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(54) **LOW TEMPERATURE HEATER FOR EXHAUST GAS PURIFICATION AND TREATMENT OF DIESEL ENGINE**

(57) A low temperature heater for exhaust gas purification and treatment of a diesel engine, including a tubular shell having an inlet end and an outlet end, and the inlet end being in communication with the exhaust pipe of the engine; an ignition portion arranged on a sidewall of the shell near the inlet end, and an oil inlet arranged at a center of the ignition portion; an ignition cylinder connected to the ignition portion and in communication with the ignition portion, the ignition cylinder having an open end and a closed end, the closed end being near the inlet

end of the tubular shell and the open end being near the outlet end of the tubular shell; and an air intake pipe which passes through the tubular shell and a sidewall of the ignition cylinder and enters the ignition cylinder. The intake pipe has a first air outlet and a second air outlet, the first air outlet is directly inside the ignition cylinder, the second air outlet is in communication with the ignition portion, and the ignition portion is located between the first air outlet and the closed end.

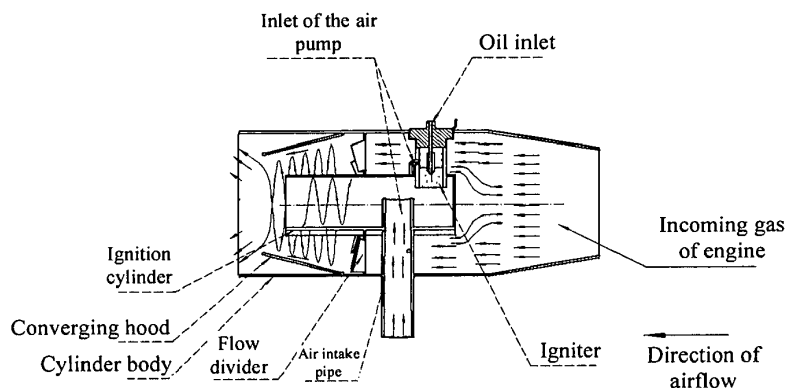


Figure 1

Description**FIELD**

5 **[0001]** The present application relates to the technical field of vehicle exhaust gas purification and treatment, and specifically relates to the technical field of heating exhaust gas from a diesel engine to realize regeneration of a particulate filter.

BACKGROUND

10 **[0002]** With the implementation of Euro V emission standard, diesel particulate filter (DPF) has become an indispensable technology for diesel vehicles. In recent years, with the increase of motor vehicle ownership, vehicle emissions have gradually become the main source of air pollution in China's big cities. In the sources of particulate matters with a particulate diameter not more than 2.5 μm (referred to PM2.5) in atmospheric air of Beijing, the share ratio of vehicle exhaust emissions is as high as 22%. Moreover, particulates exhausted from vehicles mainly come from diesel vehicles. With the China's diesel vehicle emission control regulations become increasingly strict in recent years, the application of DPF will have a wide market prospect.

15 **[0003]** In diesel engines, the combustion of diesel fuel is realized by self-ignition of different air-fuel mixtures. If the combustion is incomplete, particulates are produced due to oxygen deficiency. The particulates mainly include carbon (carbon black), sulfates and incompletely combusted hydrocarbons. In order to filter out these particulates, a diesel particulate filter has been disclosed in the conventional technology.

20 **[0004]** When the diesel particulate filter is used, an exhaust backpressure normally rises due to a rising load of the filter. Since engine manufacturers do not allow the exhaust backpressure to exceed an allowable value and do not expect maintenance costs resulting from filter evacuation, passive or active regeneration of the filter is necessary.

25 **[0005]** In general, an active diesel particulate filter system includes an electrical regeneration system or a combustor support system, and the regeneration can be triggered manually, or the triggering of the regeneration can also be controlled in an open loop mode or a closed loop mode by monitoring the exhaust backpressure.

