# DESCRIPTION

## TITLE OF INVENTION: [A HEATING APPARATUS WITH AN INTEGRATED MULTI-COMPARTMENT 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 heating apparatus (100), comprising: a first compartment (101) configured to hold liquid to be heated; wherein the first compartment (101) comprises: a first liquid channel (109) configured to direct the liquid from outside the first compartment (101) into the first compartment (101), and; a second liquid channel (111) configured to direct the liquid out of the first compartment (101); wherein the first liquid channel (109) is configured to comprise a first inlet (117) configured to receive the liquid from outside the first compartment (101) and a first outlet (119) configured to release the liquid from the first liquid channel (109) into the first compartment (101); wherein the second liquid channel (111) is configured to comprise a second inlet (123) configured to receive the liquid from the first compartment (101), and a second outlet (121) configured to direct the liquid from the second liquid channel (111) out of the first compartment (101); a second compartment (103) configured to be attached to the first compartment (101) at an attachment surface (102); wherein the second compartment (103) is configured to house a computing unit (107) operable to perform a computing task and generate computing waste heat.

**[0008]** In some embodiments, the first outlet (119) is configured to be positioned in proximity to the attachment surface (102); and the second inlet (123) is configured to be positioned distal to the attachment surface (102).

**[0009]** In some embodiments, the heating apparatus (100) further comprises a first heating source (115) configured to be positioned inside the first compartment (101).

**[0010]** In some embodiments, the first heating source (115) is configured to be positioned in proximity to the second inlet (123).

**[0011]** In some embodiments, the first heating source (115) is an electrical heating element.

**[0012]** In some embodiments, the electrical heating element is a heating coil, a heating plate, a heating rod or a heating pad.

**[0013]** In some embodiments, the second compartment (103) is configured to further house a first heat transfer facilitation element (105) configured to be positioned between the computing unit (107) and the attachment surface (102).

**[0014]** In some embodiments, the first heat transfer facilitation element (105) is a radiator, a vapour chamber, a graphene sheet, or one or more peltier elements.

**[0015]** In some embodiments, the radiator is made of aluminium, copper, graphite-based composite or ceramic-coated metal.

**[0016]** In some embodiments, the radiator is liquid-containing layer configured to contain a heat-transfer liquid for facilitating heat transfer between the computing unit (107) and the attachment surface (102).

**[0017]** In some embodiments, the heat-transfer liquid is water or mineral oil.

**[0018]** In some embodiments, the heating apparatus (100) further comprises a second heat transfer facilitation element (125) configured to be in thermal contact with the first heat transfer facilitation element (105), and extends across the attachment surface (102) into the first compartment (101).

**[0019]** In some embodiments, second heating transfer facilitation element (125) comprises a heat dissipation end (127) configured to be positioned in proximity to the first outlet (119).

**[0020]** In some embodiments, the second heating transfer facilitation element (125) is configured to comprise one or more of: rod, pad, plate, pad and pipe.

**[0021]** In some embodiments, the pipe is configured to house heat transfer liquid, circulating between the first compartment (101) and the second compartment (103) through the pipe.

**[0022]** In some embodiments, the liquid is water suitable for domestic use.

**[0023]** In some embodiments, the first compartment (101) comprises a thermal protection coating (113) on exterior surface of the first compartment (101).

**[0024]** In some embodiments, the second compartment (103) comprises a thermal protection coating (113) on exterior surface of the second compartment (103).

**[0025]** In some embodiments, the first compartment (101) is configured to be positioned above the second compartment (103).

**[0026]** In some embodiments, the attachment surface (102) is bottom surface of the first compartment (101), and the first inlet (117) and the second inlet (121) are configured to be positioned on top surface of the first compartment (101).

**[0027]** In some embodiments, the second compartment (103) is configured to be positioned beside the first compartment (101).

**[0028]** In some embodiments, the computing unit (107) comprises one or more of: 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).

