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

(11) **EP 4 390 282 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
01.01.2025 Bulletin 2025/01

(21) Application number: **22383253.6**

(22) Date of filing: **21.12.2022**

(51) International Patent Classification (IPC):
F26B 11/04 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F26B 3/347; F26B 11/04

(54) DEVICE FOR GENERATION AND DISTRIBUTION OF MICROWAVES IN ROTARY HEAT APPLICATION SYSTEMS

VORRICHTUNG ZUR ERZEUGUNG UND VERTEILUNG VON MIKROWELLEN IN ROTIERENDEN WÄRMEANWENDUNGSSYSTEMEN

DISPOSITIF DE GÉNÉRATION ET DE DISTRIBUTION DE MICRO-ONDES DANS DES SYSTÈMES D'APPLICATION DE CHALEUR ROTATIFS

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
26.06.2024 Bulletin 2024/26

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Description

OBJECT OF THE INVENTION

[0001] The present invention falls within the technical field of drying procedures and devices of materials involving the use of heat, more specifically in that of those using electrical effects for the development of heat, and refers in particular to a device for generation and distribution of microwaves in rotary heat application systems.

[0002] The device has special application in the field of drying washed clothes, therefore it also falls within the specific technical field of heating systems for clothes dryers. However, its use is not limited to this, since it is also useful in seed drying procedures, rubber devulcanization, disinfection, and in general in any application that requires significant heating uniformity.

BACKGROUND OF THE INVENTION

[0003] Drying is one of the processes that consumes most energy, since it implies the contribution of energy to the internal water of a material, as well as to its own solid structure or dry mass. When these materials are poor thermal conductors (thermal insulators), as is the case of clothing or textile materials, the transmission of energy by heat exchange with hot air is an inefficient system because the low thermal conductivity prevents a rapid absorption of airborne heat.

[0004] Due to the high latent heat of evaporation of the water, in addition, the amount of energy to provide to the internal humidity of the materials that are being dried is very important. For this reason, drying processes based on hot air are usually slow and inefficient.

[0005] On the other hand, microwaves heat materials based on their electric permittivity, which is usually optimal when these materials contain water, since water is a polar material that converts microwaves into heat and finally allows the water to evaporate.

[0006] Despite these well-known advantages, commercial devices that use microwave energy to speed up the drying process of textiles are not common, and this is due to several reasons:

- it is technologically complex to use rotating metal drums in which microwaves can be introduced at significant levels to facilitate rapid drying;
- it is difficult to use mobile filters at the microwave frequency that allow this rotation while preventing microwave radiation to the outside;
- the air inlet and outlet in the drum must be adequately compatible with the elimination or significant reduction of microwave radiation through those air inlet and outlet points;
- when several microwave sources are used, they can couple mutually during the drying process and end up being damaged;
- textile materials change their dielectric properties a lot when they lose water, so the load detected by microwave sources varies a lot and, therefore, achieving an efficient and uniform system throughout the process is extremely complex;
- the exact stopping point of the process must be known so as not to overheat or burn the garments; and
- as uniform heating as possible must be provided to all the clothes located inside the dryer.

[0007] In the current state of the art there are patent documents that try to solve some of these disadvantages and provide microwave drying devices. It should be mentioned at this point that rotating drum microwave dryers can be classified into two main types.

[0008] In the first type, the microwave or magnetron source is fixed and heats a cavity where a rotating drum is located and where the clothes or items to be dried are inserted. This drum can be made of plastic so that the microwaves penetrate through it or can be metallic and equipped with a series of holes so that the microwaves can enter the drum and carry out their function of heating and drying.

[0009] An example of this first type can be found in patent publication number US6393725B1, which describes a compact microwave clothes dryer that is small enough to be placed on a counter. Air circulates through the microwave generator and power supply components into the drying chamber to transfer heat from the components to the clothes in the chamber. The feeding occurs directly with the antenna of the magnetron directed towards the rectangular microwave cavity, in which a rotating cylinder is located where the clothes are inserted.

[0010] In the second type, the microwave or magnetron source is located on the axis of the drum, either at the back or at the door, and emits directly into the rotating drum where the clothes or items to be dried are located.

[0011] An example of this second type can be found in the document with publication number CN110318230A. This relates to a clothes dryer comprising a box assembly, a door assembly, a cylinder assembly, a condensing assembly and a microwave assembly. The box assembly comprises a front sealing door with an opening for placing objects, the door assembly covers the front sealing door, and the cylinder and the door assembly are correspondingly arranged within the box assembly. The cylinder assembly comprises an inner cylinder that contains the clothes to be dried and an outer cylinder that covers the outer cylinder, wherein the condensing assembly is disposed within the case assembly and the condensing assembly is disposed below the cylinder assembly to condense gas exiting the cylinder assembly. The microwave assembly is arranged on the outer surface of the outer cylinder, and the microwave assembly transmits microwaves through the inner space of the outer cylinder through the outer cylinder.

[0012] This same applicant has a previous utility model, ES1246295U, related to a dryer that allows the waves

to be redirected towards the drum where the clothes are located. The dryer comprises a microwave-impermeable casing, with a door, equally impermeable, for introducing the clothes into a prismatic cavity configured to dry the clothes, which has one or more magnetrons with waveguides oriented towards the cavity, and one or more spaces isolated from microwaves for electronic or electrical equipment and other devices sensitive to microwaves, characterized in that the cavity has one or more microwave reflectors oblique to the walls of the cavity at its edges.

[0013] In both types of rotating drum microwave dryers, the problem is that as the clothes dry, they absorb less microwaves. Unused and uncontrolled, these microwaves end up damaging the magnetron and making the device very inefficient. In the case of magnetrons that directly feed the drum, there is also a greater risk of fire due to the high temperature that the clothes closest to the source can reach.

[0014] To avoid damage to the magnetron, current devices finish the drying process before the object in question, usually clothing, is completely dry. Therefore, to avoid damage to the device, the final objective is not achieved, which is to completely dry the inserted object.

[0015] Document CN206752162 provides a microwave clothes dryer that includes a cavity assembly, one end of the bottom of the cavity assembly is provided with an air inlet, and the other end of the cavity assembly is provided with a first opening. An air suction component is located outside the cavity component and communicates with the air inlet. A drum assembly is installed inside the cavity assembly. One end of the bottom of the drum assembly is provided with a first ventilation hole, and the other end of the drum assembly is provided with a second ventilation hole. A door assembly is installed at the first opening and is cooperatively connected with the cavity assembly. The door assembly is provided with a third ventilation hole and an air outlet. The external wind is introduced by the air suction component and flows into the cavity component through the air inlet hole, and passes through the first ventilation hole, the second ventilation hole, and the third ventilation hole.

[0016] This invention basically refers to solving a cleaning problem of a rotary drum used to dry clothes and in the air flow mechanisms but does not solve the main electromagnetic problems that arise in microwave drying of textiles.

[0017] Document NL8700130 discloses a mechanism for drying textile items that comprises a container for such items, heating means and a blower to pass air through the container. The heating means consist of a magnetron to emit microwaves at a frequency to produce excitation of water molecules whilst the mechanism has an enclosure impermeable to microwaves. The container may be a drum rotatable about a horizontal axis and at least partly consisting of microwave-permeable plastic whilst the emitter tube of the magnetron is arranged outside the drum. The enclosure may have a blower air inlet and outlet provided with metal mesh covers with mesh width to prevent passing of microwaves.

