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(54) **Title:** SYSTEM FOR TREATING THE EXHAUST GASES OF AN INTERNAL COMBUSTION ENGINE ARRANGEMENT, AND PROCESS FOR CONTROLLING AN ENGINE ARRANGEMENT COMPRISING SUCH A SYSTEM

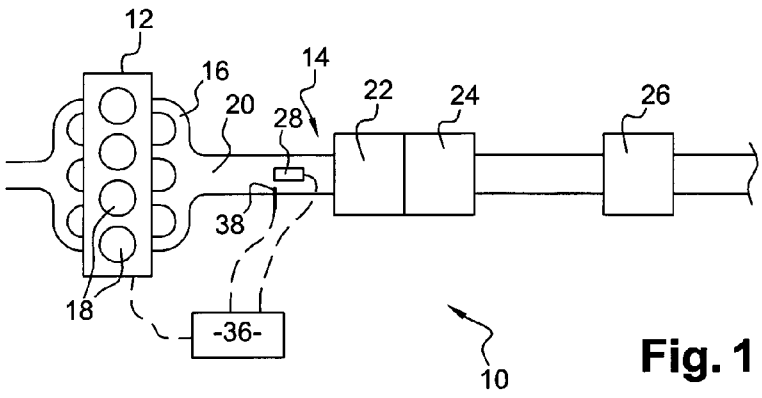


Fig. 1

(57) **Abstract:** The invention relates to a system for treating the exhaust gases of an internal combustion engine arrangement (10), said device comprising: at least one catalytic converter (22); a catalytic sensor (28) upstream from or in parallel with the catalytic converter (22), said catalytic sensor being equipped with a temperature detector (34), and characterized in that the catalytic sensor core (30) exhibits a higher exothermicity per units of volume of sensor core (30) compared to the exothermicity per units of volume of the catalytic converter core.

System for treating the exhaust gases of an internal combustion engine arrangement, and process for controlling an engine arrangement comprising such a system

Technical field

The invention pertains to the field of systems for treating the exhaust gases of an internal combustion engine arrangement.

Background

To comply with ever more strict emission regulations, internal combustion engine arrangements, such as those found on vehicles, on machines or in fixed industrial installations, are more and more frequently equipped with systems for treating the exhaust gases of an internal combustion engine. Such systems are often referred to as exhaust after-treatment systems (EATS). Many of these systems comprise a catalytic converter able to partly convert at least a selected inbound chemical specie or group of inbound chemical source species ordinarily present in the exhaust gases into outbound chemical species. These outbound species are usually considered less harmful and can be released to the atmosphere, or could be intermediate species which need to be further treated in a further element of the system. A catalytic converter comprises a core on which is found a catalyst material promoting said conversion. The core is usually made of metal or ceramics and it is installed in the exhaust arrangement of the engine so the exhaust gases flow through the core. The core is constructed so as to exhibit a high contact surface area with the exhaust gases, especially a high ratio between the contact surface area and the volume of the core. The contact surface area is coated with a material which comprises catalyst species.

Very well-known examples of catalytic converters include the so-called "three way" converters, in which the three main pollutants exhaust gases produced by engines running on gasoline, natural gas or liquid petrol gas (LPG) are treated following three catalytic reactions: an oxidation of carbon monoxide (CO) and unburned hydrocarbons (HC), and a reduction of nitrogen oxides (NOx) to produce carbon dioxide (C02), nitrogen (N2), and water (H20). In diesel engine arrangements, the most-commonly-used catalytic converter is the Diesel Oxidation Catalyst (DOC). This catalyst uses 0 2 (oxygen) in the exhaust gas stream to convert CO (carbon monoxide) to C02 (carbon dioxide) and HC (hydrocarbons) to H20 (water) and C02.

Document US-6.242.263 discloses a system for measuring the non-methane HC concentration of automotive exhaust gas, which comprises a sensor catalyst capable of selectively oxidizing the combination of CO+H2+alkene hydrocarbons in a gas sample and a catalytic differential calorimetric sensor downstream of the sensor catalyst, capable of producing an output signal representative of the exothermic effect of oxidation of the remaining aromatic and alkane hydrocarbons in the gas sample. In the shown examples, the measuring system is arranged downstream of a catalytic converter.

