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(54) **CYLINDRICAL PREMIX GAS BURNER**

(57) A cylindrical premix gas burner comprises a cylindrical burner deck on the outside of which premix gas is combusted; a mixing chamber inside the cylindrical burner deck; an inlet for the introduction of premix gas in the mixing chamber; and an end cap delimiting the mixing chamber at the opposite side of the cylindrical burner from the inlet. The burner comprises a tube extending in the mixing chamber. The tube is at a first end attached to the end cap. The other end of the tube is open.

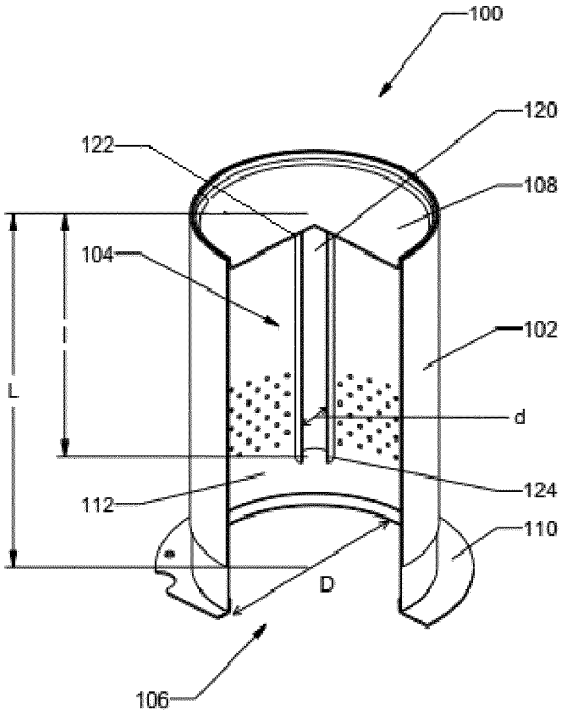

Fig. 1

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Description

Technical Field

[0001] The invention relates to cylindrical premix gas burners having a cylindrical burner deck.

Background Art

[0002] Cylindrical premix gas burners have a burner deck of cylindrical shape around a mixing chamber. The premixed gas and air mixture is supplied via an inlet and is further mixed in a mixing chamber surrounded by the cylindrical burner deck. From the mixing chamber the gas and air is supplied to the burner deck through holes and/or pores in the burner deck. The flames are produced on the external surface of the burner deck. The process of gas being mixed with air immediately followed by the heavy burner reaction and flames gives rise to waves travelling in the direction of the gas-air mixture and to waves travelling back from the burner deck in the opposite direction. Depending upon the mode of the combustion and the geometry of the combustion system a resonance phenomenon may be created resulting in standing waves inside the volume of the mixing chamber. These standing waves generate noise.

[0003] EP-A-1087180 solves the noise problem by inserting an axial flow element in the entry of a cylinder or cone shaped burner surface. Short circuit openings are arranged parallel to this axial flow element. The axial flow element together with the parallel openings avoid or at least decrease the generation of standing waves and thus reduce the level of noise and improve the quality of the combustion. The solution provided by EP-A-1087180 has been called the anti-noise tube. This anti-noise tube also has some drawbacks. As there is an additional and separate part, it is an expensive solution. Secondly, the creation of the short-circuit openings is mainly carried out by welding the anti-noise tube on a flange leaving a small gap; this process is difficult and time consuming. Furthermore, the presence of the anti-noise tube creates a considerable pressure drop over the burner.

[0004] WO2009/112909A2 shows a burner comprising an inlet for the premix gas to be combusted. A channelling element for the introduction of premix gas in the mixing chamber can be surrounded by one or more holes in the plate around the channelling element through which further premix gas is flowing into the mixing chamber. Such inlet system does not provide satisfactorily noise reduction in all circumstances. Such system also increases the pressure drop over the burner.

Disclosure of Invention

[0005] The first aspect of the invention is a cylindrical premix gas burner. The burner comprises a cylindrical burner deck on the outside of which premix gas is combusted when the burner is in use; a mixing chamber inside the cylindrical burner deck; an inlet for the introduction of premix gas in the mixing chamber; and an end cap delimiting the mixing chamber at the opposite side of the cylindrical burner from the inlet. The burner further comprises a tube extending in the mixing chamber. The tube is at a first end of the tube attached to the end cap. The other end of the tube is open. The tube is closed - e.g. by attaching the tube to the end cap - such that no flow through the tube is possible.

