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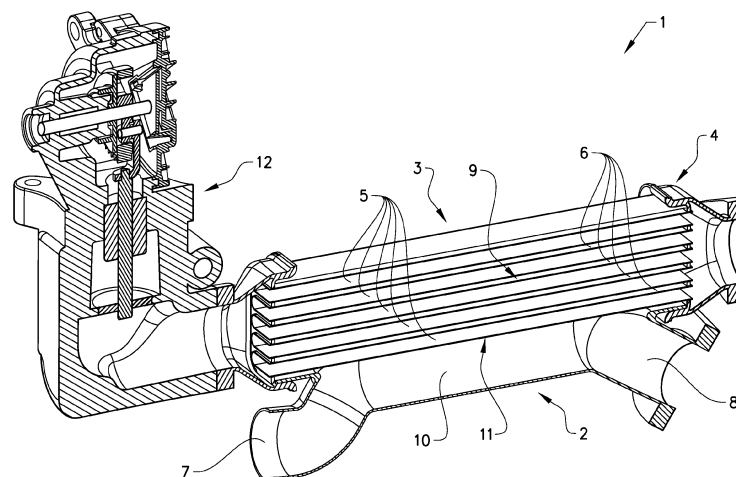
BA ME• **Moren, Mats****42361 Torslanda (SE)**• **Marandi, Sassan****42256 Hisings Backa (SE)**(71) Applicant: **Volvo Car Corporation****40 531 Göteborg (SE)**(74) Representative: **Kraenzmer, Martin et al****Volvo Car Corporation****Intellectual Property****Dept 50094 HBBVN****405 31 Göteborg (SE)**

(72) Inventors:

• **Sohrabi, Saeed****41713 Göteborg (SE)**(54) **An arrangement for cooling exhaust gases in an internal combustion engine**

(57) The invention relates to an arrangement (1) for cooling exhaust gases for exhaust gas recirculation (EGR) in an internal combustion engine. The arrangement (1) comprises a coolant fluid circuit (2) comprising a coolant radiator and a coolant fluid pump. The arrangement (1) further comprises an EGR heat exchanger (3) comprising a heat exchanger casing (4). At least one exhaust gas passage (5) for allowing exhaust gases to pass through the EGR heat exchanger (3) and at least one coolant fluid passage (6) for allowing coolant fluid to pass through the EGR heat exchanger (3) allows heat transfer to take place between the exhaust gases and

the coolant fluid. The EGR heat exchanger (3) comprises an inlet (7) and an outlet (8) connected to the coolant fluid circuit (2). The EGR heat exchanger (3) further comprises a heat exchange section (9) and a bypass section (10). The heat exchange section (9) comprises the at least one exhaust gas passage (5) and the at least one coolant fluid passage (6). The heat exchange section (9) and the bypass section (10) are in fluid connection with each other through at least one heat exchange opening (11). A predetermined flow of coolant fluid through the heat exchange section (9) is determined by the area of the at least one heat exchange opening (11).

**FIG. 1**

Description

Technical Field

[0001] The invention relates to an arrangement for cooling exhaust gases for exhaust gas recirculation (EGR) in an internal combustion engine. The arrangement comprises a coolant fluid circuit comprising a coolant radiator and a coolant fluid pump. The arrangement further comprises an EGR heat exchanger comprising a heat exchanger casing. At least one exhaust gas passage for allowing exhaust gases to pass through the EGR heat exchanger and at least one coolant fluid passage for allowing coolant fluid to pass through the EGR heat exchanger allows heat transfer to take place between the exhaust gases and the coolant fluid.

Background Art

[0002] In a modern internal combustion engine, more and more systems are added to save fuel or to meet new emission requirements. However, it is very difficult to find space for all new systems and additionally engine cost is increasing rapidly with increased complexity. One system that is essential for the reduction of emissions of pollutants is exhaust gas recirculation (EGR). Today, the exhaust gases are cooled in an EGR cooler which is provided with coolant fluid from the coolant fluid circuit of the engine. The coolant fluid is provided with tubes that extend from the coolant fluid circuit to the EGR cooler. This system takes up a lot of space in the engine room and requires tubing which adds both procurement costs and assembly costs.

[0003] There is obviously a need for an improved arrangement for cooling exhaust gases in an internal combustion.

