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(54) **DEVICE FOR GENERATING HOT AIR BY MEANS OF BIOMASS COMBUSTION**

(57) The invention comprises an auger feeder (2), a receiving hopper (3), a combustion chamber (9), a burner (8), a blower fan (20) and a second outlet (21) for hot air; which incorporates a heat-exchanger unit (13) which is independent of the detachable combustion chamber (9); formed by second vertical tubes (16) with the blower fan (20) coupled on the heat-exchanger unit (13) at the opposite end furthest from the combustion chamber (9). Between the heat-exchanger unit (13) and a combustion-gas outlet (12) from the combustion chamber (9), there is a first combustion-gas passage (I) formed by a further set of first vertical tubes (14) that are detachable and sliding, said tubes having a diameter greater than the second vertical tubes (16) of the heat-exchanger unit (13).

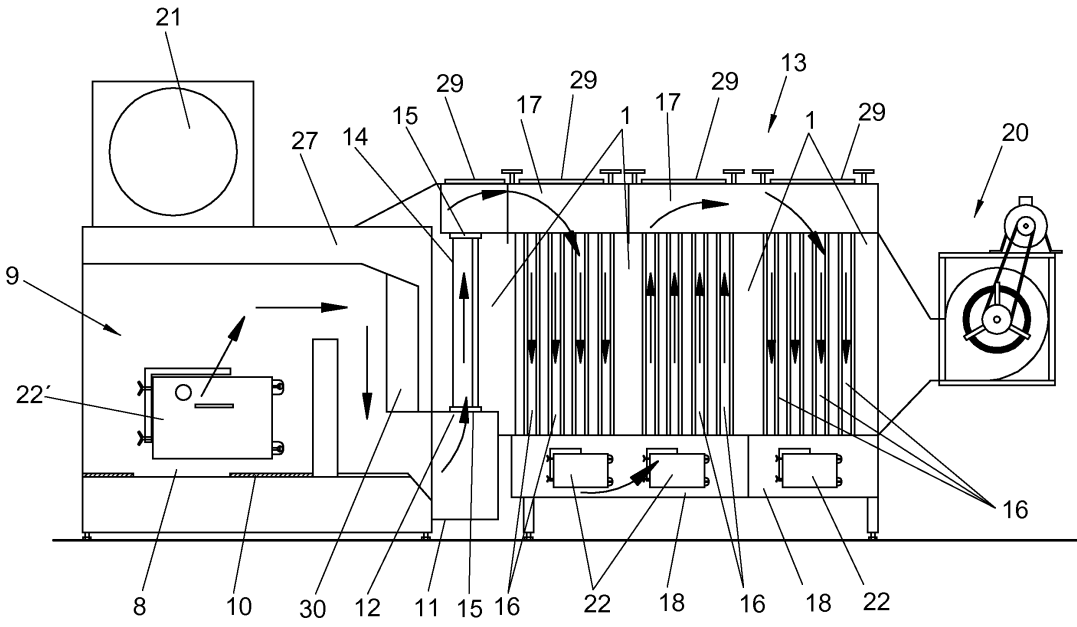

FIG. 2

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Description

OBJECT OF THE INVENTION

[0001] The present invention, as expressed in the title of this specification, relates to a device for generating hot air by means of biomass combustion, which provides several advantages to the function for which it is intended, as well as novelty features which will be described in detail below, and which represents an improved alternative to the currently known systems serving the same purpose.

[0002] More specifically, the object of the invention focuses on a device for generating hot air, which can be applied to the heating of industrial premises or large enclosures, and uses pellets and other types of biomass as fuel, essentially made up of a combustion chamber, a tubular heat-exchanger unit where the heat from the combustion gases is transferred to the air driven by a blower fan designed for this purpose, presenting the particular feature of being structurally configured so that said heat-exchanger unit, which is arranged behind the combustion chamber, is detachable and couples to the tubes vertically, thereby providing advantages of transport and assembly, extending the useful life of the device, generating less ash accumulation, ensuring easy cleaning, greater efficiency and lowering the costs of maintenance.

FIELD OF APPLICATION OF THE INVENTION

[0003] The field of application of the present invention falls within the industrial sector dedicated to the manufacturing of equipment and devices for generating hot air, particularly focused in the area of those that use biomass as fuel.

BACKGROUND OF THE INVENTION

[0004] It is a known fact that currently biomass is the most economical and environmentally friendly fuel because it generates energy savings ranging from 40-60% when compared to other fuels. It is therefore increasingly common to use devices which are powered by said fuels such as those generating hot air to heat large premises.

[0005] These devices are conventionally made up of, amongst other elements, auger feeders which move the biomass towards the burner of a combustion chamber from which the combustion gases are expelled to a heat-exchanger unit where heat transfer is achieved.

[0006] The essential problem involved with these devices is usually the difficulty encountered in detaching the tube assembly, which makes up the heat-exchanger unit, since it is normally designed as a single part, integrated on the combustion chamber, which implies difficulty in transport and assembly. Furthermore, said layout is usually arranged with the heat-exchanger unit tubes in horizontal position, which causes the accumulation of solids and ash inside said tubes, thus constituting a factor which impedes the optimal performance of the device making it necessary to clean the tubes periodically, which, moreover, is not an easy task.

[0007] Utility models under publication No. ES 1053357 and ES 1070424 consist of a hot air heating system fuelled by organic and industrial waste aimed at the heating of industrial and livestock buildings, where combustion gases heat an air fluid by means of a heat-exchanger unit, thereafter introducing this hot air into those buildings for their heating.

[0008] The patent under publication No. ES 2482215 relates to a biomass hot air device comprised by a set made up of a furnace, connecting tubes and a heat-exchanger combined with a turbine in order to drive the hot air into the industrial building.

[0009] The patent under publication No. US 2013133560 describes a device for generating hot gas by means of biomass combustion comprised of a combustion chamber with a burner and a heat-exchanger with vertical tubes behind the combustion chamber.

[0010] The patent under publication No. US 4232732 describes a system for the extraction of heat from the combustion gases based on vertical pipe exchangers.

[0011] Thus, the object of the present invention is to structurally configure said heat-exchanger so that it can be easily detachable and to improve the mentioned issues of cleaning and efficiency of the device by means of its layout as an independent element behind the combustion chamber and having the tubes in vertical position.

