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(54) **Title**: A WATERBORNE DATA CENTER FACILITY AND PROCESS THAT UTILIZES A CLOSED-LOOPED HEAT MANAGEMENT SYSTEM

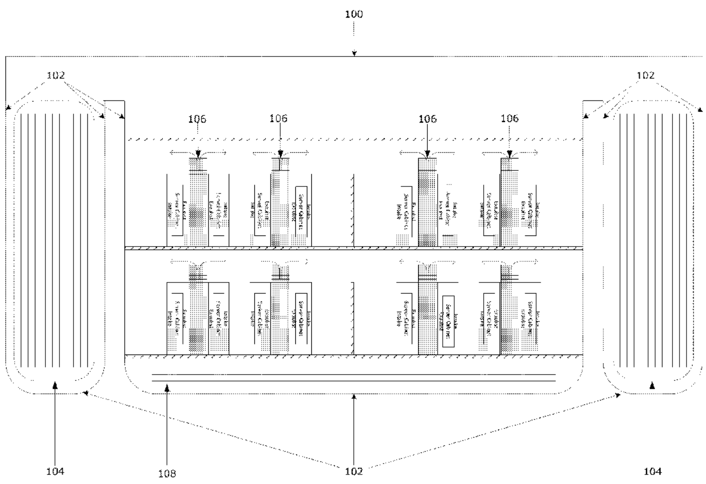

Fig. 1
Waterborne Data Center – Front Sectional View

(57) **Abstract**: A waterborne data center facility that utilizes a closed-looped heat management system that is both energy-efficient and cost-effective is disclosed. Embodiments employ a closed-looped, energy efficient, cost effective thermal management system that leverages natural resources to control thermal conditions and reduce the overall requirement for cooling power.

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A Waterborne Data Center Facility And Process That Utilizes A Closed-Looped Heat Management System

Cross-References to Related Applications

[0001] This application claims priority from U.S. Application Serial Number 61/861,197 filed on August 1, 2013 and U.S. Application Serial Number 14/200,461, filed March 7, 2014 which are each hereby incorporated herein by reference in their respective entirety.

Technical Field

[0002] The present invention relates to data center facilities housed on marine vessels.

Background of the Invention

[0003] Data centers and co-location providers in particular struggle with both supplying requisite power as well as cooling. As data center density continues to increase there is a growing demand for more energy efficient and cost effective data centers and co location solutions.

[0004] A data center is designed to maintain interior ambient conditions suitable for proper operation of the computer systems therein. Typical data centers may consume more than twice the power needed to support the plurality of computer systems housed therein. This is a result of the inefficient air conditioning units that may account for half of the total power consumed in the data center to cool the plurality of computer systems therein. This inefficiency prohibits support of high density computing systems in today's data centers.

[0005] Embodiments disclose a waterborne data center facility employing a closed-looped, energy efficient, cost effective thermal management system that leverages natural surrounding resources to control thermal conditions and reduce the overall requirement for cooling power.

Brief Summary of Embodiments of the Invention

[0006] A data center facility comprising: a marine vessel comprising a heat exchange system, a bow section, a stern section, a starboard section, and a port section; a computer data center, wherein the computer data center comprises a plurality of computing units, and wherein the computer data center is comprised in the marine vessel; an electrical power generator; a thermal containment system; a thermal airflow system; a hot water return cooling system; and a software management suite. The water--- based closed-- - loop cooling system comprises a single or plurality of filtered water intake pipes and water exhaust pipes; a single or plurality of water pumps, heat exchangers, coolant heat exchange piping; a closed-loop coolant distribution unit comprising means for using surrounding water as a coolant; and coolant distribution piping. The software management suite further comprises a Data Center Infrastructure Management (DCIM) system with predictive analytics and configured for continuously collecting and analyzing data from a plurality of infrastructure systems, components and wireless sensors. According to alternate embodiments the heat exchange system is partially or completely comprised in the hull of the marine vessel, making for a hull heat exchange system, or a hull heat exchanger.

[0007] In a data center facility, a method comprising generating electrical power and providing the generated electrical power to the data-center, wherein any excess power is stored as back up or transmitted through a grid network; pumping surrounding water in close proximity to the data center facility and circulating the pumped water through a closed loop cooling system; wherein the closed loop cooling system is comprised in a heat exchanger; wherein the surrounding water is drawn by water pumps through filtered water intake pipes to be pumped through one side of the heat exchanger, where it serves 4 as a heat sink to cool hot coolant from a coolant distribution unit being pumped through the other side of the heat exchanger; and expelling the pumped water after absorbing the heat from the hot coolant through filtered water exhaust pipes.

[0008] In a data center facility, a method of monitoring and managing the facility, the method comprising collecting of environmental data by a plurality of infrastructure systems, components and wireless sensors; storing the collected data in a database; analyzing the stored data by a predictive analytics engine, wherein the analyzed data is employed by a Data Center Infrastructure Management (DCIM) element controller to manage infrastructure systems and components' operational states to sustain optimal infrastructure efficiency.

Brief Description of the Drawings

[0009] The present invention, in accordance with one or more various embodiments, is described in detail with reference to the following figures. The drawings are provided for purposes of illustration only and merely depict typical or example embodiments of the invention. These drawings are provided to facilitate the reader's understanding of the invention and shall not be considered limiting of the breadth, scope, or applicability of the invention. It should be noted that for clarity and ease of illustration these drawings are not necessarily made to scale.

[0010] FIG. 1 illustrates a waterborne data center front sectional view.

[0011] FIG. 2 illustrates a heat exchange and closed-loop cooling side sectional view.

[0012] FIG. 3 illustrates a thermal containment top closed-loop cooling sectional view.

[0013] FIG. 4 illustrates a thermal containment rear closed-loop cooling sectional view.

[0014] FIG. 5 illustrates a waterborne data center side sectional view.

[0015] FIG. 6 illustrates a waterborne data center top sectional view.

[0016] FIG. 7 illustrates a waterborne data center top sectional view below main deck.

[0017] FIG. 8 illustrates a waterborne data center top sectional view.

[0018] The figures are not intended to be exhaustive or to limit the invention to the precise form disclosed. It should be understood that the invention can be practiced with modification and alteration, and that the invention be limited only by the claims and the equivalents thereof.

[0019] Implementation of the method and/or system of embodiments of the invention can involve performing or completing selected tasks manually, automatically, or a combination thereof. Moreover, according to actual instrumentation and equipment of embodiments of the method and/or system of the invention, several selected tasks could be implemented by hardware, by software or by firmware or by a combination thereof using an operating system.

[0020] For example, hardware for performing selected tasks according to embodiments of the invention could be implemented as a chip or a circuit. As software, selected tasks according to embodiments of the invention could be implemented as a plurality of software instructions being executed by a computer using any suitable operating system. In an exemplary embodiment of the invention, one or more tasks according to exemplary embodiments of method and/or system as described herein are performed by a data processor, such as a computing platform for executing a plurality of instructions. Optionally, the data processor includes a volatile memory for storing instructions and/or data and/or a non-volatile storage, for example, a magnetic hard-disk and/or removable media, for storing instructions and/or data. Optionally, a network connection is provided as well. A display and/or a user input device such as a keyboard or mouse are optionally provided as well.

