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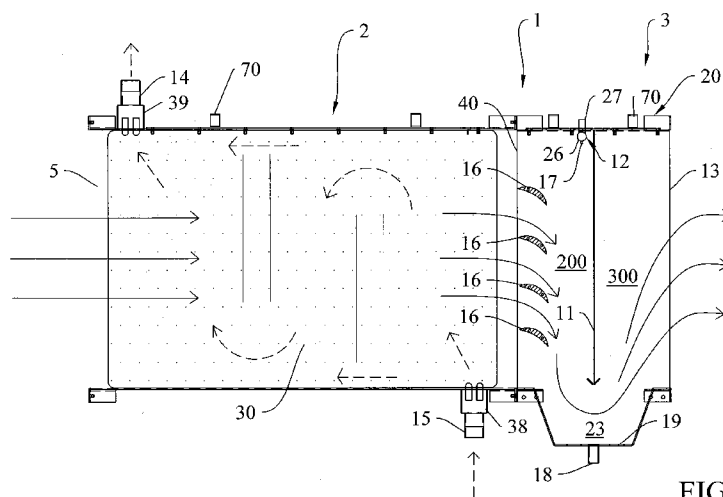


FIG.1

(57) Abstract: A modular apparatus (1) for the recovery of heat and for the purification of fumes coming from a boiler is described, said apparatus (1) comprising an inlet (5) adapted to receive the outlet fumes from the boiler, a heat exchanger module (2), a fume purification module (3) and an outlet (13) connected to a flue. The fume purification module (3) has an inlet (30) connected downstream of the horizontal heat exchanger (2) and an outlet coincident with the outlet (13) of the apparatus, said module (3) comprising a frame (20) with substantially "U"-shaped profile in turn comprising a baffle (11) adapted to divide said frame (20) into a first chamber (200) and into a second chamber (300), said first (200) and second (300) chambers being communicating by means of a passage (23) between the lower end of the baffle (11) and a bottom (19) of said frame (20) provided with drain (18). The heat exchanger module (2) comprises a plurality of plates (30) overlapped staggered with lying substantially parallel to the direction of motion of the fumes between adjacent plates (30), each plate (30) providing a chamber (31) for the motion of a heat-carrying fluid substantially counter-current with respect to the fumes.

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“Modular apparatus for the recovery of heat and for the purification of
fumes”

* * * *

DESCRIPTION

The present invention relates to a modular apparatus for the recovery of heat and for the purification of fumes.

More specifically, the invention relates to an apparatus for the recovery of heat with a fume purification module which, installed between a boiler and the flue thereof, is capable of intercepting the fumes generated by combustion, thus recovering and reusing the thermal energy contained therein.

Normal boilers can use only a portion of the sensible heat of combustion fumes, furthermore they cannot use the latent heat of vaporization due to the need to avoid the condensation of the heat contained in the fumes which gives rise to corrosive phenomena. The steam generated by the combustion process is therefore totally dispersed into the atmosphere through the stack.

Condensing boilers instead can recover a portion of the latent heat contained in the fumes expelled through the stack. The particular technology of condensation indeed allows the fumes to be cooled until they return to their saturated liquid state (or in certain cases to steam), with a heat recovery used to preheat the return water from the plant. Thereby the temperature of the outlet fumes maintains a very low value close to the return temperature value of the water.

A condensing apparatus for the recovery of heat from a boiler comprising a heat exchanger is known from Patent MI2012A001766, said apparatus being provided with an inlet adapted to collect the outlet fumes from the boiler and an outlet connected to a flue. The flow of fumes through the apparatus occurs by means of a vertical path, and the inlet of the apparatus is provided with at least a detector of the fume flow adapted to

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send a signal from a control unit, said control unit being adapted to command a modulating device for extracting the fumes at the outlet of the apparatus.

US-4031862 describes a heat exchanger positioned inside a chamber for the purification of fumes.

In view of the state of the art, the object of the present invention is to make an apparatus which allows the vaporization heat contained in the vapours generated by combustion in boilers to be recovered by means of a horizontal exchanger, thus at the same time reducing the emissions into the atmosphere.

In accordance with the invention, such an object is achieved by an apparatus as described in claim 1.

These and other features of the present invention will become increasingly apparent from the following detailed description of one of its non-limiting embodiments, disclosed in the accompanying drawings, in which:

figure 1 shows a sectional view of the apparatus for the recovery of heat according to the present invention;

figure 2 shows an axonometric view of the apparatus for the recovery of heat in figure 1;

figure 3 shows an axonometric view of a module adapted to the purification of fumes;

figure 4 shows a sectional view of a first embodiment of the module adapted to the purification of fumes in figure 3;

figure 5 shows a sectional view of a second embodiment of the module adapted to the purification of fumes in figure 3;

figure 6 shows the parallel connection of several apparatuses for the recovery of heat in figure 1;

figure 7 shows a plan view of the plate of a heat exchanger;

figure 8 shows a plan view of the plate in figure 7 rotated by 180°

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about a first axis;

figure 9 shows a plan view of the plate in figure 8 rotated by 180° about a second axis orthogonal to said first axis;

figure 10 shows the plates in figures 7 and 9, overlapped;

figure 11 shows a sectional view of the exchanger formed by a plurality of overlapped plates as shown in figure 10;

figure 12 shows an enlarged detail of figure 11, rotated by 180°.

Figure 1 shows a modular apparatus 1 for the recovery of heat and for the purification of fumes. Said apparatus 1 is installed between a boiler (water or steam) and a flue (not shown in the figures) and is configured to intercept the flow of outlet fumes from the boiler, recover from such fumes a portion of the sensible and latent heat of vaporization and purify them before the emission into atmosphere. In the case in point, apparatus 1 comprises an inlet 5 adapted to receive the outlet fumes from the boiler, a heat exchanger module 2, a fume purification module 3 and an outlet 13.

Module 3 adapted to the purification of fumes comprises an inlet 40 directly connected downstream of the heat exchanger 2 and an outlet coincident with outlet 13 of the apparatus, said module 3 comprising a frame 20 with substantially "U"-shaped profile in turn comprising a baffle 11 adapted to divide said frame 20 into a first chamber 200 and into a second chamber 300, said first 200 and second 300 chambers being communicating by means of a passage 23 between the lower end of baffle 11 and a bottom 19 of said frame 20. Such a bottom 19 is then provided with a drain 18 adapted to the expulsion of the acid condensates.

