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(54) HIGH MODULATION RANGE MIXER AND A PREMIX SYSTEM COMPRISING THEREOF

(57) A mixer of a premix system comprising an outer body (1) and an inner body (2) connected with the outer body (1) characterized in that the inner body (2) comprises gas injection holes (22) located in the the circumference of the inner body (2) through which the gas (G) enters inside the inner body (2), and the mixer further comprises a motor assembly (3) connected with the inner body (2) wherein the motor assembly (3) having control means to regulate the gas (G) and air (A) paths at the same time.

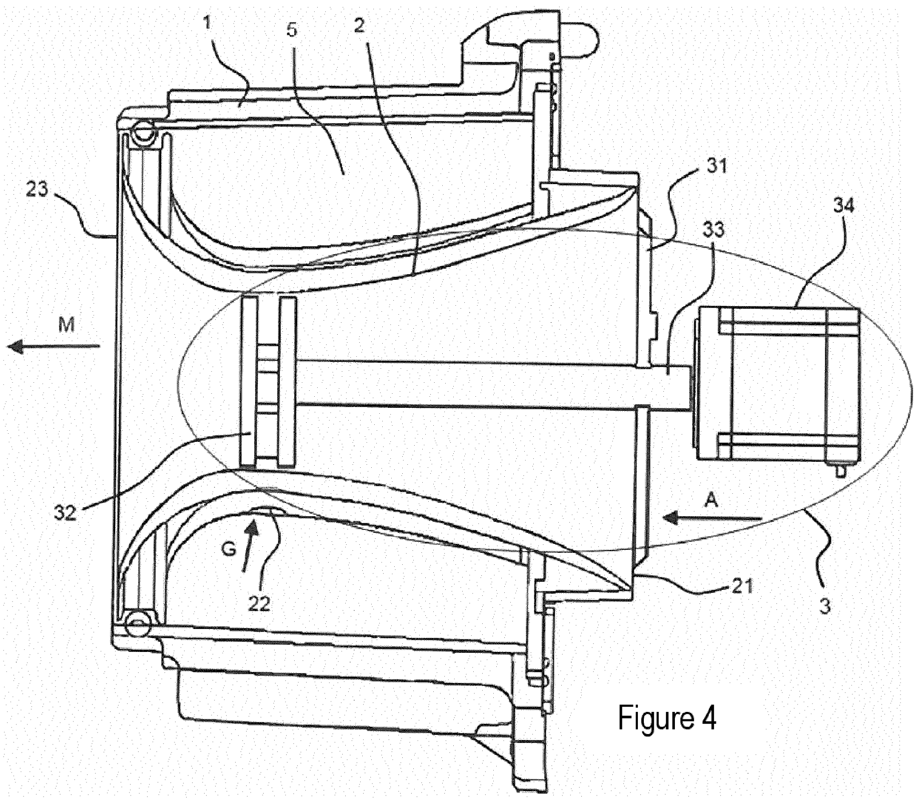

Figure 4

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Description

Technical Field

[0001] The present invention relates to premix systems for heating appliances especially for wall hung boilers.

[0002] The invention particularly relates to an air-gas mixer design that will allow a 1:1 pneumatic system to achieve 1:10 or more modulation range with minor changes. This system uses pneumatic gas valves without electrical modulation and has progressive modulation via small steps. These steps are provided by a motor assembly that controls at the same time both gas and air paths.

Background of the Invention

[0003] The markets for wall hung boilers are constantly demanding differentiating features from competition. Nowadays, main trend is related with reduction of minimum heat input of appliances. In order to achieve this aim, high modulation range is required.

[0004] Standard combi boilers generally have modulation ranges in the order of 1:5 using standard 1:1 premix technology, pneumatic gas valve connected to fan using mixer. This 1:1 modulation system is extremely robust and reliable but it is limited in modulation range to 1:5. With custom designed mixers, like venturis, modulation ranges up to 1:6 are achievable.

[0005] In European patent application EP1356234, an air-gas mixer device, to suppy a burner with forced ventilation, comprising an air-gas chamber which being supplied through a first duct and a second duct. The first duct has a cross-section which decreases in the direction of the flow of the air and gas mixture and is coaxial with the second duct. The device also comprises a tubular body and the first duct being disposed inside the tubular body. The second duct being defined by the tubular body and the first duct.

Brief Description of the Invention

[0006] The purpose of the present invention is to provide a mixer design that will allow a 1:1 pneumatic system to achieve 1:10 or more with minor changes. This system have progressive modulation via small steps which are provided by a motor assembly. The motor assembly controls both gas and air paths at the same time.

[0007] The main idea herein is to keep air/gas mixture proportional by opening/closing air passage and additional gas injection holes progressively.

[0008] The embodiment suggested in this description provides a higher modulation range in minimum heat input which allows long life components, higher efficiency and performance in water heating appliances.

[0009] Above said advantages according to the invention can be achieved through characteristics according to main claim 1, 13, and 14. Other useful embodiments of the invention are disclosed in the dependent claims.

[0010] The invention is a mixer of a premix system comprising an outer body and an inner body connected with the outer body characterized in that the inner body comprises gas injection holes located in the circumference of the inner body through which the gas enters interior of the inner body, and the mixer further comprises a motor assembly connected with the inner body wherein the motor assembly has control means to regulate the gas and air paths at the same time.

[0011] In an embodiment of the invention, the inner body has venturi shape and gas injection holes are located into venturi throat.

[0012] In a further embodiment, the motor assembly comprises a motor shaft located in the axis of the inner body, and a motor mounted in one end of the shaft outside the inner body. Preferably, the motor assembly comprises a stepper motor.

[0013] The motor assembly further comprises a gas restrictor in hollow disc form mounted on the shaft so as to face with the gas injection holes and constitute a concentric form with the inner body.