[0012] Additionally, affixing the air supply blower fan to the closest end of the combustion gas outlet also favors an increased performance of the device.

[0013] Moreover, it should be noted that at least the applicant is unaware of the existence of any other device for generating hot air by means of biomass combustion or similar invention which has like technical, structural and constituent features to those contained in the device advocated herein, according to claim.

DESCRIPTION OF THE INVENTION

[0014] Thus, the device for generating hot air by means of biomass combustion which the present invention proposes is configured as an innovation within its field of application, since according to its implementation, and in an exhaustive manner, the above-mentioned objectives are satisfactorily achieved, the characteristic details that make it possible and that distinguish it from what is already known are conveniently compiled in the final claims which accompany the present specification thereof.

[0015] Specifically, what the invention advocates, as noted above, is a device for generating hot air by means of biomass combustion essentially comprised of the following elements:

- A biomass feeder with a worm shaft
- A receiving hopper with an agitator shaft and burner

feed.

- A combustion chamber with combustion-gas outlet (first gaseous fluid) to a heat-exchanger unit and hot air outlet (second gaseous fluid).
- A previous first combustion-gas passage towards the heat-exchanger unit comprised of a set of first vertical tubes that are detachable and sliding, which are assembled in a sliding manner on bushings; wherein below said first vertical tubes there is a first decanter of the solid particles contained in the combustion gases.
- The heat-exchanger unit contains groups of second vertical tubes.
- Superior and inferior caissons for the outlet of fumes or combustion gases which form a part of the structure of the heat-exchanger unit, wherein the inferior caissons are also intermediate decanters for the solid particles contained in the fumes.
- A combustion-gas passage of a second decanter towards a fume extractor fan.
- A hot air blower fan located in the portion of the heat-exchanger unit next to the first combustion-gas outlet materialized by a chimney.
- A second hot air outlet.

[0016] Thus, the device is fitted with a feeding system for the receiving hopper which incorporates a safety locking system between said feeder and said receiving hopper in order to prevent flame blowback. The biomass can be stored directly on the feeder worm shaft or in another previous hopper closed and arranged for this purpose.

[0017] The biomass receiving system is composed of said receiving hopper in which a central mixing unit is provided, which is in charge of supplying the burner installed at the other end of a horizontal connecting tube, inside the combustion chamber. Inside this horizontal tube which forms part of the said receiving system there is an auger which rotates by means of an electric motor and which is responsible for measuring out the biomass into the burner.

[0018] In the combustion chamber, the fuel that fills the burner partially overflows onto a grate with boreholes which increases the combustion surface. Combustion is completed through tubes which provide air onto the top of the flame (secondary air) with a variable flow fan.

[0019] Once combustion has been produced, high temperature gas passes through the first decanter of solid particles, entering through the first previous passage of fumes made up of the first vertical tubes that are detachable and sliding, which slide on bushings, so that in this first passage of fumes, in which temperatures are very high, these first vertical tubes avoid being subjected to stresses that could destabilize the structure of the device. These first vertical tubes are designed as a replacement part, extremely lowering the costs of repair work in the future. In order to change these first vertical tubes it is not necessary to remove the heat-exchanger unit, the side doors arranged for this purpose and other upper doors can be opened, through which the first vertical tubes can be removed and replaced with others.

[0020] Once the combustion gases have passed through this first previous passage, they pass on to the multi tubular heat-exchanger unit, which contains the second set of vertical tubes, said tubes having a smaller diameter than the vertical tubes of the first previous passage in order to facilitate the cooling of the combustion gases. The gases are forced to pass through several groups of second vertical tubes to ensure that the air from the air supply blower fan cools the gases efficiently, thus achieving high performance though heat exchange between the combustion gases and the air from the air supply blower fan.

[0021] As the combustion gases pass through these groups of second vertical tubes, they have to change the direction of displacement from bottom to top and vice versa. At this point they lower their speed, thereby achieving the decanting of most of the solid particles incorporated in the combustion gases. This method of the passage of combustion gases enables the effective filtering of said solid particles from these same combustion gases. In addition, the cleaning of the combustion gas passage decanters is very simple as they have easy to open side doors available for this purpose.

[0022] The groups of second vertical tubes, at their ends, lead into the upper and lower caissons, while at the same time, the combustion chamber connects with one of the top caissons through the first vertical tubes.

[0023] Once the entire cycle of the combustion gases within the heat-exchanger unit has passed, these gases pass on to a final decanter wherein the duct of a gas extractor is installed. Said extractor has variable flow in order to regulate the depression and the outlet flow of the combustion gases. The extractor is coupled to a chimney with a regulated size, in order to remove the gases to the exterior.

[0024] To sum up, the main differential features presented by the advocated device for generating hot air and the advantages that said features provide to the same compared to other conventional devices are:

First, the heat-exchanger unit is coupled in a detachable manner next to the combustion chamber, such that this arrangement facilitates the coupling of the heat-exchanger unit as an element which is independent of the combustion chamber and therefore detachable.

Thus, in this position, the equipment object of the invention can easily be transported in a conventional truck and the coupling of the components is simple, thereby lowering the costs of transport and assembly. This possibility also allows that the first previous passage of the combustion gases occurs through the first vertical tubes, which are also replaceable, and for which they are coupled onto metal bushings, thereby avoiding structural tensions that would harm the lifespan of the device. This arrangement of the

detachable heat-exchanger unit makes it possible to classify it as an easily reparable replacement part, thus contributing to facilitate the amortization and durability of the device object of the invention.

The second essential and distinguishing feature is the vertical arrangement of the heat-exchanger unit, that is, having its tubes installed vertically, which also provides great advantages. The passage of combustion gases through a vertical exchanger does not allow the ash (solid particles) to settle within the tubes. This greatly facilitates the cleaning the heat-exchanger unit, allowing to carry out these cleaning tasks over longer periods of time than in horizontal exchanger units. The side doors arranged in the bottom caissons of the heat-exchanger unit allow for the periodic cleaning tasks to be carried out with great ease and little effort.

