



(51) International Patent Classification:

B60H 1/22 (2006.01) *F01P 7/04* (2006.01)
F01P 3/20 (2006.01)

(21) International Application Number:

PCT/SE2019/051017

(22) International Filing Date:

16 October 2019 (16.10.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1851308-5 23 October 2018 (23.10.2018) SE

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

(72) Inventors: KLINGNELL, Daniel; Marieviksgatan 43, Stockholm 117 60 (SE). STRÖM, David; Lustigknoppsvägen 20, 144 62 Rönninge (SE). ENEFALK, Tommy; Färjestadens Trädgård 7, Svartsjö 179 95 (SE).

(74) Agent: HAGSTRÖM, Åsa; 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, JO, 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,

(54) Title: HEATING ARRANGEMENT, POWERTRAIN, AND VEHICLE

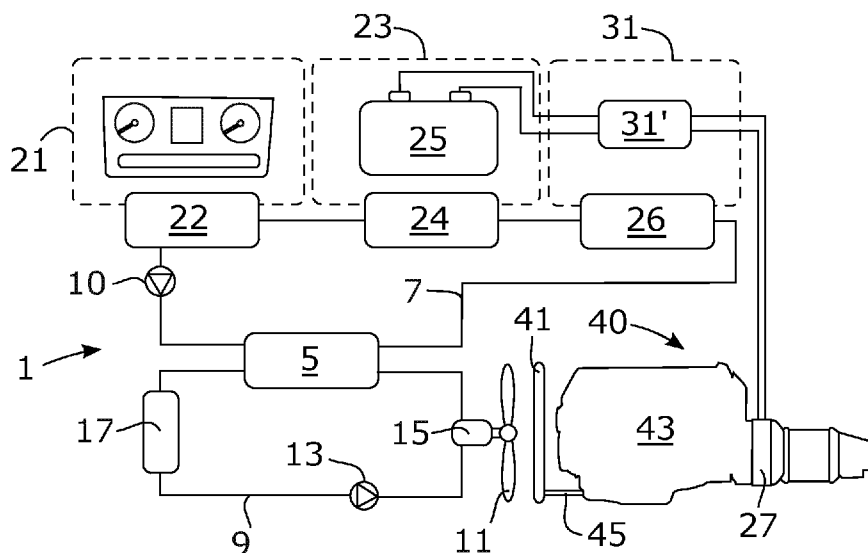


Fig. 1

(57) Abstract: A heating arrangement (1) for a vehicle (3) is disclosed. The heating arrangement (1) comprises a heat exchanger (5), a heating circuit (7), and a hydraulic fan drive circuit (9) configured to drive a cooling fan (11) of the vehicle (3). The heat exchanger (5) is arranged to transfer heat from the hydraulic fan drive circuit (9) to the heating circuit (7). The present disclosure further relates to a powertrain (40) for a vehicle (3), as well as a vehicle (3) comprising a powertrain (40).

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))*

Heating Arrangement, Powertrain, and Vehicle

TECHNICAL FIELD

The present disclosure relates to a heating arrangement for a vehicle. The present disclosure
5 further relates to a powertrain for a vehicle and a vehicle comprising a powertrain.

BACKGROUND

Vehicles usually comprise one or more cooling systems arranged to cool components such as combustion engines, electric motors, retarders, and the like. Such cooling systems usually
10 comprise one or more coolers arranged to transfer heat from the cooling system to ambient air. In order to increase heat transfer to ambient air, the coolers can be provided with a cooling fan arranged to blow air through the cooler. Traditionally, such cooling fans are driven by a belt connected to a crank shaft of the vehicle.

15 However, development has led to hydraulically driven cooling fans. Hydraulically driven cooling fans provide some advantages over belt driven cooling fans. For example, a hydraulically driven fan gives more freedom in the positioning of the cooler and cooling fan, than the belt driven ones. Moreover, the rotational speed of a hydraulically driven fan is more controllable and can be controlled in a manner being less dependent on the rotational speed
20 of the crank shaft of the engine. Thereby, conditions are provided for keeping the temperature of the cooling system in a narrower temperature range, which is advantageous for many systems and components. As an example, an internal combustion engine, such as a diesel engine, has a quite narrow temperature range in which it operates in the most fuel-efficient manner. Thus, by controlling the temperature of the internal combustion engine
25 within a narrow temperature range, the fuel efficiency can be improved.

However, hydraulically driven cooling fans are also associated with some drawbacks. One drawback is that the efficiency of the hydraulic drive circuit is lower than the efficiency of a belt drive, mainly due to pumping losses in the hydraulic drive circuit of the hydraulically
30 driven cooling fan. Moreover, generally, environmental concerns require an efficient use of energy in products and arrangements, such as in vehicles and vehicle arrangements.

