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(71) Applicant: **Bosch Thermotechnology Ltd (UK)**
Worcester, Worcestershire WR4 9SW (GB)

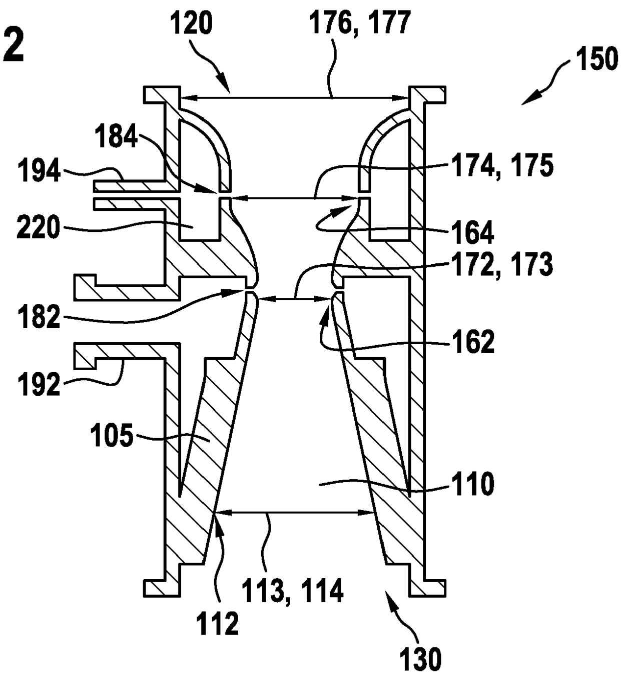
(72) Inventor: **Collins, Tom**
Worcester, WR3 8XA (GB)

(74) Representative: **Bee, Joachim**
Robert Bosch GmbH
C/IPE
Wernerstrasse 51
70469 Stuttgart (DE)

(54) VENTURI-TYPE MIXING NOZZLE AND COMBUSTION DEVICE WITH A VENTURI-TYPE MIXING NOZZLE

(57) A Venturi-type mixing nozzle (150) with a nozzle body (105) that comprises a main flow passage (110) having an inlet end (120) with an inlet cross-sectional flow area (177) and an outlet end (130), the inlet end being provided to permit inflow of a first fluid into the main flow passage, the main flow passage comprising a first throat (162) forming a first reduced cross-sectional flow area (173) that is smaller than the inlet cross-sectional flow area, the first throat being provided with at least one lateral inlet opening (182) that is provided to permit inflow of a second fluid into the main flow passage, wherein at least one second throat (164) is arranged in the main flow passage between inlet end and first throat, the at least one second throat forming at least one second reduced cross-sectional flow area (175) that is smaller than the inlet cross-sectional flow area.

Fig. 2



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Description

Background of the Invention

[0001] The present invention relates to a Venturi-type mixing nozzle with a nozzle body that comprises a main flow passage having an inlet end with an inlet cross-sectional flow area and an outlet end, wherein the inlet end is provided to permit inflow of a first fluid into the main flow passage, the main flow passage comprising a first throat forming a first reduced cross-sectional flow area that is smaller than the inlet cross-sectional flow area and arranged between the inlet end and the outlet end for creation of a negative pressure region in the main flow passage, the first throat being provided with at least one lateral inlet opening that is provided to permit inflow of a second fluid into the main flow passage for being mixed with the first fluid in the main flow passage. Moreover, the present invention relates to an air-gas mixing unit having such a Venturi-type mixing nozzle.

[0002] Document WO 2018/015130 A1 describes a Venturi-type mixing nozzle having a nozzle body with a main flow passage that has an inlet end and an outlet end. The main flow passage includes a throat that forms a passage constriction between the inlet end and the outlet end for creation of a negative pressure region in the main flow passage. The passage constriction is provided with a plurality of lateral inlet openings. In operation, a first fluid enters the main flow passage via the inlet end and a second fluid enters the main flow passage via the lateral inlet openings for being mixed with the first fluid in the main flow passage.

