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(54) **System and Method for Thermal Management in Electric Vehicles.**

(57) The present invention proposes a vehicle comprising a battery, an in-vehicle thermal management system thermally coupled to the battery in order to exchange heat with said battery, and a washer tank. The thermal management system is thermally coupled to the washer tank by means of a secondary circuit, said secondary circuit comprising a heat exchanger connected to the thermal management system and in thermal conduction relationship with the washer tank in order to exchange heat with said washer tank and the washer fluid stored therein. The vehicle further comprises a control unit configured to direct waste heat produced by the battery and/or other components from said battery and/or other components to the washer tank, said waste heat being stored in the washer tank and the washer fluid stored therein as thermal energy. The stored energy is maintained through insulation of the washer tank and may be released after an overnight cycle to assist heat-up of critical components like the battery, a fuel cell or the passenger cabin.

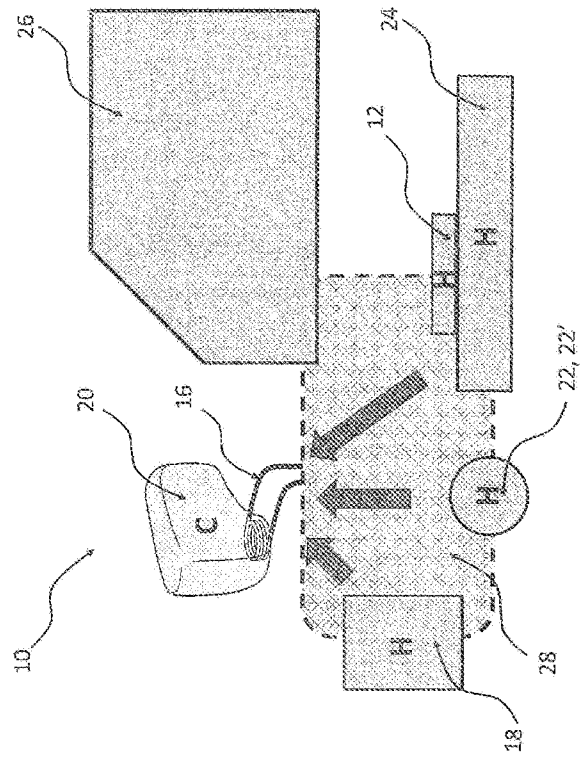


Fig.1

System and Method for Thermal Management in Electric Vehicles

Technical field

[0001] The present invention generally relates to a system and method for thermal management in electric, hybrid or fuel cell vehicles. More particularly, the invention relates to a system and method for efficiently storing and reusing the thermal energy released by an electric vehicle battery and drive components.

Background of the Invention

[0002] Vehicles such as battery electric vehicles (BEV) or hybrid vehicles use large batteries to store energy. The energy flowing into the battery pack as it is charged either from regenerative braking or from the grid and discharged from the pack to power the vehicle and its accessories is measured by electrical current and voltage. The flow of current causes heating in the battery cells and their interconnection systems proportional to the square of the current flowing multiplied by the internal resistance of the cells and the interconnect systems. The higher the current flow the more the heating effect will be. This equally applies to the onboard power electronics and to the electric drive motor. If chemically bound energy is used in a hybrid arrangement, e.g. in a combustion engine or a hydrogen fuel cell, conversion thereof will also generate waste heat.

[0003] The performance of e.g. Lithium-Ion battery cells is greatly impacted by their temperature, they do not perform well when too cold or too hot, which can lead to permanent and extreme damage of the cells or accelerated degradation. It follows that, in addition to cooling, heating of the cells may be required at lower ambient temperatures to enable charging when the cells are too cold; this is because the internal resistance of the cells rises when they are cold. Most lithium battery cells cannot be fast-charged when they are less than 5°C and cannot be charged at all when they are below 0°C. Lithium cells also begin to degrade quickly when their temperature is above 45°C.

[0004] Similar to batteries, proton-exchange membrane hydrogen fuel cells (PEMFC) also require tight operating temperature controls in a certain range (50-100°C) to work efficiently, therefore thermal management is also required here.

[0005] In the past, the largest battery packs did not necessarily need any special cooling as the physical size of the packs was sufficient and the relative flow of current was not large compared to the overall capacity of the pack. As faster battery charging rates are demanded with recharge power of over 200kW to deliver times of 30 minutes or less, higher performance electric vehicles with a requirement for consistent performance and adequate durability in global markets has meant that special thermal management systems and methods for the battery packs are now required.

[0006] US patent US 6,138,466 discloses a battery cooling system to cool an electric vehicle battery pack and extend the operating range of an automotive heat pump system. Waste heat produced by the battery pack is transferred to a coolant system and a heat exchanger is coupled between the cooling system and a reversible heating, ventilation and air conditioning (HVAC) system. The heat exchanger transfers heat energy from the coolant system to the reversible HVAC system, and the transferred thermal energy supplements the existing stored energy, thereby extending the heating mode operating range of the HVAC system. The requirement for supplemental electric heating is reduced, further increasing the electric vehicle energy efficiency. However, the thermal energy generated by the waste heat can neither be stored nor reused after a vehicle shut-down to help heat up the battery pack in winter conditions.

[0007] The thermal management system proposed in patent application DE 10 2013 010 294 A1 presents the notable advantage of being meant for both cooling and heating an electric motor depending on the external conditions, especially depending on the outer temperature and the operating phase of the motor. However, such a device is cumbersome as an electric or hybrid vehicle has to be equipped with a dedicated water tank to store thermal energy and already circulating vehicles cannot be easily retrofitted to be equipped with such water tanks.

Object of the invention

[0008] It is therefore desirable to provide a system and a method for thermal management of a vehicle without the above described shortcomings.

