DESCRIPTION

TITLE OF INVENTION: [A DETACHABLE HEATING APPARATUS WITH A MULTI CIRCUIT DESIGN AND A HEATING CONTROL METHOD AND SYSTEM THEREFOR]

TECHNICAL FIELD

[0001] The present disclosure generally relates to the field of liquid heating and, more specifically, to heating apparatuses that utilize computing-generated heat as a heating source.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] In recent years, the demand for more energy-efficient domestic water heaters has grown due to rising energy costs and heightened environmental concerns. However, conventional water heaters remain largely dependent on traditional heating elements, which operate without considering alternative heat sources like computing waste heat. This singular reliance not only results in higher energy consumption but also fails to address the inefficiencies inherent in the current approach.

[0004] Present solutions often overlook the potential to integrate secondary heat sources, such as the waste heat generated by computing units, leaving this energy resource untapped. Instead, computing waste heat is typically dissipated into the environment, contributing to unnecessary energy loss and thermal pollution. The failure to leverage this readily available heat results in water heaters that are less efficient and more costly to operate, while also exacerbating their environmental impact. As energy demands continue to grow, the limitations of these conventional systems highlight the need for more innovative approaches to domestic water heating.

[0005] There exists a need to develop a more efficient liquid heating apparatus that utilizes computing-generated heat as a heating source, addressing at least one of the problems associated with conventional systems.

SUMMARY

[0006] Specifically, to address the above-mentioned technical problems, the present invention specifically uses the following technical solutions:

[0007] Accordingly, an aspect of the invention refers to a detachable heating apparatus (200), comprising: a chamber (209) and a computing unit (207) housed inside the chamber (209); wherein the computing unit (207) is operable to perform a computing task and generate computing waste heat;

[0008] a heat exchange unit (400), comprising: (i) a first circuit configured to liquidly connect the chamber (209) and direct a heat transfer fluid to flow between the chamber (209) and the heat exchange unit (400); and (ii) a second circuit configured to be liquidly connectable to a tank inlet pipe (313) and a tank outlet pipe (315) of a liquid tank (300) to direct a utility liquid to flow between the heat exchange unit (400) and the liquid tank (300);

[0009] wherein, the first circuit is operable to direct the heat transfer fluid through the chamber (209) to absorb the computing waste heat from the computing unit (207) and transfer the heat transfer fluid to the heat exchange unit (400); and the second circuit is operable to direct the utility liquid from the liquid tank (300) through the heat exchange unit (400) to exchange heat with the heat transfer fluid, and then return the utility liquid to the liquid tank (300).

[0010] In some embodiments, the first circuit comprises a first input segment (401), a first heat exchange segment (402) and a first output segment (403), liquidly connected together in sequence; wherein the first input segment (401) and the first output segment (403) are configured to be liquidly connected to the chamber (209), and the first heat exchange segment (402) is configured to be housed inside the heat exchange unit (400).

[0011] In some embodiments, the second circuit comprises a second input segment (405), a second heat exchange segment (406) and a second output segment (407), liquidly connected together in sequence; wherein the second input segment (405) is configured to be connectable to the tank inlet pipe (313), the second output segment (407)

is configured to be connectable to the tank outlet pipe (315), and the second heat exchange segment (406) is configured to be housed inside the heat exchange unit (400).

[0012] In some embodiments, the first input segment (401) comprises a fluid pump (404) configured to pump the heat transfer fluid from the first exchange segment (402) into the chamber (209).

[0013] In some embodiments, the second input segment (405) comprises a utility liquid pump (409) configured to pump the utility liquid from the tank inlet pipe (313) into the heat exchange unit (400).

[0014] In some embodiments, the chamber (209) further comprises one or more of the following placed upon the computing unit (207): a radiator, a vapour chamber, a graphene sheet and peltier element; wherein the radiator is optionally made of aluminium, copper, graphite-based composite or ceramic-coated metal.

[0015] In some embodiments, the computing unit (207) comprises one or more of: a bitcoin miner, a cryptocurrency miner, a server-grade central processing unit (CPU), a simulation processor and an artificial intelligence-related computing unit; wherein the artificial intelligence-related computing unit comprises one or more of: a graphics processing unit (GPU), a tensor processing unit (TPU), an AI accelerator and a neural processing unit (NPU).

[0016] In some embodiments, the computing unit (207) is arranged to be in data communication with a network.

[0017] In some embodiments, the detachable heating apparatus (200) further comprises a thermal protection coating on exterior surface of one or more of: the chamber (209), the first output segment (403), the second output segment (407), and the heat exchange unit (400).

[0018] In some embodiments, the computing unit (207) is configured to be removable from the chamber (209).

[0019] In some embodiments, the chamber (209) further comprises an attachment element configured to secure the chamber (209) to the liquid tank (300).

[0020] In some embodiments, the attachment element is integrally formed on the exterior surface of the chamber (209).

[0021] In some embodiments, the attachment element is configured to be detachably connected to the chamber (209)

[0022] In some embodiments, the second output segment comprises a fourth valve operable to regulate flow of the utility liquid.

[0023] In some embodiments, the detachable heating apparatus (200) further comprises a power adapter configured to connect to an electrical power cable of the liquid tank (300) and to plug into an electrical power socket.

[0024] Another aspect of the invention refers to a heating system, comprising: the detachable heating apparatus (200) of the present invention, and the liquid tank (300); wherein the second input segment (405) of the detachable heating apparatus (200) is liquidly connected to the tank inlet pipe (313), and the second output segment (407) is liquidly connected to the tank outlet pipe (315); wherein the tank inlet pipe (313) comprises a first interior opening (305) extending inside the liquid tank (300); wherein the liquid tank (300) comprises a second heating source (309) housed inside the liquid tank (300).

[0025] In some embodiments, the tank outlet pipe (315) comprises a second interior opening (307) extending into the liquid tank (300); and wherein the second heating source (309) is positioned in proximity to the second interior opening (307).

