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(54) **Burner**

(57) Burner consisting of external cylindrical casing (1), an air generator with vanes (2) and a fuel distribution tube (3), creating together a cylindrical mixing chamber (4), where behind the vanes (2) fuel distribution devices in the form of pipes with slots in lengthwise arrangement for fuel supply to the mixing chamber (4) are arranged, wherein the pipes (5) are arranged parallel with the burner axis and their length (L) equipped with the slots (6) for the fuel supply into the mixing chamber (4) is calculated according to the formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi),$$

Where

D - is the diameter of the circle in which the pipes are arranged

N - is the number of pipes in the circle

n - is the number of slots for fuel feeding in each pipe

φ - is the angle of the air flow from the whirl vanes

k - is the coefficient

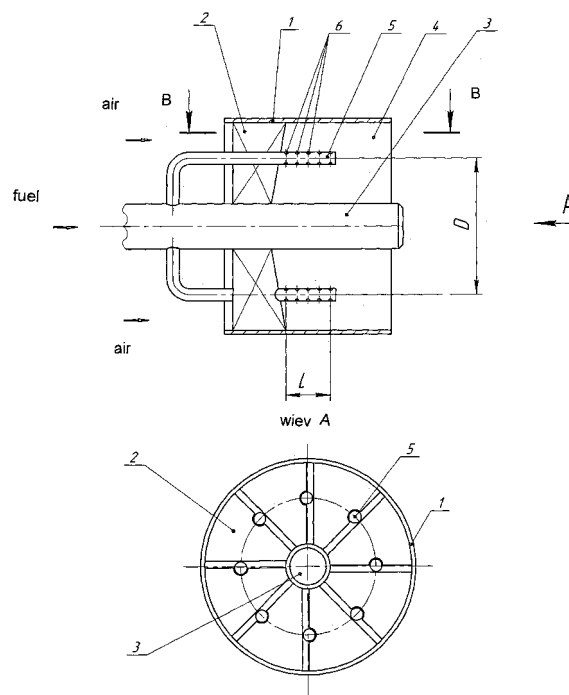


Fig. 1

Description

[0001] The invention concerns power, transport and chemical engineering in common and especially may be used in combustion turbines.

[0002] Document RU2099634 describes a burner consisting of an external cylindrical casing, an air generator with vanes and in front of them there is a fuel distributor in the form of a supply tube with radially arranged distribution pipes with longitudinal slots for fuel feeding to the mixing chamber.

[0003] Due to the radial arrangement of the pipes and the lengthwise slots all fuel is supplied into the mixing chamber in the same profile. The time delay between the fuel feeding into the mixing chamber and its burning out seems to be the cause of pressure pulsations, whose frequency is on the other hand proportional to the delay, and which often, cause serious problems. In the case of concentrated fuel supply to the mixing chamber in the same profile the length of the delay is uniform and the curve of pressure pulsation frequency is maximal. Low stability of the burning process resulting in pressure pulsations represents a serious disadvantage of the burner.

[0004] Another drawback of the above mentioned burner is represented by its short working life caused by the possibility of flame flashing into the mixing chamber and its stabilisation in the zones behind the fuel distribution pipes. When the pipes are arranged in front of the air generator, the speed of the air flow is low (in comparison to the speed behind the generator), which creates conditions for stabilisation of the head of the flame in the zones of air leak behind the fuel distribution pipes. The operation of the combustion chamber cannot exclude short-term unexpected working modes allowing the flame flashing reaching the fuel distribution pipes. Flame stabilisation behind the pipes after such flash inevitably leads to through-burning of the air generator vanes that may cause a serious accident.

[0005] Another document RU 2137042 presents a burner with the correction of the above drawback, which has so far reached the stage of a prototype. This burner consists of an external cylindrical casing, a coaxial air generator with the vanes and in front of them there is a fuel distributor in the form of a supply tube with radially arranged distribution pipes arranged along the cylindrical body of the tube and in a distance from each other with longitudinal slots for fuel feeding to the mixing chamber.

[0006] Both burners have the above mentioned drawbacks, namely low stability of the burning process due to the flow pressure pulsations. As the fuel is supplied into the mixing chamber in the case of a single row of fuel distribution pipes or in several pipes arranged in a distance from each other and in various places with various profiles, the above mentioned mechanism of development of pressure pulsations works here too.

