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(54) Benævnelse: **Fremgangsmåde til reduktion af kvælstofoxider og kuloxid i brændekamre på vand- og dampkedler, især ristekedler samt et system til reduktion af kvælstofoxider og kuloxid i brændekamre på vand- og dampkedler, især ristekedler.**

(56) Fremdragne publikationer:
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DESCRIPTION

[0001] The subject of the invention is a method of reduction of nitrogen oxides and carbon monoxide in furnace chambers of water boilers and steam boilers, especially grate boilers, and a water and steam boiler with a system for reduction of nitrogen oxides and carbon monoxide in the furnace chamber, which system is also applicable to the reduction of generation of nitrogen oxides and carbon monoxide and/or their reduction in combustion chambers of heating boilers and power boilers, especially grate boilers.

[0002] The methods described in the patents No. PL 196745 B1 and WO 95/15463 require large capital expenditures due to the necessity of installing complex cooling systems, moreover, the introduction of a pipe into the combustion chamber requires its periodic or emergency pulling out, which results in the need to install expensive drive systems, and also requires a relatively large space around the combustion chamber, which is not always possible and practically makes the implementation of these solutions impossible in some cases.

[0003] The methods described in the patent No. US 20160003473 A1 present solutions consisting in introducing into the combustion chamber one or more lances supplying air with a reactant through one or two side walls of the boiler. These solutions assume a "rigid" installation of the lances directly in the boiler plating and eliminate the need to install the drive systems for pulling out the lances as well as the need to provide a considerable space around the combustion chamber, periodic inspection and cleaning of the lances require however the stoppage of combustion process inside the boiler. This method of assembly also causes the length and diameter of the lances to be limited due to the stresses that they are subjected to inside the boiler, and the total mass of devices.

[0004] The methods described in the patents No. US 2006/0118013 A1 and WO 2013/09566 A2 focus on the methods of introducing a reactant with secondary air through nozzles located in one or more boiler walls. Such a method of injecting the reactant together with secondary air greatly reduces the investment and operating costs of the solution, however, it also limits the selection of an appropriate injection angle of the reactant with the secondary air and can cause that these substances are not directly introduced right into the centre of combustion process, but they only affect its part located closer to the boiler walls.

[0005] The method described in the patent No. WO 2004/085922 A2 assumes the reduction of NOx emissions by using the method of primary reduction of toxic compounds that consists in dividing the combustion air stream. In this solution, a part of the air is supplied near the fuel supply as primary air, and the remaining part of air necessary for a complete and perfect combustion of the fuel is fed above the fuel supply point, in higher parts of the combustion area, by means of nozzles located on the walls of the combustion chamber, the air stream fed in this area forms a vortex that is parallel to or close to the plane perpendicular to the vertical axis of the combustion chamber.

[0006] WO 92/02290 A1 discloses a method and apparatus for reducing nitrogen oxides in the flue gas from a boiler furnace. The nitrogen oxides are reduced by injecting an ammonia-containing treatment gas comprising a carrier gas into the flue gas.

[0007] Elimination of the above inconveniences and limitations, with the guarantee of: further reduction of NO_X emissions, reduction of CO emission, reduction to a minimum or complete elimination of the reactant in flue gas and ash, increase in system efficiency by limiting the proportion of oxygen in the flue gas, and reduction of investment outlays and operating costs in comparison with known methods of NO_X reduction and CO emission reduction, can be achieved by a method according to the present invention.

[0008] In the method embodiment variations, in addition to the process gas, a reactant, preferably NH_3 or $CO(NH_2)_2$, may be injected into the furnace chamber in a manner analogous to the process gas, by means of process gas lances or additional lances.

[0009] According to one aspect of the invention, there is provided a a method of reducing nitrogen oxides and carbon monoxide in furnace chambers of water boilers and steam boilers, especially grate boilers, as set out in claim 1.

[0010] According to a further aspect of the invention, a water and steam boiler, especially a grate boiler, comprising a furnace chamber and a system for the reduction of nitrogen oxides and carbon monoxide is provided as set out in claim 7.

[0011] In an embodiment variation, the process gas lances are located on the front wall of the furnace chamber in a specially made panel wall deflection at one, two or three levels, and the process gas is injected in a direction opposite to the main, natural flow direction of products / semi-products of the combustion process, maintaining a deviation of +/-15° in the plane parallel to the longitudinal symmetry plane of the furnace chamber, the injection points from the highest level of lances being at a distance of 0.5 to 1 height of the furnace chamber above the grate, preferably at the level of the lower edge of the bull nose, and the remaining rows below them.

[0012] In a further embodiment variation, the process gas lances are placed on the front or/and on the side wall of the furnace chamber at one, two or three levels, and the process gas is introduced into the furnace chamber by means of lances similar in their shape to the letter "L", in the direction opposite to the main, natural flow direction of the products / semi-products of the combustion process, maintaining a stream deviation of +/-15°, in a plane parallel to the longitudinal symmetry plane of the furnace chamber, the injection points from the highest level of lances being at a distance of 0.5 to 1 height of the furnace chamber above the grate, preferably at the level of the lower edge of the bull nose, and the remaining rows below.

[0013] In another embodiment variation, instead of the process gas, a mixture of process gas and reactant is injected into the furnace chamber through the same lances and at the same speed as the process gas, i.e. from 30 to 180 m/s, preferably 135 m/s, the reactant being injected through a reactant feed consisting of a reservoir, a pump, a flow regulator, a flow meter and at least one lance, into the process gas collector in a central manner through at least one lance, in order to form a homogeneous mixture therein, whereas in the convection part of the boiler or behind it, a device measuring NOx concentration in the flue gas is built in, from which the signal is sent to the control device, which in turn controls the reactant flow rate through the actuating and measuring devices built on this installation.

[0014] In a further embodiment variation, in addition to the process gas, the reactant in form of a liquid, gas or gas-liquid mixture is injected into the furnace chamber through nozzles located coaxially in the process gas lances, the number of reactant nozzles being equal to or smaller than the number of process gas lances.

[0015] In a further embodiment variation, in addition to the process gas, the reactant in form of a liquid, gas or gas-liquid mixture is injected into the furnace chamber through nozzles located eccentrically in the process gas lances, the number of reactant nozzles being equal to or smaller than the number of process gas lances.

[0016] In another embodiment variation, in addition to the process gas, the reactant in form of a liquid, gas or gas-liquid mixture is injected into furnace chamber through the lances located between the process gas lances, the number of reactant lances being equal to or smaller than the number of process gas lances.

[0017] In a further embodiment variation, the process gas lances are located on the back wall of the furnace chamber at the level of the lower edge of the furnace chamber bull nose, i.e. at the connection point of the furnace chamber with the boiler convection draught, in a number of from a few up to a dozen or so, depending on the size of the furnace chamber, the process gas being supplied through these lances in the horizontal direction, with maintaining a stream deviation of +/-45°, in an amount of up to 20%, preferably 10% of the air stream supplied to the device, necessary to completely and perfectly burn the fuel, in the understanding of accepted standards for this type of devices, with maintaining or reducing the proportion of oxygen in the flue gas.

[0018] There are also embodiment variations where the process gas is injected into the furnace chamber of the device through the lances installed on the back wall of the furnace chamber, as described in one of the above variants, while the reactant in form of a liquid, gas or gas-iiquid mixture and a part of the air in an amount of up to 5% of the air stream supplied to the furnace chamber, are injected into the furnace chamber through lances installed at one, two or three levels from the opposite wall of the furnace chamber in a direction opposite to the direction of the main, natural flow of combustion process products/semi-products flowing through the furnace chamber of the device, maintaining the stream deviation of +/-15°. In a further variant, the process gas is introduced into the combustion chamber through the lances located at a level different from the reactant feed level.

[0019] In a further embodiment variation, the amount of media flowing through the lances may vary for individual lances depending on the boiler load, in order to balance the temperature profiles in the furnace chamber and to shape the reduction and oxidation zone.

[0020] In a further embodiment variation, for different loadings of the device, a part of the lances may be switched off in order to balance the temperature profiles in the furnace chamber and to shape the reduction and oxidation zone.

