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(54) **INDOOR UNIT POWER CONSUMPTION MEASUREMENT METHOD, HEAT RECOVERY MULTI-SPLIT UNIT, STORAGE MEDIUM, AND APPARATUS**

(57) Disclosed in the present application are an indoor unit power consumption measurement method, a heat recovery multi-split unit, a storage medium, and an apparatus, the method comprising: acquiring a multi-split unit operating mode and multi-split unit information of a heat recovery multi-split unit and, on the basis of the multi-split unit information, determining indoor units to be measured; acquiring an indoor unit operating mode of the indoor units and, on the basis of the multi-split unit operating mode and the indoor unit operating modes, screening the indoor units to obtain a target indoor unit; acquiring indoor unit information of the target indoor unit and acquiring outdoor unit information of the heat recovery multi-split unit; and, on the basis of the indoor unit information and the outdoor unit information, determining the total power consumption of the target indoor unit; compared to existing methods of only measuring the overall power consumption of the multi-split unit, the present application can determine the total power consumption of the target indoor unit on the basis of the indoor unit information and the outdoor unit information,

and can therefore measure the power consumption of each indoor unit.

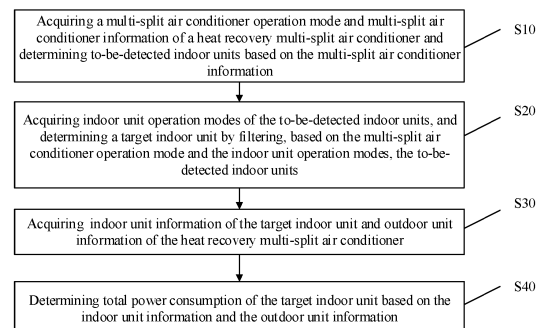


FIG. 2

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Description**PRIORITY INFORMATION**

5 **[0001]** The present application claims priority to Chinese Patent Applications No. 202110084743.1, filed on January 21, 2021, the entire contents of which are incorporated herein by reference.

FIELD

10 **[0002]** The present disclosure relates to the field of air conditioner technologies, and more particularly, to a method for detecting an indoor unit power consumption, a heat recovery multi-split air conditioner, a storage medium and an apparatus.

BACKGROUND

15 **[0003]** With the continuous progress of society and the ongoing development of science and technology, the use of a multi-split air conditioner as a heating, ventilation, and air conditioning device for a building is becoming more and more widespread. An existing heat recovery multi-split air conditioner system requires cooling, heating, and provision of hot water, which result in high energy consumption.

20 **[0004]** However, instead of detecting power consumed by individual indoor units separately, an existing system for detecting a power consumption can only detect overall power consumption of the multi-split air conditioner. Thus, it is impossible to optimize power consumption of the indoor units.

25 **[0005]** The above content is intended to assist in understanding of technical solutions of the present disclosure only, and does not represent an admission that the above content is the related art.

SUMMARY

30 **[0006]** Embodiments of the present disclosure provide a method for detecting an indoor unit power consumption, a heat recovery multi-split air conditioner, a storage medium, and an apparatus, aiming to solve a technical problem in the related art of an inability to detect power consumed by each indoor unit.

35 **[0007]** To achieve the above embodiments, the present disclosure provides a method for detecting an indoor unit power consumption. The method for detecting the indoor unit power consumption includes: acquiring a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner and determining to-be-detected indoor units based on the multi-split air conditioner information; acquiring indoor unit operation modes of the to-be-detected indoor units and determining a target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units; acquiring indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner; and determining total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information.

40 **[0008]** In an embodiment, determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information includes: extracting an electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is a preset main cooling mode; extracting outdoor unit power and an outdoor unit operation duration of the heat recovery multi-split air conditioner from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

45 **[0009]** In an embodiment, determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration includes: determining current power consumption of the target indoor unit based on the electronic expansion valve flow coefficient and the outdoor unit power; and determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

50 **[0010]** In an embodiment, extracting the electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode includes: extracting electronic expansion valve opening degree of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode; and determining the electronic expansion valve flow rate coefficient of the target indoor unit based on the electronic expansion valve opening degree.

55 **[0011]** In an embodiment, determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information includes: extracting an indoor unit heat transfer area, an indoor unit heat transfer coefficient, and an indoor unit ambient temperature from the indoor unit information when the multi-split air

conditioner operation mode is a preset main heating mode; extracting an exhaust pressure saturation temperature, outdoor unit power, and an outdoor unit operation duration from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

[0012] In an embodiment, determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration includes: determining current power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, and the outdoor unit power; and determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

[0013] In an embodiment, acquiring the indoor unit operation modes of the to-be-detected indoor units and determining the target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units includes: acquiring the indoor unit operation modes of the to-be-detected indoor units, and obtaining matching results by matching the multi-split air conditioner operation mode with the indoor unit operation modes; and obtaining the target indoor unit by filtering, based on the matching results, the to-be-detected indoor units.

[0014] In addition, to achieve the above embodiments, the present disclosure further provides a heat recovery multi-split air conditioner. The heat recovery multi-split air conditioner includes: a memory; a processor; and a program for detecting an indoor unit power consumption stored in the memory and executable on the processor. The program for detecting the indoor unit power consumption is configured to implement the steps of the method for detecting the indoor unit power consumption as described above.

[0015] In addition, to achieve the above embodiments, the present disclosure further provides a storage medium. The storage medium stores a program for detecting an indoor unit power consumption. The program for detecting the indoor unit power consumption, when executed by a processor, implements the steps of the method for detecting the indoor unit power consumption as described above.

[0016] In addition, to achieve the above embodiments, the present disclosure further provides an apparatus for detecting an indoor unit power consumption. The apparatus for detecting the indoor unit power consumption includes: a determination module configured to acquire a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner, and determine to-be-detected indoor units based on the multi-split air conditioner information; a filter module configured to acquire indoor unit operation modes of the to-be-detected indoor units, and determine a target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units; an acquiring module configured to acquire indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner; and a detection module configured to determine total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information.

[0017] In the present disclosure, the multi-split air conditioner operation mode and the multi-split air conditioner information of the heat recovery multi-split air conditioner are acquired. The to-be-detected indoor units are determined based on the multi-split air conditioner information. The indoor unit operation modes of the to-be-detected indoor units are acquired. The target indoor unit is obtained by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units. The indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner are acquired. The total power consumption of the target indoor unit is determined based on the indoor unit information and the outdoor unit information. Compared with an existing method of only detecting overall power consumption of the multi-split air conditioner, the present disclosure is able to detect power consumption of each indoor unit since the total power consumption of the target indoor unit can be determined based on the indoor unit information and the outdoor unit information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a schematic structural diagram of a hardware operating environment of a heat recovery multi-split air conditioner involved in a solution according to an embodiment of the present disclosure.

FIG. 2 is a schematic flowchart illustrating an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 3 is a schematic diagram of a heat recovery multi-split air conditioner system according to an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 4 is a schematic flowchart illustrating an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 5 is a schematic diagram of a heat recovery multi-split air conditioner system operating in a main cooling mode according to an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 6 is a schematic flowchart illustrating an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 7 is a schematic diagram of a heat recovery multi-split air conditioner system operating in a main heating mode according to an embodiment of a method for detecting an indoor unit power consumption of the present disclosure.

FIG. 8 is a block diagram showing a structure of an embodiment of an apparatus for detecting an indoor unit power consumption of the present disclosure.

[0019] Reference numerals of the accompanying drawings:

Reference number	Name	Reference number	Name
1	outdoor unit	18	low-pressure tank
11	compressor	2	refrigerant switching device
12	four-way valve	21	refrigerant switching device heating solenoid valve
13	four-way valve	22	cooling solenoid valve
14	external heat exchanger	3	indoor unit of a multi-split air conditioner
15	outdoor unit main electronic expansion valve	31	indoor unit electronic expansion valve
16	economizer	32	indoor unit heat exchanger
17	economizer auxiliary electronic expansion valve		

[0020] Implementations of the embodiments, functional features, and advantages of the present disclosure will be further described in connection with the embodiments and with reference to the accompanying drawings.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0021] It should be understood that exemplary embodiments described herein are intended to explain the present disclosure only, rather than to limit the present disclosure.