[0014] The motor assembly further comprises an air plate restrictor mounted between the motor and the air plate restrictor. And preferably, the air plate restrictor mounted on the shaft so as to located into air inlet of the inner body or integrated with the gas restrictor.

[0015] In an alternative embodiment of the invention, the air plate restrictor comprises at least 2 fan shaped plates one of which is fixed plate and other one is moving plate.

[0016] The mentioned moving plate is rotatable around the shaft and has a stopper to limit the rotation until the stopper hits the stopper of the next plate.

[0017] In further embodiment of the invention, the gas restrictor comprises a restrictor surface which covers a part of the lateral side of its hollow disc shape to close the gas injecting holes; an open area which covers the remaining part of the lateral side of its hollow disc shape to allow the air inflow; and a connection rod to attach the gas restrictor to the motor shaft.

[0018] In another embodiment of the invention, the inner body comprises permanently open gas injection holes which are equally spaced in angle α, and temporarily gas injecting holes which are equally spaced in angle β. Preferably, the value of β is higher than the value of α.

[0019] The invention is also a heating system for heating appliances comprising the mixer according to previous embodiments.

[0020] The invention is a method for regulating the air and gas proportion of a mixture in a mixer defined above the method comprises the following;

[0021] in off or minimum working mode, air inlet is partially closed with air plate restrictor and temporarily open gas injecting holes are closed using restrictor surface of the gas restrictor.

[0022] in need of more power, the motor rotates to open air inlet by opening moving plates one by one, and gas inlet is open by opening the temporarily open gas injection holes in a way that for each injection hole that is opened, a moving plate is also opened.

[0023] In an alternative embodiment of the method, each 50° rotation of the motor assembly opens one gas injection hole for entering gas, and at the same time opens corresponding moving plates for entering air.

[0024] In further embodiment of the method, the number of moving plates is the same as the number of temporarily open gas injecting holes.

Brief Description of the Drawings

[0025] The structural and characteristic features of the invention will be understood more clearly by means of figures given below and the detailed description with reference to the figures. Therefore, the assessment should be made by taking the said figures and detailed description into account.

Figure 1 is the side sectional view of the mixer.

Figure 2 is the perspective view of the air plate restrictor and gas restrictor.

Figure 3 is the perspective view of the gas restrictor.

Figure 4 is the side sectional view of the complete mixer.

Figure 5 is the cross sectional view of mixer with gas hole locations.

Figure 6 is the design of the air plate restrictor.

Figure 7 is the chart 1 showing possible modulation with the present invention.

Reference List

[0026]

1 outer body
2 inner body
- 21 air inlet
- 22 gas injection hole
- 22.1 gas injection hole
- 22.2 gas injection hole
- 22.3 gas injection hole
- 22.4 gas injection hole
- 22.5 gas injection hole
- 22.6 gas injection hole
- 23 mixture outlet
- 24 throat

3 motor assembly
- 31 air plate restrictor
- 31.1 moving plate
- 31.2 fixed plate
- 31.3 stopper

32 gas restrictor
32.1 restrictor surface
32.2 open area
32.3 connection rod
33 motor shaft
34 motor

4 inner body sealing
5 gas chamber
A air
G gas
M mixture
d1 air inlet diameter
d2 throat diameter
d3 mixture outlet diameter
d4 injection hole diameter

Detailed Description of the Invention

[0027] The present invention is a mixer (Figure 1) for modulation of the air/gas mixture (M) delivered to heating appliance constituted by an outer body (1) with an inner body (2) assembled. Both bodies (1, 2) are in a hollow cylindrical form having the same axis. There is inner body sealing (4) between these two components.

[0028] According to the Figure 1, the mixer has a gas chamber (5) confined by outer body (1) and inner body (2). The inner body (2) comprises an air inlet (21) in one opening of the body (2) for intake of the air (A); gas injection holes (22) in lateral area of the body (2) for connecting the gas chamber (5) to interior of the inner body (2); and a mixture outlet (23) in other opening of the body (2) for transferring the air (A) gas (G) mixture (M) from body (2) to fan impeller.

[0029] In the preferred embodiment of the invention, the inner body (2) has a venturi shape and the gas injection holes (22) are located in the throat (24) of the venturi inner body (2). The air (A) enters trough air inlet (21), gas (G) is injected through gas injection holes (22) and they form the air/gas mixture (M) which enters fan impeller through mixture outlet (23). In venturi throat (24), gas (G) is injected in N holes with diameter d4. The dimensions of air inlet diameter (d1), throat diameter (d2) and injection hole diameter (d4) are decided according to desired minimum and maximum heat inputs. Mixture outlet diameter (d3) depends on fan case inlet dimensions.

[0030] As shown in Figure 4, in the air inlet (21) of the inner body (2), a motor assembly (3), which controls at the same time both gas (G) and air (A) paths, is assembled. The motor assembly (3) comprises a motor (34) (represented by arrow in Figure 2) with a motor shaft (33). The shaft (33) extends from the motor (34) into the venturi throat (24). On one side of the shaft (33), a disc shaped air plate restrictor (31) is mounted. This restrictor (31) is mounted such that it can partially rotate with the shaft (33) which is explained in more detail later. Furthermore, a gas restrictor (32) in cylindrical form located on the shaft (33) between the motor (34) and the air plate restrictor (31).

[0031] Preferably, the air plate restrictor (31) is located on the air inlet (21) of the inner body (2) (see fig. 4). However, it is also possible to mount it on the shaft (33) such that it is integrated with the gas restrictor (32). In other words, they can have the same diameter and rotate together like a unique body in the same section of the inner body (2).

