

A METHOD AND A SYSTEM FOR DETERMINING A VOLUME OF LIQUID IN A CONTAINER BASED ON MEAN TEMPERATURE CHANGE RATE

TECHNICAL FIELD

5 The present invention relates to a method for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided. More particularly, the invention relates to a method for determining a volume of a reducing agent in a container of an SCR-system. The invention relates also to a computer program product comprising program code for a computer for implementing a method according to the invention. It relates also to a
10 system for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided and a motor vehicle equipped with the system. More particularly, the invention relates to a system for determining a volume of a reducing agent in a container of an SCR-system.

15 BACKGROUND

Vehicles today use, for example, urea as reducing agent in SCR (selective catalytic reduction) systems which comprise an SCR catalyst in which said reducing agent and NO_x gas can react and be converted to nitrogen gas and water. Various types of reducing agents may be used
20 in SCR systems. AdBlue is an example of a commonly used reducing agent.

One type of SCR system comprises a container which holds a reducing agent. The system has also a pump adapted to drawing said reducing agent from the container via a suction hose and supplying it via a pressure hose to a dosing unit situated adjacent to an exhaust system
25 of the vehicle. The dosing unit is adapted to injecting a necessary amount of reducing agent into the exhaust pipe upstream of the SCR catalyst according to operating routines which are stored in a control unit of the vehicle. To make it easier to regulate the pressure when there are small or no dosing amounts, the system comprises also a return hose which runs back to the container from a pressure side of the system.

Said container is arranged with a volume measuring arrangement for measuring a prevailing volume of said reducing agent. According to one example there is provided a floater based measuring device being arranged on a rigid elongated member. This rigid elongated member comprises electronics to as to detect a position of said floater based measuring device and
5 thus detect said volume of said reducing agent in said container. This method works satisfactory in cases where said container is relatively high, whereby said volume measuring arrangement may detect said volume with relative high accuracy. However, in cases where said container is relatively low measuring accuracy is decreased, due to movement of said reducing agent during propulsion of said vehicle.

- 10 US20080087009 relates to a method for detecting volume of a reducing agent in a container by means of a temperature sensitive reducing agent sensor.

SUMMARY OF THE INVENTION

- 15 An object of the present invention is to propose a novel and advantageous method for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided.

- Another object of the invention is to propose a novel and advantageous system and a novel
20 and advantageous computer program for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided.

An object of the present invention is to propose a novel and advantageous method for determining a volume of a reducing agent in a container of an SCR-system.

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Another object of the invention is to propose a novel and advantageous system and a novel and advantageous computer program for determining a volume of a reducing agent in a container of an SCR-system.

Yet another object of the invention is to propose a method, a system and a computer program which achieve an efficient and accurate determination of a volume of a liquid in a container.

- 5 Yet another object of the invention is to propose a method, a system and a computer program for achieving a robust, reliable and cost-effective determination of a volume of a liquid in a container of an SCR-system.

- 10 Yet another object of the invention is to propose an alternative method, an alternative system and an alternative computer program for determining a volume of a liquid in a container.

- Yet another object of the invention is to propose an alternative method, an alternative system and an alternative computer program for determining a volume of a reducing agent
15 in a container of an SCR-system.

- Some of these objects are achieved with a method for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided according to claim 1. Other objects are achieved with a system according to claim 6. Advantageous embodiments
20 are depicted in the dependent claims. Substantially the same advantages of method steps of the innovative method hold true for corresponding means of the innovative system.

- According to an aspect of the invention there is provided a method for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided,
25 comprising the steps of:

- determining a prevailing temperature of said liquid;
- determining a prevailing temperature of said heat transfer provision arrangement; and
- determining a prevailing temperature of a medium surrounding said container;
- for a predetermined time period, determining a mean temperature change rate for said
30 liquid; and

- determining said volume of liquid in said container on the basis of said mean temperature change rate, said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container.

5 Hereby a reliable, accurate and robust method for determining a prevailing volume of said liquid in said container is achieved. Hereby a method for determining said volume of said liquid in said container considering heat transfer from said heat transfer provision arrangement via said liquid and container to a surrounding medium of the container is advantageously achieved. Hereby a method for determining said volume of said liquid in said container considering heat transfer from said surrounding medium of the container via said
10 container and liquid to said heat transfer provision arrangement is advantageously achieved. Hereby a versatile method is achieved.

The method may comprise the step of:

- determining a specified development of a connection between said volume and said mean temperature change rate as a basis for said determination of said volume for said prevailing
15 temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container. Said specified development of a connection between said volume and said mean temperature change rate may be a predetermined development. Hereby a reliable, accurate and robust method for determining a prevailing volume of said liquid in said container is achieved.

20 At the innovative method said mean temperature change rate for said liquid may be a continuous temperature increase or a continuous temperature decrease. Hereby a versatile method for determining a method for determining said volume of said liquid is achieved.

The method may comprise the step of:

- providing a flow of a liquid of a substantially constant temperature in a pipe arrangement
25 of said heat transfer provision arrangement during said predetermined time period. This provides for an effective heat transfer between said heat transfer provision arrangement and said liquid, which advantageously provides a possibility to determine said volume within a relatively short period of time.

The method may comprise the step of:

- choosing said predetermined time period to provide a temperature change for said liquid of at least about 2-10 degrees Celsius. Hereby a versatile method for determining a method for determining said volume of said liquid is achieved. Hereby a reliable, accurate and robust method for determining a prevailing volume of said liquid in said container is achieved.

5 According to an embodiment there is provided a method for determining a volume of a reducing agent in a container of an SCR-system in which container a heat transfer provision arrangement is provided, comprising the steps of:

- determining a prevailing temperature of said reducing agent;

- determining a prevailing temperature of said heat transfer provision arrangement; and

10 - determining a prevailing temperature of a medium surrounding said container;

- for a predetermined time period, determining a mean temperature change rate for said reducing agent; and

- determining said volume of reducing agent in said container on the basis of said mean temperature change rate, said prevailing temperature of said heat transfer provision

15 arrangement and said prevailing temperature of said medium surrounding said container.

According to an aspect of the invention there is provided a system for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided, comprising:

20 - means for determining a prevailing temperature of said liquid;

- means for determining a prevailing temperature of said heat transfer provision arrangement;

- means for determining a prevailing temperature of a medium surrounding said container;

- means for determining a mean temperature change rate for said liquid regarding a
25 predetermined time period; and

- means for determining said volume of liquid in said container on the basis of said mean temperature change rate, said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container.

The system may comprise:

- 5 - means for determining a specified development of a connection between said volume and said mean temperature change rate as a basis for said determination of said volume for said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container.

