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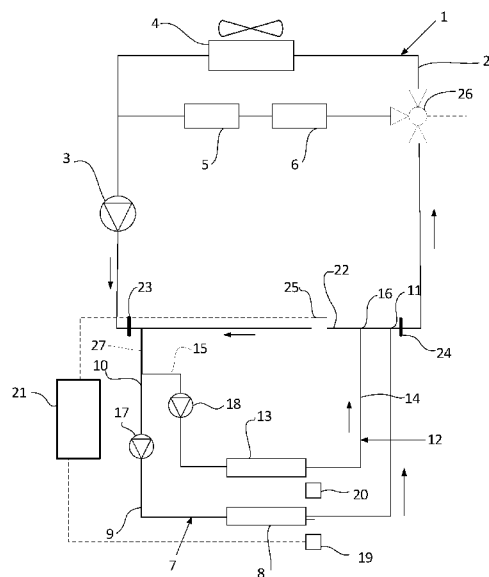


Fig. 1

(57) Abstract: A temperature control system for a vehicle, comprising a main circuit (1) comprising a tubing (2) in which there is provided a coolant, a main circuit pump (3) configured to pump said coolant through the tubing (2) of the main circuit (1) in a first direction. Connected in parallel to the main circuit are a first and second sub-circuit for cooling or heating of components connected thereto. In the sub-circuits (7, 12) there are provided first and second pumps (17, 18) that pump coolant through said sub-circuits from a first end (10, 15) to second end (11, 16) at which the respective sub-circuit (7, 12) is connected to the main circuit (1). The first end (10, 15) is upstream the second end (11, 16) as seen in the first direction in the first circuit (1), and the first end (10) of the first sub-circuit (7) and the first end (15) of the at least one second sub-circuit (12) are joined to a common tubing section (27) which in its turn is connected to the tubing (2) of the main circuit (1).

**A temperature control system, a vehicle provided therewith
and a method for controlling the operation thereof**

TECHNICAL FIELD OF THE INVENTION

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The present invention relates to a temperature control system for a vehicle, comprising

- a main circuit comprising a tubing in which there is provided a coolant, a main circuit pump configured to pump said coolant
10 through the tubing of the main circuit in a first direction, and at least one unit for cooling or heating the coolant in the main circuit,
- a first sub-circuit for cooling or heating a first component, said first sub-circuit comprising a tubing that has a first end and a second end, which are connected to respective openings in the
15 tubing of the main circuit at positions that are spaced apart from each other as seen in a longitudinal direction of the tubing of the main circuit, wherein the first end is connected to the tubing of the main circuit at a position upstream the position at which the second end is connected to the tubing of the main circuit as seen in said
20 first direction, and
- at least one second sub-circuit for cooling or heating a second component, said second sub-circuit comprising a tubing that has a first end and a second end, which are connected to respective openings in the tubing of the main circuit at positions that are
25 spaced apart from each other as seen in a longitudinal direction of the tubing of the main circuit, wherein the first end is connected to the tubing of the main circuit at a position upstream the position at which the second end is connected to the tubing of the main circuit as seen in said first direction, wherein

- the first sub-circuit comprises a first pump configured to pump a coolant in a direction from said first end of the tubing of the first sub-circuit to the second end thereof, and
- the second sub-circuit comprises a second pump configured to pump a coolant in a direction from said first end of the tubing of the second sub-circuit to the second end thereof.

The present invention also relates to a vehicle provided with a temperature control system as defined in this application.

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The present invention also relates to a method of controlling the operation of a temperature control system according to the invention.

- 15 The term “tubing” as applied in this disclosure should be regarded in a wide sense and may include all sorts of structural elements that define a channel through which a coolant may flow. A tubing as used in this disclosure may also comprise a plurality of structural elements that together define the tubing, said structural elements not necessarily having the traditional geometric tubular shape of a tube.

20

BACKGROUND AND PRIOR ART

- 25 When designing any coolant system which involves multiple components it is always a struggle to ensure enough flow and coolant temperature to all components. Connecting the components in series allows for the same coolant flow to all components. However as the coolant gets warmer from each component it will cool the following components less and less. If,

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as an alternative, the components are connected in a parallel flow the coolant temperature will be the same. However, the flow rate depends on the pressure drop of the components and lengths and diameters of hoses/pipes. It is therefore an objective to find an
5 installation which gives the required coolant flow rate and coolant temperature to all components, the temperature of which is controlled by means of heat exchange with the coolant.

In contemporary coolant systems for vehicles most coolant
10 systems utilizes a single pump and tries to balance the properties of all components until they find a setup which works and requires as little of over-dimensioning of the pump as possible. Using a bigger pump to increase the coolant flow rate or using a bigger radiator in order to achieve more powerful cooling of the coolant
15 is always a solution but will also induce extra costs and extra space.

For battery installations, for example provided in a vehicle as a power source of the vehicle, it is important to ensure equal cooling
20 of all batteries. For this purpose the batteries may require the same temperature on the coolant and the same coolant flow rate. This can be solved by placing the batteries close to each other, dimensioning the coolant pump for the given amount of batteries and arranging the tubing in parallel circuits. However this requires
25 the batteries to be close to each other, and whenever a further battery is added to the installation, the existing pump, if not over-dimensioned, will need to be substituted to a more powerful one. Prior art solutions are thus not easily adapted to changing set ups of components that need to be cooled, or heated, by the coolant
30 in the temperature control system.

