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(54) **HEATING CONTROL SYSTEM WITH HYDRAULIC BALANCING**

(57) A system for distributing heat to multiple rooms from a boiler is disclosed, wherein the system comprises a corresponding thermostat, a corresponding adjustable valve and a corresponding valve controller for controlling the temperature of each room, wherein the opening gap of each adjustable valve is capable of varying from the minimum opening gap when the adjustable valve is fully closed to the maximum opening gap when the adjustable valve is fully opened with a plurality of different opening gaps between said minimum opening gap and said maximum opening gap, wherein the opening gap of each adjustable valve is capable of being adjusted by its corresponding valve controller according to information comprising a temperature of each room detected by its corresponding thermostat and a set temperature of each room set by a user for distributing heat from the boiler to each room via its corresponding adjustable valve.

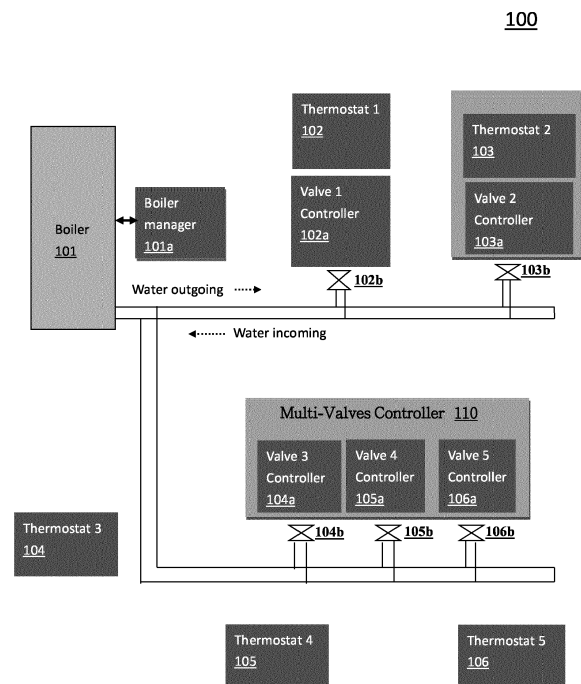


FIG. 1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The invention relates to a heating system to warm rooms, and in particular, to a heating system with intelligence to save energy and balancing heat distribution among the multiple rooms.

Description of the Related Art

[0002] Conventionally, a heating system to warm multiple rooms includes a boiler to provide hot water to the multiple rooms through water pipes. In each room, there are devices to radiate the heat of the hot water to keep room warm. Usually, there are valves to control the flow of the hot water. A valve can be located in a room for providing hot water to a radiator for radiating heat to the rooms or multiple valves can be located inside a central manifold for providing multiple under floor pipes to warm rooms. However, in such conventional heating system, each valve is either fully closed or fully opened, which is not efficient for distributing heat among rooms if each room has a different set temperature and might waste heat energy when the heat provided by the boiler is higher than necessary to maintain the set temperatures of the rooms.

[0003] Accordingly, there is demand for a heating system with intelligence to solve the aforementioned problems.

BRIEF SUMMARY OF THE INVENTION

[0004] One objective of the present invention is to provide a heating system with intelligence to balance heat among multiple rooms in such it avoids big fluctuation of water flow of each valve during the heating adjustment process.

[0005] One objective of the present invention is to provide a heating system with intelligence to balance heat among multiple rooms when the output heat of the boiler is not enough to allow each room to reach its set temperature.

[0006] One objective of the present invention is to provide a heating system with intelligence to adjust the output heat of the boiler to save energy.

[0007] In one embodiment of the present invention, a system for distributing heat to multiple rooms from a boiler is disclosed, wherein the system comprises a corresponding adjustable valve, a corresponding valve controller and a corresponding thermostat for controlling the temperature of each room, wherein the opening gap of adjustable valve is capable of varying from the minimum opening gap when the adjustable valve is fully closed to the maximum opening gap when the adjustable valve is fully opened with a plurality of different opening gaps be-

tween said minimum opening gap and said maximum opening gap, wherein the opening gap of each adjustable valve is capable of being adjusted by its corresponding valve controller according to information comprising a temperature of each room detected by its corresponding thermostat and a set temperature of each room set by a user for distributing heat from the boiler to each room via its corresponding adjustable valve.

[0008] In one embodiment, said information further comprises the current opening gap of each adjustable valve for adjusting the output heat of the boiler to save energy.

[0009] In one embodiment, each of a first room and a second room is warmed through a pipe located under the floor of the room, respectively, wherein a thermostat corresponding to the first room is located in the first room and a thermostat corresponding to the second room is located in the second room, and wherein a first valve and a first valve controller corresponding to the first room and a second valve and a second valve controller corresponding to the second room are located in a manifold outside the first room and the second room.

[0010] In one embodiment, a third room is warmed through a radiator, wherein a third valve, a third valve controller and a third thermostat are located inside the third room.

[0011] In one embodiment of the present invention, a system for distributing heat to multiple rooms from a boiler is disclosed, wherein each room is warmed through a pipe located under the floor of the room, the system comprising a corresponding valve, a corresponding valve controller and a corresponding thermostat for controlling the temperature of each room, wherein the opening gap of each adjustable valve is capable of varying from the minimum opening gap when the adjustable valve is fully closed to the maximum opening gap when the adjustable valve is fully opened with a plurality of different opening gaps between said minimum opening gap and said maximum opening gap, wherein said valves and said valve controllers are located in a manifold outside of each of the multiple rooms for distributing heat from the boiler to each room.