At the system said mean temperature change rate for said liquid is a continuous
10 temperature increase or a continuous temperature decrease.

The system may comprise:

- means for providing a flow of a liquid of a substantially constant temperature in a pipe arrangement of said heat transfer provision arrangement during said predetermined time period.

15 The system may comprise:

- means for choosing said predetermined time period to provide a temperature change for said liquid of at least about 2-10 degrees Celsius

According to an embodiment there is provided a system for determining a volume of a reducing agent in a container of an SCR-system in which container a heat transfer provision
20 arrangement is provided, comprising:

- means for determining a prevailing temperature of said reducing agent;

- means for determining a prevailing temperature of said heat transfer provision arrangement; and

- means for determining a prevailing temperature of a medium surrounding said container;

25 - means for determining a mean temperature change rate for said reducing agent regarding a predetermined time period; and

- means for determining said volume of reducing agent in said container on the basis of said mean temperature change rate, said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container.

- 5 According to an aspect of the invention there is provided a vehicle comprising a system according to what is presented herein. Said vehicle may be a motor vehicle. Said vehicle may be any from among a truck, bus or passenger car. According to an embodiment the system is provided for a marine application or industrial application.

10 According to an aspect of the invention there is provided a computer program for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided, wherein said computer program comprises program code for causing an electronic control unit or a computer connected to said electronic control unit to perform the steps according to anyone of the claims 1-5, when run on said electronic control unit or said computer.

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According to an aspect of the invention there is provided a computer program for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided, wherein said computer program comprises program code stored on a computer-readable medium for causing an electronic control unit or a computer connected to said
20 electronic control unit to perform the steps according to anyone of the claims 1-5.

According to an aspect of the invention there is provided a computer program for determining a volume of liquid in a container in which a heat transfer provision arrangement is provided, wherein said computer program comprises program code stored on a computer-
25 readable medium for causing an electronic control unit or a computer connected to said electronic control unit to perform the steps according to anyone of the claims 1-5, when run on said electronic control unit or said computer.

According to an aspect of the invention there is provided a computer program product
30 containing a program code stored on a computer-readable medium for performing method

steps according to anyone of claims 1-5, when said computer program is run on an electronic control unit or a computer connected to said electronic control unit.

According to an aspect of the invention there is provided a computer program product

- 5 containing a program code stored non-volatile on a computer-readable medium for performing method steps according to anyone of claims 1-5, when said computer program is run on an electronic control unit or a computer connected to said electronic control unit.

Further objects, advantages and novel features of the present invention will become
10 apparent to one skilled in the art from the following details, and also by putting the invention into practice. Whereas the invention is described below, it should be noted that it is not confined to the specific details described. One skilled in the art having access to the teachings herein will recognise further applications, modifications and incorporations in other fields, which are within the scope of the invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

For fuller understanding of the present invention and its further objects and advantages, the detailed description set out below should be read in conjunction with the accompanying
20 drawings, in which the same reference notations denote similar items in the various diagrams, and in which:

Figure 1 schematically illustrates a vehicle according to an embodiment of the invention;

Figure 2a schematically illustrates a subsystem for the vehicle depicted in Figure 1, according
25 to an embodiment of the invention;

Figure 2b schematically illustrates a subsystem for the vehicle depicted in Figure 1, according to an embodiment of the invention;

Figure 2c schematically illustrates a container being provided with a heat transfer provision arrangement;

30 Figure 3 schematically illustrates a diagram presenting a volume of a liquid as a function of temperature change rate, according to an embodiment of the invention;

Figure 4a is a schematic flowchart of a method according to an embodiment of the invention;

Figure 4b is a more detailed schematic flowchart of a method according to an embodiment of the invention; and

5 Figure 5 schematically illustrates a computer according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 depicts a side view of a vehicle 100. The exemplified vehicle 100 comprises a tractor
10 unit 110 and a trailer 112. The vehicle may be a heavy vehicle, e.g. a truck or a bus. It may alternatively be a car.

It should be noted that the invention is suitable for application in various systems comprising a container holding a liquid and a heat transfer arrangement. It should be noted that the
15 invention is suitable for application in any SCR system and is therefore not confined to SCR systems of motor vehicles. The innovative method and the innovative system in one aspect of the invention are well suited to other platforms which comprise an SCR system than motor vehicles, e.g. watercraft. The watercraft may be of any kind, e.g. motor boats, steamers, ferries or ships.

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The innovative method and the innovative system according to one aspect of the invention are also well suited to, for example, systems which comprise industrial engines and/or engine-powered industrial robots.

25 The innovative method and the innovative system according to one aspect of the invention are also well suited to various kinds of power plants, e.g. an electric power plant which comprises an engine-powered generator.

The innovative method and the innovative system are also well suited to any engine system
30 which comprises an engine and an SCR system, e.g. on a locomotive or some other platform.

The innovative method and the innovative system are also well suited to any system which comprises a NO_x generator and an SCR-system.

The term "link" refers herein to a communication link which may be a physical connection
5 such as an opto-electronic communication line, or a non-physical connection such as a wireless connection, e.g. a radio link or microwave link.

The term "line" refers herein to a passage for holding and conveying a fluid, e.g. a reductant in liquid form. The line may be a pipe of any desired size and be made of any suitable
10 material, e.g. plastic, rubber or metal.

The term "reductant" or "reducing agent" refers herein to an agent used for reacting with certain emissions in an SCR system. These emissions may for example comprise NO_x gas. The terms "reductant" and "reducing agent" are herein used synonymously. In one version, said
15 reductant is so-called AdBlue. Other kinds of reductants may of course be used. AdBlue is herein cited as an example of a reductant, but one skilled in the art will appreciate that the innovative method and the innovative SCR system are feasible with other types of reductants, subject to necessary adaptations in control algorithms for executing program code in accordance with the innovative method.

Figure 2a depicts a subsystem 299 of the vehicle 100. The subsystem 299 is situated in the tractor unit 110. It may be part of an SCR system. It comprises in this example a container 205 arranged to hold a reductant. The container 205 is adapted to contain a suitable amount of reductant and also to being replenishable as necessary. The container 205 is depicted in
25 greater detail with reference to Figure 2c.

A first line 271 is adapted to leading the reductant to a pump 230 from the container 205. The pump 230 may be any suitable pump. It may be adapted to being driven by an electric motor. It is adapted to drawing the reductant from the container 205 via the first line 271
30 and supplying it via a second line 272 to a dosing unit 250. The dosing unit 250 may comprise an electrically operated dosing valve by means of which a flow of reductant added to the exhaust system can be controlled. The pump 230 is adapted to pressurising the reductant in

the second line 272. Said dosing unit 250 is provided with a throttle unit against which said pressure of the reductant is built up in the subsystem 299.

