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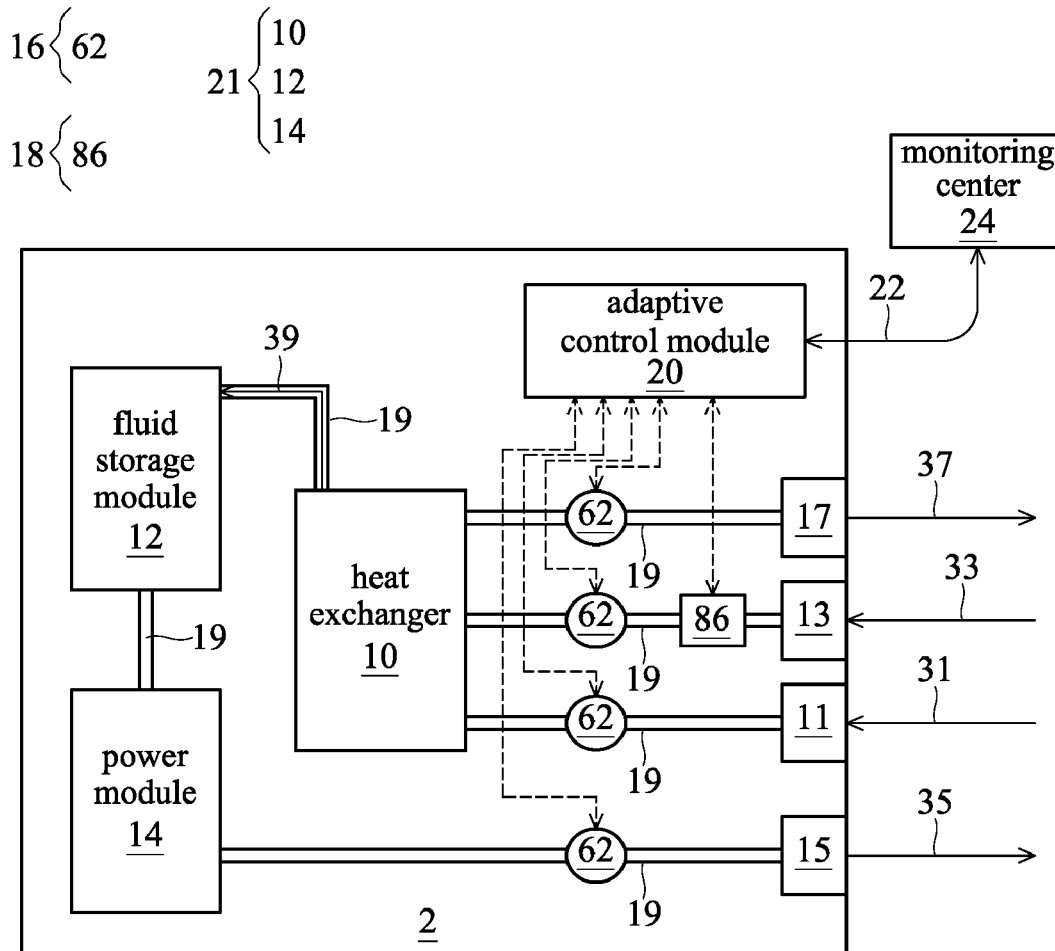
(19) **United States**(12) **Patent Application Publication**
CHEN et al.(10) **Pub. No.: US 2019/0178592 A1**(43) **Pub. Date: Jun. 13, 2019**(54) **COOLANT DISTRIBUTION UNIT****Publication Classification**(71) Applicant: **AURAS Technology Co., Ltd.**, New Taipei City (TW)(51) **Int. Cl.**
F28F 27/02 (2006.01)(72) Inventors: **CHIEN-AN CHEN**, New Taipei City (TW); **MU-SHU FAN**, New Taipei City (TW); **CHIEN-YU CHEN**, New Taipei City (TW)(52) **U.S. Cl.**
CPC **F28F 27/02** (2013.01)(57) **ABSTRACT**(21) Appl. No.: **16/217,139**(22) Filed: **Dec. 12, 2018****Related U.S. Application Data**

(60) Provisional application No. 62/597,963, filed on Dec. 13, 2017.

(30) **Foreign Application Priority Data**

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A coolant distribution unit includes plural fluid inlets, plural fluid outlets and a piping channel. The piping channel is connected with the fluid inlets and the fluid outlets. The sensed temperature or the measured pressure or flowrate of a working fluid in the piping channel is transmitted to an adaptive control module. The sensed temperature or the measured pressure or flowrate is further transmitted to an external monitoring center. Consequently, the supervisor of the monitoring center can manage and control the operating situation of the coolant distribution unit.



