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(54) **A METHOD OF PURIFYING WASTE GASES AND A GAS BURNER**

VERFAHREN ZUR REINIGUNG VON ABGASEN UND GASBRENNER

PROCEDE D'EPURATION DES GAZ DE COMBUSTION ET BRULEUR

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Description

[0001] The present invention relates to a method of purifying waste gases, and also to a gas burner.

[0002] More specifically, the invention relates to a method of purifying waste gases that originate from a gas burner or some other combustion source, such as oil-fired burners or the exhaust gases from internal combustion engines. The invention also relates to a gas burner in which the method is applied.

[0003] It is usual to heat industrial furnaces with gas burners. A normal fuel in this respect is natural gas, although other gases such as propane, butane and bottled gas can be used.

[0004] In the case of one efficient gas burner, the burner is of the kind in which the burner head is placed on one end of an inner tube around which there is placed an outer, protective tube which is closed at the bottom. The gases or fumes from the burner chamber pass inside the inner tube and down towards the bottom of the outer tube and flow from there in an opposite direction between the outer tube and the inner tube and thereafter into an exhaust passageway that leads to the surroundings. Heat is delivered by the protective tube to a furnace space, this heat comprising 30% convection heat and 70% radiation heat.

[0005] Another similar type of burner also includes an inner tube on which there is placed an outer protective tube. In this case, however, the bottom of the protective tube is not closed. The protective tube has an arcuate shape, e.g. a U-shape, with one free end of the protective tube connected to an exhaust passageway. The inner tube with the burner head is straight and is thus located within the straight part of the protective tube.

[0006] Such gas burners deliver high concentrations of hydrocarbons (HC) and nitrogen compounds (NO_x).

[0007] It would be desirable to be able to increase the temperature of the outer tube to about 1155-1200°C, so as to enhance the burner power concentration. This can be achieved by making the outer tube from a high temperature material, such as silicon carbide (SiC) or from a material in accordance with Advanced Powder Metallurgy (APM), such material containing about 73% Fe, 22% Cr and 5% Al. The powder is extruded in a tubular form.

[0008] However, NO_x concentrations increase significantly in waste gases at such high temperatures.

[0009] It is known to purify the gases originating from gas burners catalytically in a laboratory environment. The gases are caused to pass through a three-way catalyst that includes ceramic monolith. The NO_x concentrations are herewith reduced by bringing the lambda value (L) to beneath L = 1. However, this results in a significant increase in the CO-content of the gas instead.

[0010] EP-A- 0 555 936 describes a method where H_2 and H_2O are delivered into combustion gases prior to a catalyst. Hereby formation of NH_3 is avoided at the same time as NO_x is reduced to N_2.

[0011] In this method H_2 is used as a reduction media whereby NH_3 is formed which is oxidised to NO_x in a second catalyst step.

[0012] DE-A- 33 37 902 describes the geometry of an invention where a reducing part of a catalyst is surrounded by an oxidising catalyst. The catalyst is so designed that carbon is collected in the oxidising catalyst where it is oxidised to CO and/or CO_2. Thus DE 33 37 902 discloses a carbon filter."

[0013] One problem encountered at high temperatures is that the catalyst is subjected to high thermal stresses, which are liable to destroy a conventional catalyst that includes a ceramic monolith unless the catalyst is cooled.

[0014] The present invention solves these problems and enables much lower concentrations of CO, NO_x and HC to be achieved than those achieved with conventional catalytic purification.

[0015] This enables a gas burner to operate at higher temperatures without increasing the load on the environment. Contrary to increasing the load on the environment, the concentrations of said substances will be significantly lower at high temperatures than the concentrations obtained with a conventional burner at typically lower temperatures.

[0016] A significant advantage afforded by the present invention is that it can be applied in a corresponding manner to lower the concentrations of HC, CO and NO_x in the exhaust gases of internal combustion engines, such as automobile engines.

[0017] The present invention thus relates to a method of cleansing waste gases from their nitrogen oxide (NO_x), hydrocarbon (HC) and carbon monoxide (CO) contents, such as the waste gases or exhaust gases originating from burners and internal combustion engines wherein the waste gases, or exhaust gases are led through a catalyst for catalytic cleansing of the gases, where the lambda value (L) is brought to a level beneath L = 1; leading the gases through a first catalyst and then through a second catalyst; and is characterised in that the fuel and the combustion air are mixed before the combustion bringing the CO-content of the gas in the first catalyst to a sufficiently high level to reduce NO_x to N_2 to an extent such as to bring said NO_x content to a predetermined level; delivering sufficient oxygen O_2 between the first and the second catalysts to oxidise both CO and HC to CO_2 and H_2O to an extent such as to reduce the CO-content of the gas to a predetermined level; and including in one or both of said catalysts a net comprised of woven high-temperature wire that has been coated with a covering of Rhodium, Platinum and/or Palladium, or alternatively thin, pleated ribbons of a corresponding material as catalysts.

[0018] The invention also relates to a gas burner that includes a catalytic gas purification or cleansing facility of the aforesaid kind and that has the features set forth in Claim 6.

