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(54) END APPARATUS COMPRISING A PROGRESSIVE COMBUSTION HEAD FOR LOW NOX EMISSIONS AND BURNER COMPRISING THIS END APPARATUS

ENDVORRICHTUNG MIT PROGRESSIVEM BRENNERKOPF FÜR NIEDRIGE NOX-EMISSIONEN UND BRENNER MIT DIESER ENDVORRICHTUNG

APPAREIL D'EXTRÉMITÉ COMPRENANT UNE TÊTE DE COMBUSTION PROGRESSIVE POUR FAIBLES ÉMISSIONS DE NOX ET BRÛLEUR COMPRENANT CET APPAREIL D'EXTRÉMITÉ

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(56) References cited:
EP-A1- 3 734 154
EP-A1- 3 967 924
US-A1- 2020 386 401

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Description

Technical field

[0001] The object of the present invention is an end apparatus for a burner and a burner.

[0002] In particular, the end apparatus for a burner that is the object of the present invention is adapted to be applied to burners that have to be installed in a combustion chamber, particularly on boilers for generating hot water or steam, diathermic oil boilers, kilns, dryers, etc ...but can also be applied to air duct solutions. Generally, the burners can be supplied with combustion gas or diesel or mixtures (gas and diesel or gas and naphtha or yet another mixture that is not expressly indicated here).

Background of the invention

[0003] The burners generally comprise a fan or a supply conduit for supplying the comburent, a supply conduit for supplying the fuel and a combustion head, i.e. the front part of the burner adapted to generate and support the flame, optimising mixing of the fuel and the comburent and maintaining stability thereof during operation.

[0004] Currently, various conformations are known for end apparatuses for blown air burners that generally have in common the presence of an outer tubular body and an inner tubular body supplying the gas, fixed to the body of the burner and ending in the front part with a distributor of the gas. In other words, the two tubular bodies are coaxial and the comburent air is supplied therebetween.

[0005] The end apparatus comprises the combustion head that has in the zone adapted to generate the flame a diffuser that is usually of discoid or truncated conical shape.

[0006] The diffuser is normally provided with uniformly distributed passage holes or gaps that enable the comburent air to pass into the mixing zone with the fuel and the flame to be ignited and maintained.

[0007] Substantially, the diffuser retains the flame near the end part of the combustion head to enable the flame to be supported.

[0008] The outer tubular casing conveys, with the cylindrical body thereof, the comburent air blown by the fan of the burner.

[0009] Some examples of known prior art are described in documents EP3734154A1 and EP3967924A1. The end apparatus in these documents correspond to the preamble of claim 1.

[0010] Disadvantageously, the technical solutions described above often do not enable the burners to so contain the emissions as to maintain the emissions below current emission limits for NOx (nitrogen oxides) specified by recent regulations that set increasingly strict limits (also below 15 ppm) for burners for domestic and industrial use.

Objects of the present invention

[0011] In this situation, the object of the present invention is to make an end apparatus for a burner and a burner that obviate the aforementioned drawbacks.

[0012] A particular object of the present invention is to make an end apparatus for a burner and a burner that enables NOx emissions to be reduced.

[0013] An object of the present invention is moreover to make an end apparatus for a burner and a burner without the use of techniques for recirculating burnt fumes to the flue that are expensive and often involve a reduction in efficiency (and consequently dispensed power) of the machine.

[0014] A still further object of the present invention is to make an end apparatus for a burner and a burner that enable NOx emissions to be reduced without however increasing the value of other polluting substances (like for example carbon monoxide), on the contrary maintaining other polluting substances as low as possible.

[0015] A yet further object of the invention is to make an end apparatus that can maintain the advantages set out above but with significant adjusting elasticity of the fuel/-comburent mixture (range of extended excess air approximately comprised between $1.05 < \lambda < 1.35$).

[0016] The objects indicated are substantially attained by an end apparatus for a burner and a burner according to what is described in the appended claims.

Brief description of the figures

[0017] Further characteristics and the advantages of the present invention will appear more clearly from the detailed description of some preferred, but not exclusive, embodiments illustrated in the appended drawings, wherein:

- figures 1-3 are perspective views according to respective angles of an end apparatus for a burner according to one possible embodiment of the present invention;
- figures 4-5 are partially broken perspective views according to respective angles of the end apparatus for a burner of figures 1-3;
- figure 6 is a section view of the end apparatus for a burner of figures 1-3;
- figure 7 is an exploded view of the end apparatus for a burner of figures 1-3;
- figure 8 is a perspective view of a burner according to one possible embodiment of the present invention;
- figure 9 is a schematic representation of a software simulation of the distribution of the temperature generated inside a container (e.g. boiler) to which the burner according to the present invention is applied in one operating step thereof;
- figure 10 is a schematic representation of a software simulation of the distribution of the speed of the flows generated inside a container (e.g. boiler) to which the

burner according to the present invention is applied in one operating step thereof.

Description of one or more preferred embodiments according to the present invention

[0018] With reference to the appended drawings, the reference number 1 has been used to generally designate an end apparatus for a burner, which will be referred to here as apparatus 1 for the sake of descriptive simplicity.

[0019] The apparatus 1 comprises a combustion head 2 connectable to supply means for supplying a fuel 101 and having at least one inlet opening 3, adapted to enable a fuel to enter, and a plurality of outlet openings 4 adapted to enable an outflow of fuel.

[0020] It should be noted that between the fuel inlet and the inlet opening 3 a butterfly adjusting valve can be housed (not shown in the drawings).

[0021] For example, the fuel supplied by the supplying means for supplying a fuel 101 can be natural gas or other gaseous fuels, like LPG, biogas, hydrogen or mixtures with variable H2 content.

[0022] The apparatus 1 further comprises a comburent supply conduit 5 configured to convey a comburent to the combustion head 2 and extending between a comburent introduction opening 6 of the comburent and an emission opening 7 thereof along a main extension direction "X".

[0023] Advantageously, the combustion head 2 can have a passage conduit 1000 defining an inlet 1001 and an outlet 1002 through which a flow of comburent "C" can flow.

[0024] Further, the apparatus 1 can comprise flame ignition means 8, the means being adapted to promote the ignition of the mixture and usable both for the fuel supplied by the supplying means 101, and for the fuel supplied by the further supply conduit 17 (e.g. diesel) which will be discussed subsequently. According to one possible embodiment of the present invention and as illustrated in the appended figures, the combustion head 2 is at least partially inserted into the supply conduit 5, at the emission opening 7, so as to define a passage gap 9 between the combustion head 2 and the supply conduit 5 for the flow of comburent "C".

[0025] In other words, the flow of comburent "C" can comprise a component passing through the outlet 1002 and/or a component passing through the passage gap 9.

[0026] Advantageously, the combustion head 2 can be movable (both in one direction and the opposite direction) relative to the supply conduit 5 along a movement direction parallel to, preferably coincident with, the main extension direction "X" so as to permit adjustment of the dimensions of the passage gap 9 and thus, of the speed of the flow of comburent "C".

[0027] In this manner, the apparatus 1 enables the conformation of the flame to be modified and the extension of the flame to be varied along a direction prevalently parallel to the main extension direction "X".

[0028] In other words, the relative movement between the combustion head 2 and the supply conduit 5 enables the shape of the flame to be varied.

[0029] Advantageously, further, the supply conduit 5 can have an end portion 10 defining a convergent profile near the emission opening 7.

[0030] In particular, the end portion 10 determines the convergence of the flow of comburent "C" to the centre of the head, promoting the flame detachment from the surface thereof, apart from the retaining surface 22 that will be disclosed below.

[0031] In greater detail, the end portion 10 interacting with the combustion head 2 (as will be described in greater detail below) conveys the flow of comburent "C" such that the flame extends and is sustained at a greater distance from the end part of the combustion head 2 relative to prior art apparatuses.

[0032] Advantageously, the combustion head 2 comprises a plurality of outer openings 11 configured to emit a first flow of fuel "F1" outside the flow of comburent "C".

[0033] In particular, the outer openings 11 are arranged outside the passage gap 9 according to a direction that is radial to the main extension direction "X". The fuel introduced from the openings 11 preferably follows the direction "X".

[0034] In other words, the outer openings 11 are arranged outside the supply conduit 5.

[0035] Preferably, the outer openings 11 are arranged on the perimeter of the supply conduit 5.

[0036] Still more preferably, the outer openings 11 are distributed uniformly on the perimeter of the end portion 10 of the supply conduit 5.

[0037] Further, the combustion head 2 comprises a plurality of inner openings 12 arranged at and/or inside the passage gap 9 according to a direction that is radial to the main extension direction "X".

[0038] In particular, the inner openings 12 are adapted to introduce a second flow of fuel "F2', F2"" inside the flow of a comburent "C".

[0039] The presence of the first flow of fuel "F1" and of the second flow of fuel "F2', F2"" that join in the flow of comburent in different positions enable the flame to be developed in different zones. In detail, the first flow of fuel "F1" promotes "delayed" mixing that is achieved forwards in the combustion chamber in direction "X", owing to the fact that it introduces the comburent by means of relatively big sections (by way of purely non-limiting example, sections having a diameter equal to 15 millimetres) in a zone lacking comburent. The second flow of fuel "F2"", owing to the shaped nozzles thereof and with a profile substantially parallel to the end portion 10, tends to diffuse the gas in a rear/radial zone through a recirculating effect with flow reversal.

