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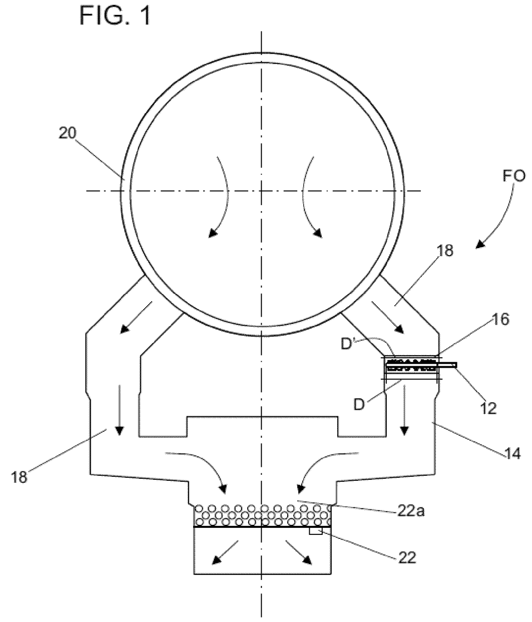
(54) LOW NOX EMISSION BURNER AND OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO AN IRON ORE PELLET SINTERING AND/OR HARDENING METHOD

(57) A burner (12) using the oxygen present in the descending flow (18) of gases, composed by a mixture of air with combustion products that circulates through the iron ore pelletizing furnace zones. The burner set (12) includes a fuel collector ring (24) equipped with fins (26) mounted on the inner part of the collector and further counts on a plurality of openings (30) for discharge of fuel gas. Said openings (30) make up a sequence of groups (32) aligned with each fin (26). The burner set (12) is inserted through the special window (16) and installed where the descending flow (18) needs to be heated, for example, from 850 to 1350°C. The fins (26) deflect part of the descending flow (18) and create the rotating effect in the gases in the furnace downcomer. The fuel gas jets discharged from the collector ring (24) are mixed with the flow of gases and burn in the descending flow current in a swirl. The even distribution of the fuel gas around the perimeter of the descending passage together with the descending flow swirling effect allows the quick mixing of the fuel gas with the descending oxygen flow and for this reason significantly reduces the NOx formation in the combustion zone.

FIG. 1



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Description

TECHNICAL FIELD OF INVENTION

[0001] The present patent of invention relates to low NOx emission burner and operating method for reducing NOx formation applied to iron ore pellet sintering and/or enduring method, more specifically a burner of the type used in industrial combustion for reducing NOx emission through the rapid mixing of fuel gas with the descending flow of oxidant before self-ignition and flame stabilization.

[0002] Said innovative burner integrates an operating method wherein the fuel gas jets discharged from the collector ring mix firstly with the oxidant and continue, in combustion, in a rotating movement, through the descending duct flow, also known as furnace downcomer. The even distribution of the fuel gas around the perimeter of the passage section of the downcomer, allied to the rotational effect of the downcomer flow allows the rapid mixing of fuel gas with oxygen diluted in this current.

HISTORY OF THE INVENTION

[0003] The nitrogen oxide gases NO and NO_2 (NOx) are typically formed during the combustion process, particularly industrial. The highest temperatures are observed around the stoichiometric zones of the flames and can reach 1925° C/3500 F for the combustion of natural gas mixed with ambient air. The maximum thermal NOx is formed in these zones.

[0004] The above cited nitrogen oxides when transported through air and reacting with water, form nitric acid, affecting the entire natural cycle of the environment, contaminating soils, rivers and subterranean waters, reaching food chains, corroding metallic structures, historical monuments and buildings, among other inconveniences, as well as being able to cause the phenomenom called photochemical smog which corresponds to atmospheric pollution wherein a dark and poisonous cloud is formed consisting of smoke, fog, air, polluting gases and particulate matter.

[0005] The formation of NOx in burning processes depends on several factors, such as: fuel composition, system operation mode, burner design and combustion chamber. One of the determinant parameters of this pollutant is the presence of temperature peaks which occur in certain regions of the flame, for which reason the goal of many burner manufacturers and designers of combustion systems with low NOx emission is to reduce or eliminate the occurrence of said peaks.

[0006] During research in specialized databanks there were found documents that disclose burner models and pre-heating models for crculating air flows used in the iron ore pellet sintering process. Among the documents found there are foreseen documents JP2009235507A, AU2009272126B2, CH104114681B, JP2005060762A, US2676095A, KR101665066B1, JP5458860B2, US8961650B2 and JP2008185054A.

[0007] Generally, the burners used in the sintering process and/or endurance of iron ore pellets use small quantities of primary air, provided by blower or fan, and the remaining oxidant that is necessary for the combustion reaction is obtained from the circulating hot gas flow, which is usually a mixture of hot air with combustion products. The oxygen content in this hot circulating flow is usually higher than 10% (volumetric basis). The staging of the injection of fuel gas is a commonly used technique for the control of NOx emissions, since it allows the dispersion of fuel gas inside the flame envelope, and thus reduces the temperature peaks in the flame and respective NOx formation. However, this technique does not allow a significant reduction of the NOx emissions in sintering furnaces and/or endurance of NOx iron ore pellets.

[0008] Firstly, the flame of the burner used in the process is formed by consuming oxidants at extremely high temperatures, around 850 to 1050 °C.

[0009] In the second place, even with the staged injection of the fuel gas, for example, using lances surrounding the primary air jet, the burner flame has a large envelope shape being relatively wide and more or less long. The combustion reaction restricts the envelope volume, as, in this case, the envelope flame or jet type flame, always tends to present average higher temperature and thus higher NOx, in comparison with the reaction which occurs spread throughout the oven or furnace volume.

[0010] In the same manner, the I-Jet type burner provided by FCT Combustion - is an example of burners used in the iron ore pellet industries. This forms jet type flame, with the chemical combustion reaction concluded in the flame envelope formed in the front of the burner. The primary air and staging of fuel gas injection, in contact and mixed with the ambient furnace gases, form the flame, which can be longer or shorter, wider, or narrower. However, it is still a jet type flame, with high temperature. Due to the staging of the fuel gas injection, the average temperature of the flame can be reduced, which can help with the NOx reduction. However, the reduction is not significant, particularly in the process of iron ore pellet sintering and/or enduring at high temperature. This is largely due to the significant contribution of the high temperature of the oxidant used in combustion.

OBJECTIVES OF THE INVENTION

[0011] It is one purpose of the invention to present a low NOx emission burner and operating method for reducing NOx formation applied in iron ore pellet sintering and/or endurance which allows overcoming the disadvantages of the prior art.

[0012] It is another purpose of the invention to present a low emission NOx burner which comprises a fuel gas distribution and injection manifold, which is inserted in the descending channel of the sintering or iron ore pellet enduring furnace. This combination of fuel gas distribution together with the descending passage of the furnace configures the burner of this invention.

[0013] It is a further objective of this invention to present a low NOx emission burner which uses the oxygen present in the downcomer flow of hot gases, consisting mostly of hot air mixed to combustion products. This flow circulates through the zones of the iron ore pellet sintering and/or enduring furnace of the moving grate type. The flow of hot gases from the downcomer is directly heated by the burner flame to a temperature of around 1300 °C/1400°C, necessary for the process of endurance of iron ore pellets. Thus, the function of this innovative burner is to heat the circulating flow to the temperature levels required for the process and have the NOx emission output as low as possible.

