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(54) **ENERGY-SAVING VENTILATION SYSTEM USING PROCESS EXHAUST AIR**

(57) Provided is an energy-saving ventilation system using process exhaust air. The energy-saving ventilation system comprises a fresh air handling unit used for handling outdoor fresh air and then supplying same to a production room; and an exhaust air recycling device used for transferring the available process exhaust air and/or energy in the production room back to the production room and/or an air inlet of the fresh air handling unit. In the energy-saving ventilation system, the exhaust air recycling device can transfer the available process exhaust air and/or energy in the production room back to the production room or the air inlet of the fresh air handling unit, such that the process exhaust air or the energy contained in the process exhaust air are recycled and reused, so as to avoid the wasting of energy and reduce the energy needed for handling fresh air by the fresh air handling unit, thereby saving energy.

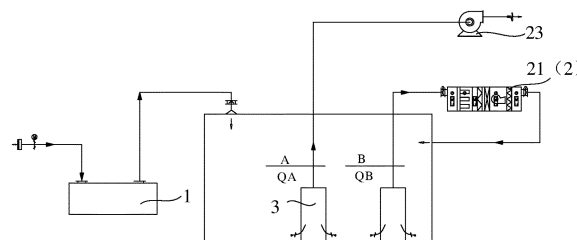


Fig. 2

Description

Cross-Reference of Related Applications

[0001] The present application claims priority to Chinese Patent Application No. 201910662624.2, filed with the China National Intellectual Property Administration on July 22, 2019 and entitled "Ventilation System Using Process Hot Exhaust Air", the content of which is herein incorporated by reference in its entirety; and the present application claims priority to Chinese Patent Application No. 201910663309.1, filed with the China National Intellectual Property Administration on July 22, 2019 and entitled "Ventilation System Using Process Exhaust Air", the content of which is herein incorporated by reference in its entirety.

Field

[0002] The present application relates to the technical field of industrial production, and particularly to an energy-saving ventilation system using process exhaust air.

Background

[0003] In the production fields of integrated circuits, flat panel displays and optoelectronic devices, there are different kinds of process exhaust air due to requirements of process production. Generally, such process exhaust air is directly discharged into the atmosphere. However, as shown in Fig. 1, a considerable part of process exhaust air discharged from a process equipment 03 in a production room (production plant) 04 is very clean exhaust air (or containing only a small amount of dust) at ordinary temperature, or very clean exhaust air (or containing only a small amount of dust) at high temperature (or low temperature). If the process exhaust air is directly discharged through an exhaust fan 02, energy (cold/heat) contained in the exhaust air is not used, resulting in a waste of energy; and at the same time, in order to maintain parameter requirements of a plant environment, it is also necessary to set up a corresponding fresh air handling unit 01 for such exhaust air. The fresh air needs to be filtered, cooled, heated, humidified, etc., consuming a lot of energy.

Summary

[0004] Embodiments of the present application provide an energy-saving ventilation system using process exhaust air, which can make full use of the process exhaust air and transfer available process exhaust air itself and/or energy of the available process exhaust air back to a production room and/or an air inlet of a fresh air handling unit for cyclic utilization, saving the energy.

[0005] The present application provides an energy-saving ventilation system using process exhaust air, including: a fresh air handling unit configured to handle

outdoor fresh air and then supply handled outdoor fresh air to a production room; an exhaust air recycling device configured to transfer available process exhaust air itself and/or energy of the available process exhaust air in the production room back to the production room and/or an air inlet of the fresh air handling unit.

[0006] The energy-saving ventilation system provided by an embodiment of the present application includes the fresh air handling unit and the exhaust air recycling device. The fresh air handling unit may supply the outdoor fresh air after handling such as filtering, cooling, heating, humidifying to the production room (production plant). Different process equipments in the production room discharge different process exhaust air, where the process exhaust air of some process equipment is available process exhaust air at ordinary temperature, and the process exhaust air of some process equipment is available process exhaust air at high temperature or low temperature. The exhaust air recycling device may transfer the available process exhaust air itself and/or energy of the available process exhaust air in the production room back to the production room and/or the air inlet of the fresh air handling unit, avoiding the energy waste, reducing the energy by the fresh air handling unit to handle the fresh air, and thus saving the energy.

[0007] Optionally, the exhaust air recycling device includes a process exhaust air recycling unit configured to recycle and transport the available process exhaust air in the production room back to the production room.

[0008] Optionally, the process exhaust air recycling unit includes: an air inlet section connected to an outlet of the production room for exhausting the available process exhaust air, an air outlet section connected to an inlet of the production room for receiving the available process exhaust air, and a fan section located between the air inlet section and the air outlet section.

[0009] Optionally, at least one filter section is provided between the air inlet section and the fan section, and/or, at least one filter section is provided between the fan section and the air outlet section.

[0010] Optionally, the filter section provided between the air inlet section and the fan section includes a chemical filter section and/or a medium-efficiency filter section.

[0011] Optionally, the filter section provided between the fan section and the air outlet section includes a high-efficiency filter section.

[0012] Optionally, the system further includes a connection air pipe, and one end of the connection air pipe is connected to the air outlet section and another end of the connection air pipe is connected to the production room.

[0013] Optionally, the system further includes an air outlet section air pipe, where the connection air pipe is provided with a first electric seal valve, one end of the air outlet section air pipe is connected to the connection air pipe between the air outlet section and the first electric seal valve, another end of the air outlet section air pipe is connected to atmosphere outside the production room,

the air outlet section air pipe is provided with a second electric seal valve, a portion of the connection air pipe between the air outlet section and the first electric seal valve is provided with a hazardous substance probe, the hazardous substance probe is connected to a controller by signal, and the controller is connected to the first electric seal valve and the second electric seal valve by signal respectively to control opening and closing of the first electric seal valve and the second electric seal valve respectively; when the hazardous substance probe detects a hazardous substance in the connection air pipe, the controller controls the first electric seal valve to close and the second electric seal valve to open.

[0014] Optionally, the process exhaust air recycling unit is installed in a ventilation air conditioner machine room, in a suspended ceiling, in a technical interlayer under a clean production plant, or in a process room.

[0015] Optionally, the air inlet of the fresh air handling unit is connected to an air inlet pipe for introducing outdoor fresh air, the exhaust air recycling device includes a first exhaust fan, and a first exhaust pipe and a second exhaust pipe connected to an air outlet of the first exhaust fan, the first exhaust pipe is connected to atmosphere outside the production room, the first exhaust pipe is provided with a first electric valve for controlling air volume of the first exhaust pipe, the second exhaust pipe cooperates with the air inlet pipe to transfer the available process exhaust air itself and/or energy of the available process exhaust air to the outdoor fresh air at the air inlet of the fresh air handling unit, and the second exhaust pipe is provided with a second electric valve for controlling air volume of the second exhaust pipe.

[0016] Optionally, the system further includes a temperature detector installed at the air inlet of the fresh air handling unit or in the fresh air handling unit for detecting a temperature of fresh air at the air inlet of the fresh air handling unit, the temperature detector is connected to a controller by signal, the controller is connected to the first electric valve and the second electric valve by signal respectively, and the controller is configured to control opening and closing degrees of the first electric valve and the second electric valve respectively according to a temperature detected by the temperature detector and a preset temperature.

[0017] Optionally, the second exhaust pipe is directly connected to the air inlet pipe.

[0018] Optionally, a filter section is provided in the first exhaust fan, in the second exhaust pipe or in the fresh air handling unit.

[0019] Optionally, a filter is provided in the filter section in the first exhaust fan, in the second exhaust pipe or in the fresh air handling unit.

[0020] Optionally, an air inlet of the first exhaust fan is connected to an air outlet of a process equipment through a hot exhaust main pipe.

[0021] Optionally, a hazardous substance probe is provided in the hot exhaust main pipe; the hazardous substance probe is connected to a controller by signal, and

the controller is connected to the first electric valve and the second electric valve respectively; when the hazardous substance probe detects a hazardous substance in the hot exhaust main pipe, the second electric valve is closed and the first electric valve is fully opened.

[0022] Optionally, the system further includes a heat recycling device, where an air inlet of the heat recycling device is connected to the first exhaust pipe, an air outlet of the heat recycling device is connected to atmosphere outside the production room, and the first exhaust pipe cooperates with the air inlet of the fresh air handling unit through the heat recycling device to indirectly transfer energy of the available process exhaust air in the first exhaust pipe to the outdoor fresh air at the air inlet of the fresh air handling unit.