[0021] In the method according to the present invention, the dynamic effect of the process gas stream is used to intensify the mixing process in the furnace chamber by causing a strong internal flue gas recirculation and strong swirl therein, the direction of which is opposite to the main, natural flue gas flow direction, and the spinning plane is parallel to the longitudinal plane of symmetry of the furnace chamber. This solution results in the balance of the temperature profile in the furnace chamber, which causes the thermal load of the furnace chamber to be balanced, which in turn directly translates into an increase in the efficiency and durability of the device, the solution according to the method makes possible a precise temperature control in the furnace chamber in the area where the phenomenon of reduction of nitrogen oxides and CO afterburning occurs, reduces the concentration of the reactant in the furnace chamber, minimizing the risk of corrosion of the device parts, moreover, the invention according to one of variants, by deploying the lances at several levels of the furnace chamber, increases the possibilities of the system, in particular in a wide scope of boiler load variability and it is usually applied in units of higher power. The invention according to the method also limits the reactant consumption in comparison to the methods known up to now, and thus makes possible to minimize the content of unreacted reactant in ash or flue gas, which plays a very important role in terms of system operating costs, environmental protection and ash management. The opposite direction of the reactant injection in relation to the main, natural flue gas flow direction, away from the point of connection of the furnace chamber with the convection draught of the device, at which there are no conditions of appropriate temperature window for the occurrence of reduction reaction, has a very important advantage over traditional directions and points of the reactant injection cited in the prior art search, because in the described method according to the invention, the phenomenon consisting in "entrainment" of unreacted reactant particles by the flue gas into the convection part of the boiler immediately after their injection into the furnace chamber, and further into flue gas cleaning and discharging systems does not occur or is minimized, another advantage of the method according to the invention, resulting from the direction of the reactant feed opposite to the flue gas flow direction away from the point of the flue gas exit from the combustion chamber is that in relation to the methods known up to now, the time interval from the reactant injection into the furnace chamber in a region of relatively low temperature until the reduction reaction occurrence is considerably extended, at which time interval the reactant is mixed with the injected process gas and combustion products, moving in the direction of temperature increase, i.e. towards the combustion area, where in the temperature range from 850°C up to 1050°C and in the presence of nitrogen compounds the reduction reaction occurs, the still not reacted reactant particles reach the temperature area of above 1050°C, where they are bound with oxygen and form NO_X type compounds, which then along with the combustion products are directed upwards the furnace chamber in accordance with the main, natural draught prevailing in the furnace chamber, where they encounter still not reacted reactant and the temperature conditions required for the reduction reaction occurrence, a part of still not reacted reactant and not reduced nitrogen compounds (NO_X) are recycled to an area convenient from the point of view of the reduction reaction occurrence by a strong stream of recirculated flue gas produced by the process gas stream. Such a process conducting influences in a natural and spontaneous way the effectiveness of the reduction process and in a wide range protects the system against the penetration of unreacted reactant into the installations that discharge ash and dust or into the flue gas purification and discharge systems.

[0022] Such a method of feeding the process gas or process gas and reactant results in creation of a strong reverse internal recirculation vortex, which sucks in the flue gas from the main flue gas stream, from the area just before the connection of the furnace chamber with the convection draught, and thus creates optimal conditions for conducting the process of reduction of nitrogen oxides and post-combustion of carbon monoxide, with a minimum proportion of oxygen in the final flue gas, and minimizes the loss of the reactant into the chimney due to the fact that the reactant injection point is located away from the flue gas exit point from the furnace chamber, which protects the system from the "entrainment" of unreacted, only just injected reactant particles into the convection draught of the boiler, moreover, the opposite direction of injection of the reagent, towards the temperature increase in the furnace chamber, and strong internal recirculation give the time necessary for mixing the reactant with the process gas and the flue gas, which results in creation of a homogeneous mixture, and thus contributes to shortening the time required for the NO_X reduction reaction, which occurs when that mixture enters the temperature area from 850°C to 1050°C, the excess of unreacted reactant then enters an area with a temperature of above 1050°C, where it combines with oxygen to form NO_X compounds, which are transported together with the main stream of flue gas to the combustion chamber area with lower temperature, where they encounter the reactant again and are reduced, a part of the flue gas just before the connection of the furnace chamber with the boiler convection draught is recycled again due to the action of a strong recirculation vortex and riches the subsequent zones, such a self-bonding of the process according to the method ensures low NO_X emission from the system at low reactant consumption and low CO emission, with low oxygen content in the final flue gas.

[0023] The invention in exemplary, but not limiting embodiments is shown in the figures, in which the following is presented:

fig. 1

- block diagram of a system for the injection of process gas and reactant into a furnace chamber

fig. 2

- method idea according to the invention together with an illustration of the process course and an illustrative representation of distribution of zones in the furnace chamber for the injection points located on the front wall of the furnace chamber or on the furnace chamber ceiling, the reactant nozzles being located in the interior of process gas lances,

fig. 3

- method idea according to the invention together with an illustration of the process course and an illustrative representation of the distribution of zones in the furnace chamber for injection points located on the front wall of the furnace chamber or on the furnace chamber ceiling, the reactant lances located between the process gas lances,

fig. 4

- method idea according to the invention together with an illustration of the process course for the injection points of the process gas located on the back wall of the furnace chamber and for the injection points of the reactant and process gas located on the opposite wall of the furnace chamber,

fig. 5

- boiler diagram in cross-section in the vertical plane, showing the location of the injection lances on the upper wail of the furnace chamber with marked flow directions of flue gas, process gas and reactant, as well as marked resulting reverse vortex and internal flue gas recirculation,

fig. 6

- boiler diagram in cross-section in the vertical plane, showing the location of the injection lances on the front wall of the furnace chamber in a specially made wall deflection, with marked flue gas, process gas and reactant flow directions and marked resulting reverse vortex and internal flue gas recirculation,

fig. 7

- boiler diagram in cross-section in the vertical plane, showing the location of injection lances on the front wall of the furnace chamber, the injection lances made in the shape of the letter "L", with marked flow directions of flue gas, process gas and reactant, and marked resulting reverse vortex and internal flue gas recirculation,

fig. 8

- boiler diagram in cross-section in the vertical plane, showing the location of the process gas injection lances on the back wall of the furnace chamber, and of the injection lances of process gas and reactant on the front wall of the furnace chamber, with marked flow directions of process gas and reactant, and marked resulting reverse vortex and internal flue gas recirculation,

fig. 9

- boiler diagram in cross-section in the vertical plane, showing the location of injection lances on the front wall of the furnace chamber, at two levels, the injection lances made in the shape of the letter "L", with marked flow directions of process gas and reactant and marked resulting reverse vortex and internal flue gas recirculation,

fig. 10

- schematic diagram of the boiler in cross-section in the vertical plane, showing vectors of vortices generated in the furnace chamber according to CFD calculations,

fig. 11

- schematic diagram of the boiler in cross-section in the vertical plane, showing the lines of currents generated in the furnace chamber according to CFD calculations.

[0024] The block diagram of a system for the injection of process gas and reactant into a furnace chamber is shown in figure 1, where: 6 - means the process gas injection lance, 7 - means the reactant injection lance/nozzle, 10 - means the furnace chamber of the device, 11 - means the process gas intake, 12 - means the process gas fan, 13 - means the measuring system installed on the process gas collector, 14 - means the regulating and shut-off element installed on the process gas collector, 15 - means the reactant tank, 16 - means the reactant pump, 17- means the measuring system built on the reactant installation, 18 - means the regulating and shut-off element built on the reactant installation, 19 - means the central injection lance of the reactant into the process gas.

[0025] In figures 2, 3 and 4, the processes occurring during combustion in the furnace chamber of the device, preferably a grate boiler, and the main flow and rotation directions of the process gas, flue gas and reactant are schematically and visually shown, where: A - means the blast (primary) air stream, PG - means the process gas stream, R - means the reactant stream, FG - means the flue gas stream, iFGR - means the internal flue gas recirculation, PG + R - defines the area of occurrence of the process gas and reactant mixture, RZ - defines the area in which the reduction reaction takes place, PZ - defines the production area of nitrogen compounds, CZ - defines the main combustion area.

[0026] In figures 5, 6, 7, 8 and 9, a schematic and visual representation of the place of installation of process gas and reactant injection lances is shown, as well as the current lines and spin directions that arise during combustion in the furnace chamber of the device, preferably a grate boiler, where: 1 - means the under-grate air-box, 2 - means the fuel layer moving on the grate, 3 - means the grate, 4 - means the furnace chamber, 5 - means the process gas / reactant collector, 6 - means the injection lance of the process gas, 7 - means the reactant injection lance/nozzle, 8 - means the convection part of the boiler, 9 - means the process gas collector, A - means the blast (primary) air stream, PG - means the process gas stream, PG+R - means the process gas and reactant stream, FG - means flue gas stream, iFGR - means the internal flue gas recirculation.

