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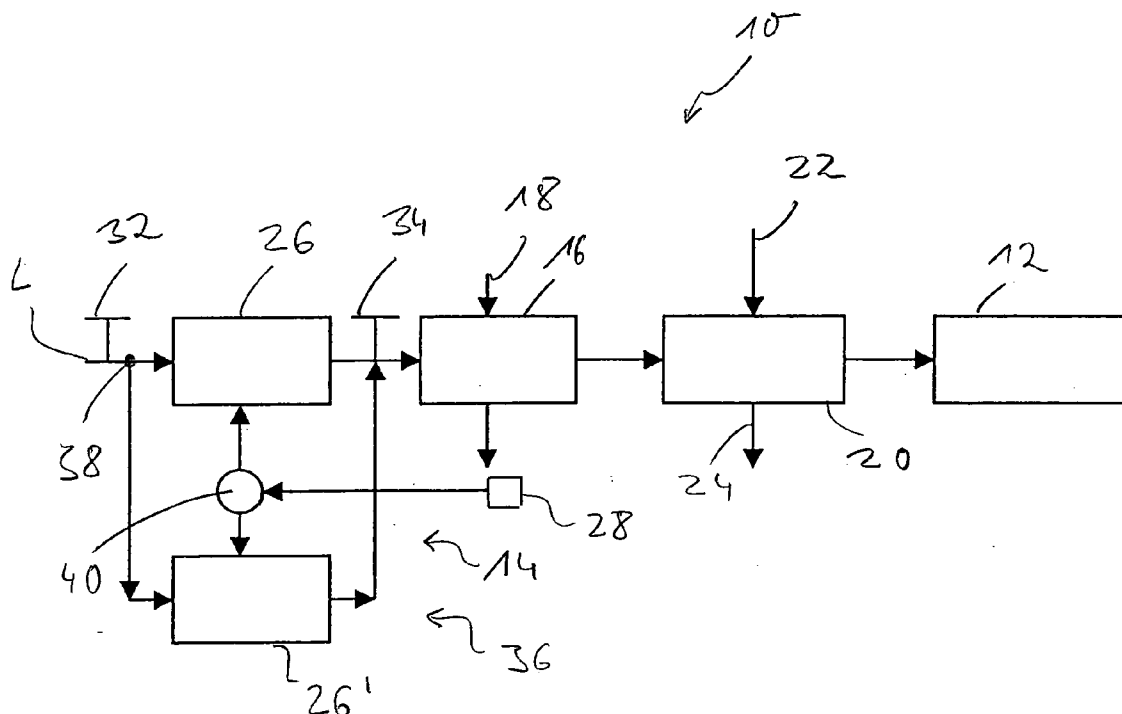
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(57) **ABSTRACT**

An air conditioning system is provided for a vehicle for conditioning the air to be introduced into the interior space of a vehicle. The system has a drying unit (14), through which the air (L) can flow and by which moisture can be extracted from the air (L).