[0012] In one embodiment of the present invention, a system for distributing heat output from a boiler to multiple rooms, wherein the system comprises a corresponding valve, a corresponding valve controller and a corresponding thermostat for controlling the temperature of each room, wherein the opening gap of each adjustable valve is capable of varying from the minimum opening gap when the adjustable valve is fully closed to the maximum opening gap when the adjustable valve is fully opened with a plurality of different opening gaps between said minimum opening gap and said maximum opening gap, wherein the output heat from the boiler is controlled according to information comprising a difference between the current temperature of each room detected by its corresponding thermostat and a set temperature of each room set by a user and the current opening gap of

each valve.

[0013] In one embodiment of the present invention, a boiler system for outputting heat to multiple rooms is disclosed, wherein a corresponding adjustable valve, a corresponding valve controller and a corresponding thermostat are used for controlling the temperature of each room, wherein the boiler system comprises a boiler and a boiler manager connected to the boiler, wherein the boiler manager instructs the boiler to adjust heat output according to information comprising a temperature of each room detected by its corresponding thermostat, a set temperature of each room set by a user, and the current opening gap of each adjustable valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention can be more fully understood by reading the subsequent description and examples with references made to the accompanying drawings, wherein:

FIG. 1 is a schematic view of a heating system in accordance with an embodiment of the invention;
 FIG. 2 is a schematic view of an example of FIG. 1 for distributing heat among multiple rooms in accordance with an embodiment of the invention;
 FIG. 3A is a schematic view of a valve controller to position a corresponding adjustable valve to control the water volume flowing through an particular opening gap of the adjustable valve in accordance with an embodiment of the invention;
 FIG. 3B is a schematic view of a dumb valve controller to position a corresponding adjustable valve in a manifold in accordance with an embodiment of the invention;
 FIG. 3C is a schematic view showing an integrated device comprising a thermostat and a valve controller and having wireless communication capability in accordance with an embodiment of the invention;
 FIG. 4 is a schematic view of using a Multi-Valves controller connecting two dumb valve controller in a manifold in accordance with an embodiment of the invention; and
 FIG. 5 is a schematic view of a boiler with as associated manager for controlling the heat output of the boiler in accordance with an embodiment of the invention.

Detailed Description of the Invention

[0015] It is understood that the following disclosure provides many different embodiments, or examples, for implementing different features of the invention. Specific examples of devices and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over or on a second feature in the description that follows may

include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features are formed between the first and second features, such that the first and second features are not in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

[0016] Heating control system with hydraulic balancing according to one embodiment of the present invention is based on the following design architecture: (A) All devices in the heating system of present invention can have wireless communication capability. Any device can communicate to any other devices by wireless communication; (B) valve controller has a built in electric-mechanism module which partitions the valve open gap, from fully open to fully closed, into hundreds of step so that valve controller can control valve to open its gap at any step among these partitioned steps; (C) both of thermostat and valve controller could be combined into different type of products to meet different working environment. But, they all have the same working characteristics: thermostat continuously measures room temperatures and compare with set temperature to determine how much valve gap should be open and commands valve controller to set valve to open gap to the calculated step. The process is ongoing and dynamically adjust valve gap.

[0017] FIG. 1 is a schematic view of a heating system **100** in accordance with an embodiment of the present invention. As shown in FIG. 1, wherein the boiler **101** will supply hot water to a first radiator (not shown) via the adjustable valve **1 102b**, and the water volume flowing through the first radiator can be controlled by using the valve **1** controller **102a** to adjust the opening gap of the adjustable valve **1 102b**. Thermostat **1 102** is a wireless device which communicates with valve **1** controller **102a** via a wireless connection to control the opening gap of an adjustable valve **1 102b** in order to meet a desired room temperature set by user. The boiler **101** will also supply hot water to a second radiator (not shown) via an adjustable valve **103b**, and the water volume flowing through the second radiator can be controlled by using the valve **2** controller **103a** to adjust the opening gap of the adjustable valve **2 103b**, wherein the valve **2** controller **103a** is integrated with the thermostat **2 103** as a single device. This single device will measure room temperature and compare with the set temperature set by user and then adjust the opening gap of the adjustable valve **2 103b** as desired. The boiler **101** will also supply hot water flowing to a manifold that provides water loops to under floor pipes for warming rooms. Thermostat **3 104**, thermostat **4 105**, thermostat **5 106** are wireless devices which communicate with a Multi-Valves Controller **110** which is connected to valve controller **3 104a**, valve controller **4 105a** and valve controller **5 106a**, wherein thermostat **3 104**, thermostat **4 105**, thermostat **5 106** are

paired with valve controller 3 **104a**, valve controller 4 **105a**, valve controller 5 **106a**, respectively. The Multi-Valves Controller **110**, valve controller 3 **104a**, valve controller 4 **105a**, valve controller 5 **106a** and adjustable valves **104b**, **105b**, **106b** are located inside a manifold, wherein Multi-Valves Controller **110** receives commands from the thermostat 3 **104**, thermostat 4 **105**, thermostat 5 **106** to control valve controller 3 **104a**, valve controller 4 **105a** and valve controller 5 **106a** respectively to adjust the opening gap of the adjustable valves **104b**, **105b**, **106b**. Please note that each of the above valve controllers can be an intelligent valve controller such as valve controller **102b**, one of the implementations of the intelligent valve controller is shown in FIG. 3A, or a dumb valve controller such as **104a**, **105a**, **106a**, one of the implementations of the dumb valve controller is shown in FIG. 3B. In addition, valve 2 controller **103a** is integrated with the thermostat 2 **103** as a single device, which is called a thermoactuator, one of the implementations of the thermoactuator is shown in FIG. 3C.

[0018] As shown in FIG. 1, a boiler manager **101a** is connected with the boiler **101** via an interface such as a RS232 interface. The boiler manager communicates with other devices in the heating system via wireless connections. For example, the boiler manager from obtained room temperatures, set temperatures and opening gaps of the adjustable valves from thermostats and can instruct the boiler to adjust the heat output. When all rooms can reach set temperature of the steady state, but none of the adjustable valves is fully opened, it means that the heat output of the boiler is too large, a waste of energy. At this time, boiler manager can instruct boiler to reduce its heat output to save energy. When there is a room which has valve full open but could not reach its set temperature while other rooms have reached set temperature of the steady state, it means heat output from boiler is not enough. Under such case, boiler manager will inform boiler to increase heat output.