Summary of the Invention

[0003] The present invention relates to a Venturi-type mixing nozzle with a nozzle body that comprises a main flow passage having an inlet end with an inlet cross-sectional flow area and an outlet end, wherein the inlet end is provided to permit inflow of a first fluid into the main flow passage, the main flow passage comprising a first throat forming a first reduced cross-sectional flow area that is smaller than the inlet cross-sectional flow area and arranged between the inlet end and the outlet end for creation of a negative pressure region in the main flow passage, the first throat being provided with at least one lateral inlet opening that is provided to permit inflow of a second fluid into the main flow passage for being mixed with the first fluid in the main flow passage. At least one second throat is arranged in the main flow passage between the inlet end and the first throat, the at least one second throat forming at least one second reduced cross-sectional flow area that is smaller than the inlet cross-sectional flow area. The at least one second throat is provided to accelerate the first fluid upstream of the first throat. The first throat is provided to further accelerate the first fluid in direction of the outlet end.

[0004] Advantageously, by providing the inventive Venturi-type mixing nozzle with the at least one second throat, a signal pressure of the first fluid may be created at the second throat which is lower than a sum of respective downstream flow resistances, by partially accelerating a flow of the first fluid at the point where the signal pressure is measured, i.e. at the second throat. More specifically, the flow of the first fluid is accelerated at the second throat by a certain amount and a respective signal pressure sampling point of the Venturi-type mixing nozzle is located at the second throat such that a respectively measured signal pressure of the first fluid at this sampling point is lower than upstream of the second throat and, thus, lower than respective signal pressures that are measurable at the inlet end, as in conventional Venturi-type mixing nozzles. The first fluid then flows from the second throat toward and through the first throat downstream of the second throat, where the flow of the first fluid is even further accelerated and where the second fluid is injected through the at least one lateral inlet opening into the Venturi-type mixing nozzle and, thus, mixed with the flow of the first fluid, before decelerating downstream of the first throat. The second fluid may beneficially be provided with a reduced fluid pressure at the at least one lateral inlet opening at the first throat as a result of the reduced signal pressure of the first fluid at the second throat, such that mixing of the first and second fluid may advantageously be improved.

[0005] According to one aspect, the nozzle body comprises a pressure signal port that is connected to the main flow passage at the at least one second throat for generation of a pressure signal that is indicative of a static pressure of the first fluid in the main flow passage at the at least one second throat.

[0006] Thus, an improved pressure signal that is indicative of a signal pressure of the first fluid and, more specifically, of a static pressure of the first fluid in the main flow passage at the at least one second throat may be determined and used for an ameliorated regulation of an associated supply pressure of the second fluid at the at least one lateral inlet opening at the first throat.

[0007] Preferably, the Venturi-type mixing nozzle further comprises a diffuser that is arranged between the first throat and the outlet end, the diffuser forming a cross-sectional flow area that increases steadily from the first throat up to the outlet end.

[0008] Thus, after mixing of the first and second fluids at the first throat, a respective flow speed of the mixed first and second fluids may be reduced by means of the diffuser to a certain flow speed that is, for instance, required to enable an efficient burning of the mixed first and second fluids in an associated combustion device, such as e.g. a combustion device used in a building heating system.

[0009] According to one aspect, a ratio between the at least one second reduced cross-sectional flow area and the first reduced cross-sectional flow area is greater than 1.15.

[0010] Adjusting the ratio to a value greater than 1.15

beneficially enables recording of a signal pressure of the first fluid at the second throat that is sufficiently close to a respective signal pressure of the first fluid at the first throat, where the second fluid is injected into the main flow passage. Thus, a required supply pressure of the second fluid at the first throat may advantageously be reduced, while still ensuring that the second fluid is injected into the main flow passage at the first throat. However, if the ratio is too high, then a respective flow distance between the first and second throats will likely need to be increased to avoid a respective venturi wall gradient being too shallow, as this could cause an undesirable rebounding effect on the flow of the first fluid.

[0011] Preferably, the ratio between the at least one second reduced cross-sectional flow area and the first reduced cross-sectional flow area is minimised such that a static pressure of the first fluid in the main flow passage at the at least one second throat approximates a static pressure of the first fluid in the main flow passage at the first throat.

