

## Arrangement for supplying a direct liquid cooling with electrical energy

The invention relates to an arrangement for supplying a direct liquid cooling (DLC) with electrical energy, wherein the arrangement has at least one IT rack with a plurality of slide-in units, arranged one above the other in the height direction of the IT rack, for slide-in devices of a direct liquid cooling and/or an IT infrastructure. Such an arrangement is known from US 2007/0274043 A1 or US 2022/0210953 A1. Similar arrangements are described in U.S. Pat. No. 11,395,443 B2, US 2023/0056298 A1, US 2022/0330459 A1 and US 2019/0 037730 A1.

The known arrangements have the disadvantage that, in the event of failure of one of the slide-in devices inserted into the slide-in units, the replacement of the relevant slide-in device is complicated, in particular takes a certain amount of time. During this time, the direct liquid cooling cannot be operated or can only be operated with reduced cooling power, which can lead, for example, to IT components installed in the IT racks, for instance server slide-in units, having to be taken out of operation or operated with reduced power in order to avoid overheating of the devices. In this case, the creation of the necessary cabling of the slide-in devices with a power supply is particularly time-consuming.

It is therefore the object of the invention to further develop the arrangement described at the outset in such a way that it is prepared for the simple replacement of the slide-in devices.

This object is achieved by an arrangement having the features of claim 1.

Advantageous embodiments of the invention are each the subject matter of the dependent claims.

For this purpose, in an arrangement of the type described at the outset, it can be provided that the IT rack has a DC voltage supply for slide-in devices accommodated in the slide-in units, with a rectifier and a power distribution, for example a busbar, which runs along a rear side of the IT rack in the height direction of the IT rack and is supplied with a DC voltage by the rectifier, wherein at least one slide-in device of a direct liquid

cooling is accommodated in one of the slide-in units and is electrically contacted to the power distribution, in particular the busbar.

In a preferred embodiment, the power distribution is a busbar, for example a copper rail, particularly preferably a busbar, which is accommodated in a contact protector, which has contact openings for the electrical contacting of the busbar. The power distribution, in particular the busbar, is particularly preferably designed as a straight strip.

The slide-in devices, in particular, but not exclusively, the slide-in devices of the direct liquid cooling, can be operated with DC voltage. A DC voltage supply is provided in the IT rack, which extends at least in the height direction of the IT rack and with which slide-in devices inserted into the slide-in units can be supplied with DC voltage. The DC voltage supply, in particular the power distribution, for example a busbar, can have a self-contacting. Preferably, the power distribution, for example a busbar, and the slide-in devices have, on their rear side facing the power distribution, complementary contact elements, which come into engagement when the slide-in devices are arranged in a position completely inserted into the slide-in units, wherein the electrical contacting is disengaged when the slide-in devices are inserted into the slide-in units in a position not completely inserted.

The arrangement can be part of an IT cabinet, an IT cabinet row or a data center. The arrangement can thus in particular be part of a switch cabinet housing. The switch cabinet housing can have, in a known manner, in addition to the direct liquid cooling, an air cooling for the cooling-required components accommodated in the switch cabinet. For this purpose, cooled air can flow through the switch cabinet housing. It can be provided that the switch cabinet housing has an air-liquid heat exchanger on an air outlet side, for example on a front side or a rear side. The heat exchanger can be configured, for example, as a rear door heat exchanger. Thus, when flowing through the switch cabinet, heated air can be emitted as cooled air into the switch cabinet surroundings. Alternatively or additionally, cooled air can, for example in a switch cabinet row in a cold aisle-hot aisle configuration, enter the housing from a cold aisle via a front or rear side of the switch cabinet and enter the hot aisle as heated air on the opposite side. The cooled air can, for example, be emitted into the cold aisle by an air-

liquid heat exchanger arranged in a double floor of the data center. The cooled air can also be provided in a different manner in the cold aisle.

In order to achieve a further increase in the ease of maintenance of the DLC system, it can be provided that the DLC system is of modular construction, with a plurality of sub-units interconnected with one another. This enables embodiments of the DLC system in which sub-units or modules which are particularly susceptible to faults are provided redundantly. Thus, for example, a plurality of pump modules can be provided for the liquid transport. The pump modules can be connected in parallel. Each of the pump modules can have a plurality of pumps, which in turn are preferably connected in parallel.

