(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 September 2017 (21.09.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/160214 A1

(51) International Patent Classification:
F01N 3/20 (2006.01) *F01N 13/08* (2010.01)
F01N 5/02 (2006.01)

(21) International Application Number:
PCT/SE2017/050249

(22) International Filing Date:
15 March 2017 (15.03.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1650345-0 15 March 2016 (15.03.2016) SE

(71) Applicant: **SCANIA CV AB** [SE/SE]; 151 87 Södertälje (SE).

(72) Inventors: **LINDERYD, Johan**; Rosenstigen 16, 144 62 Rönninge (SE). **USSNER, Matthias**; Stångarö 60, 151 52 Södertälje (SE). **ELIASSEN, Torbjörn**; Bretorp gård, 155 93 Nykvarn (SE). **TIMREN, Thomas**; Östersjövägen 15, 619 91 Trosa (SE).

(74) Agent: **WALLIN, Ulf**; Scania CV AB, 151 87 Södertälje (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: A CONTROL SYSTEM AND A METHOD FOR CONTROLLING THE EXHAUST GAS FLOW IN AN EXHAUST LINE OF A COMBUSTION ENGINE

(57) Abstract: The present invention relates a control system and a method for controlling the exhaust flow in an exhaust line (3) of a combustion engine (2) comprising at least one exhaust treatment component (5) and an evaporator (7) of a WHR system. The control system comprises a valve arrangement (8, 9, 34-36) in the exhaust line control unit (10), a temperature sensor configured to sense a temperature related to the temperature of the exhaust treatment component (5) and a control unit (10) configured to position the valve arrangement (8, 9) in a first position when the exhaust treatment component has a lower temperature than a specific temperature in which position the exhaust gases are directed to the exhaust treatment component (5) before they are directed to the evaporator (7) and in a second position when the exhaust treatment component has a higher temperature than said specific temperature in which position the exhaust gases are directed to enter the evaporator (7) before they are directed to the exhaust treatment component (5).

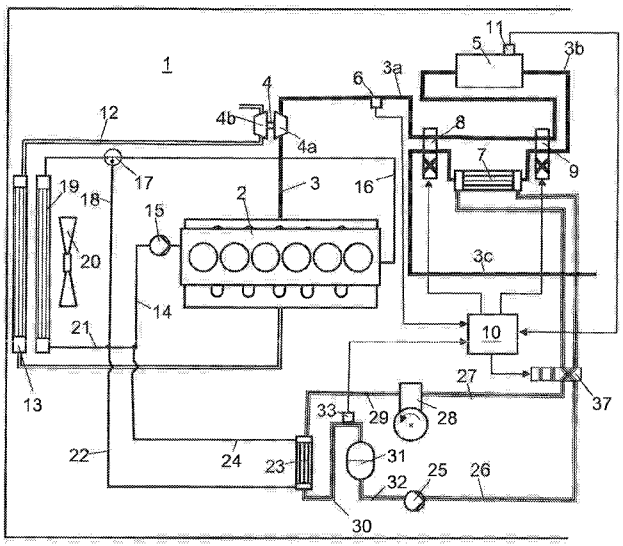


Fig 1

WO 2017/160214 A1

A control system and a method for controlling the exhaust gas flow in an exhaust line of a combustion engine

BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention relates to a control system and a method for controlling the exhaust gas flow in an exhaust line of a combustion engine according to the preamble of claim 1.

Exhaust lines of internal combustion engines such as diesel engines may comprise a plurality of exhaust treatment components such as, for example, a SCR catalyst (Selective Catalytic Reduction). In order to clean the exhaust gases from nitrogen oxides, a urea solution is sprayed into the exhaust line in a position upstream of the SCR catalyst. The urea solution is vaporized by the hot exhaust gases so that ammonia is formed. The ammonia and nitrogen oxides in the exhaust gases react with each other in the SCR catalyst so that nitrogen gas and water vapor are formed. The efficiency of a SCR catalyst depends on its temperature. The ability of the SCR catalyst to reduce nitrogen oxides is optimal within a temperature range which may be about 300-450°C. At lower and higher exhaust gas temperatures the capacity of the SCR catalyst to reduce nitrogen oxides is reduced.

WHR system (Waste Heat Recovery System) can be used for recovering waste thermal energy and convert it to mechanical energy or electric energy. A WHR system includes a pump which pressurizes and circulates a working medium in a closed circuit. The circuit comprises an evaporator where the working medium is heated and evaporated by a heat source such as, for example, exhaust gases. The pressurized and heated gaseous working medium expands in an expander. The expander generates mechanical energy which can be used to support the engine and/or apparatuses in a vehicle. Alternatively, the expander is connected to a generator generating electric energy. The working medium leaving the expander is directed to a condenser. The working medium is cooled down in the condenser to a temperature at which it condenses. The fuel consumption of a combustion engine can be reduced by means of a WHR-system.

The exhaust gases are cooled down in an evaporator of a WHR system. In view of this fact, the evaporator is arranged in a downstream position of the exhaust treatment components. In this position, the existence of the evaporator does not influence on the operation of the exhaust treatment components. However, in case when the combustion engine is high loaded during a longer period of time, there is a risk that the exhaust gases heat the exhaust treatment components to a too high temperature. In this cases, the exhaust treatment components do not provide an optimal treatment of the exhaust gases and might be permanently damaged.

SUMMARY OF THE INVENTION

The object of the present invention is to control the exhaust gas flow in an exhaust line comprising at least one exhaust treatment component and an evaporator of a WHR system in a manner such that the exhaust treatment component provides a substantially optimal treatment of the exhaust gases also during operating conditions when the exhaust gases have a high temperature.

