(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 April 2008 (24.04.2008)

PCT

(10) International Publication Number
WO 2008/047262 A2

(51) International Patent Classification:
B60H 1/00 (2006.01)

(21) International Application Number:
PCT/IB2007/053768

(22) International Filing Date:
18 September 2007 (18.09.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
102006044922.3
22 September 2006 (22.09.2006) DE

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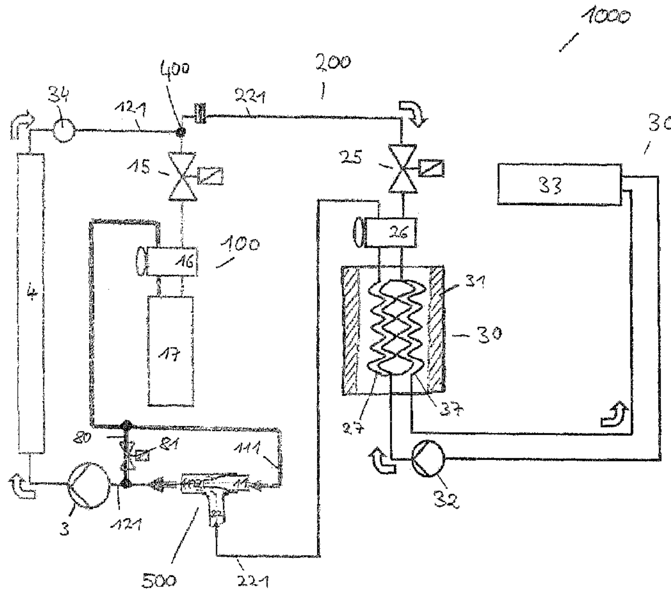
(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

(54) Title: LATENT STORAGE COOLING CYCLE



(57) Abstract: The invention relates to an air conditioner (1000) and to a method for operating the air conditioner (1000), especially for a vehicle, with a primary cycle (100) and a secondary cycle (200) linked in parallel thereto, as well as with at least one useful cycle (300) which can be coupled to the secondary cycle (2 00), at least one device (500) with at least two inlets (1, 2) and one outlet (12) being provided for the fluid mechanical linkage of the primary cycle (100) to the secondary cycle (200), for which a cycle medium (11) flowing therein is exposed to boundary conditions different from that of another cycle medium (22) flowing therein in such a manner that the one cycle medium (11) decreases the static pressure of the other cycle medium (22) before the cycle media comes together.

WO 2008/047262 A2

LATENT STORAGE COOLING CYCLE

Specification

The invention relates to an air conditioner which, with regard to performance and mode of operation, works optimally and economically, i.e. efficiently, in a vehicle, for example, with a primary cycle and a secondary cycle which is linked in parallel to the primary cycle and has at least one useful cycle which can be coupled to a secondary cycle.

In addition to the driver cockpit, many of the present-day, mostly heavy trucks used for transport frequently also have a cabin in which the driver has the capability of resting or sleeping. It is well known that, especially in summer, many drivers of heavy trucks which have conventional air conditioners frequently let the driving unit of the vehicle, i.e. the combustion engine, run overnight in order to operate the air conditioner and thereby bring about appropriate cooling of the sleeping cabin. However, because of the high fuel consumption of the running engine, such a mode of operation (idling) heavily contaminates the environment and, in terms of energy, is very unfavorable and results in high consumption and maintenance costs in addition to the associated heavy wear, especially to the engine of the vehicle. In addition, the driver is therewith constantly exposed to annoying and unpleasant noise as well as to vibrations.

In order to appropriately air condition the driver cockpit as well as the sleeping cabin to produce acceptable working and recovery conditions, integrated, engine-independent air conditioners which can be installed inside vehicles have been developed.

Several engine-independent air conditioning solutions corresponding to prior art are known which, due to their capability to operate with the combustion engine switched off, counter the additional fuel and maintenance costs that would result mostly from a continuously running combustion engine and therewith reduce the resultant exhaust gases.

Aside from using so-called independent air conditioners which are driven by an additional combustion engine, a primary air conditioner can also be operated, while the combustion engine of the vehicle is switched off, by an electric motor which drives the compressor of the air conditioner. Electrical energy for additional batteries intended for this purpose is produced while driving and stored within the batteries.

Aside from other alternatives for integrated, engine-independent air conditioners for vehicles, so-called latent cold storage systems, which have high energy density and can make sufficient cooling energy available even when the drive assembly is stopped, are also known for fulfilling the requirements and objectives described herein. In addition to a first, conventional primary cycle constructed with known components acting thermodynamically on the flowing, circulating medium of the air conditioner, such systems have another, second secondary or cooling agent cycle of the same configuration which is connected in parallel to the primary cycle of the air conditioner and charges a latent cold storage of a thermodynamically coupled cooling agent cycle. The second cycle, linked or connected in parallel to the first cycle, is coupled with the cooling agent cycle by means of a heat exchanger unit which is integrated within a latent cold storage device of the cooling agent cycle.

The DE 10 2004 019 607 A1 discloses a heating and cooling system for a vehicle which can heat and cool the front and rear regions of a motor vehicle interior separately. The air conditioner comprises a front installation, a rear installation and an integrated engine-independent installation which is integrated in the rear installation and can be used for heating and cooling the rear region when the combustion engine is switched off. A method for air conditioning with the help of the HVAC system (heating, ventilating and air conditioning) is also described in this publication. The disclosure accordingly represents an air conditioner which, in the area of the front installation, comprises a compressor, condenser, blower, collector, magnetic valve, expansion device and evaporator. Furthermore, another evaporator which is assigned to the rear installation is connected in parallel to the first evaporator. Aside from the other evaporator, the second cycle, i.e. the rear installation, comprises a magnetic valve, expansion device and blower. Parallel to the evaporators of the front and rear installations, a storage-evaporator-heat exchanger unit, which is a component of the rear installation as well as of the integrated engine-independent installation, is connected over another magnetic valve as well as over an expansion unit. The cycle of the rear installation also has a pump and a heat exchanger. The latent cold storage of the storage-evaporator-heat exchanger unit can thus be charged over the cycle of the front and rear installations. In the event that additional cooling performance beyond that produced by the front and rear installations is required for cooling the interior of the vehicle, the cold storage of the storage-evaporator-heat exchanger unit can be discharged with the help of the pump over the heat transfer cycle of the integrated, engine-independent installation. In order to bring about the charging process of the latent cold storage in a timely manner, the evaporation temperature, which is below 0°C, must decrease from the start of the charging process up until the withdrawal of heat from the storage unit. The decreasing evaporation temperature can be realized with this system only if the corresponding magnetic valves are closed, mostly to avoid icing problems at the evaporators of the front installation. In this state, only the storage-evaporator-heat exchanger unit is connected with the cycle, which is operated by the compressor. Via this configuration of the system and the mode of operation associated therewith, the evaporator for the cold storage reaches the temperature necessary for evaporation, below 0°C, thereby preventing icing of the evaporator and averting the risk of inadequately or not supplying the driver cabin with fresh air and the resultant increase in the carbon dioxide level above the maximum permissible concentration (MAC). With the air conditioner described in this document, it is not possible to cool the interior of the vehicle and in parallel, i.e. simultaneously, charge the latent cold storage of the storage-evaporator-heat exchanger unit. It is therefore not possible to completely switch off the interior cooling for the duration of the charging process of the cold storage. The process of charging the cold storage should therefore be carried out when the air outlet temperature of the evaporator of the front installation drops below the icing temperature. Once the air outlet temperature of the evaporator has again reached a value clearly above 0°C, the charging process of the cold storage is interrupted and the conventional air conditioning cycle is reactivated. This results in a more or less cyclic operation of the magnetic valve and the therewith associated cycles and, related thereto, in a large fluctuation of the temperature of the air leaving the evaporator of the front installation. This substantially reduces the air conditioning comfort. Moreover, a more or less periodic mode of operation of the magnetic valve of the HVAC system with respect to the charging process of the latent cold storage produces a highly unsteady flow of cooling agent which generates unpleasant noises and vibrations. It should be added that, due to this configuration, the optimized air distribution system of the front installation is not suitable for appropriately distributing warm air. Consequently, with the additional necessary blowers, i.e. fans and filters, there are additional maintenance requirements which also increase costs accordingly. Moreover, it may be noted that the charging process of the latent cold storage takes an accordingly long time in this case.

The DE 198 38 880 A1 describes a device for cooling an internal space of a vehicle which has a primary cooling cycle, equipped with known components and cooling a main cycle of a secondary cycle, the main cycle being coupled thermodynamically with a cold storage subsidiary cycle having a cold storage and a heat exchanger secondary cycle having a heat exchanger. The subsidiary storage cycle and the heat exchanger secondary cycle can be operated in parallel, i.e. simultaneously. The control- and valve unit of the secondary cycle can adjust the proportion or amount of cooling agent flowing in the main cycle for the cold storage of the subsidiary storage cycle, as well as for the heat exchanger of the subsidiary heat exchanger cycle and therewith make a parallel mode of operation possible. For the main task of air conditioning or cooling the interior of a vehicle, additional heat transfer is required which permits the intake temperature of the cycle medium of the compressor to drop significantly. This lower temperature in the intake region of the compressor is thus responsible for decreased efficiency and therewith increased fuel consumption for cooling the interior of the vehicle.

The aim of the present invention is to make available an advantageous, efficiently operating air conditioner which has a primary cycle and a secondary cycle linked fluid mechanically in parallel thereto, for which a useful cycle can be coupled thermally to the secondary cycle, whereby the operation and mode of action of the air conditioner is optimized.

This aim is achieved by the distinguishing features of the independent claims, whereas appropriate embodiments are described by the distinguishing features of the dependent claims.

According to the invention, an air conditioner is provided which can be particularly advantageous when installed in a vehicle. Moreover, the air conditioner has at least one primary cycle and at least one secondary cycle which can be linked thereto in parallel, as well as at least one useful cycle which can be coupled to the secondary cycle and may, for example, be a latent cold storage cycle of an integrated, engine-independent air conditioner with a latent cold storage. The primary cycle which may, for example, advantageously function as a standard air conditioning cycle operating according to known methods, is connected fluid mechanically with the secondary cycle, i.e. the primary cycle and the secondary cycle of the air conditioner form closed systems with respect to the circulating or flowing working medium or cycling medium. A closed system is understood here to be a defined closed space filled with a material, to which matter is not supplied and from which matter is not removed, though technical work can be carried on in this space and/or heat transported over the system boundaries. The closed, useful cycle can be coupled thermally over a heat-exchanging device with the secondary cycle. Accordingly, heat exchange can take place between the secondary cycle and the useful cycle.