In one embodiment, the direct liquid cooling has at least one pump module which is formed independently of further functional modules of the liquid cooling. The at least one module or one of the modules of the direct liquid cooling can be a slide-in device of the direct liquid cooling which is connected to the DC voltage supply in the manner described above.

If the arrangement for supplying a direct liquid cooling (DLC) with electrical energy is a constituent part of a switch cabinet housing, of a switch cabinet row, or of a data center, and furthermore an air cooling with at least one air-liquid heat exchanger is provided, it can be provided that a return flow of the air-liquid heat exchanger is connected to a forward flow of the direct liquid cooling, in particular to a forward flow of a liquid-liquid heat exchanger of the direct liquid cooling. In this way, it is possible for the heated liquid emerging from the air-liquid heat exchanger to still be used as a heat sink for the recooling of the cooling liquid of the primary circuit of the direct liquid cooling. This is possible because liquid cooling can be operated at a higher forward flow temperature in comparison to the air of an air cooling flowing through the switch cabinet, in order in particular still to enable an effective heat transfer from the component requiring cooling to the liquid of the primary circuit of the liquid cooling.

In one embodiment, the return flow of an air-liquid heat exchanger accommodated in a switch cabinet door can be connected to a forward flow of a liquid-liquid heat exchanger of the direct liquid cooling, in particular to the outer circuit of the direct liquid cooling. The air-liquid heat exchanger can also assume an alternative position in

relation to the switch cabinet, a switch cabinet row or a data center which have the DLC. For example, the air-liquid heat exchanger can be arranged in a double floor of a data center and be configured to blow cooled air into a cold aisle, which air was previously conducted out of the hot aisle as heated air and through the double floor and the air-liquid heat exchanger. The heat exchanger can also be part of an inline cooling device which is lined up in a switch cabinet row. The switch cabinet row can, for example, separate a cold aisle from a hot aisle, wherein heated air is drawn in from the hot aisle via the rear side of the inline cooling device, passed through the air-liquid heat exchanger in the inline cooling device and blown out into the cold aisle as cooled air on the front side.

In one embodiment, the arrangement is part of a switch cabinet housing or of an IT rack in which, in addition to the components of the arrangement according to the invention, exclusively components of a liquid cooling and optionally components of an air-liquid cooling are arranged. Such a switch cabinet housing or such an IT rack can be part of a switch cabinet row, for example lined up in a row of switch cabinets or IT racks, and be configured to provide cooled liquid for a liquid cooling of components accommodated in adjacent switch cabinet housings or in IT racks. Optionally, the switch cabinet housing or IT rack having the arrangement can also have at least one air-liquid heat exchanger for providing cooled air for cooling the said components. The liquid circuit of the air-liquid heat exchanger can be interconnected with a liquid circuit of the outer circuit of a liquid-liquid heat exchanger of the liquid cooling in the manner described above, in particular in such a way that the return flow of the air-liquid heat exchanger is connected to the forward flow of the outer circuit of the liquid-liquid heat exchanger. The return flow of the outer circuit of the liquid-liquid heat exchanger can be connected to a recooling, for example to a chiller. The forward flow of the chiller can be connected to the forward flow of the air-liquid heat exchanger. However, the air-liquid heat exchanger and the liquid-liquid heat exchanger of the direct liquid cooling can also be formed independently of one another and in each case connected to the recooler for providing cooled liquid. It is also possible to dispense with the air-liquid heat exchanger and implement liquid cooling only.

A plurality of first blind mating connectors for the tool-free connection of sub-units of the direct liquid cooling and/or of an IT infrastructure to the power distribution, for example a busbar, can be arranged along the power distribution, in particular the busbar, at a

distance from one another in the height direction. The slide-in devices to be received in the slide-in units can have connectors complementary to the first blind mating connectors. The connectors complementary to one another can have self-centering, such that, when the slide-in devices are inserted into the slide-in units, when a completely inserted position of the slide-in devices in the slide-in units is reached, reliable contacting between the slide-in devices and the busbar is achieved.

The direct liquid cooling can have at least one coolant distribution manifold which runs along the rear side of the IT rack in the height direction of the IT rack, wherein a plurality of second blind mating connectors for the tool-free connection of sub-units of the direct liquid cooling and/or of an IT infrastructure to the coolant distribution manifold are arranged along the coolant distribution manifold at a distance from one another in the height direction.

The slide-in units can have a linear guide for sub-units of the direct liquid cooling and/or of an IT infrastructure, wherein the linear guide extends parallel to an insertion direction of the first and/or second blind mating connectors.

