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

(11) EP 3 819 541 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.05.2021 Bulletin 2021/19

(51) Int Cl.:
F23D 1/00 *(2006.01)*

(21) Application number: **20206296.4**

(22) Date of filing: **06.11.2020**

(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 MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **06.11.2019 IT 201900020506**

(71) Applicant: **AC Boilers S.p.A.**
20122 Milano (IT)

(72) Inventors:
- **DADDUZIO, Ruggiero**
  21013 GALLARATE (VA) (IT)
- **PANEBIANCO, Vincenzo**
  21013 GALLARATE (VA) (IT)
- **GIANI, Thomas**
  21013 GALLARATE (VA) (IT)
- **TORRESI, Marco**
  21013 GALLARATE (VA) (IT)
- **SAPONARO, Alessandro**
  21013 GALLARATE (VA) (IT)
- **ROGORA, Massimo**
  21013 GALLARATE (VA) (IT)
- **CAIVANO, Giuseppe**
  21013 GALLARATE (VA) (IT)
- **MAININI, Giovanni**
  21013 GALLARATE (VA) (IT)

(74) Representative: **Andreotti, Erika et al**
Studio Torta S.p.A.
Via Viotti, 9
10121 Torino (IT)

(54) **BURNER ASSEMBLY, METHOD FOR OPERATING SAID BURNER ASSEMBLY AND PLANT COMPRISING SAID BURNER ASSEMBLY**

(57) A burner assembly for burning pulverised fuel including: a primary duct (2) extending along a longitudinal axis (A) wherein a flow of air and pulverised fuel flows in one direction (D); the primary duct (2) being provided with an inlet (7) and an outlet (8); and a homogeniser device (26) housed inside the primary duct (2) and comprising a hollow body (37) substantially centred on the longitudinal axis (A) and provided with an outer surface (38) and an inner surface (39); at least one swirler (40; 41) arranged on the outer surface (38) and/or on the inner surface (39) so as to create a gradient between the tangential components of the velocities of the air and fuel flow flowing outside the hollow body (37) and inside the hollow body (37).

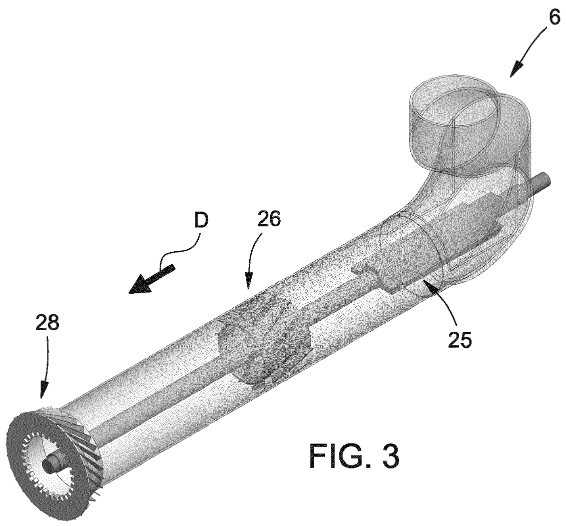

FIG. 3

EP 3 819 541 A1

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102019000020506 filed on 06/11/2019.

TECHNICAL FIELD

[0002] The present invention relates to a burner assembly and a method for operating said burner assembly. In particular, the present invention relates to a burner assembly configured to burn pulverised fuel such as, for example, pulverised coal or pulverised biomass.

[0003] The present invention also relates to a thermal steam generation plant comprising said burner assembly.

BACKGROUND ART

[0004] In the solid fuel combustion sector, there is an ever-increasing need to optimize combustion processes by reducing the unburnt fuel and the excess air. However, this optimization must be carried out by always keeping the harmful emission levels (such as, for example, CO and NOx) below the legal limits.

[0005] Some solutions are described in documents WO2015/037589, US2010/123027 and US4924784. In particular, document WO2015/037589 illustrates the features of the preamble of claim 1.

DISCLOSURE OF INVENTION

[0006] Therefore, one object of the present invention is to provide a burner assembly, which is capable of optimizing the combustion of solid fuels and, at the same time, of complying with the legal limits in terms of emissions.

[0007] In accordance with these objects, the present invention relates to a burner assembly for burning pulverised fuel, comprising:

- a primary duct extending along a longitudinal axis wherein a flow of air and pulverised fuel flows in one direction; the primary duct being provided with an inlet and an outlet;
- a homogeniser device housed inside the primary duct and comprising a hollow body substantially centred on the longitudinal axis and provided with an outer surface and an inner surface; at least one swirler arranged on the outer surface and/or on the inner surface so as to create a gradient between the tangential components of the velocities of the air and fuel flows flowing outside the hollow body and inside the hollow body.

[0008] A further object of the present invention is to provide a method for operating a burner assembly as claimed in claim 15.

[0009] Still a further object of the present invention is to provide a steam generation plant as claimed in claim 16.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Further features and advantages of the present invention will be apparent from the following description of a non-limiting embodiment thereof, with reference to the figures of the accompanying drawings, wherein:

- Figure 1 is a schematic sectional view, with parts removed for clarity, of the burner assembly according to the present invention;
- Figure 2 is a schematic perspective view, with parts in section and parts removed for clarity, of a burner assembly according to the present invention;
- Figure 3 is a schematic perspective view, with parts in section and parts removed for clarity, of a burner assembly according to the present invention in accordance with a first embodiment;
- Figure 4 is a schematic perspective view, with parts in section and parts removed for clarity, of a burner assembly according to the present invention in accordance with a second embodiment;
- Figure 5 is a schematic perspective view of a first detail of Figure 1;
- Figure 6 is a schematic perspective view of a second detail of Figure 1;
- Figure 7 is a schematic sectional view of a third detail of Figure 1;
- Figure 8 is a schematic perspective view of the third detail of Figure 1;
- Figure 9 is a schematic representation of the burner assembly according to the present invention including a velocity diagram.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] In Figure 1, reference number 1 indicates a burner assembly according to the present invention.

[0012] In particular, the burner assembly 1 is configured to burn pulverised solid fuel and is part of a thermal plant for generating steam.

[0013] In the non-limiting example described and illustrated herein, the burner assembly 1 is configured to burn pulverised coal. Embodiments provide that the burner assembly 1 is configured to burn biomass (for example pellets, pits of various kinds and types, shells of various kinds and types, etc.), or to burn secondary solid fuel (CSS), etc.

[0014] In principle, the burner assembly 1 can burn any solid fuel that can be adequately pulverised.

[0015] The burner assembly 1 comprises a primary duct 2, a secondary duct 3, a tertiary duct 5 and an inlet assembly 6.

[0016] The primary duct 2 extends along a longitudinal axis A and is provided with an inlet 7 connected to the inlet assembly 6, and an outlet 8 facing the combustion chamber of the thermal plant (not shown for simplicity).

[0017] The outlet 8 and the inlet 7 are preferably axial.