[0018] The mechanism disclosed in this document uses an external cavity to contain the microwave energy and then an internal rotating drum, in this case partially made with plastic, to hold the textiles. It does not include a launcher, and the microwave energy dispersed in the outer cavity, which provides lower efficiencies for microwave energy.

[0019] Finally, document WO2005073449 relates to a washer/dryer wherein ducts circulating the drying air during drying process of the laundry, are designed to utilize the limited volumes efficiently, wherein a compact and vibration resistant structure is attained, the pressure drops of the drying air are minimized and microwave energy is effectively directed to the laundry to be dried.

[0020] This machine uses an external cavity that must totally contain the rotating drum and act as a means to contain the microwaves. No slots are used there, and therefore the rotating drum must be permeable or semipermeable to microwaves. In this case, no mobile waveguide is installed since it is fixed in the waxing tank (external cavity). Therefore, the microwaves are not totally confined in the drum but also in the washing tank, providing a poorer microwave efficiency. This implies that this microwave dryer does not solve the problem of loss of efficiency when the textiles lose water. Also, the problem of placing several magnetrons without coupling is not solved either.

[0021] Therefore, there continues to be a need for a device for generating and distributing microwaves in rotary heat application systems that, in a simple and efficient manner, allows overcoming the mentioned objections of the current state of the art.

DESCRIPTION OF THE INVENTION

[0022] The object of the invention consists of a device for the generation and distribution of microwaves in rotary heat application systems, which basically comprises the following elements:

- a rotating drum, preferably cylindrical, into which the material to be heated or dried is introduced, which includes through slots distributed on the side wall of the drum;
- at least one microwave emitting source, comprising magnetrons or solid-state generators, for generating and emitting a microwave electromagnetic field;
- fixed microwave filters, located on the slots of the drum without impeding its rotation, while they form a partially mobile slotted waveguide that distributes the microwave electromagnetic field selectively and uniformly throughout the material to be heated or dried; and
- an external structure that supports the previous elements.

[0023] Microwave filters are preferably materialized in the form of metallic cylinders that encase at least partially an outer surface of the rotating drum to prevent microwave radiation from escaping from the waveguide surrounding the rotating drum, confining it without leaving it more than one outlet through a set of slots described later, and therefore forcing said radiation to move inside the metal drum, where the materials are heated and/or dried. The microwave filters are attached to the external structure of the rotating system, allowing the microwave emitting sources to be installed on them.

[0024] The cylindrical filters can also comprise metal screws that are inserted into the partially mobile slotted waveguide to adapt the initial impedance of the process and improve its efficiency, with a fixed or adaptable configuration in the event of possible changes in the electromagnetic response of the load. Likewise, the cylindrical filters can be divided into several parts to allow their installation in the device in a simple way or to increase the number of microwave emitting sources.

[0025] Since the processed materials can change their internal moisture appreciably during the process, and with it their dielectric properties, a gradual or abrupt mismatch can occur between the microwave sources and their load, that is, the rotating drum with the material inside. To avoid this, a launcher is additionally added inside the partially mobile slotted waveguide, which makes it possible to make the impedance detected by the microwave emitting source independent with respect to the heating and/or drying conditions of the material and provide, consequently, an adaptation with reflection coefficient values less than -10 dB during the entire heating and/or drying process. Thus, high efficiency and homogeneity in the process are achieved.

[0026] In its preferred embodiment, the launcher is made up of two metal plates: one vertical and parallel to the antenna of the magnetron or solid-state generator, and another that is located below said antenna. The magnetrons or the antennas of the solid-state generators are therefore arranged on the cylindrical filters and the slots of the drum. The antenna of the microwave emitting source is located between the wall of the corresponding filter and the metallic launcher, to direct the microwave beam towards a determined direction of the drum and its slots. Likewise, these launchers allow one or more microwave sources to be mounted on the same filter, since the slots act as distributed antennas and there is little power available at the end of its journey through the partially mobile slotted waveguide under which they are located.

[0027] Regarding the distribution of the rotating drum slots, these can be configured in different radiant groups in such a way that, when there are several microwave sources, they are uncoupled from each other, allowing the use of several microwave sources simultaneously without occurring any breakage due to power transfers between these sources, nor loss of efficiency in the heating and/or drying process.

[0028] The decoupling between the groupings of slots is achieved by distributing them along the surface of the cylindrical side wall of the drum and making said groupings of slots cause an electric field perpendicular to that emitted by the other group of slots. Likewise, the lower and upper slots of the same radiating group also generate perpendicular electric fields, there being no coupling between slots of the same group. This also favors the use of several microwave sources simultaneously without the risk of breakage due to source coupling and, therefore, the energy is directed exclusively to the material that must be dried and/or heated.

[0029] In this way, one of the advantages of the device is achieved, since by being able to install and use several microwave sources simultaneously, faster and more effective heating and extraction of humidity is achieved than in the previously reviewed inventions.

[0030] The interior of the rotating drum can contain metal blades, or preferably dielectric blades, which allow the material heated inside to be moved so that there is a greater uniformity of heating and/or drying, and so that the steam can escape from the dried material in a simpler way. Generally, these blades are made of a material that is transparent to microwaves, although it is also possible to use metal with rounded edges or other types of materials.

[0031] To close the faces of the drum, a front wall and a rear wall are arranged, perpendicular to the axis of rotation of said drum. Each one of them comprises a plurality of grid-type metal holes acting as cut-off waveguides, which totally or partially cover said walls in order to allow the evacuation of water vapor or other gases from the interior of the rotating drum. These walls can be integral with the body of the drum, and therefore rotate at the same time as it, or they can be independent and remain stationary while the drum rotates. In this second case, it is necessary to insert an additional cylindrical filter that, as a joint, prevents the microwave radiation from escaping.

[0032] Each metal wall is linked to the drum maintaining electrical continuity so that the passage of microwaves through these cut-off waveguides is prevented, but the passage of air, water vapor or any other gas is allowed. In the case of the front wall, it is necessary that there is at least one folding sector as a door to allow the introduction and extraction of materials from inside the drum.

[0033] A flow of air or another type of inert gas, such as nitrogen or helium, is generated before the rear perpendicular wall. Said gas flow crosses the cylindrical drum, evacuating the water vapor or any other gas generated inside. The length and internal dimensions of each cut-off guide are designed to provide enough attenuation to the electric field so that it comes out minimally through these holes and, in any case, complying with the electromagnetic compatibility regulations applicable to equipment that uses microwave radiation.

[0034] The metal grill on the front wall can be fixed or

mobile to introduce and extract the materials to be heated or dried inside the drum. In this second case, the most common, it incorporates a filter in its contour that prevents contact with the rotating drum and prevents microwaves from radiating out of it, acting as a door for the rotating system.

[0035] With the device thus described, multiple advantages are achieved over the current state of the art. The most notable is derived from the fact that more efficient, uniform and rapid heating and drying is achieved, which has a positive effect on total energy consumption, due to the optimal use of the microwave flow. Reflections and interactions between the various microwave flows are minimized, which also prolongs the life of the magnetron by avoiding the couplings that occur with known devices.