SUMMARY

It is an object of the present invention to overcome, or at least alleviate, at least some of the
35 above-mentioned problems and drawbacks.

According to a first aspect of the invention, the object is achieved by a heating arrangement for a vehicle. The heating arrangement comprises a heat exchanger, a heating circuit, and a hydraulic fan drive circuit configured to drive a cooling fan of the vehicle. The heat exchanger is arranged to transfer heat from the hydraulic fan drive circuit to the heating circuit.

5

Since the heat exchanger is arranged to transfer heat from the hydraulic fan drive circuit to the heating circuit, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into useful heat which can be used for useful purposes in a vehicle comprising the heating arrangement. Thereby, the need for the input of supplementary heat is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

10

Accordingly, a heating arrangement is provided overcoming, or at least alleviating, at least some of the above-mentioned problems and drawbacks. As a result, the above-mentioned object is achieved.

15

Optionally, the hydraulic fan drive circuit comprises a hydraulic pump and a hydraulic motor, wherein the heat exchanger is arranged downstream of the hydraulic motor. The hydraulic fluid in the hydraulic fan drive circuit is subjected to a significant temperature increase when passing the hydraulic motor. Thus, since the heat exchanger is arranged downstream of the hydraulic motor, a large proportion of the waste heat generated in the hydraulic fan drive circuit is transferred to the heating circuit via the heat exchanger. Accordingly, conditions are provided for using a large proportion of the waste heat generated in the hydraulic fan drive circuit for useful purposes in a vehicle comprising the heating arrangement.

20

25

Optionally, the hydraulic fan drive circuit further comprises a cooler. Thereby, the risk of overheating the hydraulic fan drive circuit is reduced.

Optionally, the heat exchanger is arranged upstream of the cooler. Thereby, the heat of hydraulic fluid in the hydraulic fan drive circuit is effectively transferred to the heating circuit via the heat exchanger before the hydraulic fluid is further cooled in the cooler.

30

Optionally, the heat exchanger is arranged in parallel to the cooler. Thereby, the heat of hydraulic fluid in the hydraulic fan drive circuit is effectively transferred to the heating circuit via the heat exchanger, while the hydraulic fluid in the hydraulic fan drive circuit is effectively cooled.

35

Optionally, the hydraulic fan drive circuit further comprises a valve arranged to control the flow of hydraulic fluid through the cooler. Thereby, the flow of hydraulic fluid to the cooler and to the heat exchanger can be controlled in an efficient manner. As a result, a heating arrangement is provided in which the amount of heat transferred to the heating circuit, via the heat exchanger, can be controlled in an efficient manner.

Optionally, the valve comprises a thermostat arranged to increase the amount of hydraulic fluid flowing to the cooler when the temperature of the hydraulic fluid is above a predefined temperature. Thereby, a heating arrangement is provided in which the flow of hydraulic fluid through the heat exchanger and through the cooler is controlled in an automatic manner in dependence of the temperature of the hydraulic fluid. As a result, a great proportion of the heat generated in the hydraulic fan drive circuit can be transferred to the heating circuit, while the risk of overheating the hydraulic fan drive circuit is reduced.

Optionally, the heating circuit is arranged to heat a compartment, and/or a subsystem, of the vehicle. Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of a compartment, and/or a subsystem, of the vehicle. Thereby, the need for the input of supplementary heat for heating the compartment, and/or the subsystem, of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

Optionally, the heating circuit is arranged to heat a compartment of the vehicle, and wherein the compartment is a passenger compartment of the vehicle. Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of the passenger compartment of the vehicle. Thereby, the need for the input of supplementary heat for heating the passenger compartment of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

Optionally, the heating circuit is arranged to heat a compartment of the vehicle, and wherein the compartment is a battery compartment of the vehicle. Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of the battery compartment of the vehicle. Thereby, the need for the input of supplementary heat for heating the battery compartment of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

Optionally, the battery compartment comprises one or more batteries configured to supply electricity to one or more electrical machines for providing motive power to the vehicle.

Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of the one or more batteries of the vehicle.

5 Thereby, the need for the input of supplementary heat for heating the one or more batteries of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

Optionally, the heating circuit is arranged to heat a subsystem of the vehicle, and wherein the
10 subsystem comprises power electronics. Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of the power electronics of the vehicle. Thereby, the need for the input of supplementary heat for heating the power electronics of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

15 Optionally, the heating circuit is arranged to heat a subsystem of the vehicle, and wherein the subsystem comprises a gas panel. Thereby, a heating arrangement is provided capable of converting waste heat generated in the hydraulic fan drive circuit into a useful heating of the gas panel of the vehicle. Thereby, the need for the input of supplementary heat for heating
20 the gas panel of the vehicle is reduced. As a result, the total energy efficiency of a vehicle comprising the heating arrangement can be improved.

