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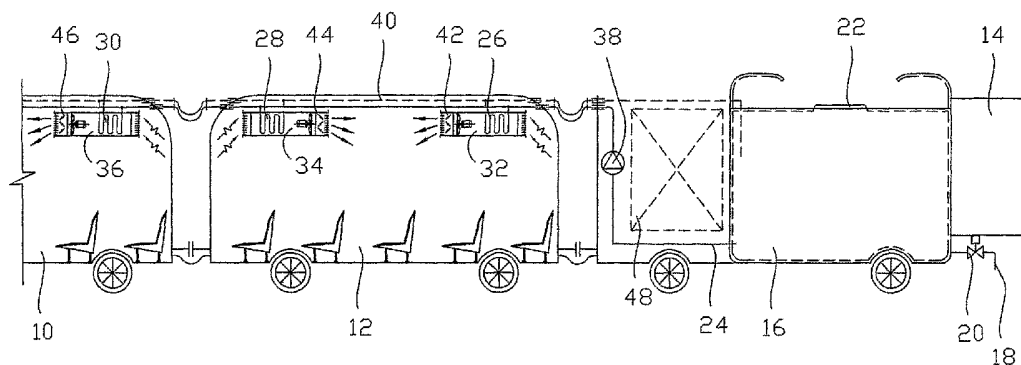
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ning of each regular issue of the PCT Gazette.

(54) Title: AIR CONDITIONING OF VEHICLES TRAVELING THROUGH CLOSED SPACES



(57) Abstract: An air conditioning system and method for vehicles consisting of coaches or cars (10, 12), which during their travel should pass closed spaces. The system utilizes energy accumulating media, e.g. ice stored in a vessel (16) deployed in a single dedicated location immediately within the vehicle. The system is provided with liquid circulating means, means for permanent circulating liquid suitable for transfer of energy between the media and the air within the cars (19, 12). The system is provided with means for heat exchange between the energy accumulating media and the liquid and with air handling units (32, 34, 36) mounted within the passenger cars (10, 12). Each air-handling unit is capable upon supplying thereto the circulating liquid to transfer the cooling or heating energy to the indoor air within the car.

Air conditioning of vehicles traveling through closed spaces

5

Background of the invention

1. Field of the invention

The present invention relates to air conditioning, more particularly to air conditioning method and system suitable for use in trains of vehicles, which occasionally or permanently travel in closed spaces.

- 10 The need for air conditioning (cooling and eventually heating) always exists in vehicles like cars, coaches, wagons, trains and the like. This need becomes even more acute for vehicles, which travel in closed spaces, such as tunnels and the like, and in harsh climatic conditions where heat discharge and/or pollution is either limited or prohibited.
- 15 The problem of providing moving vehicles with air conditioning systems stems from the necessity to exhaust the reject heat and/or the pollution caused by the system. In the case of vehicles moving in closed spaces the discharge of heat is in many cases limited or impossible or may even be forbidden because the closed space is incapable of absorbing it.
- 20 The present invention deals with air conditioning method and system suitable for vehicles moving in closed spaces. By virtue of the present invention some of the air conditioning takes place in the vehicles during predetermined times of several hours and without any discharge of reject heat or pollution in the closed space. The present invention can be implemented for example in underground trains (metro) or other
- 25 railway passenger cars. It should be understood, however that the invention is not limited strictly to railway cars. The present invention is suitable for and can be implemented in any other unmanned or passengers' cars, which travel through closed spaces, e.g. subterranean passages or any other passages going through or under an obstruction.

A non-limited list of such vehicles includes underground trains (metro), LRT (light rail trains), APMs (automatic people movers), PRT (personal rapid transits), shuttle transport systems, etc.

5 2. Description of the related art

When the reject heat emission into the closed space calls for ventilation of the closed space, which is not acceptable or permitted or sufficient, cooling energy is required in accordance with the local climatic conditions. These conditions do not allow, however for a standard air conditioning system, which is conventionally provided with a
10 separate heat exchanger (condenser). Limitations associated with closed environmental spaces, their geometric configuration, climatic conditions and travel time do not allow the use of conventional air conditioning.

Various solutions devised for cooling closed spaces, e.g. tunnels, through which trains (vehicles) travel, have failed due to the required large capacity of air conditioning
15 and/or the large amount of ventilation required in order to operate efficiently the air conditioning systems working in the closed spaces (trains' surrounding).