[0032] Said motor (34) can be of any type but it is preferably a stepper motor since stepper motors can be rotated to a specific angle in discrete steps and precise rotations are required for controlling the quantity of the air (A) and gas (G) inlet for this embodiment.

[0033] In Figure 4, the location of the gas restrictor (32) is shown from lateral side. It is located on one end of the shaft (33) such that it faces with the gas injection holes (22) and constitute a concentric form with the inner body (2).

[0034] A detailed drawing of the gas restrictor (32) is also given in Figure 3. The restrictor (32) has a restrictor surface (32.1) covers a part of the lateral side of its hollow disc shape so that the gas injecting holes (22) of the inner body (2) can be closed while the rotation of the gas restrictor (32). The remaining part of the lateral side of its hollow disc shape is designed as open area (32.2) to open the gas injecting holes (22). The gas restrictor (32) also comprises connection rods (32.3) to connect the motor shaft (33) shown in Figure 2.

[0035] The details of the air plate restrictor (31) is given in Figure 2 and Figure 6. The air plate restrictor (31) comprises fan shaped plates in 2 types: a fixed plate (31.2) and a desired number of moving plates (31.1). The moving plates (31.1) are rotatable around the shaft (33) and each of the moving plates (31.1) has a stopper (31.3) placed on one edge of the plate (31.1).

Sample embodiment of the mixer:

[0036] The inner body (2) of the mixer is designed with six holes (22.1, 22.2, 22.3, 22.4, 22.5, 22.6) for gas (G) injection.

The distribution of the holes (22.1, 22.2, 22.3, 22.4, 22.5, 22.6) throughout the circumference of the inner body (2) is described in Figure 5. Permanently open holes (22.1, 22.2, 22.3) are equally spaced in α and remaining temporarily open holes (22.4, 22.5, 22.6) are equally spaced in β. In the preferred embodiment of the invention, value of β is higher than the value of α.

[0037] For this configuration, Figure 6 shows the front view of the preferred configuration of the air plate restrictor (31). It has three moving plates (31.1) and one fixed plate (31.2). Each moving plate (31.1) has a stopper (31.3) so that they rotates until the stopper (31.3) hits the stopper (31.3) of the next plate (31.1). In each moving plate (31.1), the stopper (31.3) will be located more distant to the motor shaft (33) or center of the air plate restrictor (31) than the previous one so that they do not coincide in the maximum working mode of the appliance.

[0038] In this embodiment, each 50° rotation of the motor assembly (3) will open one gas injection hole (22) and corresponding area for entering air (A) as seen in Figure 5. This degree of angle was adjusted according to the number of moving blades (31.1) in this example which means that the each moving blade (31.1) rotation corresponds to 50° rotation of the motor assembly (3). This configuration enable us to calculate the value of β as 150°. This angle degree is also same with the angle corresponding to the circumference of the restrictor surface (32.1). With the stepwise rotation of the motor (34) in the clockwise direction, the gas injecting holes (22.4, 22.5, 22.6) are open respectively.

Working principle:

[0039] When appliance is off or working in minimum mode, air inlet (21) is partially closed with air plate restrictor (31) and temporarily open gas injecting holes (22.4, 22.5, 22.6) are also closed using restrictor surface (32.1) of the gas restrictor (32). By actuating the motor (34), the air inlet (21) and temporarily open gas injection holes (22.4, 22.5, 22.6) are opened progressively so that both gas (G) and air (A) paths can be modulated at the same time by the same assembly (3).

[0040] When more power is demanded, stepper motor (34) rotates to open air inlet (21) and all gas injecting holes (22), one by one. For each injection hole (22.4, 22.5, 22.6) that is opened, a moving plate (31.1) is also opened. The gas/air proportion in the mixture (M) is maintained constant by this way.

Calculation of the gas flow:

[0041] The gas (G) flow through the injection holes (22.1, 22.2, 22.3) is generically:

$$Q_{Gas} = n_{Gas\ Holes} \times A \times C_D \times \sqrt{\frac{\Delta p}{d}} \quad \Leftrightarrow \quad Q_{Gas} = 3 \times A \times C_D \times \sqrt{\frac{\Delta p}{d}}$$

where A is the area of each hole (22.1, 22.2, 22.3), p is pressure in gas chamber, d relative density of gas, and C_D is the discharge coefficient.

[0042] By opening remaining 3 injection holes (22.4, 22.5, 22.6), new gas (G) flow will be the double:

$$\frac{Q_{Gas6inj}}{Q_{Gas3inj}} = \frac{6 \times A \times C_D \times \sqrt{\frac{\Delta p}{d}}}{3 \times A \times C_D \times \sqrt{\frac{\Delta p}{d}}} = 2$$

[0043] With air (A) flow, same will happen. By opening plates (31.1, 31.2, 31.3) through rotation, pressure drop decreases and for same fan speed, air (A) flow increases.

[0044] With the above configuration, a modulation of 1:10 is achieved in 3 small steps (1 step per moving blade (31.1)).

Chart 1:

[0045] It was chosen an overlap of 1kW per modulation band with above described configuration in Figure 7.

[0046] The transition steps don't require modulation from maximum to minimum like in existing applications. The number of injection holes (22) and plates (31.1) can increase in order to decrease the step size in each transition.

[0047] The modulation range can be increased by changing location of injection holes (22) together with venturi (2) size and plate (31.1) dimensions. The diameters of injection holes (22.1, 22.2, 22.3) are not necessarily equal to diameters of remaining 3 injection holes (22.4, 22.5, 22.6). More injection holes (22) with more moving plates (31.1) provides even smaller steps.