The dosing unit 250 is arranged to supply said reducing agent to an exhaust gas system (see Figure 2b) of the vehicle 100. In particular the dosing unit 250 is arranged to in a controlled way supply a suitable amount of reducing agent to an exhaust gas system of the vehicle 100. An SCR-unit 260 (see Figure 2b) is arranged downstream of a position of the exhaust gas system where injection of reducing agent is achieved by means of the dosing unit 250.

A third line 273 runs between the dosing unit 250 and the container 205. The third line 273 is arranged to lead back a certain amount of reducing agent which been feed to the dosing unit 250 to the container 205. With this configuration there is advantageously achieved cooling of the dosing unit 250. In this way the dosing unit 250 is cooled by means of a flow of the reducing agent as this is fed through the dosing unit 250 from the pump 230 to the container 205.

The first control unit 200 is arranged for communication with the pump 230 via a link L292 and is adapted to control the operation of the pump 230 in order to for example regulate flows of reductant within the subsystem 299. The first control unit 200 is adapted to controlling an operating power of the pump 230 by regulating the electric motor associated with said pump 230.

The first control unit 200 is arranged for communication with the dosing unit 250 via a link L250 and is adapted to controlling the operation of the dosing unit 250 in order for example to regulate the supply of reductant to the exhaust gas system of the vehicle 100. The first control unit 200 is adapted to controlling the operation of the dosing unit 250 in order for example to regulate the supply of reductant back to the container 205.

A second control unit 210 is arranged for communication with the first control unit 200 via a link L210 and may be detachably connected to it. It may be a control unit external to the vehicle 100. It may be adapted to conducting the innovative method steps according to the invention. The second control unit 210 may be arranged to perform the inventive method

steps according to the invention. It may be used to cross-load software to the first control unit 200, particularly software for conducting the innovative method. It may alternatively be arranged for communication with the first control unit 200 via an internal network on board the vehicle. It may be adapted to performing substantially the same functions as the first control unit 200, such as determining said volume of liquid in said container on the basis of said mean temperature change rate, said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container. This is depicted in greater detail below. The innovative method may be conducted by the first control unit 200 or the second control unit 210, or by both of them.

Figure 2b schematically illustrates a portion of an SCR-system 289 of the vehicle 100 shown in Figure 1.

An engine 231 is during operation generating an exhaust gas flow which is lead via a first passage 235 to an SCR-unit 260. Said engine 231 may be a combustion engine. A second passage 245 is arranged to lead exhaust gas from said SCR-unit 260 to an ammonia slip catalyst 265. A third passage 245 is arranged to lead exhaust gas from said ammonia slip catalyst 265 to a surrounding of said SCR-system 289/vehicle 100

Said SCR-system 289 may also comprise a DPF-unit (Diesel Particulate Filter) and/or a DOC-unit (Diesel Oxidation Unit). These units may be arranged at the first passage 235.

The first control unit 200 is arranged for communication with said engine 231 via a link L231. The first control unit 200 is arranged to control operation of the engine 231 according to stored operational routines. The first control unit 200 is arranged to control operation of the dosing unit 250 for injecting reducing agent into the first passage 235.

Figure 2c schematically illustrates the container 205 in greater detail. Said container 205 is arranged to hold a liquid, such as a reducing agent. Herein is presented said first line 271 which is arranged to convey said liquid to said pump 230. Herein is presented said third line

273 which is arranged to convey said liquid back to said container 205 from said dosing unit 205.

Said container 205 is arranged with a volume measuring device 290. Said volume measuring device comprises a floater based measuring unit being arranged on a rigid elongated member for slideably holding said floater based measuring unit. Alternatively an ultrasonic based measuring unit is provided in said container for determining said prevailing volume of said liquid. Said rigid elongated member comprises electronics for detecting a prevailing position, corresponding to a prevailing volume of said liquid, as the floater based measuring device is floating on a surface on said liquid. Hereby signals comprising said volume information is transmitted to said first control unit 200 via a link (not shown). Said first control unit is according to an example compare a value of said volume determined by means of said volume measuring device 290 with a value of a volume determined according to the innovative method. Hereby said first control unit is arranged to perform various diagnose procedures on the basis of said comparison. It may e.g. be determined if it is likely that said floater based measuring device 290 has got stuck on said rigid elongated member and thus is measuring said volume inadequately.

A heat transfer provision arrangement 240 is arranged in said container 205. Said heat transfer provision arrangement 240 comprises a line, also referred to as pipe arrangement, for conveying a fluid for heat transfer to/from said liquid in said container. According to this example said fluid is flowing in said line in a closed circuit from said engine 231 via said heat transfer provision arrangement 240 and back to said engine 231. Said heat transfer provision arrangement 240 may advantageously at least partly present a helical form surrounding said rigid elongated member so as to more efficiently allow said heat transfer to/from said liquid. Said fluid may be cooling water from said engine 231. According to one embodiment said cooling water is heated from cooling said engine 231 and thus present a relatively high temperature, or at least a higher temperature than said liquid. Hereby said liquid is heated by means of said heat transfer provision arrangement 240.

A first temperature sensor 241 is arranged to measure a prevailing temperature T1 of said liquid. Said first temperature sensor 241 is arranged for communication with said first control unit 200 via a link L241. Said first temperature sensor 241 is arranged to continuously

or intermittently send signals S1 comprising information about said prevailing temperature T1 of said liquid to said first control unit 200 via said link L241. Said first temperature sensor 241 may be arranged at the bottom of said container 205.

5 A second temperature sensor 242 is arranged to measure a prevailing temperature Tf of said fluid in said heat transfer provision arrangement 240. Said second temperature sensor 242 is arranged for communication with said first control unit 200 via a link L242. Said second temperature sensor 242 is arranged to continuously or intermittently send signals S2 comprising information about said prevailing temperature Tf of said fluid of said heat transfer provision arrangement 240 to said first control unit 200 via said link L242. Said
10 second temperature sensor 242 may be arranged at an inlet side of said heat transfer provision arrangement 240 at the container 205. According to an example said prevailing temperature Tf of said fluid in said heat transfer provision arrangement 240 is used by said first control unit 200 to determine a prevailing temperature T2 of said heat transfer provision arrangement 240. This may be performed by means of a model stored in a
15 memory of said first control unit 200. According to one example it is assumed that said heat transfer provision arrangement 240 has substantially the same temperature as said fluid. According to this example said prevailing temperature Tf of said fluid is set to be said second temperature T2 of said heat transfer provision arrangement 240.