[0012] Minimising the ratio beneficially enables recording of a signal pressure of the first fluid at the second throat that is as close as possible to a respective signal pressure of the first fluid at the first throat, where the second fluid is injected into the main flow passage. Thus, a required supply pressure of the second fluid at the first throat may advantageously be minimised, while still ensuring that the second fluid is injected into the main flow passage at the first throat. This is preferably accomplished by selecting the ratio greater than 1.15, as the gas valve pressure may not be set sufficiently to ensure that the second fluid is injected into the main flow passage at the first throat if the ratio is less than 1.15.

[0013] According to one aspect, a ratio between the inlet cross-sectional flow area and the at least one second reduced cross-sectional flow area is greater than 1.15.

[0014] Thus, acceleration of the first fluid at the second throat and, consequently, a respective decrease of an associated signal pressure of the first fluid at the second throat may be guaranteed.

[0015] Preferably, the ratio between the inlet cross-sectional flow area and the at least one second reduced cross-sectional flow area is minimised.

[0016] Thus, undesired turbulences in the flow of the first fluid from the inlet end to the second throat may advantageously be avoided.

[0017] According to one aspect, the nozzle body comprises a gradient between the at least one second throat and the first throat which is predefined to prevent a rebounding effect of the first fluid from the nozzle body into the main flow passage upstream of the first throat.

[0018] If the gradient of the nozzle body and, more particularly, of a respective nozzle body inner wall between the at least one second throat and the first throat is too shallow, this may cause an undesired deceleration in flow speed of the first fluid at the second throat by means of a rebounding effect. Thus, in order to keep the gradient steep, a longer flow path between the at least one second throat and the first throat would be necessary which, however, induces extra flow resistance. Therefore, in order to avoid the need for a longer flow path, a minimisation of an underlying ratio of respective diameters of the at least one second throat and the first throat is advantageous.

[0019] According to one aspect, the first fluid is air and the second fluid is a combustible gas.

[0020] Thus, the Venturi-type mixing nozzle may advantageously be used with a combustion device that is adapted for combustion of a gas/air mixture, e.g. a hydrogen/air mixture.

[0021] Furthermore, the present invention relates to an air-gas mixing unit with a Venturi-type mixing nozzle as described above, and a gas governor that is adapted to control supply of gas to the Venturi-type mixing nozzle dependant on an air pressure signal that is indicative of a static air pressure in the main flow passage of the Venturi-type mixing nozzle at the at least one second throat.

[0022] Thus, an improved air-gas mixing unit for a combustion device that is adapted for combustion of a gas/air mixture, e.g. a hydrogen/air mixture, may be provided.

Brief Description of the Drawings

[0023] Exemplary embodiments of the present invention are described in detail hereinafter with reference to the attached drawings. In these attached drawings, identical or identically functioning components and elements are labelled with identical reference signs and they are generally only described once in the following description.

Fig. 1 shows a schematic view of an air-gas mixing unit with a Venturi-type mixing nozzle according to an embodiment,

Fig. 2 shows a sectional view of the Venturi-type mixing nozzle of Fig. 1, and

Fig. 3 shows a schematic view of a nozzle body of the Venturi-type mixing nozzle of Fig. 1 and Fig. 2.

Detailed Description

[0024] Fig. 1 shows an illustrative air-gas mixing unit 100 with a Venturi-type mixing nozzle 150 according to an embodiment. By way of example, the air-gas mixing unit 100 may be integrated into an associated combustion device that may e.g. be used in building heating systems.

[0025] Preferably, the Venturi-type mixing nozzle 150 is used for mixing of a combustible gas, e.g. hydrogen, with air at a desired concentration or ratio. Therefore, the air-gas mixing unit 100 illustratively comprises a gas governor 190 that is adapted to control supply of gas to the Venturi-type mixing nozzle 150 dependant on an air pressure signal 198 that is indicative of a static air pressure in the main flow passage 110 of the Venturi-type mixing nozzle 150.