[0018] The secondary duct 3 extends around at least a portion of the primary duct 2 and is coaxial with the primary duct 2. In particular, the secondary duct 3 extends around an outlet portion 9 of the primary duct 2, which includes the outlet 8.

[0019] The tertiary duct 5 extends around the secondary duct 3 and is coaxial with the primary duct 2 and the secondary duct 3.

[0020] In use, a mixture of air and pulverised fuel flows in the primary duct 2 in a direction D coming from the inlet assembly 6. The inlet assembly 6 receives a mixture of air and pulverised fuel from a dryer mill (not shown for simplicity).

[0021] Air, normally defined in technical jargon as "secondary air", flows in the secondary duct 3, whereas air, normally defined in technical jargon as "tertiary air", flows in the tertiary duct 5.

[0022] With reference to Figures 1 and 2, the inlet assembly 6 is provided with an elbow duct 10 and at least one inclined portion 13.

[0023] The first elbow duct 10 is coupled to the inlet 7 of the primary duct 2.

[0024] The inclined portion 13 is arranged upstream of the first elbow duct 10 along the flow direction of the flow in the inlet assembly 6.

[0025] The first elbow duct 10 is provided with a back wall 11. The back wall 11 is preferably transverse to the longitudinal axis A. In particular, the back wall 11 forms with the longitudinal axis A an angle β facing the inlet 7. Preferably, the angle β is greater than 90°, more preferably greater than 120°.

[0026] In the non-limiting example described and illustrated herein, the first elbow duct 10 defines a curve of approximately 90°.

[0027] Preferably, the inclined portion 13 is directly coupled to the first elbow duct 10.

[0028] One embodiment, not shown, provides that an intermediate duct, preferably substantially rectilinear, is arranged between the first elbow duct 10 and the inclined portion 13.

[0029] The inclined portion 13 is configured to deflect the flow of air and fuel in such a way that the flow itself has a velocity component opposite to direction D.

[0030] In other words, the flow of air and pulverised fuel flowing in the inclined portion 13 is deflected in a direction substantially opposite to direction D.

[0031] The inclined portion 13 is defined by a first wall 16 provided with a first outer lateral surface 17 facing the primary duct 2, and a second wall 18 provided with a second outer lateral surface 19 not facing the primary duct 2.

[0032] The inclined portion 13 is configured in such a way that at least the first wall 16 helps to deflect the flow of air and pulverised fuel. In particular, the first wall 16 is inclined with respect to the longitudinal axis A.

[0033] In particular, the first wall 16 is inclined so as to form with the longitudinal axis A an angle α facing the elbow duct 10, preferably less than 60°.

[0034] In the non-limiting example described and illustrated herein, the second wall 18 also helps to deflect the flow of air and pulverised fuel. In particular, the second wall 18 is also inclined with respect to the longitudinal axis A.

[0035] Preferably, the first wall 16 and the second wall 18 have the same inclination with respect to the longitudinal axis A. One embodiment, not shown, provides that the second wall 18 has a different inclination from that of the first wall 16 with respect to the longitudinal axis A.

[0036] Basically, in the non-limiting example described and illustrated herein, the inclined portion 13 substantially defines a further elbow duct of the inlet assembly 6.

[0037] Preferably, the inclined portion 13 has a constant passage section. Therefore, the axis of extension B of the inclined portion 13 forms with the longitudinal axis A an angle facing the primary duct 2 substantially identical to the angle α.

[0038] The inclined portion 13 is arranged between a coupling portion 20 of the elbow duct 10 and an inlet portion 22 of the inlet assembly 6, connected to the dryer mill (not shown for simplicity).

[0039] The coupling portion 20 and the inlet portion 22 are preferably configured so as to extend substantially along respective axes C, D orthogonal to the longitudinal axis A.

[0040] Preferably, the distance between the axes C and D is equal to the diameter of the inclined portion 13.

[0041] Preferably, the coupling portion 20 and the inlet portion 22 also have a constant passage section.

[0042] The burner assembly 1 also includes a baffle element 25, a swirler device 27, a stabiliser device 28 and a lance 30 (optional), a part of which extends inside the primary duct 2 along the longitudinal axis A.

[0043] In the non-limiting example, the lance 30 is an oil lance. One embodiment, not shown, provides that the lance 30 is fuelled by gas or diesel.

[0044] In detail, the lance 30 is housed in a lance holder tube 31 extending along the longitudinal axis A.

[0045] With reference to Figure 1 and Figure 2, the baffle element 25 is housed, at least in part, in the elbow duct 10 of the inlet assembly 6.

[0046] In particular, the baffle element 25 is housed in a coupling portion 23 of the elbow duct 10, which is coupled, in use, to the inlet 7 of the primary duct 2.

[0047] The baffle element 25 is provided with at least one axial portion 32.

[0048] In the non-limiting example described herein, the axial portion 32 includes two axial fins 34 (as better visible in Figure 2), which extend on opposite sides of the longitudinal axis A.

[0049] Preferably, the axial fins 34 extend in the same plane passing through the longitudinal axis A.

[0050] Preferably, the axial fins 34 extend in a plane passing through the longitudinal axis A and orthogonal to the axis C of extension of the coupling portion 20 of the elbow duct 10.

[0051] Preferably, the axial fins 34 are substantially identical.

[0052] Preferably, the baffle element 25 is substantially in contact with the back wall 11. In the non-limiting example described and illustrated herein, the baffle element 25 is arranged in such a way that the axial fins 34 are also substantially in contact with the back wall 10.

[0053] Preferably, the axial length of the axial fins 34 is determined as a function of the diameter of the inclined portion 13.

[0054] Preferably, the baffle element 25 is provided with a seat 35 extending along the axis A and configured to house at least a portion of the lance holder tube 31.

[0055] In use, the baffle 25 deflects the flow entering the primary duct 2 and coming from the inlet assembly 6.

[0056] The swirler device 27 is housed inside the primary duct 2 and substantially centred on the longitudinal axis A.

[0057] The swirler device 27 is configured to rotate the inlet flow so as to convey the pulverised fuel towards the inner wall of the primary duct 2.

[0058] With reference to Figure 5, the swirler device 27 comprises a main body 47, which extends along the longitudinal axis A, and a plurality of blades 49, which are fixed to an outer surface 48 of the main body 47 and are evenly distributed around the longitudinal axis A.

[0059] The main body 47 is preferably provided with a substantially central, axial cavity 50 designed to house the lance holder tube 31.

[0060] The outer surface 48 of the main body 47 comprises a first truncated-cone portion 51, a second truncated-cone portion 52, and a cylindrical portion 53 arranged between the first truncated-cone portion 51 and the second truncated-cone portion 52. The first truncated-cone portion 51 faces the inlet 7 of the primary duct 2, whereas the second truncated-cone portion 52 faces the outlet 8 of the primary duct 2. The first truncated-cone portion 51 has a radius increasing along the direction D, whereas the second truncated-cone portion 52 has a radius decreasing along the direction D.