[0026] In some embodiments, the heating system further comprises: a temperature monitoring module (501) operable to detect and measure temperature of the utility liquid inside the liquid tank (300); and an operation control module (502) operable to adjust operation of the computing unit (207) and/or the second heating source (309) according to the temperature of the utility liquid measured by the temperature monitoring module (501).

[0027] In some embodiments, the heating system further comprises a mode switch module (503) operable to transmit an instruction signal to the operation control module (502); wherein, when the mode switch module (503) is switched to a liquid use mode, the operation control module (502) is operable to deactivate the fourth valve (411) to direct

the utility liquid to flow through the tank inlet pipe (313) into the liquid tank (300), and further out of the liquid tank (300) through the tank outlet pipe (315); when the mode switch module (503) is switched to a standby mode, the operation control module (502) is operable to activate the fourth valve and deactivate a third valve of the tank outlet pipe (315), to direct the utility liquid to circulate between the liquid tank (300) and the heat exchange unit (400) through the second circuit.

[0028] In some embodiments, the mode switch module (503) is switched to the liquid use mode, the operation control module (502) activates the second heating source (309) or maintains the second heating source (309) in an active state to heat the utility liquid inside the liquid tank (300).

[0029] In some embodiments, wherein, when the mode switch module (503) is switched to the standby mode, the operation control module (502) deactivates the second heating source (309) or maintains the second heating source (309) in a deactivated state.

[0030] In some embodiments, wherein, when the mode switch module (503) is switched to the standby mode, the operation control module (502) is operable to: (i) activate the utility liquid pump (409) to initiate or enhance circulation of the utility liquid through the second circuit; and/or (ii) activate the fluid pump (404) to initiate or enhance circulation of the heat transfer fluid through the first circuit.

[0031] In some embodiments, wherein, when the temperature monitoring module (501) detects that the temperature of the utility liquid in a third temperature zone within the liquid tank (300) drops below a third predetermined temperature threshold, the operation control module (502) is operable to activate or enhance the heating process of the second heating source (309).

[0032] In some embodiments, the third temperature zone is defined to encompass a second interior opening (307).

[0033] In some embodiments, wherein, when the temperature monitoring module (501) detects that the temperature of the heat transfer fluid inside the chamber (209) exceeds a fourth predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (207).

[0034] In some embodiments, the second heating source (309) is an electrical heating element.

[0035] In some embodiments, the electrical heating element is a heating coil, a heating plate, a heating rod or a heating pad.

[0036] In some embodiments, the electrical heating element comprises a power cable of the second heating source (309) that is plugged into a power adapter of the detachable heating apparatus (200).

[0037] In some embodiments, the utility liquid is water suitable for domestic use.

[0038] In some embodiments, the liquid tank (300) comprises a thermal protection coating on exterior surface of the liquid tank (300).

[0039] In some embodiments, wherein the detachable heating apparatus (200) is configured to be positioned below, above, or beside the liquid tank (300).

[0040] Other aspects and features of the present invention will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] In the figures, which illustrate, by way of non-limiting examples only, embodiments of the present invention,

[0042] **[Fig. 1]:** illustrates a perspective view of a detachable heating apparatus according to various embodiments of the present invention, installed on a liquid tank.

[0043] **[Fig. 2]:** illustrates a perspective cross-sectional view of a detachable heating apparatus according to various embodiments of the present invention, installed on a liquid tank.

[0044] **[Fig. 3]:** illustrates a front view of a detachable heating apparatus according to various embodiments of the present invention, installed on a liquid tank.

[0045] **[Fig. 4]:** illustrates a front cross-sectional view of a detachable heating apparatus according to various embodiments of the present invention, installed on a liquid tank.

[0046] **[Fig. 5]:** illustrates a perspective cross-sectional view of a heating apparatus according to various embodiments of the present invention, installed on a liquid tank.

[0047] **[Fig. 6]:** illustrates, in a block diagram, a heating control system according to various embodiments of the present invention.

[0048] **DETAILED DESCRIPTION**

[0049] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0050] Furthermore, throughout the document, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0051] Unless defined otherwise, all other technical and scientific terms used herein have the same meaning as is commonly understood by a skilled person to which the subject matter herein belongs.

[0052] **Embodiment 1**

[0053] The present invention discloses a detachable heating apparatus (200C) comprises a chamber (209) and a computing unit (207) housed inside the chamber (209); wherein the computing unit (207) is operable to perform computing tasks and generate computing waste heat. The heating apparatus (200C) further comprises a heat exchange unit (400), wherein the heat exchange unit (400) is configured to comprise:

[0054] (i) a first circuit liquidly connected to the chamber (209) and configured to direct a heat transfer fluid to flow between the chamber (209) and the heat exchange unit (400); and (ii) a second circuit liquidly connected to a tank inlet pipe (313) and a tank outlet pipe (315) of a liquid tank (300) (e.g., a liquid reservoir), configured to direct a utility liquid to flow between the heat exchange unit (400) and the liquid tank (300).

[0055] The first circuit is configured to direct the heat transfer fluid through the chamber (209) to absorb computing waste heat from the computing unit (207) and transfer the heat transfer fluid to the heat exchange unit (400). The second circuit is configured to direct the utility liquid from the liquid tank (300) through the heat exchange unit (400) to exchange heat with the heat transfer fluid, and then return the utility liquid to the liquid tank (300).

[0056] In some embodiments, the first circuit comprises a first input segment (401), a first heat exchange segment (402), and a first output segment (403), liquidly connected in sequence. The first input segment (401) and the first output segment (403) are configured to be liquidly connected to the chamber (209), and the first heat exchange segment (402) is configured to be housed inside the heat exchange unit (400).

[0057] In some embodiments, the second circuit comprises a second input segment (405), a second heat exchange segment (406), and a second output segment (407), liquidly connected in sequence. The second input segment (405) is configured to be connectable to the tank inlet pipe (313), the second output segment (407) is configured to be connectable to the tank outlet pipe (315), and the second heat exchange segment (406) is configured to be housed inside the heat exchange unit (400).