[0022] Reference can be made to FIG. 1. FIG. 1 is a schematic structural diagram of a hardware operating environment of a heat recovery multi-split air conditioner involved in a solution according to an embodiment of the present disclosure.

[0023] As illustrated in FIG. 1, the heat recovery multi-split air conditioner may include a processor 1001 such as a Central Processing Unit (CPU), a communication bus 1002, a user interface 1003, a network interface 1004, and a memory 1005. The communication bus 1002 is configured to implement connection and communication between these members. The user interface 1003 may include a display. In some embodiments, the user interface 1003 may further include a standard wired interface and a wireless interface. In the present disclosure, the wired interface of the user interface 1003 may be a Universal Serial Bus (USB) interface. In some embodiments, the network interface 1004 may include a standard wired interface and a wireless interface (e.g., a Wireless-Fidelity (WI-FI) interface). The memory 1005 may be a high-speed Random Access Memory (RAM) or a Non-Volatile Memory (NVM), such as a disk memory. In some embodiments, the memory 1005 may further be a storage device independent of the aforementioned processor 1001.

[0024] It should be understood by those skilled in the art that the structure illustrated in FIG. 1 does not constitute a limitation of the heat recovery multi-split air conditioner. The heat recovery multi-split air conditioner may include more or fewer members than those illustrated in the figures, or combine certain members, or have a different arrangement of members.

[0025] As illustrated in FIG. 1, the memory 1005 identified as a computer storage medium may include an operating system, a network communication device, a user interface device, and a program for detecting an indoor unit power consumption.

[0026] In the heat recovery multi-split air conditioner illustrated in FIG. 1, the network interface 1004 is mainly configured to connect to a backend server to perform data communication with the backend server. The user interface 1003 is mainly configured to connect to a user device. The heat recovery multi-split air conditioner invokes, through the processor 1001, the program for detecting the indoor unit power consumption stored in the memory 1005, and performs a method for detecting an indoor unit power consumption according to the embodiments of the present disclosure.

[0027] Based on the above hardware structure, the embodiments of the method for detecting the indoor unit power consumption of the present disclosure are proposed.

[0028] FIG. 2 is a schematic flowchart illustrating an embodiment of the method for detecting the indoor unit power consumption of the present disclosure. As illustrated in FIG. 2, the embodiment of the method for detecting the indoor unit power consumption of the present disclosure is proposed.

[0029] At block S10, a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner are acquired, and to-be-detected indoor units are determined based on the multi-split air conditioner information.

[0030] It should be understood that an executive subject of the embodiment is the heat recovery multi-split air conditioner, which is not limited in the embodiment.

[0031] It should be noted that the multi-split air conditioner operation mode of the heat recovery multi-split air conditioner may include a main cooling mode and a main heating mode. The multi-split air conditioner information may include outdoor unit information, indoor unit information, or the like of the heat recovery multi-split air conditioner. The to-be-detected indoor units may be indoor units in the heat recovery multi-split air conditioner, which is not limited in the embodiment.

[0032] It should be understood that the determining the to-be-detected indoor units based on the multi-split air conditioner information may include: extracting a device identifier from the multi-split air conditioner information, and determining the to-be-detected indoor units based on the device identifier.

[0033] In an exemplary implementation, for ease of understanding, description is made with reference to FIG. 3. FIG. 3 is a schematic diagram of a heat recovery multi-split air conditioner system. In FIG. 3, 1 represents an outdoor unit of the multi-split air conditioner, 2 represents a refrigerant switching device, 3 represents indoor units of the multi-split air conditioner, 11 represents a compressor, 12 and 13 represent four-way valves, 14 represents an external heat exchanger, 15 represents an outdoor unit main electronic expansion valve, 16 represents an economizer, 17 represents an auxiliary electronic expansion valve, 18 represents a low-pressure tank, 21 represents a refrigerant switching device heating solenoid valve, 22 represents a cooling solenoid valve, 31 represents an indoor unit electronic expansion valve, and 32 represents an indoor unit heat exchanger.

[0034] At block S20, indoor unit operation modes of the to-be-detected indoor units are acquired, and a target indoor unit is determined by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units.

[0035] It should be understood that when the heat recovery multi-split air conditioner is in the main cooling mode, power consumption of the outdoor unit is allocated to an cooling indoor unit only, while the amount of the power consumption of the outdoor unit allocated to the heating indoor unit is 0. When the heat recovery multi-split air conditioner is in the main heating mode, the power consumption of the outdoor unit is allocated to the heating indoor unit only, while the power consumption of the outdoor unit allocated to the cooling indoor unit is 0. Therefore, power consumption of indoor units can be obtained by simply detecting the indoor unit having a corresponding indoor unit operation mode which matches with the multi-split air conditioner operation mode.

[0036] It should be understood that acquiring the indoor unit operation modes of the to-be-detected indoor units and determining the target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units may include: acquiring the indoor unit operation modes of the to-be-detected indoor units, and obtaining matching results by matching the multi-split air conditioner operation mode with the indoor unit operation modes; and obtaining the target indoor unit by filtering, based on the matching results, the to-be-detected indoor units.

[0037] In an exemplary implementation, for example, when the multi-split air conditioner operation mode is the main cooling mode and an indoor unit operation mode is a cooling mode, the multi-split air conditioner operation mode is determined as matching the indoor unit operation mode successfully; and when the multi-split air conditioner operation mode is the main cooling mode and an indoor unit operation mode is a non-cooling mode, the multi-split air conditioner operation mode is determined as failing to match the indoor unit operation mode.

[0038] At block S30, indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner are acquired.

[0039] It should be noted that the indoor unit information may include information such as electronic expansion valve opening degree of the indoor unit; and the outdoor unit information may include outdoor unit power and an outdoor unit operation duration, which is not limited in the embodiment.

[0040] It should be understood that the acquiring the indoor unit information of the target indoor unit and the outdoor

unit information of the heat recovery multi-split air conditioner may include acquiring the indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner through a preset sensor mounted on the heat recovery multi-split air conditioner. The preset sensor may be preset by a manufacturer of the heat recovery multi-split air conditioner, which is not limited in the embodiment.

[0041] At block S40, total power consumption of the target indoor unit is determined based on the indoor unit information and the outdoor unit information.

[0042] It should be understood that the determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information may include: extracting an electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is a preset main cooling mode; extracting outdoor unit power and an outdoor unit operation duration of the heat recovery multi-split air conditioner from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

[0043] Or it should be understood that the determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information may include: extracting an indoor unit heat transfer area, an indoor unit heat transfer coefficient, and an indoor unit ambient temperature from the indoor unit information when the multi-split air conditioner operation mode is a preset main heating mode; extracting an exhaust pressure saturation temperature, outdoor unit power, and an outdoor unit operation duration from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

[0044] In the embodiment, the multi-split air conditioner operation mode and the multi-split air conditioner information of the heat recovery multi-split air conditioner are acquired. The to-be-detected indoor units are determined based on the multi-split air conditioner information. The indoor unit operation modes of the to-be-detected indoor units are acquired. The target indoor unit is obtained by filtering the to-be-detected indoor units based on the multi-split air conditioner operation mode and the indoor unit operation modes. The indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner are acquired. The total power consumption of the target indoor unit is determined based on the indoor unit information and the outdoor unit information. Compared with an existing method of only detecting overall power consumption of a multi-split air conditioner, the present disclosure is able to detect power consumption of each indoor unit since the total power consumption of the target indoor unit can be determined based on the indoor unit information and the outdoor unit information.

[0045] Reference can be made to FIG. 4. FIG. 4 is a schematic flowchart illustrating an embodiment of a method for detecting an indoor unit power consumption of the present disclosure. The embodiment of the method for detecting the indoor unit power consumption of the present disclosure is provided based on the embodiment illustrated in FIG. 2.

