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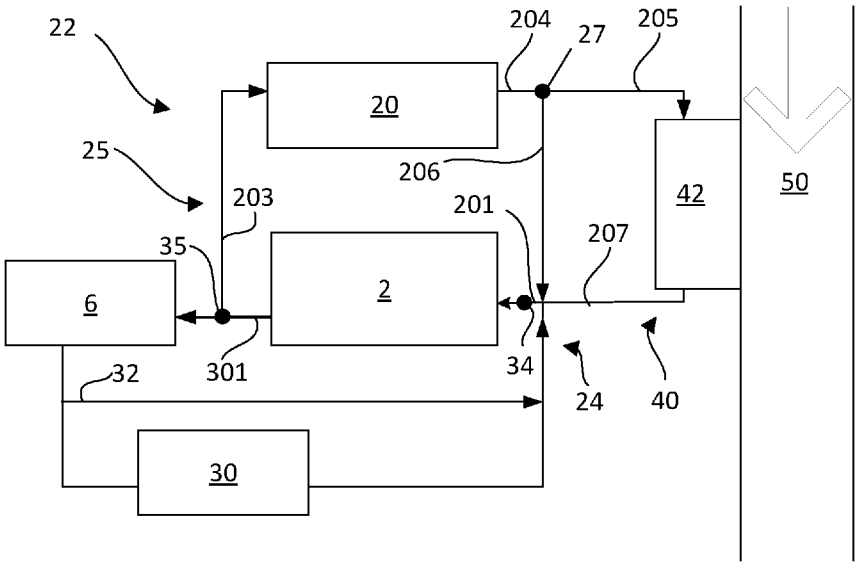


Fig. 3a

(57) Abstract: The present invention relates to a heating arrangement (40) for an internal combustion engine coolant, and to a cooling circuit (22), wherein the coolant is arranged to circulate in the cooling circuit (22) and cool the internal combustion engine (2) and heat a fluid in a fluid tank (20) located downstream of the internal combustion engine (2) in the cooling circuit (22). The heating arrangement (40) comprises a heat transfer unit (42) configured to be positioned downstream of the fluid tank (20) and upstream of the internal combustion engine (2), wherein the heat transfer unit (40) is arranged to be heated by an exhaust gas line (50) of the internal combustion engine (2) and comprises means (46) to transfer the heat from the exhaust t gases to the coolant. Also, a vehicle (1) comprising the heating arrangement or a cooling circuit (22) is claimed.

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Heating arrangement

TECHNICAL FIELD

The present disclosure relates to a heating arrangement for an internal combustion engine coolant arranged to circulate in a cooling circuit, a cooling circuit of a vehicle and a vehicle comprising the heating arrangement and/or the cooling circuit as defined in the appended claims.

BACKGROUND ART

Internal combustion engines, such as diesel engines, are provided with a cooling circuit which keeps the engine temperature below a pre-determined maximal temperature to protect the engine. Especially, cooling is needed to reduce the risk for damage in engine materials and e.g. lubricants. Modern vehicles are also often provided with an exhaust gas purification system to reduce emissions from the engines. Such exhaust gas purification systems may comprise one or several devices to reduce harmful discharges, which may include e.g. carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x) and particulate matter (PM). While it is important to cool the engine to prevent damages, it is at the same time important factor that the engine maintains sufficiently high temperature during the operation to keep the emission levels as low as possible.

Emission reduction technologies suitable for diesel vehicles may include exhaust gas recirculation (EGR), particulate filters, diesel oxidation catalysts (DOC) and selective catalytic reduction (SCR), which is used to reduce gaseous nitrogen oxide (NO_x) -emissions from internal combustion engines. The SCR-system comprises a dosing system or arrangement for dosing a diesel exhaust fluid and a catalyst with an SCR-substrate. The diesel exhaust fluid used is usually a urea-containing aqueous solution, also known as reducing agent or diesel exhaust fluid (DEF) according to standard AUS 32 of ISO 22241 or called by the tradename AdBlue. Injecting the diesel exhaust fluid and mixing it with the exhaust gases results in a chemical reaction whereby nitrogen gas and water are formed over the SCR-catalyst.

The diesel exhaust fluid is normally contained in a tank located in contact with the surrounding environment in a vehicle. Thus, in cold climates, there is a risk that the diesel exhaust fluid is subjected to temperatures below its freezing point of about -8°C and it freezes. To heat the diesel exhaust fluid, warming elements can be used as shown for example by WO2011087430. The warming elements may utilize coolant from an engine. However, when the coolant is returned back to the engine, it may have too low temperature causing higher emissions from the internal combustion engine. Thus, despite existing solutions to decrease emissions, further improvements are still needed.

SUMMARY OF THE INVENTION

As mentioned above, solutions for warming or heating diesel exhaust fluid exist, whereby the risk for operational disturbances in an SCR-system at low temperatures can be decreased. By heating and/or thawing the diesel exhaust fluid by means of the engine coolant, it can be ensured that the diesel exhaust fluid is in a liquid phase and that any "plugs" of frozen diesel exhaust fluid are thawed. In heating systems involving the use of the engine coolant, the warm coolant from the engine is used to heat a diesel exhaust fluid tank and then returned to the engine. When the coolant heats the diesel exhaust fluid tank, it may gain a temperature, which cools the internal combustion engine below a certain pre-determined temperature when returned to the engine. The pre-determined temperature may be a temperature, which is required for effective emission reduction. When the internal combustion engine has a temperature below the pre-determined temperature, it may lead to increased emission levels. Therefore, there is a need to retain the engine temperature at a level, which is still acceptable from the emission point of view.

The objective of the present invention is thus to provide means to retain the internal combustion engine temperature during the operation of the engine at a level which is acceptable from the emission point of view.

Another objective is to provide a simple and robust cooling circuit in which the temperature of the coolant can be controlled. It is a further objective to provide an energy saving heating arrangement.

The objectives above are attained by a heating arrangement for an internal combustion engine coolant as claimed in the appended claims. By means of the heating arrangement, it can be assured that the diesel exhaust fluid can be heated while the engine temperature can be kept at a desired level, i.e. that the temperature of the engine will not be too low.