[0025] On the other hand, installing the air supply blower fan right before the gas combustion outlet achieves greater heat exchange and lowers the temperature of the combustion gases which exit through the chimney, because there is a greater temperature difference between the air supply and the combustion gases. This arrangement of the blower fan also achieves that when the air reaches the combustion chamber, it already has a high temperature and upon arriving onto said combustion chamber, the hottest spot in the device, its temperature increases substantially, thus achieving higher air temperature than in traditional systems. The low temperature of the gas combustion outlet allows for optimal performance.

[0026] The vertical arrangement of the heat-exchanger unit also provides the advantage of facilitating the decanting of the ash generated in the combustion chamber, which settles easily in the lower portion of the heat-exchanger unit. The large volume and surface of this decanter allows significantly lowering the speed of the combustion gases, and due to said decrease in speed, they settle on the bottom, thereby achieving an ash-free combustion-gas outlet. There are easy-opening doors for the cleaning of this decanter, which facilitate the periodical cleaning operations.

[0027] On the other hand, there are known heat exchangers on the market, similar to those used in vehicles, which use thermal oil conducted by a tubular coil to heat the air.

[0028] In light of the above, it is determined that the described device for generating hot air by means of biomass combustion is an innovative structure having structural and constitutive features unknown until now, which linked to its practical use, provide sufficient grounds for obtaining the requested privilege of exclusivity.

DESCRIPTION OF THE DRAWINGS

[0029] To complete the present description, and for the purpose of aiding in a better understanding of the characteristics of the invention, the present specification is accompanied by a set of drawings constituting an integral part of the same, which by way of illustration and not limitation, represent the following:

Figure 1.- Shows a schematic side view of an example of the embodiment of the device for generating hot air by means of biomass combustion, object of the invention. A set of the comprising elements and parts can be seen, as well as the configuration and arrangement of each of these. In addition, this figure also shows, by means of dotted arrows, the circuit which the combustion gases travel from the combustion chamber to the heat-exchanger unit passing through the vertical tubes toward the extractor.

Figure 2.- Shows an also very schematic side elevation view of the combustion chamber and the vertical heat-exchanger unit of the device object of the invention, for a clearer appreciation of its configuration and arrangement, as well as the main comprising elements.

Figure 3.- Shows a plan view of the device of the invention.

Figure 4.- Shows a front view of the combustion chamber combined with a casing chamber.

Figure 5.- Shows a sectional view of a portion of the device of the invention.

Figure 6.- Shows a perspective view of the bottom portion of the combustion chamber, where a set of welded bushings is highlighted, in which a series of first vertical tubes for the passage of combustion gases are adjusted.

PREFERRED EMBODIMENT OF THE INVENTION

[0030] With reference to the mentioned figures and according to the adopted numbering, an example of preferred, but not limited, embodiment of the advocated device for generating hot air by means of biomass combustion can be observed therein, which comprises the indicated parts and elements described in detail herebelow:

Thus as shown in Figure 1, the device in question comprises: an auger feeder with an outer worm shaft (2) which supplies biomass to a receiving hopper (3) having a safety locking system (4) between said auger feeder with outer worm shaft (2) and said hopper (3) in order to avoid flame blowback.

[0031] Said receiving hopper (3) which is provided with a central mixing unit (5), feeds biomass to a horizontal tube (6) with another auger feeder with an inner worm shaft (2') which, driven by an electric motor (7) conveys the biomass to a burner (8) located at the other end of said horizontal tube (6) within a combustion chamber (9).

[0032] In the combustion chamber (9) the burner (8) incorporates a lower grate (10) with boreholes onto which

the biomass partially overflows, thus increasing the area of combustion.

[0033] As seen in Figures 1 and 2, in the rear portion of the combustion chamber (9) a first decanter (11) of solid particles can be seen, as a kind of caisson, which is located before a gas-combustion outlet (12) (first gaseous fluid) towards a heat-exchanger unit (13) which is an independent element between it and said outlet (12) a first previous combustion-gas passage (I) formed by a set of several first vertical tubes (14) that are detachable and sliding, having a diameter greater than the second vertical tubes (16) of the heat-exchanger unit (13), with the particularity that said first vertical tubes (14) are assembled between the combustion chamber (9) and the heat-exchanger unit (13) located after the combustion chamber (9), on bushings (15). Thus, stresses due to dilations are avoided and easy removal is allowed through side registry doors (not shown in the Figures), provided for this purpose in a casing (19) of the heat-exchanger unit (13), in combination with other upper doors (29) located in upper caissons (17) described in the following paragraph.

[0034] The first vertical tubes (14) have upper and lower end sections which are fitted and assembled into recesses of the bushings.

[0035] In another embodiment, the upper and lower end sections of the first vertical tubes (14) are fitted directly into recesses made in the structure of the upper caisson (17) and the combustion chamber (9).

[0036] On the other hand, the heat-exchanger unit (13) which is characteristically arranged as already noted behind the combustion chamber (9) constituting an independent element thereof, that can be detached and contains a second passage (II) determined by second vertical tubes (16); in this case having a smaller diameter than the first vertical tubes (14) from the first combustion-gas passage (I), and through which said combustion gases are also required to pass following a sinusoidal path, ascending and descending through these second vertical tubes (16) already connected in groups by means of the upper caissons (17) and other lower caissons (18) transmitting its heat to the air passing over the outside of one and the other vertical tubes (14, 16) which form part of the heat-exchanger unit (13) which is closed at the sides by the casing (19).

[0037] In addition, the device of the invention incorporates a blower fan (20) which is coupled to the heat-exchanger unit (13) in correspondence with the opposite end furthest from the combustion chamber (9), thus achieving optimal performance for heat exchange with the combustion gases; so that the blower fan (20) drives the hot air to a second outlet (21) for hot air located on top of the combustion chamber (9).

[0038] In order to clean the lower caissons (18) of the passage of combustion gases in the heat-exchanger unit (13), side cleaning doors (22) are provided in the casing (19) for this purpose, having also foreseen another cleaning door (22').

[0039] Behind the last lower caisson (18) of the heat-exchanger unit (13), a last decanter caisson (23) is installed, which is connected to the suction tube (24) of an extractor (25) having variable flow to regulate the depression and outlet flow of the combustion gases, to which, in turn, a chimney-tube (26) is coupled for the outlet of said gases to the exterior.