As already stated, the useful cycle may, for example, advantageously be a standard air conditioner with a latent cold storage in which case, when the inventive air conditioner is used, the latent cold storage can be charged optimally, continuously and rapidly, preferably within 2½ hours, during the operation of the primary and/or standard air conditioning cycle while the driving unit is running. Therefore, the following mainly describes in greater detail the use and effects of the inventive air conditioner in conjunction with a standard air conditioner with latent cold storage. However, it should be noted that the useful cycle need not necessarily be an integrated engine-independent air conditioner with latent cold storage.

The fluid mechanical linkage of the primary cycle and the secondary cycle, i.e. the bringing together or coming together of the respective streams of the cycling medium which flow through the primary cycle and the secondary cycle, takes place at least with one device, advantageously having at least two inlets and one outlet. As a result, the streams of the cycling medium are combined into one stream which later can or will divide again depending on the operating mode of the air conditioner. A cycling medium flowing into the device is subjected to different geometric boundary conditions than a different cycling medium flowing thereinto in such a manner that the one cycling medium flowing in reduces the static pressure of the other cycling medium flowing in before the cycling media come together.

The primary cycle as well as the secondary cycle of the inventive air conditioner comprises correspondingly known, essential or necessary components and works in each case according to known thermodynamic cycling methods or cycling processes. These components are, for example, heat exchanger devices, of which advantageously one functions as condenser for the heat exchanging device common to the two cycles, i.e. as condenser for the flowing, cycling medium and two heat exchangers function as an evaporator, one for each cycle, for the flowing, cycling medium. Moreover, an expansion device, for example, advantageously in the form of an expansion valve or throttle, is provided between the condenser and the evaporator for each cycle upstream from the heat-exchanging device functioning as evaporator. This serves to, for example, transfer a flowing or incoming cycling medium, which is under a high pressure and in a liquid state of aggregation, into a state of lower pressure and lower temperature so that, by a subsequent evaporation process, it can take up heat from the surroundings in the evaporator disposed downstream.

Moreover, in order to operate such a thermodynamic cycle for air conditioning at least one compressor is required, which ensures that the cycle medium is, on the one hand, circulated in the closed system of the cycle or cycles, i.e. set in motion and, on the other hand, is compressed. Advantageously, for the operation of two air conditioning cycles linked fluid mechanically in parallel as in the case of the inventive air conditioner, only one compressing device is provided, it being located between the two evaporators of the cycle and the common condenser. Other components such as temperature switches, liquid containers, filter dryers, etc. which may be integrated in such air conditioners are not dealt with since they are known, and likewise for the components or air conditioners with two cycles which are connected in parallel fluid mechanically and have already been presented and described.

Owing to the fact that, for the inventive air conditioner for which a primary cycle is connected fluid mechanically with a secondary cycle over at least one device, the one cycle medium which flows through the one cycle reduces the static pressure of the other cycle medium, the significant advantage arises for the cycle with the cycle medium for which the static pressure of the cycle medium decreases, as this cycle is thermally more efficient, i.e. more effective with regard to heat-exchanging processes over a heat exchanger, than such a cycle without such a device. The static pressure of the other cycle medium flowing into the device is reduced by the one cycle medium flowing into the device immediately before the cycle media come together. For example, an even lower evaporator temperature of an evaporator (advantageously -7°C) of the cycle with the cycle medium, the static pressure of which will be or is reduced, is associated therewith. In other words, even more heat can be withdrawn from a latent cold storage cycle of an integrated, engine-independent air conditioner with latent cold storage (latent cold storage system) in the form of a latent cold storage system, coupled, for example, thermally to this cycle, in less time or during an even shorter duration, preferably within 2½ hours. Further advantages, according to which the static pressure and the temperature of the other cycle medium are significantly reduced by using such a device, arise in the following by means of a coupled latent cold storage cycle, for example. It should be noted that it is evident to someone of ordinary skill in the art that the geometric boundary conditions of such a device for linking two cycles or cycle media of a closed system of an air conditioner, so described, may also comprise, aside from curvatures and/or cross sections or cross-sectional changes, for example, special surfaces for achieving frictional effect or effects due to friction which have the same effect as the lowering of the static pressure or the temperature of the respective cycle medium.

Preferably, the dynamic pressure of the other cycle medium is increased. Thereby, the process of charging a corresponding latent cold storage, thermally coupled, may occur optimally and in a shorter time.

Advantageously, the device of the inventive air conditioner is in the suction area of a common compressor device for the primary cycle and the secondary cycle. By these means, for example, a continuous parallel operation of the primary cycle and the secondary cycle is possible.

In an advantageous development of the inventive air conditioner, the secondary cycle, through which the other cycle medium flows, is connected with the second inlet of the device. As already shown and partly described, this results in an optimum mode of operation of the secondary cycle with respect to the possible thermal coupling of a useful cycle, such as, for example, a latent cold storage cycle. Advantageously, the evaporator temperature of the evaporator of the secondary cycle is then about 2° to 10°K lower than the evaporator temperature of the evaporator of the primary cycle and advantageously lies within the range of -4°C and -12°C. By these means, as already indicated, a latent cold storage coupled, for example, within the scope of the useful cycle, can be charged very advantageously.

Particularly advantageously, the useful cycle, which can be coupled to the secondary cycle, is at least one integrated, engine-independent air conditioner with a latent cold storage device. Thus, the latent cold storage of the inventive air conditioner can be charged efficiently over the secondary cycle, for example, quickly and at very low evaporator temperatures of an evaporator of the secondary cycle. Alternatively, however, other useful cycles are also conceivable, for example, for operating a refrigerator which is carried inside the vehicle.

Advantageously, the device is constructed as a tubular combination of pipes essentially in the form of a T. This is mostly due to the simpler and more cost-effective manufacturing process associated therewith. Of course, a pipe joint essentially in the form of a Y, for which the geometric boundary conditions are to be carried out accordingly, would also be conceivable.

Advantageously, for an inventive air conditioner with a device of the type described, the position of the cross-sectional plane of a first inlet and the position of the cross-sectional plane of a second inlet of the device for fluid mechanically linking two cycles are at an angle ranging from 60° to 120°, preferably 90°. Additionally, the advantageous position of the cross section of the first inlet is parallel to the position of the cross section of the outlet of the device. By these means, a further advantageous effect on the cycle media correspondingly flowing in is achieved, according to which a compressor device, disposed appropriately after the outlet, can work more efficiently, i.e. requires less driving power.

Advantageously, the tubular combination of pipes has a circular cross section. By these means, it is possible to implement a relatively simple manufacturing process for the device. The circular cross sections have an advantageous effect on the flowing cycle media with respect to losses. Of course, a device or a combination of pipes with square, rectangular or oval, i.e. elliptical cross sections is also conceivable.

Preferably, the internal diameter of the second inlet is larger than the internal diameter of the first inlet. By these means, more space is made available to the cycle medium which flows into the second inlet, thereby leading to a decrease in pressure.

Advantageously, the internal diameter of the first inlet of the device ranges from 12 mm to 14 mm and the internal diameter of the second inlet of the device ranges from 14 mm to 16 mm. The same is preferable for the corresponding pipes carrying cycle medium.

In an advantageous embodiment, the device comprises a nozzle structure after the first inlet. By these means, and with appropriate construction, a suction effect can be achieved on the other cycle medium flowing into the device. The suction effect, on the one hand, for example, decreases the necessary driving power of a compressing device and, on the other hand, increases the efficiency of the other cycle medium in relation to heat-exchanging processes. By these means, for example, the evaporative temperature of an evaporator, operated accordingly with this cycle medium for charging a latent cold storage, can be reduced by 3°K to -10°C.

Advantageously, the nozzle structure is constructed essentially in the form of a Laval nozzle. For such a nozzle, the cross section initially decreases continuously (convergence) to a minimum and subsequently expands up to the outlet of the fluid or cycle medium (divergence). Accordingly, by integrating a nozzle of the described shape, the cycle medium flowing into the first inlet experiences an acceleration, i.e. the kinetic energy of the first cycle medium increases. As a result, upon leaving the Laval nozzle, a suction effect, i.e. a reduced pressure is exerted on the other cycle medium flowing into the second inlet. For example, the therewith associated suction effect on the one hand can lead to relieving the load on a compressor device positioned after the outlet of the device. On the other hand, the thermal effectiveness of the other, suctioned cycle medium is increased, according to which, for example, during the operation of an evaporator which is positioned upstream and through which the other cycle medium flows, the temperature of the evaporator decreases during the evaporation process, i.e. during the heat exchange, and the heat taken up is transported away more quickly.

Preferably, the nozzle structure extends at least over the width of a recess for the second inlet into the device. By these means, mostly the suction effect, i.e. the reduced pressure of the cycle medium passing or flowing through the nozzle structure on the other cycle medium flowing into the second inlet, is increased.

Advantageously, the device comprises a diffuser structure, i.e. a steady increase in cross section extending continuously downstream, before the outlet. Advantageously, the diffuser structure is rotationally symmetric. Advantageously, the diffuser structure is located at a place beyond where the cycle media entering the device meet. A diffuser structure has the reverse effect of a nozzle, i.e. the velocity of the flowing cycle medium or of the now mixed cycle media of the cycle medium entering the first inlet and of the cycle medium entering the second inlet is decreased, with the pressure, at the same time, being increased. This has the advantage that the work to be carried out by the compressor device for the suction can be or is reduced.

Preferably, the conical angle made by the diffuser structure with the longitudinal axis of the diffuser structure ranges from 2° to 15°, especially from 3° to 8°. By these means, for example, a condition advantageous to the flow of the cycle medium is attained, as a result of which losses are reduced.

It is particularly preferred if, for an inventive air conditioner, the nozzle structure and/or the diffuser structure is produced by an extrusion process. By these means, these components of the device can be produced quickly and simply. Moreover, production by a blowing process, an injection molding process or a casting process by means of appropriate molds would also be conceivable.

Preferably, the second inlet of the device is constructed as a drawn connecting sleeve. By these means, an appropriate pipe carrying the cycle medium can be connected easily with the second inlet, for example, by a welding or soldering process. Accordingly, the assembly and/or the installation of the device with pipes carrying the cycle medium is simplified significantly. On the other hand, for example, an integral construction of the first inlet with the second inlet and the outlet can also be realized.