30 **[0006]** In the conventional technology, the combustor is normally designed to have an ejector with a small opening, so as to atomize fuel in a combustion chamber, and the fuel is mixed with the air required for combustion in the combustion chamber. A defect of such design is that carbon may be quickly deposited on the tiny atomizing opening of a nozzle due to combustion residues, which disturbs the operation of the combustor. For example, combustion residues may be formed when the combustor is closed.

35 **[0007]** In addition, the currently designed combustor has a relatively complicated structure, thus not only the manufacturing process is troublesome and costly, but also problems may easily arise during operation, as mentioned in Chinese Patent Application No. CN 201310019585.7. Furthermore, there're also some combustors which can only be regenerated when the vehicle is parked or in idle, while cannot be regenerated when the vehicle is accelerating or running at a high speed, as mentioned in Chinese Patent Application No. CN200780021783.1.

40 **[0008]** Therefore, a combustor or a low temperature heater is still required in this field, which can heat exhaust gas from the diesel engine to a regeneration temperature of the diesel particulate filter and can realize particulate filter regeneration when the vehicle is running at a high speed or even is accelerated.

SUMMARY

45 **[0009]** In order to achieve the above objects, a structure is provided according to the present application, which employs simple structures to achieve fuel oil combustion and exhaust gas heating. This structure utilizes the principle of eccentric air admission to allow the introduced fresh air to form a vortex in a combustion chamber, such that the fresh air can be fully mixed with fuel gas, to improve combustion efficiency. Then, flames produced by the combustion is directly introduced into a mixing chamber of a particulate filter to be fully mixed with the exhaust gas from an exhaust pipe, thereby increasing the exhaust gas temperature and realizing the regeneration of the particulate filter.

50 **[0010]** A low temperature heater for exhaust gas purification and treatment of a diesel engine is provided according to a first aspect of the present application. The low temperature heater includes: a tubular shell, having an inlet end and an outlet end, and the inlet end being in communication with an exhaust pipe of the diesel engine; an ignition portion arranged on a sidewall of the shell near the inlet end, and an oil inlet being arranged at a center of the ignition portion; an ignition cylinder connected to the ignition portion and in communication with the ignition portion, the ignition cylinder having an open end and a closed end, the closed end being near the inlet end of the tubular shell and the open end being near the outlet end of the tubular shell; and an air intake pipe which passes through the tubular shell and a sidewall of the ignition cylinder and enters the ignition cylinder. The intake pipe has a first air outlet and a second air outlet, the first air outlet is directly inside the ignition cylinder, the second air outlet is in communication with the ignition portion,

and the ignition portion is located between the first air outlet and the closed end. The low temperature heater according to the present application not only can perform real-time online regeneration on the particulate filter, that is the DPF, accumulated with soot, when the vehicle is parked or idling, but also can perform real-time online regeneration on the particulate filter, that is the DPF, accumulated with soot, when the vehicle is traveling at a high speed or is accelerating. Further, more importantly, compared with the conventional low temperature heater or combustor, the time required for the online regeneration of DPF of the low temperature heater is greatly reduced, and may even only be a half of the regeneration time of the conventional exhaust gas treatment system.

[0011] In the low temperature heater according to the first aspect, the first air outlet is inserted into the ignition cylinder in an eccentric manner.

[0012] In the low temperature heater according to the first aspect, a flow divider is further arranged between an outer wall of the ignition cylinder and the tubular shell, and an annular portion of the flow divider is cut equidistantly to form multiple rectangular or trapezoidal notches and outwardly curved fin-shaped portions.

[0013] In the low temperature heater according to the first aspect, the fin-shaped portions bend toward the outlet end of the tubular shell, and are at an angle of 10 to 90 degrees with respect to a plane on which the annular portion of the flow divider lies, and the angle is preferable to be 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30 degrees, 35 degrees, 40 degrees, 45 degrees, 50 degrees, 55 degrees, 60 degrees, 65 degrees, 70 degrees, 75 degrees, 80 degrees or 85 degrees.