[0046] In the embodiment, the operation at block S40 includes the following operations.

[0047] At block S401, an electronic expansion valve flow coefficient of the target indoor unit is extracted from the indoor unit information when the multi-split air conditioner operation mode is a preset main cooling mode.

[0048] For ease of understanding, description is made with reference to FIG. 5. FIG. 5 is a schematic diagram of a heat recovery multi-split air conditioner system operating in a main cooling mode. When a current operation mode is the main cooling mode, a refrigerant is compressed into a high-temperature and high-pressure refrigerant in the compressor. Part of the refrigerant enters the external heat exchanger for condensation, while the other part of the refrigerant enters the refrigerant switching device 2. A heating solenoid valve corresponding to the heating indoor unit opens, while a cooling solenoid valve corresponding to the heating indoor unit closes. The other part of the refrigerant enters the heating indoor unit for condensation. The two parts of the condensed liquid refrigerant converge. The refrigerant switching device cooling solenoid valve of the cooling indoor unit opens, while the refrigerant switching device heating solenoid valve of the cooling indoor unit closes. The liquid refrigerant enters the cooling indoor unit for throttling and evaporation, is changed to a low-pressure gaseous refrigerant, and returns to the compressor for compression, finishing a refrigerant cycle in the main cooling mode.

[0049] Unlike a pure cooling mode of a heat pump air conditioner, part of the indoor units of the heat recovery multi-split air conditioner also serves as a condenser, which is equivalent to enlarging a heat transfer area of a condenser of the outdoor unit and increasing a heat transfer capacity of the condenser. For heat emitted into the air by the outdoor unit when the heat pump air conditioner is in the pure cooling mode, part of the heat is recovered into the heating indoor unit in the main cooling mode of the heat recovery multi-split air conditioner. The heating capacity of the heating indoor unit in the main cooling mode is therefore heat recovered from other cooling indoor units, and does not consume the power consumption of the outdoor unit in power allocation. In addition, an energy efficiency of the system is increased due to the enlarged heat transfer area of the condenser. Therefore, in the main cooling mode, the power consumption of the outdoor unit is allocated to the cooling indoor unit only.

[0050] It should be understood that that extracting the electronic expansion valve flow coefficient of the target indoor

unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode may include: extracting electronic expansion valve opening degree of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode; and determining the electronic expansion valve flow rate coefficient of the target indoor unit based on the electronic expansion valve opening degree.

[0051] At block S402, outdoor unit power and an outdoor unit operation duration of the heat recovery multi-split air conditioner are extracted from the outdoor unit information.

[0052] It should be understood that an extraction on the outdoor unit information may include the extraction performed on the outdoor unit information based on an outdoor unit information identifier. The outdoor unit information identifier may be an information identity identifier set when outdoor unit information is stored, which is not limited in the embodiment.

[0053] At block S403, the total power consumption of the target indoor unit is determined based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

[0054] It should be understood that the determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration may include determining the total power consumption of the target indoor unit through a preset power consumption model based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

[0055] The preset power consumption model may be:

$$I_{\text{total}} = \sum_{j=1}^k \frac{cv_idu_i_T_j}{\sum_{i=1}^n cv_idu_i_T_j * W_odu_T_j},$$

where I_{total} represents the total power consumption of the target indoor unit, i.e., power allocated to an i -th cooling indoor unit in a duration $T_1 \sim T_k$, $cv_idu_i_T_j$ represents the electronic expansion valve flow coefficient of the cooling indoor unit at a time point j , and $W_odu_T_j$ represents outdoor unit power at the time point j .

[0056] Further, to improve an accuracy of the total power consumption of the target indoor unit, the operation at block S403 includes: determining current power consumption of the target indoor unit based on the electronic expansion valve flow coefficient and the outdoor unit power; and determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

[0057] It should be understood that the determining the current power consumption of the target indoor unit based on the electronic expansion valve flow coefficient and the outdoor unit power may include calculating the total power consumption of the target indoor unit through a preset current power consumption model based on the electronic expansion valve flow coefficient and the outdoor unit power,

[0058] The preset current power consumption model may be:

$$I = \frac{cv_idu_i_T_1}{\sum_{i=1}^n cv_idu_i_T_1 * W_odu_T_1},$$

where I represents current power consumption of the target indoor unit, $cv_idu_i_T_1$ represents a current electronic expansion valve flow coefficient for the cooling indoor unit, and $W_odu_T_1$ represents current outdoor unit power.

[0059] In the embodiment, the electronic expansion valve flow coefficient of the target indoor unit is extracted from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode. The outdoor unit power and the outdoor unit operation duration of the heat recovery multi-split air conditioner are extracted from the outdoor unit information. The total power consumption of the target indoor unit is determined based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration. Therefore, when the multi-split air conditioner operation mode is the preset main cooling mode, the total power consumption of the target indoor unit can be quickly determined.

[0060] Reference can be made to FIG. 6. FIG. 6 is a schematic flowchart illustrating an embodiment of a method for detecting an indoor unit power consumption of the present disclosure. The embodiment of the method for detecting the indoor unit power consumption of the present disclosure is provided based on the embodiment illustrated in FIG. 4.

[0061] In the embodiment, the operation at block S40 includes the following operations.

[0062] At block S401', extracting an indoor unit heat transfer area, an indoor unit heat transfer coefficient, and an indoor unit ambient temperature from the indoor unit information when the multi-split air conditioner operation mode is a preset main heating mode.

[0063] For ease of understanding, description is made with reference to FIG. 7. FIG. 7 is a schematic diagram of a heat recovery multi-split air conditioner system operating in a main heating mode. When the current operation mode is

the main heating mode, the refrigerant is compressed into the high-temperature and high-pressure refrigerant in the compressor, and passes through the refrigerant switching device. The refrigerant switching device heating solenoid valve corresponding to the heating indoor unit opens, while the refrigerant switching device cooling solenoid valve corresponding to the heating indoor unit closes. The high-temperature and high-pressure refrigerant enters the heating indoor unit for condensation, condenses into a liquid refrigerant, and then enters the refrigerant switching device. Part of the liquid refrigerant enters the external heat exchanger for evaporation, while the other part of the liquid refrigerant enters the cooling solenoid valve corresponding to the refrigerant switching device, enters the cooling indoor unit for evaporation, converges with the refrigerant evaporated from the outdoor unit, and then returns to the compressor for compression, finishing a refrigerant cycle in the main heating mode.

[0064] Unlike a pure heating mode of the heat pump air conditioner, part of the indoor units of the heat recovery multi-split air conditioner also serves as the evaporator, which is equivalent to enlarging the heat transfer area of the evaporator of the outdoor unit and increasing the heat transfer capacity of the evaporator. The outdoor unit of the heat pump air conditioner in the pure heating mode absorbs heat from the air, and part of the indoor units of the heat recovery multi-split air conditioner in the main heating mode also absorbs heat from an indoor space. The two kinds of absorbed heat release heat in the heating indoor unit. Thus, the cooling capacity of the cooling indoor unit in the main heating mode is heat recovered from other heating indoor units, which does not consume the power consumption of the outdoor unit in the power allocation. In addition, the energy efficiency of the system is increased due to the enlarged heat transfer area of the evaporator. Therefore, in the main heating mode, the power consumption of the outdoor unit is allocated to the heating indoor unit only.

[0065] At block S402', an exhaust pressure saturation temperature, outdoor unit power, and an outdoor unit operation duration are extracted from the outdoor unit information.

[0066] It should be understood that the extraction on the outdoor unit information may include the extraction performed on the outdoor unit information based on the outdoor unit information identifier. The outdoor unit information identifier may be the information identity identifier set in response to storing outdoor unit information, which is not limited in the embodiment.