**[0029]** In some embodiments, the computing unit (107) is arranged to be in data communication with a network.

**[0030]** In some embodiments, the heating apparatus (100) further comprises a heating control system (500) arranged to control heating process of the heating apparatus (100); wherein the heating control system (500) comprises: a temperature monitoring module (501) operable to detect and measure temperature of the liquid inside the first compartment (101) and/or inside the second compartment (103); and, an operation control module (502) operable to adjust operation of the computing unit (107) and/or the first heating source (115) according to the temperature of the liquid measured by the temperature monitoring module (501).

**[0031]** In some embodiments, wherein, when the temperature monitoring module (501) detects that the temperature of the liquid at a first temperature zone within the first compartment (101) drops below a first predetermined temperature threshold, the operation control module (502) is operable to activate or enhance the heating process of the first heating source (115).

**[0032]** In some embodiments, the first temperature zone is defined to encompass the second inlet (123).

**[0033]** In some embodiments, wherein, when the temperature monitoring module (501) detects that the temperature of the liquid at a second temperature zone within the first compartment (101) exceeds a second predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (107).

**[0034]** In some embodiments, the second temperature zone is defined to cover the attachment surface (102).

**[0035]** In some embodiments, wherein, when the temperature monitoring module (501) detects that the temperature inside the second compartment (103) exceeds a second predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (107).

**[0036]** In some embodiments, the heating apparatus (100) further comprises a mode switch module (503) arranged to transmit an instruction signal to the operation control module; when the mode switch module (503) is switched to a liquid use mode, the operation control module is operable to activate the first heating source (115); when the mode switch module (503) is switched to a standby mode, the operation control module is operable to deactivate the first heating source (115).

**[0037]** In some embodiments, wherein, when the mode switch module (503) is switched to the standby mode, operation control module is operable to also regulate the operation of the computing unit (107).

**[0038]** In some embodiments, the computing unit (107) is configured to be removable from the second compartment (103).

**[0039]** 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

**[0040]** In the figures, which illustrate, by way of non-limiting examples only, embodiments of the present invention,

**[0041]** **[Fig. 1]:** illustrates a perspective view of a heating apparatus according to various embodiments of the present invention.

**[0042]** **[Fig. 2]:** illustrates another perspective view of a heating apparatus according to various embodiments of the present invention.

**[0043]** **[Fig. 3]:** illustrates an exploded view showing various components of a heating apparatus according to various embodiments of the present invention.

**[0044]** **[Fig. 4]:** illustrates a front cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0045]** **[Fig. 5]:** illustrates a perspective cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0046]** **[Fig. 6]:** illustrates a bottom cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0047]** **[Fig. 7]:** illustrates a perspective view of a heating apparatus according to various embodiments of the present invention.

**[0048]** **[Fig. 8]:** illustrates a front cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0049]** **[Fig. 9]:** illustrates a front cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0050]** **[Fig. 10]:** illustrates a perspective cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0051]** **[Fig. 11]:** illustrates a bottom cross-sectional view of a heating apparatus according to various embodiments of the present invention.

**[0052]** **[Fig. 12]:** illustrates a heating apparatus according to various embodiments of the present invention.

**[0053]** **[Fig. 13]:** illustrates a heating apparatus according to various embodiments of the present invention.

**[0054]** **[Fig. 14]:** illustrates, in a block diagram, a heating control system according to various embodiments of the present invention.

**[0055]** **DETAILED DESCRIPTION**

**[0056]** 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”.

**[0057]** 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.

**[0058]** 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.

**[0059]** **Embodiment 1 Heating Apparatus (Integrated Multi-Compartment Design)**

**[0060]** The present invention provides a heating apparatus (100B), which includes a first compartment (101) configured to contain liquid to be heated and a second compartment (103) configured to house a computing unit (107). The second compartment (103) is connected to the first compartment (101) at an attachment surface (102). The heat generated by the computing unit (107) during computation tasks (such as bitcoin mining, crypto mining, artificial intelligence computing) can be used to heat the liquid within the first compartment (101).