Baffle 11 is adapted to deviate vertically the flow of fumes coming from the heat exchanger 2 toward the bottom through passage 23. In a first embodiment (figure 4), baffle 11 consists of a vertical wall of dimensions such as not to oppose the flow of inlet fumes to module 3, i.e. to ensure a suitable passage area between said baffle 11 and bottom 19 of frame 20.

Advantageously, in a second embodiment thereof (figure 5), baffle 11

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may provide a first inclined wall 110 facing toward the first chamber 200 and a second curved wall 111 facing toward the second chamber 300. This particular conformation is adapted to promote the vertical deviation of the fumes downward and the successive emission toward the outside.

Inlet 40 of module 3 may comprise a plurality of deflectors 16 connected between the two lateral walls of frame 20, said deflectors 16 being adapted to canalize the flow of inlet fumes to module 3 through the path defined by the "U"-shaped profile of frame 20.

A vaporizer device 12 (figures 1, 3, 4), adapted to vaporize inhibited water for washing the outlet fumes from the horizontal heat exchanger 2, is positioned at the top of said first chamber 200. Said vaporizer device 12 provides a tube 26 arranged perpendicular to the flow direction of the fumes. Tube 26 comprises a conduit 27 for emitting the inhibited water and also a plurality of vaporizer nozzles 17 arranged along said tube 26. Preferably, the vaporizer nozzles 17 are oriented in direction of baffle 11, in particular, in the case of the second embodiment of module 3, the sprays are directed toward the inclined wall 110 facing toward the first chamber 200.

While the first chamber 200 is adapted to convey the inlet fumes to module 3, the second chamber 300, which branches off from said passage 23 in direction of outlet 13, is adapted to conduct the flow of purified fumes toward outlet 13.

The heat exchanger 2 comprises a plurality of plates 30, each with a substantially rectangular-shaped surface mounted oriented substantially in the same direction as the fumes, and a passage chamber 31 adapted to accommodate a heat-carrying fluid.

Each plate 30 is obtained from two laminas 301, 302 joined by means of welding spots 32 and bellied according to a known technique for obtaining said passage chamber 31.

Each plate 30 further comprises two linear weldings 33 adapted to form a path for the heat-carrying fluid to increase the turbulence thereof.

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More specifically, said linear weldings (33), which are substantially transverse to the motion of the heat-carrying fluid, are realized with one adjacent end at opposite sides of plate (30), thus leaving a larger opening (36) on one side and a smaller opening (37) on the other side, the latter to facilitate the counter-current motion of the heat-carrying fluid with respect to the fumes.

Indeed, by observing figure 7 it is noted that the linear weldings 33 are substantially transverse to the motion of the heat-carrying fluid (broken arrows) and therefore obstruct the counter-current motion thereof; the smaller openings 37 instead promote said counter-current motion.

Inlet 35 and outlet 34 orifices of the heat-carrying fluid are also noted.

The plates 30 are packed staggered, although with the edges aligned in the following manner.

Given a first plate 3a (figure 7), a second plate below 3b is identical to the first one and is obtained from the latter by rotating it about a first axis V and then about a second axis O orthogonal to said first axis V (figures 8-9).

Then the first plate 3a and the second plate 3b are overlapped, which therefore are staggered as is clearly apparent by observing figures 11 and 12.

Said method allows the plates 30 to be packed staggered with the passage chambers 31 while keeping the edges of the plates aligned.

Advantageously, the assembly of the plates 30 is therefore easier and more accurate.

An inlet conduit 15, adapted to introduce the heat-carrying fluid into the passage chambers 31 of each plate 30, is positioned bottomly to the heat exchanger 2 (figures 1, 2) and is connected to a plurality of said inlet orifices 35 by means of an inlet manifold 38. In the same manner, an outlet conduit 14, adapted to the defluxion of the heat-carrying fluid from exchanger 2, is positioned at the top of the heat exchanger 2 and is connected to a plurality of said outlet orifices 35 by means of an outlet manifold 39.

The particular conformation of the heat exchanger 2, in particular the

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presence of said smaller openings 37 without which the water would remain blocked by the linear weldings 33, allows the natural emptying of the water therein in such a manner that, in the case of breakdown and of stopped circulation of the heat-carrying fluid, the latter flows spontaneously thus emptying the heat exchanger 2. This allows the boiler to continue its normal operation without the danger of the hot fumes horizontally flowing through the heat exchanger 2 allowing the formation of pressurized steam inside exchanger 2.

In operation (figure 1), apparatus 1 intercepts at its inlet 5 the fumes expelled from boiler 6. The fumes horizontally cross the heat exchanger 2 according to the direction of the arrows (solid) lapping tangentially the plates 30, thus yielding heat to the counter-current heat-carrying fluid (broken arrows). The increased plate contact surface and the optimal distance thereof and the turbulence surface also facilitate the encapsulation of part of the pollutants generated in the condensate.

As already indicated above, the weldings 33 promote the turbulence of the heat-carrying fluid, the smaller openings 37 the counter-current flow thereof, while the arrangement of the overlapped plates 30 intensifies the turbulence of the fumes: indeed the passage chambers 31 in fact positively disturb the tangent flow of the fumes.

More specifically, said arrangement of the plates 30 resulting from the assembly method explained above deviates the fumes in a double direction, both in a first direction orthogonal to the direction of the solid arrows in figure 1 and coplanar to the plane of depiction in said figure 1, and in a second direction orthogonal to the direction of the solid arrows in figure 1 but on a plane orthogonal to the plane of depiction in figure 1.

A hydraulic circuit (not shown in the figures), connected to said inlet 15 and outlet conduits 14 of exchanger 2, transports the heat-carrying fluid, through the boiler up to what may be a heating system, or through a boiler for the accumulation of domestic hot water, or again other devices to which

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to transfer the energy recovered.