General Description of the Invention

[0009] In one aspect of the invention, the above object is solved by vehicle comprising a battery, a thermal management system thermally coupled to the battery in order to exchange heat with said battery and a washer tank sometimes also referred to as washer fluid tank or washer reservoir, for storing a washer fluid therein, said washer fluid for cleaning a windshield of the vehicle and/or the optics of one or more additional driver assistance devices to be cleaned, like cameras and Lidars or the like. According to the invention, the thermal management system is thermally coupled to the washer tank by means of a secondary circuit, said secondary circuit comprising a heat exchanger connected to the thermal management system and arranged in thermal conduction relationship with the washer tank in order to exchange heat with said washer tank and the washer fluid stored therein. Moreover, a vehicle according to the invention further comprises a control unit configured to direct waste heat produced by the battery from said battery to the washer tank, said waste heat being stored in the washer tank and the washer fluid stored therein as thermal energy. In other words, waste heat generated by the battery, either during its fast charge or during a drive of the vehicle, is accumulated in the washer tank.

[0010] In the context of the present invention, the term "heat exchanger" is to be understood in its broadest possible way, and refers to any device meant for exchanging heat. In its easiest embodiment, a heat exchanger is a part of a coolant circuit comprising a pipe through which a cooling fluid, or coolant, circulates and in which the coolant exchanges heat with a fluid, such as air or water or the like, circulating outside the pipe.

[0011] The inventive principle of the presently described vehicle lies in the use of the heat capacity of a pre-existing, pre-mounted washer tank as a thermal storage tank. The washer reservoir acts as a conventional thermal storage tank, i.e. as a heat sink to store waste heat as thermal energy in conditions when excess heat needs to be removed.

[0012] Since all vehicles are currently equipped with a washer tank, the mass and space needed for the heat sink is already present on board of the vehicles. In other words, energetic efficiency of electric or hybrid vehicles can be improved without adding extra mass or new and/or large devices to the vehicles. It should be

noted that waste heat being stored as thermal energy in the washer tank, the washer liquid would thus be heated up. This side effect is beneficial, as issues with frozen washer liquid would no longer occur and no anti-freeze additive would be needed. Furthermore, as better cleaning results are achieved with a warmer washer liquid, overall safety of the vehicle's driver and possible passengers would be increased.

[0013] Moreover, since many electric vehicles are already equipped with smart liquid thermal management systems which can be used and configured as control units according to the present invention, the retrofitting of vehicles is limited to a small hardware addition on the water tank, i.e. addition of the secondary circuit .

[0014] The skilled person will appreciate that the amount of thermal energy which can be stored in the washer tank is depending on the amount of washer fluid contained therein and increases with the volume of washer fluid stored in the tank. In this context, it is interesting to note that the manufacturers will provide future vehicles with bigger and bigger washer tanks because the future generations of vehicles will have increasing needs for washer fluid. In fact, as the number of driver assistance devices, such as cameras, LIDARs and the like, increases in future vehicle generations, the required amount of washer fluid increases as the optics and/or covers of these devices must be periodically cleaned to ensure that the driver assistance system could properly work. This means of course that the thermal storage capacity will increase in future vehicle generations and appropriate fill level of the washer system will have to be assured for the aforementioned reasons anyway.

[0015] According to particularly preferred embodiments, the thermal management system or the secondary circuit is a coolant circuit, preferably both the thermal management system and the secondary circuit are simple coolant circuits. Each one of the coolant circuits comprises a coolant pipe and coolant circulating through the coolant pipe. Depending on the vehicle, each coolant pipe may be made of only one pipe section. Alternatively, each coolant pipe may comprise a plurality of pipe sections, the sections being in fluid communication with one another.

[0016] In such very simple embodiments, the coolant circuits of the thermal management system and secondary circuit act as fluid-based heat exchangers,

with no need for further dedicated heat exchanging devices. It will be appreciated, that the coolant circuits of the first and second cooling systems may be arranged and interconnected together to form a common cooling system. In alternative embodiments, the coolant circuits of the first and second cooling systems may be individual circuits, which are thermally coupled by means of a dedicated heat exchanger.

[0017] Advantageously, the heat exchanger of the secondary circuit may be a simple coolant circuit pipe extending through the washer tank. The pipe may be coiled in order to enlarge the surface of the pipe and thus optimize the heat exchange in the fixed volume of the washer tank. Moreover, as most electric and/or hybrid vehicles are already equipped with thermal management systems, the coolant circuit of the secondary circuit may be simply branched off from an existing circuit of the thermal management system and routed through the reservoir, thus considerably facilitating retrofitting of existing vehicle lines.

[0018] As stated before, the secondary circuit may be a coolant pipe branched off from a coolant pipe of the thermal management system and routed through the washer tank, as thermal exchanges between said cooling system and the washer liquid would thus be optimal. However, a skilled person knows that any other configuration of the secondary circuit allowing heat exchanges with the washer liquid can be used, such as arranging the secondary circuit in close contact with an external surface of the washer tank.

[0019] According to an embodiment of the invention, the washer tank may further be thermally coupled to other heat sources like a motor and/or a fuel cell and/or to onboard electronics of the vehicle. The motor may of course refer to the electrical motor of the electrical or hybrid vehicle, or in case of a hybrid vehicle also to an internal combustion engine with which the vehicle is equipped. The skilled person would know that the thermal management system of a hybrid or electric vehicle further comprises a cooling system thermally coupled to the motor and/or the fuel cell and/or to the onboard electronics in order to exchange heat with said motor and/or said fuel cell and/or onboard electronics. This cooling system is then preferably configured to be in direct or indirect thermal conduction relationship with the washer tank to exchange heat with said washer tank through the thermal management system.

[0020] In embodiments wherein the vehicle thermal management system comprises a cooling circuit for the motor and/or the fuel cell and/or the onboard electronics, the control unit may be configured in a further mode to direct waste heat from said motor and/or fuel cell and/or onboard electronics to the washer tank, said waste heat being stored in the washer tank and the washer fluid stored therein as thermal energy. Advantageously, no thermal energy would be lost during operation of the vehicle, and motor and/or fuel cell and/or onboard electronics would be further cooled as some thermal energy generated by said component would be transferred to the washer tank and the washer fluid stored therein.

[0021] Moreover, the control unit may be advantageously configured in yet a further mode to direct the thermal energy stored in the washer tank and the washer fluid stored therein from said washer tank to a component to heat up. In other words, the control unit may be configured to release the thermal energy stored in the washer tank and the washer fluid stored therein. In a preferred embodiment, the component to heat up is the battery. In cold battery conditions, such as vehicle start-up phases in winter conditions but more generally in conditions wherein battery temperature is lower than an ideal operating temperature, the release of stored thermal energy reduces the drain on the battery and helps preserve its range. Furthermore, using previously stored thermal energy to heat up the battery instead of electric energy and/or fuel in case of a hybrid vehicle allows for increased electrical range and/or reduced consumption of primary energy sources, thereby decreasing the carbon footprint of the vehicle.