[0014] Another objective of this invention is to present a low NOx emission burner, which set includes the fuel gas collector manufactured in the shape of a circular ring and made, for example, from stainless steel or silicon carbide. The fuel gas collector is equipped with a set of fins mounted in the inner part of the collector. The fins present innovative special profile and are fixed to the collector so as to deflect the descending gas flow from the vertical movement with the addition of horizontal movement vector. This vector, together with the cylindrical shape of the descending channel, creates a rotating movement of the gases downstream the collector ring/fins set. The collector further comprises a plurality of fuel gas discharge openings. These openings form groups aligned with each fin. Each group can comprise, for example, from four to six fuel gas discharge openings which discharge gas against the wall of each fin. The fuel gas collector ring has at least one inlet, which is connected to the fuel gas supply system.

[0015] The burner set is inserted in the vertical passage of the furnace wherein the descending flow needs to be heated, for example from 900 to 1300 °C, before entering the iron ore pellet moving grate. The fins deflect part of the descending flow and create the rotational flow effect in the vertical passage of the furnace. The descending vertical passage is necessary to create this swirling effect and allows in this manner the quick mixing of the fuel gas with oxidant before the occurrence of the combustion reaction. Therefore, the definition of the insertion place of the burner in the vertical passage is essential to achieve the desired result.

[0016] The new method, according to this invention, proposes that the fuel gas jets discharged from the collector ring mix predominantly first with the oxidant and next burn in the rotating descending flow current. The uniform distribution of the fuel gas around the perimeter of the passage of the downcomer allows the rapid mixing of the fuel gas with the descending flow diluted oxygen.

[0017] Thus, the temperature peaks are reduced. The descending flow gases are comprised mainly of oxygen (O_2), nitrogen (N_2), carbon dioxide (CO_2) and water vapor. (H_2O). The presence of these inert gases (CO_2, N_2 and H_2O) significantly reduces the adiabatic temperature of the combustion reaction. All these factors together can lead to a significant reduction in the NOx formation in the combustion zone.

DESCRIPTION OF THE FIGURES

[0018] In order to complement the present description so as to obtain a better understanding of the characteristics of the present invention and in accordance with a preferred practical embodiment of same, there is accompanying the description, attached, a set of drawings wherein, in an exemplified manner, although not limitative, the operation thereof is represented:

Figure 1 discloses a side view in schematic elevation of the sintering and/or iron ore pellet enduring furnace with innovative window for insertion of a burner in a vertical passage;

Figure 2 represents a top view of a burner set, represented inside the furnace cylindrical descending channel;

Figure 3 illustrates a perspective view of the burner collector ring with the fins installed on the inner circumference of the collector;

Figure 4 shows a side view 'A' indicated in figure 2 of the inner part of the gas collector ring of the burner and demonstrating the positioning of the fins;

Figure 5 reveals a longitudinal sectional view on a plane through the middle of the fins to illustrate the positioning of the gas injectors relative to each fin;

Figure 6 illustrates a view 'B' of the profile of the fin indicated in figure 4;

Figure 7 shows the fins in perspective illustrating the most intense deflection effect of the descending flow; and

Figure 8 shows a portion of the downcomer channel, wherein the burner is installed, to illustrate the swirling pattern of the burn flow in the channel.

DESCRIPTION OF THE INVENTION

[0019] The present patent of invention relates to a "LOW NOX EMISSION BURNER AND OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD", more precisely, it relates to an industrial combustion type burner (12) and process for pelletizing iron ore, and more exactly, to the iron ore pellet sintering and/or enduring furnaces.

[0020] According to the present invention, said burner (12) is installed in the descending passage (14) of the furnace (FO) by means of the window (16), located on the upper portion of the descending passage (14). Said burner (12) elevates the temperature of the descending circulating flow (18) originating from the flue gas collector (20) to the required level before entering the moving grate (22) provided with iron ore pellets (22a). The burner (12) is comprised of a circular or rectangular section fuel gas collector ring (24). The outer diameter (D) of the ring (24) is smaller than the inner diameter (D') of the descending passage (14).

[0021] The collector ring (24) is equipped with fins (26) (see figures 2, 3 and 4) on the inner circumference thereof, oblique, in (α) angulation relative to the horizontal transversal place of the collector, which allows deflecting the descending flow and introducing horizontal velocity components to the same. Said (α) angulation promotes the speed vector to obtain tangential component and so that, in the cylindrical profile of the descending channel, there is generated the swirling or rotational effect.

[0022] The (α) deflection angle of the fin (26) can be from 30° to 60° relative to the horizontal transversal plane of the fuel gas collector ring (24). If the (α) angle is greater than 60°, the deflection and, in this manner, the rotational effect, will not be sufficiently intense to achieve the desired rapid mix of fuel gas with oxidant. On the other hand, if the (α) angle is less than 30°, the resistance to the descending flow (18) increases significantly resulting in less flow running along the fins (26) and more flow in the center of the descending channel (14).

[0023] The distance (K) between the fins (26), the length (L) of each fin (26) and number of fins (26) are determined to create the necessary descending flow rotating intensity (18) without significantly increasing the pressure loss through the burner (12) installed in the descending channel.

[0024] The determination of the three parameters (K), (L) and number of fins (26) depends on the diameter (D') and transversal area of the descending channel (14) wherein the burner (12) is installed.

[0025] The larger the diameter (D') of the channel (14), the larger will be the diameter (D) of the ring (24) of the burner (12) and consequently greater the number of fins (26).

[0026] The fuel gas collector ring (24) of the burner (12) is equipped with at least one inlet pipe (28) positioned orthogonally to the collector ring (24), which is connected to the fuel gas supply line. The fuel gas is injected in the hot air current (18) through a plurality of openings (30) (see figure 5). Said openings form aligned groups (32) and have the discharge thereof pointed in the direction of the wall of each aligned fin (26). Each group (32) can be formed by two up to eight openings (30), in this case we present a model with five openings for fuel jet discharge (34) in each fin passage (26). Part of the total descending flow (18) runs along the passage of the fin (26) mixing with the five fuel jets (34) and all together are deflected to create a rotating flow downstream the burner (12).

[0027] Each fin (26) (see figures 4 and 6) is constructed as an 'L' shaped profile, with flap (26a) forming (β) angle 90° (see figure 6). This varies preferably between 45°and 90°. If the (β) angle exceeds 90°, the fuel gas jets (34) can partly escape the passage of the fin (26) and reduce the efficiency of the mixture. On the other hand, if this (β) angle is less than 45°, the fuel gas jets (34) can create unecessary pressure fluctuations and possibly vibration of the burner (12). The choice of the dimension (N) of the fin (26) depends on the diameter (D') and area of the descending flow (14), wherein the burner (12) is installed. The ratio of the dimensions (M)/(N) of each fin (26) is preferably between 0,25 and 0,5, if less than 0,25, the fuel gas jets (34) can escape from the passage of the fin (26), if greater than 0,5 the fin (26) will be heavier without any additional benefit to the burner.