Summary of Invention

[0004] The object of the present invention is to provide an attachment arrangement for a vehicle where the previously mentioned problem is avoided. This object is achieved by the features of the characterising portion of claim 1.

[0005] The invention relates to an arrangement for cooling exhaust gases for exhaust gas recirculation (EGR) in an internal combustion engine. The arrangement comprises a coolant fluid circuit comprising a coolant radiator and a coolant fluid pump. The arrangement further comprises an EGR heat exchanger comprising a heat exchanger casing. At least one exhaust gas passage for allowing exhaust gases to pass through the EGR heat exchanger and at least one coolant fluid passage for allowing coolant fluid to pass through the EGR heat exchanger enables heat transfer to take place between the exhaust gases and the coolant fluid. The EGR heat exchanger comprises an inlet and an outlet connected to the coolant fluid circuit. The EGR heat exchanger fur-

ther comprises a heat exchange section and a bypass section. The heat exchange section comprises the at least one exhaust gas passage and the at least one coolant fluid passage. The heat exchange section and the bypass section is in fluid connection with each other through at least one heat exchange opening, such that a predetermined flow of coolant fluid through the heat exchange section is determined by the area of the at least one heat exchange opening.

[0006] One advantage with an arrangement according to the invention is that the arrangement can be made smaller due to that the temperature in the EGR heat exchanger can be lower than in a conventional cooling arrangement where the coolant fluid is connected to the EGR heat exchanger via tubes from the coolant circuit. The fact that the EGR heat exchanger is directly connected to the coolant fluid circuit allows for a higher flow of coolant fluid through the EGR heat exchanger thereby allowing for a reduction in operating temperature of the EGR heat exchanger.

[0007] Another advantage is that the tubes normally supplying the EGR heat exchanger with coolant fluid are made unnecessary as the EGR heat exchanger and the coolant fluid circuit are in direct contact with each other. This leads to a reduction in assembly cost and procurement cost. Further, as both the EGR heat exchanger is smaller and the tubes are removed it is possible to save installation space for the EGR heat exchanger. This leads to that other equipment can be placed in the engine compartment or that the engine compartment can be made smaller while still maintaining the same functionality.

[0008] An arrangement according to the invention can be beneficial for both petrol and diesel engines. In a diesel engine the temperature of the gases out from the engine can be lowered due to an increased flow through the coolant circuit and by having a lower temperature of the fluid that enters the EGR heat exchanger. This leads to reduced NOx emissions and lower fuel consumption. In a petrol engine the coolant fluid can be heated by the exhaust gases during a cold start by using the heat in the exhaust gases, thereby reducing the time it takes to warm the engine to a proper operating temperature.

[0009] The heat exchange opening can be regulated to extend from between 0 % - 100 % of a bottom area of the EGR heat exchanger. The regulation can be made either automatically, i.e. by the vehicle's electronic control unit (ECU) or manually by the driver as a response to an indication that the flow of coolant fluid is not optimal. As the EGR heat exchanger is placed directly on the coolant fluid circuit a part of the coolant fluid circuit can be made to function as a bypass section where part of the coolant fluid can bypass the EGR heat exchanger without entering the EGR heat exchanger. The EGR heat exchanger can be made to fit on the coolant fluid circuit such that the heat exchange opening may be equipped with a valve that can be regulated such that the bottom area of the EGR heat exchanger can be opened towards the bypass section from between 0 % and 100 %. This

means that at 0 % opening no coolant fluid passes through the EGR heat exchanger and that at 100 % opening the entire coolant fluid flow passes through the EGR heat exchanger. In order to obtain a control of the flow of coolant fluid a control valve is installed in the front of or in the rear of the coolant radiator. The flow of coolant fluid through the EGR heat exchanger is controlled by the design of the heat exchanger.

[0010] The heat exchange opening may extend along the whole length of the EGR heat exchanger.

[0011] The bypass section may have a reduced cross section area over the length of the coolant fluid pipe where the coolant fluid pipe and the EGR cooler are connected. One advantage of having a reduced cross section area of the bypass section is that the flow velocity through the EGR heat exchanger thus can be increased. The cross section area of the bypass section can be chosen such that a desired maximum flow velocity can be achieved when heat exchange opening of the EGR heat exchanger is maximally open towards the bypass section.