[0023] Optionally, the heat recycling device includes one or a combination of runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type.

[0024] Optionally, the system further includes a heat recycling device, where the second exhaust pipe cooperates with the air inlet pipe through the heat recycling device to indirectly transfer energy of the available process exhaust air in the second exhaust pipe to the outdoor fresh air at the air inlet of the fresh air handling unit.

[0025] Optionally, the heat recycling device includes one or a combination of runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type.

[0026] Optionally, the heat recycling device is provided in the fresh air handling unit, or in the second exhaust pipe, or in the first exhaust fan.

[0027] Optionally, the system further includes a second exhaust fan configured to exhaust unavailable process exhaust air in the production room.

Brief Description of the Drawings

[0028]

Fig. 1 is a structural schematic diagram of a ventilation system in the related art;

Fig. 2 is a structural schematic diagram of an energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 3 is a structural schematic diagram of a functional section of a process exhaust air recycling unit according to an embodiment of the present application;

Fig. 4 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 5 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 6 is a partial enlarged view of a region C in Fig. 4; Fig. 7 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 8 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 9 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application;

Fig. 10 is a structural schematic diagram of another energy-saving ventilation system using process exhaust air according to an embodiment of the present application.

[0029] Reference numbers are: 01 - fresh air handling unit; 02 - exhaust fan; 03 - process equipment; 04 - production room; 1 - fresh air handling unit; 11 - air inlet pipe; 12 - temperature detector; 2 - exhaust air recycling device; 21 - process exhaust air recycling unit; 211 - air inlet section; 212 - chemical filter section; 213 - medium-efficiency filter section; 214 - fan section; 215 - high-efficiency filter section; 216 - air outlet section; 22 - first exhaust fan; 23 - second exhaust fan; 24 - connection air pipe; 241 - first electric seal valve; 242 - hazardous substance probe; 25 - air outlet section air pipe; 251 - second electric seal valve; 3 - process equipment; 41 - first exhaust pipe; 411 - first electric valve; 42 - second exhaust pipe; 421 - second electric valve; 43 - hot exhaust main pipe; 431 - hazardous substance probe; 51, 52 - heat recycling device.

Detailed Description

[0030] The technical solution in embodiments of the present application will be described below clearly and completely in combination with drawings and embodiments of the present application.

[0031] Referring to Fig. 2 and Fig. 5, the present application provides an energy-saving ventilation system using process exhaust air, including: a fresh air handling unit 1 configured to handle outdoor fresh air and then supply handled outdoor fresh air to a production room; an exhaust air recycling device 2 configured to transfer the available process exhaust air itself and/or energy of the available process exhaust air in the production room back to the production room and/or an air inlet of the fresh air handling unit.

[0032] The energy-saving ventilation system provided by an embodiment of the present application includes the fresh air handling unit 1 and the exhaust air recycling device 2. The fresh air handling unit 1 may supply the outdoor fresh air after handling such as filtering, cooling, heating, humidifying to the production room (production plant). Different process equipments 3 in the production

room discharge different process exhaust air, where the process exhaust air of some process equipment 03 is available process exhaust air at ordinary temperature, and the process exhaust air of some process equipment is available process exhaust air at high temperature or low temperature. The exhaust air recycling device 2 may transfer the available process exhaust air itself and/or energy of the available process exhaust air in the production room back to the production room and/or the air inlet of the fresh air handling unit, avoiding the energy waste, reducing the energy required by the fresh air handling unit 1 to handle the fresh air, and thus saving the energy.

[0033] It should be noted that the available process exhaust air may be ordinary-temperature exhaust air, high-temperature exhaust air or low-temperature exhaust air. The energy recycled from the high-temperature exhaust air is the heat of the exhaust air, and the energy recycled from the low-temperature exhaust air is cold energy of the exhaust air.

[0034] In a possible embodiment, as shown in Fig. 2, the exhaust air recycling device 2 may be a process exhaust air recycling unit 21 configured to recycle and transport the available process exhaust air in the production room back to the production room. Here, the available process exhaust air may be the ordinary-temperature exhaust air of which the temperature and humidity match the environment in the production room.

[0035] In the energy-saving ventilation system described above, as shown in Fig. 2, the production room is equipped with two types of process exhaust air outlets. The fresh air handling unit 1 filters, cools, heats and humidifies the fresh air and then supplies the fresh air to the production room. The process exhaust air A that cannot be used in the production room is directly discharged into the atmosphere, and the air volume is QA. The process exhaust air B (ordinary-temperature exhaust air) that can be directly used is transported back to the room directly by the process exhaust air recycling unit 21 or transported back to the room after being filtered, and the air volume is QB. The fresh air volume that needs to be supplemented by the fresh air handling unit 1 is QA. However, in the ventilation system in the related art, as shown in Fig. 1, the process exhaust air that cannot be used in the production room is directly discharged into the atmosphere, and the air volume is QA; the available process exhaust air B is also directly discharged into the atmosphere, and the air volume is QB; the fresh air volume that needs to be supplemented by the fresh air handling unit 1 is QA+QB. Compared with the ventilation system in the related art, for the ventilation system in an embodiment of the present application, the fresh air volume that needs to be supplemented by the fresh air handling unit 1 is QA, and the newly supplemented air volume is reduced by QB.

[0036] Therefore, in the above embodiment, the available ordinary-temperature exhaust air is transported back to the production room for reuse through the proc-

ess exhaust air recycling unit 21, reducing the fresh air volume in the production room, reducing the cold/heat energy for processing the fresh air and also reducing the capacity of the fresh air handling unit 1, thus saving the energy.

[0037] In an embodiment of the present application, for the available process exhaust air, a part of the process exhaust air that meets the requirements for temperature, humidity and cleanliness is directly transported back to the production room, and a part of the process exhaust air that meets the requirements for temperature and humidity but does not meet the requirement for cleanliness is filtered and then transported to the production room. Here, although the process exhaust air also needs to be processed, the treatment process is simpler than the fresh air processing process of the fresh air handling unit 1, and requires less energy consumption.

[0038] The production room in the above embodiment may include a clean room.

[0039] Further, in order to enable the available ordinary-temperature exhaust air to meet all the requirements and be transported back to the production room, referring to Fig. 3, the process exhaust air recycling unit 21 in an embodiment of the present application may include: an air inlet section 211 connected to an outlet of the production room for exhausting the available process exhaust air, an air outlet section 216 connected to an inlet of the production room for receiving the available process exhaust air, and a fan section 214 located between the air inlet section 211 and the air outlet section 216. If the temperature, humidity and cleanliness of the available process exhaust air meet the requirements, such process exhaust air is directly transported back to the production room through the air outlet section 216 under the action of the fan section 214 after entering the process exhaust air recycling unit 21.

[0040] Further, at least one filter section may be provided between the air inlet section 211 and the fan section 214 or between the fan section 214 and the air outlet section 216, or at least one filtering section may be provided between the air inlet section 211 and the fan section 214 and between the fan section 214 and the air outlet section 216 respectively. The available process exhaust air enters from the air inlet section 211, and the process exhaust air of which the cleanliness does not meet the requirement passes through the filter section and is then transported back to the production room, to ensure the cleanliness of the production room.

[0041] Optionally, taking Fig. 3 as an example, the filter section provided between the air inlet section 211 and the fan section 214 may include, but is not limited to: a chemical filter section 212 and/or a medium-efficiency filter section 213. The chemical filter section 212 may absorb molecular-level pollutants mixed into the process exhaust air, and the medium-efficiency filter section 213 may further filter the process exhaust air containing particulate matter, so that the recycled process exhaust air reaches the cleanliness requirement.

[0042] Optionally, the filter section provided between the fan section 214 and the air outlet section 216 may include, but is not limited to: a high-efficiency filter section 215, which further performs high-efficiency filtering on the process exhaust air passing through the fan section 214, to ensure that the recycled process exhaust air can reach the cleanliness requirement and be then transported back to the production room for reuse.

[0043] It should be noted that each filter section of the process exhaust air recycling unit 21 in an embodiment of the present application is selected and set according to the nature of the exhaust air and the requirements of the production room and is not a section that must be configured, and the position of each filter section may be adjusted as needed. At the same time, the purification of the available process exhaust air can not only include filtering processing of the filter, but also include other types of filter purification forms (for example, water washing, adhesion, absorption, combustion, etc.).

[0044] In an embodiment of the present application, the process exhaust air recycling unit 21 may be installed in a ventilation air conditioner machine room, or in a suspended ceiling, or in a technical interlayer under a clean production plant, or in a process room, or in any location that meets the installation requirement.