The direct liquid cooling can have a plurality of slide-in devices which are each accommodated in one of the slide-in units and of which at least two slide-in devices are designed as redundant slide-in devices, preferably redundant pump units, for example as a reservoir pumping unit (RPU) in each case. All of the slide-in devices, but preferably at least one of the slide-in devices of the direct liquid cooling, can be contacted to the power distribution, in particular a busbar, in particular via a blind mating connector, such that, in the event of failure, a simple replacement is possible.

The rectifier can be designed as one of the slide-in devices. The rectifier can be designed, for example, as a power supply unit (PSU) which is accommodated as a slide-in device in one of the slide-in units. The PSU can have, on a rear side facing the power distribution, a blind mating connector via which the PSU is electrically connected to the power distribution in order to apply the DC voltage to the power distribution, for example a busbar of the power distribution.

The at least one slide-in device of the direct liquid cooling can be a coolant distribution unit (CDU) or at least one sub-unit of a coolant distribution unit. The coolant distribution

unit preferably has a plurality of sub-units formed independently of one another. The coolant distribution unit can preferably have at least two redundant sub-units. The redundant sub-units can be designed as identical parts and connected in parallel. Particularly preferably, the coolant distribution unit has at least two sub-units with different functionality. The sub-units can each be designed as a slide-in device for accommodation in one of the slide-in units.

Sub-units of the coolant distribution unit (CDU) can be, for example: at least one pump unit for coolant, with preferably 2N redundant pumps, at least one heat exchanger, at least one expansion vessel, at least one pressure and/or temperature sensor, at least one three-way valve with bypass valve, at least one AC power supply, at least one control device, at least one service valve, at least one filter, preferably a filter fan, at least one automatic deaerator, at least one pressure limiting valve. Individual sub-units can be designed as separate slide-in devices. A plurality of sub-units can form a common slide-in device. The sub-units can be designed to be hot-swappable, preferably with regard to a connection to a coolant circuit, if present, and/or a connection to a power supply, if present.

It can be provided that the pump unit of the CDU is designed as separate slide-in device. The pump unit preferably has a plurality of slide-in devices. The plurality of slide-in devices of the pump unit can be identical parts. The plurality of slide-in devices of the pump unit can be connected in series with regard to their pumping capacity for the coolant. The plurality of pump units can be configured such that the required pumping capacity can be provided by the remaining pump units even in the event of a failure of one of the plurality of pump units. For this purpose, it can be provided that the plurality of pump units are operated with reduced pumping capacity in normal operation, i.e. when none of the plurality of pump units has failed. In the event of the failure of one of the pump units, the remaining pump units can increase their pumping capacity such that the pumping capacity omitted by the failure is compensated. After the failed pump unit has been replaced, the plurality of pump units can return to normal operation.

In the case of the coolant distribution unit (CDU) known from the prior art, all of the above-mentioned sub-units, insofar as they are required in the respective application case, are often arranged in the same housing, and are consequently formed as a

single device, such that the entire CDU must be replaced in the event of a failure of one of the said sub-units. This leads to the interruption of the cooling capacity provided by the CDU and thus possibly to the failure of the IT infrastructure which is cooled by the CDU.

At least one of the sub-units of the coolant distribution unit, preferably a control device and/or an expansion vessel of the coolant distribution unit, can be arranged outside a housing of the coolant distribution unit (CDU) and inside or outside the IT rack. For example, an expansion vessel of the coolant distribution unit can be arranged on a roof of the IT rack.

The at least one sub-unit of the coolant distribution unit can be a control device of the coolant distribution unit which is electrically connected to the power supply, in particular the busbar, and is preferably designed as a slide-in device which is accommodated in one of the slide-in units.

The at least one sub-unit of the coolant distribution unit can be an expansion vessel which is fluidically connected, preferably directly, to a coolant distribution channel of the direct liquid cooling. In this case, the expansion vessel can particularly preferably be arranged outside the IT rack, for example on the roof of the IT rack.

A plurality of sub-units of the coolant distribution unit can be accommodated as individual slide-in devices in a respective slide-in unit. In this case, the sub-units of the coolant distribution unit designed as mutually independent slide-in devices can comprise at least two identical or structurally identical sub-units, preferably a plurality of identical or structurally identical pump units, for example RPUs, of the coolant distribution unit. For example, at least two of the identical or structurally identical pump units can be designed as redundant pump units. To create the redundancy, the pump units can be connected in parallel.