The above mentioned object is achieved by the control system according to the characterizing part of claim 1. During operating conditions when an exhaust treatment component has a lower temperature than a specific temperature, the control unit initiates a movement of a valve arrangement to a first position in which it directs the exhaust gases to the exhaust treatment component before the exhaust gas flow is directed to the evaporator. The specific temperature may be an upper temperature of a temperature range at which the exhaust treatment component provides a substantially optimal treatment of the exhaust gases. The specific temperature may be a constant temperature or a temperature varying with other operating parameters. When the valve arrangement is in the first position, the relatively hot exhaust gases may increase or maintain the temperature the exhaust treatment component before they are cooled down in the evaporator. During operating conditions when the exhaust treatment component has a higher temperature than the specific temperature, the control unit initiates a movement of the valve arrangement to a second position in which the exhaust gases are directed to the evaporator before they are directed to the exhaust treatment component. In this case, the exhaust gases are cooled down in the evaporator before they enter the exhaust treatment component. In this case, the exhaust gases entering the exhaust treatment component mostly have a lower temperature than the

exhaust treatment component. As a consequence, the exhaust gases cool down the exhaust treatment component. As soon as the exhaust treatment component has been cooled to a temperature below the specific temperature, the control systems initiates a movement of the valve arrangement back to the first position. The control system makes it possible to avoid heating of the exhaust treatment component to a too high temperature. As a consequence, it is possible to maintain a substantially optimal treatment of the exhaust gases even when the exhaust gases have a very high temperature. Furthermore, the exhaust gases may receive a lower temperature when they have passed through the exhaust treatment component. As a consequence, the working medium in the evaporator may be heated to a higher temperature when the valve arrangement is in the second position which increases the efficiency of the WHR system.

According to an embodiment of the invention, the valve arrangement comprises a valve member which alternatively directs exhaust gases from an upstream exhaust line section to the exhaust treatment component or to the evaporator. By means of such a valve member, it is easy to alternatively direct the exhaust gas flow initially to the exhaust treatment component or the evaporator. The exhaust line may comprise at least one intermediate exhaust line directing exhaust gases between the exhaust treatment component and the evaporator and a valve member configured to control the exhaust gas flow through the intermediate exhaust line. When the valve arrangement is in the first position, such an intermediate exhaust line directs the exhaust gases from the exhaust treatment component to the evaporator. When the valve arrangement is in the second position, such an intermediate exhaust line directs the exhaust gases from the evaporator to the exhaust treatment component. The exhaust gas flow through the intermediate exhaust line may be controlled by a valve member. Furthermore, the valve arrangement may comprise a valve member which alternatively directs the exhaust gases from the exhaust treatment component or the evaporator to a downstream exhaust line section. By means of such a valve member, it is easy to alternatively direct the exhaust gas flow from the exhaust treatment component or the evaporator to a downstream located part of the exhaust line. The valve member may be of arbitrary kind. The valve member may, for example, be a butterfly valve.

According to an embodiment of the invention, the valve arrangement comprises a valve member which, in said first position, is configured to direct exhaust gases from an upstream exhaust line section to the exhaust treatment component and from the

evaporator to a downstream exhaust line section. Such a valve member may, in said second position, be configured to direct exhaust gases from the upstream exhaust line section to the evaporator and from the exhaust treatment component to the downstream exhaust line section. Such a valve member has several tasks. Thus, a valve arrangement including such a valve member may include few further valve members.

According to an embodiment of the invention, the valve arrangement may comprise a valve member which, in said first position, is configured to direct exhaust gases from an upstream exhaust line section to the exhaust treatment component and from the exhaust treatment component to the evaporator. Such a valve member may, in said second position, be configured to direct exhaust gases from the evaporator to the exhaust treatment component and from the exhaust treatment component to a downstream exhaust line section. Such a valve member also has several tasks. As a consequence, a valve arrangement including this valves member may include few further valve members.

According to an embodiment of the invention, the control system comprises a temperature sensor configured to sense the temperature of the exhaust gases in an upstream exhaust line section. In this case, the control unit receives information about the temperature of the exhaust gases which are led towards the exhaust treatment component and the evaporator. In view of this information, it is possible to adjust said specific temperature. Alternatively or in combination, the control system may comprise a sensor configured to sense the pressure or the temperature of the working medium in the WHR system. In order to provide an efficient operation of the WHR system, it is, for example, important to control the cooling of the working medium in a condenser of the WHR system. The cooling demand of the working medium is related to the absorption of heat in the evaporator.

According to an embodiment of the invention, the exhaust treatment component is a SCR catalyst. The ability of a SCR catalyst to reduce nitrogen oxides decreases above a temperature of about 450°C. Thus, it is suitable to use the control system for controlling the temperature of a SCR catalyst. Alternatively or in combination, the exhaust treatment component may include an oxidation catalytic converter DOC, a particulate filter DPF, or an ammonia slip catalytic converter ASC.

According to an embodiment of the invention, the valve arrangement comprises a valve member or valve part configured to change flow direction of the working medium in the evaporator. In certain cases, the exhaust gas flow may be directed through the evaporator in an opposite directions when the valve arrangement is in the first position or in the second position. In this case, it is also favorable to change the direction of the working medium flow through the evaporator in order to favor the heat transfer in the evaporator. This valve member may be a part of a valve member controlling the exhaust gas flow.

The above mentioned object is also achieved by the method defined in claim 14.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following preferred embodiments of the invention are described, as examples, with reference to the attached drawings, in which:

Fig. 1 shows a control system with a valve arrangement according to a first embodiment of the invention where the valve arrangement is in a first position,

Fig. 2 shows the valve arrangement in Fig. 1 in a second position.

