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(71) Applicant: **Fang, Moxi**
**Beijing 100086 (CN)**

(72) Inventor: **Fang, Moxi**
**Beijing 100086 (CN)**

(74) Representative: **Lohmanns, Bernard**
**Benrather Schlossallee 49-53**
**40597 Düsseldorf (DE)**

(54) **LOW-TEMPERATURE PRESERVATION DEVICE WITH DISINFECTION AND FRESH-KEEPING FUNCTIONS**

(57) A low-temperature preservation device with disinfection and fresh-keeping functions comprises low-temperature preservation spaces (11, 12, 13), an electron emission assembly (2), a refrigeration system, an electric system and a housing. The electron emission assembly (2) emits electrons to form negative electric nano particles with a certain density, thereby enabling the preservation spaces into a disinfection state. The negative electric nano particles attached to the surfaces of preserved articles, with water molecules, form hydration films on the preserved articles, so that water of the preserved articles is kept, bacteria and viruses on the surfaces of the preserved articles are killed, freshness of the preserved articles is kept, and the preservation time is prolonged.

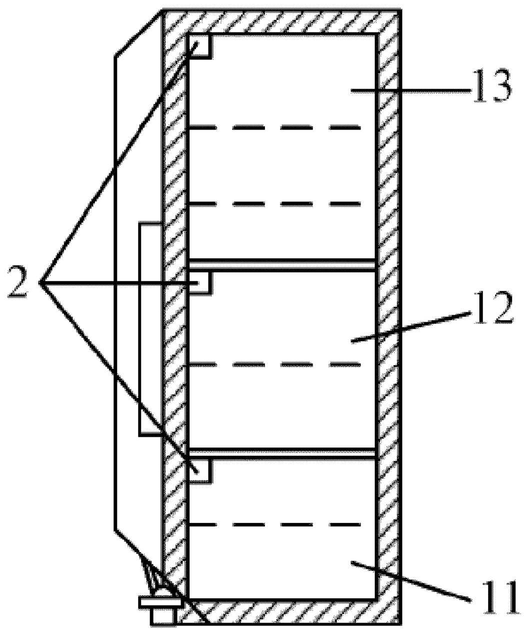


Fig. 1

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a low-temperature preservation device, and more particularly, to a low-temperature preservation device with disinfection function and fresh-keeping function for stored articles. Due to the use of negative electric nano particles, the low-temperature preservation device with multiple applications and effects can be applied in various fields including daily life, medical treatment, food, scientific technology, industrial and agricultural production, etc.

### BACKGROUND

**[0002]** Various low-temperature preservation devices are used worldwide, including domestic refrigerators, freezing and refrigerating warehouses, various low-temperature preservation devices for low-temperature storage & transportation and sales, and low-temperature preservation devices used in the medical field, industrial and agricultural production, and scientific research. These devices have the effects of: leading to the death of partial bacteria under a low temperature; and controlling and suppressing the growth and propagation of bacteria in a preserved article using low-temperature preservation in the meanwhile. However, a large number of bacteria still exists in the article subjected to low-temperature preservation substantially, and some low-temperature microorganisms can even grow and propagate under a temperature of -20°C. For example, various meat products preserved in a freezing area are still possible to go bad due to the propagation of psychrophilic bacteria and psychrophilic mold, so that the retention periods of these food products are shortened. In addition, all the low-temperature preservation devices also have two problems at present, wherein one is that ice crystals caused by a frozen article directly destroy the nutrition and taste of the food; and the other one is that the water loss of the frozen article also destroys the nutrition and taste directly. For example, when vegetables and fruits are preserved in an ordinary low-temperature device--refrigerator, the retention periods thereof are short due to the water loss and mass propagation of the bacteria. For this purpose, the most important issue for the development of the low-temperature preservation device is to overcome the problems of the current low-temperature preservation using a simple, safe and reliable method.

### SUMMARY

**[0003]** The aim of the present invention is to provide a device that can provide a disinfection function in its preservation spaces, prolong the preservation time of preserved articles, and prevent the loss of nutrition and keep the freshness and taste of food. Since a new type of preservation devices having a disinfection function emerge, the new preservation devices play a greater role in fields of daily life, medicine, industrial and agricultural production, and scientific research, for multiple purposes.