[0019] The present invention will now be described in more detail with reference to exemplifying embodiments of the invention and also with reference to the accompanying drawings, in which

- Figure 1 is a schematic cross-sectional view of a gas burner;
- Figure 2 is an illustration relating to Figure 3;
- Figure 3 is a schematic diagram illustrating the sequence of events that take place with respect to O_2, HC, CO and NO_x when the present invention is applied;
- Figure 4 is a diagram showing NO_x concentration against waste gas temperature, with and without a catalyst;
- Figure 5 is a diagram showing NO_x concentration against temperature difference over a catalyst;
- Figure 6 is a block schematic illustrating a control circuit; and
- Figure 7 is a schematic sectioned view of a burner according to an alternative embodiment.

[0020] Figure 1 illustrates a known type of gas burner for heating furnaces. The gas burner is of the kind where the burner head 1 is placed in one end of an inner tube 2 that is housed in an outer protective tube 3. The bottom 4 of the protective tube 3 is closed. This means that the gases from the burner head will pass down in the inner tube 2 towards the bottom 4 of the outer tube 3, where the gases turn and flow between the outer tube and inner tube in the opposite direction and thereafter enter a waste-gas passageway 5 leading to the surroundings.

[0021] The invention is not restricted to any particular gas burner, or other burner, but may equally as well be described with reference to the aforesaid type of burner that includes an inner tube which is housed in an outer protective tube whose bottom is not closed but where the protective tube extends in an arc with its free end connected to an exhaust gas passageway.

[0022] A recuperator is comprised of that part of the inner tube 2 that surrounds the burner head. Alternatively, a recuperator may comprise a separate tube that surrounds the burner head and where a separate inner tube is provided in the extension of said separate tube. The separate tube and the separate inner tube are thus axially in line with one another. The separate inner tube commences at the open end of the separate tube.

[0023] Gaseous fuel is delivered through an inlet 6 and air is supplied through an inlet 7.

[0024] According to the invention, two catalysts 8, 9 are placed one after the other in the flow direction. When the concentration of carbon monoxide in the exhaust gas, or waste gas, is sufficiently high, the first catalyst 8 functions to reduce NO_x to N_2 to an extent in which the NO_x content of the gas is brought down to a predetermined level. An oxygen inlet 10 is provided between the first and the second catalysts 8 and 9. When oxygen is delivered through the inlet 10, the second catalyst functions to oxidise carbon monoxide CO and HC to carbon dioxide CO_2 and water H_2O to an extent such as to reduce the carbon monoxide content of the gas to a predetermined level. The oxygen delivered is preferably in the form of air.

[0025] According to the present invention, the lambda value (L) is brought to beneath a value L = 1. The exhaust gas, or waste gas, is thus conducted through the first catalyst 8 and then through the second catalyst. As a result of the substoichiometric lambda value, the CO-concentration in the first catalyst will be sufficiently high for the reduction of NO_x to N_2 to an extent such as to reduce the NO_X - concentration to a predetermined value. The NO_x-reducing reaction can be written as NO_x + CO -> 1/2 N_2 + CO_2. An increase in the CO-content of the exhaust gas will drive this reaction further to the right.

[0026] The exhaust gas exiting from the first catalyst 8 contains essentially carbon monoxide (CO) and hydrocarbons (HC).

[0027] According to the invention, there is introduced between the first catalyst 8 and the second catalyst 9 sufficient oxygen to oxidise both carbon monoxide and hydrocarbons to carbon dioxide (CO_2) and water (H_2O) to an extent at which the carbon monoxide content of the gas is reduced to a predetermined value. The oxygen is preferably delivered by causing air to flow in through the inlet 10. Those reactions that take place in the second catalyst 9 can be written as CO + 1/2 $O_2 \rightarrow CO_2$ and H_nC_m + (m + n/2) O_2 -> mCO_2 + n/2 H_2O. These reactions can be driven very far to the right, by supplying sufficient oxygen through the inlet 10.

[0028] Carbon monoxide thus acts as the fuel for reducing the nitrogen oxide (NO_x). Tests have shown that the CO-content of the gas upstream of the first catalyst should be sufficiently high for the CO-content downstream of said first catalyst to be in the order of 5000 ppm. The oxygen content downstream of the first catalyst is therewith about 0 ppm.

[0029] According to one preferred embodiment, the lambda value is brought to between 0.940 and 0.995. It is preferred to operate at a lambda value of 0.970. This lambda value provides a high carbon monoxide content that is sufficiently high to reduce the No_x-content to very low values in the first catalyst 8.

[0030] It is preferred that the lambda value will be such as to cause the NO_x-content to be less than from 50 to 100 ppm downstream of the second catalyst. The drawback with a lambda value below L = 1 is that not all of the fuel will be utilized.

[0031] It is also preferred to introduce oxygen between the first catalyst 8 and the second catalyst 9 in an amount such that the CO-content will be less than 5-20 ppm downstream of the second catalyst 9. The HC-content will herewith also be less than 5-20 ppm.

[0032] According to one highly preferred embodiment, one or both catalysts 8, 9 includes (include) a woven high-temperature filament or wire that is coated with a layer which includes Rhodium, Platinum and/or Palladium as catalyst(s). Such high temperature filaments, or wires, are produced by the Applicants of this present patent application, and contain essentially the same constituents as the aforesaid APM material. Thin pleated ribbons of corresponding material may be used instead of nets. Such ribbons are supplied by Sandvik AB, Sweden.

[0033] The reference numeral 11 in Figure 1 designates a ring-shaped net in the first catalyst 8, whereas the reference numeral 12 designates a disc-shaped net in the second catalyst 9. The advantage of such catalysts is that they withstand higher temperatures than ceramic monolithic catalysts. The flow resistance is also lower than that of conventional catalysts.