[0040] The second flow "F2'" facilitates the retention of the flame by promoting fast mixing with the comburent "C" in a low pressure zone that is substantially arranged at the connecting surface 22 that will be described in greater detail below.

[0041] According to one possible embodiment and as illustrated in the appended figures, the combustion head 2 can comprise a central body 13 extending between a first end 14, defining the inlet opening 3, and a second end 15, distal from the inlet opening 3, along an extension direction "E".

[0042] In particular, the extension direction "E" can be parallel to, preferably coincident with, the main extension direction "X".

[0043] The central body 13 can be at least partially inserted into the supply conduit 5.

[0044] Further, the second end 15 can define with the supply conduit 5 at least partially the passage gap 9.

[0045] Preferably, the second end 15 can define with the end portion 10 of the supply conduit 5 at least partially the passage gap 9.

[0046] Advantageously, the central body 13 can have an extension that is substantially axially symmetric relative to the extension direction "E".

[0047] In this manner, the central body 13 can define with the supply conduit 5 a passage gap 9 having a conformation that is at least partially annular that confers stability and uniformity on the flow of comburent "C" and, thus, on the flame.

[0048] According to one possible embodiment and as illustrated in the appended figures, the central body 13 can have a housing 16 that is adapted to receive in a reversibly inserted manner a supply conduit 17 for supplying a fuel.

[0049] In particular, the housing 16 can extend between the first end 14 and the second end 15 parallel to the extension direction "E".

[0050] According to one possible embodiment of the present invention, the conduit passage conduit 1000 and the central body 13 are operationally connected so as to define a prolongation of the housing 16. In this manner, the housing 16 can extend substantially between the inlet 1001 of the passage conduit 1000 and the second end 15 of the central body 13.

[0051] The further supply conduit 17 can enable the supply of a fuel that is different from the one supplied by the supply conduit 5, for example diesel or fuel oil, ensuring great operating flexibility for the apparatus 1.

[0052] Further, the apparatus 1 can comprise at least one switch-on conduit 18 in fluid communication with the supply conduit 5 and passing through the central body 13 adapted to insert the aforesaid flame ignition means 8 according to one possible embodiment of the present invention.

[0053] In this case, flame ignition means 8 can exit suitable switch-on openings 18a of the switch-on conduit 18.

[0054] According to some possible embodiments not illustrated in the appended figures, these switch-on openings 18a can have different positioning along the extension direction "E" without the inventive concept at the basis of the present invention being altered.

[0055] For example, the switch-on openings 18a can be arranged upstream of the plurality of outflow holes 20b-that will be described in greater detail below.

[0056] Advantageously, the second end 15 of the central body 13 can have a convergent portion 19, for example truncated conically shaped, along the extension direction "E" and defining with the supply conduit at least partially the passage gap 9.

[0057] This shaping promotes the detachment of the flame from the second end 15, contributing to move the second end 15 away from the combustion head 2 and at the same time ensuring, also owing to the particular divergent geometry of the profile 21, a zone of minimum flame retention on the retaining surface 22.

[0058] The convergent portion 19 can have a plurality of outflow holes 20a adapted to introduce at least partially the second flow "F2'" of fuel inside the flow of a comburent "C".

[0059] In other words, the central body 13 can have a plurality of outflow holes 20a, 20b for introducing at least partially the second flow "F2'" of fuel in the flow of a comburent "C".

[0060] In particular, the aforesaid plurality of outflow holes 20a defines at least partially the inner openings 12.

[0061] Purely by way of non-limiting example, the plurality of outflow holes 20a, 20b can have a diameter equal to 2.5 millimetres.

[0062] The convergent 19 and divergent 21 portions, together with the plurality of outflow holes 20a, 20b contribute to limiting the turbulent formation of components in the flow of comburent "C" and concomitant with the introduction of the second flow of fuel "F2'" inside the flow of comburent "C". Optimum mixing between fuel and comburent in this stage occurs near the surface 22, thus ensuring increased stability of the flame in this zone and thus ensuring reliability, safety and operating elasticity for the burner during the operating step. This elasticity characteristic enables operation with very extensive λ factors (in which λ indicates the excess air coefficient).

[0063] This stability, permitted by the flame anchoring zone at the retaining surface 22, enables the flame to be maintained distant from the combustion head 2 and the need for the diffuser (the aforesaid disc or truncated conical element) in the end zone of the combustion head 2 to be overcome.

[0064] In other words, the apparatus 1 can be devoid of the traditional flame retention diffuser.

[0065] Further, the absence of the diffuser enables the generation of turbulent zones to be avoided that result in great mixing, enabling the flame to be moved further away from the combustion head 2 and diffusing the flame homogeneously in the volume of the combustion chamber. The reduction of the specific thermal load (W/m3) and the reduction of the temperature of the flame near the head 2 favour a great reduction of the emissions of thermal NOx.

[0066] Further, this effect enables the influence of thermal stress factors to be reduced, permitting an improvement to the life of the components and the possible

application of less noble and expensive materials.

[0067] According to one possible embodiment and as illustrated in the appended drawings, the second end 15 can have at least one divergent portion 21 along the extension direction "E".

[0068] In particular, the divergent portion 21 can be arranged at least partially inside the convergent portion 19.

[0069] Advantageously, the further supply conduit 17 can be at least partially insertable from the inlet 1001 as far as inside the divergent portion 21, permitting dispensing of the further fuel at the zone of the combustion head 2 adapted to the generation of the flame.

[0070] The divergent geometry of the profile 21 enables the cone of the spray of the atomizer to be followed, preferably at a solid spray angle comprised between 50° and 70°, ensuring an optimal flame extension of the secondary fuel. Also in this case, the principle of partial flame detachment with partial retention near the retaining surface 22 enables NOx emissions to be kept very small.

[0071] Further, this insertion enables the overall operating dimensions to be reduced that are induced by the presence of the further supply conduit 17. As illustrated in the appended drawings, the plurality of outflow holes 20b can be obtained at least partially on the divergent portion 21 to introduce at least partially the second flow of fuel "F2'" inside the flow of a comburent "C".

[0072] According to one possible embodiment of the present invention that is not illustrated in the appended figures, the plurality of outflow holes 20a, 20b can be provided only on the divergent portion 21 without altering the inventive concept underlying the present invention.

[0073] It is emphasised that the outflow holes 20a are made on the convergent portion 19. Preferably, both the pluralities of outflow holes 20a, 20b as illustrated in appended figures are present.

[0074] Alternatively, only the plurality of outflow holes 20b and not the outflow holes 20a can be present.

[0075] Further, the second end 13 has at least one retaining surface 22 (previously mentioned) adapted to connect the divergent portion 21 and the convergent portion 19.

[0076] In particular, the retaining surface 22 can be perpendicular to the extension direction "E".

[0077] Advantageously, the retaining surface 22 can be at least partially lobe-shaped.

[0078] As illustrated in the appended drawings, the aforesaid flame ignition means 8 can be arranged at least partially inside the divergent portion 21 so as to promote the generation of the flame near the retaining surface 22.

[0079] According to one possible embodiment of the present invention and as illustrated in the appended drawings, the combustion head 2 comprises a plurality of outflow conduits 23 branching off from the first end of the central body 13.

[0080] Further, the plurality of outflow conduits 23 extends at least partially along a direction parallel to the extension direction "E".

[0081] In particular, the plurality of outflow conduits 23 defines at least partially the aforesaid plurality of outer openings 11.

[0082] Preferably, the combustion head 2 can comprise at least one inner nozzle 24, still more preferably a plurality of inner nozzles 24, arranged inside the supply conduit 5 according to a direction that is radial to the main extension direction "X".

[0083] In other words, the at least one inner nozzle 24 can be interposed between the central body 13 and the supply conduit 5 and, preferably, inside the end portion 10 and the passage gap 9.

[0084] In particular, the inner nozzles 24 define a part of said plurality of inner openings 12.

[0085] According to one possible embodiment of the present invention, the inner nozzles 24 can have a diameter equal to about 16 millimetres.

[0086] Further, the at least one inner nozzle 24 can have different conformations, for example, circular, oval elliptic or the like without altering the inventive concept underlying the present invention.

[0087] Advantageously, the at least one inner nozzle 24 can have an extension axis tilted relative to the extension direction "E".

[0088] In this manner, the inner nozzle 24 limits the turbulent formation of components inside the flow of comburent "C" and/or the second flow "F2"" promoting the introduction of the second flow "F2"" along a direction substantially parallel to the surface of the convergent portion 19 and 10.

[0089] Preferably, the combustion head 2 comprises a plurality of inner nozzles 24 having an extension that is transverse to the extension direction "E" such that the second flow "F2"" is at least partially convergent along the extension direction "E".

[0090] Preferably, the combustion head 2 further comprises a plurality of outer nozzles 25 in fluid communication with the inlet opening 3.

[0091] In particular, the outer nozzles 25 can be arranged outside the supply conduit 5 according to a direction that is radial to the main extension direction "X".

[0092] Specifically, the outer nozzles 25 can define at least partially the plurality of outer openings 11.

[0093] Advantageously, the outer nozzles 25 can have an extension substantially parallel to the main extension direction "X" such as to emit the aforesaid first flow "F1" of fuel outside the flow of comburent "C".

[0094] In this manner, the first flow "F1" contributes to delaying mixing by enabling the flame to be moved away from the end part of the combustion head 2 according to what has been set out previously.

[0095] According to one possible embodiment and as illustrated in the appended drawings, the outer nozzles 25 can be arranged perimetrically to the supply conduit and near the emission opening 7.