The outlet fumes from the heat exchanger 2 are then conducted to inlet 40 of module 3 inside the first chamber 200, where they are deviated vertically in direction of passage 23 between the lower end of baffle 11 and bottom 19 of frame 20. In the second embodiment of module 3, the deflectors 16 at inlet 40 canalize the flow of fumes, thus facilitating the transit thereof and also the washing process. In this step the vaporizer nozzles 17 vaporize inhibited water on the micro particles of the fumes transiting inside the first chamber 200, close to the surface of baffle 11. By conveniently selecting the inclination of the spray of inhibited water, the wetting action can be maximized by the vaporizer nozzles 17 on the inlet fumes 40. Advantageously, better performance is obtained in terms of purification percentage by directing the nozzles 17 toward baffle 11. The suspended particles in the transiting fumes are thus captured by the inhibited water and, having become heavier, fall onto bottom 19 of frame 20, from where they are expelled through drain 18.

The purified fumes are then conducted by means of passage 23 into the second chamber 300 toward the flue and therefore toward the outside.

As shown in figure 6, apparatus 1 is provided with further lateral flanges adapted to allow the connection in series and/or parallel connection of several apparatuses 1. In this application, an element 50 is required which is adapted to convey the outlet fumes, by adapting to the connection of the flue.

By carefully observing figures 1 and 2, the modularity is noted of the individual apparatus 1 which in fact is formed by a heat exchanger module 2 and by a fume purification module 3.

Advantageously, it is possible to make separately exchanger 2 and the purification module 3, which may be associated separately from exchanger 2 only as required.

The purification module 3 does not accommodate any exchanger 2,

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hence being easy to remove and clean.

Apparatus 1 is easily transportable also by means of handles 70, by separating exchanger 2 and the module 3.

CLAIMS

1. A modular apparatus (1) for the recovery of heat and the purification of fumes coming from a boiler, characterized in that it comprises a heat exchanger module (2) and a fume purification module (3) directly and separately associated downstream of said heat exchanger module (2),

said heat exchanger module (2) comprising a plurality of plates (30) overlapped staggered with lying substantially parallel to the direction of motion of the fumes between adjacent plates (30), each plate (30) providing a chamber (31) for the motion of a heat-carrying fluid substantially counter-current with respect to the fumes,

said fume purification module (3) comprising a frame (20) with substantially "U"-shaped profile in turn comprising a baffle (11) adapted to divide said frame (20) into a first chamber (200) and into a second chamber (300), said first (200) and second (300) chambers being communicating by means of a passage (23) between the lower end of the baffle (11) and a bottom (19) of said frame (20) provided with drain (18).

2. An apparatus (1) according to claim 1, characterized in that each plate (30) is formed by two overlapped laminas (301, 302) joined by means of welding spots (32), a passage chamber (31) for the heat-carrying fluid being provided between said laminas (301, 302), each plate (30) further comprising linear weldings (33) adapted to form a path for the heat-carrying fluid to increase the turbulence thereof.

3. An apparatus (1) according to claim 2, characterized in that said linear weldings (33), substantially transverse to the motion of the heat-carrying fluid, are realized with one adjacent end at opposite sides of the plate (30), thus leaving a larger opening (36) on one side and a smaller opening (37) on the other side, said smaller opening (37) being adapted to facilitate the counter-current motion of the heat-carrying fluid with respect to the fumes.

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4. An apparatus (1) according to any one of the preceding claims, characterized in that each plate (30) has an inlet orifice (35) and an outlet orifice (34) of the heat-carrying fluid, which are connected to an inlet conduit (15) and to an outlet conduit (34) of the heat exchanger module (2) by means of an inlet manifold (35) and an outlet manifold (34) which are common to all the orifices (34, 35) of the plates (30).

5. An apparatus (1) according to any one of the preceding claims, characterized in that said first chamber (200) of the frame comprises at the top a vaporizer device (12), adapted to vaporize inhibited water for washing the outlet fumes from the horizontal heat exchanger (2), said vaporizer device (12) providing a tube (26) arranged perpendicular to the flow direction of the fumes, said tube (26) comprising a conduit (27) for emitting the inhibited water and also a plurality of vaporizer nozzles (17) arranged along said tube (26), said vaporizer nozzles (17) being directed toward the baffle (11) to maximize the wetting action on the inlet fumes (30).

6. An apparatus (1) according to any one of the preceding claims, characterized in that the fume purification module (3) comprises at inlet (40) a plurality of deflectors (16) connected between the two lateral walls of the frame (20), said deflectors (16) being adapted to canalize the flow of inlet fumes through the path defined by the "U"-shaped profile.

7. An apparatus (1) according to any one of the preceding claims, characterized in that said baffle (11) comprises a first inclined wall (110) facing toward the first chamber (200) and a second curved wall (111) facing toward the second chamber (300), this particular conformation being adapted to promote the vertical deviation of the fumes toward the bottom and the successive emission toward the outside.

8. A method for making a heat exchanger module (2) having staggered plates (30) as described in any one of claims 1-4, characterized in that it provides obtaining a second plate (3b) to be overlapped on a first plate (3a), by rotating the first plate (3a) about a first axis (V) and then about a second

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axis (O) orthogonal to said first axis (V), finally proceeding to overlap the first (3a) and the second (3b) plates by aligning the edges thereof, said heat exchanger module (2) being therefore formed by adjacent plates (30) with staggered chambers (31) for the passage of the heat-carrying fluid even though the edges of said adjacent plates (30) are aligned.

