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# (54) AIR PURIFICATION APPARATUS FOR REDUCING RADIOACTIVE SUBSTANCES

(57) The embodiments of the present disclosure relate to an air purification apparatus disposed in a workplace for dismantling a nuclear power plant. The air purification apparatus for reducing radioactive substances includes a particle processing module that processes dust containing particles or aerosol-type radioactive substances, a first transfer unit that enables the particle processing module to move, a first damper positioned on one side of the particle processing module and selectively blocking the inflow and discharge of dust, and a second damper positioned on the other side of the particle processing module and selectively blocking the discharge of dust that has passed through the particle processing module.

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## Description

## BACKGROUND OF THE INVENTION

### Technical Field

**[0001]** The embodiments of the present disclosure relate to an air purification apparatus for reducing radioactive substances. More particularly, they relate to an air purification apparatus that reduces dust generated by cutting metal or concrete or radioactive substances contained in aerosols contained in the dust when dismantling a nuclear power plant.

### Background Art

**[0002]** In general, when dismantling a nuclear power plant, processes such as cutting metal or concrete are performed. In this case, there is a problem in that workers are exposed to not only dust generated from components inside the nuclear power plant exposed to radiation but also radioactive contaminants remaining inside the nuclear power plant.

**[0003]** Specifically, there is a problem in that workers are exposed to radioactive substances remaining in the air and dust generated by cutting metal or concrete of structures exposed to radiation when working in a special working environment of a nuclear power plant. Radioactive substances are released into the air in the form of aerosols when the cutting process is performed inside a nuclear power plant being dismantled, so an air purification apparatus capable of reducing the radioactive substances in the form of aerosols is required in such a working environment.

**[0004]** In addition, there is a restriction on working space or power supply when working inside a nuclear power plant being dismantled, so an air purification apparatus capable of responding to a variable situation in such a workplace and working environment is required.

## SUMMARY

### Technical Problem

**[0005]** According to the embodiments of the present disclosure, there is provided an air purification apparatus that reduces radioactive substances contained in dust generated when performing processes such as cutting, decontamination, and the disposal of waste in a nuclear power plant being dismantled.

### Technical Solution

**[0006]** According to an embodiment of the present disclosure, the air purification apparatus for reducing radioactive substances includes a particle processing module that processes dust containing particles or aerosol-type radioactive substances, a first transfer unit that enables the particle processing module to move, a first damper positioned on one side of the particle processing module and selectively blocking the inflow and discharge of dust, and a second damper positioned on the other side of the particle processing module and selectively blocking the discharge of dust that has passed through the particle processing module.

**[0007]** The particle processing module includes a pre-processing module for reducing radioactive substances contained in dust and a filter module for reducing radioactive substances contained in the dust that has passed through the pre-processing module.

**[0008]** The pre-processing module includes a pre-processing chamber, a pre-processing filter installed inside the pre-processing chamber to filter radioactive substances contained in dust, and a pre-processing collection unit installed in a lower portion of the pre-processing chamber to collect particles contained in dust.

**[0009]** The pre-processing module includes the pre-processing chamber, a pre-processing inclined portion that is formed in the pre-processing chamber and guides dust introduced into the pre-processing chamber to move with a swirling flow so that particles contained in the dust are separated therefrom.

**[0010]** The filter module includes a filter chamber into which dust that has passed through the pre-processing chamber is introduced, a first filter inclined toward a lower portion of the filter chamber in the filter chamber, a second filter spaced apart from the first filter in the filter chamber, a fluid ejection unit for ejecting fluids toward the first filter so that dust in the first filter is removed therefrom, a filter chamber inclined unit that is more contiguous to the first filter than to the second filter and is disposed to protrude outwardly in an inclined shape on a portion of a lower surface of the filter chamber, and a chamber collection unit disposed under the filter chamber inclined unit and capable of collecting materials separated from the first filter.

**[0011]** The first transfer unit includes a pre-processing transfer unit installed in the pre-processing chamber and a filter transfer unit installed in the filter chamber.