According to another aspect, the objectives are attained by a cooling circuit according to the appended claims.

The present disclosure relates to a heating arrangement for an internal combustion engine coolant. A coolant is arranged to circulate in a cooling circuit and cool the engine and/or heat a fluid in a fluid tank in the vehicle. The heating arrangement is arranged upstream of the internal combustion engine in the cooling circuit. The heating arrangement comprises a heat transfer unit, which is arranged to be heated by exhaust gases exiting the internal combustion engine in an exhaust gas line. The heat transfer unit comprises a heat transferring body configured to transfer the heat from the exhaust gases to the coolant. By heating the coolant before it enters the internal combustion engine, the heat from the exhaust gases can be utilized and the temperature of the engine can be kept at a desired level in an energy efficient way. Also, a risk for increased emission levels due to low combustion temperature of the fuel can be decreased.

The heat transfer unit may comprise a channel for receiving a coolant line of the cooling circuit. In this way, efficient thermal transfer may be obtained. The channel may be surrounded by the heat transferring body, whereby a further improved heating of the coolant can be obtained.

The heat transferring body may comprise a heat conducting material. Alternatively, the heat transferring body may consist or be made of a heat conducting material. Thus, it is possible to adapt the construction of the heat transferring body to the vehicle in question.

The heat transfer unit may be connected to the exhaust gas line. In this way, a compact construction for the heating arrangement can be obtained. For example, the heat transfer unit can be connected to the exhaust gas line by connecting means comprising a flange of a heat conducting material and having a shape adapted to the exhaust gas line. Thus, a simple and robust construction can be obtained.

The fluid tank in the above-described heating arrangement may be any fluid tank in which the fluid to be used may freeze in cold climates. However, according to an embodiment, the fluid

tank is a diesel exhaust fluid tank. By the heating arrangement, the diesel exhaust fluid which may freeze at a temperature of about -8°C, can be efficiently thawed and heated.

The present disclosure also relates to a cooling circuit of a vehicle comprising an engine cooling circuit arranged to cool an internal combustion engine and a diesel exhaust fluid heating circuit arranged to heat a diesel exhaust fluid contained in a diesel exhaust fluid tank. The diesel exhaust fluid heating circuit is connected to the engine cooling circuit and the cooling circuit is arranged in thermal connection with the above-describe heating arrangement arranged upstream of the internal combustion engine.

According to an embodiment, the engine cooling circuit and the diesel exhaust fluid heating circuit may be directly connected, wherein the fluid tank is located downstream of the internal combustion engine and the heating arrangement is located downstream of the fluid tank and upstream of the internal combustion engine. Thus, a cooling circuit with a simple and robust structure can be provided.

According to another embodiment, the engine cooling circuit and the diesel exhaust fluid heating circuit are indirectly connected via a heat exchanger. The fluid tank is located downstream of the heat exchanger, which is arranged in thermal connection with the engine cooling circuit. By this arrangement risk for operational disturbances in the engine cooling circuit can be decreased, in case there are operational disturbances in the diesel exhaust fluid heating circuit.

The cooling circuit may comprise a heat transfer unit by-pass line, whereby the temperature of the coolant can be controlled in an efficient way.

The engine cooling circuit may comprise a temperature sensor arranged upstream of the internal combustion engine and configured to determine the temperature of the coolant. In this way, control of the coolant flow in the cooling circuit is facilitated.

The diesel exhaust fluid heating circuit may comprise a heating arrangement by-pass line. In this way, the temperature of the coolant can be kept below a desired temperature. The engine cooling circuit may comprise a temperature sensor upstream of the internal combustion engine, which is configured to determine the temperature of the coolant. Thus, the temperature of the

coolant entering the internal combustion engine may be monitored and the cooling circuit controller based on the temperature.

The by-pass line may be arranged in connection with a valve configured to direct the coolant through the by-pass line, when the temperature of the coolant upstream of the engine is higher than a pre-determined temperature, or through the heating arrangement, when the temperature of the coolant upstream of the engine is lower than a pre-determined temperature. Thus, a simple manner to control the flow can be obtained.

The engine cooling circuit may comprise a radiator configured to cool the coolant in the engine cooling circuit. Thus, if the temperature of the coolant entering the internal combustion engine is too high, it is possible to lower the temperature. However, the engine cooling circuit may comprise a radiator by-pass line, through which the coolant is arranged to pass when the temperature of the coolant is below a pre-determined temperature.

The present invention also relates to a vehicle comprising the heating arrangement or a cooling circuit as described above.

Further features and advantages of the present invention will be described in more detail in the detailed description below with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a schematic side view of a vehicle, which comprises a heating arrangement and a cooling circuit for an internal combustion engine coolant according to the present disclosure,

Fig. 2 shows an alternative vehicle, which is a bus,

Fig. 3a shows schematically a flow chart for a cooling circuit according to one embodiment of the invention,

Fig. 3b shows schematically a flow chart for a cooling circuit according to another embodiment of the invention,

Fig. 4 shows an example embodiment of a heat transfer unit of the invention.

DETAILED DESCRIPTION

Internal combustion engines are used in various types of applications and vehicles today, e.g. in heavy vehicles such as trucks or buses, in cars, motorboats, steamers, ferries or ships. They may also be used in industrial engines and/or engine-powered industrial robots, power plants, e.g. electric power plants provided with a diesel generator, and in locomotives. The internal combustion engines need to be cooled during the operation of the vehicle, and are therefore provided with a cooling system comprising a cooling circuit configured to cool the engine.

Due to emission regulations, exhaust gases from the internal combustion engines need to be purified. Therefore, vehicles are provided with an exhaust gas purification system, also referred to as an exhaust system, which may comprise several components. The exhaust gas system described in the present disclosure and in which the heating arrangement can be used, may comprise a selective catalytic reduction (SCR) purification system comprising a dosing system for adding a diesel exhaust fluid (DEF), also referred to as a reducing agent, to the exhaust gas flow in order to reduce NO_x contents of the exhaust gas flow. The diesel exhaust fluid may be for example a urea-containing solution, such as a mixture containing water and urea according to standard AUS 32 of ISO 22241 valid at the priority date of the present application, e.g. a product with the trade name AdBlue. Generally, the SCR purification system comprises a SCR-substrate, which may comprise vanadium, iron, or copper catalyst, which breaks NO_x down to water vapour and nitrogen. Further, an ammonia slip catalyst (ASC), which is designed to convert the NH_3 slip to N_2 and H_2O, may be arranged downstream of the SCR purification system.