[0028] As an option for best efficiency of the mixture, the discharge end (40) of each fin (26) can be cast so as to (see figure 7) deflect the descending flow (18) more horizontally, and, by doing this, promote higher rotation degree inside the cylindrical descending channel downstream of the burner (12).

[0029] The cylindrical descending channel (14) must be considered as being part of the burner (12). Part of the descending flow (18) deflected by the fins (26) is premixed with the fuel gas and acquires rotating movement (42) along the cylindrical surface of the descending channel (14). In this region, with length (L) equal to approximately a diameter (D') of the channel, the current is burned. The fuel gas is evenly distributed around the circumference (46) of this channel, the mixing occurs quickly with oxygen diluted in the inert gases, and, as a result, the temperature peaks reduce significantly, and the combustion reaction produces a very low NOx emission when compared to the prior art.

[0030] All the new and exclusive elements described above of the new model and burner method (12) of the rapid mixing allows the mixing of the gas jets (34) and descending flow oxidant (18) in a much more even manner and, therefore quicker, resulting in reduction of the average adiabatic temperature of the flame. Due to all these factors, the NOx output emission is much lower and less than that obtained with the prior art techniques.

[0031] It is certain that when the present invention is put in practice modifications relating to certain construction and shape details can be introduced, without this implying a departure from the fundamental principles which are clearly substantiated in the set of claims, being therefore understood that the terminology used does not have the purpose of limitation.

Claims

1. Low nox emission burner, more precisely, this refers to a burner (12) for heating process applications mainly in iron ore pellet furnaces (F) with low NOx emission; **characterized by** a burner (12) comprising a collector ring (24) which fuel gas discharge is performed through multiple openings (30) for mixing the fuel gas with oxidant and formation of flames for direct heating of circulating gas medium; said process heating medium being the downward circulating hot air flow (18) diluted with the combustion gases originating from fuel gas burning; the collector ring (24) being equipped with at least one inlet (28) for fuel gas supply; the fuel gas discharge being ar-

ranged by means of multiple openings (30) located on the ring (24) equipped with fins (26) arranged on the inner part of the collector (24) in (α) angle with respect to the horizontal plane of the collector ring (24) to deflect part of the downward flow (18) from the vertical direction to the horizontal, resulting in a speed vector obtaining the tangential component and which in the cylindrical profile of the downward channel generates the rotation or whirlwind effect.

2. Low nox emission burner, according to claim 1, **characterized by** fuel gas collector (24) presenting a ring shape, manufactured with circular or rectangular section, the outer diameter (D) of the collector ring (24) being reduced relative to the inner diameter (D') of the descending passage (14).

3. Low nox emission burner,according to claim 1, **characterized by** the deflection angle (α) of the fin (26) being between 30° to 60° relative to the horizontal transversal plane of the fuel gas collector ring (24).

4. Low nox emission burner, according to claim 1, **characterized by** each fin (26) being modelled in 'L' profile with flap in 90° (β) angle.

5. Low nox emission burner, according to claim 4 and in a constructive option, **characterized by** the angle (β) varying from about 45° to 90°.

6. Low nox emission burner, according to claim 4, **characterized by** the dimension (N) of the fin (26) being related to the diameter (D') and the area of the descending channel (14), wherein the burner (12) is installed.

7. Low nox emission burner, according to claim 4, **characterized by** the relation of the dimensions (M)/(N) of each fin (2) being between 0,25 and 0,5.

8. Low nox emission burner, according to claim 4, **characterized by** the distance (K) between the fins (26), the length (L) of each fin (26) being determined to create an intensity of the descending swirling flow (18) without significantly increasing the loss of charge through the burner (12) installed in the descending channel; the determination of the three parameters (K), (L) and number of fins (26) depending on the diameter (D') and descending channel area (14), wherein the burner (12) is installed; the larger the diameter (D') of the channel (14), the greater will be the diameter (D) of the ring (24) of the burner (12) and greater the number of fins (26).

9. Low nox emission burner, according to claim 4, **characterized by** the shape of each fin (26) being capable of being plane, curved, tubular or any other shape suitable for a better mixture of the fuel gas with the oxidant flow.

10. Low nox emission burner, according to claim 4, **characterized by** the discharge of the fuel gas being positioned through the plurality of openings (30) formed in groups (32), aligned, and with the discharges thereof pointed in the direction of the wall of each fin; each group (32) of openings discharges the fuel jets (34) in the direction of a single fin (26); there is a group (32) of openings for each fin (26); part of the total descending flow (18) runs along the passage of the fin (26) mixing with the five fuel jets (34) and all together are deflected so as to create a rotational flow downstream of the burner (12); each group (32) having at least one opening (30), depending on the diameter of the collector ring (24), transversal section of the ring and number of fins (26) installed.

11. Low nox emission burner, according to claim 1, **characterized by** the cylindrical descending channel (14) being considered as being part of the burner (12); part of the descending flow (18), deflected by the fins (26), is pre-mixed with the fuel gas and acquires rotational movement (42) along the cylindrical surface of the descending channel (14); in this region, having length (L) equal to approximately a diameter (D') of the channel, the fuel is burned; the fuel gas is evenly distributed around the circumference (46) of this channel, the mixing occurs quickly with oxygen diluted in the inert gases, and, as a result, the temperature peaks are reduced.

12. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claims 1 to 11, **characterized by** said method comprising the steps:

- the fuel gas jets are discharged from the plurality of openings (30) to be mixed with an oxidant flow which can be predominantly a flow of low or high temperature gases, which circulates, for example, in the iron ore pellet furnace (FO) for heating the pellets during the sintering or hardening process;
- the fuel jets mixed with oxidant form a jet or jets of flame, which are mixing and directly heating a circulating process flow;
- circulating process flow, which is the descending flow (18) in iron ore pelletizing furnace (FO), containing nitrogen, oxygen, carbon dioxide and water vapor are heated until the temperatures required by the process, continuing through the iron ore pellet bed, transferring the required heat for the occurrence of the necessary chemical reactions and physical transformations in the pellets.

13. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claim 11, **characterized by** part of the descending flow (18) being deflected, running through and between the passages of the fins, from vertical direction to horizontal direction, creating a swirling movement along the circumference of the cylindrical descending channel downstream of the burner ring.

14. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claim 11, **characterized by** fuel gas being discharged from the openings (30) of the collector ring (24) in the form of multiple jets and directed to each deflection surface of the fin (26).

15. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claim 11, **characterized by** fuel gas jets starting to mix with the descending oxidant flow (18) on the surface of the fin (26).

16. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claim 11, **characterized by** the descending flow (18) of oxidant pre-mixed with the fuel gas on the surface of the fin (26) being discharged to the descending furnace channel (FO); the rotational (swirling) current is self-inflamed from the temperature of the process and the flames with rotational components are stabilized on the inner surface of the descending channel.

17. Operating method for reducing nox formation applied to iron ore pellet sintering and/or enduring method, according to claim 11, **characterized by** fuel gas evenly distributed around the circumference of the descending channel being quickly mixed with the oxygen diluted in the inert gases, and obtaining, as a result, a significant reduction of the temperature peaks and consequent reduction in the NOX formation in the combustion process.