[0067] At block S403', the total power consumption of the target indoor unit is determined based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

[0068] It should be understood that the determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration may include determining the total power consumption of the target indoor unit through the preset power consumption model based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

[0069] The preset power consumption model may be:

$$I_{\text{total}} = \sum_{j=1}^k \frac{K_{-i-T_j} * A_{-i-T_j} * (T_{c-T_j} - T_{a-T_j})}{K_{-i-T_j} * A_{-i-T_j} * (T_{c-T_j} - T_{a-T_j}) * W_{-odu-T_j}},$$

where I_{total} represents the total power consumption of the target indoor unit, i.e., the power allocated to an i -th heating indoor unit in the duration $T_1 \sim T_k$, A_{-i-T_j} represents the indoor unit heat transfer area at the time point j , K_{-i-T_j} represents the indoor unit heat transfer coefficient at the time point j , T_{c-T_j} represents the indoor unit ambient temperature at the time point j , T_{a-T_j} represents the exhaust pressure saturation temperature at the time point j , and W_{-odu-T_j} represents the outdoor unit power at the time point j .

[0070] Further, to improve the accuracy of the total power consumption of the target indoor unit, the operation at block S403' includes: determining current power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, and the outdoor unit power; and determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

[0071] It should be understood that the determining the current power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, and the outdoor unit power may include determining the current power consumption of the target indoor unit through the preset current power consumption model based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, and the outdoor unit power.

[0072] The preset current power consumption model may be:

$$I = \frac{K_{i_T_1} * A_{i_T_1} * (T_{c_T_1} - T_{a_T_1})}{K_{i_T_1} * A_{i_T_1} * (T_{c_T_1} - T_{a_T_1}) * W_{odu_T_1}},$$

where I represents the current power consumption of the target indoor unit, $A_{i_T_1}$ represents a current indoor unit heat transfer area, $K_{i_T_1}$ represents a current indoor unit heat transfer coefficient, $T_{c_T_1}$ represents a current indoor unit ambient temperature, $T_{a_T_1}$ represents a current exhaust pressure saturation temperature, and $W_{odu_T_1}$ represents the current outdoor unit power.

[0073] In the embodiment, the indoor unit heat transfer area, the indoor unit heat transfer coefficient, and the indoor unit ambient temperature are extracted from the indoor unit information when the multi-split air conditioner operation mode is the preset main heating mode. The exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration are extracted from the outdoor unit information. The total power consumption of the target indoor unit is determined based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration. Therefore, the total power consumption of the target indoor unit can be quickly determined when the multi-split air conditioner operation mode is the preset main heating mode.

[0074] In addition, the embodiments of the present disclosure further provided a storage medium. The storage medium stores a program for detecting an indoor unit power consumption. The program for detecting the indoor unit power consumption, when executed by a processor, implements the steps of the method for detecting the indoor unit power consumption described above.

[0075] In addition, as illustrated in FIG. 7, the embodiments of the present disclosure further provide an apparatus for detecting an indoor unit power consumption. The apparatus for detecting the indoor unit power consumption includes a determination module 10, a filter module 20, an acquiring module 30, and a detection module 40;

[0076] The determination module 10 is configured to acquire a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner and determine to-be-detected indoor units based on the multi-split air conditioner information.

[0077] It should be noted that the multi-split air conditioner operation mode of the heat recovery multi-split air conditioner may include the main cooling mode and the main heating mode. The multi-split air conditioner information may include the outdoor unit information, the indoor unit information, or the like of the heat recovery multi-split air conditioner. The to-be-detected indoor unit may be the indoor unit in the heat recovery multi-split air conditioner, which is not limited in the embodiment.

[0078] It should be understood that the determining the to-be-detected indoor units based on the multi-split air conditioner information may include: performing the information extraction on the multi-split air conditioner information to obtain the device identifier, and determining the to-be-detected indoor units based on the device identifier.

[0079] In an exemplary implementation, for ease of understanding, description is made with reference to FIG. 3. FIG. 3 is a schematic diagram of a heat recovery multi-split air conditioner system. In FIG. 3, 1 represents an outdoor unit of the multi-split air conditioner, 2 represents a refrigerant switching device, 3 represents the indoor unit of the multi-split air conditioner, 11 represents a compressor, 12 and 13 represent four-way valves, 14 represents an external heat exchanger, 15 represents an outdoor unit main electronic expansion valve, 16 represents an economizer, 17 represents an auxiliary electronic expansion valve, 18 represents a low-pressure tank, 21 represents a refrigerant switching device heating solenoid valve, 22 represents a cooling solenoid valve, 31 represents an indoor unit electronic expansion valve, and 32 represents an indoor unit heat exchanger.

[0080] The filter module 20 is configured to acquire indoor unit operation modes of the to-be-detected indoor units and obtain a target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units.

[0081] It should be understood that when the heat recovery multi-split air conditioner is in the main cooling mode, the power consumption of the outdoor unit is allocated to the cooling indoor unit only, while power consumption of the outdoor unit allocated to the heating indoor unit is 0. When the heat recovery multi-split air conditioner is in the main heating mode, the power consumption of the outdoor unit is allocated to the heating indoor unit only, while power consumption of the outdoor unit allocated to the cooling indoor unit is 0. Therefore, the power consumption of indoor units can be obtained by simply detecting each indoor unit where the multi-split air conditioner operation mode matches with the indoor unit operation modes.

[0082] It should be understood that acquiring the indoor unit operation modes of the to-be-detected indoor units and obtaining the target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units may include: acquiring the indoor unit operation modes of the to-be-detected indoor units, and obtaining matching results by matching the multi-split air conditioner operation mode with the indoor unit operation modes; and obtaining the target indoor unit by filtering, based on the matching results, the to-be-detected indoor units.

[0083] In an exemplary implementation, for example, when the multi-split air conditioner operation mode is the main cooling mode and an indoor unit operation mode is the cooling mode, the multi-split air conditioner operation mode is determined as matching the indoor unit operation mode successfully; and when the multi-split air conditioner operation mode is the main cooling mode and an indoor unit operation mode is the non-cooling mode, the multi-split air conditioner operation mode is determined as failing to match the indoor unit operation mode.

[0084] The acquiring module 30 is configured to acquire indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner.

[0085] It should be noted that the indoor unit information may include information such as the electronic expansion valve opening degree of the indoor unit; and the outdoor unit information may include the outdoor unit power and the outdoor unit operation duration, which is not limited in the embodiment.

[0086] It should be understood that the acquiring the indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner may include acquiring the indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner through the preset sensor mounted on the heat recovery multi-split air conditioner. The preset sensor may be preset by the manufacturer of the heat recovery multi-split air conditioner. The embodiment is not limited in this respect.

[0087] The detection module 40 is configured to determine total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information.

[0088] It should be understood that the determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information may include: extracting an electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is a preset main cooling mode; extracting outdoor unit power and an outdoor unit operation duration of the heat recovery multi-split air conditioner from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

[0089] Or it should be understood that the determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information may include: obtaining an indoor unit heat transfer area, an indoor unit heat transfer coefficient, and an indoor unit ambient temperature by performing, when the multi-split air conditioner operation mode is a preset main heating mode, an information extraction on the indoor unit information; extracting an exhaust pressure saturation temperature, outdoor unit power, and an outdoor unit operation duration from the outdoor unit information; and determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

[0090] In the embodiment, the multi-split air conditioner operation mode and the multi-split air conditioner information of the heat recovery multi-split air conditioner are acquired. The to-be-detected indoor units are determined based on the multi-split air conditioner information. The indoor unit operation modes of the to-be-detected indoor units are acquired. The target indoor unit is obtained by filtering the to-be-detected indoor units based on the multi-split air conditioner operation mode and the indoor unit operation modes. The indoor unit information of the target indoor unit and the outdoor unit information of the heat recovery multi-split air conditioner are acquired. The total power consumption of the target indoor unit is determined based on the indoor unit information and the outdoor unit information. Compared with the existing method of only detecting the overall power consumption of the multi-split air conditioner, the present disclosure is able to detect the power consumption of each indoor unit since the total power consumption of the target indoor unit can be determined based on the indoor unit information and the outdoor unit information.