[0026] According to one aspect, the Venturi-type mixing nozzle 150 has a nozzle body 105 that forms a main flow passage 110. The main flow passage 110 in the nozzle body 105 is generally formed as a tubular channel with a smooth inner surface. Illustratively, the main flow passage 110 is formed along the longitudinal direction of the nozzle body 105 and has an inlet end 120 with an inlet cross-sectional flow area 177, as well as an outlet end 130. The inlet cross-sectional flow area 177 has an associated diameter 176.

[0027] Furthermore, the main flow passage 110 comprises a first throat 162 forming a first reduced cross-sectional flow area 173 that is smaller than the inlet cross-sectional flow area 177. The first reduced cross-sectional flow area 173 has an associated diameter 172.

[0028] Illustratively, the first throat 162 and, thus, the first reduced cross-sectional flow area 173 is arranged in the longitudinal direction of the nozzle body 105 between the inlet end 120 and the outlet end 130 for creation of a negative pressure region 125 in the main flow passage 110. The first throat 162 is preferably provided with at least one lateral inlet opening 182.

[0029] Preferably, a diffuser 112 is arranged between the first throat 162 and the outlet end 130. Illustratively, the diffuser 112 forms a cross-sectional flow area 114 that increases steadily from the first throat 162 up to the outlet end 130. In other words, the cross-sectional flow area 114 of the diffuser 112 has an associated diameter 113 that increases steadily from the first throat 162 up to the outlet end 130.

[0030] According to one aspect, at least one second throat 164 is arranged in the main flow passage 110 in the longitudinal direction of the nozzle body 105 between the inlet end 120 and the first throat 162. The first throat 162 and the at least one second throat 164 are preferably spaced apart from each other in the longitudinal direction of the nozzle body 105 by a predetermined distance 178. Preferably, the nozzle body 105 comprises a pressure signal port 184 that is connected to the main flow passage 110 at the at least one second throat 164.

[0031] Illustratively, the at least one second throat 164 forms at least one second reduced cross-sectional flow area 175 that is smaller than the inlet cross-sectional flow area 177. The second reduced cross-sectional flow area 175 has an associated diameter 174.

[0032] In an illustrative operation of the air-gas mixing unit 100 and, thus, the Venturi-type mixing nozzle 150, a first fluid 142 enters the main flow passage 110 of the Venturi-type mixing nozzle 150 via the inlet end 120. By way of example, the first fluid 142 is air and a respective flow of the air has a pressure Po at the inlet end 120. The first fluid 142 is accelerated at the at least one second throat 164 which is, thus, provided to accelerate the first fluid 142 upstream of the first throat 162. At the pressure signal port 184, which is connected to the main flow passage 110 at the at least one second throat 164, the pressure signal 198 that is indicative of a static pressure P_1 of the first fluid 142 in the main flow passage 110 at the at least one second throat 164 is generated, with $P_1<P_0$. The pressure signal 198 is illustratively provided to the gas governor 190 via an associated signal line 194. At the gas governor 190, a gas pressure P_g of gas 197, e.g. a combustible gas such as hydrogen, that is supplied to the gas governor 190 via a conduit 196, is regulated on the basis of the pressure signal 198, with $P_g \geq P_1$. Thus, supply of gas from the gas governor 190 via a supply conduit 192 to the at least one lateral inlet opening 182 at the first throat 162 is controlled dependant on the pressure signal 198. At the first throat 162, the first fluid 142 is preferably further accelerated such that it has a pressure P_2, with $P_2<P_1$, and the gas illustratively forms a second fluid 144 that enters the main flow passage 110 via the at least one lateral inlet opening 182 for being mixed with the first fluid 142 in the main flow passage 110, with $P_g>P_2$. Thus, a mixed fluid 146 is created, e.g. an air-gas mixture, that exits the main flow passage 110 at the outlet end 130.