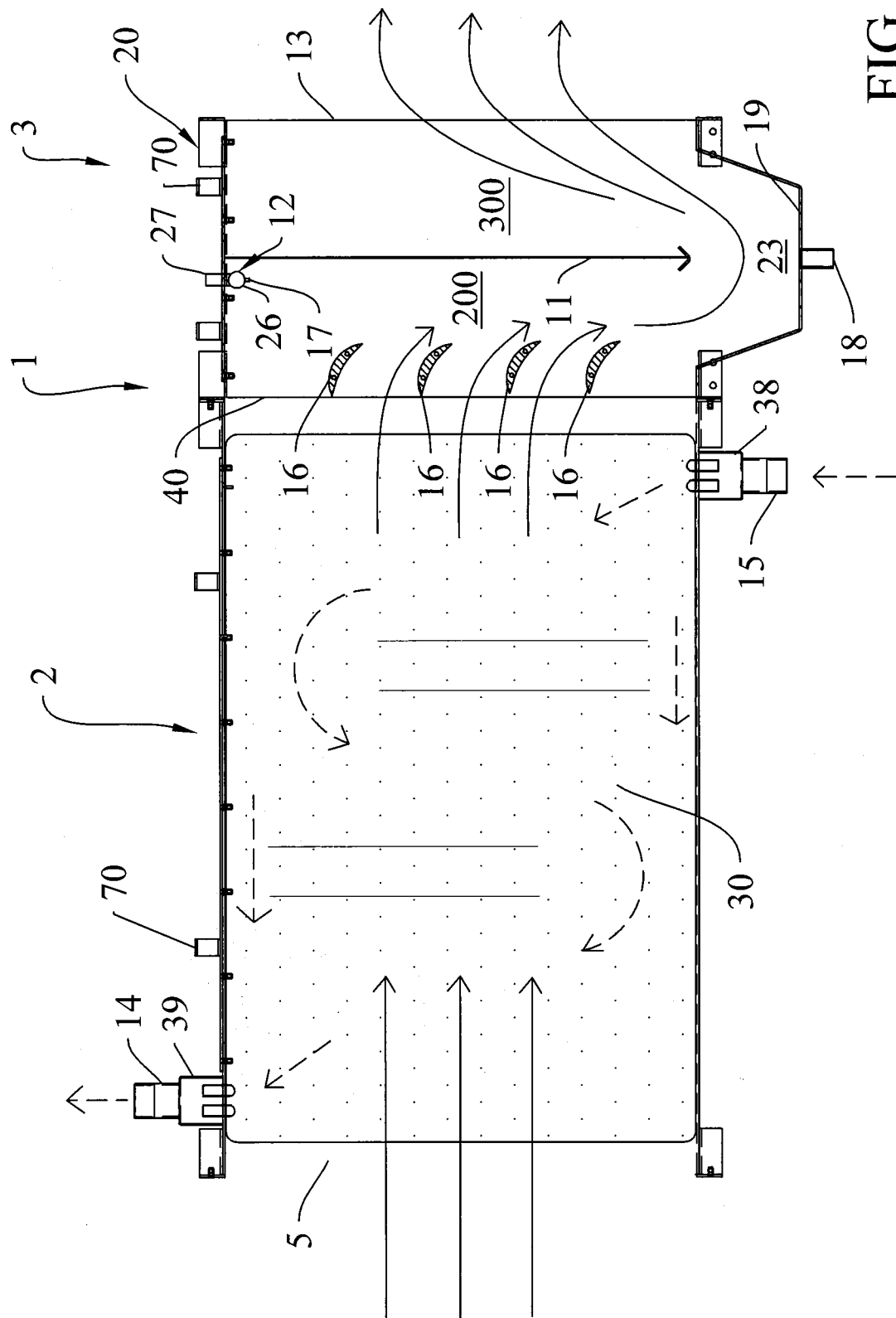
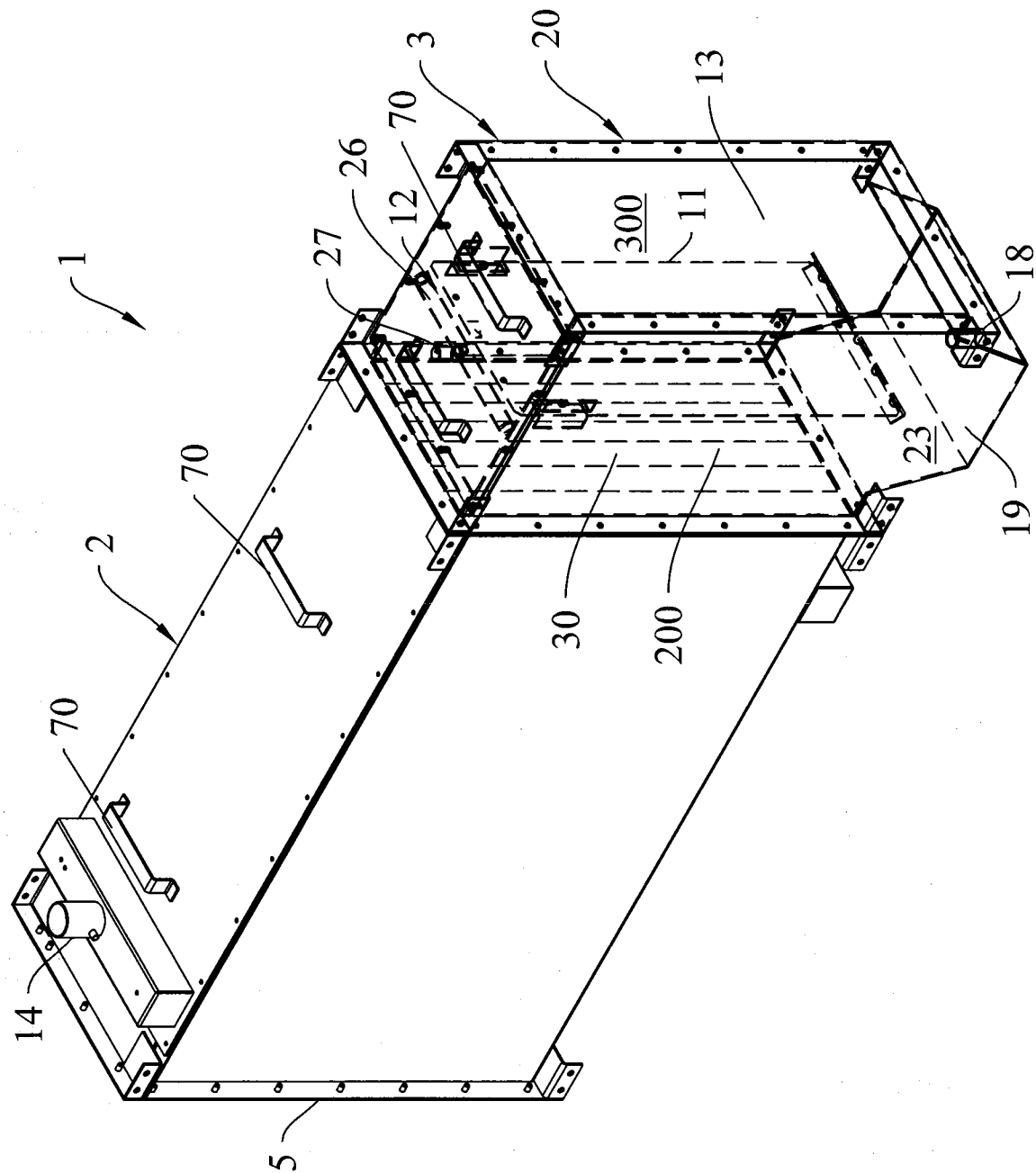


