(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 556 800 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.05.2025 Bulletin 2025/21

(21) Application number: **23210840.7**

(22) Date of filing: **20.11.2023**

(51) International Patent Classification (IPC):
F24D 12/02 *(2006.01)* ***F24D 19/10*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F24D 19/10; F24D 12/02; F24D 2200/04; F24D 2200/12; F24H 15/156; F24H 15/176; F24H 15/34; F24H 15/355

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(54) HYDRONIC BALANCING MODE IN A MULTI-SOURCE HEATING SYSTEM

(57) An implementation of the disclosed technology provides a method for automatically configuring a multi-source heating system for hydronic balancing. The multi-source heating system includes a plurality of heating appliances on a source side of a decoupling buffer and one or more load circuits on a load side of the decoupling buffer. Each load circuit includes a load circulator pump, and one or more of the load circuits are associated with heating zones to be hydronically balanced. The heating system also includes a controller that controls the heating system. The method includes: providing a user interface that permits a user to make a selection to place the heating system in a hydronic balancing mode; receiving a selection of the hydronic balancing mode; receiving a selected heating zone to be hydronically balanced; stopping, automatically by the controller, all heating and/or cooling demands in the heating system; stopping, automatically by the controller, all load circulator pumps except for a load circulator pump associated with the selected heating zone; and initialising, automatically by the controller, a pump mode to be used for hydronic balancing in the circulator pump associated with the selected heating zone.

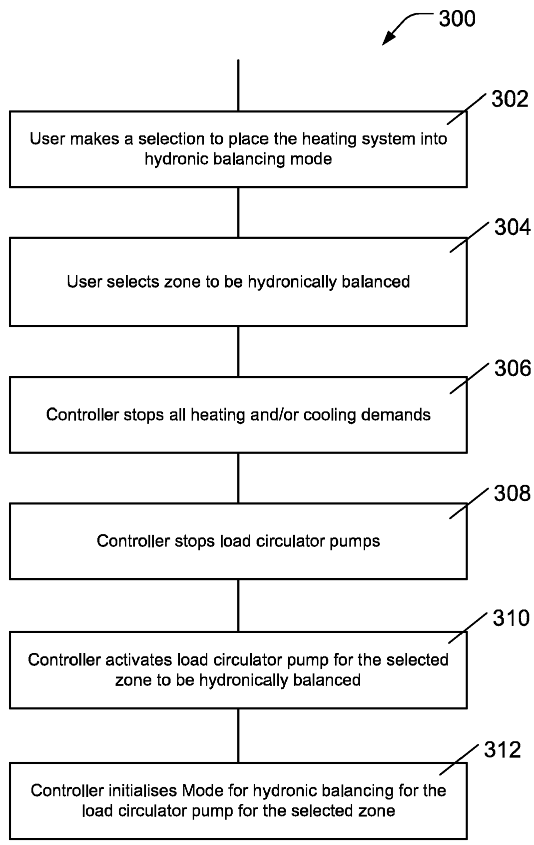

FIG. 3

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Description

TECHNICAL FIELD

[0001] The disclosed technology relates to controlling a multi-source (e.g., hybrid or cascade) heating and/or cooling system to place the system.in a mode used to carry out hydronic balancing.

BACKGROUND

[0002] Hydronic balancing in heating and/or cooling systems is an important process for ensuring the efficient and effective distribution of heat and cooling within residential, commercial, or industrial buildings that use water as a heat transfer medium, such as those with radiators or underfloor heating. The goal is to ensure that each heating and/or cooling unit (such as a radiator or a floor loop) receives the right amount of heated and/or cooled water or other heat-transfer fluid to meet its and/or cooling heating needs. Water will naturally flow more towards heating and/or cooling units with higher flow rates or lower resistance. For example, the resistance of radiators that are closer to the load pump for their heating zone, or that are lower in a building may be lower than the resistance of radiators that are far from the load pump, leading to the distant radiators receiving less heated and/or cooled water or other heat-transfer fluid. Without proper balancing, some rooms may be too hot or too cold, leading to discomfort.

[0003] Proper hydronic balancing can also improve energy efficiency. For example, an unbalanced system may force generators and pumps to work harder than necessary to meet heat and/or cooling demands, leading to increased energy consumption and higher operational costs. This can also lead to increased wear on heating and/or cooling system components, reducing the longevity of components of the heating and/or cooling system, and increasing the frequency of repairs. Additionally, proper hydronic balancing can reduce noise in a heating and/or cooling system, such as knocking or gurgling sounds in pipes and radiators that may be caused by uneven water flow.

[0004] For these reasons, some countries and/or regions make subsidies available to owners of hydronically balanced heating and/or cooling systems. These subsidies may encourage consumers to use hydronic balancing to increase the energy efficiency of their heating and/or cooling systems.

[0005] Hydronic balancing is a labour-intensive process, generally performed by a heating system installer. It typically involves manually adjusting the flow through each radiator or underfloor heating loop. For a system having radiators, for example, this requires the installer to adjust a flow control valve (also referred to as a "balancing valve", a "manual radiator valve", or a "lockshield valve") at each radiator, and then validate the results manually on a heating appliance, such as a boiler. For systems having multiple heating zones, this process would generally be carried out separately for each zone.

[0006] The efficiency of the process can be improved using smart pumps and applications for mobile devices that communicate with the smart pumps to facilitate hydronic balancing. For example, to reduce the effort of manual verification and walking back and forth between radiators and a heating appliance, the installer can use a mobile device in conjunction with an app that communicates directly with a smart pump to validate any result. The freedom of movement and reduced validation time reduces the time an installer spends balancing a system significantly. Smart pumps and a mobile application for hydronic balancing are available, for example, from Grundfos Holdings A/S, of Bjerringbro, Denmark.

[0007] Even using such smart pumps and applications, the process may still involve significant effort in preparing a heating and/or cooling system for hydronic balancing, particularly in systems having multiple heat generating appliances (i.e., multi-source systems). Such multi-source systems include, for example, hybrid systems, including, e.g., a boiler and a heat pump, or cascaded systems, including multiple boilers, multiple heat pumps, or both (i.e., hybrid cascades). In such systems, prior to hydronic balancing, each heat generating appliance needs to be put into an appropriate mode for hydronic balancing. Even on systems having centralized control over all of the heating and/or cooling appliances (whether using a separate system controller or a master/slave configuration in which one of the appliances controls the others), setting up the heating and/or cooling appliances may require changing multiple settings, buried in numerous menus. If the centralized control for the system also controls the load pumps (e.g., zone pumps, or a pump for an underfloor heating loop), even more configuration will be needed to prepare the system for hydronic balancing, since the load pumps will need to be placed in appropriate modes. This setup process may need to be undertaken multiple times, for example, to configure the load pumps for balancing each zone. Once hydronic balancing has been completed, the entire system will need to be reconfigured for normal operation, which again requires manually adjusting all the settings of the heating appliances and load pumps.