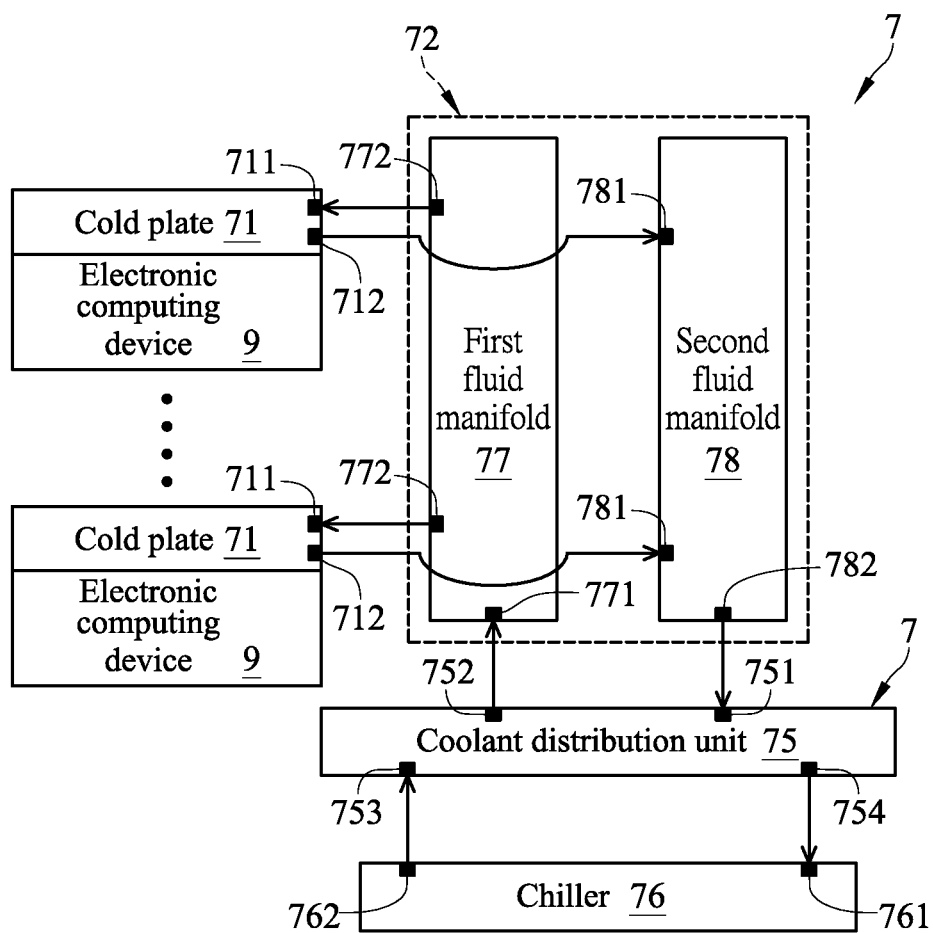


FIG. 1
PRIOR ART

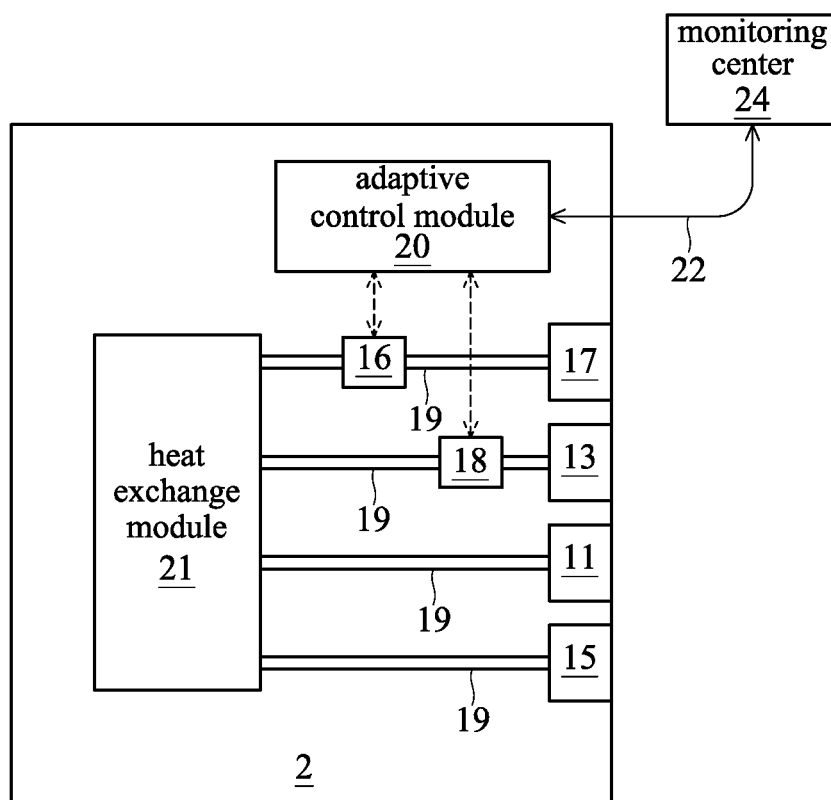


FIG. 2

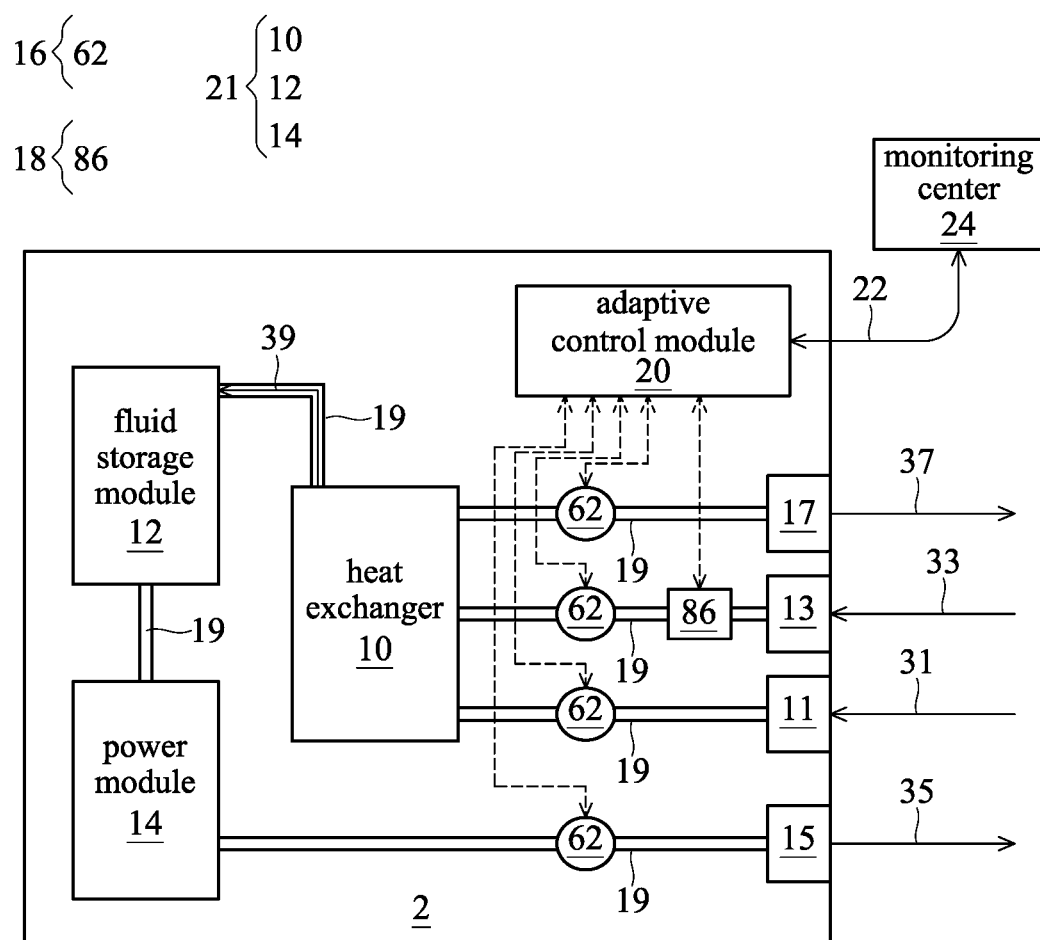


FIG. 3

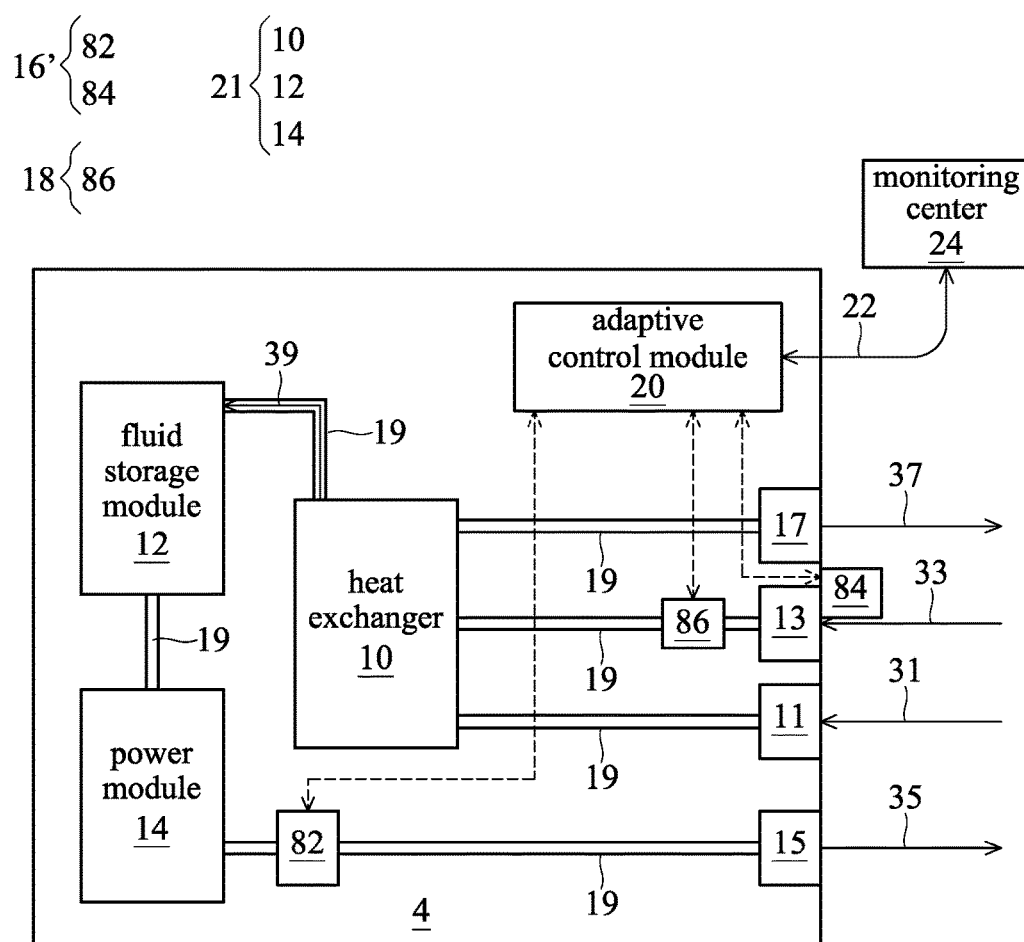


FIG. 4

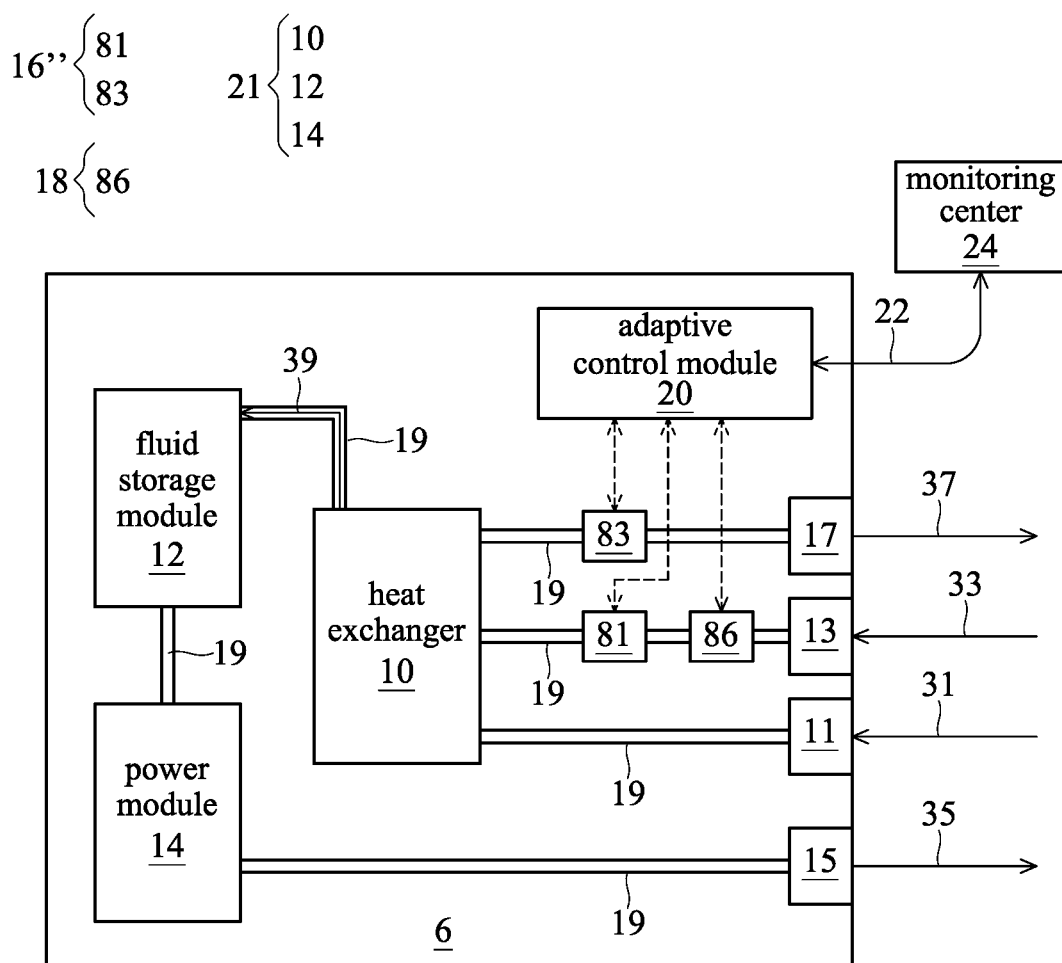


FIG. 5

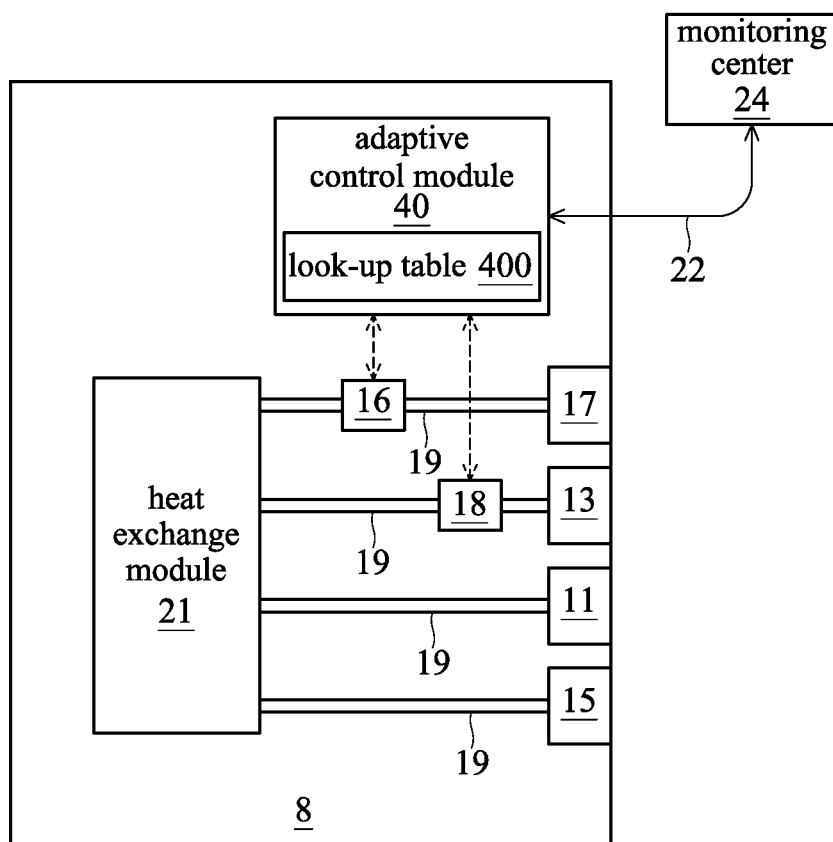


FIG. 6

COOLANT DISTRIBUTION UNIT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 62/597,963 filed Dec. 13, 2017, the contents of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a field of a coolant distribution unit (CDU), and more particularly to a coolant distribution unit for a machine room/rack cabinet liquid cooling system.

BACKGROUND OF THE INVENTION

[0003] With the increasing development and popularization of science and technology, various electronic computing devices such as network storage devices or servers have been essential parts of people's daily lives. Generally, these electronic computing devices are stored in a rack cabinet that is made of cold-rolled steel or alloy. Consequently, these electronic computing devices are protected from electromagnetic interference and arranged in an orderly and neat manner. Moreover, the electronic computing devices in the rack cabinet can be easily maintained or repaired in the future.

[0004] With the advent of big data and the Internet era, the processing power of the electronic computing device is increasing and the amount of the generated heat is large. It is important to effectively dissipate the heat from the electronic computing devices in the rack cabinet so as to increase the performance and the use lives of these electronic computing devices. In views of the power-saving benefit, it is important to achieve the proper heat dissipation efficacy with less power consumption.

