A sub-rack (1) for plugging and unplugging electronic plug-in modules (3) includes a housing (2) which has a front cover plate (5). Each plug-in module includes a cooling device including a heat sink (19). A liquid distributor (12) is mounted on the cover plate and in flow connection with each of the heat sinks via a feed line (10) and a return line (11), and the liquid distributor is arranged on the outside of and in the front region (4) of the sub-rack.
Fig. 3
SUB-RACK WITH HOUSING FOR RECEIVING PLUG-IN MODULES

BACKGROUND OF THE INVENTION

[0001] The present invention pertains to a sub-rack for plugging and unplugging electronic plug-in modules with a housing, which has a front cover plate and a cooling device for the plug-in modules. The power consumption of electronic plug-in modules today continues to increase. In connection with the power consumption, waste heat or the thermal output also increases. For a few modules, special cooling devices must be provided, with which the plug-in module is cooled by means of liquid cooling.

[0002] From German patent publication DE 102 10 480 A1, a housing with electronic modules is known, in which a rigidly installed cooling plate carrying a liquid flow is allocated to each module. This arrangement, however, has a difficult construction of the cooling transfer points to the insertable and removable plug-in modules with their electronic components to be contacted.

[0003] German patent publication DE 43 27 444 A1 describes a cooling device for a switchgear cabinet with electrical devices, which are liquid cooled. The liquid cooled components are each connected via a feed line and a return line to a common distributor, which is preferably constructed as a block. Disadvantages include a relatively complicated overall construction and likewise heat transfer that is difficult to implement.

[0004] German patent publication DE 20 004 010 204 U1 describes a sub-rack with a housing and with modular electronic components, which are insertable and removable. The sub-rack has at least one liquid distributor in the housing. The liquid distributors are arranged in the housing above or below the push-in area of the plug-in modules. The housing is designed for pure liquid cooling. In this embodiment, liquid cooling must be provided in the housing of the sub-rack in advance. Subsequent installation in an air cooled sub-rack is not possible or is possible only with much difficulty.

[0005] For many sub-racks, however, individual plug-in modules are set up after the fact or replaced by updated, more powerful plug-in modules, so that liquid cooling is to be provided later for individual or all plug-in modules.

[0006] Therefore, the problem of the present invention is to create a sub-rack with a housing for receiving electronic plug-in modules, which can be easily equipped with liquid cooling at a later time. This should be possible, in particular for housings with sub-racks installed in an electronics cabinet.

SUMMARY OF THE INVENTION

[0007] The present invention provides a sub-rack for plugging and unplugging electronic plug-in modules including a housing with a front cover plate and a cooling device for the plug-in modules. The cooling device comprises a heat sink arranged on the plug-in module and a liquid distributor that is in flow connection with the heat sink via a feed line and a return line. The liquid distributor is arranged on the outside in the front region of the sub-rack.

[0008] According to the invention, simple retrofitting of such a distributor on the sub-rack is allowed by this construction. If individual plug-in modules are replaced and if there is a need for liquid cooling for these replaced modules, a liquid distributor can be easily arranged on the outside of the sub-rack. For an arrangement in the front region, there is also the advantage that the liquid distributor is easily accessible. First, the feed line and the return line to the heat sink can be easily coupled and fixed to the liquid distributor on the plug-in module. In this way, sub-racks installed in switchgear cabinets can be easily expanded. The sub-rack need not be removed from the switchgear cabinet to subsequently install a cooling device for the plug-in modules.

[0009] Preferably, the liquid distributor is arranged for this purpose detachably in the front region. The ability to detach the distributor allows not only simple assembly but also disassembly, if the distributor is no longer necessary, or retrofitting, if, for example, a different liquid distributor is necessary due to changed requirements.

[0010] The sub-rack according to the invention has the advantage that the liquid distributor is freely accessible from the front side of the sub-rack, because it is located in the front region. Maintaining and checking the liquid distributor, especially visual checking, is especially easy to perform also during the operation of the modules.

[0011] Preferably, the sub-rack according to the invention has a receptacle for receiving the liquid distributor in its front region. This receptacle can be constructed, for example, in the form of a flange, into which the liquid distributor can be pressed or clipped. The receptacle can also consist of one or more bores, so that the liquid distributor can be screwed in the front region of the sub-rack.

[0012] Especially preferred is providing a receptacle for receiving the liquid distributor on the front cover plate of the sub-rack. In this way, the liquid distributor sits in the front region above or below the plug-in modules. Inserting and removing plug-in modules into and out of the sub-rack is not obstructed by the liquid distributor. This arrangement also has the advantage that the feed and return line to the heat sink, which is arranged on the plug-in module, can be relatively short, because the liquid distributor is arranged in the immediate vicinity of the modules.