[0007] There is one more drawback that needs to be mentioned, and that exists more or less in both cases of the above burners. The radial fuel distribution pipes partly

cover the through pass section of the cylindrical mixing chamber. The fuel distribution pipes are connected with the distribution tube and they interrupt the inside channel of the pass section. As a consequence the speed of the air flow is uneven and causes uneven mixing of the fuel and the air at the outlet from the mixing chamber with corresponding deterioration of environmental properties of the burner. This drawback is more evident in the case of the prototype burner, for the burner according to RU 2099331 the speed is partially equalised during the air flow pass through the narrow section of the air whirl generator.

[0008] The aim of the invention is to present a burner with reduced concentration at the outlet from the mixing chamber and increased stability of the burning process with elimination of the possibility of the pressure pulsations with high amplitudes.

Summary of the invention

[0009] The above shortcomings are eliminated to a great extent by the burner consisting of external cylindrical casing, an air generator with vanes and a distribution tube, creating together a cylindrical mixing chamber, where behind the vanes fuel distribution devices in the form of pipes with slots in lengthwise arrangement for fuel supply into the mixing chamber are arranged, wherein the pipes are arranged parallel with the burner axis and their length L equipped with the slots for the fuel supply into the mixing chamber is calculated according to the formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi),$$

Where

D - is the diameter of the circle in which the pipes are arranged

N - is the number of pipes in the circle

n - is the number of slots for fuel feeding in each pipe

φ - is the angle of the air flow from the whirl vanes

k - is the coefficient

[0010] From the technical point of view the environmental properties of the burner are improved and the combustion turbine life is extended.

[0011] The above mentioned result is achieved by the arrangement of the pipes in parallel to the burner axis. Their active length L , it means the length L of the pipes equipped with the slots for the fuel supply into the mixing chamber is calculated on the basis of the following formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi)$$

Where

D - is the diameter of the circle in which the pipes are arranged
 N - is the number of pipes in the circle
 n - is the number of slots for fuel feeding in each pipe
 φ - is the angle of the air flow from the whirl vanes
 k - is the coefficient

[0012] This will be explained as follows: It is a well known fact that the time delay T between the moment of the fuel feeding into the air flow and the moment of its complete burning out accompanied by release of the thermal energy may cause destabilisation of the burning process resulting in the pressure pulsations with the frequency

$$f = 1/(2T).$$

[0013] The mechanism of this phenomenon is based on the fact that in the case of slight air and fuel flow disturbances with frequency f is the phase excursion between the through flow fluctuation, pressure fluctuation and heat release conditioned in the given case with the time delay T, when in the combustion zone of the fuel/air mixture heat radiation varies, which results in a resonance.

[0014] In the case of radial distribution of the fuel due to the feeding pipes in the mixing chamber, as it is the case of the prototype, all fuel (in the type with a single row of pipes) or a significant part of the fuel (in the type with several rows) is fed into the air flow in a concentrated manner in a single section of the mixing chamber. The time delay between the moment of the fuel supply to the air flow and the moment of the fuel burning out and release of the thermal energy, as mentioned above, may be a reason for dangerous pressure pulsations damaging the machine construction.

[0015] It is clear that the amplitude of the pressure pulsations is as high as the proportion of fuel supplied in a specific section of the mixing chamber. In the case of parallel arrangement of the pipes and the burner axis the fuel is supplied to the flowing air in small doses distributed across the pipe's length, which eliminates the possibility of development of air flow pressure pulsation, increasing the working life of the combustion turbine.

[0016] It is a well known fact that in low-toxicity burners the mixing chamber is used for mixing the fuel with air before entry to the combustion zone. The higher is the quality of mixing (evenness of the fields of fuel concentration in the mixture), the better is the environmental characteristics of the burner.