[0019] In one embodiment, in order to prevent water flow of each valve from large fluctuation during the temperature adjustment process, each room divides from its room temperature to target set temperature into many sections. Each section has its target set temperature and a target pre-defined room temperature changing rule. In every section, valve is adjusted every fixed pre-defined time interval to have room temperature change per pre-defined time interval conform to the target pre-defined room temperature changing value per pre-defined time interval according to the pre-defined time interval rule so that each room in the section will enable room temperature gradually changing to reach section target set temperature. By the time, room reaches set temperature and valves gap are also at stable.

[0020] For example, for a room, if the current temperature is 16°C and user sets the set temperature to 22°C, then this room could partition set temperature adjustment process into 3 sections: 16°C -19°C, 19°C-21°C, and 21°C -22°C, wherein in section 16°C -19°C, the temper-

ature will be increased from 16°C to target section set temperature 19°C, then enter section 19°C-21°C to increase the temperature to target section set temperature 21°C. Finally, enter section 21°C -22°C to increase the temperature to the set temperature 22°C. In each section, valve movement is controlled and guided by a pre-defined temperature changing rule: increase or decrease valve gap by certain amount of adjustable valve gap steps depending on the difference of measured room temperature change per pre-defined time compared to the pre-defined room temperature change per pre-defined time interval. For example, in section 16°C-19°C, rule could be : pre-defined time interval is 5 minutes , targeted room temperature change per 5 minutes is to be within [0.3, 0.4] degree, if measured room temperature change per 5 minutes is less than 0.3 degree and no less than 0, valve gap will be increased by 1% of total valve gap ; if measured room temperature change per 5 minutes is less than 0, valve gap will be increase by 3 % of total valve gap; If measured room temperature change larger than 0.4 degree and no larger than 0.7 degree, valve gap will be reduced by 1% of total valve gap; if measured room temperature change larger than 0.7 degree, valve gap will be reduced by 3% of total valve gap. By continuing examine room temperature changing and adjust valve gap following the rule of pre-defined room temperature change per pre-defined time interval, the room temperature will start from current temperature gradually reach the target set temperature of the section and continue going though each section to reach set temperature as user desired.

[0021] That is, for each room, the temperature difference between the current room temperature when user sets set temperature and the set temperature could be divided into multiple sections, wherein the multiple rooms respectively adjust its current room temperature toward a corresponding targeted set temperature of the section and guided by said pre-defined room temperature changing rule of the section. There are many ways to decide the number of sections for each room and the pre-defined room temperature changing rule of section. In one embodiment, one of the guidelines is to select the pre-defined room temperature change per pre-defined time interval by considering how much time it needs to travel through the section and to adjust the valve gap in a way that ongoing room temperature change per pre-defined time interval will converge to the pre-defined room temperature change per pre-defined time interval of the section, and another guideline is that the section closer to last section which has user set temperature as section targeted temperature, the pre-defined room temperature change per pre-defined time interval for the section will be smaller and associated valves gap amount adjustment will be more fine adjustment. Furthermore, in order to have further smoothness of the water flow during the temperature adjustments process among the multiple rooms in each section, valve control steps, pre-defined time interval, pre-defined temperature changing range

per time interval can be also further changed at each time interval checking point within the section. The above examples are just for illustration purpose, the number of sections for each room between the current room temperature and the set temperature and parameter of valve adjust steps, pre-defined time interval, temperature changing range per pre-defined time interval of each section can be defined based on the requirements in each different scenario or at user's needs.

[0022] In one embodiment, the operations of the heat system is described as follows:

1. Valve controller has electric-mechanic module which can partition valve gap from fully closed to fully open into many steps and control valve gap stay at any desired step so that the water volume flowing through the corresponding radiator or under floor pipe for warming rooms can be controlled.
2. Valve controller will initially move valve to be fully closed and then to fully opened to measure how many steps of the valve gap could be partitioned after the valve controller is installed onto the valve.
3. After user enters room set temperature, thermostat partitions between room temperature and set temperature into several sections and guided by a pre-defined temperature changing rule of each section. Then, follow the pre-defined temperature changing rule on each section, room temperature will be gradually adjusted to section set temperature.
4. When set temperature is higher than room temperature, valve gap will be open more to get more heat. When set temperature is lower than room temperature, valve gap will be open less to reduce heat. Larger the difference between set temperature and room temperature, larger the valve gap will be adjusted.
5. Thermostat can send a command to at least one set of valve controller to adjust corresponding adjustable valve.
6. Boiler manager is constantly collecting set temperature, room temperature, valve gap from each heating device. By examining all the data from devices, boiler manager will inform boiler to raise heat output when there is not sufficient heat or to reduce heat output when there is too much heat.
7. This system is very flexible. It could be used for radiator heating, under floor heating, also both mixed together heating environment. It could also be used when the boiler manager is not available.

[0023] FIG. 2 is a schematic view of a heating system **200** in accordance with an embodiment of the present invention. As shown in FIG. 2, the heating system **200** distributes heat to three rooms **201**, **202**, **203** from a boiler **204** that provides hot water to warm each room. Room 1 has a radiator with control device Dev 1 **201a**. Room 2 **202** and room 3 **203** are using under floor heating with hot water coming from a manifold **205**, while thermostat

2 **202a** and thermostat 3 **203a** are at room 2 **202** and room 3 **203** respectively. There are Multi-Valves Controller **205a**, and dumb valve controllers **205b** and **205c** in manifold to control the adjustable valves of each water loop to room 2 **202** and room 3 **203**. Dev 1 **201a** is at room 1 which detects room temperature and adjusts water volume flow through the radiator by control the open size of its corresponding adjustable valve. Thermostat 2 **202a** is at room 2 **202** which detects room temperature and commands Multi-Valves Controller **205a** at the manifold controls the dumb valve controllers **205b** and **205c** to adjust the opening gap of its corresponding adjustable valve for determining the water volume following to room 2 **202** and room 3 **203**. Dev 4 **204a** is a boiler manager which is connected to the boiler, wherein the boiler manager controls the boiler to generate right amount of heat output.