Amended claims under Art. 19.1 PCT

1. **LOW NOX EMISSION BURNER,** more precisely, relative to burner (12) for applying to heating process predominantly in iron ore pelletizing furnaces (FO) with low NOx emission of the type including a collector ring (24) with openings for mixing the fuel gas with oxidant and formation of flames for direct heating of the circulating gaseous medium; ***characterized*** **by** the fuel gas discharge being executed through a collector ring (24) provided with multiple openings (30) for mixing the fuel gas with oxidant and flame formation; the collector ring (24) being equipped with at least one input (28) for fuel gas supply; said ring (24) being, additionally, equipped with fins (26) installed on the inner part of said collector (24) in (α) angulation relative to the horizontal plane of the collector ring (24) deflecting part of the descending flow (18) of circulating hot air diluted with the combustion gases originating from burning the fuel gas in the vertical diretion to the horizontal resulting in a speed vector obtaining the tangential component and which in the cylindrical profile of the descending channel generates the rotation or swirling effect.

2. **LOW NOX EMISSION BURNER,** according to claim 1, ***characterized*** **by** fuel gas collector (24) presenting a ring shape, manufactured with circular or rectangular section, the outer diameter (D) of the collector ring (24) being reduced relative to the inner diameter (D') of the descending passage (14).

3. **LOW NOX EMISSION BURNER,** according to claim 1, ***characterized*** **by** the deflection angle (α) of the fin (26) being between 30° to 60° relative to the horizontal transversal plane of the fuel gas collector ring (24).

4. **LOW NOX EMISSION BURNER,** according to claim 1, ***characterized*** **by** each fin (26) being modelled in 'L' profile with flap in 90° (β) angle.

5. **LOW NOX EMISSION BURNER,** according to claim 4 and alternatively ***characterized*** **by** the angle (β) varying from about 45° to 90°.

6. **LOW NOX EMISSION BURNER,** according to claim 4, ***characterized*** **by** the dimension (N) of the fin (26) being related to the diameter (D') and the area of the descending channel (14), wherein the burner (12) is installed.

7. **LOW NOX EMISSION BURNER,** according to claim 4, ***characterized*** **by** the relation of the dimensions (M)/(N) of each fin (2) being between 0,25 and 0,5.

8. **LOW NOX EMISSION BURNER,** according to claim 4, ***characterized*** **by** the distance (K) between the fins (26), the length (L) of each fin (26) being determined to create an intensity of the descending swirling flow (18) without significantly increasing the loss of charge through the burner (12) installed in the descending channel; the determination of the three parameters (K), (L) and number of fins (26) depending on the diameter (D') and descending channel area (14), wherein the burner (12) is installed; the larger the diameter (D') of the channel (14), the greater will be the diameter (D) of the ring (24) of the burner (12) and greater the number of fins (26).

9. **LOW NOX EMISSION BURNER,** according to claim

4, ***characterized*** **by** the shape of each fin (26) being capable of being plane, curved, tubular or any other shape suitable for a better mixture of the fuel gas with the oxidant flow.

10. LOW NOX EMISSION BURNER, according to claim 4, ***characterized*** **by** the discharge of the fuel gas being positioned through the plurality of openings (30) formed in groups (32), aligned, and with the discharges thereof pointed in the direction of the wall of each fin; each group (32) of openings discharges the fuel jets (34) in the direction of a single fin (26); there is a group (32) of openings for each fin (26); part of the total descending flow (18) runs along the passage of the fin (26) mixing with the five fuel jets (34) and all together are deflected so as to create a rotational flow downstream of the burner (12); each group (32) having at least one opening (30), depending on the diameter of the collector ring (24), transversal section of the ring and number of fins (26) installed.

11. LOW NOX EMISSION BURNER, according to claim 1, ***characterized*** **by** the cylindrical descending channel (14) being considered as being part of the burner (12); part of the descending flow (18), deflected by the fins (26), is pre-mixed with the fuel gas and acquires rotational movement (42) along the cylindrical surface of the descending channel (14); in this region, having length (L) equal to approximately a diameter (D') of the channel, the fuel is burned; the fuel gas is evenly distributed around the circumference (46) of this channel, the mixing occurs quickly with oxygen diluted in the inert gases, and, as a result, the temperature peaks are reduced.

12. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURINGMETHOD, according to any of claims 1 a 11, ***characterized*** **by** said method comprising the steps:

- the fuel gas jets are discharged from the plurality of openings (30) to be mixed with an oxidant flow which can be predominantly a flow of low or high temperature gases, which circulates, for example, in the iron ore pellet furnace (FO) for heating the pellets during the sintering or hardening process;
- the fuel jets mixed with oxidant form a jet or jets of flame, which are mixing and directly heating a circulating process flow;
- circulating process flow, which is the descending flow (18) in iron ore pelletizing furnace (FO), containing nitrogen, oxygen, carbon dioxide and water vapor are heated until the temperatures required by the process, continuing through the iron ore pellet bed, transferring the required heat for the occurrence of the necessary chemical reactions and physical transformations in the pellets.

13. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD, according to claim 11, ***characterized*** **by** part of the descending flow (18) being deflected, running through and between the passages of the fins, from vertical direction to horizontal direction, creating a swirling movement along the circumference of the cylindrical descending channel downstream of the burner ring.

