are subjected to drying tests, a temperature curve of the drying process is obtained as shown in Fig. 2. The temperature values of clothes of different weights during drying process are marked in the above figure and connected together to form a curve, and the curve is a quadratic function. The quadratic function further covers the corresponding relationship of the time and temperature of the clothes of undetected weights during drying process. Therefore, the quadratic function contains the corresponding relationship of the time and temperature of all the loads in a drying state. As long as the temperature curve of the clothes drying process is intersected with the quadratic function, the clothes are dried, that is to say, when the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum can be judged to be dried. This judgment method realizes quantitative judgment of continuous loads, and can judge the accurate drying state of all the loads, thereby ensuring the drying effect of any load of the clothes dryer.

[0022] The clothes dryer obtains the curve formula of the quadratic function through experimental tests, stores the curve formula in a main control board of the clothes dryer, and directly calls the curve formula in the drying process. When the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum are judged to be dried.

[0023] Before the clothes dryer leaves the manufacture factory, for the clothes dryer of such a model, the time t and temperature T_1 in the drum of at least three loads in the drying process are got through experiments, and the quadratic function curve formula is determined based on the three groups of time t and temperature T_1 in the drum. When the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum are judged to be dried.

[0024] The clothes dryer tests the time t and temperature T_1 in the drum of multiple loads during drying process through experiments, and connects the multiple groups of time t and temperature T_1 in the drum into a smooth curve, wherein the smooth curve is a quadratic function curve. The quadratic function curve contains the corresponding relationship of the time and temperature of all the loads in a drying state, as long as the temperature curve of the clothes drying process is intersected with the quadratic function, the clothes are dried, that is to say, when the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum can be judged to be dried. The quadratic function curve formula is determined and stored in a main control board of the clothes drier, and is directly taken in the drying process. When the temperature in the drum is greater than or equal to the temperature on the quadratic function curve corresponding to the time, the clothes in the drum are judged to be dried.

[0025] A temperature sensor is arranged at an air outlet of a drum of the clothes dryer and is used for detecting the temperature in the drum in real time. Preferably, the air outlet of the drum of the clothes dryer is provided with an NTC (a thermistor).

[0026] The quadratic function appears at different positions of the coordinate system along with the different ambient temperatures, and after tests, the value of c is in a linear relationship with 0.9 time of T_3. The value of c is amended along with the changing of the ambient temperature. When drying process begins, the ambient temperature is measured and is recorded as T_3, then

$c=72-T_3*0.9$. The amended quadratic function is more accurate, and accurate drying finishing point of clothes of different weights can be more accurately obtained.

[0027] The present disclosure provides a clothes dryer using the above judgment method. A temperature sensor is arranged at an air outlet of a drum of the clothes dryer and is used for detecting the temperature in the drum in real time. Before the clothes dryer leaves the manufacture factory, for the clothes dryer of such a model, it is obtained through experimental tests that the corresponding relationship between time t and temperature T_1 of all the loads in a drying state is a quadratic function curve formula, the curve formula is stored in a main control board of a clothes dryer. In the drying process, the clothes dryer detects the temperature T_2 in the drum in real time, directly calls the curve formula, and compares with the set temperature T_1 corresponding to the time. When the temperature T_2 detected in real time is greater than or equal to the set temperature T_1 corresponding to the time, the clothes in the drum are judged to be dried. For the clothes dryer of such a model, the time t and temperature T_1 in the drum of at least three loads in the drying process are tested through experiments, and the quadratic function curve formula is determined based on the three groups of time t and temperature T_1 in the drum.

Embodiment 1

[0028] The present disclosure describes a direct discharging clothes dryer with a drying capacity of 6kg, the rated voltage is 220V/50Hz, the heating power is 1800W, the discharge temperature is controlled to be not greater than 60°C, the air inlet temperature is not greater than 120°C, and the designed maximum air volume is $150m^3/h$. The following quadratic function is obtained through tests: $T_1=at^2+bt+c$, wherein a=0.0009, b=-0.2035, c=50.0000, namely, the following quadratic function is obtained through tests: $T_1=0.0009t^2+0.2035t+50.0000$, wherein $0<t\leq110$.