[0024] When there is a room that has a room temperature below the set temperature and the corresponding adjustable valve is fully opened while other rooms have reached their set temperatures at steady state, it means that the heat output of the boiler is insufficient. At this time, the boiler can increase its heat output if possible to relieve such situation. However, if the boiler cannot provide more heat at this time, heat redistribution among rooms needs to be carried out so as to avoid a room with an unacceptable low temperature.

[0025] There are many ways to redistribute heat from the boiler to the rooms when the heat output of the boiler is insufficient. For example, the room having the highest room temperature can transfer certain amount of heat to the room with the lowest room temperature that has not yet met its set temperature, wherein the room has the highest room temperature is a heat contributor and the room with the lowest room temperature as a heat recipient. The heat contributor can lower its set temperature for transferring certain amount of heat to the heat recipient. During the heat transfer process, the contributor will reduce the opening gap of the corresponding adjustable valve while the heat recipient will have its adjustable valve fully opened, wherein all other rooms are stable at their current room temperature. The above heat transfer process from the room with the highest room temperature to the room with the lowest room temperature can be iterated to ensure there is no room with an unacceptable low room temperature. Please note that there can be multiple contributors and/or multiple recipients during a heat transfer process among rooms. Alternatively, the system can calculate optimum temperatures for all of the rooms and each room can set its set temperature to the calculated optimum temperature to balance heat among rooms and repeat the process.

[0026] When each room reaches its set temperature of the steady state, but none of the adjustable valves is fully opened, it means that the heat output of the boiler is too large, a waste of energy. At this time, the boiler manager will inform boiler to reduce its heat output to save energy.

[0027] FIG. 3A is a schematic view of valve controller **300** to position a corresponding adjustable valve to control the water volume flowing through a suitable opening gap of the adjustable valve in accordance with an embodiment of the present invention. The main blocks of valve controller are: Electronic control center, communication block, motor driver, gear sets, infra-red transceiver, interface to move valve. Working principle of each element of the valve controller is described as follows: Motor driver: control motor speed, clock or clockwise rotation. When motor works, it will push gear sets to rotate and move its pod forward or backward. This pod connects to interface to move valve. Interface to move valve will transform up down movement of the pod into a larger torque pod to on-off push-pull valve or into a larger torque rotation cap to open-close ball valve. With such mechanism transformation, it can control the opening gap of the adjustable valve. When motor starts to work, infra-red transceiver will transmit infra-red. When gear sets move to an infra-red reflection dot on the gear, the reflection of the infra-red will be received by the infra-red transceiver. When infra-red transceiver receives reflected infra-red, it knows the gear sets has rotated to another reflection position. By recording the number of the infra-red reflections, it can calculate how much the gear sets have been moved and convert them into a distance the gear sets pod has moved, which can be used to determine the opening gap of the adjustable valve. When the desired opening gap of the adjustable valve is reached, the motor will be stopped. Another possible implementation is to use a stepping motor to measure how many steps between full open and full close of the adjustable valve, and then the stepping motor can be controlled to the opening gap of the adjustable valve.

[0028] The Intelligent valve controller and its corresponding thermostat can communicate with each other through wireless communications, the thermostat is responsible to send a command to the intelligent valve controller to adjust the adjustable valve to a desired opening gap, and the intelligent valve controller will adjust the adjustable valve to the desired opening gap according to the command. The FIG. 3A is a design based on a microcontroller, however, the present invention is not limited to the implementations of the intelligent valve controller **300**. For example, intelligent valve controller **300** can be based on a hardware design as well.

[0029] FIG. 3B is a schematic view of a dumb valve controller **400** to position a corresponding adjustable valve in a manifold in accordance with an embodiment of the present invention. The dumb valve controllers in the manifold can be connected to a Multi-Valves Controller using RJ11 connector, wherein the Multi-Valves Controller has multiple RJ11 female sockets, and each dumb valve controller also has female a socket, wherein both ends of the RJ11 cable are equipped with male plugs to connect the Multi-Valves Controller and to the dumb valve controller. The Multi-Valves Controller can communicate with each of the thermostats corresponding to the

manifold for receiving a command from each of the thermostats and control corresponding dumb valve controller to adjust the corresponding adjustable valve to the desired opening gap, respectively. After the Multi-Valves Controller receives the command from a thermostat, the Multi-Valves Controller will control the corresponding dumb valve controller to adjust a corresponding adjustable valve to the desired opening gap. Although other type connector instead of RJ11 connector can be used in the example, however, the RJ11 connector makes the installing process easier.

[0030] FIG. 3C is a schematic view of a thermoactuator **500** comprising a thermostat and a valve controller and having wireless communication capability in accordance with an embodiment of the present invention. Thermoactuator **500** can measure/record room temperatures, compare with set up temperature, and analyze the room temperature changing curve, also collect other similar information from other thermoactuators in the system. Thermoactuator **500** will decide when and how much to change valve gap open size according its computation. When room temperature is lower than set temperature, thermoactuator **500** will increase the opening gap of the adjustable valve. When the room temperature is higher set temperature, thermoactuator **500** will reduce the opening gap of the adjustable valve. FIG. 3C is a design based on a microcontroller, however, the present invention is not limited to the implementations of the thermoactuator **500**. For example, the thermoactuator **500** can be based on a hardware design as well.