[0058] In some embodiments, the second input segment (405) comprises a utility liquid pump (409) configured to pump the utility liquid from the tank inlet pipe (313) into the heat exchange unit (400).

[0059] In some embodiments, the chamber (209) further comprises one or more of the following components placed upon the computing unit (207): a radiator, a vapor chamber, a graphene sheet, and a Peltier element. The radiator is optionally made of aluminum, copper, graphite-based composite, or ceramic-coated metal.

[0060] In some embodiments, the computing unit (207) comprises one or more of the following components: a bitcoin miner, a cryptocurrency miner, a server-grade central processing unit (CPU), a simulation processor and an artificial intelligence-related computing unit. Any computing unit (207) capable of generating significant waste heat is well-suited for use in the present invention, as the waste heat can be effectively utilized to contribute to the heating process.

[0061] In some embodiments, the artificial intelligence-related computing unit

comprises one or more of: a graphics processing unit (GPU), a tensor processing unit (TPU), an AI accelerator and a neural processing unit (NPU).

[0062] The computing unit (207) is further configured to be in data communication with a network. In some embodiments, the computing unit (107) is connected to a network using wired cables. In some embodiments, the computing unit (207) includes a wireless communication module. For example, the wireless communication module comprises a wireless communication chip and an antenna.

[0063] In some embodiments, the computing unit (207) is configured to perform bitcoin mining and other computational tasks, both of which rely on consistent data transmission to achieve efficient and uninterrupted operation, at least in some application scenarios. Although the volume of data transmitted may not be substantial, maintaining a stable and reliable connection is crucial to ensure uninterrupted performance. To achieve this, the wireless communication module within the computing unit (207) is equipped with both a wireless communication chip and an antenna. These components work together to facilitate communication with external networks. Additionally, to extend the effective communication range, a wireless communication range extension device may be incorporated. Such as wireless communication range extension device can be integrated with the heating apparatus itself, positioned at an existing Internet or Wi-Fi access point (e.g., a router), or placed independently between the access point/router and the heating apparatus. This ensures that the computing unit (207) remains within the extended communication range, allowing for stable connectivity regardless of the placement of the heating apparatus.

[0064] To further enhance the flexibility and usability of the heating apparatus, the computing unit (207) may also be equipped with additional wireless communication technologies, enabling it to operate in environments where traditional Internet access is unavailable. For instance, the computing unit (207) can support communication standards such as EDGE, 2G, 3G, 4G, 5G, or their future iterations. By incorporating such diverse communication options, the dependency of the heating apparatus on Wi-Fi connections is alleviated, at least to some extent, thereby improving convenience and making the device suitable for a wider range of scenarios, including remote locations or areas with limited network infrastructure.

[0065] During operation of the heating apparatus (e.g., a domestic water heater), the user or installer can connect the wireless communication module of the computing unit (207) to an existing Wi-Fi network to activate the heating function. Alternatively, if Wi-Fi is not available or preferred, the user can rely on other communication standards, such as EDGE, 2G, 3G, 4G, or 5G, to establish connectivity. Ensuring the proper connection setup is an essential step before the device begins its heating operations.

[0066] In the event of a data connection disruption, the system is designed to notify the user promptly through various channels. Notifications can be delivered via mobile applications, push alerts, SMS messages, chat applications, device indicators, or standalone notification devices. These alerts inform the user of the connectivity issue, prompting them to take timely action to restore the connection and resume normal operation.

[0067] Moreover, if a data connection issue is detected, the heating control system is programmed to adjust its functionality to mitigate potential inefficiencies. For example, the operation control module (502G) may issue a control signal to the computing unit (207), instructing it to suspend its computing tasks temporarily. This ensures that the heating control system prioritizes maintaining efficient operations while reducing the strain on the heating apparatus during periods of network instability.

[0068] To ensure reliable data communication in the heating apparatus that utilizes a computing unit as a heating source, various advanced methods can be implemented to enhance connectivity and maintain efficient operation. These methods are particularly critical in systems where uninterrupted data transfer directly supports both computational tasks and the heat generated by the computing unit.

[0069] One effective approach is adaptive frequency hopping, where the wireless communication module in the computing unit dynamically scans and switches between frequencies to avoid interference. By identifying less congested channels in real time, the system ensures stable data transmission, which is essential for continuous computational operations and efficient heat generation.

[0070] Signal amplification can be employed to adaptively boost signal strength based on the distance between devices and surrounding environmental conditions. This ensures

that the computing unit maintains robust connectivity, even when the heating apparatus is located far from the network access point or in challenging environments.

[0071] Using multi-antenna beamforming, the system leverages multiple antennas to focus the wireless signal directly toward the target device, such as a router or range extender. By minimizing signal dispersion and interference, this technique ensures that the computing unit remains reliably connected, enabling uninterrupted computational activity.

[0072] To address potential data errors during transmission, error correction algorithms like forward error correction (FEC) can be integrated into the computing unit's communication protocol. These algorithms detect and rectify errors in real time, preserving the integrity of data essential for computational tasks.

[0073] In addition, proactive buffering is utilized to mitigate the effects of brief connectivity interruptions. By temporarily storing data, the computing unit ensures continuous operation, preventing computational delays or disruptions in heat generation that could impact the performance of the heating apparatus.

[0074] Dynamic power control is another key feature, allowing the computing unit to adjust its wireless transmission power based on the quality of the connection. Lower power is used for nearby connections to conserve energy, while higher power is employed for distant or weaker connections, ensuring that the computing unit remains operational without compromising energy efficiency.

[0075] Dual-band communication enables the computing unit to transmit data simultaneously over two frequency bands, such as 2.4 GHz and 5 GHz. This redundancy ensures that computational tasks continue seamlessly, even if one band experiences interference, thus maintaining consistent heat generation.

[0076] In scenarios where direct communication between the computing unit and the network is obstructed, peer-assisted relaying allows nearby devices to act as relay points, extending the range and reliability of the connection. This ensures that the computing unit remains functional, even in complex or obstructed environments.