[0033] Fig. 2 shows the Venturi-type mixing nozzle 150 of Fig. 1. As described above, the Venturi-type mixing nozzle 150 has the nozzle body 105 that comprises the main flow passage 110 having the inlet end 120 with the inlet cross-sectional flow area 177, and the outlet end 130. The main flow passage 110 comprises the first throat 162 that forms the first reduced cross-sectional flow area 173 that is smaller than the inlet cross-sectional flow area 177 and arranged between the inlet end 120 and the outlet end 130. The first throat 162 is provided with the at least one lateral inlet opening 182. Furthermore, the at least one second throat 164 is arranged in the main flow passage 110 between the inlet end 120 and the first throat 162. The at least one second throat 164 forms the at least one second reduced cross-sectional flow area 175 that is smaller than the inlet cross-sectional flow area 177.

[0034] However, in contrast to Fig. 1 the pressure signal port 184 of Fig. 1 at the at least one second throat 164 is now connected to the signal line 194 via a plenum chamber 220. Thus, an enhanced stability and accuracy in reading of the pressure signal 198 of Fig. 1 is enabled.

[0035] Illustratively, the main flow passage 110 is funnel-shaped between the at least one second throat 164 and the first throat 162. According to one aspect, a ratio between the at least one second reduced cross-sectional flow area 175 and the first reduced cross-sectional flow area 173 is greater than 1.15. By way of example, the ratio decreases exponentially from the at least one second throat 164 toward the first throat 162.

[0036] Preferably, this ratio between the at least one second reduced cross-sectional flow area 175 and the first reduced cross-sectional flow area 173 is minimised. More specifically, the ratio is preferably minimised such that a static pressure of the first fluid (142 of Fig. 1) in the main flow passage 110 at the at least one second throat 164 approximates a static pressure of the first fluid

(142 of Fig. 1) in the main flow passage 110 at the first throat 162, while still ensuring that the second fluid will flow into the main flow passage 110.

[0037] Furthermore, the main flow passage 110 between the inlet end 120 and the at least one second throat 164 is preferably also funnel-shaped. According to one aspect a ratio between the inlet cross-sectional flow area 177 and the at least one second reduced cross-sectional flow area 175 is greater than 1.15. By way of example, this ratio decreases exponentially from the inlet end 120 toward the at least one second throat 164. Preferably, the ratio between the inlet cross-sectional flow area 177 and the at least one second reduced cross-sectional flow area 175 is also minimised.

[0038] Moreover, according to one aspect a gradient between the at least one second throat 164 and the first throat 162 is predefined to prevent a rebounding effect of the first fluid (142 of Fig. 1) from the nozzle body 105 into the main flow passage 110 upstream of the first throat 162. The gradient may be predefined by adapting the predetermined distance 178 of Fig. 1 in order to avoid the undesired rebounding effect.

[0039] Fig. 3 shows the nozzle body 105 of the Venturi-type mixing nozzle 150 of Fig. 1 and Fig. 2. Fig. 3 further illustrates the overall funnel-shaped configuration of an inlet section of the nozzle body 105 formed between the inlet end 120 and the first throat 162, which forms a converging inflow section. Furthermore, an illustrative flow of the first fluid 142 of Fig. 1 is shown. Between the first throat 162 and the outlet end 130, the main flow passage 110 is illustratively conical and, thus, forming a diverging outflow section.

Claims

1. Venturi-type mixing nozzle (150) with a nozzle body (105) that comprises a main flow passage (110) having an inlet end (120) with an inlet cross-sectional flow area (177) and an outlet end (130), wherein the inlet end (120) is provided to permit inflow of a first fluid (142) into the main flow passage (110), the main flow passage (110) comprising a first throat (162) forming a first reduced cross-sectional flow area (173) that is smaller than the inlet cross-sectional flow area (177) and arranged between the inlet end (120) and the outlet end (130) for creation of a negative pressure region (125) in the main flow passage (110), the first throat (162) being provided with at least one lateral inlet opening (182) that is provided to permit inflow of a second fluid (144) into the main flow passage (110) for being mixed with the first fluid (142) in the main flow passage (110), wherein at least one second throat (164) is arranged in the main flow passage (110) between the inlet end (120) and the first throat (162), the at least one second throat (164) forming at least one second reduced cross-sectional flow area (175) that is smaller than the inlet cross-sectional flow area (177), wherein the at least one second throat (164) is provided to accelerate the first fluid (142) upstream of the first throat (162), and wherein the first throat (162) is provided to further accelerate the first fluid (142) in direction of the outlet end (130).

