A liquid cooled rack with compliant heat exchanger support structure includes a rack having a rigid frame for supporting electronic components therein, a plurality of flexible supports connected to the rigid frame, and a liquid-fed heat exchanger mounted within the rack via the plurality of flexible supports. The plurality of flexible supports are connected to the heat exchanger and configured to flexibly support the liquid-fed heat exchanger with respect to the rigid frame.
FIG. 3

FIG. 4
LIQUID COOLED RACK WITH COMPLIANT HEAT EXCHANGER SUPPORT STRUCTURE

BACKGROUND OF INVENTION

[0001] FIG. 1 shows a perspective view of a typical server rack with a heat exchanger located in an enclosure where a part of a frame is removed so as to expose internal components therein. As can be seen from FIG. 1, the server rack 100 has a rigid frame 101 and liquid-fed heat exchangers 102. The server rack 100 also has a variety of electric components (not shown) disposed therein. In the data room, a pipe system 103 is installed, typically overhead, and delivers a liquid coolant to the heat exchangers 102 to cool the electronic components therein. FIG. 2 shows a perspective view of a liquid cooled rack with compliant heat exchanger support structure in a data room in accordance with one or more embodiments of the present invention where a part of a frame is removed so to expose internal components therein. As can be seen from FIG. 2, the rack 200 has a rigid frame 201 and liquid-fed heat exchangers 202. The liquid-fed heat exchangers 202 are secured to the rigid frame 201 by compliant attachment members 206. With reference to the following figures, various embodiments of the compliant attachment members 206 are discussed in detail. In one or more embodiments, the compliant attachment members 206 may comprise springs, flexible plates, flexible rods, flexible bands, or any other flexible supports, which are connected to the liquid-fed heat exchangers 202 in various ways depending on the configuration of the rack 200. The frame 201 supports a variety of electric components, such as electronic modules, blade servers, or the like (not shown) disposed therein. The different numbers of liquid-fed heat exchangers 202 may be used.

[0002] One or more embodiments of the present invention relate to a liquid cooled rack with compliant heat exchanger support structure includes a rack having a rigid frame for supporting electronic components therein, a plurality of flexible supports connected to the rigid frame, and a liquid-fed heat exchanger mounted within the rack via the plurality of flexible supports. The plurality of flexible supports are connected to the heat exchanger and configured to flexibly support the liquid-fed heat exchanger with respect to the rigid frame.

SUMMARY OF INVENTION

[0003] Other aspects and advantageous of the invention will be apparent from the following description and appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0005] FIG. 1 shows a perspective view of a typical server rack with a heat exchanger located in a data room where a part of a frame is removed so as to expose internal components therein.

[0006] FIG. 2 shows a perspective view of a liquid cooled rack with compliant heat exchanger support structure in a data room in accordance with one or more embodiments of the present invention where a part of a frame are removed so as to expose internal components therein.

[0007] FIG. 3 shows an enlarged bottom view of the heat exchanger shown in FIG. 2.

[0008] FIG. 4 shows an enlarged side view of the heat exchanger shown in FIG. 2.

[0009] FIG. 5 shows an enlarged top view of the heat exchanger shown in FIG. 2 in accordance with another embodiment of the present invention.

[0010] FIG. 6 shows an enlarged side view of the heat exchanger shown in FIG. 5.

DETAILED DESCRIPTION

[0011] Specific embodiments of the invention will now be described in detail with reference to the accompanying figures. Like elements in the various figures are denoted by like reference numerals for consistency.

[0012] In the following detailed description of embodiments of the invention, numerous specific details are set forth in order to provide a more thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

[0013] FIG. 1 shows a perspective view of a liquid cooled rack with compliant heat exchanger support structure in a data room in accordance with one or more embodiments of the present invention where a part of a frame is removed so as to expose internal components therein. As can be seen from FIG. 2, the rack 200 has a rigid frame 201 and liquid-fed heat exchangers 202. The liquid-fed heat exchangers 202 are secured to the rigid frame 201 by compliant attachment members 206. With reference to the following figures, various embodiments of the compliant attachment members 206 are discussed in detail. In one or more embodiments, the compliant attachment members 206 may comprise springs, flexible plates, flexible rods, flexible bands, or any other flexible supports, which are connected to the liquid-fed heat exchangers 202 in various ways depending on the configuration of the rack 200. The frame 201 supports a variety of electric components, such as electronic modules, blade servers, or the like (not shown) disposed therein. The different numbers of liquid-fed heat exchangers 202 may be used.

[0014] In the data room, an overhead pipe system 203 may be installed over the rack 200. The position of the overhead pipe system 203 may be adjusted according to the design of the data room and position of the rack 200. The overhead pipe system 203 delivers a liquid coolant to the heat exchangers 202 to cool the electronic components therein.

[0015] Although the overhead pipe system 203 is connected to each of the heat exchangers 202 in FIG. 2, one skilled in the art will appreciate that any other connections between the overhead pipe system 203 and the heat exchangers 202 could be used as long as the overhead pipe system 203 delivers a liquid coolant to the heat exchangers 202 to cool the electronic components properly.

[0016] Further, the rack 200 may include fans 208 for propagating air across the heat exchangers 202 through the rack 200 to cool the electronic components. The number of the fans and the position of the fans may be determined based on the design of the rack 200 and the electric components disposed therein.

[0017] FIG. 3 shows an enlarged bottom view of the heat exchanger shown in FIG. 2. Those skilled in the art will appreciate that the top view of the heat exchanger may be the same as that shown in FIG. 2. FIG. 4 shows an enlarged side view of the heat exchanger shown in FIG. 2.