[0077] To further enhance bandwidth and redundancy, real-time channel bonding combines multiple communication channels into a single high-capacity data

path. This allows for increased data transfer speeds and ensures that computational tasks remain uninterrupted, even if one channel degrades.

[0078] Intelligent packet scheduling prioritizes data packets based on their importance and latency requirements. For example, time-sensitive computations necessary for heating optimization can be prioritized over less critical tasks, ensuring the apparatus operates efficiently.

[0079] Additionally, interference cancellation leverages advanced signal processing to identify and neutralize external interference. This maintains clear and stable communication between the computing unit and the network, supporting uninterrupted computational and heating functions.

[0080] Lastly, self-healing network protocols are implemented to automatically detect and recover from connection failures. These protocols enable the computing unit to re-establish the network connection or reroute data via alternative paths without user intervention, ensuring continuous operation of the heating apparatus.

[0081] In some embodiments, the detachable heating apparatus (200C) further comprises a thermal protection coating (113) provided on the exterior surface of one or more of the following: the chamber (209), the first output segment (403), the second output segment (407), and the heat exchange unit (400).

[0082] In some embodiments, the computing unit (207) is removably installed inside the chamber (209), allowing it to be easily removed for maintenance or replaced with a new computing unit (207) as needed.

[0083] In some embodiments, the heating apparatus (200C) further comprises an attachment element configured to secure the chamber (209) to the liquid tank (300). Specifically, the attachment element is integrally formed on the exterior surface of the chamber (209) or is detachably connected to the chamber (209).

[0084] In some embodiments, the attachment element adopts a magnetic mounting base. For example, a strong neodymium magnet is installed on the back of the heating apparatus (200C), paired with a compatible magnetic plate or directly attached to the liquid tank (300) made of metallic material. This magnetic mounting method facilitates easy installation/removal without permanent modifications.

[0085] In some embodiments, the attachment element uses adjustable straps. Specifically, durable and heat-resistant straps (e.g., Velcro or nylon straps) are wrapped around the liquid tank (300) and fixed to the detachable heating apparatus (200C). This adjustable strap mounting method is non-invasive and adaptable to various positions.

[0086] In some embodiments, the attachment element uses an adhesive mounting plate. Specifically, an industrial-grade, heat-resistant adhesive is used to attach the mounting plate to the exterior wall of the liquid tank (300). The detachable heating apparatus (200C) can slide or snap onto the mounting plate. This mounting method offers a compact and tidy appearance while alleviating the need for invasive or complex installation processes, such as drilling.

[0087] In some embodiments, the attachment element adopts a clamping bracket. Specifically, an adjustable metal bracket is designed to clamp onto both sides of the liquid tank (300) to secure the heating apparatus (200C). This clamping method is reusable, adjustable, and does not require permanent modifications. Bolted installation is also an option. For instance, holes are drilled into specified non-structural areas of the liquid tank (300), and the auxiliary device is bolted using prefabricated mounting brackets. This bolted method is highly secure and suitable for long-term installation.

[0088] In some embodiments, the attachment element uses hanging hooks. For example, hooks are installed on the heating apparatus (200C), allowing it to be hung from sturdy horizontal bars or edges on the liquid tank (300). This hanging installation method is convenient to implement and easy to remove.

[0089] In some embodiments, the attachment element uses suction cups. For example, heat-resistant suction cups are installed on the back of the heating apparatus (200C) and directly adhere to the liquid tank (300). This installation method does not require permanent modifications and allows for quick setup.

[0090] In some embodiments, the attachment element uses a sliding rail system. Specifically, sliding rails (or tracks) are installed on the liquid tank (300), enabling the heating apparatus (200C) to slide in and out along the rails for convenient positioning. This adjustable system is user-friendly.

[0091] In some embodiments, the attachment element uses an integrated stand. For instance, the heating apparatus (200C) is designed with adjustable clamps or legs,

allowing it to stably rest against the liquid tank (300) and remain fixed through friction or tension. This installation method is tool-free and portable.

[0092] In some embodiments, the attachment element adopts a pipeline-integrated approach. For example, brackets or clamps are used to directly connect the heating apparatus (200C) to the inlet/outlet pipes of the liquid tank (300) (e.g., the tank inlet pipe (313) or tank outlet pipe (315)), making it "float" beside the liquid tank (300). This method achieves dual functionality by integrating with the existing pipeline system.

[0093] In some embodiments, a fourth valve (411) operable to regulate the flow of the utility liquid is provided on the second output segment (407).

[0094] In some embodiments, the detachable heating apparatus (200C) further comprises a power adapter configured to connect to the power cable of the liquid tank (300) and plug into a power socket.

[0095] Embodiment 2

[0096] In some embodiments, there is provided a heating system comprising the detachable heating apparatus (200C) of the present invention and a liquid tank (300). The second input segment (405) of the detachable heating apparatus (200C) is removably and liquidly connected to the tank inlet pipe (313), and the second output segment (407) is removably and liquidly connected to the tank outlet pipe (315). The tank inlet pipe (313) comprises a first interior opening (305) extending inside the liquid tank (300). The liquid tank (300) is further provided with a second heating source (309).

[0097] The detachable heating apparatus (200C) can be connected to the liquid tank (300) by securing the second input segment (405) to the tank inlet pipe (313) and the second output segment (407) to the tank outlet pipe (315). Conversely, the heating apparatus (200C) can be detached from the liquid tank (300) by disconnecting the second input segment (405) from the tank inlet pipe (313) and second output segment (407) from the tank outlet pipe (315). The connections between the second input segment (405) and tank inlet pipe (313), as well as the second output segment (407) and tank outlet pipe (315), can be facilitated by suitable pipe connectors configured to securely attach and easily detach the components as needed.

[0098] In some embodiments, the tank outlet pipe (315) comprises a second interior

opening (307) extending into the liquid tank (300), and the second heating source (309) is positioned near the second interior opening (307).