DESCRIPTION OF THE DRAWINGS

[0036] To complement the description that is being made and in order to help a better understanding of the characteristics of the invention, according to a preferred example of its practical embodiment, a set of drawings is attached as an integral part of said description, where, with an illustrative and non-limiting nature, the following has been represented:

Figure 1.- Shows a front perspective view of the assembly made up of the rotating drum and the cylindrical filters for microwaves.

Figure 2.- Shows a rear perspective view of the assembly made up of the rotating drum and the cylindrical filters.

Figure 3.- Shows a partial exploded view of Figure 2 in which the interior of the rotating drum can be seen.

Figure 4.- Shows a schematic front view of the device.

Figure 5.- Shows a schematic rear view of the device.

Figure 6.- Shows a partial exploded view of the device.

Figure 7.- Shows a perspective view of a cylindrical filter.

PREFERRED EMBODIMENT OF THE INVENTION

[0037] A detailed explanation of a preferred embodiment of the object of the present invention is provided below, with the help of the aforementioned figures.

[0038] The device for generating and distributing microwaves in rotating heat application systems that is described is made up of a rotating drum (1), at least one microwave emitter (2), at least one fixed microwave filter (3), and an external structure (4) that supports the previous elements.

[0039] The rotating drum (1), essentially cylindrical and made of a metallic material, comprises a continuous side wall (5), a front closure (6) and a rear closure (7), which delimit an internal housing intended to house an element to which to apply heat, either for drying or heating. The side wall (5) comprises a plurality of through slots (8) distributed along its surface that allow a beam of microwave energy from the microwave emitters (2) to pass towards the interior housing of the drum (1).

[0040] As can be seen in the attached figures, especially in figures 3 and 6, in this preferred embodiment the slots (8) have an oblique orientation with respect to an axis of rotation passing through the center of the rotating drum (1). Likewise, in this embodiment the slots (8) are distributed in an annular alignment along the side wall (5) and in such a way that two slots (8) diametrically opposing each other do not exactly face each other.

[0041] In a preferred embodiment of the device, shown in the attached figures, the side wall (5) of the rotating drum (1) comprises two alignments, parallel and separated from each other, of slots (8), separated from each other by an intermediate annular extension (9). The rotating drum (1) also includes two further annular extensions (9), one front and one rear. In this way, each of the alignments of slots (8) is delimited between two annular extensions (9).

[0042] Each one of the microwave filters (3) is made up of a cylindrical body of metallic material, intended to encase the exterior of a sector of the side wall (5) of the rotating drum (1) in which a grouping of slots (8) is located, so that it is covered by the microwave filter (3). In the preferred embodiment shown in the figures, the device comprises two microwave filters (3), each one covering a respective alignment of slots (8). The cylinder that makes up each microwave filter (3) has an internal diameter greater than the diameter of the rotating drum (1).

[0043] The microwave filters (3) are fixed to the external structure (4) by means of fastening elements (10), which in this case are columns. In this way the rotation of the rotating drum (1) is not hindered while ensuring that the alignment of slots (8) is always covered, as illustrated in Figures 4 and 5. The fastening elements (10) must ensure the correct mechanical stability of the assembly.

[0044] As can be seen in Figure 7, each microwave filter (3) has an external face and an internal face intended to face the external face of the side wall (5) and cover an alignment of slots (8). The internal face additionally comprises a band-eliminating filter (11), which in this case is made up of metallic corrugations intended to interact with the annular extensions (9) of the rotating drum (1).

[0045] Each microwave filter (3) also has at least one through hole (12), and in correspondence with said through hole (12) a support (13) is arranged to house the microwave emitter (2) on the external face of the micro-

wave filter (3). The microwave emitter (2), which in this preferred embodiment consists of a magnetron, comprises an antenna insertable through the through hole (12), to direct the microwave beam towards the side wall (5) of the rotating drum (1).

[0046] Likewise, on the internal face of the microwave filter (3) and in correspondence with the through hole (12) there is a launcher (14) for directing and adapting the microwave beam towards a certain direction of the side wall (5) and the slots (8) of the rotating drum (1).

[0047] In this preferred embodiment, the launcher (14) comprises a vertical wall (15), which projects perpendicularly from the internal face of the microwave filter (3) and parallel to the antenna of the microwave emitter (2), and a horizontal wall (16), which heads perpendicularly towards a free end of the vertical wall (15), giving the launcher (14) an L-shaped profile. All the elements of the launcher (14) are metallic.

[0048] Therefore, a partially mobile slotted waveguide is formed in the device, which in this preferred embodiment is delimited by the following elements:

- the external face of the side wall (5) of the rotating drum (1), with the slots (8);
- the internal face of the microwave filter (3), including the band-eliminating filter (11) and the launcher (14); and
- two opposing faces of two annular extensions (9) of the rotating drum (1).

[0049] The partially mobile slotted waveguide has a mobile part, the one made up of the elements of the rotating drum (1), and another fixed part, the one corresponding to the microwave filter (3) and the elements linked to it. Said guide confines within it the microwave beam coming from the microwave emitter (2) introduced into the guide through the through hole (12), and forces said microwave beam to radiate, which penetrates into the interior of the rotating drum (1) through the slots (8).

[0050] The launcher (14) also allows microwave energy to be radiated in a direction predetermined within this waveguide, as well as one or more microwave emitters (2) to be mounted on the same microwave filter (3), since the slots (8) act as distributed antennas and there is little power available at the end of their run through the partially mobile slotted waveguide under which they are located.

[0051] With the guide thus described, the propagated electromagnetic wave is introduced through each of the slots (8) and gradually loses intensity, distributing the energy evenly inside the rotating drum (1). If said rotating drum (1) has a sufficiently large diameter, at the end of the cylindrical path the wave has practically no residual power, which allows good load adaptation and high energy efficiency.

[0052] The front closure (6), which in this case is attached to the front open face of the side wall (5), allows the passage of water vapor or other types of gases for its evacuation and condensation, and is at least partially foldable with respect to the side wall (5) to allow the introduction and extraction of materials in the device, as well as the confinement of the microwave energy inside the rotating drum (1). The air flow allows the extraction of water vapor and other gases and suspended particles generated during the heat application process and comes from a generating system external to the device.

[0053] Said front closure (6) has a central grid and a perimeter frame, which is connected with electrical continuity to the corresponding microwave filter (3). The grid allows the passage of an air flow into the rotating drum (1).

[0054] In an alternative embodiment of the device, the front closure (6) does not have electrical contact with the rotating drum (1) and interacts with it through a metallic plate perpendicular to the drum, which is connected to it with electrical continuity. Thus, the front closure (6) with the metal grid and the microwave filters (3) remains stationary and is located a few millimeters from this metal wall, but without any contact, filtering microwaves and allowing rotation of the rotating drum (1), as well as the air flow through the metal grid.

[0055] In this preferred embodiment, the rear closure (7) is integral with the side wall (5) of the rotating drum (1), and includes, like the front closure (6), a central grid and a perimeter frame, which connects with electrical continuity to the corresponding microwave filter (3) and to the side wall (5) of the drum (1). In the rear closure (7) a rotating axis and some mechanical reinforcements are installed that allow the joint rotation of these elements together with the rotating drum (1). Said metallic axis is mechanically supported on the external structure (4) of the device to have a point around which to rotate.

