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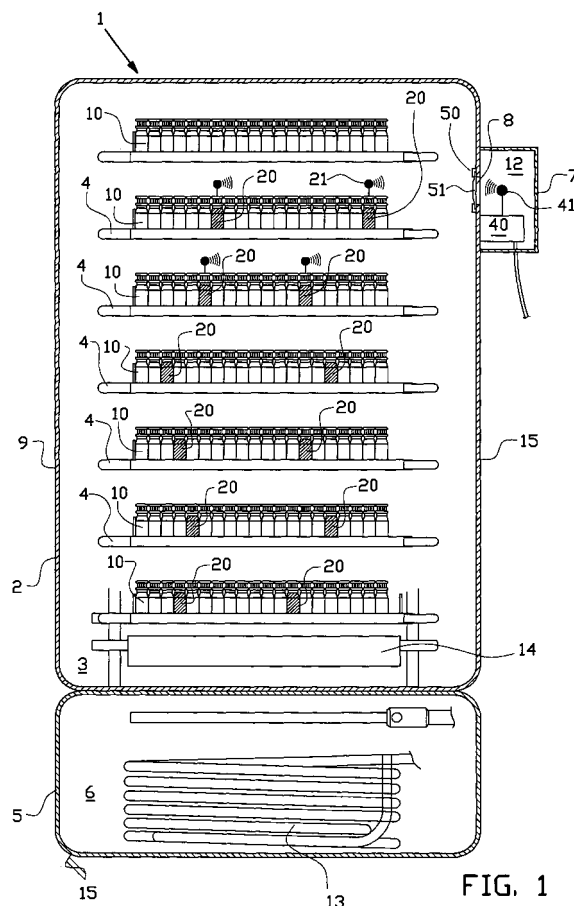
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(54) **Freeze drying chamber with external antenna**

(57) Device for treatment of materials by freeze drying, comprising a housing (2) having first walls (9) that define a drying chamber (3) that is equipped for the accommodation of the material for drying and destined for carrying out the freeze drying process, and a controller assembly (40) for the evaluation of process parameters during the freeze drying process, wherein the controller assembly (40) comprises a controller antenna (41) for high frequency electromagnetic wireless communication with measuring transponders (23) arranged within the drying chamber (3), which controller antenna (41) is placed outside the drying chamber (3).



**FIG. 1**

## Description

### BACKGROUND OF THE INVENTION

**[0001]** The invention relates to device for treatment of materials by freeze drying, comprising a housing having walls that define a drying chamber that is equipped for the accommodation of the material for drying and intended for carrying out the drying process, and a controller assembly for the monitoring and evaluation of process parameters during the freeze drying process.

**[0002]** Such devices are already known. An example of such known device comprises an electronic controller having an antenna inside the housing for wireless communication with measuring transponders that are placed into some sample vials. The antenna may form a surface for the accumulation of contamination, whereby special attention is needed during cleaning to comply with the very high sterility standards for the drying chamber. The cleaning and sterilisation process may require the use of aggressive sterilants and high temperatures which may damage the antenna. Moreover, in a sterile environment only non-toxic materials are permitted and, as a result, the antenna may not be optimised for the communication with the measuring transponders.

**[0003]** It is an object of the invention to provide a device for treatment of materials by freeze drying, having a controller assembly for the monitoring and evaluation of process parameters that can comply with high sterility standards.

### SUMMARY OF THE INVENTION

**[0004]** The invention provides a device for treatment of materials by freeze drying, comprising a housing having first walls that define a drying chamber that is equipped for the accommodation of the material for drying and intended for carrying out the freeze drying process, and a controller assembly for the monitoring and evaluation of process parameters during the freeze drying process, wherein the controller assembly includes a controller antenna for high frequency electromagnetic wireless communication with measuring transponders arranged within the drying chamber, which controller antenna is located outside of the drying chamber.

**[0005]** In the device according to the invention, the antenna of the controller assembly is located outside of the drying chamber, whereby accumulation of contamination on the antenna does not affect the inside sterility of the drying chamber. The device with this controller assembly can therefore comply with high sterility standards.

**[0006]** The controller antenna can be protected against mechanical harm if the housing has second walls that define an antenna chamber in which the controller antenna is confined.

**[0007]** Interference by surrounding electromagnetic sources can be reduced if the drying chamber is screened off electromagnetically to the greatest possible extent

from an outer area of the device, wherein at least one first wall of the housing comprises an opening near the controller antenna for pass-through of the high frequency electromagnetic wireless communication between the controller antenna and the transponders.