[0099] In some embodiments, the heating system further comprises:

[0100] A temperature monitoring module (501G) configured to monitor the temperature of the utility liquid inside the liquid tank (300). Preferably, the temperature monitoring module (501G) employs a temperature sensor.

[0101] An operation control module (502G) configured to adjust or control the computing unit (207) and/or the second heating source (309) based on the temperature measured by the temperature monitoring module (501G). Specifically, the operation may include activating the computing unit (207), executing high-load computational tasks, periodically performing computational tasks, stopping the operation of the computing unit (207), or turning the second heating source (309) on or off.

[0102] In some embodiments, the heating system further comprises a mode switch module (503G) configured to send instruction signals to the operation control module (502G). Specifically, when the mode switch module (503G) is switched to a liquid use mode, the operation control module (502G) closes the fourth valve (411) on the second output segment (407) to direct the utility liquid to flow through the tank inlet pipe (313) into the liquid tank (300) and further out of the liquid tank (300) through the tank outlet pipe (315). When the mode switch module (503G) is switched to a standby mode, the operation control module (502G) opens the fourth valve (411) and closes the third valve (319) on the tank outlet pipe (315), as well as the second valve (317) on the tank inlet pipe (313), to direct the utility liquid to circulate between the liquid tank (300) and the heat exchange unit (400).

[0103] In some embodiments, when the mode switch module (503G) is switched to a liquid use mode, the operation control module (502G) activates the second heating source (309) or maintains the second heating source (309) in an active state to heat the utility liquid inside the liquid tank (300). This ensures that, during prolonged use of the heated utility liquid (e.g., hot water for bathing), the temperature of the utility liquid exiting the liquid tank (300) is consistently maintained at the desired level.

[0104] In some embodiments, when the mode switch module (503G) is switched to a standby mode, the operation control module (502G) deactivates the second heating

source (309) or maintains the second heating source (309) in a deactivated state.

[0105] In some embodiments, when the mode switch module (503G) is switched to a standby mode, the operation control module (502G) is operable to: (i) activate the utility liquid pump (409) to initiate or enhance the circulation of the utility liquid in the second circuit; and/or (ii) activate the fluid pump (404) to initiate or enhance the circulation of the heat transfer fluid in the first circuit. This arrangement is designed to optimize heat transfer from the computing unit to the utility liquid within the liquid tank, ensuring that the utility liquid remains at the desired temperature during standby mode.

[0106] In some embodiments, when the temperature monitoring module (501G) detects that the temperature of the utility liquid in a third temperature zone within the liquid tank (300) falls below a third predetermined temperature threshold, the operation control module (502G) is operable to activate or enhance the heating process of the second heating source (309). Enhancing the heating process refers to increasing the heating power of the second heating source (309). The third temperature zone is defined to encompass the second interior opening (307).

[0107] In some embodiments, when the temperature monitoring module (501G) detects that the temperature of the heat transfer fluid inside the chamber (209) exceeds a fourth predetermined temperature threshold, the operation control module (502G) is operable to deactivate or reduce the operation of the computing unit (207), such as reducing runtime or employing periodic operation.

[0108] In some embodiments, the second heating source (309) is an electric heating element, such as a heating coil, a heating plate, a heating rod, or a heating pad. Specifically, the electric heating element comprises a power cable of the second heating source (309), which is plugged into the power adapter of the detachable heating apparatus (200C).

[0109] In some embodiments, the utility liquid is water suitable for domestic use.

[0110] In some embodiments, the exterior surface of the liquid tank (300) is provided with a thermal protection coating (113).

[0111] In some embodiments, the detachable heating apparatus (200C) is configured to be positioned below, above, or beside the liquid tank (300).

[0112] As described, the heating system of the present invention comprises a standby mode and a use mode. The standby mode refers to when the user does not need to use the liquid from the liquid tank (300), while the use mode refers to when the user requires the liquid from the liquid tank (300), such as for washing the face or taking a bath. When detecting user usage (e.g., when the user turns on a switch connected to the liquid tank (300)), the mode switch module automatically transitions between modes.

[0113] The heating system of the present invention provides dual heating modes, with the computing unit (207) serving as the primary heating source and the second heating source (309) as auxiliary. For example, when the heating system is in standby mode, the computing unit (207) heats the utility liquid circulating within the chamber (209), and the heated liquid returns to the liquid tank (300), maintaining a constant or near-constant temperature. When liquid demand is low, users can directly use the liquid from the liquid tank (300) in this "economy mode". When the heating system is in use mode and liquid demand is high (e.g., during peak usage), the second heating source (309) quickly heats the liquid in the liquid tank (300), continuously providing heated liquid to users in this "enhanced mode". Users can also select the desired mode via a preset control panel, such as a touchscreen or control buttons.

[0114] In some embodiments, the heating power of the computing unit (207) is significantly lower than that of the second heating source (309). For instance, the heating power of the computing unit (207) is 400W, while that of the second heating source (309) is 2000W. Furthermore, a relay may be configured between the heating control system, the second heating source (309), and the computing unit (207) to ensure that the two heating sources do not operate simultaneously. Under normal circumstances, only the computing unit (207) provides heating, and the second heating source (309) is activated only when rapid heating is required. In some embodiments, the computing unit (207) and the second heating source (309) may operate together to provide heating.

[0115] Embodiment 3

[0116] Referring to Fig. 1 and Fig. 2, this embodiment provides a heating apparatus (200C) comprising a chamber (209) and a heat exchange unit (400). The chamber (209) is configured to removably house a computing unit (207), which is configured to perform computational tasks and generate computing waste heat. The heat exchange unit (400) is configured to comprise:

[0117] (i) A first circuit comprising a first input segment (401), a first heat exchange segment (402), and a first output segment (403), sequentially connected. One end of the first input segment (401) and one end of the first output segment (403) are both connected to the chamber (209). The first heat exchange segment (402) is housed within the heat exchange unit (400), with its two ends connected to the other ends of the first input segment (401) and the first output segment (403), respectively. A fluid pump (404) (e.g., located on the first input segment (401)) is provided within the first circuit, enabling the heat transfer fluid to circulate between the chamber (209) and the heat exchange unit (400) under the action of the fluid pump (404).