A third temperature sensor 243 is arranged to measure a prevailing temperature T3 of a
20 surrounding medium of said container 205. Said third temperature sensor 243 is arranged for communication with said first control unit 200 via a link L243. Said third temperature sensor 243 is arranged to continuously or intermittently send signals S3 comprising information about said prevailing temperature T3 of said surrounding medium to said first control unit 241 via said link L243. Said third temperature sensor 243 may be arranged in a
25 close proximity of said container 205.

Hereby said first control unit 200 is arranged to, for a predetermined time period, determine a mean temperature change rate Tprim for said liquid. This may be a mean time derivative of said first temperature T1 regarding said predetermined time period of heat transfer between said heat transfer provision arrangement 240 and said liquid.

Hereby said first control unit 200 is arranged to determine said volume of said liquid in said container 205 on the basis of said mean temperature change rate T_{prim} , said prevailing temperature T_2 of said heat transfer provision arrangement 240 and said prevailing temperature T_3 of said medium surrounding said container 205. This is depicted in greater
5 detail with reference to Figure 3.

Hereby said first control unit 200 is arranged to determine a specified development of a connection between said volume V and said mean temperature change rate T_{prim} as a basis for said determination of said volume V for said prevailing temperature T_2 of said heat transfer provision arrangement 240 and said prevailing temperature T_3 of said medium
10 surrounding said container 205.

It should be noted that said mean temperature change rate T_{prim} for said liquid may be a continuous temperature increase or a continuous temperature decrease. The inventive method may thus be used during heat transfer from said liquid to said heat transfer provision arrangement 240 (and thus said fluid in said pipe arrangement).

Figure 3 schematically illustrates a diagram wherein a volume V of said reducing agent is presented as a function of said temperature change rate T_{prim} . Said Volume V is given in Litres L. Said temperature change rate T_{prim} is given in degrees Celsius/minute. Said temperature change rate T_{prim} may be a mean temperature change rate T_{prim} regarding a
20 temperature T_1 of said reducing agent in said container 205. Said mean temperature change rate T_{prim} may be determined as a mean value of the time derivative regarding said reducing agent temperature T_1 relating to predetermined time period, such as 600 seconds, during heating of said reducing agent in said container 205.

The diagram presented in Figure 3 is related to a specific prevailing temperature T_2 of said heat transfer provision arrangement 240 and said prevailing temperature T_3 of said medium surrounding said container 205. The first control unit 200 is hereby arranged to select a specific graph relating to said prevailing temperature T_2 of said heat transfer provision arrangement 240 and said prevailing temperature T_3 of said medium surrounding said
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container 240 and also determine a volume V of said reducing agent in said container 205 on the basis of said determined temperature change rate T_{prim} .

The graph representing said volume V as a function of said temperature change rate T_{prim} is hereby predetermined. The graph representing said volume V as a function of said

5 temperature change rate T_{prim} may alternatively be in a form of a so called map, which is stored in a memory of said first control unit 200.

A number of such diagrams are stored in a memory of the first control unit 200. Each diagram refers to a specific combination of a prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said
10 container. According to an embodiment more than 100 such diagrams may be used according to the invention.

In this case a prevailing temperature of said heat transfer provision arrangement is determined to be 90 degrees Celsius and said prevailing temperature of said medium surrounding said container is determined to be 10 degrees Celsius.

15 During heating of said reducing agent by means of a heat transfer provision arrangement, a prevailing temperature of said reducing agent is measured. Regarding a specific period of time, a mean temperature change rate T_{prim} is determined. In this case a mean temperature change rate T_{primX} is determined. Hereby a corresponding volume V_X may be determined by use of said diagram.

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Figure 4a schematically illustrates a flow chart of a method for determining a volume V of liquid in a container 205 in which a heat transfer provision arrangement 240 is provided. The method comprises the method step s401. The method step s401 comprises the steps of:

- determining a prevailing temperature T_1 of said liquid;
- 25 - determining a prevailing temperature T_2 of said heat transfer provision arrangement; and
- determining a prevailing temperature T_3 of a medium surrounding said container;

- for a predetermined time period, determining a mean temperature change rate T_{prim} for said liquid; and

- determining said volume V of liquid in said container 205 on the basis of said mean temperature change rate T_{prim} , said prevailing temperature T_2 of said heat transfer

5 provision arrangement 240 and said prevailing temperature T_3 of said medium surrounding said container 205. After the method step s401 the method ends.

Figure 4b schematically illustrates a flow chart of a method for determining a volume V of liquid in a container 205 in which a heat transfer provision arrangement is provided.

10 The method comprises a first method step s410. The method step s410 comprises the step of determining a prevailing temperature T_1 of said liquid. This may be performed by means of said first temperature sensor 241. After the method step s410 a subsequent method step s420 is performed.

The method step s420 comprises the step of determining a prevailing second temperature
15 T_2 of said heat transfer provision arrangement 240. This may be performed by measuring a prevailing temperature T_f of said fluid in said heat transfer provision arrangement 240. This may be performed by means of said second temperature sensor 242. Said prevailing temperature T_2 of said heat transfer provision arrangement 240 may be determined on the basis of said temperature T_f of said fluid in said heat transfer provision arrangement 240.

20 According to an embodiment said prevailing temperature T_2 of said heat transfer provision arrangement 240 is set substantially equal to said prevailing temperature T_f of said fluid. According to one example said prevailing temperature T_2 of said heat transfer provision arrangement 240 is set equal to a temperature value being equal to said prevailing temperature T_f adjusted by means of an off-set value. Said off-set value may be a
25 predetermined off-set value. Alternatively said off-set value may be dynamically determined in any suitable way.

After the method step s420 a subsequent method step s430 is performed.

The method step s430 comprises the step of determining a prevailing temperature T3 of a medium surrounding said container 205. This may be performed by means of said third temperature sensor 243. After the method step s430 a subsequent method step s440 is performed.

- 5 The method step s440 comprises the step of, for a predetermined time period, determining a mean temperature change rate T_{prim} for said liquid. This may be performed by means of said first control unit 200.

The method step s440 may comprise the step of determining a specified development of a connection between said volume and said mean temperature change rate as a basis for said
10 determination of said volume for said prevailing temperature of said heat transfer provision arrangement and said prevailing temperature of said medium surrounding said container

After the method step s440 a subsequent method step s450 is performed.

The method step s450 comprises the step of determining said volume V of liquid in said container 205 on the basis of said mean temperature change rate T_{prim} , said prevailing
15 temperature T2 of said heat transfer provision arrangement 240 and said prevailing temperature T3 of said medium surrounding said container 205.

After the method step s450 the method ends.