[0022] If the vehicle is equipped with a hydrogen fuel cell, the control unit may be advantageously configured in yet a further mode to direct the thermal energy stored in the washer tank and the washer fluid stored therein from said washer tank to the hydrogen fuel cell unit to get it up to operational temperature more rapidly while reducing the drain on the battery.

[0023] Alternatively, the vehicle component to heat up may be a passenger cabin of the vehicle, the passenger cabin for accommodating at least a driver and possibly one or more passengers. At low temperatures, the need to heat up the passenger cabin for safety and comfort poses an extra challenge as electric heating is a heavy drain on battery capacity. Therefore, re-use of previously stored

thermal energy is highly desirable to relieve the battery and preserve driving range. In this variant of the invention the thermal energy stored in the washer tank and the washer fluid stored therein may be released for a fast passenger cabin heating up process. Advantageously, no electrical energy will be used to generate heat and heat up the passenger cabin, thus increasing the vehicle range and/or reducing the fuel consumption in case of an hybrid vehicle. Moreover, as thermal energy stored in the washer tank is instantly available in cold conditions to heat up the passenger cabin, passengers' comfort is increased.

[0024] To reduce heat loss of the washer tank over extended periods, such as overnight, the washer tank may be covered with a thermal insulation material. Any thermal insulation material with low thermal conductivity can be used, in particular any thermal insulation material with a thermal conductivity comprised between 0.02 and 0.05 W/mK but the washer tank is preferably covered with natural fiber, mineral fiber, glass wool, polystyrene foam, polyurethane foam or a reflective layer. It is preferable to insulate an already mounted washer tank in order to reduce heat losses without having to substitute said washer tank, but alternatively replacement washer tanks made from a material having a lower thermal conductivity and no additional layer of thermal insulation may be used. Furthermore, some other constructive advantages may be related to the use of an insulation layer to cover the washer tank, such as a reduction of noise transmitted from water pumps operating inside said washer tank, as easily understandable for a skilled person.

[0025] It will be appreciated that in a further aspect, the present invention also relates to a method for thermal battery management of a vehicle as described above. The method according to the invention comprises the step of, when the temperature of the washer tank or the washer fluid stored therein is lower than a set maximum for the washer fluid, directing waste heat produced by said at least one component producing excess thermal energy to the washer tank and storing said waste heat into said washer tank and the washer fluid stored therein as thermal energy. This directing of the waste heat to the washer tank may e.g. be continued until the temperature of the washer tank equals the set maximum for the washer fluid.

[0026] The component producing excess thermal energy is advantageously either the battery and/or a hydrogen fuel cell and/or the motor and/or the onboard electronics.

[0027] In embodiments, the method for thermal battery management of a vehicle according to the invention may further comprise the step of, when the temperature of the washer tank is higher than the temperature of a component to heat up, releasing the stored thermal energy by directing said thermal energy from the washer tank to the component to heat up. The component to heat up may e.g. be the battery, the hydrogen fuel cell or the passenger cabin of the vehicle. The step of releasing the stored thermal energy may e.g. be continued until an operating temperature is reached in the component to heat up and/or until all the stored thermal energy has been released. Once this is the case, the thermal management will preferably switch back to the step of directing of the waste heat to the washer tank.

[0028] In other words, the method for thermal battery management of a vehicle according to the present invention comprises two main phases. First, an accumulating phase occurs during charging of the battery and/or during driving of the vehicle. During said accumulating phase, excess thermal energy generated during operation is removed from the battery, the motor and/or the fuel cell and/or the onboard electronics and is stored in the washer tank as thermal energy. Such a heat removal also allows to extend the time in the fast charging mode of the battery, where it assists the active heat removal needed to enable fast charging operation. Fast charging is intended to compress the charging time of the battery to less than 30 minutes, which means that great amounts of thermal power in the order of 5-50kW need to be removed from the battery and the electronics. In this mode, the vehicle thermal management system may benefit from the extra heat capacity of the washer tank to absorb this power temporarily and enable extended time in fast charging mode, regardless of whether this thermal energy is reusable or not, e.g. in case of high outside temperatures.

[0029] Second, a releasing phase may occur once thermal energy has been stored in the washer tank in case the battery, the fuel cell, the passenger cabin or any other vehicle's component needs to be heated up. Thermal energy can be used instead of electric energy and/or fuel when starting up the vehicle in order to

heat up any component needing to be heated up, thus increasing the vehicle range. Once the vehicle, (meaning the battery, the fuel cell, the passenger cabin or any other component) is up to operating temperature, excess thermal energy could once again be stored, i.e. accumulated in the washer tank, in that a switching back to accumulating phase is operated.

[0030] Other benefits described in context with the vehicle according to the invention apply to the proposed method to the full extent.

Brief Description of the Drawings

[0031] Further details and advantages of the present invention will be apparent from the following detailed description of not limiting embodiments with reference to the attached drawing, wherein:

Fig.1 is a functional diagram of a first embodiment of a vehicle according to the invention;

Fig.2 is a functional diagram of a second embodiment of a vehicle according to the invention;

Fig.3 is a functional diagram of a third embodiment of a vehicle according to the invention; and

Fig.4 is a schematic view of an embodiment of a washer tank and a second cooling system to be used in a vehicle according to the invention.

Description of Preferred Embodiments

[0032] Fig.1 to Fig.3 schematically show three different operating modes of a vehicle 10 according to the present invention. Only some selected components and their relations to each other have been represented on said Figures in order to explain the inventive principle of a vehicle 10 with thermal management system according to the present application while avoiding overloading them with unnecessary information.