Preferably, the nozzle structure after the first inlet of the device is positioned in a cross-sectionally expanded section, being installed advantageously, for example, from the side on which the outlet is located. Associated with this is also the position of the diffuser structure which is located before the outlet and which, like the nozzle structure, can also be inserted into the device from the opening of the outlet.

Advantageously, there is, at least on a portion of the areas of the nozzle structure, at least one O-ring, i.e. at least one part of the area of the nozzle structure is surrounded by an O-ring or the O-ring is surrounded by the nozzle structure. The advantage arising therefrom is, for example, in the case of an appropriate construction and an appropriate installation, the nozzle structure is sealed from the surface of the first inlet. On the other hand, the possibility of fastening the nozzle structure is provided therewith since, advantageously, the O-ring is present in a compressed state and, accordingly, slippage of a nozzle structure, so constructed in the device, is also avoided.

The nozzle structure and the diffuser structure preferably can be produced as separate components or individual parts of the device, there being after the installation at least one spacer between the nozzle structure and the diffuser structure. The corresponding manufacturing processes are simplified greatly by producing the nozzle structure and the diffuser structure separately. The mounting and the fastening or the installation in the device by means of spacers, O-rings, etc. is also simplified. Likewise, by such a construction, interchangeability of these cycle medium-influencing components of the device is also provided in the event that one component is damaged or broken. Of course, interchangeability of other nozzle structure geometries or diffuser structure geometries or components and adaptability of the device for air conditioning cycle systems provided and differently dimensioned appropriately therefore is also associated therewith.

Advantageously, the nozzle structure with the cycle medium-carrying pipe for the first inlet is connected at the first inlet over a clamping device of the device and the cycle medium-carrying pipe at the second inlet and at the outlet of the device is connected with the device with a positive material fit. This results in the advantage that the installation is simplified.

In a preferred embodiment of the inventive air conditioner, the nozzle structure and/or the diffuser structure can be introduced into the device over the outlet. By these means, on the one hand, the interchangeability of these cycle medium-influencing components of the device is provided and, on the other, aside from a therewith-associated simplified manufacture of the device and its components, the installation or assembly is also simplified. Of course, the device may also be constructed completely in an integral manner.

Advantageously, the diffuser structure is connected by friction with the outlet or the outlet region, the outlet or outlet region having a conical shape. By these means, the diffuser structure may be integrated quickly and simply in the device.

Advantageously, in the case of an inventive air conditioner, the flow rate of the cycle medium through the diffuser structure (14) ranges from 50 kg/h to 250 kg/h, the ratio of flow rates $R = \frac{\dot{m}_{primary cycle}}{\dot{m}_{secondary cycle}}$ between the primary cycles 100 and the secondary cycle 200 ranges from 0.4 to 0.8.

Advantageously, for an inventive air conditioner, a bypass pipe with control equipment between the intake region of the compressor device and the region of the first inlet of the device is provided in addition to the device. Moreover, for example, the operation of the primary cycle can be switched off or on, while the secondary cycle is used for rapidly charging an empty latent cold storage of a thermally coupled latent cold storage cycle of an integrated, engine-independent air conditioner with latent cold storage.

Advantageously, the control equipment is constructed as a magnetic valve. Magnetic valves operate reliably, have a simple construction and can be conveniently manufactured.

Advantageously, the control equipment is constructed as a differential pressure valve. Thus, for example, one of the two cycles, depending on the pressure level set, can be operated automatically as a function of the operating state of the other cycle.

Preferably, in the case of the inventive air conditioner, the pressure difference between the outlet and the second inlet of the other cycle medium of the device ranges from about 0.2 bar to 1 bar less than between the outlet and the first inlet of the one cycle medium of the device, in order therewith to find a pressure difference of practically the same magnitude at the thermally-active component.

Advantageously, the device is made from plastic, preferably from polypropylene (PP), polyamide (PA), polyphthalamide (PPA) or polyphenylene sulfide (PPS). Thus, an accordingly simple manufacturing process of the device or, depending on the construction and design, of the components of the device can be realized.

Preferably, the device of the inventive air conditioner is constructed as an integral component of the connecting region of a compressor device.

Furthermore, a method is also provided for operating an air conditioner, especially for a vehicle, with a primary cycle and a secondary cycle, linked in parallel thereto, as well as with at least one useful cycle which can be coupled to the secondary cycle, at least one device with at least two inlets and one outlet being provided for the fluid mechanical linkage of the primary cycle to the secondary cycle, for which a cycle medium flowing therein is subjected to different geometric boundary conditions than a different cycle medium flowing therein, the static pressure of the other cycle medium being decreased by the one cycle medium before the cycle media come together.

Advantageously, for the method of operating an air conditioner, the dynamic pressure of the other cycle medium is increased.

Furthermore, it may be noted that, when the inventive air conditioner is used, there is no danger that one of the evaporators of the primary cycle will ice up. It should be mentioned that, by integrating a device, so described, in an air conditioner, there is also no cycle-damaging oil recirculation.

The disclosed distinguishing features of the inventive air conditioner or of the inventive method can, of course, be combined at will with one another in order to achieve further advantages and properties.

The above-mentioned and other objectives, distinguishing features, aspects and advantages of the present invention will become evident to persons of ordinary skill in the art by means of the following detailed description, which, in conjunction with the attached Figures, discloses a preferred embodiment of the present invention, which, however, is to be understood strictly as an example and not as limiting.

In the drawing,

Figure 1 shows a cross section of a preferred embodiment of the device 500 of the inventive air conditioner 1000 with an integrated Laval nozzle 13,

Figure 2 shows a cross section of a further preferred embodiment of the device 500 of the inventive air conditioner 1000 with an integrated Laval nozzle 13 and with an integrated diffuser 14,

Figure 3 shows a cross section of a further preferred embodiment of the device 500 of the inventive air conditioner 1000 with an integrated Laval nozzle 13 and with an integrated diffuser 14,

Figure 4 shows a cross section of a further preferred embodiment of the device 500 of the inventive air conditioner 1000 with an integrated Laval nozzle 13 and with an integrated diffuser 14,

Figure 5 shows an embodiment of the inventive air conditioner 1000 in a diagrammatic representation, the useful cycle 300 being a latent cold storage cycle of an integrated, engine-independent air conditioner with a latent cold storage 31 and

Figure 6 shows a further embodiment of the inventive air conditioner 1000 in a diagrammatic representation, the useful cycle 300 being a latent cold storage cycle of an integrated, engine-independent air conditioner with a latent cold storage 31.

Figure 1, with reference to the representation of an example of the inventive air conditioner 1000, shown diagrammatically in Figures 5 or 6, shows an advantageous embodiment of the device 500 for the fluid mechanical coupling with the first air conditioning cycle, i.e. the primary cycle 100 fluid mechanically with the second air conditioner cycle, i.e. the secondary cycle 200.

Accordingly, a pipe joint 500 is shown, to which, among other things, a first cycle medium-carrying pipe 111 of the primary cycle 100 and a second cycle medium-carrying pipe 221 of the secondary cycle 200 are connected. Accordingly, the flowing cycle medium 11 of the primary cycle 100, which flows into the first pipe 111, with the flowing cycle medium 22 of the secondary cycle 200, which flows into the second pipe 221, is combined or mixed into a common stream 1122 in the device 500. The common stream 1122, which results from the coming together or mixing of the flowing cycle media 11 and 22 and which, in turn, is divided further on once again among the appropriate pipes of the primary cycle 100 and the secondary cycle 200, flows in the common pipe 121 (main pipe) for the primary and secondary cycles 100, 200 to the outlet 12 out of the pipe joint 500.

The pipe joint 500 advantageously is constructed accordingly from pipes 111, 221, 121 which are circular in cross section, and has a first inlet 1, a second inlet 2 and a (common) outlet 12. The cross section of the first inlet 1, through which the cycle medium 11 of the primary cycle 100 flows, is disposed advantageously parallel to the cross-sectional plane of the common outlet 12, in which the cycle streams or cycle media 11, 22 of the primary cycle 100 and of the secondary cycle 200 are combined.

In the example shown, the cross section of the second inlet 2, through which the cycle medium 22 of the secondary cycle 200 flows, makes an angle of 90° with the position of the cross-sectional plane of the first inlet 1, through which the cycle medium 11 of the primary cycle 100 flows. Accordingly, the pipe joint 500 is constructed with a T-shaped configuration. Of course, a different value or range for the angle, preferably ranging from 60° to 120° and the therewith associated position of the second inlet 2 or of the resulting flow vector of the cycle flow 22 in the second inlet 2 to the first inlet 1 would also be conceivable here.

For the embodiment shown, the internal diameter of the first inlet 1 is smaller than the internal diameter of the second inlet 2, as a result of which the flow cross sections, i.e. the cross sections through which the cycle media 11, 22 flow, also correspond thereto. Preferably, the internal diameter of the first inlet 1 or of the first cycle medium-carrying pipe 111 ranges from 12 mm to 14 mm and the internal diameter of the second inlet 2 or of the second cycle medium-carrying pipe 222 ranges from 14 mm to 16 mm. Associated therewith is a significant change in the state, that is, in the characteristic physical and thermodynamic values of the cycle medium 22 of the secondary cycle 200, flowing in the second pipe 221, according to which, for example, the velocity of the flowing cycle medium 22 of the secondary cycle 200 is decreased. The further effects on the flowing cycle media and, with that, on the mode of operation of the inventive air conditioner 1000 with the useful cycle 300, which can be coupled to the secondary cycle 200, will be explained and described in greater detail in the following by means of Figures 5 and 6.

Moreover, for improving the mode of action and for a therewith associated increase in the efficiency of the operating manner of the inventive air conditioner 1000 with a useful cycle 300, which can be coupled, the pipe joint 500 has an integrated nozzle structure in the form of a Laval nozzle 13 with a circular cross section throughout. The effects and advantages on the mode of operation, arising from the integration of the Laval nozzle 13 in the pipe joint 500, will be explained and shown by means of Figures 5 and 6. The Laval nozzle 13 is integrated downstream at the first cycle medium-carrying pipe 111 after the first inlet 1 in the region of the common pipe 121. As can be inferred from the example of the device 500, shown in Figure 1, the Laval nozzle 13 advantageously is an integral component of the first cycle medium-carrying pipe 111 here.