Generally, diesel exhaust fluid dosing systems include a tank or a container for the diesel exhaust fluid, at least one filter and a pump to supply the diesel exhaust fluid to the vaporization chamber in the exhaust gas system of a vehicle. The diesel exhaust fluid may be for example injected to the vaporization chamber by means of an injection device.

Due to a limited space in vehicles, the tank containing the diesel exhaust fluid may be arranged in direct contact with ambient air, whereby there is a risk for freezing of the diesel exhaust fluid in cold climates, i.e. in climates where the temperature reaches temperatures

below a freezing temperature of the diesel exhaust fluid of about -8°C. If the diesel exhaust fluid freezes, there is an increased risk for operational disturbances in the exhaust gas system. To avoid operational disturbances caused by freezing of the diesel exhaust gas fluid, it may be heated. One way to provide heat is to utilize the engine coolant, which has a high temperature when leaving the combustion engine.

Heating arrangements utilizing engine coolant are advantageous since a quick and energy efficient process of warming or thawing of at least partly frozen diesel exhaust fluid can be obtained. In arrangements utilizing the engine coolant, a fluid tank containing the diesel exhaust fluid and which is in contact with ambient air, may be positioned in proximity of the internal combustion engine and the engine cooling circuit. The cooling circuit may comprise a diesel exhaust fluid circuit, in which the engine coolant is arranged to flow and heat the diesel engine fluid. The coolant may be arranged to be in thermal connection with a warming element which is heated by a hot coolant exiting the engine. The coolant may be for example be arranged to flow into a warming element, which is arranged to heat the diesel exhaust fluid in a tank. The at least one warming element may be contained in the tank or may be external to the tank. Alternatively, the cooling circuit may be arranged to be in thermal connection with the tank, by which is meant that the hot coolant circulating in the engine cooling circuit is arranged such that it can radiate heat to the diesel exhaust fluid tank.

However, internal combustion engines provided with a cooling circuit in which the engine coolant is used for heating or thawing of freezed diesel exhaust fluid, may suffer from a drawback that the coolant may have undesirably low temperature when entering the engine and therefore cool the engine down to a temperature in which emissions, such as NO_x emissions, are increased. Increase of emissions due to a low engine temperature and/or due to operational disturbances caused by frozen diesel exhaust fluid are highly undesirable. There is thus a need to reduce a risk for increased emissions from the internal combustion engines, and the objective of the present invention is to decrease a risk for increased emissions due to a low engine temperature and/or due to operational disturbances caused by frozen diesel exhaust fluid. According to the present invention, it is possible to reduce the risk by heating the coolant in an energy efficient way before it enters the engine.

Reference is made to Fig. 1, which depicts a vehicle 1. In the illustrated example the vehicle is a truck and is shown in a schematic partially cut side view. The vehicle 1 is provided with an internal combustion engine 2 that powers the vehicle's tractive wheels 4 via a gearbox 6 and a propeller shaft 8. The engine 2 is powered by fuel 14 supplied to it via a fuel system 16 comprising a fuel tank 18. The internal combustion engine 2 is provided with an exhaust gas system 10, which may be a part of a silencer 12, as illustrated in Fig. 1. The vehicle could alternatively be a bus 1' as shown in Fig. 2, a passenger car or a marine engine (not shown). Such vehicles may include substantially similar powertrain components and exhaust gas system as the truck 1 shown in Fig. 1, and therefore, details of the powertrain components and the exhaust gas system are only shown in connection with Fig. 1.

The exhaust gas system 10 includes a SCR purification system which comprises a diesel exhaust fluid tank 20, from which the diesel exhaust fluid is supplied to the SCR purification system via a diesel exhaust fluid dosing system. The diesel exhaust fluid dosing system may comprise a filter device and a pump (not shown), which is arranged to feed the diesel exhaust fluid further to a vaporization chamber and SCR-catalyst in the exhaust system 10.

The vehicle 1 comprises a cooling circuit 22 comprising an engine cooling circuit 24 arranged to cool the internal combustion engine 2, and a diesel exhaust fluid heating circuit 25 arranged to heat a diesel exhaust fluid arranged in the diesel exhaust fluid tank 20.

The engine cooling circuit and the diesel exhaust fluid heating circuit may be connected to each other either directly or indirectly. By directly connected is meant that the circuits are integrated such that the same coolant circulates in both circuits. An example of such cooling circuit is illustrated in Fig. 3a, and is explained more in detail below. By indirectly connected is meant that the diesel exhaust fluid heating circuit is arranged in thermal connection, via e.g. a heat exchanger, with the engine cooling circuit. This means that the engine coolant in the engine cooling circuit may heat the coolant circulating in the diesel exhaust fluid heating circuit. However, different coolants circulate in the respective diesel exhaust fluid heating and engine cooling circuits. The diesel exhaust fluid heating circuit and the engine cooling circuit can thus be two separate circuits as illustrated in the example of Fig. 3b.

When the diesel exhaust fluid heating circuit is directly connected and thus integrated to the engine cooling circuit, it is configured to receive coolant from the engine cooling circuit and

return the same coolant back to the engine cooling circuit. An example of an integrated cooling circuit 22 of this type is illustrated in Fig. 3a in more detail. As illustrated in Fig. 3a, at least part of the coolant is arranged to flow from the internal combustion engine 2 to the diesel exhaust fluid tank 20 downstream of the engine in the flow direction of the coolant. The coolant may enter a heating element 21 (see Fig. 1) arranged inside the tank 20 or an external heating element arranged outside the tank to heat the diesel exhaust fluid in the tank 20. Further, the coolant is arranged to circulate such that at least part of the coolant flows through a gearbox 6.