[0029] The formula is preset in the main control board of the clothes dryer, then accurate drying finishing points of clothes of different weights can be achieved. It should be noted that, the constants a, b and c in the formula are tested under an ambient temperature of 20°C. The value of c needs to be amended along with the difference of the ambient temperature, when the clothes dryer begins to operate, the ambient temperature is measured and is recorded as T_3, then $c=72-T_3*0.9$. The value of c is calculated due to the following reason: the quadratic function appears at different positions of the coordinate system along with the difference of the ambient temperature, and after tests, the value of c is in a linear relationship with 0.9 time of T_3. The amended quadratic function is more accurate, and accurate drying finishing point of clothes of different weights can be more accurately obtained.

[0030] What is described above is merely preferred implementation of the present disclosure. It should be noted that, under the premise of not departing from the principle of the present disclosure, those of ordinary skill in the art can further make various transformations and improvements, and such transformations and improvements shall also be deemed as falling into the protection scope of the present disclosure.

Claims

1. An automatic drying judgment method for a clothes dryer, comprising
   setting up a corresponding relationship between a time t and a temperature T_1 of all loads in a drying state in the clothes dryer;
   in a drying process, the clothes dryer detecting a temperature T_2 in a drum in real time, and comparing with the temperature T_1 corresponding to the time; and
   when the temperature T_2 detected in real time is greater than or equal to the temperature T_1 corresponding to the time, clothes in the drum being judged to be dried.

2. The automatic drying judgment method for the clothes dryer according to claim 1, wherein the corresponding relationship between the time t and the temperature T_1 of all the loads in the drying state is satisfied with a quadratic function.

3. The automatic drying judgment method for the clothes dryer according to claim 2, wherein the quadratic function is a quadratic function with its graphic concave up, and
   a corresponding relationship curve of the time t and temperature T_1 of all the loads in the drying state is a left part of a vertex of the quadratic function.

4. The automatic drying judgment method for the clothes dryer according to any one of claims 1-3, wherein through experimental tests, the clothes dryer obtains a formula of the corresponding relationship of the time t and temperature T_1 of all the loads in the drying state, stores the formula in a main control board of the clothes dryer, and directly calls the formula in the drying process.

5. The automatic drying judgment method for the clothes dryer according to any one of claims 1-4, wherein the time t and temperature T_1 are got for multiple loads in the drum during the drying process through experiments,
   a smooth curve is obtained by connecting multiple groups of time t and temperature T_1 in the drum, and the smooth curve is a quadratic function curve, and the formula of the quadratic function curve is determined.

6. The automatic drying judgment method for the clothes dryer according to claim 2 or 3, wherein the time t and temperature T_1 are got for at least three loads in the drum during the drying process through experiments, and the formula of the quadratic function curve based on the three groups of time t and the temperature T_1 in the drum is determined.

7. The automatic drying judgment method for the clothes dryer according to any one of claims 1-6, wherein a temperature sensor is arranged at an air outlet of the drum of the clothes dryer and is used for detecting the temperature in the drum in real time.

8. The automatic drying judgment method for the clothes dryer according to any one of claims 1-7, wherein the corresponding relationship between time t and temperature T_1 of all the loads in the drying state is as follows: $T_1=at^2+bt+c$, which a, b and c are constants.

9. The automatic drying judgment method for the clothes dryer according to claim 8, wherein a value of c is amended along with different ambient temperatures,
when drying begins, the ambient temperature is measured and is recorded as T_3, then $c=72-T_3*0.9$.