**[0061]** The first compartment (101) is provided with a first liquid channel (109) for introducing liquid (e.g., ambient-temperature liquid, such as water for domestic use) from outside the first compartment (101) into the first compartment (101) and a second liquid channel (111) for discharging liquid (e.g., heated liquid, such as hot water) from the first compartment (101). The first liquid channel (109) comprises a first inlet (117) for receiving liquid from outside the first compartment (101) and a first outlet (119) for releasing liquid into the first compartment (101).

**[0062]** The first outlet (119) is positioned within the first compartment (101),

proximate to the attachment surface (102) or the second compartment (103), allowing the low-temperature liquid entering the first compartment (101) to absorb heat dissipated from the second compartment (103) and become heated efficiently.

**[0063]** In some embodiments, the first inlet (117) is located on the upper surface of the first compartment (101) and may extend outward. The second liquid channel (111) comprises a second inlet (123) for receiving liquid from the first compartment (101) and a second outlet (121) for discharging liquid from the second liquid channel (111). The second inlet (123) is positioned adjacent to a first heating source (115) within the first compartment (101), enabling the liquid exiting the first compartment (101) to be heated to the desired temperature as needed (e.g., when large amount of the hot water is being used for extensive dish washing or showering). In some embodiments, the second outlet (121) is located on the upper surface of the first compartment (101) and may extend outward.

**[0064]** In some embodiments, the first heating source (115) is an electric heating element, such as a heating coil, heating plate, heating rod, or heating pad.

**[0065]** To enhance heat exchange efficiency, the second compartment (103) is located above the first compartment (101) and comprises a first heat transfer facilitation element (105) positioned between the computing unit (107) and the attachment surface (102). The first heat transfer facilitation element (105) is fixed on the attachment surface (102), which is in some embodiments the bottom surface of the first compartment (101). The computing unit (107) is fixed or detachable within the second compartment (103).

**[0066]** In some embodiments, the attachment surface (102) features an opening to allow direct contact between the first heat transfer facilitation element (105) and the liquid within the first compartment (101). This enables heat exchange but requires sealing between the attachment surface and the first heat transfer facilitation element (105). Alternatively, the attachment surface (102) may fully separate the first and second compartments, with the first heat transfer facilitation element (105) mounted on the side of the attachment surface facing the second compartment (103). In such embodiments, the attachment surface (102) is made of a thermally conductive material.

**[0067]** In some embodiments, the first heat transfer facilitation element (105) is a radiator, vapor chamber, graphene sheet, or one or more Peltier elements. The radiator can be made of aluminum, copper, graphite-based composites, or ceramic-coated metal. In further embodiments, the radiator includes a liquid-containing layer configured to hold a heat transfer liquid (e.g., water or mineral oil) for facilitating heat transfer between the computing unit (107) and the attachment surface (102).

**[0068]** The second compartment (103) may also be located beside the first compartment (101), as show in Fig. 13.

**[0069]** In some embodiments, the computing unit (107) includes components such as a bitcoin miner, a cryptocurrency miner, server-grade CPU, simulation processor, or an artificial intelligence-related computing unit. 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).

**[0070]** The computing unit (107) is configured for 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 (107) includes a wireless communication module with a wireless communication chip and antenna. This ensures stable connectivity for computational tasks like Bitcoin mining and AI computation.

**[0071]** In some embodiments, the computing unit (107) 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 (107) 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

(107) remains within the extended communication range, allowing for stable connectivity regardless of the placement of the heating apparatus.

**[0072]**

**[0073]** The system may also include additional wireless communication devices, such as EDGE, 2G, 3G, 4G, 5G, or future iterations, to maintain functionality in scenarios without internet access. To address connection interruptions, the system can notify users via mobile apps, push notifications, or other communication means. When a connection issue is detected, the operation control module (502) may reduce heating functionality by instructing the computing unit (107) to halt computation tasks.

**[0074]** 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.

**[0075]** 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 (502) may issue a control signal to the computing unit (107), 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.