[0096] Preferably, the inner nozzles and/or the outer nozzles can be an end portion of a respective outflow conduit 23.

[0097] According to a further aspect, the present invention refers to a burner 100 comprising an apparatus 1 according to what has been previously disclosed and suction means 102 configured to suck at least one quantity of comburent from an environment outside the burner 100 and to move the quantity from the introduction opening 6 to the emission opening 7.

[0098] Further, the burner can comprise supplying means for supplying a fuel 101 adapted to supply a fuel to the combustion head 2.

[0099] It is thus observed that the present invention achieves the proposed objects by making an end apparatus for a burner able to reduce NOx emissions owing to the presence of a plurality of outer openings arranged outside the passage gap of the flow of comburent and a plurality of inner openings arranged at and/or inside the passage gap of the comburent operationally connected to move the flame away from the end part of the combustion head.

[0100] Advantageously, the combustion head 2 works by promoting a diffusing extension of a flame that is thus as homogeneous as possible inside the hearth. This is ensured by progressive combustion and is possible according to the particular conformation of the combustion head 2, in function of the geometry of the convergent portion 19, of the end portion 10 and of the position and the dimension of the nozzles 24, 25 and of the outflow holes 20a, 20b. Owing to this principle, a generally more uniform temperature is ensured with concentrated peaks of value lower than a traditional combustion head in which there is a more localized concentration of flame in the same thermal load conditions [W/m3].

Claims

1. An end apparatus (1) for a burner configured to generate a flame, comprising:

- a combustion head (2) connectable to supply means for supplying a fuel and having at least one inlet opening (3), adapted to enable a fuel to enter, and a plurality of outlet openings (4), adapted to enable an outflow of fuel;
- a comburent supply conduit (5) configured to convey a comburent to said combustion head (2) and extending between a comburent introduction opening (6) and an emission opening (7) along a main extension direction (X);

wherein said combustion head (2) is at least partially inserted into said supply conduit (5), at the emission opening (7), so as to define a passage gap (9) between said combustion head (2) and said supply conduit (5) for a flow of comburent (C);

wherein said combustion head (2) comprises:

- a plurality of outer openings (11) arranged outside said passage gap (9) according to a direction that is radial to said main extension direction (X) and configured to emit a first flow of fuel (F1) outside said flow of a comburent; and
- a plurality of inner openings (12) arranged at and/or inside said passage gap (9) according to a direction that is radial to said main extension direction (X), said inner openings (12) being adapted to introduce a second flow of fuel (F2', F2") inside said flow of a comburent.
- a central body (13) at least partially inserted into said supply conduit (5) and extending between a first end (14), defining said inlet opening (3), and a second end (15) along an extension direction (E); said second end (15) defining with said supply conduit (5) at least partially said passage gap (9),
- at least one inner nozzle (24) arranged inside said supply conduit (5) according to a direction that is radial to said main extension direction (X), said inner nozzle (24) defining at least partially said plurality of inner openings (12);

characterized in that said at least one inner nozzle (24) is interposed between said central body (13) and said supply conduit (5).

2. The apparatus according to claim 1, wherein said central body (13) has a substantially axially symmetric extension relative to said extension direction (E).

3. The apparatus according to claim 1 or 2, wherein said extension direction (E) is parallel to, preferably coincident with, said main extension direction (X).

4. The apparatus according to one or more of the preceding claims, wherein said central body (13) has a housing (16) adapted to receive a reversibly inserted further supply conduit (17) for supplying a fuel, said housing (16) extending between said first end (14) and said second end (15) parallel to said extension direction (E).

5. The apparatus according to one or more of the preceding claims, comprising at least one switch-on conduit (18) in fluid communication with said supply conduit (5) and passing through said central body (13) to convey a quantity of comburent to said second end (15) of said central body (13).

6. The apparatus according to one or more of the preceding claims, wherein said second end (15) has a convergent portion (19), preferably truncated coni-

cally shaped, along said extension direction (E) and defining with said supply conduit (5) at least partially said passage gap (9).

7. The apparatus according to claim 6, wherein said convergent portion (19) has a plurality of outflow holes (20a) adapted to introduce at least partially said second flow of fuel (F2') inside said flow of a comburent, said plurality of outflow holes (20a) defining at least partially said inner openings (12).

8. The apparatus according to claim 6 or 7, wherein said second end (15) has at least one divergent portion (21) along said extension direction said divergent portion (21) being arranged at least partially inside said convergent portion (19).

9. The apparatus according to claim 8, wherein said divergent portion (21) has a plurality of outflow holes (20b) adapted to introduce at least partially said second flow of fuel (F2') inside said flow of a comburent, said plurality of outflow holes (20b) defining at least partially said inner openings (12).

10. The apparatus according to claim 9, wherein said second end (15) has at least one retaining surface (22) adapted to connect said divergent portion (21) and said convergent portion (19).

11. The apparatus according to claim 10, wherein said retaining surface (22) is perpendicular to said extension direction (E).

12. The apparatus according to claim 10 or 11, wherein said retaining surface (22) is at least partially lobe-shaped.

13. The apparatus according to one or more of the preceding claims, wherein said combustion head (2) comprises a plurality of outflow conduits (23) branching off from said first end (14) of said central body (13) and extending at least partially along a direction parallel to said extension direction (E), said plurality of outflow conduits (23) defining at least partially said plurality of outer openings (11) and/or said plurality of inner openings (12).

14. The apparatus according to one or more of the preceding claims, wherein said at least one inner nozzle (24) has an extension axis tilted relative to said extension direction (E).

15. The apparatus according to one or more of the preceding claims, wherein said combustion head (2) comprises a plurality of inner nozzles (24) having an extension transverse to said extension direction (E) so that said second flow is at least partially convergent along said extension direction (E).

16. The apparatus according to one or more of the preceding claims, wherein said combustion head (2) comprises a plurality of outer nozzles (25) in fluid communication with said inlet opening (3) and arranged outside said supply conduit (5) according to a direction that is radial to said main extension direction (X), said outer nozzles (25) defining at least partially said plurality of outer openings (11).

17. The apparatus according to claim 16, wherein said outer nozzles (25) has an extension that is substantially parallel to said main extension direction (X) so as to emit said first flow of fuel (F1) outside said flow of a comburent.

18. The apparatus according to claim 16 or 17, wherein said outer nozzles (25) are arranged perimetrically to said supply conduit (5) and near said emission opening (7).

19. The apparatus according to one or more of the preceding claims, wherein said combustion head (2) is reversibly moveable relative to said supply conduit (5) along a movement direction that is parallel to, preferably coincident with, said main extension direction (X).

20. The apparatus according to one or more of the preceding claims, wherein said supply conduit (5) has an end portion (10) defining a convergent profile near said emission opening (7).

21. The apparatus according to one or more of the preceding claims, comprising flame ignition means (8) adapted to promote combustion between said fuel and said comburent.

22. The apparatus according to one or more of the preceding claims, wherein said combustion head (2) has a passage conduit (1000) defining an inlet (1001) and an outlet (1002) through which the flow of comburent (C) can flow at least partially.

23. A burner comprising:

- an end apparatus (1) according to one or more of the preceding claims;
- suction means (102) configured to suck at least an amount of comburent from an environment outside said burner and to move said at least an amount of comburent from said second introduction opening (6) to said second emission opening (7).

Patentansprüche

1. Endvorrichtung (1) für einen Brenner, ausgelegt, um

eine Flamme zu erzeugen, umfassend:

- einen Brennkopf (2), der mit Zuführungsmitteln verbindbar ist, um einen Brennstoff zuzuführen, und der mindestens eine Einlassöffnung (3) aufweist, die dazu geeignet ist, einem Brennstoff das Einströmen zu ermöglichen, und eine Vielzahl von Auslassöffnungen (4), die dazu geeignet sind, ein Ausströmen von Brennstoff zu ermöglichen;
- eine Sauerstoffträgerzuführungsleitung (5), die ausgelegt ist, um einen Sauerstoffträger zum Brennkopf (2) zu fördern, und die sich zwischen einer Sauerstoffträgereinbringungsöffnung (6) und einer Ausstoßöffnung (7) entlang einer Hauptausdehnungsrichtung (X) erstreckt, wobei der Brennkopf (2) zumindest teilweise in die Zuführungsleitung (5) an der Ausstoßöffnung (7) eingefügt ist, sodass ein Durchgangsspalt (9) zwischen dem Brennkopf (2) und der Zuführungsleitung (5) für einen Sauerstoffträgerstrom (C) definiert wird,
wobei der Brennkopf (2) Folgendes umfasst:

  - eine Vielzahl von äußeren Öffnungen (11), die außerhalb des Durchgangsspalts (9) gemäß einer Richtung, die radial zur Hauptausdehnungsrichtung (X) verläuft, angeordnet und ausgelegt sind, um eine ersten Brennstoffstrom (F1) außerhalb des Stroms eines Sauerstoffträgers auszustoßen, und
  - eine Vielzahl von inneren Öffnungen (12), die am und/oder innerhalb des Durchgangsspalts (9) gemäß einer Richtung, die radial zur Hauptausdehnungsrichtung (X) verläuft, angeordnet sind, wobei diese inneren Öffnungen (12) dazu geeignet sind, einen zweiten Brennstoffstrom (F2', F2") in den Strom eines Sauerstoffträgers einzubringen,
  - einen mittigen Körper (13), der zumindest teilweise in die Zuführungsleitung (5) eingefügt ist und sich zwischen einem ersten Ende (14), das die Einlassöffnung (3) definiert, und einem zweiten Ende (15) entlang einer Ausdehnungsrichtung (E) erstreckt, wobei das zweite Ende (15) mit der Zuführungsleitung (5) den Durchgangsspalt (9) zumindest teilweise definiert,
  - mindestens eine innere Düse (24), die innenseitig der Zuführungsleitung (5) gemäß einer Richtung, die radial zur Hauptausdehnungsrichtung (X) verläuft, angeordnet ist, wobei die innere Düse (24) die Vielzahl von inneren Öffnungen (12) zumindest teilweise definiert,

dadurch gekennzeichnet, dass die zumindest eine innere Düse (24) zwischen dem mittigen Körper (13) und der Zuführungsleitung (5) eingesetzt ist.