[0006] The tube of the cylindrical premix gas burner of the invention allows cancelling in a very effective way a standing wave (and thus eliminating a noise problem) occurring in an enclosed combustion system comprising the burner. The length of the tube can be selected to be one quarter of the wave length of the standing wave. The location of the open end of the tube can be selected to coincide with the antinode of the standing wave. This way, a standing wave is effectively cancelled. It has been shown that even if the length of the tube does not exactly coincide with one quarter of the wave length of the standing wave and the location of the open end of the tube does not exactly coincide with the antinode of the standing wave, noise reduction still occurs in a sufficient way.

[0007] It is a further benefit that the burner of the invention has a lower pressure drop than prior art solutions to reduce or cancel noise.

[0008] Preferably, the tube is attached to the end cap in the centre of the end cap.

[0009] Preferably, the tube has a fully closed circumferential surface. It is meant that no openings are provided in the circumference of the tube.

[0010] In a preferred embodiment, the tube is curved or bent over at least part of its length. More preferably, the tube is curved or bent over part of its length in combination with having a straight part.

[0011] Preferably, the tube has a circular or a rectangular cross section.

[0012] Preferably, the cross section of the tube is constant along the length of the tube.

[0013] Preferably, the first end of the tube is attached to the end cap by means of welding. More preferably the first end of the tube is attached to the end cap by means of at least one spot weld, and preferably by a plurality of spot welds; e.g. by three spot welds. Even more preferably the plurality of welds, e.g. the plurality of spot welds, are equally distanced around the circumference of the tube.

[0014] In a preferred embodiment, the length of the tube is longer than the length of the cylindrical premix gas burner.

[0015] Preferably, the equivalent diameter of the tube is less than 33% of the diameter of the cylindrical premix gas burner, and more preferably less than 20% of the diameter of the cylindrical premix gas burner, even more preferably less than 15% of the diameter of the cylindrical premix gas burner. With equivalent diameter is meant the diameter of a circle having the same surface area as the cross section of the tube which is not necessarily

circular.

[0016] Preferably, the equivalent diameter of the tube is more than 7 mm.

[0017] A preferred cylindrical premix gas burner comprises a cylindrical gas distributor inside the burner. More preferably, the cylindrical gas distributor is provided at less than 10 mm, preferably less than 5 mm, from the burner deck. Preferably, the end cap is attached to the cylindrical gas distributor. Preferably, the cylindrical gas distributor comprises or consists out of a perforated metal plate bent into cylindrical shape, or out of a perforated metal cylinder.

[0018] In a preferred embodiment comprising a cylindrical gas distributor inside the burner, a second end cap is provided. The second end cap is attached to the burner deck. The second end cap is parallel with and spaced from the end cap delimiting the mixing chamber.

[0019] In a preferred cylindrical premix gas burner the tube is from the open end not open over its full length. Burners according to such embodiments allow tailoring the open length of the tube as measured from the open end and the position of the open end in a combustion system in which the burner is installed. The tube can have the open length equal to a quarter of the wavelength of the noise wave that would occur if the tube is not present; and the open end can be positioned at the antinode of the noise wave that would occur if the tube would not be present in the burner. This way, optimum noise reduction can be obtained.

[0020] A preferred cylindrical premix gas burner comprises a woven, knitted or braided fabric comprising metal fibers providing the burner deck. Preferably, the fabric comprises yarns comprising a plurality of metal fibers in the cross section of the yarns. Preferably, the woven, knitted or braided fabric is provided on a cylindrical perforated metal plate.

[0021] A preferred cylindrical premix gas burner comprises a perforated metal plate providing the burner deck. It is meant that combustion will take place on the outer surface of the perforated metal plate. Preferably, the perforated metal plate comprises slits and circular holes.

[0022] A preferred cylindrical premix gas burner comprises a plurality of tubes extending in the mixing chamber. Each tube is at one end attached to the end cap and the other end of each tube is open. Each tube can be provided to cancel a specific standing wave. In this way, noise of different frequencies can be effectively and efficiently cancelled.

[0023] The second aspect of the invention is an enclosed combustion system comprising a combustion chamber and a cylindrical premix gas burner as in any embodiment of the first aspect of the invention. The cylindrical premix gas burner is provided in the combustion chamber. Examples of such an enclosed combustion system are a heat cell of a boiler or of a water heater.

[0024] Preferably, the length of the tube is selected such as to solve noise in the enclosed combustion system that would occur when the tube is not provided in the cylindrical premix gas burner. More preferably, the length of the tube is selected such that from the open end of the tube, an open length of the tube is provided between 1/8th (=12.5%) and 3/8th (=27.5%) of the wavelength of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner. More preferably, an open length of the tube is provided between 3/16th and 5/16th of the wavelength of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner. Even more preferably, an open length of the tube is provided equal to one quarter of the wavelength of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner.