[0061] Preferably, the second truncated-cone portion 52 has an inclination with respect to the axial direction at least 3 times greater than the inclination with respect to the axial direction of the first truncated-cone portion 51.

[0062] The plurality of blades 49 is fixed to the cylindrical portion 53.

[0063] In accordance with an embodiment shown in Figure 3, the swirler device 27 is replaced by a homogeniser device 26 housed inside the primary duct 2 downstream of the baffle 25 along the direction D.

[0064] With reference to Figure 6, the homogeniser device 26 comprises a hollow body 37, which is substantially centred on the longitudinal axis A and provided with an outer surface 38 and an inner surface 39. The flow of air and pulverised fuel flows inside and outside the hollow body 37.

[0065] The homogeniser device 26 is provided with at least one swirler arranged on the outer surface 38 and/or on the inner surface 39 so as to create a gradient between the tangential components of the velocities of the flow of air and fuel flowing outside the hollow body 37 and flowing inside the hollow body 37.

[0066] Preferably, the tangential component of the velocity of the flow of air and fuel flowing outside the hollow body 37 is opposite to the tangential component of the velocity of the flow of air and fuel flowing inside the hollow body 37.

[0067] In the non-limiting example described and illustrated herein, the homogeniser device 26 comprises an outer swirler 40 coupled to the outer surface 38 of the hollow body 37 and an inner swirler 41 coupled to the inner surface 39 of the hollow body 37.

[0068] Preferably, the homogeniser device 26 is fixed to the lance holder tube 31.

[0069] Preferably, the hollow body 37 is cylindrical.

[0070] In detail, the outer swirler 40 is configured to give the flow a first tangential velocity component and the inner swirler 41 is configured to give the flow a second tangential velocity component different from the first tangential velocity component.

[0071] Preferably, the first tangential velocity component is opposite to the second tangential velocity component.

[0072] In the non-limiting example described and illustrated herein, the outer swirler 40 is configured to rotate the flow in direction VI. Whereas, the inner swirler 41 is configured to rotate the flow in direction V2 opposite to direction VI.

[0073] The outer swirler 40 comprises a plurality of outer fins 43, which protrude from the outer surface 38 of the hollow body 37.

[0074] Preferably, the outer fins 43 extend orthogonally from the outer surface 38 and are arranged parallel and equidistant from one another along the outer surface 38.

[0075] Preferably, the outer fins 43 are arranged along a direction transverse to the longitudinal axis A.

[0076] Similarly, the inner swirler 41 comprises a plurality of inner fins 45, which protrude from the inner surface 39 of the hollow body 37.

[0077] Preferably, the inner fins 45 extend orthogonally from the inner surface 39 and are arranged parallel and equidistant from one another along the inner surface 39.

[0078] Preferably, the inner fins 45 are arranged along a direction transverse to the longitudinal axis A.

[0079] Preferably, the plurality of inner fins extends inside the hollow body 37 up to the lance holder tube 31. At least one of the inner fins 45 has one end coupled to the lance holder tube 31 and one end coupled to the inner surface 39 in order to fix the homogeniser device 26 to the lance holder tube 31.

[0080] One embodiment, not shown, provides that the inner ends of the inner fins 45 can be coupled to a tubular portion which, in use, will be fitted on the lance holder tube 31.

[0081] In accordance with an embodiment shown in Figure 4, the burner assembly 1 includes the homogeniser device 26 and the swirler device 27, both housed inside the primary duct 2.

[0082] Preferably, the homogeniser device 26 is housed downstream of the baffle element 25 and upstream of the swirler device 27 along direction D.

[0083] With reference to Figures 2, 7 and 8, the stabiliser device 28 is arranged at the outlet 8 of the primary duct 2.

[0084] The stabiliser device 28 comprises an annular element 55 centred on the longitudinal axis A and provided with an inner surface 56 and an outer surface 57, and a plurality of cooling fins 59 coupled to the outer surface 57 and facing the secondary duct 3.

[0085] The cooling fins 59 are substantially evenly distributed around the longitudinal axis A and arranged equidistant.

[0086] Preferably, the cooling fins 59 are arranged transverse to the longitudinal axis A.

[0087] More preferably, the cooling fins 59 are configured to deflect the secondary air flow without changing its tangential component.

[0088] The annular element 55 is provided with an inlet 61 coupled to the primary duct 2, and an outlet 62 facing the combustion chamber (not shown).

[0089] The inner surface 56 of the annular element is substantially cylindrical and preferably has a diameter d2 substantially identical to the diameter d1 of the primary duct 2.

[0090] Preferably, the stabiliser device 28 also comprises a toothed ring 65 arranged along the inner surface 56 near the outlet 62.

[0091] The toothed ring 65 can be arranged flush with the outlet 65 or in a slightly rearward position (as shown in the examples of Figures 1, 7 and 8).

[0092] The toothed ring 65 is provided with a plurality of radially arranged and evenly distributed teeth 66.

[0093] The outer surface 57 of the annular element 55 comprises at least a first truncated-cone portion 68 and a second truncated-cone portion 69, which are preferably contiguous.

[0094] Preferably, the outer surface 57 also comprises a cylindrical portion 70 coupled to the second truncated-cone portion 69. In other words, the second truncated-cone portion 69 is arranged between the first truncated-cone portion 68 and the cylindrical portion 70. The cylindrical portion 70 is near the inlet 61 of the annular element 55, whereas the first truncated-cone portion 68 is near the outlet 62 of the annular element 55.

[0095] The inclination $\delta 1$ of the first truncated-cone portion 68 and the inclination $\delta 2$ of the second truncated-cone portion 69 with respect to a direction parallel to the longitudinal axis A are different.

[0096] In particular, the inclination $\delta 1$ of the first truncated-cone portion 68 is greater than the inclination $\delta 2$ of the second truncated-cone portion 69 with respect to a direction parallel to the longitudinal axis A.

[0097] Furthermore, the first truncated-cone portion 68 and the second truncated-cone portion 69 have a radius increasing in the advancing direction D of the flow.

[0098] In this way, an annular face 72 is defined at the outlet, which face preferably extends along a plane orthogonal to the longitudinal axis A.

[0099] In use, the mixture of air and fuel powder is fed to the inlet assembly 6.

[0100] The conformation of the inlet assembly 6 causes a deflection of the flow of air and fuel powder such as to concentrate the fuel powder in a given area of the primary duct 2. In the non-limiting example described and illustrated herein, the conformation of the inlet assembly 6 causes a deflection of the flow of air and fuel powder such as to concentrate the fuel powder near the back wall 11 of the elbow duct 10 of the inlet assembly 6.

[0101] In the primary duct 2, the succession of the baffle element 25 and the swirler element 27 helps to generate a flow entering the stabiliser device 28 in which the fuel powder is homogeneously concentrated in a peripheral annular ring. In this way, the annular ring with a high concentration of fuel powder impacts on the toothed ring 65, which slows down the fuel powder and conveys it along the axis of the duct 2.