Starting from the internal diameter of the first inlet 1, the internal diameter of the pipe forming the section of the Laval nozzle 13 decreases steadily, starting from the first inlet, in the direction of the common outlet 12 to a minimum and subsequently increases somewhat once again. The flow of the cycle medium 11 of the primary cycle 100 is accelerated thereby downstream in the region or in the nozzle and accordingly reaches a velocity higher than the entrance velocity into the first inlet 1 of the pipe joint 500.

The structure of the Laval nozzle 13 advantageously extends over the region of a recess for the cycle medium 22, flowing into the pipe joint 500 over the second inlet 2 and ends downstream only shortly after the region of the recess 20 for the second inlet 2. The suction effect of the flowing cycle medium 11 of the primary cycle 100, therewith associated in the case of an appropriate operation of the inventive air conditioner with a device so constructed on the flowing cycle medium 22 of the secondary cycle 200, optimizes this clearly. As already indicated repeatedly above, this suction effect is also described and represented in even greater detail by means of a consideration of the system, based on Figures 5 and 6.

From the common outlet 12 of the pipe joint 500 of T-shaped configuration, the cycle medium 22 of the secondary cycle 200, combined or mixed with the cycle medium 11 of the primary cycle 100, preferably is in the intake region of a compressor device 3 (see Figures 5 or 6) of the inventive air conditioner 1000 with a useful cycle 300, which can be coupled.

With respect to boundary conditions of the pipe joint 500, favoring flow and cycling and, accordingly, an optimum mode of operating the inventive air conditioner 1000 with the useful cycle 300, which can be coupled, the connecting ends of the second pipe 221 connected to the common pipe 121 in the region of the recess 20 appropriately provided for this purpose for the embodiment shown in Figure 1, are advantageously rounded off. The first pipe 111 and the second pipe 221 are advantageously connected with one another with a positive material fit in the example of the device or the pipe joint 500 shown. Thus, above all, the required leakproofness of the pipe joint 500 is ensured. Likewise, a pipe joint so constructed can be produced quickly and easily.

Likewise, a continuous, integral construction of the pipe joint 500 in the region, in which the flow of the cycle medium 11 of the primary cycle 100 is combined with the flow of the cycle medium 22 of the secondary cycle 200, is conceivable, for which the respective transitions of the pipes or of the connecting devices are appropriately configured geometrically.

The example of the device 500 as a pipe joint of T-shaped configuration shows the device 500 as a separate, independent component of the cycle of the inventive air conditioner 1000 with useful cycle 300, which can be coupled. Likewise, it would be conceivable or obvious to provide the device 500 as an integral component of the housing of a compressor device, i.e., for example, of a compressor 3, appropriate connecting devices at the housing of the compressor 3 then having to be provided for the first pipe 111 and the second pipe 221.

The cross section of a further embodiment of the device 500 of the inventive air conditioner 1000 with useful cycle 300, which can be coupled, is shown in Figure 2. This embodiment corresponds essentially to that of the example of the device 500, which has already been shown and explained in greater detail in Figure 1. In addition, however, the embodiment of the device 500 of the inventive air conditioner 1000 with useful cycle 300, which can be coupled, shown in Figure 2, has, before the outlet 12 of the (common) pipe 121, a section or region in which the pipe 121 is constructed as a diffuser structure 14. Moreover, the diffuser structure 14 advantageously is downstream in the direction of the flowing cycle media 11, 22 or of the flowing cycle medium 1122. The internal diameter of the conical diffuser 14 increases continuously and steadily, i.e. without jumps, to the diameter, which is present at the outlet 12 of the pipe joint 500. This internal diameter is advantageously retained up to a compressor device 3 (see Figure 5). The angle between the inner surfaces and the longitudinal axis of the diffuser, i.e. the conical angle of the diffuser 14, which preferably is constructed rotationally symmetrically, advantageously ranges from 2° to 15° and especially from 3° to 8°.

Within the framework of the flow conditions of the cycle medium (subsonic flow), existing here and customary, the diffuser 14 has an effect which is opposite to that of a nozzle and according to which the velocity of the cycle medium 1122 flowing through the diffuser is decreased by the increase or expansion in cross section, and, thus, the kinetic energy represented, for example, by the dynamic pressure, decreases and the pressure (static pressure) increases. Since the delay of the flow of the cycle medium 1122 through such a cross-sectional change results in an increase in pressure, this phenomenon, for example, has an advantageous effect on a compressor device 3 (compare Figures 5 or 6) connected downstream from the outlet 12 of such a device or pipe joint 500, according to which the power required for operating the compressor device 3, i.e. the compressor, is less. Accordingly, in view of the operation of an inventive air conditioner 1000 explained in the following, the integration of a diffuser 14 at the appropriate place of the cycle optimizes this operation. Moreover, the pipe joint 500 is advantageously designed so that the flow rate of the cycle medium 1122 ranges from 50 kg/h to 250 kg/h. It should be noted here that pipe 121 and diffuser structure 14 as well as the first pipe 111 and the nozzle structure 14 and also the second pipe can be produced simply by shaping pipes.

Figure 3 shows in cross section a further example of the device 500 of the inventive air conditioner 1000 with the useful cycle 300, which can be coupled. As already shown by means of the examples of Figures 1 and/or 2, the pipe joint 500 has essentially a T-shaped configuration or a T-shaped structure. The components essential for the effect, namely the nozzle structure or Laval nozzle 13 and the diffuser structure or diffuser 14, are produced here separately as individual parts. By these means, above all a simpler and more cost effective manufacturing process can be realized, for example, by extrusion or injection molding, especially when these components are made from a plastic such as polypropylene (PP), polyamide (PA), polyphthalamide (PPA) or polyphenylene sulfide (PPS).

In the example shown, the pipe joint 500 preferably consists of a solid rectangular basic body 58 and, with respect to the Laval nozzle 13 and the first cycle medium-carrying pipe 14, a clamping device or clamping body 59 with an appropriate recess or contacting surface for the Laval nozzle 13 and the first cycle medium-carrying pipe 111. The Laval nozzle structure 13 is inserted or integrated in the basic body over an appropriately provided recess or borehole in the basic body 58 of the pipe joint 500. A portion of the first pipe 111 is integrated in the Laval nozzle 13 over an appropriately provided recess or borehole in the Laval nozzle 13. For the example shown in Figure 5, advantageously after the first inlet 1 and before the Laval nozzle structure 13, the first pipe 111 has a downstream peripheral offset or a correspondingly formed, peripheral edge produced, for example, by a converting or pressing process which on one side functions as a contacting element or contacting surface for a region of the Laval nozzle 13, and on the other side as a contacting element or contacting surface for a region of the clamping body 59. The Laval nozzle 13 and the first pipe 111 are pressed together or connected positively over an appropriate device for connecting the clamping body 59 with the basic body 58 of the device 500. For the embodiment shown here, the device for connecting is constructed as a borehole with an internal thread at the basic body 58, as a borehole at the clamping body 59 and as a screw 61. Likewise, other devices for connecting the clamping body 59 or the Laval nozzle 13 and the first pipe 111 with the basic body are also conceivable.

In order to ensure that the device or the pipe joint 500 has the required leakproofness, at least one O ring is integrated or pressed between a section of the borehole area of the basic body 58 for the Laval nozzle structure 13 which is to be accommodated, and a section of the outer structure surface of the Laval nozzle 13.

Moreover, at least one further O ring 60 is between a section of the borehole surface of the Laval nozzle 13 and a section or a part of the outer surface of the section of the first pipe 111. Of course, other devices for sealing, such as a sealing paste, are also conceivable here.

In the example of the device 500 of the inventive air conditioner 1000 with the useful cycle 300, which can be coupled, shown in Figure 3, the diffuser structure 14 is integrated in a section of the common pipe 121 before the outlet 12 of the pipe joint 500 or advantageously pressed together frictionally with the latter. Moreover, the common pipe 121 as well as the pipe 221 of the second inlet 2 is pressed together advantageously with the basic body 58 of the pipe joint 500; it is, however, particularly advantageous with respect to leakproofness if they are welded together with a positive material fit. Alternatively, cycle medium-carrying pipes 111, 221, 121 could also be connected, for example, with flange connections. The installation, i.e. the assembly of the pipe joint 500 and the individual components such as the Laval nozzle 13 or the diffuser inset or diffuser 14 which can be produced easily because of their configuration are an essential advantage which arises from such an embodiment.

Figure 4 shows a cross-sectional view of a further embodiment of the device 500 of the inventive air conditioner 1000 with a useful cycle 300, which can be coupled. The first cycle medium-carrying pipe 111, preferably of the primary cycle 100, extends here up to the outlet 12 of the pipe joint 500 and, at the outlet 12, has a peripheral edge, produced, for example, by a shaping process. The Laval nozzle 13 and the diffuser 14 are produced here once again advantageously as separate, individual parts and are integrated or installed, as already described, in a corresponding section of the pipe 11 of expanding cross section. At least one spacer 18 fixes the distance here between the nozzle structure 13 and the diffuser structure 14. In the region of the recess 20 for the cycle medium 22 entering the pipe joint 500 over the second inlet 2, this spacer 18 likewise comprises a corresponding recess, so that the streams of cycle media 11, 22 of the primary cycle 100 and of the secondary cycle 200 can come together and mix. For the installation, accordingly, the Laval nozzle 13, the spacer 18 as well as the structure of the diffuser 14 are introduced over the outlet 12 into the pipe joint 500. With the already described simplified installation described, there is also the possibility of exchanging these components rapidly.

Moreover, the region of the second inlet 2 or the second inlet 2 advantageously is constructed as a drawn sleeve or as a drawn pipe section. With that, the cycle medium-carrying pipe 22 of the secondary cycle 200 can be connected simply and quickly to the pipe joint 500 of the secondary cycle 200. For the installation, the end section of the second pipe 221 only has to be inverted here over the pipe section of the second inlet 2 before the second pipe is connected by means of a welding or soldering process advantageously with a positive material fit with the pipe joint 500.

Moreover, the first pipe 111, at its downstream end at the outlet 12, is connected with the pipe 121 over the peripheral edge by means of a flange connection 70. The flange connection 70 advantageously consists of two partial bodies which can be connected with one another and have corresponding recesses or boreholes for the pipe 111, 121. The partial bodies of the flange connection 70 are advantageously connected, as shown in the example of Figure 5, by means of at least one screw and thread connection. Alternatively, it would also be conceivable here to connect the two partial bodies by means of clamps or other devices.