2. Venturi-type mixing nozzle of claim 1, wherein the nozzle body (105) comprises a pressure signal port (184) that is connected to the main flow passage (110) at the at least one second throat (164) for generation of a pressure signal (198) that is indicative of a static pressure of the first fluid (142) in the main flow passage (110) at the at least one second throat (164).

3. Venturi-type mixing nozzle of claim 1 or 2, further comprising a diffuser (112) that is arranged between the first throat (162) and the outlet end (130), the diffuser (112) forming a cross-sectional flow area (114) that increases steadily from the first throat (162) up to the outlet end (130).

4. Venturi-type mixing nozzle of any one of the preceding claims, wherein a ratio between the at least one second reduced cross-sectional flow area (175) and the first reduced cross-sectional flow area (173) is greater than 1.15.

5. Venturi-type mixing nozzle of claim 4, wherein the ratio between the at least one second reduced cross-sectional flow area (175) and the first reduced cross-sectional flow area (173) is minimised such that a static pressure of the first fluid (142) in the main flow passage (110) at the at least one second throat (164) approximates a static pressure of the first fluid (142) in the main flow passage (110) at the first throat (162).

6. Venturi-type mixing nozzle of any one of the preceding claims, wherein a ratio between the inlet cross-sectional flow area (177) and the at least one second reduced cross-sectional flow area (175) is greater than 1.15.

7. Venturi-type mixing nozzle of claim 6, wherein the ratio between the inlet cross-sectional flow area (177) and the at least one second reduced cross-sectional flow area (175) is minimised.

8. Venturi-type mixing nozzle of any one of the preceding claims, wherein the nozzle body (105) comprises a gradient between the at least one second throat (164) and the first throat (162) which is predefined to prevent a rebounding effect of the first fluid (142) from the nozzle body (105) into the main flow passage (110) upstream of the first throat (162).

9. Venturi-type mixing nozzle of any one of the preceding claims, wherein the first fluid (142) is air and the second fluid (144) is a combustible gas.

10. An air-gas mixing unit (100) with a Venturi-type mixing nozzle (150) of any one of the preceding claims, and a gas governor (190) that is adapted to control supply of gas to the Venturi-type mixing nozzle (150) dependant on an air pressure signal (198) that is indicative of a static air pressure in the main flow passage (110) of the Venturi-type mixing nozzle (150) at the at least one second throat (164).