[0045] When the process exhaust air recycling unit 21 is installed in a ventilation air conditioner machine room or in a suspended ceiling, the energy-saving ventilation system in an embodiment of the present application further includes a connection air pipe 24. One end of the connection air pipe 24 is connected to the air outlet section 216 and the other end of the connection air pipe is connected to the production room, so that the available process exhaust air is returned to the production room through the connection air pipe.

[0046] In practical applications, due to the process production requirements, there are process equipments using hazardous chemicals in the production room, and the process exhaust air with hazardous substances is discharged. If the process exhaust air with hazardous substances leaks, the available process exhaust air may be contaminated. In order to prevent the contaminated process exhaust air from being recycled, an air outlet section air pipe 25 may be connected to the connection air pipe. As shown in Fig. 4, the connection air pipe 24 is provided with a first electric seal valve 241, one end of the air outlet section air pipe 25 is connected to the connection air pipe 24 between the air outlet section 216 and the first electric seal valve 241, the other end of the air outlet section air pipe 25 is connected to the atmosphere outside the production room, the air outlet section air pipe 25 is provided with a second electric seal valve 251, a portion of the connection air pipe 24 between the air outlet section 216 and the first electric seal valve 241 is provided with a hazardous substance probe 242, the hazardous substance probe 242 is connected to a controller by signal, and the controller is connected to the first electric seal valve 241 and the second electric seal valve 251 by signal.

respectively to control opening and closing of the first electric seal valve 241 and the second electric seal valve 251 respectively. If the hazardous substance probe 242 detects no hazardous substance, the controller controls the first electric seal valve to open and controls the second electric seal valve to close, to recycle the available process exhaust air; if the hazardous substance detector detects the hazardous substance, the controller controls the first electric seal valve to close and controls the second electric seal valve to open, so that the contaminated available process exhaust air is directly exhausted to the atmosphere, avoiding the pollution of the environment in the production room.

[0047] The process exhaust air recycling unit 21 is installed in the production room or in the technical interlayer under the clean production plant. The air outlet section 216 of the process exhaust air recycling unit 21 may also be directly set in the form of air outlet to directly supply the recycled air to the production room or the technical interlayer under the clean production plant.

[0048] In another possible embodiment, as shown in Figs. 5 and 6, the air inlet of the fresh air handling unit 1 is connected to an air inlet pipe 11 for introducing the outdoor fresh air, the exhaust air recycling device 2 may include a first exhaust fan 22, and a first exhaust pipe 41 and a second exhaust pipe 42 connected to an air outlet of the first exhaust fan 22, the first exhaust pipe 41 is connected to the atmosphere outside the production room, the first exhaust pipe 41 is provided with a first electric valve 411 for controlling the air volume of the first exhaust pipe 41, the second exhaust pipe 42 cooperates with the air inlet pipe 11 to transfer the available process exhaust air itself and/or energy of the available process exhaust air to the outdoor fresh air at the air inlet of the fresh air handling unit 1, and the second exhaust pipe 42 is provided with a second electric valve 421 for controlling the air volume of the second exhaust pipe 42. In this structure, the available process exhaust air may be high-temperature exhaust air or low-temperature exhaust air.

[0049] The above energy-saving ventilation system includes the fresh air handling unit 1 and the first exhaust fan 22. The fresh air handling unit 1 may handle the outdoor fresh air and transfer handled outdoor fresh air into the production room, and the first exhaust fan 22 may discharge the available process exhaust air generated by the process equipment 3 in the production room from the production room. Since the air outlet of the first exhaust fan 22 is connected to the first exhaust pipe 41 and the second exhaust pipe 42, the first exhaust pipe 41 is connected to the atmosphere outside the production room and the second exhaust pipe 42 cooperates with the air inlet pipe 11, the available process exhaust air itself and/or energy of the available process exhaust air can be transferred to the outdoor fresh air at the air inlet of the fresh air handling unit 1. When the first electric valve 411 is turned down or closed and the second electric valve 421 is opened, the available process exhaust air itself and/or energy of the available process exhaust

air generated by the process equipment 3 may be transferred to the outdoor fresh air entering the air inlet of the fresh air handling unit 1 through the second exhaust pipe 42, and the energy contained in the process exhaust air can be recycled for reuse, avoiding the energy waste, reducing the energy required by the fresh air handling unit 1 to handle the fresh air, and saving the energy.

[0050] In practical applications, assuming that the available process exhaust air is high-temperature exhaust air, the fresh air is supplemented by the fresh air handling unit 1 in winter, and the fresh air needs to be heated in the fresh air handling unit 1 to reach a suitable temperature before being transported to the production room, consuming a lot of energy. In the above ventilation system, the first exhaust fan 22 may discharge the high-temperature exhaust air generated by the process equipment 3 in the production plant from the production plant. Since the air outlet of the exhaust fan 2 is connected to the first exhaust pipe 41 and the second exhaust pipe 42, and the first exhaust pipe 41 is connected to the atmosphere outside the production plant and the second exhaust pipe 42 cooperates with the air inlet pipe 11, the heat of the high-temperature exhaust air may be transferred to the outdoor fresh air at the air inlet of the fresh air handling unit. When the first electric valve 411 is closed and the second electric valve 421 is opened, the heat of the high-temperature exhaust air generated by the process equipment 3 may be transferred to the outdoor fresh air entering the air inlet of the fresh air handling unit 1 through the second exhaust pipe 42, so that the temperature of the outdoor fresh air at the air inlet of the fresh air handling unit 1 can be increased, thereby reducing the heating amount of the fresh air handling unit 1 for the outdoor fresh air in winter and achieving the purpose of saving the energy; and in summer, the second electric valve 421 is closed and the first electric valve 411 is fully opened, and the high-temperature exhaust air generated by the process equipment 3 may be directly discharged into the atmosphere without affecting the temperature of the outdoor fresh air at the air inlet of the fresh air handling unit 1.

[0051] Furthermore, the available exhaust air may also be low-temperature exhaust air. In summer, the second exhaust pipe 42 cooperates with the air inlet pipe 11 to transfer the cold energy of the low-temperature exhaust air to the outdoor fresh air at the air inlet of the fresh air handling unit. When the first electric valve 411 is closed and the second electric valve 421 is opened, the cold energy of the low-temperature exhaust air generated by the process equipment 3 may be transferred to the outdoor fresh air at the air inlet of the fresh air handling unit 1 through the second exhaust pipe 42, so that the temperature of the outdoor fresh air at the air inlet of the fresh air handling unit 1 can be reduced, thereby reducing the cooling amount of the fresh air handling unit 1 for the outdoor fresh air in summer and achieving the purpose of saving the energy.

[0052] The outdoor temperature varies in different sea-

sons, and different temperatures are required for production in the production room. When the exhaust air recycling device is used to recycle the energy in the process exhaust air, it is necessary to control the amount of energy recycled from the available process exhaust air to reduce the energy consumed by the fresh air handling unit. In order to adjust the amount of energy recycled from the available process exhaust air, the ventilation system may also be provided with a temperature detector 12. As shown in Fig. 7, the temperature detector 12 is installed at the air inlet of the fresh air handling unit 1 or in the fresh air handling unit 1 for detecting a temperature of the fresh air at the air inlet of the fresh air handling unit, where the fresh air at the air inlet of the fresh air handling unit is the fresh air after receiving the energy of the process exhaust air. The temperature detector 12 is connected to a controller by signal, the controller is connected to the first electric valve 411 and the second electric valve 421 by signal respectively, and the controller is configured to control opening and closing degrees of the first electric valve 411 and the second electric valve 421 respectively according to a temperature detected by the temperature detector and a preset temperature.

[0053] In practical applications, the preset temperature is the required temperature under the condition of the lowest energy consumption of the fresh air handling unit. If the available process exhaust air is high-temperature exhaust air, the heat of the high-temperature exhaust air is transferred to the outdoor fresh air at the air inlet of the fresh air handling unit through the second exhaust pipe 42 in cooperation with the air inlet pipe 11. The temperature detector detects the temperature of the fresh air at the air inlet of the fresh air handling unit, and the controller compares the preset temperature with the temperature of the fresh air at the air inlet of the fresh air handling unit. According to the difference value, the controller respectively controls the opening and closing degrees of the first electric valve and the second electric valve. For example, the temperature of the fresh air at the air inlet of the fresh air handling unit is lower than the preset temperature, and then the controller controls the second electric valve 421 to turn up or fully open to increase the air volume in the second exhaust pipe and controls the first electric valve 411 to turn down or close to reduce the air volume in the first exhaust pipe, thereby increasing the amount of energy recycling; or, the temperature of the fresh air at the air inlet of the fresh air handling unit is higher than the preset temperature, and then the controller controls the second electric valve 421 to turn down or close to reduce the air volume in the second exhaust pipe and controls the first electric valve to turn up or fully open to increase the air volume in the first exhaust pipe, thereby reducing the amount of energy recycling.