The (common) pipe 121 is configured appropriately at its upstream end section, i.e. the section facing the device 500, a peripheral edge for fastening to or connecting with the first pipe 111 of the flange connection 70 and a peripheral groove for accommodating or integrating at least one O ring 60 being provided for forming a seal. The pipe 121, which advantageously passes the flowing cycle medium 1122 to a common compressor device 3 (Figures 5 or 6) for the primary cycle 100 and the secondary cycle 200, is introduced into the first cycle medium-carrying pipe 111 up to the stop of the peripheral edge at the peripheral edge of the first pipe 111 at the outlet 12 of the pipe joint 500.

Figure 5 shows an embodiment of the inventive air conditioner 1000 with the useful cycle 300, which can be coupled, in a diagrammatic representation, the useful cycle 300 being a latent cold storage cycle of an integrated engine-independent air conditioning system with a latent cold storage 31. As already pointed out repeatedly, the air conditioner has a standard air conditioning cycle, i.e. a primary cycle 100, which is linked in parallel with a second cycle, the secondary cycle 200, fluid mechanically with respect to the circulating or flowing cycle medium, on the one hand, over the distributor device, i.e. the pipe branching 400 and the device, i.e. the pipe joint 500. Moreover, there is a latent cold storage cycle 300 which is coupled thermally, i.e. in a heat-exchanging relationship, with the secondary cycle 200.

In the example of the air conditioner 1000 shown, with the integrated, engine-independent air conditioning, the primary cycle 100 comprises the essential components, namely a compressor device in the form of a compressor 3 functioning for the primary cycle 100 as well as for the secondary cycle 200 for compressing and pumping the circulating cycle or working medium, a heat-exchanging device which, with respect to the working medium, works as a condenser 4, i.e. as a liquefier, a control device in the form of a magnetic valve 15, an expansion organ, advantageously in the form of a throttle 16, as well as a heat exchanger acting as an evaporator 17 in relation to the cycle medium 11 of the primary cycle 100. Of course, for example, a collecting organ (not shown in Figure 5), which usually is constructed in the form of a liquid container with filter and advantageously is positioned between the condenser 4 and the magnetic valve 3, may be added to the above-mentioned most important components of the primary cycle 100.

With respect to the evaporator 17 of the primary cycle 100 and the heat-exchanging device, i.e. the evaporator 27 of the secondary cycle 200, the latter is a second cycle of the inventive air conditioner 1000 which can be linked or operated in parallel to the primary cycle 100. In the example shown in Figure 5 and corresponding to the primary cycle 100, the secondary cycle 200 has a magnetic valve 25, an expansion organ, i.e. a throttle 26, an evaporator 27, as well as a device for permitting flow in one direction in the form of a check valve 28. The check valve 28, preferably automatically, blocks passage of the cycle medium in one direction of flow (upstream). As shown, a portion of the cycling or working medium flows through the secondary cycle 200. The pipe which carries the cycling medium and is essential for the primary cycle 100 is labeled 111 and the pipe which carries the cycling medium and is essential for the secondary cycle 200 is labeled 221.

The secondary cycle 200 is connected in parallel or coupled fluid mechanically to the primary cycle 100, on the one hand, over a distributing device 400 which divides the flowing cycle medium of pipe 121 and is provided appropriately between the condenser 4 and the magnetic valve 15 of the primary cycle 100, as well as, on the other hand, over the device or pipe joint 500 for (re)combining the flow of the cycle medium 11 of the pipe 111 of the primary cycle 100 with the flow of the cycle medium 22 of pipe 221 of the secondary cycle 200, which is located between the evaporator 27 or the check valve 28 of the secondary cycle 200 and the compressor 3, or which is between the evaporator 17 of the primary cycle 100 and the compressor 3. Accordingly, the pipe joint 500 is advantageously positioned in the intake region of the common compressor 3 for the primary cycle 100 as well as for the secondary cycle 200. Moreover, the pipe 221 of the secondary cycle 200 is connected with the second inlet 2 and the pipe 111 of the primary cycle 100 is connected with the first inlet 1 of the pipe joint 500.

Moreover, as already mentioned, a closed latent cold storage cycle 300, independent with respect to the cycle medium, is shown which is coupled thermally to the secondary cycle 200 over the evaporator 27 of the secondary cycle 200. The latent cold storage cycle 300 has a pumping device 32 which is intended for the circulation of a cycle medium of the latent cold storage cycle 300, a heat exchanger 33 as well as a latent cold storage device 30. The evaporator 27 of the secondary cycle 200 is integrated advantageously in the latent cold storage device 30. Moreover, the latent cold storage device 30 comprises a heat exchanger 37 of the latent cold storage cycle 300 and a latent cold storage 31 of the latent cold storage cycle 300.

The primary cycle 100 of the air conditioner with the integrated engine-independent air conditioning 1000 is provided for the standard cooling of the interior of a vehicle. When it is operated independently, which is possible only when the drive assembly or combustion engine is running, it is therefore a conventional air conditioner operating according to a known method. The magnetic valve 15 of the primary cycle 100 is then open and the magnetic valve 25 of the secondary cycle 200 closed. Accordingly, only cycle medium driven by the compressor 3 flows through the primary cycle 100.

In order to be able to air condition the interior of the vehicle overnight, i.e. while sleeping, without having to run the drive assembly or the combustion engine and, thus, having to accept the disadvantages described, it is necessary to operate the latent cold storage cycle 300 which is coupled over the secondary cycle 200. Because the combustion engine is switched off, it is not possible to operate the primary cycle 100. Consequently, the primary cycle is not available for cooling the interior of the vehicle.

The cold stored in the latent cold storage 31 is now emitted here over the cycle medium of the latent cold storage cycle 300 by means of the pump device 32 of the heat exchanger 37 of the latent cold storage device 30 and of the heat exchanger 33 of the latent cold storage cycle 300 to the interior of the vehicle and, accordingly, dissipated from the latent cold storage 31.

However, in order to discharge the latent cold storage 31, i.e. to be able to withdraw and use the cold stored therein for cooling, the latent cold storage 31 must first of all be charged with the combustion engine running, for example, during driving time over the parallel operation of the secondary cycle 200 in addition to the primary cycle 100 and the compressor 3 by means of appropriate mechanisms and methods which will be shown in the following.

The latent cold storage 31 is charged, as described for the operation of the primary cycle 100, with the help of the secondary cycle 200, consisting of known and conventional components, according to a known method, an evaporation process in the evaporator 27 of the secondary cycle 200, taking place with respect to the cycle medium 22 which is a liquid under low pressure entering the evaporator 27, being used not for withdrawing heat for cooling air intended for the interior of the vehicle for cooling purposes but instead for withdrawing heat contained in the latent cold storage 31 and thus cooling the latter.

As with conventional air conditioners without an integrated, engine-independent air conditioning, the cooling output for the interior of the vehicle with the combustion engine running and the primary cycle 100 in use is usually determined and controlled by the temperature of the air which is entering the interior of the vehicle and passed over the evaporator 17 of the primary cycle 100. In view of the efficiency of the system and the method and of maintaining these, it is the aim here to operate the evaporator 17 only barely above the icing limit, i.e. the icing temperature. Accordingly, evaporation temperatures of -4°C to -2°C are usually employed so that the desired so-called outlet temperature of the evaporator 17 of the primary cycle 100 has corresponding values.

The latent cold storage 31 can now be charged by the integration of an already-described device 500 for combining the primary cycle 100 and the secondary cycle 200 in the form of flowing cycle medium 11, 22 of the primary cycle 100 and of the secondary cycle 200 in parallel and continuously for the operation of the primary cycle 100. Moreover, the device 500, as shown, for example, in Figure 1 and already described, is positioned between the evaporator 27 or the check valve 28 of the secondary cycle 200 and the compressor 3 or between the evaporator 17 of the primary cycle 100 and the compressor 3. Accordingly, the magnetic valves 15 and 25 are open for a desired vehicle air conditioning with the help of the operation of the primary cycle 100 as well as the simultaneous charging of the latent cold storage 31 of the latent cold storage device 30 of the latent cold storage cycle 300 using the secondary cycle 200.

As already shown, for example, by means of the embodiment of the device 500, shown by way of example in Figure 1, the inlet 2 of the device 500, through which the cycle medium 22 of the secondary cycle 200 is flowing, has a larger cross section than the inlet 1 of the device 500 through which the cycle medium 11 of the primary cycle 100 is flowing. This is associated with a change in the flow and thermodynamic state of the cycle medium 22 of the secondary cycle 200, present in vapor form under a low pressure after leaving the evaporator 27, in that the characteristic value of the static pressure characterizing the cycle medium 22 of the secondary cycle 200, and the characteristic value of the dynamic pressure, i.e. the back pressure, are less than the corresponding values of the cycle medium 11 of the primary cycle 100.

As a result, the pressure difference between the intake region of the compressor 3 and the evaporator 27 of the secondary cycle 200 is usually 0.2 bar to 1 bar less than the pressure difference between the intake region of the compressor 3 and the evaporator 17 of the primary cycle 100. Accordingly, the latent cold storage 31 is charged over the secondary cycle 200 continuously and simultaneously with the operation of the primary cycle 100 without icing the evaporator 17 of the primary cycle 100 by frozen condensed water.

Due to the use of the device 500 for linking the primary cycle 100 with the secondary cycle 200 in parallel, the cycle medium 22 of the secondary cycle 200 has a lower temperature than the cycle medium 11 of the primary cycle 100. The evaporation temperature level of the evaporator 27, important for the charging process of the latent cold storage 31, accordingly is below the evaporation temperature of the evaporator 17 of the primary cycle 100, preferably by 2°C to 10°C, and accordingly is in a usual range of -4°C to -12°C.

For operating optimally in the long run, the charging process of the latent cold storage 31 of the latent cold storage device 30 requires an evaporator temperature which constantly becomes colder. Associated therewith, in the sense of an even lower, i.e. colder attainable temperature of the evaporator 27 of the secondary cycle 200, a Laval nozzle 13 is integrated appropriately with respect to the cycle medium 11 in the examples of the device 500 which is shown in Figures 1 to 4. In addition to correspondingly even more advantageous cross-sectional relationships, the Laval nozzle 13 provides the cycle medium 11 of the primary cycle 100, after leaving the Laval nozzle 13 downstream with an aspirating property in relation to the cycle medium 22 of the secondary cycle 200. By these means, while essentially retaining the anyhow already low static pressure level of the cycle medium 22 of the secondary cycle 200, the dynamic pressure and, thus, the velocity of the cycle medium 22 of the secondary cycle 200 which is to be discharged from the evaporator 27 is increased which, in combination, proves to be even more advantageous for carrying away heat from the latent cold storage 31 over the heat exchanger 37 of the secondary cycle 200. By this measure, the evaporation temperature of the evaporator 27 of the secondary cycle 200 can be reduced even further. This is associated with a more rapid charging of the latent cold storage 31 of the latent cold storage device 30 of the latent cold storage cycle 300 which advantageously does not take longer than 2½ hours even if, as already described, the primary cycle 100 is operated in parallel thereto.