FIG. 1

FIG.2



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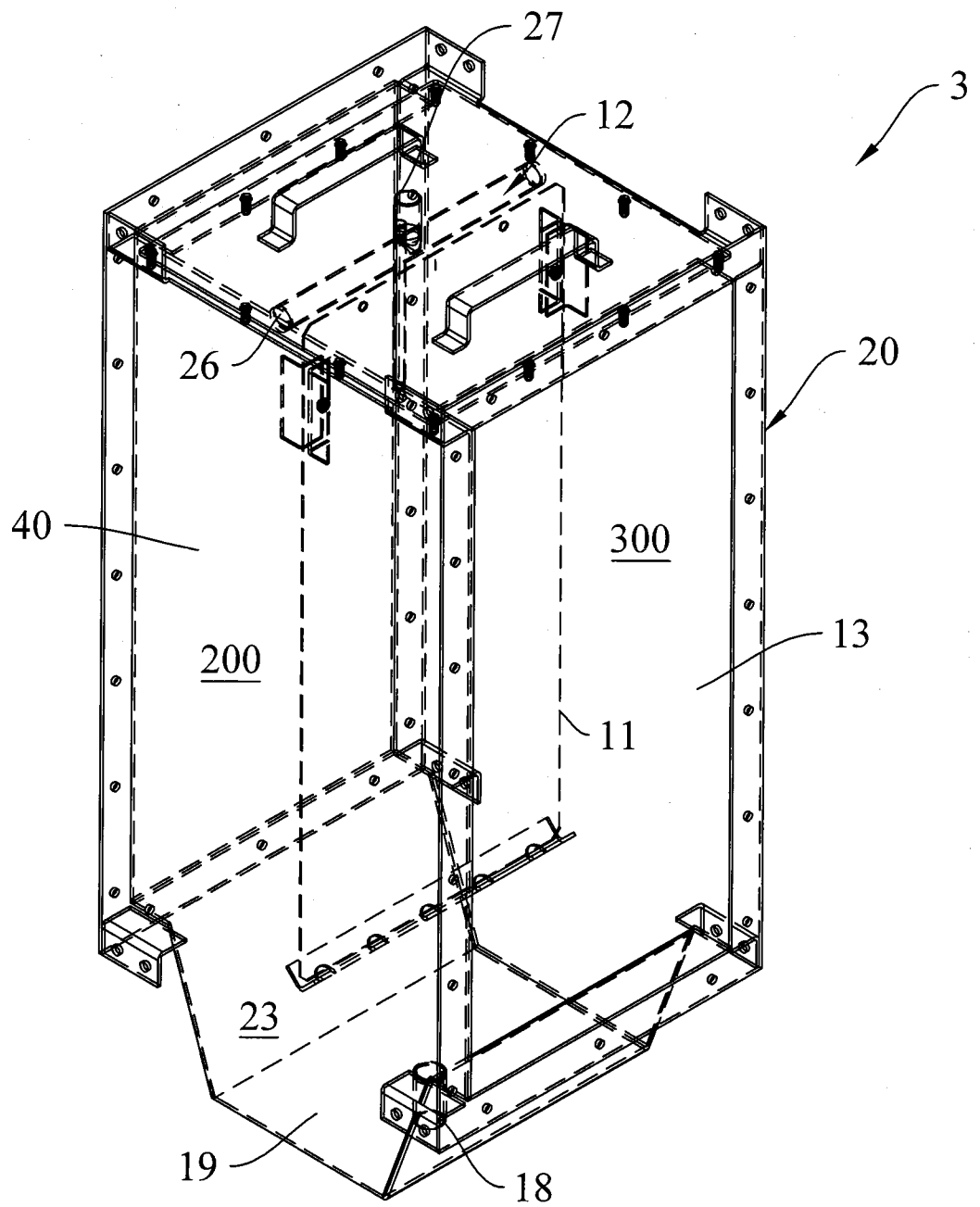