**[0012]** The air purification apparatus for reducing radioactive substances further includes a third damper installed on the other side of the pre-processing chamber to selectively block the discharge of dust that has passed through the pre-processing chamber while the first damper is installed on one side of the pre-processing chamber and a fourth damper installed on one side of the filter chamber to selectively block the inflow of dust into the filter chamber and the discharge of dust therefrom while the second damper is installed on the other side of the filter chamber.

**[0013]** The air purification apparatus for reducing radioactive substances further includes an adsorption module including an adsorption chamber into which dust that has passed through the filter module is introduced, an adsorption filter disposed inside the adsorption chamber to process harmful gases contained in the dust, a fifth

damper installed on one side of the adsorption chamber to selectively block the inflow of the dust into the adsorption chamber and the discharge of the dust therefrom, and a sixth damper installed on the other side of the adsorption chamber to selectively block the discharge of the dust that has passed through the adsorption chamber.

**[0014]** The air purification apparatus for reducing radioactive substances further includes a blowing module forming a flow of air so that dust is introduced into the adsorption module or the particle processing module.

**[0015]** The air purification apparatus for reducing radioactive substances further includes a control module including a battery capable of providing power, an environment detection unit collecting information on a working environment, an alarm unit for providing an alarm to a worker based on the information from the environment detection unit, and a control transfer unit for mobility.

## ADVANTAGEOUS EFFECTS

**[0016]** An air purification apparatus for reducing radioactive substances according to the embodiments of the present disclosure is capable of effectively reducing radioactive substances contained in dust generated when performing processes such as cutting, decontamination, and the disposal of waste in a nuclear power plant being dismantled.

**[0017]** In addition, the air purification apparatus for reducing radioactive substances is capable of responding to the needs of the work site by selectively combining each module. Since the modules include a damper, it is possible to prevent the dust remaining inside the modules from being discharged to the front and rear of the modules, thereby effectively preventing the spread of contamination generated when the modules are moved.

**[0018]** Furthermore, each module includes a transfer unit, so it is possible to select the space for the installation of the air purification apparatus for reducing radioactive substances without restrictions.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]**

FIG. 1 shows an air purification apparatus for reducing radioactive substances according to an embodiment of the present disclosure.

FIG. 2 shows a filter module in FIG. 1.

FIG. 3 shows an air purification apparatus for reducing radioactive substances according to another embodiment of the present disclosure.

FIG. 4 shows an arrangement structure of a spray nozzle disposed behind a first filter in FIG. 2.

FIG. 5 shows a control module.

## DESCRIPTION OF EXEMPLARY EMBODIMENTS

**[0020]** Hereinafter, with reference to the appended drawings, the embodiments of the present disclosure will be described in detail so that a person having ordinary skill in the technical field to which the present disclosure belongs can easily perform them. The present disclosure may be embodied in several different forms and is not limited to the embodiments described herein.

**[0021]** It should be noted that the drawings are schematic and not drawn to scale. Relative dimensions and proportions of parts in the drawings have been exaggerated or reduced in size for the clarity in the drawings and convenience of illustration. The dimensions are exemplary only, and actual dimensions are not limited thereto. In addition, the same reference numeral is used for the same structural elements or parts appearing in two or more drawings to indicate their like features.

**[0022]** The embodiments of the present disclosure specifically show ideal embodiments of the present disclosure. As a result, various modifications of the drawings are expected. Therefore, the embodiments are not limited to a specific shape of an illustrated area and also include variations in shape generated during a process of manufacture, etc.

**[0023]** Hereinafter, with reference to FIGS. 1 to 5, an air purification apparatus 101 for reducing radioactive substances will be described.

**[0024]** As shown in FIG. 1, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may include a particle processing module 300, a first transfer unit 370, a first damper 191, and a second damper 292.

**[0025]** The particle processing module 300 may process dust containing particles or aerosol-type radioactive substances contained in air. Specifically, such air contains dust containing particles or aerosol-type radioactive substances generated by processes such as decontamination, cutting, and the disposal of waste required for dismantling a nuclear power plant. That is, the air is generated in a place where the processes involved in dismantling a nuclear power plant are performed.