The at least one slide-in device can be a sub-unit of the direct liquid cooling, in which the slide-in device has a housing in which at least two redundant, preferably parallel-connected, pumps are arranged. The housing can otherwise be at least free of a compressor, an expansion means and a condenser. The housing can preferably be free of all further active components of a refrigerating machine. In this way, an embodiment of the invention can be provided in which the pump units which are

particularly susceptible to faults can be replaced simply and in ongoing operation. This can be further optimized in that not only one of the slide-in devices with at least two redundant pumps is provided, but also a plurality of these slide-in devices, which particularly preferably act in a fluidically parallel-connected manner on a coolant distribution channel with cooled coolant.

In one embodiment, in addition to the at least two redundant pumps, a heat exchanger can be accommodated in the housing. In this case, for the component cooling of an IT infrastructure, coolant can be conveyed or can be conveyed through an inner circuit of the heat exchanger by means of the redundant pumps. When the heat exchanger is a liquid-liquid heat exchanger, an outer circuit of the liquid-liquid heat exchanger can be connected or can be connected to a recooling unit for coolant. Alternatively, in the manner already described, the outer circuit of the liquid-liquid heat exchanger can be connected to the return flow of an air-liquid heat exchanger of an existing IT infrastructure.

The housing can have on an outer side at least one forward flow and a first return for the connection of the inner circuit to a coolant distribution manifold of the direct liquid cooling. Furthermore, a single-pole or two-pole electrical contact for the electrical connection to the power distribution, for example a busbar, can be present on the outer side, preferably on a rear side of the housing facing the power distribution. When the heat exchanger is a liquid-liquid heat exchanger, preferably a second forward flow and a second return for the connection of the outer circuit to a recooling unit can be provided. Preferably all of the feeds and returns and the electrical contact can be designed as blind mating connectors.

At least one further slide-in device can be accommodated or can be accommodated in at least one further of the slide-in units. In this case, the at least one further slide-in device can be a server or an uninterruptible power supply (backup battery unit—BBU).

The direct liquid cooling can have at least one further slide-in device, preferably a coolant-conducting sub-unit of a coolant distribution unit of the direct liquid cooling. The slide-in device can be or have a heat exchanger. Furthermore, the slide-in device can be or have an expansion vessel. In this case, the further slide-in device is intended to be accommodated in one of the slide-in units without contact with the busbar.

The slide-in devices and the further slide-in devices can have standardized housings which, in particular with regard to their dimensions in the depth direction, and consequently in the insertion direction of the slide-in devices into the slide-in units, have the same dimensions. Furthermore, the first blind mating connectors formed on the rear sides facing the busbar are preferably of identical design independently of the type of slide-in device.

Exclusively slide-in devices of the direct liquid cooling can be accommodated in the slide-in units of the IT rack. Consequently, the IT rack can be lined up in a switch cabinet row of the components requiring cooling. For this purpose, the IT rack accommodating exclusively slide-in devices of the liquid cooling can have, via suitable interfaces, for example line-up connectors to adjacent IT racks of the switch cabinet row, including fluidic transitions between the IT rack having exclusively the slide-in devices of the liquid cooling and the adjacent IT racks of the switch cabinet row, which can accommodate, for example, servers requiring cooling.

At least one of the slide-in devices can be or have a heat exchanger, preferably a liquid-liquid heat exchanger, an expansion vessel, a pump unit, a control device or a DC voltage supply.

Further details of the invention will be explained with reference to the following figures. In the figures:

- FIG. 1 shows a schematic illustration of a direct liquid cooling;
- FIG. 2 shows an exemplary embodiment of a slide-in device designed as a pump unit;
- FIG. 3 shows an exemplary embodiment of a direct liquid cooling with additional rear door air cooling;
- FIG. 4 shows a schematic illustration of an exemplary embodiment of a slide-in device;
- FIG. 5 shows a further embodiment of a slide-in device;

- FIG. 6 shows yet a further embodiment of a slide-in device;
- FIG. 7 shows an embodiment of an arrangement according to the invention in the front view (a) and side view (b); and
- FIG. 8 shows yet a further embodiment of an arrangement according to the invention in the side view of the IT rack.