Detailed Description of the Embodiments of the Invention

[0021] From time-to-time, the present invention is described herein in terms of example environments. Description in terms of these environments is provided to allow the various features and embodiments of the invention to be portrayed in the context of an exemplary application. After reading this description, it will become apparent to one of ordinary skill in the art how the invention can be implemented in different and alternative environments.

[0022] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this invention belongs. All patents, applications, published applications and other publications referred to herein are incorporated by reference in their entirety. If a definition set forth in this section is contrary to or otherwise inconsistent with a definition set forth in applications, published applications and other publications that are herein incorporated by reference, the definition set forth in this document prevails over the definition that is incorporated herein by reference.

[0023] As stated above, Data centers and co-location providers in particular struggle with both supplying requisite power as well as cooling. As data center density continues to increase there is a growing demand for more energy efficient and cost effective data centers and co-location solutions. The invention claimed here solves this problem.

[0024] Through our holistic approach to data center architecture, thermal management and energy consumption, we are creating state of the art waterborne data center facilities that maximize efficiencies by leveraging technology and the surrounding environment, with virtually no ecological impact, ultimately passing substantial savings on energy spent to our partners and customers.

[0025] The claimed invention differs from, and is an improvement on what currently exists. Embodiments disclose a waterborne solution to data center thermal management and energy consumption. Preferred embodiments are designed to maximize efficiencies by leveraging technology and Nature with virtually no impact to the surrounding environment, resulting in substantial costs savings passed on to customers.

[0026] Computer room air conditioner (CRAC) units are poorly designed for data centers because they are energy inefficient and are typically designed to be approximately 6’ tall, limiting the ability of the units to treat the hottest air in the data center which rises closer to ceiling height. Hot air and cold air are allowed to freely mix in today's typical data center, which greatly reduces the efficiency of cooling systems.

[0027] Embodiments of our waterborne data center facility employ a closed-looped, energy efficient, cost effective thermal management system that leverages natural resources to control thermal conditions and reduce the overall requirement for cooling power.

[0028] An embodiment includes the following: 1. A Purpose built marine vessel (FIG. 5, 500; FIG. 6, 600; FIG. 7, 700; FIG. 8, 800); 2. A Hull heat exchange system (FIG. 1, 102; FIG. 2, 202); 3. A water based closed-- - looped cooling system (FIG. 1, 104; FIG. 2, 204; FIG. 3, 302; FIG. 4, 402; FIG. 5, 516;FIG. 6, 616; FIG. 8, 816); 4. A thermal containment system (FIG. 2, 206; FIG. 3, 300; FIG. 4, 400); 5. A thermal airflow system (FIG. 1, 106; FIG. 2, 208; FIG. 3, 308; FIG.4, 408); 6. A hot water return cooling system (FIG. 1, 108; FIG. 2, 210); and 7. A management software suite.

Relationship Between The Components:

[0029] FIG. 1 illustrates a waterborne data center front sectional view. According to an embodiment, water borne data center 100 comprises a heat exchanger 102 (wherein, in an optional embodiment the heat exchanger is partially or wholly comprised in the hull of the water borne data center), a water based closed loop cooling system 104, a thermal air flow cool air return system 106, and a hot water return cooling system 108.

[0030] According to an embodiment the purpose built marine vessel (1) is used to house all components. The data center space is comprised in the marine vessel, wherein thermal containment systems (4) and thermal airflow system (5) are built into the data center space in the purpose-built, non-navigable marine vessel (1). It should be noted however, that alternate embodiments may include a navigable marine vessel. The water based closed-loop cooling system (3) is comprised within the thermal containment system (4) situated behind or above each rack and also within the sides and bottom of the purpose built, non-navigable marine vessel (1). The management software suite (7) can be run in the data center within the purpose-built marine vessel (1) or from a remote site.

[0031] FIG. 2 illustrates heat exchange and closed-loop cooling sides sectional view. According to an embodiment, the water based closed-loop cooling system (FIG. 1, 104; FIG. 2, 204; FIG. 3, 302; FIG. 4, 402; FIG. 8, 816) comprises filtered water intake pipes (FIG. 5, 502; FIG. 6, 602; FIG. 7, 702; FIG. 8, 802), filtered water exhaust pipes (FIG. 7, 708), water pumps (FIG. 5, 504;

FIG. 7, 704; FIG. 8, 804), heat exchangers (FIG. 1, 102; FIG. 2, 202; FIG. 5, 506; FIG. 6, 606; FIG. 7, 706; FIG. 8, 806), coolant heat exchange piping, closed-loop coolant distribution unit that may use freshwater as a coolant, and coolant distribution piping. The datacenter facility 100 comprises a plurality of computer systems installed in a plurality of data center modules. Data center modules are structurally similar in shape and size to shipping containers. The data center modules in general comprise a plurality of racks, a plurality of rack-mounted computer systems and water-based cooling units. In alternate embodiments, the filtered water intake pipes and filtered water exhaust pipes may be installed in the bow (front) or stern (back) section of the waterborne data center vessel instead of on the starboard (right) or port (left) sides of the vessel. The closed-loop coolant distribution unit may be connected to the heat exchangers and to the data center modules according to an embodiment.

[0032] FIG. 3 illustrates thermal containment top closed-loop cooling sectional view. FIG. 4 illustrates thermal containment rear closed-loop cooling sectional view. Thermal containment (300, 400) comprises water based closed loop cooling (302, 402), quick connects water (304, 404), fiber ladder (306, 406), thermal air flow cool air return (308, 408), VFD fans cool air return (310, 410), cable power management (312, 412) and pallet jack slots/recessed wheels (314, 414). The heat generated by the computing systems in the data center modules is absorbed by the energy efficient water-based closed-loop cooling system 302, 402.

[0033] FIG. 5 illustrates a side sectional view of the water borne data center. FIG. 6 illustrates a top sectional view of the waterborne data center. FIG. 7 illustrates the waterborne data center top sectional view below the main deck. And FIG. 8 further illustrates waterborne data center top sectional view. According to an embodiment the water borne data center comprises the purpose built marine vessel (500, 600, 700, 800), filtered water intake tubes (502, 602, 702, 802), filtered water exhaust tubes 708, water pumps (504, 704, 804), heat exchangers (506, 606, 706, 806), containers (508, 608), row of racks 808, generators (510, 610, 710, 812), data center facility (512, 604, 810), electrical switch room (514, 614, 814), closed loop cooling system (516, 616, 816), main deck 612, 712. Naturally cold water may be drawn by the water pumps through the filtered water intake pipes to be pumped through one side of the heat exchangers where it serves as a heat sink to cool the hot coolant from the coolant distribution unit being pumped through the other side of the heat exchangers. The naturally cold water after absorbing the heat from the hot coolant may then be pumped from the waterborne data center facility and expelled through filtered water exhaust pipes. In an embodiment, freshwater may be used as a coolant wherein the coolant is pumped to the data center module cooling units (not pictured) where it absorbs heat generated by the plurality of computing systems therein. The heated coolant is returned from the data center module cooling units, pumped through one side of the heat exchangers while naturally cold water is being pumped through the other side of the heat exchanger absorbing heat from the hot coolant.