**[0076]** 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.

**[0077]** 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.

**[0078]** 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.

**[0079]** 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.

**[0080]** 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.

**[0081]** 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.

**[0082]** 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.

**[0083]** 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.

**[0084]** 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.

**[0085]** 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.

**[0086]** 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.

**[0087]** 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.

**[0088]** 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.

**Embodiment 2:**

**[0089]** Referring to Figures 7 to 11, the present invention also provides another heating apparatus (100C), which includes the components described in Embodiment 1. The difference is that the heating apparatus (100C) in this embodiment further includes: a second heat transfer facilitation element (125), configured to be in thermal contact with the first heat transfer facilitation element (105) and extend across the attachment surface (102) into the first compartment (101) (e.g., the first heat transfer facilitation element (105) penetrates the bottom of the first compartment (101)). This arrangement enhances the transfer of heat from the computing unit (107) to the liquid within the first compartment (101), enabling more effective cooling of the computing unit (107) and more efficient heating of the liquid in the first compartment (101) simultaneously.

**[0090]** Specifically, the second heat transfer facilitation element (125) comprises a heat dissipation end (127), configured to be positioned near the first outlet (119).

**[0091]** In some embodiments, the second heat transfer facilitation element (125) is configured to comprise one or more of the following forms: rod, pad, plate, pad, and pipe.

**[0092]** In some embodiments, if the second heat transfer facilitation element (125) is a pipe, the pipe is configured to hold a heat transfer liquid (e.g., water, mineral oil or any other liquid or fluid suitable for efficient heat transfer), which circulates between the first compartment (101) and the second compartment (103) through the pipe.

**[0093]** In some embodiments, to prevent unnecessary heat loss from the heating apparatus to the ambient environment, the external surface of the first compartment (101) is provided with a thermal protection coating (113).

**[0094]** In some embodiments, to prevent heat loss, the external surface of the second compartment (103) is also provided with a thermal protection coating (113).

**[0095]** Referring to Figures 9 to 11, in other embodiments, if the attachment surface (102) comprises an opening and the first heat transfer facilitation element (105) is installed in the opening such that the first heat transfer facilitation element (105) directly contacts the liquid to be heated inside the first compartment (101), the heat dissipation end (127) can be directly installed on the first heat transfer facilitation element (105) to enhance efficiency.

**Embodiment 3: Heating Control System**

**[0096]** Referring to Figure 14, the heating apparatus in this embodiment, in addition to the components described in the previous embodiments, further comprises a heating control system (500) for controlling the heating process. The heating control system (500) comprises the following components:

**[0097]** The temperature monitoring module (501) detects and measures the temperature of the liquid within the first compartment (101) and/or the second compartment (103). In some embodiments, the temperature monitoring module (501) comprises temperature sensors. Specifically, at least two temperature sensors may be installed within the first compartment (101) to monitor the first temperature zone and the second temperature zone, respectively.

**[0098]** The operation control module (502) adjusts the operation of the computing

unit (107) and/or the first heating source (115) based on the liquid temperature measured by the temperature monitoring module (501). The adjustments may include activating the computing unit (107), executing intensive or periodic computation tasks, stopping the operation of the computing unit (107), or turning the first heating source (115) on or off.

**[0099]** In some embodiments, when the temperature monitoring module (501) detects that the liquid temperature in the first temperature zone within the first compartment (101) is below a first predetermined temperature threshold, the operation control module (502) initiates or enhances the heating process of the first heating source (115). Enhancing the heating process refers to increasing the heating power of the first heating source (115). The first temperature zone is defined as the area surrounding the second inlet (123).

**[0100]** In other embodiments, when the temperature monitoring module (501) detects that the liquid temperature in the second temperature zone within the first compartment (101) exceeds a second predetermined temperature threshold, the operation control module (502) stops or reduces the operation of the computing unit (107). For example, this may involve reducing operation time or switching to periodic operation. The second temperature zone may be defined as the area surrounding the first outlet (119), the area around the attachment surface (102), or the area surrounding the heat dissipation end (127).

**[0101]** In some embodiments, at least one temperature sensor is installed within the second compartment (103). If the operation control module (502) determines from this sensor’s temperature data that the temperature inside the second compartment (103) exceeds a second or third predetermined temperature threshold, it stops or reduces the operation of the computing unit (107).