[0056] The option of adding a thin sheet of dielectric material transparent to microwaves is contemplated on the inside of the microwave filter (3) and on the slots (8). Said sheet prevents airflow leaks through the annular extensions (9) of the rotating drum (1) and prevents the water vapor from the materials that are dried inside from penetrating the interior of the partially mobile slotted waveguide, thus forcing them to come out through the front closure (6). This supposes an additional protection for the microwave emitters (2).

[0057] Tuning elements (17) are provided on the external face of the microwave filters (3), made of metal screws, which allow the adaptation of the microwave emitter (2), either for the initial adjustment of the application process of heat, or for a continuous adaptation of the same by means of its intelligent introduction when changing the conditions of heating or drying. These tuning elements (17) can be fixed or movable. In the second case, the introduction and extraction of the tuning elements (17) occurs automatically by artificial intelligence and an electronic board and according to data obtained through sensors in the microwave emitters (2).

[0058] In an alternative embodiment of the device, the fixed filter (3) rests on the side wall (5) of the rotating drum (1) with interposition of metallic bearings, to provide greater electromagnetic isolation and to provide greater

mechanical stability against device vibrations.

[0059] Finally, on the inside face of the side wall (5) of the rotating drum (1) there are some transversal blades (18) made of dielectrics transparent to microwaves, to move the clothes or the heated material, favoring a more uniform heating and drying and that water vapor or other gases pass from the material into the drum (1). These blades (18) also provide a smoothing and conditioning mechanism for the garments thus dried.

Claims

1. Device for generating and distributing microwaves in rotary heat application systems, comprising:

- an essentially cylindrical rotating drum (1) which in turn comprises:

  - a side wall (5) with at least one group of through slots (8);
  - annular extensions (9) projecting from an external face of the side wall (5);
  - a front closure (6); and
  - a rear closure (7);

which delimit an internal housing intended to house an element to be heated, and where each group of slots (8) is located between two consecutive annular extensions (9);
- at least one microwave emitter (2);
- at least one fixed microwave filter (3), without direct contact with the rotating drum (1), made up of a cylindrical body of metallic material, for outer covering of a sector of the side wall (5) of the rotating drum (1) in which a group of slots (8) is located; and
- a fixed external structure (4) that supports the above elements;

the device being **characterized in that** the microwave filter (3) comprises:

- at least one through hole (12) for insertion of the microwave emitter (2);
- an external face, for fixing the microwave emitter (2); and
- an internal face, opposable to the external face of the side wall (5) for covering the group of slots (8), comprising at least one band-eliminating filter (11);

so that in the device a partially mobile slotted waveguide is formed, delimited by:

- the external face of the side wall (5) of the rotating drum (1), with the slots (8);
- the internal face of the microwave filter (3), with the band-eliminating filter (11); and
- two opposing faces of two consecutive annular extensions (9).

2. Device according to claim 1 further comprising a metallic launcher (14) located on the internal face of the filter (3) in correspondence with the through hole (12), for directing and adapting a microwave beam coming from the microwave emitter (2) towards a determined direction. of the side wall (5) and the slots (8) of the rotating drum (1).

3. Device according to claim 2, wherein the launcher (14) has an L-shaped profile and comprises:

- a vertical wall (15), which projects perpendicularly from the inner face of the microwave filter (3) and parallel to the antenna of the microwave emitter (2); and
- a horizontal wall (16), which heads perpendicularly towards a free end of the vertical wall (15).

4. Device according to any of the preceding claims wherein:

- each grouping of slots (8) is located between two sectors of the rotating drum (1), and where the annular extensions (9) have a height close to 0 cm.; and
- the microwave filters (3) have side walls forming an inverted U, at the lower end of which the band-eliminating filters (11) are located, which completely cover each grouping of slots (8) and interact with the side wall (5) of the drum.

5. Device according to any of the preceding claims, wherein the slots (8) have an oblique orientation with respect to an axis of rotation passing through the center of the rotating drum (1).

6. Device according to any of the preceding claims, wherein the slots (8) are distributed aligned along the side wall (5) in such a way that two slots (8) diametrically opposed to one another do not face each other.

7. Device according to any of claims 1-6, wherein the front closure (6) and/or the rear closure (7) are integral with the side wall (5).

8. Device according to any of the claims 1-6, wherein the front closure (6) and/or the rear closure (7) are independent of the side wall (5).

9. Device according to claim 8 further comprising two additional microwave filters (3) insertable between the front (6) and rear (7) closures and the side wall (5).

10. Device according to any of the preceding claims, wherein the microwave filters (3) additionally comprise fastening elements (10) for fixing to internal walls of the external structure (4).

11. Device according to any of the preceding claims further comprising a sheet of dielectric material transparent to microwaves, located on the internal face and/or on the external face of the side wall (5) of the drum (1) and on the slots (8).

12. Device according to any of the preceding claims, wherein the microwave filters (3) additionally comprise tuning elements (17) located in the microwave filters (3) for adapting the microwave emitter (2) to the material to be heated.

13. Device according to claim 12, wherein the tuning elements (17) are automatically movable and insertable by means of artificial intelligence and an electronic board and according to data obtained through sensors associated with the microwave emitters (2).

14. Device according to any of the preceding claims, wherein the rotating drum (1) comprises transversal blades (18) made of dielectrics transparent to microwaves or metallic materials and attached to the internal face of the side wall (5).

15. Device according to any of the preceding claims, wherein the fixed filter (3) rests on the side wall of the rotating drum to provide greater electromagnetic isolation and/or to give greater mechanical stability against vibrations from the dryer.

Patentansprüche

1. Vorrichtung zum Erzeugen und Verteilen von Mikrowellen in drehenden Wärmezufuhrsystemen, die folgende Merkmale aufweist:

eine im Wesentlichen zylindrische Drehtrommel (1), die wiederum folgende Merkmale aufweist:

eine Seitenwand (5) mit zumindest einer Gruppe von Durchgangsschlitzen (8);
ringförmige Erweiterungen (9), die von einer Außenfläche der Seitenwand (5) vorstehen;
einen vorderen Verschluss (6); und
einen hinteren Verschluss (7);

die ein inneres Gehäuse begrenzen, das dazu vorgesehen ist, ein zu erwärmendes Element aufzunehmen, und wobei sich jede Gruppe von Schlitzen (8) zwischen zwei aufeinanderfolgenden ringförmigen Erweiterungen (9) befindet;

zumindest einen Mikrowellenemitter (2);
zumindest ein fixiertes Mikrowellenfilter (3) ohne direkten Kontakt mit der Drehtrommel (1), das aus einem zylindrischen Körper aus metallischem Material besteht, zur äußeren Abdeckung eines Sektors der Seitenwand (5) der Drehtrommel (1), in dem sich eine Gruppe von Schlitzen (8) befindet; und
eine fixierte äußere Struktur (4), die die obigen Elemente trägt;
wobei die Vorrichtung **dadurch gekennzeichnet ist, dass** das Mikrowellenfilter (3) folgende Merkmale aufweist:

zumindest ein Durchgangsloch (12) für eine Einfügung des Mikrowellenemitters (2);
eine Außenfläche zum Fixieren des Mikrowellenemitters (2); und
eine Innenfläche, die der Außenfläche der Seitenwand (5) gegenüberliegt, zum Abdecken der Gruppe von Schlitzen (8), die zumindest ein Bandeliminierungsfilter (11) aufweist;
so dass in der Vorrichtung ein teilweise beweglicher geschlitzter Wellenleiter gebildet wird, begrenzt durch:

die Außenfläche der Seitenwand (5) der Drehtrommel (1) mit den Schlitzen (8);
die Innenfläche des Mikrowellenfilters (3) mit dem Bandeliminierungsfilter (11); und
zwei gegenüberliegende Flächen von zwei aufeinanderfolgenden ringförmigen Erweiterungen (9).