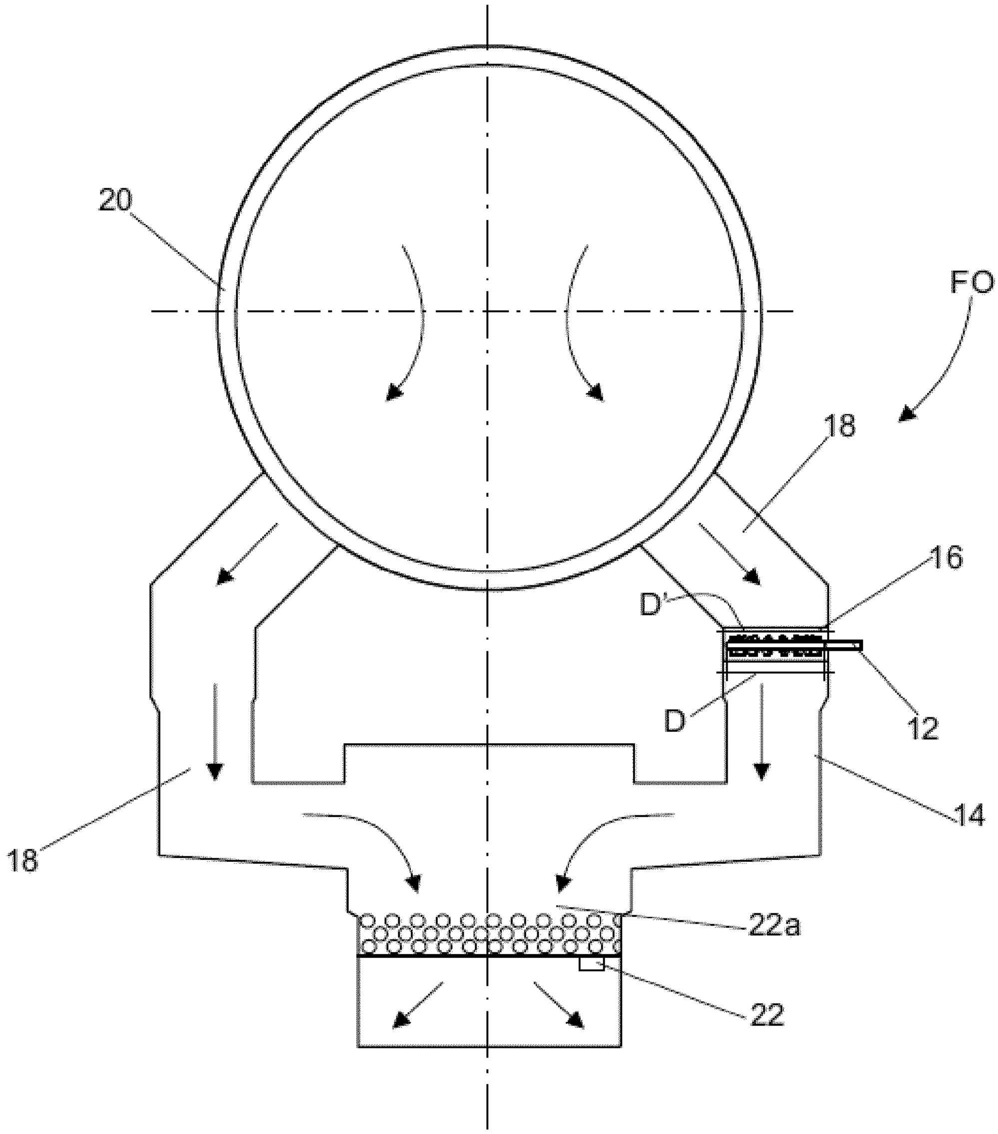
14. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD, according to claim 11, ***characterized*** **by** fuel gas being discharged from the openings (30) of the collector ring (24) in the form of multiple jets and directed to each deflection surface of the fin (26).

15. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD, according to claim 11, ***characterized*** **by** fuel gas jets starting to mix with the descending oxidant flow (18) on the surface of the fin (26).

16. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD, according to claim 11, ***characterized*** **by** the descending flow (18) of oxidant pre-mixed with the fuel gas on the surface of the fin (26) being discharged to the descending furnace channel (FO); the rotational (swirling) current is self-inflamed from the temperature of the process and the flames with rotational components are stabilized on the inner surface of the descending channel.

17. OPERATING METHOD FOR REDUCING NOX FORMATION APPLIED TO IRON ORE PELLET SINTERING AND/OR ENDURING METHOD, according to claim 11, ***characterized*** **by** fuel gas evenly distributed around the circumference of the descending channel being quickly mixed with the oxygen diluted in the inert gases, and obtaining, as a result, a significant reduction of the temperature peaks and consequent reduction in the NOX formation in the combustion process.