The diesel exhaust fluid heating circuit 25 comprises and/or is connected to a heating arrangement 40 arranged to heat the coolant downstream of the diesel exhaust fluid heating tank 20 and upstream of the internal combustion engine 2, i.e. before the coolant enters the engine 2. In this way, the coolant may be heated before it enters the internal combustion engine 2.

I Fig. 3a, the coolant is arranged to circulate in the cooling circuit 22 and is pressurized so that the coolant can circulate in both circuits by means of a coolant pump (not shown), which may be of any known type, such as a conventional water pump, and may be mechanically driven or electrically driven by an electrical motor. Generally, the coolant circuit 22 is a closed circuit, whereby no coolant needs to be added during the normal operation of the internal combustion engine.

In the cooling circuit 22 of Fig. 3a, the coolant enters the internal combustion engine 2 via an engine coolant inlet line 201, which may be provided with the pump. When the coolant has cooled the internal combustion engine 2, it is received in an engine outlet line 301. A first valve 35 may be arranged in the engine outlet line 301, and it may be configured to be operable such that it allows a part of the coolant to flow to a diesel exhaust fluid tank inlet line 203, when the diesel exhaust fluid in the tank 20 has a temperature below a pre-determined temperature and when the diesel exhaust fluid needs to be heated. The first valve 35 may be a thermostat or it may be an electrically controllable valve. If heating of the tank 20 is needed, the coolant is fed through a tank inlet line 203 to heat the tank 20. The tank inlet line 203 is arranged in thermal connection with the tank so that the coolant can heat the tank. When the coolant has heated the diesel exhaust fluid in the tank 20, it enters a diesel exhaust fluid tank outlet line 204. The

outlet line 204 comprises a second valve 27 arranged to feed the coolant either to the heating arrangement 40 comprising a heat transfer unit 42 with inlet and outlet lines, or to by-pass the heat transfer unit 42, if no heating is required. The engine cooling circuit 24 may comprise a temperature sensor 34 upstream of the internal combustion engine 2. The temperature sensor 34 is configured to determine the temperature of the coolant upstream of the internal combustion engine and may be connected to a control system (not shown) of the vehicle 1.

Thus, the heating arrangement 40 may comprise or be connected to the second valve 27 configured to lead the coolant flow from the tank 20 either to the heat transfer unit 42 or to by-pass the heat transfer unit 42 through a by-pass line 206 and thus directly flow to the internal combustion engine 2. The second valve 27 may be a self-regulating thermostatic valve, or it may be an electrically controllable valve. The second valve 27 is arranged to regulate the flow in the coolant heating circuit 25 and is based on the coolant temperature upstream of the internal combustion engine 2, which temperature is determined by means of the temperature sensor 34. Thus, if the temperature of the coolant is lower than a pre-determined coolant temperature, the coolant is arranged to flow through the heat transfer unit 42 via a heat transfer unit inlet line 205. The coolant is arranged to exit the heat transfer unit 42 via an exit line 207, which is arranged in fluid connection with the engine coolant inlet line 201. If the temperature of the coolant is higher than a pre-determined coolant temperature, the coolant is arranged to by-pass the heat transfer unit 42 via a by-pass line 206.

Reference is made to Fig. 3b, which differs from the embodiment of 3a in that the engine cooling circuit 2 and the diesel exhaust fluid heating circuit 25 are indirectly connected via a heat exchanger 43. In the cooling circuit 22 of Fig. 3b, the coolant enters the internal combustion engine 2 via an engine coolant inlet line 201, which may be provided with a coolant pump of the type as described above. When the coolant has cooled the internal combustion engine 2, it is received in an engine outlet line 301. A first valve 35 may be arranged in the engine outlet line 301, and it may be configured to be operable such that it allows a part of the coolant to flow to a heat exchanger inlet line 302, when the diesel exhaust fluid in the tank 20 has a temperature below a pre-determined temperature and when the diesel exhaust fluid needs to be heated. The first valve 35 may be a thermostat or it may be an electrically controllable valve. If heating of the tank 20 is needed, the coolant is fed through the heat exchanger inlet line 302 to the heat exchanger 43, which is arranged in connection with the diesel exhaust fluid heating circuit 25

arranged to heat the tank 20 via a tank inlet line 203. The tank inlet line 203 is arranged in thermal connection with the tank 20 so that the coolant can heat the tank. When the coolant in the diesel exhaust fluid heating circuit 25 has heated the diesel exhaust fluid in the tank 20 it enters a diesel exhaust fluid tank outlet line 204, circulating the coolant back to the heat exchanger 43. The diesel exhaust fluid heating circuit 25 may be provided with a pump to pressurize and circulate the coolant in the diesel exhaust fluid heating circuit 25.

In the engine cooling circuit 24, a heat exchanger outlet line 303 is arranged in connection with a second valve 27. The second valve 27 is connected to the heat exchanger outlet line 303 and is arranged to feed the coolant either to the heat transfer unit 42 or to by-pass the heat transfer unit 42 via a heat transfer unit by-pass line 206, if no heating is required. The engine cooling circuit 24 may comprise a temperature sensor 34 upstream of the internal combustion engine 2. The temperature sensor 34 is configured to determine the temperature of the coolant upstream of the internal combustion engine and may be connected to a control system (not shown) of the vehicle 1.

Thus, the heating arrangement 40 may comprise or be connected to the second valve 27 configured to lead the coolant flow from the heat exchanger 43 either to the heat transfer unit 42 or to by-pass the heat transfer unit 42 through a by-pass line 206 and thus directly flow to the internal combustion engine 2. The second valve 27 may be a self-regulating thermostatic valve, or it may be an electrically controllable valve. The second valve 27 is arranged to regulate the flow in the coolant heating circuit 25 and is based on the coolant temperature upstream of the internal combustion engine 2, which temperature is determined by means of the temperature sensor 34. Thus, if the temperature of the coolant is lower than a pre-determined coolant temperature, the coolant is arranged to flow through the heat transfer unit 42. If the temperature of the coolant is higher than a pre-determined coolant temperature, the coolant is arranged to by-pass the heat transfer unit 42 via a by-pass line 206.

