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(54) **CONTROL METHOD OF PARALLEL CONNECTION MULTI-HEATING TANK INSTANT WATER HEATER**

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(57) **ABSTRACT**

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This invention discloses a controlling method of instant water heater having multiple heating tanks parallel with each other. The branches of the heating tanks are all set with valve unit that controls on/off of the heating tank's water inlet terminal except for one branch; the control method are: setting two flow comparison value, L1 and L2 respectively; if current tested flow rate is higher than L2, then gradually turn on branches' valve unit; if current tested flow rate is lower than L1, then gradually turn off branches' valve unit; current heating tanks separately control heating power change based on current flow rate and temperature, and heat the water in it to preset temperature, one of these heating tanks will feedback according to mixed temperature, then feedback to slightly adjust temperature control, so water heater's outlet temperature reaches set temperature completely.

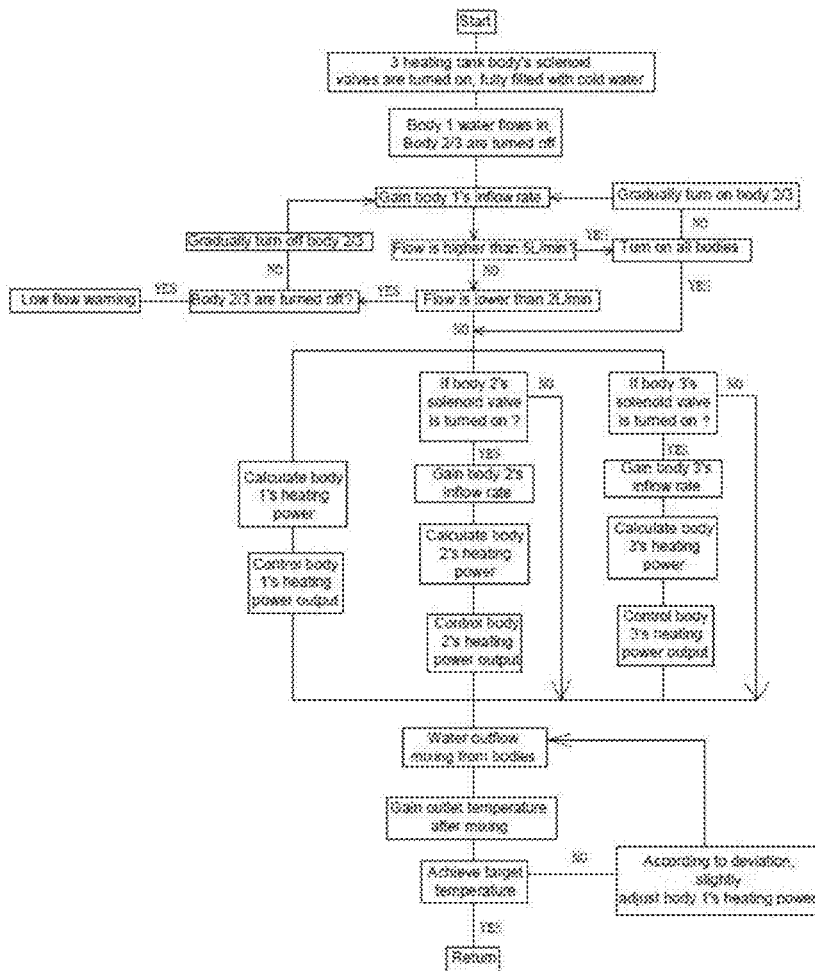
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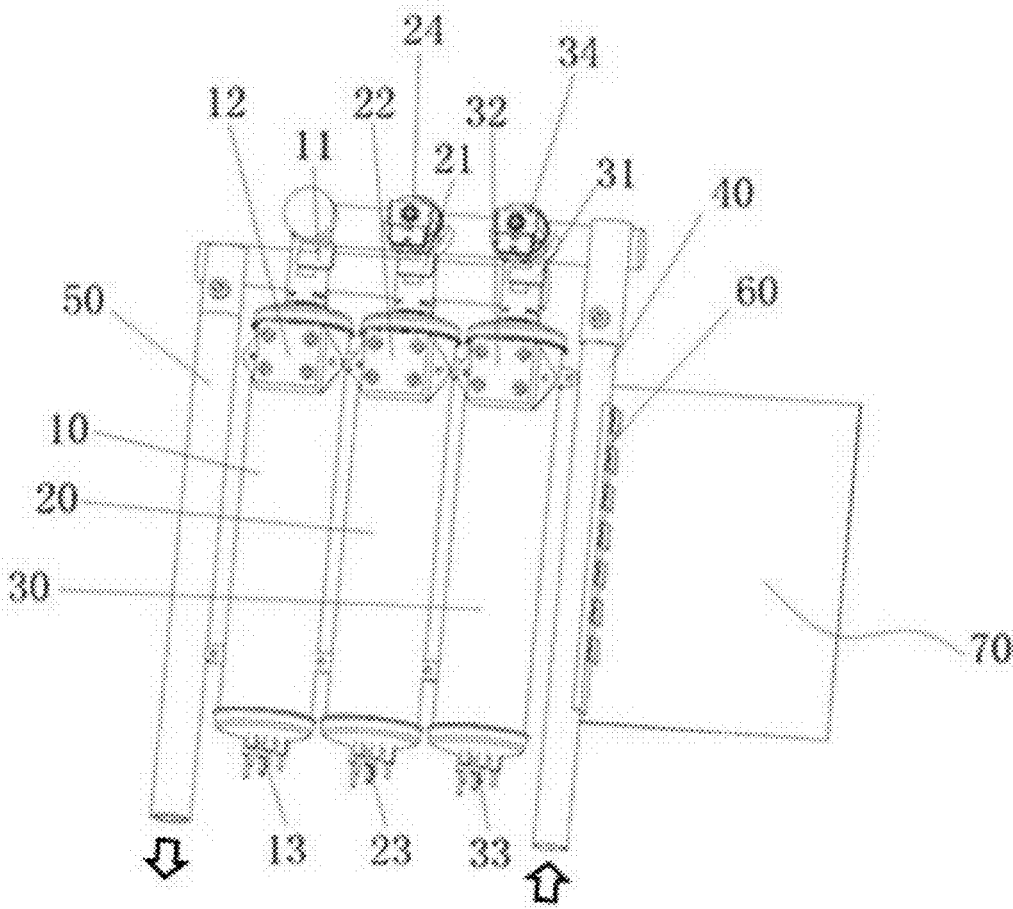