According to a second aspect of the invention, the object is achieved by a powertrain for a vehicle, wherein the powertrain comprises a power source and a heating arrangement
25 according to some embodiments of the present disclosure, and wherein the power source is configured to provide motive power to the vehicle.

Thereby, a powertrain is provided capable of converting waste heat generated in the hydraulic fan drive circuit of the powertrain into useful heat which can be used for useful
30 purposes in a vehicle comprising the powertrain. Thereby, the need for the input of supplementary heat is reduced. As a result, the total energy efficiency of a vehicle comprising the powertrain can be improved.

Accordingly, a powertrain is provided overcoming, or at least alleviating, at least some of the
35 above-mentioned problems and drawbacks. As a result, the above-mentioned object is achieved.

Optionally, wherein the power source comprises a cooling system arranged to cool the power source, and wherein the cooling fan is a cooling fan of the cooling system. Thereby, a powertrain is provided capable of converting waste heat generated in the hydraulic fan drive circuit of the cooling fan into useful heat which can be used for useful purposes in a vehicle comprising the powertrain.

Optionally, the power source is an internal combustion engine. Thereby, a powertrain is provided capable of converting waste heat generated in the hydraulic fan drive circuit of the cooling fan of the internal combustion engine into useful heat which can be used for useful purposes in a vehicle comprising the powertrain.

According to a third aspect of the invention, the object is achieved by a vehicle comprising a powertrain according to some embodiments of the present disclosure.

Thereby, a vehicle is provided capable of converting waste heat generated in the hydraulic fan drive circuit of the vehicle into useful heat which can be used for useful purposes in the vehicle. Thereby, the need for the input of supplementary heat is reduced. As a result, the total energy efficiency of the vehicle can be improved.

Accordingly, a vehicle is provided overcoming, or at least alleviating, at least some of the above-mentioned problems and drawbacks. As a result, the above-mentioned object is achieved.

Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Various aspects of the invention, including its particular features and advantages, will be readily understood from the example embodiments discussed in the following detailed description and the accompanying drawings, in which:

Fig. 1 illustrates a heating arrangement according to some embodiments,
Fig. 2 illustrates a heating arrangement according to some further embodiments, and
Fig. 3 illustrates a vehicle according to some embodiments.

DETAILED DESCRIPTION

Aspects of the present invention will now be described more fully. Like numbers refer to like elements throughout. Well-known functions or constructions will not necessarily be described in detail for brevity and/or clarity.

5

Fig. 1 illustrates a heating arrangement 1 according to some embodiments. As is further explained herein, the heating arrangement 1 is configured to provide useful heat to a component 25, 31', a compartment 21, 23, and/or subsystem 31 of a vehicle. Fig. 1 also illustrates a powertrain 40 for a vehicle according to some embodiments. The powertrain 40 comprises a power source 43 and the heating arrangement 1. The power source 43 is configured to provide motive power to the vehicle. The power source 43 comprises a cooling system 45 arranged to cool the power source 43. Moreover, the powertrain 40 comprises a cooling fan 11 arranged to generate a flow of air through a cooler 41 of the cooling system 45. According to the illustrated embodiments, the power source 43 is an internal combustion engine 43. The internal combustion engine 43 may for example be a compression ignition engine, such as a diesel engine, or an Otto engine with a spark-ignition device, wherein the Otto engine may be configured to run on gas, petrol, alcohol, similar volatile fuels, or combinations thereof. Moreover, the powertrain 40 comprises an electrical machine 27 configured to provide motive power to the vehicle using electricity from a battery 25 by an amount controlled by power electronics 31'. The powertrain 40 according to the embodiments illustrated in Fig. 1 may be referred to as a hybrid electric powertrain.

10

15

20

The heating arrangement 1 comprises a heat exchanger 5, a heating circuit 7, and a hydraulic fan drive circuit 9. The hydraulic fan drive circuit 9 is configured to drive the cooling fan 11. The hydraulic fan drive circuit 9 comprises a hydraulic pump 13 and a hydraulic motor 15. The hydraulic pump 13 may be driven by the power source 43, for example via a so-called power take off arrangement, usually abbreviated PTO. The hydraulic motor 15 is arranged to rotate the cooling fan 11. That is, according to the illustrated embodiments, hydraulic fluid in the hydraulic fan drive circuit 9 is pumped from the hydraulic pump 13 to the hydraulic motor 15. In the hydraulic motor 15, some of the work produced by the hydraulic pump 13 is converted into torque used to rotate the cooling fan 11. During operation, the temperature of the hydraulic fluid in the hydraulic fan drive circuit 9 increases, especially when passing the hydraulic pump 13 and the hydraulic motor 15.

