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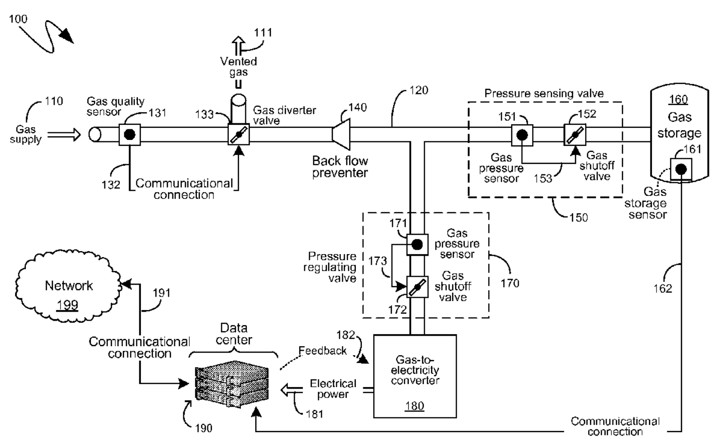

Figure 1

(57) **Abstract**: Gas supply pressure spikes are absorbed and leveled-out by a gas supply shock absorber comprising gas storage, which is charged during positive pressure spikes and utilized during negative pressure spikes. The gas supply shock absorber also comprises pressure sensing and regulating valves, which direct positive pressure spikes to the gas storage and draw gas from storage during negative pressure spikes. A backflow preventer limits shock absorption to co-located equipment, but gas supply shock absorbers operate in aggregate to create additional demand during positive pressure spikes and reduced demand during negative pressure spikes. If the gas storage has sufficient gas, a co-located data center utilizes such gas for increased electrical power generation during increased processing activity, which can be requested or generated. Conversely, if the gas storage has insufficient gas, and a

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GAS SUPPLY SHOCK ABSORBER FOR DATACENTER POWER GENERATION

BACKGROUND

[0001] The throughput of communications between multiple computing devices continues to increase. Modern networking hardware enables physically separate computing devices to communicate with one another orders of magnitude faster than was possible with prior generations of networking hardware. Furthermore, high-speed network communication capabilities are being made available to a greater number of people, both in the locations where people work, and in their homes. As a result, an increasing amount of data and services can be meaningfully provided via such network communications. As a result, the utility of computing devices increasingly lies in their ability to communicate with one another. For example, users of computing devices traditionally used to utilize computing devices for content creation, such as the creation of textual documents or graphical images. Increasingly, however, the most popular utilizations of computing devices are in the browsing of information sourced from other computing devices, the interaction with other users of other computing devices, the utilization of the processing capabilities of other computing devices and the like.

[0002] In particular, it has become more practical to perform digital data processing at a location remote from the location where such data is initially generated, and where the processed data will be consumed. For example, a user can upload a digital photograph to a server and then cause the server to process the digital photograph, changing its colors and applying other visual edits to it. In such an example, the digital processing, such as of the photograph, is being performed by a device that is remote from the user. Indeed, in such an example, if the user was utilizing a battery-operated computing device to interact with the server such as, for example, a laptop or smartphone, the user could be in a location that was not receiving any electrical power at all. Instead, electrical power can have been delivered to the server, which is remote from the user, and the server can have utilized electrical power to process the data provided by the user and then return the processed data to the user.

[0003] To provide such data and processing capabilities, via network communications, from a centralized location, the centralized location typically comprises hundreds or thousands of computing devices, typically mounted in vertically oriented racks. Such a collection of computing devices, as well as the associated hardware necessary to support such computing devices, and the physical structure that houses the computing devices and associated hardware, is traditionally referred to as a "data center". With the increasing availability of high-speed network communication capabilities, and thus the increasing provision of data and services from centralized locations, as well as the traditional utilization of data centers, such as the provision of advanced computing services and massive amounts of computing processing capability, the size and quantity of datacenters continues to increase.