Returning to the engine cooling circuit 25 in connection with both embodiments shown in Figs. 3a and 3b, the first valve 35 regulates also the flow such that at least part of the flow is directed to the gear box 6. In case no heating of the fluid in the tank 20 is required, all coolant can be directed to flow through the gear box 6. Downstream of the gear box 6, a radiator 30 is located, in which the coolant loses heat to the atmosphere, and thus the temperature of the coolant is

lowered. A further valve, which is not shown in the drawings, may be arranged to control the flow of the coolant in the engine cooling circuit downstream of the gearbox 6 and upstream of the radiator 30. The valve may be a self-regulating thermostatic valve, or it may be an electrically controllable valve controlled based on the determined temperature of the coolant. For example, when the temperature of the coolant in the engine cooling circuit 24 is higher than a pre-determined coolant temperature, the coolant may be arranged to flow through a radiator 30 and on the other hand, when the temperature of the coolant is below the pre-determined temperature, the coolant may be arranged to by-pass the radiator via a by-pass line 32.

According to the present disclosure the cooling circuit 22 comprises or is connected to a heating arrangement 40 comprising a heat transfer unit 42 downstream of the fluid tank, which in this case is a diesel exhaust fluid tank 20, and upstream of the internal combustion engine 2. The heat transfer unit 42 is arranged to be heated by exhaust gases from the internal combustion engine flowing in an exhaust gas line 50. The exhaust gases result from the combustion of fuel and flowing in the exhaust gas line 50 may have a temperature of over 300°C. The heat transfer unit 42 is arranged or configured to transfer the heat from the exhaust gases to the coolant upstream of the internal combustion engine 2, and may be constructed in many different ways. By using the heat transfer unit 42, the coolant can be heated to a desired temperature before the coolant enters the internal combustion engine 2, and thus the engine temperature can be kept at a desired level. Therefore, the risk for increased emission levels resulting from a low engine temperature is decreased.

Reference is made to Fig. 4, in which an example construction for the heat transfer unit 42 is illustrated. The heat transfer unit comprises means in the form of a heat transferring body 46 configured to transfer the heat from the exhaust gases to the coolant and a channel 48 for receiving a coolant line 28 of the cooling circuit 22. The channel 48 may be surrounded by the heat transferring body 46, whereby maximal heat transfer can be obtained. The heat transferring body 46 may be made of, or at least comprise, a heat conducting material, and it may be a solid element including cavities for attachment means, such as screws or the like. The heat transfer unit 42 may be connected to the exhaust gas line 50 by any suitable means as long as the heat from the exhaust gases may be thermally transferred to the heat transferring body 46, and thus to the coolant passing through the heat transferring body 46. In the illustrated example, the heat transfer unit 42 is connected to the exhaust gas line 50 by connecting means

44 comprising a flange of heat a conducting material and having a shape adapted to the exhaust gas line 50. Thus, a simple and compact construction for the heat transfer unit may be obtained. However, any other type of connecting means could be used.

The foregoing description of the present invention is provided for illustrative and descriptive purposes. It is not intended to be exhaustive or to restrict the invention to the variants described, but instead the invention is to be limited by the scope of the appended claims. Many modifications and variations will obviously be apparent to one skilled in the art. The embodiments have been chosen and described in order best to explain the principles of the invention and its practical applications and hence make it possible for a skilled person to understand the invention for various embodiments and with the various modifications appropriate to the intended use.

CLAIMS

1. Heating arrangement (40) for an internal combustion engine coolant in a vehicle (1), wherein the coolant is arranged to circulate in a cooling circuit (22) and cool the internal combustion engine (2) and heat a fluid in a fluid tank (20) in the vehicle (1), **characterized in** that the heating arrangement (40) is arranged upstream of the internal combustion engine (2) in the cooling circuit and wherein the heating arrangement comprises a heat transfer unit (42), which is arranged to be heated by exhaust gases exiting the internal combustion engine (2) in an exhaust gas line (50) and which heat transfer unit (42) comprises a heat transferring body (46) configured to transfer the heat from the exhaust gases to the coolant.

2. Heating arrangement according to any one of claims 1, **characterized in** that the heat transfer unit comprises a channel (48) for receiving a coolant line (28) of the cooling circuit (22).

3. Heating arrangement according to claim 2, **characterized in** that the channel (48) is surrounded by the heat transferring body (46).

4. Heating arrangement according to any of claims 1 to 3, **characterized in** that the heat transferring body (46) comprises a heat conducting material.

5. Heating arrangement according to any one of the preceding clams, **characterized in** that the heat transfer unit (42) is connected to the exhaust gas line (50) by means of connecting means (44).

6. Heating arrangement according to claim 5, **characterized in** that the connecting means (44) comprises a flange of a heat conducting material and has a shape adapted to the exhaust gas line (50).

7. Heating arrangement according to any one of the preceding clams, **characterized in** that the fluid tank is a diesel exhaust fluid tank (20).

8. A cooling circuit (22) of a vehicle (1; 1') comprising an engine cooling circuit (24) arranged to cool an internal combustion engine (2) and a diesel exhaust fluid heating circuit (25) arranged to heat a diesel exhaust fluid contained in a diesel exhaust fluid tank (20), **characterized in** that the diesel exhaust fluid heating circuit (25) is connected to the engine cooling circuit (24) and wherein the engine cooling circuit (24) is arranged in thermal connection with the heating arrangement (40) of any one of claims 1 to 7 upstream of the internal combustion engine (2).

9. The cooling circuit (22) of claim 8, **characterized in** that the engine cooling circuit (24) and the diesel exhaust fluid heating circuit (25) are directly connected, and wherein the fluid tank (20) is located downstream of the internal combustion engine (2) and the heating arrangement (40) is located downstream of the fluid tank (20) and upstream of the internal combustion engine (2).

10. The cooling circuit (22) of claim 8, **characterized in** that the engine cooling circuit (24) and the diesel exhaust fluid heating circuit (25) are indirectly connected via a heat exchanger (43), and wherein the fluid tank (20) is located downstream of the heat exchanger (43) arranged in thermal connection with the engine cooling circuit (24).