2. Vorrichtung nach Anspruch 1, wobei der mittige Körper (13) eine im Wesentlichen axialsymmetrische Ausdehnung in Bezug auf die Ausdehnungsrichtung (E) aufweist.

3. Vorrichtung nach Anspruch 1 oder 2, wobei die Ausdehnungsrichtung (E) parallel zur Hauptausdehnungsrichtung (X) verläuft und vorzugsweise mit dieser übereinstimmt.

4. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der mittige Körper (13) eine Aufnahme (16) aufweist, die dazu geeignet ist, eine reversierbar eingefügte weitere Zuführungsleitung (17) zur Zuführung eines Brennstoffs aufzunehmen, wobei sich die Aufnahme (16) zwischen dem ersten Ende (14) und dem zweiten Ende (15) parallel zur Ausdehnungsrichtung (E) erstreckt.

5. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, umfassend mindestens eine Einschaltleitung (18) in Fluidkommunikation mit der Zuführungsleitung (5), die durch den mittigen Körper (13) führt, um eine Sauerstoffträgermenge zum zweiten Ende (15) des mittigen Körpers (13) zu fördern.

6. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei das zweite Ende (15) einen zusammenlaufenden Abschnitt (19), der vorzugsweise kegelstumpfförmig ist, entlang der Ausdehnungsrichtung (E) aufweist und mit der Zuführungsleitung (5) den Durchgangsspalt (9) zumindest teilweise definiert.

7. Vorrichtung nach Anspruch 6, wobei der zusammenlaufende Abschnitt (19) eine Vielzahl von Ausströmungslöchern (20a) aufweist, die dazu geeignet sind, den zweiten Brennstoffstrom (F2') zumindest teilweise in den Strom eines Sauerstoffträgers einzubringen, wobei die Vielzahl von Ausströmungslöchern (20a) die inneren Öffnungen (12) zumindest teilweise definiert.

8. Vorrichtung nach Anspruch 6 oder 7, wobei das zweite Ende (15) zumindest einen auseinanderlaufenden Abschnitt (21) entlang der Ausdehnungsrichtung aufweist, wobei der auseinanderlaufende Abschnitt (21) zumindest teilweise im zusammenlaufenden Abschnitt (19) angeordnet ist.

9. Vorrichtung nach Anspruch 8, wobei der auseinanderlaufende Abschnitt (21) eine Vielzahl von Ausströmungslöchern (20b) aufweist, die dazu geeignet

sind, den zweiten Brennstoffstrom (F2') zumindest teilweise in den Strom eines Sauerstoffträgers einzubringen, wobei die Vielzahl von Ausströmungslöchern (20b) die inneren Öffnungen (12) zumindest teilweise definiert.

10. Vorrichtung nach Anspruch 9, wobei das zweite Ende (15) mindestens eine Rückhalteoberfläche (22) aufweist, die dazu geeignet ist, den auseinanderlaufenden Abschnitt (21) und den zusammenlaufenden Abschnitt (19) zu verbinden.

11. Vorrichtung nach Anspruch 10, wobei die Rückhalteoberfläche (22) senkrecht zur Ausdehnungsrichtung (E) angeordnet ist.

12. Vorrichtung nach Anspruch 10 oder 11, wobei die Rückhalteoberfläche (22) zumindest teilweise lappenförmig ist.

13. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Brennkopf (2) eine Vielzahl von Ausströmungsleitungen (23) umfasst, die vom ersten Ende (14) des mittigen Körpers (13) abzweigen und sich zumindest teilweise entlang einer Richtung erstrecken, die parallel zur Ausdehnungsrichtung (E) verläuft, wobei die Vielzahl von Ausströmungsleitungen (23) die Vielzahl von äußeren Öffnungen (11) und/oder die Vielzahl von inneren Öffnungen (12) zumindest teilweise definiert.

14. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei die mindestens eine innere Düse (24) eine Ausdehnungsachse aufweist, die in Bezug auf die Ausdehnungsrichtung (E) gekippt ist.

15. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Brennkopf (2) eine Vielzahl von inneren Düsen (24) umfasst, aufweisend eine Ausdehnung quer zur Ausdehnungsrichtung (E), sodass der zweite Strom entlang der Ausdehnungsrichtung (E) zumindest teilweise zusammenlaufend ist.

16. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Brennkopf (2) eine Vielzahl von äußeren Düsen (25) aufweist, die in Fluidkommunikation mit der Einlassöffnung (3) und außerhalb der Zuführungsleitung (5) gemäß einer Richtung, die radial zur Hauptausdehnungsrichtung (X) verläuft, angeordnet sind, wobei die äußeren Düsen (25) die Vielzahl von äußeren Öffnungen (11) zumindest teilweise definieren.

17. Vorrichtung nach Anspruch 16, wobei die äußeren Düsen (25) eine Ausdehnung aufweisen, die im Wesentlichen parallel zur Hauptausdehnungsrichtung (X) verläuft, sodass der erste Brennstoffstrom (F1) außerhalb des Stroms eines Sauerstoffträgers ausgestoßen wird.

18. Vorrichtung nach Anspruch 16 oder 17, wobei die äußeren Düsen (25) umfangseitig zur Zuführungsleitung (5) und in der Nähe der Ausstoßöffnung (7) angeordnet sind.

19. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Brennkopf (2) reversierbar in Bezug auf die Zuführungsleitung (5) entlang einer Bewegungsrichtung bewegbar ist, die parallel zur Hauptausdehnungsrichtung (X) verläuft und vorzugsweise mit dieser übereinstimmt.

20. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei die Zuführungsleitung (5) einen Endabschnitt (10) aufweist, der ein zusammenlaufendes Profil in der Nähe der Ausstoßöffnung (7) definiert.

21. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, umfassend Flammenzündmittel (8), die dazu geeignet sind, die Verbrennung zwischen dem Brennstoff und dem Sauerstoffträger zu fördern.

22. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Brennkopf (2) eine Durchgangsleitung (1000) aufweist, die einen Einlass (1001) und einen Auslass (1002) definiert, durch die der Sauerstoffträgerstrom (C) zumindest teilweise strömen kann.

23. Brenner, umfassend:

- eine Endvorrichtung (1) nach einem oder mehreren der vorhergehenden Ansprüche;
- Saugmittel (102), die ausgelegt sind, um zumindest eine Sauerstoffträgermenge aus einer Umgebung außerhalb des Brenners anzusaugen und die mindestens eine Sauerstoffträgermenge von der zweiten Einbringungsöffnung (6) zur zweiten Ausstoßöffnung (7) zu bewegen.

Revendications

1. Appareil d'extrémité (1) pour un brûleur, configuré pour générer une flamme, comprenant :

- une tête de combustion (2) reliable à des moyens d'alimentation pour alimenter un carburant et ayant au moins une ouverture d'entrée (3), adaptée pour permettre à un carburant d'entrer, et une pluralité d'ouvertures de sortie (4), adaptées pour permettre un écoulement de car-

burant ;
- un conduit d'alimentation en comburant (5) configuré pour transporter un comburant vers ladite tête de combustion (2) et s'étendant entre une ouverture d'introduction de comburant (6) et une ouverture d'émission (7) le long d'une direction d'extension principale (X) ;
dans lequel ladite tête de combustion (2) est au moins partiellement insérée dans ledit conduit d'alimentation (5), au niveau de l'ouverture d'émission (7), de manière à définir un espace de passage (9) entre ladite tête de combustion (2) et ledit conduit d'alimentation (5) pour un flux de comburant (C) ;
dans lequel ladite tête de combustion (2) comprend :

- une pluralité d'ouvertures extérieures (11) agencées à l'extérieur dudit espace de passage (9) selon une direction qui est radiale à ladite direction d'extension principale (X) et configurées pour émettre un premier flux de carburant (F1) à l'extérieur dudit flux d'un comburant ; et
- une pluralité d'ouvertures intérieures (12) agencées au niveau et/ou à l'intérieur dudit espace de passage (9) selon une direction qui est radiale à ladite direction d'extension principale (X), lesdites ouvertures intérieures (12) étant adaptées pour introduire un second flux de carburant (F2', F2") à l'intérieur dudit flux d'un comburant ;
- un corps central (13) au moins partiellement inséré dans ledit conduit d'alimentation (5) et s'étendant entre une première extrémité (14), définissant ladite ouverture d'entrée (3), et une seconde extrémité (15) le long d'une direction d'extension (E) ; ladite seconde extrémité (15) définissant avec ledit conduit d'alimentation (5) au moins partiellement ledit espace de passage (9) ;
- au moins une buse intérieure (24) agencée à l'intérieur dudit conduit d'alimentation (5) selon une direction qui est radiale à ladite direction d'extension principale (X), ladite buse intérieure (24) définissant au moins partiellement ladite pluralité d'ouvertures intérieures (12) ;

caractérisé en ce que ladite au moins une buse intérieure (24) est interposée entre ledit corps central (13) et ledit conduit d'alimentation (5).