[0033] The hybrid or electric vehicle 10 schematically comprises a passenger cabin 26 for accommodating at least a driver and possibly one or more passengers and at least one motor 22 for generating the drive energy to drive the vehicle. The motor 22 may of course refer to the electrical motor of the electrical or

hybrid vehicle, or in case of a hybrid vehicle also to an internal combustion engine 22' with which the vehicle is equipped. A battery 24 is provided for storing the electrical energy required to drive the electrical motor 22. The vehicle is further provided with a thermal management system 28 thermally coupled to the battery 24 and dedicated to cooling said battery 24 by exchanging heat with said battery 24. The vehicle thermal management system 28 may comprise HVAC components such as air conditioning unit, heat pump, heat exchangers, coolant pumps, valves, one or more radiators and/or condensers as well as the related electronic controls. If the vehicle is equipped with a hydrogen fuel cell 18, this hydrogen fuel cell 18 will be connected to the thermal management system 28 in a similar way than the other components.

[0034] A washer tank 20, sometimes also referred to as washer fluid tank or washer reservoir, is provided for storing a washer fluid therein, said washer fluid for cleaning a windshield of the vehicle and/or the optics of one or more additional driver assistance devices to be cleaned, like cameras and Lidars or the like.

[0035] According to a preferred embodiment, the secondary circuit 16 is a coolant circuit comprising a coiled coolant pipe circulating through the washer tank 20 and the washer fluid stored therein as detailed on Fig.4.

[0036] A 5 L washer tank 20 can store approximately 0.5 kWh of thermal energy, equivalent to 2.5 km of electric city drive range if this energy where to be produced electrically. To present an equivalent added capacity, a battery 24 would have to weight approximately 3 kg more. The thermal management system storing waste heat as thermal energy in the washer tank 20 thus allows for substantial weight savings.

[0037] In a first operating mode, the vehicle stores, i.e. accumulates heat as thermal energy inside the washer tank 20, as illustrated on Fig.1. The heat may be produced by various components acting as heat sources H, such as the battery 24, the electric motor 22, the fuel cell 18 or onboard power electronics 12.

[0038] Indeed, in order to circulate using electric energy as energy source, electrical or hybrid vehicles 10 need an at least partially charged battery 24. During the charge of a battery 24, a large amount of heat is generated as current flows through said battery 24. The charge of the battery 24 occurs either during

regenerative braking of the vehicle 10 or from the grid. Particularities of the battery charging operation are of no importance for the presently described first operating mode of a vehicle 10 according to the invention, as heat is generated and the battery needs to be actively cooled in both cases.

[0039] As illustrated on Fig.1, the battery 24 is thermally coupled to the thermal management system 28, provided to thermally regulate said battery 24 by way of heat exchanges. Excess heat from battery 24 is exchanged between said battery 24 and the washer tank 20 through the thermal management system 28. This is likely to involve active heat transfer through an air conditioning or heat pump unit as part of the thermal management system 28. Thanks to such heat exchanges, temperature of the battery 24 may be controlled while the temperature of the washer liquid increases.

[0040] According to the present invention, the thermal management system 28 is thermally coupled to the washer tank 20 by means of a secondary circuit 16 branched off of the thermal management system 28. The secondary circuit 16 is advantageously a fluid-based heat exchanger. The thermal management system 28 exchanges heat with the washer tank 20 via the secondary circuit 16 as long as the temperature of the washer liquid is lower than a set limit, typically safely below the water boiling point, for example 85°C. As the washer tank 20 acts as a heat sink, temperature of the washer liquid contained in the washer tank 20 increases. In other words, the washer tank 20 provides for a thermal buffer before heat is released to the environment.

[0041] When a battery 24 is at least partially charged, electric energy stored therein can be used to power the electric motor 22 during a drive of the vehicle 10. The electric motor 22 gives out heat while converting the electric energy provided by the battery 24 into mechanical energy, and needs to be cooled. The internal combustion engine 22', the fuel cell 18 and the onboard electronics may also produce heat during operation, as it is known in the art.

[0042] As illustrated in Fig. 1, each of the electric motor 22, the internal combustion engine 22' and the fuel cell 18 are also thermally coupled to the thermal management system 28, whose main goal is to control the temperature of said motors 22, 22' and/or fuel cell 18. A skilled person would know that temperatures within those circuits would allow a direct connection with the

secondary circuit 16, or an indirect connection using the heat exchanger(s) or air conditioning components included in the thermal management system 28. As the temperature of the washer liquid increases, heat is stored as thermal energy inside the washer tank 20. Waste heat produced by the electric motor 20, the internal combustion engine 22' or the hydrogen fuel cell 18 during a drive of the vehicle 10 may then be stored as thermal energy in said washer tank 20 and the washer liquid therein.

[0043] Onboard power electronics 12 may exchange heat with the washer tank in a similar way through a cooling system similar to either the battery or the motor and fuel cell cooling systems.

[0044] After a drive, the vehicle 10 may be shut-down for a long period of time, such as overnight. Thermal insulation of the washer tank 20 prevents a too high decrease of the washer liquid temperature. According to the present embodiment, the washer tank 20 is covered with a thermal insulation layer 30 and the used insulation material is a commercially available 22 mm thick layer of natural fiber, and presenting a thermal conductivity λ of 0.035 W/mK. After ten hours in winter conditions with an outside temperature of -5°C, the temperature of the washer liquid contained in a washer tank 20 with a capacity of 9.6 L decreased only from 80°C to 49°C.

[0045] Thermal energy (i.e. heat) still stored in the washer tank 20 when a driver starts the vehicle 10 may then be used in order to heat up the different components to their respective operating temperatures. Fig.2 illustrates a second operating mode of a vehicle according to the invention, wherein the heat stored inside the washer tank and the washer fluid therein is released toward components requiring heat C.

[0046] Using the stored thermal energy, the battery 24 is heated up to minimal operating temperature, and the passenger cabin 26 may also be fast-heated to reach an acceptable temperature inside said cabin and/or help defog the windshield. In order to heat up these components, heat exchanges occur in a similar way as previously described, the hot source and the cold source being inverted, the washer tank acting now as the hot source.

[0047] Considering the previously described washer tank 20 of 9.6 L and a starting temperature of 49°C, 0.53 kWh can be instantly deployed to heat up the battery 24 and/or the passenger cabin 26. Such a developed energy corresponds to almost 3 km possibly driven using only the electric energy stored inside the battery 24 as energy source. In other words, the vehicle's range may be increased by almost 3 km only by better managing waste heat generated by the battery 24 and/or the other heat sources and re-using said waste heat.