A further aspect, increasing the mode of operation and efficiency of the inventive air conditioner 1000 with a useful cycle 300, which can be coupled or, above all, of the evaporator 27 of the secondary cycle 200, is the advantageous integration, which has already been presented by means of the examples of the device 500 in Figures 2 to 4, of a diffuser structure 14 in the flow direction of the flowing cycle medium 1122 in the device or pipe joint 500.

The flow 1122 resulting from the flows of the cycle medium 11 of the primary cycle 100 and of the cycle medium 22 of the secondary cycle 200 by combination or by mixing is exposed to a constantly expanding cross section within the device 500 in the region of the diffuser structure 14. At the same time, there is mostly a decrease in the kinetic energy, i.e. in the flow velocity, and an increase in the static pressure. Since the flow 1122 of the cycle medium, after leaving the diffuser 14 or the outlet 12 of the pipe joint 500, is directly in the intake region of the compressor 3, a further optimization of the mode of operation is provided by the changed flow condition of the cycle medium produced by the diffuser 14, according to which, on the one hand, the power required to drive the compressor 3 may be or is less. However, associated with this, on the other hand, there is also a further reduction in the evaporation temperature of the evaporator 27 of the secondary cycle 200. This is the result of the lower pressure in pipe 221 and increases the thermal efficiency.

Figure 6 shows a further example of the inventive air conditioner 1000 in the form of a diagrammatic representation, the useful cycle 300 being a latent cold storage cycle of an integrated, engine-independent air conditioner with a latent cold storage 31. In the embodiment shown here, the air conditioner 1000, which is based essentially on that shown in Figure 5, has in the embodiment shown here a further component 34 which advantageously is constructed as a liquid container with filter. The liquid container 34 preferably is disposed between the condenser 4 and the distributing device 400. Moreover, in addition to the device or pipe joint 500, a bypass line 80 for the cycle medium 11 of the primary cycle 100 with control equipment 81 is disposed between the intake region of the compressing device, i.e. of the compressor 1 and the region of the first inlet 1 of the pipe joint 500. The control equipment 81 advantageously is constructed as a magnetic valve. Likewise, the control equipment 81 may also be constructed as a differential pressure valve. The mode of functioning and operating of the inventive air conditioner 1000, in the embodiment shown here, basically corresponds to the mode of operation shown in its essential points by means of the examples in Figure 5, i.e. during the charging process of the latent cold storage 31 over the heat exchanger or evaporator 27 of the secondary cycle 200, the control equipment 81 is closed, i.e. cycle medium 11 of the primary cycle 100 does not flow through the bypass line 80.

However, with the bypass pipe 80 with the integrated control equipment 81 described and present, the possibility exists of operating the primary cycle 100 exclusively with maximum efficiency since, for this purpose, the control equipment 81 is opened and the cycle medium 11 of the primary cycle 100 can no longer flow over the pipe joint 500 to the compressing device, i.e. the compressor 3, and instead flows directly over the bypass pipe 80 to the compressor 3. It should be noted that, for such a mode of operation of the inventive air conditioner 1000, the magnetic valve 25 of the secondary cycle 200 is closed, i.e. cycle medium 22 does not flow through the secondary cycle 200. Alternatively, as already mentioned, the flow of cycle medium 11 through the bypass pipe 80 could be made dependent on the existing pressure. In this case, the control equipment 81 is to be constructed as a differential pressure valve, the pressure difference between the inlet and the outlet of the differential pressure valve 81 being kept constant. Preferably, the pressure difference ranges here from 0.2 bar to 0.8 bar.

It should be noted that the charging process of an empty, i.e. thermal energy-containing latent cold storage 31 over the secondary cycle 200 is not critical with respect to the danger of any icing of the evaporator 17 of the primary cycle 100 when the latter is operated in parallel, since the charging process of the latent cold storage 31 takes place at an evaporation temperature level of the evaporator 27 of the secondary cycle 200, which corresponds to that of the evaporator 17 of the primary cycle 100. Furthermore, the use of the refrigerant R134a as cycle medium is advantageously preferred.

Aside from being able to operate cycles 100 and 200 continuously, a further advantage of the inventive air conditioner 1000 with the useful cycle 300, which can be coupled, is that the system makes no undesirable noise.

In summarizing, it may be noted that an inventive air conditioner 1000, so described and proposed, works efficiently, is robust and has a high service life, making a long product life cycle possible.

Claims

1. Air conditioner (1000), especially for a vehicle, with a primary cycle (100) and a secondary cycle (200), linked in parallel thereto, as well as with at least one useful cycle (300), which can be coupled to the secondary cycle (200), at least one device (500) with at least two inlets (1, 2) and one outlet (12) being provided for the fluid mechanical linkage of the primary cycle (100) to the secondary cycle (200), for which a cycle medium (11), flowing therein, is exposed to boundary conditions different from that of another cycle medium (22), flowing therein in such a manner that the one cycle medium (11) decreases the static pressure of the other cycle medium (22) before the cycle media comes together.

2. The air conditioner (1000) of claim 1, the dynamic pressure of the other cycle medium (22) increasing.

3. The air conditioner (1000) of claims 1 or 2, the device (500) being in the intake region of a compressing device (3), which is common to the primary cycle (100) and the secondary cycle (200).

4. The air conditioner (1000) of one of the preceding claims, the secondary cycle (200) being connected with the second inlet (2) of the device (500) and the other cycle medium (22) flowing through the secondary cycle (200).

5. The air conditioner (1000) of one of the preceding claims, the useful cycle (300) being an integrated,

engine-independent system with a latent cold storage device (31).

6. The air conditioner (1000) of one of the preceding claims, the device (500) being constructed as a tubular pipe joint in an essentially T-shaped configuration.

7. The air conditioner (1000) of claim 6, the position of the cross-sectional plane of the first inlet (1) making an angle which ranges from 60° to 120°, preferably 90°, with the position of the cross-sectional plane of the second inlet (2).

8. The air conditioner (1000) of claims 6 or 7, the tubular pipe joint (500) having a circular cross section.

9. The air conditioner (1000) of claim 8, the internal diameter of the second inlet (2) being larger than the internal diameter of the first inlet (1).

10. The air conditioner (1000) of claims 8 or 9, the internal diameter of the first inlet (1) ranging from 12 mm to 14 mm and the internal diameter of the second inlet (2) ranging from 14 mm to 16 mm.

11. The air conditioner (1000) of one of the preceding claims, the device (500) comprising a nozzle structure (13) after first inlet (1).

12. The air conditioner (1000) of claim 11, the nozzle structure (13) being constructed essentially in the form of a Laval nozzle.

13. The air conditioner (1000) of claims 11 or 12, the nozzle structure (13) extending at least over the width of a recess (20) for the second inlet (2).

14. The air conditioner (1000) of one of the preceding claims, the device (500) comprising a diffuser structure (14) before the outlet (12).

15. The air conditioner (1000) of claim 14, the conical angle (140) of the diffuser structure (14) to the longitudinal axis of the diffuser structure (14) ranging from 2° to 15° and preferably from 3° to 8°.

16. The air conditioner (1000) of claims 14 or 15, the nozzle structure (13) and/or the diffuser structure (14) being produced by an extrusion process.

17. The air conditioner (1000) of one of the claims 14 to 16, the second inlet (2) being constructed as a drawn connecting sleeve.

18. The air conditioner (1000) of one of the claims 14 to 17, the nozzle structure (13), after the first inlet (1), being positioned in a section of expanding cross section.

19. The air conditioner (1000) of one of the claims 14 to 18, at least one O-ring (60) being present on at least one portion of the area of the nozzle structure (13).

20. The air conditioner (1000) of one of the claims 14 to 19, the nozzle structure (13) and the diffuser structure

(14) being produced as separate components, at least one spacer (18) being located between the nozzle structure (13) and the diffuser structure (14).

21. The air conditioner (1000) of one of the claims 14 to 19, the nozzle structure (13) being connected with the pipe of the first inlet (111) over a clamping device (58, 59) with the device (500) and the pipes (221, 121) to the second inlet (2) and to the outlet (12) being connected with a positive material fit with the device (500).

22. The air conditioner (1000) of one of the claims 14 to 21, the nozzle structure (13) and/or the diffuser structure (14) being introduced over the outlet (12) into the device (500).

23. The air conditioner (1000) of claim 22, the diffuser structure (14) being connected with the outlet (12) with a frictional connection owing to the fact that the outlet (12) has a conical shape.

24. The air conditioner (1000) of one of the claims 14 to 23, the flow rate of the cycle medium through the diffuser structure (14) ranging from 50 kg/h to 200 kg/h, the flow rate ratio $R = \frac{\dot{m}_{primary\,cycle}}{\dot{m}_{secondary\,cycle}}$ between the primary cycle (100) and the secondary cycle (200) ranging from 0.4 to 0.8.

25. The air conditioner (1000) of one of the claims 3 to 24, a bypass pipe (80) with control equipment (81) being provided in addition to the device (500) between the

intake region of the compressing device (3) and the region before the first inlet (1) of the device (500).

26. The air conditioner (1000) of claim 25, the control equipment (81) being constructed as a magnetic valve.

27. The air conditioner (1000) of claim 25, the control equipment (81) being constructed as a differential pressure valve.

28. The air conditioner (1000) of one of the preceding claims, the pressure difference between the outlet (12) and the second inlet (2) of the other cycle medium (22) being smaller by 0.2 bar to 1 bar than the pressure difference between the outlet (12) and the first inlet (1) of the one cycle medium (11).