SUMMARY

[0008] Based on the above, it is an object to provide a method of placing a multi-source heating and/or cooling system into a mode in which all heating and/or cooling appliances and load pumps are automatically configured appropriately for hydronic balancing. This will save the installer the time and effort required to properly configure a complex multi-source and multi-zone heating and/or cooling system both before and during hydronic balancing. This may also prevent errors in configuring the system for hydronic balancing.

[0009] It is a further object to provide a method of returning a multi-source heating and/or cooling system to normal operation in an automated manner following hydronic balancing. This will save the installer the time and effort required to properly reconfigure a complex multi-source and multi-zone heating and/or cooling system for operation after hydronic balancing, and may prevent errors in configuring the system for normal operation following hydronic balancing.

[0010] It should be understood that implementations of the present technology each have at least one of the above-mentioned objects and/or aspects, but do not necessarily have all of them. Some aspects of the present technology that have resulted from attempting to attain the above-mentioned objects may not satisfy these objects and/or may satisfy other objects not specifically recited herein.

[0011] It will further be understood that as used herein (including as used in the claims), a heating system can provide heating and/or cooling, a heat demand may result in heating and/or cooling (i.e., it is a heat and/or cooling demand), a heating request may be a request for heating or cooling, a heat generator or heating appliance may provide heating and/or cooling depending on the nature of the heat generator or heating appliance (e.g., many heat pumps may provide heating and/or cooling), a heating zone may provide heating and/or cooling, etc. While the terms "heat" or "heating" are used throughout, due to their common use in the art, it will be understood that such terms are used to cover heat and/or cold, heating and/or cooling, etc.

[0012] In some implementations, the disclosed technology provides a method for automatically configuring a multi-source heating system for hydronic balancing. The multi-source heating system includes a plurality of heating appliances on a source side of a decoupling buffer and one or more load circuits on a load side of the decoupling buffer. Each load circuit includes a load circulator pump, and one or more of the load circuits are associated with heating zones to be hydronically balanced. The heating system also includes a controller that controls the heating system. The method includes: providing a user interface that permits a user to make a selection to place the heating system in a hydronic balancing mode; receiving a selection of the hydronic balancing mode; receiving a selected heating zone to be hydronically balanced; stopping, automatically by the controller, all heating and/or cooling demands in the heating system; stopping, automatically by the controller, all load circulator pumps except for a load circulator pump associated with the selected heating zone; and initialising, automatically by the controller, a pump mode to be used for hydronic balancing in the circulator pump associated with the selected heating zone.

[0013] In some implementations, receiving a selected heating zone to be hydronically balanced includes providing a user interface that permits a user to make a selection of the selected heating zone. In some implementations, receiving a selected heating zone to be hydronically balanced includes automatically selecting a heating zone by cycling through heating zones that are to be hydronically balanced.

[0014] In some implementations, stopping, automatically by the controller, all heating and/or cooling demands in the heating system includes blocking incoming heating and/or cooling demands at the controller. In some implementations, stopping, automatically by the controller, all heating and/or cooling demands in the heating system includes sending control signals to each of the heating appliances to stop generating heat and/or cool. In some implementations, stopping, automatically by the controller, all heating and/or cooling demands in the heating system comprises stopping any source side pumps that are built into a heating appliance or that are associated with a heating appliance.

[0015] In some implementations, stopping, automatically by the controller, all load circulator pumps except for a load circulator pump associated with the selected heating zone includes: stopping, automatically by the controller, all load circulator pumps; and activating, automatically by the controller, the load circulator pump associated with the selected heating zone.

[0016] In some implementations, the method further includes returning the heating system to an operational mode after hydronic balancing is completed. In some implementations, returning the heating system to an operational mode after hydronic balancing is completed includes: terminating the hydronic balancing mode; placing, automatically by the controller, the load circulator pumps in modes for normal operation; re-starting, automatically by the controller, the heating appliances; and accepting, by the controller, heating requests and/or allowing, by the controller, heating requests to be sent in the heating system.

[0017] In some implementations, terminating the hydronic balancing mode includes terminating the hydronic balancing mode automatically when automatic hydronic balancing operations have completed and/or after a predetermined timeout period has elapsed since receiving the selection of the hydronic balancing mode. In some implementations, terminating the hydronic balancing mode includes: providing a user interface that permits a user to make a selection to terminate the hydronic balancing mode; and receiving a selection to terminate the hydronic balancing mode.

[0018] In some implementations, the disclosed technology provides a multi-source heating system, including: a decoupling buffer; two or more heating appliances on a source side of the decoupling buffer; and one or more load circuits on a load side of the decoupling buffer, each load circuit including a load circulator pump, and one or more of the load circuits being associated with heating zones to be hydronically balanced. The heating system further includes a controller configured to execute any of the methods discussed above.

[0019] In some implementations, the decoupling buffer includes a low loss header, and/or a low capacity decoupling buffer tank, and/or a high capacity buffer tank. In some implementations, the heating appliances operate in a master/slave configuration, and the controller is implemented within a master heating appliance.

[0020] In some implementations, the disclosed technology provides a computer program product comprising program instructions operable to cause a processor to perform operations according to any of the methods discussed above.

[0021] In the context of the present specification, unless expressly provided otherwise, the words "first", "second", "third", etc. have been used as adjectives only for the purpose of allowing for distinction between the nouns that they modify from one another, and not for the purpose of describing any particular relationship between those nouns.

[0022] In the context of the present specification, unless expressly provided otherwise, directions indicated by terms such as "top", "bottom", "upper", "lower", "above", "below", etc., are used in their usual sense - i.e., relative to a gravitational direction or axis.

[0023] Additional and/or alternative features, aspects and advantages of implementations of the present technology will become apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] In the figures, the subject-matter of the disclosure is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

FIG. 1 is a block diagram of an example controller that could be used in some implementations of an energy management system.

FIG. 2 is a block diagram of an example energy management system.

FIG. 3 is block diagram of a method for placing a multi-source heating system into a hydronic balancing mode, in accordance with the described technology.

FIG. 4 is a block diagram of a method for terminating the hydronic balancing mode and returning the heating to normal operation, in accordance with the described technology.

DETAILED DESCRIPTION

[0025] The examples and conditional language recited herein are principally intended to aid the reader in understanding the principles of the present technology and not to limit its scope to such specifically recited examples and conditions. It will be appreciated that those skilled in the art may devise various arrangements that, although not explicitly described or shown herein, nonetheless embody the principles of the present technology.

[0026] Furthermore, as an aid to understanding, the following description may describe relatively simplified implementations of the present technology. As persons skilled in the art would understand, various implementations of the present technology may be of a greater complexity.

[0027] In some cases, what are believed to be helpful examples of modifications to the present technology may also be set forth. This is done merely as an aid to understanding, and, again, not to define the scope or set forth the bounds of the present technology. These modifications are not an exhaustive list, and a person skilled in the art may make other modifications while nonetheless remaining within the scope of the present technology. Further, where no examples of modifications have been set forth, it should not be interpreted that no modifications are possible and/or that what is described is the sole manner of implementing that element of the present technology.