[0048] It will be appreciated that the washer tank 20 and the washer fluid stored therein may be used to divert heat generated by the battery 24 during fast-charge (Fig.3). The aim of this operating mode is mainly to absorb some of the heat produced by the charging process, the storage of the heat as thermal energy inside the washer tank 20 being an advantageous side effect.

[0049] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

[0050] Other variations to be disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. Moreover, in the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality, which is meant to express a quantity of at least two.

List of Reference Symbols

10 Electric vehicle

12 Power Electronics

16 Secondary circuit through the washer tank

18 Hydrogen Fuel Cell

20 Washer tank

22 Electric motor

22' Internal combustion engine

24 Drive Battery

26 Passenger cabin

28 Vehicle Thermal Management

30 thermal insulation layer

H Heat sources

C Components requiring heat

Claims

1. A vehicle comprising a battery, a thermal management system thermally coupled to the battery in order to exchange heat with said battery and a washer tank for storing a washer fluid, characterized in that:

the thermal management system is thermally coupled to the washer tank by means of a secondary circuit, said secondary circuit comprising a heat exchanger arranged in thermal conduction relationship with the washer tank in order to exchange heat with said washer tank and the washer fluid stored therein; and

the vehicle further comprises a control unit configured to direct waste heat produced by the battery from said battery to the washer tank, said waste heat being stored in the washer tank and the washer fluid stored therein as thermal energy.

2. The vehicle as claimed in claim 1, characterized in that the thermal management system and/or the secondary circuit is a coolant circuit, said coolant circuit comprising a coolant pipe and coolant circulating through the coolant pipe.

3. The vehicle as claimed in claim 1 or 2, characterized in that the heat exchanger of the secondary circuit is a coolant circuit pipe extending through the washer tank.

4. The vehicle as claimed in any one of the preceding claims 1 to 3, characterized in that the thermal management system and the secondary circuit are arranged as part of a common cooling system, preferably the secondary circuit is branched off from the thermal management system.

5. The vehicle as claimed in any one of the preceding claims 1 to 3, characterized in that the thermal management system and secondary circuit are thermally coupled by means of a heat exchanger.

6. The vehicle as claimed in any one of the preceding claims, characterized in that the vehicle further comprises a motor and/or a hydrogen fuel cell and/or onboard electronics and the washer tank is further thermally coupled to the motor and/or to the hydrogen fuel cell and/or to the onboard electronics.

7. The vehicle as claimed claim 6, characterized in that the control unit is configured in a further mode to direct waste heat produced by the motor and/or the hydrogen fuel cell and/or the onboard electronics from said motor and/or hydrogen fuel cell and/or onboard electronics to the washer tank, said waste heat being stored in the washer tank and the washer fluid stored therein as thermal energy.

8. The vehicle as claimed in any of the preceding claims, characterized in that the control unit is configured in a further mode to direct the thermal energy stored in the washer tank and the washer fluid stored therein from said washer tank to a component to heat up.

9. The vehicle as claimed in claim 8, characterized in that the component to heat up is the battery and/or a hydrogen fuel cell and/or the passenger cabin of the vehicle.

10. The vehicle as claimed in any of the preceding claims, characterized in that the washer tank is covered with a thermal insulation material.

11. The vehicle as claimed in claim 10, characterized in that the thermal insulation material is made of natural fiber, mineral fiber, glass wool, polystyrene foam, or polyurethane foam or is a reflective layer.

12. A method for thermal management of a vehicle as claimed in any of the preceding claims, comprising the step of:

when the temperature of the washer tank or the washer fluid stored therein is lower than a set maximum for the washer fluid, directing waste heat produced by at least one component producing excess thermal energy to the washer tank and storing said waste heat into said washer tank and the washer fluid stored therein as thermal energy.

13. The method according to claim 12, characterized in that the at least one component producing excess thermal energy is the battery and/or a hydrogen fuel cell and/or a motor and/or onboard electronics.

14. The method according to claim 12 or 13, characterized in that, said method further comprises the following step:

when the temperature of the washer tank is higher than the temperature of a component to heat up, releasing the stored thermal energy by directing said thermal energy from the washer tank to the component to heat up.

15. The method according to claim 14, characterized in that the component to heat up is the battery and/or a hydrogen fuel cell and/or a passenger cabin.

P-CEBI-009/LU

REVENDICATIONS

1. Véhicule comprenant une batterie, un système de gestion thermique couplé de manière thermique à la batterie afin d'échanger de la chaleur avec ladite batterie et un réservoir de lavage pour stocker un fluide de lavage, **caractérisé en ce que** :
le système de gestion thermique est couplé de manière thermique au réservoir de lavage au moyen d'un circuit secondaire, ledit circuit secondaire comprenant un échangeur de chaleur agencé en relation de conduction thermique avec le réservoir de lavage afin d'échanger de la chaleur avec ledit réservoir de lavage et le fluide de lavage stocké dans celui-ci ; et
le véhicule comprend en outre une unité de commande configurée pour diriger la chaleur perdue produite par la batterie de ladite batterie au réservoir de lavage, ladite chaleur perdue étant stockée dans le réservoir de lavage et le fluide de lavage stocké dans celui-ci en tant qu'énergie thermique.

2. Véhicule selon la revendication 1, **caractérisé en ce que** le système de gestion thermique et/ou le circuit secondaire est un circuit de réfrigérant, ledit circuit de réfrigérant comprenant un tuyau de réfrigérant et un réfrigérant circulant à travers le tuyau de réfrigérant.

3. Véhicule selon la revendication 1 ou 2, **caractérisé en ce que** l'échangeur de chaleur du circuit secondaire est un tuyau d'un circuit de réfrigérant s'étendant à travers le réservoir de lavage.

4. Véhicule selon l'une quelconque des revendications précédentes 1 à 3, **caractérisé en ce que** le système de gestion thermique et le circuit secondaire sont agencés en tant que partie d'un système de refroidissement commun, le circuit secondaire de préférence est débranché du système de gestion thermique.