[0005] FIG. 1 schematically illustrates the architecture of a conventional rack-type heat dissipation system. As shown in FIG. 1, the conventional rack-type heat dissipation system 7 comprises plural cold plates 71, a manifold device 72, a coolant distribution unit (CDU) 75 and a chiller 76. The manifold device 72 comprises a first fluid manifold 77 and a second fluid manifold 78. The plural cold plates 71 correspond to plural electronic computing devices 9 in a rack cabinet (not shown). For example, each cold plate 71 is in thermal contact with the heat source of the corresponding electronic computing device 9. Each cold plate 71 comprises a cold plate inlet 711 and a cold plate outlet 712. The first fluid manifold 77 comprises a first manifold inlet 771 and plural first manifold outlets 772 corresponding to the plural cold plates 71. The second fluid manifold 78 comprises plural second manifold inlets 781 corresponding to the plural cold plates 71 and a second manifold outlet 782. The coolant distribution unit 75 comprises a first fluid inlet 751, a first fluid outlet 752, a second fluid inlet 753 and a second fluid outlet 754. The chiller 76 comprises a chiller inlet 761 and a chiller outlet 762.

[0006] The cold plate inlet 711 of each cold plate 71 is in fluid communication with the corresponding first manifold outlet 772 of the first fluid manifold 77. The cold plate outlet 712 of each cold plate 71 is in fluid communication with the corresponding second manifold inlet 781 of the second fluid manifold 78. The first fluid inlet 751 of the coolant distribution unit 75 is in communication with the second manifold