[0091] Reference of other embodiments or exemplary implementations of the apparatus for detecting the indoor unit power consumption of the present disclosure can be made to the above method embodiments, and will not be repeated herein.

[0092] It should be noted that in the present disclosure, terms "include", "have", and any variations thereof are intended to cover non-exclusive inclusions, such that a process, method, product, or system that includes a series of elements is not necessarily limited to those clearly listed elements, but may also include other elements that are not clearly listed or are inherent to the process, method, product, or system. Without further limitation, an element defined by the phrase "including a ..." does not preclude the presence of additional identical elements in the process, method, product, or system that includes the element.

[0093] The above sequence numbers of the embodiments of the present disclosure are for description only, and do not represent superiority or inferiority of the embodiments. In a unit claim listing a number of devices, several of these devices may be exemplary embodied by a same hardware item. The use of words first, second, third, etc., does not indicate any sequence. The words can be interpreted as names.

[0094] From the above description of the implementations, it will be clear to those skilled in the art that the method of the above embodiments can be implemented with the aid of software and a necessary common hardware platform or can be implemented through hardware. In many cases, the former one is a better implementation. Based on this under-

standing, all or part of the technical solutions according to the embodiments of the present disclosure, or the part thereof that contributes to the related art, can be embodied in the form of a software product. The computer software product may be stored in a storage medium (such as a Read Only Memory (ROM)/Random Access Memory (RAM), a disk, and an optical disk) and contain instructions to enable a terminal device (which may be a mobile phone, a computer, a server,

a heat recovery multi-split air conditioner, a network device, etc.) to perform the method described in each of the embodiments of the present disclosure.

[0095] Although some embodiments of the present disclosure are described above, the scope of the present disclosure is not limited to the embodiments. Any equivalent structure or equivalent process transformation made using the contents of the specification and the accompanying drawings, or any direct or indirect application of the contents of the specification and the accompanying drawings in other related fields, shall equally fall within the scope of the present disclosure.

Claims

1. A method for detecting an indoor unit power consumption, comprising:

acquiring a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner and determining to-be-detected indoor units based on the multi-split air conditioner information;

acquiring indoor unit operation modes of the to-be-detected indoor units, and determining a target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units;

acquiring indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner; and

determining total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information.

2. The indoor unit power consumption detection method according to claim 1, wherein said determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information comprises:

extracting an electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is a preset main cooling mode;

extracting outdoor unit power and an outdoor unit operation duration of the heat recovery multi-split air conditioner from the outdoor unit information; and

determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration.

3. The indoor unit power consumption detection method according to claim 2, wherein said determining the total power consumption of the target indoor unit based on the electronic expansion valve flow coefficient, the outdoor unit power, and the outdoor unit operation duration comprises:

determining current power consumption of the target indoor unit based on the electronic expansion valve flow coefficient and the outdoor unit power; and

determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

4. The indoor unit power consumption detection method according to claim 2, wherein said extracting the electronic expansion valve flow coefficient of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode comprises:

extracting electronic expansion valve opening degree of the target indoor unit from the indoor unit information when the multi-split air conditioner operation mode is the preset main cooling mode; and

determining the electronic expansion valve flow rate coefficient of the target indoor unit based on the electronic expansion valve opening degree.

5. The indoor unit power consumption detection method according to claim 1, wherein said determining the total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information comprises:

extracting an indoor unit heat transfer area, an indoor unit heat transfer coefficient, and an indoor unit ambient temperature from the indoor unit information when the multi-split air conditioner operation mode is a preset main heating mode;

extracting an exhaust pressure saturation temperature, outdoor unit power, and an outdoor unit operation duration from the outdoor unit information; and

determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration.

6. The indoor unit power consumption detection method according to claim 5, wherein said determining the total power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, the outdoor unit power, and the outdoor unit operation duration comprises:

determining current power consumption of the target indoor unit based on the indoor unit heat transfer coefficient, the indoor unit heat transfer area, the indoor unit ambient temperature, the exhaust pressure saturation temperature, and the outdoor unit power; and

determining the total power consumption of the target indoor unit based on the current power consumption and the outdoor unit operation duration.

7. The indoor unit power consumption detection method according to any one of claims 1 to 6, wherein said acquiring the indoor unit operation modes of the to-be-detected indoor units and determining the target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units comprises:

acquiring the indoor unit operation modes of the to-be-detected indoor units, and obtaining matching results by matching the multi-split air conditioner operation mode with the indoor unit operation modes; and obtaining the target indoor unit by filtering, based on the matching results, the to-be-detected indoor units.

8. A heat recovery multi-split air conditioner, comprising:

a memory;

a processor; and

a program for detecting an indoor unit power consumption stored in the memory and executable on the processor, wherein the program for detecting the indoor unit power consumption, when executed by the processor, implements the steps of the method for detecting the indoor unit power consumption according to any one of claims 1 to 7.

9. A storage medium, having a program for detecting an indoor unit power consumption stored thereon, wherein the program for detecting the indoor unit power consumption, when executed by a processor, implements the steps of the method for detecting the indoor unit power consumption according to any one of claims 1 to 7.

10. An apparatus for detecting an indoor unit power consumption, comprising:

a determination module configured to acquire a multi-split air conditioner operation mode and multi-split air conditioner information of a heat recovery multi-split air conditioner, and determine to-be-detected indoor units based on the multi-split air conditioner information;

a filter module configured to acquire indoor unit operation modes of the to-be-detected indoor units, and determine a target indoor unit by filtering, based on the multi-split air conditioner operation mode and the indoor unit operation modes, the to-be-detected indoor units;

an acquiring module configured to acquire indoor unit information of the target indoor unit and outdoor unit information of the heat recovery multi-split air conditioner; and

a detection module configured to determine total power consumption of the target indoor unit based on the indoor unit information and the outdoor unit information.