Occasionally, there may be a need of delivering different degrees of cooling to different components in a temperature cooling system. In a system having a single pump and a plurality of parallel
5 cooling circuits into which the coolant is pumped by said pump, such differential cooling is then solved by means of flow-regulating valves provided in the respective circuit.

SUMMARY OF THE INVENTION

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It is an object of the present invention to present a temperature control system that reduces the above-mentioned drawbacks of prior art and that presents an alternative solution to existing solutions. The temperature control system shall be designed so as
15 to enable delivery of coolant of generally the same temperature to the components of the respective sub-circuits.

The object of the invention is achieved by means a temperature control system as defined hereinabove and in the preamble of
20 claim 1, which system is characterized in that the first end of the first sub-circuit and the first end of the at least one second sub-circuit are joined to a common tubing section which in its turn is connected to the tubing of the main circuit.

25 For each added component to be cooled, a further sub-circuit as defined hereinabove may be added. No substitution of the pump of the main circuit may be needed in order to adapt the system to such addition of components. Different coolant flow rates can easily be achieved for the different sub-circuits by individual
30 control of the respective pump of the sub-circuits. In those

operational states in which the sum of coolant pumped by the pumps, i.e. the output, of the sub-circuits is larger than the amount of coolant pumped by the main circuit pump, there will be a return flow of coolant in a section of the main circuit between the inlet to the sub-circuits, defined by the common tubing section, and the outlets of the sub-circuits. Provided that there is a flow of coolant from the main circuit pump, the coolant from the main circuit pump will mix with the coolant of the return flow in the common tubing section, and the temperature of the coolant delivered from the common tubing section to the different sub-circuits will be generally the same. A separate connection point of each inlet of the sub-circuits to the tubing of the main circuit would, on the other hand, result in a different temperature of the coolant delivered to the different sub-circuit.

15

The term "upstream" is used for defining a position of a component relative to another component along the tubing of the main circuit. The outlet of the main circuit pump is herein used as a reference position. Thus, by a first component being upstream a second component is herein meant that the first component is arranged closer to the outlet of the main circuit pump than the second component from a connection point of view.

20

According to one embodiment, said common tubing section has a length which is sufficient for mixing in said common tubing a flow of coolant delivered by the main circuit pump and a flow of coolant delivered by said first pump of the first sub-circuit and by said second pump of the at least one second sub-circuit such that the temperature of the coolant is homogenous at an end of the

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common tubing where the first and second sub-circuits depart from each other.

According to one embodiment, the temperature control system
5 comprises a control unit, wherein, at least in one mode of operation, the control unit is configured to control the output, as measured in volume per time unit, of the main circuit pump, the first pump of the first sub-circuit and the second pump of the at least one second sub-circuit, such that the sum of the output of
10 the first pump of the first sub-circuit and the output of the second pump of the at least one second sub-circuit exceeds the output of the main circuit pump. Thereby, the return flow of coolant in a section of the main circuit described above is achieved.

15 According to one embodiment, the temperature control system comprises:

- a first sensor configured to measure a parameter reflecting the temperature t_1 of said first component,
- a second sensor configured to measure a parameter reflecting the
20 temperature t_2 of said second component, and
- a control unit which is connected to the first sensor and to the second sensor and which is configured to control the operation of the first pump on basis of input received from the first sensor and to control the operation of the second pump on basis of input
25 received from the second sensor. The parameter reflecting the temperature may be the temperature itself (direct measurement) or any other parameter, such as a property of the component that reflects its temperature, for example electric current flowing through the component (indirect measurement). The control unit
30 may be configured to make a temperature prediction based on

repeated measurements by each sensor and thus to control the respective pump not only on basis of the momentary temperature indication but also on basis of a temperature change trend.

- 5 According to one embodiment, the control unit is connected to the pump of the main circuit and to the at least one unit for cooling or heating the coolant in the main circuit and is configured to control the operation of the pump of the main circuit and said unit for cooling or heating the coolant in the main circuit on basis of input
10 received from the first sensor and the second sensor.

According to one embodiment, the control unit is configured to activate the pump of the main circuit and/or said unit for cooling or heating the coolant in the main circuit, as a response to input
15 received from said first or second sensor, or from a sensor that measures the temperature of the coolant in the first sub-circuit and the second sub-circuit, that indicates that sufficient heating or cooling of the first component or second component is not achieved by control of the first and second pump.

20

According to one embodiment, the pump of the main circuit has a lower maximum output, measured in liters per minute, than the sum of the maximum output of the first and second pumps.

- 25 According to one embodiment, a portion of the tubing of the main circuit that presents the openings to which the first and second ends of the first and second sub-circuits are connected is separable from an upstream part of said tubing and a downstream part of said tubing by means of tubing connections via which it is
30 connected to said upstream part and downstream part

respectively. Said portion may thus be provided as an add-on component that could be added to an already existing system, which could then be provided with sub-circuits in accordance with the teaching of the present invention. Different such add-on
5 portions, provided with different numbers openings could be provided depending on the number of components that are to be cooled or heated by the temperature control system.

According to one embodiment, said first component and said
10 second component are components of a vehicle.

According to one embodiment, at least one of the first component and the second component is a battery for the accumulation of electric energy.
15

According to one embodiment, the first component has a preferred operation temperature range a-b, and the second component has a preferred operation temperature range c-d, and that a-b overlaps c-d.
20

The invention also relates to a vehicle, comprising a first component which has a preferred operating temperature range a-b, and at least one second component which has a preferred operating temperature range c-d, said vehicle being characterized
25 in that it comprises a temperature control system according to the present invention, wherein the first component is provided in connection to the first sub-circuit and configured to be heated or cooled by heat exchange with coolant flowing through the first sub-circuit, and wherein the second component is provided in
30 connection to the second sub-circuit and configured to be heated

or cooled by heat exchange with coolant flowing through the second sub-circuit.