[0014] In the low temperature heater according to the first aspect, in front of the flow divider, a tapered flow converging hood is arranged on an inner wall of the tubular shell, and the flow converging hood extends toward the outlet end and has a gradually decreasing diameter.

[0015] In the low temperature heater according to the first aspect, an angle formed between a sidewall of the flow converging hood and a sidewall of the tubular shell ranges from 10 degrees to 50 degrees, and is preferable to be 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30 degrees, 35 degrees, 40 degrees, 45 degrees or 50 degrees.

[0016] In the low temperature heater according to the first aspect, the low temperature heater is in communication with a housing for mounting a particulate filter, the housing includes the particulate filter located at a rear part and a mixing chamber located at a front part, the outlet end of the tubular shell is inserted into the mixing chamber; and the exhaust pipe of the diesel engine is inserted into the mixing chamber in an eccentric manner.

[0017] Compared with the conventional technology, the low temperature heater according to the present application can ignite stably and regenerate the blocked DPF evenly when the vehicle is accelerating or even travelling at a high speed, instead, in the conventional technology, stable ignition and regeneration of the rear-mounted DPF can only be realized when the vehicle is parked or idling. Without being restricted to any theories, the reason may be that flames produced in this manner are forcefully pushed into the exhaust gas, the flames are pushed more powerfully, thus cannot be blown out even when the exhaust gas speed is fast or getting faster, so that the stable ignition and regeneration can be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The present application will be described hereinafter with reference to the drawings. It should be understood that, the drawings are only examples used to explain and illustrate principles of the present application and are not intended to limit the present application to the specific solutions shown in the drawings. In the drawings:

Figure 1 is a sectional view showing a low temperature heater according to an embodiment of the present application; and

Figure 2 is a schematic view showing a gas flow path according to the low temperature heater in Figure 1;

DETAILED DESCRIPTION

[0019] The low temperature heater according to the present application will be described hereinafter in detail with reference to the drawings. However, it should be understood by those skilled in the art that, the embodiments hereinafter are only used to allow those skilled in the art to better understand the present application, and are not intended to limit the present application. The scope of the present application is defined by the claims.

[0020] A combustor according to an embodiment of the present application is shown in Figure 1, that is, the low temperature heater for increasing the exhaust gas temperature of the engine. The low temperature heater is installed at a tail end of the exhaust pipe of the engine of a vehicle (especially a diesel vehicle) to provide heat by combustion, thereby increasing the exhaust gas temperature of the engine and realize the regeneration of the particulate filter.

[0021] In the embodiment shown in Figure 1, the low temperature heater includes a tubular shell having an inlet end and an outlet end, and the inlet end being in communication with the exhaust pipe of the engine; an ignition portion

arranged on a sidewall of the shell near the inlet end, and an oil inlet being arranged at a center of the ignition portion; an ignition cylinder connected to the ignition portion and in communication with the ignition portion, the ignition cylinder having an open end near the inlet end of the tubular shell and a closed end near the outlet end of the tubular shell; and an air intake pipe which passes through the tubular shell and the sidewall of the ignition cylinder and enters into the ignition cylinder. The intake pipe has a first air outlet and a second air outlet, the first air outlet is directly within the ignition cylinder, the second air outlet is in communication with the ignition portion, and the ignition portion is located between the first air outlet and the closed end.

[0022] An ignition plug is mounted on the combustion chamber through a tubular mounting seat. The ignition plug is near the closed end of the combustion chamber and is configured to ignite a mixture of fuel oil and air in the combustion chamber. In an embodiment, the fuel oil is sprayed into the combustion chamber through a tube at the center of the ignition plug, and is ignited by the ignition plug. In other embodiments, the ignition plug may also be a conventional electronic ignition plug, such as an electronic ignition plug conventionally used in diesel engines. Of course, the ignition plug may also be a high temperature ceramic ignition rod, such as an ignition rod which is made of a silicon nitride rod body and a heating filament like a tungsten filament arranged in the rod body.