[0034] According to one preferred embodiment of the type of gas burner described above, the first catalyst 8 is placed between the inner tube 2 and the outer tube 3 at the location of the recuperator 13, and the second catalyst 9 is placed in the exhaust gas passageway.

[0035] Figure 2 is an illustration which relates to Figure 3 and which illustrates the flame 12 in the burner chamber, the exhaust gas flow 13 towards the first catalyst 8, the exhaust gas flow 14 towards the catalyst 9, and the supply of air 15 via the inlet 10, and the finally cleansed exhaust gas 16.

[0036] Figure 3 is a diagram which illustrates schematically the course of events in respect of O_2, HC, CO and NO_x when the present invention is applied. The Y-axis shows content and the X-axis the physical position of the exhaust gas, or waste gas. The upright line 16 relates to the position after combustion of the fuel, the upright line 17 relates to entry of the exhaust gas into the first catalyst 8, the upright line 18 relates to the entry of the exhaust gas into the second catalyst 9, and the upright line 19 relates to the exit of exhaust gas from the second catalyst 9.

[0037] Thus, it will be seen from Figure 3 that the CO-content is high subsequent to combustion and that the NO_x-content is reduced in the first catalyst while the CO-content and the HC-content are still high. The supply of oxygen results in the oxidation of CO and HC in the second catalyst 9, so that the exhaust gas leaving the system will have a very low HC, CO and NO_x content.

[0038] Full scale tests have been carried out with a so-called WS 80 millimetre burner that had an outer tube 3 made of APM material and an outer diameter/inner diameter of 91/78 millimetres. Corresponding dimensions of the inner tube 2 were 64/56 millimetres. The first catalyst 8 included ten nets comprised of high temperature filaments, while the second catalyst 9 included five such nets.

[0039] By way of standard values, about 240 litres of combustion air were delivered each minute, while about 30 litres of air were delivered to the inlet 10 per minute. This gave the burner a power of about 10 kW.

[0040] It is preferred to supply air between the catalysts in an amount corresponding to about 10-20% of the amount of combustion air delivered to the burner.

[0041] Figure 4 illustrates diagrammatically the result obtained with respect to NO_x-content versus exhaust gas temperature downstream of the second catalyst, with and without catalysts. The curves show that the highest NO_x-contents are obtained without catalysts and with a lambda value beneath L = 1; see the curve that includes solid squares. A certain reduction in the NO_x-content is obtained with a lambda value of L = 1.15; see the curve that includes open squares with a centre dot. When no catalyst is included, the NO_x value increases with exhaust gas temperature.

[0042] However, the NO_x-content is lowered dramatically when applying the present invention. This is shown by the lowermost curve that includes empty squares, where the lambda value is L = 0.950-0.995 and the catalysts 8, 9 are used. As can be seen, the NO_x value is about 20 ppm relatively regardless of exhaust temperature. The CO-content and HC-content were essentially 0 ppm in the aforesaid tests.

[0043] Figure 5 is a diagrammatic illustration of the NO_x-content versus the temperature difference over the second catalyst 9. The temperature is measured with a first thermocouple 20 at the inlet to the second catalyst, and with a second thermocouple 21 at the catalyst outlet.

[0044] The curves on the left in Figure 5 show measurements without catalysts at the lambda value L = 1.15 and below L = 1 respectively. The NO_x-content is therewith between 100 and 250 ppm. In this case, the HC-content has a mean value of 350 ppm.

[0045] The reactions that take place in the second catalyst are exothermic on the whole. Large quantities of air are also delivered through the inlet 10. It has been found that the temperature difference over the second catalyst can be used to control the lambda value, by varying the volume of air supplied to the burner. This is because more carbon monoxide is formed at a lower lambda value, this carbon monoxide being combusted in the second catalyst and resulting in a rise in temperature difference, and vice versa.

[0046] It has also been found that the NO_x value is low and roughly constant within a certain interval; in figure 5 at a temperature difference of -10°C to 40°C. The NO_X value then increases slightly.

[0047] Figure 7 illustrates an alternative embodiment of the burner shown in Figure 1. In this alternative embodiment, the inner tube is divided into two inner tubes 25, 26 that lie one after the other in an axial direction. The longitudinal distance between the inner tube 25, 26 may be at least 5-30 millimetres, or somewhat greater. In this embodiment, the waste gases or ehaust fumes are caused to partially recirculate around the lower inner tube 25, as indicated by the arrows 27, 28.

[0048] This results in a lower exhaust gas temperature and a more uniform temperature over the outer tube 3. Complete combustion is also achieved, meaning that a smaller amount of non-combusted CO and HC will enter the exhaust passageway. This enables both lower NO_x-contents and lower CO-contents to be achieved simultaneously.

[0049] It is mentioned in the aforegoing that gaseous fuel is introduced through the inlet 6 and that air is introduced through the inlet 7. It has been found that combustion becomes more complete when the fuel is well mixed with the combustion air. In accordance with one preferred embodiment, a certain amount of air is introduced together with the fuel in the fuel inlet 6, while the remainder of the combustion air is introduced through the inlet 7. This applies to both the burner embodiment of Figure 1 and the burner embodiment of Figure 7.