- According to one embodiment, said first component and second
- 5 component is any one of
- a battery for accumulation of electric energy,
 - a compressor,
 - an electric heater device,
 - a condenser,
 - 10 -power electronics.

According to one embodiment, at least one of the first and second component is a battery for the accumulation of electric energy.

- 15 The invention also relates to a method of controlling the operation of a temperature control system as defined hereinabove or hereinafter, comprising the following steps:
- measuring a parameter reflecting the temperature t_1 of a first component,
 - 20 -comparing the measured parameter to a preferred operational temperature range $a-b$ of the first component,
 - controlling the output of the first pump on basis of said comparison such that $a < t_1 < b$,
 - measure a parameter reflecting the temperature t_2 of a second
 - 25 component,
 - comparing the measured parameter to a preferred operational temperature range $c-d$ of the second component,
 - controlling the output of the second pump on basis of said comparison such that $c < t_2 < d$, and
 - 30 repeating said steps continuously.

The method is preferably implemented by use of a control unit provided with a computer program comprising a computer program code causing a computer to implement the method as disclosed
5 hereinabove or hereinafter. The control unit preferably defines a computer program product that comprises storage medium which can be read by a computer and on which the program code is stored.

10 According to one embodiment, the method also comprises the following step.

-if any of the conditions $a < t_1 < b$ or $c < t_2 < d$ is not achieved by means of control of the output of the first pump or the second pump, controlling the operation of the pump of the main circuit and the
15 operation of the unit for cooling or heating the coolant in the main circuit in addition to controlling the output of the first and second pump such that $a < t_1 < b$ and $c < t_2 < d$.

Further features and advantages of the present invention are
20 presented in the following detailed description of an embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described
25 more in detail, by way of example, with reference to the drawing, on which:

Fig. 1 is a schematic representation of temperature control system according to the invention,

Fig. 2 is a schematic representation of an alternative embodiment
30 and

Fig. 3 is a flow chart showing essential steps of an embodiment of the method according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

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Fig. 1 is a schematic representation of a temperature control system according to the present invention. Preferably the temperature control system is arranged in a vehicle, such as a bus or truck, for the purpose of heating or cooling components, including masses of gas and/or masses of liquid. According to one embodiment, the temperature control system is configured to cool a plurality of batteries which are configured to operate as accumulators of electric energy and to act as an energy storage which is used for feeding one or more electric motors/engines configured for the propulsion of the vehicle.

The temperature control system comprises a main circuit 1 comprising tubing 2 in which there is provided a coolant. The system further comprises a main circuit pump 3 configured to pump said coolant through the tubing 2 of the main circuit 1 in a first direction, shown with an arrow in fig. 1. The temperature control system also comprises at least one unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1. Said unit 4, 5, 6 may comprise a fan-cooled radiator 4, a heater 5 and/or a cooler 6. The cooler 6 may comprise an evaporator via which the coolant exchanges heat with a refrigerant of a cooling system provided with a compressor, a condenser and said evaporator. In the shown embodiment, the radiator 4 is connected in parallel with the heater 5 and the cooler 6. A directing valve 26 is provided for controlling coolant flow to the radiator 4 and the heater 5 and cooler 6. Other

set ups and arrangements are of course conceivable. For example, the unit for heating or cooling may comprise at least one further circuit from which coolant of predetermined temperature is introduced into the main circuit. Such further circuits then, per
5 definition, becomes part of the main circuit disclosed in this application.

In addition to the main circuit 1, the temperature control system also comprises a first sub-circuit 7 for cooling or heating a first
10 component 8, said first sub-circuit comprising a tubing 9 that has a first end 10 and a second end 11, which are connected to respective openings in the tubing 2 of the main circuit at positions that are spaced apart from each other as seen in a longitudinal direction of the tubing of the main circuit. The first end 10 is
15 connected to the tubing 2 of the main circuit 1 at a position upstream the position at which the second end 11 is connected to the tubing 2 of the main circuit 1 as seen in said first direction.

The temperature control system also comprises a second sub-circuit 12 for cooling or heating a second component 13, said
20 second sub-circuit 12 comprising a tubing 14 that has a first end 15 and a second end 16, which are connected to respective openings in the tubing 2 of the main circuit 1 at positions that are spaced apart from each other as seen in a longitudinal direction of the tubing of the main circuit 1. The first end 15 is connected to the tubing 2 of the main circuit 1 at a position upstream the position at which the second end 16 is connected to the tubing 2 of the main circuit 1 as seen in said first direction.

. According to one embodiment, the first component 8 has a preferred operational temperature range a-b, and the second component 13 has a preferred operational temperature range c-d, wherein a-b overlaps c-d.

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There is also provided a sensor 25 for sensing the temperature of the coolant in a section of the main circuit situated between the common tubing section 27 and the second ends 11, 16 of the first and second sub-circuits 7, 12.. Alternatively the sensor 25 is
10 supplemented or replaced by corresponding sensors arranged for the measurement of the coolant temperature in the common tubing section 27 or in the first and second sub-circuits 7, 12 downstream the first ends 10, 15 of the first and second sub-circuits 7, 13, but upstream the first and second components 8, 13 as seen in the
15 flow directions generated in the first and second sub-circuits 7, 12.