Fig. 3 shows an alternative embodiment of the valve arrangement in a first position,

Fig. 4 shows the valve arrangement in Fig. 3 in a second position,

Fig. 5 shows a further alternative embodiment of the valve arrangement in a first position,

Fig. 6 shows the valve arrangement in Fig. 5 in a second position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Fig. 1 shows a schematically disclosed vehicle 1 powered by a supercharged combustion engine 2. The combustion engine 2 may be a diesel engine. The vehicle 1 may be a heavy vehicle. The vehicle 1comprises an exhaust line 3 receiving exhaust gases from the combustion engine 2. The exhaust line 3 comprises a turbine 4 of a turbo aggregate. The exhaust gases in the exhaust line 3 receive a reduced pressure and a reduced temperature when they expand through the turbine 4a of a turbo charger 4. A

number of schematically disclosed exhaust treatment components 5 are arranged in the exhaust line 3 in a position downstream of the turbine 4a. The exhaust treatment components 5 may, for example, include one or several of the following exhaust treatment components namely an oxidation catalytic converter DOC, a particulate filter DPF, a SCR catalytic converter and an ammonia slip catalytic converter ASC. The efficiency of each exhaust treatment component 5 depends on its temperature. An efficient operating temperature of such exhaust treatment components are usually above 200°C. The ability of the SCR catalyst 6 to reduce nitrogen oxides may be optimal within the temperature range 300-450°C. At higher and lower temperatures the capacity of the SCR catalyst to reduce nitrogen oxides is reduced.

A temperature sensor 6 senses the temperature of the exhaust gases in an exhaust line section 3a located upstream of the exhaust treatment components 5 and an evaporator 7 of a WHR system. The upstream exhaust line section 3a comprises a first valve member 8 and a second valve 9. A control unit 10 controls the first valve member 8 and a second valve 9. A temperature sensor 11 senses the temperature of the at least one of the exhaust treatment components 5. The exhaust line 3 has an intermediate exhaust line 3b arranged between the exhaust treatment component 5 and the evaporator 7. An exhaust line section 3c is located downstream of the exhaust treatment component 5 and the evaporator 7. The turbine 4a drives a compressor 4b of the turbo charger 4. The compressor 4b compresses air which is led, via a charged air line 12 to the combustion engine 2. The charged air line 12 comprises a charge air cooler 13 arranged at a front portion of the vehicle 1.

The combustion engine 2 is cooled by a cooling system with a circulating coolant. The cooling system comprises an engine inlet line 14 provided with a coolant pump 15 circulating the coolant in the cooling system. An engine outlet line 16 receives the coolant leaving the combustion engine 2. A thermostat 17 is arranged at an end of the engine outlet line 16. In case the coolant has a lower temperature than the regulating temperature of the thermostat 17, the coolant is directed back to the coolant pump 15 via a bypass line 18. In case the coolant has a higher temperature than the regulating temperature of the thermostat 17, the coolant is directed to a radiator 19 arranged at a front portion of the vehicle 1 in a position behind the charge air cooler 13. The radiator fan 20 and ram air provide a cooling air flow through the charge air cooler 13 and the radiator 19. The coolant that has circulated through the radiator 19, it is directed, via a radiator outlet line 21, back to the engine inlet line 14 and the coolant pump 15. The

cooling system comprises a loop. The loop comprises a coolant inlet line 22 receiving coolant from the bypass line 18 or the radiator outlet line 21 depending on the position of the thermostat 17. The inlet line 22 leads coolant to a condenser 23. The loop comprises an outlet line 24 leading the coolant from the condenser 23 to the engine inlet line 14 and the coolant pump 15.

The vehicle is provided with a WHR-system (Waste Heat Recovery system). The WHR system comprises a pump 25 which pressurizes and circulates a working medium. The working medium may be ethanol, R245fa or other kind of working medium. The pump 25 pressurizes and circulates the working medium, via an evaporator inlet line 26, to the evaporator 7. The working medium is heated in the evaporator 7 by exhaust gases to a temperature at which it evaporates. The working medium is directed from the evaporator 7, via an expander inlet line 27, to an expander 28. A third valve member 37 is arranged in contact with the evaporator inlet line 26 and the evaporator outlet line 27. The third valve member 37 is settable in a first position in which it directs the working medium in one direction through the evaporator 7 and in a second position in which it directs the working medium in an opposite direction through the evaporator 7. The pressurized and heated working medium expands in the expander 28. The expander 28 generates a rotary motion which may be transmitted, via a suitable mechanical transmission, to a shaft of the drive train of the vehicle 1. Alternatively, the expander 28 may be connected to a generator transforming mechanical energy into electrical energy. The electrical energy may be stored in e.g. a battery. After the working medium has passed through the expander 28, it is directed, via an expander outlet line 29 to the condenser 23. The working medium is cooled in the condenser 23 by the coolant in the loop 22, 24 of the cooling system. The working medium is directed from the condenser 23, via a condenser outlet line 30, to a receiver 31. Working medium sucks, via an inlet line 32 from the receiver 31, to the pump 25.

During operation of the combustion engine 2, the control unit 10 receives substantially continuously information from the sensor 11 about the temperature of the exhaust treatment component 5. The control unit 6 may also receive information from the sensor 6 about the exhaust gas temperature in the upstream exhaust line section 3a and information from the sensor 33 about the temperature or the pressure of the working medium in the WHR system. The control unit 10 verifies if the temperature of the exhaust treatment component 5 is higher than a specific temperature. The specific

temperature may be an upper temperature of a temperature range at which the exhaust treatment component 5 provides a substantially optimal treatment of the exhaust gases. The specific temperature may be a constant temperature or a temperature varying with other operating parameters such as the temperature of the exhaust gases in the upstream exhaust line section 3a or the temperature /pressure of the working medium in the WHR system.

During operating conditions when the exhaust treatment component 5 has a lower temperature than a predetermined operating temperature, the control unit 10 initiate a movement of the first valve member 8, the second valve member 9 and the third valve member 37 to a first position which is shown in Fig. 1. In this case, the first valve member 8 and the second valve member 9 direct the exhaust gases from the upstream exhaust line section 3a to the treatment component 5. In this case, the exhaust gases may heat the treatment component 5. The exhaust gases leave the exhaust treatment component 5 and enter the intermediate exhaust line 3b. The second valve member 9 directs the exhaust gases from the intermediate exhaust line 3b of the exhaust line 3 to the evaporator 7. The exhaust gases heat the working medium in the evaporator 7 which flows in an opposite direction through the evaporator 7. The exhaust gases leaving the evaporator 7 are directed to the downstream exhaust line section 3c by the first valve member 8. Consequently, the first valve member 8 and the second valve member 9 direct the exhaust gases to the exhaust treatment component 5 before they are directed to the evaporator 7 when they are in the first position.