**[0102]** The heating control system further comprises a mode switching module (503) that transmits instruction signals to the operation control module (502). When the mode switching module (503) is set to a "use mode," the operation control module (502) activates the first heating source (115) to begin operation (e.g., perform computation tasks). When the mode switching module (503) is set to a "standby mode," the operation control module (502) stops the operation of the first heating source (115). In some embodiments, when the mode switching module (503) is set to

standby mode, the operation control module (502) also adjusts the operation of the computing unit (107).

**[0103]** In this embodiment, the heating apparatus operates in two modes: standby mode and use mode. Standby mode is used when the user does not require heated liquid, whereas use mode is for scenarios where the user needs heated liquid, such as for washing their face or bathing. When user activity is detected (e.g., opening the valve connected to the second liquid channel (111)), the mode switching module (503) automatically changes the mode.

**[0104]** The heating apparatus in this embodiment supports dual heating modes. The computing unit (107) serves as one heating source, while the first heating source (115) serves as another. These two heating sources are positioned at different heights within the first compartment (101), dividing it into upper and lower heating zones. The computing unit (107) heats the lower zone (liquid with lower temperature, higher density), and the first heating source (115) heats the upper zone (liquid with higher temperature, lower density). In other embodiments, the first compartment (101) may be oriented horizontally, with the second compartment (103) positioned adjacent to one side of the first compartment (101). The second compartment (103) can be arranged relative to the first compartment (101) in various configurations, provided the waste heat from the computing unit (107) is directed to a low-temperature zone within the first compartment (101) (e.g., the bottom region of the first compartment (101)). In this zone, the first liquid channel (109) directs lower-temperature liquid. Meanwhile, the first heating source (115) can be positioned in the high-temperature zone (e.g., the top region of the first compartment (101)), where the second liquid channel (111) facilitates the discharge of heated liquid from the first compartment (101).

For example, in the case of a horizontally oriented first compartment (101), such as a cylindrical water tank, the first liquid channel (109) can be configured to enter through the bottom surface, where denser cold water naturally accumulates. This ensures that cold water is directed to the bottom region of the first compartment (101), where the second compartment (103), housing the computing unit (107), is located, positioned nearby, or equipped with a heat exchange unit to transfer heat to this region. Similarly, the second liquid channel (111) can be configured to exit from the top region, enabling the efficient discharge of less dense hot water, which naturally rises.

**[0105]** In standby mode or use mode with low liquid demand (e.g., washing hands or face), only the computing unit (107) is used for heating, referred to as the "economic mode." In use mode with high liquid demand, where low-temperature liquid continuously enters through the first liquid channel (109) and heated liquid exits through the second liquid channel (111), the first heating source (115) is activated for rapid heating, referred to as the "enhanced mode". In some cases, only the first heating source (115) is used for heating during high demand. Alternatively, both the first heating source (115) and the computing unit (107) can operate simultaneously. In some embodiments, the heating power of the computing unit (107) is significantly lower than that of the first heating source (115), such as 400W for the computing unit (107) and 2000W for the first heating source (115).

**[0106]** In standby mode, the operation control module (502) sends instructions to the computing unit (107) to activate and execute computation tasks, using the generated heat to warm the liquid within the first compartment (101). The temperature monitoring module (501) continuously or periodically monitors the liquid temperature in the second temperature zone. If the temperature exceeds a second predetermined threshold, the operation control module (502) reduces or stops the operation of the computing unit (107).

**[0107]** In use mode with low liquid demand, the computing unit (107) maintains the liquid at the desired temperature, eliminating the need to activate the first heating source (115), thereby conserving energy. For high liquid demand such as extensive dish washing and bathing, when the computing unit (107) alone cannot maintain the desired liquid temperature due to the continuous flow of low-temperature liquid into the first compartment (101), the operation control module (502) activates the first heating source (115) for rapid heating.