25

30

35

The heat exchanger 5 of the heating arrangement 1 is arranged to transfer heat from the hydraulic fan drive circuit 9 to the heating circuit 7. In this manner, the heating arrangement 1 is capable of converting waste heat generated in the hydraulic fan drive circuit 7 into useful

heat which can be used for useful purposes in a vehicle comprising the heating arrangement 1.

According to the illustrated embodiments, the heat exchanger 5 is arranged downstream of the hydraulic motor 15 and of the hydraulic pump 13. Moreover, the hydraulic fan drive circuit 9 comprises a cooler 17. As can be seen in Fig. 1, the heat exchanger 5 is arranged upstream of the cooler 17. Thus, according to the illustrated embodiments, the hydraulic fluid flows from the hydraulic motor 15 to the heat exchanger 5. In the heat exchanger 5, some of the heat of the hydraulic fluid of the hydraulic fan drive circuit 9 is transferred to the heating circuit 7. Moreover, the hydraulic fluid flows from the heat exchanger 5 to the cooler 17. In the cooler 17, the hydraulic fluid of the hydraulic fan drive circuit 7 is further cooled before the hydraulic fluid flows back towards an inlet of the hydraulic pump 13.

According to the illustrated embodiments, the heating circuit 7 is a hydraulic heating circuit 7 comprising a pump 10 arranged to pump a coolant through the heating circuit 7. The coolant may for example comprise a mixture of water and glycol.

According to the illustrated embodiments, the heating circuit 7 is arranged to heat a passenger compartment 21 of the vehicle. That is, the heating circuit 7 comprises a heater 22 arranged to transfer heat from the heating circuit 7 to the passenger compartment 21. In this manner, the waste heat generated in the hydraulic fan drive circuit 9 is utilized for heating the passenger compartment 21 of the vehicle. Thereby, the need for inputting supplementary heat for heating the passenger compartment 21 is reduced. As an alternative to the heater 22, or in addition thereto, the heating circuit 7 may comprise coolant channels in heat exchanging contact with the passenger compartment 21 to thereby transfer heat from the heating circuit 7 to the passenger compartment 21.

Moreover, according to the illustrated embodiments, the heating circuit 7 is arranged to heat a battery compartment 23 of the vehicle. The battery compartment 23 comprises the battery 25 which is configured to supply electricity to the electrical machine 27 to thereby provide motive power to the vehicle. The battery compartment 23 may comprise more batteries 25 than depicted in Fig. 1. According to the illustrated embodiments, the heating circuit 7 comprises a heater 24 arranged to transfer heat from the heating circuit 7 to the battery compartment 23. As an alternative to, or in addition to, the heater 24, the heating circuit 7 may comprise coolant channels in heat exchanging contact with the battery compartment 23 and/or the battery/batteries 25, to thereby transfer heat from the heating circuit 7 to the battery compartment 23 and/or to the battery/batteries 25. The coolant channels may extend

through, and/or past, portions of the battery/batteries 25, and/or may extend through, and/or past, portions of the battery compartment 23. In this manner, the waste heat generated in the hydraulic fan drive circuit 9 is utilized for heating the battery/batteries 25 of the vehicle.

Thereby, the need for inputting supplementary heat for heating the battery/batteries 25 is reduced.

Furthermore, according to the illustrated embodiments, the heating circuit 7 is arranged to heat a subsystem 31 of the vehicle. According to the illustrated embodiments, the subsystem 31 comprises power electronics 31' arranged to control the amount of electricity supplied to the electrical machine 27. According to the illustrated embodiments, the heating circuit 7 comprises a heater 26 arranged to transfer heat from the heating circuit 7 to the power electronics 31'. As an alternative to, or in addition to, the heater 26, the heating circuit 7 may comprise coolant channels in heat exchanging contact with the power electronics 31'. The coolant channels may extend through, and/or past, portions of the power electronics 31', and/or may extend through, and/or past, portions of a compartment in which the power electronics 31' is arranged. In this manner, the waste heat generated in the hydraulic fan drive circuit 9 is utilized for heating the power electronics 31' of the vehicle. Thereby, the need for inputting supplementary heat for heating the power electronics 31' is reduced.

According to the embodiments depicted in Fig. 1, the heating circuit 7 of the heating arrangement 1 is configured to provide useful heat to several components 25, 31', compartments 21, 23, and subsystems 31 of the vehicle. However, according to embodiments of the present disclosure, the heating arrangement 1 may be configured to provide useful heat to one or more of such components 25, 31', compartments 21, 23, and subsystems 31. Moreover, as is further explained herein, according to some embodiments, the heating circuit 7 of the heating arrangement 1 may be configured to provide useful heat to one or more other types of components, compartments, and subsystems of the vehicle, than depicted in Fig. 1.