[0031] FIG. 4 is a schematic view **600** of using a Multi-Valves Controller **603** in a manifold to control each dumb valve controller **604**, **605** in accordance with an embodiment of the present invention. Each thermostat **610**, **602** can command its associated dumb valve controller **604**, **605** through the Multi-Valves Controller **603**. Each thermostat **610**, **602** computes the needed opening gap of its corresponding adjustable valve and sends the request to the Multi-Valves Controller **603**. The Multi-Valves Controller **603** will control each dumb valve controller **604**, **605** to adjust the opening gap of each adjustable valve, respectively. FIG. 4 is a design based on a microcontroller, however, the present invention is not limited to the implementations of the Multi-Valves Controller **603**. For example, the Multi-Valves Controller **603** can be based on a hardware design as well.

[0032] FIG. 5 is a schematic view of a boiler system **700** including a boiler **101** comprising an interface to connect with an associated boiler manager **101a** for controlling the heat output of the boiler **101** in accordance with an embodiment of the present invention. As shown in FIG. 5, a boiler manager **101a** is directly connected with the boiler **101** via a RS232 interface, but the present invention is not limited to the type of interface to connect the boiler manager **101a** to the boiler **101**. The boiler manager comprises a communication interface such as a wireless interface to communicate with other devices in the heating system via wireless connections. For ex-

ample, the boiler manager **101a** can obtain room temperatures, set temperatures and opening gaps of the adjustable valves from thermostats so that it can instruct the boiler to decrease or increase heat output accordingly. When all the rooms reach set temperature of the steady state, but none of the adjustable valves is fully opened, it means that the heat output of the boiler is too large, a waste of energy. At this time, the boiler manager **101a** instructs boiler **101** to reduce its heat output to save energy. When there is at least one room could not reach its set temperature of the steady state, and the adjustable valves are fully opened, while other rooms have reached set temperature of steady state, it means that the heat output of the boiler is not enough. Boiler manager **101a** can instruct boiler **101** to increase its heat output. In FIG. 5, the boiler manager **101a** is a design based on a microcontroller or a processor, however, the present invention is not limited to the implementations of the boiler manager **101a**. For example, the boiler manager **101a** can be based on a hardware design as well.

[0033] Please note that the boiler system **700** and boiler manager **101a** can be used for warming one room only, and the boiler manager **101a** can obtain the room temperature set temperature and the opening gap of the adjustable valves from the thermostat so that it can instruct the boiler **101** to adjust the heat output accordingly. When the room reaches set temperature of the steady state, but the adjustable valves are not fully opened, it means that the heat output of the boiler is too large, a waste of energy. At this time, the boiler manager **101a** instructs boiler **101** to reduce its heat output to save energy. When the room could not reach its set temperature of the steady state, but the adjustable valves are fully opened, it means that the heat output of the boiler is not enough. Boiler manager **101a** can instruct boiler **101** to increase its heat output.

[0034] From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the disclosure. Furthermore, where an alternative is disclosed for a particular embodiment, this alternative may also apply to other embodiments even if not specifically stated.

Claims

1. A system for distributing heat to multiple rooms from a boiler, wherein the system comprises a corresponding thermostat, corresponding at least one set of adjustable valve and valve controller for controlling the temperature of each room, wherein the opening gap of each adjustable valve is capable of varying from the minimum opening gap when the adjustable valve is fully closed to the maximum opening gap when the adjustable valve is fully opened with a plurality of different opening gaps between said mini-

mum opening gap and said maximum opening gap, wherein the opening gap of each adjustable valve is capable of being adjusted by its corresponding valve controller according to information comprising a temperature of each room detected by its corresponding thermostat and a set temperature of each room for distributing heat from the boiler to the rooms via the corresponding at least one set of adjustable valve and valve controller of the room.

2. The system of claim 1, wherein a boiler manager is connected to the boiler, and the boiler manager instructs the boiler to adjust the output heat of the boiler according to the information comprising a temperature of each room detected by its corresponding thermostat, a set temperature of each room and opening gap size of each adjustable valve.
3. The system of claim 1, wherein the thermostats, valve controllers, and the boiler manager communicate with each other through a wireless network.
4. The system of claim 1, wherein for each room, in order to adjust the current room temperature to the set temperature of the room, the temperature difference between the current room temperature and the set temperature of the room is divided into multiple sections, wherein the multiple rooms respectively in each section gradually reaches a corresponding section targeted set temperature by adjusting its corresponding adjustable valves through valve controllers according to a pre-defined temperature changing rule associated with each section.
5. The system of claim 4, wherein the pre-defined temperature changing rule defines a pre-defined room temperature change per pre-defined time interval and how to adjust valve, wherein valve gap is adjusted according to the difference of room temperature change measured per pre-defined time interval and said pre-defined room temperature change per pre-defined time interval so as to have the ongoing room temperature change per pre-defined time interval to conform to the pre-defined room temperature change per pre-defined time interval.
6. The system of claim 1, wherein when the heat output of the boiler is insufficient, the room having the highest room temperature lowers its set temperature for transferring certain amount of heat to the room with the lowest room temperature that has not yet met its set temperature, wherein the room having the highest room temperature reduces the opening gap of at least one corresponding adjustable valve, and the room with the lowest room temperature keeps all of its corresponding adjustable valve fully opened with each of the other rooms maintaining its current room temperature.