In many cases, the catalytic reactions which occur in a catalytic converter are exothermic. This heat production can even be desirable for a good overall functioning of the EATS. For example, Diesel engines are often equipped with an EATS having a Diesel Particulate Filter (DPF) for collecting un-burnt residues contained in the gases coming out of the combustion chambers. In some cases, the DPF comprises a core which is coated with catalytic material. From time to time, or on a continuous basis, it is desirable that the particulates collected by the filter are further oxidized or burnt, to avoid clogging of the DPF. This can be achieved by maintaining the temperature in the DPF above a certain level, typically in the order of 500°C, during a certain amount of time. Such temperature can for example be obtained thanks to the heat released by a DOC placed upstream of the DPF. Nevertheless, the temperature in the exhaust system should not exceed certain levels, otherwise the integrity of some of the EATS components would be compromised. A catalytic converter is an example of such components which should not be exposed to excessive temperatures which could lead to a more rapid ageing of the converter, or even to its destruction. The temperature increase in a converter can result both from the temperature of the incoming gases and from the thermal release of the reactions which occur inside the converter itself. The thermal release depends, amongst other factors, on the composition of the exhaust gases, and especially on the amount of incoming species which are to be the subject of the exothermal reaction occurring in the converter. In engine arrangements having wide operating ranges, for example such as those found on automotive vehicles, the operating conditions may vary a lot. Therefore, the amount of carbon monoxides and of hydrocarbons may vary a lot, even over a very limited time period. In some cases, this could lead to problems for the DOC which is often placed quite close to the engine in the exhaust system.

There is therefore the need to propose new ways to detect as quickly and reliably as possible that the operating conditions of the engine arrangement may put some of its components at risk, and to propose new ways of controlling the engine arrangement accordingly.

Summary

In view of the above mentioned objective, the invention proposes a system for treating the exhaust gases of an internal combustion engine arrangement, said device comprising:

- at least one catalytic converter able to at least partly convert at least a selected inbound chemical specie or group of inbound chemical species ordinarily present in the exhaust gases into outbound chemical species, wherein said converter comprises a core on which is found a catalyst material promoting said conversion;
- a catalytic sensor provided in the flow of exhaust gases upstream from or in parallel with the catalytic converter, wherein said sensor comprises a core which carries a catalyst material, said catalytic sensor being equipped with a temperature detector.

The system is further characterized in that, when exposed to a flow of exhaust gases comprising the selected inbound chemical specie or group of inbound chemical species, the catalytic sensor core (30) exhibits a higher exothermicity per units of volume of sensor core (30) compared to the exothermicity per units of volume of the catalytic converter core.

According to further potential features of the invention:

- the catalytic sensor - comprises a catalyst material such that the sensor exhibits a higher reactivity than the catalytic converter in the conversion of at least one of said selected inbound chemical specie(s);
- the catalytic sensor exhibits a higher content of catalyst material per units of volume of sensor core compared to the content of catalyst material per units of volume of the catalytic converter core;
- the catalyst material contained in the catalytic sensor is different from the catalyst material contained in the catalytic converter but promotes similar reactions with the same inbound chemical sources than the catalyst material contained in the catalytic converter;
- the core of the catalytic sensor has a volume which at least 5 times smaller, preferably 10 times smaller, and more preferably 20 times smaller than the volume of the catalytic converter;
- the catalyst material contained in the catalytic sensor promotes oxidation of hydrocarbons and/or carbon monoxide;
- the catalytic converter is a three-way catalytic converter able to partly convert hydrocarbons and carbon monoxide and nitrogen oxides;
- the catalytic converter is a Diesel oxydation catalytic converter able to partly convert hydrocarbons and carbon monoxide;
- only part of the flow of exhaust gases generated by the engine arrangement flow through the catalytic sensor; and/or

- that the proportion of exhaust gases which flow through the catalytic sensor is less than 40 percent, and preferably less than 20 percent of the mass flow of exhaust gases generated by the engine arrangement.

The invention is also directed to a process for controlling an internal combustion engine arrangement comprising a system as described above, characterized in that it comprises the steps of:

- monitoring the temperature of the catalytic sensor;
- if the temperature of the catalytic sensor reaches or exceeds a threshold temperature, controlling at least one operating parameter of the internal combustion engine arrangement so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature;

The invention is also directed to a process controlling an internal combustion engine arrangement comprising a system as described above, characterized in that the process comprises the steps of:

- post-injecting fuel;
- monitoring the temperature of the catalytic sensor;
- if the temperature of the catalytic sensor reaches or exceeds a threshold temperature, controlling at least one operating parameter of the fuel post injection so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature.