**[0026]** The particle processing module 300 may reduce particles or aerosol-type radioactive substances resulting from the process of dismantling a nuclear power plant. While the air containing the particles or aerosol-type radioactive substances is passing through the particle processing module 300, the radioactive substances may be reduced so that the risk of workers' exposure to radiation may be lowered.

**[0027]** The first transfer unit 370 may enable the particle processing module 300 to move. Specifically, the first transfer unit 370 may be provided to facilitate the movement of the particle processing module 300 within the dismantling site.

**[0028]** For example, the first transfer unit 370 may be a wheel on which the particle processing module 300 of the air purification apparatus 101 moves within the dis-

mantling site.

**[0029]** The first damper 191 on one side of the particle processing module 300 may selectively block the inflow and discharge of air. Specifically, the first damper 191 may selectively shield the particle processing module 300 from the outside.

**[0030]** The second damper 292 on the other side of the particle processing module 300 may selectively block the discharge of the air that has passed through the particle processing module 300. Specifically, the second damper 292 may selectively shield the particle processing module 300 from the outside.

**[0031]** As such, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may include the first transfer unit 370, so it may be possible to move the air purification apparatus 101 according to changes in the working environment.

**[0032]** In addition, when the particle processing module 300 is moved, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may close the first damper 191 and the second damper 292 to shield both one side and the other side of the particle processing module 300 from the outside. Therefore, the problem that the risk of workers' exposure to radiation is increased due to the discharge of particles or aerosol-type radioactive substances remaining in the particle processing module 300 when the particle processing module 300 is moved may be effectively solved.

**[0033]** In addition, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may reduce particles or aerosol-type radioactive substances contained in the air in the working environment in which the processes such as decontamination, cutting, and the disposal of waste are performed, thereby lowering the risk of workers' exposure to radiation.

**[0034]** Furthermore, the particle processing module 300 according to an embodiment of the present disclosure may include a pre-processing module 100 and a filter module 200.

**[0035]** The pre-processing module 100 may reduce radioactive substances contained in the air inside the working environment for dismantling a nuclear power plant.

**[0036]** The filter module 200 may reduce radioactive substances contained in the air that has passed through the pre-processing module 100. In detail, the pre-processing module 100 and the filter module 200 may be detachably coupled to each other.

**[0037]** For example, a first flow path 810 may be disposed between the pre-processing module 100 and the filter module 200 to connect the pre-processing module 100 and the filter module 200.

**[0038]** As described above, the particle processing module 300 of the air purification apparatus 101 according to an embodiment of the present disclosure may include the pre-processing module 100 and the filter module 200, so it may effectively reduce radioactive substances contained in the air.

**[0039]** In addition, as shown in FIG. 1, the pre-processing module 100 according to an embodiment of the present disclosure may include a pre-processing chamber 110, a pre-processing filter 120, and a pre-processing collection unit 130.

**[0040]** The pre-processing chamber 110 may have a pre-processing inlet 112 and a pre-processing outlet 113. Air may be introduced through the pre-processing inlet 112, and the air that has passed through the pre-processing chamber 110 may be discharged through the pre-processing outlet 113.

**[0041]** For example, as shown in FIG. 1, in the pre-processing module 100 according to an embodiment of the present disclosure, the pre-processing inlet 112 may be formed on a side surface of the pre-processing chamber 110.

**[0042]** Specifically, the pre-processing inlet 112 may be formed close to a lower portion of the pre-processing chamber 110.

**[0043]** The pre-processing outlet 113 may be formed on the pre-processing chamber 110.

**[0044]** The pre-processing filter 120 for filtering radioactive substances contained in the air in the working environment may be installed inside the pre-processing chamber 110. For example, the pre-processing filter 120 may be a bag filter. Such a bag filter may be used to remove large particles of aerosol-type radioactive substances.