FIG. 1 shows a schematic illustration of a direct liquid cooling (DLC). Cooled liquid is provided by a recooling unit 16 which can be configured, for example, as a chiller, with or without a refrigerating machine. For this purpose, the recooling unit 16 has, in particular, an air-liquid heat exchanger and at least one fan with which ambient air is transported through the air-liquid heat exchanger. The cooled liquid provided by the recooling unit is fed to a coolant distribution unit (CDU), in particular via the forward flow of an outer circuit of the CDU. Via a return flow of the outer circuit, the liquid provided by the recooling unit leaves the CDU as a heated liquid and the outer circuit of the CDU, which at the same time forms the liquid circuit of the recooling unit 16, is denoted by the reference numeral 17.

The coolant distribution unit CDU has, in particular, a liquid-liquid heat exchanger and at least one pump in order to transport liquid through the inner circuit 15 of the CDU. The forward flow of the inner circuit of the CDU is connected to a return flow of a coolant distribution manifold and the return flow of the inner circuit 15 of the CDU is connected to a forward flow of the coolant distribution manifold 7. The coolant distribution manifold 7 can have a plurality of connections at a distance from one another in the longitudinal direction, consequently in the vertical direction, on the one hand to a forward flow of the coolant distribution manifold 7, via which cooled coolant is provided, and on the other hand to a return flow of the coolant distribution manifold 7, via which heated coolant is discharged. The slide-in devices 2 can be, for example, server slide-in units of an IT infrastructure which are connected to the distribution manifold 7, for example, in the manner known from US 2007/0274043 A1. In the slide-in devices, the coolant, which is preferably an electrically nonconductive refrigerant, flows over the components requiring cooling, for example CPUs or GPUs, or another component which has a high power loss and otherwise a high temperature sensitivity,

with the result that air cooling is unsuitable owing to the lower thermal conductivity of air in comparison to liquid.

FIG. 2 shows an exemplary embodiment of a slide-in device which can be used in an arrangement according to the invention. The slide-in device 2.1 has a housing 13 which can be standardized, for example, with regard to its dimensions, for example at least to the effect that, when the slide-in device 2.1 is inserted into a slide-in unit of an IT rack, both contacting of the first and of the second blind coupling plug-in connection 6.1, 6.2 for the electrical contacting of the power distribution on the one hand and the fluidic connection to the direct liquid cooling, in particular a coolant distribution channel, can take place automatically, that is to say in particular without tools. Three redundant pumps 14 which are interconnected in particular in parallel with one another are arranged in the housing 13. Furthermore, a heat exchanger 12, in particular a liquid-liquid heat exchanger, is arranged in the housing 13. The only active components inside the housing 13 are thus the pumps 14 which are provided in a triple design and connected in parallel. The pump unit shown in FIG. 2 thus has a very high failure insensitivity. Owing to the use of the first and of the second blind coupling plug-in connectors 6.1, 6.2, the entire unit, that is to say the slide-in device 2.1, can be replaced quickly and without relevant downtimes in the event of failure of all of the pumps or in the event of a decrease in pump power. further redundancy of the direct liquid cooling (DLC) can be achieved by a plurality of the slide-in devices 2.1 shown in FIG. 2 being provided at the same time, which slide-in devices 2.1 are in turn connected in parallel with one another, such that, even in the event of failure of all of the in the present case three pumps 14 of one of the plurality of slide-in devices 2.1, further operation of the DLC is ensured and downtimes can be substantially completely avoided.

FIG. 3 shows an embodiment in which the arrangement according to the invention is accommodated in a switch cabinet housing which is designed according to the design of an IT cabinet with a plurality of 19-inch slide-in units which are arranged vertically one above the other. The slide-in devices 2.1 in the slide-in units 2 of the IT rack 1 are occupied in part by servers and in part by built-in devices 2.1 of the direct liquid cooling. For example, an uppermost slide-in unit 2 of the IT rack 1 is occupied by a DC voltage supply 3 which is provided as a built-in device 2.1. A lower slide-in unit 2 is occupied by a coolant distribution unit (CDU). A coolant distribution manifold 7 with its