5. Véhicule selon l'une quelconque des revendications précédentes 1 à 3, **caractérisé en ce que** le système de gestion thermique et le circuit secondaire sont couplés thermiquement au moyen d'un échangeur de chaleur.

6. Véhicule selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le véhicule comprend en outre un moteur et/ou une pile à combustible à hydrogène et/ou de l'électronique embarquée, et le réservoir de lavage est en outre couplé thermiquement au moteur et/ou à la pile à combustible à hydrogène et/ou à l'électronique embarquée.

7. Véhicule selon la revendication 6, **caractérisé en ce que** l'unité de commande est configurée dans un mode supplémentaire pour diriger la chaleur perdue produite par le moteur et/ou la pile à combustible à hydrogène et/ou l'électronique embarquée desdits moteur et/ou pile à combustible à hydrogène et/ou électronique embarquée vers le réservoir de lavage, ladite chaleur perdue étant stockée dans le réservoir de lavage et le fluide de lavage stocké dans celui-ci en tant qu'énergie thermique.

8. Véhicule selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'unité de commande est configurée dans un mode supplémentaire pour diriger l'énergie thermique stockée dans le réservoir de lavage et le fluide de lavage stocké dans celui-ci dudit réservoir de lavage à un composant destiné à chauffer.

9. Véhicule selon la revendication 8, **caractérisé en ce que** le composant destiné à chauffer est la batterie et/ou une pile à combustible à hydrogène et/ou la cabine passager du véhicule.

10. Véhicule selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le réservoir de lavage est recouvert d'un matériau d'isolation thermique.

11. Véhicule selon la revendication 10, **caractérisé en ce que** le matériau d'isolation thermique est composé de fibre naturelle, de fibre minérale, de laine de verre, de mousse de polystyrène ou de mousse de polyuréthane, ou est une couche réfléchissante.

12. Procédé de gestion thermique d'un véhicule selon l'une quelconque des revendications précédentes, comprenant l'étape consistant à :
lorsque la température du réservoir de lavage ou du fluide de lavage stocké dans celui-ci est inférieure à un maximum défini pour le fluide de lavage, diriger la chaleur perdue produite par au moins un composant produisant de l'énergie thermique en excès vers le réservoir de lavage et stocker ladite chaleur perdue dans ledit réservoir de lavage et le fluide de lavage stocké dans celui-ci en tant qu'énergie thermique.

13. Procédé selon la revendication 12, **caractérisé en ce que** le au moins un composant produisant de l'énergie thermique en excès est la batterie et/ou une pile à combustible à hydrogène et/ou un moteur et/ou de l'électronique embarquée.

14. Procédé selon la revendication 12 ou 13, **caractérisé en ce que** ledit procédé comprend en outre l'étape suivante :
lorsque la température du réservoir de lavage est supérieure à la température d'un composant destiné à chauffer, libérer l'énergie thermique stockée en dirigeant ladite énergie thermique du réservoir de lavage vers le composant destiné à chauffer.

15. Procédé selon la revendication 14, **caractérisé en ce que** le composant destiné à chauffer est la batterie et/ou une pile à combustible à hydrogène et/ou une cabine passager.