[0102] Furthermore, the special conformation of the stabiliser device 28 causes the generation of a flame provided with, near the outlet 62, a recirculation area with low air content and high fuel content in which, advantageously, volatiles are released.

[0103] The toothed ring 65 slows down the fuel-rich flow and conveys it along the axis of the duct 2, whilst the arrangement of the two truncated-cone portions 68 and 69 facilitates the creation of recirculation areas with low air content. The primary air, in fact, is concentrated in the axial area, whereas the secondary air is deflected by the two truncated-cone portions 68 and 69 away from the axial area.

[0104] In particular, the toothed ring 65 forces the carbon particles to slow down below the backfire speed of the fuel. This causes the ignition to occur substantially at the toothed ring 65, and the resulting hot exhaust gases are carried to the recirculation areas. The recirculation of the hot gases self-sustains the ignition of fresh fuel entering the chamber despite the presence of a low-oxygen area.

[0105] In this way, a very high flame stability is obtained, which allows operation with reduced loads. In fact, in the absence of controlled backfire and recirculation of hot fumes, the flame would go out with low loads.

[0106] Basically, with reference to the schematic axial velocity diagram shown in Figure 9, the burner assembly 1 according to the present invention causes the generation of a substantially toroidal recirculation volume VR with low air content, surrounded by an area ZO with higher oxygen concentration.

[0107] In the VR recirculation volume, the high temperature in conditions of low oxygen causes the release of coal volatile matter. In this way, the formation of nitrogen oxides (NOx) from fuel-bound nitrogen (N2) is hindered and the reduction of nitrogenous compounds (NO2, NO, N2O, N2O) into N2 is promoted.

[0108] In the recirculation volume VR, the fuel flow is drawn into a recirculation motion instead of immediately leaving the combustion chamber. Therefore, the residence time of the fuel in the combustion chamber increases. This facilitates the completion of the combustion and therefore reduces the unburnt materials.

[0109] This solution allows recirculation even with reduced loads. This leads to a strong reduction of unburnt materials with reduced loads.

[0110] This results in a significant improvement in combustion efficiency.

[0111] The presence of the homogeniser device 26, albeit optional, improves the homogeneity and segregation of the fuel powder in the peripheral annular ring, resulting in a further improved combustion efficiency.

[0112] Lastly, it is clear that modifications and variations may be made to the burner assembly and method described herein without departing from the scope of the appended claims.

Claims

1. A burner assembly for burning pulverised fuel including:

- a primary duct (2) extending along a longitudinal axis (A) wherein a flow of air and pulverised fuel flows in one advancing direction (D); the primary duct (2) being provided with an inlet (7) and an outlet (8);
- a homogeniser device (26) housed inside the primary duct (2) and comprising a hollow body (37) substantially centred on the longitudinal axis (A) and provided with an outer surface (38) and an inner surface (39);

the burner assembly being **characterised in that** the homogeniser device (26) comprises at least one swirler (40; 41) arranged on the outer surface (38) and/or on the inner surface (39) so as to create a gradient between the tangential components of the velocities of the air and pulverised fuel flow flowing outside the hollow body (37) and inside the hollow body (37).

2. The burner assembly according to claim 1, wherein the tangential component of the velocity of the flow of air and pulverised fuel flowing outside the hollow body (37) is opposite to the tangential component of the velocity of the flow of air and pulverised fuel flowing inside the hollow body (37).

3. The burner assembly according to claim 1, wherein the homogeniser device (26) comprises an outer swirler (40), coupled to the outer surface (38) of the hollow body (37) and configured to give the flow a first tangential velocity component, and an inner swirler (41), coupled to the inner surface (39) of the hollow body (37) and configured to give the flow a second tangential velocity component different from the first tangential velocity component.

4. The burner assembly according to claim 3, wherein the outer swirler (40) is configured to rotate the flow in a first direction (VI) and the inner swirler (41) is configured to rotate the flow in a second direction (V2) opposite to the first direction (VI).

5. The burner assembly according to claim 3 or 4, wherein the outer swirler (40) comprises a number of outer fins (43), which protrude from the outer surface (38) of the hollow body (37).

6. The burner assembly according to claim 5, wherein the outer fins (43) extend orthogonally from the outer surface (38) and are arranged parallel and equidistant one from the other along the outer surface (38).

7. The burner assembly according to claim 5 or 6, wherein the outer fins (43) are arranged along a direction transverse to the longitudinal axis (A).

8. The burner assembly according to anyone of the claims from 3 to 7, wherein the inner swirler (41) comprises a plurality of inner fins (45), which protrude from the inner surface (39) of the hollow body (37).

9. The burner assembly according to claim 8, wherein the inner fins (45) extend orthogonally from the inner surface (39) and are arranged parallel and equidistant one from the other along the inner surface (39).

10. The burner assembly according to claim 8 or 9, wherein the inner fins (45) are arranged along a direction transverse to the longitudinal axis (A).

11. The burner assembly according to anyone of the foregoing claims, wherein the hollow body (37) is cylindrical.

12. The burner assembly according to anyone of the foregoing claims, comprising a swirler device (27) housed inside the primary duct (2) and substantially centred on the longitudinal axis (A).

13. The burner assembly according to claim 12, wherein the homogeniser device (26) is arranged between the inlet (7) and the swirler device (27).

14. The burner assembly according to anyone of the foregoing claims, comprising at least one baffle element (25) arranged upstream the homogeniser device (26) along the advancing direction (D).

15. A method for operating a burner assembly as claimed in anyone of the previous claims, comprising the step of supplying a mixture of air and pulverised fuel to the burner assembly (1).