[0018] As can be seen from FIG. 3, the heat exchanger 202 is mounted within a holder 203. Specifically, the heat exchanger 202 may be disposed on the holder 203 by attachment methods known in the art. Also, air may easily pass through the holder 203 such that air is propagated across the heat exchangers 202 through the rack 200 to cool the electronic components. In one or more embodiments, one skilled in the art will appreciate that any other shapes of the heat exchangers 202 and the holders 203 could be used as long as the heat exchangers 202 are flexibly supported within the rack 200 as explained below.

[0019] As shown in FIGS. 3 and 4, the holder 203 may have recessed portions 204 at the top and bottom surface thereof. The recessed portions 204 may be positioned around corners
of the holder 204. Further, each of the recessed portions 204 has projections 401 and 402 on the top and bottom surfaces thereof respectively.

[0020] The frame 201 has attachments parts 401 corresponding to the recessed portions 204. Specifically, the frame 201 has the attachment parts 403 and 404 at the inside surface thereof. Each of the attachment parts 403 has a projection 405 on the bottom surface thereof. Also, each of the attachment parts 404 has a projection 406 on the top surface thereof. Correspondingly, the recessed portions 204 of the heat exchangers 202 have projections 410 and 412.

[0021] A spring 407 is installed between the projections 405 and 410. Also, a spring 408 is installed between the projections 406 and 412. Thus, the recessed portions 204 of the holder 203 are flexibly connected to the attachment parts 403 and 404 via the springs 407 and 408. That is, the springs 407 and 408 flexibly supports the heat exchangers 202 approximately horizontally with respect to the rigid frame 201.

[0022] As a result, the liquid cooled rack with compliant heat exchanger support structure allows the heat exchangers 202 to rotate/swivel and absorb displacement of the frame 201 transmitted from the frame 201 due to a vibration, such as, by an earthquake, allowing the heat exchangers 202 to maintain the spatial geometry and envelope.

[0023] The positions, the numbers, the size, and the shape of the recessed portions 204, attachment parts 403 and 404, springs 407 and 408, projections 406, 408, 410, and 412 may be adjusted in accordance with the design of the heat exchangers 202, the frame 201, and the internal electric components as long as the heat exchangers 202 are flexibly supported within the rack 200 as described.

[0024] In one or more embodiments, one skilled in the art will appreciate that, instead of springs 407 and 408, flexible plates, flexible rods, flexible bands, or any other flexible supports known in the art could be used as long as the heat exchangers 202 are flexibly supported within the rack 200 with respect to the rigid frame 201 as explained. For example, FIG. 5 shows an enlarged top view of the heat exchanger shown in FIG. 2 in accordance with another embodiment of the present invention. FIG. 6 shows an enlarged side view of the heat exchanger shown in FIG. 5.

[0025] As shown in FIGS. 5 and 6, one end of the flexible support may be attached to the holder 203 of the heat exchangers 202 by a screw 502, and the other end of the flexible support 501 may be attached to the inside surface of the frame 201 by screw 503. Specifically, each corner the heat exchangers 202 are attached to the inside surface of the frame 201 via a pair of the flexible supports 501 so that the heat exchangers 202 are supported flexibly by the flexible supports 501 with respect to the rigid frame 201.

[0026] As a result, the liquid cooled rack with compliant heat exchanger support structure allows the heat exchangers 202 to rotate/swivel and absorb displacement of the frame 201 transmitted from the frame 201 due to an earthquake, allowing the heat exchangers 202 to maintain the spatial geometry and envelope during the earthquake.

[0027] In one or more embodiments, both ends of the flexible supports may be attached by adhesives, bonding, or any other methods known in the art as long as the heat exchangers 202 are flexibly supported by the flexible supports 501 with respect to the rigid frame 201 as explained above. Also, one skilled in the art will appreciate that any other the positions, the numbers, the sizes, and the shapes of the flexible supports 501 could be used as long as the heat exchangers 202 are flexibly supported within the rack 200 as explained above.

[0028] One or more embodiments of the present invention may have one or more of the following advantages. The liquid cooled rack with compliant heat exchanger support structure allows the heat exchangers to rotate/swivel and absorb the rack's frame displacement transmitted from the frame due to an earthquake, allowing the heat exchangers to maintain the spatial geometry and envelope during the earthquake. Further, the liquid cooled rack with compliant heat exchanger support structure prevents the flexure of the heat exchangers from exceeding the allowed flexure resulting in mechanical failure and or a leakage of the coolant.

[0029] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be advised which do not depart from the scope of the invention as described therein. Accordingly, the scope of the invention should be limited only by the attached claims.

What is claimed is:

1. A liquid cooled rack with compliant heat exchanger support structure, comprising:
   a rack comprising a rigid frame for supporting electronic components therein;
   a plurality of flexible supports connected to the rigid frame; and
   a liquid-fed heat exchanger mounted within the rack via the plurality of flexible supports;
   wherein the plurality of flexible supports are connected to the heat exchanger and configured to flexibly support the liquid-fed heat exchanger with respect to the rigid frame.

2. The liquid cooled rack of claim 1, wherein the plurality of flexible supports are connected to the heat exchanger at corners thereof.

3. The liquid cooled rack of claim 1, wherein the plurality of flexible supports comprise a plurality of springs.

4. The liquid cooled rack of claim 1, wherein the plurality of flexible supports comprise a plurality of flexible plates.

5. The liquid cooled rack of claim 1, wherein the plurality of flexible supports comprise a plurality of flexible rods.

6. The liquid cooled rack of claim 1, further comprising a plurality of heat exchangers mounted within the rack via the plurality of flexible supports.

7. The liquid cooled rack of claim 1, further comprising fans mounted within the rack for propagating air across the heat exchangers through the rack to cool electronic components mounted therein.

8. The liquid cooled rack of claim 1, further comprising an overhead pipe system for delivering liquid coolant to the heat exchangers.

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