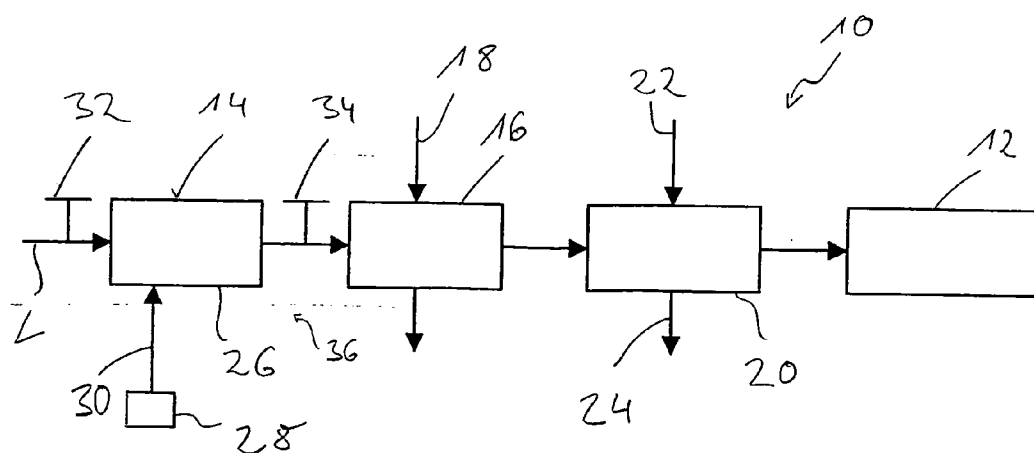


Fig. 1

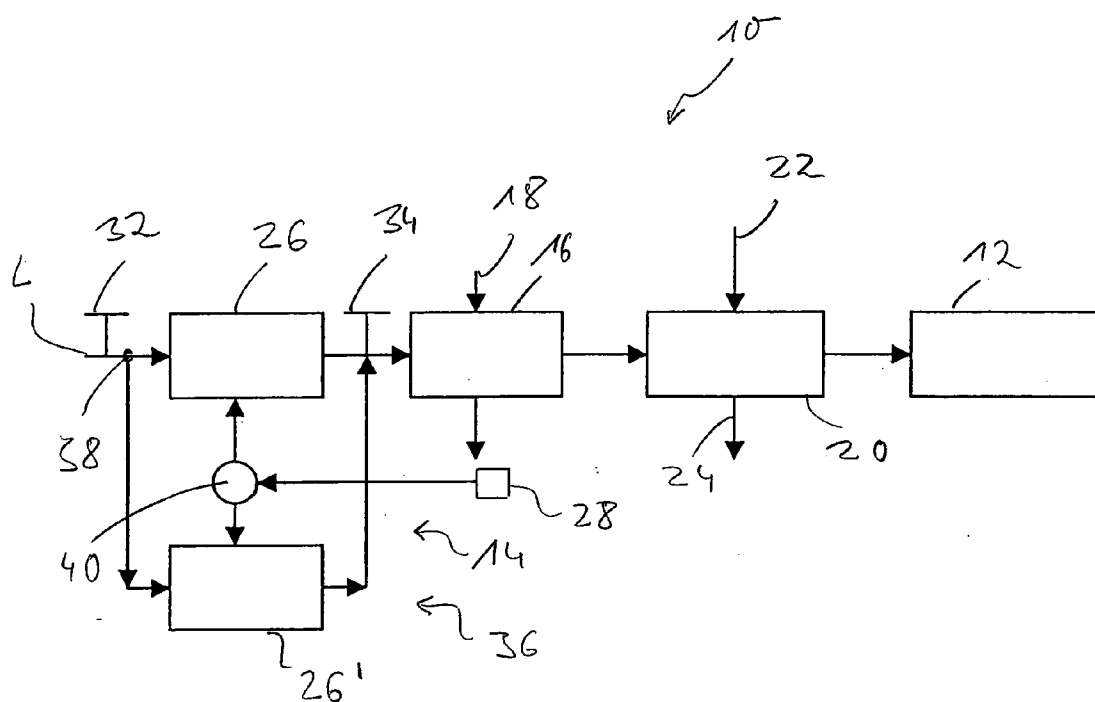


Fig. 2

AIR CONDITIONING SYSTEM FOR A VEHICLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of DE 103 60 459.6 filed Dec. 22, 2003, the entire contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention pertains to an air conditioning system for a vehicle, with which air conditioning system the air to be introduced into the interior space of a vehicle can be conditioned.

BACKGROUND OF THE INVENTION

[0003] In designing such air conditioning systems, it should, in general, be taken into account that various requirements are imposed on such air conditioning systems. On the one hand, the air to be introduced into the interior space of the vehicle shall have a state that is felt by the occupants of the vehicle to be pleasant. Consequently, this air shall be possibly cool in case of comparatively high ambient temperatures, i.e., it shall have been cooled, for example, by an air conditioning system. Furthermore, the air shall also be introduced into the interior space of the vehicle possibly in a dried or moisture-reduced state above all if the humidity of the air is relatively high in order to thus support the evaporation of the moisture collecting on the skin of the occupants of the vehicle. At the same time, such systems shall, however, also be operated with the lowest possible energy consumption, which is an elementary requirement especially when, for example, conditioning or air conditioning shall be made possible during parking, i.e., when the air to be introduced into the interior space of the vehicle is to be affected in a state in which, for example, a drive unit used as the main energy source of the vehicle is not being operated and, for example, the compressor of an air conditioning unit is therefore to be operated by auxiliary energy sources, e.g., a battery or a fuel cell.