**[0045]** The pre-processing module 100 including the bag filter may be used for the process of cutting metal.

**[0046]** The pre-processing collection unit 130 may be installed in the lower portion of the pre-processing chamber 110 to collect particles or large particles of aerosol-type radioactive substances such as relatively heavy particles contained in the air introduced into the pre-processing chamber 110. The pre-processing collection unit 130 may be disposed to be detached from the pre-processing chamber 110 so that it may be possible to remove the particles and the large particles of the radioactive substances collected in the pre-processing collection unit 130.

**[0047]** Alternatively, as shown in FIG. 3, a pre-processing module 100 of an air purification apparatus 102 for reducing radioactive substances according to another embodiment of the present disclosure may include a pre-processing chamber 110, a pre-processing inclined portion 150, and a pre-processing collection unit 130.

**[0048]** The pre-processing chamber 110 may have a pre-processing inlet 112 and a pre-processing outlet 113. Air may be introduced through the pre-processing inlet 112, and the air that has passed through the pre-processing chamber 110 may be discharged through the pre-processing outlet 113.

**[0049]** For example, as shown in FIG. 3, in the pre-processing module 100 according to another embodiment of the present disclosure, the pre-processing inlet

112 may be formed on a side surface of the pre-processing chamber 110. In addition, the pre-processing chamber 110 may have a circular cross-section in a transverse direction.

**[0050]** To be specific, the pre-processing inlet 112 may be formed close to an upper portion of the pre-processing chamber 110. Accordingly, the air introduced through the pre-processing inlet 112 may move with a swirling flow along the inside of the pre-processing chamber 110 to form a cyclone so that particles contained in the air may be separated by the action of centrifugal force.

**[0051]** The pre-processing outlet 113 may be formed on the pre-processing chamber 110.

**[0052]** The pre-processing inclined portion 150 as an area of the pre-processing chamber 110 may be formed to have a narrower cross-section toward the bottom. The pre-processing inclined portion 150 may guide the air introduced into the pre-processing chamber 110 to move with a swirling flow so that particles contained in the air may fall to the lower portion of the pre-processing chamber 110.

**[0053]** The pre-processing collection unit 130 may be installed in the lower portion of the pre-processing chamber 110 to collect particles or large particles of aerosol-type radioactive substances such as relatively heavy particles contained in the air introduced into the pre-processing chamber 110. The pre-processing collection unit 130 may be disposed to be detached from the pre-processing chamber 110 so that it may be possible to remove the particles and the large particles of the radioactive substances collected in the pre-processing collection unit 130.

**[0054]** The pre-processing module 100 according to another embodiment of the present disclosure may be a cyclone module and may be used for cutting cement.

**[0055]** The pre-processing module 100 detachably coupled to a filter module 200 according to an embodiment of the present disclosure may be selectively disposed depending on working situations, so it may be possible to effectively reduce radioactive substances contained in air generated by the processes involved in dismantling a nuclear power plant in a manner suitable for the characteristics of each process.

**[0056]** As shown in FIGS. 1 and 2, the filter module 200 of the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may include a filter chamber 201, a first filter 210, a second filter 220, a fluid ejection unit 250, a filter chamber inclined unit 230, and a chamber collection unit 240.

**[0057]** The filter chamber 201 may be hollow inside. In addition, an inlet 202 may be formed at one side of the filter chamber 201, and an outlet 203 may be formed at the other side of the filter chamber 201.

**[0058]** In detail, the filter chamber 201 may be formed to be elongated in one direction, and the inlet 202 and the outlet 203 may be formed on both sides along the longitudinal direction of the filter chamber 201.

**[0059]** The air that has passed through the pre-processing chamber 110 may be introduced through the inlet 202. In addition, the air that has passed through the filter chamber 201 may be discharged through the outlet 203.

**[0060]** The first filter 210 may be inclined inside the filter chamber 201. Specifically, the first filter 210 may be inclined toward a lower portion of the filter chamber 201. That is, a height direction of the first filter 210 may cross a height direction of the filter chamber 201.

**[0061]** The first filter 210 may filter aerosol-type radioactive substances. For example, the first filter 210 may be a metal filter.