[0050] According to one highly preferred embodiment, the temperature difference over the second catalyst 9 is measured and the lambda value is adjusted so that the temperature difference will lie within a predetermined temperature range. The current temperature range may vary with the exhaust flows and with respect to the design of the catalysts and the burner in general. However, by measuring NO_x-contents, the person skilled in this art will find no difficulty in determining the temperature interval within which the temperature difference over the second catalyst shall lie in order to obtain a low NO_x content.

[0051] Figure 6 is a block schematic illustrating a control system for this adjustment. The thermocouples 20, 21 deliver a signal to a microprocessor 22 or the like which is adapted to actuate a stepping motor 23 which, in turn, functions to manoeuvre a valve 24 with which the air supply to the burner is controlled.

[0052] The advantage with this control is that it is much simpler and cheaper than measuring the lambda value during operation with a lambda probe.

[0053] The present invention has been described above with reference to cleansing waste gases, or exhaust gases, generated in gas burners. However, the inventive method can be applied equally as well with respect to waste gases from other types of burner and also in respect of purifying exhaust gases from internal combustion engines, such as diesel engines and petrol engines.

[0054] It will be obvious that the present invention solves the problems recited in the introduction.

[0055] With regard to specific gasoline (petrol) automobile engines, the first catalyst is placed close to the engine manifold.

[0056] The second catalyst is suitably placed at a short distance from the first catalyst, along the exhaust pipe. An air inlet is provided between the catalysts. The skilled person will find no difficulty in dimensioning the catalysts, which suitably include woven high-temperature wire or thin pleated ribbons as before mentioned, or their positioning or the size and design of the air inlet.

[0057] It will thus be understood that the invention can be modified and adapted to suit different conditions, such as burner type, engine type, etc., without departing from the concept of the invention, namely to generate through a substochiometric lambda value sufficient carbon monoxide to reduce NO_x in a first catalyst and to oxidise HC and CO in a second catalyst by supplying oxygen thereto, so that the waste gases, or exhaust gases, will thereafter contain essentially H_2O, CO_2 and O_2.

[0058] The present invention shall not therefore be considered limited to the aforedescribed exemplifying embodiments thereof, since variations and modifications can be made within the scope of the following Claims.

Claims

1. A method of cleansing waste gases from their nitrogen oxide (NO_x), hydrocarbon (HC) and carbon monoxide (CO) contents, such as the waste gases or exhaust gases originating from burners and internal combustion engines wherein the waste gases, or exhaust gases are led through a catalyst for catalytic cleansing of the gases, where the lambda value (L) is brought to a level beneath L = 1; leading the gases through a first catalyst (8) and then through a second catalyst (9); **characterised in that** the fuel and the combustion air are mixed before the combustion bringing the CO-content of the gas in the first catalyst (8) to a sufficiently high level to reduce NO_x to N_2 to an extent such as to bring said NO_x content to a predetermined level; delivering sufficient oxygen (O_2) between the first and the second catalysts (8, 9) to oxidise both CO and HC to CO_2 and H_2O to an extent such as to reduce the CO-content of the gas to a predetermined level; and including in one or both of said catalysts (8, 9) a net (11, 12) comprised of woven high-temperature wire that has been coated with a covering of Rhodium, Platinum and/or Palladium, or alternatively thin, pleated ribbons of a corresponding material as catalysts.

2. A method according to Claim 1, **characterised by** bringing the lambda value to L = 0.940-0.995.

3. A method according to Claim 1 or 2, **characterised by** bringing the lambda value to a level such that the NO_x-content downstream of the second catalyst (9) will be less than 50 to 100 ppm.

4. A method according to Claim 1, 2 or 3, **characterised by** introducing oxygen between the first catalyst (8) and the second catalyst (9) in a quantity at which the CO-content will be less than 5-20 ppm downstream of the second catalyst (9).

5. A method according to Claim 1, 2, 3 or 4, **characterised by** measuring the temperature difference over the second catalyst (9), and by adjusting the lambda value so that the temperature difference will

lie within a predetermined temperature range.

6. A gas burner for heating furnaces, wherein the gas burner is of the kind with which the burner head is placed in one end of an inner tube (2) that is housed within an outer protective tube (3), and wherein the combustion gases from the burner head (1) flow within the inner tube and within the outer tube and thereafter into a waste-gas passageway (5) leading to the surroundings, where the burner includes two catalysts (8, 9) placed one after the other in the flow direction, **characterised in, that** an inlet (6) for fuel and a certain amount of combustion air is present **in that** the first catalyst (8) is adapted to reduce NO_x to N_2 in the presence of a sufficiently high CO-content of the waste gas, to an extent such as to reduce the NO_x content to a predetermined value, **in that** the burner includes an oxygen (O_2) inlet (10) between the first catalyst (8) and the second catalyst (9), **in that** the second catalyst (9) is adapted to oxidise CO and HC to CO_2 and H_2O in response to the introduction of oxygen through said inlet (10), to an extent such as to reduce the CO-content to a predetermined value, and **in that** one or both catalysts (8, 9) include nets (11, 12) of woven high-temperature wire or filament that has been coated with a covering that includes Rhodium, Platinum and/or Palladium, or alternatively thin, pleated ribbons of a corresponding material as catalysts.

7. A gas burner according to Claim 6, **characterised in that** the burner is adapted to operate at a lambda value within the range of L = 0.940-0.995.

8. A gas burner according to Claim 6 or 7, **characterised in that** the first catalyst (8) is positioned between the inner tube (2) and the other tube (3) at the location of the recuperator; and **in that** the second catalyst (9) is placed in the exhaust passageway.