SUMMARY OF THE INVENTION

[0004] The object of the present invention is to provide such an air conditioning system for a vehicle, with which an efficient conditioning of the air to be introduced into the interior space of a vehicle can be achieved with a simple design.

[0005] This object is accomplished according to the present invention by an air conditioning system for a vehicle for conditioning the air to be introduced into the interior space of a vehicle, comprising a drying means, through which the air flows and by which moisture can be extracted from the air.

[0006] Different effects can be achieved by means of the drying means to be provided according to the present invention, by which moisture can be extracted from the air to be introduced into the interior space. If, for example, an evaporator of an air conditioning unit is arranged downstream of such a means, and the air is then cooled in the evaporator before it is introduced into the interior space of the vehicle, the evaporator can operate more efficiently due to the drying, which takes place upstream of the evaporator,

because it is not necessary to also cool the moisture being transported in the air. This means that lower air temperatures can be reached at equal output of the air conditioning system, or the air conditioning system can be operated with a lower output or it can be dimensioned, in principle, for a lower output at a preset air temperature compared to conventional systems without prior drying of the air. Moisture can be extracted from the air by the drying means to be provided according to the present invention in case of a comparatively low outside temperature but high relative humidity without having to put into operation for this, for example, an air conditioning system, which can also be used to extract moisture from the air to be introduced into the interior space of the vehicle, which may, however, possibly make it necessary to subsequently reheat the air before it is introduced into the interior space of the vehicle. Furthermore, the combination of the drying means with the evaporator of an air conditioning unit has, in particular, the advantage that moisture-depleted air is already fed to the evaporator even during normal air conditioning operation, so that the amount of moisture collecting during the operation of the evaporator is also reduced and the problems arising in connection with the collection of moisture in the area of the evaporator, for example, unpleasant noise, can be markedly reduced.

[0007] Provisions may be made in an especially preferred embodiment of the system according to the present invention for the drying means to comprise a zeolite arrangement, through which the air to be introduced into the interior space flows. The zeolite material provided in such a thick zeolite arrangement possesses a highly hygroscopic property and extracts moisture from the air flowing around and through this material. The moisture collects in the zeolite material, and the air will then flow further in the direction of the interior space of the vehicle in a moisture-depleted state. Since no energy has to be consumed for this drying operation, such a system is especially suitable for air conditioning a vehicle during parking, i.e., for air conditioning in a state in which the necessary energy would have to be provided, for example, by a battery or another energy storage unit or a fuel cell system.

[0008] The zeolite arrangement may be designed, for example, such that it comprises a plurality of zeolite units, and individual zeolite units or a plurality of such zeolite units can then be released for the flow of the air to be introduced into the interior space of the vehicle and blocked to prevent such a flow as desired. Such an embodiment is therefore especially advantageous because the capacity of extracting moisture from the air decreases due to the uptake of the moisture in the zeolite material. If the zeolite material contained in one of the units is then saturated or in a state in which efficient drying of the air is no longer possible, this unit can be removed from the flow path and another zeolite unit can be released, instead, or a plurality of units can be optionally released in order to continue to ensure efficient drying of the air.

[0009] As was described above, the zeolite material of the zeolite arrangement takes up moisture during the flow of air carrying moisture through it. To make it possible to ensure after the uptake of moisture that this moisture is removed from the zeolite material and the latter can thus be used again for drying, it is proposed that at least one heat source be associated with the zeolite arrangement for heating same.

Various areas of the system can be considered for use in a vehicle as such heat sources for this zeolite arrangement. For example, a fuel-operated burner can be used to provide the heat necessary for drying the zeolite material. Such a burner could be, for example, a burner which is otherwise used as a parking heater or as an auxiliary heater. The heat being transported in the exhaust gases in an exhaust gas guiding system of an internal combustion engine may also be used to dry the zeolite material. A fuel cell also generates heat during its operation, and this heat can, of course, also be transferred to the zeolite material of the zeolite arrangement. Especially if a fuel cell is present, the above-mentioned burner may also use as the fuel the gas that leaves the fuel cell and still contains residual hydrogen in order to thus effect the highly efficient operation of the overall system. The heat source may, of course, also comprise a heater that can be operated electrically, in which case this heater, which can be operated electrically, can again use, for example, the aforementioned fuel cell as the energy source. It is obvious that only the heat sources available in the different phases of operation of the vehicle can be used during the different phases of operation of the vehicle, and it is thus obvious that the internal combustion engine or the exhaust guiding system of the internal combustion engine cannot contribute to the heating of the zeolite material when the vehicle is stopped.