During operating conditions when the treatment component 5 have a higher temperature than the predetermined operating temperature, the control unit 10 initiates a movement of the first valve member 8 and the second valve member to a second position which is seen in Fig. 2. In this case, the first valve member 8 and the second valve member 9 direct the exhaust gases from the upstream exhaust line section 3a to the evaporator 7. The exhaust gases are cooled down in the evaporator 7 by the working medium which also in this case flows in an opposite direction through the evaporator 7. The exhaust gases leaving the evaporator 7 are directed to the exhaust treatment component 5 by the second valve member 9. In this case, the exhaust gases have a lower temperature than the temperature of the exhaust treatment component 5. Consequently, the exhaust gases cool the exhaust treatment component 5. The exhaust gases leaving the exhaust treatment component 5 are directed to the downstream exhaust line section 3c by means of the second valve member 9 and the first valve

member 8. The first valve member 8 and the second valve member 9 direct the exhaust gases to the evaporator 7 before they are directed to the exhaust treatment component 5. In this case, it is possible to cool the exhaust treatment component 5 to a lower temperature at which they are able to provide a substantially optimal treatment of the exhaust gases. Furthermore, the exhaust gases entering the evaporator 7 may have a higher temperature which improves the efficiency of the WHR system.

Figs 3 and 4 shows an alternative embodiment of the valve arrangement. The embodiment corresponds to the embodiment show in Figs. 1 and 2 except the existence of an additional valve portion 9a of the second valve member 9. When the valve members 8, 9 are in the first position in the embodiment in Fig. 1, the exhaust gases flow and the working medium in the WHR system are directed in the same direction through the evaporator 7. In this case, the evaporator 7 works as a parallel flow heat exchanger. When the valve members 8, 9 are in the second position in the embodiment in Fig. 2, the exhaust gas flow and the working medium flow are directed in opposite directions through the evaporator 7. The evaporator 7 works as a counter flow heat exchanger. A counter flow heat exchanger has usually a higher efficiency than a parallel heat exchanger. In order to remedy the drawback with a parallel heat exchanger, the second valve member 9 is provided with the above mentioned valve portion 9a which makes it possible to change flow direction of the working medium in the evaporator 7. Fig. 3 shows the valve portion 9 in the first position in which it changes direction of the working medium flow through the evaporator 7. Fig. 4 shows the valve portion 9 in the second position in which it does not change the direction of the working medium flow through the evaporator 7.

Fig. 5 and 6 show a further embodiment of the valve arrangement. In this case, a third valve member 34 is configured to alternatively direct the exhaust gas flow from the upstream exhaust line section 3a to the exhaust treatment component 5 or the evaporator 7. A first intermediate exhaust line $3b_1$ is able to direct exhaust gases from an outlet of the exhaust treatment component 5 to an inlet line of the evaporator 7. A second intermediate exhaust line $3b_2$ is able to direct exhaust gases from an outlet line of the evaporator 7 to an inlet line of the exhaust treatment component 5. A fourth valve member 35 is configured to allow exhaust gas flow in one of the intermediate exhaust lines $3b_1$, $3b_2$ at the same time as it blocks the exhaust gas flow in the other intermediate exhaust line $3b_1$, $3b_2$. A fifth valve member 36 is configured to

alternatively direct exhaust gases from the exhaust treatment component 5 or the evaporator 7 to the downstream exhaust line section 3c.

In case the exhaust treatment component 5 has a lower temperature than the specific temperature, the control unit 10 initiates a movement of the valve members 34, 35, 36 to a first position which is shown in Fig. 5. In this case, the third valve member 34 directs the exhaust gas flow from the upstream exhaust line section 3a to the exhaust treatment component 5. The exhaust gas flow leaving the exhaust treatment component 5 is directed by the fourth valve member 35 to the evaporator 7. The exhaust gas flow leaving the evaporator 7 is directed by the fifth valve member 36 to the downstream exhaust line section 3c. In case the exhaust treatment component 5 has a higher temperature than the specific temperature, the control unit 10 initiate a movement of the valve members 34, 35, 36 to a second position which is shown in Fig. 6. In this case, the third valve member 34 directs the exhaust gas flow from the upstream exhaust line section 3a to the evaporator 7. The above mentioned design of the exhaust gas flow results in that the exhaust gases always flows in the same direction trough the evaporator 7. In this embodiment, it is not necessary change the flow direction of the working medium through the evaporator 7 in order to provide an exhaust flow and a working medium flow in opposite directions through the evaporator 7. The exhaust gas flow leaving the evaporator 7 is directed by the fourth valve member 35 to the exhaust treatment component 5. The exhaust gas flow leaving the exhaust treatment component 5 is directed by the fifth valve member 36 to the downstream exhaust line section 3c.

The invention is not restricted to the described embodiment but may be varied freely within the scope of the claims.

Claims

1. A control system for controlling the exhaust flow in an exhaust line (3) of a combustion engine (2), wherein the exhaust line (3) comprises at least one exhaust treatment component (5) and an evaporator (7) of a WHR system, and wherein the control system comprises a valve arrangement (8, 9, 34-36) in the exhaust line (3), a temperature sensor configured to sense a temperature related to the temperature of the exhaust treatment component (5) and a control unit (10) configured to position the valve arrangement (8, 9, 34-36) in a first position when the exhaust treatment component (5) has a lower temperature than a specific temperature in which position the exhaust gases are directed to the exhaust treatment component (5) before they are directed to the evaporator (7) and in a second position when the exhaust treatment component has a higher temperature than said specific temperature in which position the exhaust gases are directed to the evaporator (7) before they are directed to the exhaust treatment component (5), characterized in that the valve arrangement comprises a valve member (37) or a valve part (9a) configured to change flow direction of the working medium in the evaporator (7) in one of the above mentioned cases such that the working medium and the exhaust gases always flow in opposite directions through the evaporator (7).