[0028] Moreover, all statements herein reciting principles, aspects, and implementations of the present technology, as well as specific examples thereof, are intended to encompass both structural and functional equivalents thereof, whether they are currently known or developed in the future. Thus, for example, it will be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present technology.

[0029] With these fundamentals in place, we will now consider some nonlimiting examples to illustrate various implementations of aspects of the present disclosure.

Controller

[0030] FIG. 1 depicts an example controller 100, which may be any type of computer system or embedded controller. It will be recognized that some or all the components of the controller 100 may be virtualized and/or cloud-based. As depicted, the controller 100 may include one or more processors 102, a memory 110, a storage interface 120, and a communication interface 140. These system components may be interconnected via a bus 150, which may include one or more internal and/or external buses (not shown) (e.g. a PCI bus, universal serial bus, IEEE 1394 "Firewire" bus, SCSI bus, Serial-ATA bus, etc.), to which these various hardware components may be electronically coupled.

[0031] The memory 110, which may be a random-access memory or any other type of memory, may contain data 112, an operating system 114, and a program 116. The data 112 may be any data that serves as input to or output from any program in the controller 100. The operating system 114 may be an operating system such as MICROSOFT WINDOWS, LINUX, FreeRTOS, or any other operating system suitable for use on a computer system or microcontroller. The program 116 may be any program or set of programs that include program instructions that may be executed by the processor to control actions taken by the controller 100. In particular, the program 116 may include program instructions that, when executed by the processor, cause the processor to carry out one or more of the methods described below.

[0032] The storage interface 120 may be used to connect storage devices, such as the depicted storage device 125, to the controller 100. The storage device 125 may be a solid-state drive using an integrated circuit assembly to store data persistently. Alternatively, the storage device 125 may be a hard drive using any of a variety of types of magnetic storage media to store and retrieve digital data. As another alternative, the storage device 125 may be an optical drive, or a card reader that receives a removable non-volatile semiconductor memory card. As still another alternative, the storage interface 120 may provide a universal serial bus connection to which the storage device 125 may be hot-pluggable, and the storage device 125 may be a flash memory device (e.g., a USB thumb drive). In some implementations, in which storage of data is not necessary, the storage interface 120 and storage device 125 may optionally be omitted.

[0033] In some implementations, the controller 100 may use well-known virtual memory addressing techniques that allow the programs of the controller 100 to behave as if they have access to a large, contiguous address space instead of access to multiple, smaller storage spaces, such as the memory 110 and the storage device 125. Therefore, while the data 112, the operating system 114, and the programs 116 are depicted as residing in the memory 110, those skilled in the art will recognize that these items may not necessarily be wholly contained in the memory 110 at the same time.

[0034] The one or more processors 102 may include one or more microprocessors and/or other integrated circuits able to execute program instructions stored in the memory 110. When the controller 100 starts up, the processor(s) 102 may initially execute program instructions of a boot routine and/or the program instructions that make up the operating system 114.

[0035] The communication interface 140 may be used to communicatively connect the controller 100 to other controllers, computer systems, or still other devices (not shown) via a communication channel 160. The communication channel 160 may be a serial or parallel connection, a wired, wireless, mesh or cellular network, or any other type of communication channel or combination of channels. Data and/or program instructions may be sent to the controller 100 as signals via the communication channel. The communication interface 140 may include a combination of hardware and software that enables communications on the communication channel 160. The software in the communication interface 140 may include software that uses one or more communication protocols to communicate over the communication channel 160, including and not limited to, network protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol).

[0036] It will be understood that the depicted controller 100 is merely an example, and that the technology disclosed herein may be used with a wide variety of other controllers or computer systems, or still other computing devices having different configurations.

Heating System

[0037] FIG. 2 depicts an example heating system 200. The heating system 200 is generally used to provide heating in a building, such as a residential dwelling. However, it will be understood that the heating system 200 may be used in other types of buildings, such as apartment buildings or other multi-dwelling buildings, office buildings, or any other type of building at which heating systems are installed and/or controlled. In such buildings, each portion of the building, such as each residence, floor, or office suite, may be considered a separately controllable zone in the heating system, in some implementations.

[0038] As depicted, the heating system 200 is a hybrid heating system, including a boiler 202 and a heat pump 204 as sources. It will be understood that this configuration of the heating system 200 is only one example, and other multi-source systems having multiple boilers, multiple heat pumps, and/or other heating appliances could be used.

[0039] The boiler 202 may be powered using fossil fuels, such as natural gas, propane or oil, or may be powered using other fuel sources, such as hydrogen, or by some combination of such fuel sources. The operation of boilers is generally well known in the art. The heat pump 204 is electrically powered. The operation of electric heat pumps is well known in the art.

[0040] The heating appliances, such as the boiler 202 and heat pump 204 are hydronically connected to a decoupling buffer 206, which separates the generator or source side of the heating system 200 (i.e., heating appliances, such as the boiler 202 and heat pump 204) from the load side of the heating system 200 (i.e., load pumps that distribute heated fluid to one or more heating zones in a building, or to other heating loads). The decoupling buffer 206 may be, for example, a low loss header, having minimal capacity for storing heated water or other heat-transfer fluids. In some implementations, the decoupling buffer 206 may be a low capacity buffer tank, having the capacity to store several litres of water or other heat-transfer fluid. In some implementations, the decoupling buffer 206 may be a high capacity buffer tank, storing tens, hundreds, or thousands of litres of water or other heat-transfer fluid, depending on factors such as the output of the heating appliances, and the minimum required load of the system. In some implementations, the decoupling buffer 206 may include more than one of these, such as in systems that include a buffer tank and a low loss header. In some implementations, the system may include more than one decoupling buffer. For example, in some systems that include both heating and cooling, there may be a decoupling buffer for heating, and a separate decoupling buffer for cooling.

[0041] On the load side, the heating system 200 may include one or more load circuits 210. Each load circuit may provide heated water (or other heat-transfer fluid) to, e.g., a single heating zone of a building having multiple radiators, an underfloor heating system (which may include one or more underfloor heating zones and/or loops connected to a header), a domestic hot water tank, and/or other heating loads. Each such load circuit 210 includes a load circulator pump 212 that pumps water or other heat-transfer fluid through the load circuit. Generally, load circuits 210 that include, e.g., multiple radiators or an underfloor heating system will need to be separately hydronically balanced.

[0042] The heating system 200 may also include a controller 220 that provides centralized control over activities occurring within the heating system 200. The controller 220 may be implemented, for example, using the controller 100 depicted and described in reference to FIG. 1, or any other suitable controller, microcontroller, or computer system. As depicted, the controller 220 may be implemented as a separate unit. This separate unit may be located within the housing of one of the heating appliances, such as the boiler 202 or the heat pump 204, or it may have its own housing and power. In some implementations, each heating appliance may include its own controller, and the controller 220 may be implemented as a software module that operates on a controller built into an energy management appliance.