2. Vorrichtung gemäß Anspruch 1, die ferner einen metallischen Starter (14) aufweist, der sich an der Innenfläche des Filters (3) in Übereinstimmung mit dem Durchgangsloch (12) befindet, zum Richten und Anpassen eines Mikrowellenstrahls, der von dem Mikrowellenemitter (2) kommt, zu einer bestimmten Richtung der Seitenwand (5) und der Schlitze (8) der Drehtrommel (1).

3. Vorrichtung gemäß Anspruch 2, wobei der Starter (14) ein L-förmiges Profil aufweist und folgende Merkmale aufweist:

eine vertikale Wand (15), die senkrecht von der Innenfläche des Mikrowellenfilters (3) und parallel zu einer Antenne des Mikrowellenemitters (2) vorsteht; und
eine horizontale Wand (16), die senkrecht zu einem freien Ende der vertikalen Wand (15) verläuft.

4. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei:

jede Gruppierung von Schlitzen (8) sich zwischen zwei Sektoren der Drehtrommel (1) befindet, und wobei die ringförmigen Erweiterungen (9) eine Höhe nahe 0 cm aufweisen; und die Mikrowellenfilter (3) Seitenwände aufweisen, die ein umgekehrtes U bilden, an dessen unterem Ende sich die Bandeliminierungsfilter (11) befinden, die jede Gruppierung von Schlitzen (8) vollständig abdecken und mit der Seitenwand (5) der Trommel zusammenwirken.

5. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Schlitze (8) eine schräge Ausrichtung in Bezug auf eine Drehachse aufweisen, die durch die Mitte der Drehtrommel (1) verläuft.

6. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Schlitze (8) entlang der Seitenwand (5) derart ausgerichtet verteilt sind, dass zwei Schlitze (8), die einander diametral gegenüberliegen, einander nicht zugewandt sind.

7. Vorrichtung gemäß einem der Ansprüche 1 bis 6, wobei der vordere Verschluss (6) und/oder der hintere Verschluss (7) einstückig mit der Seitenwand (5) sind.

8. Vorrichtung gemäß einem der Ansprüche 1 bis 6, wobei der vordere Verschluss (6) und/oder der hintere Verschluss (7) unabhängig von der Seitenwand (5) sind.

9. Vorrichtung gemäß Anspruch 8, die ferner zwei zusätzliche Mikrowellenfilter (3) aufweist, die zwischen dem vorderen (6) und dem hinteren (7) Verschluss und der Seitenwand (5) eingefügt werden können.

10. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Mikrowellenfilter (3) zusätzlich Befestigungselemente (10) zum Fixieren an Innenwänden der äußeren Struktur (4) aufweisen.

11. Vorrichtung gemäß einem der vorhergehenden Ansprüche, die ferner eine Lage aus dielektrischem Material aufweist, das für Mikrowellen transparent ist, die sich an der Innenfläche und/oder an der Außenfläche der Seitenwand (5) der Trommel (1) und an den Schlitzen (8) befindet.

12. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Mikrowellenfilter (3) zusätzlich Abstimmelemente (17) aufweisen, die sich in den Mikrowellenfiltern (3) befinden, zum Anpassen des Mikrowellenemitters (2) an das zu erwärmende Material.

13. Vorrichtung gemäß Anspruch 12, wobei die Abstimmelemente (17) mittels künstlicher Intelligenz und einer elektronischen Platine und gemäß Daten, die durch Sensoren erhalten werden, die den Mikrowellenemittern (2) zugeordnet sind, automatisch bewegbar und einfügbar sind.

14. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Drehtrommel (1) Querblätter (18) aufweist, die aus Dielektrika, die für Mikrowellen transparent sind, oder metallischen Materialien bestehen und an der Innenfläche der Seitenwand (5) befestigt sind.

15. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei das Mikrowellenfilter (3) auf der Seitenwand der Drehtrommel ruht, um eine größere elektromagnetische Isolation bereitzustellen und/oder um eine größere mechanische Stabilität gegen Vibrationen von einem Trockner zu verleihen.

Revendications

1. Dispositif de génération et de distribution de micro-ondes dans des systèmes d'application de chaleur rotatifs, comprenant :

- un tambour rotatif (1) sensiblement cylindrique qui comprend :

  - une paroi latérale (5) avec au moins un groupe de fentes (8) traversantes ;
  - des extensions annulaires (9) faisant saillie depuis une face externe de la paroi latérale (5) ;
  - une fermeture avant (6) ; et
  - une fermeture arrière (7) ;

qui délimitent un logement interne destiné à loger un élément à chauffer, et où chaque groupe de fentes (8) est situé entre deux extensions annulaires (9) consécutives ;
- au moins un émetteur de micro-ondes (2) ;
- au moins un filtre à micro-ondes fixe (3), sans contact direct avec le tambour rotatif (1), constitué d'un corps cylindrique de matériau métallique, pour le recouvrement extérieur d'un secteur de la paroi latérale (5) du tambour rotatif (1) dans lequel se trouve un groupe de fentes (8) ; et
- une structure externe (4) fixe qui supporte les éléments susmentionnés ;

le dispositif étant **caractérisé en ce que** le filtre à micro-ondes (3) comprend :

- au moins un trou traversant (12) pour l'insertion de l'émetteur de micro-ondes (2) ;
- une face externe, pour la fixation de l'émet-

teur de micro-ondes (2) ; et
- une face interne, à l'opposé de la face externe de la paroi latérale (5) pour le recouvrement du groupe de fentes (8), comprenant au moins un filtre d'élimination de bande (11) ;

de manière à former, dans le dispositif, un guide d'onde à fentes partiellement mobile délimité par :

- la face externe de la paroi latérale (5) du tambour rotatif (1), avec les fentes (8) ;
- la face interne du filtre à micro-ondes (3), avec le filtre d'élimination de bande (11) ; et
- deux faces opposées de deux extensions annulaires (9) consécutives.

2. Dispositif selon la revendication 1, comprenant en outre un lanceur métallique (14) situé sur la face interne du filtre (3) en correspondance avec le trou traversant (12), pour diriger et adapter un faisceau de micro-ondes émanant de l'émetteur de micro-ondes (2) dans une direction déterminée de la paroi latérale (5) et des fentes (8) du tambour rotatif (1).

3. Dispositif selon la revendication 2, dans lequel le lanceur (14) présente un profil en forme de L et comprend :

- une paroi verticale (15), faisant saillie perpendiculairement à la face intérieure du filtre à micro-ondes (3) et parallèle à une antenne de l'émetteur de micro-ondes (2) ; et
- une paroi horizontale (16), qui se dirige perpendiculairement vers une extrémité libre de la paroi verticale (15).