11. The cooling circuit of any of claims 8-10, **characterized in** that the cooling circuit (22) comprises a heat transfer unit (42) by-pass line (206).

12. The cooling circuit of any of claims 8-11, **characterized in** that the engine cooling circuit (24) comprises a temperature sensor (34) upstream of the internal combustion engine (2) configured to determine the temperature of the coolant.

13. The cooling circuit of claim 12, **characterized in** that the by-pass line (206) is arranged in connection with a valve (27) configured to direct the coolant through the by-pass line (206), when the temperature of the coolant upstream of the engine (2) is higher than a pre-determined temperature, or through the heat transfer unit (42), when the temperature of the coolant upstream of the engine is lower than a pre-determined temperature.

14. The cooling circuit according to any one of claims 8 to 13, **characterized in** that the engine cooling circuit (24) comprises a radiator (30) configured to cool the coolant in the engine cooling circuit (24).

15. The cooling circuit according to claim 14, **characterized in** that the engine cooling circuit (24) comprises a radiator by-pass line (32), through which the coolant is arranged to pass when the temperature of the coolant is below a pre-determined temperature.

16. Vehicle (1) comprising the heating arrangement of any one of claims 1 to 7 or a cooling circuit (22) of any one of claims 8-15.

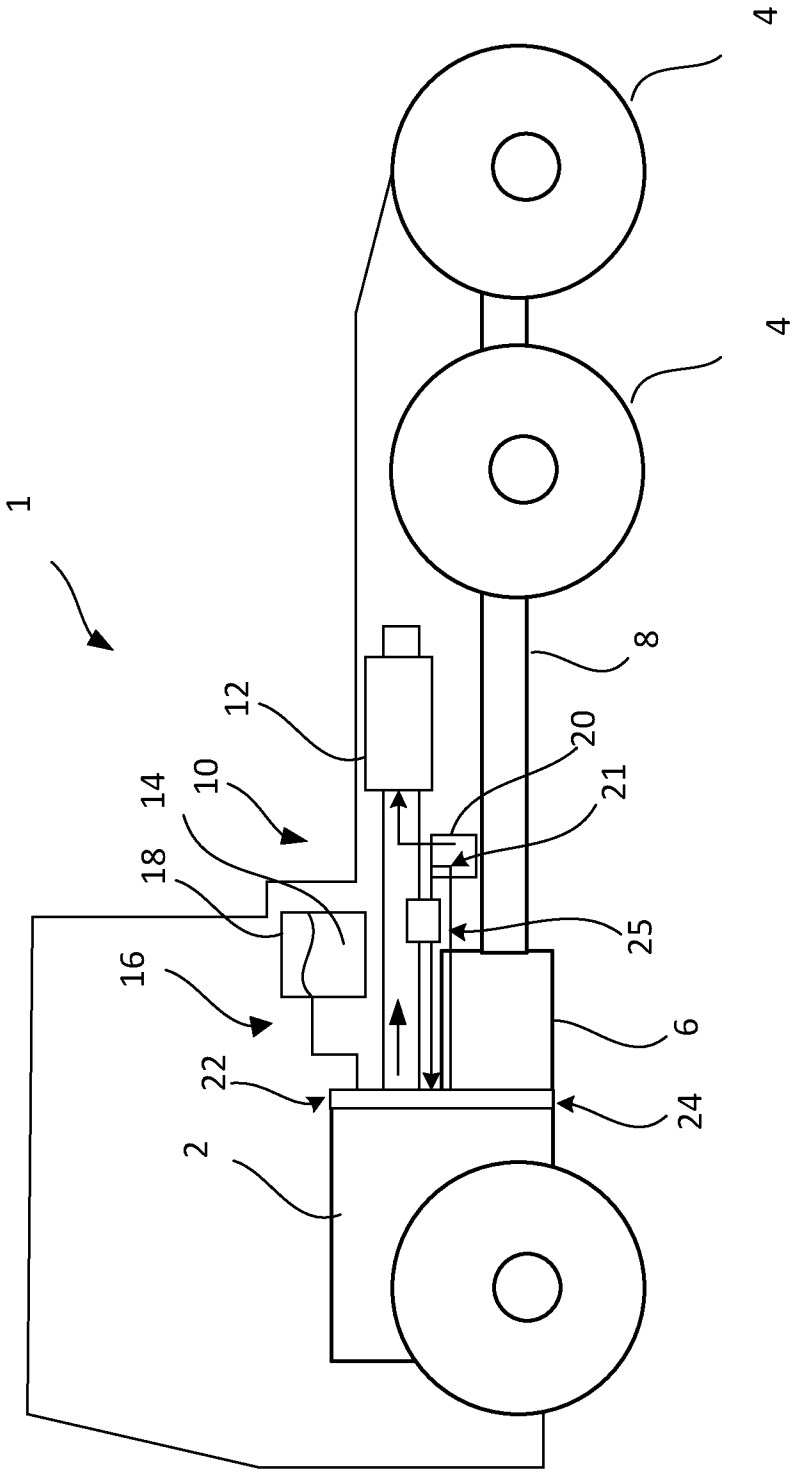


Fig. 1

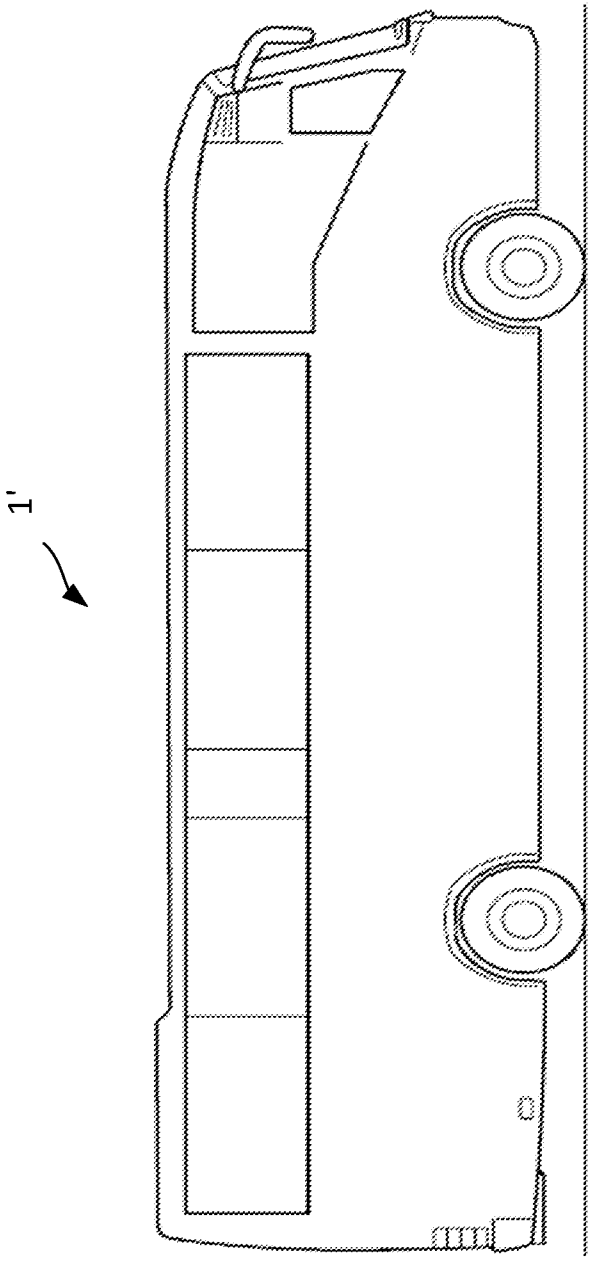


Fig. 2

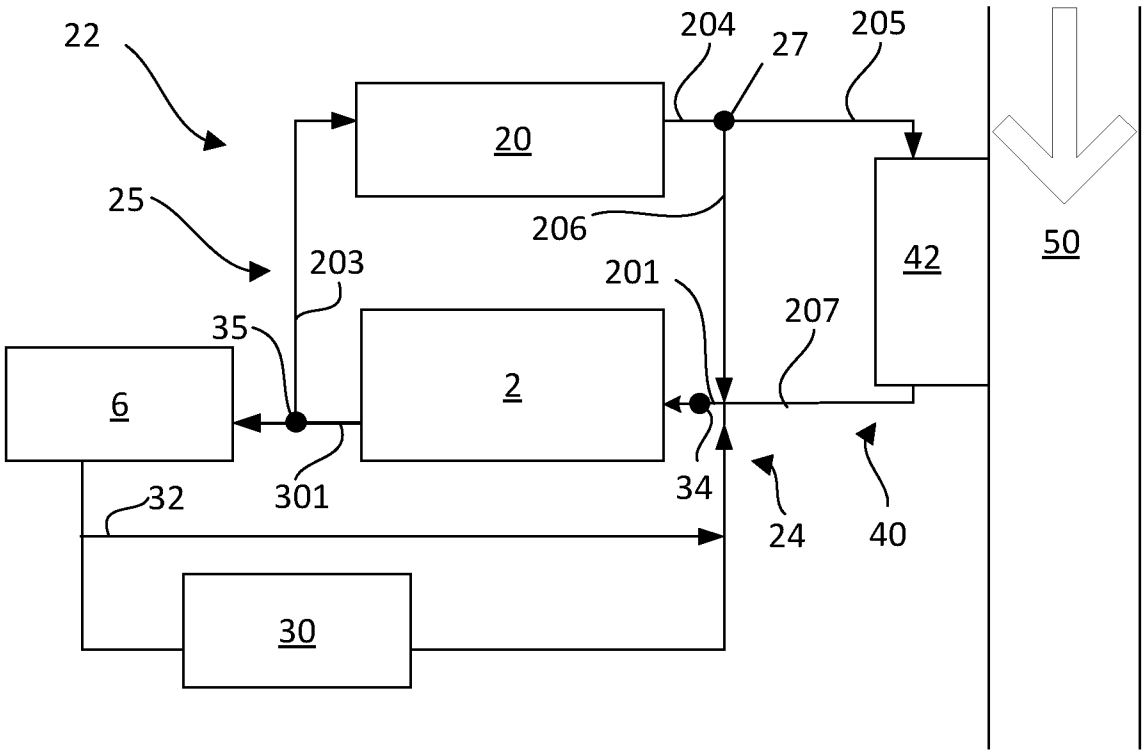

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Fig. 3a

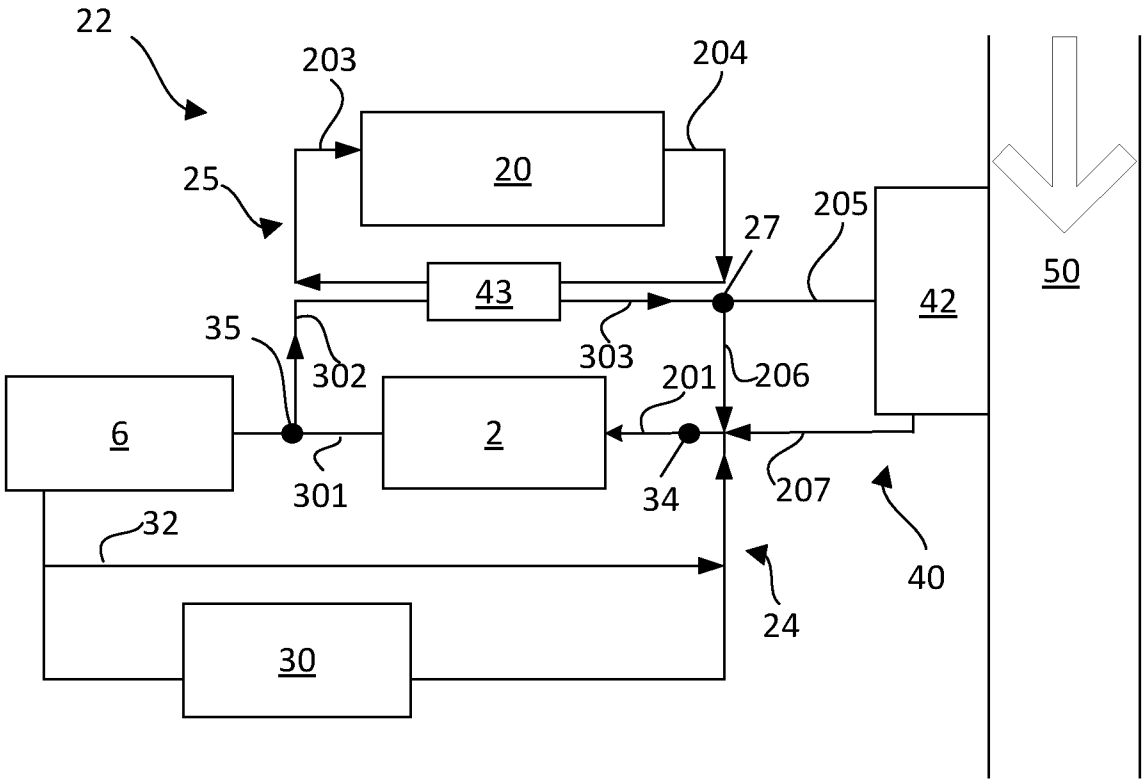

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Fig. 3b

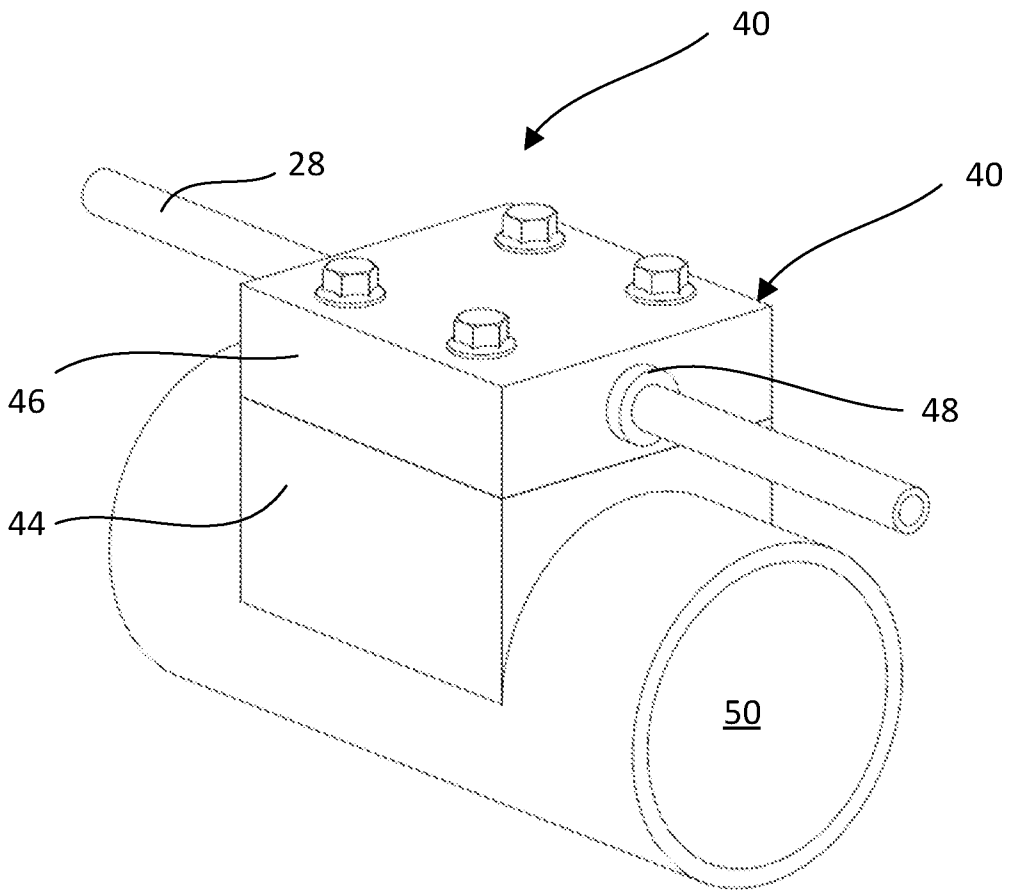


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/050992

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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)

IPC: F01N, F01P, F02G

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

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, 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	JP 2014101865 A (SUMITOMO CONSTR MACHINERY MFG), 5 June 2014 (2014-06-05); paragraphs [0019]-[0025], [0029]; figure 4; See attached translation --	1-8, 10-16