[0010] As was mentioned above, the drying means may be combined according to an advantageous aspect of the present invention with an evaporator of an air conditioning unit, which said evaporator is arranged downstream of the drying means in the flow path of the air. The air can thus enter the evaporator already in a dried and moisture-reduced state, so that less energy is needed to lower the temperature of the air to a desired level.

[0011] Since the air to be introduced into the interior space is heated during the flow through the zeolite material and the release of moisture into the zeolite material, which takes place in the process, provisions may be made according to another advantageous aspect of the present invention for providing a heat exchanger arrangement between the drying means and the evaporator for taking up heat being transported in the air to be introduced into the interior space.

[0012] The present invention will be described below with reference to the attached drawings on the basis of preferred embodiments. The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its uses, reference is made to the accompanying drawings and descriptive matter in which preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a schematic view of a first embodiment variant of a block diagram of an air conditioning system according to the present invention; and

[0014] FIG. 2 is a schematic view of a modified embodiment of the system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Referring to the drawings in particular, The air conditioning system 10, which is shown in FIG. 1 sche-

matically and with its essential system areas, comprises first a drying means designated generally by 14 in the upstream area in the flow path of the air to be introduced into the interior space 12 of a vehicle, which flow path is directed here from left to right. The air L to be introduced into the interior space 12 of the vehicle flows through this drying means 14 and then enters a heat exchanger 16. This heat exchanger 16 removes heat from the air to be introduced into the interior space 12 and transfers same to a coolant 18, which may be represented, for example, by ambient air or another coolant. It is also possible to use here, in particular, the coolant circuit provided in association with a vehicle drive unit in order to remove heat from the air to be introduced into the interior space 12 of the vehicle after it flows through the drying means 14 and thus to already achieve a preconditioning for the internal combustion engine.

[0016] After flowing through the heat exchanger 16, the air L enters an evaporator 20 of an air conditioning system, which is not shown in greater detail. To cool the air, liquid refrigerant 22 is first fed to this evaporator 20, it is evaporated there in order to extract the energy necessary for the evaporation from the air, and it is then released as a gaseous refrigerant 24 under the delivery action of a compressor, not shown in greater detail, and sent in the direction of the condenser. The air L then enters the interior space 12 of the vehicle in a dried, cooled state, in a state in which moisture had first been extracted from it in the drying means 14 and heat and possibly also more moisture were then extracted in the heat exchanger 16 and in the evaporator 20.

[0017] The drying means 14 shown in FIG. 1 comprises, according to an especially advantageous aspect of the present invention, a zeolite unit 26. This zeolite unit 26 contains zeolite material, i.e., a generally crystallized mineral. Such a zeolite material has the property of extracting moisture, i.e., water, from a gaseous medium, e.g., air L, which flows through it, and of absorbing it in its crystalline structure. Since heat is generated in the zeolite material in this process, the air is heated during its flow through this zeolite unit 26, so that it is advantageous to cool the air in the heat exchanger 16 before it is introduced into the evaporator 20. The air drying operation in the zeolite unit 26 requires that any kind of energy source be provided in the vehicle that contains such a system. The consequence of this is that the drying of the air L to be introduced into the interior space 12 of the vehicle can take place without simultaneously providing energy, which in turn entails the special suitability for use for conditioning during parking. Especially if such a system is coupled with an evaporator 20 or an air conditioning system for the vehicle, this results in the fact that less energy needs to be provided in this air conditioning system for cooling the already dried and moisture-reduced air L. This means that the air conditioning system can be operated with less energy, which is likewise especially advantageous in case of air conditioning during parking, or it can be dimensioned for a lower output and, as a consequence of this, it can have a lower energy consumption. It is, of course, also possible, in principle, to increase the cooling capacity of an air conditioning system due to the preceding drying of the air introduced into the interior space 12 of the vehicle, because the moisture that would otherwise still be present in the air does not need to be additionally cooled at equal energy consumption.