[0004] However, data centers often consume large quantities of electrical power, especially by the computing devices themselves. Increasingly, the cost of obtaining such electrical power is becoming a primary determinant in the economic success of a data center. Consequently, data centers are being located in areas where the data centers can obtain electrical power in a cost-effective manner. In some instances, data centers are being located in areas that can provide inexpensive electrical power directly, such as areas in which electricity can be purchased from electrical utilities or governmental electrical facilities inexpensively. In other instances, however, data centers are being located in areas where natural resources, from which electrical power can be derived, are abundant and can be obtained inexpensively. For example, natural gas is a byproduct of oil drilling operations and is often considered a waste byproduct since it cannot be economically captured and brought to market. Consequently, in areas where oil drilling operations are being conducted, natural gas is often available for free, or at a minimal cost. As will be recognized by those skilled in the art, natural gas can be utilized to generate electrical power, such as, for example, through a fuel cell or by generating steam to drive a steam powered electrical generator. As another example, municipal landfills and other like waste treatment and processing centers can produce a gas commonly referred to as "biogas" which can, likewise, be utilized to generate electrical power that can, then, be consumed by the computing devices of a data center. Unfortunately, gas that is available at reduced cost cannot always be provided at a well-maintained pressure. Instead, the pressure at which such gases are provided can often vary substantially, including both positive and negative gas pressure spikes where the pressure of the provided gas increases, or decreases, respectively. Not only can such gas pressure spikes damage equipment that utilizes such gas, but they can also be disruptive to the entire gas supply network.

SUMMARY

[0005] In one embodiment, a gas supply shock absorber can absorb and level out gas pressure spikes by storing gas during positive pressure spikes and then releasing the stored gas during negative pressure spikes. Such a gas supply shock absorber can comprise a gas storage for storing gas during positive pressure spikes, as well as pressure sensing and pressure regulating valves to control the flow of gas into the gas storage, such as during positive pressure spikes and to control the flow of gas out of the gas storage, such as during negative pressure spikes.

[0006] In yet another embodiment, each individual gas supply shock absorber can comprise a backflow preventer such that the gas supply shock absorber only levels out gas pressure spikes for local gas-fed equipment. A sufficient quantity of such individual gas supply shock absorbers on a gas supply network can, in aggregate, act to smooth out the gas pressure on the whole gas supply network, each utilizing their gas storage to increase the ability to consume gas during positive pressure spikes and to reduce demand during negative pressure spikes.

[0007] In a further embodiment, a gas supply shock absorber can be utilized in conjunction with a data center whose electrical power is provided at least in part by devices that consume gas to generate electricity. Such a data center can have varying electrical power demands depending on the workload of the computing devices of the data center. If a sufficient quantity of gas is available in the gas storage of the gas supply shock absorber, an increase in the workload of the computing devices of the data center can be powered by gas from the gas storage, rather than the consumption of additional gas from the gas network.

[0008] In a still further embodiment, if the gas storage of a gas supply shock absorber has a sufficient quantity of gas, the data center can request additional processing from other data centers to consume some of the gas in the gas storage. Similarly, if the gas storage of the gas supply shock absorber does not have a sufficient quantity of gas, and the gas network experiences a negative pressure spike, the data center can throttle down the processing of its computing devices, or can offload some or all of its processing to other data centers.

[0009] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0010] Additional features and advantages will be made apparent from the following detailed description that proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The following detailed description may be best understood when taken in conjunction with the accompanying drawings, of which:

[0012] Figure 1 is a component diagram of an exemplary gas shock absorber, shown together with an associated gas-powered data center;

[0013] Figure 2 is a flow diagram of an exemplary utilization of stored gas by an associated data center; and

[0014] Figure 3 is a block diagram illustrating an exemplary general purpose computing device.

DETAILED DESCRIPTION

[0015] The following description relates to the absorption and leveling out of gas supply pressure spikes by a gas supply shock absorber. A gas supply shock absorber can comprise gas storage that can be charged with pressurized gas during positive pressure spikes in the gas supply, and which can subsequently utilize such stored gas during negative pressure spikes in the gas supply, thereby leveling out gas supply pressure spikes. Together with the gas storage, a gas supply shock absorber can also comprise pressure sensing valves and pressure regulating valves, which can detect positive pressure spikes in the gas supply and enable such overly pressurized gas to charge the gas storage, and which can also detect negative pressure spikes in the gas supply and, in response, make available the gas stored in the gas storage to compensate for such negative pressure spikes. A backflow preventer can limit the absorption of gas supply pressure spikes to gas equipment co-located with the gas supply shock absorber. Nevertheless, a gas supply network having connected thereto multiple such gas supply shock absorbers can experience less disruptive gas pressure spikes, since each gas supply shock absorber can create additional gas demand during positive pressure spikes, such as in the form of accepting additional gas for storage, and can create reduced gas demand during negative pressure spikes, such as by utilizing locally stored gas. A data center co-located with a gas supply shock absorber can be provided with electrical power from a gas-consuming device, and the amount of power consumed by the data center can vary depending on the processing workload of the computing devices of the data center. If the gas storage has a sufficient quantity of gas stored therein, the data center can utilize such gas to provide increased electrical power during periods of increased processing activity and workload. The data center can additionally request workload from other data centers, in such an instance, or can generate additional workload by, for example, reducing the cost of the

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