Fig. 2 illustrates a heating arrangement 1 according to some further embodiments. Moreover, Fig. 2 illustrates a powertrain 40 for a vehicle according to some further embodiments. According to the embodiments illustrated in Fig. 2, the heating arrangement 1 comprises a hydraulic fan drive circuit 9 in which the heat exchanger 5 is arranged in parallel to the cooler 17. Each of the heat exchanger 5 and the cooler 17 is arranged downstream of the hydraulic motor 15 and of the hydraulic pump 13. The hydraulic fan drive circuit 9 further comprises a valve 19 arranged to control the flow of hydraulic fluid through the cooler 17. According to the illustrated embodiments, the valve 19 comprises a thermostat 19' arranged

to increase the amount of hydraulic fluid flowing to the cooler 17 when the temperature of the hydraulic fluid is above a predefined temperature. In this manner, the flow of hydraulic fluid through the heat exchanger 5 and through the cooler 17 is controlled in an automatic manner in dependence of the temperature of the hydraulic fluid. According to further embodiments, the valve 19 may be controlled by a control unit electrically, pneumatically, or hydraulically.

According to the illustrated embodiments, the heating circuit 7 is arranged to heat a subsystem 33 of the vehicle, wherein the subsystem 33 comprises a gas panel 33'. That is, according to the illustrated embodiments, the heating circuit 7 extends through the gas panel 33'. As an alternative, or in addition, the heating circuit 7 may comprise a separate heater arranged to transfer heat from the heating circuit 7 to the gas panel 33'. In any of these manners, the waste heat generated in the hydraulic fan drive circuit 9 is utilized for heating gas panel 33' of the vehicle. Thereby, the need for inputting supplementary heat for heating the gas panel 33' is reduced.

The powertrain 40 according to the embodiments illustrated in Fig. 2 comprises an internal combustion engine 43 arranged to operate on gaseous fuel stored in a gas tank 44. The gaseous fuel is led to an inlet of the internal combustion engine 43 via the gas panel 33'. In the gas panel 33', the gaseous fuel is heated using heat from the heating circuit 7. Thereby, the need for inputting supplementary heat for heating the gaseous fuel is reduced. Thus, according to the embodiments illustrated in Fig. 2, the heating arrangement 1 is arranged to heat a medium related to the operation of the internal combustion engine 43.

According to further embodiments, the heating arrangement 1 may be arranged to heat a reductant agent. The reductant agent may be used in a selective catalytic reduction catalyst of the vehicle to convert nitrogen oxides of exhaust gases of the internal combustion engine 43 of the vehicle into diatomic nitrogen and water. The reductant agent may for example comprise anhydrous ammonia, aqueous ammonia, or urea. According to such embodiments, the heating circuit 7 may comprise a heater arranged to heat the reductant agent. Such a heater may for example be arranged in a tank arranged to accommodate the reductant agent.

It is to be understood that the embodiments illustrated in Fig. 1 and Fig. 2 constitute example embodiments and that features of these embodiments can be combined without departing from the scope of the present invention. As an example, the heating arrangement 1 according to the embodiments illustrated in Fig. 1 may comprise a hydraulic fan drive circuit 9 according to the embodiments illustrated in Fig. 2, i.e. a hydraulic fan drive circuit 9 in which

the heat exchanger 5 is arranged in parallel to the cooler 17. Likewise, the heating arrangement 1 according to the embodiments illustrated in Fig. 2 may comprise a hydraulic fan drive circuit 9 according to the embodiments illustrated in Fig. 1, i.e. a hydraulic fan drive circuit 9 in which the heat exchanger 5 and the cooler 17 are arranged in series, wherein the heat exchanger 5 is arranged upstream of the cooler 17. As a further example, the powertrain 40 according to the embodiments illustrated in Fig. 2 may comprise one or more of an electrical machine 27, a battery 25, power electronics 31', according to the embodiments illustrated in Fig. 1.

Fig. 3 illustrates a vehicle 3 according to some embodiments. The vehicle 3 comprises a powertrain 40 configured to provide motive power to the vehicle 3, via wheels 46 of the vehicle 3. The powertrain 40 may be a powertrain 40 according to the embodiments illustrated in Fig. 1, or a powertrain 40 according to the embodiments illustrated in Fig. 2. According to the illustrated embodiments, the vehicle 3 is a bus. However, according to further embodiments, the vehicle 3, as referred to herein, may be another type of manned or unmanned vehicle for land or water based propulsion such as a truck, a lorry, a construction vehicle, a tractor, a car, a ship, a boat, or the like. In Fig. 3, the passenger compartment 21 of the vehicle 3 is indicated. As explained herein, according to some embodiments, the heating circuit of the heating arrangement may be arranged to heat the passenger compartment 21.