In such processes, the threshold temperature may vary according to the operating conditions of the internal combustion engine arrangement. For example, the threshold temperature may vary according to the exhaust gases temperature.

Description of figures

- Figure 1 is a schematic diagram of an engine arrangement comprising a system according to the invention.
- Figure 2 is a schematic drawing of one embodiment of a catalytic sensor according to the invention.

Description

On figure 1 is shown an internal combustion engine arrangement 10 comprising an internal combustion engine 12, for example a multi-cylinder 4 stroke reciprocating piston engine, and an exhaust system 14 which may comprise an engine exhaust manifold 16 merging the flow of exhaust gases out of the engine cylinders 18 into an

exhaust pipe 20. As part of the exhaust system 12, at least one catalytic converter 22 is installed on the exhaust pipe 20 so as to be flown through by the flow of exhaust gases. The catalytic converter 22 is able to at least partly convert at least one selected inbound chemical specie or a selected group of inbound chemical species ordinarily present in the exhaust gases into one or several outbound chemical species.

The invention can be used with most types of combustion engines such as compression ignition engines (for example of the Diesel type) or spark ignition engines (for example running on gas, on LPG or on gasoline). Thereby, the catalytic converter can be of many types, such as a three-way catalytic converter or a diesel oxidation catalytic converter as mentioned above. In all cases, the converter transforms at least one inbound chemical specie into an outbound specie. In most cases, the outbound chemical specie is considered as less harmful than the inbound specie. In some cases, the outbound specie will be further transformed in a downstream element of the exhaust system. The catalytic converter usually comprises a core, also called substrate, encased in a casing having an inlet and an outlet. When flowing from inlet to outlet, the exhaust gases flow through the core. The core can be made of various materials, including metals and ceramics. The core may be coated with a so-called washcoat, for example made of alumina, which preferably exhibits a high surface area and which serves a carrier for the catalyst material. The catalyst material can be either embedded in the washcoat or impregnated on the washcoat, as a coating.

The exhaust system 14 may comprise other components, located upstream or downstream of the converter 22, such as other converters, filters, mufflers, or systems for injecting substances such as fuel or reaction compositions designed to interact with the flow of exhaust gases. In the example shown on figure 1, the catalytic converter 22 is a Diesel oxidation catalytic converter (DOC) and the exhaust system comprises for example, downstream from the converter 22 a Diesel particulate filter (DPF) 24 and a SCR system 26 which itself comprises a converter able to promote the reduction of nitrogen oxides with the provision of a non-shown system for injection in the flow of exhaust gases of an ammonia containing reagent. The DPF can comprise a core coated with catalytic material.

According to the invention, the exhaust system is equipped with a catalytic sensor 28 which is provided in the flow of exhaust gases upstream from the catalytic converter 22. In the shown example, the catalytic sensor 28 is placed in the exhaust pipe 20 and has been located on the axis of the pipe. Nevertheless, the sensor could alternatively be placed in a derivation pipe, parallel to pipe 20. Such parallel pipe can either rejoin to pipe 20 upstream of the converter 22, in which case the sensor can be considered as located upstream of the converter 22, or can rejoin the pipe 20 downstream of the converter, in which case the sensor can be considered as arranged in parallel to the

converter 22. The catalytic sensor 28 is installed in the exhaust system so that exhaust gases flow through the sensor 28.

As shown on figure 1, the catalytic sensor 28 can be placed immediately upstream of the catalytic converter 22, with no other exhaust component between the sensor 28 and the converter 22. Alternatively, other exhaust components can be interposed in the flow of exhaust gases between the sensor 28 and the converter 22.