[0025] Preferably the open end of the tube is provided at a distance from the antinode of the noise wave (meant is the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner) of less than $1/8^{th}$ of the wave length of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner. More preferably, the open end of the tube is provided at a distance from the antinode of the noise wave (meant is the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner) of less than $1/16^{th}$ of the wave length of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner. Even more preferably, the open end of the tube is provided at the antinode of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner.

Brief Description of Figures in the Drawings

[0026]

Figure 1 shows an example of a cylindrical premix gas burner according to the invention.

Figure 2 shows another example of a cylindrical premix gas burner according to the invention.

Figure 3 shows yet another example of a cylindrical premix gas burner according to the invention.

Mode(s) for Carrying Out the Invention

[0027] Figure 1 shows an example of a cylindrical premix gas burner 100 according to the invention. Figure 1 is made such as to show the inside of the cylindrical premix gas burner. The burner comprises a cylindrical burner deck 102 on the outside of which premix gas is combusted when the burner is in use, a mixing chamber 104, an inlet 106 for the introduction of premix gas in the mixing chamber; and an end cap 108. The inlet is delimited by a flange 110.

[0028] The burner deck 102 is provided by a knitted fabric. The fabric is knitted from yarns comprising a plurality of stainless steel fibers in their cross section. The knitted fabric is provided on a cylindrical perforated metal plate 112. In figure 1 only part of the perforations on the

cylindrical perforated metal plate are shown.

[0029] The burner comprises a cylindrical tube 120 with constant circular cross section, extending in the mixing chamber. The tube is at its first end 122 by means of three equidistant spot welds attached to the end cap, such that the tube is closed. The tube is attached at the centre of the end cap. The other end 124 of the tube is open. The length of the tube l 70 mm is shorter than the length L 185 mm of the premix gas burner.

[0030] The diameter D of the cylindrical premix gas burner is 113 mm; whereas the diameter d of the tube is 18 mm.

[0031] Figure 2 shows another example of a cylindrical premix gas burner according to the invention. More particularly, figure 2 shows a cross section 200 through the central axis of the exemplary cylindrical premix gas burner. The gas premix burner comprises a cylindrical burner deck 202 on the outside of which premix gas is combusted when the burner is in use; a mixing chamber 204 inside the cylindrical burner deck; an inlet 206 for the introduction of premix gas in the mixing chamber; and an end cap 208 delimiting the mixing chamber at the opposite side of the cylindrical burner from the inlet.

[0032] The cylindrical burner deck 202 is provided by a perforated metal plate comprising slits and circular holes for the flow of premix gas. The burner comprises a cylindrical gas distributor 230 inside the burner. The cylindrical gas distributor is provided at 2 mm from the cylindrical burner deck. The end cap 208 is attached to the cylindrical gas distributor 230. The cylindrical gas distributor consists out of a perforated metal plate bent into cylindrical shape. The burner comprises a second end cap 232, attached to the cylindrical burner deck. The second end cap 232 is parallel with and spaced from the end cap 208 delimiting the mixing chamber. The cylindrical burner deck 202 and the cylindrical gas distributor are attached to a flange 210.

[0033] The burner comprises a cylindrical tube 220 with constant circular cross section, extending in the mixing chamber. The tube is at its first end 222 welded onto the end cap 208, such that the tube is closed. The tube is attached at the centre of the end cap. The other end 224 of the tube is open. The length of the tube l is longer than the length L of the premix gas burner.

[0034] Figure 3 shows yet another example of a cylindrical premix gas burner according to the invention. More particularly, figure 3 shows a cross section 300 through the central axis of the exemplary cylindrical premix gas burner. The gas premix burner comprises a cylindrical burner deck 302 on the outside of which premix gas is combusted when the burner is in use; a mixing chamber 304 inside the cylindrical burner deck; an inlet 306 for the introduction of premix gas in the mixing chamber; and an end cap 308 delimiting the mixing chamber at the opposite side of the cylindrical burner from the inlet.

[0035] The cylindrical burner deck 302 is provided by a perforated metal plate comprising slits and circular holes for the flow of premix gas. The cylindrical burner deck 302 is attached to a flange 310. The flange 310 comprises a perforated disk 340. Premix gas flows through the perforated disk 340 into the mixing chamber 304.

[0036] The burner comprises a cylindrical tube 320 with constant circular cross section, extending in the mixing chamber. The tube is at its first end 322 attached via welds onto the end cap 322, such that the tube is closed. The other end 324 of the tube is open. The tube is attached at the centre of the end cap. The tube extends through a central perforation 342 of the perforated disk 340. It is possible to weld the tube to the perforated disk 340. The tube is bent over part of its length and extends into the supply channel 350 supplying premix gas to the burner.