16. A steam generation plant comprising a burner assembly (1) as claimed in anyone of the claims 1 to 14.

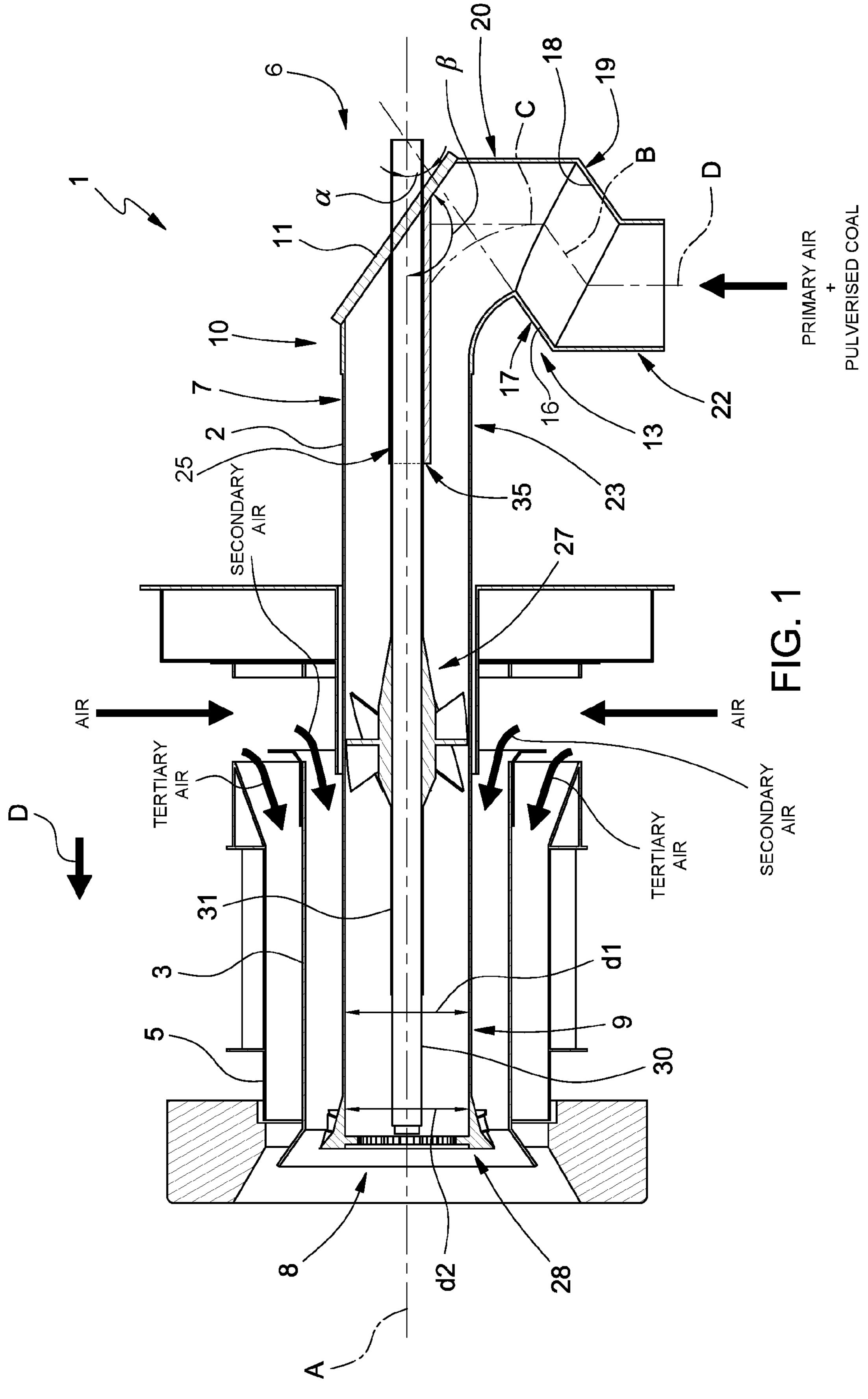
PRIMARY AIR
+
PULVERISED COAL
AIR
AIR
SECONDARY AIR
SECONDARY AIR
TERTIARY AIR
TERTIARY AIR
1
2
3
5
6
7
8
9
10
11
13
16
17
18
19
20
22
23
25
27
28
30
31
35
A
B
C
D
D
d1
d2
α
β