[0043] In some implementations, the heating appliances, such as the boiler 202 and heat pump 204 operate in a "master/slave" configuration, in which one of the heating appliances is selected to be the master, and all the other heating appliances are selected to operate in a slave mode. In such master/slave systems, the controller 220 may be implemented as a control unit or a software module in the "master" heating appliance. Because it is possible for the "master" unit to change in some systems (e.g., in case of an error or other problem on the original "master" unit), in some implementations, the functions of the controller 220 may be present in the control software for numerous of the heating appliances (e.g., any heating appliance that is capable of being used as the "master" unit), but will be unused or dormant in heating appliances that are in the slave mode.

[0044] The controller 220 may communicate with various system components in a variety of ways. For example, the controller 220 and energy management appliances may communicate wirelessly using a wireless communication protocol, such as WIFI, Bluetooth, or Zigbee. In some implementations, they may communicate over a wired bus, using protocols such as OpenTherm. Some devices, such as sensors, may be directly connected to the controller 220. For some devices, including older boilers, etc., the controller 220 may be limited to controlling the device using on/off signals. In some implementations, the controller 220 may use numerous types of communication, depending on the devices that are being controlled.

[0045] In some implementations, the load circulator pumps 212 may be controlled using different protocols. For example, some of the load circulator pumps 212 may be controlled using the local interconnect network (LIN) protocol, while other load circulator pumps 212 may use pulse width modulation control, and some load circulator pumps 212 may use on/off control. The controller 220 in such implementations should be configured to control all of these types of load circulator pumps 212, and place them in appropriate modes for hydronic balancing.

[0046] In some implementations, the controller 220 may communicate with the load circuits 210 and/or load circulator pumps 212 through one or more zone controllers (not shown). In such systems, to communicate with a load circulator pump 212, the controller 220 would send a signal or command to a zone controller associated with the zone of the load circuit 210 or load circulator pump 212, and the zone controller would then control (e.g., via LIN, PWM signals, on/off signals, etc.) the load circulator pump 212.

[0047] In some implementations, the controller 220 may also communicate with smart valves and/or temperature sensors on individual radiators and/or underfloor heating loops. In systems where the radiators are equipped with such valves and/or temperature sensors, the controller 220 may be configured for automatic hydronic balancing. In most current heating systems, however, such smart valves and sensors are not part of the system, and hydronic balancing will generally remain a manual process. In accordance with the described technology, however, the controller 220 can be configured to at least reduce some of this manual burden by automatically setting up the parts of the heating system 200 that it is able to control, such as the heating appliances (e.g., boiler 202 and heat pump 204) and the load circulator pumps 212 for hydronic balancing, and returning them to a proper state for normal operation when hydronic balancing is complete.

<u>Automated Setup for Hydronic Balancing</u>

[0048] In conventional single-source heating systems (i.e., systems having a single heating appliance), a load circulator pump is often integrated into the heating appliance, and there are relatively few devices that need to be controlled or configured to set up the system for hydronic balancing. By contrast, in multi-source systems, such as the heating system described above with reference to FIG.2, there are multiple heating appliances that need to be configured, and the load circulator pumps are often separated from the heating appliances by being installed on a load side of a low loss header or other decoupling buffer. This makes setup for hydronic balancing more complex and error-prone.

[0049] In accordance with the described technology, one way in which the process of hydronic balancing may be made easier for installers in such multi-source systems, and in which errors in setup for hydronic balancing may be avoided, is by providing an easy-to-use hydronic balancing setup option in the user interface for controlling the heating system. Without such an option, the installer would need to set all heating appliances and load circulator pumps into appropriate configurations for hydronic balancing. The operations needed to carry out this process will vary, depending on the types of heating appliances and load circulator pumps that are in use, so the potential for error is high.

[0050] FIG. 3 shows a block diagram 300 of a method for placing a multi-source heating system, such as the system described with reference to FIG. 2, into a hydronic balancing mode. This method is activated by a single selection in the user interface of a controller for the heating system.

[0051] In block 302, a user (generally an installer) makes a selection to place the heating system into a hydronic balancing mode. This selection will be made in a user interface of a controller for the heating system. In some implementations, this user interface may be displayed on a display associated with one of the heating appliances in the system, such as a "master" device in a master/slave system. In some implementations, the user interface may be displayed on a display associated with a separate controller. In some implementations, the user interface may be displayed on a mobile device, such as a mobile phone or tablet, that is connected to a controller over a network, such as WIFI or Bluetooth, and that may be running an application for communicating with the heating appliance.

[0052] In some implementations, the selection will be made using a menu option in a user interface. It will be understood that other user interface elements may also be used to make the selection. In some implementations, the selection may be made without a display, through an interface such as buttons or switches on a heating appliance or controller unit. In some implementations, the selection will be available only in an "installer mode", which may require codes, passwords, or even security devices or dongles for access.

[0053] In block 304, once the selection has been made, the user may select a zone to be hydronically balanced. The zone may be selected using user interface displays and elements similar to those described with reference to block 302 (e.g., menus displayed on a display, which may be associated with a heating appliance, a separate controller, or a mobile device running an application, etc.). In some implementations, the possible zones that may be selected may be displayed using names for the zones that were specified during installation of the heating system.

[0054] In some implementations, the zones may include a selection that causes the system to automatically cycle through all the zones, or through all the zones that can be hydronically balanced, so that the entire heating system can be hydronically balanced without requiring the installer to re-select zones. In some implementations, such a "cycle through all zones" mode may be a default setting, which is automatically activated if the installer does not make a selection. In some implementations, the zone selection of block 304 may be omitted, e.g., if there is only a single zone in the system. It should be noted that in some systems, cycling through the zones should be done in an order determined by the nature of the loads that are to be hydronically balanced. For example, in some systems, zones with radiators should be hydronically balanced before zones with underfloor heating. In implementations that automatically cycle through zones, the controller will ensure that the zones are handled in an appropriate order, should such an order be required. This further reduces the risk of error.

[0055] In block 306, the controller stops all heating demands in the system. In some implementations this can be done by blocking incoming heating demands at the controller, and/or sending appropriate control signals to each of the heating appliances to stop generating heat or cool, and/or to stop any source-side pumps that are built into the heating appliances or associated with a particular heating appliance. For some heating appliances, this may be achieved by adjusting the set point such that the appliance is not generating heat or cool. For some appliances, this may be achieved by effectively turning off the heating appliance. For some heating appliances, this may be achieved by sending a command to the heating appliance to halt its heating operations, leaving the heating appliance on and able to operate other functions that will not impact hydronic balancing. It will be understood that other control methods may also be used to control heating appliances to stop generating heat, depending on the capabilities of the heating appliance that may be accessed through the controller. The controller will necessarily be able to control each of the heating appliances in the system, so will know what control methods or steps will be needed for each connected heating appliance. This frees the user/installer from having to determine what is needed for each heating appliance in the system, and from having to manually issue commands to each heating appliance.