[0012] The coolant fluid pump may be located upstream of inlet of the EGR heat exchanger or the coolant fluid pump may be located downstream of the outlet of the EGR heat exchanger. The placement of the coolant fluid pump is dependent on where there is room for the coolant fluid pump in the engine compartment. This means that the coolant fluid pump may be located either on the suction side of the coolant fluid circuit or on the pressure side of the coolant fluid circuit.

[0013] The EGR heat exchanger may be straight or the EGR heat exchanger may be U-shaped, bent or curved. Depending on the shape of the EGR heat exchanger the EGR heat exchanger can fit on different configurations of engines. Different shapes may also allow for a more flexible mounting position of the EGR heat exchanger depending on the amount of space available in the engine compartment.

[0014] The EGR heat exchanger casing may be made of plastic. The EGR heat exchanger casing may be made of any suitable material such as a metal, a metal alloy or plastic. One advantage with arrangement according to the invention is that the reduced temperature in the EGR heat exchanger due to the higher flow of coolant fluid allows the EGR heat exchanger casing to be made of plastic. This reduces both the weight and the cost of the EGR heat exchanger.

[0015] The at least one exhaust gas passage of the EGR cooler may be made of steel or aluminium. In order for the EGR heat exchanger to be able to withstand the temperatures of the EGR the at least one exhaust gas passage is preferably made of metal, for instance steel or aluminium. The passages can be enclosed in an EGR heat exchanger casing made as described above.

[0016] A vehicle may comprise an arrangement according to the invention.

Brief Description of Drawings

[0017]

5 Figure 1 schematically shows an isometric view of an arrangement for cooling exhaust gases in an internal combustion engine according to the invention.

10 Figure 2 schematically shows a cross section view of an arrangement for cooling exhaust gases in an internal combustion engine according to the invention.

Detailed Description of Drawings

15 **[0018]** Figure 1 schematically shows a cross section view of an arrangement 1 for cooling exhaust gases in an internal combustion engine according to the invention. The arrangement 1 comprises a coolant fluid circuit 2 comprising a coolant radiator (not shown) and a coolant fluid pump (not shown). The arrangement 1 further comprises an EGR heat exchanger 3 comprising a heat exchanger casing 4, five exhaust gas passages 5 for allowing exhaust gases to pass through the EGR heat exchanger 3 and four coolant fluid passages 6 for allowing coolant fluid to pass through the EGR heat exchanger 3. Heat transfer in the EGR heat exchanger 3 takes place between the exhaust gases and the coolant fluid resulting in that the exhaust gases passing through the exhaust gas passages 5 are cooled by the coolant fluid passing through coolant fluid passages 6. The EGR heat exchanger 3 comprises an inlet 7 and an outlet 8 connected to the coolant fluid circuit 2. The EGR heat exchanger 3 further comprises a heat exchange section 9 and a bypass section 10. The heat exchange section 9 comprises a number of exhaust gas passages 5 and a number of coolant fluid passages 6. The heat exchange section 9 and the bypass section 10 are in fluid connection with each other through one heat exchange opening 11, such that a predetermined flow of coolant fluid through the heat exchange section 9 is determined by the area of the heat exchange opening 11. The heat exchange opening 11 may be one complete opening or a number of separate openings depending on the design of the heat exchange section 9 and the bypass section 10.

20 25 30 35 40 45 **[0019]** The heat exchange section 9 is connected to an EGR circuit (not shown in figure 1) which circulates exhaust gases from the engine to the EGR heat exchanger 3. The exhaust gases passes through the EGR heat exchanger 3 through the exhaust gas passages 5 in the heat exchange section 9. The bypass section 10 is part of the coolant fluid circuit 2 and is arranged to be able to support the full flow of coolant fluid even if no coolant fluid passes through the coolant fluid passages 6 of the EGR heat exchanger 3.

50 55 **[0020]** The heat exchange section 9 of the EGR heat exchanger 3 shows five exhaust gas passages 5. The number of exhaust gas passages 5 is intended to show

one example only, the number may be varied depending on the desired flow of exhaust gases through the heat exchange section 9 and the desired cooling of the exhaust gases. Similarly, as the number of coolant fluid passages 6 depend on the number of exhaust gas passages 5 this is also only meant as an example.