[0054] Optionally, as shown in Figs. 5, 6 and 7, the second exhaust pipe 42 may be directly connected to the air inlet pipe 11 of the fresh air handling unit 1 to directly transfer the available process exhaust air itself and energy of the available process exhaust air to the outdoor

fresh air entering the air inlet of the fresh air handling unit 1, so that the energy required by the fresh air handling unit 1 to handle the fresh air can be reduced, saving the energy, and the fresh air volume of the production room can be reduced, thereby reducing the capacity of the fresh air handling unit 1 and saving the energy.

[0055] Further, when the second exhaust pipe is directly connected to the air inlet pipe, a part of the process exhaust air that does not meet the requirement for cleanliness needs to be filtered and then transported back to the production room, so a filter section may be provided in the first exhaust fan 22, in the second exhaust pipe 42 or in the fresh air handling unit 1, to prevent the impurities present in the exhaust air from entering the production room in the case when there are impurities such as dust in the available process exhaust air.

[0056] A filter is provided in the filter section in the first exhaust fan 22, in the second exhaust pipe 42 or in the fresh air handling unit 1. The filter filters the available process exhaust air generated by the process equipment 3. In addition, the filter section may also use various other types of filtering methods to filter the exhaust air, such as water washing, adsorption, etc., which are not limited here.

[0057] It should be noted that one or more filter sections may be provided in the first exhaust fan 22, in the second exhaust pipe 42 or in the fresh air handling unit 1, and the filter sections may be different filtering function sections to achieve different filtering forms. The setting of the filter sections is determined according to the actual situation of the production plant, which is not limited here.

[0058] In the above energy-saving ventilation system, the air inlet of the first exhaust fan 22 is connected to the air outlet of the process equipment 3 through a hot exhaust main pipe 43.

[0059] Furthermore, a hazardous substance probe 431 may be provided in the hot exhaust main pipe 43. The hazardous substance probe 431 is connected to a controller by signal, and the controller is connected to the first electric valve 411 and the second electric valve 421 by signal respectively; when the hazardous substance probe 431 detects a hazardous substance in the hot exhaust main pipe, the second electric valve 421 is closed and the first electric valve 421 is fully opened. Due to the process production requirements, there is a process equipment 3 that uses hazardous chemicals in the production room to discharge the unavailable process exhaust air. If such process equipment 3 leaks, the hazardous substance may enter the hot exhaust main pipe 43, so that the hazardous substance may be transported to the air inlet of the fresh air handling unit 1. In order to prevent the hazardous substance from entering the air inlet of the fresh air handling unit 1, the hazardous substance probe 431 may be provided in the hot exhaust main pipe 43. When the hazardous substance probe 431 detects the hazardous substance in the hot exhaust main pipe 43, the controller may control the second electric valve 421 to close and the first electric valve 411 to fully

open, so that the process exhaust air of the process equipment 3 is discharged into the atmosphere to avoid polluting the environment in the production room.

[0060] It should be noted that the controller gives priority to respond to the signal sent by the hazardous substance probe when both the temperature detector and the hazardous substance probe are installed in the ventilation system. If the hazardous substance probe detects the hazardous substance, the second electric valve is closed and the first electric valve is fully opened. If the hazardous substance probe detects no hazardous substance, the controller responds to the signal sent by the temperature detector.

[0061] Optionally, in the above energy-saving ventilation system, not only can the process exhaust air be directly mixed with the outdoor fresh air to save energy, but also the energy (cold/heat energy) of the exhaust air generated by the process equipment 3 can be transferred to the outdoor fresh air at the air inlet of the fresh air handling unit 1 through a heat recycling device.

[0062] In one embodiment, as shown in Fig. 8, the second exhaust pipe 42 is directly connected to the air inlet pipe 11, and the first exhaust pipe 41 is connected to the atmosphere outside the production room through the heat recycling device 51. An air inlet of the heat recycling device 51 is connected to the first exhaust pipe 41, an air outlet of the heat recycling device 51 is connected to the atmosphere outside the production room, and the first exhaust pipe 41 cooperates with the air inlet of the fresh air handling unit 1 through the heat recycling device 51 to indirectly transfer the energy of the available process exhaust air in the first exhaust pipe 41 to the outdoor fresh air at the air inlet of the fresh air handling unit. In the actual production, the available process exhaust air may be contaminated by the hazardous substance and cannot be directly recycled. The hazardous substance probe 431 may detect whether there is a hazardous substance in the process exhaust air. If the hazardous substance probe detects that the gas in the hot exhaust main pipe 43 is gas without pollutant, the controller controls the first electric valve 411 to close and the second electric valve 421 to open, the high-temperature (or low-temperature) clean exhaust air can be directly mixed with the outdoor fresh air, and the energy is directly transferred to the outdoor fresh air. If the hazardous substance probe detects that there are pollutants in the hot exhaust main pipe 43, the controller controls the second electric valve 421 to close and the first electric valve 411 to open, and the energy of the high-temperature (or low-temperature) exhaust air containing the pollutants is indirectly transferred to the outdoor fresh air at the air inlet of the fresh air handling unit through the heat recycling device.

[0063] In the above embodiment, a temperature detector may also be provided at the air inlet of the fresh air handling unit 11 or in the fresh air handling unit 11. The heat recycling device 51 may adjust the recycling amount of the energy of the process exhaust air. When the process exhaust air in the hot exhaust main pipe is

detected as the clean exhaust air at high temperature (or low temperature) without pollutants, the heat recycling device 51 may not recycle the energy of the process exhaust air, and the controller controls the opening and closing degrees of the first electric valve 411 and the second electric valve 421 respectively according to the temperature detected by the temperature detector and the preset temperature to adjust the recycling amount of the energy of the process exhaust air. When it is detected that the process exhaust air in the hot exhaust main pipe contains pollutants, the controller controls the second electric valve 421 to close and the first electric valve 411 to fully open, so that the heat recycling device 51 recycles the energy of the process exhaust air in the first exhaust pipe 41.

[0064] The above heat recycling device may be in one or a combination of many forms such as runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type, which is not limited here.

[0065] In another solution, as shown in Fig. 9, the above energy-saving ventilation system includes a heat recycling device 52. The second exhaust pipe is not directly connected to the air inlet pipe of the fresh air handling unit, and the second exhaust pipe 42 cooperates with the air inlet pipe 11 through the heat recycling device 52 to indirectly transfer the energy of the high-temperature exhaust air or low-temperature exhaust air in the second exhaust pipe 42 to the outdoor fresh air at the air inlet of the fresh air handling unit 1. The second exhaust pipe 42 is connected to the air inlet of the heat recycling device 52, the air outlet of the heat recycling device 52 is connected to the atmosphere outside the production room, and the heat recycling device 52 may transfer the energy of the process exhaust air in the second exhaust pipe 42 to the outdoor fresh air at the air inlet of the fresh air handling unit 1. Through the heat exchange effect of the heat recycling device, the temperature of the outdoor fresh air at the air inlet of the fresh air handling unit 1 is increased or reduced, thereby reducing the heating or cooling amount of the outdoor fresh air by the fresh air handling unit 1 to achieve the purpose of saving energy.

[0066] The above heat recycling device 52 may be in one or a combination of many forms such as runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type, which is selected according to the actual situation and not limited here.

[0067] The above heat recycling device 52 may be provided in the fresh air handling unit 1, or in the second exhaust pipe 42, or in the exhaust fan. Here, the installation position of the heat recycling device only needs to be able to realize the installation and operation functions of the heat recycling device, and is not limited here.

[0068] It should be noted that due to different requirements for indoor environmental parameters that need to be maintained in different production rooms, the processing equipment and design parameters of the processing equipment included in the fresh air handling unit are determined according to the actual situation and not limited

here.