Fig. 1

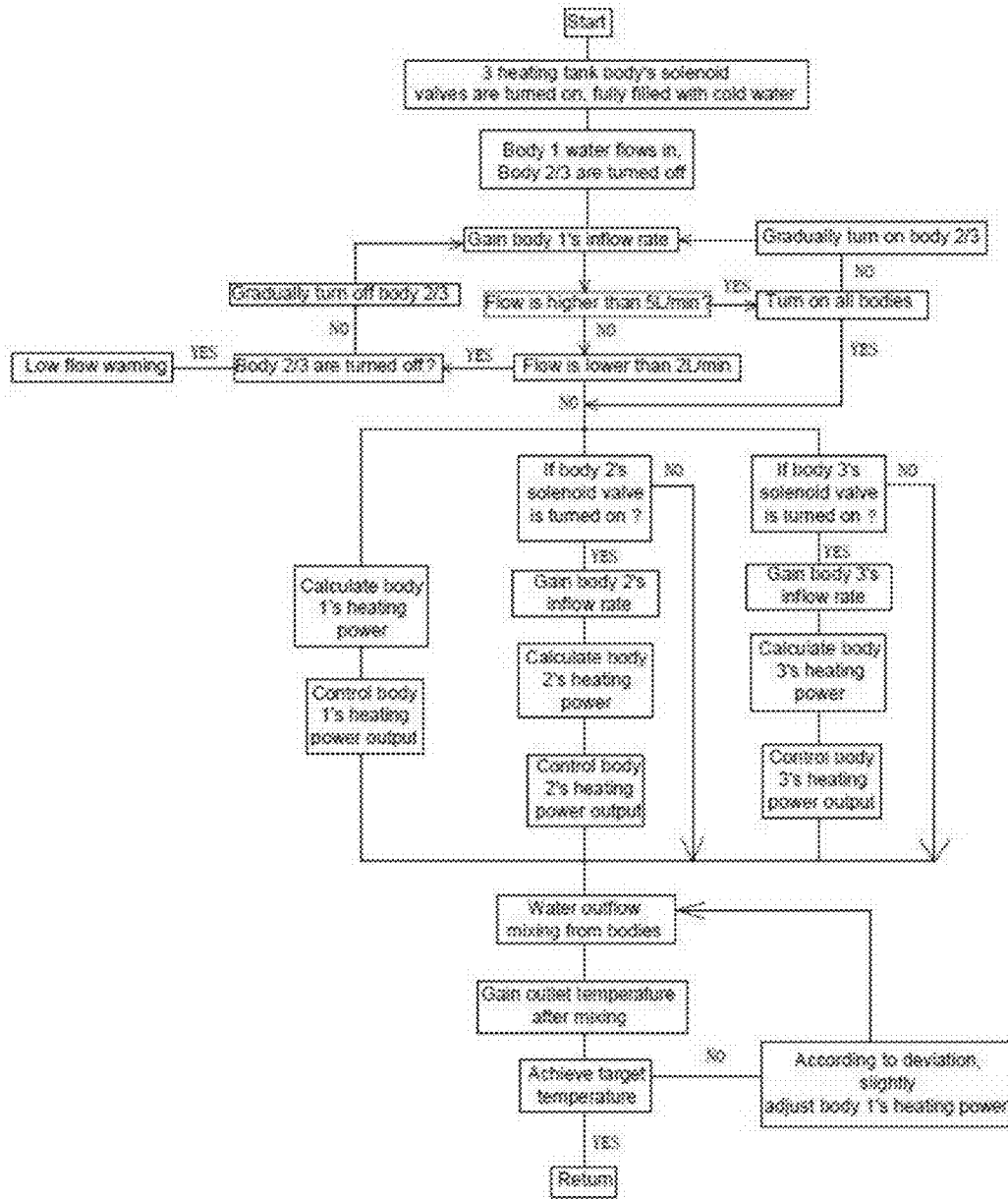


Fig. 2

## CONTROL METHOD OF PARALLEL CONNECTION MULTI-HEATING TANK INSTANT WATER HEATER

### FIELD OF THE INVENTION

**[0001]** This invention relates to electrical heating device controlling industry, and in particular relates to a parallel connection multi-heating tank structure, control method can be used for water and heat supply water heater, boilers, and other liquid heating equipments.

### BACKGROUND OF THE INVENTION

**[0002]** Normally used instant water heater is generally with one heating tank only, due to heating power limitation, hot water supply is not sufficient, cannot meet the needs of a lot of hot water. To solve this problem, need to use instant hot water with high power heating tank, but need to use special thermal cut-out, heating power switch spares to meet high power requirement, obviously the cost is high. Or use multiple low power heating tanks and series connection, then use a turning on device to control the machine, but this could easily lead to localized overheating and affect machine's use life, if turning on device is damaged, then all heating tanks will not be able to work. Also because each heating tank is working at different temperature in the long term, their use life would be different.

**[0003]** To solve this problem, the Chinese Patent Publication No. CN 201844529 U patent proposes a parallel connection multi-heating tank instant water heater. But this technical solution's water temperature control is accomplished by each heating tank individually control heating, then mix to achieve, so total water temperature's stability is poor, and outlet pipe is too long which has a heat loss. Based on this, another Chinese Patent Publication No. CN 104034046 A patent made some improvement, added additional main heating tank to heat mixed water from multiple sub-heating tanks again and adjust temperature again, which can ensure hot water outlet temperature's higher stability. But additional main heating tank increased the cost. In addition, both CN 201844529 U patent and CN 104034046 A patent have an unresolved technical problem. Both of them didn't consider when the inlet water flow is insufficient, assigned to multiple sub-heating tank's flow is small, and flow switch (or flow control valve) is detecting in certain range, for those small flow that beyond the detection limit, it cannot detect accurately, therefore, when input water flow is insufficient (water pipe pressure is not enough), it cannot provide good temperature regulation base on accurate flow rate.

### SUMMARY OF THE INVENTION

**[0004]** Therefore, this present invention proposes a parallel connection multi-heating tank instant water heater that is suitable for stable temperature regulation under low water flow condition.