10. A clothes dryer having the above methods according to any one of claims 1-9.

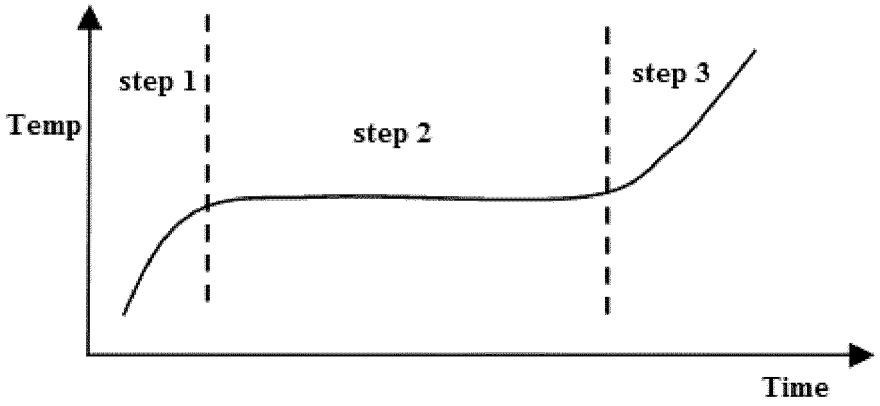

Fig. 1

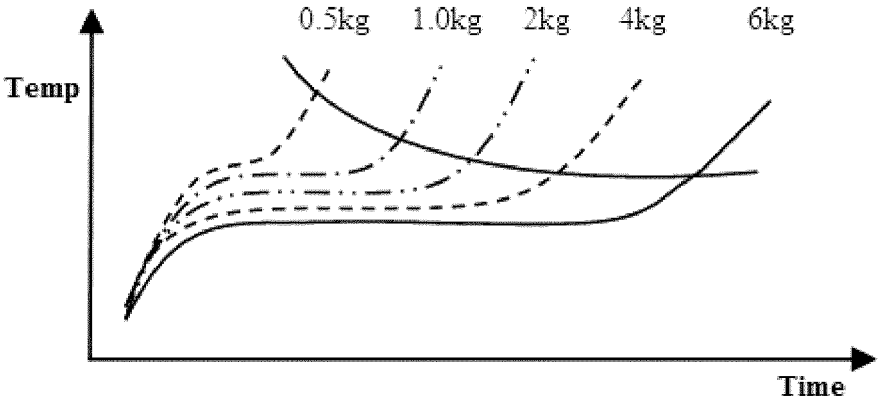

Fig. 2

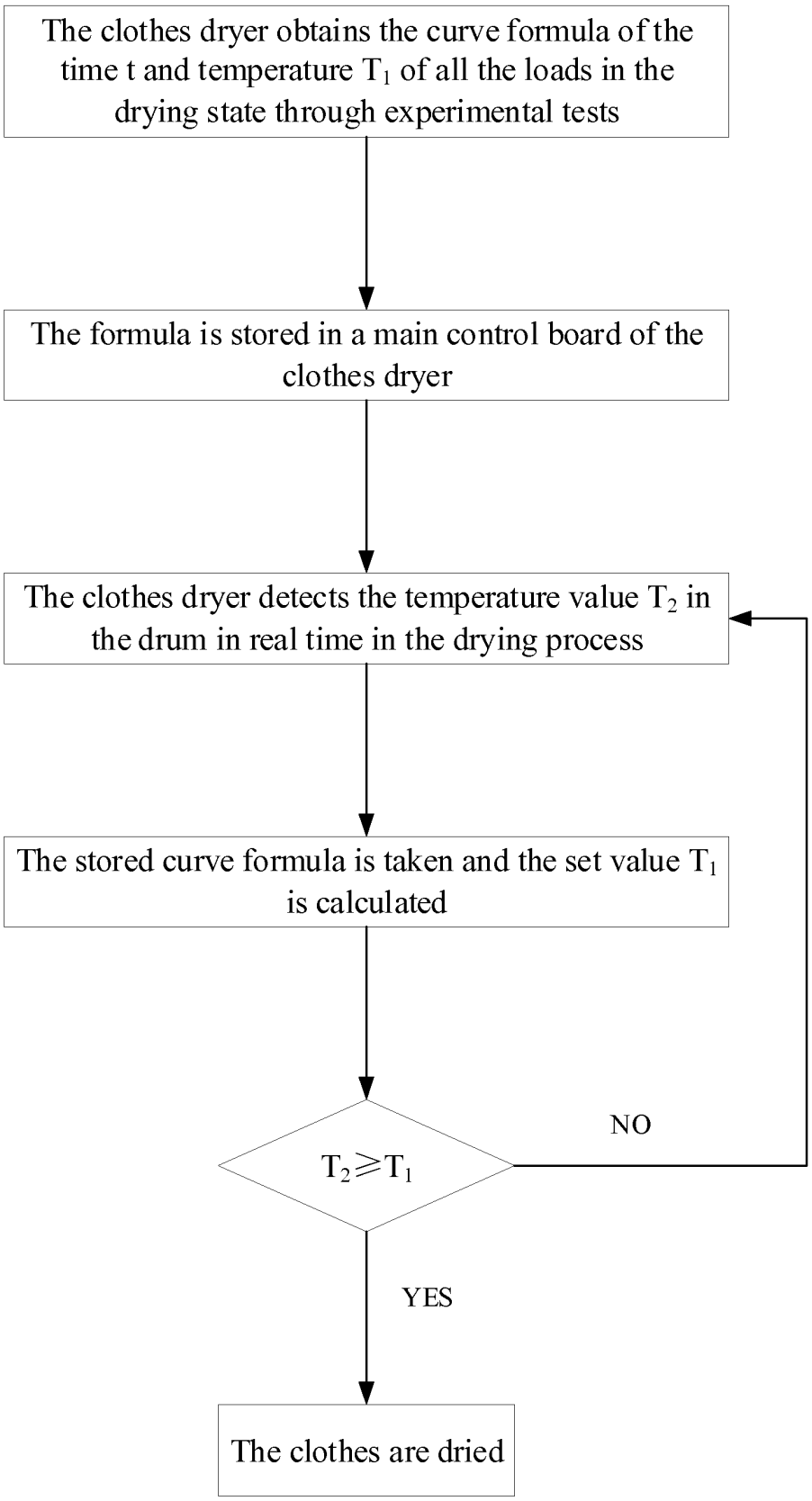
The clothes dryer obtains the curve formula of the time t and temperature T_1 of all the loads in the drying state through experimental tests
The formula is stored in a main control board of the clothes dryer
The clothes dryer detects the temperature value T_2 in the drum in real time in the drying process
The stored curve formula is taken and the set value T_1 is calculated
$T_2 \geqslant T_1$
NO
YES
The clothes are dried

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/079410

A. CLASSIFICATION OF SUBJECT MATTER

D06F 58/28 (2006.01) i; D06F 33/02 (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)

D06F

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; EPODOC; WPI: clothes drying, sensing, dry+, drier, detect+, measur+, monitor+, test+, judg+, estimat+, temperature, time, period, duration

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101410565 A (DAEWOO ELECTRONICS CORP.), 15 April 2009 (15.04.2009), description, page 6, line 7 to page 18, line 12, and figures 1-12	1-10
A	KR 20070066336 A (DAEWOO ELECTRONICS CORP.), 27 June 2007 (27.06.2007), the whole document	1-10
A	WO 2014115976 A1 (LG ELECTRONICS INC.), 31 July 2014 (31.07.2014), the whole document	1-10

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

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search	Date of mailing of the international search report
02 June 2016 (02.06.2016)	**05 July 2016 (05.07.2016)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **ZHANG, Zhen** Telephone No.: (86-10) **62084588**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/079410

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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		US 2007220683 A1	27 September 2007
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