forward flow line and its return flow line is arranged on a rear side of the IT rack 1. The forward flow line and the return flow line of the coolant distribution channel 7 are connected to the coolant distribution unit CDU. A rear door heat exchanger 200 is connected to the rear side of the IT rack 1. Said rear door heat exchanger has an air-liquid heat exchanger and a plurality of fans. With the aid of the rear door heat exchanger, cooled air is drawn in via the front side of the IT rack 1 through the IT rack 1, past the server slide-in units 2.1 requiring cooling, into the rear door heat exchanger 200, where the heated air passes the air-liquid heat exchanger and is blown out into the surroundings of the housing as cooled air. The forward flow of the air-liquid heat exchanger of the rear door cooling device 200 is fed by a recooling device 16, for example a chiller. The return flow of the air-liquid heat exchanger of the rear door cooling device 200 is connected to a forward flow of an outer circuit of the CDU. The heated liquid emitted by the air-liquid heat exchanger thus serves as a heat sink with respect to the CDU. A liquid-liquid heat exchanger 12 is arranged in the CDU, via which heat is transferred from an inner circuit of the CDU, by means of which the CDU is connected to the coolant distribution channel 7, to the outer circuit of the CDU.

All slide-in devices 2.1, apart from the DC voltage supply 3 itself, can be designed as DC devices which are operated, for example, at an operating voltage of 48 V. The entire power distribution inside the IT rack can thus take place at a DC voltage level which is less dangerous in comparison to the mains voltage, as a result of which the operational reliability of the IT rack is increased.

The modular construction of the direct liquid cooling furthermore makes it possible, for example, for the expansion vessel 10 also to be arranged in a manner which is advantageous for operation on an upper side of the IT rack 1, that is to say in particular above the coolant distribution channel 7.

FIGS. 4 to 6 show different design stages of a slide-in device 2.1 which is designed as a pump unit (RPU) in the embodiment according to FIG. 4. The RPU shown in FIG. 4 has only two parallel-connected pumps 14 which are accommodated with two power supplies 19, one for each of the pumps 14 in each case, in a housing 13. A first blind mating connector 6.1 serves for the connection to the DC voltage source and a pair of second blind mating connectors 6.2 serves for the connection to the inner circuit of the

DLC, with the result that the coolant distribution manifold (not illustrated) of the DLC can be acted on with cooled coolant by the pump unit (RPU) shown in FIG. 4.

In an extension of the embodiment shown in FIG. 4, in the embodiment shown in FIG. 5, not only is a liquid-liquid heat exchanger 12 provided, but, furthermore, the pumps 14 are of triple redundant design. Correspondingly, three power supplies 19 are also provided for the independent supply of the three pumps 14. The embodiment shown in FIG. 5 is suitable, for example, for use in a switch cabinet according to FIG. 3, in which the outer circuit of the CDU is connected to an air-liquid heat exchanger, for example to such a heat exchanger of a rear door cooling device 200.

Deviating in turn from the embodiment according to FIG. 5, in the embodiment in FIG. 6, instead of a liquid-liquid heat exchanger for the recooling of the coolant, an air-liquid heat exchanger 12 and a pair of fans 20 are provided. Otherwise, an expansion vessel 10 is also arranged in the housing. A pair of redundant pumps 14 is fed by a pair of mutually independent power supplies 19.

FIG. 7 shows in the front view (a) and in the side view (b) an exemplary embodiment of an arrangement for supplying a direct liquid cooling with electrical energy. The arrangement has an IT rack 1 which has a plurality of slide-in units 2, arranged one above the other in the height direction z, for slide-in devices 2.1 of a direct liquid cooling. In addition to the slide-in devices 2.1 for the direct liquid cooling, further slide-in devices 2.1 are also provided, which are in the present case designed as servers. The rectifier PSU is also designed as a slide-in device 2.1. A busbar of a DC voltage supply 3 for the slide-in units 2 or slide-in devices 2.1 accommodated therein extends as the power distribution 5 along the rear side R of the IT rack 1. The busbar is fed by the rectifier PSU, in particular supplied with a DC voltage. The slide-in devices 2.1 of the direct liquid cooling DLC, insofar as they require a supply with electrical energy, are accommodated in each case in one of the slide-in units 2 and electrically contact-connected to the busbar. The expansion vessel 10, which does not require an electrical power supply, is arranged at a position which is advantageous from a physical point of view on the upper side, that is to say otherwise outside the IT rack 1. A control device 9 is designed independently of other sub-units of the DLC as a separate slide-in device and contact-connected directly to the DC voltage supply 3, in particular to the busbar of the power distribution 5. The slide-in devices 2.1 have first blind mating connectors 6.1

for the tool-free connection of the slide-in devices 2.1 to the busbar. Complementary blind mating connectors can be arranged on the rear side, facing the busbar, of housings of the slide-in devices 2.1. In an analogous manner, second blind mating connectors, which are liquid-conducting, can be arranged on the rear side for the connection to a forward flow and a return flow of the coolant distribution manifold 7.