On the other hand, ice has been used for decades to refrigerate cool spaces and food and is still widely used. Refrigeration by means of ice depends upon either natural or forced circulation of air. The circulating air passes around blocks of ice and some of
20 the heat of the circulating air is transferred to the ice, thus cooling the air.

In modern air conditioning technology ice is used in so called thermal energy storage applications, in which cooling energy is stored by virtue of cooling, heating, melting or solidifying of a material. This energy becomes available as heat when the process is reversed. The thermal energy storage approach is widely used for air conditioning in
25 buildings. The known thermal energy storage systems function by chilling, freezing phase-change materials, or making ice in an insulated tank during evening, night or morning hours. The stored cooling energy is then used for space conditioning during the day hours.

Attempts to utilize ice for air conditioning in vehicles are also known.

30 For example, US 1972912 assigned to Anderson, describes a method and an apparatus for air conditioning, in which water for cooling air is brought in direct contact with a body of ice. The invention is suggested for use in railway cars, in which a receptacle

for ice is installed on the wagon's roof (or under the floor), and ice supply may be replenished from an elevated platform when the train stops at a station. The other parts of the air conditioning system, which include the cooling and the circulating system, are placed below the floor of the vehicle. The aim of this invention is to avoid using a refrigeration apparatus, which in many instances is expensive to install and maintain.

It is believed that this invention would be useful for conditioning air in railway cars during extended stops. It can be readily appreciated that installing a receptacle on the roof of each wagon, whose dimensions should be sufficient for storing the required amount of ice, considerably increases the wagon's height and even might preclude passing of such a railway car through the existing tunnels. On the other hand the space under the wagon is limited and technically problematic. Furthermore, a special elevated platform would be required for the replenishment. Furthermore, Anderson's invention uses ice water for cooling air (direct water/air heat exchanger). At certain temperatures this might cause a rise in the air relative humidity.

Handling the cooling media in every wagon renders the Anderson's invention inefficient, time and labor consuming and requires complex adaptation to the station supply.

A further attempt to employ ice for air conditioning in railway cars can be found in US 2020093, which is assigned to the same inventor. In this invention, which seeks to improve the previous one, an air-conditioning apparatus is installed in each wagon. The apparatus comprises a sump or bin to contain ice, which is located on the under side and at about the longitudinal center of the wagon. The apparatus also comprises means for moving flowing water through and around the ice in the bin. The apparatus further comprises an air-cooling unit with cooling means for conditioning the air passing through the cooling unit and for circulating water from the bin to the cooling means. The disadvantage of this solution stems from the limited space available for the bin. As a result, the amount of stored ice is limited a priori.

Furthermore, the cooling energy is supplied separately to each car and to each heat exchanger, and thus air conditioning depends on the different air conditioning demand for cooling in each car and in each part of each car. Thus it is not cost effective (because no uniform use of ice at all cars).

Furthermore, such an arrangement requires a separate pump in each heat exchanger.

Handling the cooling media in every car renders the Anderson's invention inefficient, time and labor consuming and requires complex adaptation to the station supply.

It should also be mentioned that the above-described systems, installed in each wagon, require compulsory replenishing of ice during stops, since neither of them enables
5 autonomous ice making during the travel. One could presume that none of these solutions provides air conditioning system suitable for trains moving in long closed spaces.

Another solution based on using ice in railway cars can be found in JP 1256773 assigned to NKK Corp. This solution is intended for cooling subways without
10 discharging heat from the vehicles in tunnels or at platforms. According to this solution a freezing unit and a sherbet-like ice-making machine is provided, which operates by using night electric power to convert a fusion latent heat storage agent into a sherbet-like cold latent heat storage agent. The produced latent heat cooling storage agent is stored as slurry that contains only 50% ice in a central storage tank from
15 which it is pumped into individual cold storage tanks installed in each car. The agent is pumped into the individual storage tanks in each car in parallel through the line connected to the rear car of the train, before operating the train. The cars are also equipped with individual indoor blowers, heat exchangers and slurry pumps. During travel pumps circulate the cold slurry through heat exchangers to cool air circulated by
20 the blowers. The cold air cools the cars' interior without affecting the thermal environment in tunnels and platforms.

Thus in this system a dedicated cooling agent in the form of slurry is used and the source of the cooling agent is located outside the vehicle at a dedicated station. The cooling agent is available for replenishment when the car stops at this station. The
25 cooling agent is pumped to a heat exchanger provided in each car. The slurry circulates all the time through heat exchangers when the train travels and cools the air directly.