7. The system of claim 1, further comprising a Multi-Valves Controller in a manifold, wherein the Multi-Valves Controller is connected to a set of dumb valve controllers, wherein the Multi-Valves Controller receives commands from the thermostats for instructing the corresponding set of dumb valve controllers to adjust adjustable valves, respectively. 5

8. The system of claim 7, wherein the Multi-Valves Controller is connected to each dumb valve controller via a corresponding RJ11 cable with both ends of male plug, wherein each of the Multi-Valves Controller and the dumb valve controller has a built in RJ11 female socket. 10
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9. A boiler manager for instructing a boiler to adjust heat output to at least one room, wherein a corresponding thermostat, corresponding at least one set of adjustable valve and valve controller are used for controlling the temperature of each of the at least one room, wherein the boiler manager is connected to the boiler, wherein the boiler manager instructs the boiler to adjust heat output according to information comprising a temperature of each room detected by its corresponding thermostat, a set temperature of each room and an opening gap size of each adjustable valve. 20
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10. The system of claim 9, wherein each thermostat and the boiler manager communicate with each other through a wireless network. 30

11. The system of claim 9, wherein the boiler manager instructs the boiler to reduce its heat output when every room reaches its corresponding set temperature of the steady state with none of said adjustable valves being fully opened. 35

12. The system of claim 9, wherein the boiler manager instructs the boiler to increase its heat output when there is a room could not reach its corresponding set temperature of the steady state with the corresponding adjustable valves of the room being fully opened, while all other rooms reach set temperature of the steady state. 40
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13. The system of claim 9, wherein the boiler manager instructs the boiler to stay at current heat output when every room reaches its corresponding set temperature of the steady state and there is at least one adjustable valve of the room being fully opened. 50

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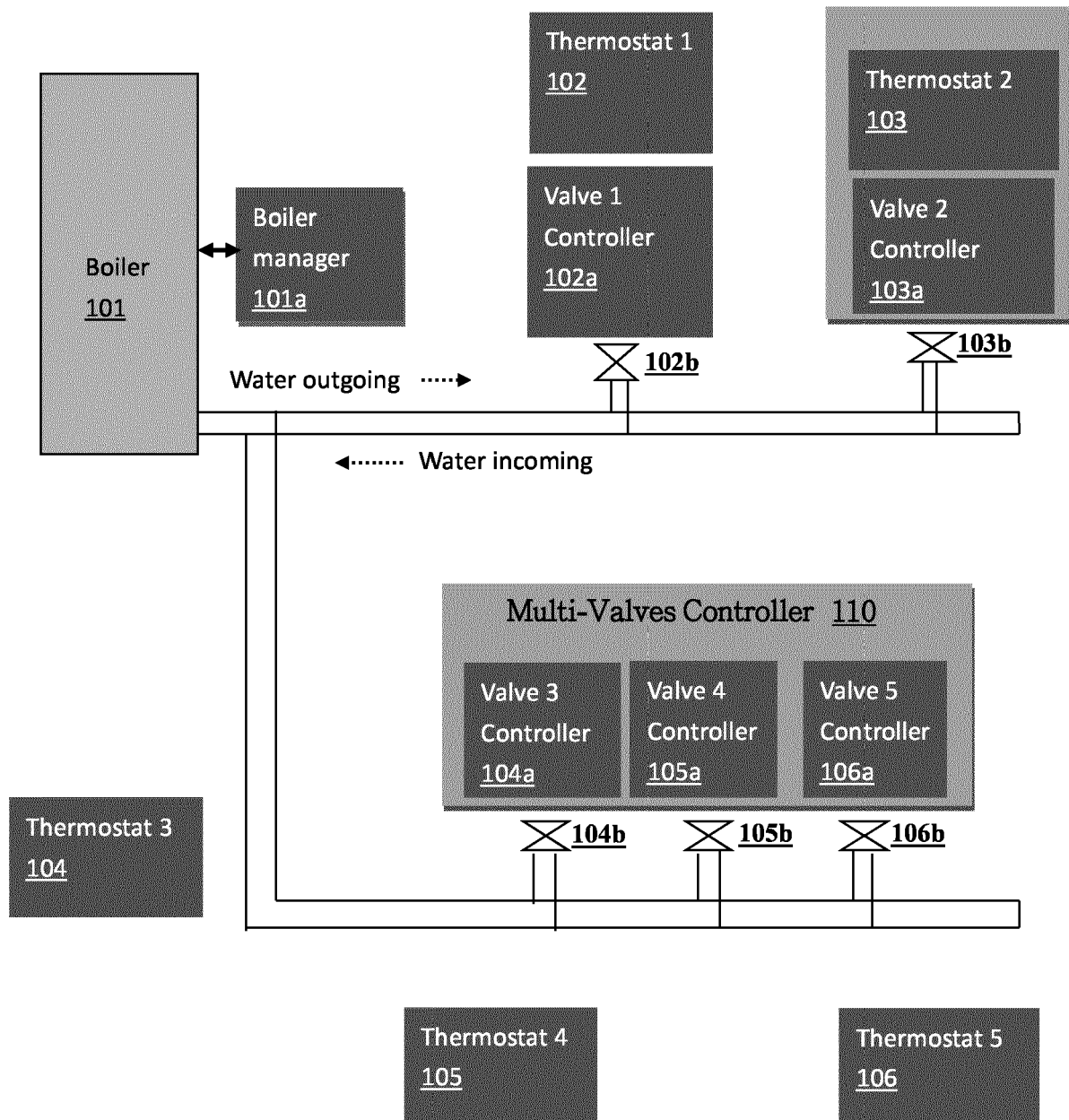