**[0062]** The second filter 220 may be disposed to be spaced apart from the first filter 210 in the filter chamber 201. To be specific, the second filter 220 may be disposed to be more contiguous to the outlet 203 than the first filter 210 is. In other words, the first filter 210 and the second filter 220 may be spaced apart from each other in one longitudinal direction of the filter chamber 201.

**[0063]** The second filter 220 may filter aerosol-type radioactive substances that have not been filtered by the first filter 210. The second filter 220 may be capable of filtering out finer radioactive aerosols compared to the first filter 210. For example, the second filter 220 may be a HEPA filter.

**[0064]** The fluid ejection unit 250 may eject fluids toward the first filter 210. Furthermore, the fluid ejection unit 250 may eject the fluids so that the first filter 210 may be purified as dust accumulated in the first filter 210 is removed therefrom.

**[0065]** The filter chamber inclined unit 230 may be disposed to protrude outwardly in an inclined shape on a portion of a lower surface of the filter chamber 201. One side of the filter chamber inclined unit 230 may be in contact with an area of the lower surface of the filter chamber 201. Specifically, the filter chamber inclined unit 230 may have a hopper shape that becomes narrower and inclined in a direction in which the filter chamber inclined unit 230 protrudes from the filter chamber 201. In addition, the filter chamber inclined unit 230 may be disposed closer to the inlet 202 than to the outlet 203.

**[0066]** An area of the open lower portion of the filter chamber 201 may face one surface of the first filter 210 so that the dust that has been removed from the first filter 210 by the fluid ejection unit 250 ejecting the fluids may be introduced into the filter chamber inclined unit 230.

**[0067]** The chamber collection unit 240 may be detachably installed under the filter chamber inclined unit 230. In addition, the chamber collection unit 240 may collect the dust, which is a material separated from the first filter 210.

**[0068]** Therefore, it may be possible that a worker detaches the chamber collection unit 240 from the filter chamber inclined unit 230 and effectively disposes of the dust containing radioactive substances collected in the chamber collection unit 240.

**[0069]** Accordingly, it may be possible to remove the

dust in the first filter 210 of the filter module 200 according to an embodiment of the present disclosure by the fluid ejection unit 250 so that the life of the first filter 210 is increased and the maintenance time and cost for its replacement are cut down.

**[0070]** In addition, since the chamber collection unit 240 may be detachably installed under the filter chamber inclined unit 230, it may be possible to prevent the spread of contamination and minimize the disposal of waste when processing the dust containing radioactive substances separated from the first filter 210.

**[0071]** The filter module 200 according to an embodiment of the present disclosure may further include a vibrating unit 260.

**[0072]** The vibrating unit 260 may be installed at the filter chamber inclined unit 230. The vibrating unit 260 may generate vibration and transmit it to the inside of the filter chamber inclined unit 230 so that the separated dust remaining inside the filter chamber inclined unit 230 may move to the chamber collection unit 240.

**[0073]** Therefore, when the dust containing radioactive substances remains in the filter chamber inclined unit 230, by the vibrating unit 260, it may be possible to effectively prevent the dust from being adsorbed back to the first filter 210 by the air introduced through the inlet 202.

**[0074]** In addition, the filter module 200 according to an embodiment of the present disclosure may further include an inspection window 241.

**[0075]** The inspection window 241 installed on one side of the chamber collection unit 240 may be formed of a transparent material so that a worker can check the inside of the chamber collection unit 240.

**[0076]** The fluid ejection unit 250 according to an embodiment of the present disclosure may further include a fluid supply member 251 and a spray nozzle 252 as shown in FIGS. 1 and 4.

**[0077]** The fluid supply member 251 may supply fluids. Specifically, the fluid supply member 251 may be a device for storing or generating compressed air.

**[0078]** For example, the fluid supply member 251 may be a device provided inside a nuclear power plant to be dismantled or a separate device for storing compressed air.

**[0079]** The spray nozzle 252 may be disposed between the first filter 210 and the second filter 220. Furthermore, the fluids supplied by the fluid supply member 251 may be sprayed toward the other surface of the first filter 210. That is, the spray nozzle 252 may eject the fluids from the rear of the first filter 210 to the front of the first filter 210 to remove the dust accumulated in the first filter 210.