**[0005]** This invention use following technical solution to achieve:

**[0006]** The control method of parallel connection multi-heating tank instant water heater, is used to control water heater with parallel connection multi-heating tank, this instant water heater with parallel connection multi-heating tank is: one water inlet pipe assigned to n pcs parallel connection heating tanks and heat, n here means more than

2 pcs. Those n pcs heating tanks' water after heating then mix and flow to outlet water pipe and supply to users, and flow to those n pcs heating tanks' n branches, except one of them, all combined with valve unit that controls on/off of heating tank's water inlet terminal; the control method is: initially, turn on all n-1 branches' valve unit, so that n pcs heating tanks will be fully filled with water, then turn off all n-1 branches' valve unit, and set two flow comparison value, L1 and L2 respectively, L2 is higher than L1, if current tested flow rate is higher than L2, then gradually turn on branches' valve unit, until current tested flow rate is between L1 and L2 range, equals to L1 or L2; if current tested flow rate is lower than L1, then gradually turn off branches' valve unit, until current tested flow rate is between L1 and L2 range, equals to L1 or L2; current branches' valve unit turns on those heating tanks and branch that is not assigned with valve unit's heating tank will control heating power change separately base on current flow rate and temperature, and heat it to basic setting temperature, current branches' valve unit turns on those heating tanks and branch that is not assigned with valve unit's heating tank mix to outlet water pipe, one of those heating tanks will feedback according to mixed temperature, then feedback to slightly adjust temperature control, so water heater's outlet temperature reaches set temperature completely.

**[0007]** The control method of parallel connection multi-heating tank instant water heater under this invention, can make sure parallel connection multi-heating tank instant water heater test flow accurately and stable temperature regulation under low water flow condition.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** FIG. 1: An example of structure diagram under this invention

**[0009]** FIG. 2: An example of control process diagram under this invention

### DETAILED DESCRIPTION OF THE INVENTION

**[0010]** To further explain the various examples, this invention is provided with the accompanying drawings. These figures are a part of the present invention, which is mainly used to illustrate examples, and with the relevant instruction manual's description to explain working principle. With reference of these contents, those ordinary technical people in this industry can understand other possible working methods and advantages of the present invention. Components in the figures are not drawn to scale, and similar components are usually indicating similar components.

**[0011]** The present invention is further described with the accompanying drawings and specific embodiments.

**[0012]** The present invention provides a control method of parallel connection multi-heating tank instant water heater, use to control parallel connection multi heating tank instant water heater. This parallel connection multi-heating tank instant water heater is similar to Patent Publication No. CN 201844529 U's structure, both of them are: one water inlet pipe assigned to n pcs parallel connection heating, tanks and heat, n here means more than 2 pcs. Those n pcs heating tanks then mix and flow to outlet water pipe and supply to users. The difference is: flow to those n pcs heating tanks' n branches, except one of them, all combined with valve unit that controls on/off of heating tank's water inlet terminal; the

control method is: initially, turn on all n-1 branches' valve unit, so that n pcs heating tanks will be fully filled with water, then turn off all n-1 branches' valve unit, and set two flow comparison value, L1 and L2 respectively, L2 is higher than L1, if current tested flow rate is higher than L2, then gradually turn on branches' valve unit, until current tested flow rate is between L1 and L2 range, equals to L1 or L2; if current tested flow rate is lower than L1, then gradually turn off branches' valve unit, until current tested flow rate is between L1 and L2 range, equals to L1 or L2; current branches' valve unit turns on those heating tanks and branch that is not assigned with valve unit's heating tank will control heating power change separately base on current flow rate and temperature, and heat it to basic setting temperature, current branches' valve unit turns on those heating tanks and branch that is not assigned with valve unit's heating tank mix to outlet water pipe, one of those heating tanks will feedback according to mixed temperature, then feedback to slightly adjust temperature control, so water heater's outlet temperature reaches set temperature completely.

**[0013]** Among them, since branches are connected in parallel, therefore tested flow value which is used to compare with L1 and L2 can be tested by any current turning on branch, as the branch which is not assigned with valve unit is always turning on, therefore it is preferable to test flow base on this branch. Also, heating tank used to feedback and slight adjust temperature regulation is branch, also prior use always turn on heating tank that is not assigned with valve unit.