Similarly to the converter 22, the sensor 28 comprises a core 30 on which is found a catalyst material. In the example on figure 2, the core is encased in a casing 32. The casing 32 can be tubular, for example with a circular cross section, and it can be made of metal. In the shown embodiment, the tubular casing 32 has a longitudinal axis, oriented parallel and coincident with the axis of pipe 20, and it is open at its two longitudinal upstream and downstream ends through which exhaust gases may respectively enter and exit the sensor 28. Inside the sensor 28, the exhaust gases flow along the core 30. The core 30 can be made of ceramics, such as cordierite, or it can be made of metal. In the latter case, the core can be made of thin metal foils, alternatively flat and corrugated, stacked and formed into a honeycomb structure. Such structure can be assembled using a number of methods, such as spiral winding of two foil layers—one flat and one corrugated— into round cross-section core, using more complex non-spiral types of winding, or else stacking straight layers of corrugated/flat foils. The foils can be held together and attached to the casing for example by brazing, or else by securing the foils mechanically using pins, retaining rings and/or cross-members at the casing inlet and outlet. More complex methods of winding the honeycomb structure are known in the art and can be used in the invention.

The sensor core 30 carries a catalytic coating which can be made as that of the converter 22. The sensor core 30 may be coated with a so-called washcoat, for example made of a porous layer of alumina or other metal oxides, which preferably exhibits a high surface area and which serves as a carrier for the catalyst material. The catalyst material can be either embedded in the washcoat or later impregnated on the washcoat, as a coating. The catalyst material itself is most often a metal or a combination of metals, such as platinum, palladium and rhodium. Rhodium can be used as a reduction catalyst, palladium can be used as an oxidation catalyst, and platinum can be used both for reduction and oxidation. Cerium, iron, manganese, copper and nickel may also be used in the composition of the catalyst material. The catalyst material can therefore be a combination of different chemical species. Different materials can differ by the list of species they contain or by the ratio between the different species. Also, it can be noted that an important factor when devising the catalytic sensor will be the catalyst material loading, which can be expressed as the mass of catalyst material per unit volume of core material (preferably expressed by its outer dimensions).

According to the invention, the catalytic sensor 28 is equipped with a temperature detector 34. Preferably, the temperature detector is able to detect the temperature inside the core of the sensor, preferably in or near the middle of the core of the sensor, so as to be able to detect the thermal activity of the sensor, i.e. the amount of heat produced by the catalytic reactions occurring in the sensor. The thermal detector may include for example a thermocouple or a resistive thermal device (RTD). The temperature detector 34 is connected to an electronic control system 36 which may comprise one or several electronic control units. This electronic control system 36 at least monitors but preferably also controls the operation of the exhaust system and it is preferably included in the engine control system or connected thereto.

Preferably, the sensor temperature detected by detector 34 is compared to the exhaust gases temperature near the sensor, so as to be able to easily determine not only the absolute temperature of the sensor, but also the temperature increase and/or the heat release due to the catalytic reactions occurring in the sensor. The exhaust gas temperature can be measured by a dedicated detector 38, such as a thermocouple or a resistive thermal device, but it could also be obtained by calculations or through a look-up table, based on observed operating conditions of the engine.

Preferably, the catalytic sensor core is contacted by only a portion of the flow of exhaust gases. For example, the proportion of exhaust gases which go through the catalytic sensor 28 is inferior to 40 percent, but preferably inferior to 20 percent of the flow of exhaust gases which are generated by the engine arrangement. In the design shown on figure 1, where the sensor is located in the exhaust pipe 20 leading to the converter 22, this translates in that the cross section of the catalytic sensor 28 is smaller than the cross-section of the exhaust pipe 20 and, in most cases, smaller than the cross-section of the catalytic converter 22. Preferably, in such design, the catalytic sensor 28 exhibits a cross section which is inferior to 40 percent, but preferably inferior to 20 percent of the cross section of the portion of the pipe in which it is installed, in order to minimize the counter pressure generated by the catalytic sensor.

According to a feature of the invention, when exposed to a flow of exhaust gases comprising the selected inbound chemical specie or group of inbound chemical species, the catalytic sensor core exhibits a higher exothermicity per units of volume of sensor core compared to the exothermicity per units of volume of the catalytic converter core. In other word the amounts of temperature released by units of volume of the device is higher for the sensor, with the aim of having a higher or quicker temperature elevation of the temperature of the sensor core than of the converter core.

According to a possible embodiment, the catalytic sensor may comprise a catalyst material which exhibits a higher reactivity than the converter catalyst material in the conversion of at least one of said selected inbound chemical specie(s). In other words, the catalyst material composition of the sensor may be different than that of the sensor. Typically, the sensor catalyst material could contain a higher proportion of platinum and or a higher proportion of rhodium or of palladium.