The disadvantage of this solution stems from the inability to produce ice autonomously within the vehicle. Furthermore, this cooling system requires relatively
30 sophisticated means to produce fluid ice slurry and is not suitable for use of ready-made, commercially available ice cubes, pellets, flakes etc. The ice slurry is to be stored within a vessel, which is located at a dedicated station and in order to replenish

the slurry the station must be approached by the rear car of the train. A further disadvantage of the cooling system described in this patent lies in the fact that it is designed to circulate the slurry through heat exchangers so as to cool the air directly and not by means of circulating water. Ice slurry contains a lot of water in addition to the ice (usually more than 50%), which hardly contribute cooling energy for the air conditioning. Due to this reason the required amount of ice slurry might be more than double in comparison to ice in particulate form. This renders the ice slurry consuming system less efficient.

Furthermore, the cooling energy is supplied separately to each car and to each heat exchanger, and thus air conditioning depends on the different air conditioning demand for cooling in each car and in each part of each car. Thus it is not cost effective (because no uniform use of ice at all cars).

Furthermore, such an arrangement requires a separate slurry pump in each heat exchanger.

Handling the cooling media in every wagon renders the NKK Corp. invention inefficient, heavy weight, time and labor consuming and requires complex adaptation to the station supply.

A further solution for air conditioning of underground tube trains has been devised recently. This solution is described in GB 2394034 assigned to Stratford. According to his invention each coach of the train is provided with the air conditioning system, which uses spherical pellets of ice held in an icebox, through which air for indoor cooling passes. Altogether eight boxes with ice are distributed in each coach. The ice is replenished at each station by delivering it to the box through a common pipe loop in a carrier flow of water from the front end of the platform. Air from inside the railway coaches is cooled when it passes through ice pellets contained in each box.

Unfortunately this air conditioning system suffers from the same disadvantages, which have been already mentioned, i.e. it does not allow autonomous production of ice for replenishment, installing ice-making equipment at each station for producing ice and it utilizes direct heat exchange between the cooling energy accumulating media and air. The cooling media is stored at each heat exchanger at several units in each car.

Furthermore, the cooling energy is supplied separately to each car and to each heat exchanger, and thus air conditioning depends on the different air conditioning demand

for cooling in each car and in each part of each car. Thus it is not cost effective (because no uniform use of ice at all cars).

Handling the cooling media in every wagon renders the Stratford's invention inefficient, time and labor consuming and requires complex adaptation to the station supply.

Thus, despite the fact that numerous solutions employing ice have been devised for air conditioning in general and for air conditioning of vehicles moving in closed spaces in particular, nevertheless there still is a need for a new air conditioning method and system, which does not increase the heat load in the surrounding closed space.

The present invention suggests a solution for air conditioning systems that does not reject heat to the closed surrounding of moving vehicles in closed spaces and which, at the same time is simple, inexpensive, convenient in operation and maintenance, efficient, reliable and environmentally friendly.

3. Objects of the invention

The object of the present invention is to provide a new and improved method and system for air conditioning in vehicles. It outweighs the drawbacks of the existing methods and systems.

In particular, the main objective of the invention is to provide a new and improved method and system, which is suitable for air conditioning of trains with many cars traveling through closed spaces.

A further objective of the invention is to provide such a method and system, which is based on utilizing cooling energy stored by phase transformation media, e.g. ice.

Yet another objective of the invention is to provide a method and system for air conditioning, which is capable of accumulating and storing a sufficient amount of cooling energy in one (or more) dedicated cars of a train so as to supply the cooling energy to all cars when they travel either through closed or open spaces during a whole day.

Another objective of the invention is to provide a new method and system for air conditioning of e.g. railroad cars, which allows the supply of cooling energy to all cars of a train simultaneously, irrespective of whether the demand of the cooling energy in

different cars is uniform or not and thus allows a more efficient use of all the stored ice despite the different demand of cooling media energy in different cars.

Another objective of the invention is to provide a new method and system for air conditioning, in which the phase transformation media is replenished at a static
5 location, where only the cooling energy storing car should be retained.

A further objective of the invention is to provide such a method and system for air conditioning, in which cooling energy is supplied from the phase transformation media to cooling water and then from cooling water to indoor air, wherein the cooling water is circulating through all the cars by means of a conventional circulating system.