[0018] To ensure that the zeolite material of the zeolite unit 26 can be brought into a state in which this material is ready to take up moisture even after the drying operation was performed during a phase of air conditioning during parking or optionally also during travel, a heat source 28 may be associated with the drying means 14. This heat source 28 can be used to heat a heat carrier medium 30, which is fed to the drying means 14 and heats same. Due to the zeolite material being heated, the moisture is expelled from the zeolite material, i.e., the zeolite material is dried and brought again into a state ready to take up moisture again. To ensure after the drying of the zeolite material that this material does not already take up moisture again in a state in which its operation is not necessary for drying the air L, shut-off members 32, 34 may be provided in front of and behind the zeolite unit 26 in the direction of flow. The dried zeolite material can be completely uncoupled from the air flow in this manner, so that it also cannot take up any moisture. It is obvious that another flow path surrounding the zeolite unit 26 must now be provided for the air L. The shut-off members 32, 34 are opened again and the air flow path through the zeolite unit 26 is again released only when the zeolite unit 26 is to be operated again to dry the air to be introduced into the interior space 12 of the vehicle.

[0019] The heat source 28 may be of many different types. For example, a fuel-operated burner may be used as the heat source 28 to provide the necessary heat energy. This fuel-operated burner, which may otherwise operate, for example, as a parking heater or as an auxiliary heater, may be fed with a liquid fuel, but, for example, if a fuel cell is provided in such a vehicle, it may also burn the gas that is released by the fuel cell and still contains residual hydrogen together with oxygen from the air and generate heat in the process and transfer same to the heat carrier medium 30. The fuel cell itself may also be used as such a heat source 28, because, depending on its design, the fuel cell is heated more or less intensely during power generation operation and the heat generated there can also be used to dry the zeolite unit 26. Furthermore, the exhaust gas guiding system of an internal combustion engine may also be used as a heat source 28. This is especially advantageous when, for example, the vehicle has been preconditioned during the parking conditioning phase and heat, which can be used to dry the zeolite material, is then provided by the internal combustion engine after it has been put into operation. It is, in principle, also possible to provide an electric heater as a heat source 28, so that no additional heat carrier medium circulation is necessary, but such an electric heater can be provided, for example, directly at the zeolite unit 26. This electric heater can in turn be supplied with electric energy from an auxiliary energy source, e.g., a fuel cell, especially in the parking operation mode.

[0020] FIG. 2 shows an alternative embodiment variant of the vehicle air conditioning system 10 according to the present invention. It can be recognized here that the drying means 14 comprises a zeolite arrangement 36 comprising two zeolite units 26, 26'. The two zeolite units 26, 26' are connected in parallel with one another in the example being shown, and using a reversing or valve unit 38, it is possible to allow the air L to be introduced into the interior space of the vehicle to flow via one of the two zeolite units 26, 26' or also via both zeolite units as desired. The advantage of this flow via the zeolite units 26, 26' as desired is that while one of these units is active for drying the air to be introduced into

the interior space of the vehicle, the other can be dried itself by supplying heat and practically unlimited operation is thus possible over time. A heat source 28 may again be provided here as described above, and the heat provided by the heat source 28 or the associated heated heat carrier medium can be sent in such embodiment via a reversing member 40 to one of the two zeolite units 26, 26' or also to both units 26, 26' as desired. If the heat source 28 is designed as an electric heater, it is possible, for example, to provide a separate heater, which can also be actuated separately, in association with each of the zeolite units 26. The shut-off members 32, 34 are again present, associated with the two zeolite units 26, 26', in order to ensure after the drying of these zeolite units 26, 26' that they remain in a dry state. It is, of course, possible to provide for these separate shut-off members 32, 34, associated with each of the zeolite units 26, 26', so that, as was described, one can be used for drying while the other is being dried itself or is maintained in a dry state.

[0021] The present invention provides an air conditioning system that can be efficiently used to dry the air to be introduced into the interior space of the vehicle. This has, on the one hand, the advantageous effect that increased comfort can be provided for the occupants of the vehicle already by the introduction of dried air, and, on the other hand, if an air conditioning system is provided, the drying of the air to be introduced into the interior space of the vehicle makes possible the more efficient operation of the air conditioning system.