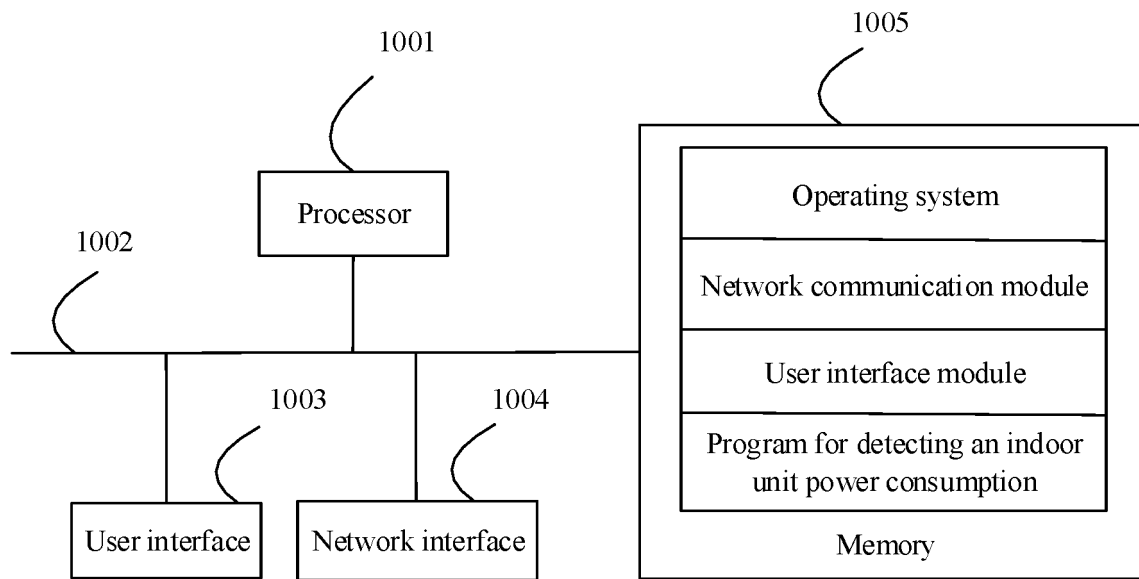


FIG. 1

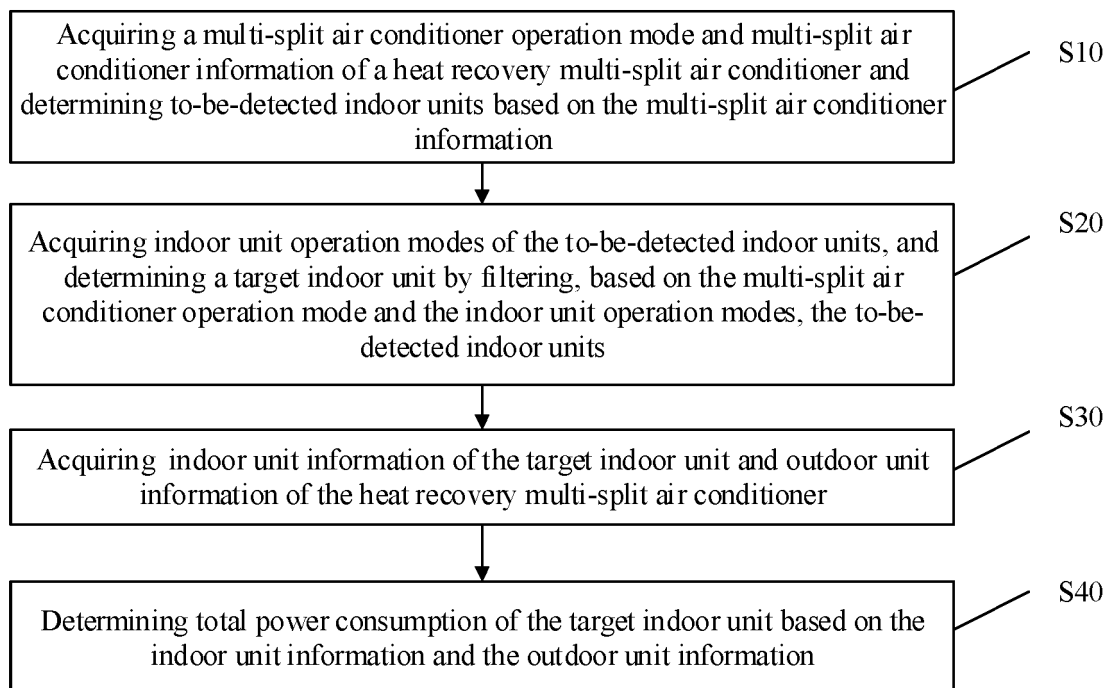


FIG. 2

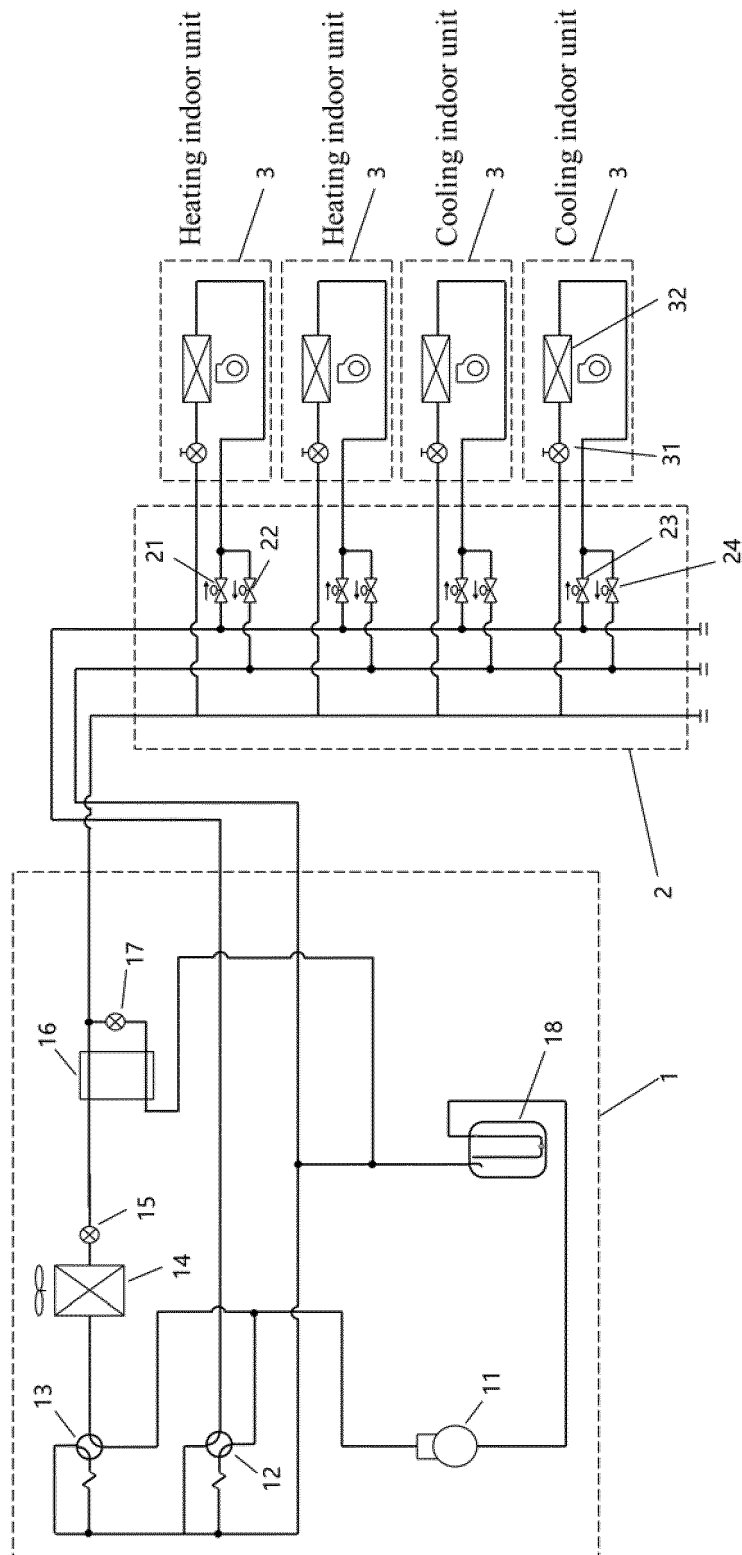


FIG. 3

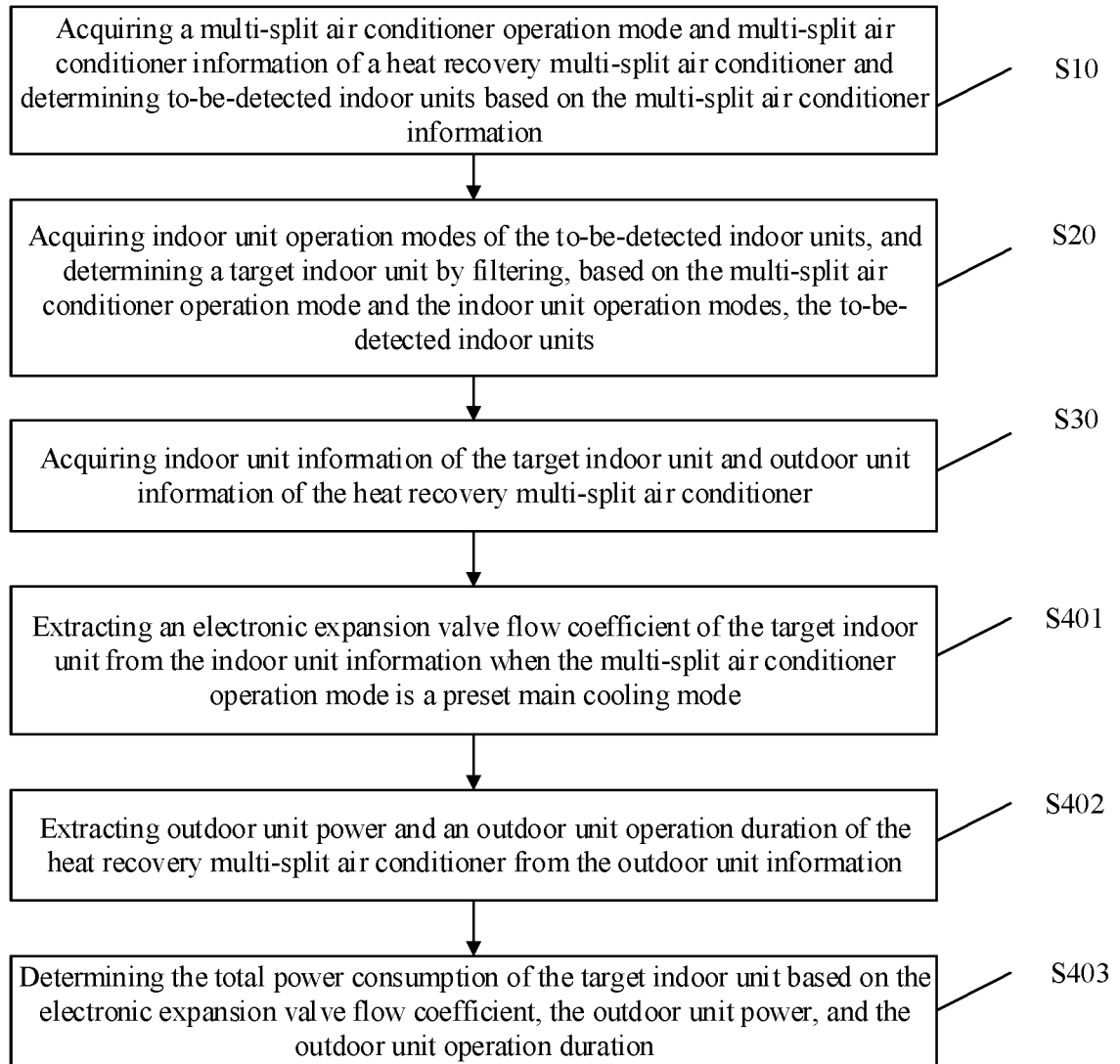


FIG. 4

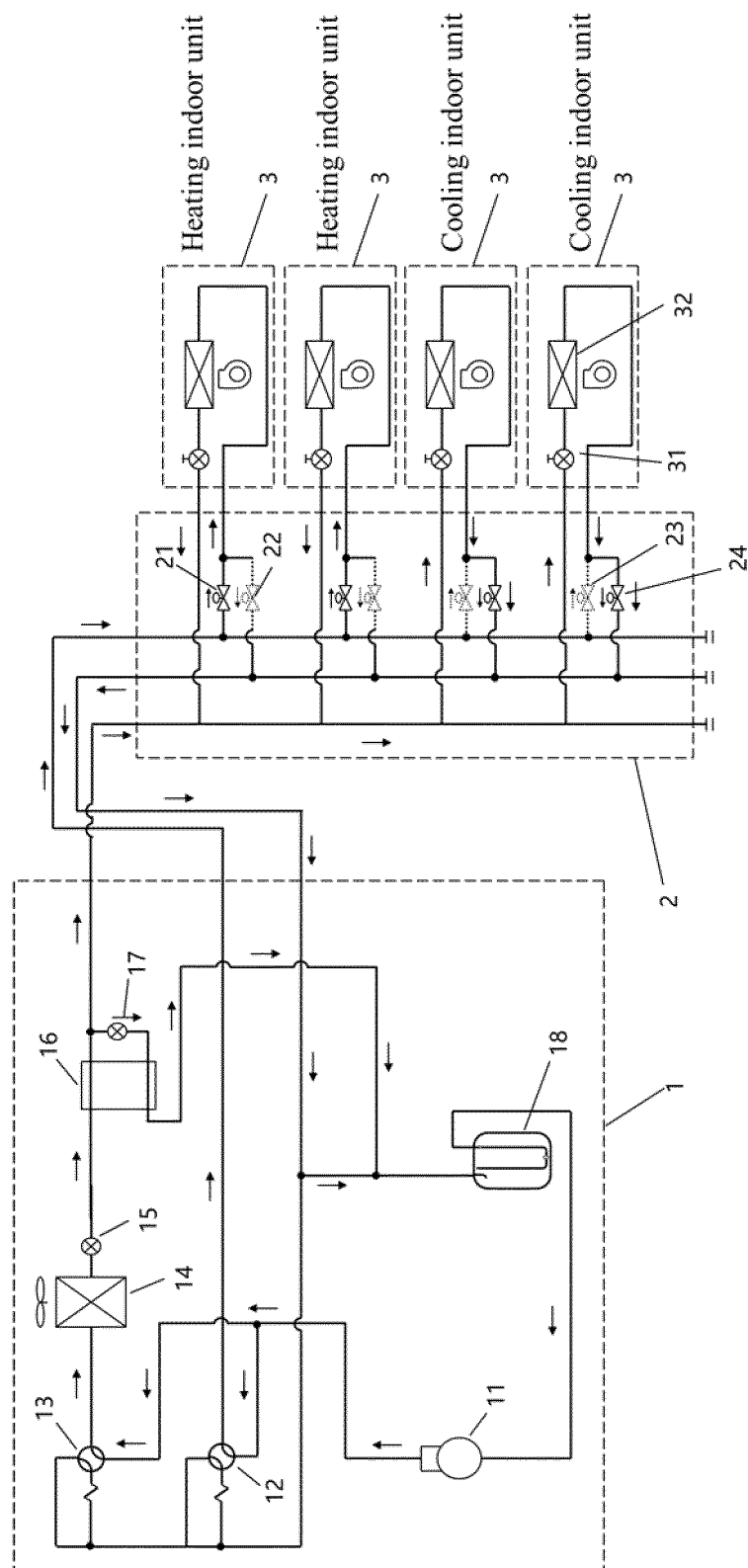


FIG. 5

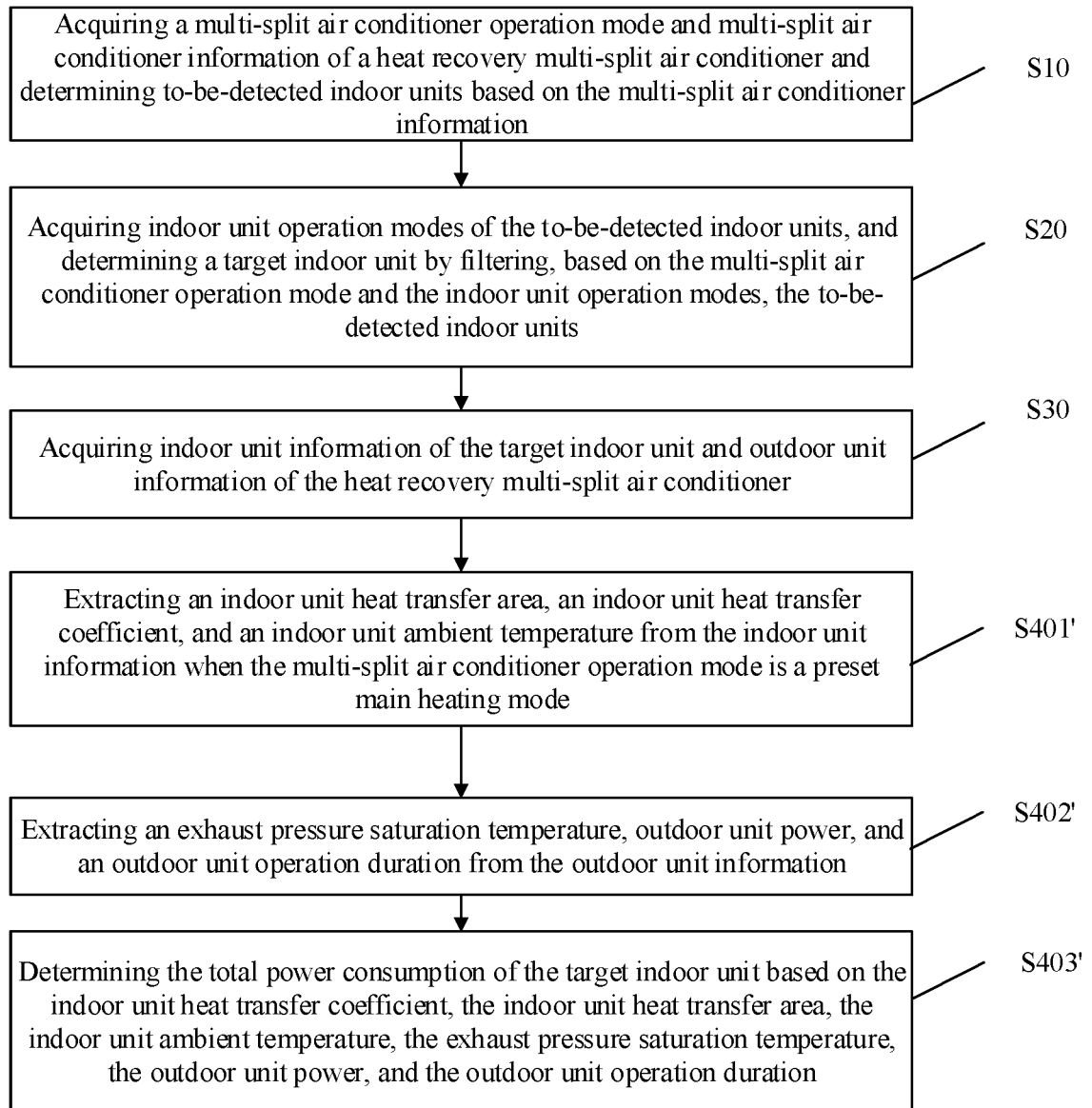


FIG. 6

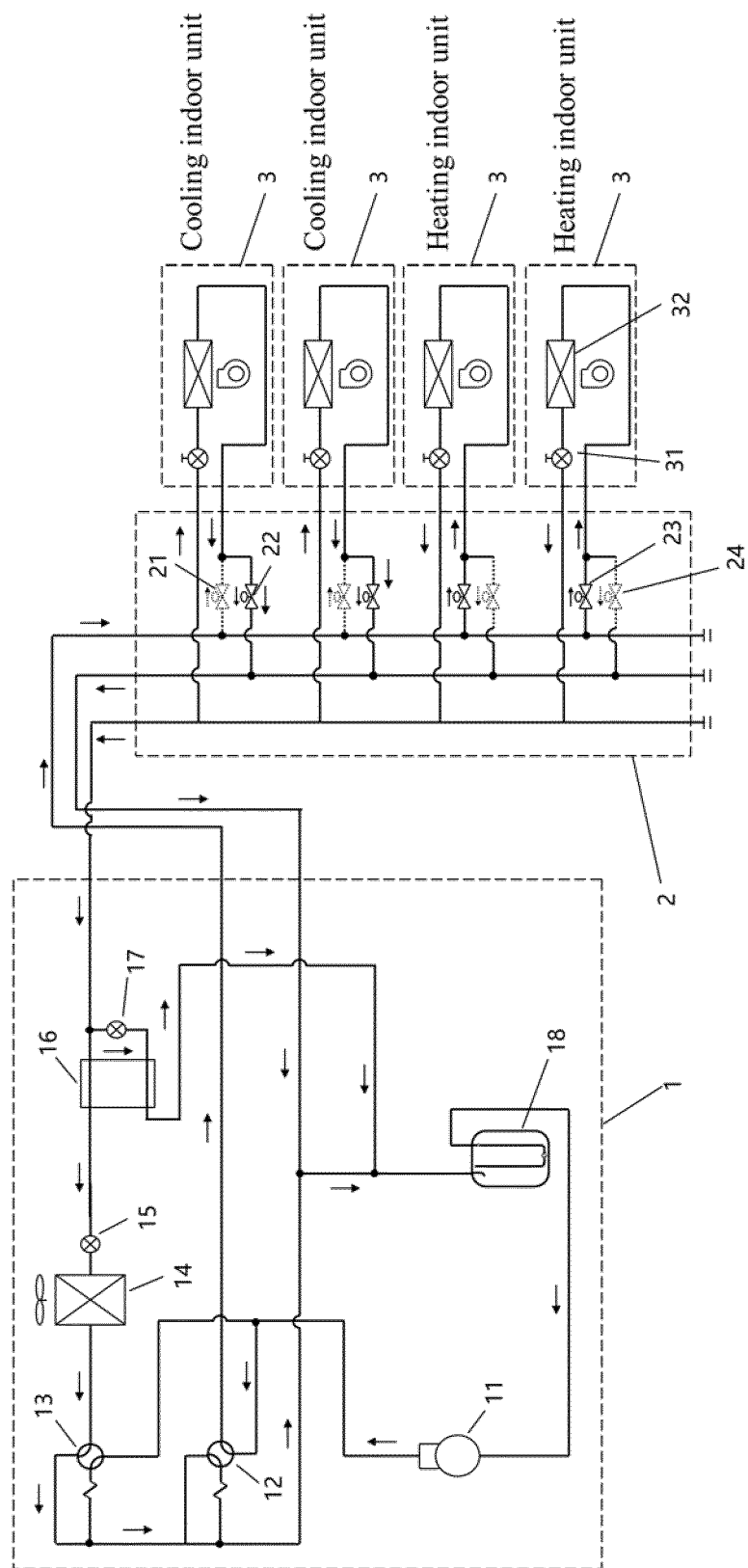


FIG. 7

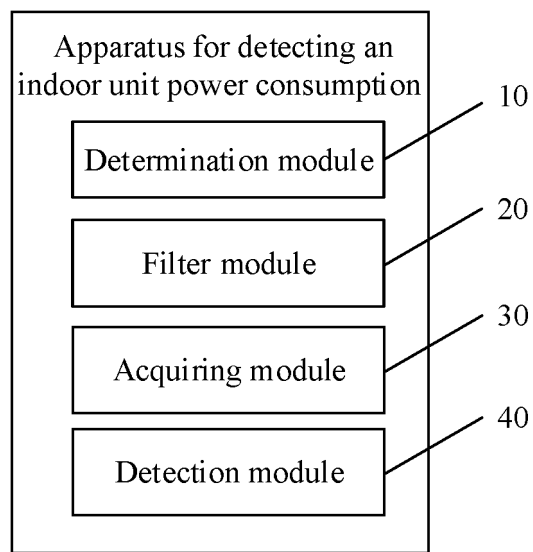


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/072345

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/46(2018.01)i; F24F 11/54(2018.01)i; F24F 11/61(2018.01)i; F24F 11/63(2018.01)i; F24F 11/65(2018.01)i;
F24F 11/10(2018.01)n; F24F 140/12(2018.01)n; F24F 140/20(2018.01)n

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNTXT, CNKI, VEN, WOTXT, USTXT, EPTXT, 广东美的暖通, 美的集团, 张宇晟, 丁云霄, 吴敌, 多联, VRV, 一拖, 内机, 电量, 耗电, 电耗, 能耗, 电能, 模式, 制热, 制冷, multi+, connect+, electric+, consumption, air condition+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 110296512 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 01 October 2019 (2019-10-01) description paragraphs 38-112	1-10
PX	CN 112762574 A (GUANGDONG MIDEA HEATING & VENTILATION EQUIPMENT CO., LTD. et al.) 07 May 2021 (2021-05-07) claims 1-10	1-10
A	JP 2012017912 A (YAMATAKE CORP.) 26 January 2012 (2012-01-26) entire document	1-10
A	CN 1590883 A (LG ELECTRONICS (TIANJIN) ELECTRICAL APPLIANCES CO., LTD.) 09 March 2005 (2005-03-09) entire document	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

10 February 2022

Date of mailing of the international search report

24 March 2022

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
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Authorized officer

Facsimile No. (86-10)62019451

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/072345

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Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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CN 1590883 A	09 March 2005	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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