10 Another objective of the invention is to provide a new method and system for air conditioning, which is capable of supplying indoor cooled fresh air to cars in a cost effective way and at the same time enables the use of a "once-through" cycle (total fresh air),, which might be especially important for crowded trains.

A still further objective of the invention is to provide a new method and system for air
15 conditioning, which is suitable for heating as well.

Yet another objective of the invention is to provide a new method and system for air conditioning, which enables the use of prefabricated phase transformation media, e.g. commercially available prefabricated ice pellets, flakes, spheres or cubes or the use of commercially available equipment for fabricating such phase transformation media.

20 And still further objective of the invention is to provide a method and system for air conditioning, which enables accumulating stored cooling energy onboard trains (vehicles) by using commercially available phase transformation media energy storage equipment, which uses as energy storage.

25 4. Summary of the invention

The present invention suggests a solution, which is based on generation and accumulation of heating or cooling energy by an energy accumulating media such as ice or other phase transformation substances, e.g. eutectic mixtures or liquids, whose energy is supplied to the air conditioned space (passengers' compartments) from the
30 dedicated car/coach during traveling of the vehicle and whose energy is replenished when the vehicle stops (or moves in open space). The car/coach, which is dedicated for storing the accumulating media, is connected to the other cars of the train or the

like, so that it is towed or pushed by it and the cooling/heating energy can be circulated through the other cars of the train. When the energy accumulating media is exhausted, i.e. when the ice has melted partially or entirely during the travel, it is recharged and replaced by the fresh energy accumulating media.

- 5 As soon as the energy accumulating media is loaded or charged onto the dedicated car, and the dedicated car is connected to the other cars/coaches, the air-conditioned vehicle can be put into motion again and its controlled heat-exchange system is operating to maintain the desired temperature. The air conditioning of the cars includes air-handling units to control the temperature of the air-conditioned space.
- 10 The dedicated car for storing the accumulated cooling/heating energy can be charged off line and/or be replaced by another dedicated car pre-charged at a station or depot. The accumulated energy is transferred from the dedicated car to the other cars by heat exchanger(s) fed by liquid circulating pump(s). The cooling/heating energy supply is temperature controlled.
- 15 The energy accumulating media in different forms can be loaded onto the dedicated car, e.g.:
- A. Loading (pouring) of ice (or hot water) or other eutectic substances onto the dedicated car.
 - B. Loading (pouring) of frozen or hot energy accumulating media encapsulated in
20 small containers.
 - C. Recharging the energy accumulating media in the dedicated car to recharge the energy accumulating media that has been consumed.

The present invention has only been summarized briefly.

- For a better understanding of additional embodiments of the invention as well of its
25 advantages, reference will now be made by the following description with reference to the accompanying drawings.

Brief description of the drawings

FIG. 1 shows the air conditioning system according to the first embodiment of the invention, which utilizes energy accumulating media as per option A and B.

- 5 FIG. 2 shows the air conditioning system according to the second embodiment of the invention, which utilizes energy accumulating media as per option C.

Detailed description of the invention

- Fig. 1 shows the first embodiment of the air conditioning system installed in a vehicle, which comprises for example a train of connected railway carriages. The train comprises cars or coaches 10,12 and a driver compartment in the front car 14. The air conditioning system of the invention is intended primarily for those trains, which travel through closed spaces, e.g. tunnels. For the sake of illustration the vehicle depicted in Fig. 1 is a railway car traveling through a closed space, e.g. tunnel. Within a dedicated location on the train, for example in the front car, is mounted a storage vessel or tank 16, which is used for storing media for accumulating the heating or cooling energy to be supplied to the other components of the air conditioning system as will be explained below. The vessel walls are provided with suitable insulation (see dashed line) to prevent dissipation of the accumulating energy into the atmosphere. It is advantageous if ice in the form of ready-made granules, cubes, spheres, pellets, flakes or other particles is used as energy accumulating media for cooling. The further description will refer to the use of ice as energy accumulating media suitable for cooling. It should be understood, however, that suitable energy accumulating media could be used also for heating.
- 25 The capacity of the storage vessel should be large enough to contain such amount of ice, which is sufficient for cooling the whole train for a day cycle when it travels through closed spaces without the necessity to replenish the media. Connected to the bottom part of the vessel, a draining line 18 is provided. A valve 20 closes this line and reopens it when it is required to drain water produced during the melting of the ice. The water obtained from the melted ice can be reused to produce fresh ice, The ice could be loaded through an opening made in the upper part of the storage vessel and closed by a cover 22.
- 30