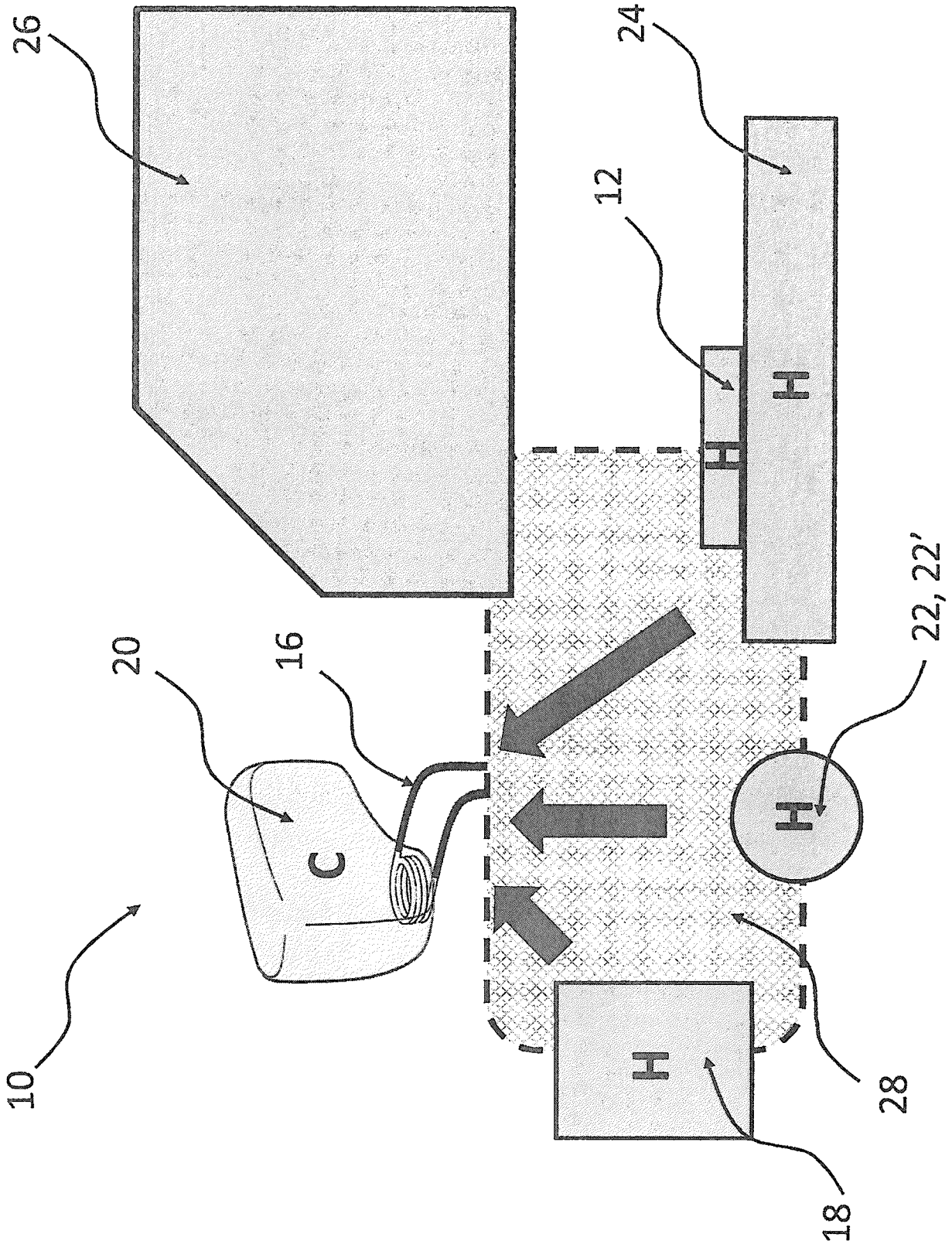


Fig.1

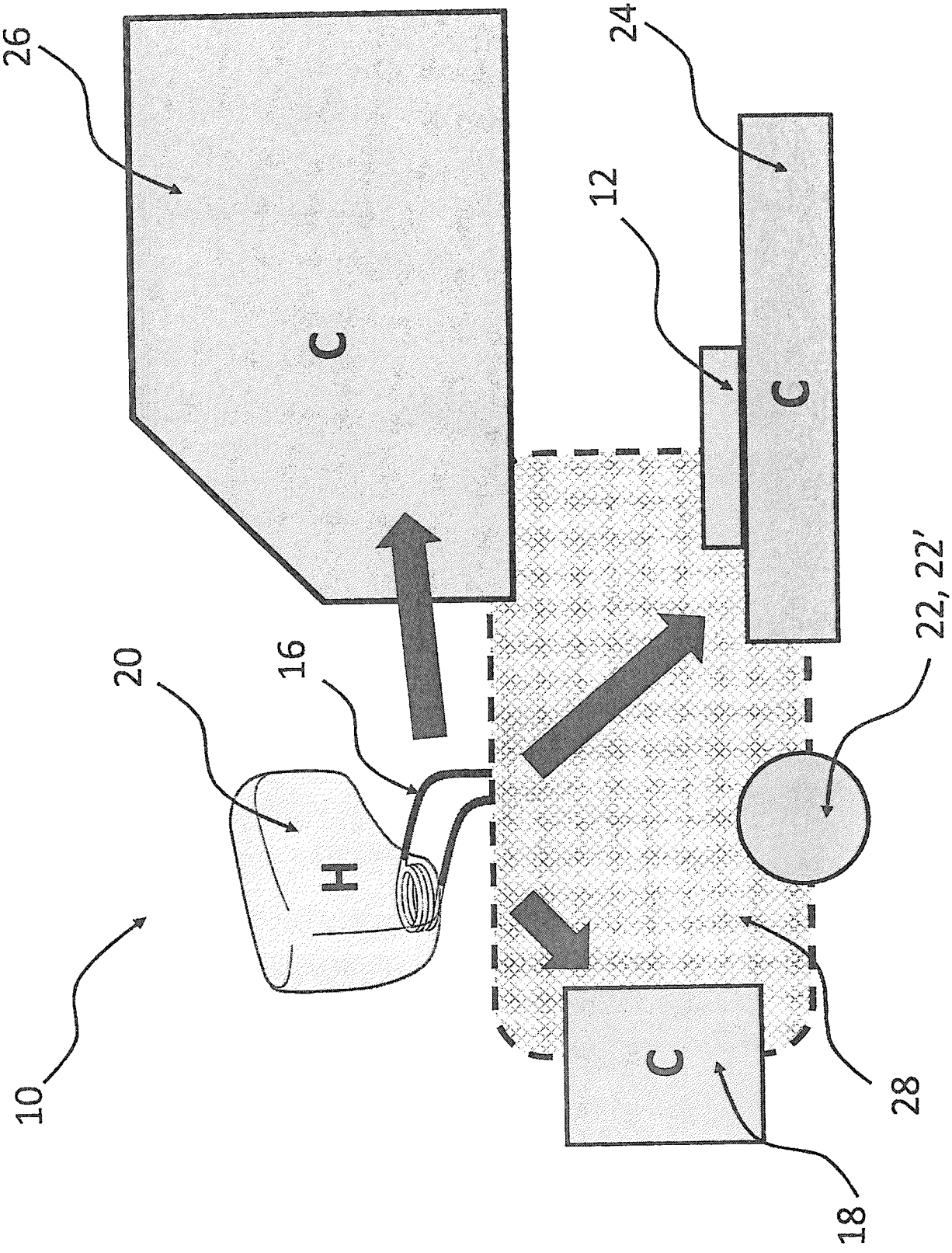


Fig.2