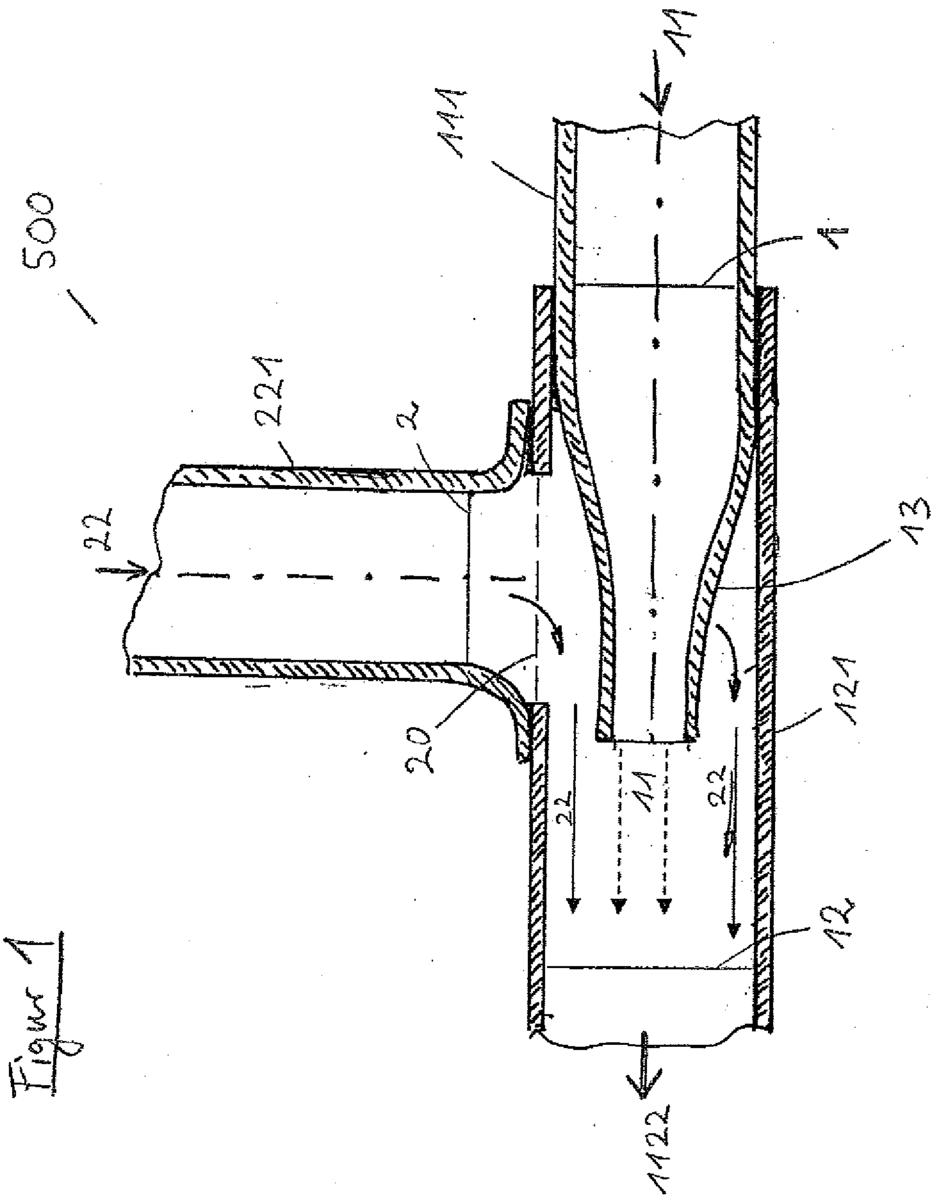
29. The air conditioner (1000) of one of the preceding claims, the device (500) being formed from a plastic, preferably from polypropylene (PP), polyamide (PA), polyphthalamide (PPA) or polyphenylene sulfide (PPS).

30. The air conditioner (1000) of one of the preceding claims, the device (500) being constructed as an integral component of the connecting region of a compressing device (3).

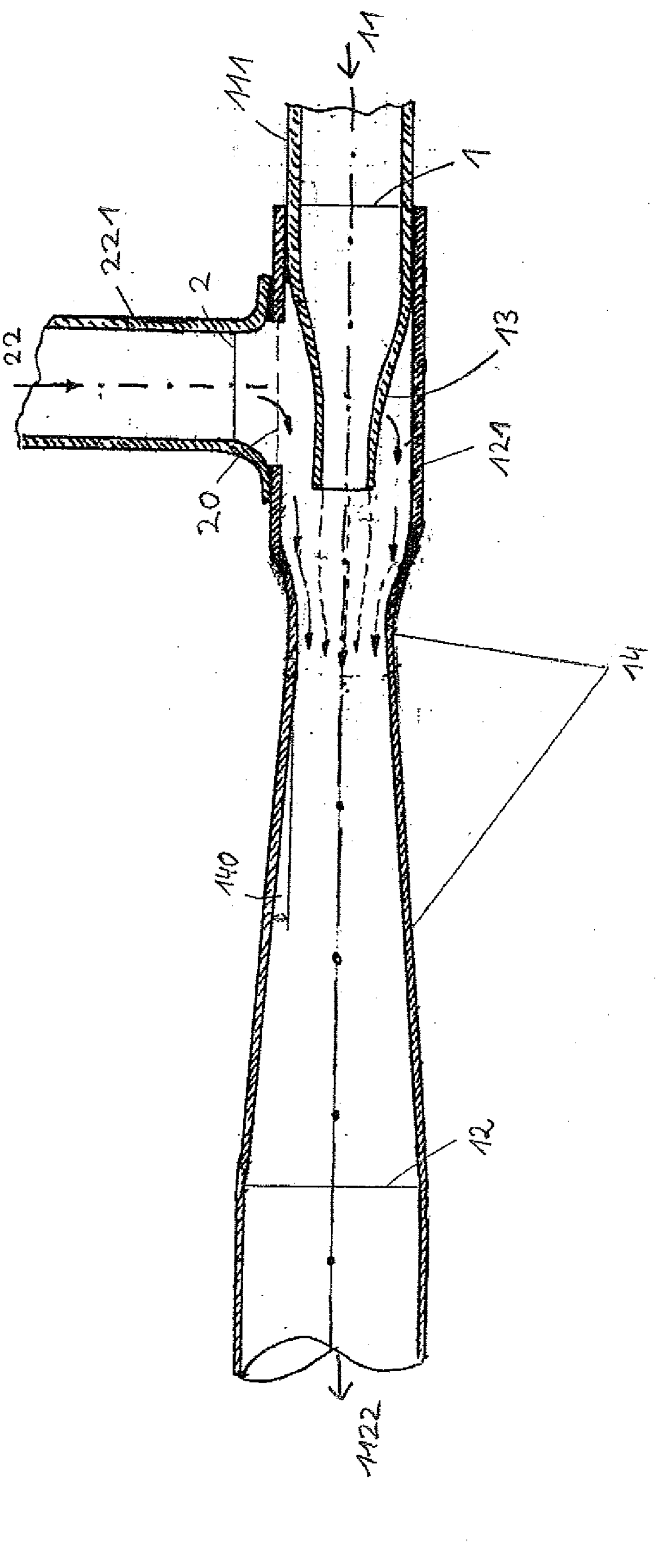
31. A method for operating an air conditioner (1000), especially for a vehicle, with a primary cycle (100) and a secondary cycle (200), linked in parallel thereto, as well as with at least one useful cycle (300), which can be coupled to the secondary cycle (200), at least one

device (500) with at least two inlets (1, 2) and one outlet (12) being provided for the fluid mechanical linkage of the primary cycle (100) to the secondary cycle (200), for which a cycle medium (11), flowing therein, is exposed to boundary conditions different from that of another cycle medium (22), flowing therein, the one cycle medium (11) decreasing the static pressure of the other cycle medium (22) before the cycle media comes together.

32. The method for operating an air conditioner (1000) of claim 31, the dynamic pressure of the other cycle medium (22) being increased.