FIG. 1

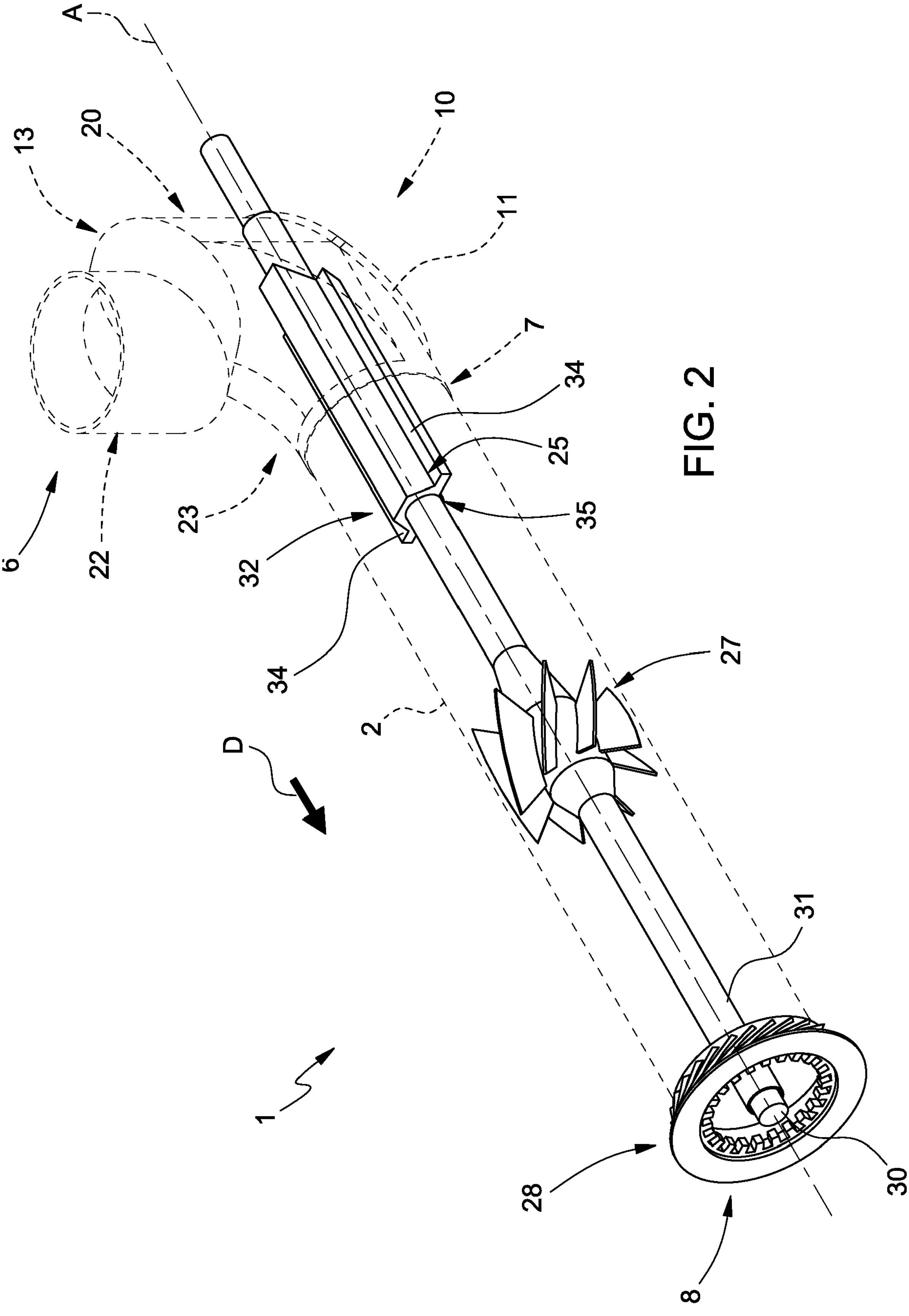

FIG. 2

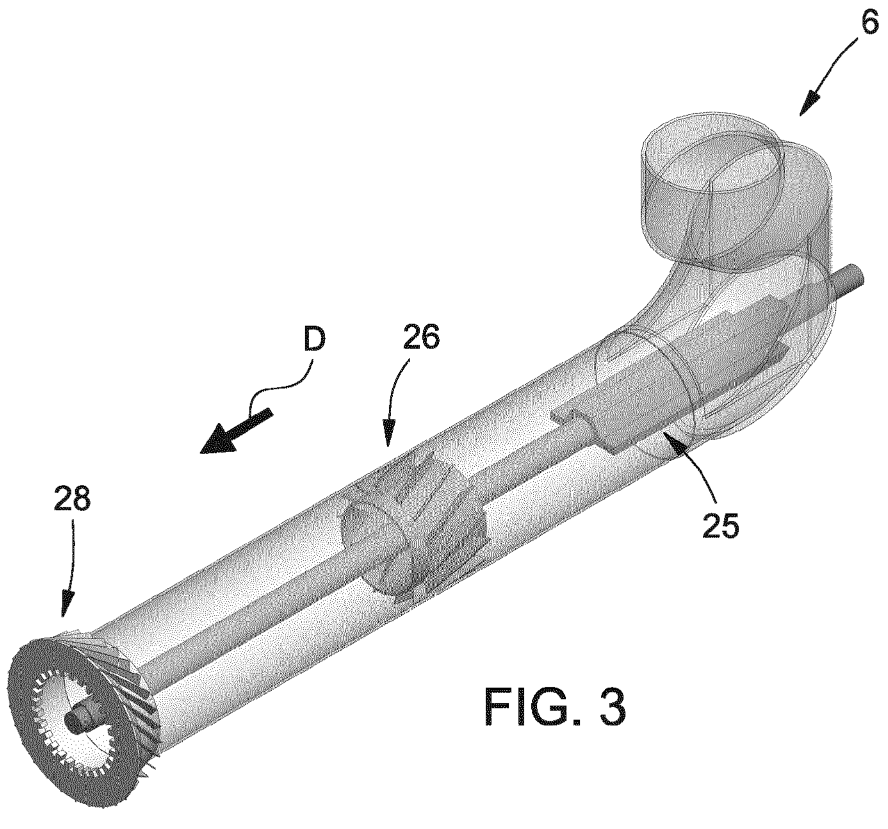

FIG. 3

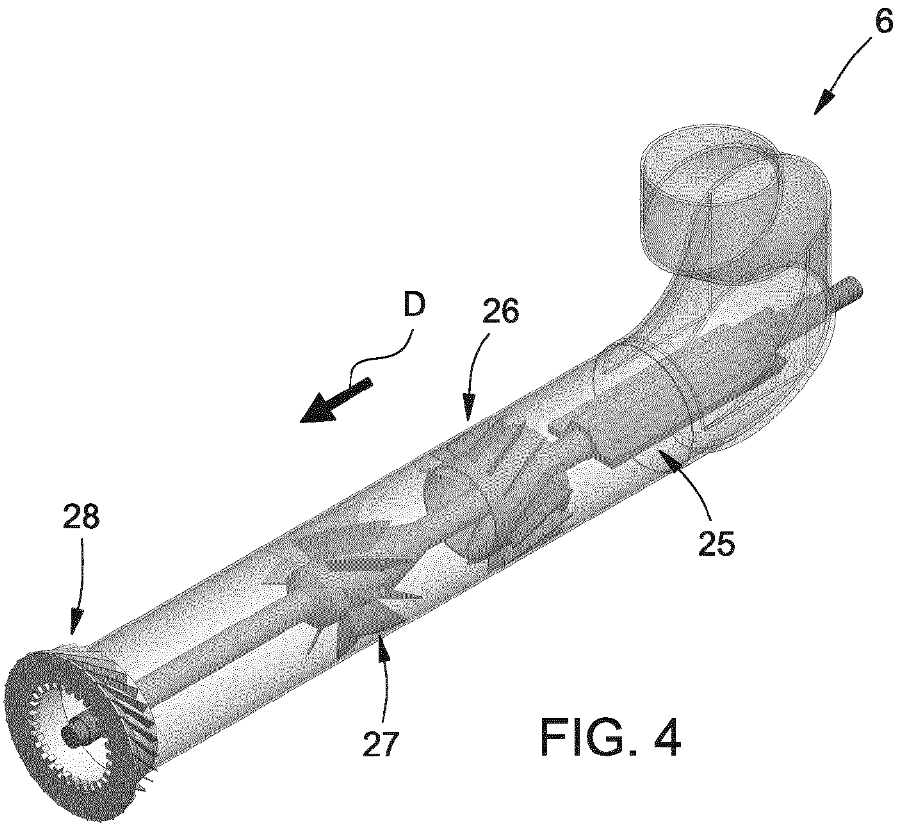

FIG. 4

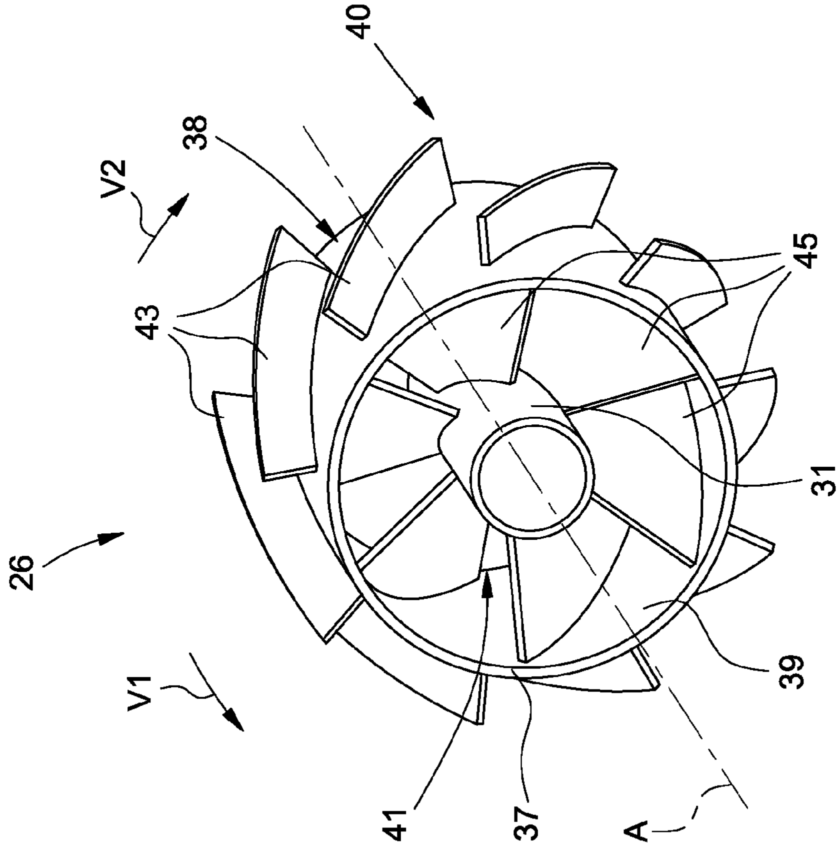

FIG. 6