[0021] The coolant fluid is arranged to enter the EGR heat exchanger 3 from the left side of the EGR heat exchanger 3 as seen in figure 1, while the exhaust gases are arranged to enter from the right of the EGR heat exchanger 3. Further, in figure 1 the EGR valve 12 is shown. The EGR valve 12 regulates the flow of EGR through the EGR circuit. The placement of the EGR valve 12 is merely illustrative. Entry of the coolant fluid and exhaust gases from the opposite sides is of course possible depending on the design of the arrangement 1. The coolant fluid and exhaust gases may also enter from the same side of the EGR heat exchanger 3, either the left or the right side.

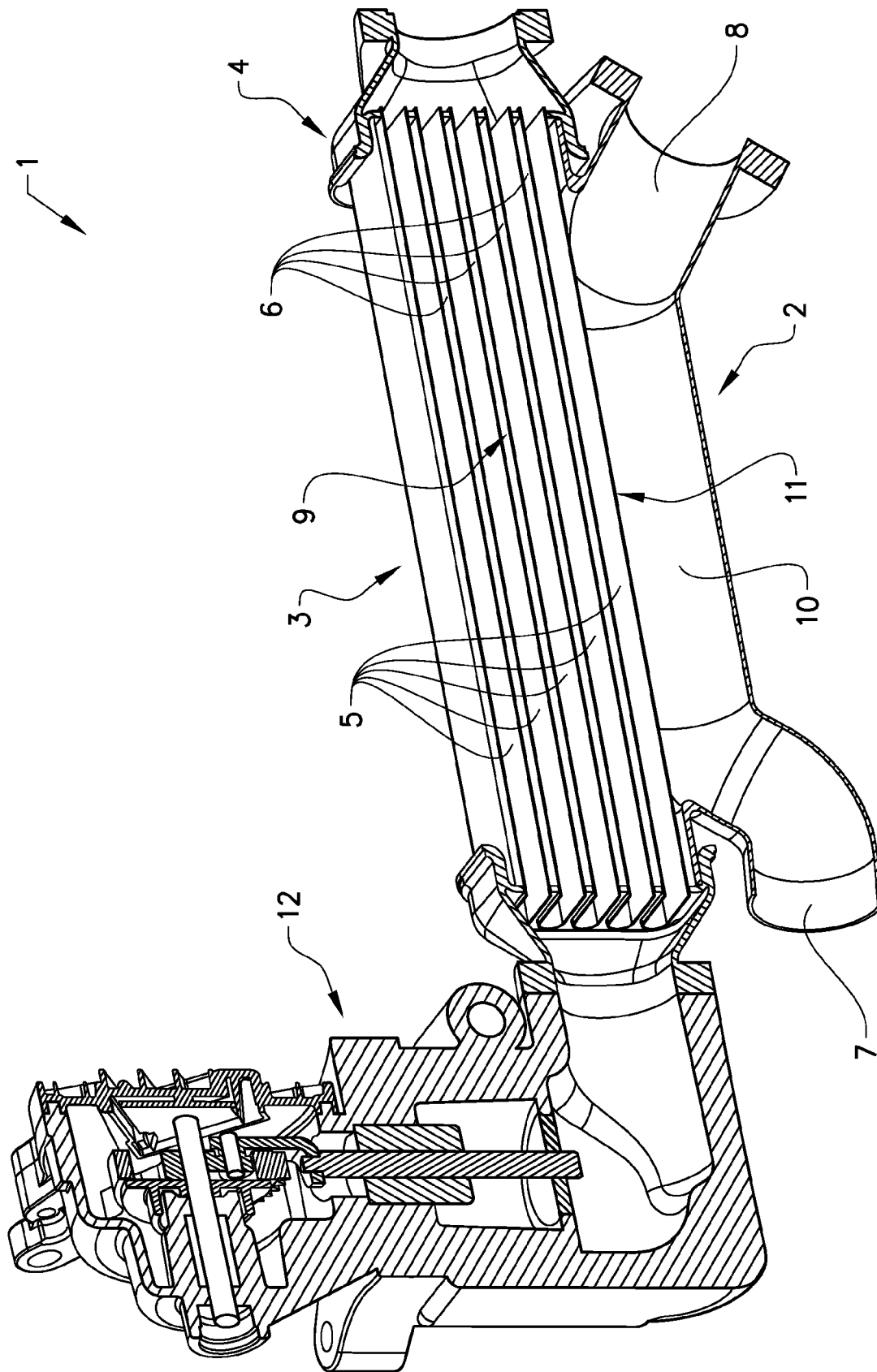
[0022] Figure 2 schematically shows an isometric view of an arrangement 1 for cooling exhaust gases in an internal combustion engine according to the invention. In figure 2 a more detailed layout of the arrangement 1 is shown. In figure 2 one possible layout of the arrangement 1 is shown. The coolant fluid circuit 2 and the EGR circuit 13 are shown in figure 2. In figure 2 the heat exchange section 9 and the bypass section 10 are also shown in order to clearer indicate the separate parts of the EGR heat exchanger 3.