[0027] An exemplary embodiment of a water and steam boiler according to the invention is shown in fig. 7, where A means the primary air forced by the blast fan to the regulating slide dampers and then into the under-grate boxes 1 whose task is to bring the oxidant in a controlled manner to the fuel 2 moving on the grate 3. On the grate 3 and directly above it, the fuel is combusted and the amount of oxidant supplied as the primary air A ranges from 0.7 to 1.1, preferably 0.9 of the stoichiometric amount of air needed for complete and perfect combustion of fuel 2 moving on the grate 3, in the meaning of standards for this type of device. The products and semi-products of FG combustion move towards the upper part of furnace chamber 4, whereas their significant part moves near the back wall of the furnace chamber 4, which is a phenomenon normally found in furnace chambers of this type of boilers. At a distance of up to 0.5 of the depth of the furnace chamber 4, at the level of the lower edge of the boiler bull nose, on the front wall of the furnace chamber 4 through the collector 5 mounted outside the furnace chamber, through a series of lances 6 and 7 made and mounted so that the direction of injection of the process gas PG or of the process gas with reactant PG+R be opposite to the main flow direction of the FG combustion products through the combustion chamber 4, with maintaining a stream deviation of +/-15° in a plane parallel to the longitudinal symmetry plane of the furnace chamber. The injection speed of the process gas PG or reactant R is from 30 up to 180 m/s, preferably 135 m/s, and the process gas stream is up to 20% of the air stream necessary for complete and perfect combustion of fuel in the meaning of the standards for this type of device, a high speed and a significant mass of the process gas stream causes a strong internal recirculation of the flue gas iFGR in the interior of the combustion chamber 4 and the creation of a strong reverse vortex in the plane parallel to the longitudinal symmetry plane of the furnace chamber. The lances 6 and 7 are formed in a shape similar to the letter "L" and are introduced through deflections made in the front wall of the furnace chamber 10. The method of attaching the lances 6 and 7 enables their position to be changed in a plane parallel to the longitudinal symmetry plane of the boiler by a value of +/-15°. This method of feeding the process gas PG and reagent R is favourable for the creation of conditions for conducting the process of reducing nitrogen oxides with very high efficiency due to the point of injection of the reactant being away from the place of flue gas exit from the furnace chamber 4, which protects the system from the entrainment of unreacted reactant particles into the boiler convection draught 8, the reactant is mixed with the injected process gas and combustion products, moving towards a temperature increase, i.e. towards the combustion area, where a reduction reaction takes place in the temperature range of from 850°C up to 1050°C and in the presence of nitrogen oxides, the excess of unreacted reactant R is transported into an area with increasingly high temperature, where the unreacted reactant reacts with oxygen and creates nitrogen oxides, which then along with the combustion products travel up to the upper part of combustion chamber, according to the main, natural draught prevailing in the furnace chamber, where they encounter the still not reacted reactant and temperature conditions required from the point of view of reduction reaction occurrence for the occurrence of reduction reactions, a part of still unreacted reactant and of unreduced nitrogen compounds (NO_x) is just before leaving the furnace chamber recycled again to the area convenient from the point of view of reduction reaction occurrence by a strong stream of recirculated flue gas produced by the process gas stream. The process gas and reactant feed by the method according to the invention results in the creation of a strong reverse vortex parallel to the longitudinal symmetry plane of the combustion chamber, which makes the system in a wide spectrum of operation a self-regulating system, and thus self-protecting one against the penetration of unreacted reactant to flue gas and ashes, moreover, the system according to the invention is not very sensitive to fluctuations in the amount of nitrogen oxides generated in the fuel combustion process on the grate.

[0028] The invention is applicable wherever emphasis is placed on the high quality of the combustion process, low emissivity especially of nitrogen oxides and carbon monoxide, investment savings, energy saving, and reactant savings, i.e. operating costs. The method according to the invention, which is illustrated in the description, has been used in heating boilers and power boilers, in particular in grate boilers.

[0029] Thanks to the invention, the following benefits have been achieved:

- minimized investment costs,
- minimized operating costs,
- significantly simplified installation,
- minimized space needed to install the system,
- operational reliability,
- reduced nitrogen oxide (NO_X)emissions,
- reduced carbon monoxide (CO) emission,
- increased device efficiency due.to reduced O_2 content in flue gas,
- increased system efficiency due to the replacement of water injection into the furnace chamber in order to distribute the reactant in the furnace chamber or to atomize the reactant, by process gas or compressed air, respectively,
- reduced content of unreacted reactant in flue gas and ash in comparison to methods known up to now,
- increased service life of the device due to reduced reactant concentration in the furnace chamber and to balanced temperature profile in the furnace chamber,
- increased thermal efficiency of the furnace chamber due to increased average heat flux transmitted to the walls of the furnace chamber.

REFERENCES CITED IN THE DESCRIPTION

Cited references

Patent documents cited in the description

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- WO9515463A **[0002]**
- US20160003473A1 **[0003]**
- US20060118013A1 **[0004]**
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Patentkrav

1. Fremgangsmåde til reduktion af kvælstofoxider og kuloxid i brændkamre på vand- og dampkedler, især ristekedler, hvor der anvendes indsprøjtning af procesgas og reagens ind i brændkammeret (4,10) via et system af indsprøjtningslanser (6, 7), **kendetegnet ved, at** procesgassen i form af luft, røggasser eller en blanding af røggasser m. luft i et forhold fra 0 til 100% og reagenset sprøjtes af procesgaslanser (6) og reagenslanser (7) ind i brændkammeret i modsat retning i forhold til den naturlige hovedretning ved gennemstrømning af røggasserne igennem brændkammeret, fortrinsvis oppefra og ned, m. en afvigelse af strømmen på +/-15° i et plan parallelt med brændkammerets midterplan i længderetningen (4,10), dvs. i retning af temperaturstigning i brændkammeret, dog således, at procesgaslanser (6) og reagenslanser (7) er placeret på mindst én væg af brændkammeret (4,10) i en afstand fra aksen af rørene på den forreste skærm svarende til 0,5 af dybden af brændkammeret (4,10), dog således, at f.eks. procesgassen indsprøjtes fra brændkammerets øverste væg, sidevæg el. forvæg, og den indsprøjtes af procesgaslanser (6) fra brændkammerets bagerste væg med henblik på en yderligere forstærkning af hvirvelen, og den tilføres i vandret retning ved opretholdelse af en afvigelse af strømmen på +/-45°, i et plan parallelt med brændkammerets midterplan i længderetningen, dog således, at procesgassen tilføres forbrændingskammeret med en hastighed på 30 op til 180 m/s, fortrinsvis 135 m/s, i en mængde af op til 20% af strømmen af luften, der er nødvendig for en fuldstændig forbrænding af brændselet ved opretholdelse af det minimale indhold af luft i røggasser, dog sådes, at indsprøjtningspunkter på procesgaslanser (6) fra brændkammerets (4,10) bagvæg er placeret i en afstand svarende til op til 0,2 af brændkammerets dybde fra aksen af rørene på skærmen på brændkammerets bagvæg. Derudover tilføres reagenset forbrændingskammeret med en hastighed på 30 op til 180 m/s, fortrinsvis 135 m/s, og procesgassen og reagenset indsprøjtes på en måde, der forårsager indvendig recirkulation af røggasserne inde i brændkammeret (4, 10), og den indvendige recirkulation opstår ved omvendt hvirvel i et plan parallelt med brændkammerets midterplan i længderetningen, og den indsprøjtede procesgas og reagens indsuger røggasserne fra røggasstrømmen langs bagvæggen fra området umiddelbart før udløb af røggaserne fra brændkammeret (4,10) i den øverste ende af bagvæggen, og blandingen af reagenset, procesgassen og røggasserne bevæger sig langs brændkammerets forvæg i retning af temperaturstigning mod brændkammerets (4, 10) forbrændingsområde (CZ).

2. Fremgangsmåde iflg. patentkrav 1 **kendetegnet ved, at** i tilfælde af indsprøjtning fra brændekammerets forvæg eller sidevæg findes punkter f/ indsprøjtning af procesgas el. procesgas m. reagens på et, to el. tre niveauer, dog findes den øverste række af indsprøjtningslanser i en afstand fra 0,5 til 1 af brændkammerets højde over risten, fortrinsvis på højde med den nederste kant af det område, hvor strømmen af røggaserne skifter retning.

3. Fremgangsmåde iflg. patentkrav 1 **kendetegnet ved, at** i tilfælde af indsprøjtning fra brændekammerets bagvæg er punkter f/ indsprøjtning af procesgas placeret på samme niveau, som den nederste kant af det område, hvor strømmen af røggaserne skifter retning.

4. Fremgangsmåde iflg. patentkrav 1 **kendetegnet ved, at** udover procesgassen, der tilføres brændkammeret af forreste og bagerste lanser og reagenset, der tilføres brændkammeret af forreste lanser, sprøjtes en del af reagenset og procesgassen, op til 20%, fortrinsvis 10% af reagenset og op til 20%, fortrinsvis 10% af procesgassen, ind i brændkammeret fra brændkammerets sidevæg el. øverste væg og ind i det område af kedlen, hvor strømmen af røggaserne skifter retning.

5. Fremgangsmåde iflg. patentkrav 1 **kendetegnet ved, at** mængde af medier, der strømmer igennem lanserne er forskellig for de enkelte lanser, afhængigt af belastning af kedlen, med henblik på udligning af temperaturprofiler i brændkammeret og mhp. at danne en reduktionszone og en oxidationszone.