It is to be understood that the foregoing is illustrative of various example embodiments and that the invention is defined only by the appended claims. A person skilled in the art will realize that the example embodiments may be modified, and that different features of the example embodiments may be combined to create embodiments other than those described herein, without departing from the scope of the present invention, as defined by the appended claims.

As used herein, the term "comprising" or "comprises" is open-ended, and includes one or more stated features, elements, steps, components, or functions but does not preclude the presence or addition of one or more other features, elements, steps, components, functions or groups thereof.

CLAIMS

1. A heating arrangement (1) for a vehicle (3), wherein the heating arrangement (1) comprises:

- a heat exchanger (5),
- a heating circuit (7), and
- a hydraulic fan drive circuit (9) configured to drive a cooling fan (11) of the vehicle (3),

wherein the heat exchanger (5) is arranged to transfer heat from the hydraulic fan drive circuit (9) to the heating circuit (7).

2. The heating arrangement (1) according to claim 1, wherein the hydraulic fan drive circuit (9) comprises a hydraulic pump (13) and a hydraulic motor (15).

3. The heating arrangement (1) according to claim 2, wherein the heat exchanger (5) is arranged downstream of the hydraulic motor (15).

4. The heating arrangement (1) according to any one of the preceding claims, wherein the hydraulic fan drive circuit (9) further comprises a cooler (17).

5. The heating arrangement (1) according to claim 4, wherein the heat exchanger (5) is arranged upstream of the cooler (17).

6. The heating arrangement (1) according to claim 4, wherein the heat exchanger (5) is arranged in parallel to the cooler (17).

7. The heating arrangement (1) according to claim 6, wherein the hydraulic fan drive circuit (9) further comprises a valve (19) arranged to control the flow of hydraulic fluid through the cooler (17).

8. The heating arrangement (1) according to claim 7, wherein the valve (19) comprises a thermostat (19') arranged to increase the amount of hydraulic fluid flowing to the cooler (17) when the temperature of the hydraulic fluid is above a predefined temperature.

9. The heating arrangement (1) according to any one of the preceding claims, wherein the heating circuit (7) is arranged to heat a compartment (21, 23), and/or a subsystem (31, 33), of the vehicle (3).

10. The heating arrangement (1) according to claim 9, wherein the heating circuit (7) is arranged to heat a compartment (21) of the vehicle (3), and wherein the compartment (21) is a passenger compartment (21) of the vehicle (3).

5 11. The heating arrangement (1) according to claim 9 or 10, wherein the heating circuit (7) is arranged to heat a compartment (23) of the vehicle (3), and wherein the compartment (23) is a battery compartment (23) of the vehicle (3).

10 12. The heating arrangement (1) according to claim 11, wherein the battery compartment (23) comprises one or more batteries (25) configured to supply electricity to one or more electrical machines (27) for providing motive power to the vehicle (3).

15 13. The heating arrangement (1) according to any one of the claims 9 - 12, wherein the heating circuit (7) is arranged to heat a subsystem (31) of the vehicle (3), and wherein the subsystem (31) comprises power electronics (31').

20 14. The heating arrangement (1) according to any one of the claims 9 - 13, wherein the heating circuit (7) is arranged to heat a subsystem (33) of the vehicle (3), and wherein the subsystem (33) comprises a gas panel (33').

25 15. A powertrain (40) for a vehicle (3), wherein the powertrain (40) comprises a power source (43) and a heating arrangement (1) according to any one of the preceding claims, and wherein the power source (43) is configured to provide motive power to the vehicle (3).

16. The powertrain (40) according to claim 15, wherein the power source (43) comprises a cooling system (45) arranged to cool the power source (43), and wherein the cooling fan (11) is a cooling fan (11) of the cooling system (45).

30 17. The powertrain (40) according to claim 15 or 16, wherein the power source (43) is an internal combustion engine (43).