2. A control system according to claim 1, characterized in that the valve arrangement comprises a valve member (8, 34) which alternatively directs the exhaust gases from an upstream exhaust line section (3a) to the exhaust treatment component (5) and to the evaporator (7).

3. A control system according to claim 1 or 2, characterized in that exhaust line (3) comprises at least one intermediate exhaust line (3b, $3b_1$, $3b_2$) which directs exhaust gases between the exhaust treatment component (5) and the evaporator (7) and a valve member (9, 35) configured to control the exhaust gas flow through the intermediate exhaust line (3b, $3b_1$, $3b_2$).

4. A control system according to any one of the preceding claims, characterized in that the valve arrangement comprises a valve member (8, 9, 36) which alternatively directs exhaust gases from the exhaust treatment component (5) and the evaporator (7) to a downstream exhaust line section (3c).

5. A control system according to any one of the preceding claims, characterized in that the valve arrangement comprises a valve member (8) which, in said first position, is configured to direct exhaust gases from an upstream exhaust line section (3a) to the exhaust treatment component (5) and from the evaporator (7) to a downstream exhaust line section (3b).

6. A control system according to claim 5, characterized in that said valve member (8) is, in said second position, configured to direct exhaust gases from the upstream exhaust line section (3a) to the evaporator (7) and from the exhaust treatment component (5) to the downstream exhaust line section (3c).

7. A control system according to any one of the preceding claims, characterized in that the valve arrangement comprises a valve member (9) which, in said first position, is configured to direct exhaust gases from an upstream exhaust line section (3a) to the exhaust treatment component (5) and from the exhaust treatment component (5) to the evaporator (7).

8. A control system according to claim 7, characterized in that said valve member (9) is, in said second position, configured to direct exhaust gases from the evaporator (7) to the exhaust treatment component (5) and from the exhaust treatment component (5) to a downstream exhaust line section (3c).

9. A control system according to any one of the preceding claims, characterized in that the control system comprises a temperature sensor (6) configured to sense the temperature of the exhaust gases in an upstream exhaust line section (3a).

10. A control system according to any one of the preceding claims, characterized in that the control system comprises a sensor (33) configured to sense the pressure or the temperature of the working medium in the WHR system.

11. A control system according to any one of the preceding claims, characterized in that the exhaust treatment component (5) is a SCR catalyst.

12. Vehicle comprising a control system according to any one of the preceding claims 1 to 11.

13. A method for controlling the exhaust flow in an exhaust line (3) of a combustion engine (2) in a vehicle (1), wherein the exhaust line comprises at least one exhaust treatment component (5) and an evaporator (7) of a WHR, a valve arrangement (8, 9), characterized by the steps of directing the exhaust gases in the exhaust line to the exhaust treatment component (5) before they are directed to the evaporator (7) when the exhaust treatment component has a lower temperature than a specific temperature, directing the exhaust gases to the evaporator (7) before they are directed to the exhaust treatment component (5) when the exhaust treatment component has a higher temperature than said specific temperature and changing flow direction of the working medium in the evaporator (7) in one of the above mentioned cases such that the working medium and the exhaust gases always flow in opposite directions through the evaporator (7).