[0118] (ii) A second circuit comprising a second input segment (405), a second heat exchange segment (406), and a second output segment (407), sequentially connected. One end of the second input segment (405) is connected to the tank inlet pipe (313), while one end of the second output segment (407) is connected to the tank outlet pipe (315). The second heat exchange segment (406) is housed within the heat exchange unit (400). A utility liquid pump (409) (e.g., located on the second input segment (401)) is provided within the second circuit to guide the utility liquid to circulate between the heat exchange unit (400) and the liquid tank (300).

[0119] In some embodiments, the heat exchange unit (400) is filled with a thermally conductive liquid medium, allowing the medium to exchange heat with both the first heat exchange segment (402) and the second heat exchange segment (406). Alternatively, the heat exchange unit (400) comprises a heat-conductive plate made of a thermally conductive material. This plate is provided with mounting grooves for the first heat exchange segment (402) and the second heat exchange segment (406), enabling direct heat exchange between the heat-conductive plate and the two heat exchange segments.

[0120] In some embodiments, if the heating apparatus (200C) is positioned above the liquid tank (300), a utility liquid pump (409) is provided on the second input segment (405). This pump (409) draws utility liquid from the liquid tank (300) into the tank inlet pipe (313) and the heat exchange unit (400). After heat exchange, the liquid flows back into the liquid tank (300) through the tank outlet pipe (315).

[0121] In other embodiments, if the heating apparatus (200C) is positioned below the liquid tank (300), the utility liquid within the liquid tank (300) flows into the tank inlet pipe (313) and the heat exchange unit (400) under the force of gravity. In this case, the utility

liquid pump (409) is provided on the second output segment (407) to ensure that, under the action of the pump (409), the heated utility liquid flows back into the liquid tank (300) through the tank outlet pipe (315).

[0122] Embodiment 4

[0123] Referring to [Fig. 3] and [Fig. 4], this embodiment provides a heating system (100G) comprising the heating apparatus (200C) described in Embodiment 3 and a liquid tank (300) equipped with a second heating source (309). The heating apparatus (200C) is installed above the liquid tank (300) using a pipeline-integrated approach.

[0124] In this embodiment, the top of the liquid tank (300) is provided with a tank inlet pipe (313) and a tank outlet pipe (315). The tank inlet pipe (313) includes a first interior opening (305) extending into the liquid tank (300), positioned near the bottom of the liquid tank (300). The tank outlet pipe (315) includes a second interior opening (307) extending into the liquid tank (300), positioned near the top of the liquid tank (300). The second heating source (309) is located near the second interior opening (307).

[0125] In this embodiment, the second input segment (405) of the detachable heating apparatus (200C) is connected to the tank inlet pipe (313), and the second output segment (407) is connected to the tank outlet pipe (315).

[0126] Referring to Fig. 4, when the fluid pump (404) and utility liquid pump (409) are both turned off, and the utility liquid enters the liquid tank (300) through the tank inlet pipe (313), the second heating source (309) inside the liquid tank (300) can be used to heat the utility liquid. The heated liquid is then supplied to the user through the tank outlet pipe (315). At this time, the third control valve (319) on the tank outlet pipe (315) is open; and, at the same time, the second valve (317) on the tank inlet pipe (313) is also open.

[0127] Referring to Fig. 5, when both the fluid pump (404) of the detachable heating apparatus (200C) and the utility liquid pump (409) are turned on, the heat transfer fluid in the chamber (209) circulates through the first circuit under the action of the fluid pump (404). Simultaneously, the utility liquid in the liquid tank (300) circulates through the second circuit under the action of the utility liquid pump (409). Heat exchange occurs in the heat exchange unit (400). After exchanging heat, the heat transfer fluid returns to the chamber (209) through the first circuit for reheating by the computing unit (207), while the heated utility liquid returns to the liquid tank (300) through the second circuit. At this time,

the third valve (319) on the tank outlet pipe (315) is closed, and the fourth valve (411) on the second output segment (407) is open; and, at the same time, the second valve (317) on the tank inlet pipe (313) is closed.

[0128] Embodiment 5

[0129] Referring to Fig. 6, this embodiment of the heating system comprises all components described in Embodiment 4, along with a heating control system (500G), which specifically comprises:

[0130] A mode switch module (503G) configured to switch to the corresponding operating mode upon receiving a mode switch trigger signal. The mode switch module (503G) sends instruction signals to the operation control module (502G) to activate or adjust the operation of the computing unit (207) or the second heating source (309).

[0131] A temperature monitoring module (501G) configured to monitor the temperature of the utility liquid inside the liquid tank (300) and the temperature of the heat transfer fluid inside the chamber (209).

[0132] An operation control module (502G) configured to:

[0133] In standby mode, activate the fluid pump (404) and the utility liquid pump (409), and close the second valve (317) on the tank inlet pipe (313) and the third valve (319) on the tank outlet pipe (315). The heat transfer fluid circulates between the chamber (209) and the heat exchange unit (400) through the first circuit, while the utility liquid circulates between the liquid tank (300) and the heat exchange unit (400) through the second circuit. This allows heat exchange to occur within the heat exchange unit (400), and the heated utility liquid returns to the liquid tank (300) through the second circuit.

[0134] In use mode, deactivate the fluid pump (404) and the utility liquid pump (409), and open the second valve (317) and the third valve (319). This directs the utility liquid through the tank inlet pipe (313) into the liquid tank (300), where it is heated by the second heating source (309) before flowing through the second interior opening (307) into the tank outlet pipe (315) and exiting the liquid tank (300). (For smaller usage demands, only the third valve (319) may be opened, allowing utility liquid to flow directly out of the tank outlet pipe (315).)

[0135] In some embodiments, during use mode, if the temperature monitoring module

(501G) detects that the temperature in the third temperature zone of the liquid tank (300) falls below a third predetermined temperature threshold, it triggers the activation or enhancement of the heating process of the second heating source (309). The third temperature zone is defined to encompass the second interior opening (307).