Further to the above-mentioned features, the first sub-circuit 7 comprises a first pump 17 configured to pump a coolant in a direction from said first end 10 of the tubing 9 of the first sub-circuit 7 to the second end 11 of the first sub-circuit 7.
20

The second sub-circuit 12 comprises a second pump 18 configured to pump a coolant in a direction from said first end 15 of the tubing 14 of the second sub-circuit 12 to the second end 16 of the second
25 sub-circuit 12.

The first end 10 of the first sub-circuit 7 and the first end 15 of the second sub-circuit 12 are joined to a common tubing section 27 which in its turn is connected to the tubing 2 of the main circuit 1.

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The common tubing section 27 has a length which is sufficient for mixing in said common tubing section 27 a flow of coolant delivered by the main circuit pump 3 and a flow of coolant delivered by said first pump 17 of the first sub-circuit 7 and by said
5 second pump 18 of the second sub-circuit 12 such that the temperature of the coolant is homogenous, i.e. equal over a cross section of the common tubing section 27, at an end of the common tubing section 27 where the first and second sub-circuits 7, 12 depart from each other.

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The temperature control system further comprises a control unit 21. At least in one mode of operation, the control unit is configured 21 to control the output, as measured in volume per time unit, of the main circuit pump 3, the first pump 17 of the first sub-circuit 7
15 and the second pump 18 of the second sub-circuit 12, such that the sum of the output of the first pump 17 of the first sub-circuit 7 and the output of the second pump 18 of the second sub-circuit 12 exceeds the output of the main circuit pump 3.

20 In the alternative embodiment shown in fig. 2, the second end 11 of the first sub-circuit 7 and the second end 16 of the second sub-circuit 12 are joined to a second common tubing section 28 which in its turn is connected to the tubing 2 of the main circuit 1

25 The temperature control system further comprises a first sensor 19 configured to measure a parameter reflecting the temperature t_1 of said first component 8 and, a second sensor 20 configured to measure a parameter reflecting the temperature t_2 of said second component 13. The control unit 21 is connected to the first sensor
30 19 and to the second sensor 20 and is configured to control the

operation of the first pump 17 on basis of input received from the first sensor 19 and to control the operation of the second pump 18 on basis of input received from the second sensor 20.

- 5 The control unit 21 is connected to the pump 3 of the main circuit 1 and to the at least one unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1 and is configured to control the operation of the pump 3 of the main circuit 1 and said unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1 on basis of
10 input received from the first sensor 19 and the second sensor 20. The control unit 21 is also connected to and configured to control the directing valve 26.

The control unit 21 is configured to activate the pump 3 of the main
15 circuit 1 and/or said unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1, as a response to input received from said first or second sensor 19, 20 that indicates that sufficient heating or cooling of the first component 8 or second component 13 is not achieved by control of the first and second pump 17, 18.

20

A portion 22 of the tubing 2 of the main circuit 1 that presents the openings to which the first and second ends 10, 11, 15, 16 of the first and second sub-circuits 8, 12 are connected via the common tubing section 27 of the first ends 10, 15 (Fig.1 and 2) and the
25 common tubing section 28 of the second ends 11, 16 (Fig. 2) is separable from an upstream part of said tubing and a downstream part of said tubing 2 by means of tubing connections 23, 24 via which it is connected to said upstream part and downstream part respectively. The portion 22 carrying said openings thus forms an
30 easily replaceable unit which can be replaced to another

corresponding unit with another setup of openings, depending on the need.

According to some embodiments, the tubing connections 23, 24
5 may comprise one or more of a threaded connection, an o-ring, a gasket, a snap-fit arrangements, and the like. Moreover, according to some embodiments, the tubing connections 23, 24 may be be soldered, welded, glued, attached via vibration welding of plastic, or the like. The distance between the pump 3 of the main circuit 1
10 and a tubing connection 23 may be large or may be short. According to some embodiments, a tubing connection 23 may be attached directly onto an outlet conduit of the pump 3 of the main circuit 1.

15 Fig. 3 shows a flow chart in which steps of the method according to the present invention is presented. The method comprises the following steps:

Measuring the temperature t of the coolant downstream the second
20 ends 11, 16 of the first and second sub-circuits 7, 12 as seen in said first direction, either by measurement in said mixing zone and/or by individual measurement of the coolant temperature in the first and second sub-circuits 7, 12 downstream the first ends 10, 15 of the first and second sub-circuits 7, 12, but upstream the
25 first and second components 8, 13, box S1.

Comparing the measured coolant temperature t with a preferred operational temperature range $a-b$ of the first component 8 and with a preferred operation temperature range $c-d$ of the second
30 component 13, box S2.

If the measured coolant temperature t is outside the ranges a - b and/or c - d , then operation of the pump 3 of the main circuit 1 and said unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1 should be controlled such that the measured coolant temperature t becomes inside said ranges a - b and c - d , box S3.

Measuring a first parameter reflecting the temperature t_1 of the first component 8 in the first sub-circuit, and measuring a second parameter reflecting the temperature t_2 of the second component 13 in the second sub-circuit, box S4.

Comparing the temperature t_1 reflected by the first measured parameter to the preferred operational temperature range a - b of the first component 8, to determine if $a < t_1 < b$, and comparing the temperature t_2 reflected by the second measured parameter to the preferred operation temperature range c - d of the second component 13 to determine if $c < t_2 < d$, box S5.