[0034] The management suite further comprises a Data Center Infrastructure Management (DCIM) system with predictive analytics and configured for continuously collecting and analyzing data from a plurality of infrastructure systems, components and wireless sensors. A plurality of wireless sensors may be employed to continuously collect environmental data. The data collected by the DCIM system may be stored in a database. The stored data may then be analyzed by a predictive analytics engine. The analyzed data may be employed by the DCIM element controller to manage infrastructure systems and components' operational states to sustain optimal infrastructure efficiency.

[0035] Presentation software comprised in the DCI M permits viewing of all the collected and analyzed data by an end user with the presentation software, and the DCIM system may be accessible over a secure IP network.

[0036] An additional embodiment includes a system and method for intelligent data center power management and energy market disaster recovery. The system is caused to employ continuous collection, monitoring and analysis of data from application services, power distribution components, virtual machines, data center facility infrastructure and utility energy markets to enable dynamic data center operation actions for migrating application loads and power loads from one data center to another without the need for manual intervention. The system and method may enable data center and application disaster recovery from utility energy market outages by quickly migrating applications loads from one data center location to another data center location.

[0037] The system and method for intelligent power management may employ a data collection layer that continuously collects data from a plurality of infrastructure elements, application elements, power elements and virtual machine elements. The data collected may then be analyzed by a plurality of analytic engines with the resulting data analysis triggering automation software comprised in the system that cause and enable the system to make data center operational state changes for application load balancing or power load balancing across multiple data centers.

[0038] According to an embodiment one or more data centers may be connected to one another by an IP network which may also connect to a plurality of energy markets. An energy market analysis layer comprised in the system software can use data collected from energy market elements to automatically manage data center and application disaster recovery from utility energy market outages. Preferred embodiments include software that causes the system to continuously monitor and analyze utility energy market status and enable intelligent application and data center load balancing that may provide financial benefits for moving applications and power loads from one data center location using power during peak energy hours to another data center location using power during off-peak hours. The described systems and methods may quickly move applications and power loads from one data center to another enabling disaster recovery from utility energy market outages.

[0039] The purpose-built marine vessel (1) is designed to comprise a heat exchange system (1) and to also cool the hot water returned from the water based closed-loop cooling system (3) acting as a hot water return cooling system (3). Some embodiments are designed to utilize the hull as a heat exchanger, wherein the heat exchange system is partially or completely comprised in the hull of the marine vessel. The thermal containment systems (4) capture the hot exhaust air and will use the thermal airflow system (5) to move the hot air through the water based closed-- -loop cooling system (3) and return the cooled air to the data center. All of the components are monitored and controlled by the management suite. (7) Logic designed to run the management software suite (7) can be implemented in several ways, with several variations and modifications, as would be apparent to a person having ordinary skill in the art.

[0040] A preferred embodiment design includes a purpose-built marine vessel to serve as a data center that will be submerged in water. Alternatively, the marine vessel is built to serve as a data center, floating on a water body. All components mentioned, namely, the heat exchange system, the water based cooling system, the hot water return cooling system, the thermal containment system, the thermal air flow system, and the software management suite, are installed in such a way that leverages the surrounding environment (Nature) for cooling and wherein all components work together to manage heat created from IT load in the data center while achieving both energy efficiency and cost effectiveness.

[0041] Preferred embodiments include all of the above mentioned elements. Alternate embodiments utilize renewable energy sources such as solar photovoltaic, solar thermal, wind energy, tidal wave energy, thermal energy, etc. which can be leveraged for additional energy efficiency. Additionally, heat from the exhaust air or hot water return from the water based cooling system could also be used as a renewable energy source or used as part of a waste heat system.

[0042] The thermal containment, water based closed-loop cooling and thermal air flow system can all be reconfigured and purpose built to be used in office buildings, residential homes, schools, government buildings, cruise ships, naval vessels, mobile homes, temporary work sites, remote work sites, hospitals, apartment buildings, etc. Other variations, modifications, and applications are possible, as would be apparent to a person having ordinary skill in the art.

[0043] To use this invention, one would simply install their servers/equipment in our waterborne data center facility.

[0044] Additionally, partial or complete embodiments of the disclosed invention can be utilized in alternate applications without departing from the scope and spirit of the disclosure. For example, water based closed loop cooling systems that leverage natural resources within close proximity can be utilized to cool virtually anything, including but not limited to buildings or dwellings, in an energy-efficient and cost-effective manner.

[0045] Since various possible embodiments might be made of the above invention, and since various changes might be made in the embodiments above set forth, it is to be understood that all matter herein described or shown in the accompanying drawings is to be interpreted as illustrative and not to be considered in a limiting sense. Thus it will be understood by those skilled in the art of water borne vessels, and computer data centers and that although the preferred and alternate embodiments have been shown and described in accordance with the Patent Statutes, the invention is not limited thereto or thereby.

[0046] The figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods and computer program products according to various embodiments of the present invention. It should also be noted that, in some alternative implementations, the functions noted/illustrated may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

[0047] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0048] Some portions of embodiments disclosed are implemented as a program product for use with an embedded processor. The program(s) of the program product defines functions of the embodiments (including the methods described herein) and can be contained on a variety of signal-bearing media. Illustrative signal-bearing media include, but are not limited to: (i) information permanently stored on non-writable storage media (e.g., read-only memory devices within a computer such as CD-ROM disks readable by a CD-ROM drive); (ii) alterable information stored on writable storage media (e.g., floppy disks within a diskette drive or hard disk drive, solid state disk drive, etc.); and (iii) information conveyed to a computer by a communications medium, such as through a computer or telephone network, including wireless communications. The latter embodiment specifically includes information downloaded from the Internet and other networks. Such signal-bearing media, when carrying computer- readable instructions that direct the functions of the present invention, represent embodiments of the present invention.

[0049] In general, the routines executed to implement the embodiments of the invention, may be part of an operating system or a specific application, component, program, module, object, or sequence of instructions. The computer program of the present invention typically is comprised of a multitude of instructions that will be translated by the native computer into a machine accessible format and hence executable instructions. Also, programs are comprised of variables and data structures that either reside locally to the program or are found in memory or on storage devices. In addition, various programs described hereinafter may be identified based upon the application for which they are implemented in a specific embodiment of the invention. However, it should be appreciated that any particular program nomenclature that follows is used merely for convenience, and thus the invention should not be limited to use solely in any specific application identified and/or implied by such nomenclature.

[0050] The present invention and some of its advantages have been described in detail for some embodiments. It should be understood that although the system and process is described with reference to a water borne data center, the system and process may be used in other contexts as well. It should also be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. An embodiment of the invention may achieve multiple objectives, but not every embodiment falling within the scope of the attached claims will achieve every objective. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. A person having ordinary skill in the art will readily appreciate from the disclosure of the present invention that processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed are equivalent to, and fall within the scope of, what is claimed. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

Claims

What is claimed is:

1. A data center facility comprising:

a marine vessel comprising a hull heat exchange system, a bow section, a stern section, a starboard section, and a port section;

a computer data center, wherein the computer data center comprises a plurality of computing units, and wherein the computer data center is comprised in the marine vessel; an electrical power generator;

a thermal containment system; a thermal airflow system; a hot water return cooling system; and a software management suite.