[0017] In the case of radial arrangement of the fuel pipes in the mixing chamber, as in the case of the prototype pursuant to RU2137042, there is always some circumferential irregularity of the concentration of the fu-

el/air mixture, due to the arrangement of many fuel pipes along the perimeter of the mixing chamber. In the presented burner the fuel pipes are arranged parallel with the burner axis and their active length L, it means the length equipped with the slots for the fuel supply into the mixing chamber is calculated on the basis of the following formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi)$$

Where

D - is the diameter of the circle in which the pipes are arranged
 N - is the number of pipes in the circle
 n - is the number of slots for fuel feeding in each pipe
 φ - is the angle of the air flow from the whirl vanes
 k - is the coefficient

[0018] In the presented embodiment, as can be seen from the unfolded axial cross section of the fuel pipes in the mixing chamber (see in detail in Fig. 2), the fuel is evenly distributed along the perimeter of the mixing chamber, which improves environmental characteristics of the burner as well as the turbine as a whole.

[0019] Coefficient k in the formula takes into the consideration some curvatures of the flow route resulting from air flow deflections and related to decreased angle of overlap of the air flow across the mixing chamber's length, due to the effects of friction, but also of the impact of the fuel pipes on the flow. The value of the coefficient k may be calculated or specified by experiment.

Brief description of the drawings

[0020] The invention will be explained by drawings in which Fig. 1 is a view of the burner in a cross section and from the front and Fig. 2 is an unfolded axial cross section of the fuel pipes in the mixing chamber.

[0021] The reference signs in the figures are:

1 - external cylindrical casing, 2 - air whirl generator vanes, 3 - fuel distribution tube, 4 - cylindrical mixing chamber, 5 - fuel distribution pipes, 6 - slots for fuel feeding into mixing chamber.

[0022] The burner in Fig.1 consists of an external cylindrical casing 1, an air whirl generator vanes 2 arranged directly on the fuel distribution tube 3 and they are turning together by the work. All these elements are part of the cylindrical mixing chamber 4 in which behind the vanes 2 the air flow is supplied by fuel due a circular arrangement of the pipes 5 with slots 6 in the lengthwise arrangement for fuel feeding into the mixing chamber. The pipes 5 arranged parallel to the burner axis protrudes through the whirl vanes 2 and are connected to the fuel distribu-

tion tube 3 and turning together with the tube 3. The length L of the active part of the pipes 5 equipped with slots 6 is calculated according to the following formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi)$$

Where

D - is the diameter of the circle in which the pipes are arranged

N - is the number of pipes in the circle

n - is the number of slots for fuel feeding in each pipe

φ - is the angle of the air flow from the whirl vanes

k - is the coefficient

[0023] The principle of this formula will be clear from the unfolded axial cross section of the fuel pipes (Fig. 2). Naturally, the pipe length L used in the formula means the active length, i.e. the length equipped with the slots for the fuel supply into the mixing chamber.

[0024] In some cases, when the burner is sufficiently big, there may be two or more circular rows of the fuel distributing pipes installed in the mixing chamber in different distances, the pipes arranged parallel with the burner axis.

[0025] The burner operates as follows:

The air flow is whirled with vanes 2 of the air generator and continues to the cylindrical mixing chamber 4. The fuel is supplied to the pipes 5 through the inside channels in the distribution tube 3, which is at the same time the carrier of the air whirl vanes 2 and through the slots 6 distributes evenly the fuel into the mixing chamber 4 into the turned and whirled air flow. In the section of the mixing chamber 4 between the ends of the pipes 5 and the outlet section there is a intense mixing of the fuel and the air due to the high whirling rate and due to the secondary flow of the whirling air. After leaving the mixing chamber 4 the fuel/air mixture with evenly created sections of fuel concentrations burns in the combustion chamber with low values of emissions of harmful substances. The presented embodiment of the burner does not limit the use of other known elements as equivalents to the presented elements and other known elements may be used for its construction such as pipes, cylindrical and conical air guiding casings, blade whirls, fuel distributors, fuel piles.

the form of pipes with slots in lengthwise arrangement for fuel supply to the mixing chamber are arranged, **characterized in that** the pipes (5) are arranged parallel with the burner axis and their length (L) equipped with the slots (6) for the fuel supply into the mixing chamber (4) is calculated according to the formula:

$$L = k * \pi * D * (n - 1) / (n * N * \operatorname{tg} \varphi),$$

Where

D - is the diameter of the circle in which the pipes are arranged

N - is the number of pipes in the circle

n - is the number of slots for fuel feeding in each pipe

φ - is the angle of the air flow from the whirl vanes

k - is the coefficient

Claims

1. A burner consisting of external cylindrical casing, an air generator with vanes and a fuel distribution tube, creating together a cylindrical mixing chamber, where behind the vanes fuel distribution devices in

