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(54) **METHOD FOR REGENERATION OF AN EXHAUST AFTERTREATMENT SYSTEM**

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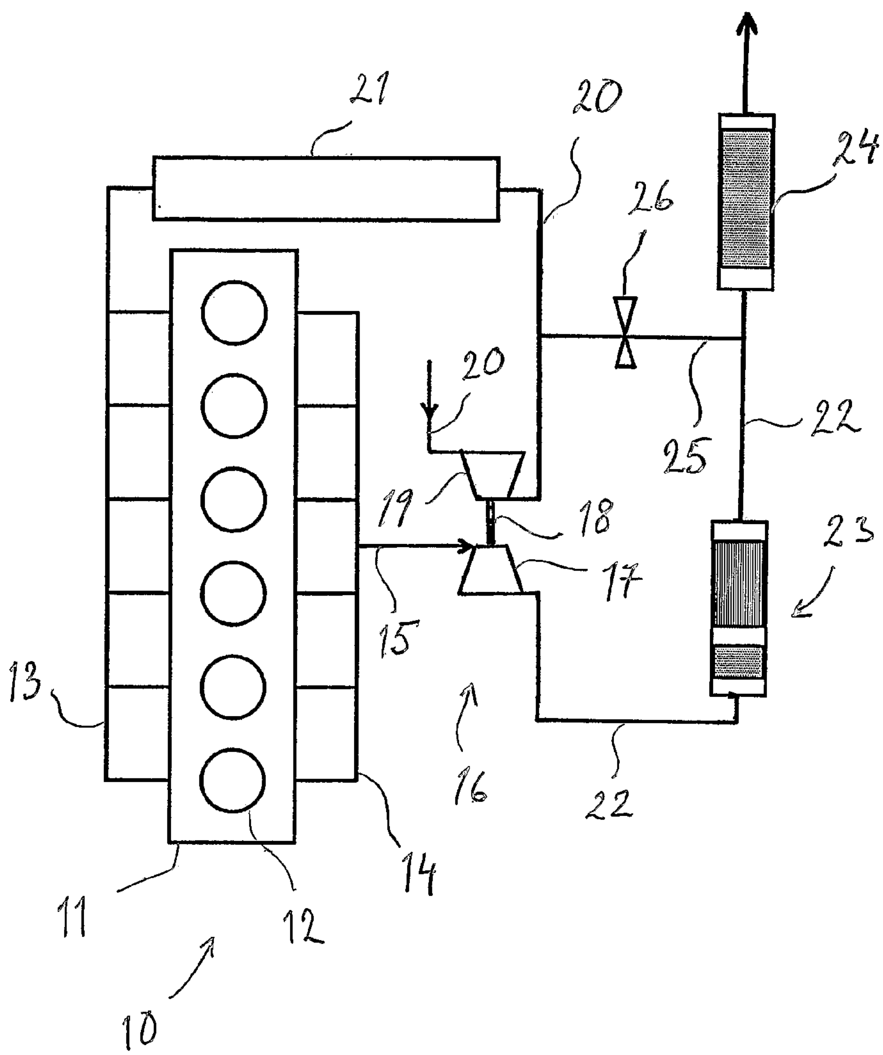
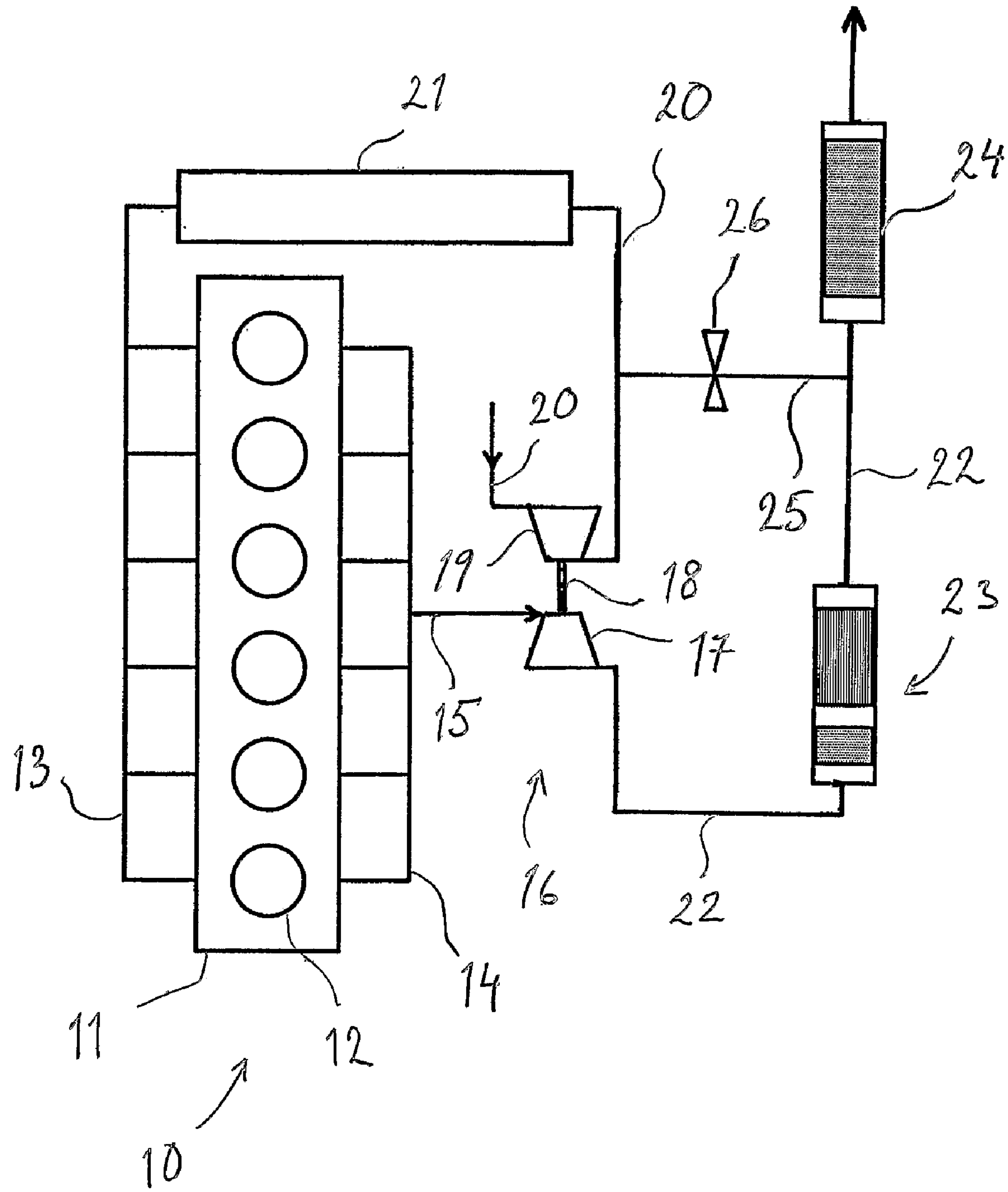
(57) **ABSTRACT**