**[0108]** In some embodiments, flow sensors installed on the first or second liquid channels allow the operation control module (502) to determine liquid demand and adjust heating accordingly. In other embodiments, the control system includes adaptive learning capabilities, pre-activating the first heating source (115) during peak demand periods.

**[0109]** Users can manually select the heating mode via a control panel on the heating apparatus or through remote control. In some embodiments, the duty cycle of

the computing unit (107) is modulated to improve efficiency, and the 2000W heating element can be activated using short pulses during peak demand.

**[0110]** The operation control module (502) can also be programmed with a start time for the first heating source (115), enabling scheduled activation.

**[0111]** 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.

**[0112]** 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.

**[0113]** Accordingly, the present invention provides a technical solution that leverages the waste heat generated by the computing unit (107) in the second compartment (103) during intensive computational tasks to heat the liquid within the first compartment (101), to which the second compartment (103) is attached. This arrangement allows the heat generated by the computing unit (107) to maintain the liquid in the first compartment (101) 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 first heating source (115) for additional heating. Conversely, for larger quantities of liquid (e.g., extensive dishwashing or showering), the first heating source (115) can be activated to heat the liquid, thereby achieving significant energy savings.

**[0114]** 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.

**[0115]** 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 heating apparatus (100), comprising:

a first compartment (101) configured to hold liquid to be heated; wherein the first compartment (101) comprises: a first liquid channel (109) configured to direct the liquid from outside the first compartment (101) into the first compartment (101), and; a second liquid channel (111) configured to direct the liquid out of the first compartment (101);

wherein the first liquid channel (109) is configured to comprise a first inlet (117) configured to receive the liquid from outside the first compartment (101) and a first outlet (119) configured to release the liquid from the first liquid channel (109) into the first compartment (101);

wherein the second liquid channel (111) is configured to comprise a second inlet (123) configured to receive the liquid from the first compartment (101), and a second outlet (121) configured to direct the liquid from the second liquid channel (111) out of the first compartment (101);

a second compartment (103) configured to be attached to the first compartment (101) at an attachment surface (102); wherein the second compartment (103) is configured to house a computing unit (107) operable to perform a computing task and generate computing waste heat.

Claim 2. The heating apparatus (100) according to Claim 1, wherein the first outlet (119) is configured to be positioned in proximity to the attachment surface (102); and the second inlet (123) is configured to be positioned distal to the attachment surface (102).

Claim 3. The heating apparatus (100) according to Claim 1 or 2, wherein further comprising a first heating source (115) configured to be positioned inside the first compartment (101).

Claim 4. The heating apparatus (100) according to Claim 3, wherein the first heating source (115) is configured to be positioned in proximity to the second inlet (123).

Claim 5. The heating apparatus (100) according to Claim 3 or 4, wherein the first heating source (115) is an electrical heating element.

Claim 6. The heating apparatus (100) according to Claim 5, wherein the electrical heating element is a heating coil, a heating plate, a heating rod or a heating pad.

Claim 7. The heating apparatus (100) according to any one of the preceding claims, wherein the second compartment (103) is configured to further house a first heat transfer facilitation element (105) configured to be positioned between the computing unit (107) and the attachment surface (102).

Claim 8.The heating apparatus (100) according to Claim 7, wherein the first heat transfer facilitation element (105) is a radiator, a vapour chamber, a graphene sheet, or one or more peltier elements.

Claim 9. The heating apparatus (100) according to Claim 8, wherein the radiator is made of aluminium, copper, graphite-based composite or ceramic-coated metal.

Claim 10. The heating apparatus (100) according to Claim 8, wherein the radiator is liquid-containing layer configured to contain a heat-transfer liquid for facilitating heat transfer between the computing unit (107) and the attachment surface (102).

Claim 11. The heating apparatus (100) according to Claim 10, wherein the heat-transfer liquid is water or mineral oil.

Claim 12. The heating apparatus (100) according to any one of Claims 7 – 11, wherein further comprising a second heat transfer facilitation element (125) configured to be in

thermal contact with the first heat transfer facilitation element (105), and extends across the attachment surface (102) into the first compartment (101).