While the embodiment shown in FIG. 7 has both server installations and thus components requiring cooling and also different sub-units of a direct liquid cooling DLC for the cooling of the servers, in the embodiment shown in FIG. 8 the IT rack 1 is equipped exclusively with components of a direct liquid cooling DLC. In particular, a plurality of the slide-in devices 2.1 are designed as redundant pump units RPU. These can be designed, for example, as one of the embodiments according to FIGS. 2 and 4. The two slide-in devices 2.1 form the heat exchanger 12 and the expansion vessel 10. The DC voltage supply 3 is also designed as a slide-in device, as is also the control device 9. The DC voltage supply 3 is the only component of the arrangement shown in FIG. 8 which is supplied with mains voltage. Otherwise, the arrangement ensures that all components and devices for the power distribution, in particular the busbar 5, are at a low DC voltage, for example 48 V.

The features given in the above-mentioned description can be relevant in any desired combination for the realization of embodiments of the invention, wherein the scope of protection is determined solely by the claims.

## List of reference numerals:

|     |                               |
|-----|-------------------------------|
| 1   | IT rack                       |
| 2   | slide-in unit                 |
| 2.1 | slide-in device               |
| 3   | DC voltage supply             |
| 5   | busbar                        |
| 6.1 | first blind mating connector  |
| 6.2 | second blind mating connector |
| 7   | coolant distribution channel  |
| 8   | linear guide                  |
| 9   | control device                |
| 10  | expansion vessel              |
| 11  | further slide-in device       |
| 12  | heat exchanger                |
| 13  | housing                       |
| 14  | pump                          |
| 15  | inner circuit                 |
| 16  | recooler                      |
| 17  | outer circuit                 |
| 19  | power supply                  |
| 20  | fan                           |
| 200 | rear door cooling device      |
| BBU | Uninterruptible Power Supply  |
| CDU | coolant distribution unit     |
| DLC | direct liquid cooling         |
| PSU | rectifier                     |
| RPU | pump unit                     |
| R   | rear side                     |
| x   | insertion direction           |
| z   | height direction              |

## Claims:

1. Arrangement for supplying a direct liquid cooling (DLC) with electrical energy, wherein the arrangement has at least one IT rack (1) with a plurality of slide-in units (2), arranged one above the other in the height direction (z) of the IT rack (1), for slide-in devices (2.1) of a direct liquid cooling (DLC) and/or of an IT infrastructure, characterized in that the IT rack (1) has a DC voltage supply (3) for slide-in devices (2.1) accommodated in the slide-in units (2), with a rectifier (PSU) and a power distribution (5), preferably a busbar, which runs along a rear side (R) of the IT rack (1) in the height direction (z) of the IT rack (1) and is supplied with a DC voltage by the rectifier (PSU), wherein at least one slide-in device (2.1) of a direct liquid cooling (DLC) is accommodated in one of the slide-in units (2) and is electrically contacted to the power distribution (5).
2. Arrangement according to claim 1, in which a plurality of first blind mating connectors (6.1) for the tool-free connection of sub-units of the direct liquid cooling (DLC) and/or of an IT infrastructure to the power distribution (5) are arranged along the power distribution (5) at a distance from one another in the height direction (z).
3. Arrangement according to claim 1 or 2, in which the direct liquid cooling (DLC) has at least one coolant distribution manifold (7) which runs along the rear side (R) of the IT rack (1) in the height direction (z) of the IT rack (1), wherein a plurality of second blind mating connectors (6.2) for the tool-free connection of sub-units of the direct liquid cooling (DLC) and/or of an IT infrastructure to the coolant distributor channel (7) are arranged along the coolant distribution manifold (7) at a distance from one another in the height direction (z).
4. Arrangement according to claim 2 or 3, in which the slide-in units (2) have a linear guide (8) for sub-units of the direct liquid cooling (DLC) and/or of an IT infrastructure, wherein the linear guide (8) extends parallel to an insertion direction (x) of the first and/or second blind mating connectors (6.1, 6.2).
5. Arrangement according to one of the preceding claims, in which the direct liquid cooling (DLC) has a plurality of slide-in devices (2.1) which are each accommodated in one of the slide-in units (2) and of which at least two slide-in

devices (2.1) are designed as redundant slide-in devices (2.1), preferably redundant pump units (RPU).