FIG.3

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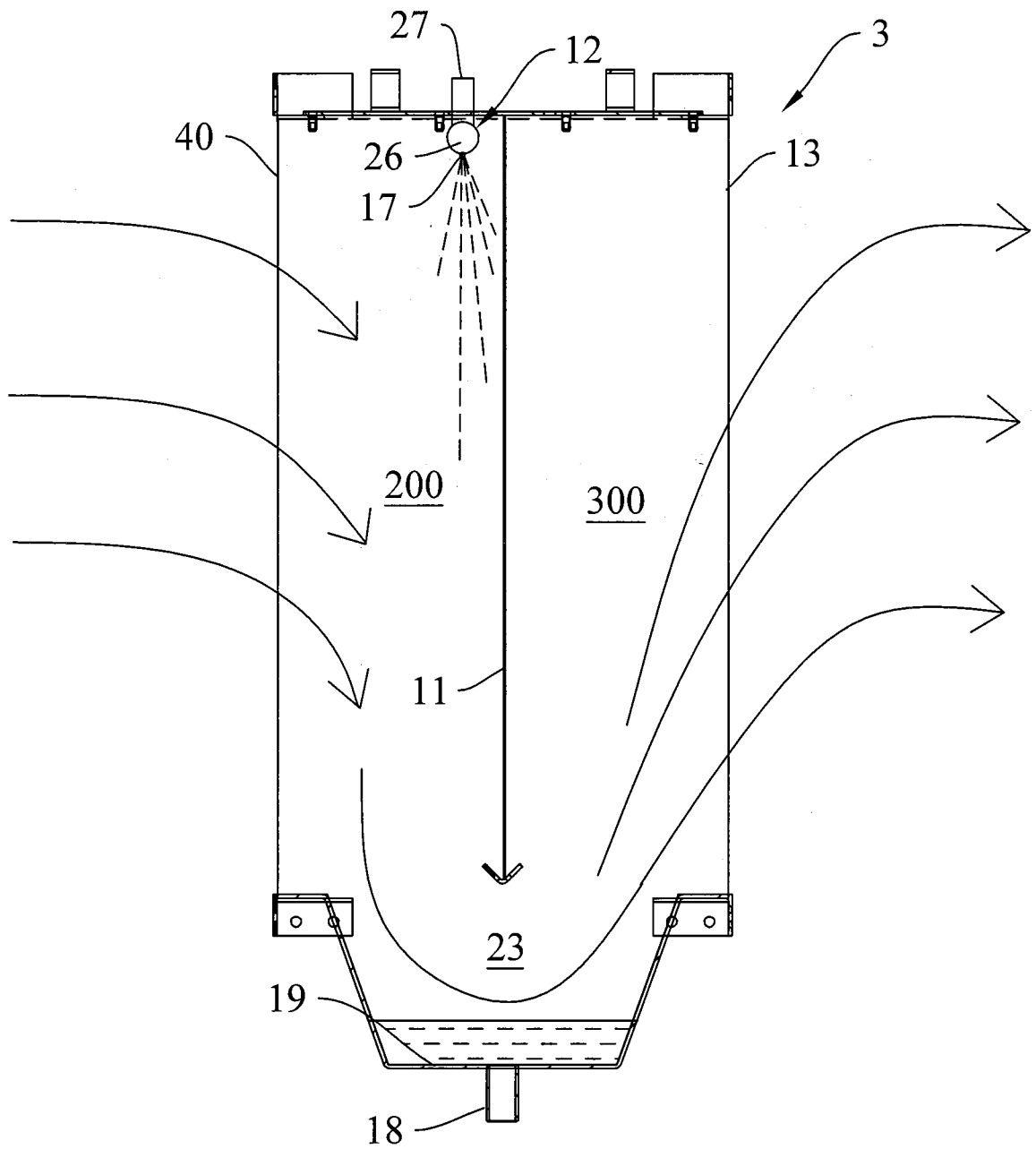