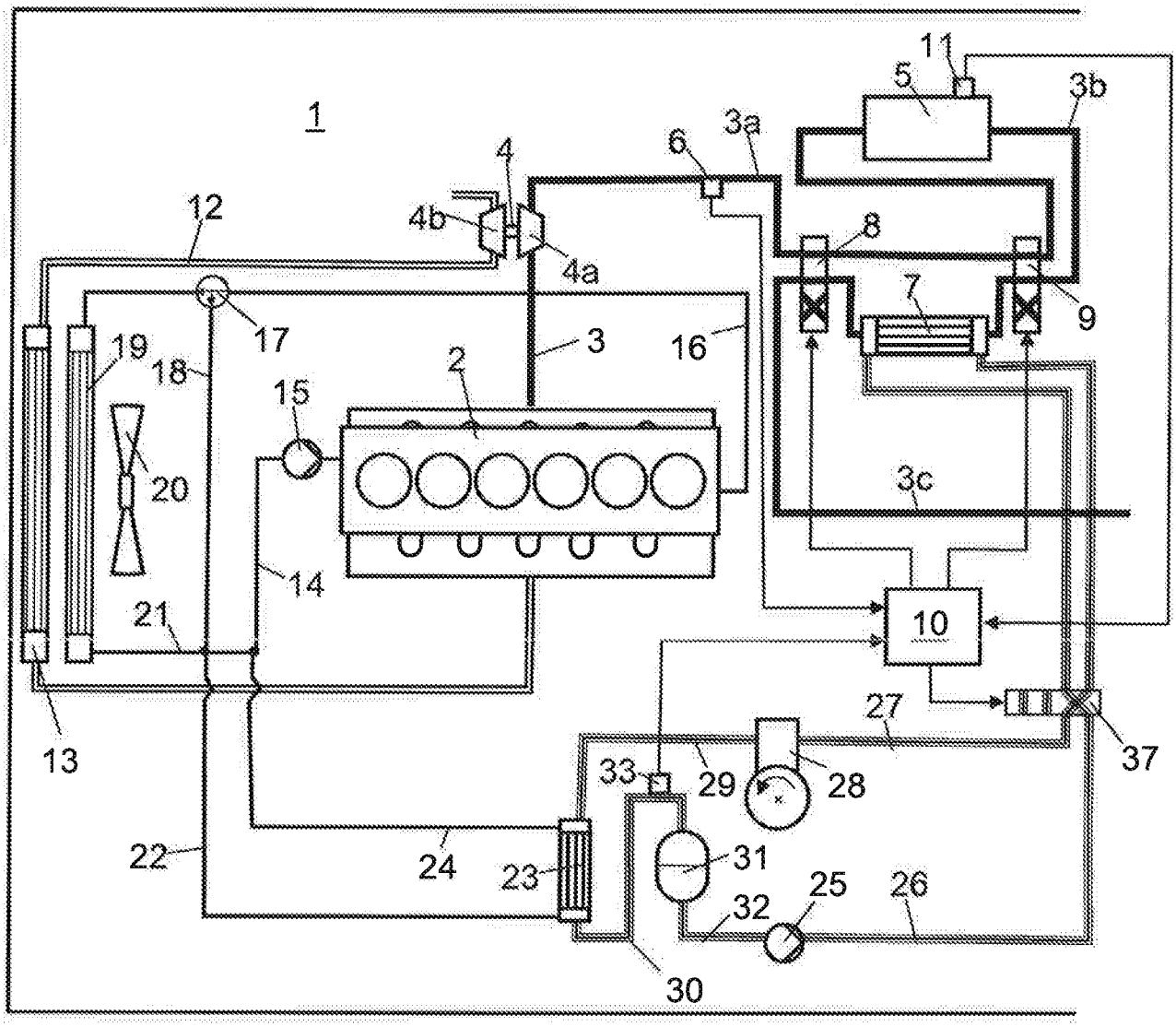

1
11
5
3b
3a
6
4
4b
4a
12
8
7
9
17
3
16
19
18
2
15
20
3c
14
21
10
27
37
13
33
29
28
22
24
23
31
25
26
32
30

Fig 1

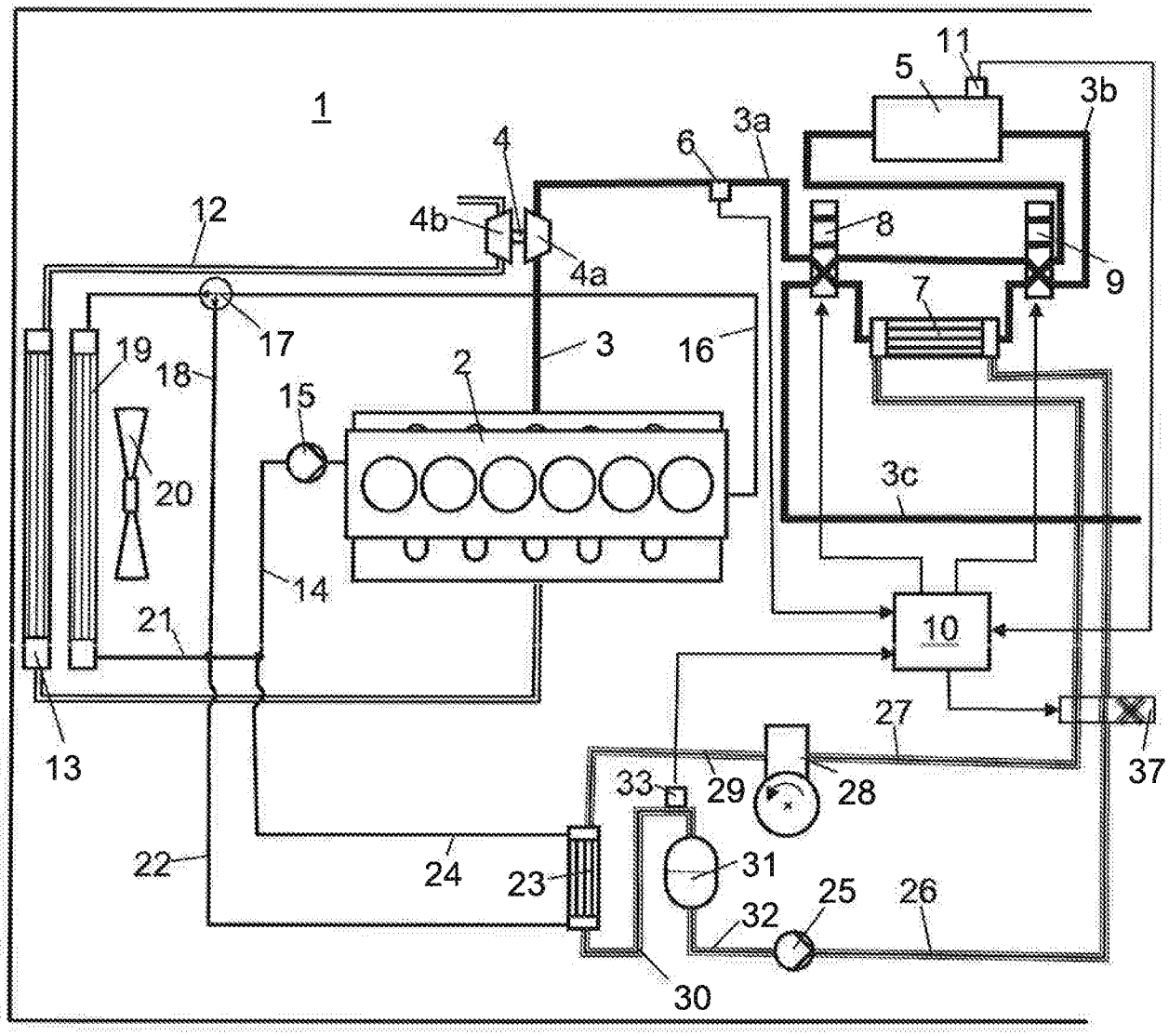

1
11
5
3b
3a
6
4
4b
4a
12
8
9
7
17
19
18
3
16
2
15
20
3c
14
21
10
27
13
37
33
29
28
22
24
23
31
25
26
32
30