Figure 5 is a diagram of one version of a device 500. The control units 200 and 210 described
20 with reference to Figure 2b may in one version comprise the device 500. The device 500 comprises a non-volatile memory 520, a data processing unit 510 and a read/write memory 550. The non-volatile memory 520 has a first memory element 530 in which a computer program, e.g. an operating system, is stored for controlling the function of the device 500. The device 500 further comprises a bus controller, a serial communication port, I/O means,
25 an A/D converter, a time and date input and transfer unit, an event counter and an interruption controller (not depicted). The non-volatile memory 520 has also a second memory element 540.

The computer program comprises routines for determining a volume V of liquid in a container 205 in which a heat transfer provision arrangement 240 is provided.

5 The computer program P comprises routines for determining a prevailing temperature T1 of said liquid. The computer program P comprises routines for determining a prevailing temperature T2 of said heat transfer provision arrangement 240. The computer program P comprises routines for determining a prevailing temperature T3 of a medium surrounding said container 205. The computer program P comprises routines for, for a predetermined time period, determining a mean temperature change rate Tprim for said liquid. The
10 computer program P comprises routines for determining said volume V of liquid in said container 205 on the basis of said mean temperature change rate Tprim, said prevailing temperature T2 of said heat transfer provision arrangement 240 and said prevailing temperature T3 of said medium surrounding said container 205.

The computer program P may comprise routines for determining a specified development of
15 a connection between said volume V and said mean temperature change rate Tprim as a basis for said determination of said volume V for said prevailing temperature T2 of said heat transfer provision arrangement and said prevailing temperature T3 of said medium surrounding said container 205.

The computer program P may comprise routines for controlling provision of a flow of a liquid
20 of a substantially constant temperature in a pipe arrangement 240 of said heat transfer provision arrangement 240 during said predetermined time period.

The computer program P may comprise routines for choosing said predetermined time period to provide a temperature change for said liquid of at least about 2-10 degrees Celsius

The program P may be stored in an executable form or in compressed form in a memory 560
25 and/or in a read/write memory 550.

Where it is stated that the data processing unit 510 performs a certain function, it means that it conducts a certain part of the program which is stored in the memory 560 or a certain part of the program which is stored in the read/write memory 550.

The data processing device 510 can communicate with a data port 599 via a data bus 515. The non-volatile memory 520 is intended for communication with the data processing unit 510 via a data bus 512. The separate memory 560 is intended to communicate with the data processing unit via a data bus 511. The read/write memory 550 is arranged to communicate
5 with the data processing unit 510 via a data bus 514. The links L210, L231, L241, L242, L243, L250 and L292, for example, may be connected to the data port 599 (see Figure 2a and Figure 2b).

When data are received on the data port 599, they are stored temporarily in the second
10 memory element 540. When input data received have been temporarily stored, the data processing unit 510 will be prepared to conduct code execution as described above.

According to one embodiment signals received on the data port 599 comprise information about.

Parts of the methods herein described may be conducted by the device 500 by means of the
15 data processing unit 510 which runs the program stored in the memory 560 or the read/write memory 550. When the device 500 runs the program, methods herein described are executed.

The foregoing description of the preferred embodiments of the present invention is
20 provided for illustrative and descriptive purposes. It is not intended to be exhaustive, nor to limit the invention to the variants described. Many modifications and variations will obviously suggest themselves to one skilled in the art. The embodiments have been chosen and described in order to best explain the principles of the invention and their practical applications and thereby make it possible for one skilled in the art to understand the
25 invention for different embodiments and with the various modifications appropriate to the intended use.

Claims

1. A method for determining a volume (V) of liquid in a container (205) in which a heat transfer provision arrangement (240) is provided, comprising the steps of:

- 5 - determining (s410) a prevailing temperature (T1) of said liquid;
- determining (s420) a prevailing temperature (T2) of said heat transfer provision arrangement (240); and
- determining (T3) a prevailing temperature of a medium surrounding said container (205),

characterized by the steps of:

- 10 - for a predetermined time period, determining (s440) a mean temperature change rate (Tprim) for said liquid; and
- determining (s450) said volume (V) of liquid in said container (205) on the basis of said mean temperature change rate (Tprim), said prevailing temperature (T2) of said heat transfer provision arrangement (240) and said prevailing temperature (T3) of said medium
- 15 surrounding said container (205).

2. The method according to claim 1, comprising the step of:

- determining (s440) a specified development of a connection between said volume (V) and said mean temperature change rate (Tprim) as a basis for said determination of said volume
- 20 (V) for said prevailing temperature (T2) of said heat transfer provision arrangement (240) and said prevailing temperature (T3) of said medium surrounding said container (205).

3. The method according to claim 1 or 2, wherein said mean temperature change rate (Tprim) for said liquid is a continuous temperature increase or a continuous temperature

25 decrease.

4. The method according to anyone of claims 1-3, comprising the step of:

- providing a flow of a liquid of a substantially constant temperature in a pipe arrangement of said heat transfer provision arrangement (240) during said predetermined time period.

5 5. The method according to anyone of claims 1-4, comprising the step of:

- choosing said predetermined time period to provide a temperature change for said liquid of at least about 2-10 degrees Celsius

10 6. A system for determining a volume (V) of liquid in a container (205) in which a heat transfer provision arrangement (240) is provided, comprising:

- means (200; 210; 500; 241) for determining a prevailing temperature (T1) of said liquid;

- means (200; 210; 500; 242) for determining a prevailing temperature (T2) of said heat transfer provision arrangement (240); and

15 - means (200; 210; 500; 243) for determining a prevailing temperature of a medium surrounding said container (205),

characterized by

- means (200; 210; 500) for determining a mean temperature change rate (T_{prim}) for said liquid regarding a predetermined time period; and

20 - means (200; 210; 500) for determining said volume (V) of liquid in said container (205) on the basis of said mean temperature change rate (T_{prim}), said prevailing temperature (T2) of said heat transfer provision arrangement (240) and said prevailing temperature (T3) of said medium surrounding said container (205).

7. The system according to claim 6, comprising:

- means (200; 210; 500) for determining a specified development of a connection between said volume (V) and said mean temperature change rate (T_{prim}) as a basis for said determination of said volume (V) for said prevailing temperature (T₂) of said heat transfer provision arrangement (240) and said prevailing temperature (T₃) of said medium

5 surrounding said container (205).

8. The system according to claim 6 or 7, wherein said mean temperature change rate (T_{prim}) for said liquid is a continuous temperature increase or a continuous temperature decrease.

10 9. The system according to anyone of claims 6-8, comprising:

- means (200; 210; 500; 240) for providing a flow of a liquid of a substantially constant temperature in a pipe arrangement of said heat transfer provision arrangement (240) during said predetermined time period.