6. Fremgangsmåde iflg. patentkrav 1 **kendetegnet ved, at** ved forskellige belastninger af udstyret bliver en del af lanserne slukket med henblik på udligning af temperaturprofiler inde i brændkammeret og dannelse af en reduktionszone og en oxidationszone.

7. Vand- eller dampkedel, især ristekedel, omfattende et brændkammer (4, 10) og et system til reduktion af kvælstofoxider og kuloxid, hvor brændkammeret (4, 10) er forsynet med en forvæg, en bagvæg og udløb af røggasser i den øverste del af bagvæggen, hvor systemet omfatter forsyningsanlæg f/ procesgas m.

flowregulator, forsyningsanlæg f/ reagens m. flowregulator, procesgaslanser (6), reagenslanser (7), udstyr til måling af koncentration af NOx, CO og O2 i røggasserne samt en styreenhed, **kendetegnet ved, at** forsyningsanlægget f/ procesgas består af en indsugningstragt (11), en ventilator (12), en gruppe udstyr til strømmåling (13), et regulerings- og afspærringsspjæld (14) og et grenrør, hvor forsyningsanlægget f/ reagens består af en beholder (15), en pumpe (16), en gruppe udstyr til strømmåling (17), og et regulerings- og afspærringselement (18), hvor forsyningsanlægget f/ procesgas og forsyningsanlægget f/ reagens er forbundet m. brændkammeret (4, 10) via procesgaslanser (6) og reagenslanser (7) placeret på mindst én af brændkammerets (4, 10) vægge, i en dybde svarende til 0,5 af brændkammerets (4, 10) dybde, regnet fra aksen af rørene på forreste skærm, hvor procesgaslanser (6) og reagenslanser (7) er indstillet således, at retning af udløb af procesgas og reagens er modsat i forhold til den naturlige hovedretning ved gennemstrømning af røggasserne i brændkammeret, med en afvigelse på +/-15° i et plan parallelt med brændkammerets midterplan i længderetningen (4, 10), dvs. i retning af temperaturstigning i brændkammeret, hvor udstyr til måling af koncentration af NOx, CO og O2 er indbygget i røggasområdet i kedlens konvektionsdel eller bag denne, hvor signal fra udstyret sendes til styreenheden, der styrer gennemstrømning af procesgas igennem udstyr til måling af strømmen af procesgas (13) og regulerings- og afspærringsspjæld (14), hvor styreenheden tillige styrer gennemstrømning af reagenset igennem udstyr til måling af reagensstrømmen (17) og et regulerings- og afspærringselement (18), hvor styreenheden er konfigureret mhp. styring af indsprøjtning af procesgassen og reagenset for dermed at forårsage en indvendig recirkulation af røggasserne inde i brændkammeret (4, 10), dog således, at recirkulationen forårsages af omvendt hvirvel i et plan parallelt med brændkammerets midterplan i længderetningen, og de indsprøjtede procesgas og reagens indsuger røggasserne fra strømmen langs bagvæggen, fra området umiddelbart før udløb af røggasserne, og en blanding af reagenset, procesgassen og røggasserne bevæger sig langs brændkammerets forvæg i retning af temperaturstigning til forbrændingsområdet (CZ) på brændkammeret (4, 10).

8. Kedel iflg. patentkrav 7 **kendetegnet ved, at** indsprøjtningslanser f/ procesgas (6) er – mhp. forstærkning af hvirvelen – monteret på brændkammerets (4, 10) bagerste skærm, i en afstand svarende til 0,2 af brændkammerets (4, 10) dybde fra aksen af rørene på den bagerste skærm og er indstillet således, at udløb af procesgassen herfra sker vandret m. en afvigelse på +/-45° i et plan parallelt med brændkammerets (4, 10) midterplan i længderetningen.

9. Kedel iflg. patentkrav 7 **kendetegnet ved, at** indsprøjtningslanser f/ procesgas (6) og reagenslanser (7) er placeret på brændkammerets (4, 10) forvæg eller/og sidevæg, på et, to eller tre niveauer, dog således, at den øverste række af indsprøjtningslanser f/ procesgas (6) og reagenslanser (7) er placeret i en afstand af 0,5 op til 1 af brændkammerets (4, 10) højde over risten (3), fortrinsvis på niveauet af den nederste kant af det område, hvor strømmen af røggaserne skifter retning og de øvrige under denne, i en specialudformet udbøjning af væggen, i en afstand fra aksen af rørene på den forreste skærm, der er lig op til 0,3 af brændkammerets (4, 10) dybde.

10. Kedel iflg. patentkrav 7 **kendetegnet ved, at** indsprøjtningslanser f/ procesgas (6) og reagenslanser (7) er placeret på brændkammerets (4, 10) forvæg eller/og sidevæg, på et, to eller tre niveauer, dog således, at den øverste række af indsprøjtningslanser f/ procesgas (6) og reagenslanser (7) er placeret i en afstand af 0,5 op til 1 af brændkammerets (4, 10) højde over risten (3), fortrinsvis på niveauet af den nederste kant af skærmens rør, og de øvrige under denne, dog har lanserne en form, der ligner bogstavet "L", og indløb herfra findes i en afstand fra aksen af rørene på den forreste skærm, der udgør op til 0,5 af brændkammerets (4, 10) dybde.

11. Kedel iflg. patentkrav 7 **kendetegnet ved, at** indsprøjtningslanser f/ procesgas (6) og reagenslanser (7) er placeret på brændkammerets (4, 10) øverste væg i en afstand fra aksen af rørene på den forreste skærm, der udgør op til 0,5 af brændkammerets (4, 10) dybde.

12. Kedel iflg. patentkrav 7 **kendetegnet ved, at** indsprøjtningslanser f/ procesgas (6) er placeret på brændkammerets (4, 10) bagvæg, i en afstand fra aksen af rørene på den bagerste skærm, der svarer op til 0,2 af brændkammerets (4, 10) dybde og/el. på brændkammerets (4, 10) forvæg, i en afstand på op til 0,5 af brændkammerets (4, 10) dybde.

13. Kedel iflg. patentkrav 7 **kendetegnet ved, at** mindst én lanse (19) bruges til central indsprøjtning af reagenset til grenrør f/ procesgas.

14. Kedel iflg. patentkrav 7 **kendetegnet ved, at** inde i indsprøjtningslanser f/ procesgas (6) findes der dyser (7) til indsprøjtning af reagens m. procesgas i brændkammeret (4, 10), dog således, at antallet reagensdyser (7) er lig antallet lanser f/ procesgas (6) el. er mindre end dette.

15. Kedel iflg. patentkrav 7 **kendetegnet ved,** at mellem indsprøjtningslanser f/ procesgas (6), på niveauet af lanserne er der indbygget lanser, der indsprøjter en reaktant (7), dog således, at antallet reagenslancer (7) er lig antallet procesgaslanser (6) eller mindre end dette.