Fig 2

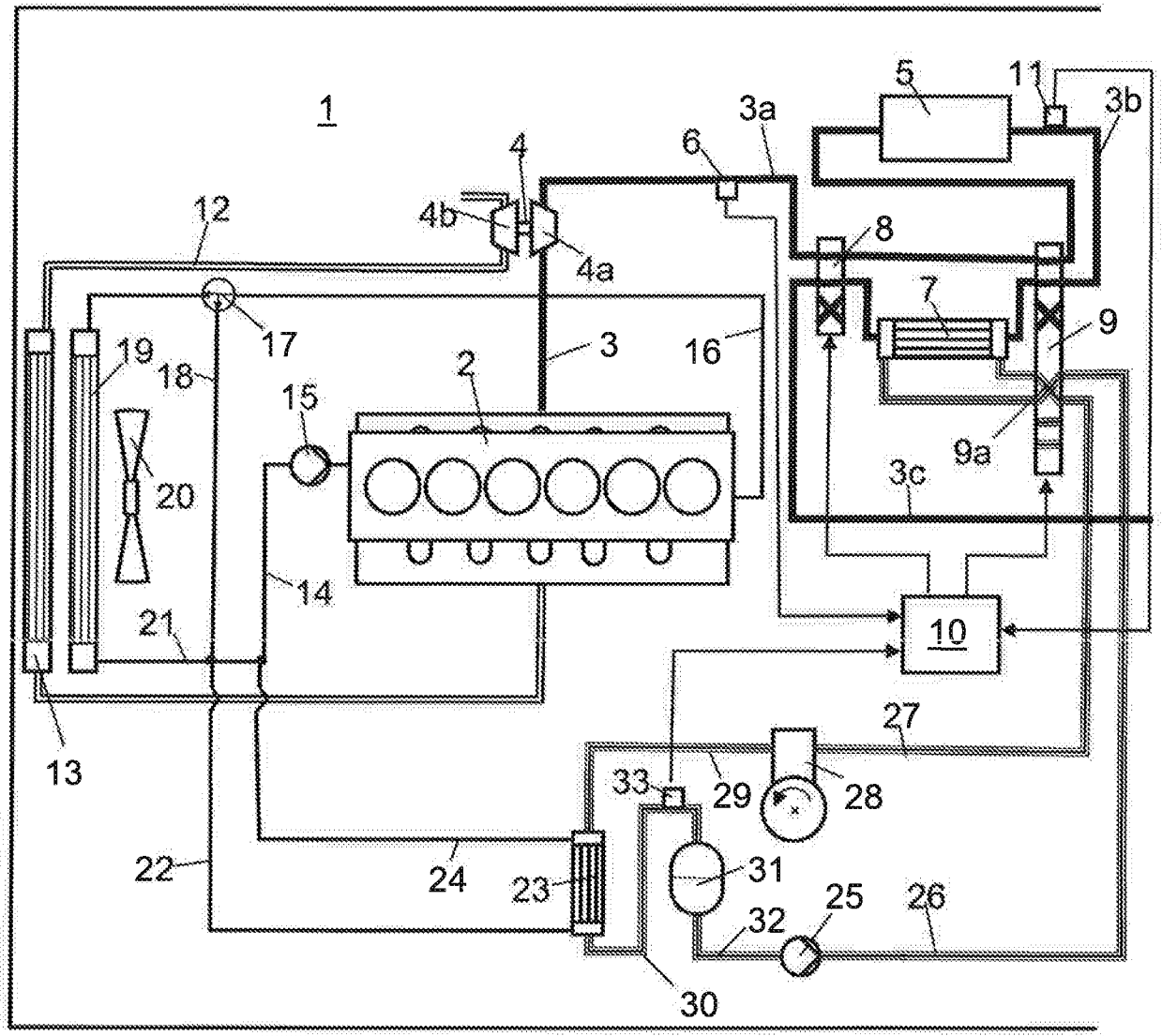

1
2
3
4
4a
4b
5
6
7
8
9
9a
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
3a
3b
3c