[0013] Alternatively, a liquid distributor can also be arranged at the edge regions of the sub-rack, that is, on the side of the push-in area of the plug-in modules. A dummy plate can also be provided, which is arranged next to or between two plug-in modules in the front region of the sub-rack and flush with the front plates of the plug-in modules. However, this embodiment is important only when the sub-rack is not completely equipped with plug-in modules.

[0014] Advantageously, a sub-rack according to the invention is constructed so that several liquid distributors can be arranged in the front region of the sub-rack. Thus, several liquid distributors can be retrofitted on one sub-rack. If several plug-in modules are to be cooled by liquid cooling, the sub-rack can also be expanded successively, in which, according to the requirements and number of plug-in modules to be cooled, several or additional liquid distributors are installed. The individual liquid distributors are correspondingly small, so that a space saving construction is possible. The individual liquid distributors can be coupled to each other, so that, in terms of flow, a large liquid distributor with many connections for several heat sinks is produced. Also when additional plug-in modules are retrofitted with liquid cooling, the existing liquid distributors can be kept. Additional liquid distributors are then installed. This can also be
realized with a “hot plug method” if the given plug-in modules are exchanged only for plug-in modules with liquid cooling, while the unaffected plug-in modules continue to operate.

In one preferred embodiment, a sub-rack according to the invention is arranged in a cabinet, especially in an electronics cabinet or switchgear cabinet with a nine-inch format. The switchgear cabinet has angular profiles in the front region, so that the liquid distributor is fixed to the angular profiles of the cabinet. In this way, the liquid distributor can be arranged and mounted directly on the angular profiles or on a special front cover plate, which is fixed, for example, to the two side angular profiles of the switchgear cabinet. In this way, more space is available for retrofitting liquid distributors, so that large liquid distributors with several feed and return lines can also be used for simultaneously supplying several plug-in modules.

It is further advantageous to provide combined air and liquid cooling. In addition to the (standard) device for air cooling, a cooling device for liquid cooling is also provided. This allows the cooling of “hot spots,” that is, especially hot zones. Plug-in modules can be cooled separately or selectively according to the individual requirements of cooling. For expanding an air cooled sub-rack by liquid cooling, the liquid cooled plug-in module is also still cooled by air cooling, so that the cooling efficiency is increased.

Additional details, features, and advantages of the invention result from the following description of preferred embodiments with reference to the enclosed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a sub-rack with a housing and two inserted plug-in modules in accordance with the invention;

FIG. 2 is a perspective view showing a sub-rack with a liquid distributor for connecting six liquid cooled plug-in modules;

FIG. 3 is a perspective view showing a sub-rack with a liquid distributor, and which is completely equipped with liquid cooled plug-in modules;

FIG. 4 is a perspective view of a plug-in module with two heat sinks;

FIG. 5 is a detail front elevation of the top corner area of the sub-rack shown in FIG. 1; and

FIG. 6 is a detail side elevation of the top corner area shown in FIG. 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the description which follows like parts are marked throughout the specification and drawings with the same reference numerals, respectively. The drawing figures may not be to scale and certain features may be shown in somewhat schematic or generalized form in the interest or clarity and conciseness.

FIGS. 1, 2, and 3 each show a sub-rack 1 with a housing 2, into which plug-in modules 3 are pushed. In the front region 4 of the sub-rack 1, a front cover plate 5 is provided above a push in area 6, which area is for inserting and removing the plug-in modules 3. Underneath the push in area 6 there is an air inlet plate 7, which has a screen-like construction, so that several small air inlet openings are provided for air-cooling the sub-rack 1.

In FIG. 1, the two plug-in modules 3 each have two through-holes 9 on their front plates 8. Cooling fluid feed lines 10 and return lines 11 of a cooling device for liquid cooling are guided through the through-holes 9, see FIG. 4 also.

The front cover plate 5 arranged above the push in area 6 for the plug-in modules 3 has a liquid distributor 12, which is a component of the cooling device. The liquid distributor 12 is fixed on the front cover plate 5 of the sub-rack 1. The front cover plate 5, however, is connected detachably to the housing 2 of the sub-rack 1 at opposed angular profiles of the housing, so that the front cover plate 5 can be exchanged together with the liquid distributor 12. Fixing the liquid distributor 12 on a separate front cover plate 5, which is fixed detachably to the sub-rack 1, is especially preferred because liquid cooling for a sub-rack can be retrofitted through simple replacement of the front cover plate 5.