DRAWINGS

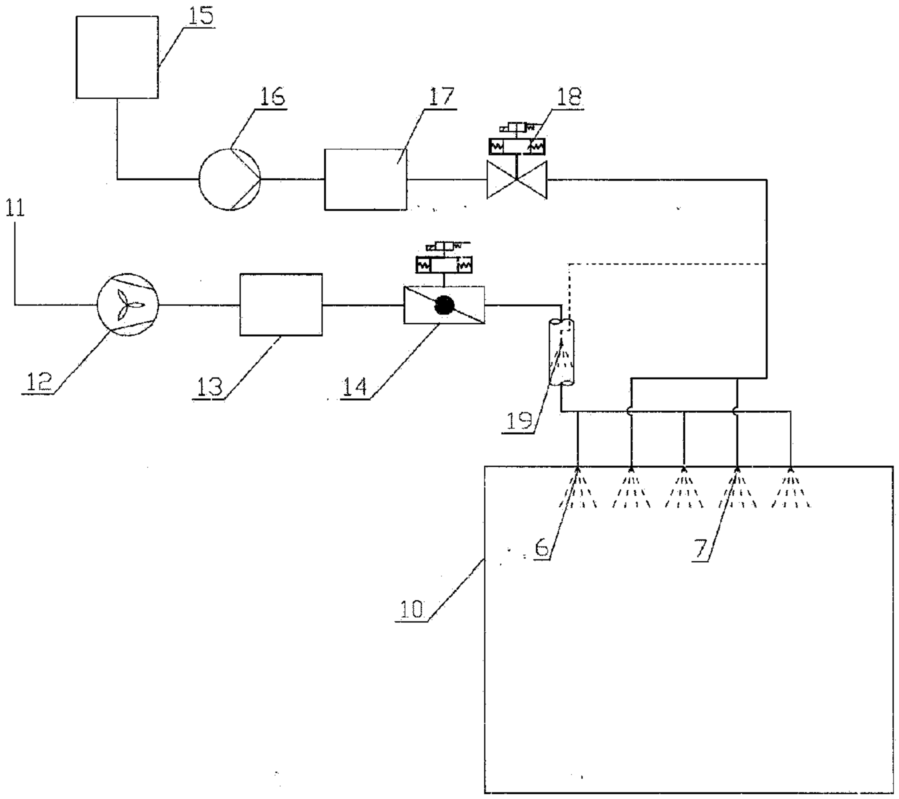
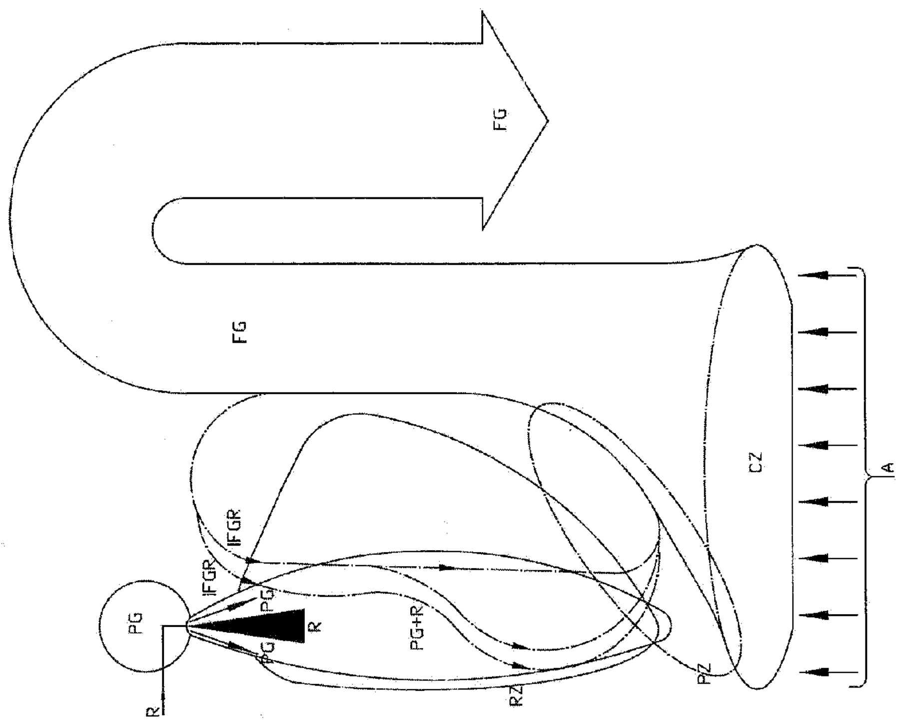


Fig. 1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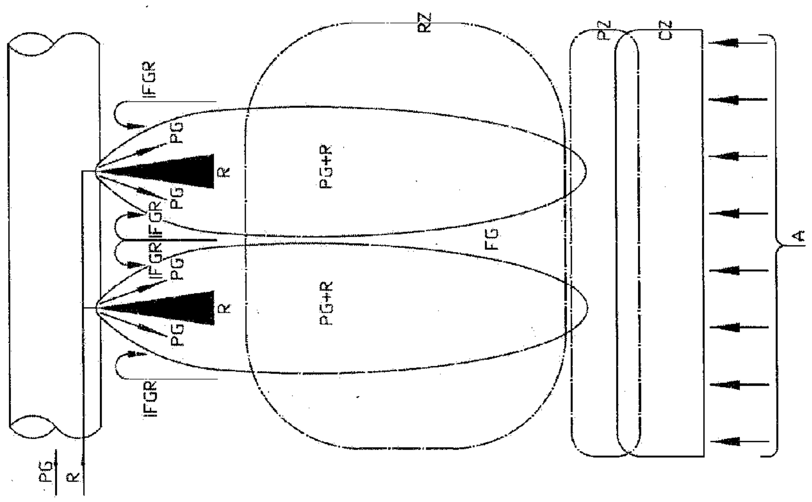
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Fig. 2

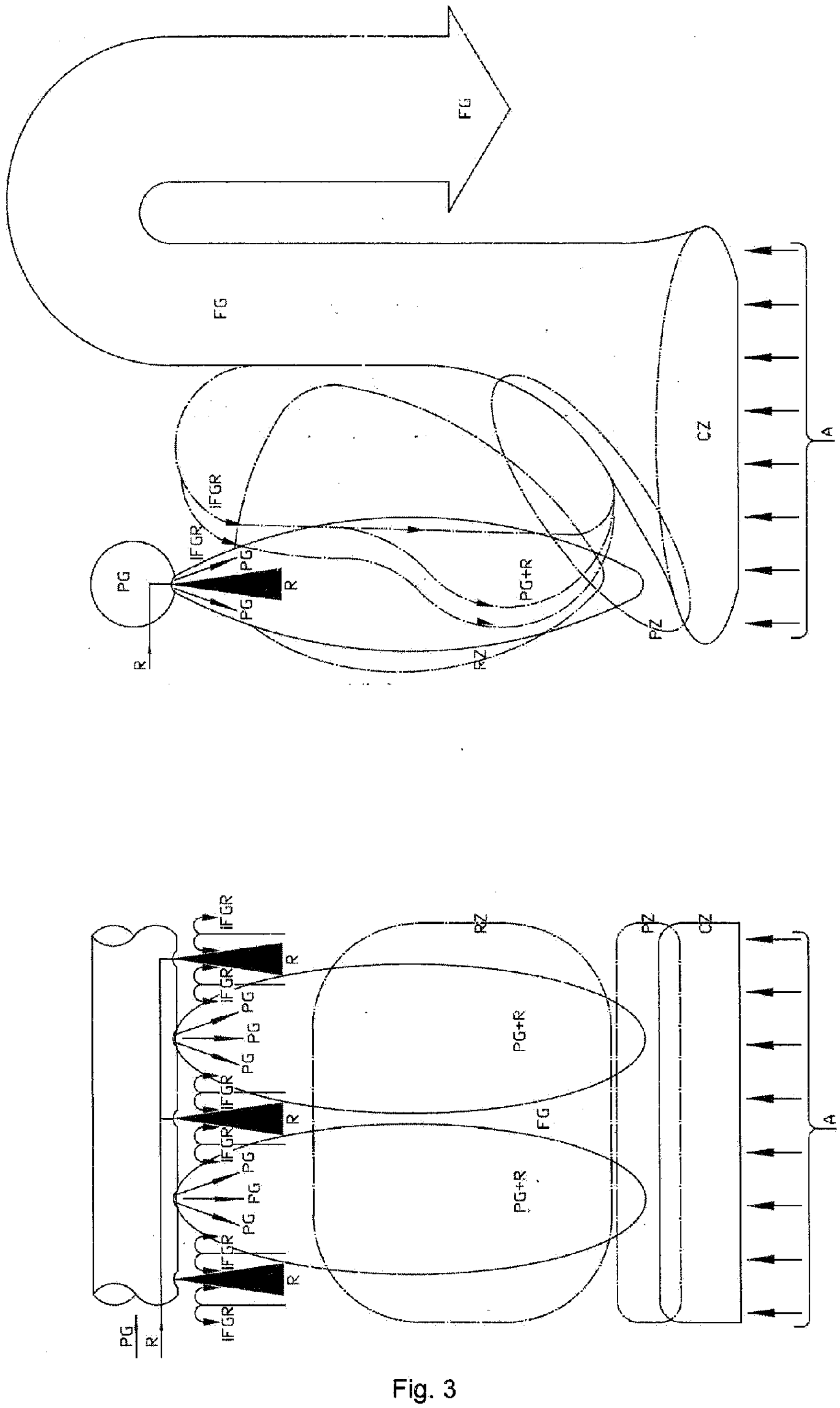
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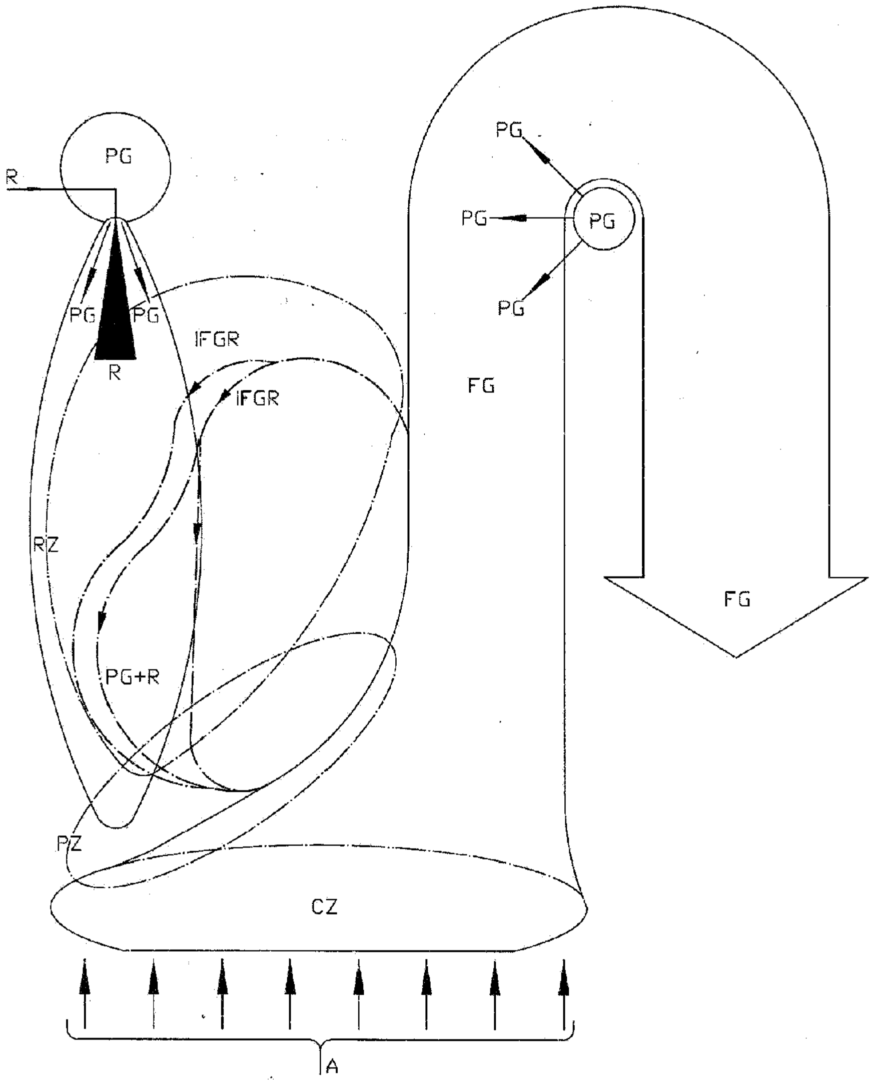
Fig. 3