**[0008]** In an alternative manner, or in addition thereto the antenna chamber at the side facing away from the drying chamber is screened off electromagnetically to the greatest possible extent from an outer area of the device.

**[0009]** In one embodiment the controller antenna is arranged in front of the opening in order to enable wireless communication with the measuring transponders over a relatively short distance, preferably when the antenna and the transponders are arranged substantially face to face or in line sight.

**[0010]** In a compact embodiment the antenna chamber is adjacent to the first wall with the opening.

**[0011]** The drying chamber can be fully closed off from its environment if the device comprises a cover for the opening, which cover enables or permits the high frequency electromagnetic radiation used for the wireless communication to pass through it. In this manner the cover can form part of the first walls, and be sterilized together therewith.

**[0012]** The cover particularly enables the pass-through of high frequency wireless communication if the cover is made of glass or borosilicate. Other materials can be used for the cover, provided that the electrical conductance is low and that the (ferro) magnetic properties can be neglected.

**[0013]** In one embodiment the cover comprises a plate that extends parallel to the opening.

**[0014]** The cover can easily be replaced if the device comprises a holder that confines the cover around the opening, wherein the holder preferably comprises a ring-shaped flexible gasket made of a chemically inert, non-toxic and stable material, that is press fitted between the cover and the first wall. In one embodiment thereof the ring-shaped flexible gasket is made of a silicone rubber. Silicone rubber is suitable to be applied in a sterile environment, as it withstands high temperatures that are applied during the sterilization. Moreover, the chemical inertness is a prerequisite to achieve the sterile process conditions required for freeze drying pharmaceutical substances.

**[0015]** In the event that the screened off drying chamber forms a Faraday cage, the high frequency electromagnetic radiation can pass through the opening with acceptable loss of signal if the opening has a main diameter that is typically substantially at least half of the wavelength of the applicable electromagnetic high frequency wireless communication.

**[0016]** In one embodiment thereof the antenna is designed for wireless communication using frequencies of approximately 2.4 GHz, wherein the opening has a main diameter of typically at least 0.062 m.

**[0017]** The various aspects and features described

and shown in the specification can be applied, individually, wherever possible. These individual aspects, in particular the aspects and features described in the attached dependent claims, can be made subject of divisional patent applications.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]** The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1 shows a cross section of a freeze dryer according to the invention; and

Figure 2 shows the controller section of the freeze dryer shown in figure 1.

#### DETAILED DESCRIPTION OF THE DRAWINGS

**[0019]** With reference to figure 1, a freeze dryer 1 according to the invention includes a drying housing 2 having walls 9, 15 that define a drying chamber 3. The front wall of the drying housing 2 comprises a slot that can be closed by a slot door (both not shown) to enable vials 10 to be loaded on and unloaded from a horizontally extending shelf 4 within the drying chamber 3. The vials 10 contain sterile pharmaceutical liquids to be dried by freeze drying. Each vial 10 is provided with a ventilating closure 24 that allows ventilation of its content during the drying process, and is pushed downwards into the vial 10 after the drying process is completed to fully close the vial 10.

**[0020]** The drying chamber 3 includes a number of shelves 4, each of which can be raised and lowered within the drying chamber 3 using a loading mechanism 14, which is known from the art. To load the shelves 4 with rows of vials 10, the shelves 4 are initially collapsed in the lower portion of the drying chamber 3 and the uppermost shelf is first moved into a loading position. After this shelf 4 has been loaded, the loading mechanism 14 automatically raises the loaded shelf 4 to enable the next shelf 4 to be moved to the loading position. This moving sequence continues until the drying chamber 3 loading has been completed. To unload the drying chamber 3, the loading sequence is reversed, with the lowermost shelf 4 being unloaded first.

**[0021]** With reference to figures 1 and 2, one side wall 15 of the drying housing 2 has a hole 8 which is fully covered with a plate 51 of borosilicate glass. The circumferential edge of the plate 51 is confined between a holder 50 and the side wall 15. A sealing ring or gasket 52, made of a material such as silicone rubber has been press fitted between the plate 51 and the side wall 15. The freeze dryer 1 is provided with an electronic controller 40 with an antenna 41 disposed on the outside of the drying housing 2. The controller 40 and the antenna 41 are confined within an antenna housing 7 defining an antenna chamber 12 adjacent to the drying chamber 3.

**[0022]** The electronic controller 40 is configured for

wireless communication with measuring transponders 23 that are placed in some sample vials 20 within the drying chamber 3. The sample vials 20 contain the same pharmaceutical liquids as the other vials 20, but are disposed off after the drying process. The communication with the measuring transponders 23 in the sample vials 20 enable accurate real time measurement of process parameters during the freeze drying process.

