HU000034250T2

(19) **HU** (11) Lajstromszám: **E 034 250** (13) **T2**

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

EURÓPAI SZABADALOM
SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 11 188879**
(22) A bejelentés napja: **2011. 11. 11.**

(51) Int. Cl.: ***F23D 14/12*** *(2006.01)*
F23L 15/04 *(2006.01)*

(96) Az európai bejelentés bejelentési száma:
EP 20110188879
(97) Az európai bejelentés közzétételi adatai:
EP 2453174 A1 **2012. 05. 16.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
EP 2453174 B1 **2017. 03. 01.**

(30) Elsőbbségi adatok:
102010051347 **2010. 11. 13.** **DE**

(72) Feltaláló(k):
Potesser, Michael, 1020 Wien (AT)

(73) Jogosult(ak):
Messer Austria GmbH, 2352 Gumpoldskirchen (AT)

(74) Képviselő:
Danubia Szabadalmi és Jogi Iroda Kft., Budapest

(54) **Sugárzásos fűtőcső égőfej külső és belső rekuperációval**

RADIANT TUBE BURNER DEVICE WITH INTERNAL AND EXTERNAL RECUPERATION

The invention relates to an apparatus for oxidizing fuels comprising a burner, which is installed in a wall of a furnace space and which has a fuel channel, which opens into a reaction space, and at least one oxidant channel for supplying fuel or oxidant, respectively, a combustion gas takeoff channel for discharging combustion gas from the reaction space and a first recuperator comprising heat exchanger surfaces, which thermally connect the combustion gas takeoff channel to the oxidant channel and to the fuel channel, wherein the burner outside the furnace space is connected to an offgas conduit, which is fluidically connected to the combustion gas takeoff channel, to a fuel feed, which is fluidically connected to the fuel channel, and to an oxidant feed, which is fluidically connected to the oxidant channel. The invention furthermore relates to a corresponding process for oxidizing fuels.

The heating of furnace spaces with direct or indirect heating by the oxidation of fuels is known. In the case of the direct heating, a fuel, for example oil or natural gas, and an oxidant, for example air or oxygen, is introduced into the furnace space by means of a burner and is combusted there. The resulting combustion gases are subsequently discharged via a combustion gas takeoff channel. For many metallurgical uses, an indirect heating of the furnace space is required, which, according to the prior art, is accomplished for the most part by means of electric heaters or radiant heating tubes. Radiant tubes are typically fired with gas or oil burners using air or an oxygen-rich gas as oxidant, which are accommodated inside a radiant heating tube consisting of metal or a ceramic material. The heat energy input into the furnace space takes place by means of radiation or convection of the furnace space atmosphere, which heats up on the outer surface of the radiant tube, without resulting a direct contact of the combustion gases with the furnace space atmosphere. The combustion gases are directly discharged from the radiant tube via a combustion gas takeoff channel.

One example for a radiant heating tube, which is designed for an oil firing, can be found in the technical article by A. Munko, F. Kleine Jäger, H. Köhler: "New burner technology for radiant heating tubes in thermoprocessing plants", BWK 54 (2002) No. 9. In the case of the subject matter described therein, a mixture of primary air and fuel is mixed in an evaporation pipe and is heated in such a way that the liquid fuel evaporates. The heat required hereby is provided by the hot offgas, heat transition of hot burner components and thermal radiation directed upstream. At the exit of the evaporation pipe, the fuel-air mixture is input in an unburned manner into a fire tube, which connects to the evaporation pipe, and is brought into contact there with secondary air, which was preheated in a recuperator, which is arranged inside the radiant heating tube, by means of heat exchange with the offgas. The mixture of the gas flows and the subsequent combustion takes place in the fire tube. Burner and fire tube are thereby constructed in such a way that, in the stationary operation of the radiant heating tube, the combustion gases created during the combustion, are partly returned and are input into the fire tube together with the fuel-air mixture (recirculation).

An apparatus for heat treatment, which can be designed as radiant heating tube or burner and in the case of which oxygen with a purity of at least 80% by volume is used as oxidant, is described in US 2005/0239005 A1. The combustion with oxygen or a gas, respectively, comprising an oxygen portion, which is higher than that in air, instead of air, leads to reduced NO_x concentrations in the offgas. A recirculation of the offgas as well as a preheating of the supplied oxygen also takes place here by means of heat exchange with the discharged combustion gas in a recuperator arranged inside the burner.