[0136] In some embodiments, during standby mode, if the temperature monitoring module (501G) detects that the temperature of the heat transfer fluid inside the chamber (209) exceeds a fourth predetermined temperature threshold, it triggers the operation control module (502G) to deactivate or reduce the operation of the computing unit (207).

[0137] Accordingly, this embodiment of the heating system provides dual heating modes: the computing unit (207) serves as the primary heat source, with the second heating source (309) as an auxiliary. For example, in standby mode, the computing unit (207) heats the heat transfer fluid circulating through the chamber (209). The heated heat transfer fluid circulates to the heat exchange unit (400) to transfer heat to the utility liquid circulating from the liquid tank (300). This process maintains a constant or near-constant temperature in the liquid tank (300), allowing users to use the utility liquid directly, especially during low-demand periods. In use mode, when demand is high (e.g., during peak periods), the second heating source (309) rapidly heats the utility liquid in the liquid tank (300), providing a continuous supply of heated liquid to users.

[0138] In some embodiments, during use mode, if the temperature monitoring module (501G) detects a significant temperature drop in the third temperature zone of the liquid tank (300) (e.g., a temperature drop exceeding a preset threshold within a specified time), the module triggers the operation control module (502G) to activate or enhance the heating process of the second heating source (309).

[0139] In some embodiments, a flow sensor may be installed on the tank inlet pipe (313) or tank outlet pipe (315). If the flow sensor detects significant water flow (e.g., flow rate exceeding a preset threshold or sustained flow above the threshold for a specific duration), it triggers the operation control module (502G) to activate or turn on the second heating source (309).

[0140] In some embodiments, a timer may be configured in the operation control module (502G). When the timer reaches a specified time, the operation control module (502G) activates or turns on the second heating source (309).

[0141] In some embodiments, when a user manually switches the operating mode via a control panel or remote control, the mode switch module (503G) receives the corresponding mode switch trigger signal. The operating modes include standby mode and use mode. In other embodiments, the system can automatically detect a transition to use mode when the user opens a switch connected to the tank outlet pipe (315), such as a water tap.

[0142] In recent years, the demand for energy-efficient solutions has become increasingly important across various industries, including computing and household utilities. As computational tasks become more intensive, the heat generated by computing units has become a significant concern, often requiring additional cooling mechanisms to prevent overheating and ensure optimal performance. This waste heat, if not managed properly, can lead to increased energy consumption and higher operational costs.

[0143] Simultaneously, the need for efficient water heating systems in residential and commercial settings has been a persistent challenge. Traditional water heating methods often rely on significant energy input to maintain or achieve desired temperatures, leading to increased energy usage and costs. The integration of computing systems with household utilities presents an opportunity to address these challenges by repurposing waste heat for practical applications, such as heating water, thereby enhancing energy efficiency and reducing overall energy consumption.

[0144] Accordingly, the present invention provides a technical solution that leverages the waste heat generated by the computing unit (207) in a detachable heating apparatus (200) to heat the utility liquid inside a liquid tank (300), to which the detachable heating apparatus (200) is attached. This arrangement allows the heat generated by the computing unit (207) to maintain the utility liquid in the liquid tank (300) at a stable temperature or gradually bring it closer to a stable temperature over time. Consequently, when only a small amount of liquid is needed (e.g., for handwashing during winter or cleaning a small coffee cup), the liquid at or near the maintained temperature can be used directly, eliminating the need to activate the second heating source (309) for additional heating. Conversely, for larger quantities of liquid (e.g., extensive dishwashing or showering), the second heating source (309) can then be activated to heat the liquid, thereby achieving significant energy savings.

[0145] It should be further appreciated by the person skilled in the art that variations and combinations of features described above, not being alternatives or substitutes, may be combined to form yet further embodiments falling within the intended scope of the invention.

[0146] As would be understood by a person skilled in the art, each embodiment, may be used in combination with other embodiment or several embodiments.

Claims

Claim 1. A detachable heating apparatus (200), comprising:

a chamber (209) and a computing unit (207) housed inside the chamber (209); wherein the computing unit (207) is operable to perform a computing task and generate computing waste heat;

a heat exchange unit (400), comprising:

(i) a first circuit configured to liquidly connect the chamber (209) and direct a heat transfer fluid to flow between the chamber (209) and the heat exchange unit (400); and

(ii) a second circuit configured to be liquidly connectable to a tank inlet pipe (313) and a tank outlet pipe (315) of a liquid tank (300) to direct a utility liquid to flow between the heat exchange unit (400) and the liquid tank (300);

wherein,

the first circuit is operable to direct the heat transfer fluid through the chamber (209) to absorb the computing waste heat from the computing unit (207) and transfer the heat transfer fluid to the heat exchange unit (400); and

the second circuit is operable to direct the utility liquid from the liquid tank (300) through the heat exchange unit (400) to exchange heat with the heat transfer fluid, and then return the utility liquid to the liquid tank (300).

Claim 2. The detachable heating apparatus (200) according to Claim 1, wherein the first circuit comprises a first input segment (401), a first heat exchange segment (402) and a first output segment (403), liquidly connected together in sequence;

wherein the first input segment (401) and the first output segment (403) are configured to be liquidly connected to the chamber (209), and the first heat exchange segment (402) is configured to be housed inside the heat exchange unit (400).

Claim 3. The detachable heating apparatus (200) according to Claim 1 or 2, wherein the second circuit comprises a second input segment (405), a second heat exchange segment (406) and a second output segment (407), liquidly connected together in sequence;

wherein the second input segment (401) is configured to be connectable to the tank inlet pipe (313), the second output segment (407) is configured to be connectable to the tank outlet pipe (315), and the second heat exchange segment (406) is configured to be housed inside the heat exchange unit (400).

Claim 4. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the first input segment (401) comprises a fluid pump (404) configured to pump the heat transfer fluid from the first exchange segment (402) into the chamber (209).