**[0023]** The measuring transponders 23 are non-mains borne, and do not have an internal energy supply such as a battery. The energy to operate the measuring transponders 23 is provided by electromagnetic waves radiated to the transponders 23 by the controller 40 via the controller antenna 41. The measuring transponders 23 each have their own exclusive operative band width, and the individual operative band widths are cascaded into a frequency band. The measuring transponders 23 comprise a sensor 22, for example a bimetallic element, having well specified electric properties related to a physical parameter to be measured, such as temperature or humidity. The sensor 22 is connected to an antenna 21 that may extend through the closure 24 as illustrated in this exemplary embodiment. When the electronic controller 40 emits an amount of electromagnetic energy via the controller antenna 41, the electromagnetic signal is transmitted through the opening 8 to a measuring transponder 23. In response, each transponder 23 generates an internal resonance frequency within its exclusive small operative band width, which resonance frequency is picked up by the antenna 41. As will be understood, the measured physical parameter can be derived from this resonance frequency. The transponders 23 operate on frequencies in the order of 2.4 GHz.

**[0024]** In this exemplary embodiment the drying housing 2 is supported by a condenser housing 5 having walls 15 that define a condenser chamber 6. A condenser unit 13 has been arranged within the condenser chamber 6. The drying chamber 3 opens to the condenser chamber 6. The combined condenser chamber 6 and drying chamber 5 can be closed off in an airtight manner from the outer area of the freeze dryer 1. The walls 9, 15 of the drying housing 2 and the condenser housing 5 are made of stainless steel in order to comply with the very high hygienic and anti toxic standards for processing pharmaceutical substances. The antenna housing 7 is also made of stainless steel, whereby the drying chamber 3, the condenser chamber 6 and the antenna chamber form a Faraday cage that is screened off electromagnetically to the greatest possible extent from its surrounding area 80.

**[0025]** As the chambers 3, 6, 12 are screened off, the high frequency electromagnetic radiation passing between the electronic controller 40 and the measuring transponders 23 can only pass through the opening 8 in the side wall 15. In order to minimise the reduction of the signal, the optimal main size or diameter D of the opening 8 is at least half of the wavelength of the electromagnetic signal. This has been derived from the formula  $S = 20 \log_{10} (W/2D)$ , wherein S is the rate of shielding in dB of

a Faraday cage if electromagnetic waves with wavelength  $W$  enters through an opening with main dimension  $D$  such as length, width or diameter. The rate of shielding is estimated at 0 dB when the main dimension  $D$  is half of the wavelength. As the transponders 23 operate on frequencies in the order of 2.4 GHz, the wavelength is 0.125 m, whereby the diameter of the opening 8 is at least 0.062 m.

**[0026]** During the freeze drying process, the controller 40 emits electromagnetic waves to the measuring transponders 23. To measure the process parameters being detected at a point in time during the freeze drying process, a frequency sweep is executed, whereby the frequency of the electromagnetic waves is increased while different resonance frequencies of the measuring transponders are picked up. These resonance frequencies are converted to the process parameters measured in the sample vials 20 at different locations within the drying chamber 3. As the controller antenna 41 is placed outside the drying chamber 3, it does not affect the freeze drying process inside the drying chamber 3.

#### Claims

1. Device for treatment of materials by freeze drying, comprising a housing having first walls that define a drying chamber that is equipped for the accommodation of the material for drying and destined for carrying out the freeze drying process, and a controller assembly for the monitoring and evaluation of process parameters during the freeze drying process, wherein the controller assembly includes a controller antenna for high frequency electromagnetic wireless communication with measuring transponders arranged within the drying chamber, which controller antenna is located outside of the drying chamber.
2. Device according to claim 1, wherein the housing has second walls that define an antenna chamber in which the controller antenna is confined.
3. Device according to claim 2, wherein the antenna chamber at the side facing away from the drying chamber is screened off electromagnetically to the greatest possible extent from an outer area of the device.
4. Device according to any one of the preceding claims, wherein the drying chamber is screened off electromagnetically to the greatest possible extent from an outer area of the device, wherein at least one first wall of the housing comprises an opening near the controller antenna for pass-through of the high frequency electromagnetic wireless communication between the controller antenna and the transponders.
5. Device according to claim 4, wherein the controller antenna is arranged in front of the opening.
6. Device according to claim 2 or 3 and 4 or 5, wherein the antenna chamber is adjacent to the first wall with the opening.
7. Device according to any one of claims 4-6, comprising a cover for the opening, which cover enables or permits the passage of the high frequency electromagnetic radiation used for the wireless communication.
8. Device according to claim 7, wherein the cover is made of glass or borosilicate.
9. Device according to claim 7 or 8, wherein the cover comprises a plate that extends parallel to the opening.
10. Device according to any one of claims 7-9, comprising a holder that confines the cover around the opening.
11. Device according to claim 10, wherein the holder comprises a ring-shaped flexible gasket made of a chemically inert, non-toxic and stable material that is press fitted between the cover and the first wall.
12. Device according to claim 11, wherein the ring-shaped flexible gasket is made of a silicone rubber.
13. Device according to any one of claims 4-12, wherein the opening has a main diameter that is typically substantially at least half of the wavelength of the applicable electromagnetic high frequency wireless communication.
14. Device according to claim 13, wherein the antenna is designed for wireless communication using frequencies of approximately 2.4 GHz, wherein the opening has a main diameter of typically at least 0.062 m.
15. Device provided with one or more of the characterising features described in the accompanying description and/or shown in the accompanying drawings.