[0023] The ignition cylinder is of a tubular shape, including a closed end and an open end. The open end faces an exhausting direction of the diesel engine, and is configured to output a hot gas flow generated by combustion. The closed end is configured to rebound the generated hot gas flow toward the open end and prevent the generated hot gas flow from flowing toward an opposite direction of the exhaust direction, so as to improve heat efficiency. In an embodiment, the ignition cylinder is made of heat resistant metal such as stainless steel.

[0024] The first air outlet of the air intake pipe is inserted into the ignition cylinder in an eccentric manner. The eccentric manner refers to that a center line of the first air outlet is not aligned with a center line of the ignition cylinder, but deviates from the center line of the ignition cylinder by a certain distance, so that an exit of the first air outlet is not aligned with the center line of the ignition cylinder, but is directed toward a part of a sidewall of the ignition cylinder. In this way, when the fresh air enters into the ignition cylinder through the air intake pipe, the fresh air impacts the sidewall of the ignition cylinder first, and then flows along the sidewall to form a swirling air flow, thus the fresh air and the fuel oil (or the atomized fuel oil) entering from an oil inlet can be fully mixed inside the ignition cylinder, which facilitates combustion.

[0025] The second air outlet of the air intake pipe is in communication with the tubular mounting seat of the ignition plug, so as to feed a part of the fresh air into the ignition plug to mix with the fuel oil, and to provide the initial combustion mixture. Generally, the ratio of the amount (for example, by volume) of the fresh air entering from the first air outlet to the amount of the fresh air entering from the second air outlet is 9:1 to 1:1, the ratio can be 8:1, 7:1, 6:1, 5:1, 4:1, 3:1 or 2:1, or an arbitrary value therebetween. By changing the amounts of the fresh air entering from the first air outlet and the second air outlet, a fuel-air ratio in the combustion chamber can be flexibly changed, so as to realize different combustion conditions. For example, when the diesel engine is in a parked or idling condition, the ratio can be appropriately increased, for example, may be 8:1, because the amount of exhaust gas is relatively small at this time, the gas composition in the combustion chamber is small, and a relatively small amount of fresh air will be able to maintain complete combustion of fuel oil. In comparison, when the diesel engine is in an accelerating condition or is travelling at a high speed, the amount of exhaust gas is relatively large, resulting in a large gas composition in the combustion chamber, in this case, more fresh air is required to be delivered into the ignition plug, so as to realize the complete combustion of the fuel oil. In an embodiment, the ratio adjustment is realized by a baffle piece (not shown) arranged at the second air outlet in a partially fixed manner. In a case that the gas flow is relatively small, an opening of the baffle piece is relatively small, therefore only a small amount of air flows into the ignition plug; and in a case that the gas flow increases, the opening of the baffle piece increases, a relatively large amount of air flows into the ignition plug, so as to realize the adjustment of the air ratio between the first air outlet and the second air outlet.

[0026] A flow divider is further arranged between an outer wall of the ignition cylinder and the tubular shell, and an annular portion of the flow divider is cut equidistantly to form multiple rectangular or trapezoidal notches and outwardly curved fin-shaped portions. The fin-shaped portions bend toward the outlet end of the tubular shell, and are at a 10 to 90 degrees angle with respect to a plane in which the annular portion of the flow divider lies. In a preferable embodiment, the angle may be 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30 degrees, 35 degrees, 40 degrees, 45 degrees, 50 degrees, 55 degrees, 60 degrees, 65 degrees, 70 degrees, 75 degrees, 80 degrees, or 85 degrees. In a more preferable embodiment, the angle is 45 degrees.

[0027] Without restriction by any theory, the flow divider turns a direction of the linear gas flow from the engine into a swirling direction, so as to increase a contact area between the gas flow and the flames, to ensure that the gas is evenly heated and to decrease a situation that the gas flow directly impacts a flow converging hood and causes turbulences accordingly.