**[0014]** Meanwhile, as the inlet water pipe's total flow is likely too low, then we need to consider safety protection. This invention also include a low water flow warning step, details are: when gradually turn off n-1 branches' valve unit (i.e. Only has turning on branch which is not assigned with valve unit), if current tested flow rate is still lower than L1, then release a low water flow warning. Later user can turn off water heater or shut-down by system automatically, in order to achieve safety purpose.

**[0015]** Additionally, each heating tank is a heating temperature control method that controls heating power change base on current flow rate and temperature, and heat to basic setting temperature, one of these heating tanks will feedback according to mixed temperature, then feedback to slightly adjust temperature control. Same as current technology, it is based on flow rate value, current temperature value and setting temperature's difference to timely control heating power, for example, it can use PO precisely control algorithm, PID fuzzy control algorithm etc. As it is not the key point of this invention, therefore it is not explained in detail here.

**[0016]** Refer to FIG. 1, parallel connection multi-heating tank instant water heater in this invention is using three parallel connection heating tanks to explain, actual number of applications may not be limited to this number. The example details include: one water inlet pipe 40 assigned to three parallel connection heating tanks and heat, they are body 1 "10", body 2 "20" and body 3 "30". Flow to these three heating tanks' three branches, except body 1 "10" branch, all combined with valve units 24, 34 that controls on/off of body 2 "20" and body 3 "30" heating tanks' water inlet terminal (firstly use solenoid valve); and in order to collect flow rate, control temperature and heating for each heating tank, body 1 "10", body 2 "20" and body 3 "30"

have flow meters 11, 21 and 31; body 1 "10", body 2 "20" and body 3 "30" have thermal cut-outs 12, 22 and 32; body 1 "10", body 2 "20" and body 3 "30" have heating, unit 13, 23 and 33 inside respectively, hot water heated by body 1 "10", body 2 "20" and body 3 "30" will be mixed to outlet pipe 50 and supply to user. Preferably, this example's water outlet pipe 50 has a temperature sensor to test outlet water temperature (not shown in the diagram). This example also has a control board 70 for overall control of this parallel connection multi-heating tank instant water heater. Similar to current technology, heating power switch elements on this example's control board 70 to control body 1 "10", body 2 "20" and body 3 "30" heating power, are fitted to inlet water pipe 40 to cool down water. Parts that not be described in detail and other parts that not be described in this example, like enclosure etc, those are similar or same to current technology's instant water heater, therefore they are not explained in detail here.

**[0017]** Refer to FIG. 2, the control method is: initially, turn on all two branches' valve units 24, 34 (body Fs number 10 branch doesn't have valve unit, it always turn on and flow), body 1 "10", body 2 "20" and body 3 "30" heating tanks are fully filled with water first, then turn off body 2 "20" and body 3 "30"'s branches' valve units 24, 34, only body 1 "10" has water flows in. According to flow meters 11, 21 and 31's measurement range (make sure within measurement range, it can collect accurate calculation), and set two flow comparison value, L1 and L2 respectively, L2 is higher than L1, for example L1 is 2 L/min, L2 is 5 L/min.

**[0018]** Collect flow rate from flow meter 11 on body 1 "10"'s inflow branch, if current tested flow rate is higher than 12 (5 L/min, then gradually turn on branches' valve units (gradually turn on body 2 "20" and body 3 "30"'s branches), until current tested flow rate for body 1 "10" is between L1 (2 L/min) and L2 (5 L/min) range, equals to L1 (2 L/min) or L2 (5 L/min), Gradually turning on branch valve units are letting water goes through body 2 "20" first, once water goes through, then water heater's inlet water pipe 40's overall flow rate will be immediately assigned to body 1 "10" and body 2 "20", if at this moment within flow comparison value range, or at two flow comparison value's extreme point, then do not turn on body 3 "30"'s branch, or, if overall flow rate assigned to body 1 "10" and body 2 "20" is still too high, then it will also have to continue to turn on body 3 "30"'s branch and split flow. Similarly, if current tested flow rate from flow meter 11 on body 1 "10"'s inflow branch is lower than L1 (2 L/min), then gradually turn off branches' valve units (gradually turn on body 2 "20" and body 3 "30"'s branches), until current tested flow rate is between L1 and L2 range, equals to L1 or L2; Thus, by the above described control process, it can make sure body 1 "10" and/or body 2 "20" and/or body 3 "30"'s flow meters 11, 21 and 31 are within the reasonable measurement range, and can do accurate collection and calculation, so that the subsequent temperature would be more stable.