[0040] The first and second vertical tubes (14), (16) are housed within a main chamber (1) of the heat-exchanger unit (13) which communicates with a casing chamber (27) located around the structure of the combustion chamber (9); wherein the stream of the second air gaseous fluid first flows through the main chamber (1) receiving heat from the first and second vertical tubes (14), (16) reaching a temperature of 300/400°C and then traverses the casing chamber (27) wherein the second air gaseous fluid increases its temperature (to 30°C and over) through heat transfer of the combustion chamber (9); the casing chamber (27) ending up in the second outlet (21) for hot air which reaches a temperature of up to 130/150°C.

[0041] The bottom edges of the first vertical tubes (14) rest on stops (28) integrated into the structure of the combustion chamber (9).

[0042] The upper caissons (17) of the heat-exchanger unit (13) have the upper doors (29) facing the upper ends of the first and second vertical tubes (14), (16). Said upper doors (29) allow to carry out the cleaning and maintenance of the upper caissons (17), first and second vertical tubes (14), (16), and also allow the extraction of the first vertical tubes (14) or replacing them when necessary, as they are subjected to elevated temperatures (up to 600°C) due to their proximity to the combustion chamber (9).

[0043] The casing chamber (27) defines an annular space delimited by an inner wall (27a) and an outer wall (27b); wherein both walls are connected by ribbings (31) which are complemented by fins (32) which come out of the inner wall (27a).

[0044] The structure of the combustion chamber (9) has a front wall (30) which receives the impact of the stream of second gaseous fluid in its flow path to the casing chamber (27) which surrounds the structure of the combustion chamber (9); wherein said front wall (30) has a conical structure with a divergent surface from its center to its perimeter edge where it flows into the casing chamber (27). In this situation, the speed of the hot air stream inside the casing chamber (27) can reach up to 12 m/s.

[0045] The combustion gases which flow through the group of second vertical tubes (16) closest to the blower fan (20) can reach a temperature below 100°C even lower temperature than the air flowing through the area of that specific group of second vertical tubes (16); all of this depending mainly on the air flow supplied by the blower fan (20). Thus, maximum heat exchange is achieved from the second vertical tubes (16) to the second flow of air. This sometimes implies that considerable condensation

is generated inside this specific group of second vertical tubes (16), condensation which will be drained by means of a drainage duct installed on the bottom of the second decanter (23).

[0046] Furthermore, it must be noted that the pressure of the flow of hot air inside the device is always greater than the pressure of the combustion gases, so that although the vertical tubes (14), (16) or other internal parts of the device break, the pressure generated by the blower fan (20) combined with the depression generated by the fume extractor (25) prevent the combustion gases from passing into the flow of hot air used for example to dry grain in industrial warehouses, thus avoiding that a spark passes into the airflow possibly causing a fire.

[0047] The upper and lower end sections of the first vertical tubes (14) easily fit into the recesses of the first upper caisson (17) and the combustion chamber (9); wherein the heating of the first vertical tubes (14) increases their dimensions fitting tightly into the recesses of the first upper caisson (17) and combustion chamber (9), highlighting that said tightening allows the sliding of the first vertical tubes (14) during dilation when said first vertical tubes (14) are heated, which in one embodiment are made of stainless steel.

[0048] The top of the heat-exchanger unit (13) integrates a baluster so that the cleaning can be carried out safely.

[0049] Having thus adequately described the nature of the present invention, as well as how to put it into practice, it is deemed unnecessary to make this description any longer in order for anyone skilled in the art to understand the scope of the invention and the advantages deriving therefrom. It must be noted that, within its essential nature, the invention may be carried out according to other embodiments differing in detail from that set out by way of example, which the protection sought would equally cover, provided that the fundamental principle thereof is not altered, changed or modified.

Claims

1. A device for generating hot air by means of biomass combustion which comprises an auger feeder, a receiving hopper, a combustion chamber with a burner, a heat-exchanger unit between two gaseous fluids: a first fluid and a second fluid; a blower fan of the second gaseous fluid, a first combustion-gas outlet of the first gaseous fluid and a second combustion-gas outlet for the second gaseous fluid; wherein the first gaseous fluid is a stream of hot gases generated by the combustion of biomass within the combustion chamber, while the second gaseous fluid is a flow of hot air expelled from the second outlet; **characterized in that**:

   - the heat-exchanger unit comprises several groups of second vertical tubes (16), whose ends lead into upper caissons (17) and lower caissons (18); wherein the first gaseous fluid flows inside second vertical tubes (16) and upper and lower caissons (17), (18), following a sinusoidal path formed by updrafts and downdrafts corresponding to the second vertical tubes (16), and by other currents flowing through the inside of the upper and lower caissons (17), (18);
   - the heat-exchanger unit (13) comprises an independent structure which is detachably coupled to a structure of the combustion chamber (9); wherein the flow of the first gaseous fluid from the combustion chamber (9) to the heat-exchanger unit (13) comprises first vertical tubes (14) which are detachable, which have lower end sections which fit into recesses of the combustion chamber (9), and upper end sections which fit into other recesses of a first upper caisson (17) of the heat-exchanger unit (13); wherein the first gaseous fluid ascends from a lower portion of the combustion chamber (9) to the first upper caisson (17) of the heat-exchanger unit (13) through the first vertical tubes (14);
   - the first and second vertical tubes (14), (16) are housed inside a main chamber (1) of the heat-exchanger unit (13) which communicates with a casing chamber (27) located around the structure of the combustion chamber (9); wherein the stream of the second gaseous fluid of air first flows through the main chamber (1) receiving heat from the first and second vertical tubes (14), (16) and then flows through the casing chamber (27) wherein the second gaseous fluid of air increases its temperature through the heat transferred by the combustion chamber (9); ending up in the casing chamber (27) in the second outlet (21) for hot air.

2. The device for generating hot air by means of biomass combustion, according to claim 1, **characterized in that** the blower fan (20) is coupled on the independent structure of the heat-exchanger unit (13) at the opposite end furthest from the combustion chamber (9).