Claim 13. The heating apparatus (100) according to Claim 12, wherein the second heating transfer facilitation element (125) comprises a heat dissipation end (127) configured to be positioned in proximity to the first outlet (119).

Claim 13. The heating apparatus (100) according to Claim 12, wherein the second heating transfer facilitation element (125) is configured to comprise one or more of: rod, pad, plate, pad and pipe.

Claim 14. The heating apparatus (100) according to Claim 13, wherein the pipe is configured to house heat transfer liquid, circulating between the first compartment (101) and the second compartment (103) through the pipe.

Claim 15. The heating apparatus (100) according to any one of the preceding claims, wherein the liquid is water suitable for domestic use.

Claim 16. The heating apparatus (100) according to any one of the preceding claims, wherein the first compartment (101) comprises a thermal protection coating (113) on exterior surface of the first compartment (101).

Claim 17. The heating apparatus (100) according to any one of the preceding claims, wherein the second compartment (103) comprises a thermal protection coating (113) on exterior surface of the second compartment (103).

Claim 18. The heating apparatus (100) according to any one of the preceding claims, wherein the first compartment (101) is configured to be positioned above the second compartment (103).

Claim 19. The heating apparatus (100) according to Claim 18, wherein the attachment surface (102) is bottom surface of the first compartment (101), and the first inlet (117) and the second inlet (121) are configured to be positioned on top surface of the first compartment (101).

Claim 20. The heating apparatus (100) according any one of Claims 1 – 17, wherein the second compartment (103) is configured to be positioned beside the first compartment (101).

Claim 21. The heating apparatus (100) according to any one of the preceding claims, wherein the computing unit (107) 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 22. The heating apparatus (100) according to any one of the preceding claims, wherein the computing unit (107) is arranged to be in data communication with a network.

Claim 23. The heating apparatus (100) according to any one of the preceding claims, wherein further comprising a heating control system (500) arranged to control heating process of the heating apparatus (100); wherein the heating control system (500) comprises:

a temperature monitoring module (501) operable to detect and measure temperature of the liquid inside the first compartment (101) and/or inside the second compartment (103); and,

an operation control module (502) operable to adjust operation of the computing unit (107) and/or the first heating source (115) according to the temperature of the liquid measured by the temperature monitoring module (501).

Claim 24. The heating apparatus (100) according to Claim 23, wherein, when the temperature monitoring module (501) detects that the temperature of the liquid at a first temperature zone within the first compartment (101) drops below a first predetermined temperature threshold, the operation control module (502) is operable to activate or enhance the heating process of the first heating source (115).

Claim 25. The heating apparatus (100) according to Claim 24, wherein the first temperature zone is defined to encompass the second inlet (123).

Claim 26. The heating apparatus (100) according to any one of Claims 23 – 25, wherein, when the temperature monitoring module (501) detects that the temperature of the liquid at a second temperature zone within the first compartment (101) exceeds a second predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (107).

Claim 27. The heating apparatus (100) according to Claim 26, wherein the second temperature zone is defined to cover the attachment surface (102).

Claim 28. The heating apparatus (100) according to any one of Claims 23 – 25, wherein, when the temperature monitoring module (501) detects that the temperature inside the second compartment (103) exceeds a second predetermined temperature threshold, the operation control module (502) is operable to deactivate or reduce the operation of the computing unit (107).

Claim 29. The heating apparatus (100) according to any one of Claims 23 – 28, wherein further comprising a mode switch module (503) arranged to transmit an instruction signal to the operation control module;

when the mode switch module (503) is switched to a liquid use mode, the operation control module is operable to activate the first heating source (115); when the mode switch module (503) is switched to a standby mode, the operation control module is operable to deactivate the first heating source (115).

Claim 30. The heating apparatus (100) according to Claim 29, wherein, when the mode switch module (503) is switched to the standby mode, operation control module is operable to also regulate the operation of the computing unit (107).

Claim 31. The heating apparatus (100) according to any one of the preceding claims, wherein the computing unit (107) is configured to be removable from the second compartment (103).