9. A gas burner according to Claim 6, 7 or 8, **characterised in that** the inner tube is divided into two inner tubes (25, 26) which lie one behind the other in the axial direction, wherein the longitudinal distance between the inner tubes (25, 26) is at least 5-30 millimetres.

Patentansprüche

1. Verfahren zum Reinigen von Abgasen von ihren Gehalten an Stickstoffoxid (NO_x), Kohlenwasserstoff (HC) und Kohlenmonoxid (CO), wie beispielsweise den Abgasen oder Auspuffgasen, die aus Brennern und Verbrennungsmotoren stammen, wobei die Abgase oder Auspuffgase für eine katalytische Reinigung der Gase durch einen Katalysator geleitet werden, wobei der Lambda-Wert (L) auf ein Niveau unter L = 1 gebracht wird; und Leiten der Gase durch einen ersten Katalysator (8) und dann durch einen zweiten Katalysator (9); **dadurch gekennzeichnet, dass** der Kraftstoff und die Verbrennungsluft vor der Verbrennung gemischt werden, wobei der CO-Gehalt des Gases in dem ersten Katalysator (8) auf ein ausreichend hohes Niveau gebracht wird, um NO_x in einem Maß derart auf N_2 zu reduzieren, dass der NO_x-Gehalt auf ein vorgegebenes Niveau gebracht wird; Abgeben von ausreichend Sauerstoff (O_2) zwischen den ersten und den zweiten Katalysator (8, 9), um sowohl CO als auch HC in einem Maß derart auf CO_2 und H_2O zu oxidieren, dass der CO-Gehalt des Gases auf ein vorgegebenes Niveau reduziert wird; und Vorsehen eines Netzes (11, 12) in einem oder beiden der Katalysatoren (8, 9), das aus gewebtem Hochtemperaturdraht besteht, der mit einer Beschichtung aus Rhodium, Platin und/oder Palladium beschichtet worden ist, oder alternativ dürme, gefaltete Bänder aus einem entsprechenden Material als Katalysatoren.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Lambda-Wert auf L = 0,940 - 0,995 gebracht wird.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Lambda-Wert auf ein Niveau derart gebracht wird, dass der NO_x-Gehalt stromabwärts von dem zweiten Katalysator (9) geringer ist als 50 bis 100 ppm.

4. Verfahren nach Anspruch 1, 2 oder 3, **gekennzeichnet durch** ein Embringen von Sauerstoff zwischen den ersten Katalysator (8) und den zweiten Katalysator (9) in einer Menge, bei der der CO-Gehalt geringer ist als 5 bis 20 ppm stromabwärts von dem zweiten Katalysator (9).

5. Verfahren nach Anspruch 1, 2, 3 oder 4, **gekennzeichnet durch** ein Messen der Temperaturdifferenz über den zweiten Katalysator (9) und **durch** ein Einstellen des LambdaWerts derart, dass die Temperaturdifferenz innerhalb eines vorgegebenen Temperaturbereichs liegt.

6. Gasbrenner zum Heizen von Öfen, wobei der Gasbrenner von der Art ist, bei der der Brennerkopf in einem Ende eines inneren Rohrs (2) angeordnet ist, das innerhalb eines äußeren schützenden Rohrs (3) untergebracht ist, und wobei die Verbrennungsgase von dem Brennerkopf (1) innerhalb des inneren Rohrs und innerhalb des äußeren Rohrs und danach in einen Abgasdurchgang (5) strömen, der zu der Umgebung führt, wobei der Brenner zwei Katalysatoren (8, 9) aufweist, die einer nach dem anderen in der Strömungsrichtung angeordnet sind, **dadurch gekennzeichnet, dass** ein Einlass (6) für Kraftstoff und eine bestimmte Menge an Verhrennungsluft vorhanden ist, dass der erste Katalysator (8) dafür ausgelegt ist, NO_x bei der Anwesenheit eines ausreichend hohen CO-Gehalts des Abgases in einem Maß derart auf N_2 zu reduzieren, dass der NO_x-Gehalt auf einen vorgegebenen Wert reduziert wird, dass der Brenner einen Sauerstoff-(O_2)-Einlass (10) zwischen dem ersten Katalysator (8) und dem zweiten Katalysator (9) aufweist, dass der zweite Katalysator (9) dafür ausgelegt ist, CO und HC in Reaktion auf die Zufuhr von Sauerstoff durch den Einlass (10) in einem Maß derart auf CO_2 und H_2O zu oxidieren, dass der CO-Gehalt auf einen vorgegebenen Wert reduziert wird, und dass einer oder beide Katalysatoren (8, 9) Netze (11, 12) aus gewebtem Hochtempersturdraht oder Filament aufweisen, der/das mit einer Beschichtung beschichtet worden ist, die Rhodium, Platin und/oder Palladium umfasst, oder alternativ dünne, gefaltete Bänder aus einem entsprechenden Material als Katalysatoren.

7. Gasbrenner nach Anspruch 6, **dadurch gekennzeichnet, dass** der Brenner dafür ausgelegt ist, bei einem Lambda-Wert innerhalb des Bereichs von L = 0,940 - 0,995 zu arbeiten.

8. Gasbrenner nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** der erste Katalysator (8) zwischen dem inneren Rohr (2) und dem äußeren Rohr (3) an der Stelle des Rekuperators angeordnet ist; und dass der zweite Katalysator (9) in dem Abgasdurchgang angeordnet ist.