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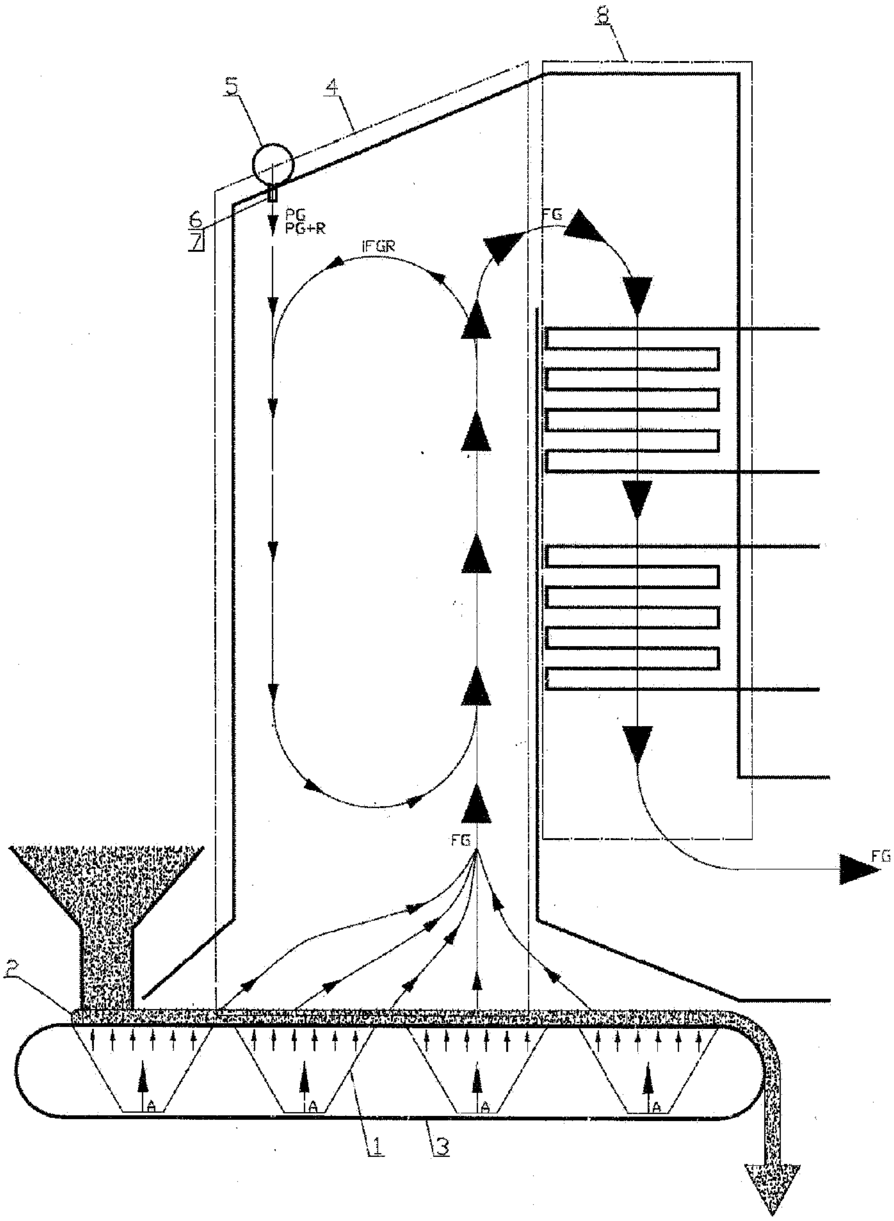

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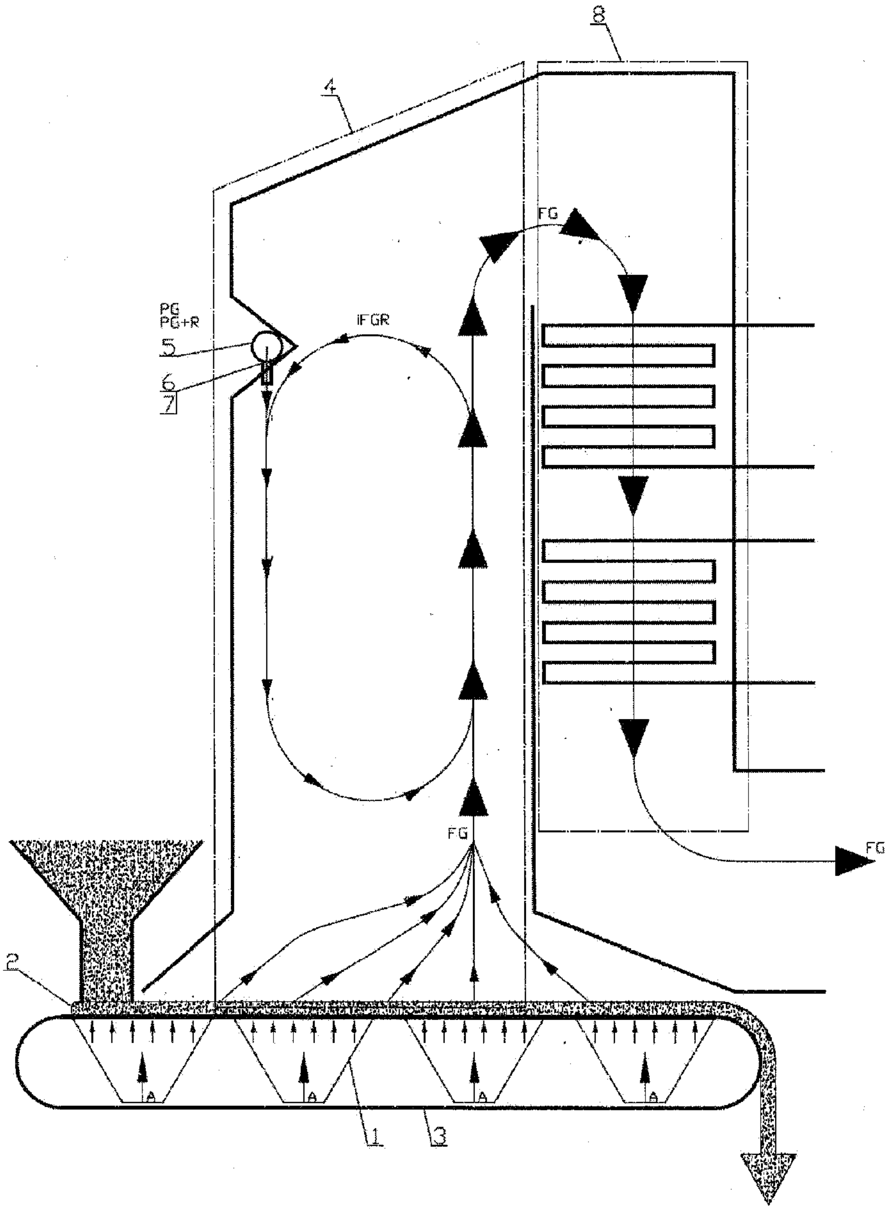