According to another possible embodiment, the catalytic sensor 28 may exhibit a higher content of catalyst material per units of volume of the sensor core 30 compared to the content of catalyst material per units of volume of the catalytic converter core. In other words the sensor core may exhibit a higher loading with catalyst material than the converter core. In such a case, the catalyst material contained in the catalytic sensor 28 may be similar to the catalyst material contained in the catalytic converter 22, but it could also be provided, in combination, to have a sensor catalyst material different from the converter catalyst material, for example exhibiting a higher reactivity.

Preferably, if the catalyst material contained in the catalytic sensor 28 is different from the catalyst material contained in the catalytic converter 22, it promotes similar reactions with the same selected inbound chemical species, or with at least one or some of them, than the catalyst material contained in the catalytic converter 22. For example, if the catalytic converter 22 is a three-way catalytic converter or a diesel oxidation catalytic converter, the catalyst material of the sensor 28 should promote oxidation of hydrocarbons and/or of carbon monoxide. Possibly, the sensor catalyst material can be chosen so that it is more selective, i.e. for example so that it promotes a reaction essentially only for a given family of hydrocarbons.

Preferably, the core 30 of the catalytic sensor 28 has a volume which at least 5 times smaller than the volume of the catalytic converter, but preferably at least 10 times smaller and most preferably at least 20 times smaller.

Thanks to the invention, the sensor 28 will react essentially in the same way as the converter upon changing operating conditions of the engine, but the reaction, as detected by the temperature sensor, will be more quickly and surely detected than it would be by monitoring the operation of the catalytic converter 22.

Thereby, it becomes possible to achieve a more effective closed loop control, for example having a shorter time lag, of the engine arrangement for performing certain number of functions. The information gathered from the sensor may also enable to protect the catalytic converter from experiencing excessive temperatures.

The above described system can be used for performing an engine controlling process comprising the steps of:

- monitoring the temperature of the catalytic sensor 28;
- if the temperature of the catalytic sensor 28 reaches or exceeds a threshold temperature, controlling at least one operating parameter of the internal combustion engine arrangement 10 so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature.

In other words, the engine arrangement is controlled using a feedback based on exhaust gas composition. If the catalytic sensor 28 is sensitive to un-burnt hydrocarbons, and if the sensor 28 is placed upstream of a catalytic converter 22 also capable of oxidizing such hydrocarbons, such feedback strategy can be particularly useful to determine such events as the occurrence of misfiring in one or several of the engine cylinders 18. Such misfiring, which implies that the fuel injected in the cylinders 18 is not burnt and is therefore sent to the exhaust, can be very harmful for the catalytic converter 22 because of a great amount of hydrocarbons being present in the catalytic converter 22 can lead to excessive overheating and potentially to the destruction of the converter. Therefore, the catalytic sensor 28 is then used as a misfiring detector because of its ability to quickly sense an excessive an amount of un-burnt or partially burnt hydrocarbons in the exhaust gases. Thanks to this detection, the electronic control system 36 can adjust the engine arrangement operating conditions, for example by adjusting injection timing and/or ignition timing, to stop the misfiring, before the increase of temperature in the catalytic converter 22 has become too harmful for the system.

A similar engine controlling process can be implemented for controlling a so-called low temperature combustion process, such as those know as Homogeneous Charge Compression Ignition (HCCI), Premixed Charge Compression Ignition (PCCI), etc.... In such combustion processes, feedback control of the combustion can be very important and should be as reactive as possible. Depending on the temperature measured by the catalytic sensor, the main process parameters could be adjusted such as the exhaust gas recirculation rate, the injection timing, the injection pressure, etc...

The above described system can also be used for performing an engine controlling process comprising the steps of:

- post-injecting fuel;
- monitoring the temperature of the catalytic sensor 28;
- if the temperature of the catalytic sensor 28 reaches or exceeds a threshold temperature, controlling at least one operating parameter of the fuel post-injection so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature.