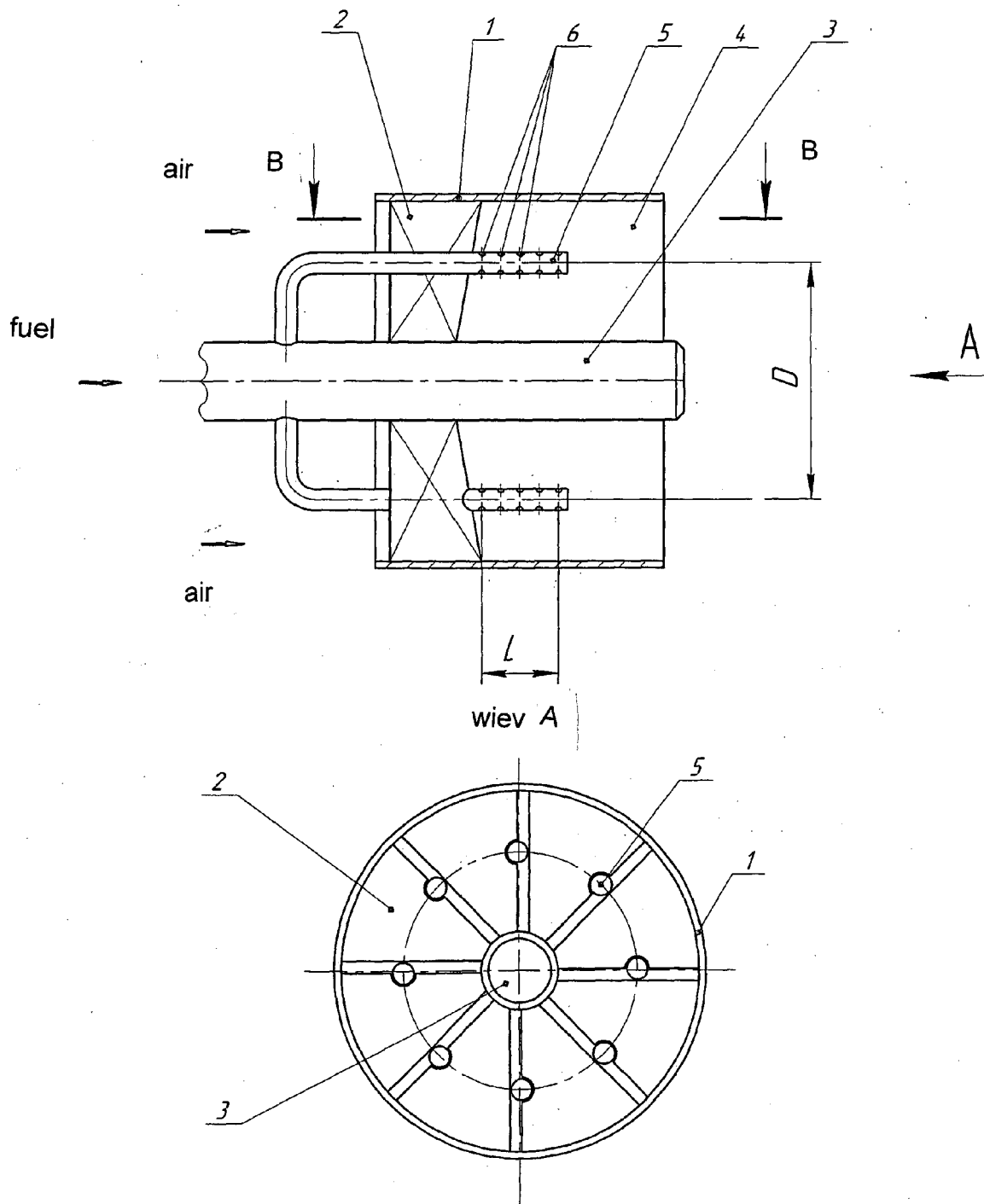
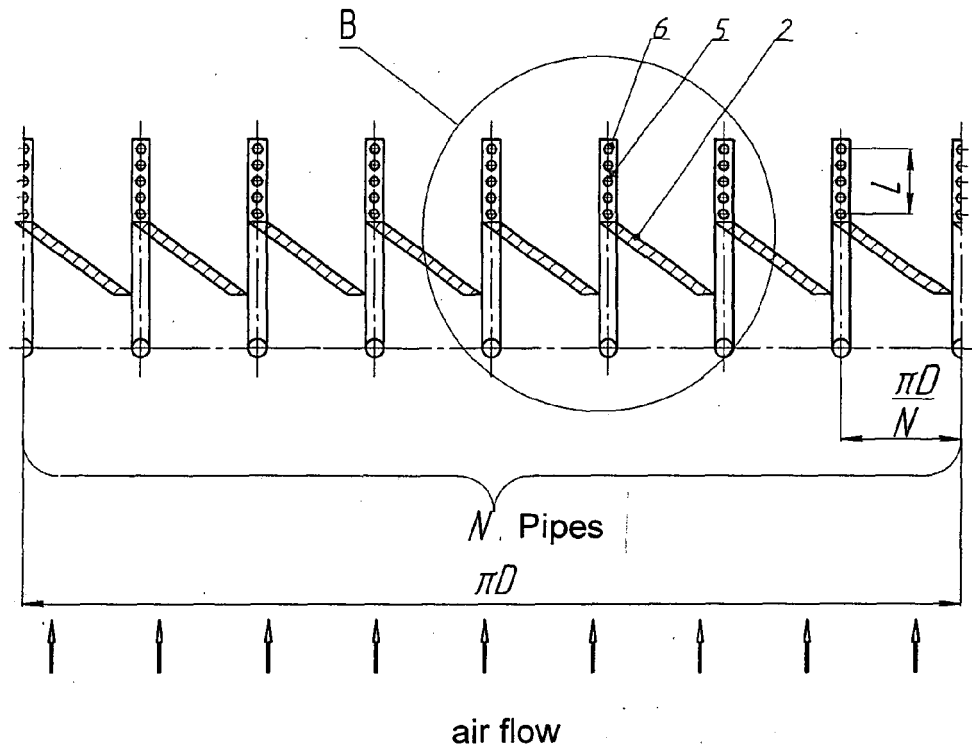