2. The data center facility of claim 1, wherein the thermal containment system further comprises a water based closed loop cooling system.

3. The data center facility of claim 2, wherein the water-based closed-loop cooling system comprises:

a single or plurality of filtered water intake pipes and water exhaust pipes;

a single or plurality of water pumps, heat exchangers, coolant heat exchange piping; a closed- loop coolant distribution unit comprising means for using surrounding water as a coolant; and

coolant distribution piping.

4. The datacenter facility of claim 1, wherein the computer data center comprises a plurality of computer systems installed in a plurality of data center modules;

wherein the data center modules comprise a plurality of racks, a plurality of rack-mounted computer systems and corresponding water-based cooling units comprised in the thermal containment system.

5. The data center facility of claim 1, wherein the computer data center comprises a plurality of racks, a plurality of rack-mounted computer systems and corresponding water-based cooling units comprised in the thermal containment system.

6. The data center facility of claim 3, wherein the filtered water intake pipes and filtered water exhaust pipes are comprised in the bow (front) or stern (back) section of the marine vessel.

7. The data center facility of claim 3, wherein the filtered water intake pipes and filtered water exhaust pipes are comprised in the starboard (right) or port (left) sides of the vessel.

8. The data center facility of claim 3 wherein the closed-loop coolant distribution unit is connected to the heat exchangers and to the data center modules.

9. The data center facility of claim 1, wherein the software management suite further comprises a Data Center Infrastructure Management (DCIM) system with predictive analytics and configured for continuously collecting and analyzing data from a plurality of infrastructure systems, components and wireless sensors.

10. The data center facility of claim 9 wherein the plurality of wireless sensors comprises means for continuously collecting environmental data.

11. In a data center facility, a method comprising:

generating electrical power and providing the generated electrical power to the data-center, wherein any excess power is stored as back up or transmitted through a grid network;

pumping surrounding water in close proximity to the data center facility and circulating the pumped water through a closed loop cooling system;

wherein the closed loop cooling system is comprised in a heat exchanger; wherein the surrounding water is drawn by water pumps through filtered water intake pipes to be pumped through one side of the heat exchanger, where it serves as a heat sink to cool hot coolant from a coolant distribution unit being pumped through the other side of the heat exchanger; and expelling the pumped water after absorbing the heat from the hot coolant through filtered water exhaust pipes.

12. The method of claim 11, further comprising:

cooling the hot coolant through a heat exchange system; wherein the heat exchange system is comprised in the hull of a marine vessel housing the data center; and capturing hot exhaust air and returning cooled air to the data center;

wherein the hot exhaust air is captured via a thermal containment system and a thermal airflow system is utilized to move the captured hot exhaust air through the closed loop cooling system, and return the cooled air.

13. The method of claim 11, further comprising:

pumping the coolant through a single or plurality of module cooling units comprised in the data center;

wherein the coolant via the cooling units absorbs heat generated by the plurality of computing systems, and wherein the absorbed heat is returned from the data center module cooling units by pumping the coolant through one side of the heat exchanger while naturally cold water is being pumped through the other side of the heat exchanger, thereby absorbing heat from the hot coolant.

14. In a data center facility, a method of monitoring and managing the facility, the method comprising:

collecting of environmental data by a plurality of infrastructure systems, components and wireless sensors;

storing the collected data in a database; analyzing the stored data by a predictive analytics engine, wherein the analyzed data is employed by a Data Center Infrastructure Management (DCIM) element controller to manage infrastructure systems and components' operational states to sustain optimal infrastructure efficiency.

15. The method of claim 14, further comprising accessing the DCIM over a secure network wherein presentation software comprised in the DCI M enables viewing of all the collected and analyzed data by a user.

16. The method of claim 14, further comprising intelligent data center power management and energy market disaster recovery comprising: collecting, monitoring and analyzing data from application services, power distribution components, virtual machines, data center facility

infrastructure and utility energy markets; based on the said collecting, monitoring, and analyzing, dynamically migrating application loads and power loads from one data center to another, automatically.

17. The method claim 16 further comprising:

collecting via a data collection layer, data from a plurality of infrastructure elements, application elements, power elements and virtual machine elements; analyzing the collected data via a plurality of analytic engines; and based on the analyzed data, triggering via automation software, data center operational state changes for application load balancing and power load balancing across multiple data centers.

18. The method of claim 16 further comprising connecting via a network, the data center to a single or plurality of energy markets such that an energy market analysis layer comprised in the DCIM software uses data collected from energy market elements to automatically manage data center and application disaster recovery from utility energy market outages.

19. The method of claim 16, further comprising monitoring and analyzing utility energy market status for data center load balancing, wherein the said load balancing comprises moving applications and power loads from one data center location using power during peak energy hours to another data center location using power during off-peak hours.