15 10. The system according to anyone of claims 6-9, comprising:

- means (200; 210; 500) for choosing said predetermined time period to provide a temperature change for said liquid of at least about 2-10 degrees Celsius

11. A vehicle (100; 110) comprising a system according to any one of claims 6-10.

20

12. The vehicle (100; 110) according to claim 11, which vehicle is any from among a truck, bus or passenger car.

13. A computer program (P) for determining a volume (V) of liquid in a container (205),

25 wherein said computer program (P) comprises program code for causing an electronic

control unit (200; 500) or a computer (210; 500) connected to said electronic control unit (200; 500) to perform the steps according to any of the claims 1-5.

14. A computer program product containing a program code stored on a computer-readable
5 medium for performing method steps according to any of claims 1-5, when said computer program is run on an electronic control unit (200; 500) or a computer (210; 500) connected to said electronic control unit (200; 500).

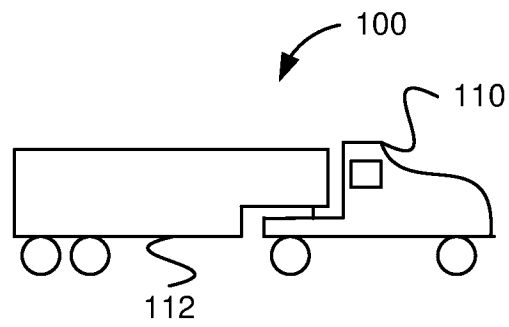


Fig. 1

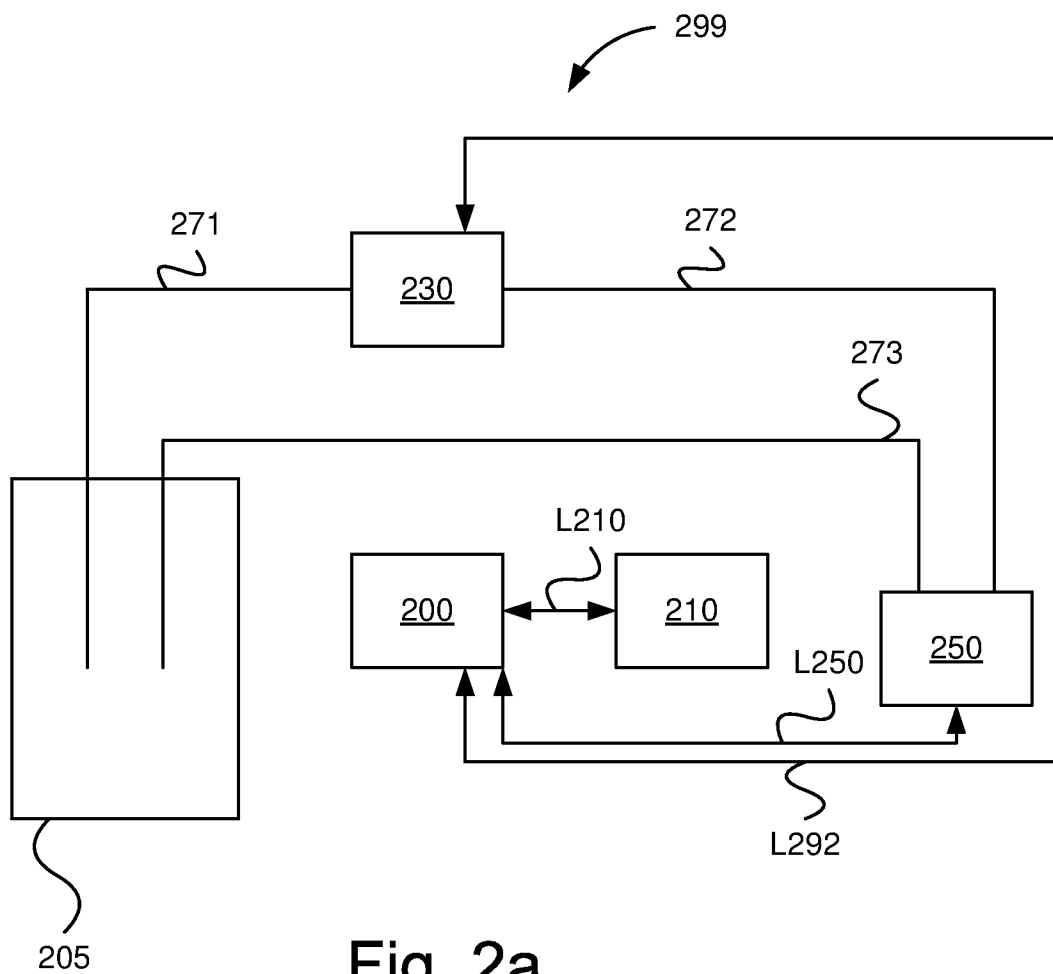


Fig. 2a

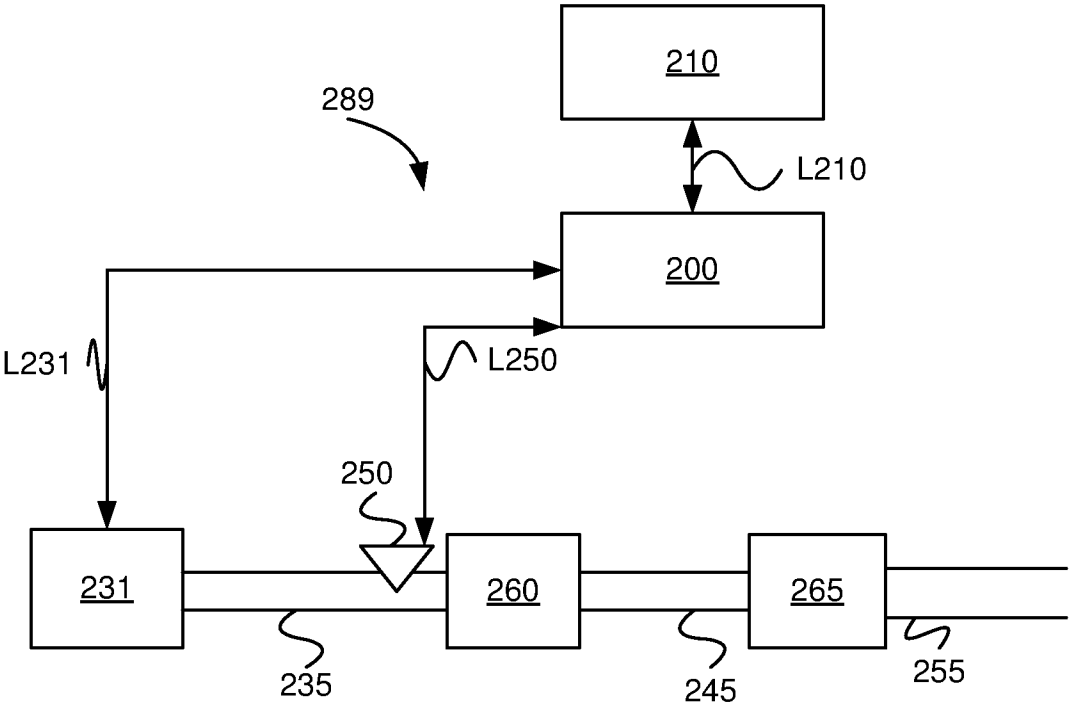


Fig. 2b

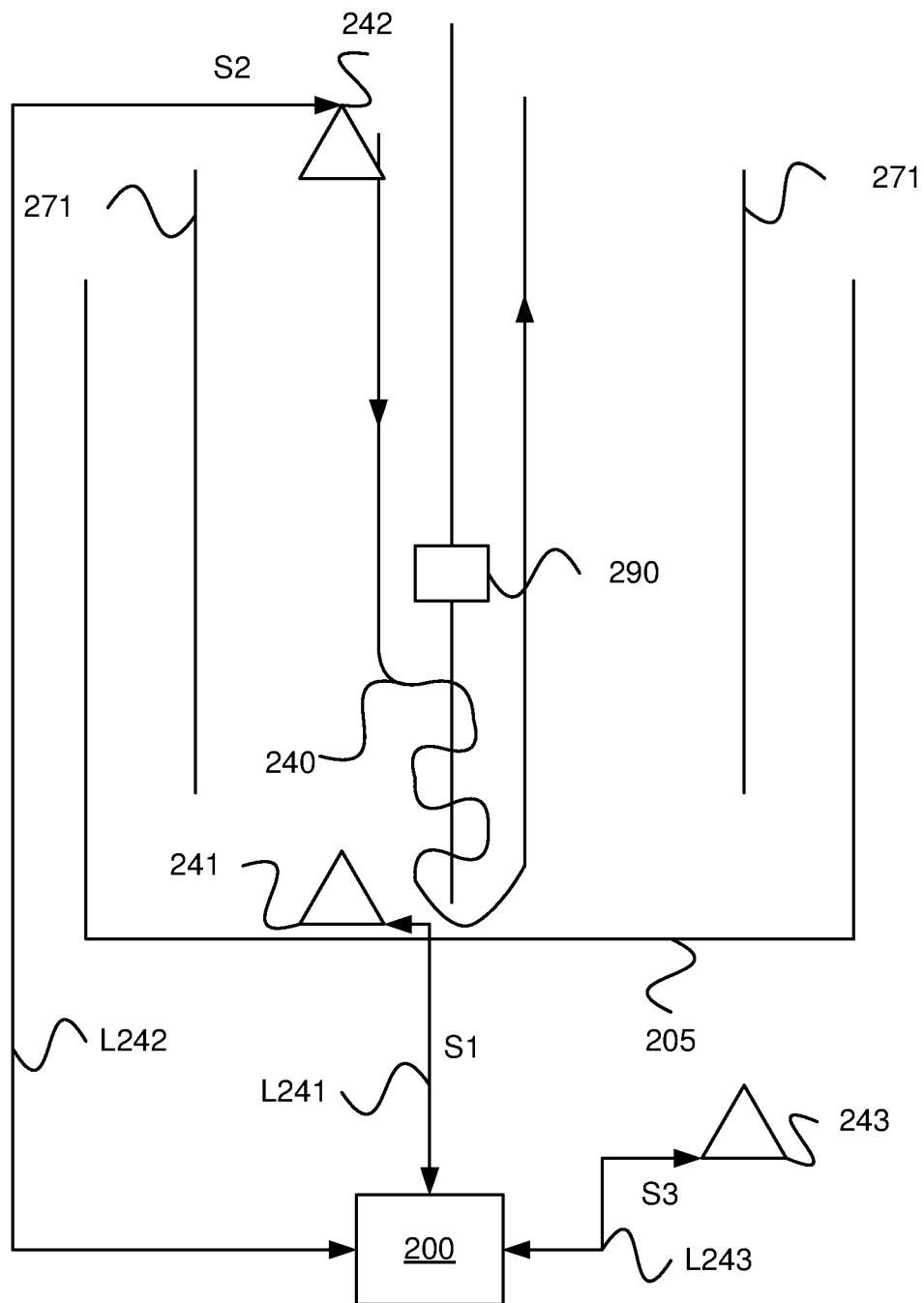


Fig. 2c

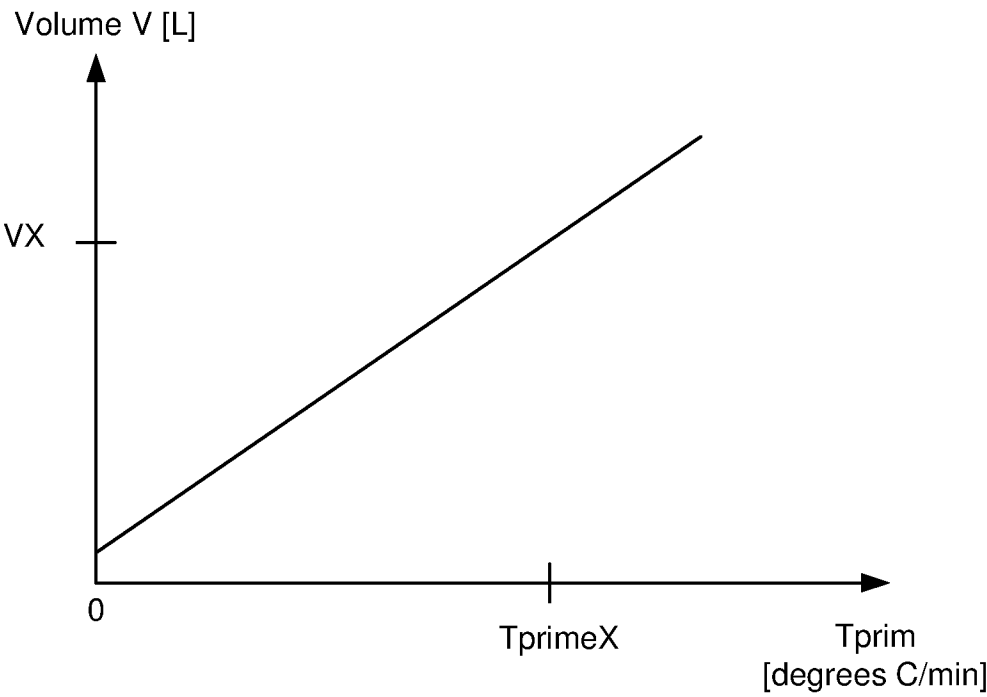


Fig. 3

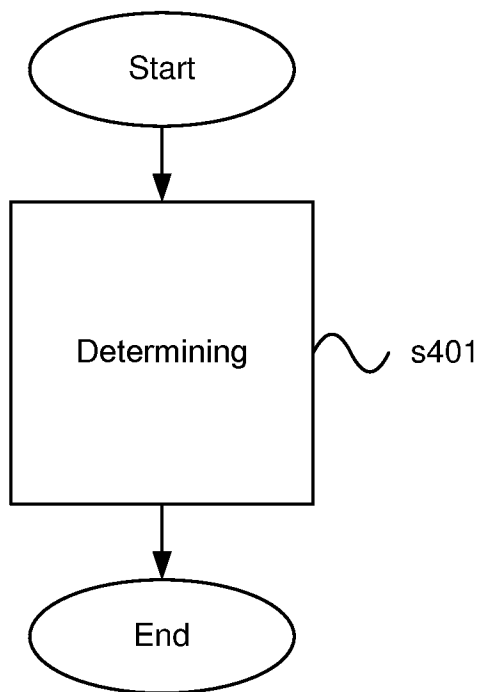


Fig. 4a

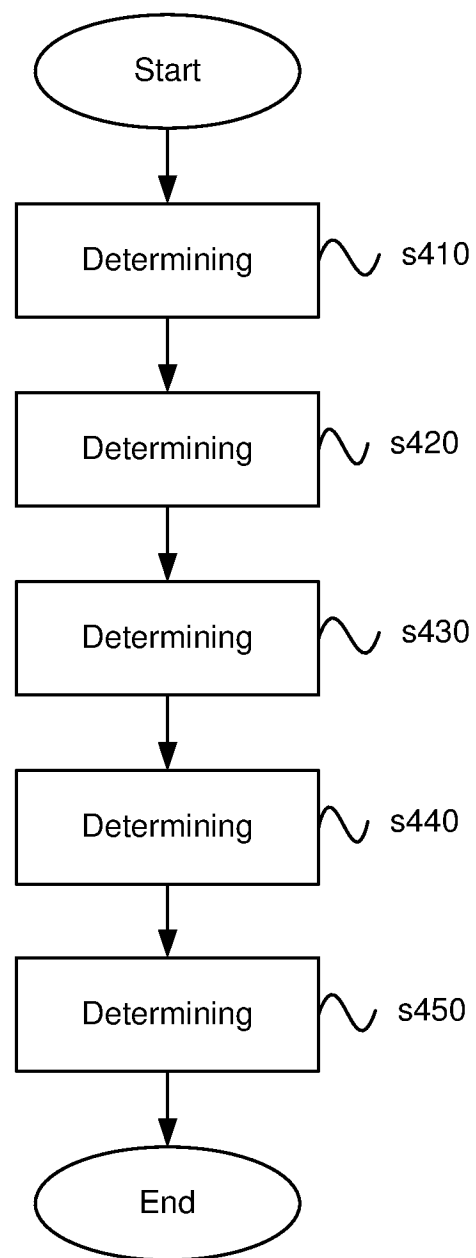


Fig. 4b

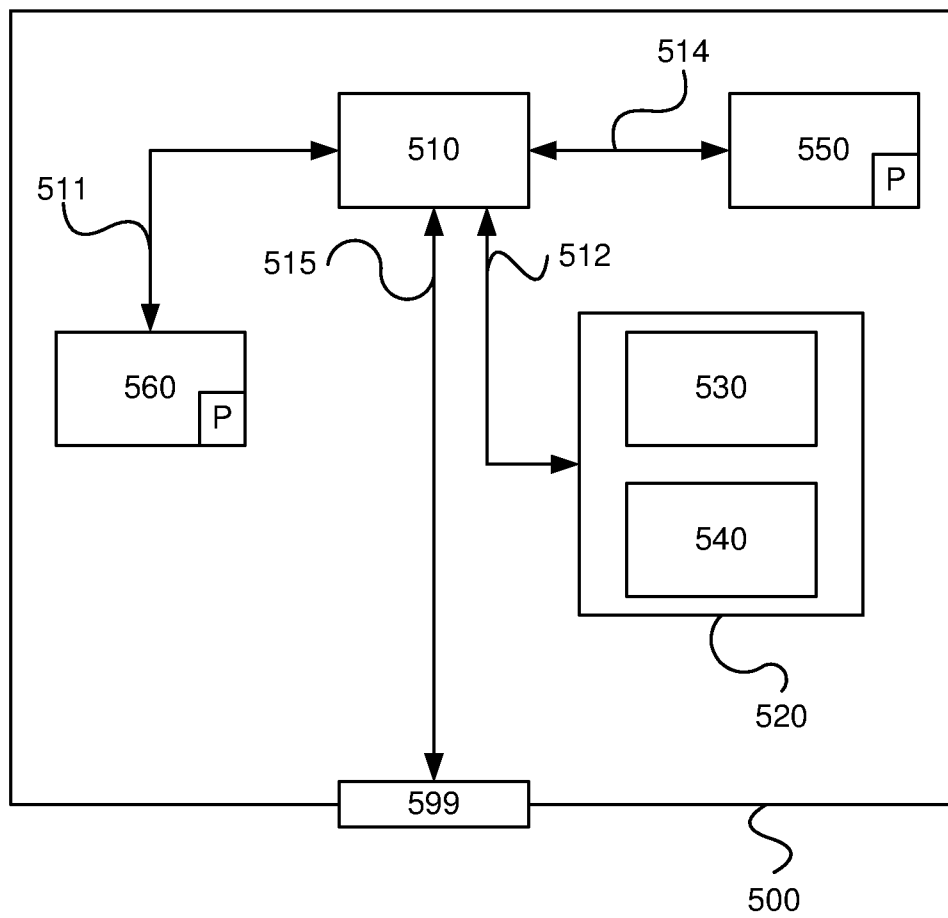


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2016/050313

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01F23/22 F01N3/20
ADD.

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)
G01F F01N

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

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

EP0-Internal, WPI Data

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Y	page 2, paragraph [0009] page 3, paragraph [0014] - [0017] page 3, paragraph [0024] - page 5, paragraph [0037] figures 1-3	4,9
X	DE 10 2007 011132 A1 (ANTIG TECH CO LTD [TW]) 20 September 2007 (2007-09-20) page 2, paragraph [0004] - page 4, paragraph [0031] page 4; claims 1-3 page 5; claims 16, 17 figures 1A, 1B, 2-4	1-3,6-8, 13,14
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 July 2016

Date of mailing of the international search report

20/07/2016

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Authorized officer

Baytekin, Hüseyin

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2016/050313

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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