WO 2004/029511 A1 also shows a radiant heating tube with recirculation of the offgas as well as an internal recuperator, in the case of which the residual heat of the offgas is transferred to the oxidant via the outer walls of the tubing, which guides the oxidant.

US 2009/0269710 A1 likewise describes a radiant heating tube, which is equipped with an internal recuperator. In the case of this subject matter, the offgases are guided through a centrally arranged tube, the walls of which are used as heat exchanger surfaces for preheating the oxidant or fuel, which is guided past the offgas tube on the outside.

It is the object of the invention to further increase the efficiency of the combustion by using a recuperator burner.

This object is solved by means of an apparatus comprising the features of patent claim 1 and by means of a process comprising the features of patent claim 6.

An apparatus of the above-mentioned type and purpose thus has the characteristics that outside of the furnace space, the burner is connected to an offgas conduit, which is fluidically connected to the combustion gas takeoff channel, to a fuel feed, which is fluidically connected to the fuel channel, and to an oxidant feed, which is fluidically connected to the oxidant channel, wherein the offgas conduit comprising the oxidant feed and the fuel feed are thermally connected to one another at heat exchanger surfaces provided in a second recuperator.

A two-stage preheating thus takes place in the burner according to the invention, wherein a first stage takes place outside the furnace space in response to the supply of the oxidant or of the fuel, respectively, to the burner (second recuperator), and a second stage takes place inside the burner (first recuperator). A portion of the heat of the combustion gas is transferred to the oxidant and/or the fuel by means of the first recuperator inside the furnace space. If the oxidant in the burner or the first recuperator, respectively, is thereby guided through a plurality of oxidant channels, all oxidant channels are also thermally connected to the returned combustion gas as a rule. By arranging a second recuperator outside of the furnace space, the residual heat contained in the combustion gas obtained after passing through the first recuperator, can also be used to preheat the oxidant and/or the fuel. The combustion efficiency is further increased by the preheating. In contrast to recuperation burners according to the prior art, it is possible according to the invention to not only preheat the oxidant, but also the fuel in the first and/or in the second recuperator. The burner according to the invention can in particular be used in furnaces for the metallurgical heat treatment.

The entire furnace space can be considered as reaction space provided that the fuel and the oxidant are input directly into the furnace space and the combustion gas is at least partly discharged from the furnace space through a fuel takeoff channel provided in the burner with first recuperator. A particularly advantageous further development of the invention, however, provides that a radiant heating tube, which is assigned to the burner, is provided as reaction space. The combustion thus does not take place in the furnace space, but inside the radiant heating tube, which is closed to the outside, and the heating of the furnace space takes place indirectly by means of the radiation emanating from the radiant heating tube or convectively, by heating the furnace space atmosphere, which comes into contact with the outer surface of the radiant heating tube.

Oxygen is preferably provided as oxidant. A gas with an oxygen content of at least 90% by volume, preferably of at least 95% by volume, is considered to be "oxygen" here. The use of oxygen instead of air leads to lower NO_x concentrations in the offgas on the one hand and to higher flame temperatures and thus to higher temperatures in the offgas on the other hand, because of which the two-stage preheating becomes particularly economical.

A gaseous fuel, such as natural gas, for example, can be provided as fuel, but liquid or powdery fuels, such as oil or carbon dust, for example, can also be used. The apparatus according to the invention, however, is also suitable for the combustion of low calorific value fuels, in particular when using oxygen as oxidant. Fuels, which, with less than 35 MJ/kg, in particular between 1.5 and 20 MJ/kg, have a significantly lower calorific value than natural gas or heating oil, in particular gaseous fuels, such as furnace gas, town gas, coke oven gas or converter gas, are to be understood as "low calorific fuels" herein. To be able to increase the calorific value, mixtures, such as, for example, a mixture of natural gas with one or a plurality of the mentioned fuels or another low-calorific fuel, can also be used in order to be able to increase the calorific value, wherein a fuel results, the calorific value of which lies between natural gas and the low-calorific fuel or the fuels, which is or are used.

A once again advantageous further development of the invention provides that channels for a first and a second oxidant, which are in each case fluidically connected to oxidant fees for a first or second oxidant, respectively, are provided to allow a staged combustion. The flame temperature can be regulated by means of the staged combustion. In the case of a radiant heating tube as reaction space, in particular an overheating of the radiant heating tube is thus avoided. One or both oxidant feeds can thereby be thermally connected to the offgas conduit in the second recuperator. One or both oxidant channels in the first recuperator can likewise be thermally connected to the combustion gas takeoff channel inside the burner, a preheating of both or only one of the oxidants can thus take place.