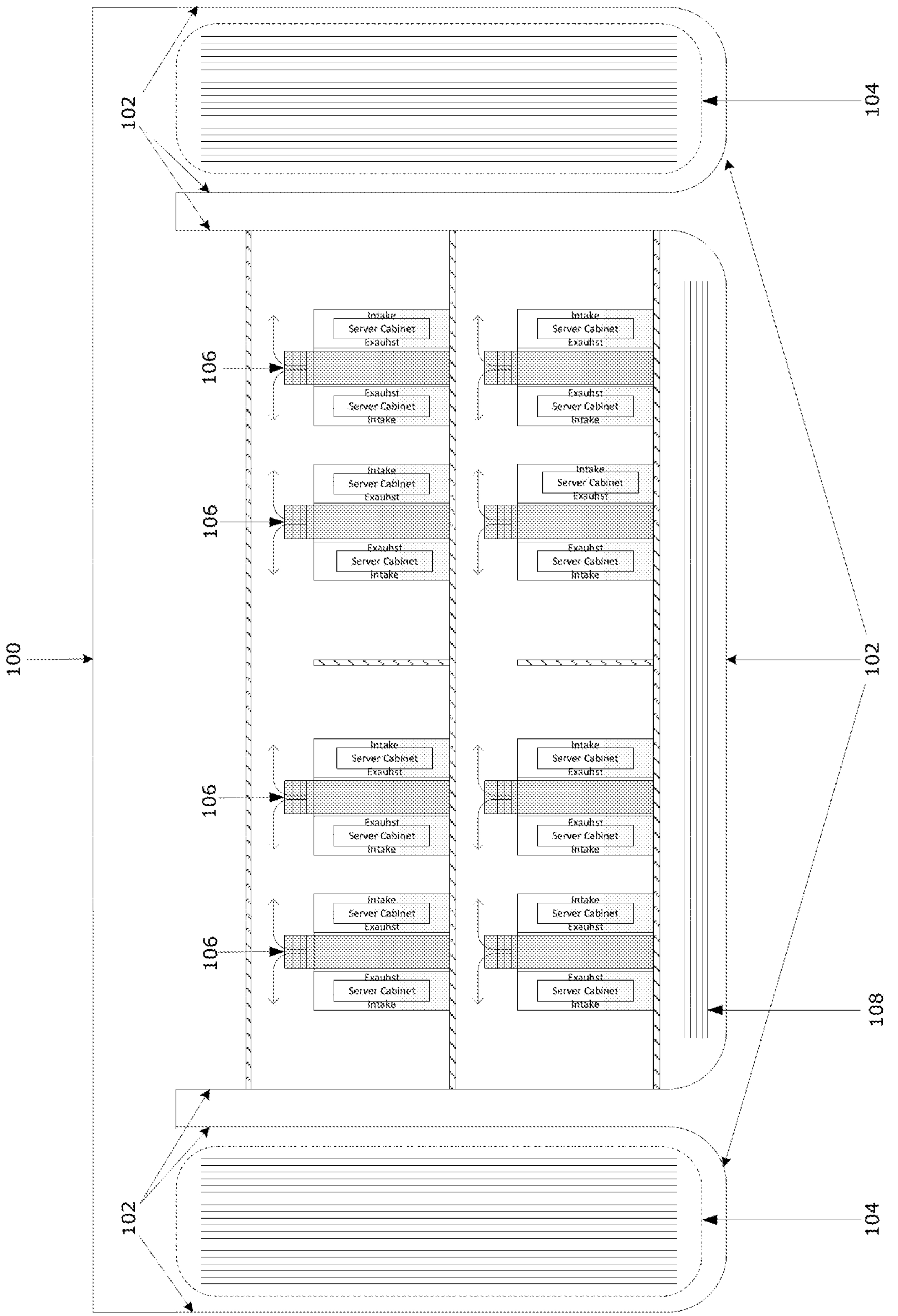

Fig. 1

Waterborne Data Center – Front Sectional View

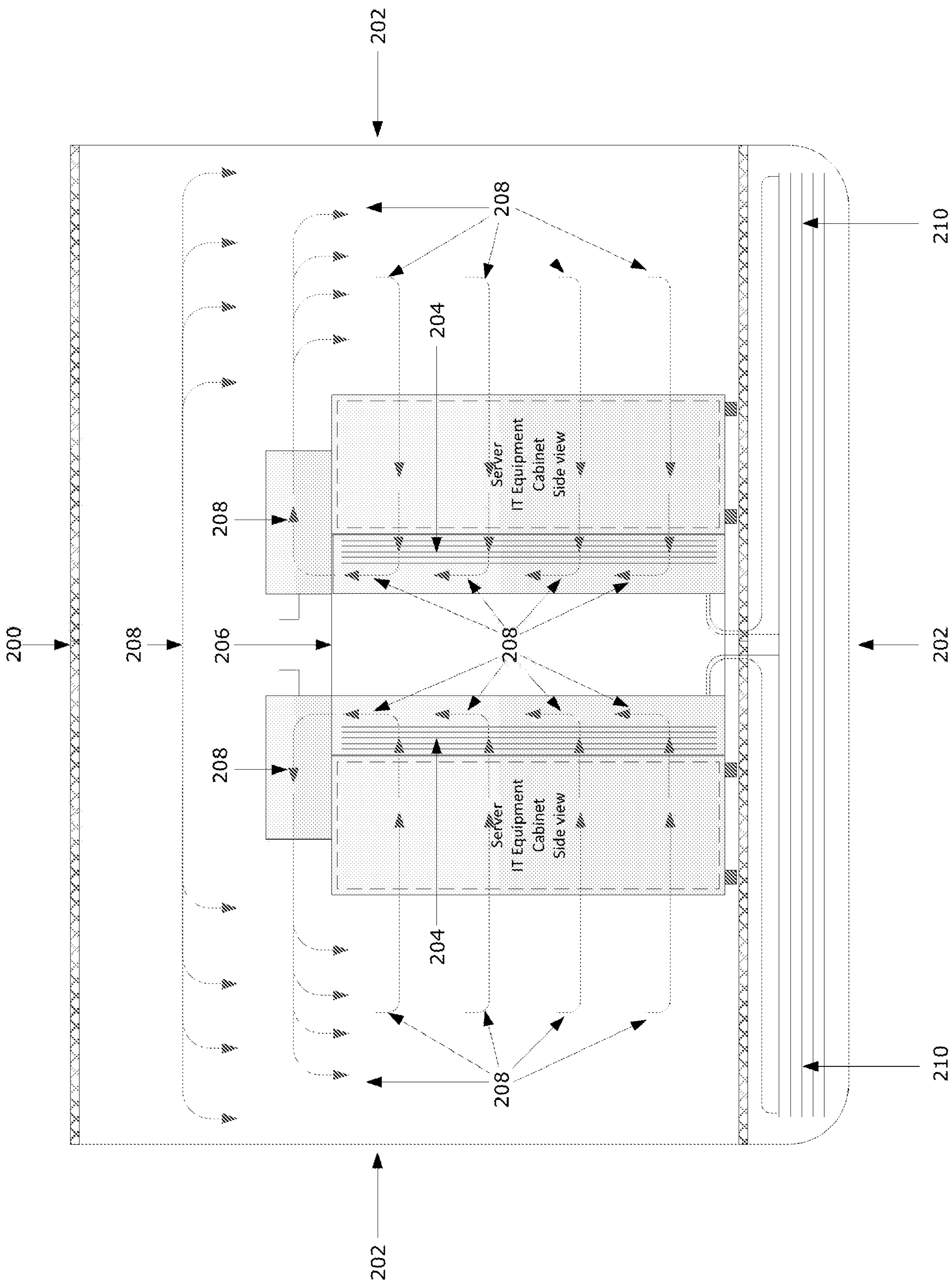

Fig. 2

Heat Exchange and Closed-Loop Cooling – Side Sectional View