[0028] In an embodiment, in front of the flow divider, a tapered flow converging hood is arranged on an inner wall of the tubular shell, and the flow converging hood extends toward the outlet end and has a gradually decreasing diameter. An angle between a sidewall of the flow converging hood and the sidewall of the tubular shell ranges from 10 degrees to 50 degrees. In a preferable embodiment, the angle may be 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30

degrees, 35 degrees, 40 degrees, 45 degrees or 50 degrees. The flow converging hood converges the deflected gas flow generated by the flow divider to be close to the flames, so as to achieve a good heating effect.

[0029] In another embodiment, the exhaust gas from the engine enters into the low temperature ignition device through the gas intake pipe, and is discharged through the flow divider and the flow converging hood. The air from an air pump enters through the air intake pipe, passes by the igniter and the ignition cylinder, brings the burning flames at the igniter to the flow converging hood, so as to heat the gas coming from the engine, and to be mixed with the air from the air pump to form a high temperature gas to be discharged. By providing the flow divider and the flow converging hood, the hot gas flow generated by the combustion and the exhaust gas from the engine are mixed to form a swirling gas flow first, and then are converged slightly, so as to realize be fully mixed, which facilitates the even regeneration of the DPF, and can prevent the DPF from being broken due to uneven heating in the regeneration process, thus prolonging its service life. In addition, such even mixing also greatly improves the heat efficiency, reduces the fuel oil consumption during the regeneration process, and further realizes the effects of energy conservation and emission reduction.

[0030] In another embodiment, the low temperature heater is in communication with a housing for mounting the particulate filter. The housing includes the particulate filter located at a rear part and a mixing chamber located at a front part, the outlet end of the tubular shell is inserted into the mixing chamber; and the exhaust pipe of the diesel engine is inserted into the mixing chamber in an eccentric manner. In this way, the exhaust gas entering into the mixing chamber forms a swirling gas flow, which facilitates the fully mix between the exhaust gas and the hot gas flow generated by combustion, so that the even regeneration of the DPF is realized. In addition, an advantage of this arrangement is that the low temperature heater can form a curved cooperation rather than a straight cooperation with the exhaust pipe, which facilitates the flexible installation and improves the adaptability of the low temperature heater.

[0031] The low temperature heater according to the present application will be described with reference to the specific embodiments. It can be understood by those skilled in the art that, the embodiments are provided for the purpose of illustrating or demonstrating that the low temperature heater according to the present application can be used and have very good effects, and are not intended to limit the solutions of the present application to these specific embodiments.

FIRST EMBODIMENT: COMBUSTION OF LOW TEMPERATURE HEATER

UNDER AN IDLING CONDITION

[0032] The low temperature heater is arranged as shown in Figure 1, which will not be described herein. The low temperature heater is linearly installed with respect to the exhaust pipe of the engine. The engine is a diesel engine of Dongfeng Motor Corporation, with an engine displacement of 2.8 liters. The comparative example is a low temperature heater disclosed in a Chinese Patent Application No. 200780021783.1.

[0033] First, the engine is started, the low temperature heater is preheated and ignited according to a program under the conditions of idling, accelerating and travelling at a high speed, the ignition reliability of the flames under the idling condition is observed, that is, to observe whether the ignition is stable and whether a situation that the flames are blown out by the exhaust gas happens, and the results are recorded.

[0034] Next, an used particulate filter, that is a DPF (wherein a large amount of soot is accumulated, but the DPF is intact), is installed at the outlet end of the low temperature heater, and a regeneration experiment is carried out according to the program. During the experiment process, it is observed whether the combustion in the DPF is even, and multiple temperatures are recorded. It is detected whether there are cracks on the DPF after the experiment.

SECOND EMBODIMENT: COMBUSTION OF LOW TEMPERATURE HEATER UNDER HIGH SPEED AND ACCELERATING CONDITIONS

[0035] The low temperature heater is arranged as shown in Figure 1, which will not be described herein. The low temperature heater is linearly installed with respect to the exhaust pipe of the engine. The engine is a diesel engine of Dongfeng Motor Corporation, with an engine displacement of 2.8 liters. The comparative example is a low temperature heater disclosed in a Chinese Patent Application No. 200780021783.1.