FIG. 1



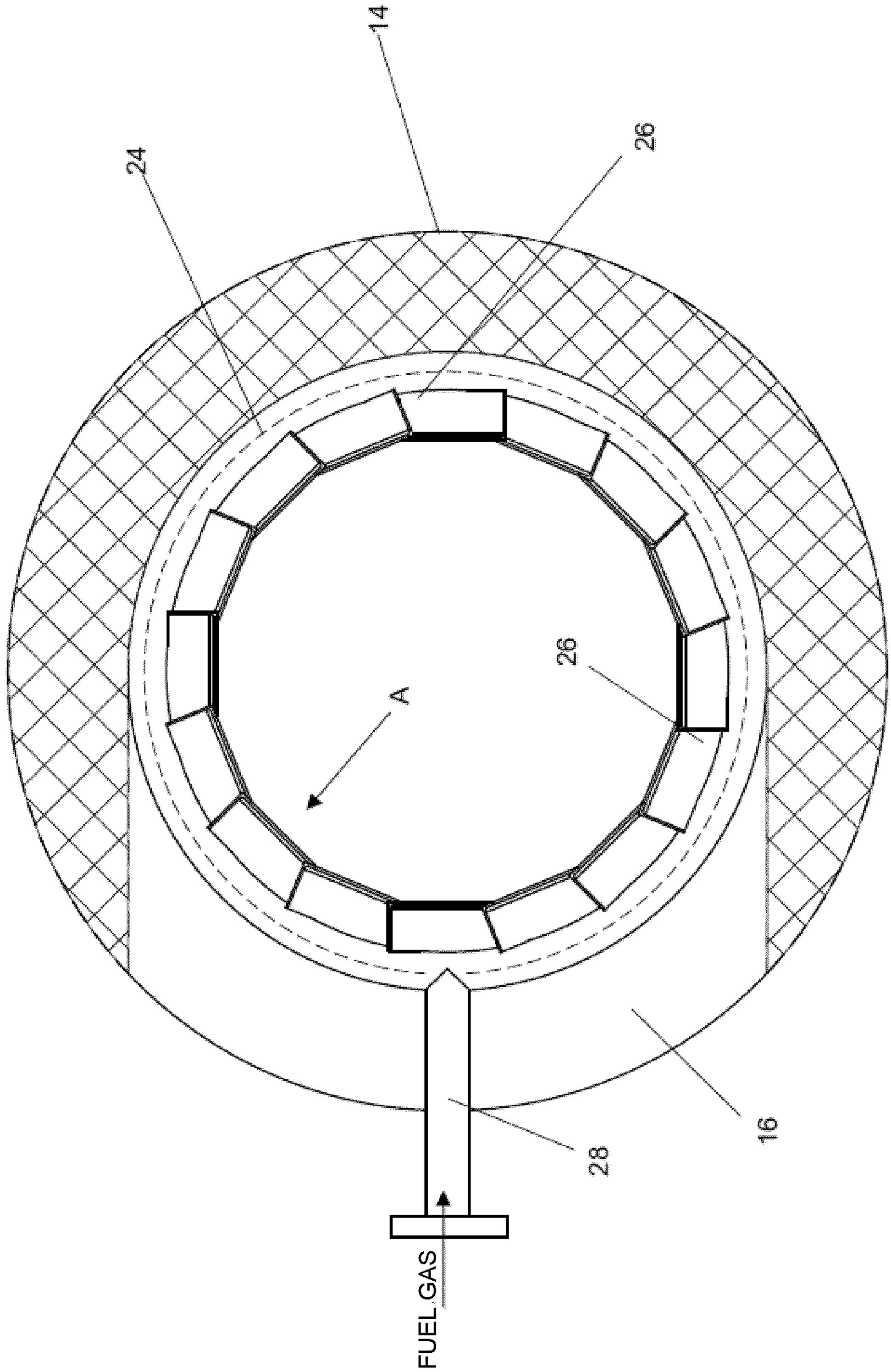


FIG. 2

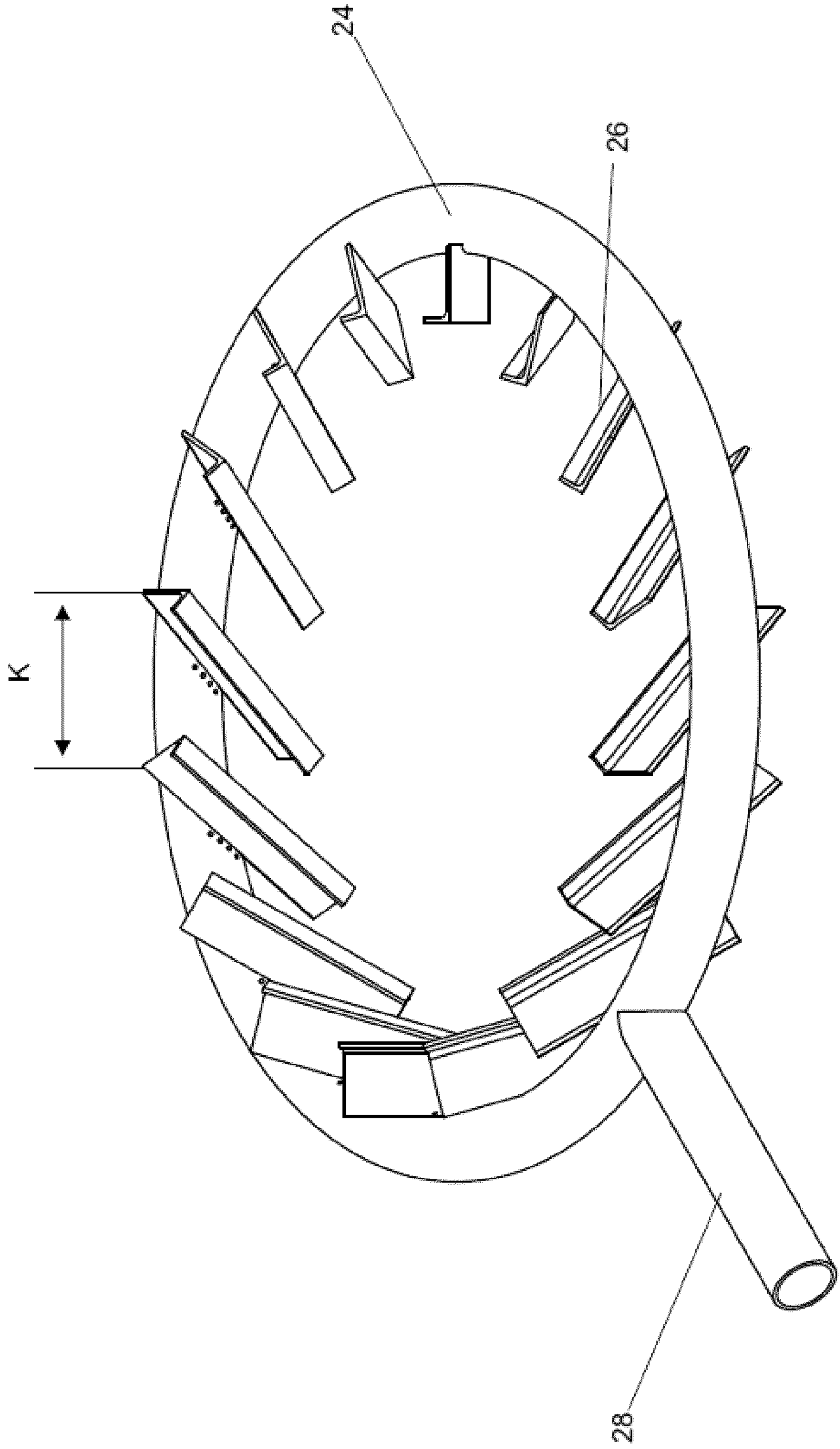


FIG. 3