FIG. 1

200

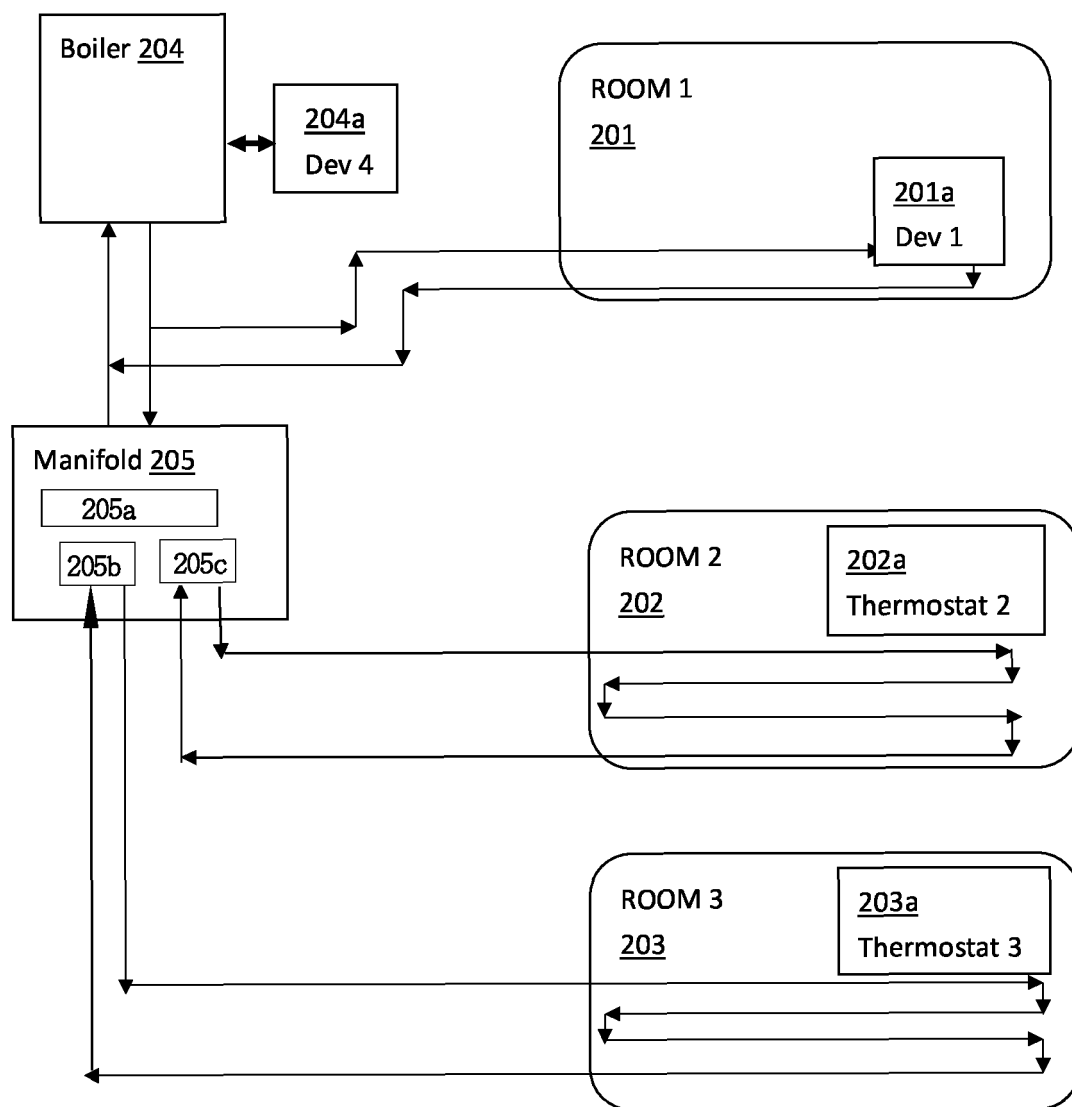


FIG. 2

300

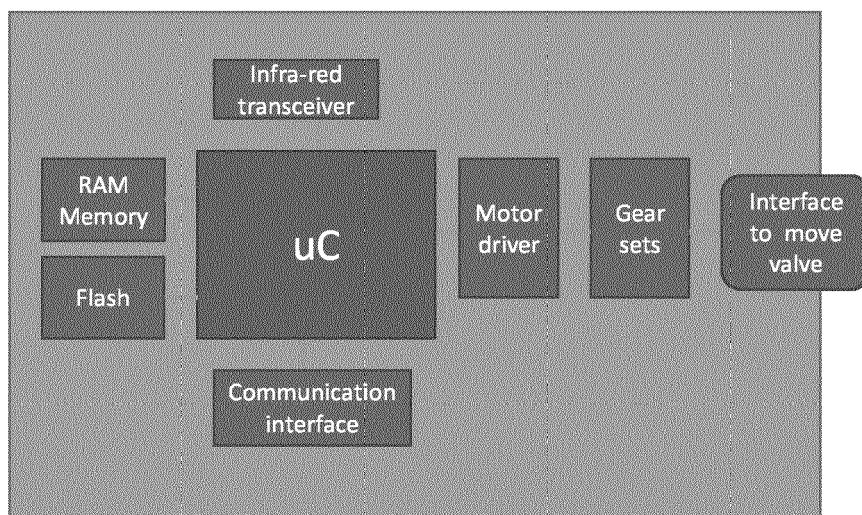


FIG. 3A

400

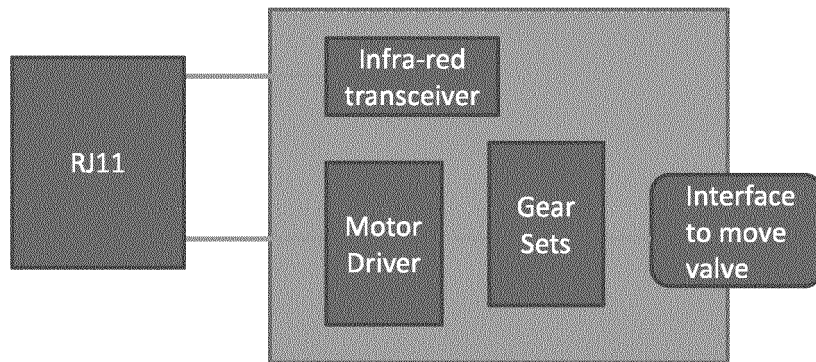


FIG. 3B

500

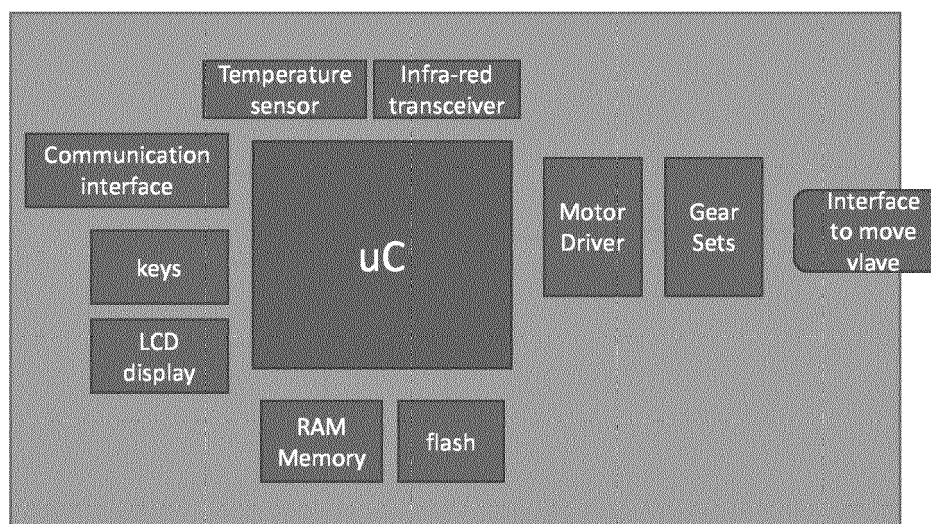