[0069] In another possible embodiment, as shown in Fig. 10, the two possible embodiments described above may also be combined. The exhaust air recycling device may include the process exhaust air recycling unit 21 and the combination of the first exhaust fan 22, first exhaust pipe 41 and second exhaust pipe 42 at the same time. The process exhaust air recycling unit 21 may be used to filter and then transfer the ordinary-temperature exhaust air at appropriate temperature in the production room into the production room. Through the first exhaust fan 22, the second exhaust pipe 42 and/or the heat recycling device, the energy of the high-temperature exhaust air or low-temperature exhaust air discharged from the process equipment may be transferred to the fresh air at the air inlet of the fresh air handling unit, realizing energy reuse and saving energy.

[0070] In the energy-saving ventilation system provided by the three possible embodiments described above, further, as shown in Fig. 2 and Fig. 10, the ventilation system further includes a second exhaust fan 23 configured to exhaust the unavailable process exhaust air in the production room.

[0071] Evidently those skilled in the art can make various modifications and variations to embodiments of the present application without departing from the spirit and scope of embodiments of the present application. Thus the present application is also intended to encompass these modifications and variations therein as long as these modifications and variations to embodiments of the present application come into the scope of the claims of the present application and their equivalents.

Claims

1. An energy-saving ventilation system using process exhaust air, the system comprising:

a fresh air handling unit configured to handle outdoor fresh air and then supply handled outdoor fresh air to a production room;

an exhaust air recycling device configured to transfer available process exhaust air itself and/or energy of the available process exhaust air in the production room back to the production room and/or an air inlet of the fresh air handling unit.

2. The energy-saving ventilation system according to claim 1, wherein the exhaust air recycling device comprises a process exhaust air recycling unit configured to recycle and transport the available process exhaust air in the production room back to the production room.

3. The energy-saving ventilation system according to claim 2, wherein the process exhaust air recycling

unit comprises: an air inlet section connected to an outlet of the production room for exhausting the available process exhaust air, an air outlet section connected to an inlet of the production room for receiving the available process exhaust air, and a fan section located between the air inlet section and the air outlet section.

4. The energy-saving ventilation system according to claim 3, wherein at least one filter section is provided between the air inlet section and the fan section, and/or, at least one filter section is provided between the fan section and the air outlet section.

5. The energy-saving ventilation system according to claim 4, wherein the filter section provided between the air inlet section and the fan section comprises a chemical filter section and/or a medium-efficiency filter section.

6. The energy-saving ventilation system according to claim 4, wherein the filter section provided between the fan section and the air outlet section comprises a high-efficiency filter section.

7. The energy-saving ventilation system according to claim 3, further comprising a connection air pipe, wherein one end of the connection air pipe is connected to the air outlet section and another end of the connection air pipe is connected to the production room.

8. The energy-saving ventilation system according to claim 7, further comprising an air outlet section air pipe, wherein the connection air pipe is provided with a first electric seal valve, one end of the air outlet section air pipe is connected to the connection air pipe between the air outlet section and the first electric seal valve, another end of the air outlet section air pipe is connected to atmosphere outside the production room, the air outlet section air pipe is provided with a second electric seal valve, a portion of the connection air pipe between the air outlet section and the first electric seal valve is provided with a hazardous substance probe, the hazardous substance probe is connected to a controller by signal, and the controller is connected to the first electric seal valve and the second electric seal valve by signal respectively to control opening and closing of the first electric seal valve and the second electric seal valve respectively; when the hazardous substance probe detects a hazardous substance in the connection air pipe, the controller controls the first electric seal valve to close and the second electric seal valve to open.

9. The energy-saving ventilation system according to claim 2, wherein the process exhaust air recycling

unit is installed in a ventilation air conditioner machine room, in a suspended ceiling, in a technical interlayer under a clean production plant, or in a process room.

10. The energy-saving ventilation system according to any one of claims 1-9, wherein the air inlet of the fresh air handling unit is connected to an air inlet pipe for introducing outdoor fresh air, the exhaust air recycling device comprises a first exhaust fan, and a first exhaust pipe and a second exhaust pipe connected to an air outlet of the first exhaust fan, the first exhaust pipe is connected to atmosphere outside the production room, the first exhaust pipe is provided with a first electric valve for controlling air volume of the first exhaust pipe, the second exhaust pipe cooperates with the air inlet pipe to transfer the available process exhaust air itself and/or energy of the available process exhaust air to the outdoor fresh air at the air inlet of the fresh air handling unit, and the second exhaust pipe is provided with a second electric valve for controlling air volume of the second exhaust pipe.
11. The energy-saving ventilation system according to claim 10, further comprising a temperature detector installed at the air inlet of the fresh air handling unit or in the fresh air handling unit for detecting a temperature of fresh air at the air inlet of the fresh air handling unit, the temperature detector is connected to a controller by signal, the controller is connected to the first electric valve and the second electric valve by signal respectively, and the controller is configured to control opening and closing degrees of the first electric valve and the second electric valve respectively according to a temperature detected by the temperature detector and a preset temperature.
12. The energy-saving ventilation system according to claim 10, wherein the second exhaust pipe is directly connected to the air inlet pipe.
13. The energy-saving ventilation system according to claim 12, wherein a filter section is provided in the first exhaust fan, in the second exhaust pipe or in the fresh air handling unit.
14. The energy-saving ventilation system according to claim 13, wherein a filter is provided in the filter section in the first exhaust fan, in the second exhaust pipe or in the fresh air handling unit.
15. The energy-saving ventilation system according to claim 12, wherein an air inlet of the first exhaust fan is connected to an air outlet of a process equipment through a hot exhaust main pipe.
16. The energy-saving ventilation system according to

claim 15, wherein a hazardous substance probe is provided in the hot exhaust main pipe; the hazardous substance probe is connected to a controller by signal, and the controller is connected to the first electric valve and the second electric valve respectively; when the hazardous substance probe detects a hazardous substance in the hot exhaust main pipe, the second electric valve is closed and the first electric valve is fully opened.

17. The energy-saving ventilation system of claim 16, further comprising a heat recycling device, wherein an air inlet of the heat recycling device is connected to the first exhaust pipe, and the first exhaust pipe cooperates with the air inlet of the fresh air handling unit through the heat recycling device to indirectly transfer energy of the available process exhaust air in the first exhaust pipe to the outdoor fresh air at the air inlet of the fresh air handling unit.
18. The energy-saving ventilation system of claim 17, wherein the heat recycling device comprises one or a combination of runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type.
19. The energy-saving ventilation system of claim 10, further comprising a heat recycling device, wherein the second exhaust pipe cooperates with the air inlet pipe through the heat recycling device to indirectly transfer energy of the available process exhaust air in the second exhaust pipe to the outdoor fresh air at the air inlet of the fresh air handling unit.
20. The energy-saving ventilation system of claim 19, wherein the heat recycling device comprises one or a combination of runner type, plate type, fin type, heat pipe type, shell-tube type, and intermediate heat medium type.
21. The energy-saving ventilation system of claim 19, wherein the heat recycling device is provided in the fresh air handling unit, or in the second exhaust pipe, or in the first exhaust fan.
22. The energy-saving ventilation system of claim 1, further comprising a second exhaust fan configured to exhaust unavailable process exhaust air in the production room.