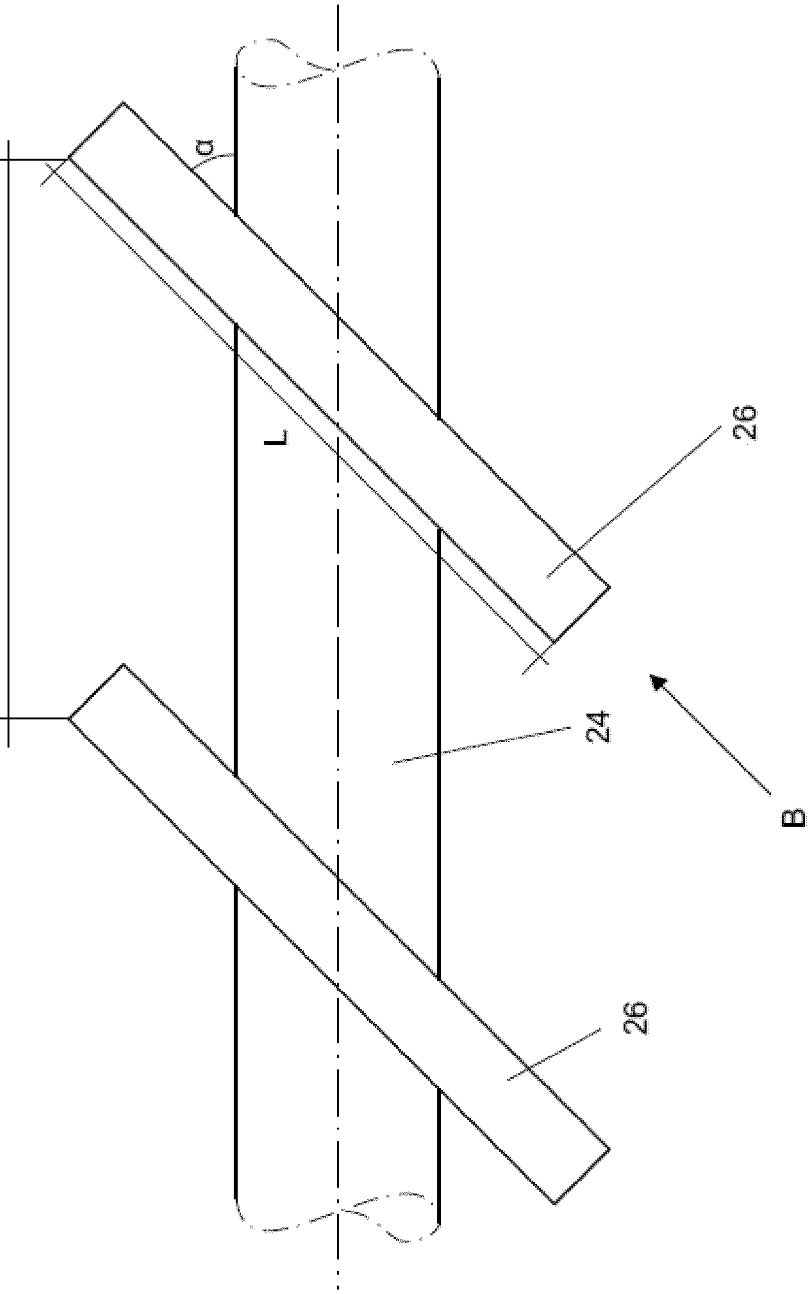


FIG. 4

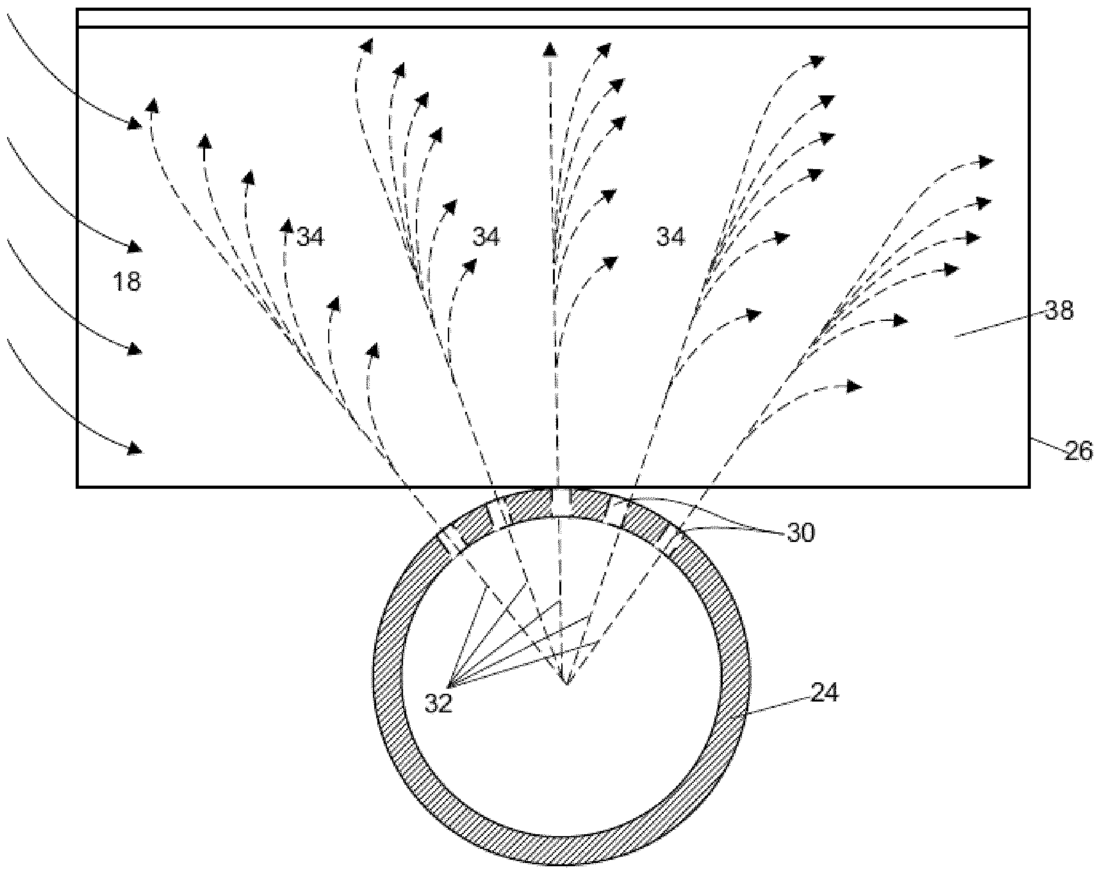
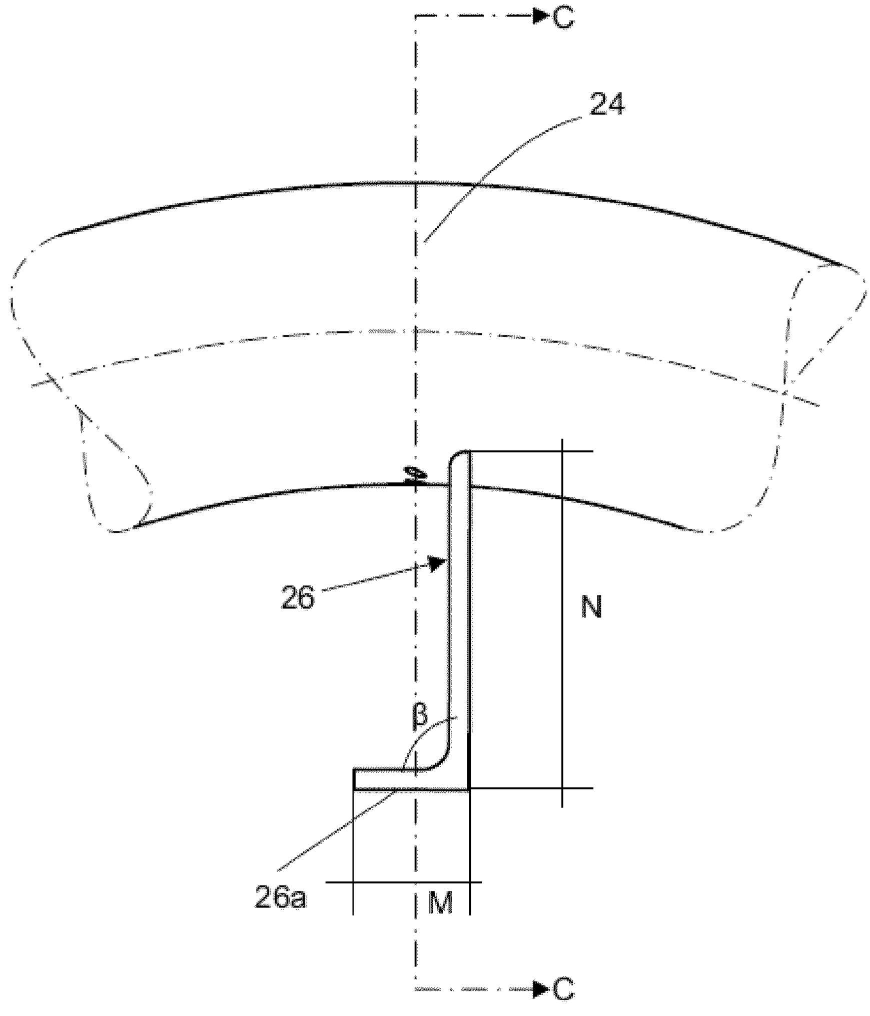