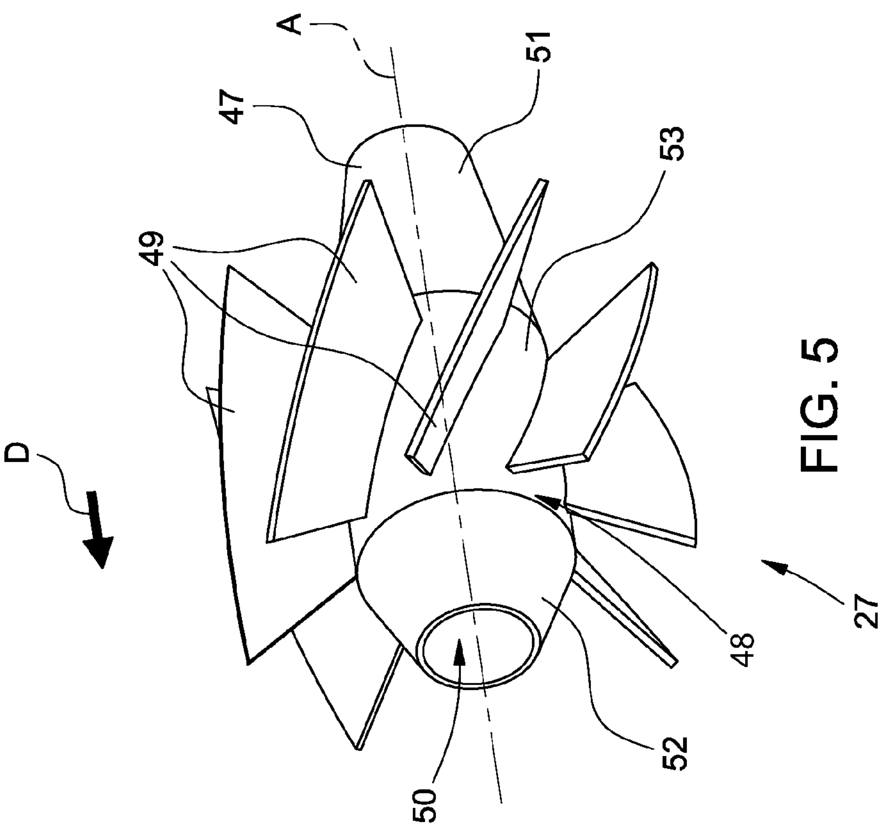

FIG. 5

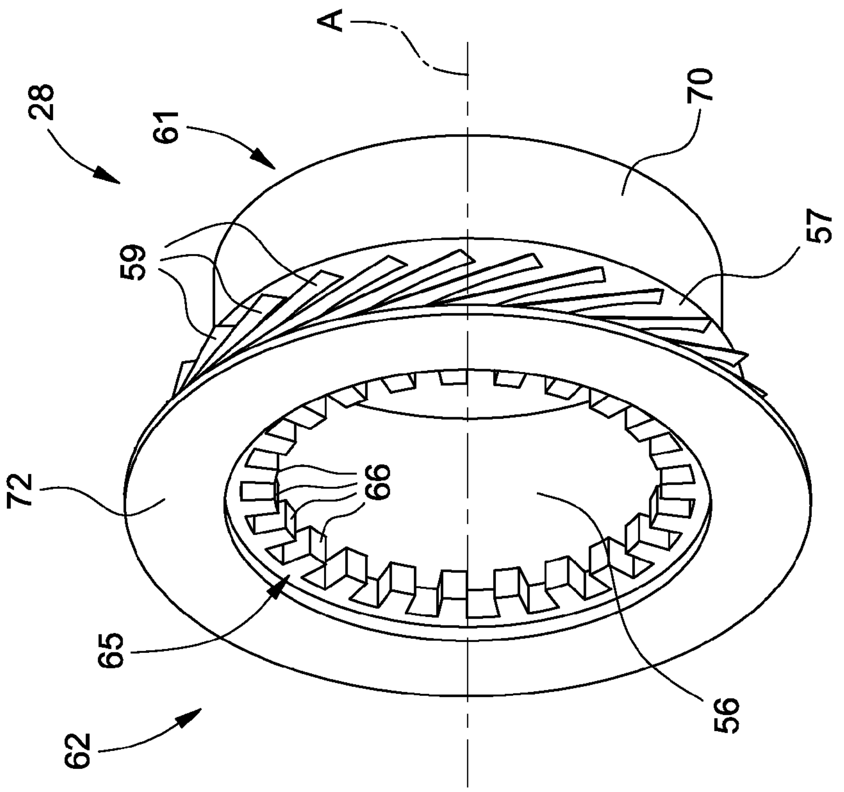
A
28
61
70
59
57
72
66
66
65
56
62

FIG. 8

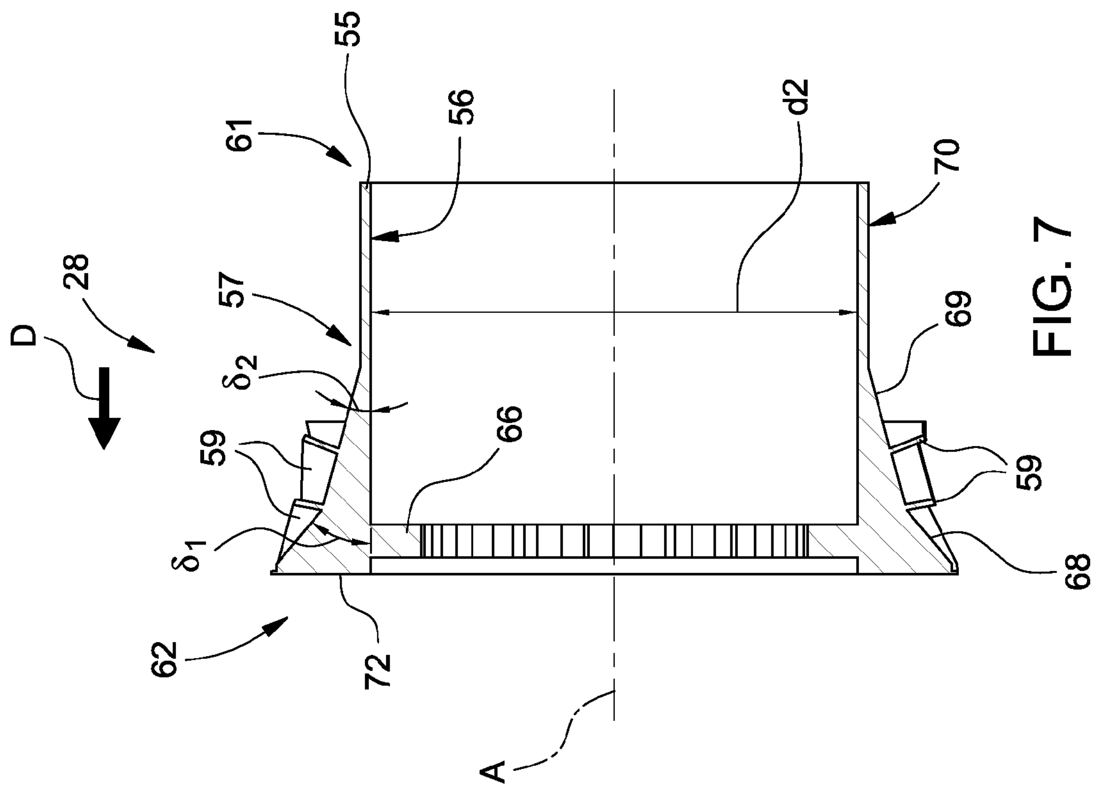
D
28
61
55
56
d2
70
57
δ_2
69
66
59
59
δ_1
68
62
72
A