FIG. 3C

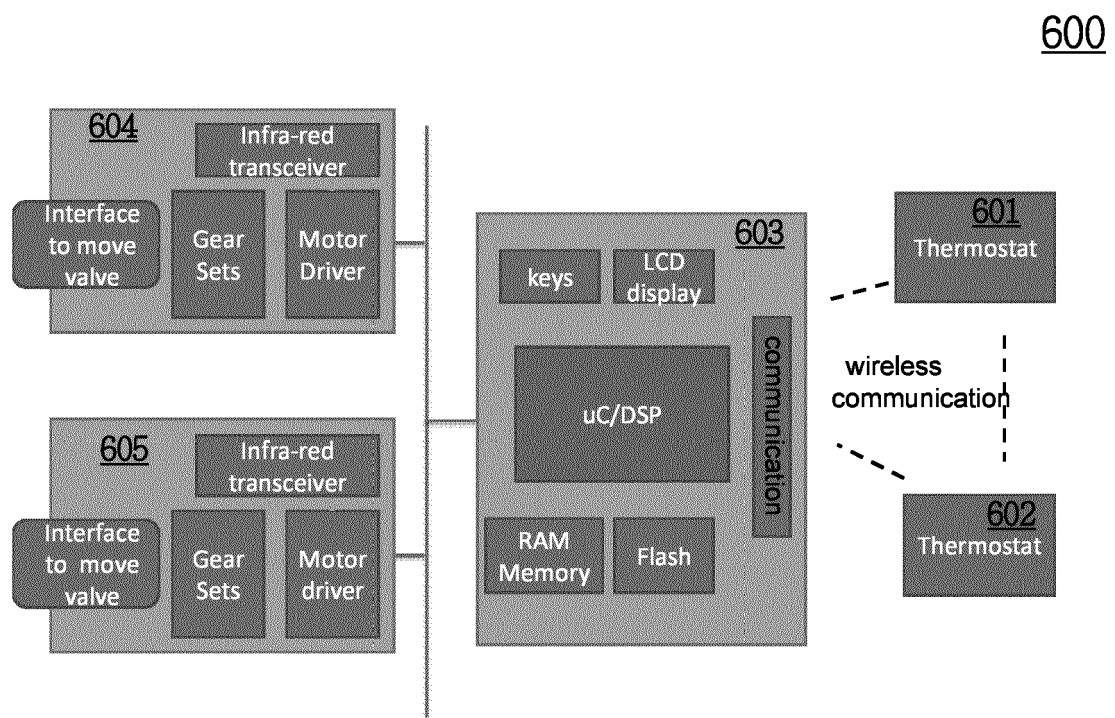


FIG. 4

700

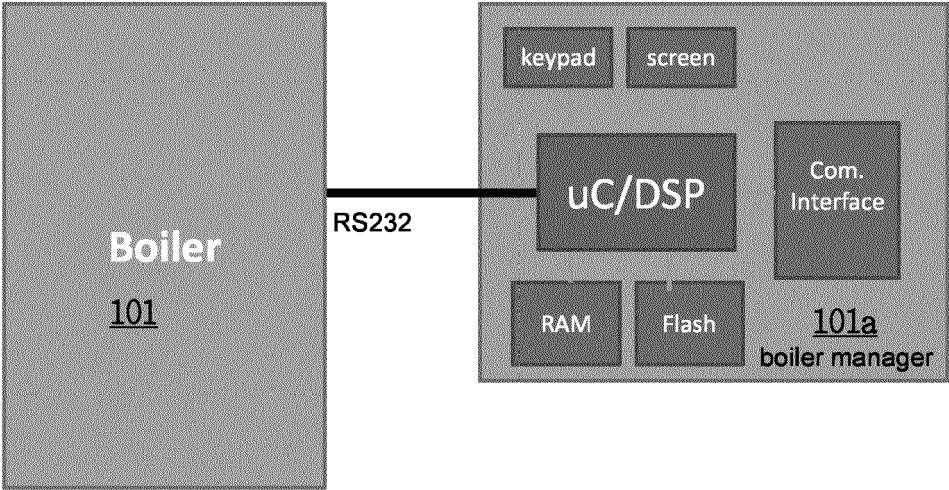


FIG. 5



EUROPEAN SEARCH REPORT

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