FIG.4

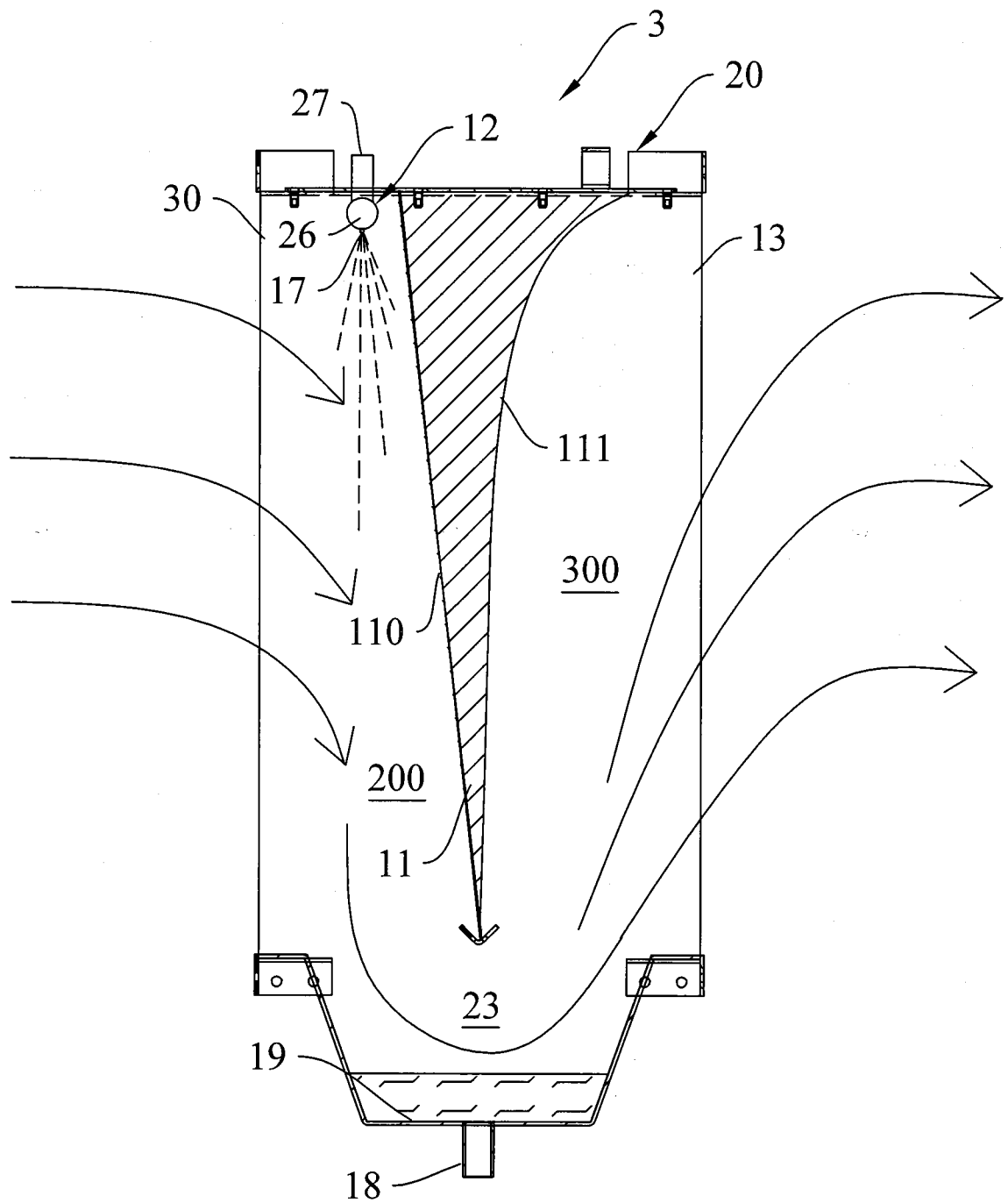
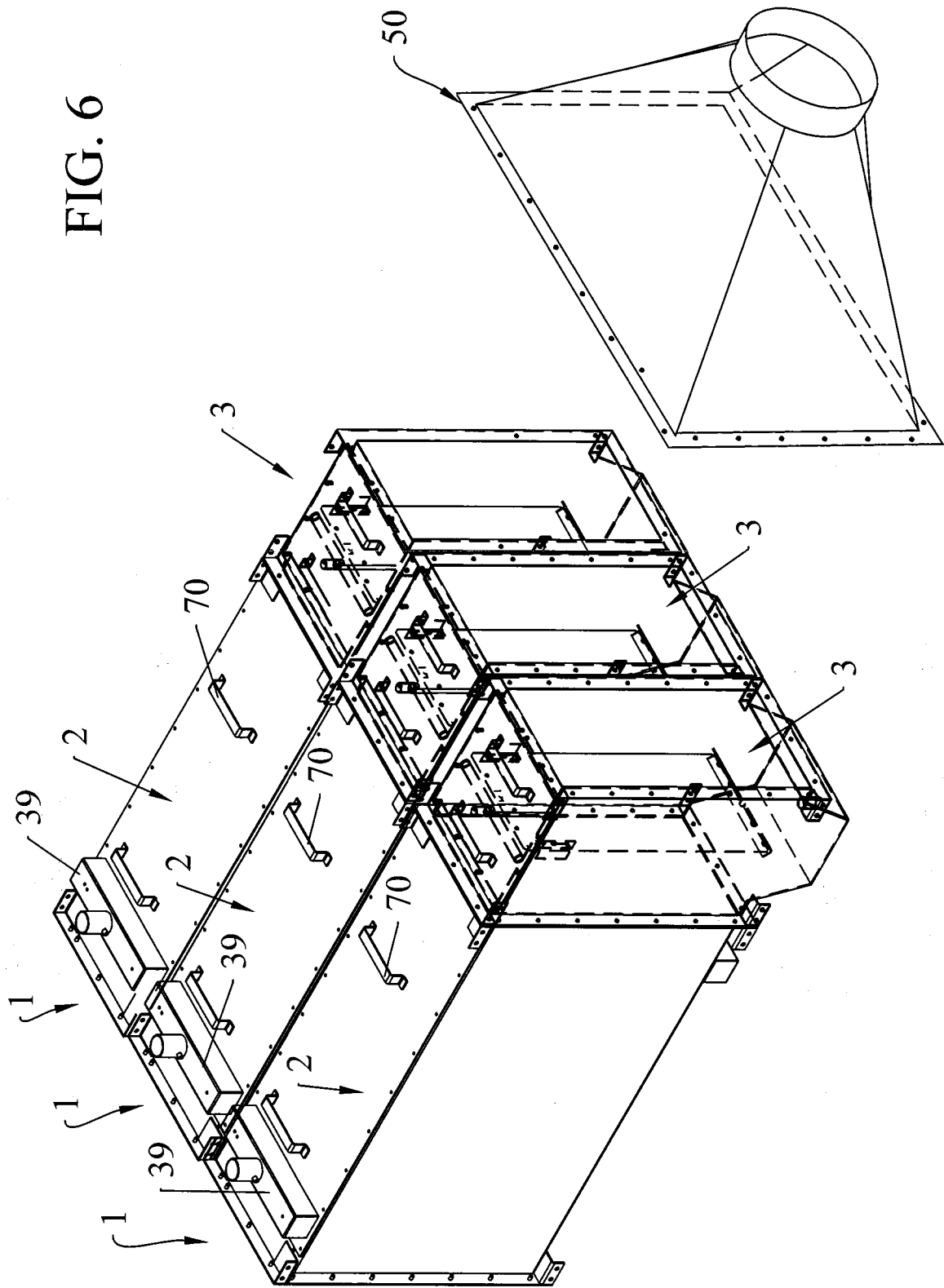