The object of the invention is also solved by means of a process comprising the features of claim 6.

According to the process according to the invention, a fuel and an oxidant are supplied to a reaction space through supply channels for fuel of oxidant, respectively, assigned to a burner and are brought to reaction there while a reaction product (combustion gas) is created, for the purpose of heating a furnace chamber. The combustion gas created in response to the reaction is discharged via a combustion gas takeoff channel, wherein the heat of the combustion gas is partly transferred to the oxidant to be supplied to the reaction space and/or to the fuel at heat exchanger surfaces of a first recuperator arranged inside the burner. The combustion gas, which still has high thermal energy, is subsequently supplied to heat exchanger surfaces, which are provided in a second recuperator outside the furnace space, and are there brought into heat exchange with the oxidant and fuel to be supplied to the first recuperator. The waste heat of the combustion gas is used in a particularly efficient manner by means of the two-staged course of the recuperator according to the invention.

In an advantageous further development of the process according to the invention, a partial flow of the combustion gas is admixed with the oxidant and/or the fuel and is thus recirculated. In this case, flow connections are provided inside the burner between the combustion gas takeoff channel and the supply channels for oxidant and/or supplied fuel, which provide for the recirculation of a partial flow of the combustion gas during operation of the burner. Such flow connections are known per se and are described for example in US 2005/0239005 A1.

Particularly advantageously, the flows of oxidant, fuel and recalculated combustion gas are controlled in such a way that a flameless combustion is effected inside the reaction space, based on which particularly low NO_x concentrations are attained in the offgas.

A supersonic injection of fuel and/or oxidant is not ruled out in the context of the invention for the operation of the burner according to the invention, but a preferred embodiment of the process according to the invention, however, provides for a clearly subsonic supply of fuel and/or oxidant into the reaction space, with a speed of preferably less than 0.5 Mach. In this embodiment, a burner, which operates according to the process according to the invention, can thus manage without extensive supersonic technology, such as laval nozzles, for example.

To design the process according to the invention to be particularly efficient, the oxidant is preferably preheated to at least 800°C, particularly preferably to at least 1000°C, and the fuel is preheated to at least 400°C by means of the heat exchange with the combustion gas in the first and second recuperator.

In response to the heat exchange with the oxidant and/or the fuel in the two recuperators, the combustion gas is preferably cooled to a temperature of less than 100°C, preferably less than 80°C, i.e. the burner according to the invention can be operated as calorific burner.

An exemplary embodiment of the invention is to be explained in more detail by means of the drawing. In schematic view, the sole figure (Fig. 1) shows, in longitudinal section, a furnace comprising a burner according to the invention, which is embodied as radiant heating tube.

The furnace 1 illustrated in the drawing has a furnace space 2, which is enclosed by a furnace wall 3, which is only shown in sections herein. A passage opening 5, which extends vertically to the inner surface of the furnace wall 3 through said inner surface and in which a burner 6 is assembled, is provided in the furnace wall 3.

The burner 6, which partly extends into the furnace space 2, is delimited form the furnace space 2 and from the passage opening 5 by means of a jacket tube 7, which, when the burner 6 is embodied as radiant heating tube as shown in the drawing, has a closed front wall 9. Supply channels 11, 12, 13 for fuel (11) or oxidants (12, 13) are provided in a rear section of the burner 6 adjacent to the furnace wall 3, while the front section of the interior of the jacket tube 7 between the openings of the supply channels 11, 12, 13 and the front wall 9 forms a reaction space 15, in which, during operation of the burner 6, an oxidation of the supplied fuel takes place. As a rule, the reaction space 15 thereby encompasses the majority of the volume surrounded by the jacket tube 7.

The supply channels 11, 12, 13 encompass a central fuel cannel 11 for supplying fuel, on which a number of, for example four, six or eight oxidant channels 12, 13, which are evenly spaced apart in circumferential direction and of which only two channels, which are located opposite one another, are in fact shown in the sectional view in Fig. 1, are provided radially on the outside. The fuel channel 11 and the oxidant channels 12, 13 open substantially flush with one another on their outlet openings, which face the reaction space 15.