Fig.1

Cross section B-B (unfolded)



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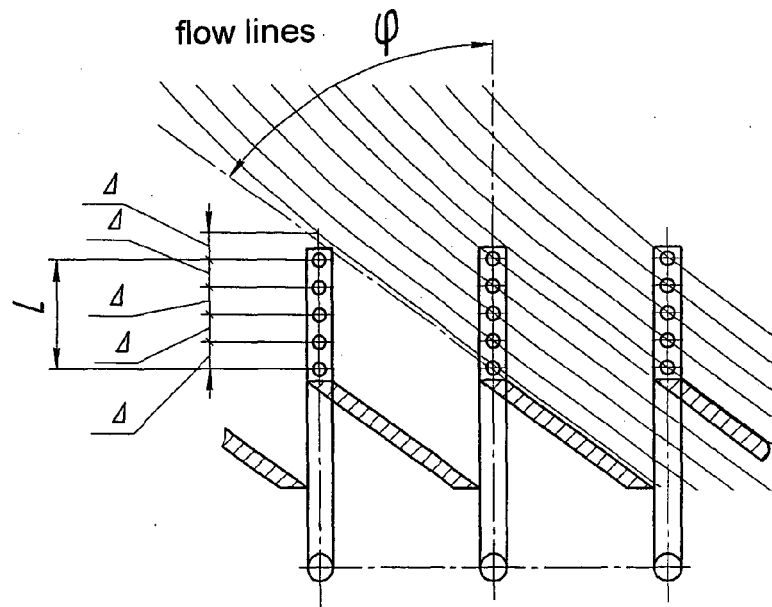


Fig.2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- RU 2099634 [0002]
- RU 2137042 [0005] [0017]
- RU 2099331 [0007]