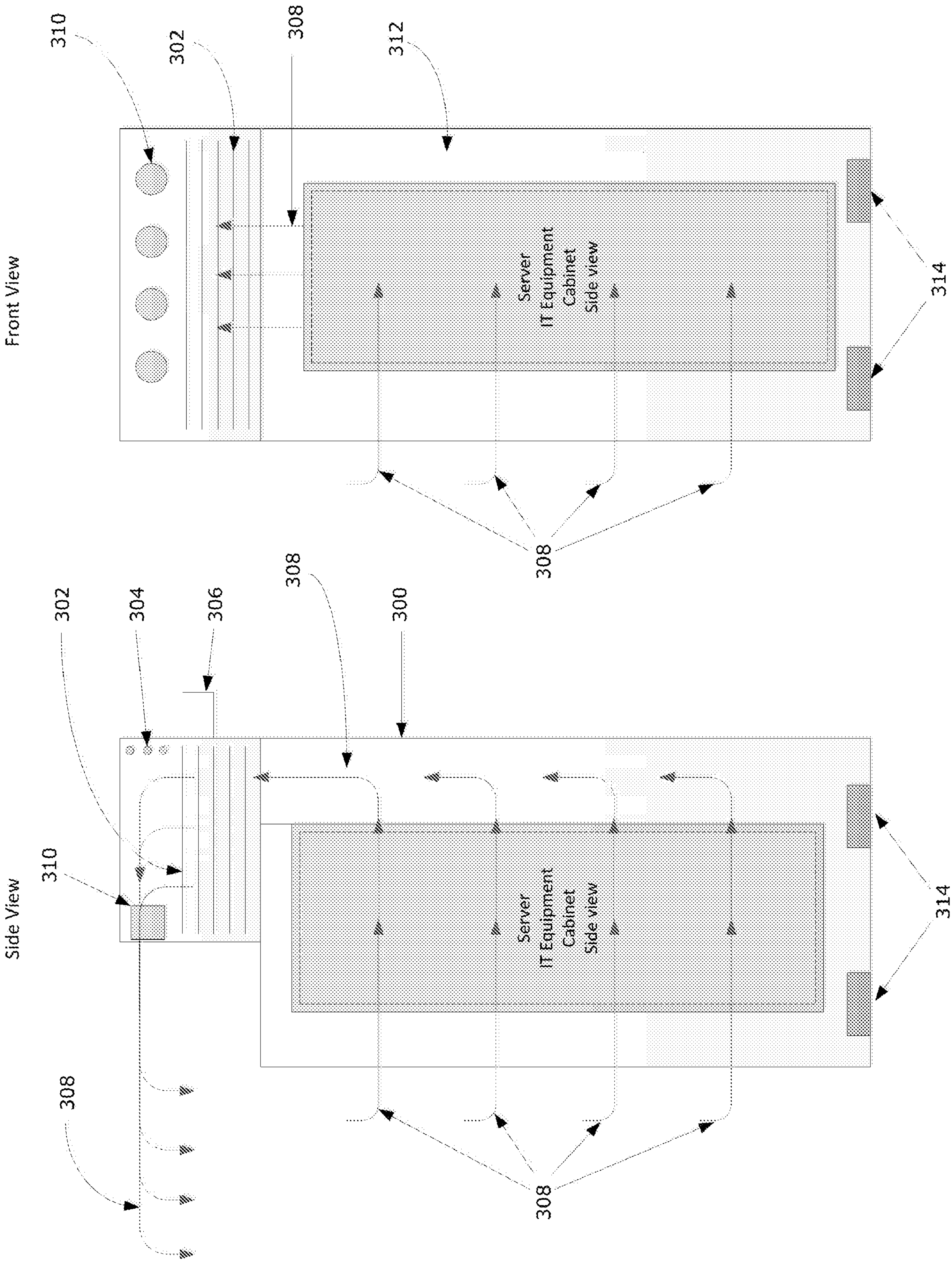

Fig. 3

Thermal Containment Top Closed-Loop Cooling – Sectional Views

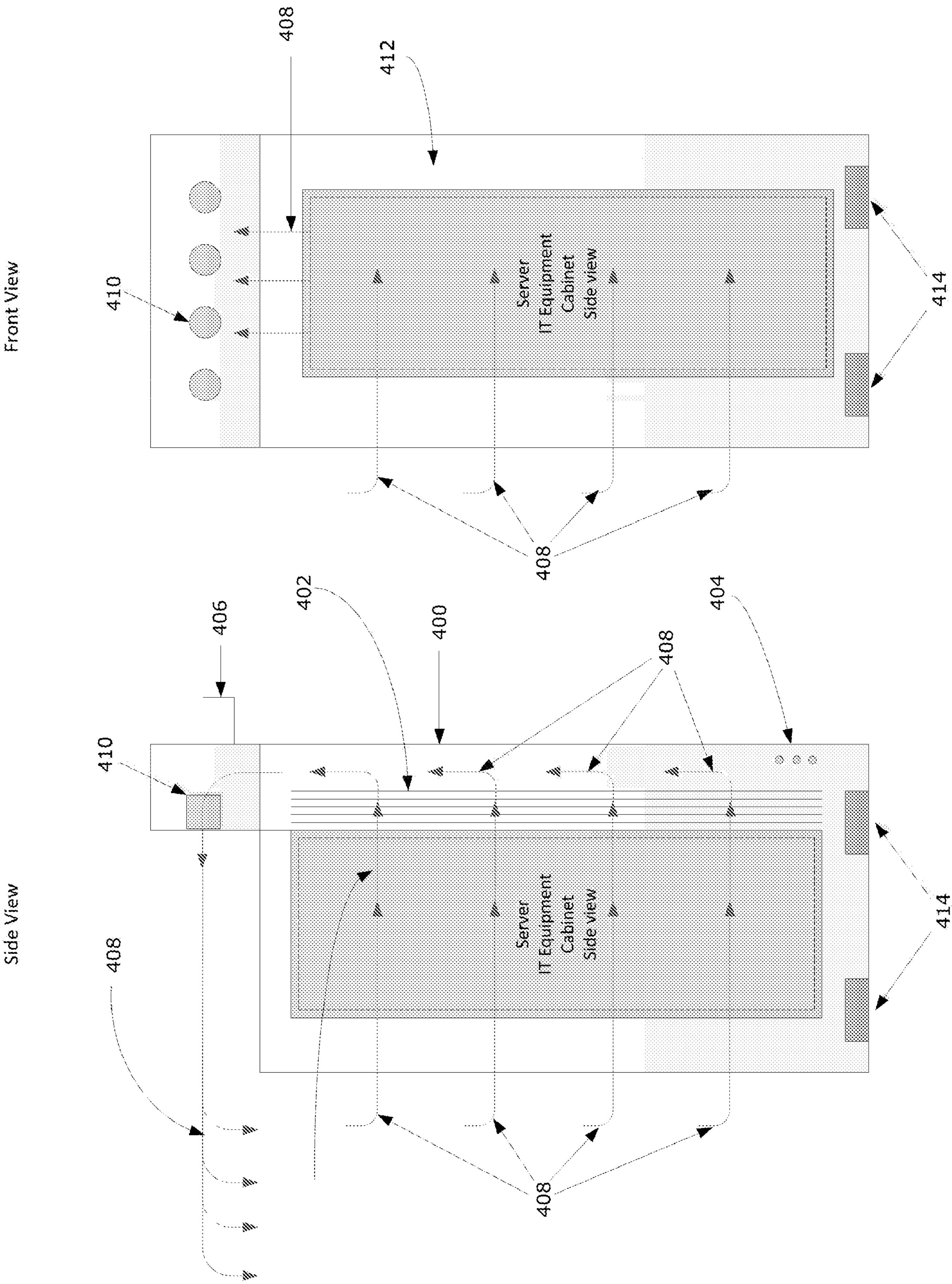

Fig. 4

Thermal Containment Rear Closed-Loop Cooling – Sectional Views