6. Arrangement according to one of the preceding claims, in which the rectifier (PSU) is designed as a slide-in device (2.1) which is accommodated in one of the slide-in units (2).
7. Arrangement according to one of the preceding claims, in which the at least one slide-in device (2.1) of the direct liquid cooling (DLC) is a coolant distribution unit (CDU) or at least one sub-unit of a coolant distribution unit (CDU).
8. Arrangement according to claim 7, in which at least one sub-unit of the coolant distribution unit (CDU), preferably a control device (9) and/or an expansion vessel (10) of the coolant distribution unit (CDU), is arranged outside a housing (13) of the coolant distribution unit (CDU) and inside or outside the IT rack (1).
9. Arrangement according to claim 8, in which the at least one sub-unit of the coolant distribution unit (CDU) is a control device (9) of the coolant distribution unit (CDU) which is electrically connected to the power distribution (5) and is preferably designed as a slide-in device which is accommodated in one of the slide-in units (2).
10. Arrangement according to claim 8 or 9, in which the at least one sub-unit of the coolant distribution unit (CDU) is an expansion vessel (10) which is fluidically connected, preferably directly, to a coolant distribution channel (7) of the direct liquid cooling (DLC), wherein the expansion vessel (10) is particularly preferably arranged outside the IT rack (1).
11. Arrangement according to one of claims 7 to 10, in which a plurality of sub-units of the coolant distribution unit (CDU) are accommodated as individual slide-in devices (2.1) in a respective slide-in unit.
12. Arrangement according to claim 11, in which the sub-units of the coolant distribution unit (CDU) designed as individual slide-in devices (2.1) have at least two identical or structurally identical sub-units, preferably a plurality of identical

or structurally identical pump units (RPU) of the coolant distribution unit (CDU), of which particularly preferably at least two of the identical or structurally identical pump units (RPU) are designed as redundant pump units (RPU).

13. Arrangement according to claim 7, in which the at least one slide-in device (2.1) is a sub-unit of the direct liquid cooling (DLC), wherein the slide-in device (2.1) has a housing (13) in which at least two redundant, preferably parallel-connected, pumps (14) are arranged, wherein the housing (13) is otherwise at least free of a compressor, an expansion means and a condenser, and preferably free of all further active components of a refrigerating machine.
14. Arrangement according to claim 13, in which furthermore at least one heat exchanger (12) is accommodated in the housing (13), wherein, for the component cooling of an IT infrastructure, cooling liquid is conveyed or can be conveyed through an inner circuit (15) of the heat exchanger (12) by means of the redundant pumps (14), and wherein, when the heat exchanger (12) is a liquid-liquid heat exchanger, preferably an outer circuit (17) of the liquid-liquid heat exchanger is connected or can be connected to a recooling (16) for coolant.
15. Arrangement according to claim 13 or 14, in which the housing (13) has on an outer side at least a first feed and a first return for the connection of the inner circuit (15) to a coolant distribution manifold (7) of the direct liquid cooling (DLC), an electrical contact for the electrical connection to the power distribution (5), and, when the heat exchanger (12) is a liquid-liquid heat exchanger, preferably a second feed and a second return for the connection of the outer circuit to a recooling, wherein preferably all of the feeds and returns and the electrical contact are designed as blind mating connectors (6).
16. Arrangement according to one of the preceding claims, in which at least one further slide-in device is accommodated or can be accommodated in at least one further of the slide-in units (2), wherein the at least one further slide-in device is a server or an uninterruptible power supply (BBU).
17. Arrangement according to one of the preceding claims, in which the direct liquid cooling (DLC) has at least one further slide-in device (11), preferably a coolant-

conducting sub-unit of a coolant distribution unit (CDU) of the direct liquid cooling (DLC), particularly preferably a heat exchanger (12) or an expansion vessel (10), wherein the further slide-in device (11) is accommodated in one of the slide-in units (2) without contact with the power distribution (5), preferably a busbar.

18. Arrangement according to one of the preceding claims, in which exclusively slide-in devices (2.1, 11) of the direct liquid cooling (DLC) are accommodated in the slide-in units (2) of the IT rack (1).
19. Arrangement according to claim 18, in which at least one of the slide-in devices (2.1, 11) is a heat exchanger (12), preferably a liquid-liquid heat exchanger, an expansion vessel (10), a pump unit (RPU), a control device (9) or a DC voltage supply (3).