[0036] First, the engine is started, the low temperature heater is preheated and ignited according to a program under the conditions of idling, accelerating and travelling at a high speed, the ignition reliability of the flames under the idling condition is observed, that is, to observe whether the ignition is stable and whether a situation that the flames are blown out by the exhaust gas happens, and the results are recorded.

[0037] Next, a used particulate filter, that is a DPF (wherein a large amount of soot is accumulated, but the DPF is intact), is installed at the outlet end of the low temperature heater, and a regeneration experiment is carried out according to the program. During the experiment process, it is observed whether the combustion in the DPF is even, and multiple temperatures are recorded. It is detected whether there are cracks on the DPF after the experiment.

[0038] Finally, the regenerated DPF is weighed, and a soot cleaning rate is calculated based on a weight of the DPF

before generation. The average value of multiple soot cleaning rates is calculated to indicate a degree of regeneration.
[0039] The results of the first embodiment and the second embodiment are shown in the following Table 1.

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Table 1: Results of the first embodiment and the second embodiment

Index	Present application				Comparative example			
	Times of ignition	Homogeneity of combustion	Crack	Average soot cleaning rate (%)	Times of ignition	Homogeneity of combustion	Crack	Average soot cleaning rate (%)
First Embodiment	5/5	homogeneous	none	92%	5/5	homogeneous	none	85%
Second Embodiment	5/5	homogeneous	none	89%	5/5	-	-	-

[0040] In the first embodiment and the second embodiment, the low temperature heaters according to the present application are both ignited stably, and can stably regenerate the DPF accumulated with soot, the soot cleaning rate reaches up to 90%, which indicates that the DPF has an excellent regeneration effect, and the situations of breakages or cracks of the DPF did not happen.

[0041] Compared with the present application, in the comparative example, the average soot cleaning rate is only 85% even under the idling condition. Moreover, under the conditions of accelerating and travelling at a high speed, a very small flame is observed, and the temperature at the inlet end of the DPF is very low, and is only about 300 °C, which cannot reach the DPF regeneration temperature at all, therefore the soot cleaning rate is almost zero, that is, the low temperature heater disclosed in the comparative example cannot regenerate the DPF under this condition.

[0042] According to the above experimental data, no matter under what conditions, including the conditions of idling, accelerating and travelling at a high speed, the low temperature heater according to the present application is superior to the low temperature heater in the comparative example in terms of the ignition reliability or ignition stability, the soot cleaning rate of the DPF, and the like.

Claims

1. A low temperature heater for exhaust gas purification and treatment of a diesel engine, comprising:

a tubular shell, having an inlet end and an outlet end, and the inlet end being in communication with an exhaust pipe of the diesel engine;
 an ignition portion arranged on a sidewall of the shell near the inlet end, and an oil inlet being arranged at a center of the ignition portion;
 an ignition cylinder connected to the ignition portion and in communication with the ignition portion, the ignition cylinder having an open end and a closed end, the closed end being near the inlet end of the tubular shell and the open end being near the outlet end of the tubular shell; and
 an air intake pipe which passes through the tubular shell and a sidewall of the ignition cylinder and enters the ignition cylinder;

wherein the intake pipe has a first air outlet and a second air outlet, the first air outlet is directly inside the ignition cylinder, the second air outlet is in communication with the ignition portion, and the ignition portion is located between the first air outlet and the closed end.

2. The low temperature heater according to claim 1, wherein the first air outlet is inserted into the ignition cylinder in an eccentric manner.

3. The low temperature heater according to claim 1 or 2, wherein a flow divider is further arranged between an outer wall of the ignition cylinder and the tubular shell, and an annular portion of the flow divider is cut equidistantly to form multiple rectangular or trapezoidal notches and outwardly curved fin-shaped portions.