A flame tube 16, which is arranged axially spaced apart upstream of the outlet openings of the fuel channel 11 or the oxidant channels 12, 13, respectively, and which has an inner radius, which is dimensioned such that the at least the majority of the oxidant, which flows out of the oxidant channels 12, 13, flows into the flame tube 16, is arranged inside the reaction space 15. An annular gap 17, which makes it possible for the reaction product (combustion gas) created in response to the oxidation of the fuel to flow back, is present between flame tube 16 and inner wall of the jacket tube 7. In the rear area of the jacket tube 8, the area around the fuel channel 11 or the oxidant channels 12, 13, respectively, serves as takeoff channel 18 for taking off the combustion gases from the reaction space 15. A recuperator 19 is arranged inside this takeoff channel 18. The recuperator 19 is designed in a manner, which is known per se, and comprises heat exchanger surfaces, for example ribs, by means of which the takeoff channel 18 is thermally connected to the fuel feed 11 and the oxidant feeds 12, 13.

To introduce fuel or oxidant, respectively, into the supply channels 11, 12, 13 as well as for discharging the combustion gases from the takeoff channel 18, the burner 6 is provided with an exhaust branch 21 as well as with connections 22, 23, 24 for fuel or oxidant, respectively, on its end section, which is located opposite furnace space 2. The fuel channel 11 is thereby connected to a fuel feed 25 via a connection 22, while the oxidant channels 12, 13 are connected via connections 23, 24 to a common oxidant feed 26, which branches off prior to reaching the connections 23, 24. The exhaust branch 21 is connected to an offgas conduit 28, which is connected in the further course to devices for cleaning the offgas flow, which are not shown herein. The offgas conduit 28 as well as the fuel feed 25 and the oxidant feed 26 run through a second recuperator 29, in which heat exchanger surfaces, which are not shown herein, are provided, which establish a thermal connection between the offgas conduit 28 on the one hand and the fuel feed 25 as well as the oxidant feed 26 on the other hand.

During operation of the apparatus 1, fuel, for example oil, natural gas or a low-calorific fuel, for example, is input via the fuel feed 25 and the fuel channel 11, and oxidants, for example oxygen with a purity of less than 95% by volume, are input into the reaction space 15 via the oxidant feed 26 and the oxidant channels 12, 13. The input speed of both mediums thereby lies within the subsonic range and is for example 0.5 Mach. In the reaction space 15, the fuel oxidizes inside the flame tube 16. The combustion gas created thereby is returned via the annular gap 17 – suggested by arrows in Fig. 1 – wherein a partial flow of the combustion gas reaches into the gap between the outlet openings of the channels 11, 12, 13 and the flame tube 16 and, together with the reaction partners, is supplied to the reaction space 15 again (recirculation). Due to the partial recirculation of the combustion gas, the formation of a flameless oxidation of the supplied fuel can also be effected in the reaction space 15.

The remaining partial flow of the combustion gas is discharged via the takeoff channel 18, the exhaust branch 21 and the offgas conduit 28. When flowing into the takeoff channel 18 at a temperature of approx. 1400°C, the combustion gas has a high thermal energy, which is largely transferred to the fuel and the oxidant in the recuperators 19, 29 in two consecutive stages. Due to this two-staged design of the recuperation, the temperature of the oxidant is increased to for example 1000°C and the temperature of the fuel is increased to for example 400°C until immediately prior to the supply into the reaction space. From the start, i.e. immediately after being created in the reaction space 15, until escaping from the second recuperator 29, the temperature of the offgas simultaneously decreases from above 1400°C to below 100°C, for example 80°C and below. Due to the high heat transfer and the fact that, in addition to the oxidant, the fuel is also preheated, an efficiency of the combustion of above 100%, based on the calorific value, results. The burner 6 according to the invention is thus characterized by a high efficiency and furthermore by low NO_x values in the offgas.

Instead of the embodiment shown in Fig. 1, separate oxidant channels can be provided for a first and a second oxidant, which, from an axial aspect, open spaced apart from one another and which provide for a burner operation in staged combustion. The primary and the secondary oxidant can thereby be the same oxidant, for example oxygen, or different oxidant, for example air, as primary oxidant and oxygen as secondary oxidant. In response to the staged combustion, the fuel is initially mixed with the primary oxidant at a sub-stoichiometric ratio. Due to the low oxidant supply, only a part of the fuel can combust with the primary oxidant. The mixture of combustion gas and non-combusted fuel reaches into a front section of the burner and the secondary oxidant is applied there, by means of which the non-combusted fuel is oxidized. The staged combustion provides for an even distribution of the heat development across the longitudinal extension of the reaction space, thus within the longitudinal extension of the flame tube, in the case of being designed as radiant heating tube.