If $a < t_1 < b$ is not fulfilled, controlling the output of the first pump 17 of the first sub-circuit 7 on basis of said comparison such in order to obtain that $a < t_1 < b$, and if $c < t_2 < d$, controlling the output of the second pump 18 on basis of said such that $c < t_2 < d$, box S6.

These steps are preferably performed by the action of the control unit 21 in interaction with the first and second sensors 19, 20, the sensor 25 for measuring the coolant temperature, the pump 3 in the main circuit 1, the unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1, and the first and second pumps 17, 18.

It should be stated that if the temperature t of the coolant is not within the ranges a-b and c-d, this will be interpreted by the control unit 21 as an indication that sufficient heating or cooling of the first component 8 or second component 13 is not achieved by control
5 of the first and second pumps 17, 18 alone, but that added functionality of the pump 3 in the main circuit 1 and the unit 4, 5, 6 for cooling or heating the coolant in the main circuit 1 is needed.

Although the invention has been exemplified only by showing an
10 embodiment in which there are only two sub-circuits it should be understood that the intended scope of protection also includes solutions in which there are numerous such sub-circuits, and by means of which the temperature of a plurality of components, including batteries, are controlled. Controlling the temperature of
15 a component also includes controlling the temperature of a mass of gas or liquid, preferably by controlling the temperature of a component that in its turn affects the temperature of the mass of gas or liquid.

20 It should be added that of course, the claimed scope of protection also covers designs in which there are further components/parts in each respective circuit. Such components/parts may be provided serially or in parallel with the components/parts that have been disclosed in this disclosure.

CLAIMS

1. A temperature control system for a vehicle, comprising
- a main circuit (1) comprising a tubing (2) in which there is provided a coolant, a main circuit pump (3) configured to pump said coolant through the tubing (2) of the main circuit (1) in a first direction, and at least one unit (4, 5, 6) for cooling or heating the coolant in the main circuit (1),
 - a first sub-circuit (7) for cooling or heating a first component (8), said first sub-circuit (7) comprising a tubing (9) that has a first end (10) and a second end (11), which are connected to respective openings in the tubing (2) of the main circuit (1) at positions that are spaced apart from each other as seen in a longitudinal direction of the tubing (2) of the main circuit (1), wherein the first end (10) is connected to the tubing (2) of the main circuit (1) at a position upstream the position at which the second end (11) is connected to the tubing (2) of the main circuit (1) as seen in said first direction, and
 - at least one second sub-circuit (12) for cooling or heating a second component (13), said second sub-circuit (12) comprising a tubing (14) that has a first end (15) and a second end (16), which are connected to respective openings in the tubing (2) of the main circuit (1) at positions that are spaced apart from each other as seen in a longitudinal direction of the tubing (2) of the main circuit (1), wherein the first end (15) is connected to the tubing (2) of the main circuit (1) at a position upstream the position at which the second end (16) is connected to the tubing (2) of the main circuit (1) as seen in said first direction,
 - wherein

- the first sub-circuit (7) comprises a first pump (17) configured to pump a coolant in a direction from said first end (10) of the tubing (9) of the first sub-circuit (7) to the second end (11) thereof, and
- the second sub-circuit (12) comprises a second pump (18) configured to pump a coolant in a direction from said first end (15) of the tubing (14) of the second sub-circuit (12) to the second end (16) thereof, said temperature control system being **characterized in** that the first end (10) of the first sub-circuit (7) and the first end (15) of the at least one second sub-circuit (12) are joined to a common tubing section (27) which in its turn is connected to the tubing (2) of the main circuit (1).

2. A temperature control system according to claim 1, **characterized in** that it said common tubing section (27) has a length which is sufficient for mixing in said common tubing section (27) a flow of coolant delivered by the main circuit pump (3) and a flow of coolant delivered by said first pump (17) of the first sub-circuit (7) and by said second pump (18) of the at least one second sub-circuit (12) such that the temperature of the coolant is homogenous at an end of the common tubing section (27) where the first and second sub-circuits (7, 12) depart from each other.

3. A temperature control system according to claim 1 or 2, **characterized in** that it comprises a control unit (21), and that, at least in one mode of operation, the control unit (21) is configured to control the output, as measured in volume per time unit, of the main circuit pump (3), the first pump (17) of the first sub-circuit (7) and the second pump (18) of the at least one second sub-circuit (12), such that the sum of the output of the first pump (17) of the first sub-circuit (7) and the output of the second pump (18) of the

at least one second sub-circuit (12) exceeds the output of the main circuit pump (3).

4. A temperature control system according to claim any one of
5 claims 1-3, **characterized in** that it comprises
- a first sensor (19) configured to measure a parameter reflecting the temperature t_1 of said first component (8),
 - a second sensor (20) configured to measure a parameter reflecting the temperature t_2 of said second component (13), and
 - 10 -a control unit (21) which is connected to the first sensor (19) and to the second sensor (20) and which is configured to control the operation of the first pump (17) on basis of input received from the first sensor (19) and to control the operation of the second pump (18) on basis of input received from the second sensor (20).

15

5. A temperature control system according to claim 4, **characterized in** that the control unit (21) is connected to the pump of the main circuit (1) and to the at least one unit (4, 5, 6) for cooling or heating the coolant in the main circuit (1) and is
20 configured to control the operation of the pump (3) of the main circuit (1) and said unit (4, 5, 6) for cooling or heating the coolant in the main circuit (1) on basis of input received from the first sensor (19) and the second sensor (20).