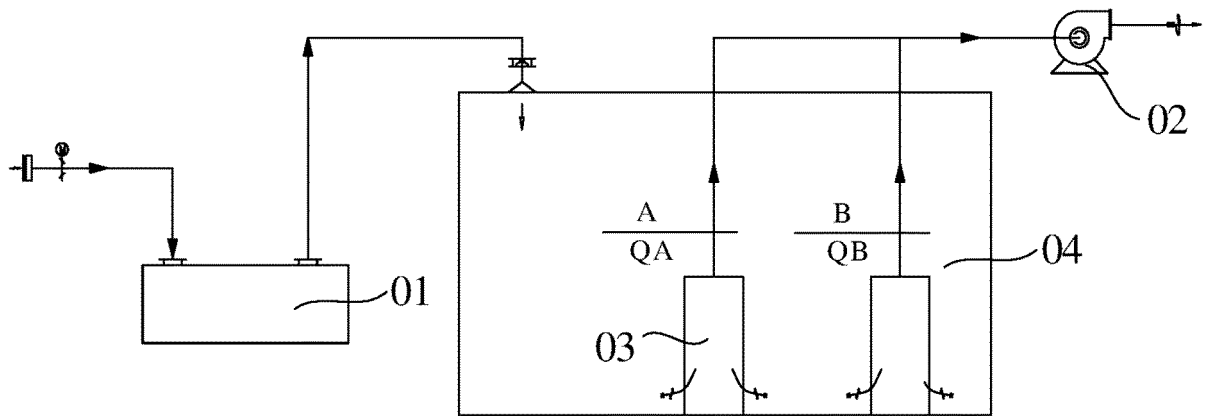


Fig. 1

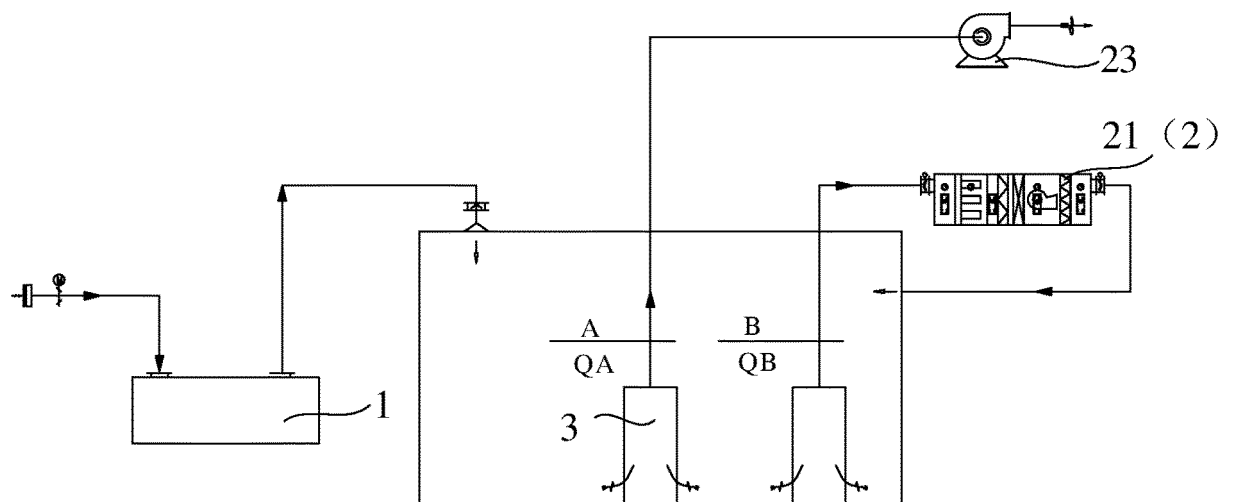


Fig. 2

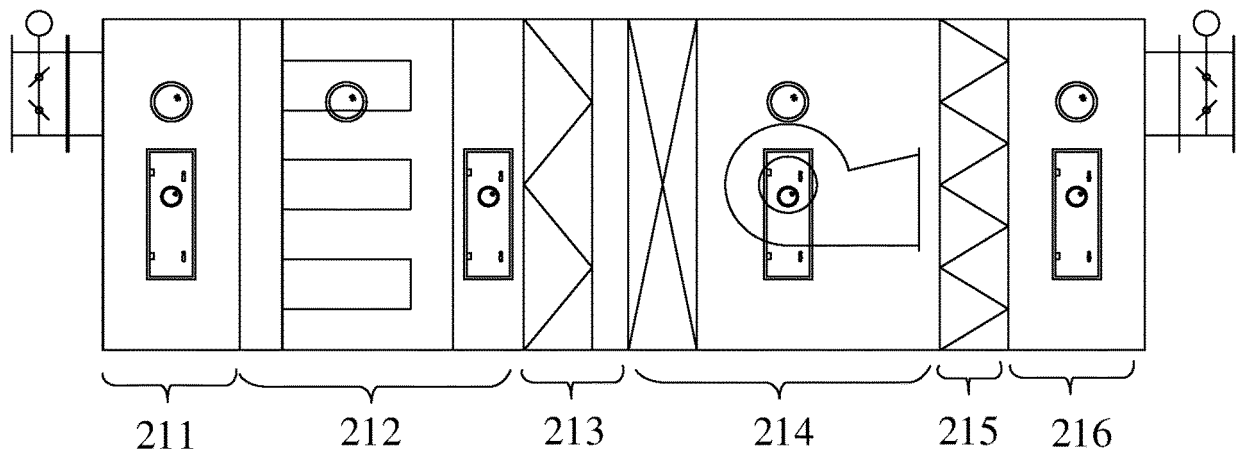


Fig. 3

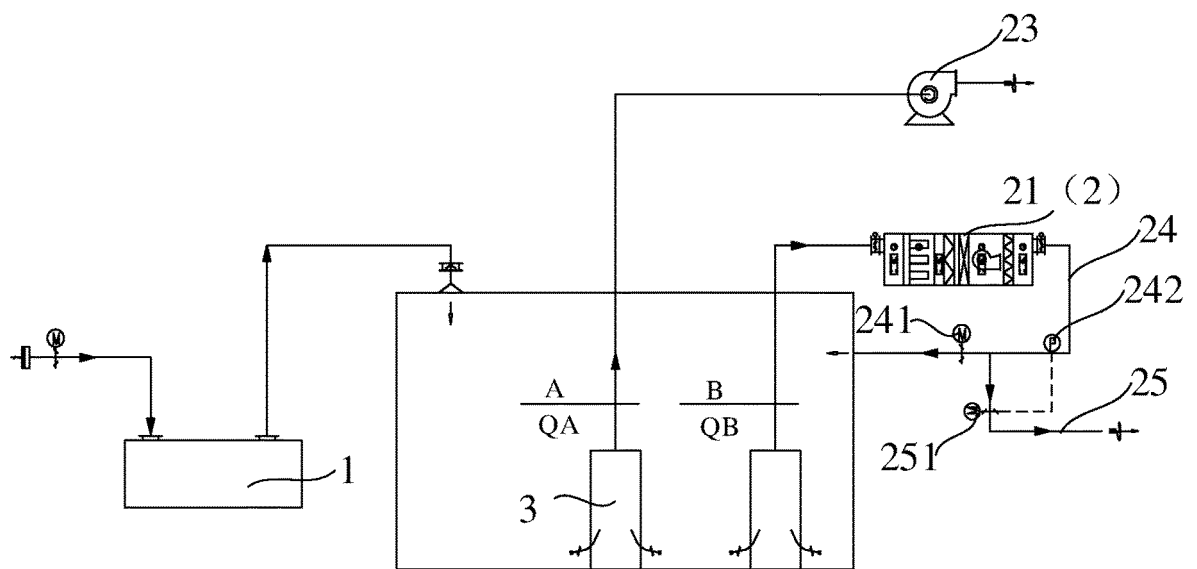


Fig. 4

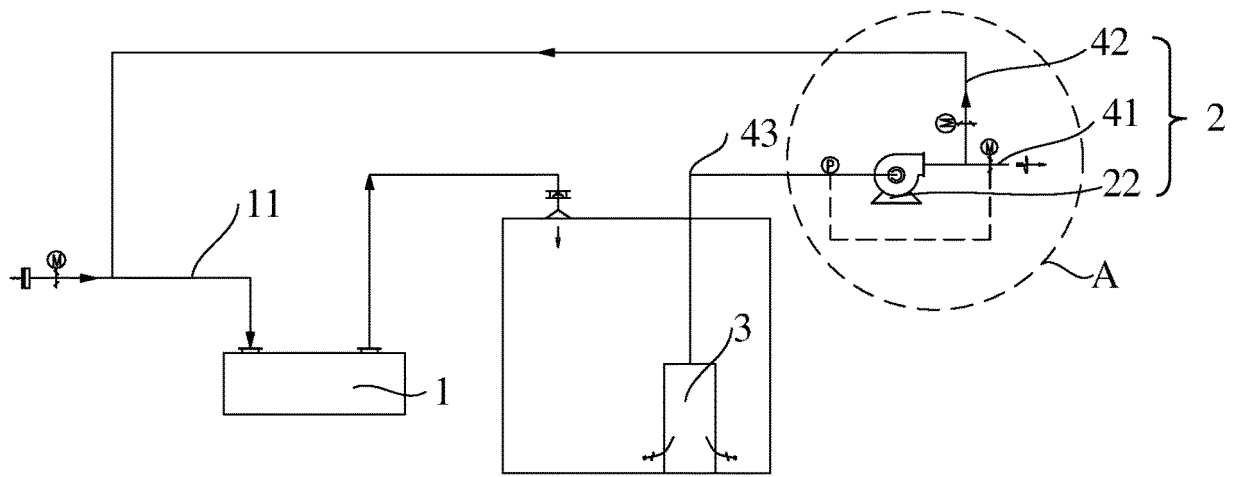


Fig. 5

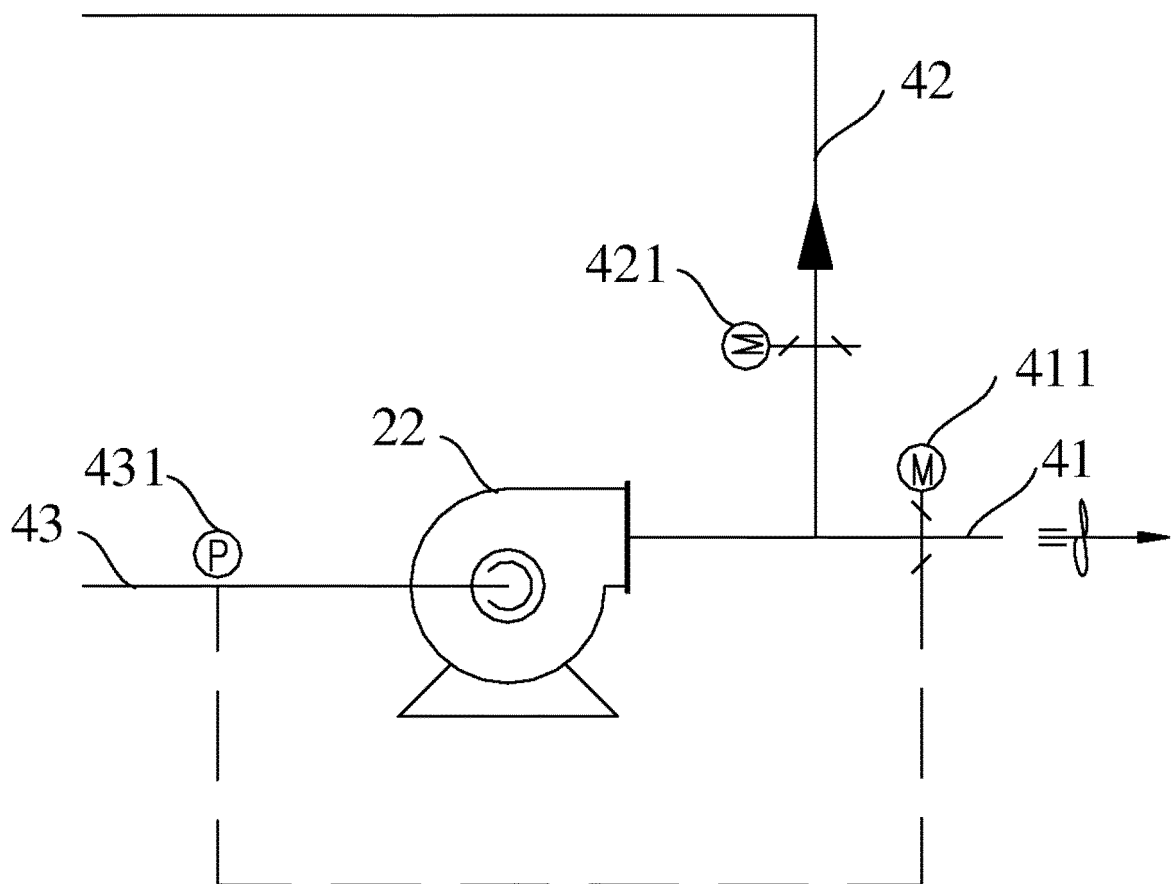


Fig. 6

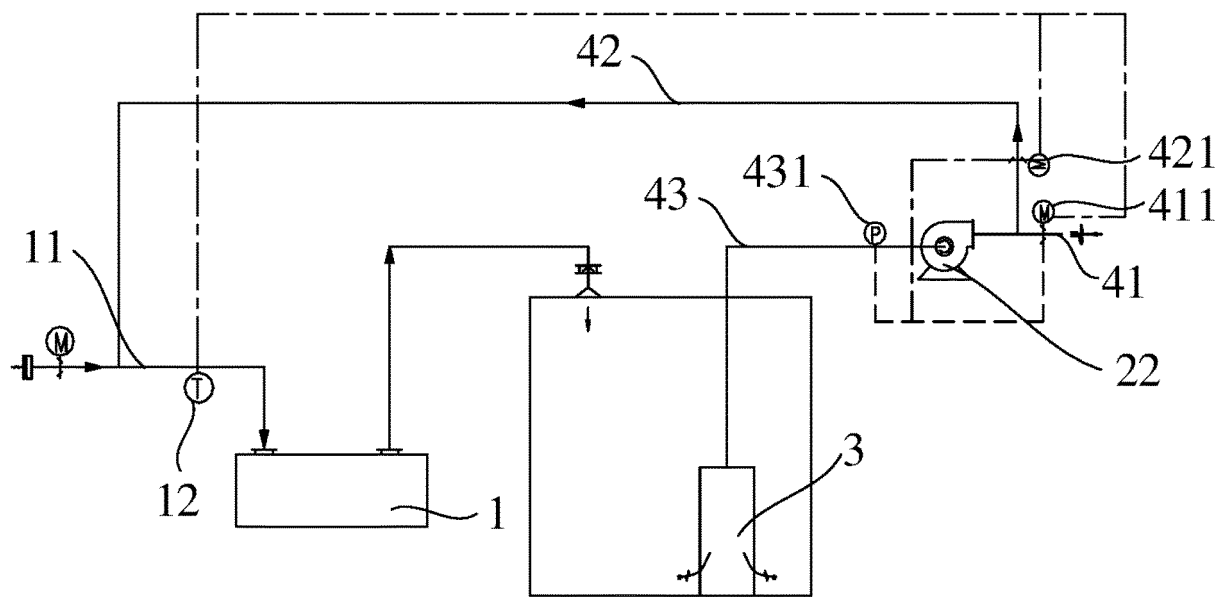


Fig. 7

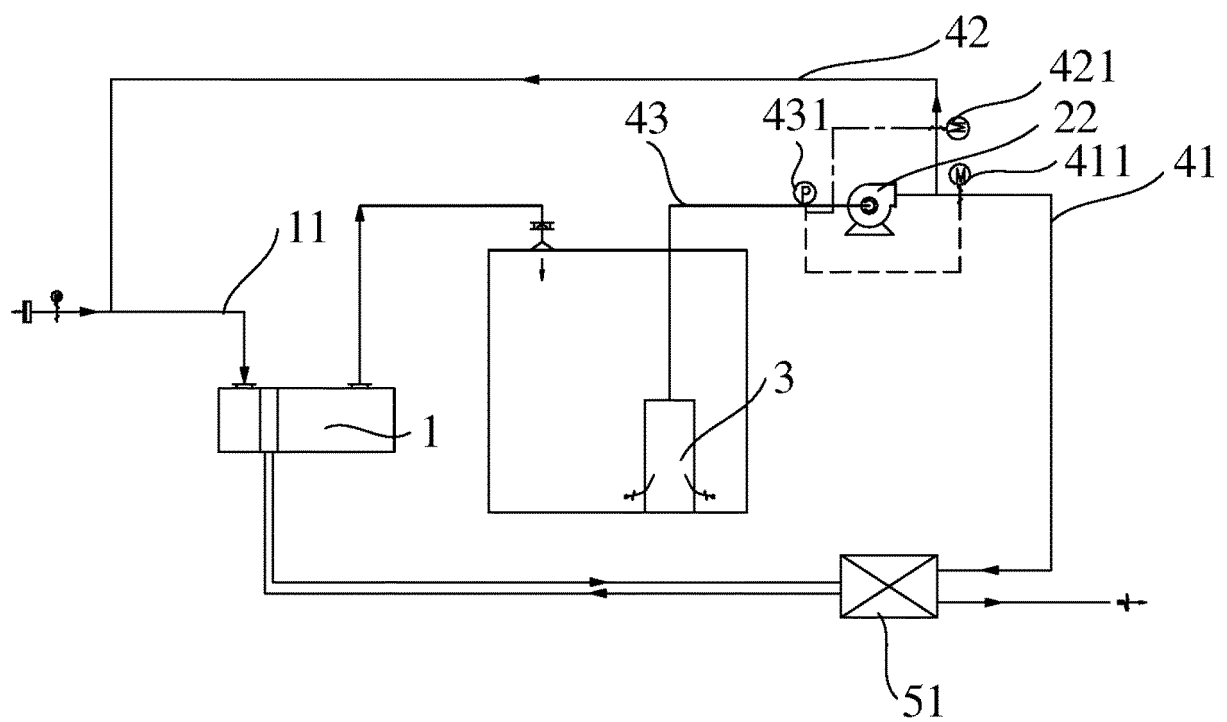


Fig. 8

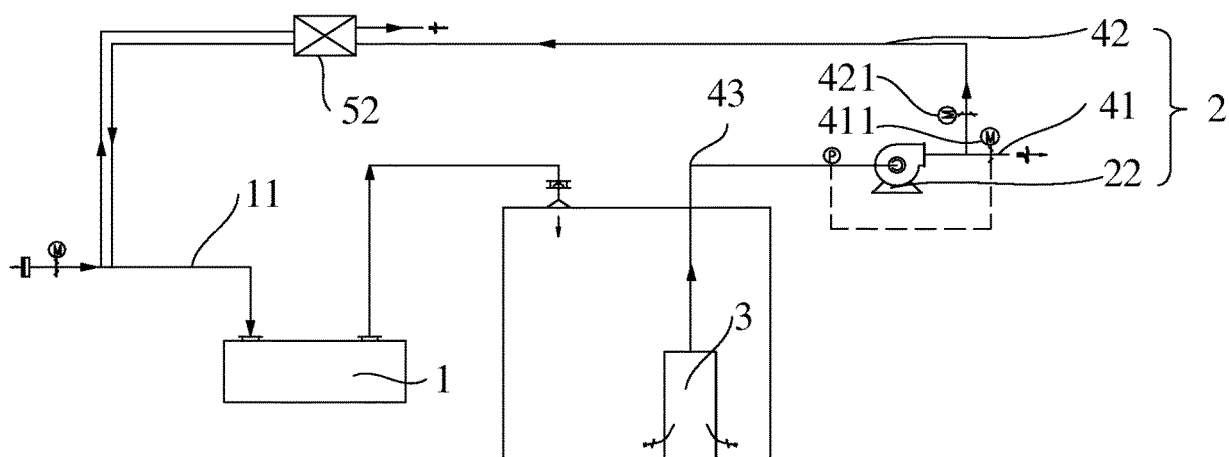


Fig. 9

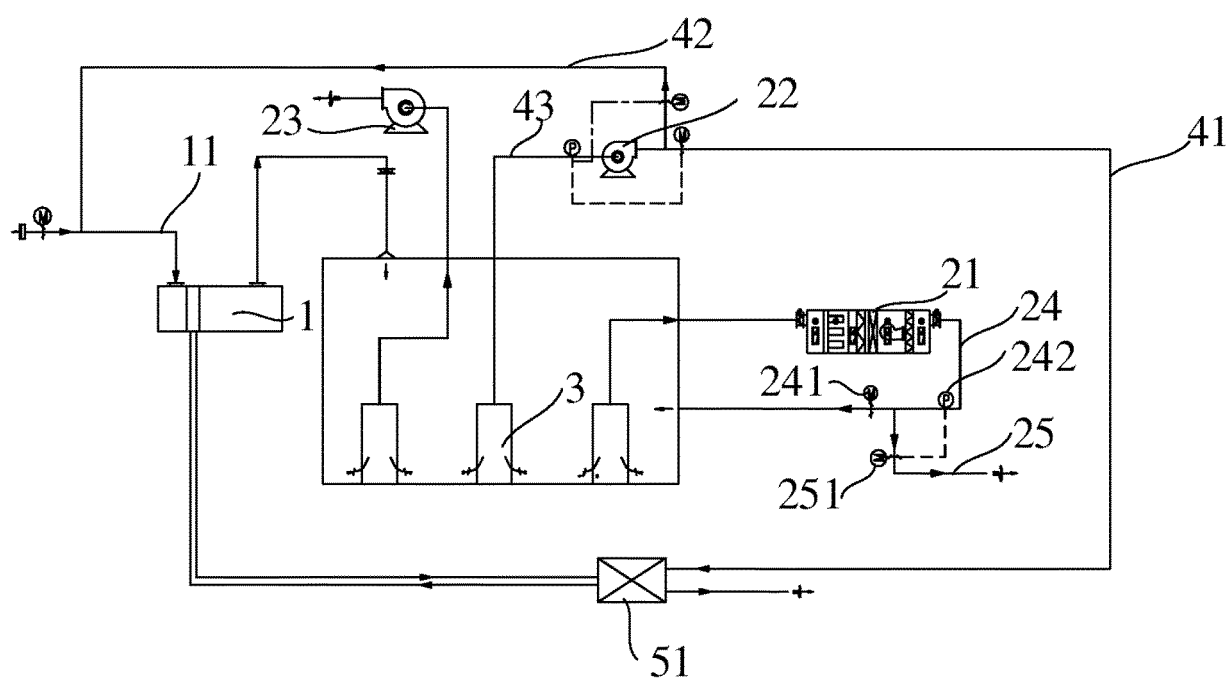


Fig.10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/102474

A. CLASSIFICATION OF SUBJECT MATTER F24F 7/08(2006.01)i; F24F 12/00(2006.01)i; F24F 13/28(2006.01)i 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, H04B, H04J, H04L 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, CNKI, DWPI, SIPOABS, EPODOC: 新风, 排风, 转轮, 通风, 过滤, 回收, fresh, exhaust, rotary, ventilat+, filter, recycl+																					
C. DOCUMENTS CONSIDERED TO BE RELEVANT																					
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>PX</td> <td>CN 210624831 U (ELECTRONICS ENGINEERING DESIGN INSTITUTE CO., LTD. et al.) 26 May 2020 (2020-05-26) description, paragraphs [0026]-[0039], and figures 1-3</td> <td>1,10,12-16,19-21</td> </tr> <tr> <td>PX</td> <td>CN 210345775 U (CHINA ELECTRONICS ENGINEERING DESIGN INSTITUTE CO., LTD. et al.) 17 April 2020 (2020-04-17) description, paragraphs [0026]-[0041], and figures 