A pipe-line 24 is provided, with one end submerged in the water or connected to a coil (not shown) located within the storage vessel and surrounded by the particles of ice and water. The other end of the line 24 is in fluid communication with a plurality of separate heat exchangers 26,28,30 belonging to corresponding air handling units 32,34,36 installed in the cars. At least one pump 38 is installed in line 24 for circulating water through line 24 and through heat exchangers. A return line 40 is provided for returning water to the storage vessel. Each air-handling unit is provided with a corresponding fan 42,44,46, which takes air from the car or from the surrounding tunnel or from both, blows it through the respective heat exchanger and supplies cooled air to the car. Line 24 and line 40 are connected in parallel to each heat exchanger, to allow permanent provision of circulating cooling water through the heat exchangers and by virtue of this provision transfer of cooling energy from the ice stored in the vessel to the air in the cars. This energy transfer might take place as long as the energy accumulating media is available and regardless of whether the vehicle travels or stops at a station. Furthermore, since the cooling water is supplied to air handling units simultaneously, melting of ice in the storage tank does not depend on whether the air handling units in different cars consume cooling energy uniformly or not.

The temperature in the cars is controlled in the conventional way used for commercial air handling units, i.e. by means of thermostats and 3-directional valves (not shown). Humidity may also be controlled (if required), e.g. by mixing of fresh air (taken from the surrounding) with the indoor air circulating in the cars.

Thus the air conditioning system of the present invention comprises the following main components:

- A storage vessel for storing energy accumulating media in the vehicle itself,
- A liquid circulating means, enabling the circulation of cooling/heating liquid between the storage vessel and the cars,
- A means for heat exchange between the energy accumulating media within the storage vessel and cooling/heating liquid,
- A plurality of separate air handling units, which are connected in parallel to the cooling/heating liquid circulating means, in order to enable transfer of

heating or cooling energy from the cooling/heating liquid to the air supplied to the cars.

In addition to the above main components the system of the invention might comprise

- 5 - A secondary low temperature liquid cooling unit (or heating unit) to produce cooling (or heating) energy (in open spaces) for storing in the storage vessel.

For the sake of brevity it is not shown specifically yet it should however be appreciated, that appropriate control means are also provided for controlling cold-water intake, fresh air intake, measuring of temperature in the cars etc. The
10 appropriate instrumentation and electrical connections between the control means and components of the system are not shown since they are common and should be obvious for one skilled in the art.

It can be appreciated that during the operation of the air conditioning system of the present invention discharge and/or pollution of reject heat is excluded as would be
15 required for vehicles traveling through closed spaces.

By virtue of locating the whole energy accumulating media within a dedicated location in the vehicle (and not outside the vehicle or in each car as in prior art solutions) it could be easily replaced without the necessity to bring the rest of the cars into the depot. Replenishment of the energy accumulating media can be carried out
20 easily, conveniently and fast when the car with the storage vessel(s) stays at a station or in the depot. If ice is used as energy accumulating media, it can be loaded into a vessel in the form of commercially available, ready-made ice particles, while water (from the melted ice) could be discharged for reuse for producing of fresh ice.

It might be advantageous to provide the car carrying the storage vessel(s) with an
25 optional cooling unit 48, which uses an alternative conventional source of cooling or heating energy, e.g. a low temperature liquid chilling unit. This unit could be operated when the vehicle travels through open spaces or is parking in a depot or at an open station where the heat discharge to the atmosphere is not a problem.

Now with reference to Fig.2, a further embodiment of the air conditioning system
30 would be explained. In this embodiment the system also comprises a media storage vessel located within a dedicated location on the car, water circulating means, a means for heat exchange and plurality of air handling units. However, in contrast to the

previous embodiment, ice is not charged in the storage vessel in the form of ready-made particles. In the air conditioning system according to the second embodiment liquid energy accumulating media is used instead of prefabricated ice in discrete form. This liquid media is produced by the use of a secondary cooling system provided outside the car at a station or depot. It should be appreciated that such a secondary cooling system could be installed also onboard the vehicle in a dedicated car(s). This system can be activated either when the entire vehicle is out of a closed space, or stops at a station/depot or when only the dedicated car is retained at the station or depot.