**[0080]** For example, a plurality of spray nozzles 252 may be disposed on the other surface of the first filter 210 to be spaced apart from each other as shown in FIGS. 1 and 4. In addition, the plurality of spray nozzles 252 may be connected to a distribution pipe 253 for transferring the fluids from the fluid supply member 251 to spray the fluids. In other words, to spray the fluids, one side of the plurality of spray nozzles 252 may be connected to the distribution pipe 253, and the other side thereof may be spaced apart from the other surface of the first filter 210.

**[0081]** As shown in FIG. 1, the vibrating unit 260 of the filter module 200 according to an embodiment of the present disclosure may receive the fluids from the fluid supply member 251 to generate vibration.

**[0082]** That is, the fluid supply member 251 may be connected to the vibrating unit 260 for the supply of fluids so that the vibrating unit 260 may be capable of generating vibration. Specifically, the vibrating unit 260 may generate vibration by rotating a turbine wheel therein with the air supplied thereto to move the dust remaining in the filter chamber inclined unit 230.

**[0083]** The filter module 200 according to an embodiment of the present disclosure may further include a pressure detector 281 and 282.

**[0084]** The pressure detector 281 and 282 may detect pressure inside the filter chamber 201 in front of the first filter 210 and pressure inside the filter chamber 201 in the rear of the first filter 210.

**[0085]** The filter module 200 according to an embodiment of the present disclosure may further include a pressure gauge 283.

**[0086]** The pressure gauge 283 may be installed at the filter chamber 201 to display the difference between the pressures detected by the pressure detector 281 and 282 to a worker. The worker may check how the dust is currently adsorbed to the first filter 210 based on the differential pressure information displayed by the pressure gauge 283.

**[0087]** Specifically, when the dust is absorbed into the first filter 210, a flow of air passing through the inside of the filter chamber 201 may be disturbed so that the difference between the pressure in front of the first filter 210 and the pressure in the rear of the second filter 220 may rise. The pressure gauge 283 may enable the worker to recognize contamination of the first filter 210 due to the dust.

**[0088]** The first transfer unit 370 according to an embodiment of the present disclosure may include a pre-processing transfer unit 170 and a filter transfer unit 270.

**[0089]** The pre-processing transfer unit 170 may be installed in the lower portion of the pre-processing chamber 110 to enable the pre-processing module 100 to move. For example, the pre-processing transfer unit 170 may be a wheel.

**[0090]** The filter transfer unit 270 may be installed in the lower portion of the filter chamber 201 to allow the filter module 200 to move. For example, the filter transfer unit 270 may be a wheel.

**[0091]** As a result, it may be possible to effectively perform the cutting of metal or cement after the pre-processing module 100 and the filter module 200 have been moved to a workplace desired by a worker to reduce the dust containing radioactive substances generated during

the dismantling of a nuclear power plant and the risk of the worker's exposure to radiation.

**[0092]** In addition, as shown in FIGS. 1 and 2, the filter module 200 of the air purification apparatus 101 according to an embodiment of the present disclosure may have a transparent window 209 installed on the side of the filter chamber 201 and in front of the first filter 210. The transparent window 209 may allow a worker to check how the dust is accumulated in the filter chamber inclined unit 230, etc. from the outside of the filter chamber 201.

**[0093]** As shown in FIG. 1, the air purification apparatus 101 according to an embodiment of the present disclosure may further include a third damper 192 and a fourth damper 291.

**[0094]** The first damper 191 may be installed on one side of the pre-processing chamber 110, and the third damper 192 may be installed on the other side of the pre-processing chamber 110. The third damper 192 may selectively block the discharge of air that has passed through the pre-processing chamber 110.

**[0095]** Accordingly, when the pre-processing module 100 is moved, the first damper 191 and the third damper 192 may be closed to prevent radioactive substances remaining inside the pre-processing module 100 from being discharged to the outside.