4. The low temperature heater according to claim 3, wherein the fin-shaped portions bend toward the outlet end of the tubular shell, and are at an angle of 10 to 90 degrees with respect to a plane on which the annular portion of the flow divider lies.

5. The low temperature heater according to claim 4, wherein the angle is 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30 degrees, 35 degrees, 40 degrees, 45 degrees, 50 degrees, 55 degrees, 60 degrees, 65 degrees, 70 degrees, 75 degrees, 80 degrees or 85 degrees.

6. The low temperature heater according to any one of claims 1 to 3, in front of the flow divider, a tapered flow converging hood is arranged on an inner wall of the tubular shell, and the flow converging hood extends toward the outlet end and has a gradually decreasing diameter.

7. The low temperature heater according to claim 6, wherein an angle formed between a sidewall of the flow converging hood and a sidewall of the tubular shell ranges from 10 degrees to 50 degrees.

8. The low temperature heater according to claim 7, wherein the angle is 10 degrees, 15 degrees, 20 degrees, 25 degrees, 30 degrees, 35 degrees, 40 degrees, 45 degrees or 50 degrees.

9. The low temperature heater according to claim 1, wherein the low temperature heater is in communication with a housing for mounting a particulate filter, the housing comprises the particulate filter located at a rear part and a mixing chamber located at a front part, the outlet end of the tubular shell is inserted into the mixing chamber; and the exhaust pipe of the diesel engine is inserted into the mixing chamber in an eccentric manner.

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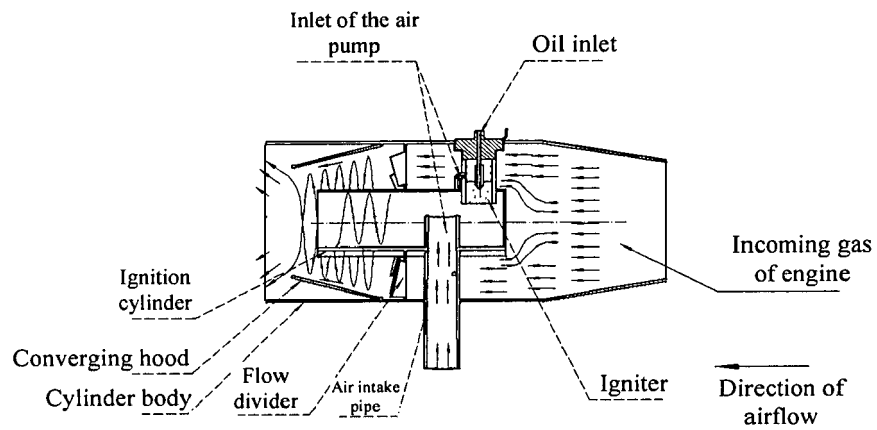


Figure 1

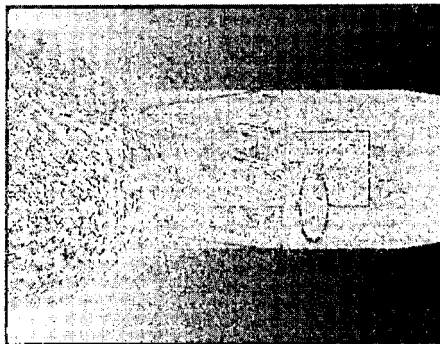


Figure 2



EUROPEAN SEARCH REPORT

Application Number
EP 18 18 7820

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EPO FORM 1503 03.82 (P04C01)

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	* figures 2-8 *		F01N3/029
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Y	* paragraphs [0001] - [0044], [0046] - [0226] *	3-9	F01N3/36
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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
Munich		19 December 2018	Buecker, Christian
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention	
X : particularly relevant if taken alone		E : earlier patent document, but published on, or after the filing date	
Y : particularly relevant if combined with another document of the same category		D : document cited in the application	
A : technological background		L : document cited for other reasons	
O : non-written disclosure		
P : intermediate document		& : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 18 7820

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201310019585 [0007]
- CN 200780021783 [0007] [0032] [0035]