Alternative embodiments:

[0048]

- Same principle can be applied with axial displacement instead of rotation. In this embodiment, there will be two disk shape plates: Plate I is located on the injection holes (22) and the Plate II is mounted on the air inlet (21) of the inner body (2). Plate I should have a new design and position of the gas injection holes (22) should be different. Plate II can move axially on the motor shaft (33) from air inlet (21) to Plate I direction. By this back and forth movement of the Plate II, the air inlet (21) of the system become restricted or extended according to the desired power.

- Same principle can be used in standard mixer (non venturi shape). Although it is easier to apply this concept to a venturi because of its natural shape, it is also possible to do this with a standard mixer if the correct modifications are provided.

- Same principle can be applied with 2 kind of air and gas inlets: one fixed for air and gas plus the second one with variable area for air and variable number of injection holes (still using one motor). Modulation range will be highly increased.

Claims

1. A mixer of a premix system comprising an outer body (1) and an inner body (2) connected with the outer body (1) **characterized in that**
the inner body (2) comprises gas injection holes (22) located in the circumference of the inner body (2) through which the gas (G) enters interior of the inner body (2), and
the mixer further comprises a motor assembly (3) connected with the inner body (2) wherein the motor assembly (3) has control means to regulate the gas (G) and air (A) paths at the same time.

2. The mixer according to claim 1 wherein the inner body (2) has venturi shape and gas injection holes (22) are located into venturi throat (24).

3. The mixer according to claim 1 or 2 wherein the motor assembly (3) comprises
a motor shaft (33) located in the axis of the inner body (2), and
a motor (34) mounted in one end of the shaft (33) outside the inner body (2).

4. The mixer according to any of the claims 1 to 3 wherein the motor assembly (3) comprises a stepper motor.

5. The mixer according to any of the claims 1 to 4 wherein the motor assembly (3) further comprises a gas restrictor (32) in hollow disc form mounted on the shaft (33) so as to face with the gas injection holes (22) and constitute a concentric form with the inner body (2).

6. The mixer according to any of the claims 1 to 5 wherein the motor assembly (3) further comprises an air plate restrictor (31) mounted between the motor (34) and the gas restrictor (32).

7. The mixer according to any of the claims 1 to 6 wherein the air plate restrictor (31) mounted on the shaft (33) so as to located into air inlet (21) or integrated with the gas restrictor (32).

8. The mixer according to any of the claims 1 to 7 wherein the air plate restrictor (31) comprises at least 2 fan shaped plates one of which is fixed plate (31.2) and other one is moving plate (31.1).

9. The mixer according to claim 8 wherein the moving plate (31.1) is rotatable around the shaft (33) and has a stopper (31.3) to limit the rotation until the stopper (31.3) hits the stopper (31.3) of the next plate (31.1).

10. The mixer according to any of the claims 5 to 9 wherein the gas restrictor (32) comprises
a restrictor surface (32.1) which covers a part of the lateral side of its hollow disc shape to close the gas injecting

holes (22),
an open area (32.2) which covers the remaining part of the lateral side of its hollow disc shape to allow the air (A) inflow, and
a connection rod (32.3) to attach the gas restrictor (32) to the motor shaft (33).

11. The mixer according to any of the claims 1 to 10 wherein the inner body (2) comprises permanently open gas injection holes (22.1, 22.2, 22.3) which are equally spaced in angle α, and temporarily gas injecting holes (22.4, 22.5, 22.6) which are equally spaced in angle β.

12. The mixer according to claim 11 wherein the value of β is higher than the value of α.

13. A heating system for heating appliances comprising the mixer according to the claims 1 to 12.

14. A method for regulating the air (A) and gas (G) proportion of a mixture (M) in a mixer according to the claims 1 to 12 **characterized in that** the method comprises the following:

in off or minimum working mode, air inlet (21) is partially closed with air plate restrictor (31) and temporarily open gas injecting holes (22.4, 22.5, 22.6) are closed using restrictor surface (32.1) of the gas restrictor (32),
in need of more power, the motor (34) rotates to open air inlet (21) by opening moving plates (31.1) one by one, and gas (G) inlet is open by opening the temporarily open gas injection holes (22.4, 22.5, 22.6) in a way that for each injection hole (22.4, 22.5, 22.6) that is opened, a moving plate (31.1) is also opened.

15. A method according to claim 14 wherein each 50° rotation of the motor assembly (3) opens one gas injection hole (22) for entering gas (G), and at the same time opens corresponding moving plates (31.1) for entering air (A).

16. A method according to claim 14 or 15 wherein the number of moving plates (31.1) is the same as the number of temporarily open gas injecting holes (22.4, 22.5, 22.6).