List of Reference Numerals

1	furnace
2	furnace space
3	furnace wall
5	passage opening
6	burner
7	jacket tube
9	front wall
11	fuel channel
12	oxidant channel
13	oxidant channel
15	reaction space
16	flame tube
17	annular gap
18	takeoff channel
19	recuperator
21	exhaust branch
22	connection for fuel feed
23	connection for oxidant feed
24	connection for oxidant feed
25	fuel feed
26	oxidant feed
28	offgas conduit
29	recuperator

SUGÁRZÁSOS FŰTŐCSŐ ÉGŐFEJ KÜLSŐ ÉS BELSŐ REKUPERÁCIÓVAL

Szabadalmi igénypontok

1. Berendezés tüzelőanyag oxidálására kemencetér (2) falába (3) beépített égőfejjel (6), melynek tüzelőanyag, illetve oxidálószer betáplálásához reakciótérbe (15) torkolló tüzelőanyag-csatornája (11) és legalább egy oxidálószer-csatornája (12, 13), égésgáz reakciótérből (15) való elvezetéséhez égésgáz-elvezető csatornája (18), valamint az égésgáz-elvezető csatornát (18) az oxidálószer-csatornával (12, 13) és a tüzelőanyag-csatornával (11) termikusan összekapcsoló hőcserélő felületeket tartalmazó első rekuperátora (19) van, ahol az égőfej (6) a kemencetéren (2) kívül egy az égésgáz-elvezető csatornával (18) közlekedő füstgázvezetékkel (28), egy a tüzelőanyag-csatornával (11) közlekedő tüzelőanyagbetápláló vezetékkel (25) és egy az oxidálószer-csatornával (12, 113) közlekedő oxidálószerbetápláló vezetékkel (26) van csatlakoztatva, ahol a füstgázvezeték (28), az

oxidálószerbetápláló vezeték (26) és a tüzelőanyagbetápláló vezeték (25) második rekuperátorban (29) elhelyezett hőcserélő felületek révén egymással termikusan össze vannak kapcsolva.

2. Az 1. igénypont szerinti berendezés, ahol az égőfej (6) sugárzásos fűtőcsőben van elrendezve.

3. Az 1. vagy a 2. igénypont szerinti berendezés, ahol az oxidálószert oxigén képezi.

4. Az előző igénypontok bármelyike szerinti berendezés, ahol a tüzelőanyagot alacsony fűtőértékű tüzelőanyag képezi.

5. Az előző igénypontok bármelyike szerinti berendezés, ahol lépcsőzetes égetés lehetővé tételéhez az égőfejnek (6) első és második oxidálószer-csatornái (12, 13) vannak, melyek rendre első, illetve második oxidálószer számára szolgáló oxidálószer-bevezetésekkel közlekednek.

6. Eljárás tüzelőanyag oxidálására, melynél kemencetér (2) hevítéséhez égőfejjel (6) társított tüzelőanyag-, illetve oxigénbetápláló csatornák (11, 12, 13) révén reakciótérbe (15) tüzelőanyagot és oxidálószert táplálunk és viszünk ott reakcióba, továbbá a reakcióban keletkező égésgázt égésgáz-elvezető csatornán (18) keresztül elvezetjük, továbbá egy az égőfej (6) belsejében elrendezett első rekuperátor (19) hőcserélő felületein az égésgáz hőjét részben a reakciótérbe (15) betáplálni szándékozott oxidálószernek és a tüzelőanyagnak adjuk át, ahol a rekuperátorban (19) lehűlt égésgázt a kemencetéren (2) kívül második rekuperátorban (29) elhelyezett hőcserélő felületekhez vezetjük és ott az első rekuperátorba (19) betáplálni szándékozott oxidálószerrel és a tüzelőanyaggal hőcserélő kapcsolatba hozzuk.

7. A 6. igénypont szerinti eljárás, ahol a reakciótérben (15) keletkezett égésgáz egy részét a reakciótérbe (15) betáplált oxidálószerhez és/vagy a tüzelőanyaghoz keverjük, és ilyen módon visszakeringtetjük.

8. A 6. vagy a 7. igénypont szerinti eljárás, ahol a reakciótérben (15) lángmentes égetést végzünk.

9. A 6-8. igénypontok bármelyike szerinti eljárás, ahol a tüzelőanyag és/vagy az oxidálószer reakciótérbe (15) történő befecskendezését hangsebesség alatti sebességgel végezzük.