In a method and a device for regeneration of a regeneratable unit which forms part of an exhaust aftertreatment system, the unit is arranged upstream of a catalytic rector in an exhaust duct connected to an internal combustion engine. Part of the inlet air of the internal combustion engine is during regeneration conducted to the exhaust duct for regulating the temperature in the gas flow to the catalytic reactor.





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METHOD FOR REGENERATION OF AN EXHAUST AFTERTREATMENT SYSTEM

BACKGROUND AND SUMMARY

[0001] The present invention relates to a method and device for regeneration of a regeneratable unit which forms part of an exhaust aftertreatment system and is arranged upstream of a catalytic reactor in an exhaust duct connected to an internal combustion engine.

[0002] In the combustion process in diesel engines, soot particles are also formed in addition to water vapor, nitrogen oxides and carbon dioxide. Small amounts of uncombusted hydrocarbons and carbon monoxide are also found. A diesel engine provided with a particle filter has greatly reduced emissions of particles. However, the particle filter has to be regenerated more or less continuously so as not to become full and cause high pressure drops across the exhaust system.

[0003] The filter can be partly regenerated spontaneously by means of NO2, but this presupposes that the temperature is sufficiently high and that there is sufficient NO2. In cases where the spontaneous NO2-based regeneration does not function satisfactorily, active regeneration must take place, it is true perhaps for only a small part of the total operating time, of the order of a few %, but at these times the gas temperature into the filter part has to be increased to approximately 600-650° C. in order for it to be possible for the remaining oxygen in the exhaust gases to oxidize the soot. When this takes place, the soot is combusted inside the filter, further heat is released and the outlet temperature can increase to 700-750° C. in the case of moderate soot loads; the temperature may be even higher if soot loading has been going on for a long time.