It is seen in Fig.2 that similarly to the previous embodiment in the cars 10,12 of the vehicle separate air handling units 32,34,36, are installed, each having corresponding heat exchanger 26,28,30 and fan 42,44,46. The heat exchangers are connected in parallel with line 24, which supplies cooling media, such as water or glycol mixture or another low temperature fluid and return pipe-line 40 is also provided for returning coolant. Pump 38 is provided for circulating the cooling water (coolant) through lines 24,40. It is seen also that within the dedicated car two storage vessels 50 are provided, each being equipped with a coil 52 in which cooling water flows and proceeds to line 24 and returns from line 40. The two storage vessels are shown in Fig.2 only as an example. It should be appreciated that in accordance with the invention at least one storage vessel or more than two storage vessels could be provided.

Both storage vessels are connected through a common line 54 to a secondary cooling system (not shown), which produces liquid cooling media supplied to the vessels by a pump 56. The cooling media is discharged from the vessels by line 58. As an example of a suitable secondary cooling system one can mention a so-called off-peak cooling system, which utilizes thermal energy storage approach to air condition buildings. In this system, cooling energy is accumulated by a suitable liquid, stored within a tank, in which a suitable coil can be submerged,(or other means for heat exchanging) through which the cooling media of the secondary system is flowing.

It can be appreciated that functioning of the air conditioning system remains the same regardless of whether it uses cooling energy of prefabricated solid ice or cooling energy of locally made ice from a cooling energy supplied by a low temperature chilling unit. Optional cooling system 48 on board the vehicle, which has been

already mentioned in connection with the first embodiment, can be employed in the second embodiment as well.

It should be appreciated that the present invention is not limited by the above-described embodiments and that one ordinarily skilled in the art can make changes and modifications without deviating from the scope of the invention as will be defined below in the appended claims.

For example, suitable energy accumulating media may comprise any phase-change materials either in liquid or in solid form, being either encapsulated in specialized containers such as tubes, shallow panels, spheres, plastic bags, etc, or be a free media intended for direct contact.

The air conditioning system of the present invention can function not only for cooling air but also for heating air in the cars. For this purpose instead of ice, or instead of liquid cooling media one can use hot water stored within the vessel.

Depending on the required amount of the energy accumulating media the storage vessel can be located in a more than one dedicated location within one or more cars.

The storage vessel can occupy the entire dedicated car(s), or occupy a compartment of the passenger car or the car in which the driver's cabin is located.

The energy accumulating media can be stored within one or more vessels for storing ice or storing any other energy accumulating eutectic media.

In the following claims the term *comprising* means "including but not limited to".

It should also be appreciated that features disclosed in the foregoing description, and/or in the foregoing drawings, and/or examples, and/or tables, and/or following claims both separately and in any combination thereof are material for realizing the present invention in diverse forms thereof.

Claims

1. A method for air conditioning of a vehicle, said vehicle comprising a connected line of passenger coaches or cars, which during their travel should occasionally or permanently pass at least one closed space, like tunnel, subterranean passage or any other passage going through or under an obstruction, said method comprising:
 - Deploying in at least one dedicated location situated immediately within the vehicle of at least one storage vessel for storing energy accumulating media capable to release cooling or heating energy,
 - Circulation of a liquid between the storage vessel and the cars, said liquid is suitable for energy transfer between the energy accumulating media and the air in the vehicle.
 - Providing heat or cooling exchange between the energy accumulating media and the liquid to submit thereto the cooling or heating energy releasable by the energy accumulating media,
 - Providing within the passenger cars of at least one air handling unit and supplying thereto the circulating liquid so as to transfer the cooling or heating energy to the air within the cars.
2. The method for air conditioning as defined in claim 1, in which said dedicated location is arranged within at least one dedicated car.
3. The method for air conditioning as defined in claim 1, in which said dedicated location is arranged within at least one passenger car.
4. The method for air conditioning as defined in claim 1, in which said liquid circulates, between the storage vessel and the passenger cars.
5. The method for air conditioning as defined in claim 1 in which said liquid is water with or without additives and said liquid is circulated by a conventional pump and is supplied simultaneously to all passenger cars.
6. The method for air conditioning as defined in claim 1, in which said energy accumulating media comprises phase-change material being either in liquid or in solid form, being either encapsulated in specialized containers or not encapsulated.
7. The method for air conditioning as defined in claim 6, in which said energy accumulating media is ice.

8. The method for air conditioning as defined in claim 7, in which said energy accumulating media is a pre-fabricated ice in the form of discrete particles.

9. The method for conditioning as defined in claim 6, in which said energy accumulating media is a liquid.

5 10. The method for air conditioning as defined in claim 2, in which for replenishing the energy accumulating media only the dedicated car is retained at an open station, or in a depot.