outlet 782 of the second fluid manifold 78. The first fluid outlet 752 of the coolant distribution unit 75 is in communication with the first manifold inlet 771 of the first fluid manifold 77. In other words, a first fluid circulation loop (also referred as an internal circulation loop) is defined by the plural cold plates 71, the manifold device 72 and the coolant distribution unit 75 collaboratively.

[0007] A first working fluid (not shown) is filled in the first fluid circulation loop. In the rack-type heat dissipation system 7, the manifold device 72 is used for connecting associated conduits, homogenizing the first working fluid and transferring the first working fluid. The coolant distribution unit 75 is capable of uniformly or intelligently transferring the first working fluid to the cold plates 71 through the first fluid manifold 77 of the manifold device 72 according to the practical requirements.

[0008] The chiller inlet 761 of the chiller 76 is in fluid communication with the second fluid outlet 754 of the coolant distribution unit 75. The chiller outlet 762 of the chiller 76 is in fluid communication with the second fluid inlet 753 of the coolant distribution unit 75. That is, a second fluid circulation loop (also referred as an external circulation loop) is defined by the chiller 76 and the coolant distribution unit 75 collaboratively. Moreover, a second working fluid (not shown) is filled in the second fluid circulation loop. The chiller 76 may be considered as a back-end heat dissipation mechanism for removing the heat from the first working fluid that is transferred through the first fluid circulation loop. That is, the first working fluid in the first fluid circulation loop and the second working fluid in the second fluid circulation loop exchange heat in the coolant distribution unit 75, wherein the first working fluid and the second working fluid are not mixed together.