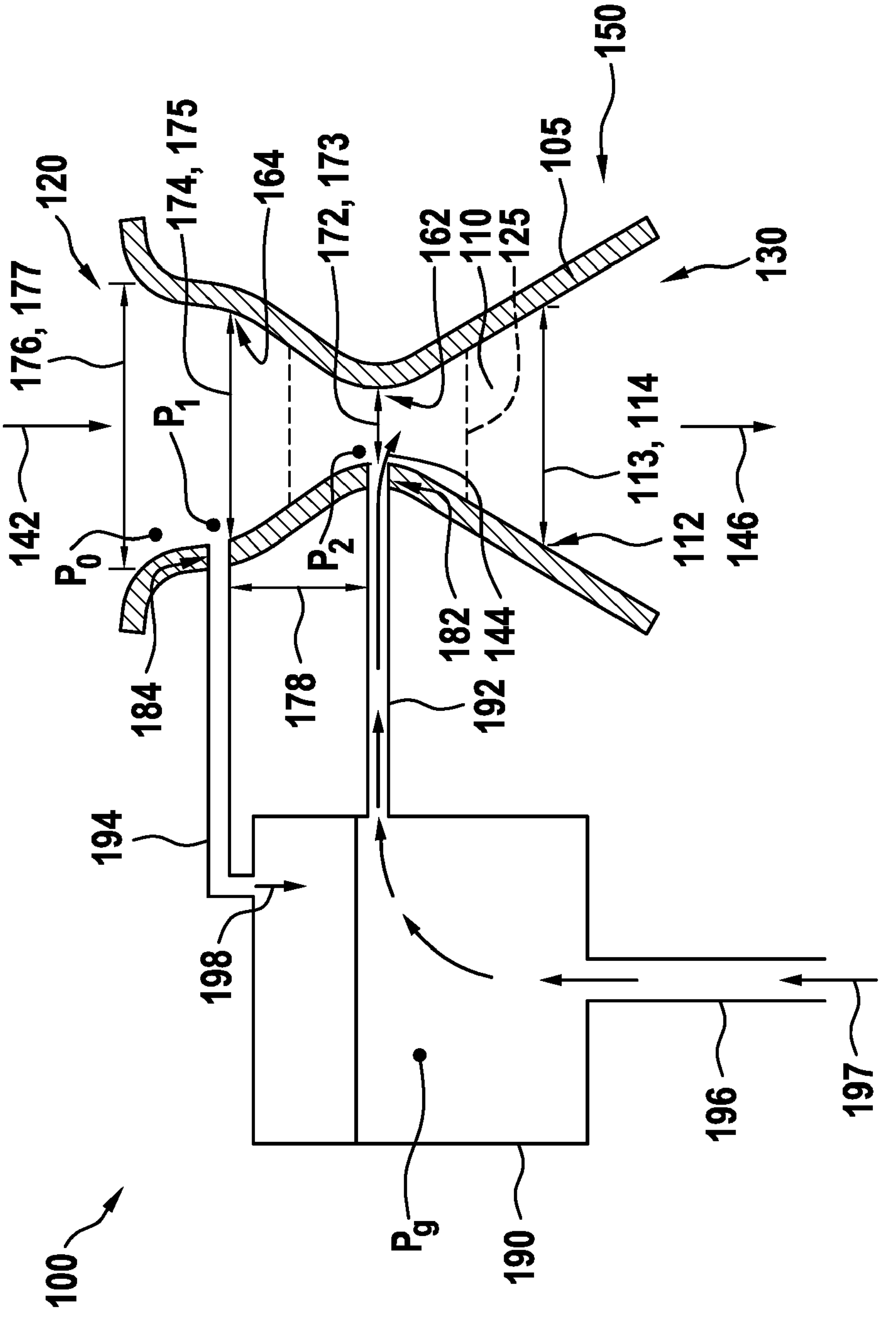

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Fig. 1

Fig. 2

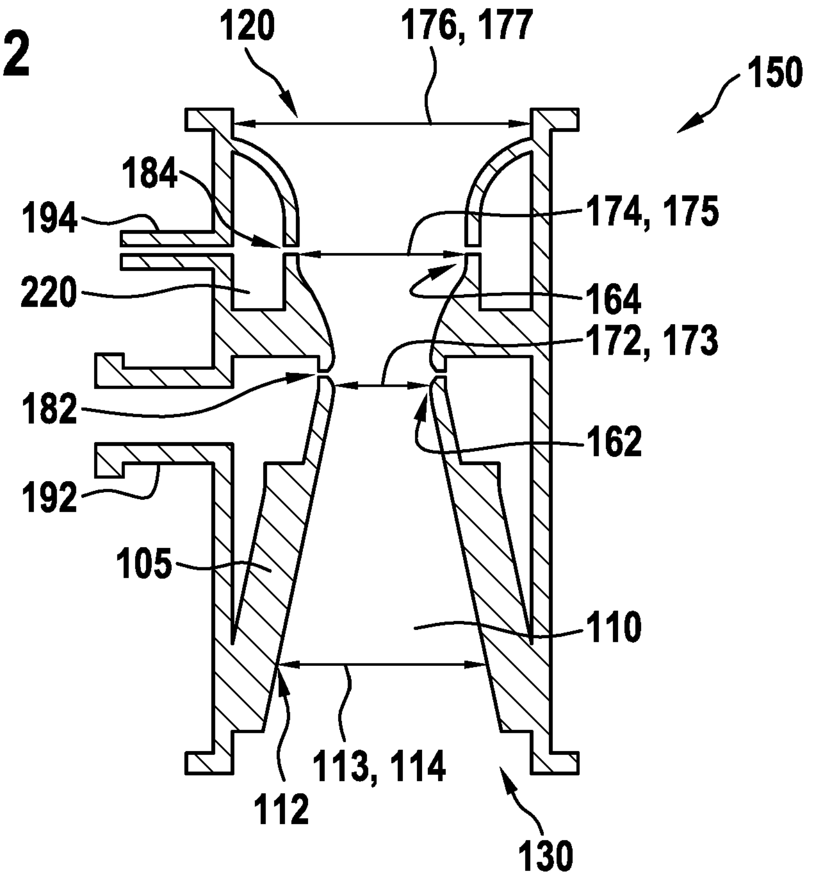
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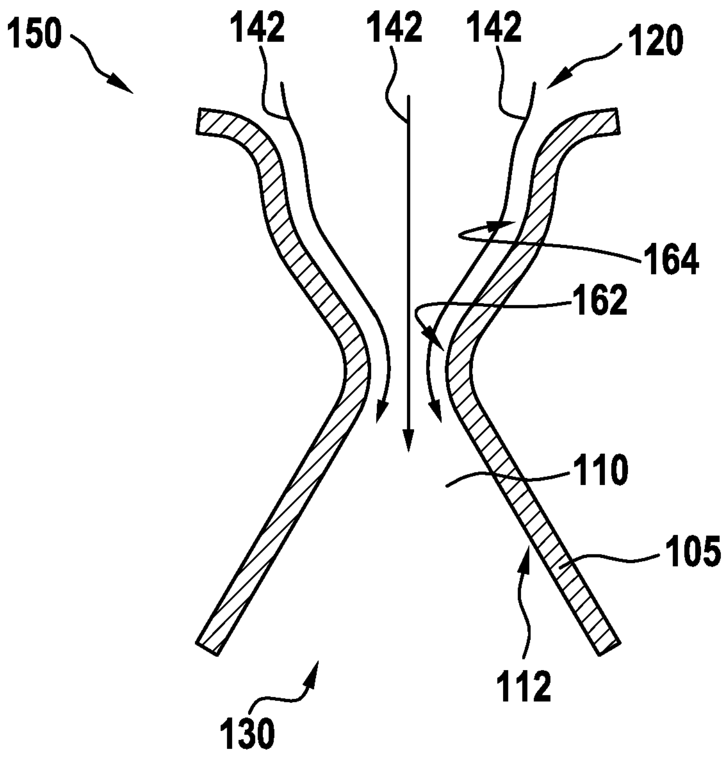
Fig. 3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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 5309

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2020/393125 A1 (PARK JANGHEE [KR] ET AL) 17 December 2020 (2020-12-17) * paragraph [0015]; figures 2,3 * * paragraph [0061] - paragraph [0081] *	1,3,4, 6-9 2,5,10	INV. F23D14/64
A	KR 2018 0088548 A (RINNAI KOREA CORP [KR]) 6 August 2018 (2018-08-06) * paragraph [0001]; figures 1-4 * * claims 1-4 *	1-10	
A	EP 0 846 916 A2 (SIT LA PRECISA SPA [IT]) 10 June 1998 (1998-06-10) * column 1, line 3 - line 11; claim 1; figure 1 * * column 2, line 1 - line 16 *	2,10	

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	4 August 2022	Hauck, Gunther

CATEGORY OF CITED DOCUMENTS

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04-08-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020393125 A1	17-12-2020	NONE	
KR 20180088548 A	06-08-2018	NONE	
EP 0846916 A2	10-06-1998	DE 846916 T1	22-10-1998
		EP 0846916 A2	10-06-1998
		IT PD960300 A1	06-06-1998

EPO FORM P0459

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Patent documents cited in the description

- WO 2018015130 A1 **[0002]**