X	US 20130269321 A (WATANABE MASANORI [JP]; MIYAMOTO TAKESHI [JP]; KUROGI FUMIYASU [JP]; BOSCH CORP [JP]), 17 October 2013 (2013-10-17); paragraphs [0061]-[0079]; figure 1 --	1-8, 10-16
A	US 20120085080 A1 (KHADIYA NAVIN), 12 April 2012 (2012-04-12); paragraphs [0012]-[0013]; figure 2 --	1-16

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17-12-2019	17-12-2019

Name and mailing address of the ISA/SE	Authorized officer
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013245652 A (ISUZU MOTORS LTD), 9 December 2013 (2013-12-09); paragraphs [0062]-[0063]; See attached translation --	1-16
A	EP 2065578 A1 (INT ENGINE INTELLECTUAL PROP), 3 June 2009 (2009-06-03); paragraphs [0030]-[0033]; figures 2-3 --	1-16
A	EP 1602805 A1 (MAN NUTZFAHRZEUGE AG [DE]), 7 December 2005 (2005-12-07); abstract; figure 2 --	1-16
A	CN 107131038 A (MA HONGBIN), 5 September 2017 (2017-09-05); abstract; figures 3-6; See attached translation -- --------	1-16

International application No.
PCT/SE2019/050992

Continuation of: second sheet

International Patent Classification (IPC)

F02G 5/02 (2006.01)
F01N 5/02 (2006.01)
F01P 3/20 (2006.01)

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CN	107131038	A	05/09/2017	NONE			