FIG. 2 likewise shows a sub-rack 1 according to the invention, whose push in area 6 is filled completely with plug-in modules 3. Five of the plug-in modules 3 are provided with liquid cooling.

The liquid distributor 12 arranged above the push in area 6 preferably has a distributor housing 13 with a cover side 14, which is aligned parallel to the front cover plate 5. At least two line connections 15 for connecting a coupling 22 are provided on the cover side 14, FIG. 5.

The liquid distributor 12 has several line connections 15, which are arranged in two rows one above the other. Line connections 15a of the top row are provided for connecting respective feed lines 10. Lower line connections 15b, FIGS. 2 and 6, are provided for connecting to respective return lines 11. Thus, two line connections 15 are used for connecting the cooling device of each plug-in module 3.

A main feed line 17a and a main return line 17b, which are connected to a not shown heat exchanger, are arranged on one side wall 16 of the distributor housing 13 of the liquid distributor 12. Usually, the heat exchanger is arranged in the same switchgear cabinet as the sub-rack.

FIG. 3 shows a sub-rack 1 with a liquid distributor, which extends over the entire width of the sub-rack 1 and which provides possible connections for each insertable plug-in module 3. For example, such a liquid distributor 12 includes possible connections for a total of fourteen plug-in modules 3 in the use of nineteen inch sub-racks.

The sub-racks 1 shown explicitly in FIGS. 2 and 3 each have a liquid distributor 12, which extends over the entire width of the sub-rack 1. In an alternate construction of the liquid distributor 12, it may have only connections for a few plug-in modules 3, especially for three plug-in modules 3, as shown in FIG. 5, for example. The liquid distributor 12 then extends only over the width of three modules. It is constructed as a small block. Such a liquid distributor 12, shown in FIG. 5, shows the arrangement at the upper left corner of a sub-rack 1. The liquid distributor 12 has line connections 15 for a total of three modules. In addition to the liquid distributor 12, in the front cover plate 5 there is a receptacle 18, on which another liquid distributor 12 can be attached, if additional plug-in modules 3 are to be later provided with liquid cooling. In the receptacle 18, which has a square construction, a cooperating clip, not shown, of a liquid distributor 12 may be disposed. In this way, the liquid distributor 12 is easy to install.
FIG. 4 shows in detail a plug-in module 3 with cooling bodies or heat sinks 19 and two through-holes 9 on a front plate 8 for feeding through the feed line 10 and the return line 11. This plug-in module 3 is likewise suitable for holding in a sub-rack 1. The spacing between the feed line 10 and return line 11 in the embodiment shown in FIG. 4 is greater than for the embodiments of the plug-in modules shown in the other drawing figures, but otherwise the embodiments are all constructed in the same way. Moreover, in the embodiments shown the feed line 10 may be disposed above or below the return line 11 in the various drawing figures. The arrangement of the feed and return lines in this respect may not be important.

As is to be taken from FIGS. 1, 5, and 6, a flexible line section 20 and 21, on each of which a coupling 22 is arranged, is provided at the free end of the feed line 10 and the return line 11, respectively. Preferably, the couplings 22 have an arc shaped or angled construction. The angle here is advantageously between 60° and 125°. Especially preferred is an angle of 90°, like that of the couplings 22 shown in the drawing figures. Such couplings 22 are especially well suited for connecting to a liquid distributor 12, whose line connections 15a and 15b are arranged on the cover side 14. Bending and resulting damage to the line sections 20, 21 is reliably prevented.

As shown in FIG. 6, in particular, the liquid distributor 12 projects only slightly past the front region 4 of the sub-rack 1, so that the sub-rack 1 with coupling 22 attached to the cooling device is deeper than an air cooled sub-rack. The couplings 22 extend only slightly past a cable collection plate 23, which is arranged above the liquid distributor 12 and which can be provided in sub-racks such as the sub-rack 1.

The sub-rack 1 according to FIGS. 1, 2, and 3 includes a combined air and liquid cooling system, because the plug-in modules 3 arranged in the sub-rack 1 can be cooled first via air cooling, and second via liquid cooling. The cold air for air cooling flows through the air inlet plate 7 in the sub-rack 1. In addition, there is the possibility, by setting up or retrofitting the sub-rack 1 with liquid distributors 12, to install some or all of the plug-in modules 3 with liquid cooling, in order also to cool individual plug-in modules 3.