1-3</td> <td>1-7,9,10,22</td> </tr> <tr> <td>X</td> <td>CN 107940662 A (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 20 April 2018 (2018-04-20) description, paragraphs [0036]-[0068], and figures 1-11</td> <td>1-10,11-16,22</td> </tr> <tr> <td>Y</td> <td>CN 107940662 A (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 20 April 2018 (2018-04-20) description, paragraphs [0036]-[0068], and figures 1-11</td> <td>17-18</td> </tr> <tr> <td>X</td> <td>CN 207649020 U (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 24 July 2018 (2018-07-24) description, paragraphs [0036]-[0068], and figures 1-11</td> <td>1-10,11-16,22</td> </tr> <tr> <td>Y</td> <td>CN 207649020 U (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 24 July 2018 (2018-07-24) description, paragraphs [0036]-[0068], and figures 1-11</td> <td>17-18</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	PX	CN 210624831 U (ELECTRONICS ENGINEERING DESIGN INSTITUTE CO., LTD. et al.) 26 May 2020 (2020-05-26) description, paragraphs [0026]-[0039], and figures 1-3	1,10,12-16,19-21	PX	CN 210345775 U (CHINA ELECTRONICS ENGINEERING DESIGN INSTITUTE CO., LTD. et al.) 17 April 2020 (2020-04-17) description, paragraphs [0026]-[0041], and figures 1-3	1-7,9,10,22	X	CN 107940662 A (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 20 April 2018 (2018-04-20) description, paragraphs [0036]-[0068], and figures 1-11	1-10,11-16,22	Y	CN 107940662 A (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 20 April 2018 (2018-04-20) description, paragraphs [0036]-[0068], and figures 1-11	17-18	X	CN 207649020 U (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 24 July 2018 (2018-07-24) description, paragraphs [0036]-[0068], and figures 1-11	1-10,11-16,22	Y	CN 207649020 U (FOSHAN HAIDUN LIGHTING ELECTRIC APPLIANCE CO., LTD.) 24 July 2018 (2018-07-24) description, paragraphs [0036]-[0068], and figures 1-11	17-18
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"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 09 October 2020	Date of mailing of the international search report 14 October 2020																				
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China Facsimile No. (86-10)62019451	Authorized officer Telephone No.																				

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/102474

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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X	CN 1540257 A (BEIJING UNIVERSITY OF TECHNOLOGY) 27 October 2004 (2004-10-27) description, pages 2 and 3, and figures 1 and 2	1,10,11,19-22
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X	CN 106440168 A (BEIJING HANCHANG LUYUAN ENVIRONMENTAL PROTECTION ENGINEERING CO., LTD.) 22 February 2017 (2017-02-22) description, paragraphs [0027]-[0037], and figures 1-5	1,10,11,19-22
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- CN 201910663309 [0001]