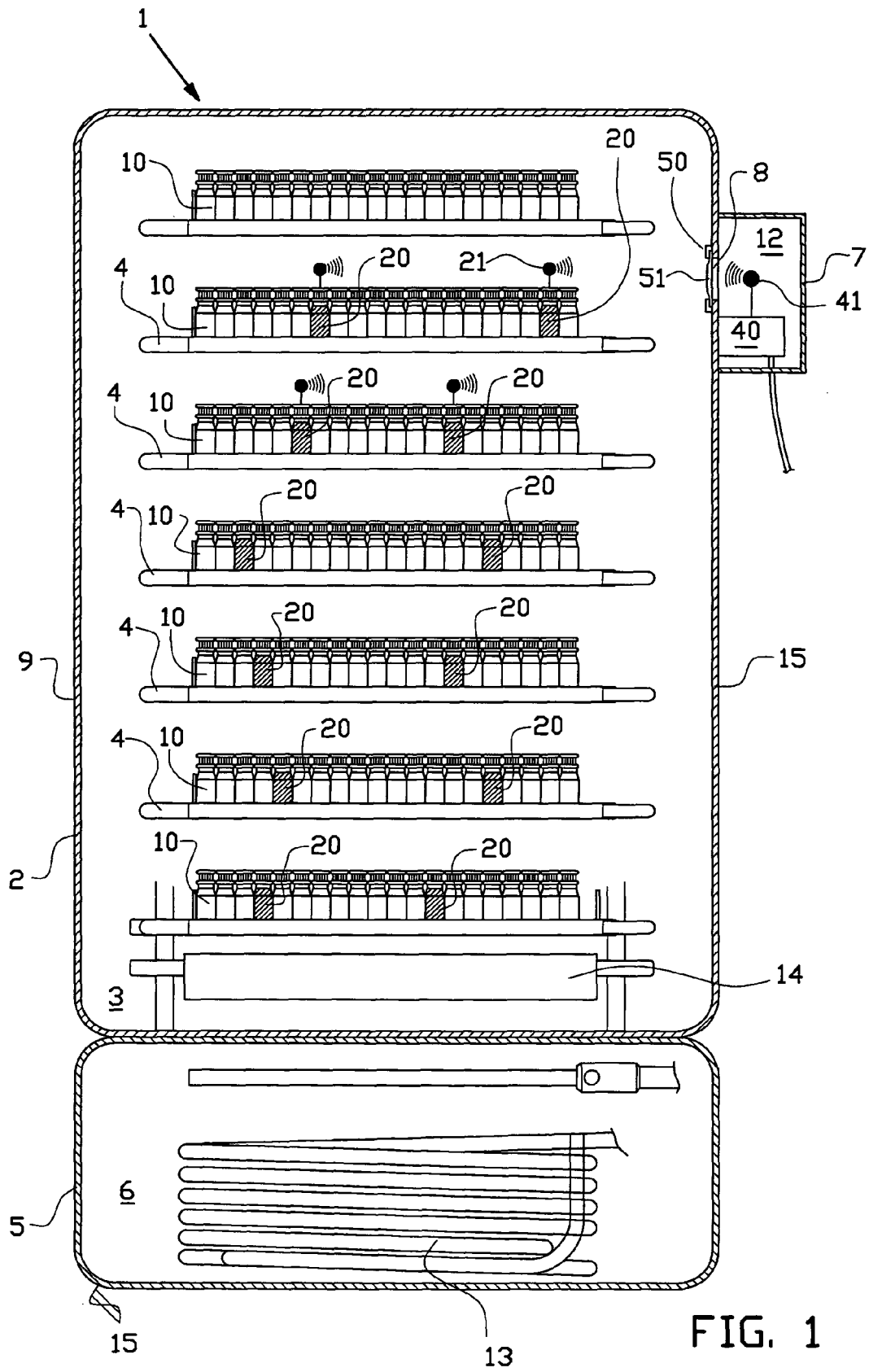


FIG. 1

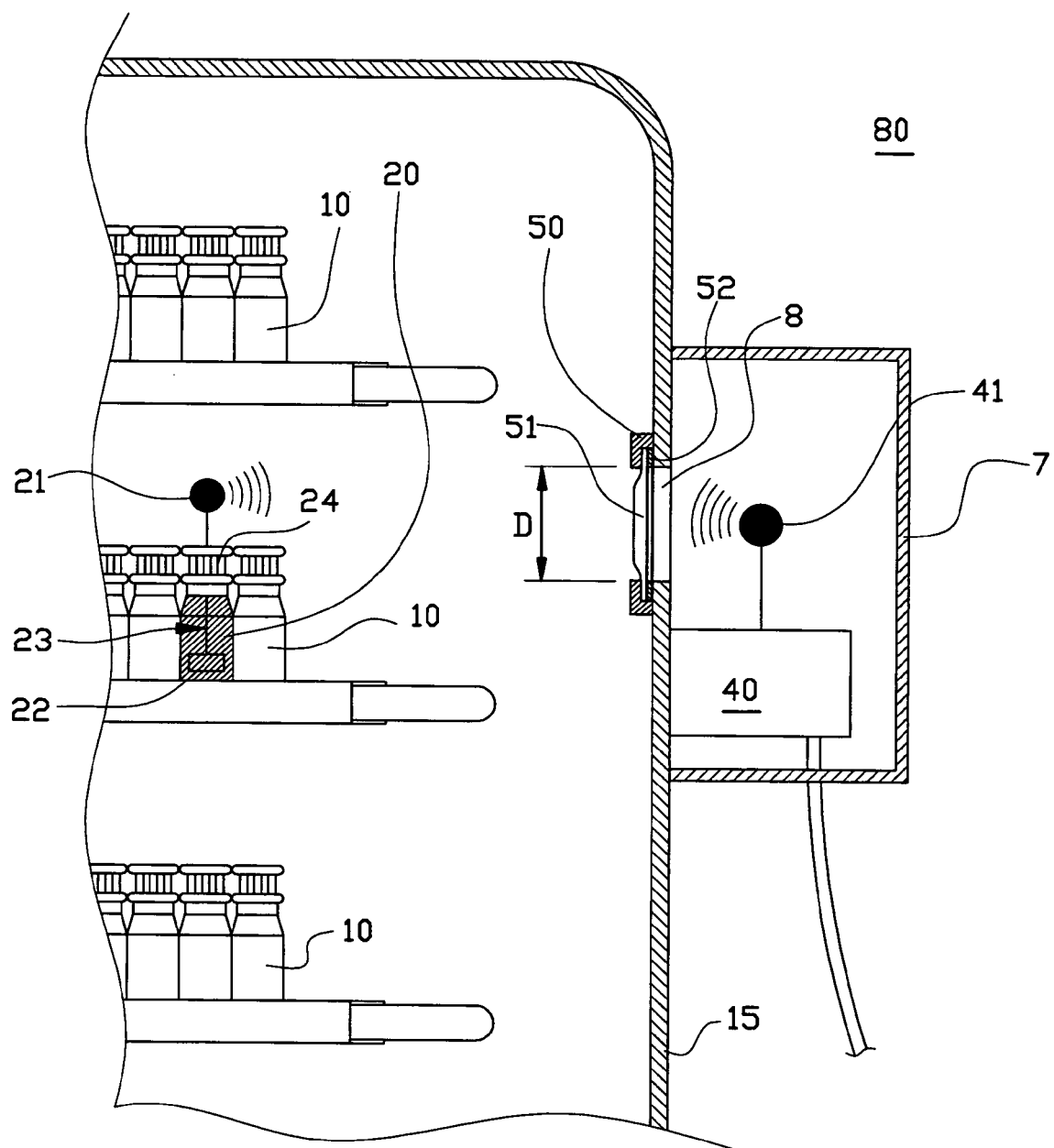


FIG. 2



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 07 07 5765

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Place of search <b>The Hague</b>		Date of completion of the search <b>14 March 2008</b>	Examiner <b>Silvis, Henk</b>
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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