4. Dispositif selon l'une quelconque des revendications précédentes, dans lequel :

- chaque groupement de fentes (8) est situé entre deux secteurs du tambour rotatif (1), et où les extensions annulaires (9) présentent une hauteur proche de 0 cm ; et
- les filtres à micro-ondes (3) présentent des parois latérales en forme de U inversé, à l'extrémité inférieure desquelles se trouvent les filtres d'élimination de bande (11) qui recouvrent complètement chaque groupement de fentes (8) et interagissent avec la paroi latérale (5) du tambour.

5. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les fentes (8) présentent une orientation oblique par rapport à un axe de rotation passant par le centre du tambour rotatif (1).

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les fentes (8) sont réparties alignées le long de la paroi latérale (5) de sorte que deux fentes (8) diamétralement opposées l'une de l'autre ne se fassent pas face.

7. Dispositif selon l'une quelconque des revendications 1 à 6, dans lequel la fermeture avant (6) et/ou la fermeture arrière (7) sont d'un seul tenant avec la paroi latérale (5).

8. Dispositif selon l'une quelconque des revendications 1 à 6, dans lequel la fermeture avant (6) et/ou la fermeture arrière (7) sont indépendantes de la paroi latérale (5).

9. Dispositif selon la revendication 8, comprenant en outre deux filtres à micro-ondes (3) supplémentaires pouvant être insérés entre les fermetures avant (6) et arrière (7) et la paroi latérale (5).

10. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les filtres à micro-ondes (3) comprennent en outre des éléments d'attache (10) pour la fixation à des parois internes de la structure externe (4).

11. Dispositif selon l'une quelconque des revendications précédentes, comprenant en outre une feuille de matériau diélectrique transparent aux micro-ondes, située sur la face interne et/ou sur la face externe de la paroi latérale (5) du tambour (1) et sur les fentes (8).

12. Dispositif selon l'une quelconque des revendications précédentes, dans lequel les filtres à micro-ondes (3) comprennent en outre des éléments de réglage (17) situés dans les filtres à micro-ondes (3) pour l'adaptation de l'émetteur de micro-ondes (2) au matériau à chauffer.

13. Dispositif selon la revendication 12, dans lequel les éléments de réglage (17) sont automatiquement mobiles et insérables par intelligence artificielle et au moyen d'une carte électronique et en fonction de données obtenues par des capteurs associés aux émetteurs de micro-ondes (2).

14. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le tambour rotatif (1) comprend des pales transversales (18) constituées de matériaux diélectriques transparents aux micro-ondes ou de matériaux métalliques et attachées à la face interne de la paroi latérale (5).

15. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le filtre à micro-ondes (3) fixe repose sur la paroi latérale du tambour rotatif pour assurer une plus grande isolation électroma-

gnétique et/ou une plus grande stabilité mécanique contre des vibrations du dispositif.