3. The device for generating hot air by means of biomass combustion, according to any one of the preceding claims, **characterized in that** the set of first vertical tubes (14) form a first combustion-gas passage (I) of the first gaseous fluid having a greater diameter than the set of second vertical tubes (16) constituting a second combustion-gas passage (II) of the first gaseous fluid.

4. The device for generating hot air by means of biomass combustion, according to any one of the preceding claims, **characterized in that** the upper and

lower end sections of the first vertical tubes (14) easily fit into the recesses of the first upper caisson (17) and the combustion chamber (9); wherein the heating of the first vertical tubes (14) increases their dimensions fitting them tightly into the recesses of the first upper caisson (17) and the combustion chamber (9).

5. The device for generating hot air by means of biomass combustion, according to claim 4, **characterized in that** the recesses wherein the upper and lower end sections of the first vertical tubes (14) are coupled, said recesses are delimited by the inner spaces of bushings (15) which are welded to the upper caisson (17) and the combustion chamber (9).

6. The device for generating hot air by means of biomass combustion, according to any one of the preceding claims, **characterized in that** bottom edges of the first vertical tubes (14) rest on stops (28) integrated into the structure of the combustion chamber (9).

7. The device for generating hot air by means of biomass combustion, according to any one of the preceding claims, **characterized in that** the heat-exchanger unit (13) is housed in a casing (19) with at least one side door accessing the heat-exchanger unit (13).

8. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the lower caissons (18) of the heat-exchanger unit (13) have side doors (22) in order to access the inside of said caissons, which are arranged vertically in the group of second vertical tubes (16).

9. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the upper caissons (17) of the heat-exchanger unit (13) have upper doors facing the upper ends of the first and second vertical tubes (14), (16).

10. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the stream of the first gaseous fluid is sucked up by an extractor (25) which expels the first gaseous fluid outside through the first fume outlet located at the end of a chimney-tube (26); wherein the absolute pressure of said first gaseous fluid is always less than the absolute pressure of the second gaseous fluid.

11. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the structure of the combustion chamber (9) has a front wall (30) which receives the impact of the stream of second gaseous fluid in its flow path to the casing chamber (27) which surrounds the structure of the combustion chamber (9); wherein said front wall (30) has a conical structure with a divergent surface from its center to its perimeter edge where it flows into the casing chamber (27).

12. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the casing chamber (27) defines an annular space delimited by an inner wall (27a) and an outer wall (27b); wherein both walls are connected by ribbings (31) which are complemented by fins (32) which come out of the inner wall (27a).

13. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the passage cross-section of the main chamber (1) of the heat-exchanger unit (13) is greater than the passage cross-section of the casing chamber (27) located around the structure of the combustion chamber (9).

14. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** the structure of the combustion chamber (9) contains a first decanter (11) of the solid particles of the first gaseous fluid; said first decanter (11) being located in the lower portion below the lower end of the second vertical tubes (16).

15. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims, **characterized in that** it contains a second decanter (23) of the solid particles of the first gaseous fluid, said second decanter (23) being located at one end of the heat-exchanger unit (13) corresponding to the outlet of the first gaseous fluid.

16. **The device for generating hot air by means of biomass combustion,** according to any one of the preceding claims 10 and 15, **characterized in that** the second decanter (23) is lodged between the heat-exchanger unit (13) and a suction tube (24) belonging to the extractor (25).