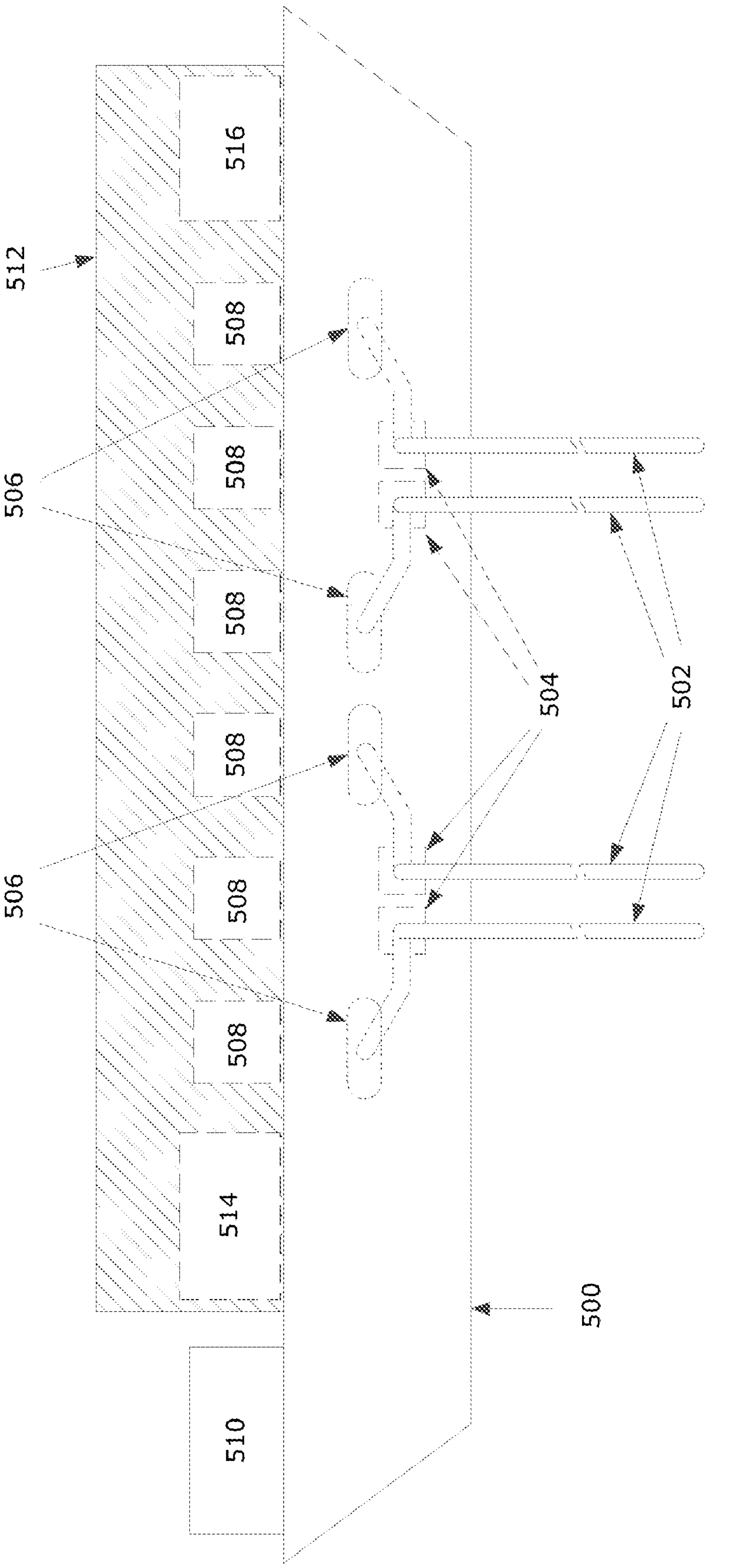

Fig. 5

Waterborne Data Center - Side Sectional View

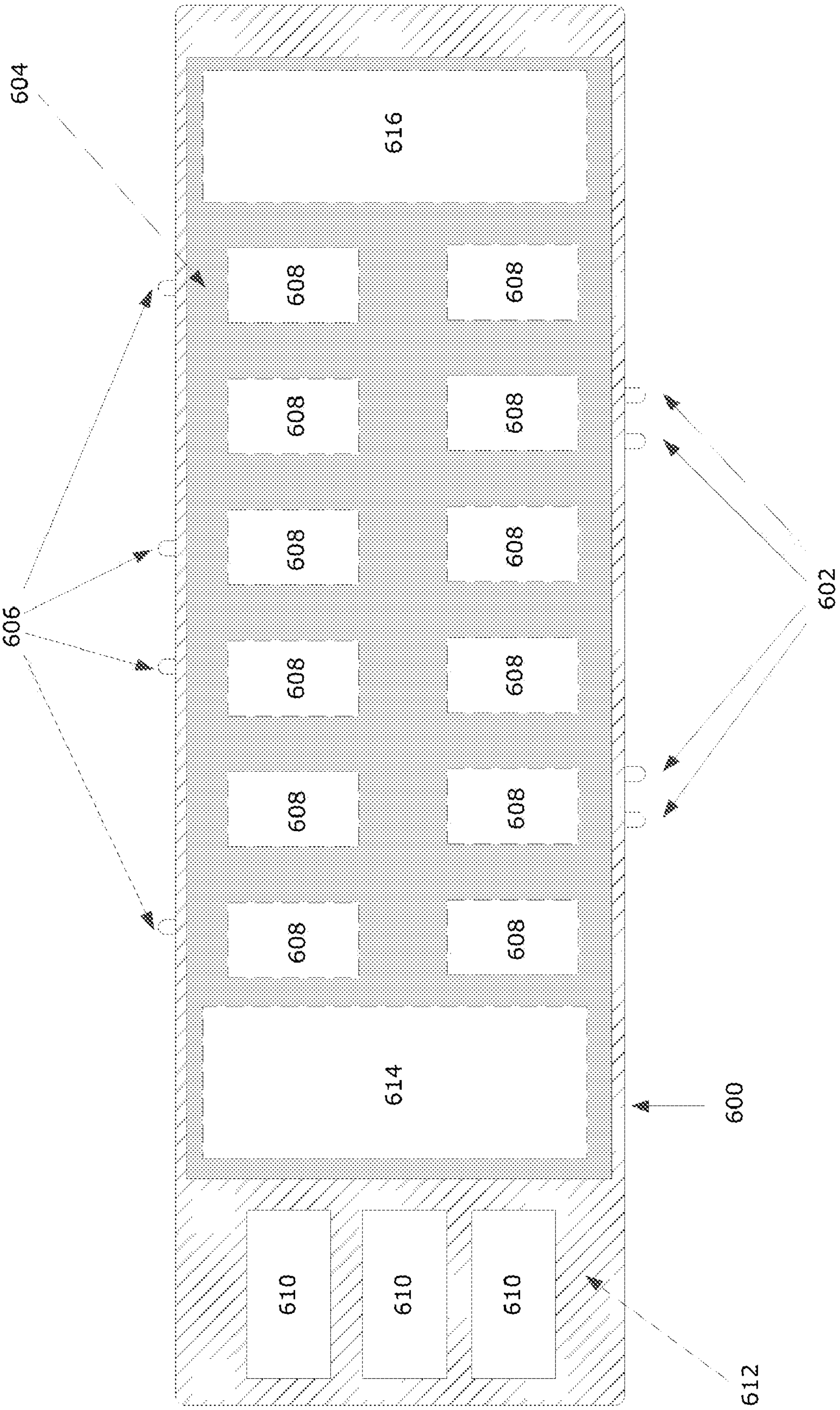

Fig. 6

Waterborne Data Center - Top Sectional View