9. Gasbrenner nach Anspruch 6, 7 oder 8, **dadurch gekennzeichnet, dass** das innere Rohr in zwei innere Rohre (25, 26) aufgeteilt ist, die in der axialen Richtung eines hinter dem anderen liegen, wobei der längs gerichtets Abstand zwischen den inneren Rohren (25, 26) mindestens 5 bis 30 mm beträgt.

Revendications

1. Procédé destiné à purifier les effluents gazeux de leurs teneurs en oxyde d'azote (NOx), en hydrocarbure (HC) et en monoxyde de carbone (CO), tels que les effluents gazeux ou les gaz d'échappement provenant de brûleurs et de moteurs à combustion interne, selon lequel on conduits les effluents gazeux, ou gaz d'échappement, au travers d'un catalyseur pour une purification catalytique des gaz, la valeur lambda (L) étant amenée à un niveau en dessous de L = 1. et en amenant les gaz à traverser un premier catalyseur (8) puis un second catalyseur (9),
caractérisé en ce que
le carburant et l'air de combustion sont mélangés avant la combustion pour amener la teneur en CO du gaz dans le premier catalyseur (8) sur un niveau suffisamment élevé pour réduire le NOx en N_2 de manière à amener la teneur en NOx à un niveau prédéterminé, on fournit suffisamment d'oxygène (O_2) entre les premier et second catalyseurs (8. 9) pour oxyder à la fois le CO et le HC en CO_2 et H_2O de manière à réduire la teneur en CO du gaz à un niveau prédéterminé, et en introduisant comme catalyseurs dans l'un des catalyseurs (8, 9) ou dans les deux, un tamis (11. 12) composé d'un fil tissé résistant à haute température qui a été recouvert d'un revêtement de Rhodium, Platine et/ou Palladium, ou en variante de minces rubans plissés d'un matériau correspondant.

2. Procédé selon la revendication 1,
caractérisé en ce que
la valeur lambda est amenée à L = 0.940-0.995.

3. Procédé selon la revendication 1 ou 2,
caractérisé en ce que
la valeur lambda est amenée à un niveau tel que la teneur en NOx en aval du second catalyseur (9) sera inférieure à 50-100 ppm.

4. Procédé selon la revendication 1. 2 ou 3,
caractérisé en ce que
l'oxygène est introduit entre le premier catalyseur (8) et le second catalyseur (9) en quantité telle que la teneur en CO sera intérieure à 5-20 ppm en aval du second catalyseur (9).

5. Procédé selon la revendication 1, 2, 3 ou 4,
caractérisé en ce qu'
on mesure la différence de température sur le second catalyseur (9) et on règle la valeur lambda de telle sorte que la différence de température sera située dans une plage de température prédéterminée.

6. Brûleur à gaz pour chauffer des fours, dont la tête de brûleur est placée à une extrémité d'un tube interne (2) logé à l'intérieur d'un tube de protection extérieur (3), et dont les gaz de combustion provenant de la tête du brûleur (1) s'écoulent à l'intérieur du tube interne et à l'intérieur du tube externe et, ensuite, dans un passage pour effluents gazeux (5) conduisant vers le milieu extérieur, le brûleur comprenant deux catalyseurs (8, 9) placés l'un après l'autre dans le sens de l'écoulement,
caractérisé en ce qu'
un orifice d'admission (6) est prévu pour le carburant et une certaine quantité d'air de combustion,
le premier catalyseur (8) est adapté pour réduire le NOx en N_2 en présence d'une teneur en CO suffi-

samment élevée de l'effluent gazeux de manière à réduire la teneur en NOx à une valeur prédéterminée,
le brûleur comprend une entrée (10) pour l'oxygène (O_2) entre le premier catalyseur (8) et le second catalyseur (9),
le second catalyseur (9) est adapté pour oxyder le CO et l'HC en CO_2 et H_2O en réponse à l'introduction d'oxygène par l'entrée (10), de manière à réduire la teneur en CO à une valeur prédéterminée, et l'un des catalyseurs (8, 9) ou les deux comportent comme catalyseurs des tamis (11, 12) composés d'un fil ou filament tissé résistant à haute température qui a été recouvert d'un revêtement composé de Rhodium. Platine et/ou Palladium, ou en variante de minces rubans plissés d'un matériau correspondant.

7. Brûleur à gaz selon la revendication 6,
caractérisé en ce que
le brûleur est adapté pour fonctionne à une valeur lambda comprise dans la plage de L = 0,940-0,995.

8. Brûleur à gaz selon la revendication 6 ou 7,
caractérisé en ce que
le premier catalyseur (8) est positionné entre le tube interne (2) et l'autre tube (3) à l'emplacement du récuperateur, et le second catalyseur (9) est placé dans le passage d'échappement.

9. Brûleur à gaz selon la revendication 6, 7 ou 8,
caractérisé en ce que
le tube interne est divisé en deux tubes internes (25, 26) qui sont situés l'un derrière l'autre dans le sens axial, la distance longitudinale entre les tubes internes (25, 26) étant au moins de 5-30 millimètres.