**[0019]** Meanwhile, this invention also includes a low water flow warning step, details are: when gradually turn off body 2 "20" and body 3 "30" branches' valve units 24, 34, if body 1 "10"'s inflow branch tested flow is still lower than L1 (2 L/min) then it means inlet water pipe 40's overall flow is insufficient, then releases a low water flow warning.

**[0020]** According to detail flow difference, current branches' valve units are turned on, these heating tanks (may include and exclude body 2 "20" and/or body 3 "30") and

branch which is not assigned with valve units' heating tank (body 1 "10") will separately control heating units 13/23/33 heating power change through current flow (preferable each flow meter 11/21/13's flow value, also each branch's flow rate is basically same, but can be slightly different) and temperature (according to temperature collecting by temperature sensor 12/22/32), so it can be heated to basic setting temperature.

[0021] Current branches' valve units are turned on, these heating tanks (may include and exclude body 2 "20" and/or body 3 "30") and branch which is not assigned with valve units' heating tank (body 1 "10") mix to outlet water pipe 50, one of those heating tanks (preferable body 1 "10") will feedback temperature according to mixed temperature collected by temperature sensor on water pipe 50, then feedback to slightly adjust temperature control, slightly adjust body 1 "10"'s temperature, so water heater's outlet temperature reaches set temperature. Since this example can turn on and turn off each heating tank's branch base on flow change, so each heating tank's flow measurement is accurate, so that temperature control is accurate and reliable, re-use can ensure a reliable temperature accurate control heating tank to slightly adjust tempestuous for outlet water temperature, compare to Patent Publication No. CN 104034046A, omitting a main heating tank structure, simplifying the structure and save the cost.

[0022] Although combined examples and introduction to describe this invention, technical people in this industry should understand, within the spirit and scope of the present invention without departing from attached patent claim, any change to this invention in the form or details, is under protection scope of this invention.

1. A controlling method of instant water heater system, wherein the instant water heater system comprises a water inlet pipe, n pcs heating tanks parallel with each other, and n-1 pcs valve units, an end of each heating tanks connects to the water inlet pipe, each valve unit located between the water inlet pipe and each heating tank, wherein the method comprises the steps of:

turning on the n-1 pcs valve units to fill the n pcs heating tanks with water;

shutting down the n-1 pcs valve units;

controlling a water flow value of each heating tanks within a pre-set range from L1 to L2, if a water flow value detected is greater than a L2, turning on the valve units until the the water flow value ranged from L1 to

L2, if a water flow value detected is less than the L2, turning off the valve units until the the water flow value is ranged from L1 to L2

heating, the water filled in the heating tanks; and mixing a heated water from the heating tanks and outputting a mixed water to the user;

wherein n is greater than two; L2 is greater than L1; each heating tank controls a heating power separately to heat the water to a predetermined temperature value depending on a water flow and a temperature detected; after the step of mixing a heated water from the heating tanks, each of the heating tank conducts a micro feedback adjustment step based on a temperature feedback after mixing to make the temperature of the outputting water are exactly the same as the preset temperature.

2. The controlling method of instant water heater system of claim 1, wherein the flow measurement is only applied to the heating tank without the valve unit on it; and wherein a value generated by the flow measurement is compared with the preset values L1 and L2.

3. The controlling method of instant water heater having multiple heating tanks parallel with each other of claim 1, wherein the heating tank used for micro feedback adjustment is the heating tank without the valve unit on it.

4. The controlling method of instant water heater having multiple heating tanks parallel with each other of claim 1, wherein the controlling method further comprises a step of low water flow alarming; wherein after the step of shutting down the n-1 pcs valve units, if the value of the current flow measure is still less than L1, outputting a low water flow alarming.

5. The controlling method of instant water heater having multiple heating tanks parallel with each other of claim 2, wherein the controlling method further comprises a step of low water flow alarming; wherein after shutting down the n-1 pcs valve units, if the value of the current flow measure is still less than L1, the low water flow alarming is output.

6. The controlling method of instant water heater having multiple heating tanks parallel with each other of claim 3, wherein the controlling method further comprises a step of low water flow alarming; wherein after the step of shutting down the n-1 pcs valve units, if the value of the current flow measure is still less than the L1, outputting the low water flow alarming.

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