[0056] It should be noted that if heating appliances are being shut off as part of this process and the controller is part of one of the heating appliances (e.g., the controller is integrated into the "master" heating appliance in a master/slave system), then the heating appliance that is hosting the controller should remain in a state such that at least the controller continues operating.

[0057] In block 308, the load circulator pumps are stopped. Depending on how each of the load circulator pumps is controlled, the controller or zone controller may use, e.g., commands sent via LIN, pulse width modulation control, on/off control, and/or other types of control to stop the load circulator pumps, depending on the capabilities of each load circulator pump. The controller will be able to control each of the load circulator pumps in the system (either directly or indirectly, e.g. through a zone controller), so will know what control signals or commands will be needed for each connected load circulator pump. This frees the user/installer from having to determine what is needed for each load circulator pump in the system, and from having to manually issue commands to each load circulator pump.

[0058] In some implementations, the load circulator pump for the selected zone (or for the next zone to be hydronically balanced, if the system is cycling through the zones) may remain active in block 308. In such implementations, the selected zone pump does not need to be activated in block 310.

[0059] In block 310, the load circulator pump for the selected zone to be hydronically balanced is activated. In some implementations, when the system has been instructed to cycle through all the zones to be hydronically balanced, the load circulator pump for the next zone to be hydronically balanced will be the "selected zone", and will be activated. Depending on how the load circulator pump for the selected zone is controlled, the controller or zone controller may use, e.g., commands sent via LIN, pulse width modulation control, on/off control, and/or other types of control to activate the load circulator pump for the selected zone. It will be understood that in implementations that do not stop the load circulator pump for the selected zone (i.e., in block 308), it may be unnecessary to activate the load circulator pump for the selected zone.

[0060] In block 312, an appropriate mode for hydronic balancing is initialised for the load circulator pump for the selected zone. Different circulator pumps and different loads in the various zones may use different modes of operation for the pump for purposes of hydronic balancing. For example, some pumps may be set at a particular fixed pump speed when being used for hydronic balancing. Some circulator pumps may include a special hydronic balancing mode that should be activated during hydronic balancing. Depending on how the load circulator pump for the selected zone is controlled, the controller (and/or zone controller) may use, e.g., commands sent via LIN, pulse width modulation control, on/off control, and/or other types of control to set or operate the selected pump in an appropriate mode for hydronic balancing (e.g., "on" in an on/off controlled pump, or balancing mode in a pump controlled via LIN that supports a balancing mode). Placing the circulator pump in an appropriate mode for hydronic balancing may also enable pump communication, e.g., with a mobile application that may be used by a user/installer to complete the manual portions of the hydronic balancing process.

[0061] Once the system has been properly configured using the above-described automated method, hydronic balancing may be performed on the selected zone. In many systems, this will be done manually by an installer. In some systems, this manual process may be supported by a mobile application, such as the Grundfos GoBalance application, provided by Grundfos Holdings A/S, of Bjerringbro, Denmark, which may be used to support hydronic balancing on load circuits that use selected models of circulator pumps manufactured by Grundfos. Such applications may use additional manual steps for system setup, which cannot be performed by the controller. For example, to use the Grundfos GoBalance application, the installer may be required to connect a special communications dongle to the selected circulator pump. It should be noted that in some implementations, in which the user interface to the controller for the heating system is operated from a mobile device that can also operate an application to support hydronic balancing, the hydronic balancing application may be automatically started once the heating system has been configured for hydronic balancing, in accordance with the disclosed technology.

[0062] As noted above, in some systems that have, e.g., smart valves that can be controlled by the controller installed on the radiators, as well as any needed sensors, the controller may be configured to handle hydronic balancing automatically, or with greatly reduced involvement of the installer in manual processes.

[0063] Once hydronic balancing has been completed for the selected zone (by whatever process - manual or automatic), the installer may select the next zone to be hydronically balanced, which can then be automatically configured for hydronic balancing using the methods described with reference to blocks 308, 310, and 312. If the system has been instructed to automatically cycle through zones (in implementations that support this capability), the next zone may be automatically selected, and configured for hydronic balancing using the methods described with reference to blocks 308, 310, and 312.

[0064] Once hydronic balancing is complete, the system may be returned to an operational mode, using the methods described below.

Termination of Hydronic Balancing Mode

[0065] FIG. 4 shows a block diagram 400 of a process for terminating the hydronic balancing mode and returning the heating to normal operation. Handling this automatically, with minimal involvement of the user/installer makes it easier for the installer to return a system to normal operation following hydronic balancing, and reduces the potential for errors.

[0066] In block 402, the hydronic balancing mode is terminated. This may be done manually, by a user (generally an installer) making a selection to terminate the hydronic balancing mode. This selection may be made in a user interface of a controller for the heating system. In some implementations, this user interface may be displayed on a display associated with one of the heating appliances in the system, such as a "master" device in a master/slave system. In some implementations, the user interface may be displayed on a display associated with a separate controller. In some implementations, the user interface may be displayed on a mobile device, such as a mobile phone or tablet, that is connected to a controller over a network, such as WIFI or Bluetooth, and that may be running an application for communicating with the heating appliance.

[0067] In some implementations, the selection may be made using a menu option in a user interface. It will be understood that other user interface elements may also be used to make the selection. In some implementations, the selection may be made without a display, through an interface such as buttons or switches on a heating appliance or controller unit. In some implementations, the selection will be available only in an "installer mode", which may require codes, passwords, or even security devices or dongles for access.

[0068] In some implementations, the hydronic balancing mode may be terminated automatically. In implementations in which hydronic balancing is done automatically, the hydronic balancing mode may be terminated automatically when the system is finished with its hydronic balancing operations. In some implementations, the hydronic balancing mode may be automatically terminated if it has not been manually terminated by a fixed amount of time (i.e., a predetermined timeout period) since it was activated. This may be useful, e.g., in cases where an installer has placed the heating system in hydronic balancing mode, and then left without putting the system back into an operational mode.

[0069] In block 404, the load circulator pumps are placed into appropriate modes for normal operation. Depending on how each of the load circulator pumps is controlled, the controller may use, e.g., commands sent via LIN, pulse width modulation control, on/off control, and/or other types of control to place the load circulator pumps in appropriate modes for operation, depending on the capabilities of each load circulator pump. The controller will be able to control each of the load circulator pumps in the system (either directly or indirectly, e.g., through a zone controller), so will know what control commands or signals will be needed for each connected load circulator pump. This frees the user/installer from having to determine what is needed for each load circulator pump in the system, and from having to manually issue commands to each load circulator pump.