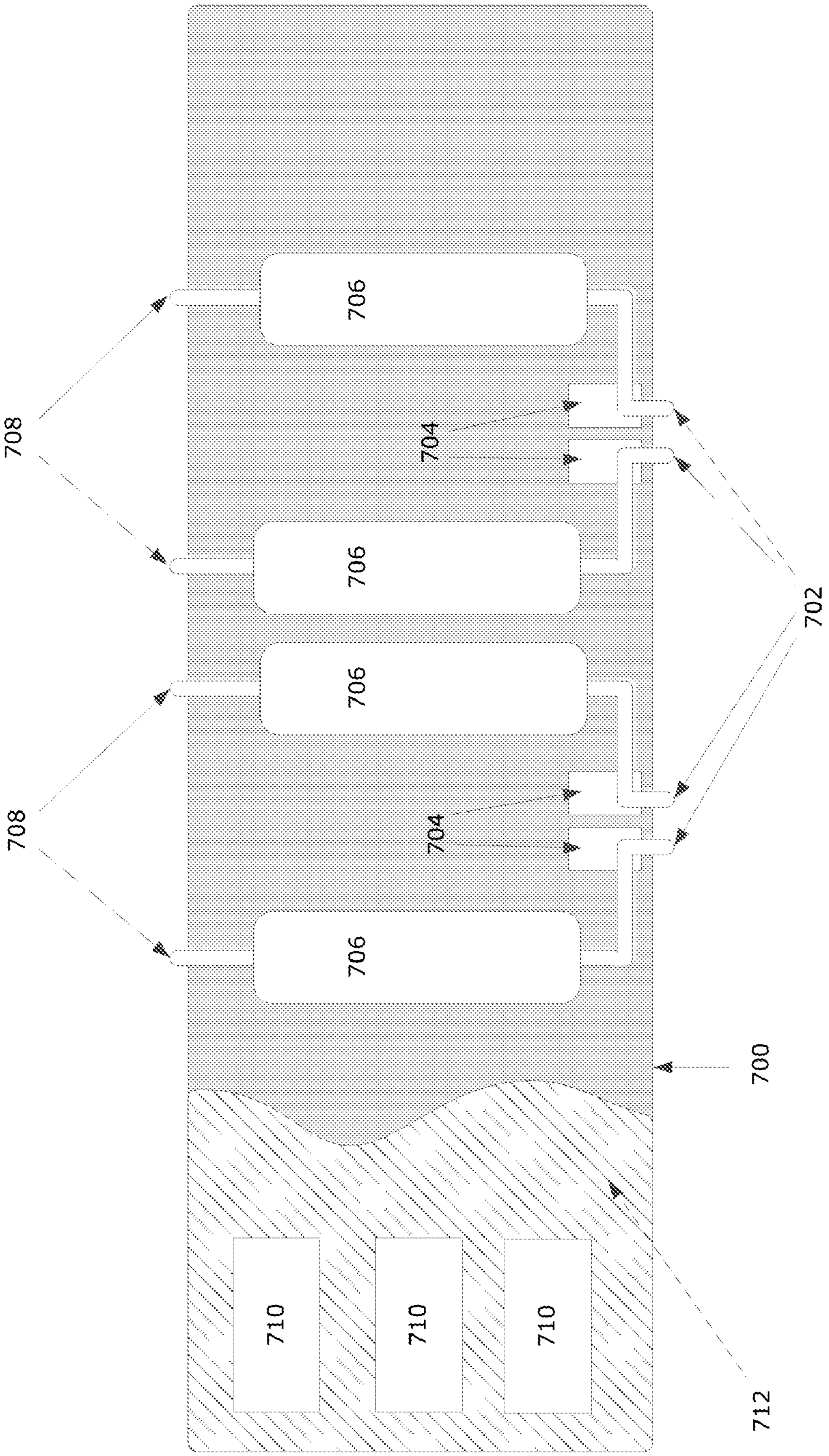

Fig. 7

Waterborne Data Center - Top Sectional View – Below Main Deck

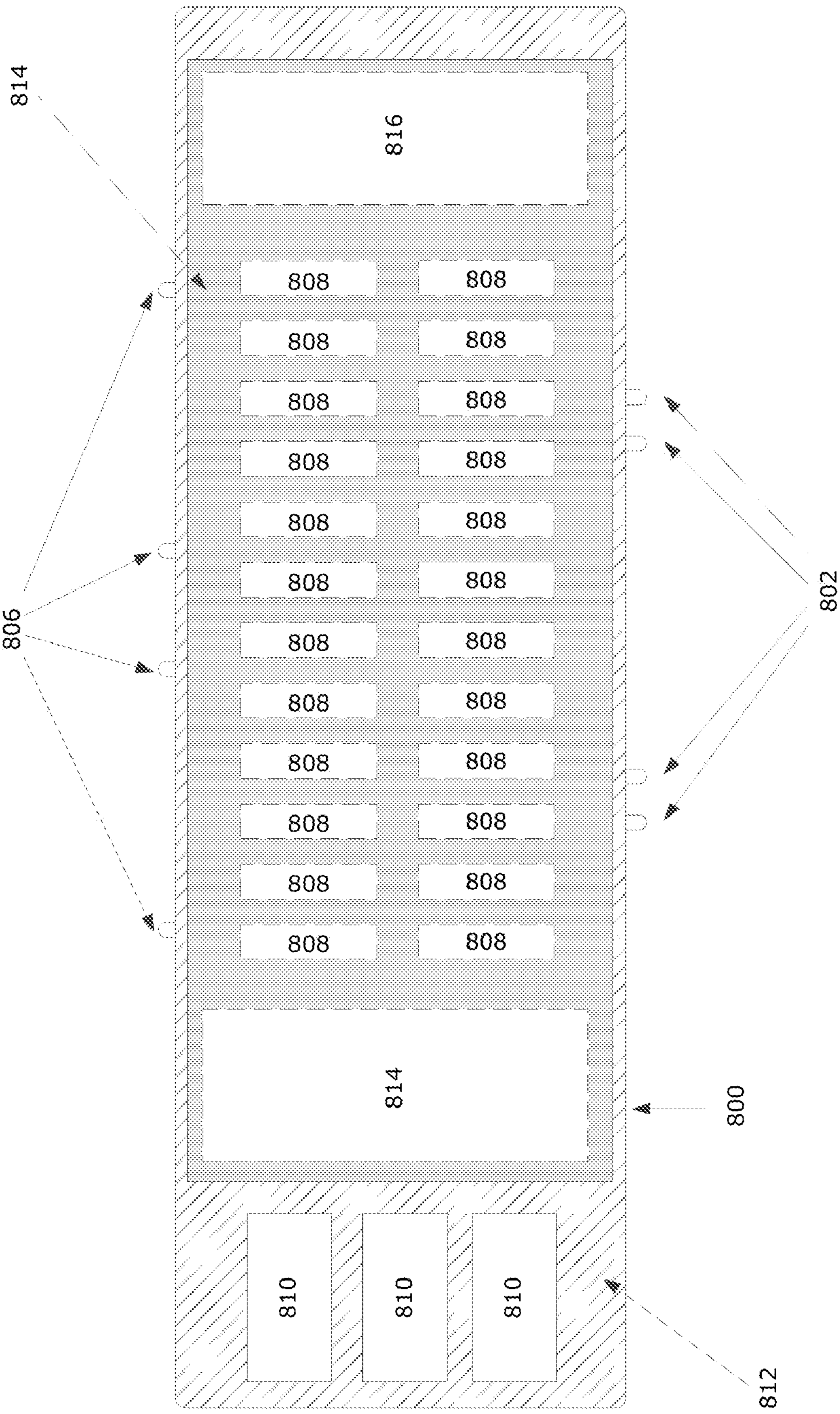

Fig. 8
Waterborne Data Center - Top Sectional View