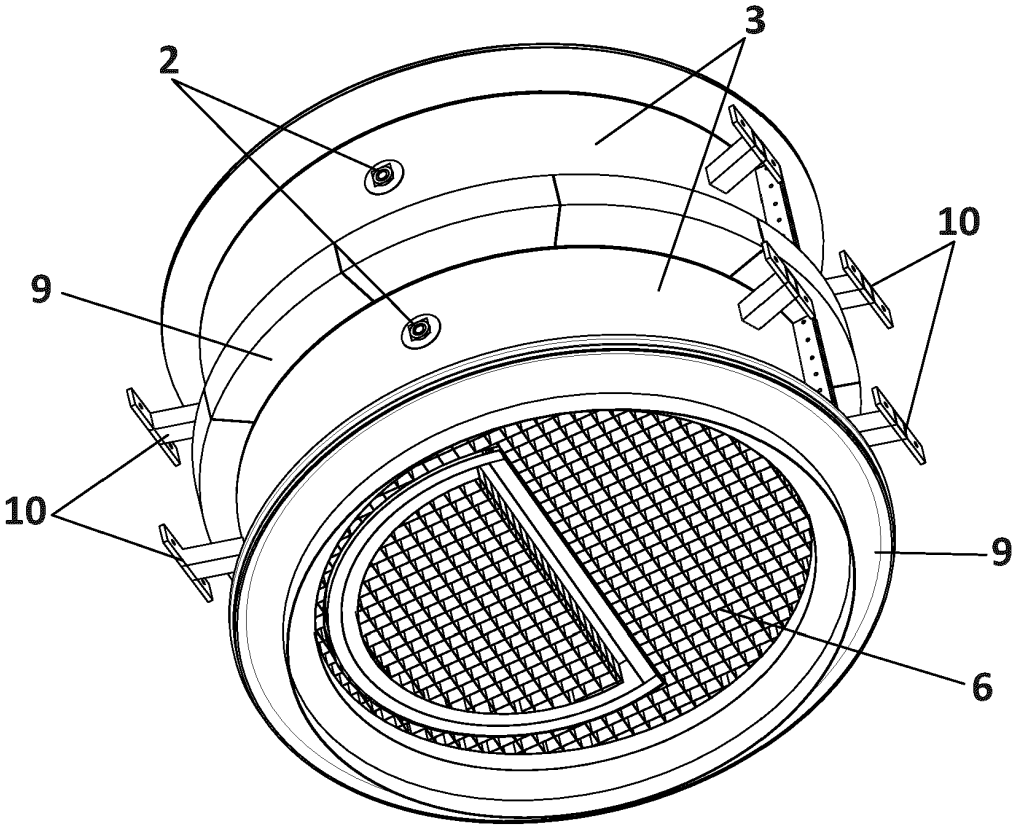

FIG. 1

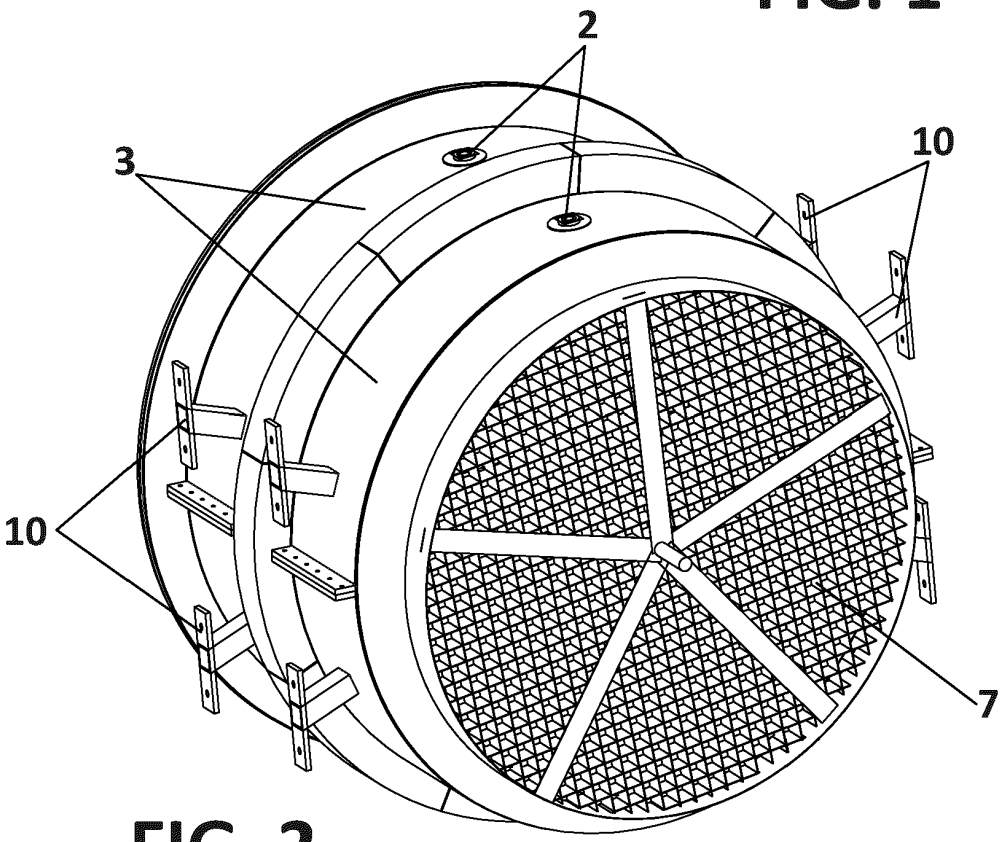

FIG. 2

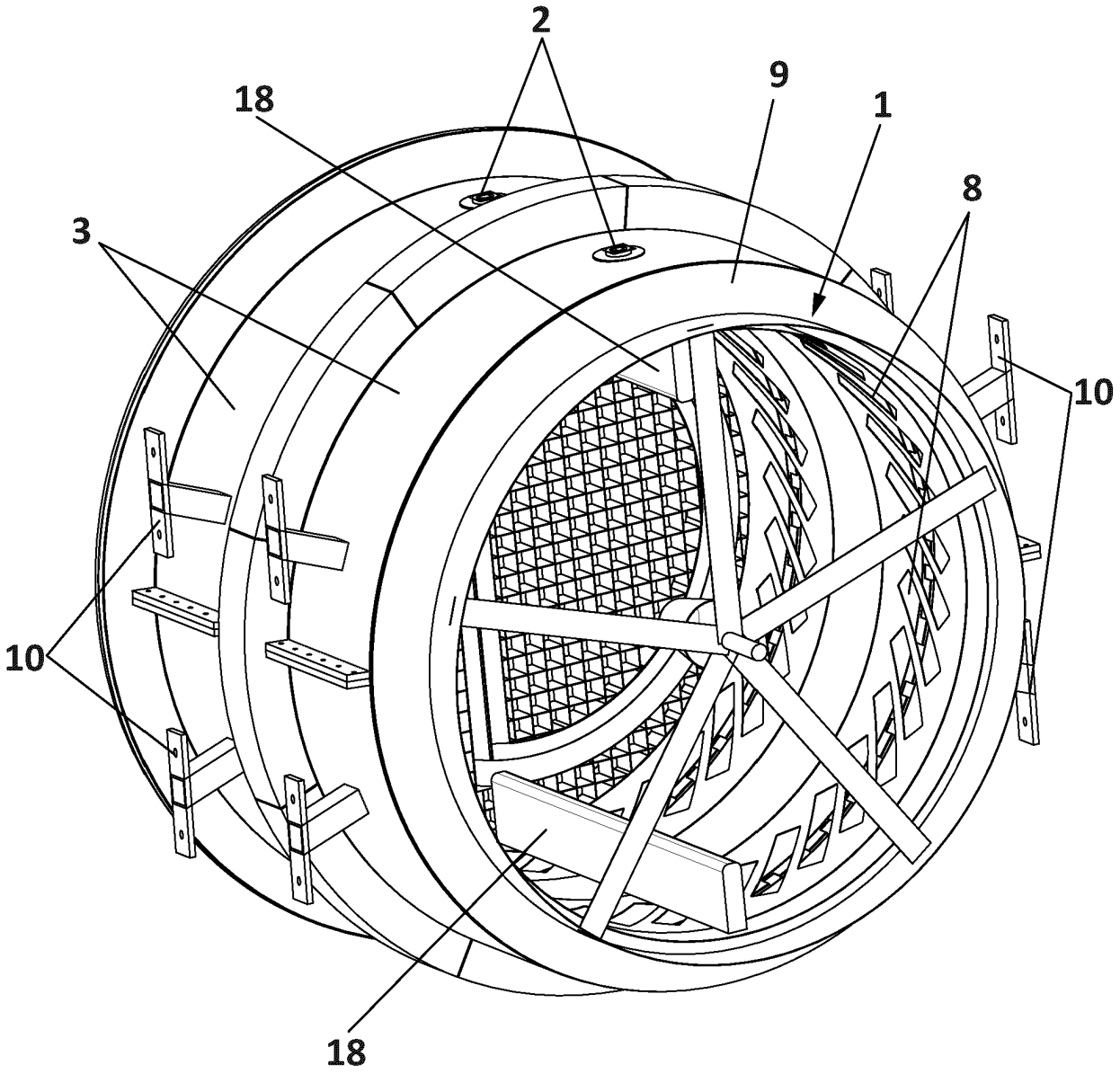

FIG. 3

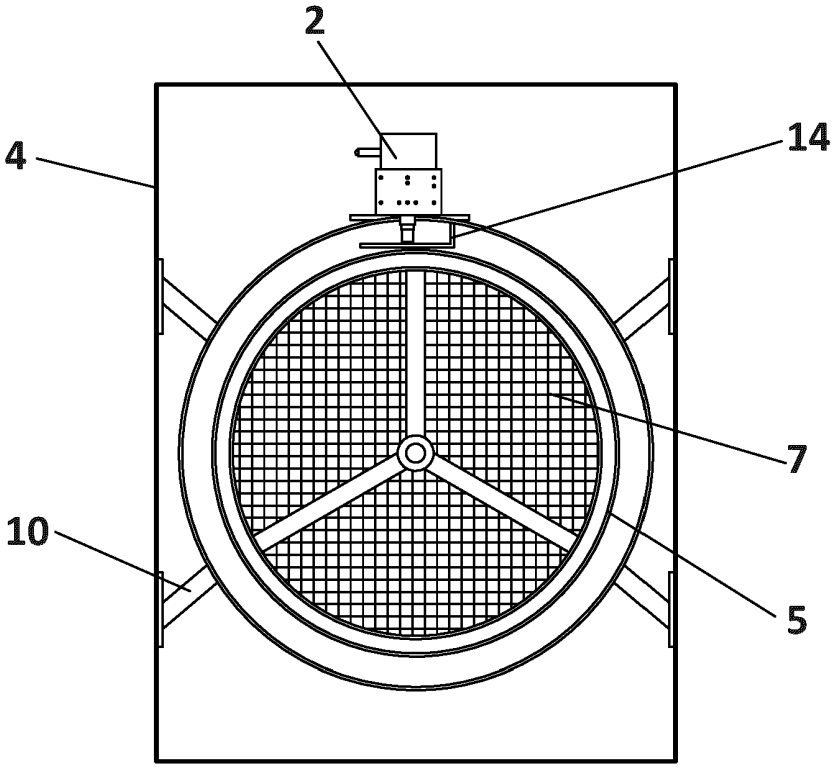

FIG. 4

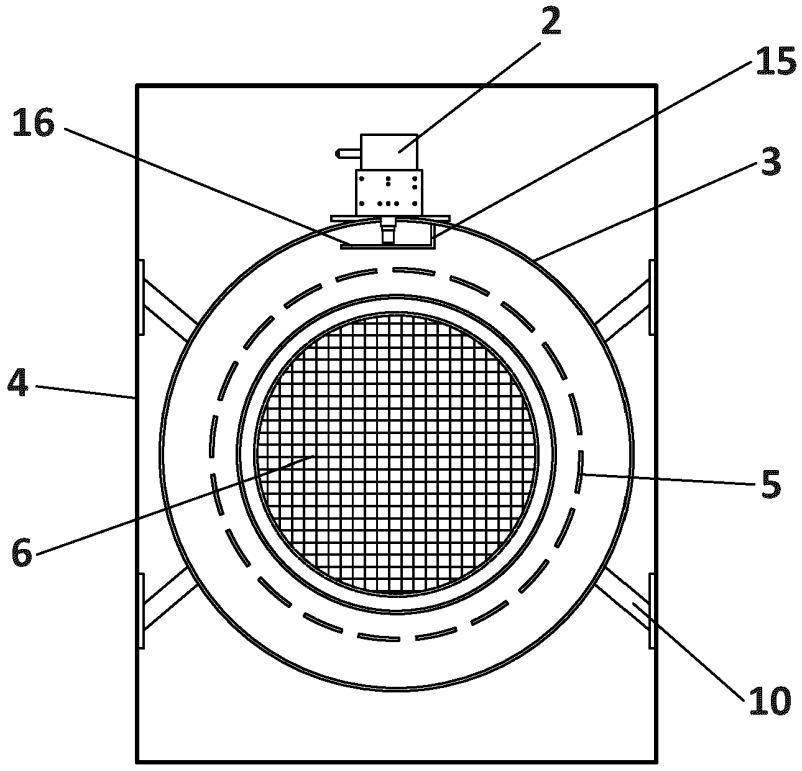