[0070] In block 406, the heating appliances (and any pumps associated with them) are re-started. This is done by the controller sending appropriate control signals to each of the heating appliances to re-start generating heat, and to re-start any source-side pumps that are built into the heating appliances or associated with a particular heating appliance. For some heating appliances, this may be achieved by setting the set point back to where it was prior to hydronic balancing. For some appliances, this may be achieved by turning on the heating appliance. For some heating appliances, this may be achieved by sending a command to the heating appliance to re-start its heating operations. It will be understood that other control methods may also be used to control heating appliances to re-start generating heat, depending on the capabilities of the heating appliance that may be accessed through the controller. The controller will be able to control each of the heating appliances in the system, so will know what control methods or steps will be needed for each connected heating appliance. This frees the user/installer from having to determine what is needed for each heating appliance in the system, and from having to manually issue commands to each heating appliance.

[0071] In block 408, the controller accepts heating requests and/or allows heating requests to be sent. This effectively returns the system to regular operation.

[0072] It will be understood that, although the embodiments and/or implementations presented herein have been described with reference to specific features and structures, various modifications and combinations may be made without departing from the disclosure. For example, it is contemplated that in some implementations, the features described above may be used in different arrangements, or in other combinations. The specification and drawings are, accordingly, to be regarded simply as an illustration of the discussed implementations or embodiments and their principles as defined by the appended claims, and are contemplated to cover any and all modifications, variations, combinations or equivalents that fall within the scope of the present disclosure.

REFERENCE SIGNS

[0073]

100	controller
102	processors
110	memory
112	data
114	operating system
116	program
120	storage interface
125	storage device
140	communication interface
150	bus
160	communication channel
200	heating system
202	boiler
204	heat pump
206	decoupling buffer
210	load circuit
212	load circulator pump
220	controller

Claims

1. A method for automatically configuring a multi-source heating system (200) for hydronic balancing, the multi-source heating system including a plurality of heating appliances (202, 204) on a source side of a decoupling buffer (206) and one or more load circuits (210) on a load side of the decoupling buffer (206), each load circuit including a load circulator pump (212), and one or more of the load circuits (210)

being associated with heating zones to be hydronically balanced, the heating system (200) including a controller (220) that controls the heating system (200), the method comprising:

providing a user interface that permits a user to make a selection to place the heating system (200) in a hydronic balancing mode;
receiving a selection of the hydronic balancing mode;
receiving a selected heating zone to be hydronically balanced;
stopping, automatically by the controller (220), all heating and/or cooling demands in the heating system (200);
stopping, automatically by the controller (220), all load circulator pumps (212) except for a load circulator pump associated with the selected heating zone; and
initialising, automatically by the controller (220), a pump mode to be used for hydronic balancing in the circulator pump associated with the selected heating zone.

2. The method of claim 1, wherein receiving a selected heating zone to be hydronically balanced comprises providing a user interface that permits a user to make a selection of the selected heating zone.

3. The method of claim 1 or claim 2, wherein receiving a selected heating zone to be hydronically balanced comprises automatically selecting a heating zone by cycling through heating zones that are to be hydronically balanced.

4. The method of any one of the preceding claims, wherein stopping, automatically by the controller (220), all heating and/or cooling demands in the heating system (200) comprises blocking incoming heating and/or cooling demands at the controller (220).

5. The method of any one of the preceding claims, wherein stopping, automatically by the controller (220), all heating and/or cooling demands in the heating system (200) comprises sending control signals to each of the heating appliances to stop generating heat and/or cool.

6. The method of any one of the preceding claims, wherein stopping, automatically by the controller (220), all heating and/or cooling demands in the heating system (200) comprises stopping any source side pumps that are built into a heating appliance (202, 204) or that are associated with a heating appliance (202, 204).

7. The method of any one of the preceding claims, wherein stopping, automatically by the controller (220), all load circulator pumps (212) except for a load circulator pump associated with the selected heating zone comprises:

stopping, automatically by the controller (220), all load circulator pumps; and
activating, automatically by the controller (220), the load circulator pump (212) associated with the selected heating zone.

8. The method of any one of the preceding claims, further comprising returning the heating system (200) to an operational mode after hydronic balancing is completed.

9. The method of claim 8, wherein returning the heating system (200) to an operational mode after hydronic balancing is completed comprises:

terminating the hydronic balancing mode;
placing, automatically by the controller (220), the load circulator pumps in modes for normal operation;
re-starting, automatically by the controller (220), the heating appliances (202, 204); and
accepting, by the controller, heating requests and/or allowing, by the controller, heating requests to be sent in the heating system (200).

10. The method of claim 9, wherein terminating the hydronic balancing mode comprises terminating the hydronic balancing mode automatically when automatic hydronic balancing operations have completed and/or after a predetermined timeout period has elapsed since receiving the selection of the hydronic balancing mode.

11. The method of claim 9 or claim 10, wherein terminating the hydronic balancing mode comprises:

providing a user interface that permits a user to make a selection to terminate the hydronic balancing mode; and
receiving a selection to terminate the hydronic balancing mode.

12. A multi-source heating system (200), comprising:

a decoupling buffer (206);
a plurality of heating appliances (202, 204) on a source side of the decoupling buffer (206); and
one or more load circuits (210) on a load side of the decoupling buffer (206), each load circuit including a load circulator pump (212), and one or more of the load circuits (210) being associated with heating zones to be hydronically balanced;

characterized in that:
the heating system (200) further comprises a controller (220) configured to execute the method of any one of claims 1 to 11.

13. The multi-source heating system (200) of claim 12, wherein the decoupling buffer (206) comprises a low loss header, and/or a low capacity decoupling buffer tank, and/or a high capacity buffer tank.

14. The multi-source heating system (200) of claim 12 or claim 13, wherein the heating appliances (202, 204) operate in a master/slave configuration, and wherein the controller (220) is implemented within a master heating appliance.

15. A computer program product comprising program instructions (116) operable to cause a processor (102) to perform operations according to any one of claims 1 to 11.