2. Appareil selon la revendication 1, dans lequel ledit corps central (13) a une extension sensiblement axialement symétrique par rapport à ladite direction d'extension (E).

3. Appareil selon la revendication 1 ou 2, dans lequel ladite direction d'extension (E) est parallèle à, de préférence coïncidant avec, ladite direction d'extension principale (X).

4. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ledit corps central (13) comporte un logement (16) adapté pour recevoir un conduit d'alimentation supplémentaire inséré réversiblement (17) pour alimenter un carburant, ledit logement (16) s'étendant entre ladite première extrémité (14) et ladite seconde extrémité (15) parallèlement à ladite direction d'extension (E).

5. Appareil selon une ou plusieurs des revendications précédentes, comprenant au moins un conduit de mise sous tension (18) en communication fluidique avec ledit conduit d'alimentation (5) et passant à travers ledit corps central (13) pour transporter une quantité de comburant vers ladite seconde extrémité (15) dudit corps central (13).

6. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite seconde extrémité (15) comporte une portion convergente (19), de préférence en forme de cône tronqué, le long de ladite direction d'extension (E) et définit avec ledit conduit d'alimentation (5) au moins partiellement ledit espace de passage (9).

7. Appareil selon la revendication 6, dans lequel ladite portion convergente (19) comporte une pluralité de trous d'écoulement (20a) adaptés pour introduire au moins partiellement ledit second flux de carburant (F2') à l'intérieur dudit flux d'un comburant, ladite pluralité de trous d'écoulement (20a) définissant au moins partiellement lesdites ouvertures intérieures (12).

8. Appareil selon la revendication 6 ou 7, dans lequel ladite seconde extrémité (15) comporte au moins une portion divergente (21) le long de ladite direction d'extension, ladite portion divergente (21) étant agencée au moins partiellement à l'intérieur de ladite portion convergente (19).

9. Appareil selon la revendication 8, dans lequel ladite portion divergente (21) comporte une pluralité de trous d'écoulement (20b) adaptés pour introduire au moins partiellement ledit second flux de carburant (F2') à l'intérieur dudit flux d'un comburant, ladite pluralité de trous d'écoulement (20b) définissant au moins partiellement lesdites ouvertures intérieures (12).

10. Appareil selon la revendication 9, dans lequel ladite seconde extrémité (15) comporte au moins une surface de retenue (22) adaptée pour relier ladite por-

tion divergente (21) et ladite portion convergente (19).

11. Appareil selon la revendication 10, dans lequel ladite surface de retenue (22) est perpendiculaire à ladite direction d'extension (E).

12. Appareil selon la revendication 10 ou 11, dans lequel ladite surface de retenue (22) est au moins partiellement en forme de lobe.

13. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite tête de combustion (2) comprend une pluralité de conduits d'écoulement (23) se ramifiant à partir de ladite première extrémité (14) dudit corps central (13) et s'étendant au moins partiellement le long d'une direction parallèle à ladite direction d'extension (E), ladite pluralité de conduits d'écoulement (23) définissant au moins partiellement ladite pluralité d'ouvertures extérieures (11) et/ou ladite pluralité d'ouvertures intérieures (12).

14. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite au moins une buse intérieure (24) comporte un axe d'extension incliné par rapport à ladite direction d'extension (E).

15. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite tête de combustion (2) comprend une pluralité de buses intérieures (24) ayant une extension transversale à ladite direction d'extension (E) de manière à ce que ledit second flux est au moins partiellement convergent le long de ladite direction d'extension (E).

16. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite tête de combustion (2) comprend une pluralité de buses extérieures (25) en communication fluidique avec ladite ouverture d'entrée (3) et agencées à l'extérieur dudit conduit d'alimentation (5) selon une direction qui est radiale à ladite direction d'extension principale (X), lesdites buses extérieures (25) définissant au moins partiellement ladite pluralité d'ouvertures extérieures (11).

17. Appareil selon la revendication 16, dans lequel lesdites buses extérieures (25) ont une extension qui est sensiblement parallèle à ladite direction d'extension principale (X) de manière à émettre ledit premier flux de carburant (F1) à l'extérieur dudit flux d'un comburant.

18. Appareil selon la revendication 16 ou 17, dans lequel lesdites buses extérieures (25) sont agencées de manière périmétrique par rapport audit conduit d'alimentation (5) et à proximité de ladite ouverture d'émission (7).

19. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite tête de combustion (2) est réversiblement mobile par rapport audit conduit d'alimentation (5) le long d'une direction de déplacement qui est parallèle à, de préférence coïncidant avec, ladite direction d'extension principale (X).

20. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ledit conduit d'alimentation (5) comporte une portion d'extrémité (10) définissant un profilé convergent à proximité de ladite ouverture d'émission (7).

21. Appareil selon une ou plusieurs des revendications précédentes, comprenant des moyens d'allumage de flamme (8) adaptés pour favoriser la combustion entre ledit combustible et ledit comburant.

22. Appareil selon une ou plusieurs des revendications précédentes, dans lequel ladite tête de combustion (2) comporte un conduit de passage (1000) définissant une entrée (1001) et une sortie (1002) à travers lesquelles le flux de comburant (C) peut s'écouler au moins partiellement.

23. Brûleur, comprenant :

- un appareil d'extrémité (1) selon une ou plusieurs des revendications précédentes ;
- des moyens d'aspiration (102) configurés pour aspirer au moins une quantité de comburant d'un environnement extérieur audit brûleur et pour déplacer ladite au moins une quantité de comburant de ladite seconde ouverture d'introduction (6) vers ladite seconde ouverture d'émission (7).