Figur 1



Figur 2

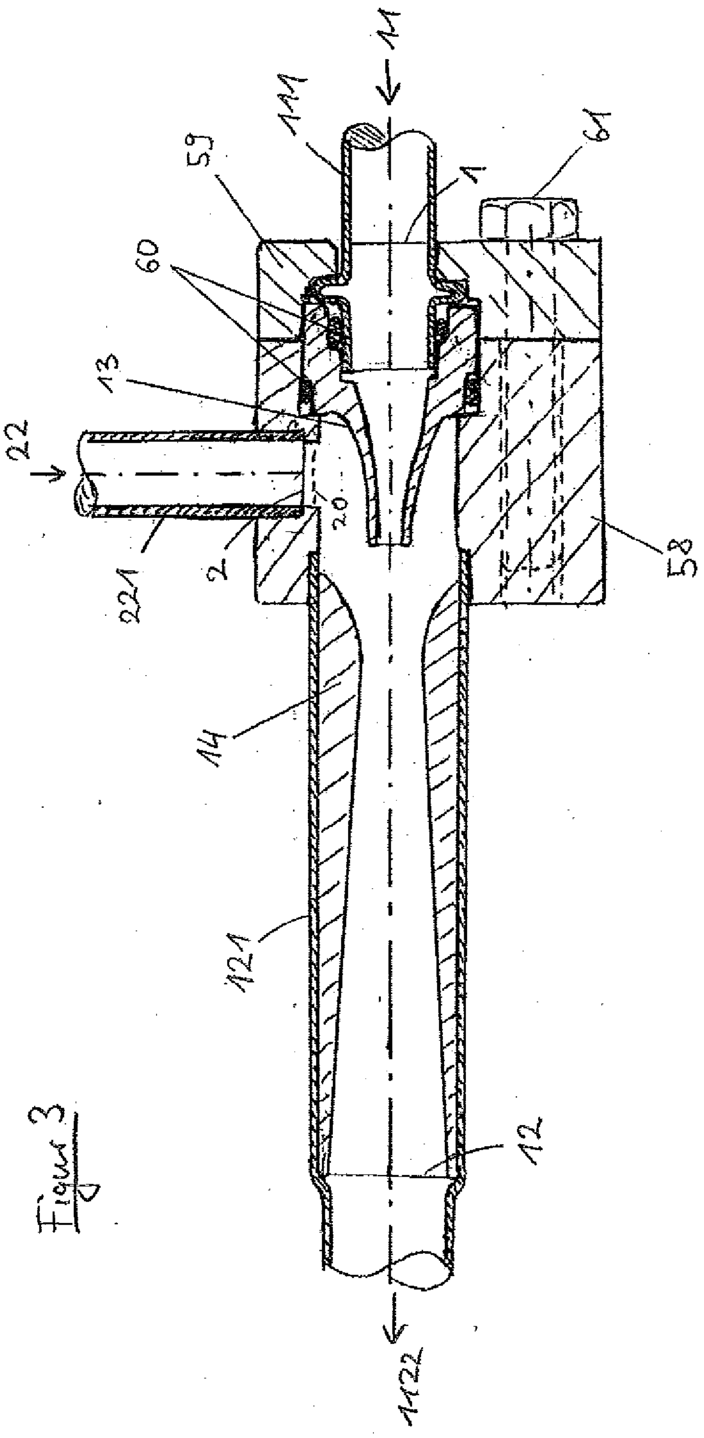
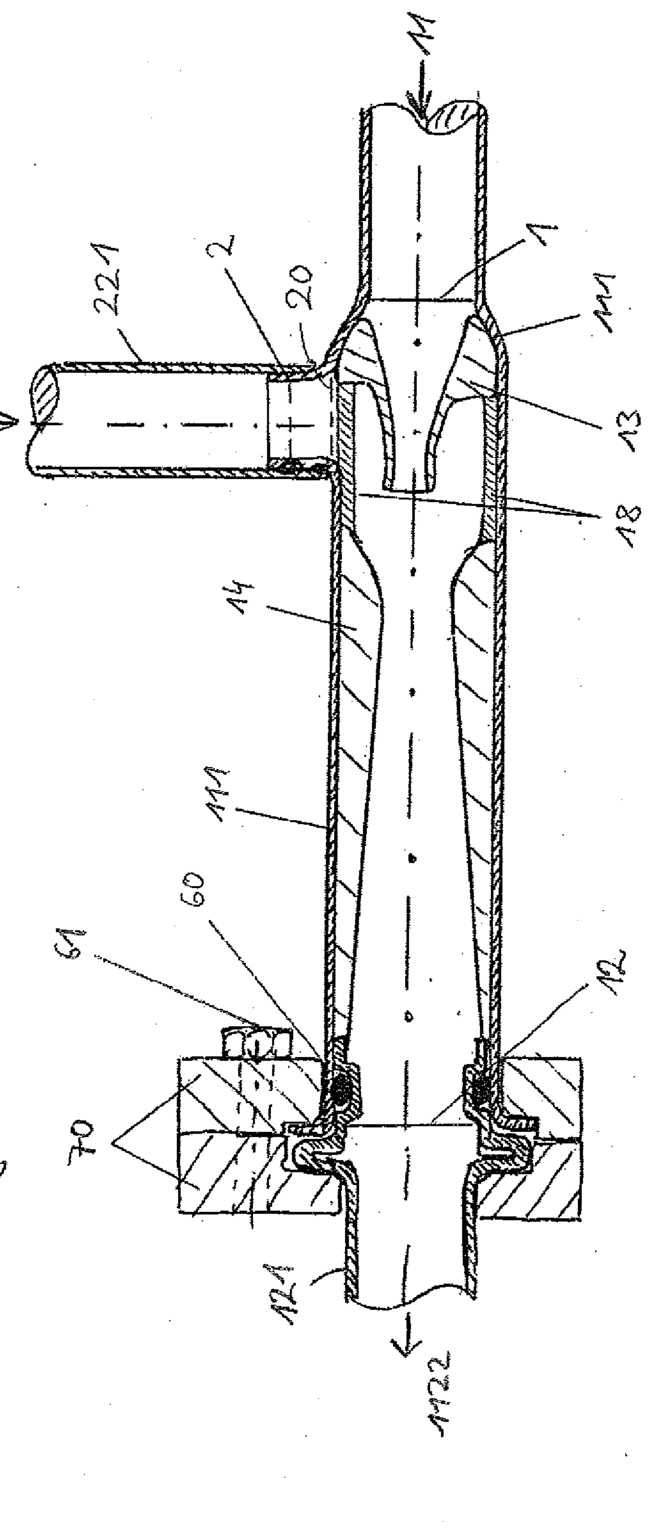
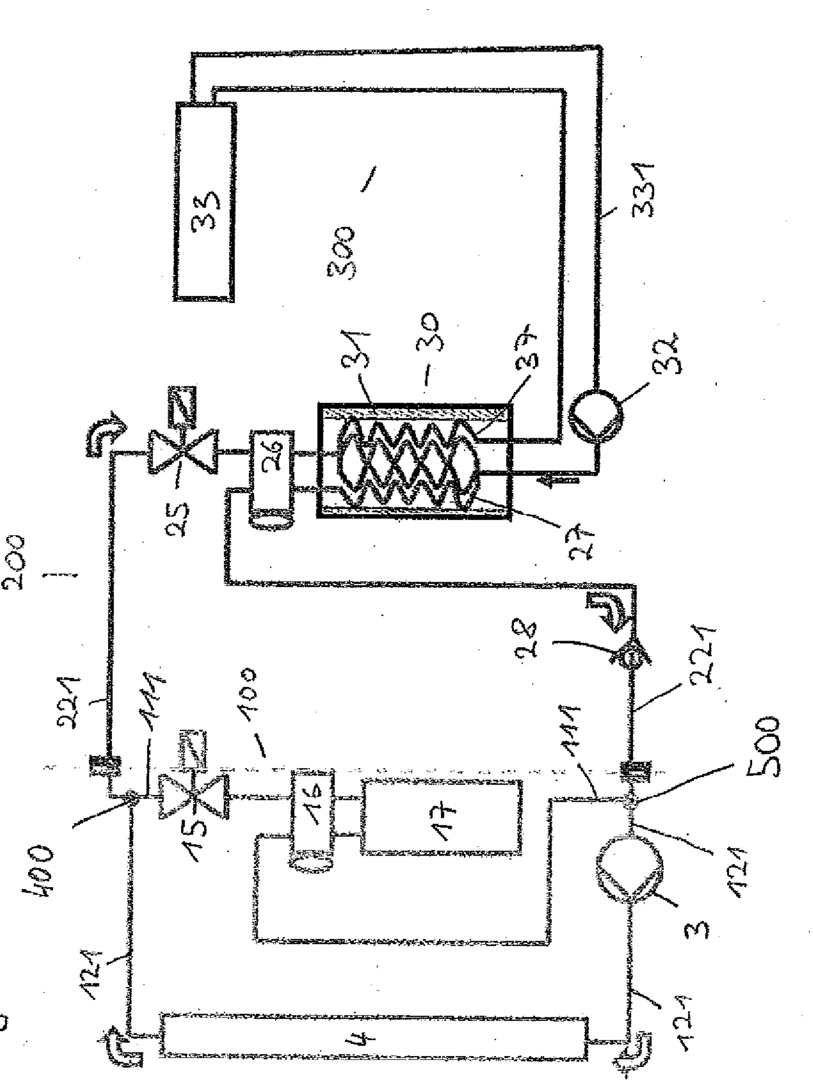


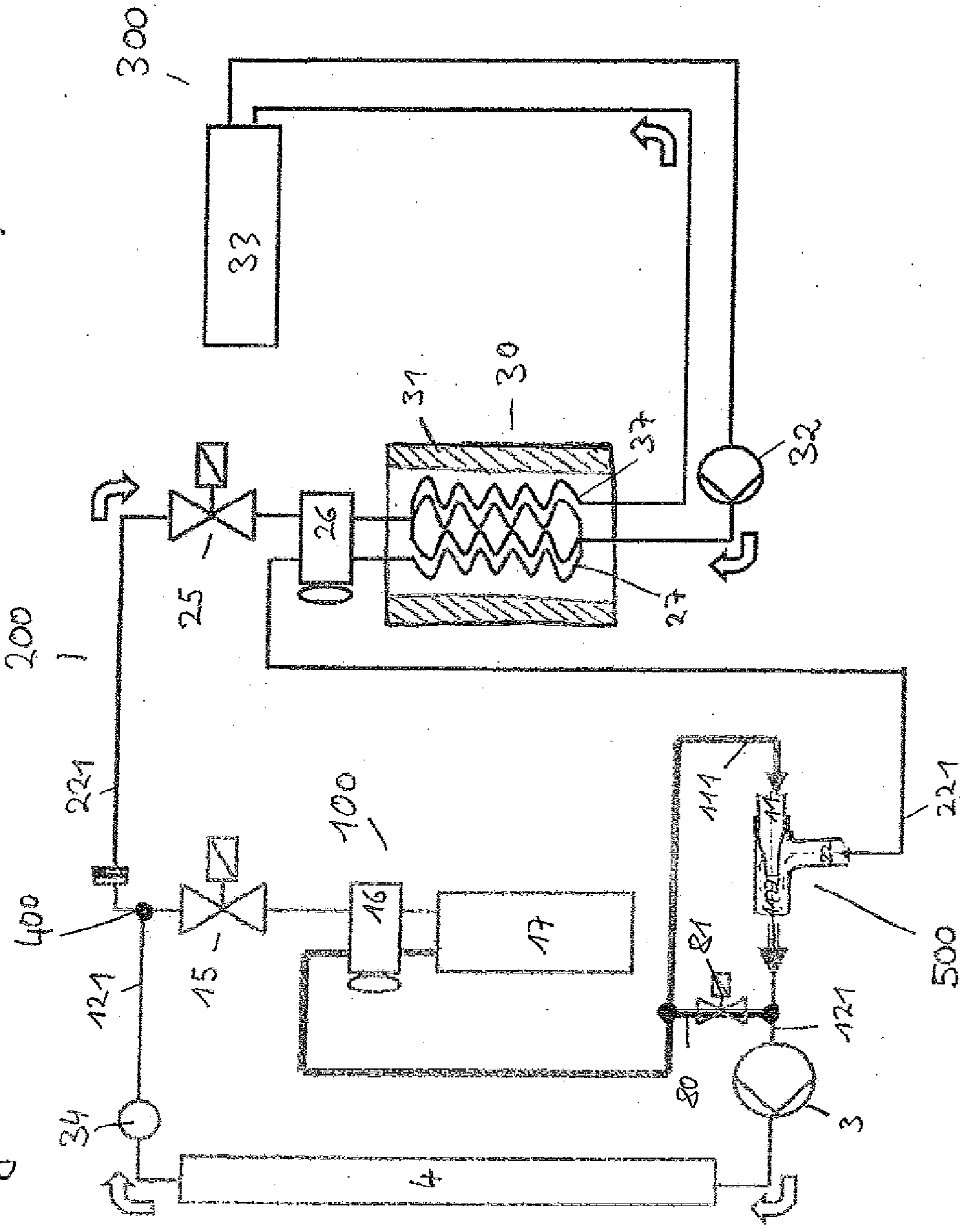
Figure 3



Figur 4


1000
33
300
331
31
30
37
32
26
25
27
200
28
221
111
100
15
16
17
400
500
121
3
4

Figur 5


1000
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100
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400
121
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4
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80
81
111
11
500

Figur 6