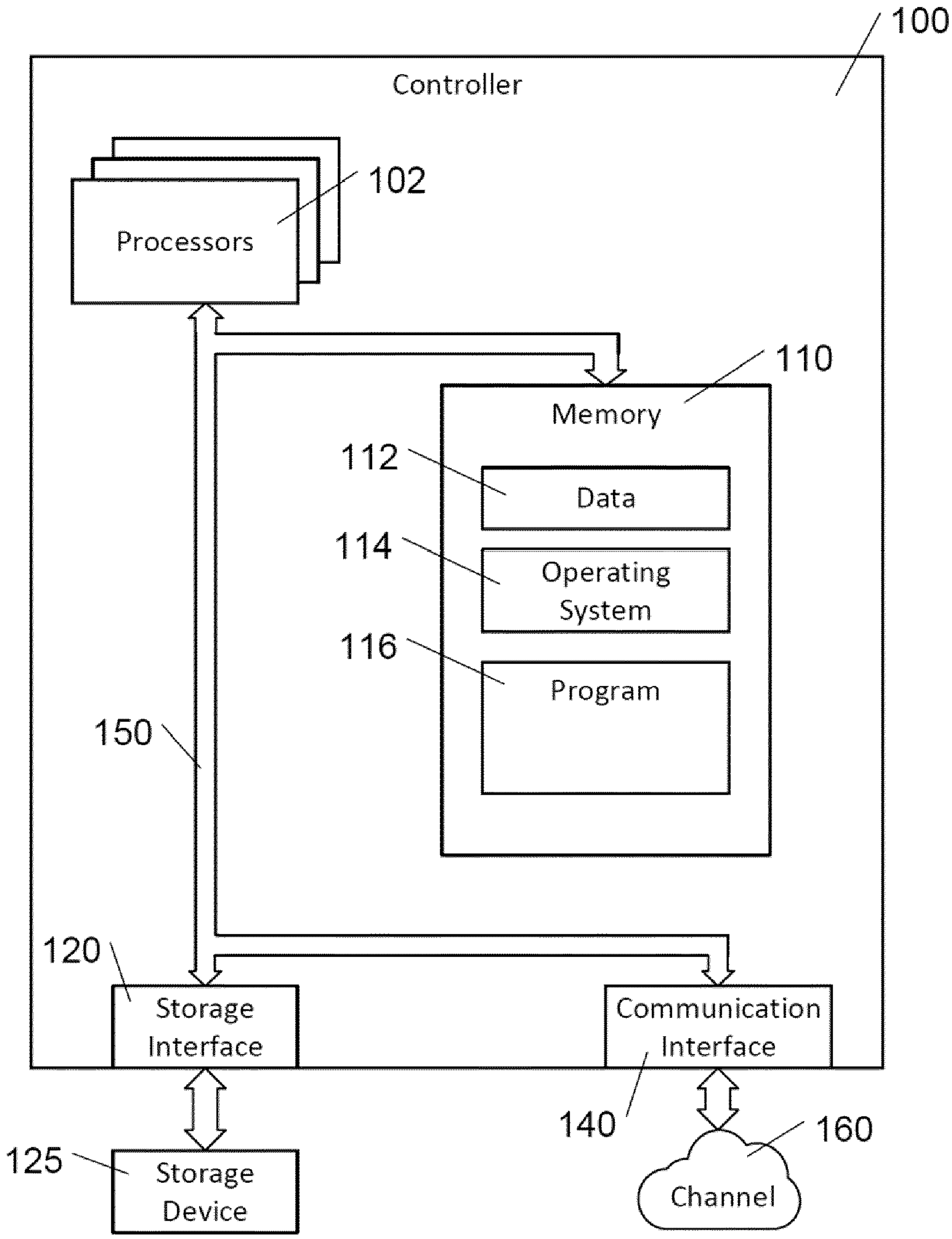
100
Controller
102
Processors
110
Memory
112
Data
114
Operating System
116
Program
150
120
Storage Interface
Communication Interface
125
Storage Device
140
160
Channel

FIG. 1

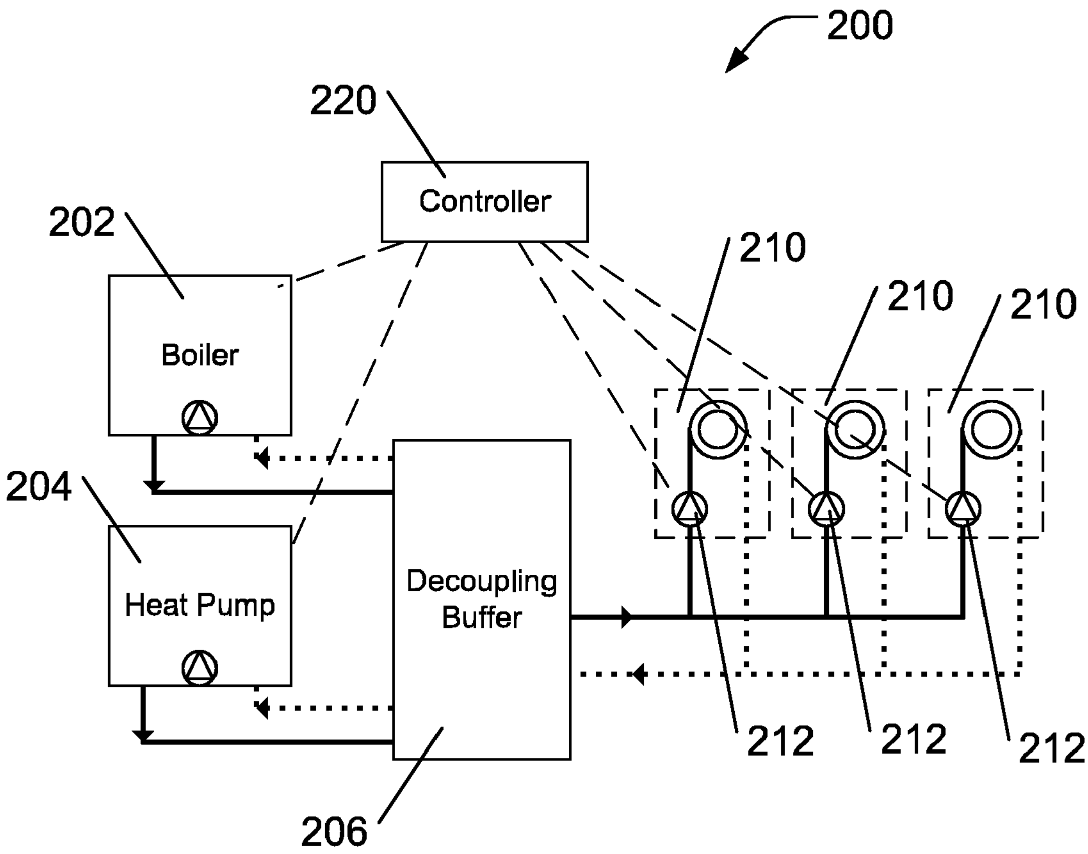
200
220
Controller
202
Boiler
210
210
210
204
Heat Pump
Decoupling
Buffer
212
212
212
206