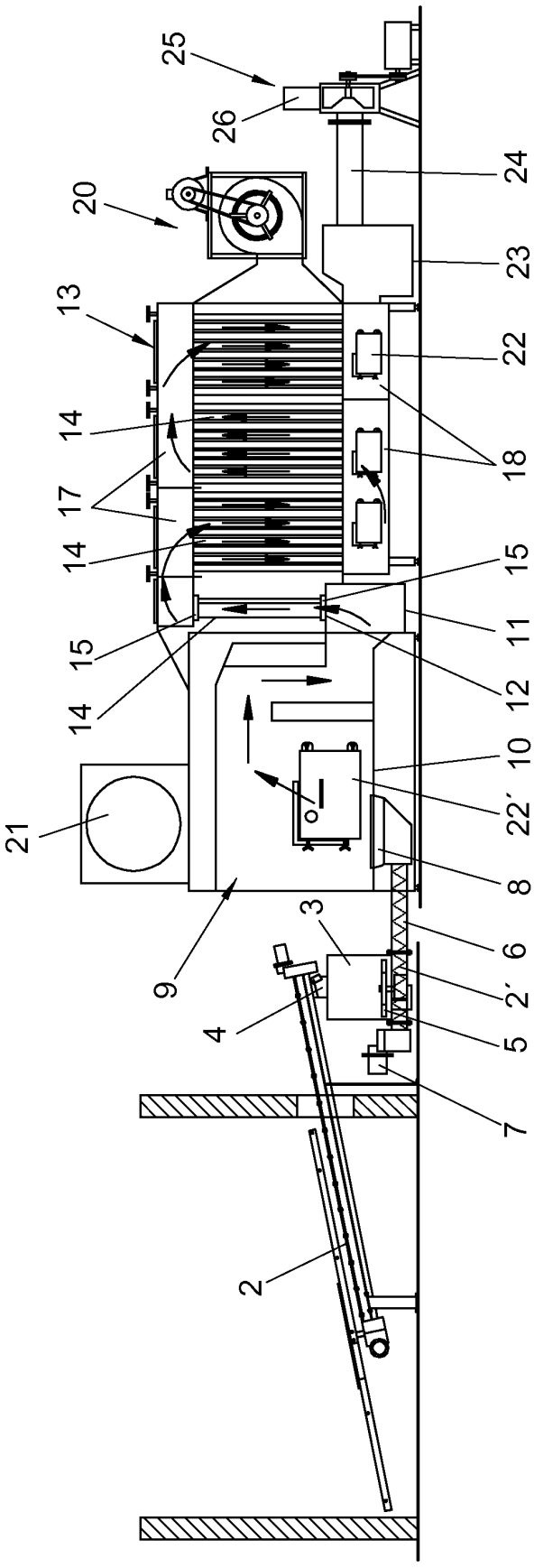
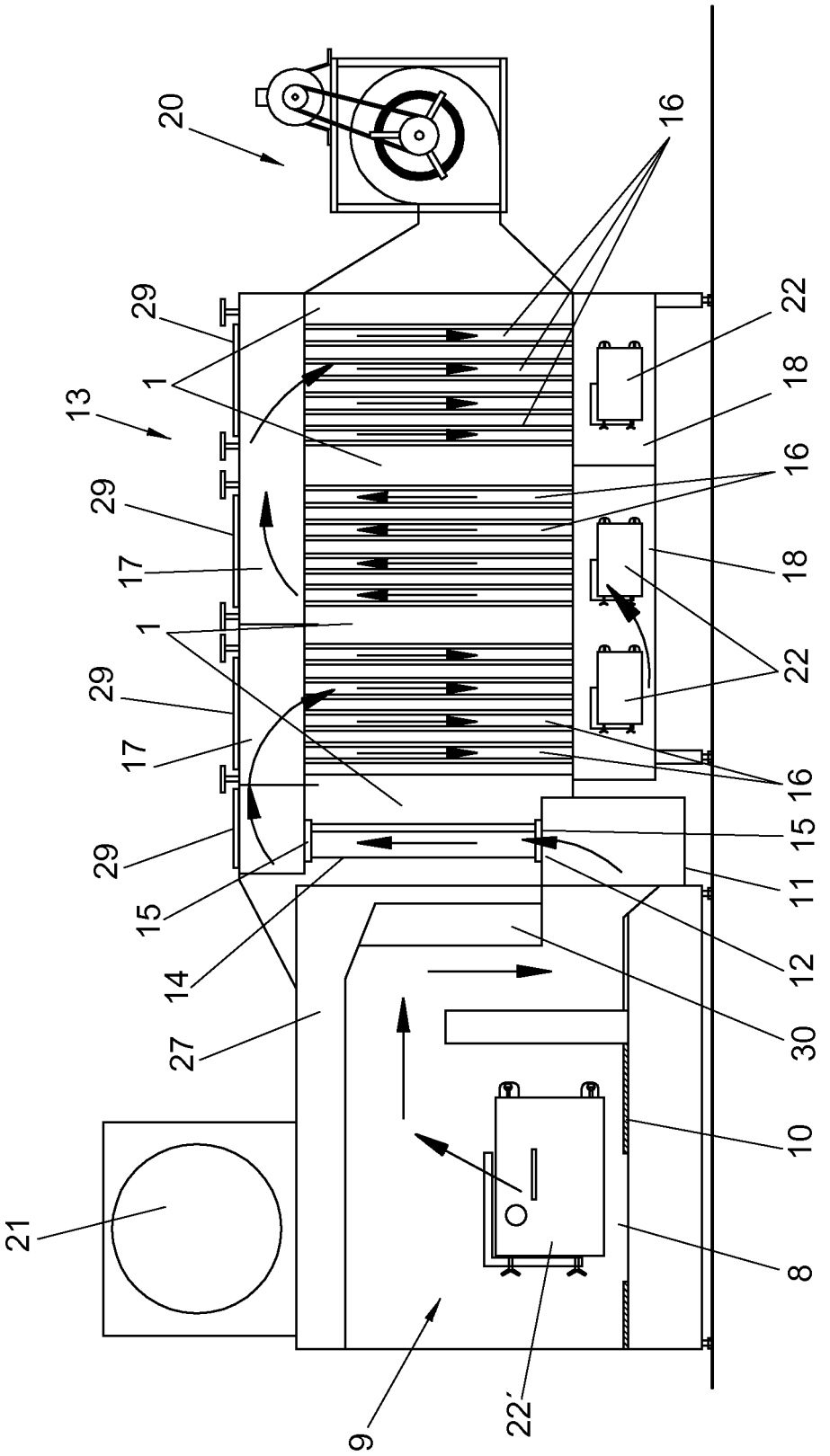


FIG. 1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22'