Fig. 1

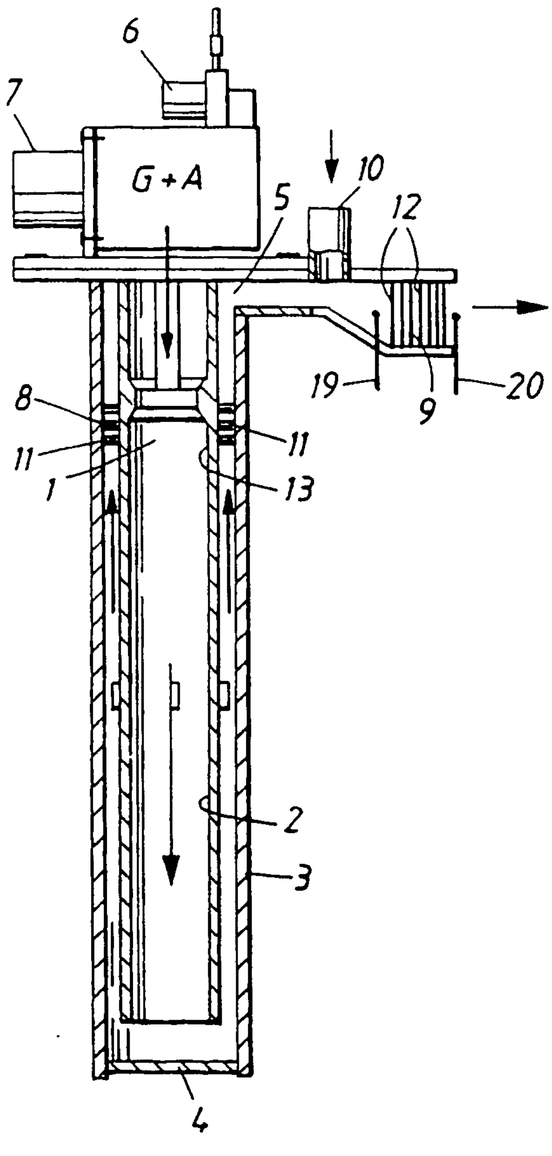

Fig. 2

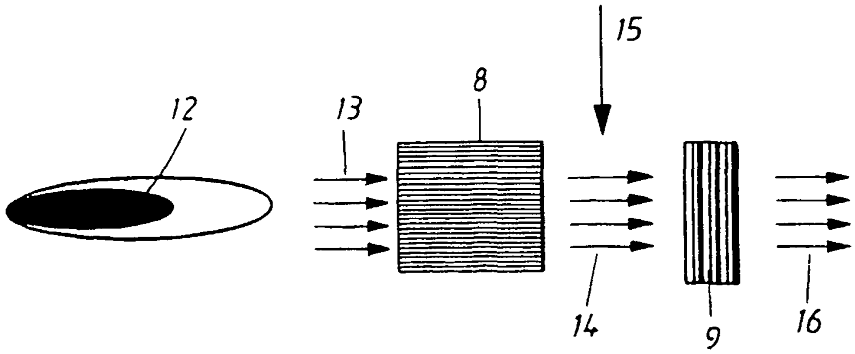

Fig. 3

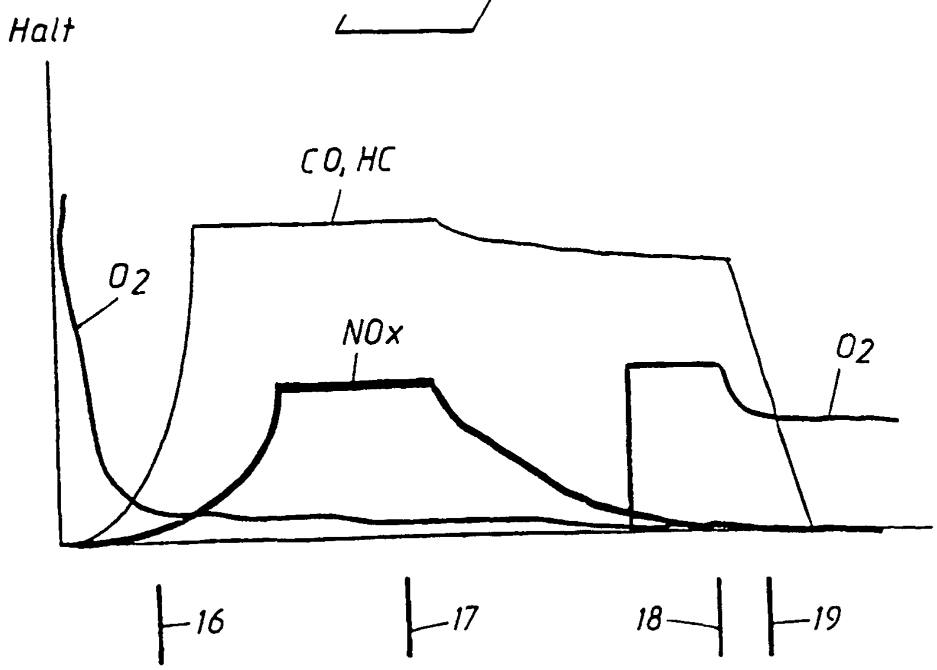

Fig. 4

NOx vs Exhaust Exit Temp with and without Catalyst