Fig 3

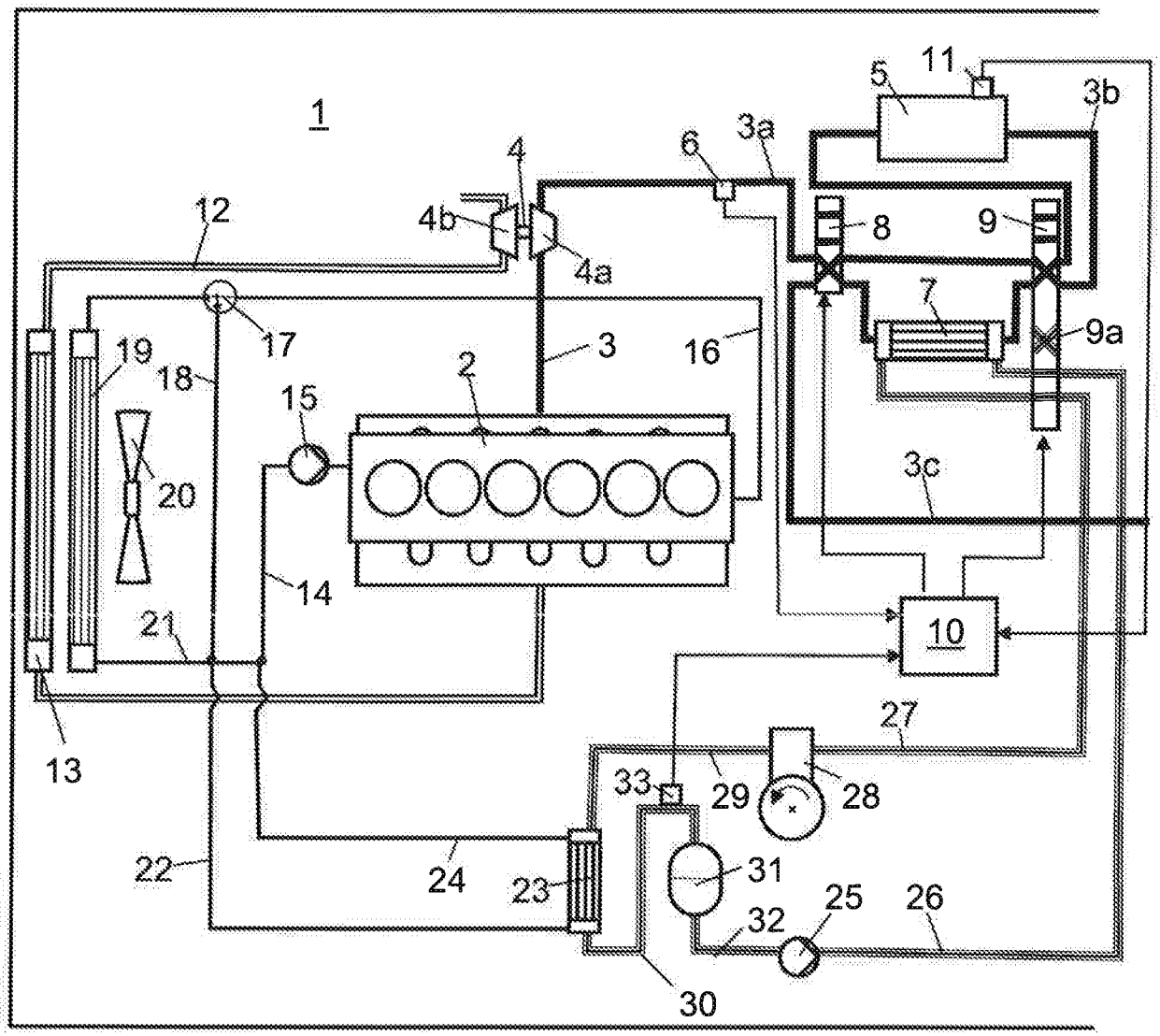

1
2
3
3a
3b
3c
4
4a
4b
5
6
7
8
9
9a
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

Fig 4

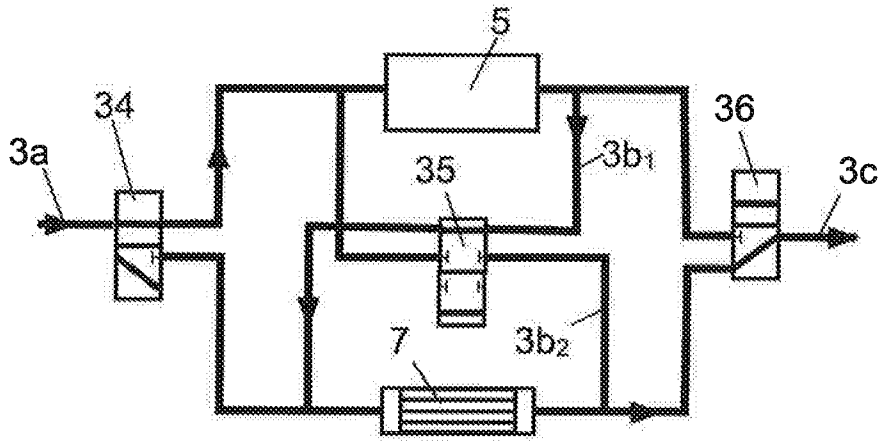


Fig 5

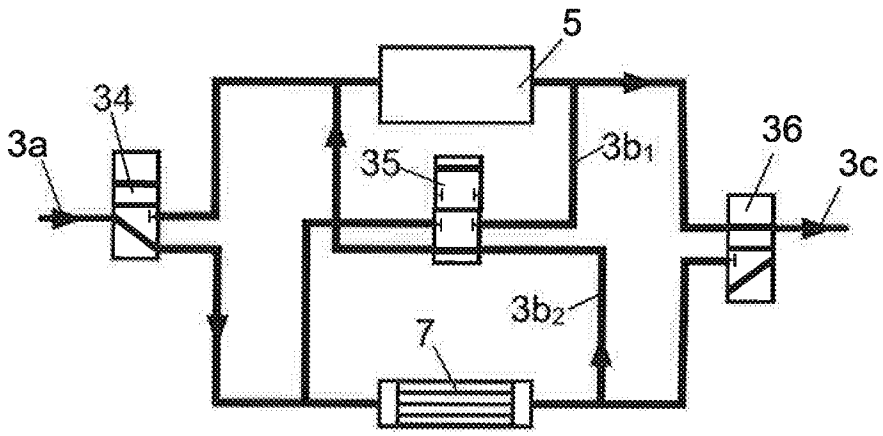


Fig 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050249

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: B60H, F01N

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.
A	EP 2700794 A2 (SCANIA CV ABP), 26 February 2014 (2014-02-26); abstract; paragraphs [0007], [0014]; figures 1b, 4-5; claims 1-3	1-13
	--	
A	US 6253548 B1 (AP NGY SRUN ET AL), 3 July 2001 (2001-07-03); abstract; column 4, line 18 - column 5, line 22; figures 3a, 3b	1-13
	--	
A	US 20100146943 A1 (MURAMATSU KENSHIROU ET AL), 17 June 2010 (2010-06-17); abstract; paragraphs [0002]-[0012]; figures 1-3	1-13
	--	

☒ 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
"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
24-05-2017	26-05-2017

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Sara Grandell Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050249

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20140013743 A1 (DANE MARTEN H), 16 January 2014 (2014-01-16); abstract; paragraphs [0035]-[0051]; figures 3-4 -- --------	1-13

International application No.
PCT/SE2017/050249

Continuation of: second sheet

International Patent Classification (IPC)

F01N 3/20 (2006.01)
F01N 5/02 (2006.01)
F01N 13/08 (2010.01)

EP	2700794	A2	26/02/2014	SE	538389	C2	07/06/2016
				SE	1250939	A1	23/02/2014
US	6253548	B1	03/07/2001	BR	9803881	A	14/12/1999
				DE	69801472	T2	08/05/2002
				EP	0908606	B1	29/08/2001
				FR	2769666	B1	24/12/1999
				JP	11218020	A	10/08/1999
US	20100146943	A1	17/06/2010	DE	102009057367	A1	17/06/2010
				JP	2010138811	A	24/06/2010
				JP	5195381	B2	08/05/2013
				US	8333068	B2	18/12/2012
US	20140013743	A1	16/01/2014	US	20150040541	A1	12/02/2015
				US	8893495	B2	25/11/2014