- 25 6. A temperature control system according to claim 5, **characterized in** that the control unit (21) is configured to activate the pump (3) of the main circuit (1) and/or said unit (4, 5, 6) for cooling or heating the coolant in the main circuit (1), as a response to input received from said first or second sensor (19, 20), or from
30 a sensor (25) that measures the temperature of the coolant in the

first sub-circuit (7) and the second sub-circuit (12), that indicates that sufficient heating or cooling of the first component (8) or second component (13) is not achieved by control of the first and second pump (17, 18).

5

7. A temperature control system according to any one of claims 1-6, **characterized in** that the pump (3) of the main circuit (1) has a lower maximum output, measured in liters per minute, than the sum of the maximum output of the first and second pumps (17, 18).

10

8. A temperature control system according to any one of claims 1-7, **characterized in** that a portion (22) of the tubing (2) of the main circuit (1) that presents the openings to which the first and second ends (10, 11, 15, 16) of the first and second sub-circuits (7, 12) are connected is separable from an upstream part of said tubing (2) and a downstream part of said tubing by means of tubing connections (23, 24) via which it is connected to said upstream part and downstream part respectively.

20

9. A temperature control system according to any one of claims 1-8, **characterized in** that said first component (8) and said second component (13) are components of a vehicle.

25

10. A temperature control system according to claim 9, **characterized in** that at least one of first component (8) and the second component (13) is a battery for the accumulation of electric energy.

30

11. A temperature control system according to any one of claims 1-10, **characterized in** that the first component (8) has a preferred

operation temperature range a-b, and the second component (13) has a preferred operation temperature range c-d, and that a-b overlaps c-d.

5 12. A vehicle, comprising a first component (8) which has a preferred operating temperature range a-b, and at least one second component (13) which has a preferred operating temperature range c-d, said vehicle being **characterized in** that it comprises a temperature control system according to any one of
10 claims 1-11, wherein the first component (8) is provided in connection to the first sub-circuit (7) and configured to be heated or cooled by heat exchange with coolant flowing through the first sub-circuit (7), and wherein the second component (13) is provided in connection to the second sub-circuit (12) and configured to be
15 heated or cooled by heat exchange with coolant flowing through the second sub-circuit (12).

13. A vehicle according to claim 12, **characterized in** that said first component (8) and second component (13) is any one of
20 -a battery for accumulation of electric energy,
-a compressor,
-an electric heater device,
-a condenser,
-power electronics.

25

14. A vehicle according to claim 13, **characterized in** that at least one of the first and second component (8, 13) is a battery for the accumulation of electric energy.

15. A method of controlling the operation of a temperature control system according to any one of claims 1-11, comprising the following steps:

- 5 - measuring a parameter reflecting the temperature t_1 of a first component (8),
- comparing the measured parameter to a preferred operational temperature range a-b of the first component (8),
- controlling the output of the first pump on basis of said comparison such that $a < t_1 < b$,
- 10 -measure a parameter reflecting the temperature t_2 of a second component (13),
- comparing the measured parameter to a preferred operational temperature range c-d of the second component (13),
- controlling the output of the second pump on basis of said comparison such that $c < t_2 < d$, and repeating said steps
- 15 continuously.

16. A method according to claim 15, comprising the following step.

- 20 -if any of the conditions $a < t_1 < b$ or $c < t_2 < d$ is not achieved by means of control of the output of the first pump or the second pump, controlling the operation of the pump of the main circuit (1) and the operation of the unit for cooling or heating the coolant in the main circuit (1) in addition to controlling the output of the first and
- 25 second pump such that $a < t_1 < b$ and $c < t_2 < d$.