Claims

1. A cylindrical premix gas burner comprising

- a cylindrical burner deck on the outside of which premix gas is combusted when the burner is in use;
- a mixing chamber inside the cylindrical burner deck;
- an inlet for the introduction of premix gas in the mixing chamber;
- an end cap delimiting the mixing chamber at the opposite side of the cylindrical burner from the inlet;

characterized in that the burner comprises a tube extending in the mixing chamber,
wherein the tube is at a first end attached to the end cap;
and wherein the other end of the tube is open.

2. A cylindrical premix gas burner as in claim 1, wherein the tube is curved or bent over at least part of its length.

3. A cylindrical premix gas burner as in any of the preceding claims, wherein the first end of the tube is attached to the end cap by means of welding.

4. A cylindrical premix gas burner as in any of the preceding claims, wherein the length of the tube is longer than the length of the cylindrical premix gas burner.

5. A cylindrical premix gas burner as in any of the preceding claims, wherein the equivalent diameter of the tube is less than 33% of the diameter of the cylindrical premix gas burner.

6. A cylindrical premix gas burner as in any of the preceding claims, wherein the burner comprises a cy-

lindrical gas distributor inside the burner; preferably provided at less than 10 mm from the cylindrical burner deck.

7. A cylindrical premix as in claim 6, wherein a second end cap is provided; wherein the second end cap is attached to the burner deck; and wherein the second end cap is parallel with and spaced from the end cap delimiting the mixing chamber.

8. A cylindrical premix gas burner as in any of the preceding claims, wherein the tube is from the open end not open over its full length.

9. A cylindrical premix gas burner as in any of the preceding claims 1 - 8; wherein the burner deck is provided by a woven, knitted or braided fabric comprising metal fibers.

10. A cylindrical premix gas burner as in any of the preceding claims 1 - 8; wherein the burner deck is provided by a perforated metal plate.

11. A cylindrical premix gas burner as in any of the preceding claims,
wherein the burner comprises a plurality of tubes extending in the mixing chamber,
wherein each tube is at one end attached to the end cap;
and wherein the other end of each tube is open.

12. Enclosed combustion system comprising a combustion chamber and a cylindrical premix gas burner as in any of the claims 1 - 11;
wherein the cylindrical premix gas burner is provided in the combustion chamber.

13. Enclosed combustion system as in claim 12;
wherein the length of the tube is selected such as to solve noise in the enclosed combustion system that would occur when the tube is not provided in the cylindrical premix gas burner.

14. Enclosed combustion system as in claim 13;
wherein the length of the tube is selected such that from the open end of the tube, an open length of the tube is provided between 1/8th and 3/8th of the wavelength of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner.

15. Enclosed combustion system as in any of the claims 13 - 14, wherein the open end of the tube is provided at a distance from the antinode of the noise wave of less than $1/8^{th}$ of the wave length of the noise wave that would occur when the tube is not provided in the cylindrical premix gas burner.

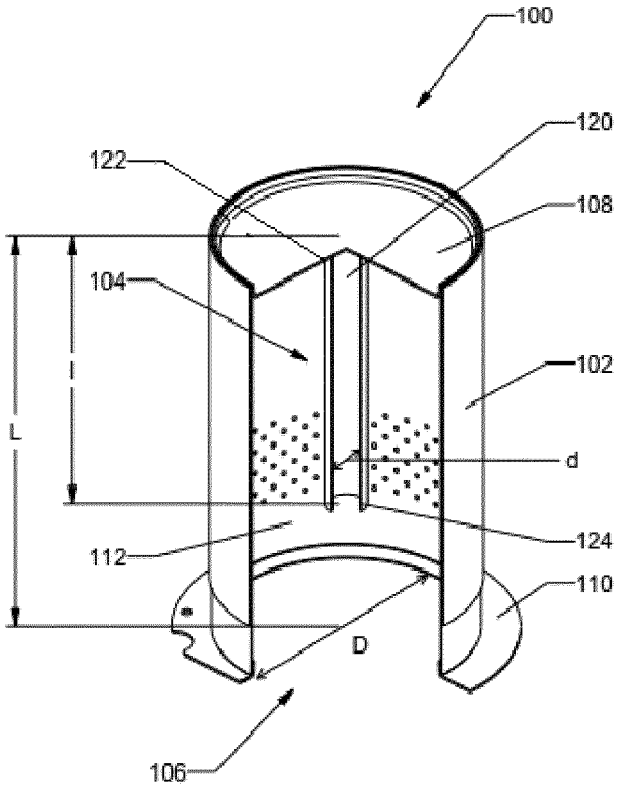
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Fig. 1