Claim 5. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the second input segment (405) comprises a utility liquid pump (409) configured to pump the utility liquid from the tank inlet pipe (313) into the heat exchange unit (400).

Claim 6. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the chamber (209) further comprises one or more of the following placed upon the computing unit (207):

a radiator, a vapour chamber, a graphene sheet and peltier element;

wherein the radiator is optionally made of aluminium, copper, graphite-based composite or ceramic-coated metal.

Claim 7. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the computing unit (207) comprises one or more of: a bitcoin miner, a cryptocurrency miner, a server-grade central processing unit (CPU), a simulation processor and an artificial intelligence-related computing unit; wherein the artificial intelligence-related computing unit comprises one or more of: a graphics processing unit

(GPU), a tensor processing unit (TPU), an AI accelerator and a neural processing unit (NPU).

Claim 8. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the computing unit (207) is arranged to be in data communication with a network.

Claim 9. The detachable heating apparatus (200) according to any one of the preceding claims, wherein, further comprising a thermal protection coating on exterior surface of one or more of: the chamber (209), the first output segment (403), the second output segment (407), and the heat exchange unit (400).

Claim 10. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the computing unit (207) is configured to be removable from the chamber (209).

Claim 11. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the chamber (209) further comprises an attachment element configured to secure the chamber (209) to the liquid tank (300).

Claim 13. The detachable heating apparatus (200) according to Claim 11, wherein the attachment element is integrally formed on the exterior surface of the chamber (209).

Claim 14. The detachable heating apparatus (200) according to Claim 13, wherein the attachment element is configured to be detachably connected to the chamber (209)

Claim 15. The detachable heating apparatus (200) according to any one of the preceding claims, wherein the second output segment comprises a fourth valve operable to regulate flow of the utility liquid.

Claim 16. The detachable heating apparatus (200) according to any one of the preceding claims, wherein, further comprising a power adapter configured to connect to an electrical power cable of the liquid tank (300) and to plug into an electrical power socket.

Claim 17. A heating system, comprising:

the detachable heating apparatus (200) according to any one of Claims 1 – 16, and the liquid tank (300);

wherein the second input segment (405) of the detachable heating apparatus (200) is liquidly connected to the tank inlet pipe (313), and the second output segment (407) is liquidly connected to the tank outlet pipe (315); wherein the tank inlet pipe (313) comprises a first interior opening (305) extending inside the liquid tank (300);

wherein the liquid tank (300) comprises a second heating source (309) housed inside the liquid tank (300).

Claim 18. The heating system according to Claim 17, wherein the tank outlet pipe (315) comprises a second interior opening (307) extending into the liquid tank (300); and wherein the second heating source (309) is positioned in proximity to the second interior opening (307).

Claim 19. The heating system according to Claim 17 or 18, further comprising:

a temperature monitoring module (501) operable to detect and measure temperature of the utility liquid inside the liquid tank (300); and

an operation control module (502) operable to adjust operation of the computing unit (207) and/or the second heating source (309) according to the temperature of the utility liquid measured by the temperature monitoring module (501).

Claim 20. The heating system according to Claim 19, further comprising:

a mode switch module (503) operable to transmit an instruction signal to the operation control module (502); wherein,

when the mode switch module (503) is switched to a liquid use mode,

the operation control module (502) is operable to deactivate the fourth valve (411) to direct the utility liquid to flow through the tank inlet pipe (313) into the liquid tank (300), and further out of the liquid tank (300) through the tank outlet pipe (315);

when the mode switch module (503) is switched to a standby mode,

the operation control module (502) is operable to activate the fourth valve and deactivate a third valve of the tank outlet pipe (315), to direct the utility liquid to circulate between the liquid tank (300) and the heat exchange unit (400) through the second circuit.

Claim 21. The heating system according to Claim 20, wherein, when the mode switch module (503) is switched to the liquid use mode, the operation control module (502) activates the second heating source (309) or maintains the second heating source (309) in an active state to heat the utility liquid inside the liquid tank (300).

Claim 22. The heating system according to Claim 20 or 21, wherein, when the mode switch module (503) is switched to the standby mode, the operation control module (502) deactivates the second heating source (309) or maintains the second heating source (309) in a deactivated state.

Claim 23. The heating system according to any one of Claims 20 – 22, wherein, when the mode switch module (503) is switched to the standby mode, the operation control module (502) is operable to:

(i) activate the utility liquid pump (409) to initiate or enhance circulation of the utility liquid through the second circuit; and/or

(ii) activate the fluid pump (404) to initiate or enhance circulation of the heat transfer fluid through the first circuit.

Claim 24. The heating system according to any one of Claims 17 – 23, wherein, when the temperature monitoring module (501) detects that the temperature of the utility liquid in a third temperature zone within the liquid tank (300) drops below a third predetermined temperature threshold, the operation control module (502) is operable to activate or enhance the heating process of the second heating source (309).

Claim 25. The heating system according to Claim 24, wherein the third temperature zone is defined to encompass a second interior opening (307).

Claim 26. The heating system according to any one of Claims 17 – 25, wherein, when the temperature monitoring module (501) detects that the temperature of the heat transfer fluid inside the chamber (209) exceeds a fourth predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (207).

Claim 27. The heating system according to any one of Claims 17 – 26, wherein the second heating source (309) is an electrical heating element.

Claim 28. The heating system according to Claim 27, wherein the electrical heating element is a heating coil, a heating plate, a heating rod or a heating pad.

Claim 29. The heating system according to Claim 27 or 28, wherein the electrical heating element comprises a power cable of the second heating source (309) that is plugged into a power adapter of the detachable heating apparatus (200).

Claim 30. The heating system according to any one of Claims 17 – 29, wherein the utility liquid is water suitable for domestic use.

Claim 31. The heating system according to any one of Claims 17 – 30, wherein the liquid tank (300) comprises a thermal protection coating on exterior surface of the liquid tank (300).

Claim 32. The heating system according to any one of Claims 17 – 31, wherein the detachable heating apparatus (200) is configured to be positioned below, above, or beside the liquid tank (300).