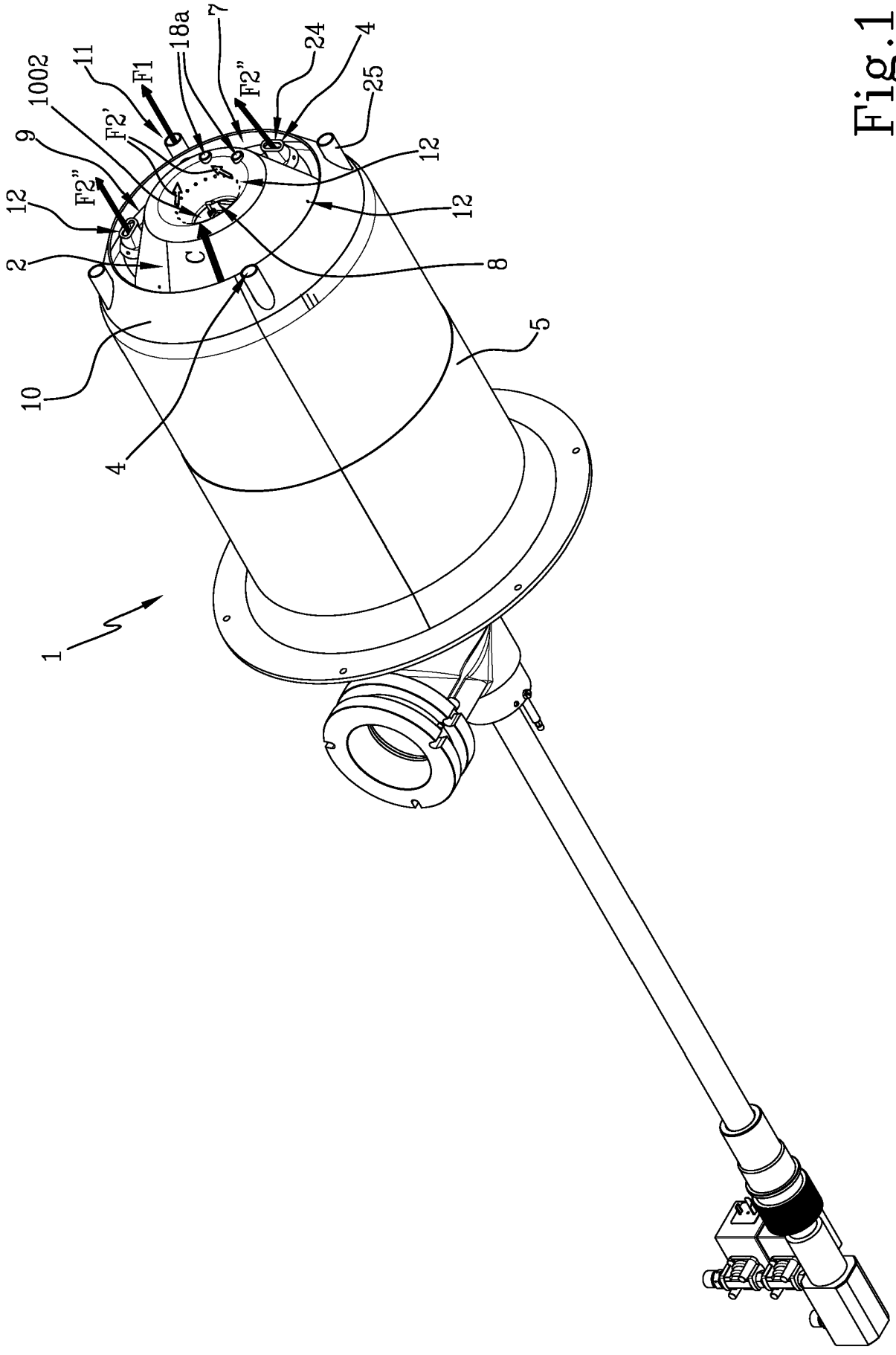


Fig.1

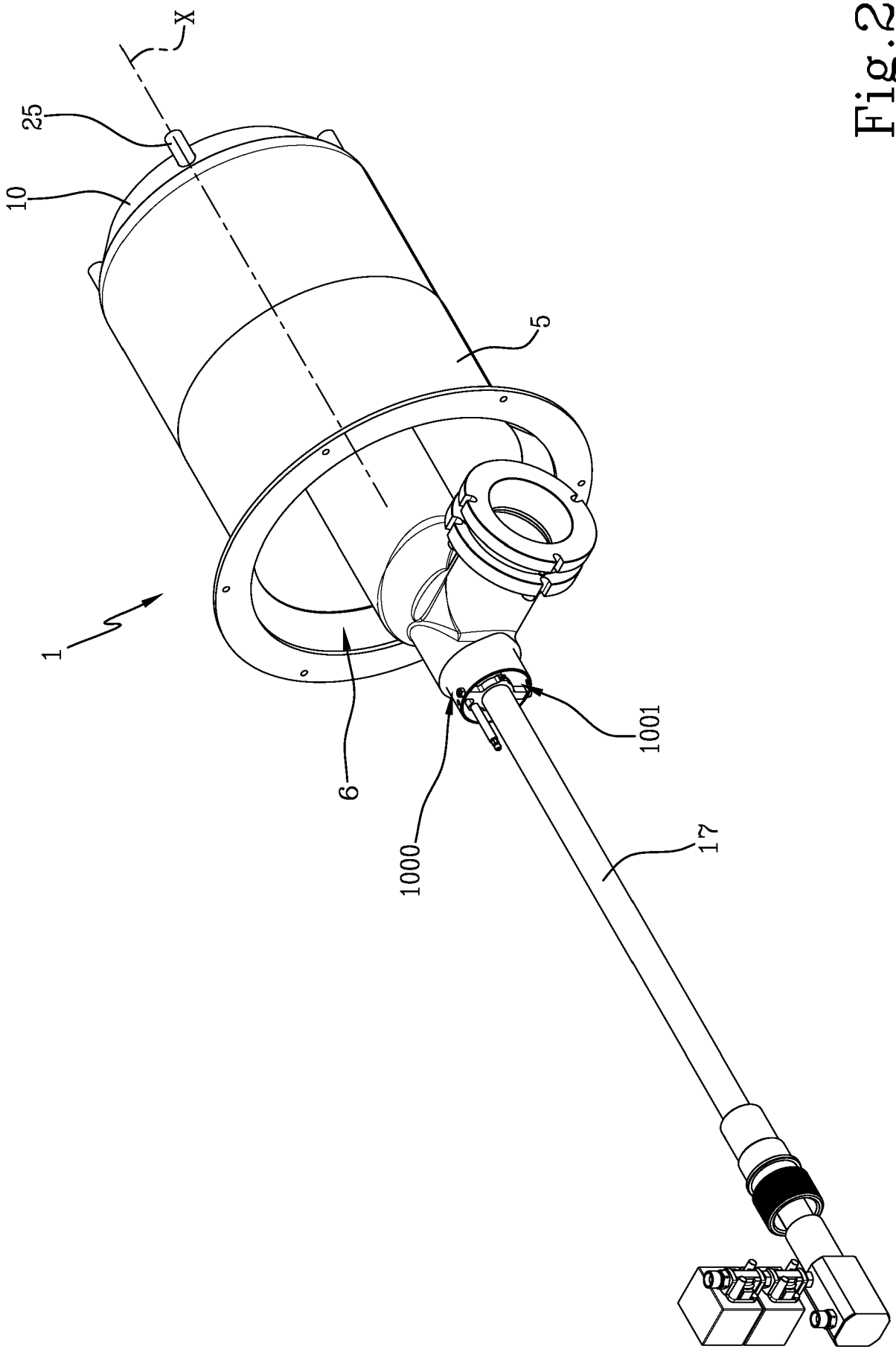


Fig.2

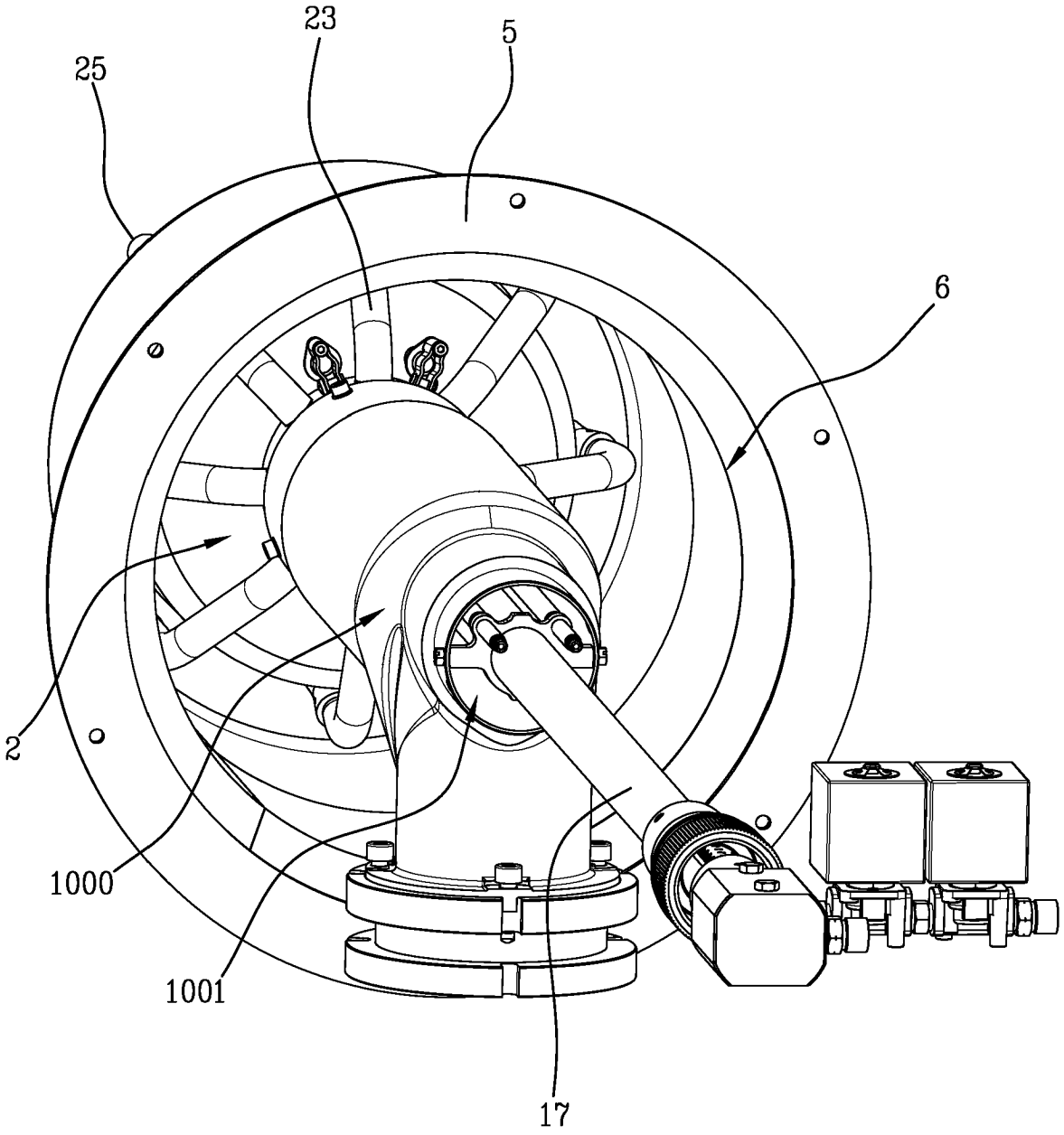


Fig.3

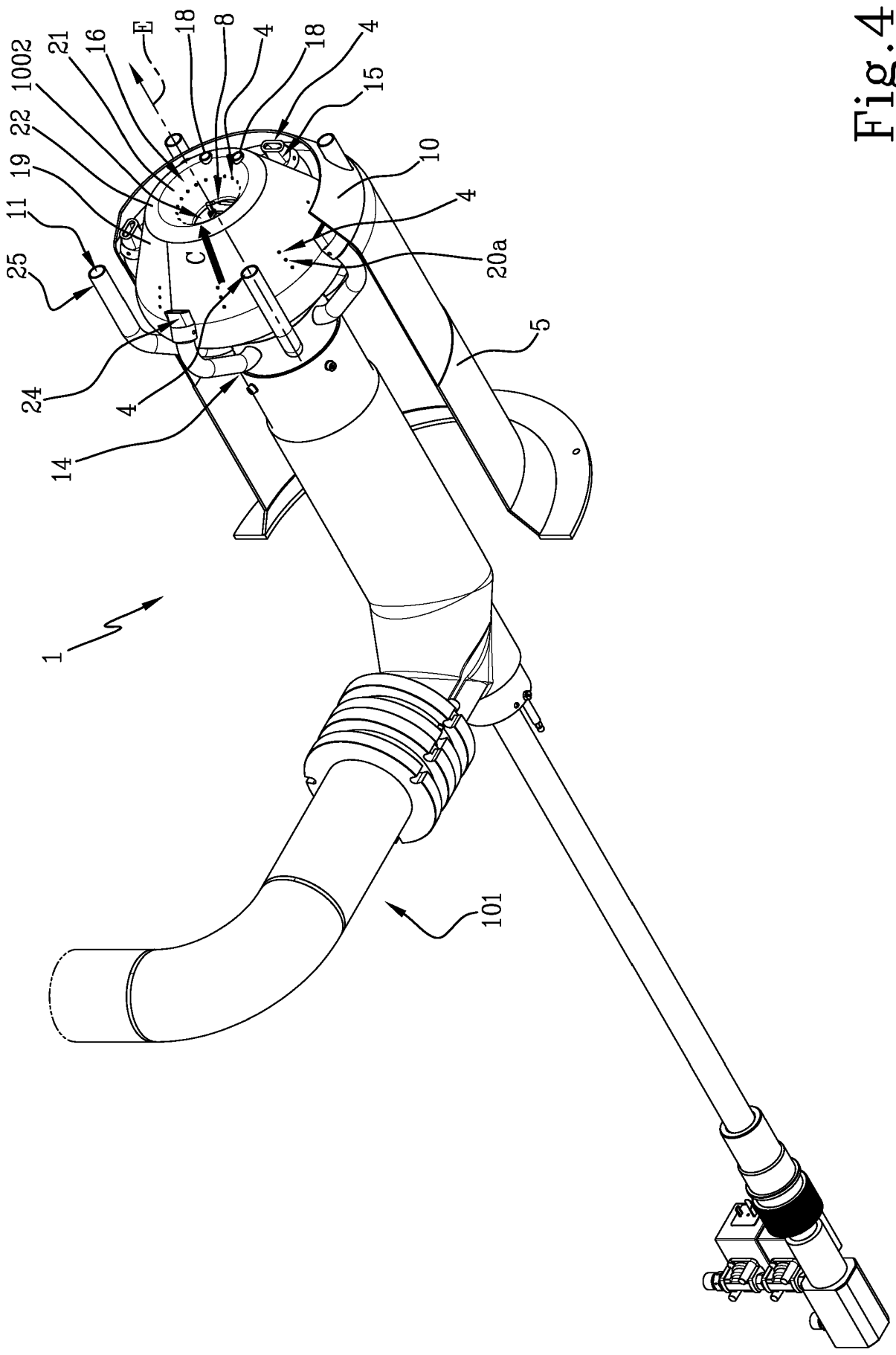


Fig.4

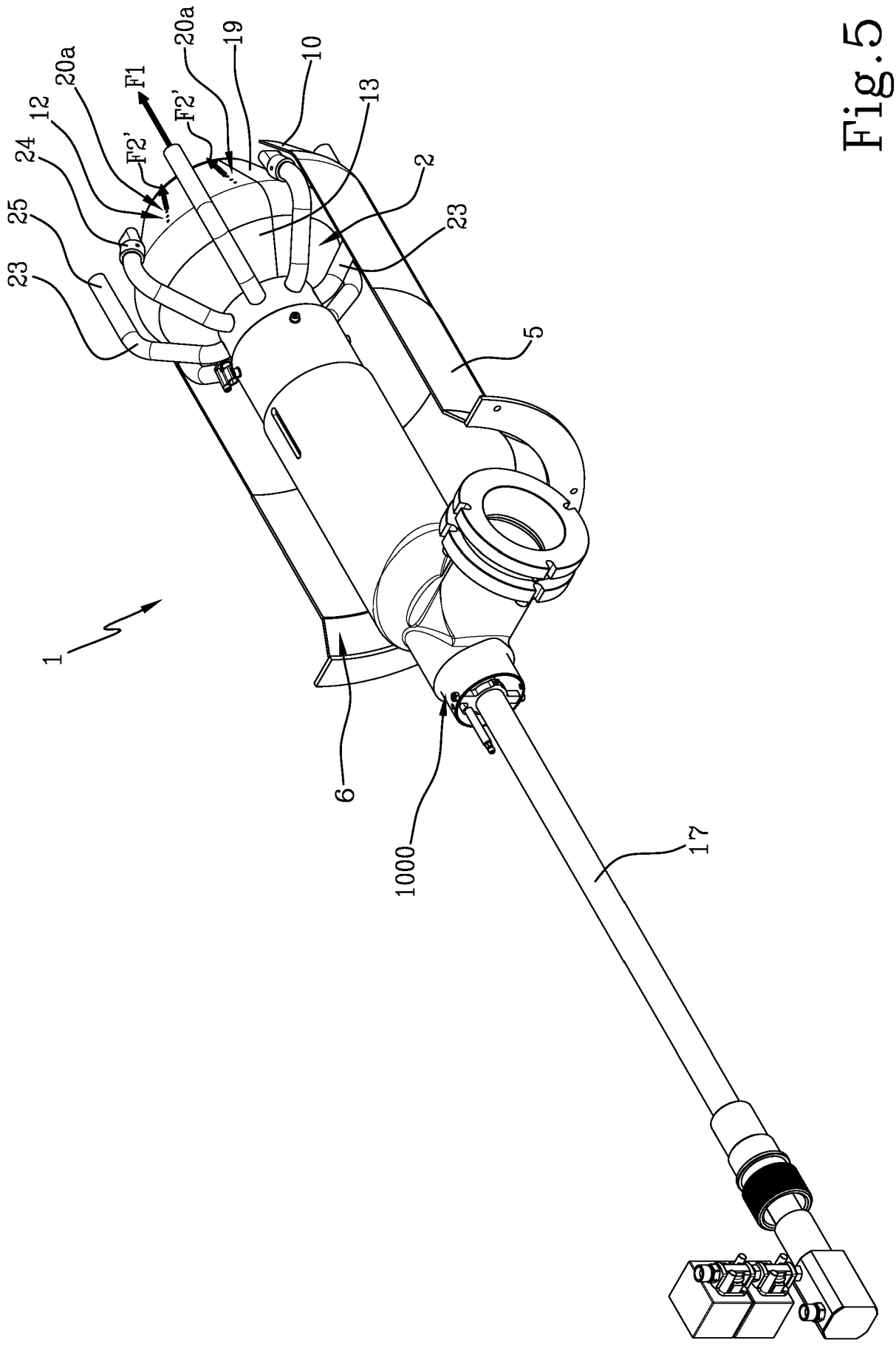


Fig.5

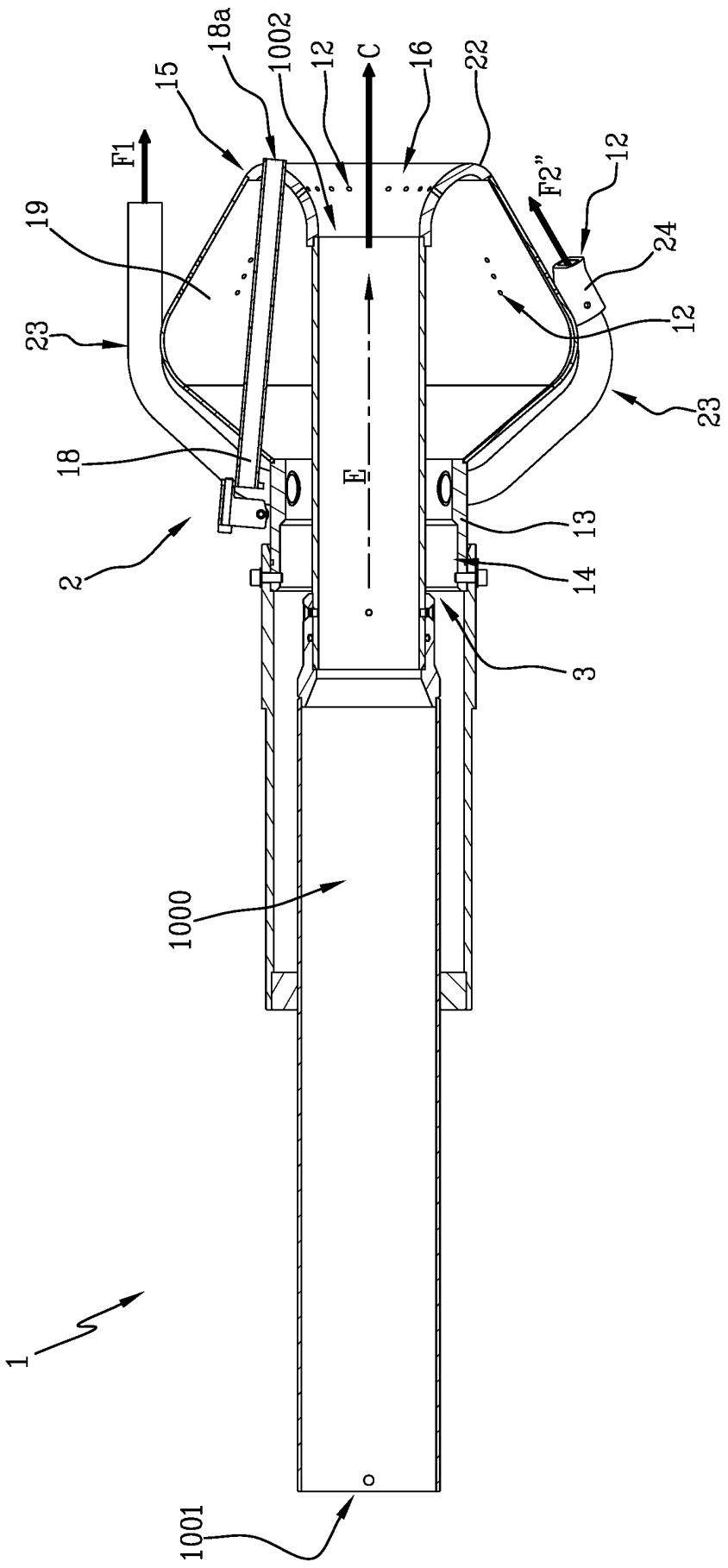

F1
15
18a
1002
12
C
16
22
F2"
12
19
24
23
12
23
18
E
13
2