[0004] If the exhaust aftertreatment system also includes other types of unit for, for example, NOx reduction in addition to a particle filter, an SCR catalyst may be located downstream of the particle filter, for example. In order not to jeopardize the life of the SCR catalyst, the gas temperature into the same should not exceed 5800 C. The SCR catalyst must therefore be protected against the gas temperatures which can occur after the particle filter when active oxygen-based regeneration takes place.

[0005] Various alternatives have been proposed, which are intended to avoid damage to a unit for exhaust aftertreatment located downstream of a regeneratable particle filter. A common method is to arrange a bypass duct past the SCR but then NOx reduction does not take place while soot regeneration is going on. Although it is only a small part of the operating time, increased emissions are obtained when soot regeneration is in progress.

[0006] It is desirable to provide a method and a device which make possible effective temperature regulation of the gas flow between a regeneratable unit and a catalytic reactor located downstream of it.

[0007] According to an aspect of the present invention a method is provided for regeneration of a regeneratable unit which forms part of an exhaust aftertreatment system and is arranged upstream of a catalytic reactor in an exhaust duct connected to an internal combustion engine, the method comprising conducting part of the inlet air of the internal combustion engine during regeneration to the exhaust duct for regulating the temperature in the gas flow to the catalytic reactor.

[0008] According to another aspect of the present invention, an exhaust aftertreatment system for a diesel engine comprises an exhaust line with a regeneratable unit located upstream of a catalytic reactor, wherein a pipe connects the inlet line of the engine to the exhaust line at a point between the regeneratable unit and the catalytic reactor, which pipe makes it possible to shunt inlet air to the exhaust line for regulating the temperature in the gas flow to the catalytic reactor.

BRIEF DESCRIPTION OF FIGURE

[0009] The invention is to be described in greater detail with reference to the accompanying drawing FIGURE which shows diagrammatically a diesel engine with an inlet system and exhaust system according to an aspect of the invention.

DETAILED DESCRIPTION

[0010] The FIGURE shows an internal combustion engine, suitably a diesel engine **10** which comprises an engine block **11** with six piston cylinders **12** and an inlet manifold **13** and an exhaust manifold **14**. Exhaust gases from the engine are conducted via an exhaust line **15** to the turbine wheel **17** of a turbine unit **16**. The turbine shaft **18** drives the compressor wheel **19** of the turbine unit, which, via an inlet line **20**, compresses incoming air and conveys it on via a charge air cooler **21** to the inlet manifold **13**. Fuel is fed to the cylinders **12** via respective injection devices (not shown). Although the FIGURE illustrates an engine with six cylinders, the invention can also be used in conjunction with other cylinder configurations.

[0011] Exhaust gases which have passed through the turbine unit **16** are conducted on via the exhaust line **22** to a regeneratable filter device **23**, a diesel particle filter (DPF), for separation of particles from the exhaust flow, which filter works in series with an oxidation catalyst. For this purpose, the oxidation catalyst is mounted upstream and in close proximity to the particle filter, but it is also conceivable to integrate the particle filter and the oxidation catalyst on a common supporting structure where catalyst material is spread on the filtering body.

[0012] The exhaust line **22** extends on downstream of the particle filter **23** to a catalytic reactor **24**. The catalytic reactor can comprise a selective catalyst reactor (SCR), for example, mixing reductant, urea or ammonia into the exhaust flow bringing about a chemical reaction with NOx in the SCR unit to form N2. The exhaust flow is then conducted on into the atmosphere. When active regeneration of the particle filter takes place, there is a risk of the SCR unit being exposed to detrimentally high temperatures. In order to avoid this, a pipe **25** forms a connection between the inlet line **20** and the exhaust line **22**, which pipe **25** makes it possible to conduct cold inlet air to the exhaust duct **22** for regulating the temperature in the exhaust flow to the SCR unit **24**. A valve **26** makes it possible to open, close and regulate the flow through the pipe **25**, so that an appropriate dilution level can be maintained during regeneration without unnecessary loss of charging pressure on the inlet side of the engine. In this way, regeneration of the particle filter **23** can take place at the same time as NOx reduction continues without risk of damage to the SCR unit.