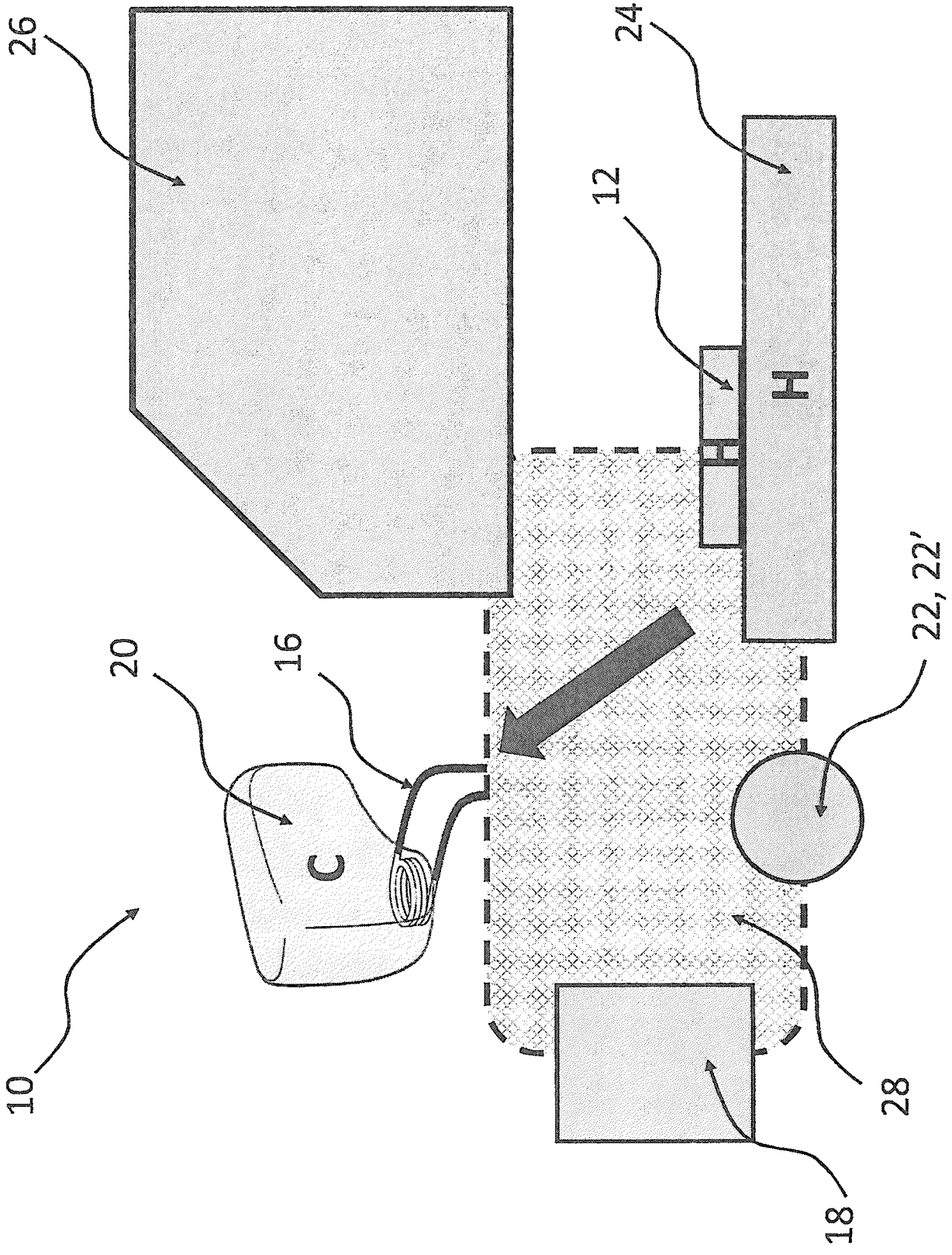


Fig.3

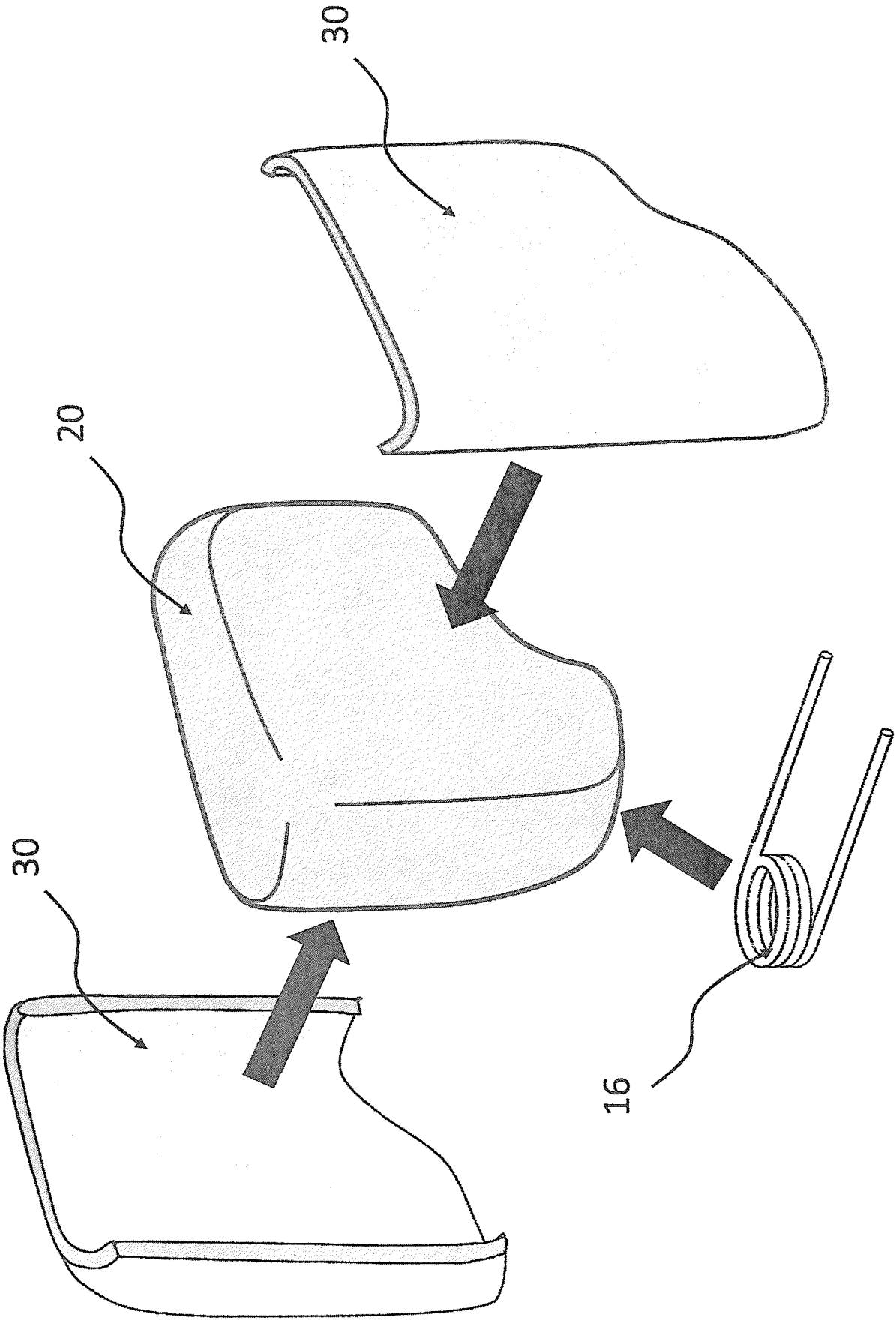


Fig.4