[0023] Reference signs mentioned in the claims should not be seen as limiting the extent of the matter protected by the claims, and their sole function is to make claims easier to understand.

[0024] As will be realised, the invention is capable of modification in various obvious respects, all without departing from the scope of the appended claims. Accordingly, the drawings and the description thereto are to be regarded as illustrative in nature, and not restrictive. For instance the shape of the EGR heat exchanger can be made in various shapes to fit different engine designs, such as for instance U-shaped, bent or curved.

Claims

1. An arrangement (1) for cooling exhaust gases for exhaust gas recirculation (EGR) in an internal combustion engine, the arrangement (1) comprising a coolant fluid circuit (2) comprising a coolant radiator and a coolant fluid pump, the arrangement (1) further comprising an EGR heat exchanger (3) comprising a heat exchanger casing (4), at least one exhaust gas passage (5) for allowing exhaust gases to pass through the EGR heat exchanger (3) and at least one coolant fluid passage (6) for allowing coolant fluid to pass through the EGR heat exchanger (3) such that heat transfer takes place between the exhaust gases and the coolant fluid; **characterized in that** the EGR heat exchanger (3) comprises an inlet (7) and an outlet (8) connected to the coolant fluid circuit (2), the EGR heat exchanger (3) further comprising a heat exchange section (9) and a bypass section (10); the heat exchange section (9) comprising the at least one exhaust gas passage (5) and the at least one coolant fluid passage (6); the heat exchange section (9) and the bypass section (10) being in fluid connection with each other through at least one heat exchange opening (11), such that a predetermined flow of coolant fluid through the heat exchange section (9) is determined by the area of the at least one heat exchange opening (11).
2. An arrangement (1) according to claim 1, wherein the heat exchange opening (11) can be regulated to extend from between 0 % - 100 % of a bottom area of the EGR heat exchanger (3).
3. An arrangement (1) according to claim 1, wherein the heat exchange opening (11) extends along the whole length of the EGR heat exchanger (3).
4. An arrangement (1) according to claim 1 or 2, wherein the bypass section (10) has a reduced cross section area over the length of the coolant fluid pipe where the coolant fluid pipe and the EGR cooler are connected.
5. An arrangement (1) according to any one of the preceding claims, wherein the coolant fluid pump is located upstream of inlet (7) of the EGR heat exchanger (3).
6. An arrangement (1) according to any one of claims 1-4, wherein the coolant fluid pump is located downstream of the outlet (8) of the EGR heat exchanger (3).
7. An arrangement (1) according to any one of the preceding claims, wherein the EGR heat exchanger (3) is straight.
8. An arrangement (1) according to any one the claims 1-6, wherein the EGR heat exchanger (3) is U-shaped, bent or curved.
9. An arrangement (1) according to any one of the preceding claims, wherein the EGR heat exchanger (3) casing is made of plastic.
10. An arrangement (1) according to any one of the preceding claims, wherein the at least one exhaust gas passage (5) of the EGR cooler is made of metal, such as steel or aluminium.
11. A vehicle comprising an arrangement (1) according to any one of the preceding claims.