Indeed, in some cases, it is known to deliberately inject some fuel which is to be directed to the exhaust system without having been burnt in the combustion

chamber. This is for example done in diesel engine arrangements having a diesel oxydation catalytic converter (DOC) and a diesel particu late filter (DPF), with the aim that the heat generated by the oxidation of the fuel in the converter causes a sharp elevation of the temperatu re of the exhaust gases entering the DPF able to cause a combustion of a particles trapped in the filter, thereby regenerating the filter and avoiding it becoming clogged. Such temperature increase of the flow of exhaust gases can also achieve a de-poisoning of the converters in the exhaust system, such as the desulfurization of the converters. The fuel injection can be performed inside the cylinder, for example during an exhaust stroke of the engine. It can also be performed by a dedicated fuel injection apparatus installed on the exhaust pipe 20. In both cases, where the fuel injection can be called post-injection, there is an interest in precisely adjusting the amou nt of fuel which is post-injected so that it is enough to cause the required temperature elevation in, but so that it does not exceed that amount up to a point where the temperature elevation wou ld risk harming the exhaust system or wou ld cause an undue over-consumption of fuel. In such a case, the use of the catalytic sensor 28 as mentioned above allows having a precise control of the effect of the fuel injection and can therefore allow a precise and stable feedback control of the fuel post-injection.

In all these processes, it can be advantageous that the threshold temperature varies according to the operating conditions of the internal combustion engine arrangement. One way to implement this is for example to take into account the exhaust gases temperature, for example by using the information provided by a detector such as temperature detector 38 described above. Thereby, rather than evaluating only the absolute temperature in the cata lytic sensor 28, the engine controlling process can take into account the temperature difference between the catalytic sensor 28 and the incoming exhaust gases, thereby having a better evaluation of the thermal energy release due to the catalytic reaction.

CLAIMS

1. System for treating the exhaust gases of an internal combustion engine arrangement (10), said device comprising:

- at least one catalytic converter (22) able to at least partly convert at least a selected inbound chemical specie or group of inbound chemical species ordinarily present in the exhaust gases into outbound chemical species, wherein said converter (22) comprises a core on which is found a catalyst material promoting said conversion;

- a catalytic sensor (28) provided in the flow of exhaust gases upstream from or in parallel with the catalytic converter (22), wherein said sensor comprises a core (30) which carries a catalyst material, said catalytic sensor being equipped with a temperature detector (34), and

characterized in that, when exposed to a flow of exhaust gases comprising the selected inbound chemical specie or group of inbound chemical species, the catalytic sensor core (30) exhibits a higher exothermicity per units of volume of sensor core (30) compared to the exothermicity per units of volume of the catalytic converter core.

2. System according to claim 1, characterized in that the catalytic sensor (28) comprises a catalyst material such that the sensor (28) exhibits a higher reactivity than the catalytic converter (22) in the conversion of at least one of said selected inbound chemical specie(s).

3. System according to any of claims 1 or 2, characterized in that the catalytic sensor (28) exhibits a higher content of catalyst material per units of volume of sensor core (30) compared to the content of catalyst material per units of volume of the catalytic converter core.

4. System according to any of claims 1 to 3, characterized in that that the catalyst material contained in the catalytic sensor (28) is different from the catalyst material contained in the catalytic converter (22) but promotes similar reactions with the same inbound chemical sources than the catalyst material contained in the catalytic converter (22).

5. System according to any preceding claim, characterized in that the core (30) of the catalytic sensor (28) has a volume which at least 5 times smaller,

preferably 10 times smaller, and more preferably 20 times smaller than the volume of the catalytic converter (22).

6. System, characterized in that the catalyst material contained in the catalytic sensor (28) promotes oxidation of hydrocarbons and/or carbon monoxide.

7. System according to any preceding claim, characterized in that the catalytic converter (22) is a three-way catalytic converter able to partly convert hydrocarbons and carbon monoxide and nitrogen oxides.

8. System according to any of claims 1 to 8, characterized in that the catalytic converter (22) is a Diesel oxydation catalytic converter able to partly convert hydrocarbons and carbon monoxide.

9. System according to any preceding claim, characterized in that only part of the flow of exhaust gases generated by the engine arrangement flow through the catalytic sensor (28).

10. System according to claim 9, characterized in that the proportion of exhaust gases which flow through the catalytic sensor (28) is less than 40 percent, and preferably less than 20 percent of the mass flow of exhaust gases generated by the engine arrangement (10).