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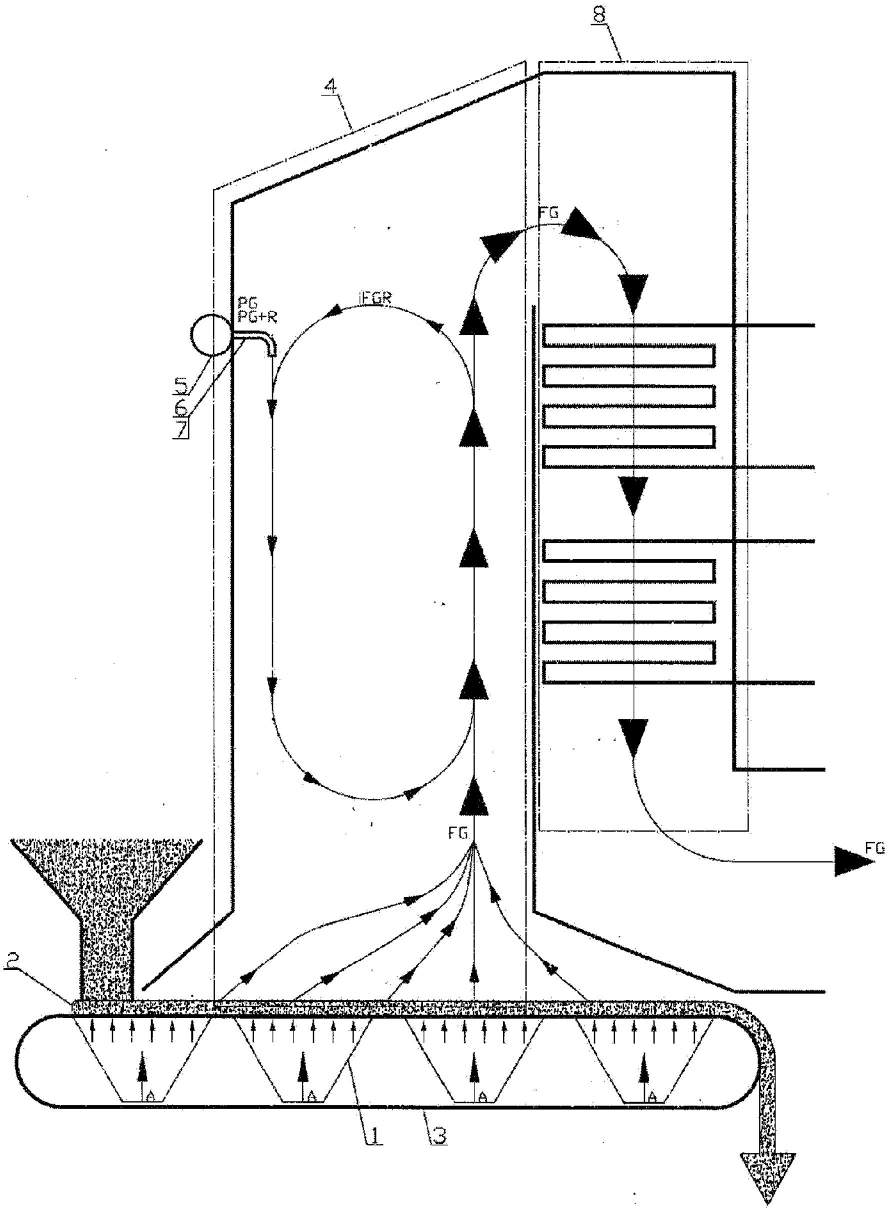
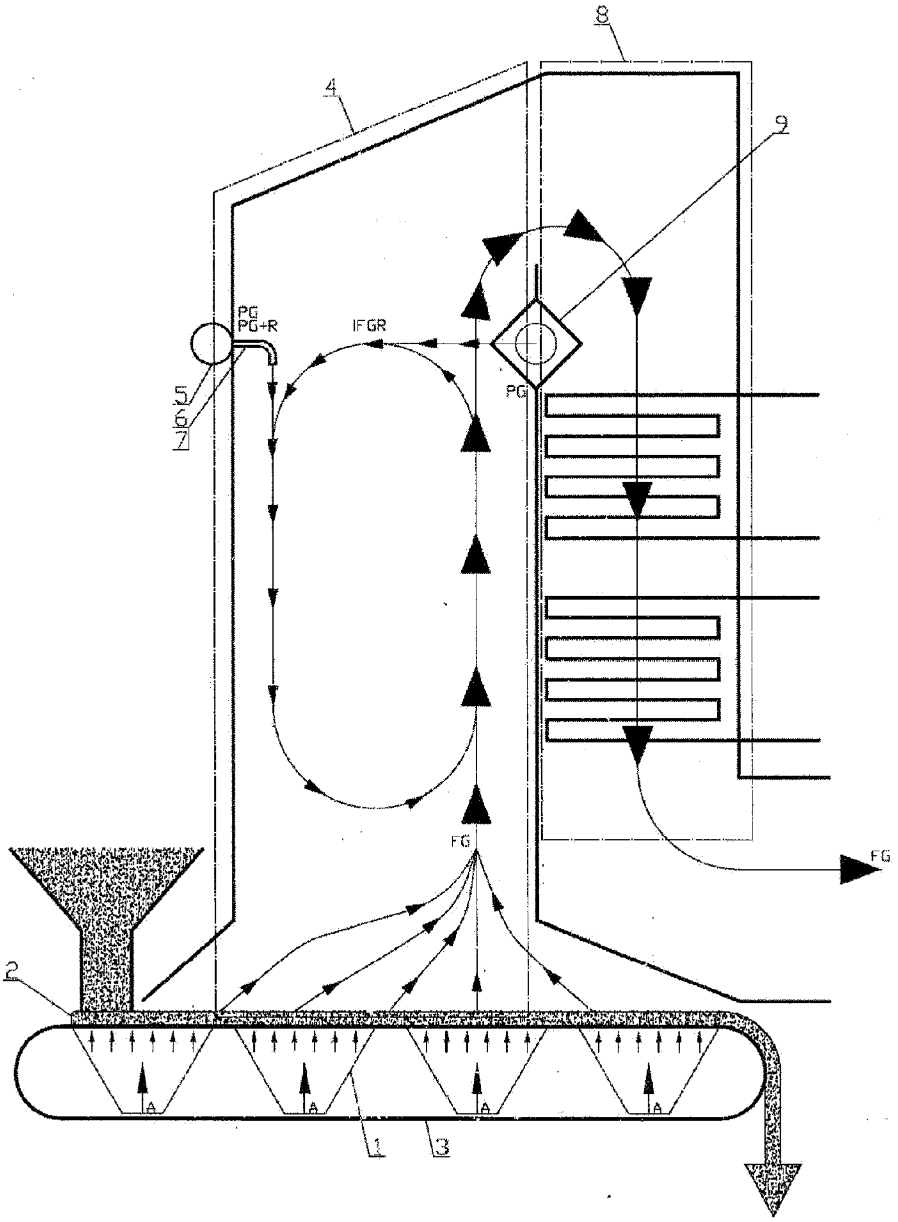