**[0004]** In the patent of "Device and Method for Producing Negative Electric Nano Particles" it is mentioned that negative electric nanoparticles can kill bacteria and viruses, but introducing the negative electric nanoparticles into a new field--food technology and low-temperature preservation field is completely different. Firstly, it is needed to figure out what effects can be achieved by applying the negative electric nanoparticles into the low-temperature preservation device, and whether it can overcome the existing problems of existing low-temperature preservation devices in the world. Secondly, it is needed to answer what density value of the negative electric nanoparticles in the preservation spaces of the low-temperature preservation device can achieve disinfection in the low-temperature preservation spaces and have the sterilization and fresh-keeping effects to the preserved articles, and what type of structural arrangements and working parameters shall be used for different low-temperature preservation devices or apparatuses, to enable the low-temperature preservation device or apparatuses to meet the disinfection and fresh-keeping requirements. A desire low-temperature preservation device with disinfection and fresh-keeping functions can be created only when these questions are answered. However, these questions are not answered in the patent of "Device and Method for Producing Negative Electric Nano Particles". Presently, no documents or practices in the world mentions applying the negative electric nano particles into the low-temperature preservation device to improve the performance of the low-temperature preservation device.

**[0005]** The present invention is embodied as follows: according to the present invention, negative electric nano particles are introduced into a low-temperature preservation device, and the low-temperature preservation device is made of thermal insulation materials, and having one or more preservation spaces with various temperatures in various removable or fixed devices, a refrigerating system, an electron emission assembly, an electric system, and a housing. The electron emission assembly comprising an electron emitter, an emission window, a case, and various corresponding components is provided in each of the low-temperature preservation spaces, and is connected to a power supply and a control unit associated through wires, and the related power supply and control unit are a part of the electric system.

**[0006]** The electron emitter in the electron emission assembly is a unique electrode having a certain potential relative to a ground potential outside the preservation device, and emits electrons to a corresponding low-temperature preservation space only. The electron emitter may be comprised of a single or multiple electrodes with the same potential. The electron emitter may be made of different materials, such as metal, alloy, carbon material, composite material, or other materials for emitting the electrons. The electron emitter may have different shapes, such as an acicular shape, a sharp shape, a threadlike shape, a clavate shape, a serrated shape, or a plate shape. The electron emitter may be designed into different structures and sizes according to the need, so as to have different potentials relative to the ground potential outside the device, in the range of -2KV to -35KV. The electrons emitted by the electron emitter in the electron emission assembly are bound to oxygen molecules, carbon dioxide molecules, and water vapor molecules in the preservation spaces, or a molecular group comprised of these molecules, or a nanoscale molecular group comprised of these molecules with other molecules in air, so as to form negative electric nano particles distributed in the preservation space. The electron emission assemblies with different quantities and the electron emission assemblies with different structures, shapes and sizes are deployed according to different volumes, shapes and sizes of the low-temperature preservation spaces and the low-temperature preservation spaces having different temperatures. Once the density of the negative electric nanoparticles in each of the independent low-temperature preservation spaces is more than $5*10^3/cm^3$ but less than or equal to $10^8/cm^3$, the corresponding preservation space is in a disinfection state. The low-temperature preservation space is full of the negative electric nano particles with a certain density, and a preserved article therein is surrounded by an environment full of the negative electric nano particles. The electron emission assemblies with different quantities, structures and sizes are provided according to the requirements of the low-temperature preservation devices and the structure, size and shape of the low-temperature preservation spaces. The electron emitter emits electrons to form the negative electric nano particles in the preservation spaces, and the negative electric nano particles are distributed in the low-temperature preservation space by a certain density, and act on the surface of a preserved article, so that the preservation space is in a disinfection state. Meanwhile, the negative electric nano particles are bound to the water molecules on the surface of the preserved article to form a hydration film on the surface of the preserved article, so that water of the preserved article is kept; and the negative electric nano particles attached on the surface of the preserved article kill the bacteria and viruses on the surface of the preserved article. An optimal combination of parameters and temperature, the volume, structure, and size of the preservation device is selected according to an actual requirement and an application field and a refrigerant of the preservation device to manufacture various special and dedicated low-temperature preservation devices with different temperatures and different structures adapted to the fields including daily life, medical treatment, food, scientific research, industrial and agricultural production, so as to achieve the purposes of reducing the energy consumption and extending the time of low-temperature preservation.