FIG.5

FIG. 6



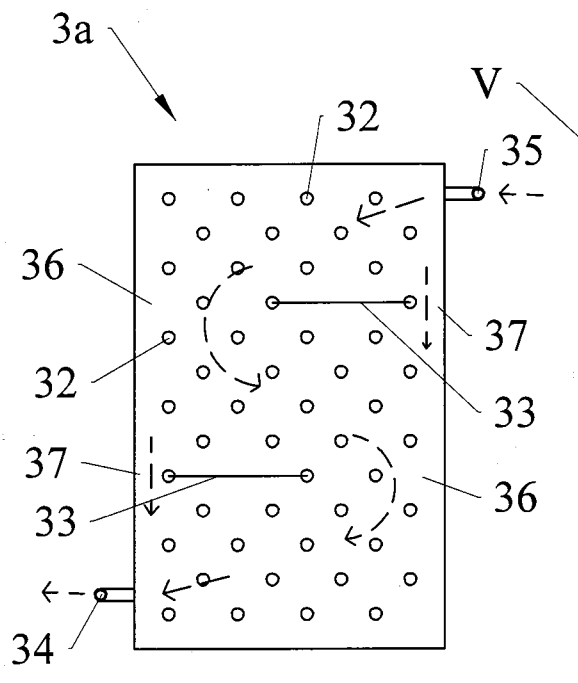


FIG. 7

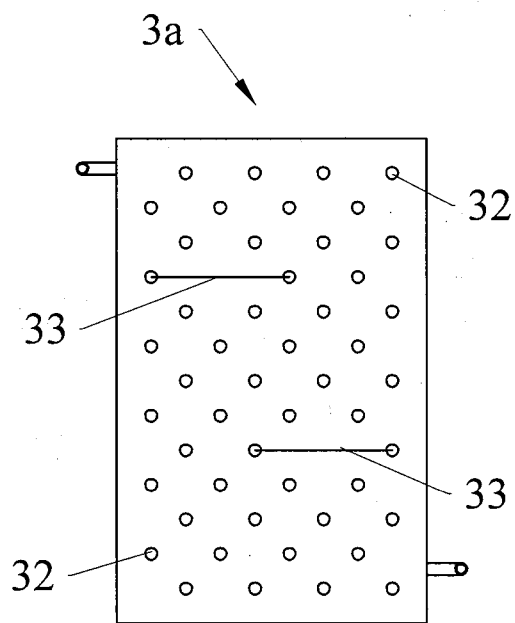


FIG. 8

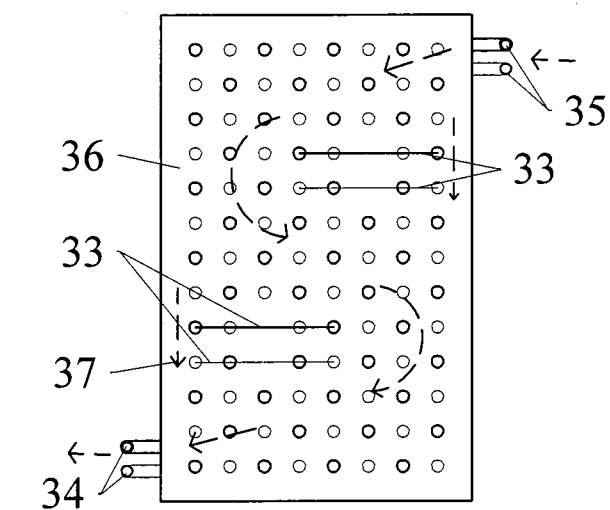


FIG. 10

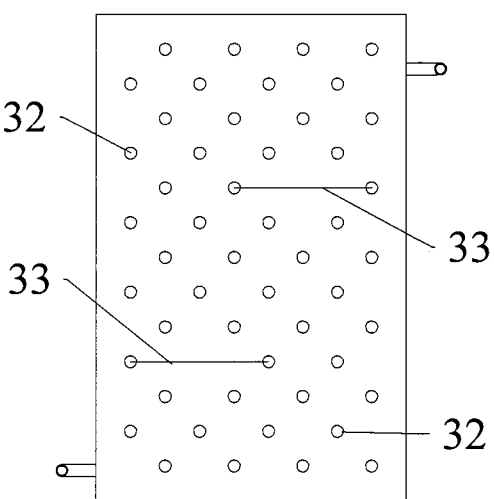


FIG. 9

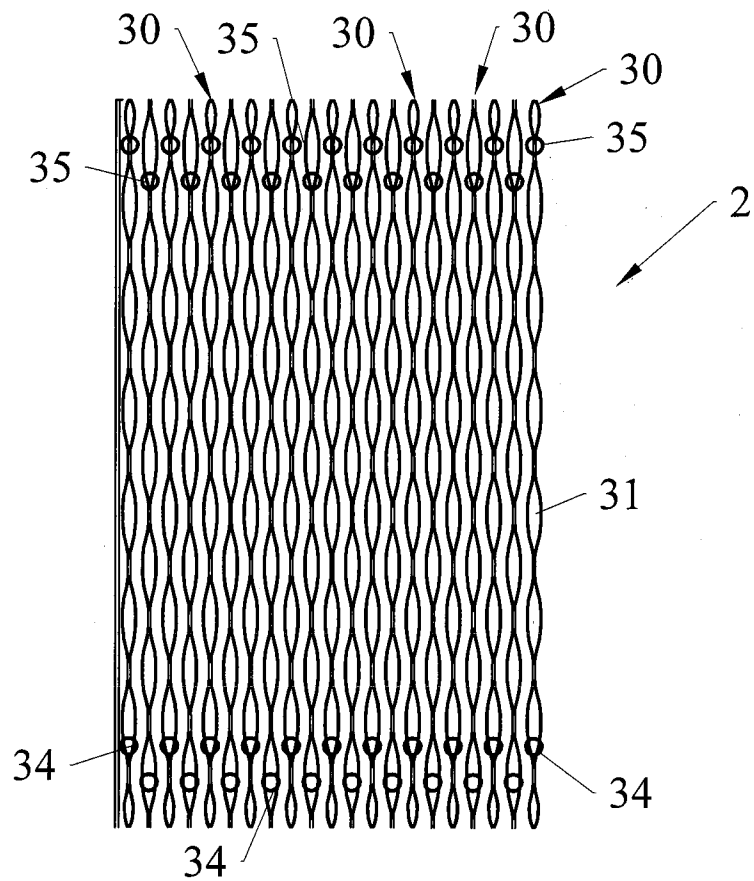


FIG. 11

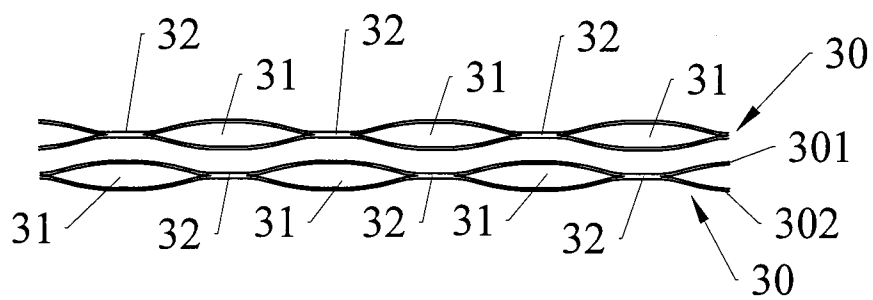


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. F23J15/04 F23J15/06 F24D12/02 B01D53/50 B01D53/78
F28F3/04 F28F3/14 F28D1/03 F28D9/00

ADD.

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)

F23J F24D B01D F28F F28D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	----- US 4 031 862 A (SMITH FRANK J) 28 June 1977 (1977-06-28) column 3, line 49 - column 8, line 25; figure 1 page 1, lines 3-29	1,5-7
A	----- US 6 357 396 B1 (STANSFIELD TOD A [US] ET AL) 19 March 2002 (2002-03-19) column 3, line 53 - column 8, line 50; figures 1-12 ----- -/--	1-4

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

25 November 2014

Date of mailing of the international search report

04/12/2014

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2014/062917

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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