FIG. 5

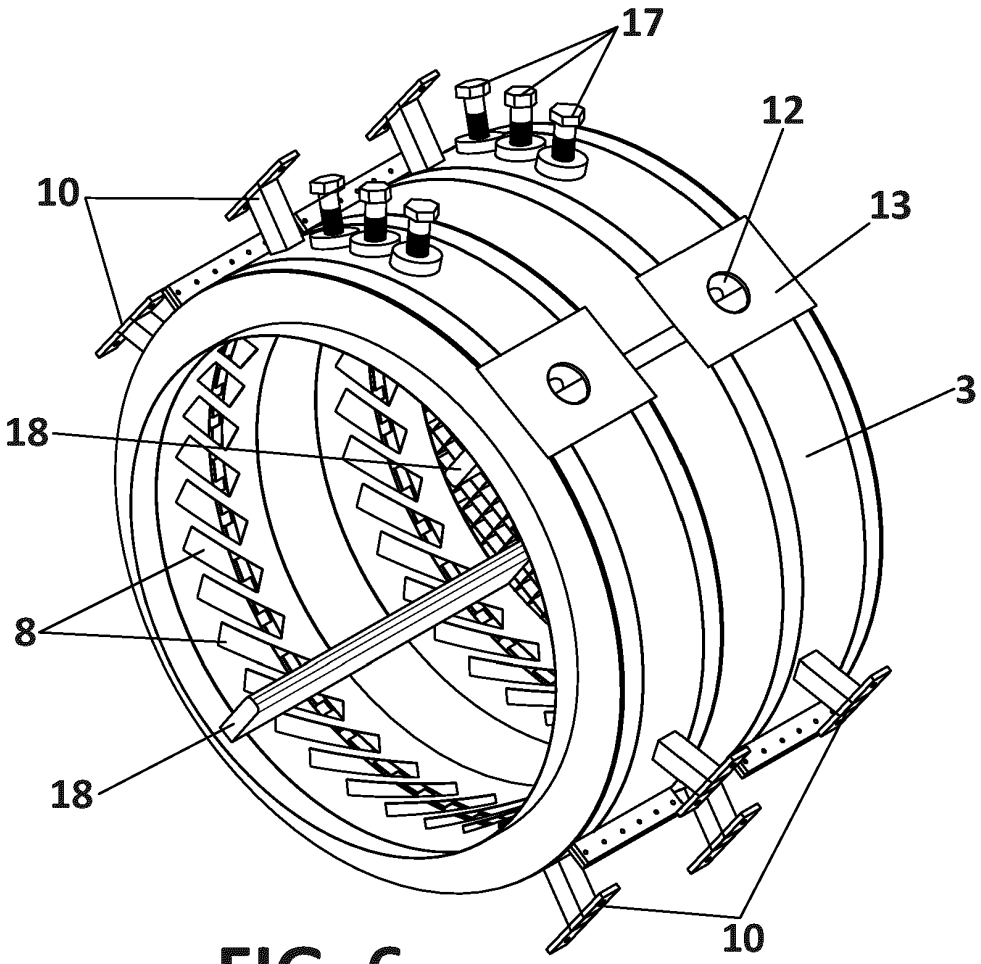

FIG. 6

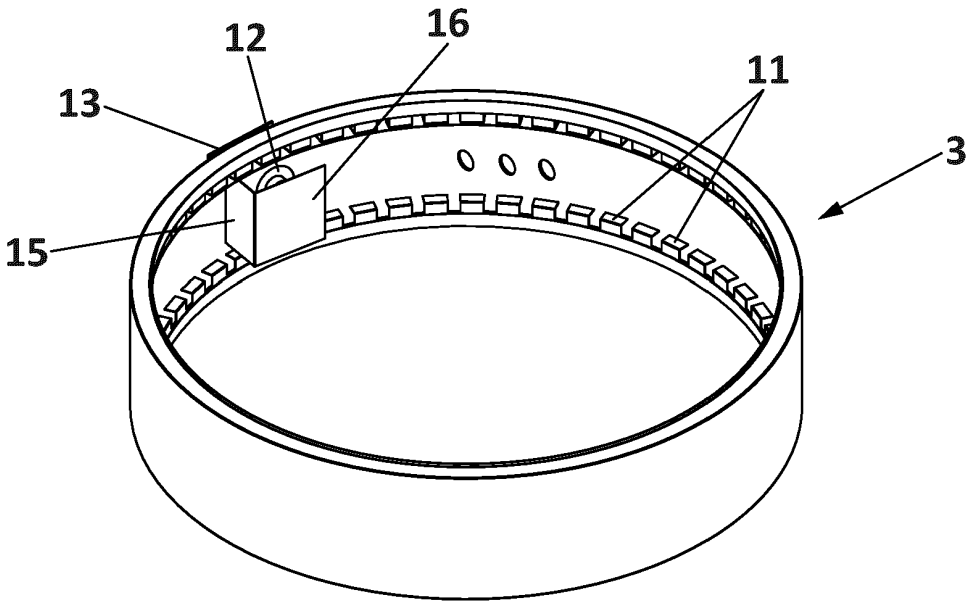

FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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