FIG. 2

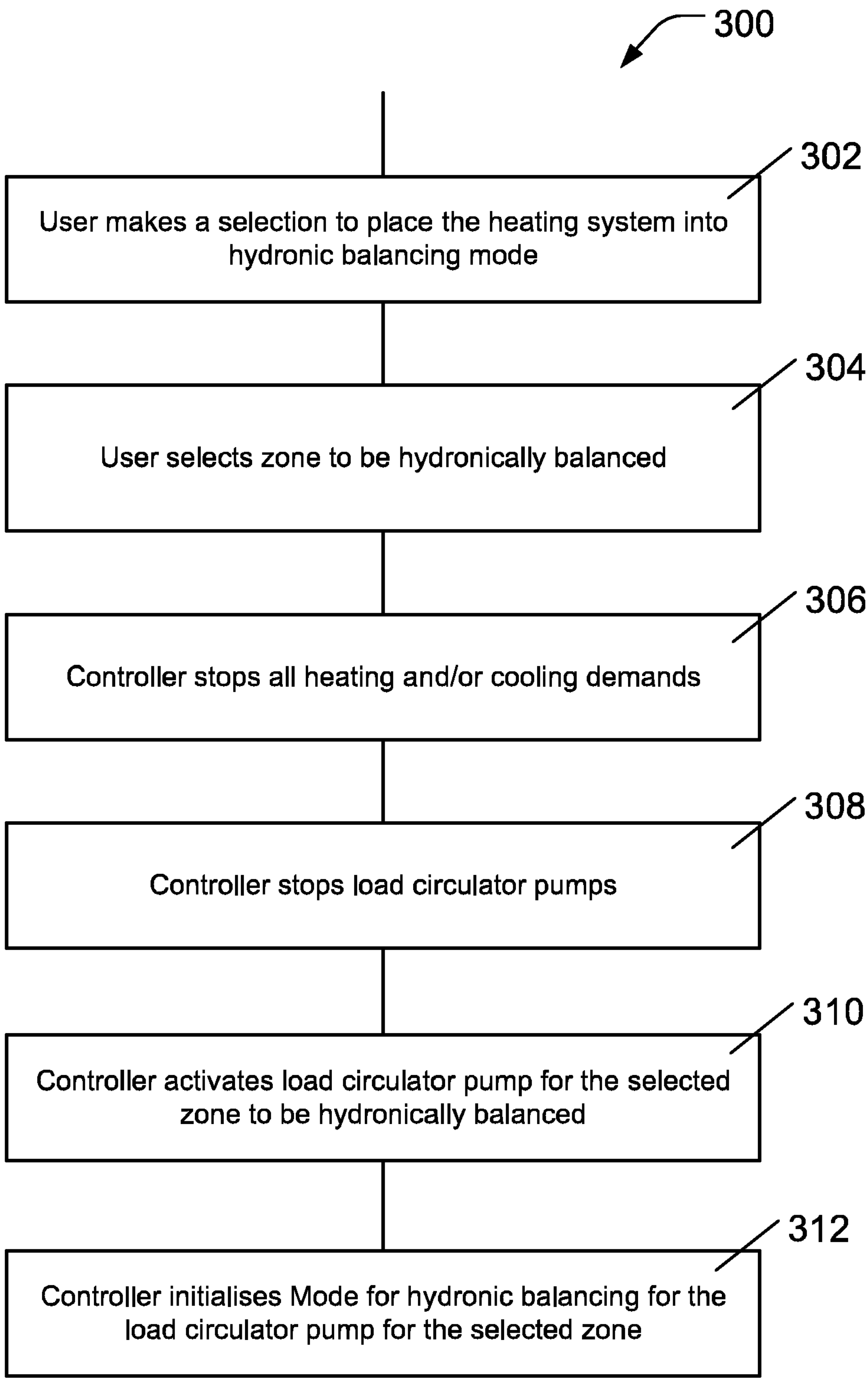
300
302
User makes a selection to place the heating system into hydronic balancing mode
304
User selects zone to be hydronically balanced
306
Controller stops all heating and/or cooling demands
308
Controller stops load circulator pumps
310
Controller activates load circulator pump for the selected zone to be hydronically balanced
312
Controller initialises Mode for hydronic balancing for the load circulator pump for the selected zone

FIG. 3

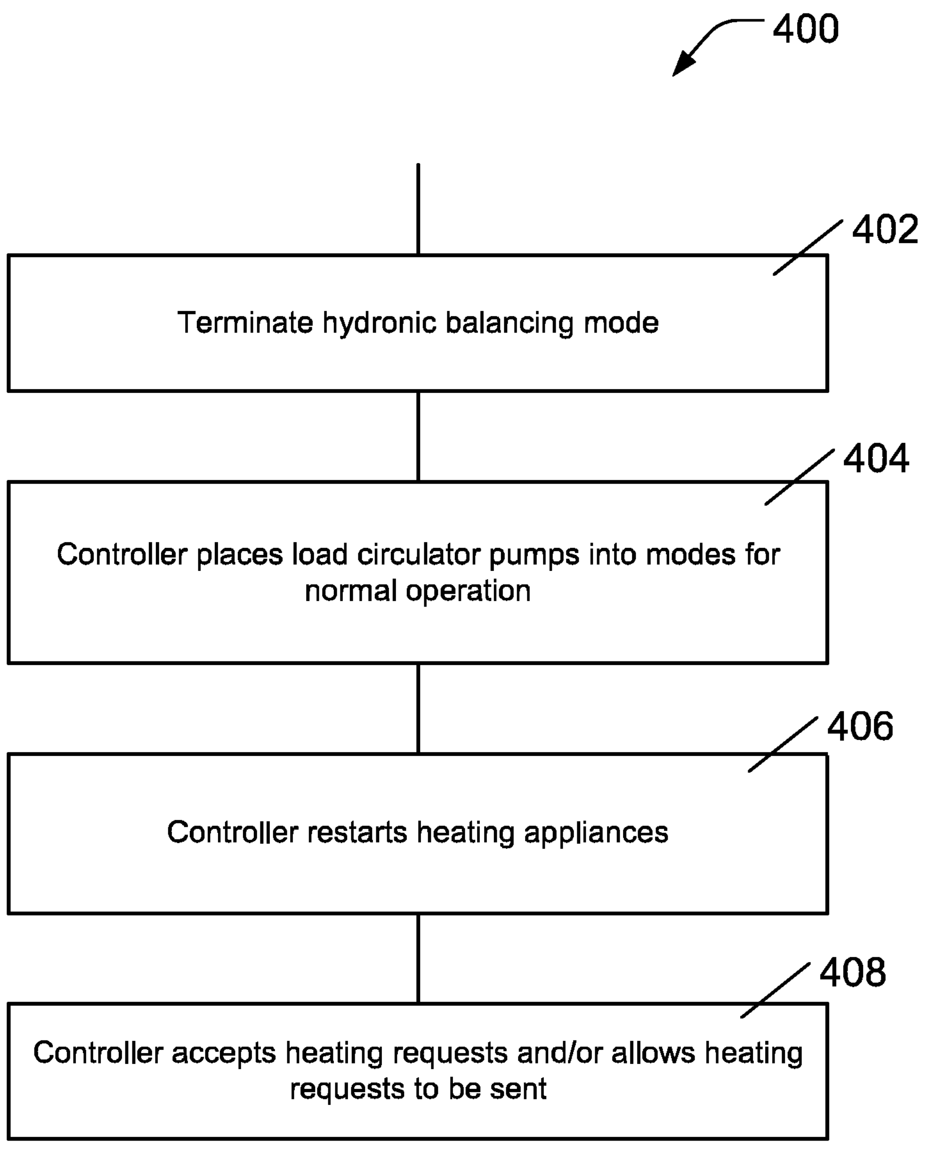
400
402
Terminate hydronic balancing mode
404
Controller places load circulator pumps into modes for normal operation
406
Controller restarts heating appliances
408
Controller accepts heating requests and/or allows heating requests to be sent

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 0840

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Place of search	Date of completion of the search	Examiner
Munich	11 April 2024	Riesen, Jörg

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