18. A vehicle (3) comprising a powertrain (40) according to any one of the claims 15 - 17.

35

1/2

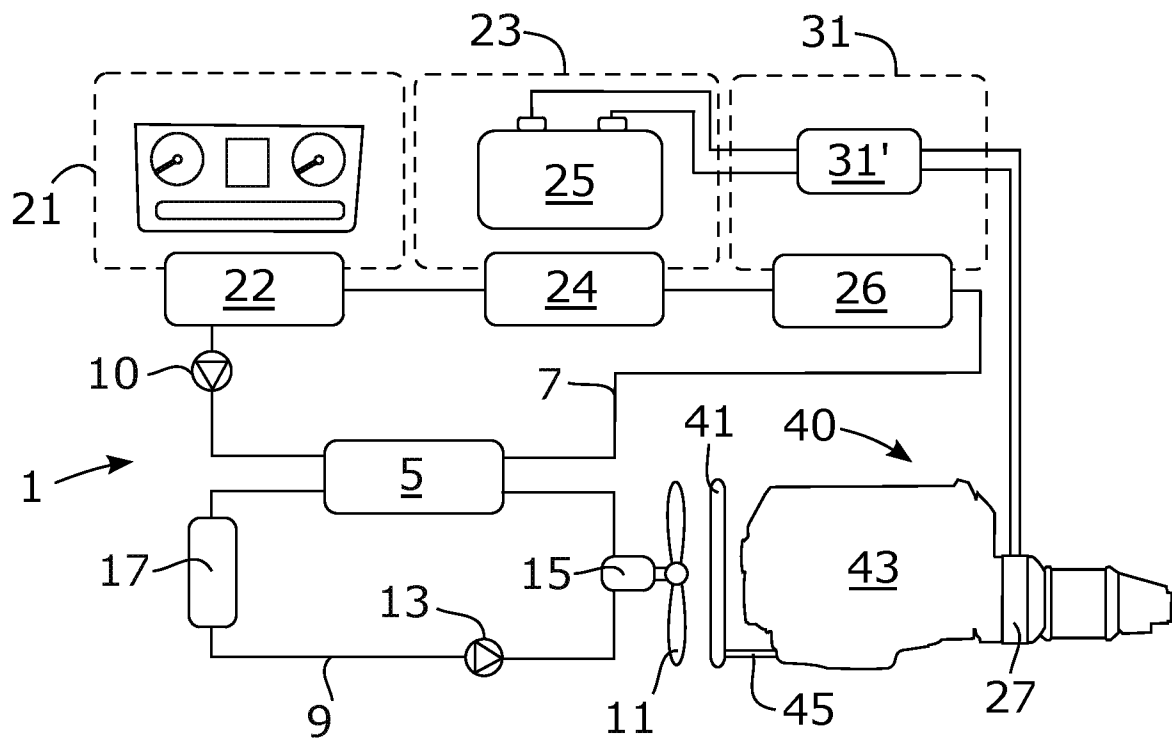


Fig. 1

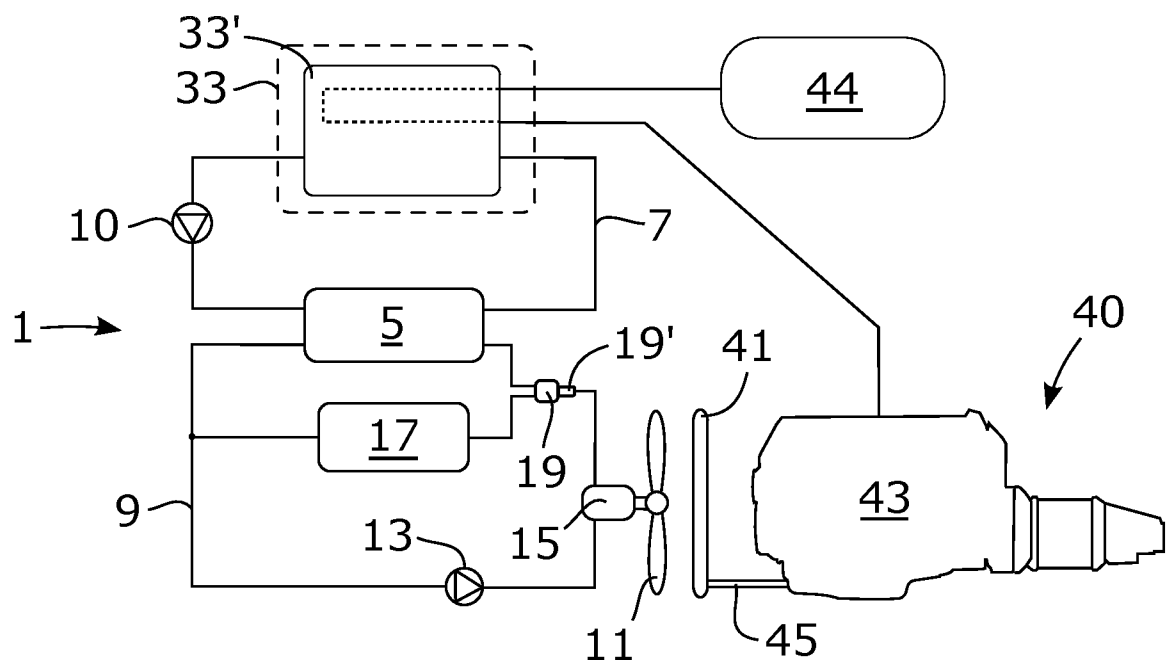


Fig. 2

2/2

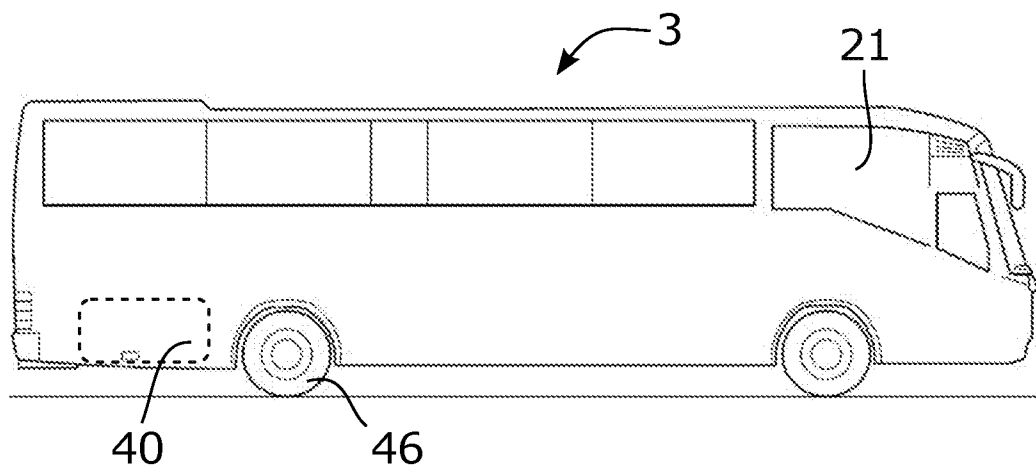


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/051017

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, F01P, F04D

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	US 20050139176 A1 (BERGSTROM MAGNUS ET AL), 30 June 2005 (2005-06-30); paragraphs [0020]-[0033]; figures 1-2 --	1-18
X	JP 0610669 A (NIPPON DENSO CO), 18 January 1994 (1994-01-18); paragraphs [0007]-[0008], [0010]-[0011]; figure 1; See attached translation --	1-3, 9, 15-18
X	WO 2008012586 A1 (ARTEMIS INTELLIGENT POWER LTD ET AL), 31 January 2008 (2008-01-31); paragraph [0028]; figure 1 --	1-3, 9, 15-18

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"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	

Date of the actual completion of the international search
17-01-2020

Date of mailing of the international search report
17-01-2020

Name and mailing address of the ISA/SE
Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer
Fredrik Timoteusson
Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2019/051017