[0009] The operations of the conventional rack-type heat dissipation system 7 will be described as follows. When the first working fluid flows through the cold plate 71 along the first fluid circulation loop, the first working fluid is heated by the heat source of the electronic computing device 9 corresponding to the cold plate 71. Then, the heated first working fluid is transferred to the coolant distribution unit 75 through the second fluid manifold 78 of the manifold device 72. When the second working fluid flows through the coolant distribution unit 75 along the second fluid circulation loop, the second working fluid is heated by the first working fluid that is introduced into the coolant distribution unit 75. After the heated second working fluid is outputted from the coolant distribution unit 75, the second working fluid is transferred to the chiller 76 through the chiller inlet 761. Consequently, the second working fluid is cooled down. After the second working fluid is cooled down, the second working fluid is transferred to the coolant distribution unit 75 again. Since the first working fluid flowing into the coolant distribution unit 75 along the first fluid circulation loop exchanges heat with the second working fluid, the first working fluid is cooled down. After the first working fluid is cooled down, the first working fluid is transferred to the cold plate 71 again through the first fluid manifold 77 of the manifold device 72. The above steps are repeatedly done to circulate the first working fluid along the first fluid circulation loop and circulate the second working fluid along the second fluid circulation loop. Since the heat of the electronic computing device 9 is dissipated to the low-temperature site, the efficacy of reducing the temperature of the first working fluid is enhanced.

[0010] However, as the science and technology change very quickly, the rack cabinets for storing the electronic computing devices **9** have diversified specifications and designs according to different requirements. Even if the rack cabinets comply with the same specifications, the heat dissipation demands are not always identical. In other words, the conventional rack-type heat dissipation system **7** still has some drawbacks. For example, in case that the rack cabinet or the electronic computing devices **9** is abnormal and a great deal of heat is abruptly increased, the coolant distribution unit **75** is unable to adjust the flowrate of the working fluid according to the specification of the rack cabinet. Under this circumstance, the heat dissipating capacities of some rack cabinets in some abnormal situations are insufficient. Therefore, it is important to overcome the above drawbacks.

SUMMARY OF THE INVENTION

[0011] For increasing the application value of the coolant distribution unit, the present invention provides a novel coolant distribution unit. The coolant distribution unit has the function of adaptively adjusting the flowrate of a working fluid. Consequently, the energy utilization of the coolant distribution unit is optimized.

[0012] For increasing the application value of the coolant distribution unit, the present invention provides a novel coolant distribution unit. The coolant distribution unit comprises an adaptive control module. The data about the operating situation of the coolant distribution unit are transmitted to an external device through the adaptive control module. Consequently, the supervisor at the remote side can realize the operating situation of the coolant distribution unit in real time and further control the operating situation of the coolant distribution unit.

[0013] In accordance with an aspect of the present invention, there is provided a coolant distribution unit. The coolant distribution unit includes plural fluid inlets, plural fluid outlets and a piping channel. The piping channel is connected with the fluid inlets and the fluid outlets. The coolant distribution unit includes a sensing module, a flowrate control module and an adaptive control module. The sensing module senses at least one of the fluid inlets, the fluid outlets and the piping channel to obtain a sensed data. The flowrate control module controls a flowrate of a working fluid in the piping channel. The adaptive control module is electrically connected with the sensing module and the flowrate control module. The adaptive control module receives the sensed data and transmits the sensed data to an external device. The external device issues a control command to the adaptive control module according to the sensed data. The adaptive control module controls an operation of the flowrate control module according to the control command.

[0014] In accordance with another aspect of the present invention, there is provided a coolant distribution unit. The coolant distribution unit includes plural fluid inlets, plural fluid outlets and a piping channel. The piping channel is connected with the fluid inlets and the fluid outlets. The coolant distribution unit includes a sensing module, a flowrate control module and an adaptive control module. The sensing module senses at least one of the fluid inlets, the fluid outlets and the piping channel to obtain a sensed data. The flowrate control module controls a flowrate of a working fluid in the piping channel. The adaptive control module

is electrically connected with the sensing module and the flowrate control module. The adaptive control module receives the sensed data. The adaptive control module controls an operation of the flowrate control module according to the sensed data.

[0015] The above objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 schematically illustrates the architecture of a conventional rack-type heat dissipation system;

[0017] FIG. 2 is a schematic functional block diagram illustrating the concepts of a coolant distribution unit according to an embodiment of the present invention;

[0018] FIG. 3 is a schematic functional block diagram illustrating the detailed architecture of the coolant distribution unit as shown in FIG. 2;

[0019] FIG. 4 is a schematic functional block diagram illustrating the detailed architecture of a coolant distribution unit according to another embodiment of the present invention;

[0020] FIG. 5 is a schematic functional block diagram illustrating the detailed architecture of a coolant distribution unit according to another embodiment of the present invention; and

[0021] FIG. 6 is a schematic functional block diagram illustrating the concepts of a coolant distribution unit according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0022] For illustration, the structures, organizations or components of the coolant distribution unit shown in the drawings of the present invention are in scale with the elements of the practical product. According to the requirements of descriptions, the components may be scaled up or scaled down in an unequal proportion. The implementations of the coolant distribution unit not limited by the drawings.

[0023] In this context, the working fluid is the fluid that is used in a heat exchanger and is in the liquid state in the normal temperature. Generally, water is the widely-used fluid. It is noted that the example of the working fluid is not restricted. In other embodiments, the working fluid is aqueous solution or other organic solution. At different temperatures, the working fluid has the corresponding vapor-liquid equilibrium pressures. The working fluid retained in, transferred through or moved across the piping channel or the overall system is a liquid-state fluid. In practice, the working fluid may be a gaseous working fluid.

[0024] Please refer to FIG. 2 and FIG. 3. FIG. 2 is a schematic functional block diagram illustrating the concepts of a coolant distribution unit according to an embodiment of the present invention. FIG. 3 is a schematic functional block diagram illustrating the detailed architecture of the coolant distribution unit as shown in FIG. 2.