FIG. 5
CROSS SECTION

FIG. 6
VIEW B



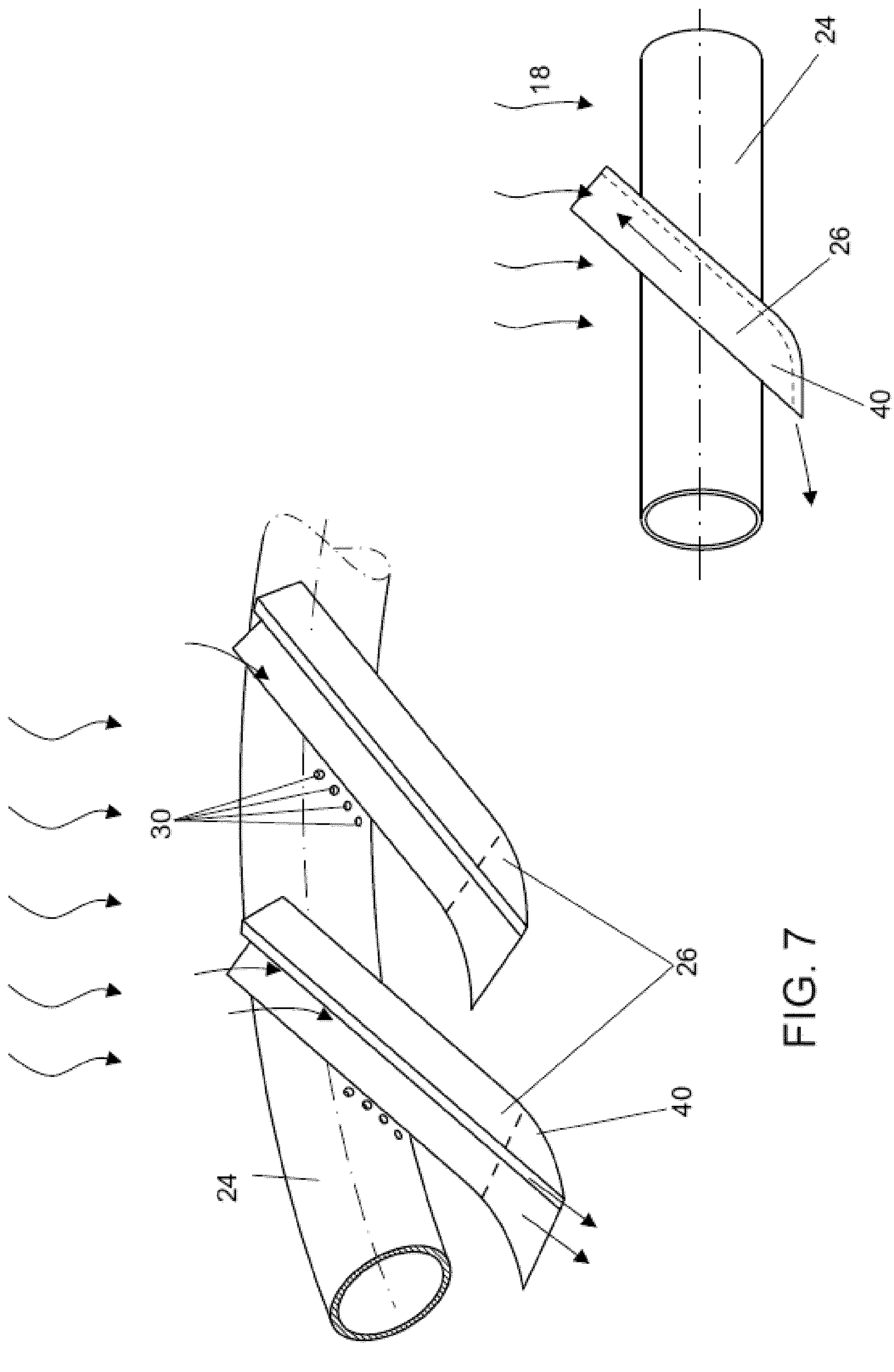


FIG. 7

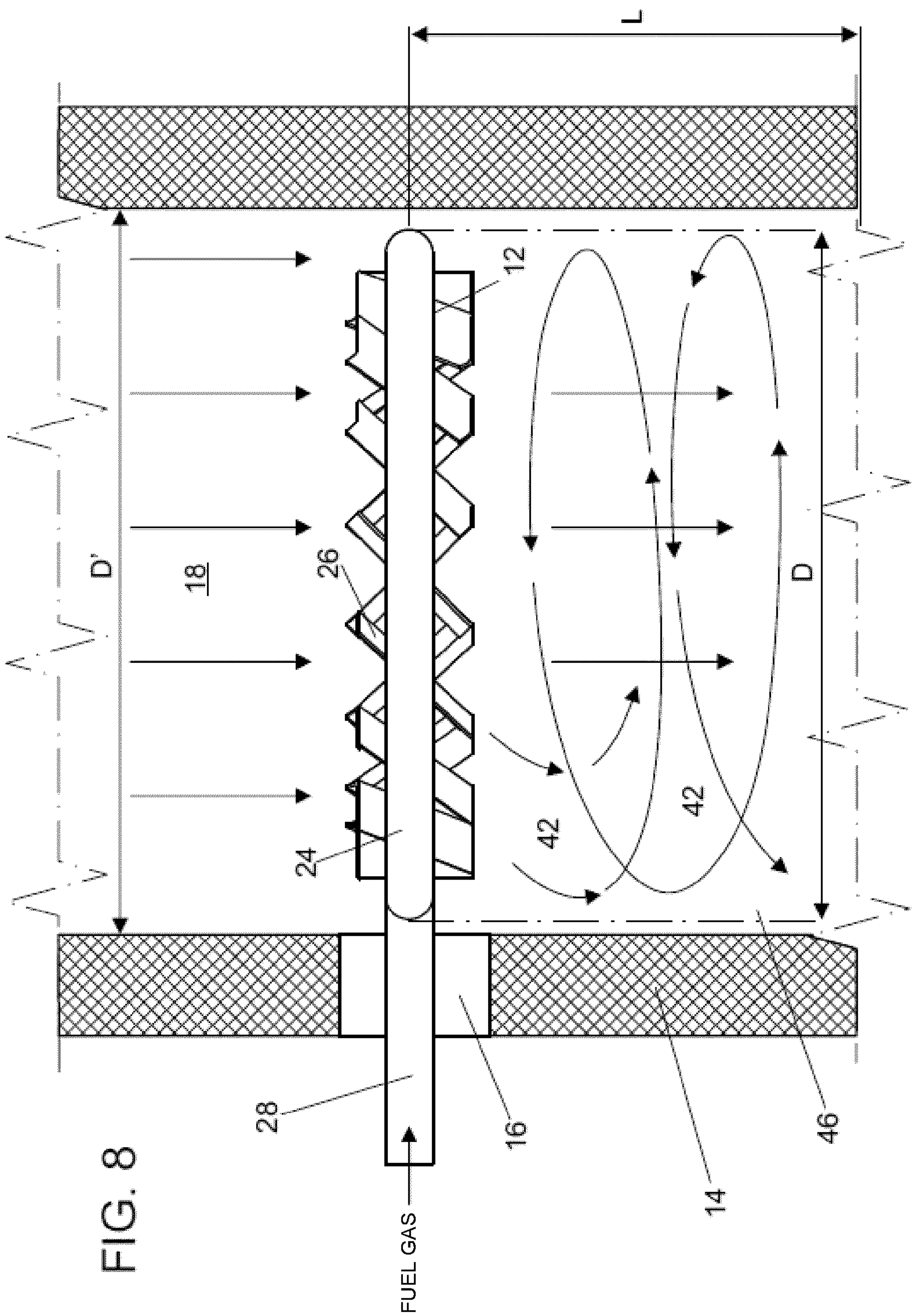


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR2021/050386

A. CLASSIFICATION OF SUBJECT MATTER

IPC: F23D14/70 (2006.01), F23D14/64 (2006.01), F23D14/62 (2006.01), F23D14/02 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Banco de Patentes do INPI-BR

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, Derwent Innovation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	CN 111397357 A (FENG XIANHUA) 10 July 2020 (2020-07-10) Abstract and figures 1-5	1-17

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2022	7 June 0222

Name and mailing address of the ISA/	Authorized officer
INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL Rua Mayrink Veiga nº 9, 6º andar cep: 20090-910, Centro - Rio de Janeiro/RJ	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT
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