

COMPRESSED AIR COOLING SYSTEM FOR DATA CENTER

BACKGROUND

[0001] Organizations such as on-line retailers, Internet service providers, search
5 providers, financial institutions, universities, and other computing-intensive organizations often
conduct computer operations from large scale computing facilities. Such computing facilities
house and accommodate a large amount of server, network, and computer equipment to process,
store, and exchange data as needed to carried out an organization's operations. Typically, a
computer room of a computing facility includes many server racks. Each server rack, in turn,
10 includes many servers and associated computer equipment.

[0002] Computer systems typically include a number of components that generate waste
heat. Such components include printed circuit boards, mass storage devices, power supplies, and
processors. For example, some computers with multiple processors may generate 250 watts of
waste heat. Some known computer systems include a plurality of such larger, multiple-processor
15 computers that are configured into rack-mounted components, and then are subsequently
positioned within a racking system. Some known racking systems include 40 such rack-mounted
components and such racking systems will therefore generate as much as 10 kilowatts of waste
heat. Moreover, some known data centers include a plurality of such racking systems. Some
known data centers include methods and apparatus that facilitate waste heat removal from a
20 plurality of racking systems, typically by circulating air through one or more of the rack systems.
The air handling and cooling equipment often used to cool a data center may include various
combinations of HVAC systems, chilled water systems, evaporative cooling systems, and related
components such cooling towers, blowers, refrigerant loops, and variable frequency drives. Such
air handling and cooling equipment adds substantial cost and complexity to the data center.
25 Moreover, in some cases, such equipment may create acoustic noise that exceeds acceptable
limits for an environment, such as noise limits imposed under municipal noise control
ordinances. Examples of air handling systems are disclosed in US 2004/020224, EP 2053911, US
2007/074525, EP0741269, WO 98/34450 and WO 2008/143503.

[0003] The amount of computing capacity needed for any given data center may change
30 rapidly as business needs dictate. Most often, there is a need for increased computing capacity at
a location. Initially providing computing capacity in a data center, or expanding the existing
capacity of a data center (in the form of additional servers, for example), is resource-intensive
and may take many months to effect. Substantial time and resources are typically required to
design and build a data center (or expansion thereof), lay cables, install racks and cooling

systems. Additional time and resources are typically needed to conduct inspections and obtain certifications and approvals, such as for electrical and HVAC systems.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 [0004] FIG. 1 is a schematic diagram illustrating a cooling system for a data center using compressed air according to one embodiment.
- [0005] FIG. 2 is a schematic diagram illustrating one embodiment of a data center including a sub-floor supply plenum.
- [0006] FIG. 3 is a schematic diagram illustrating one embodiment of a data center
10 including a central fan and evaporative cooling.
- [0007] FIG. 4 is a schematic end view illustrating one embodiment of a compressed air cooling system for cooling rows of rack systems having air directing devices.
- [0008] FIG. 5A illustrates a schematic end view of one embodiment of a data center including rack systems with a shared aisle.
- 15 [0009] FIG. 5B illustrates a schematic top view of the computer room of a data center including rack systems with a shared aisle.
- [0010] FIG. 6 illustrates an embodiment of a data center including pipes to carry air from a compressed air cooling system to a rack system.
- [0011] FIG. 7 illustrates one embodiment of cooling a data center using compressed air.
- 20 [0012] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the
25 ~~spirit and~~ scope of the present invention as defined by the appended claims. The headings used herein are for organizational purposes only and are not meant to be used to limit the scope of the description or the claims. As used throughout this application, the word “may” is used in a permissive sense (i.e., meaning having the potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words “include,” “including,” and “includes” mean including, but
30 not limited to.

DETAILED DESCRIPTION OF EMBODIMENTS

- [0013] Various embodiments of systems and method using compressed air for cooling computer systems in a data center are disclosed. According to one embodiment, a system for
35 removing heat from components in a computer room of data center includes one or more air storage containers that hold compressed air, one or more compressors that supply compressed air