14
3
1000
1
1001

Fig.6

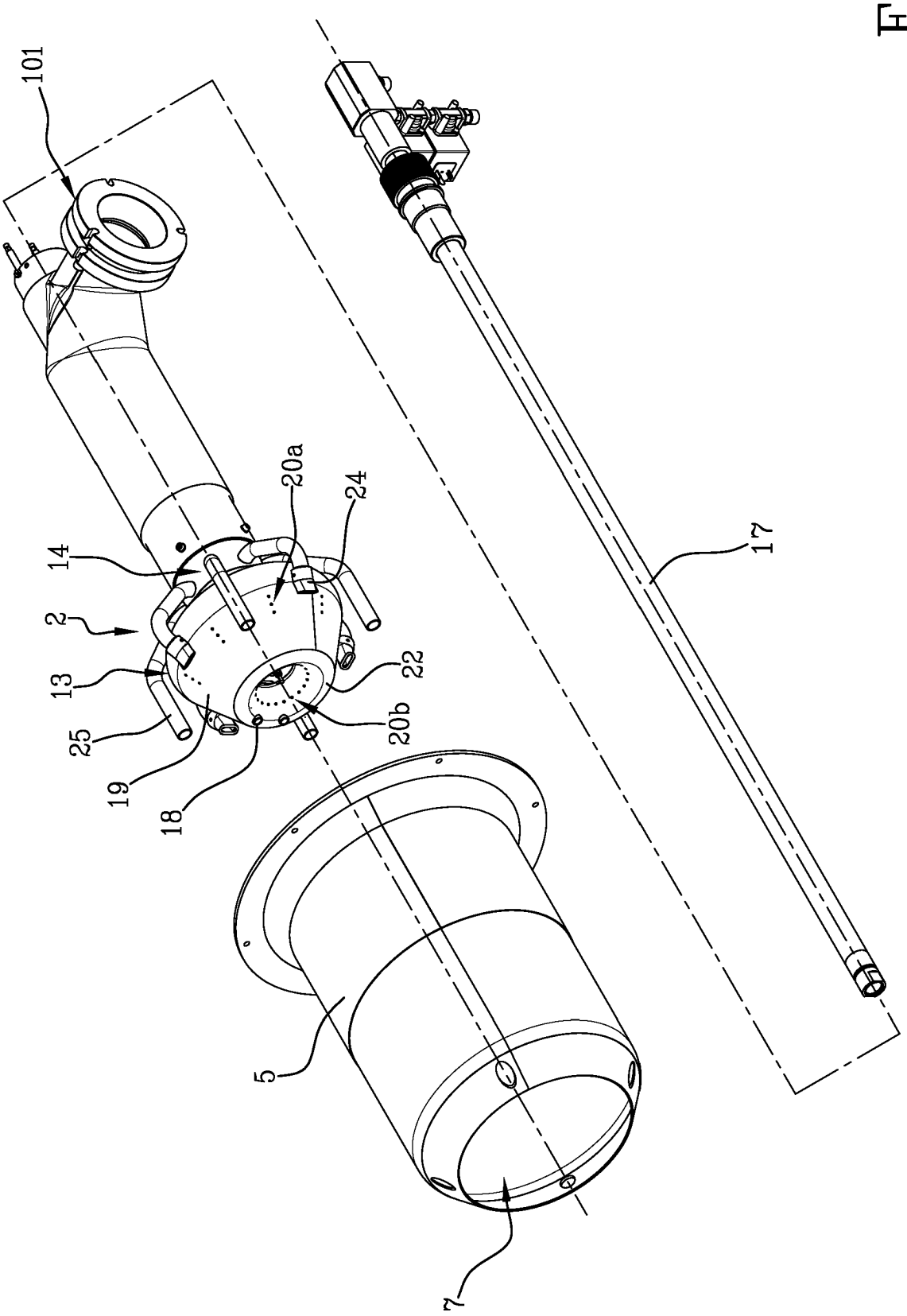
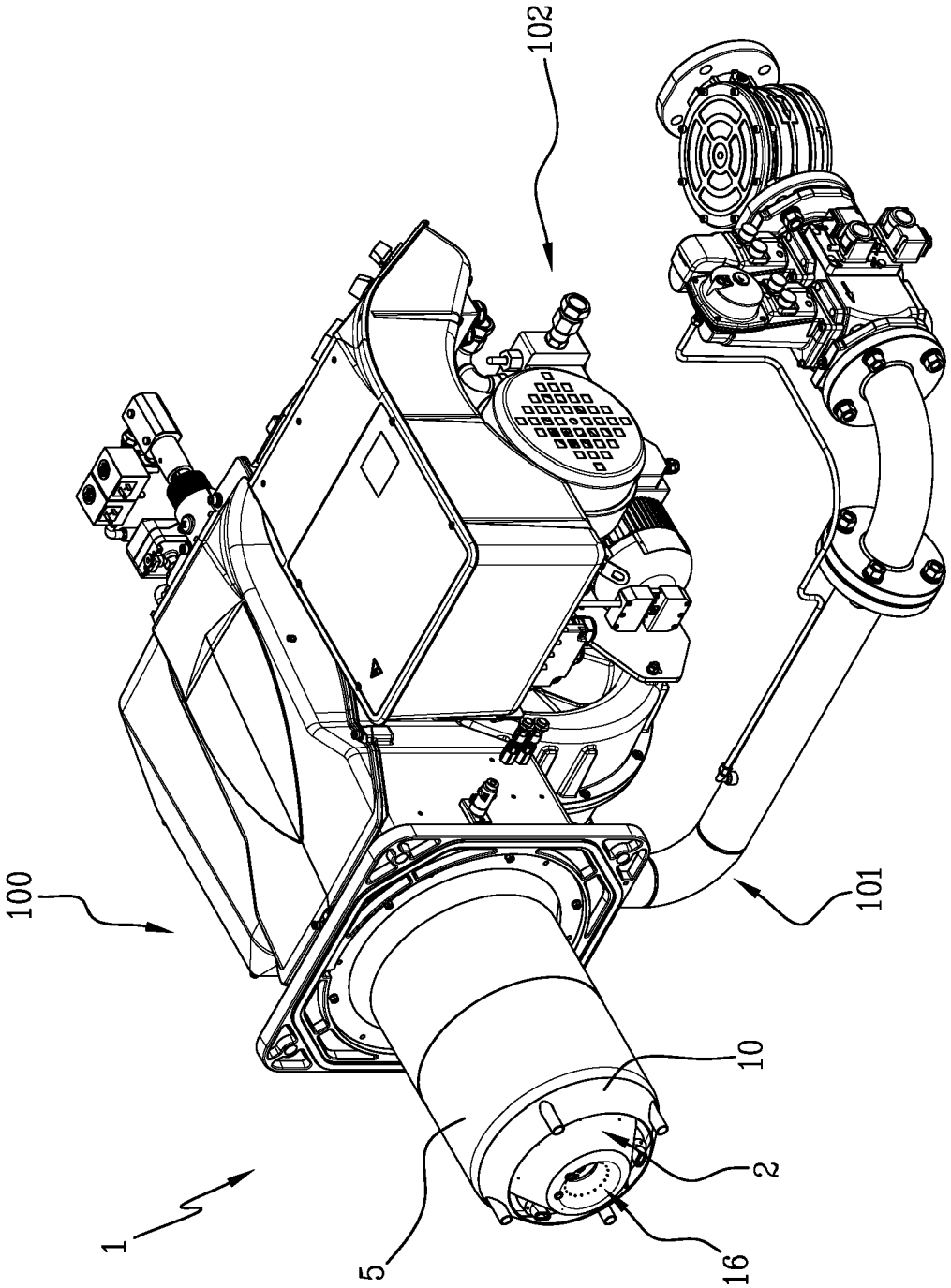


Fig.7

Fig.8




Temperature
Contour 2
2.067e+03
1.956e+03
1.846e+03
1.735e+03
1.625e+03
1.514e+03
1.404e+03
1.293e+03
1.183e+03
1.072e+03
9.615e+02
8.510e+02
7.405e+02
6.299e+02
5.194e+02
4.089e+02
2.984e+02
[K]
0
0.250
0.500
0.750
1.000 (m)

Fig.9


Velocity
Contour 2
9.642e+01
9.040e+01
8.437e+01
7.835e+01
7.232e+01
6.629e+01
6.027e+01
5.424e+01
4.821e+01
4.219e+01
3.616e+01
3.013e+01
2.411e+01
1.808e+01
1.205e+01
6.027e+00
0.000e+00
[m s^-1]
0
0.250
0.500
0.750
1.000 (m)

Fig.10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 3734154 A1 **[0009]**
- EP 3967924 A1 **[0009]**