[0022] Finally, it shall be pointed out that both synthetic zeolites and natural zeolites may be used as the zeolite material in the system according to the present invention. The zeolite material may be kept ready in the zeolite unit or zeolite units in the powdered configuration or with a coarse granular structure. It is also possible to provide the zeolite material in a honeycomb-like form, in which it consequently can have air flow pass therethrough/therepast efficiently. In this embodiment only the surface of a substrate material of the honeycomb-like form may be coated with zeolite material, or the entire honeycomb body or a body that may have any shape and can have air flow pass therethrough/therepast in any way may be built up of zeolite material.

[0023] While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. An air conditioning system for a vehicle for conditioning the air to be introduced into the interior space of a vehicle, the system comprising:

a flow path means defining an air conditioning system air flow path for air to be introduced into the interior space of a vehicle; and

a drying means through which the air of the air flow path can flow for extracting moisture from the air flowing in the flow path.

2. An air conditioning system in accordance with claim 1, wherein said drying means comprises a zeolite arrangement through which the to be introduced into the interior space of the vehicle can flow.

3. An air conditioning system in accordance with claim 2, wherein said zeolite arrangement comprises a plurality of said zeolite units.

4. An air conditioning system in accordance with claim 3, wherein said individual zeolite units or some said of said plurality of said zeolite units can be released for the flow of said air to be introduced into said interior space of the vehicle through them and blocked against such flow as desired.

5. An air conditioning system in accordance with claim 2, further comprising a heat source for heating said zeolite arrangement and associated with said zeolite arrangement.

6. An air conditioning system in accordance with claim 5, wherein said heat source comprises one or more of:

a fuel-operated burner;

an exhaust guiding system of an internal combustion engine;

a fuel cell; and

an electrically operated heater.

7. Air conditioning system in accordance with claim 1, further comprising an air conditioning unit with an evaporator arranged downstream of said drying means in the direction of air flow of said air flow path.

8. An air conditioning system in accordance with claim 7, further comprising a heat exchanger arrangement for taking up heat being transported in the air to be introduced into the interior space of the vehicle, said heat exchanger arrangement being provided between said drying means and said evaporator.

9. A vehicle air conditioning system for conditioning the air to be introduced into the interior space of a vehicle, the system comprising:

air conditioning system flow passage providing a flow path for the air to be introduced into the interior space of a vehicle; and

a drying unit including a drying unit body with an air inlet and an air outlet and a mass of moisture extracting substance through which the air in the flow path can flow, said drying unit body having an operative connection with said flow passage.

10. An air conditioning system in accordance with claim 9, wherein said operative connection includes an inlet flow

passage shutoff member shutting off and opening a flow connection with said flow passage at said air inlet and an outlet flow passage shutoff member shutting off and opening a flow connection with said flow passage at said air outlet.

11. An air conditioning system in accordance with claim 10, wherein said drying unit includes another drying unit body with an air inlet and an air outlet and a mass of moisture extracting substance through which the air in the flow path can flow, said another drying unit body having an operative connection with said flow passage including an inlet flow passage shutoff member shutting off and opening a flow connection with said flow passage at said air inlet and an outlet flow passage shutoff member shutting off and opening a flow connection with said flow passage at said air outlet, said another drying unit and said drying unit forming a drying body arrangement that can be operated jointly or individually.

12. An air conditioning system in accordance with claim 11, wherein said moisture extracting substance comprises zeolite and said drying unit comprises a zeolite arrangement.

13. An air conditioning system in accordance with claim 12, further comprising a heat source operatively connected to said zeolite arrangement for heating said zeolite arrangement.

14. An air conditioning system in accordance with claim 13, wherein said heat source comprises one or more of:

a fuel-operated burner;

an exhaust guiding system of an internal combustion engine;

a fuel cell; and

an electrically operated heater.

15. An air conditioning system in accordance with claim 9, further comprising an air conditioning unit with an evaporator arranged downstream of said drying unit in the direction of air flow of said air flow path.

16. An air conditioning system in accordance with claim 15, further comprising a heat exchanger arrangement for taking up heat being transported in the air to be introduced into the interior space of the vehicle, said heat exchanger arrangement being provided between said drying means and said evaporator.

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