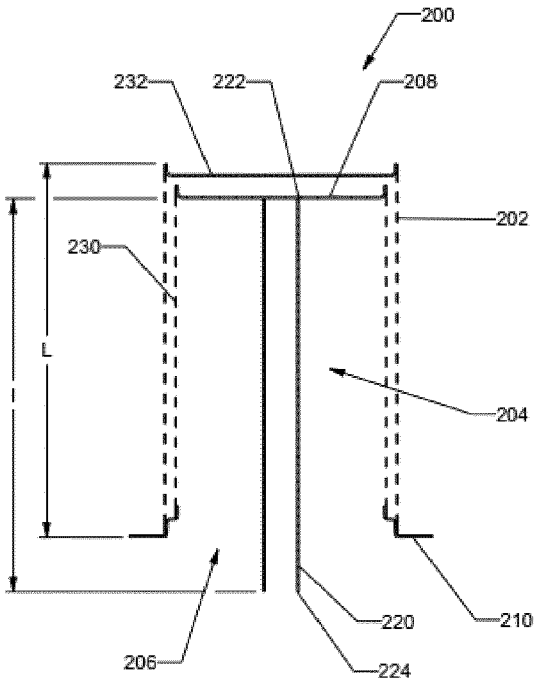
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Fig. 2

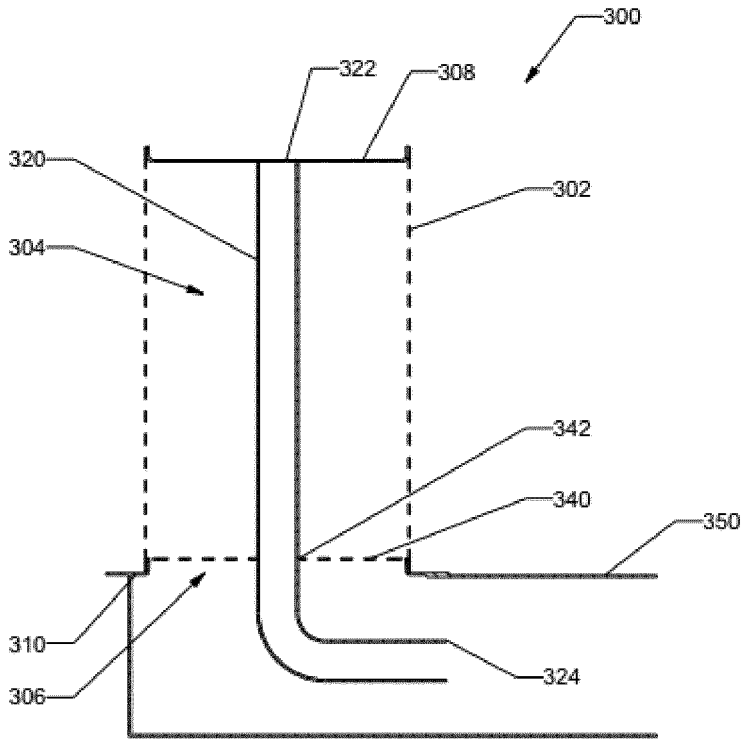

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 1583

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 Y	EP 1 914 476 A2 (POLIDORO S P A [IT]) 23 April 2008 (2008-04-23) * column 1, paragraph 1 - column 2, paragraph 15 * * column 2, paragraph 17 - column 3, paragraph 20 * * column 3, paragraph 23 - paragraph 24 * * column 4, paragraph 27 * * figures 1,4 * -----	1-8, 11-15 9,10	INV. F23D14/10 F23D14/14 F23D14/46
Y	US 2002/092482 A1 (BODNAR TIMOTHY J [US] ET AL) 18 July 2002 (2002-07-18) * page 5, paragraph 78 - paragraph 89 * * figure 6 * -----	9	
Y	EP 1 431 657 A1 (AEROMATIX LTD [GB]) 23 June 2004 (2004-06-23) * column 3, paragraph 25 - paragraph 30 * * figures 1-3 * -----	10	
A	EP 1 538 395 A1 (RIELLO SPA [IT]) 8 June 2005 (2005-06-08) * column 1, paragraph 1 - paragraph 7 * * column 3, paragraph 38 - paragraph 39 * * figures 7-10 * -----	1	TECHNICAL FIELDS SEARCHED (IPC) F23D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 December 2017	Gavriliu, Costin

CATEGORY OF CITED DOCUMENTS

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

REFERENCES CITED IN THE DESCRIPTION

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