The construction and operation of the sub-rack housing for receiving plug-in modules according to the present invention is believed to be within the purview of one skilled in the art based on the foregoing description. Conventional engineering materials and practices may be used to construct the sub-rack with housing for receiving plug-in modules as shown and described.

Although preferred embodiments of the invention have been shown and described, those skilled in the art will recognize that various substitutions and modifications may be made without departing from the scope and spirit of the appended claims.

What is claimed is:
1. A sub-rack for plugging and unplugging electronic plug-in modules including:
   a housing which has a front cover plate;
   a cooling device for each plug-in module comprising a heat sink which is arranged on the plug-in module; and
   a liquid distributor which is in flow connection with the heat sink via a feed line and a return line wherein the liquid distributor is arranged on the outside in the front region of the sub-rack.
2. The sub-rack according to claim 1, characterized in that:
   a receptacle for receiving the liquid distributor is provided in the front region.
3. The sub-rack according to claim 2, characterized in that:
   the receptacle is provided on the front cover plate.
4. The sub-rack according to claim 1, characterized in that:
   the liquid distributor is fixed on the front cover plate which is detachably secured to the housing.
5. The sub-rack according to claim 1, characterized in that:
   the plug-in module has a front plate with at least two through-holes for the return line and the feed line.
6. The sub-rack according to claim 1, characterized in that:
   a coupling for connecting to the liquid distributor is provided on the free end of at least one of the return line and the feed line.
7. The sub-rack according to claim 6 characterized in that:
   the coupling has one of an arc shape or angled construction, preferably forming an angle between 60° and 125°.
8. The sub-rack according to claim 6, characterized in that:
   the liquid distributor has a distributor housing with a cover side on which at least two line connections are provided for connecting to couplings, respectively.
9. The sub-rack according to claim 1, characterized in that:
   plural liquid distributors are retrofitted in the front region of the sub-rack.
10. The sub-rack according to claim 1, characterized in that:
   the housing has opposed angular profiles in the front region, and the liquid distributor is supported by the angular profiles.
11. The sub-rack according to claim 1, characterized in that:
   a device for air cooling is provided, so that combined air and liquid cooling is performed on at least one of the plug-in modules.
12. A sub-rack for plugging and unplugging plural electronic plug-in modules including:
   a housing;
   a cooling device for each of the plug-in modules which is arranged on the plug-in modules; and
   a liquid distributor which is in fluid flow connection with each cooling device via a feed line and a return line, respectively, wherein the liquid distributor is arranged on the outside in the front region of the sub-rack and wherein the liquid distributor has a distributor housing on which at least two line connections are provided for connecting to couplings for the feed lines and the return lines, respectively.
13. The sub-rack according to claim 12, characterized in that:
   the liquid distributor is fixed on a front cover plate which is detachably secured to the housing.
14. The sub-rack according to claim 12, characterized in that:
   the couplings have one of an arc shape or angled construction, preferably forming an angle between 60° and 125°.

15. The sub-rack according to claim 12, characterized in that:
   a device for air cooling is provided, so that combined air and liquid cooling is performed on the plug-in modules.

16. A sub-rack for plugging and unplugging electronic plug-in modules including:
   a housing;
   a cooling device for each of selected ones of the plug-in modules comprising a heat sink which is arranged on the plug-in modules; and
   a liquid distributor which is in fluid flow connection with the respective heat sinks via feed lines and return lines wherein the liquid distributor is arranged in the front region of the sub-rack and the liquid distributor is secured on a front cover plate which is secured to the housing above the plug-in modules.

17. The sub-rack according to claim 16, characterized in that:
   the liquid distributor has a distributor housing with a cover side on which at least two line connections are provided for connecting to couplings, respectively, the couplings being provided on the return lines and the feed lines, respectively.

18. The sub-rack according to claim 17 characterized in that:
   the couplings have one of an arc shape or angled construction, preferably forming an angle between 60° and 125°.

19. The sub-rack according to claim 16, characterized in that:
   a device for air cooling is provided, so that combined air and liquid cooling is performed on the plug-in modules.

20. A sub-rack for plugging and unplugging electronic plug-in modules including:
   a housing which has a front cover plate;
   a cooling device for each plug-in module comprising a heat sink which is arranged on the plug-in module;
   a liquid distributor which is in fluid flow connection with the heat sink via a feed line and a return line wherein the liquid distributor is arranged on the outside in the front region of the subrack; and
   the subrack is arranged in a cabinet which has opposed angular profiles in the front region, the liquid distributor being supported by the angular profiles.

* * * * *