FIG. 2

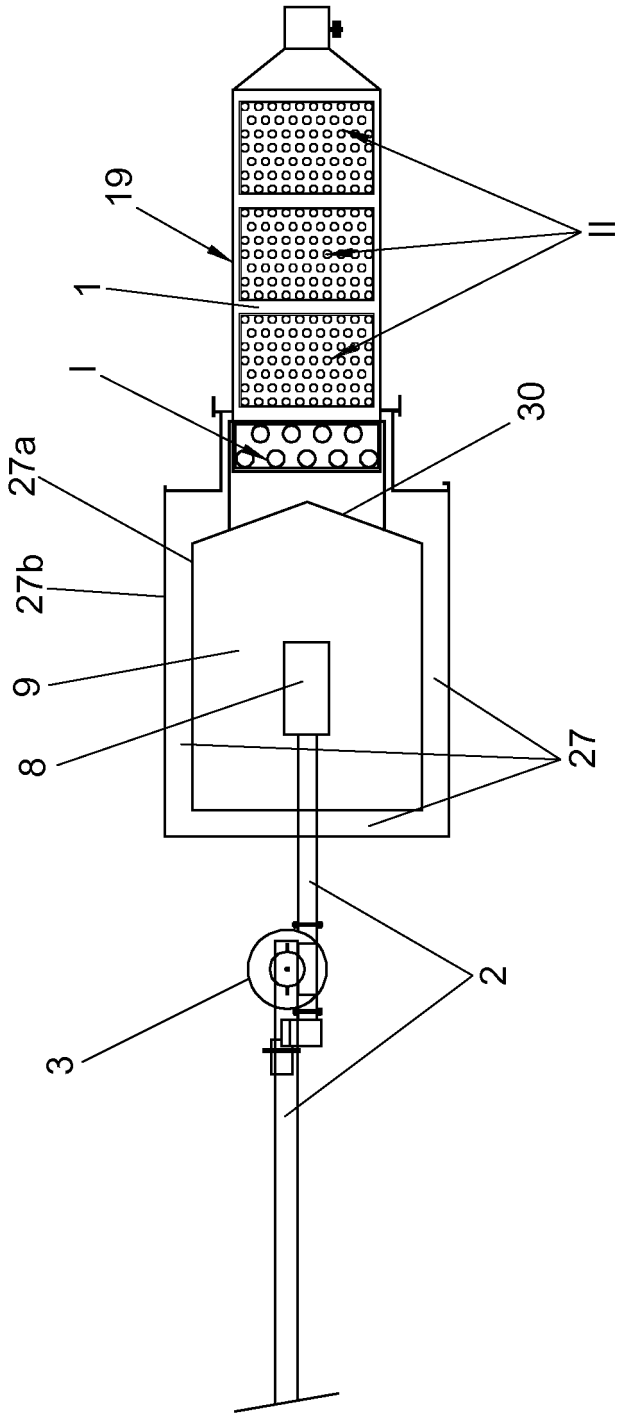

FIG. 3

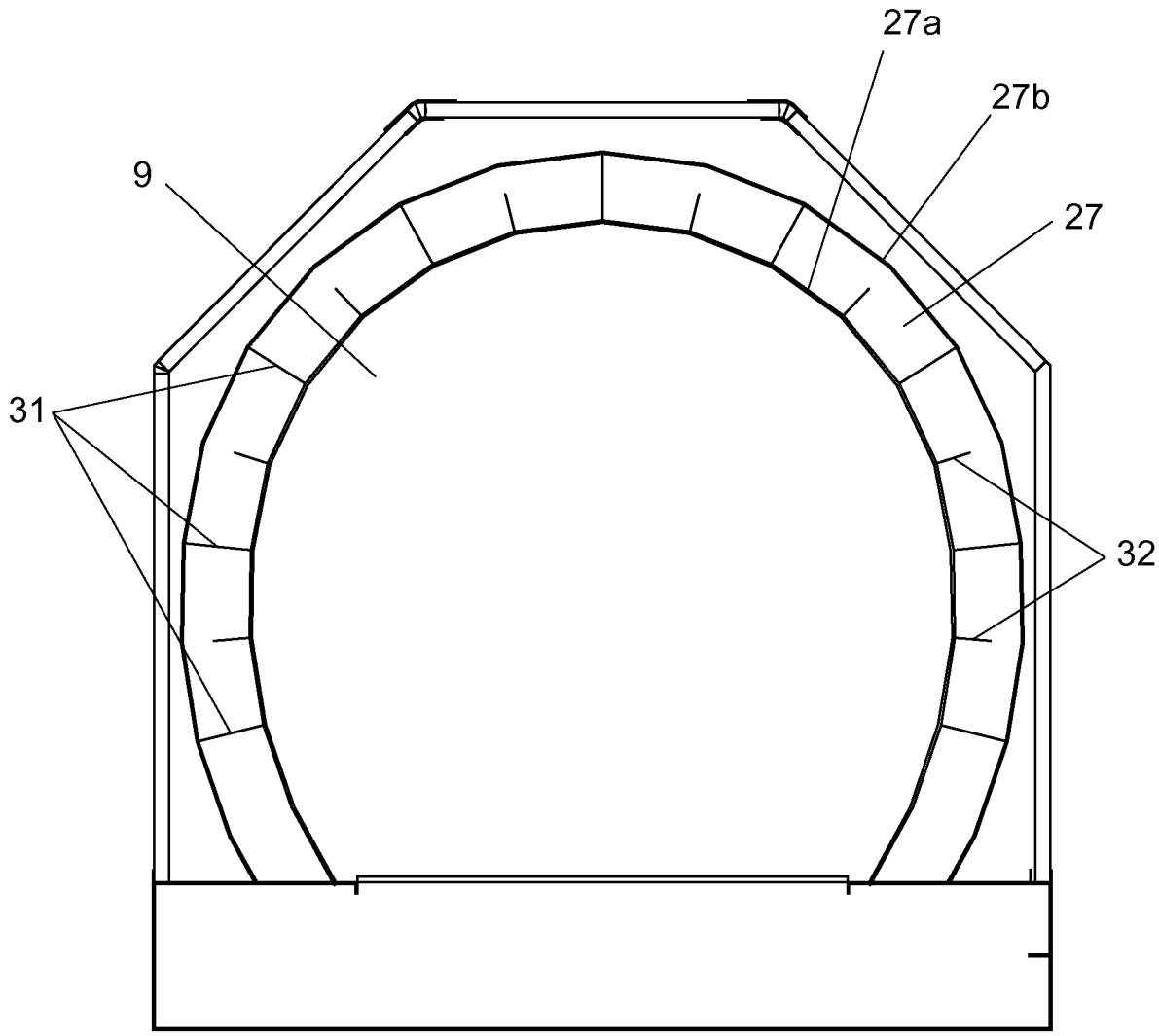

FIG. 4

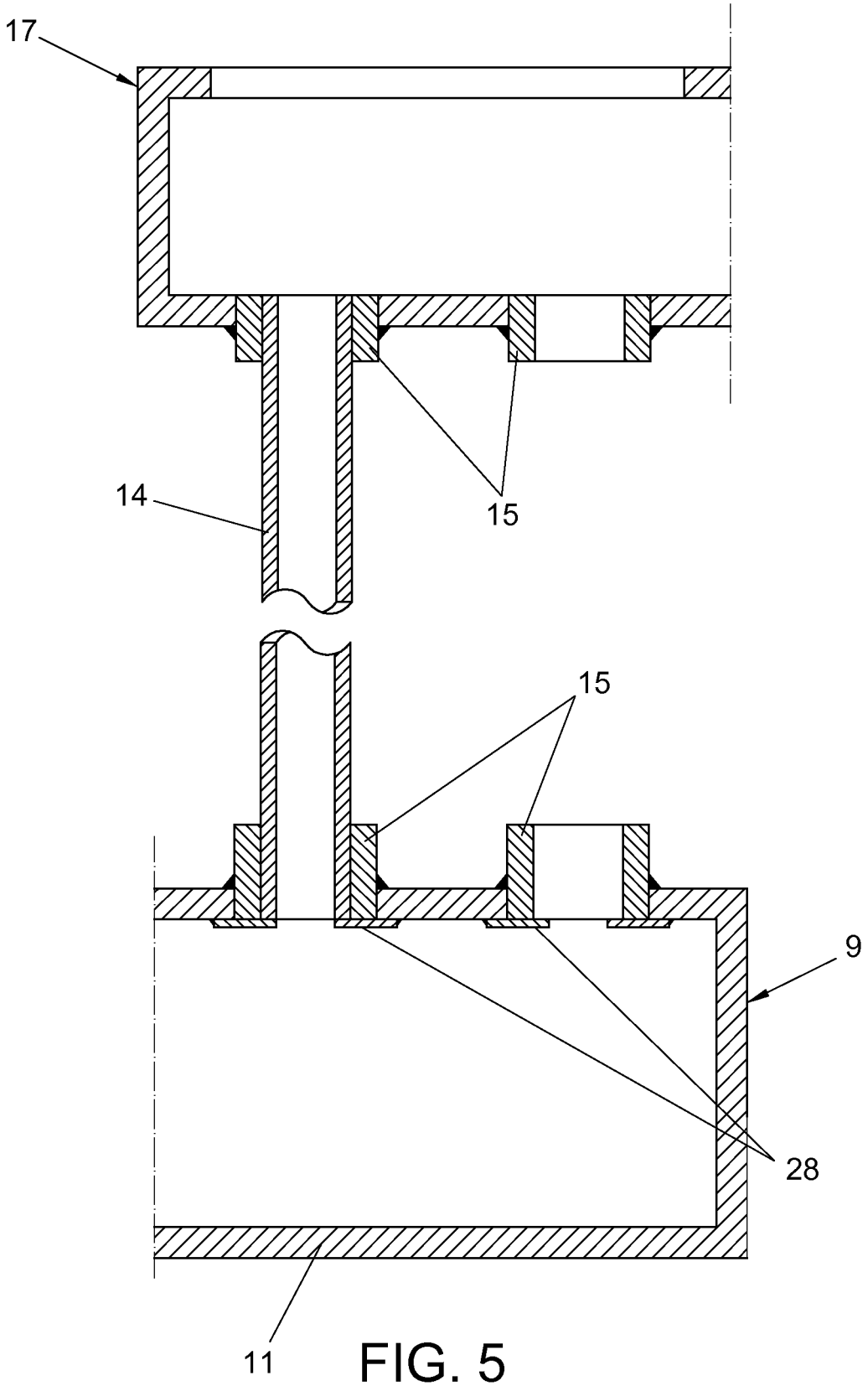

FIG. 5

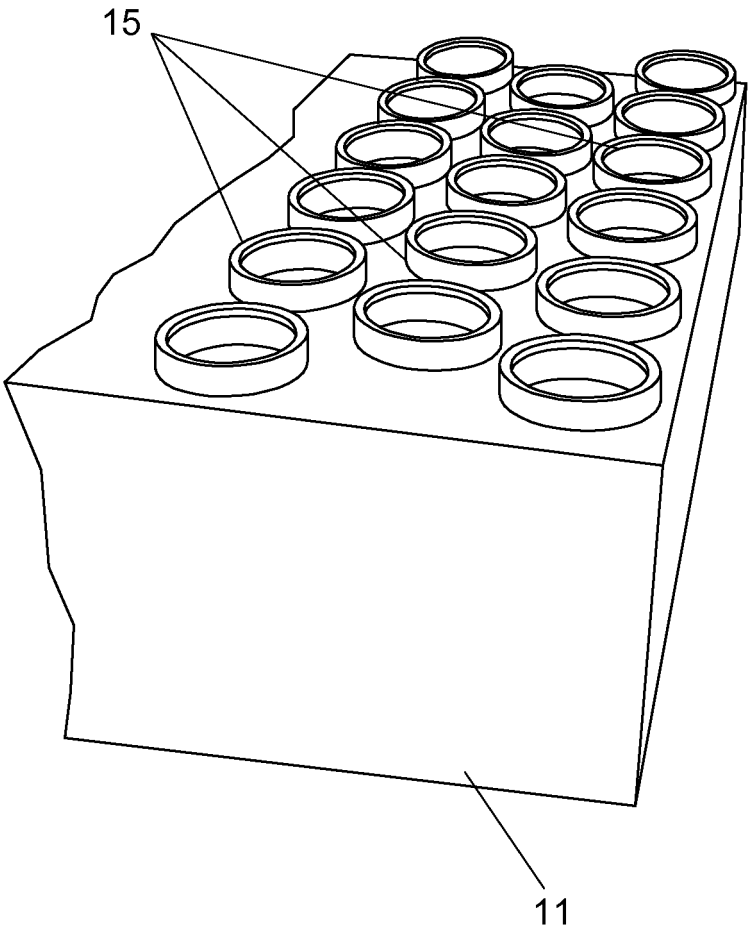

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070732

A. CLASSIFICATION OF SUBJECT MATTER

F24H3/08 (2006.01)

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)
F24H

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)

EPODOC, INVENES

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013133560 A1 (LASKOWSKI SCOTT ET AL.) 30/05/2013, abstract; paragraphs 3, 5, 17, 18, 42, 43, 45; figures 2-7.	1, 8
A	US 4232732 A (JOHNSON ALBERT V) 11/11/1980, abstract; column 3 lines 16-37; figures.	1
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A	US 6336449 B1 (DRISDELLE MARK ET AL.) 08/01/2002, abstract; column 5 lines 62-27; figures 8 and 9.	1

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25/11/2014	**(28/11/2014)**
Name and mailing address of the ISA/ OFICINA ESPAÑOLA DE PATENTES Y MARCAS Paseo de la Castellana, 75 - 28071 Madrid (España) Facsimile No.: 91 349 53 04	Authorized officer P. Del Castillo Penabad Telephone No. 91 3495579

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2014/070732

C (continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of documents, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007215021 A1 (KRUMREI TERRY L) 20/09/2007, abstract; paragraphs 5, 52, 54, 59, 60, 70; figures 1-4, 10.	1
A	US 2008173297 A1 (RUPPEL ROBERT J ET AL.) 24/07/2008, abstract; figures.	1
A	US 4402302 A (WESTELAKEN CHRISTIANUS M T) 06/09/1983, abstract; column 1 lines 48-59, column 12 lines 23-61; figures.	1
A	US 5979433 A (O&APOS ET AL.) 09/11/1999, the whole the document.	1, 3, 8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/ES2014/070732

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REFERENCES CITED IN THE DESCRIPTION

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- US 4232732 A **[0010]**