10. A 6-9. igénypontok bármelyike szerinti eljárás, ahol az oxidálószert legalább 1000°C hőmérsékletre és a tüzelőanyagot legalább 400°C hőmérsékletre előmelegítjük.

11. A 6-10. igénypontok bármelyike szerinti eljárás, ahol az égésgázt az oxidálószerrel és/vagy a tüzelőanyaggal az első rekuperátorban (19) és a második rekuperátorban (29) történő hőcsere útján 100°C hőmérsékletnél alacsonyabb hőmérsékletre hűtjük.

SZTNH-100026097

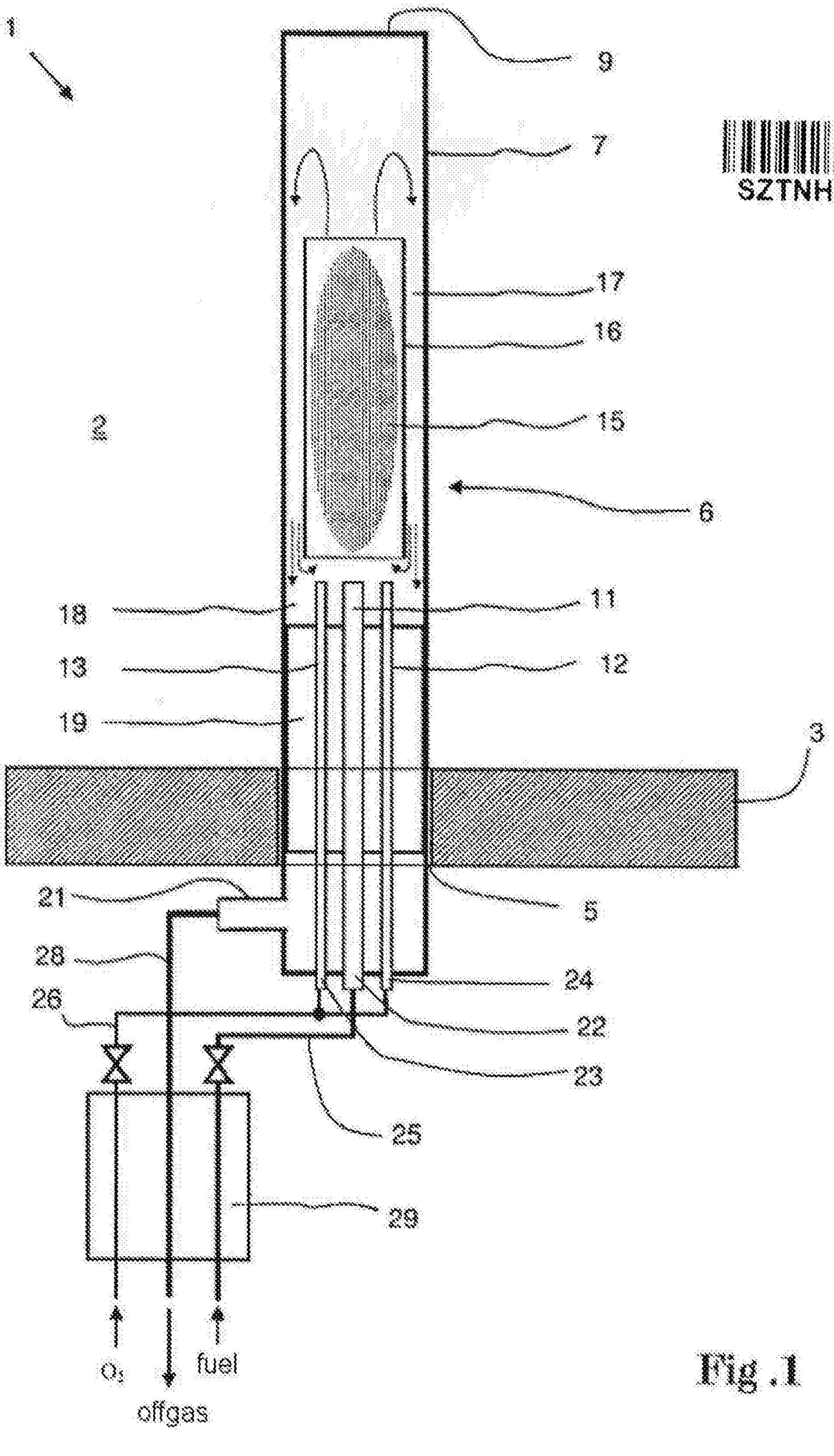

Fig .1