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4794883 A (FUKAMI KASHIROU ET AL), 3 January 1989 (1989-01-03); column 5, line 29 - line 47; column 6, line 7 - line 17; figure 2 --	1-3, 9, 15-18
X	US 4066047 A (VIDAKOVIC ALEKSANDAR ET AL), 3 January 1978 (1978-01-03); column 5, line 9 - line 35 --	1-3, 9, 15-18
A	DE 3617262 A1 (FENDT & CO XAVER), 26 November 1987 (1987-11-26); abstract; figure 2 --	1-18
A	JP 10203139 A (NIPPON SOKEN ET AL), 4 August 1998 (1998-08-04); paragraphs [0010]-[0015]; figure 1; claims 1-3; See attached translation --	1-18
A	EP 3267007 A1 (AGCO INT GMBH), 10 January 2018 (2018-01-10); abstract; figures 2-3 -- -----	1-18

Continuation of: second sheet

International Patent Classification (IPC)

B60H 1/22 (2006.01)

F01P 3/20 (2006.01)

F01P 7/04 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2019/051017

US	20050139176 A1	30/06/2005	US	6945200 B2	20/09/2005
JP	0610669 A	18/01/1994	NONE		
WO	2008012586 A1	31/01/2008	AT	450700 T	15/12/2009
			CN	101506485 B	26/01/2011
			DE	602007003609 D1	14/01/2010
			EP	2049778 A1	22/04/2009
			US	8646264 B2	11/02/2014
			US	20090235657 A1	24/09/2009
US	4794883 A	03/01/1989	JP	6378701 U	25/05/1988
			JP	0650282 Y2	21/12/1994
US	4066047 A	03/01/1978	DE	2716997 B2	29/03/1979
			JP	52127531 A	26/10/1977
DE	3617262 A1	26/11/1987	NONE		
JP	10203139 A	04/08/1998	NONE		
EP	3267007 A1	10/01/2018	US	10436084 B2	08/10/2019
			US	20180010493 A1	11/01/2018