11. Process for controlling an internal combustion engine arrangement comprising a system according to any preceding claim, characterized in that it comprises the steps of:

- monitoring the temperature of the catalytic sensor (28);
- if the temperature of the catalytic sensor (28) reaches or exceeds a threshold temperature, controlling at least one operating parameter of the internal combustion engine arrangement (10) so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature;

12. Process for controlling an internal combustion engine arrangement comprising a system according to claims 1 to 10, characterized in that the process comprises the steps of:

- post-injecting fuel;
- monitoring the temperature of the catalytic sensor (28);
- if the temperature of the catalytic sensor (28) reaches or exceeds a threshold temperature, controlling at least one operating parameter of the fuel post injection so as to limit or to stop the sensor temperature increase, or to decrease the sensor temperature.

13. Process according to claims 11 or 12, characterized in that the threshold temperature varies according to the operating conditions of the internal combustion engine arrangement (10.)

14. Process according to claim 11, 12 or 13, characterized in that the threshold temperature varies according to the exhaust gases temperature.

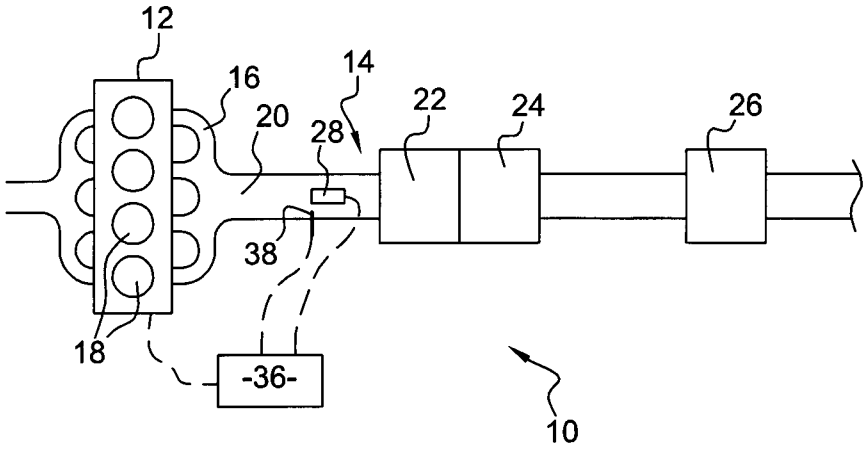


Fig. 1

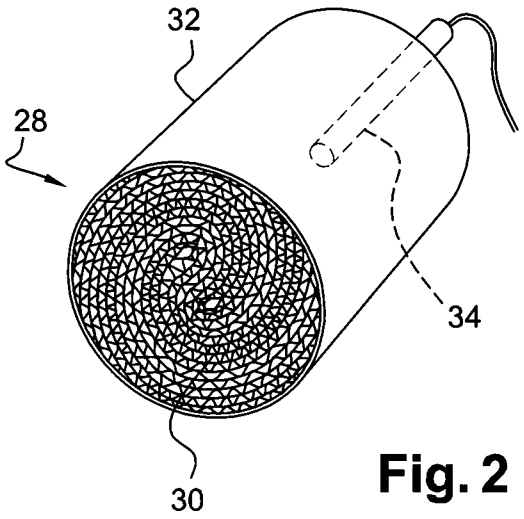


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/003230

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01N11/0Q G01N25/30 G01N27/16
ADD. F01N13/OQ F02D9/Q2 F02D35/OQ

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01N G01N

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/26064 Al (MOTOROLA INC [US] ; ENGELHARD CORP [US]) 27 May 1999 (1999-05-27) page 1, line 18 - line 26 page 12, line 14 - line 29; figures 1,2 ,8,9 page 6, line 14 - line 25	1-4,6, 8-10
X	WO 2007/099363 Al (JOHNSON MATTHEY PLC [GB] ; PHILLIPS PAUL RICHARD [GB] ; TWIGG MARTYN VIN) 7 September 2007 (2007-09-07) page 4, line 17 - line 24; claim 1; figure 2	1,6,8, 11
X	US 6 344 173 BI (FABER MARGARET K [US] ET AL) 5 February 2002 (2002-02-05) column 3 - line 55	1,7 , 11

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
7 September 2012	14/09/2012

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