**[0007]** Compared with the prior art, the present invention has the beneficial effects that: the low-temperature preservation space is a disinfection space; the water loss of the preserved article is reduced and the nutrition and taste of the preserved article are improved; and the bacteria and viruses on the surface of the preserved article are killed. Since the three comprehensive effects above are implemented to the low-temperature preservation space and the preserved article at the same time, the temperature of the preservation space is no longer limited by the factors above, the temperatures of the preservation spaces for various preserved articles may be matched again, and the temperatures of the preservation spaces of various preserved articles may be increased correspondingly, and a most suitable temperature may be selected according to the actual requirement, so as to reduce the energy consumption of the preservation device. Because the temperature of the low-temperature preservation spaces is increased, it is more beneficial to select a fluoride-free, safe, and cheap new refrigerant for the low-temperature preservation device.

**[0008]** Researches show that, the electron emission assembly, in which electrons are emitted based on a tunnel effect, is matched with the current low-temperature preservation device, and can be the most suitable technology. When the density of the negative electric nano particles full of the preservation space is more than $5*10^3/cm^3$ but less than or equal to $10^8/cm^3$, the preservation space is thus in a disinfection state. Because the negative electric nano particles attached on the surface of the preserved article have a binding force that attracts the water molecules on the surface of the preserved article to the negative electric nano particles, establishing a special hydration phenomenon that enables the water molecules to form a hydration film on the surface of the preserved article, and the water molecules are uneasy to be affected by the temperature to move easily, the water on the surface of the preserved article can be kept well; and the negative electric nano particles attached on the surface of the preserved article kill the bacteria and viruses on the surface of the preserved article at the same time. The electron emission assemblies with different structures and quantities are distributed according to the volumes, shapes, and sizes of the low-temperature preservation spaces, so as to enable the density of the negative electric nano particles full of each independent low-temperature preservation space to be more than $5*10^3/cm^3$ but less than or equal to 108/cm3. The energy consumption of the electron emission assembly of the invention is lower than 3W, which is mainly the loss of its electronic circuit elements, and this energy consumption value can be greatly reduced by further technical improvement.

**[0009]** With regard to the low-temperature preservation device with the electron emission assembly, the preservation space can be served as a disinfection area, the negative electric nano particles do not pollute the environment, and on the contrary, the negative electric nano particles are beneficial to body health. The space with a density of negative electric nano particles less than or equal to $10^8/cm^3$ is a disinfection and sterile area, in which the negative electric nano particles are bound to the water molecules on the surface of the preserved article to form a hydration film on the surface of the preserved article. These water molecules are uneasy to be affected by the change of environment temperature to move or evaporate, the water of various preserved articles can still be kept well when the temperature of a refrigerating space is increased to 6°C to 9°C from 4°C to 5°C, the fresh-keeping effect of the refrigerating space exceeds that of a current commercially available refrigerator having a preservation area with the temperature ranging from -3°C to 0°C, and meanwhile, the fresh-keeping time of the food product is further increased.

**[0010]** For example, the freezing chamber of the refrigerator has two preservation spaces with the temperatures of -5°C and -12°C respectively, the articles may be respectively stored in the freezing spaces with different temperatures, wherein frozen food products (including various meats) or food products like ice-cream may be moved into or directly stored in the freezing space with the temperature of -5°C, while new food products to be frozen may be placed into the freezing space with the temperature of -12°C for freezing. Although quick freezing and deep freezing are cancelled, for the fresh food products stored in the sterile preservation space of the refrigerating space with an electron emission assembly, and the surfaces of the food products are sterilized during the freezing process, so that the fresh-keeping and preservation effects thereof are still greatly superior to that of various commercially available refrigerators at current.