[0025] As shown in FIG. 2, the coolant distribution unit **2** comprises a sensing module **16**, a flowrate control module **18**, an adaptive control module **20** and a heat exchange module **21**. Generally, the coolant distribution unit **2** has two fluid inlets and two fluid outlets. For example, the coolant distribution unit **2** comprises a first fluid inlet **11**, a second

fluid inlet 13, a second fluid outlet 15 and a second fluid outlet 17. The first fluid inlet 11, the second fluid inlet 13, the second fluid outlet 15 and the second fluid outlet 17 are in fluid communication with each other through a piping channel 19. A working fluid can be transferred through the piping channel 19. The sensing module 16 is used for sensing at least one of the fluid inlets 11, 13, the fluid outlets 15, 17 and the piping channel 19 to acquire associated sensed data (e.g., the temperature value, the flowrate value or the pressure value). The flowrate control module 18 is used for controlling the flowrate of the working fluid that is transferred through the piping channel 19. The adaptive control module 20 is electrically connected with the sensing module 16 and the flowrate control module 18. The adaptive control module 20 receives the sensed data from the sensing module 16 and transmits the sensed data to an external monitoring center 24 outside the coolant distribution unit 2. According to the sensed data, the monitoring center 24 issues a control command to the adaptive control module 20. According to the control command, the adaptive control module 20 controls the operating situation of the flowrate control module 18. The heat exchange module 21 is connected with the piping channel 19. Moreover, the heat exchange module 21 is in fluid connected with the fluid inlets 11, 13 and the fluid outlets 15, 17 through the piping channel 19.

[0026] As shown in FIG. 3, the heat exchange module 21 comprises a heat exchanger 10, a fluid storage module 12 and a power module 14. The high temperature working fluid 31 from plural chassis (not shown) is received by the first fluid inlet 11. The low temperature working fluid 33 from the external device (e.g., the chiller as shown in FIG. 1) and without carrying waste heat is introduced into the coolant distribution unit 2 through the second fluid inlet 13. After the high temperature working fluid 31 is transferred through the heat exchanger 10, the fluid storage module 12 and the power module 14 sequentially and cooled down, the low temperature working fluid 35 is outputted from the coolant distribution unit 2 through the first fluid outlet 15. After the low temperature working fluid 33 is transferred through the heat exchanger 10, the high temperature working fluid 37 with the waste heat is outputted from the second fluid outlet 17. Consequently, the path from the first fluid inlet 11 to the first fluid outlet 15 may be considered as an internal circulation loop of the coolant distribution unit 2, and the path from the second fluid inlet 13 to the second fluid outlet 17 may be considered as an external circulation loop of the coolant distribution unit 2. In this context, the high temperature and the low temperature are exemplified for comparison only. For example, the temperature of the high temperature working fluid 31 is higher than the temperature of the low temperature working fluid 33, and the temperature of the high temperature working fluid 37 is higher than the temperature of the low temperature working fluid 33.

[0027] Please refer to FIG. 3 again. The heat exchanger 10 is a plate-type heat exchanger for transferring the heat between the high temperature working fluid 31 and the low temperature working fluid 33. That is, the heat from the chassis and carried by the high temperature working fluid 31 is transferred to the low temperature working fluid 33. After the waste heat from the chassis is carried by the low temperature working fluid 33, the low temperature working fluid 33 becomes the high temperature working fluid 37. After the high temperature working fluid 31 is transferred

through the heat exchanger 10, the high temperature working fluid 31 becomes the working fluid 39. The working fluid 39 is introduced into the fluid storage module 12 for storage. The temperature of the working fluid 39 is lower than the temperature of the high temperature working fluid 31. It is preferred that the occupied space of the heat exchanger 10 of the coolant distribution unit 2 is small. Consequently, the heat exchanger 10 is not restricted to the plate-type heat exchanger. After the working fluid 39 is left from the heat exchanger 10, the working fluid 39 is temporarily stored in the fluid storage module 12. That is, the fluid storage module 12 is a buffer tank. For example, the fluid storage module 12 is a water storage tank or a liquid storage tank with an arbitrary geometric shape. The fluid storage module 12 is made of a material that is unable to react with the working fluid (e.g., stainless steel). The power module 14 comprises one or plural pumps. The power module 14 provides motive power to move the low temperature working fluid 35 from the fluid storage module 12 to the first fluid outlet 15 and then discharge the low temperature working fluid 35.

[0028] In this embodiment, the fluid storage module 12 is arranged between the heat exchanger 10 and the power module 14, but is not limited thereto. In some other embodiments, the positions of the fluid storage module 12 and the power module 14 are exchanged. That is, the power module 14 is arranged between the heat exchanger 10 and the fluid storage module 12.

[0029] Please refer to FIG. 3 again. The sensing module 16 and the flowrate control module 18 are located at proper positions of the coolant distribution unit 2. The sensing module 16 and the flowrate control module 18 are in communication with the adaptive control module 20. In an embodiment, the sensing module 16 comprises one or plural thermal sensors 62. The thermal sensors 62 are located at the positions that the working fluid is transferred through. The flowrate control module 18 comprises at least one proportional valve 86. The at least one proportional valve 86 is arranged in the piping channel 19 and located near the second fluid inlet 13. In this embodiment, the plural thermal sensors 62 are arranged in the piping channel 19 and located near the first fluid inlet 11, arranged in the piping channel 19 and located near the second fluid inlet 13, arranged in the piping channel 19 and located near the first fluid outlet 15, and arranged in the piping channel 19 and located near the second fluid outlet 17. That is, the thermal sensors 62 are used for sensing the high temperature working fluid 31, the low temperature working fluid 33, the low temperature working fluid 35 and the high temperature working fluid 37. The positions of the thermal sensors 62 and the proportional valve 86 are not restricted. In some other embodiments, the thermal sensor 62 is arranged in the piping channel 19 and located near the first fluid inlet 11 only, or arranged in the piping channel 19 and located near the second fluid inlet 13 only, or arranged in the piping channel 19 and located near the first fluid outlet 15 only, or arranged in the piping channel 19 and located near the second fluid outlet 17 only. In some other embodiments, the proportional valve 86 is arranged in the piping channel 19 and located near the first fluid inlet 11 only. Alternatively, other thermal sensors 62 may be arranged in the piping system of the coolant distribution unit 2. The temperature value of the working fluid sensed by the sensing module 16 is transmitted to the adaptive control module 20 in a wired communication manner. Alternatively, the sensed temperature value is trans-

mitted in a wireless communication manner. The temperature values from the thermal sensors 62 are transmitted from the adaptive control module 20 to a monitoring center 24 outside the coolant distribution unit 2 through a communication means 22. Consequently, the monitoring center realizes the operating situation of the coolant distribution unit 2. Moreover, the supervisor of the monitoring center 24 may issue a control command to the adaptive control module 20 according to the temperature values sensed by the thermal sensors 62. According to the control command, the adaptive control module 20 controls the proportional valve 86 to adjust the flowrate of the working fluid that is fed into the second fluid inlet 13. The communication means 22 is a wired communication means or a wireless communication means.