11. A system for air conditioning of a vehicle, said vehicle comprising a connected line of passenger coaches or cars, which during their travel should occasionally or
10 permanently pass at least one closed space, like tunnel, subterranean passage or any other passage going through or under an obstruction, said system comprising:

- At least one storage vessel for storing energy accumulating media capable to release cooling or heating energy said vessel is deployed in at least one dedicated location immediately within the vehicle,

15 - A liquid circulating means, enabling circulation of a liquid, which is suitable for energy transfer between the energy accumulating media and the air in the vehicle,

- A means for heat exchange between the energy accumulating media and the liquid,

20 - At least one air handling unit mounted within the passenger cars, said unit is capable upon supplying thereto the liquid to transfer the cooling or heating energy to the air within the cars.

12. The system as defined in claim 11, in which the liquid circulating means comprises at least a supply line, a return line and at least one pump.

25 13. The system as defined in claim 12, in which said, at least one air handling unit comprises a heat-exchanger and a fan, wherein heat-exchanger of each air handling unit is connected in parallel to the supply line and to the return line.

14. The system as defined in claim 11, in which said dedicated location is arranged within at least one dedicated car.

30 15. The system as defined in claim 11, in which said dedicated location is arranged within at least one passenger car.

16. The system as defined in claim 11, in which said energy accumulating media comprises phase-change material being either in liquid or in solid form, being either encapsulated in specialized containers or not encapsulated.

17. The system as defined in claim 16, in which said energy accumulating media is ice.

5 18. The system as defined in claim 17, in which said energy accumulating media is a pre-fabricated ice in the form of discrete particles.

19. The system as defined in claim 16, in which said energy accumulating media is a liquid.

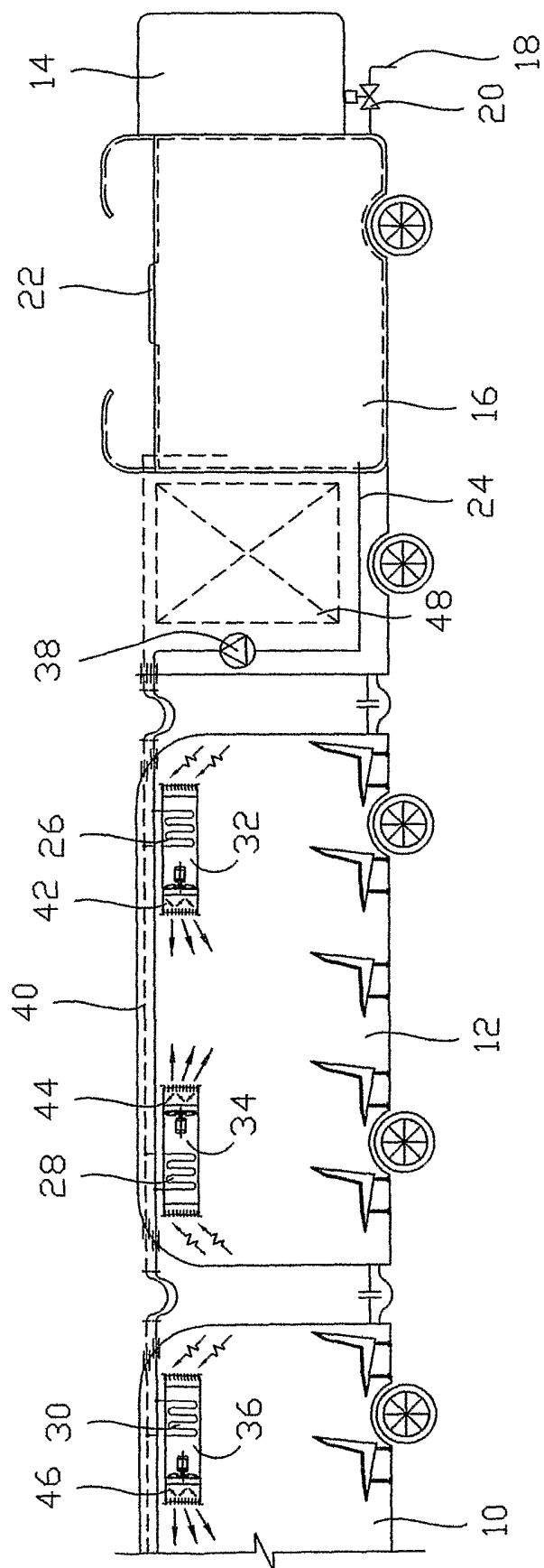
10 20. The air conditioning system as defined in claim 11, in which the said storage vessel is connectable to a secondary cooling system capable of producing a cooling liquid, supplying the fresh cooling liquid to the storage vessel and discharging exhausted liquid from the storage vessel.