**[0011]** Because the temperatures in the refrigerating space and the freezing space are increased, the energy consumption of the refrigerator with electronic emission assembly is lower than that of the commercially available refrigerator by at least 30%. Moreover, since the temperature of the low-temperature refrigeration device is increased, it is more beneficial to select a new cooling agent of the refrigerator or other low-temperature refrigeration devices, which makes a contribution to further eliminate the destruction of the carbide to the atmosphere ozone layer.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0012]**

Fig. 1 is a cross-sectional view of a domestic refrigerator with an electron emission assembly according to the present invention;

Fig. 2 is a cross-sectional view of a vehicle-mounted low-temperature refrigeration device with an electron emission assembly according to the present invention; and

Fig. 3 is a cross-sectional view of a large-size refrigerating warehouse with an electron emission assembly according to the present invention.

DETAILED DESCRIPTION

**[0013]** Fig. 1 is a cross-sectional view of a domestic refrigerator with an electron emission assembly according to the present invention. Different from commercially available refrigerators at current, a refrigerator of the invention is additionally equipped with an electron emission assembly 2 in each of freezing and refrigerating chambers. In the refrigerator with the electron emission assembly 2, electrons emitted by an electron emitter form negative electric nano particles, which can kill bacteria and viruses when the density of the negative electric nano particles is more than $5*10^3/cm^3$, in the preservation spaces. Typically, the temperature in a first freezing area 11 of the refrigerator may range from -8°C to -12°C, the temperature in a second freezing area 12 may be -5°C, and the temperature in a refrigerating and fresh-keeping area 13 may range from 6°C to 9°C. The refrigerator comprises a refrigerating system and an electric system, which are consisted of a compressor, a condenser, a dry filter, a capillary tube, an evaporator, etc. An emission window of the electron emission assembly occupies less than 0.2L of space in the refrigerator which has hundreds liter independent preservation spaces, and is located in a comer of the preservation spaces, therefore the preservation spaces may not be affected in its usage as long as a proper position arrangement is in place. As shown in Fig. 1, the low-temperature preservation spaces may be used as disinfection chambers at the same time, and may also be regarded as an exemplary embodiment illustrating the integration of the preservation device and the disinfection device. Moreover, the temperature in each of the preservation spaces may also be changed, so as to enable each of the preservation spaces to become a special and dedicated disinfection chamber.

**[0014]** Generally, temperatures in the refrigerating areas of the commercially available refrigerators range from 4°C to 5°C, even some of the refrigerators further have a fresh-keeping area with a temperature ranging from -3°C to 0°C. As the refrigerators of the existing art lack a sterilization function, various food products, vegetables, and fruits may still cause bacteria propagation in the preservation areas, thereby leading to food spoilage. Even though foods, such as various meats and frozen foods, preserved in the freezing area with a temperature ranging from -18 °C to -24 °C, may still go bad under the effect of the propagation of psychrophilic bacteria including various psychrophilic molds, resulting in shortened preservation time.

**[0015]** Fig. 2 is a cross-sectional view of a vehicle-mounted low-temperature refrigeration device with the electron emission assembly according to the invention. The refrigeration device according to the present invention is comprised of a refrigerating or freezing preservation space 1, an electron emission assembly 2, a refrigerating system, an electric system, and a power system. As generally the volume of its low-temperature preservation space is less than 50M$^3$ to 80 M$^3$, and its maximum size is less than 6m, only one electron emission assembly 2 is required. If the preservation space 1 of a refrigerator car is divided into two portions for freezing and refrigerating, an electron emission assembly 2 may be installed in each of the portions. The areas of the emission windows may be decreased, and a set of power supply could be used for both the electron emitters of the electron emission assemblies 2. The effects described above can be achieved once the density of the negative electric nano-particles in respective portions of the preservation space 1 is more than 5 * 10$^3$/cm$^3$ but less than or equal to 10$^8$/cm$^3$.

**[0016]** Fig. 3 is a cross-sectional view of a large size refrigerated warehouse with the electron emission assemblies according to the present invention. The size of the refrigerating space 1 is 24m (length) * 12m (width) * 4m (height), eight electron emission assemblies 2 are respectively arranged at the two sides with a width of 12m of the preservation space (a total of 16 electron emission assemblies 2 are distributed), and a set of power supply are shared by the 16 electron emission assemblies 2. The area of the emission window of each of the electron emission assemblies 2 is less than 25 x 50 cm$^2$, and the low-temperature preservation effects described above can be achieved once the density of the negative electric nanoparticles in the preservation space 1 of the refrigerating warehouse is more than 5 * 10$^3$/cm$^3$ but less than and equal to 10$^8$/cm$^3$.