[0030] In an embodiment, the proportional valve 86 is enabled to adjust the flowrate of the low temperature working fluid 33 from the second fluid inlet 13. The operation of the proportional valve 86 is controlled by the adaptive control module 20. For example, if the temperature sensed by the thermal sensor 62 is too high, the sensed data is transmitted to the monitoring center 24 outside the coolant distribution unit 2 through the adaptive control module 20. After the sensed value is judged, the supervisor of the monitoring center 24 issues a control command to the adaptive control module 20. According to the control command, the adaptive control module 20 controls or adjusts the operation of the proportional valve 86. During the operation of the proportional valve 86, the flowrate of the low temperature working fluid 33 from the second fluid inlet 13 is increased. Consequently, the operation of the coolant distribution unit 2 is optimized.

[0031] FIG. 4 is a schematic functional block diagram illustrating the detailed architecture of a coolant distribution unit according to another embodiment of the present invention. In comparison with the coolant distribution unit 2 as shown in FIGS. 2 and 3, the sensing module 16' of the coolant distribution unit 4 of this embodiment comprises one or plural flow meters. The flow meters are located at the positions that the working fluid is transferred through. The flow meters are used for measuring the flowrate of the working fluid in the piping system of the coolant distribution unit 4. For example, the flow meter 84 is arranged in the pipe channel 19 of the power module 14 for transferring the low temperature working fluid 35 to the first fluid outlet 15. The flow meter 84 is arranged in the pipe channel 19 for introducing the low temperature working fluid 33 from the second fluid inlet 13. The locations of the flow meters are not restricted. For example, the flow meter is arranged in the piping channel 19 and located near the first fluid inlet 11, arranged in the piping channel 19 and located near the first fluid outlet 15, or arranged in the piping channel 19 and located near the second fluid outlet 17. The values of the flowrate measured by the flow meters 82 and 84 may be transmitted to the adaptive control module 20 in a wired communication manner or a wireless communication manner. Similarly, the flowrate value may be transmitted from the adaptive control module 20 to the monitoring center 24 outside the coolant distribution unit 4. Moreover, the adaptive control module 20 may receive a control command from the supervisor of the monitoring center 24. According to the command, the operating situation of the coolant distribution unit 4 is adjusted or controlled by the adaptive control module 20. For example, if the flowrate values measured by

the flow meter or pressure meters 82 and 84 are too low, a control command for increasing the flowrate is issued from the monitoring center 24 to the adaptive control module 20. According to the control command, the adaptive control module 20 controls the operation of the proportional valve 86. During the operation of the proportional valve 86, the flowrate of the low temperature working fluid 33 from the second fluid inlet 13 is increased. Consequently, the heat dissipating efficiency of the coolant distribution unit 4 is enhanced.

[0032] FIG. 5 is a schematic functional block diagram illustrating the detailed architecture of a coolant distribution unit according to another embodiment of the present invention. In comparison with the coolant distribution unit 2 as shown in FIGS. 2 and 3, the sensing module 16" of the coolant distribution unit 6 of this embodiment comprises one or plural pressure meters. The pressure meters are located at the positions that the working fluid is transferred through. The flow meters are used for measuring the flowrate of the working fluid in the piping system of the coolant distribution unit 6. For example, the pressure meter 81 is located near the second fluid inlet 13 and arranged in the piping channel 19 between the heat changer 10 and the second fluid inlet 13, and the pressure meter 83 is located near the second fluid outlet 17 and arranged in the piping channel 19 between the heat changer 10 and the second fluid outlet 17. Consequently, the pressure meters 81 and 83 are used for the pressure value of the low temperature working fluid 33 from the second fluid inlet 13 and measuring the pressure value of the high temperature working fluid 37 to be outputted from the second fluid outlet 17. Consequently, the pressure difference between the piping channel 19 of the second fluid inlet 13 and the piping channel 19 of the second fluid outlet 17 is obtained. The locations of the pressure meters are not restricted. For example, the pressure meter 81 is located near the first fluid inlet 11 and arranged in the piping channel 19 between the heat changer 10 and the first fluid inlet 11, and the pressure meter 83 is located near the first fluid outlet 15 and arranged in the piping channel 19 between the power module 14 and the first fluid outlet 15. The values of the pressure measured by the sensing module 16" may be transmitted to the adaptive control module 20 in a wired communication manner or a wireless communication manner. Similarly, the pressure values may be transmitted from the adaptive control module 20 to the monitoring center 24 outside the coolant distribution unit 6. Moreover, the adaptive control module 20 may receive a control command from the supervisor of the monitoring center 24. According to the command, the operating situation of the coolant distribution unit 6 is adjusted or controlled by the adaptive control module 20.

[0033] As mentioned above, the coolant distribution unit is in communication with the external monitoring center through the adaptive control module 20. The information about the heat exchange efficiency of the coolant distribution unit is transmitted to the external device to be referred by the supervisor of the monitoring center. The coolant distribution unit can receive the control command from the external device through the adaptive control module 20. According to the control command, the heat exchange efficiency of the coolant distribution unit is further optimized. The arrangement of the adaptive control module 20 has the following benefit. For example, even if the resources in the environment are limited, the communication control of the adaptive

control module 20 of the coolant distribution unit can make full use of the energy source. When the electronic device (e.g., a server or a workstation) in the chassis is operated in the peak period and a great deal of waste heat needs to be dissipated away, the supervisor at the remote side can realize the operational peak through the adaptive control module 20. Moreover, the supervisor may issue the control command to the adaptive control module 20. According to the control command, the adaptive control module 20 controls the operation of the flowrate control module 18 to increase the flowrate of the low temperature working fluid 33 from the second fluid inlet 13. Whereas, when the server or the workstation is operated in an off-peak period and a small amount of waste heat needs to be removed, the adaptive control module 20 controls the operation of the flowrate control module 18 according to the control command. Consequently, the flowrate of the low temperature working fluid 33 from the second fluid inlet 13 is decreased. The arrangement of the adaptive control module 20 has another benefit of avoiding the closed adaptive control of the coolant distribution unit. Since the adaptive control module 20 is in communication with the external device in the wired communication manner or the wireless communication manner, the operating situation of the coolant distribution unit can be transmitted to the external device. Moreover, when the flowrate control module 18 is enabled, the sensed data about the values of the temperature and the flowrate can be transmitted to the external device through the adaptive control module 20.