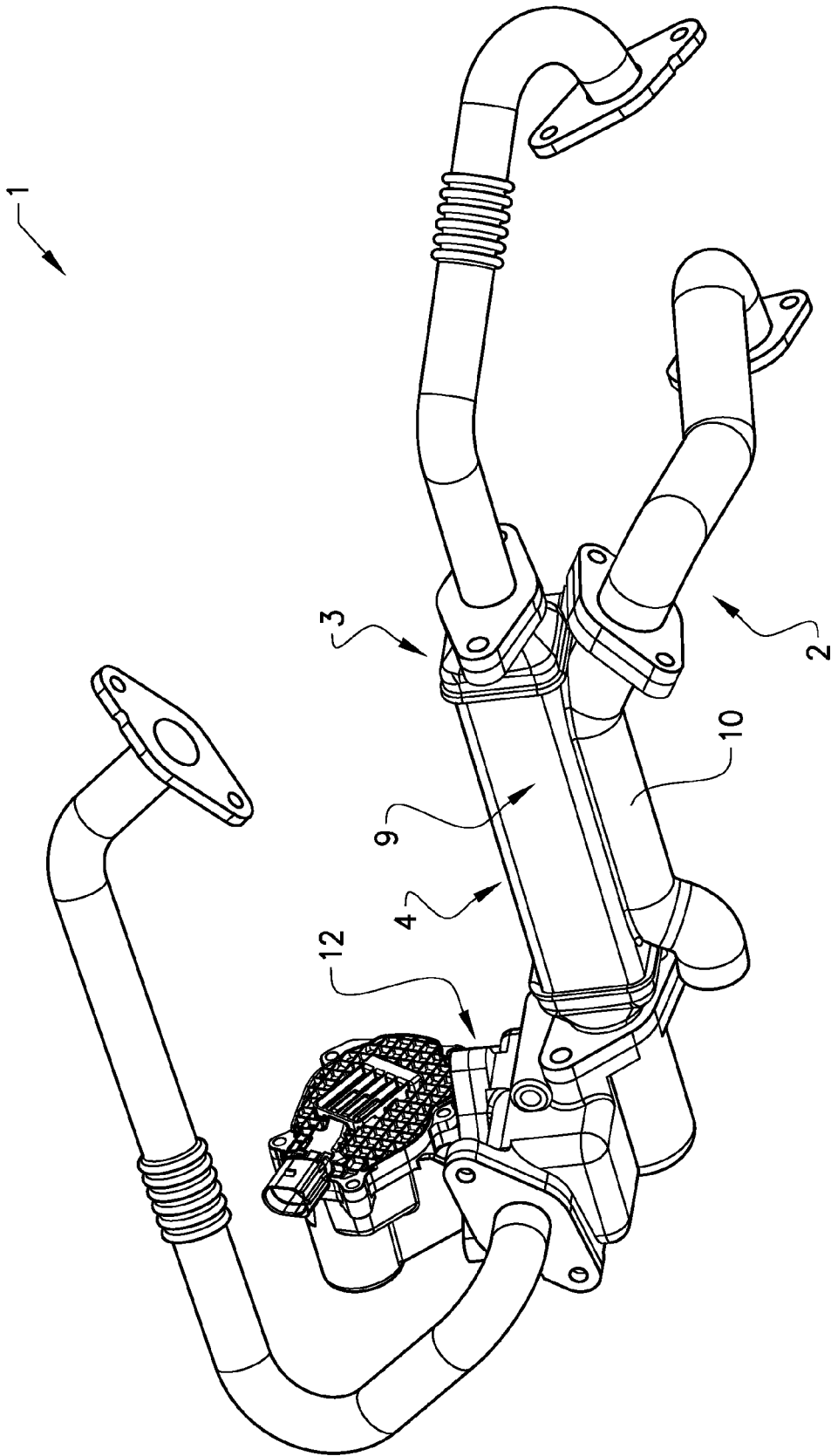


FIG. 2



EUROPEAN SEARCH REPORT

Application Number
EP 12 18 8094

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 548 267 A1 (HINO MOTORS LTD [JP]; SANKYO RADIATOR CO LTD [JP]) 29 June 2005 (2005-06-29) * abstract * * figures 6-12 * * paragraph [0028] - paragraph [0050] *	1-11	INV. F02M25/07 F28F27/02
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			TECHNICAL FIELDS SEARCHED (IPC)
			F02M F28F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 February 2013	Examiner Payr, Matthias
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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EPO FORM 1503 03.82 (F04C01)

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

EP 12 18 8094

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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15-02-2013

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