FIG. 7

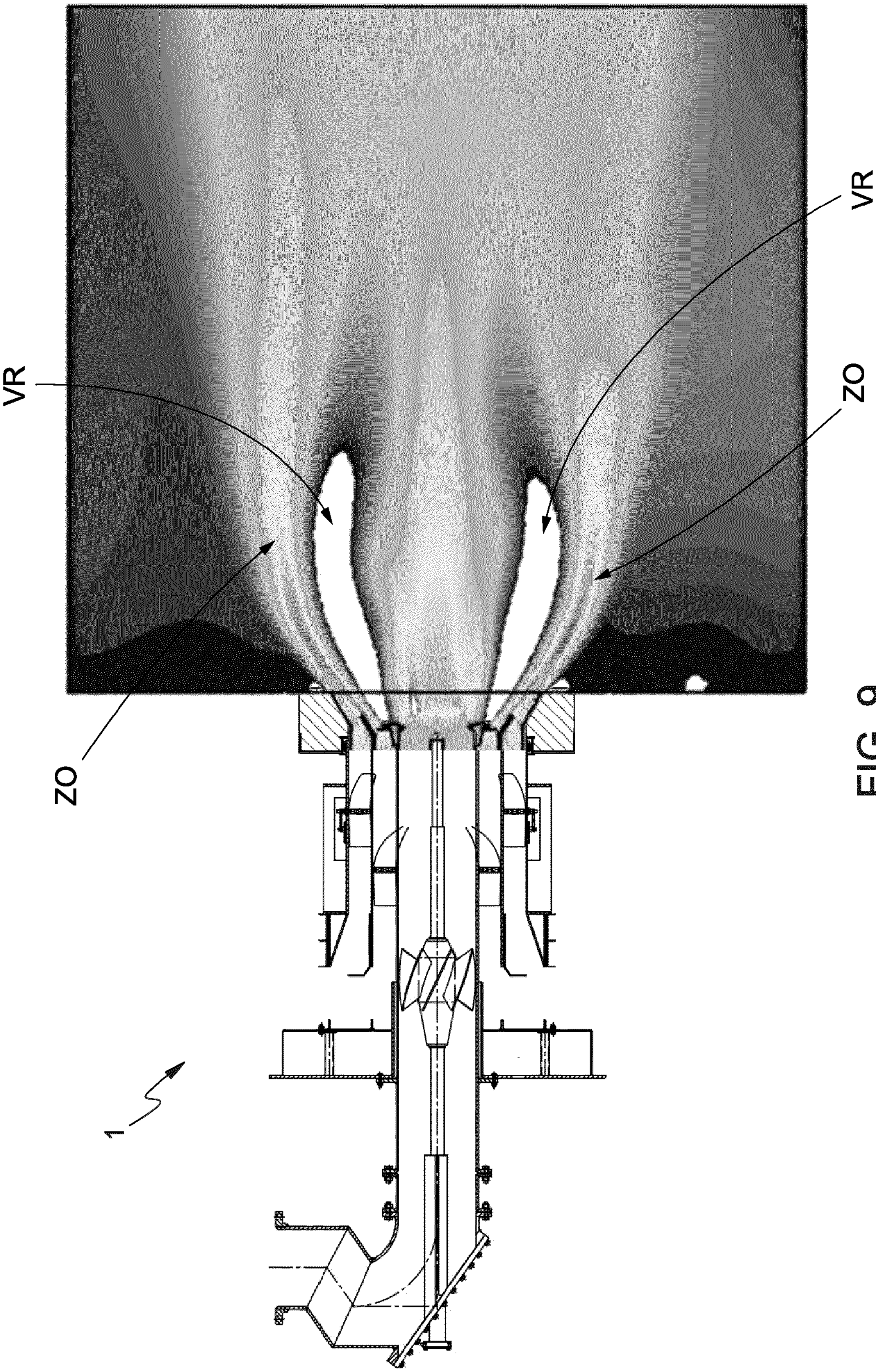

FIG. 9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 20 6296

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2015/037589 A1 (MITSUBISHI HITACHI POWER SYS [JP]) 19 March 2015 (2015-03-19) * paragraph [0019] - paragraph [0021]; figure 2 * -----	1	INV. F23D1/00
A	US 2010/123027 A1 (LARUE ALBERT D [US] ET AL) 20 May 2010 (2010-05-20) * the whole document * -----	1	
A	US 4 924 784 A (LENNON DENNIS R [US] ET AL) 15 May 1990 (1990-05-15) * the whole document * -----	1	
A	US 5 832 847 A (LEISSE ALFONS [DE] ET AL) 10 November 1998 (1998-11-10) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

F23D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	1 March 2021	Theis, Gilbert

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 20 6296

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-03-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015037589 A1	19-03-2015	NONE	
US 2010123027 A1	20-05-2010	AU 2009236029 A1	03-06-2010
		CA 2685657 A1	14-05-2010
		CN 101956973 A	26-01-2011
		EP 2187123 A2	19-05-2010
		ES 2694033 T3	17-12-2018
		NZ 581129 A	26-08-2011
		PL 2187123 T3	30-04-2019
		PT 2187123 T	16-11-2018
		TW 201027010 A	16-07-2010
		US 2010123027 A1	20-05-2010
		ZA 200907919 B	29-10-2010
US 4924784 A	15-05-1990	NONE	
US 5832847 A	10-11-1998	AU 727761 B2	21-12-2000
		CA 2175113 A1	26-01-1997
		CN 1152686 A	25-06-1997
		DE 19527083 A1	30-01-1997
		DK 0756134 T3	06-11-2000
		EP 0756134 A1	29-01-1997
		ES 2149402 T3	01-11-2000
		JP H0942611 A	14-02-1997
		PL 314866 A1	03-02-1997
		RU 2147708 C1	20-04-2000
		US 5832847 A	10-11-1998
		US 5979342 A	09-11-1999
		ZA 963667 B	20-11-1996

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- IT 102019000020506 **[0001]**
- WO 2015037589 A **[0005]**
- US 2010123027 A **[0005]**
- US 4924784 A **[0005]**