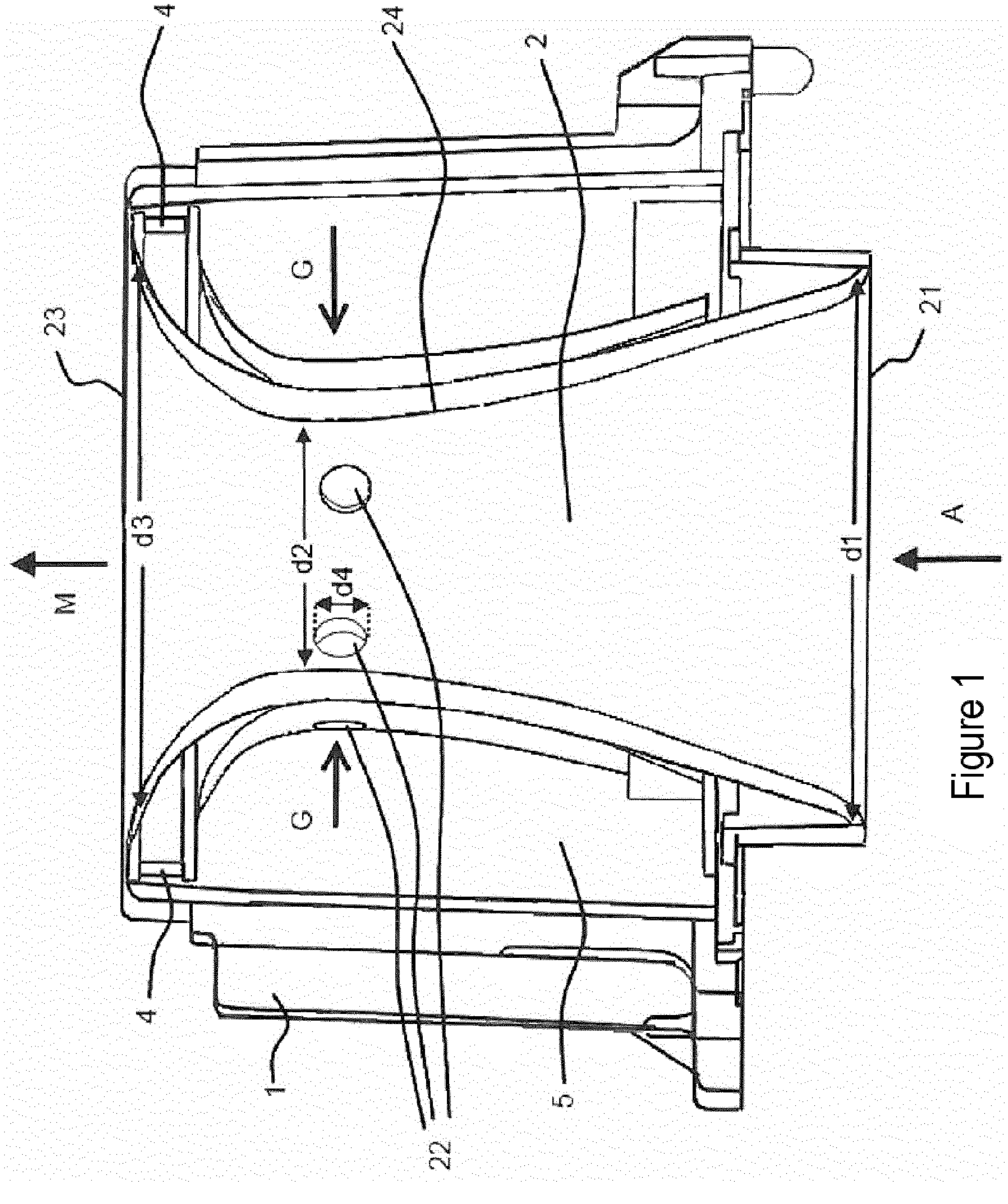

Figure 1

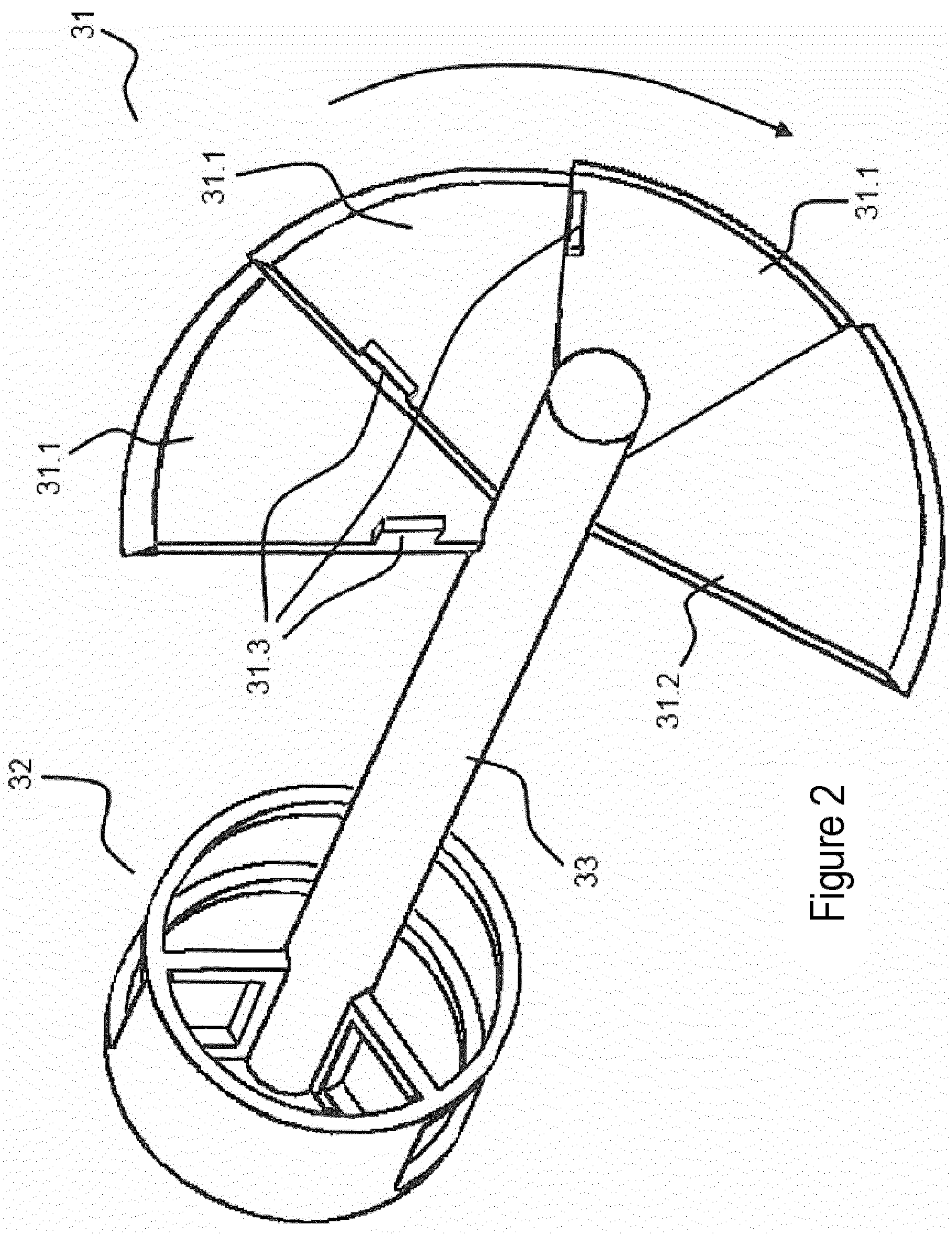

Figure 2

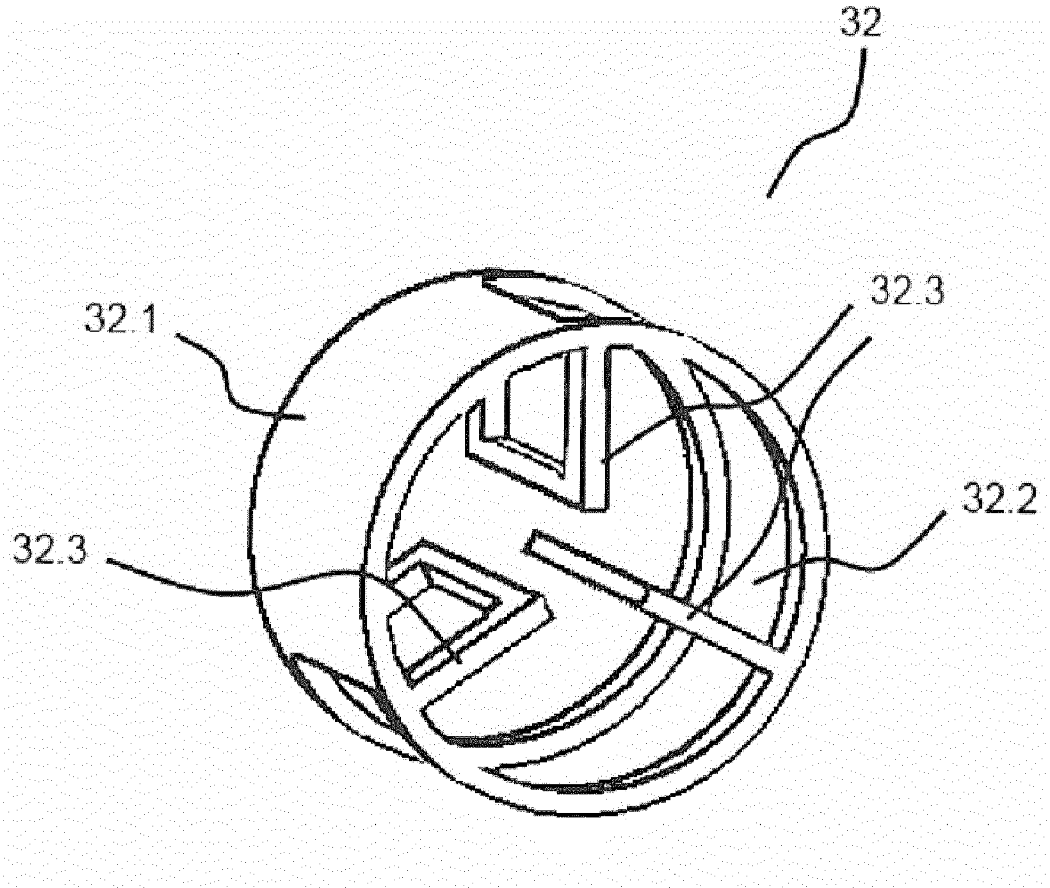

Figure 3

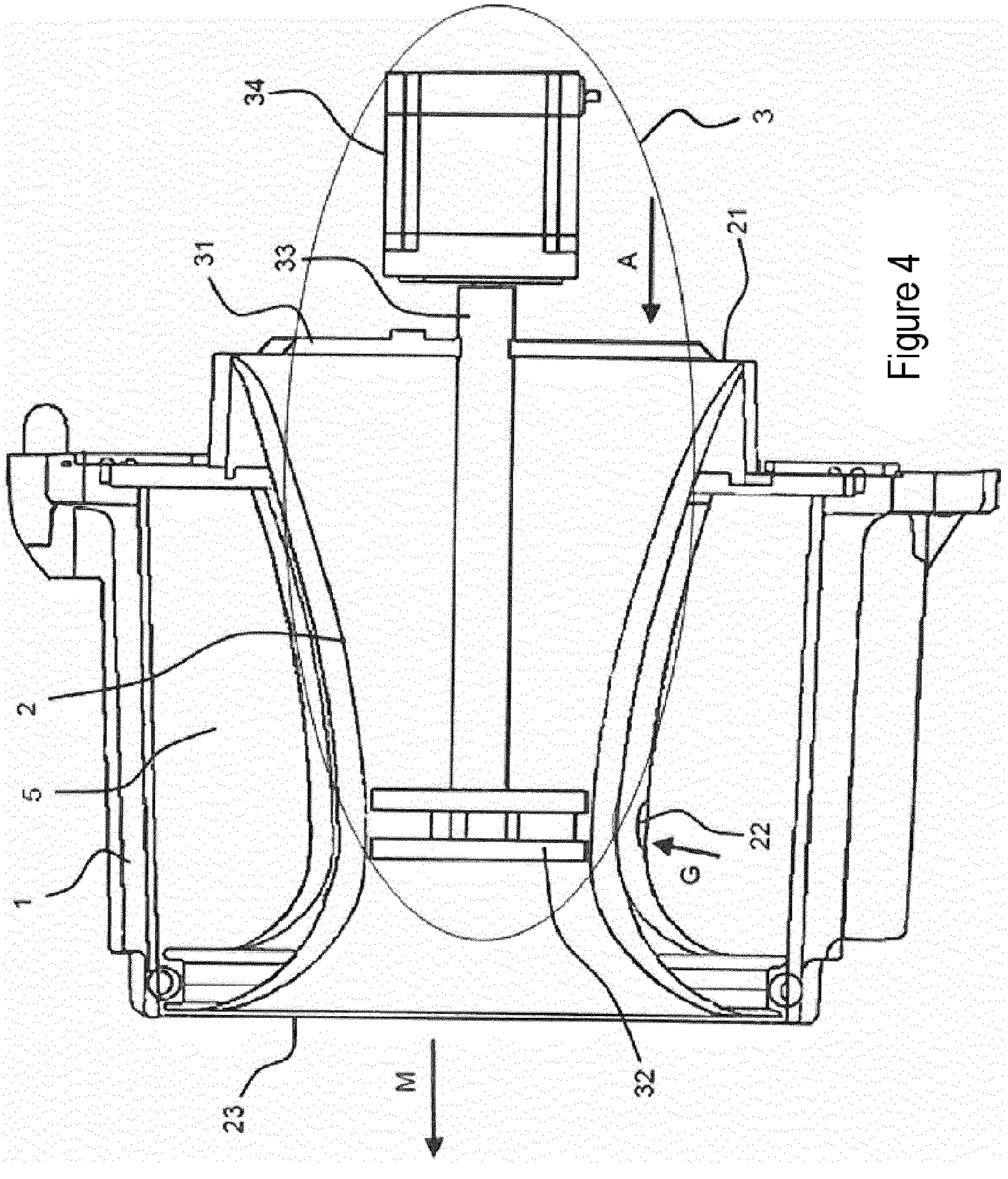

Figure 4

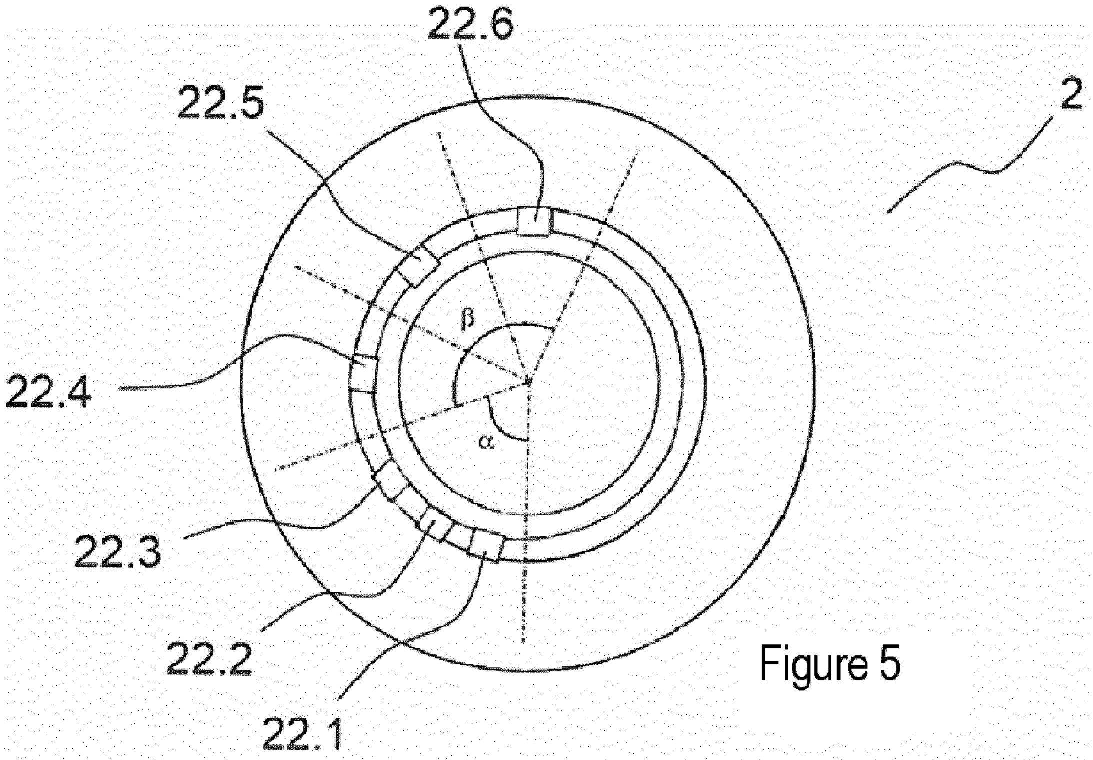