**[0017]** In conclusion, the object of the present invention can be achieved by deploying at least one electron emission assembly 2 in different arrangements in the low-temperature preservation box, preservation car or preservation warehouse. For example, one electron emission assembly 2 is arranged in a refrigerator for a preservation space of a maximum size of 6m and for a low-temperature preservation space with a volume no more than 50 M$^3$ to 80 M$^3$; and in this case the area of the emission window of the electron emission assembly 2 could be less than 25 * 50cm$^2$. For a domestic electric refrigerator with a low-temperature preservation space far less than 50M$^3$, the area of the emission window of the electron emission assembly 2 and the number of the electrodes of the same potential may be reduced. The electric components of the electron emission assembly 2 can be easily matched with the ones of the low-temperature preservation device to form a reliable entirety. Since the low-temperature preservation space is a disinfection space, the low-temperature preservation device may be served as a disinfection box or a disinfection cabinet at the same time, or the preservation space 1 may be served as a disinfection space. Alternatively, various special and dedicated disinfection preservation devices with different temperatures and different structures are manufactured and applied to multiple fields including daily life, medical treatment, food, scientific research, industrial and agricultural production, etc. for multiple purposes.

**[0018]** As the low-temperature preservation space of the present invention is in a disinfection state, a hydration film is formed on the surface of the preserved article and the negative electric nanoparticles attached on the surface of the preserved article kill the bacteria and viruses on the surface of the preserved article at the same time. Therefore, the temperature of the low-temperature preservation space is no longer limited by the factors, and an optimal combination of the parameters and temperature with the volume and structure of the preservation device may be selected according to an actual requirement and with reference to a refrigerant selected for the preservation device. Primary revolution is conducted to the existing low-temperature preservation devices to achieve comprehensive objects of reducing energy consumption, comprehensively improving the performance of the low-temperature preservation device, and implementing environmental protection.

## Claims

1. A low-temperature preservation device with disinfection and fresh-keeping functions, comprising:

    At least one preservation space;
    a refrigerating system;
    an electric system;
    a housing; and
    at least one electron emission assembly, comprising an electron emitter, an emission window, a case, and various components, and connected to an power supply and a control unit associated via wires;

    wherein the electron emitter is a unique electrode having one potential relative to a ground potential outside the preservation device, and is configured to emit electrons into the low-temperature preservation spaces only.

2. The low-temperature preservation device according to claim 1, wherein the quantity, structure and size of the electron emission assembly vary in accordance with requirements of a low-temperature preservation device and the structure, size, and shape of the low-temperature preservation space.

3. The low-temperature preservation device according to claim 1, wherein the electron emitter comprises a single or multiple electrodes with the same potential; the electron emitter is made of metal, alloy, carbon or composite material, or any other materials suitable for emitting electrons; the electron emitter is formed in an acicular shape, a sharp shape, a threadlike shape, a clavate shape, a serrated shape, or a plate shape; the electron emitter is configured to have dif-

ferent structures and sizes for needs; and the potential of the electron emitter ranges from -2kv to -35kv.

4. The low-temperature preservation device according to claim 1, wherein the electrons emitted by the electron emitter are bound with oxygen molecules, carbon dioxide molecules and water vapor molecules in the preservation space, or a molecular group composed of these molecules, or a nanoscale molecular group composed of these molecules with other molecules in air, to form negative electric nano particles distributed in the preservation space; the quantity, structure and size of the electron emission assembly vary in accordance with requirements of a low-temperature preservation device and the structure, size, and shape of the low-temperature preservation space; and the preservation space comes into a disinfection state once in which the density of the negative electric nano particles therein is more than $5 * 10^3/cm^3$ but less than or equal to $10^8/cm^3$.

5. The low-temperature preservation device according to claim 1, wherein the electron emitter emits electrons to form negative electric nano particles in the preservation space, which are distributed in the low-temperature preservation spaces with a certain density and act on the surface of a preserved article, to allow the preservation space in a disinfection state; and meanwhile, the negative electric nano particles are bound with the water molecules on surfaces of preserved articles to form a hydration film on the surface of the preserved articles.