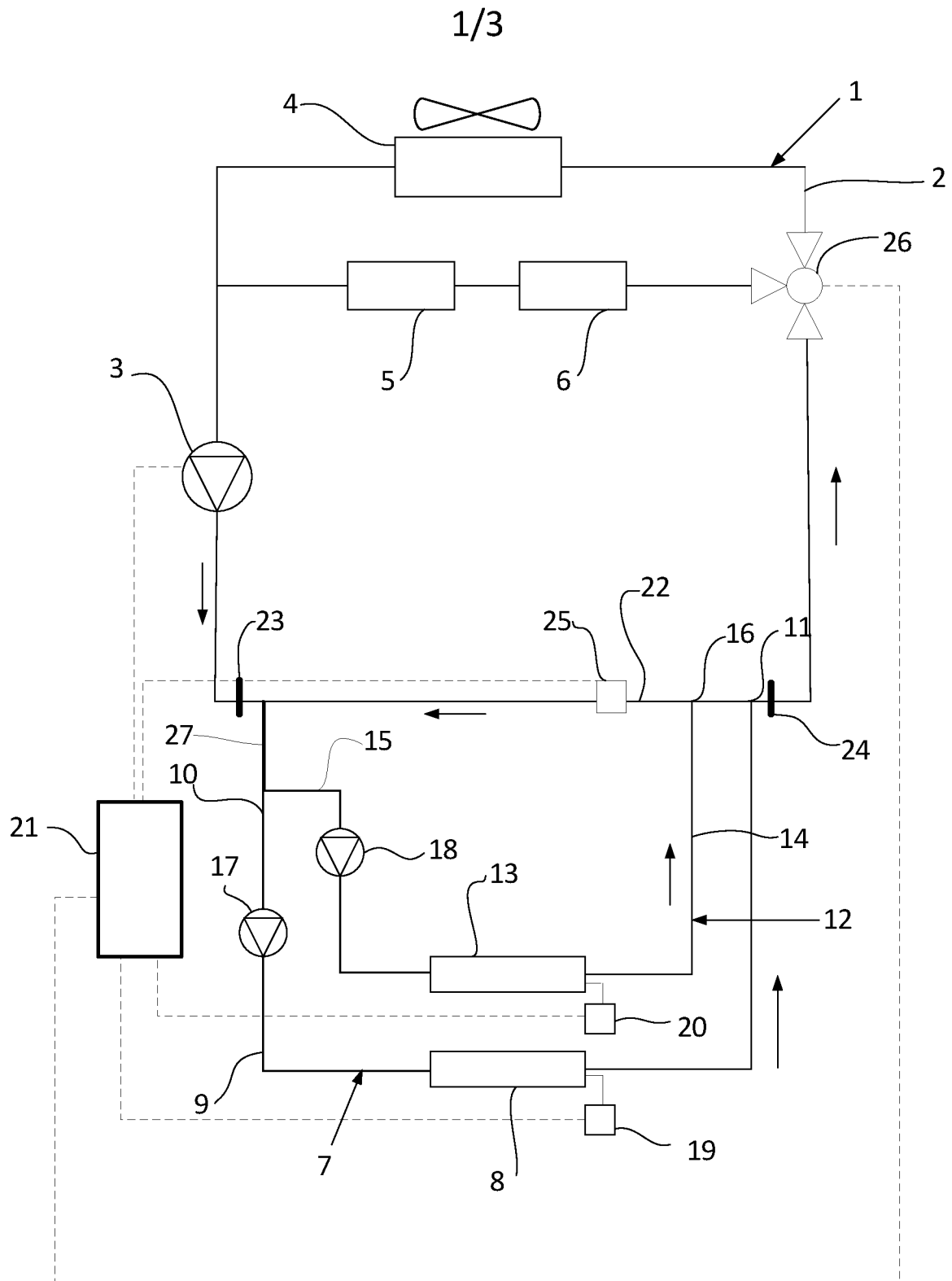


Fig. 1

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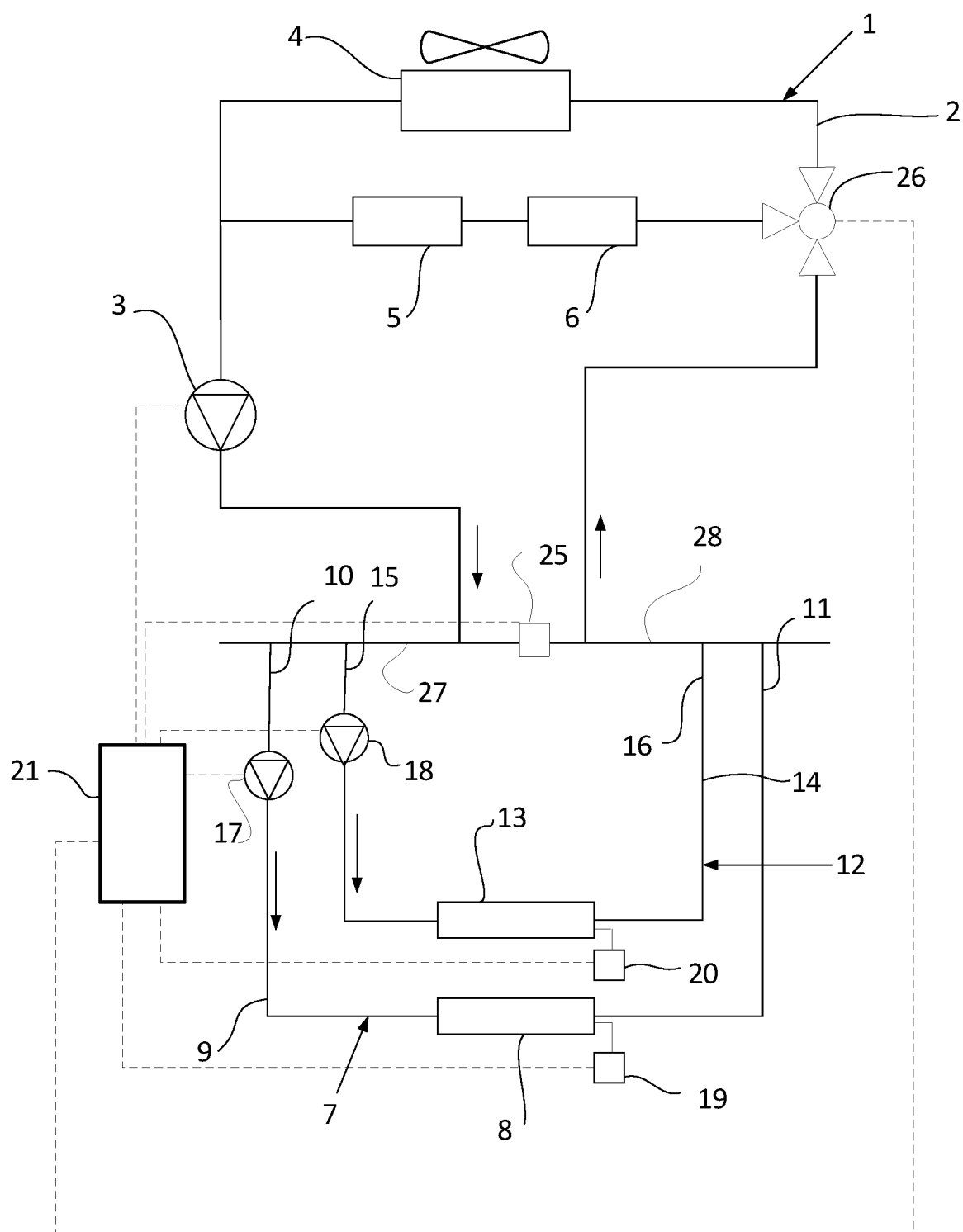
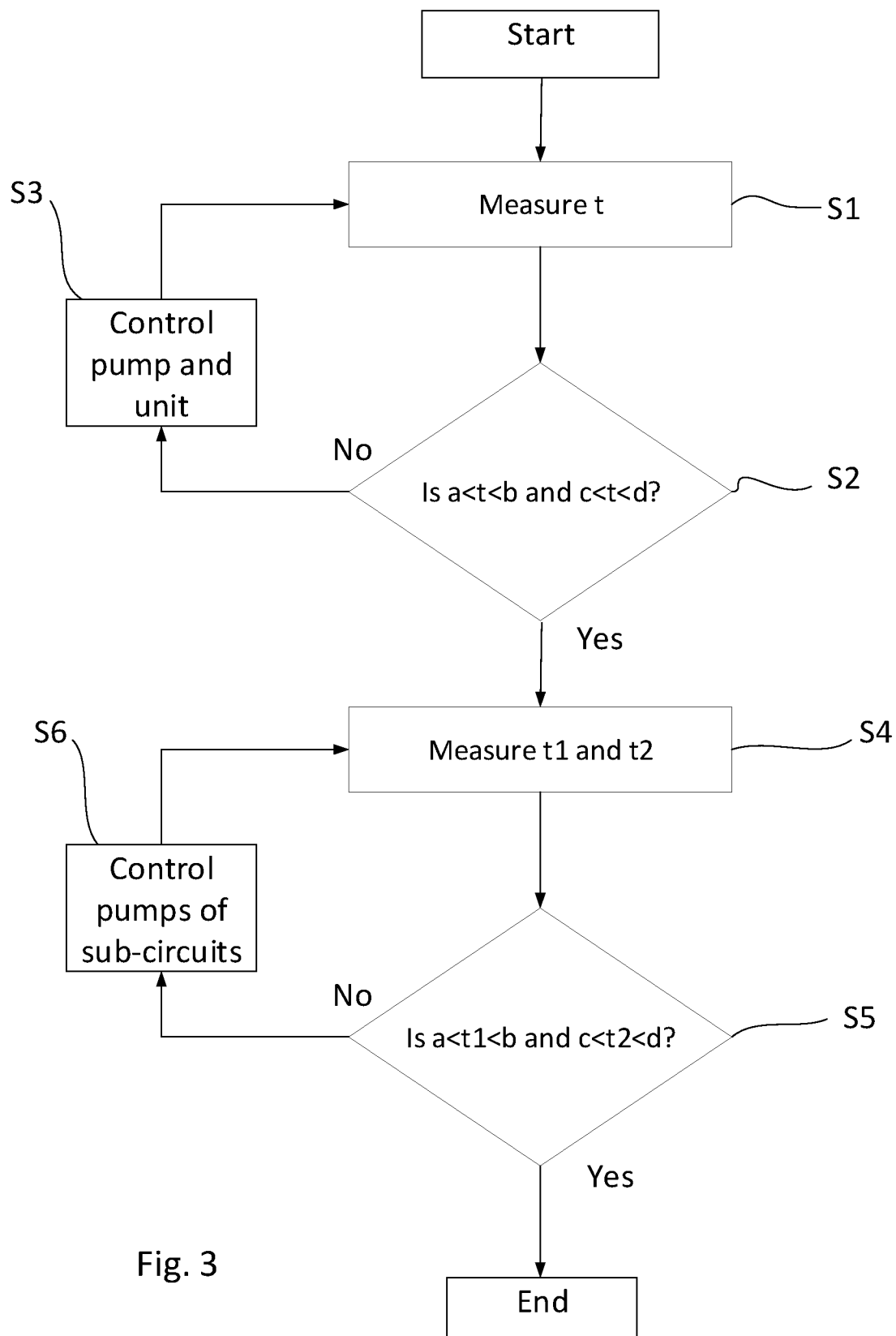


Fig. 2

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2021/050228

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: B60K, F01P, H01M

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

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X	US 20180163607 A1 (UTO HAJIME ET AL), 14 June 2018 (2018-06-14); abstract; paragraphs [0027]-[0029], [0031]-[0042], [0057], [0075]-[0077]; figures 1,6a --	1-4, 7, 9-15
X	DE 102018207852 A1 (SIEMENS AG), 21 November 2019 (2019-11-21); abstract; paragraph [0033]; figures 1,2 --	1, 9, 12
X	US 20160031288 A1 (NISHIKAWA MICHIO ET AL), 4 February 2016 (2016-02-04); abstract; paragraphs [0205]-[0231], [0271]; figure 20 --	1, 9, 12

☒ 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
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"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 01-04-2021	Date of mailing of the international search report 06-04-2021
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 Jonas Kronqvist Telephone No. + 46 8 782 28 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2021/050228

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	FR 2799505 A1 (PEUGEOT CITROEN AUTOMOBILES SA), 13 April 2001 (2001-04-13); abstract; page 5, line 32 - page 6, line 2; figure 1 --	1-16
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Continuation of: second sheet

International Patent Classification (IPC)

F01P 7/16 (2006.01)

B60K 11/02 (2006.01)

F01P 3/20 (2006.01)

F01P 5/10 (2006.01)

H01M 10/625 (2014.01)

H01M 10/6568 (2014.01)

H01M 10/663 (2014.01)

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