[0013] Another example of an area of application of the method of diluting with air after an aftertreatment system is diluting the exhaust flow after an LNA (lean NOx absorber) with cold inlet air upstream of a clean-up catalyst. The result of this is that on the one hand the temperature is reduced slightly before said cleanup catalyst and on the other hand it is ensured that there is access to oxygen (in addition to the oxygen incorporated into the clean-up catalyst). In the case of sulfur regeneration by LNA, H2S is usually formed, but, if dilution with air is carried out before cleanup, this is converted to SO2 and odor effects are avoided.

[0014] Air for diluting the exhaust gases at a suitable location can be obtained from the inlet system of the engine where the pressure is higher than in the exhaust system. The pressure is higher in the inlet system after the compressor than the pressure which is present in the exhaust system. At zero load, however, the pressure difference may be non-existent. In order to remedy this, a venturi in the exhaust system can help to suck diluting air from the inlet side. When air is taken from the inlet side, it is possible either to drain air directly after the compressor before the charge air cooler **21** and then the pressure drop across the charge air cooler is avoided or to drain air after the charge air cooler, which it is true provides a slightly lower pressure, but the temperature of the diluting air is also lower and the necessary quantity of diluting air can be reduced in order to obtain a given maximum exhaust temperature before a temperature-sensitive part of the exhaust aftertreatment system.

[0015] The invention is not to be regarded as being limited to the illustrative embodiments described above but a number of further variants and modifications are conceivable within the scope of the following patent claims.

1. A method for regeneration of a regeneratable unit which forms part of an exhaust aftertreatment system and is arranged upstream of a catalytic reactor in an exhaust duct connected to an internal combustion engine, comprising conducting part of inlet air of the internal combustion engine during regeneration to the exhaust duct for regulating temperature in a gas flow to the catalytic reactor.

2. The method for regeneration as claimed in claim **1**, wherein a quantity of inlet air to the exhaust duct is regulated with regard to the temperature of the gas flow to the catalytic reactor.

3. The method for regeneration as claimed in claim **1**, wherein the inlet air conducted to the exhaust duct is taken upstream of a charge air cooler arranged in the intake air line.

4. The method for regeneration as claimed in claim **1**, wherein the inlet air conducted to the exhaust duct is taken downstream of a charge air cooler arranged in the intake air line.

5. An exhaust aftertreatment system for a diesel engine, comprising an exhaust line with a regeneratable unit located upstream of a catalytic reactor, and a pipe that connects an inlet line of the engine to the exhaust line at a point between the regeneratable unit and the catalytic reactor, permitting shunting of inlet air to the exhaust line for regulating temperature in a gas flow to the catalytic reactor.

6. The exhaust aftertreatment system as claimed in claim **5**, wherein the pipe is provided with an adjustable choke for regulating flow through the pipe.

7. The exhaust aftertreatment system as claimed in claim **5**, wherein the catalytic reactor comprises a selective catalyst reactor for NOx reduction of the exhaust flow.

8. The exhaust aftertreatment system as claimed in claim **7**, wherein the regeneratable unit comprises a particle filter.

9. The exhaust aftertreatment system as claimed in claim **5**, wherein the catalytic reactor comprises a clean-up catalyst which is located downstream of a lean NOx absorber.

10. The method for regeneration as claimed in claim **2**, wherein the inlet air conducted to the exhaust duct is taken upstream of a charge air cooler arranged in the intake air line.

11. The method for regeneration as claimed in claim **2**, wherein the inlet air conducted to the exhaust duct is taken downstream of a charge air cooler arranged in the intake air line.

12. The exhaust aftertreatment system as claimed in claim **6**, wherein the catalytic reactor comprises a selective catalyst reactor for NOx reduction of the exhaust flow.

13. The exhaust aftertreatment system as claimed in claim **12**, wherein the regeneratable unit comprises a particle filter.

14. The exhaust aftertreatment system as claimed in claim **5**, wherein the catalytic reactor comprises a clean-up catalyst which is located downstream of a lean NOx absorber.

15. The exhaust aftertreatment system as claimed in claim **6**, wherein the catalytic reactor consists of a selective catalyst reactor for NOx reduction of the exhaust flow.

16. The exhaust aftertreatment system as claimed in claim **15**, wherein the regeneratable unit consists of a particle filter.

17. The exhaust aftertreatment system as claimed in claim **5**, wherein the catalytic reactor consists of a clean-up catalyst which is located downstream of a lean NOx absorber.

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