6. A method of using a low-temperature preservation device with disinfection and fresh-keeping functions, comprising: selecting an optimal combination of parameter and temperature of the preservation device with the volume, structure, and size thereof according to an actual requirement and application field and with reference to a refrigerating agent of the preservation device, to manufacture to various special and dedicated low-temperature preservation devices with different temperatures and different structures adapted to various fields including daily life, medical treatment, food product, scientific research, industrial and agricultural production, so as to achieve the purposes of reducing the energy consumption and extending the time of low-temperature preservation.

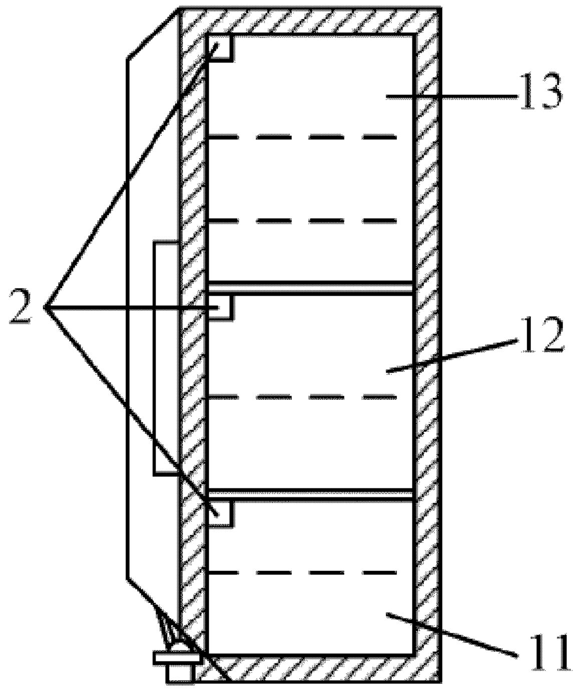


Fig. 1

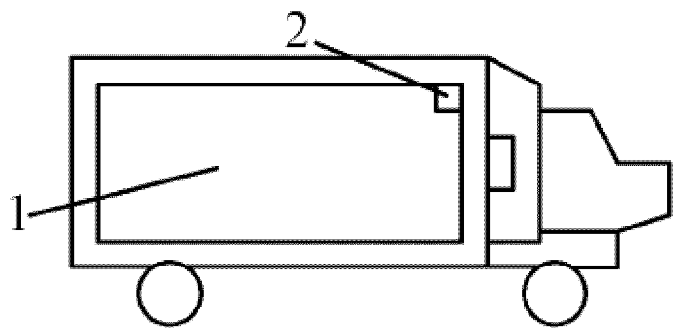


Fig. 2

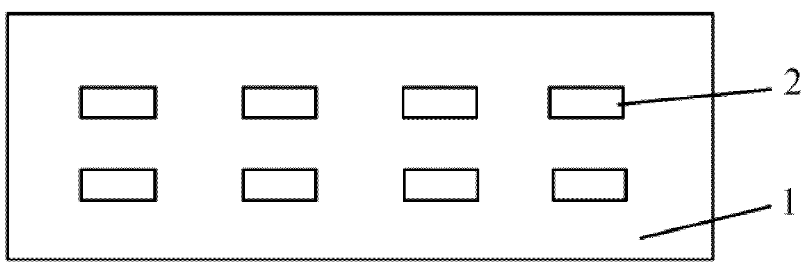


Fig. 3

# INTERNATIONAL SEARCH REPORT

International application No. PCT/CN2015/075124

**A. CLASSIFICATION OF SUBJECT MATTER**

F25D 23/12 (2006.01) i; A61L 2/02 (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)

F25D; A23L 3; A61L 2; CPC: A61L 2/007; A61L 2/087

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)

WPI, EPODOC, CNTXT, CNKI: electric+, electrif+, charg+, electron, nm, nano+, particle?, emit+, irradiat+, emission, electrode, disinfect+, steriliz+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 03 June 2015 | 17 June 2015 |
| Name and mailing address of the ISA/CN<br>State Intellectual Property Office of the P. R. China (ISA/CN)<br>No. 6, Xitucheng Road, Jimenqiao<br>Haidian District, Beijing 100088, China<br>Facsimile No. (86-10) 62019451 | Authorized officer<br>ZHANG, Lihong<br>Telephone No. (86-10) 62085509 |

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