Fig. 7



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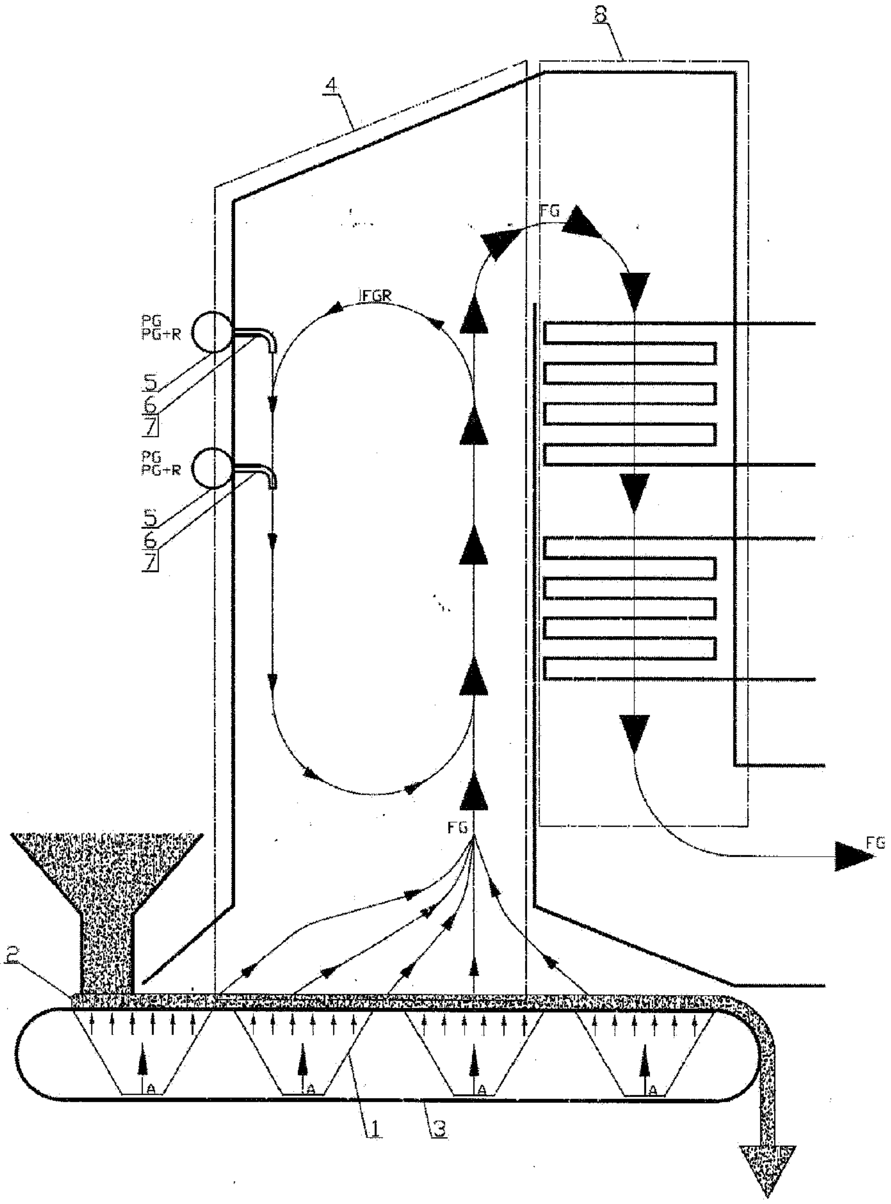

Fig. 9

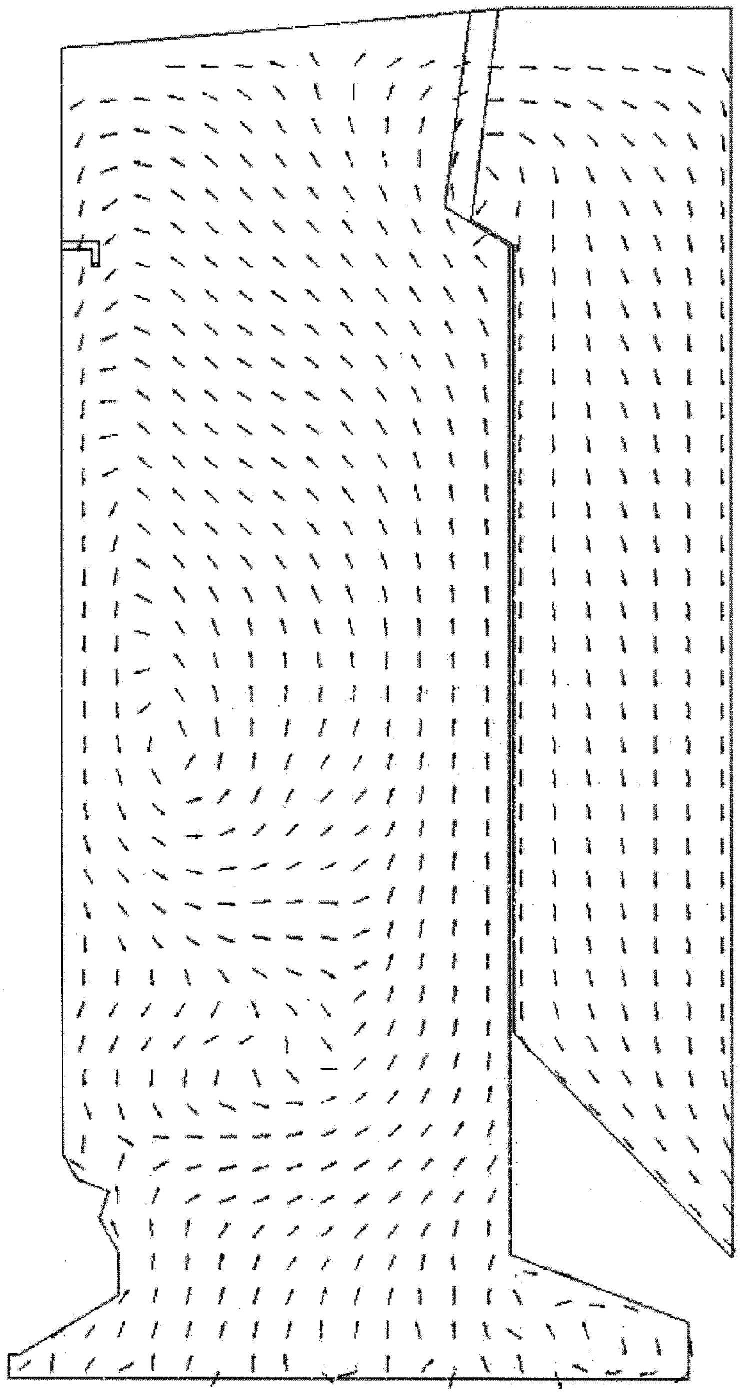

Fig. 10

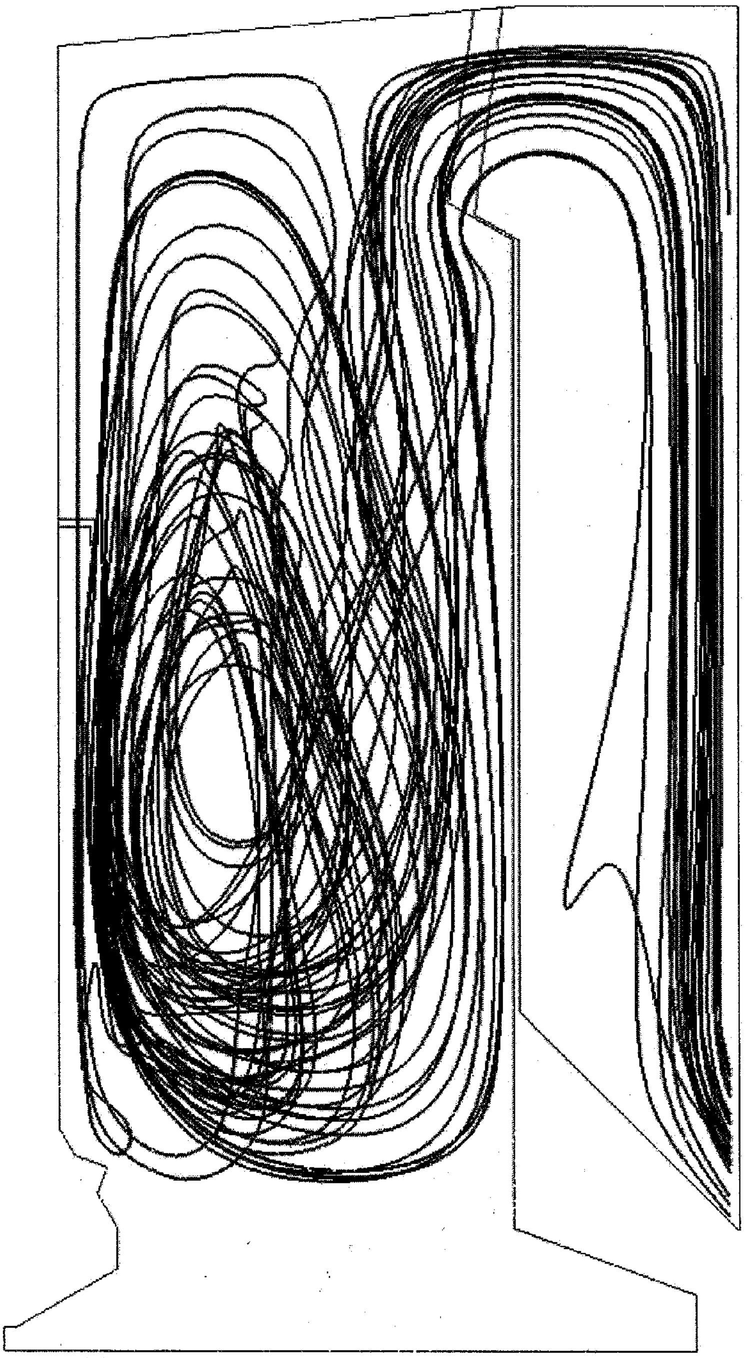

Fig. 11