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Fi. 1

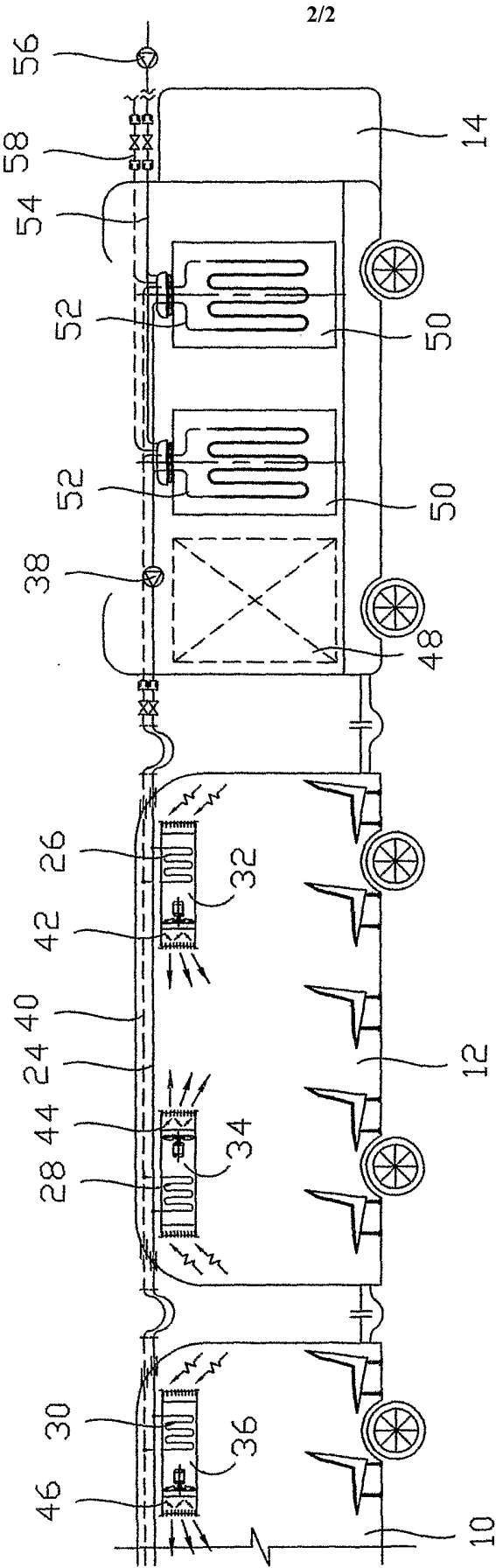


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL2004/000722

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B61D27/00 B60H1/00

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 7 B61D B60H

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 practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 27 10 766 A (SEICO IND ELEKTROWAERME GMBH) 21 September 1978 (1978-09-21)	1-5, 11-15,20
Y	page 7, paragraph 5 - page 10, paragraph 5; figure	6-10, 16-19
Y	----- NL 1 019 756 C (ECOFYS B V) 17 July 2003 (2003-07-17) the whole document	6-10, 16-19
X	----- DE 199 54 190 A (SICARS STEPHAN) 17 May 2001 (2001-05-17) column 1, line 1 - column 2, line 41 column 4, line 64 - column 6, line 47; figure	1,6,11, 16
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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- *O* document referring to an oral disclosure, use, exhibition or other means
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- *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
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- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

10 November 2004

Date of mailing of the international search report

19/11/2004

Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL2004/000722

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 196 32 073 A (SIEMENS AG) 12 February 1998 (1998-02-12) column 3, line 9 - column 4, line 23; figure -----	1,11
X	DE 19 60 056 A (VOITH GETRIEBE KG) 3 June 1971 (1971-06-03) the whole document -----	1,11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IL2004/000722

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			EP 1468228 A1	20-10-2004
			WO 03073027 A1	04-09-2003
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DE 19632073	A	12-02-1998	DE 19632073 A1	12-02-1998
DE 1960056	A	03-06-1971	DE 1960056 A1	03-06-1971