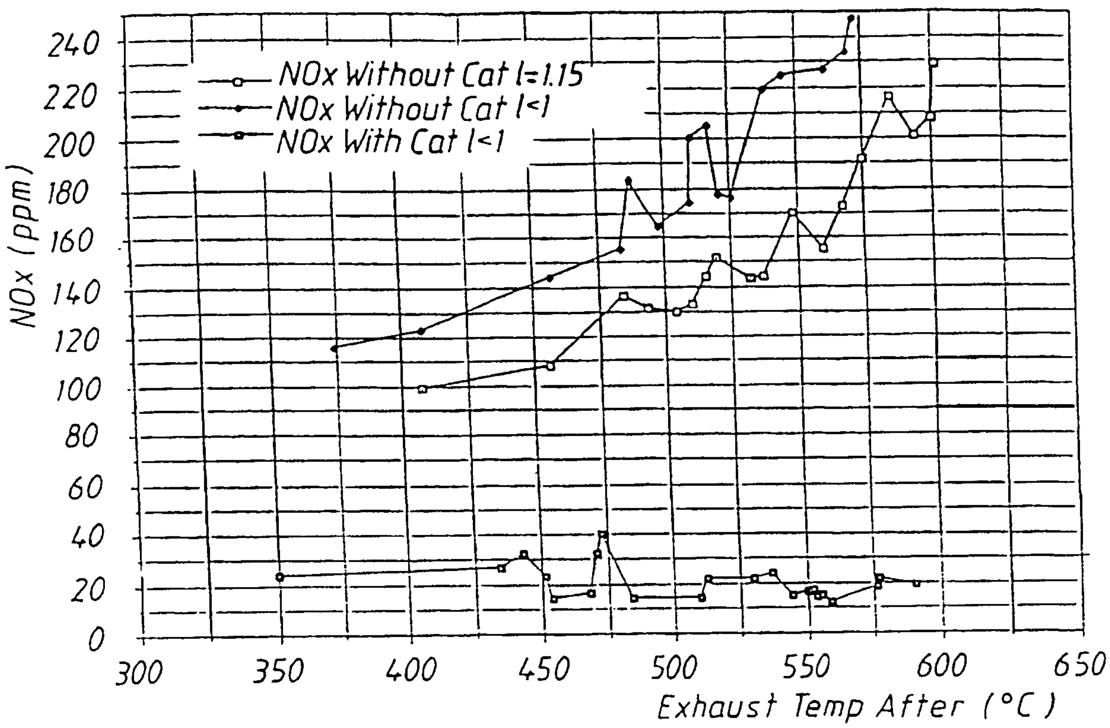

Fig. 5

NOx vs Temp Difference over Exhaust Cat

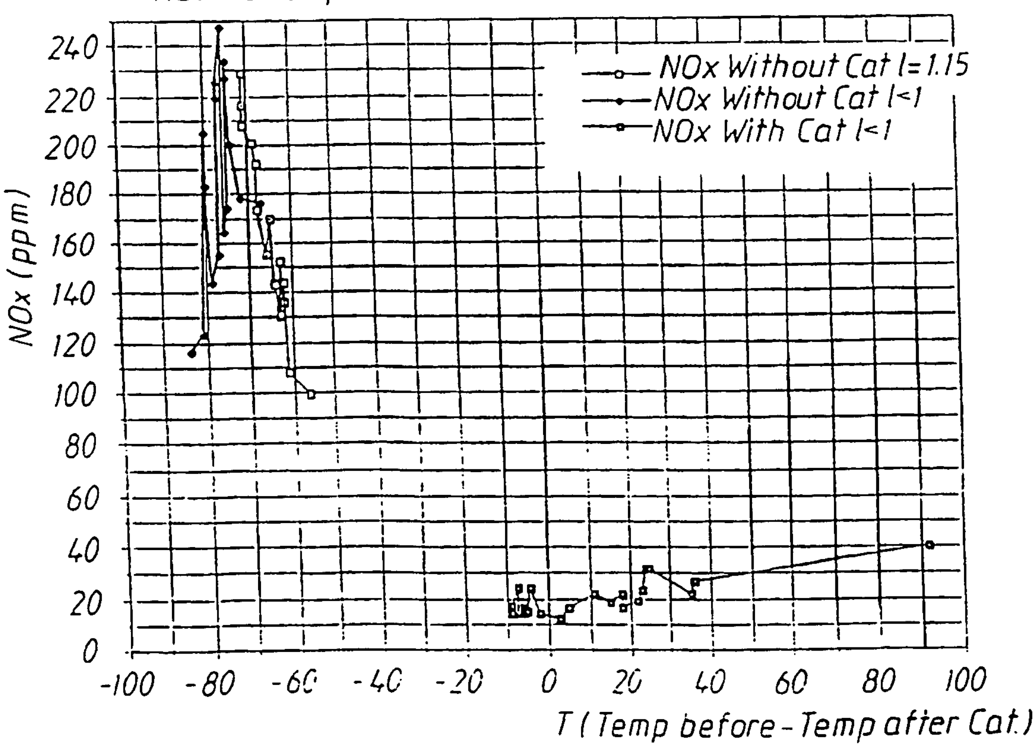

Fig. 6

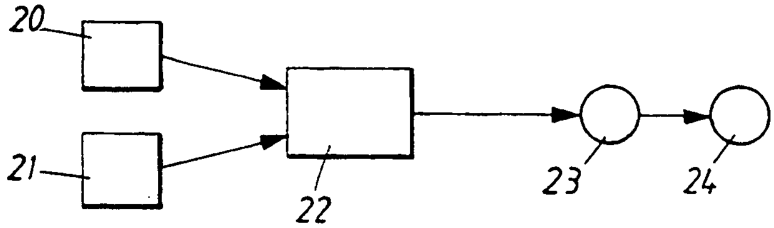

Fig. 7