Figure 5

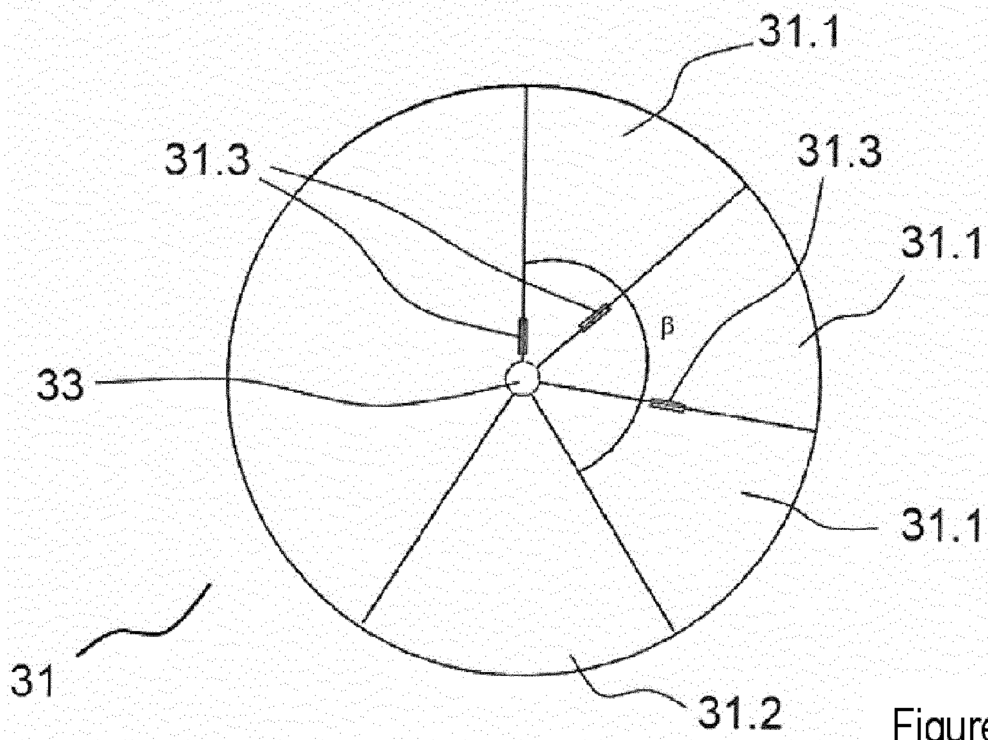

Figure 6

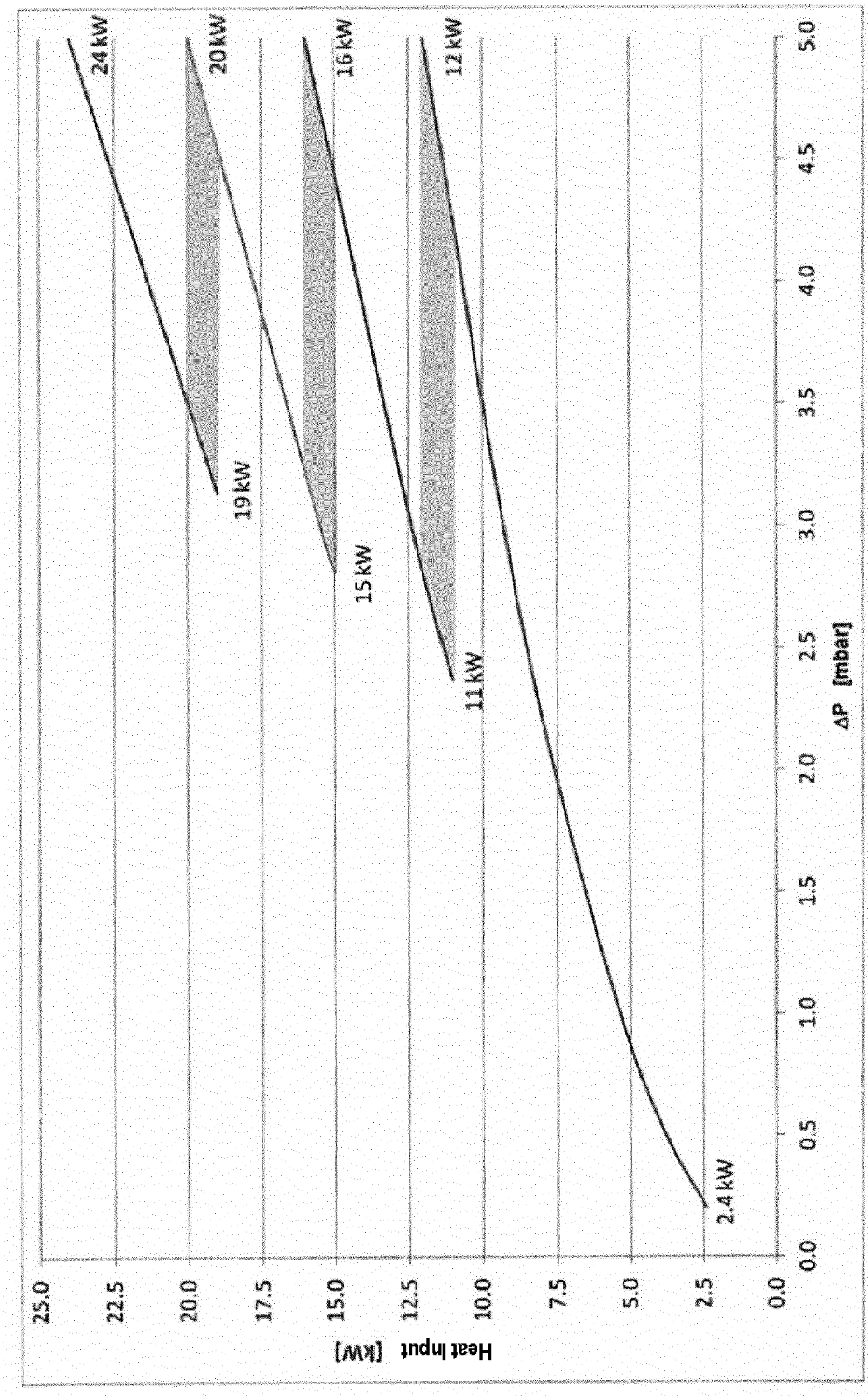
Heat Input [kW]
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
ΔP [mbar]
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
24 kW
20 kW
16 kW
12 kW
19 kW
15 kW
11 kW
2.4 kW

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 15 18 6392

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TECHNICAL FIELDS SEARCHED (IPC)

F23D
F23L

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	1 February 2016	Munteh, Louis

CATEGORY OF CITED DOCUMENTS

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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