[0034] FIG. 6 is a schematic functional block diagram illustrating the concepts of a coolant distribution unit according to another embodiment of the present invention. As shown in FIG. 6, the adaptive control module 40 of the coolant distribution unit 8 further comprises a look-up table 400 and associated data. According to the look-up table 400, the adaptive control module 40 judges whether the sensed data of the sensing module 16, 16' or 16'' is in one or plural reasonable ranges. According to the judging result, the adaptive control module 40 directly controls the operation of the flowrate control module 18. Moreover, the adaptive control module 40 is in communication with the external device in the wired communication manner. Consequently, the process and result of directly controlling or adjusting the operation of the proportional valve may be transmitted to the external monitoring center. In such way, the supervisor of the monitoring center can fully realize the operating situation of the coolant distribution unit 8. The actions of the sensing module 16, the flowrate control module 18 and the heat exchange module 21 are similar to those of the coolant distribution units as shown in FIGS. 2 to 5, and are not redundantly described herein.

[0035] While the invention has been described in terms of what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention needs not be limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims which are to be accorded with the broadest interpretation so as to encompass all modifications and similar structures.

What is claimed is:

1. A coolant distribution unit comprising plural fluid inlets, plural fluid outlets and a piping channel connected with the fluid inlets and the fluid outlets, the coolant distribution unit comprising:

a sensing module sensing at least one of the fluid inlets, the fluid outlets and the piping channel to obtain a sensed data;

a flowrate control module controlling a flowrate of a working fluid in the piping channel; and

an adaptive control module electrically connected with the sensing module and the flowrate control module, wherein the adaptive control module receives the sensed data and transmits the sensed data to an external device, wherein the external device issues a control command to the adaptive control module according to the sensed data, and the adaptive control module controls an operation of the flowrate control module according to the control command.

2. The coolant distribution unit according to claim 1, wherein the sensing module comprises at least one thermal sensor, and the at least one thermal sensor senses at least one of the fluid inlets, the fluid outlets and the piping channel to obtain the sensed data, wherein the sensed data is a temperature value.

3. The coolant distribution unit according to claim 1, wherein the sensing module comprises at least one flow meter, and the at least one flow meter senses at least one of the fluid inlets, the fluid outlets and the piping channel to obtain the sensed data, wherein the sensed data is a flowrate value.

4. The coolant distribution unit according to claim 1, wherein the sensing module comprises at least one pressure meter, and the at least one pressure meter senses at least one of the fluid inlets, the fluid outlets and the piping channel to obtain the sensed data, wherein the sensed data is a pressure value.

5. The coolant distribution unit according to claim 1, wherein the flowrate control module comprises a proportional valve, and the flowrate of the working fluid in the piping channel is adjusted through the proportional valve.

6. The coolant distribution unit according to claim 1, further comprising a heat exchange module, wherein the heat exchange module is connected with the piping channel, and the heat exchange module is in communication with the plural fluid inlets and the plural fluid outlets through the piping channel.

7. The coolant distribution unit according to claim 6, wherein the heat exchange module comprises a heat exchanger, a fluid storage module and a power module, the plural fluid inlets include a first fluid inlet and a second fluid inlet, and the plural fluid outlets include a first fluid outlet and a second fluid outlet, wherein after a high temperature working fluid is fed into the first fluid inlet and transferred through the heat exchanger, the fluid storage module and the power module sequentially, the high temperature working fluid is cooled down and outputted from the first fluid outlet, wherein after a low temperature working fluid is fed into the second fluid inlet and transferred through the heat exchanger, the low temperature working fluid is heated and outputted from the second fluid outlet.

8. The coolant distribution unit according to claim 7, wherein the piping channel is connected between the first fluid inlet and the heat exchanger, between the heat exchanger and the fluid storage module, between the fluid

storage module and the power module, between the power module and the first fluid outlet, and between the second fluid inlet and the second fluid outlet.

9. The coolant distribution unit according to claim 7, wherein the heat exchanger is a plate-type heat exchanger, where the high temperature working fluid fed into the first fluid inlet and the low temperature working fluid fed into the second fluid inlet exchange heat in the heat exchanger.

10. The coolant distribution unit according to claim 7, wherein the fluid storage module includes a fluid storage tank, the working fluid cooled by the heat exchanger is temporarily stored in the fluid storage tank, and the power module comprises at least one pump, wherein the working fluid cooled by the heat exchanger is moved from the fluid storage module to the first fluid outlet by the pump.

11. A coolant distribution unit comprising plural fluid inlets, plural fluid outlets and a piping channel connected with the fluid inlets and the fluid outlets, the coolant distribution unit comprising:

- a sensing module sensing at least one of the fluid inlets, the fluid outlets and the piping channel to obtain a sensed data;
- a flowrate control module controlling a flowrate of a working fluid in the piping channel; and
- an adaptive control module electrically connected with the sensing module and the flowrate control module, wherein the adaptive control module receives the sensed data, and the adaptive control module controls an operation of the flowrate control module according to the sensed data.

12. A coolant distribution unit, comprising:

- a heat exchanger;
- a fluid storage module;
- a power module;
- a sensing module;

a flowrate control module;

a first fluid inlet and a second fluid inlet;

a first fluid outlet and a second fluid outlet, wherein after a high temperature working fluid is fed into the first fluid inlet and transferred through the heat exchanger, the fluid storage module and the power module sequentially, the high temperature working fluid is cooled down and outputted from the first fluid outlet, wherein after a low temperature working fluid is fed into the second fluid inlet and transferred through the heat exchange, the low temperature working fluid is heated and outputted from the second fluid outlet;

a piping channel connected between the first fluid inlet and the heat exchanger, between the heat exchanger and the fluid storage module, between the fluid storage module and the power module, between the power module and the first fluid outlet and between the second fluid inlet and the second fluid outlet, wherein the sensing module senses the piping channel to obtain a sensed data, and a flowrate of the high temperature working fluid or the low temperature working fluid in the piping channel is controlled by the flowrate control module; and

an adaptive control module electrically connected with the sensing module and the flowrate control module, wherein the adaptive control module receives the sensed data and transmits the sensed data to an external device,

wherein the adaptive control module controls an operation of a flowrate control module according to the sensed data, or the adaptive control module receives a control command from the external device and controls the operation of the flowrate control module according to the control command.

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