**[0096]** The fourth damper 291 may be installed on one side of the filter chamber 201, and the second damper 292 may be installed on the other side of the filter chamber 201. The fourth damper 291 may be installed on one side of the filter chamber 201 to selectively block air flowing into the filter chamber 201 and air discharged therefrom.

**[0097]** Accordingly, when the filter module 200 is moved, the fourth damper 291 and the second damper 292 may be closed to prevent radioactive substances remaining in the filter module 200 from being discharged to the outside.

**[0098]** In detail, the first flow path 810 may be detachably disposed between the pre-processing outlet 113 and the inlet 202 to guide the air that has passed through the pre-processing module 100 to be introduced into the filter module 200. The third damper 192 may shield the pre-processing outlet 113, and the fourth damper 291 may shield the inlet 202.

**[0099]** It may be possible to move the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure to a place where the processes are performed, so the air purification apparatus 101 may be manufactured in a compact size. That is, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may not be intended to purify a large space. Instead, it may be possible that the air purification apparatus 101 is moved close to a place where the dismantling process is performed to be operated, so the air purification apparatus 101 may be capable of effectively reducing radioactive substances even though it is manufactured in a compact size.

**[0100]** The air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may further include an adsorption module 400 including an adsorption chamber 401, an adsorption filter 410, a fifth damper 491, and a sixth damper 492.

**[0101]** The adsorption module 400 may be detachably coupled to the rear of the filter module 200. The adsorption module 400 may process harmful gases contained in the air that has passed through the filter module 200.

**[0102]** The adsorption chamber 401 may be hollow inside. In addition, an adsorption inlet 402 may be formed on one side of the adsorption chamber 401, and an adsorption outlet 403 may be formed on the other side of the adsorption chamber 401.

**[0103]** The adsorption filter 410 may be installed inside the adsorption chamber 401. To be specific, the adsorption filter 410 may remove harmful gases by the air pollution standards contained in the air that has passed through the filter module 200. In other words, the adsorption chamber 401 may remove harmful substances in gaseous form.

**[0104]** For example, the adsorption filter 410 may adsorb and process gases such as carbon monoxide, sulfur dioxide, and nitrogen dioxide. In addition, the adsorption filter 410 may be a carbon filter.

**[0105]** The fifth damper 491 may be installed on one side of the adsorption chamber 401 to selectively shield the adsorption inlet 402. Specifically, the fifth damper 491 may selectively block air flowing into the adsorption chamber 401 and air discharged from the adsorption chamber 401.

**[0106]** The fifth damper 491 may selectively block the discharge of the air that has passed through the adsorption chamber 401. Furthermore, the sixth damper 492 may be installed on the other side of the adsorption chamber 401 to selectively shield the adsorption outlet 403.

**[0107]** Specifically, the adsorption inlet 402 of the adsorption chamber 401 and the outlet 203 of the filter chamber 201 may be connected by a second flow path 820, so the air containing the dust that has passed through the filter chamber 201 may be introduced into the adsorption chamber 401.

**[0108]** Therefore, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may also remove harmful substances in gaseous form contained in the air to purify the pollutants in the working environment where a worker performs the processes.

**[0109]** In addition, the adsorption module 400 according to an embodiment of the present disclosure may further include an adsorption transfer unit 470.

**[0110]** The adsorption transfer unit 470 may be a wheel installed in a lower portion of the adsorption chamber 401. Accordingly, it may be possible to move the adsorption module 400 together with the filter module 200 and the pre-processing module 100 to a place desired by a worker.

**[0111]** In that case, by closing the fifth damper 491 and the sixth damper 492, it may be possible to prevent gaseous harmful substances remaining inside the adsorption chamber 401 from being discharged to the outside of the adsorption chamber 401.

**[0112]** The air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may further include a blowing module 500.

**[0113]** The blowing module 500 may be detachably coupled to the particle processing module 300 or the adsorption module 400 to form a flow of air so that air may be introduced into the particle processing module 300 or the adsorption module 400. In detail, the blowing module 500 may include a blower 510 to form a flow of air so that air may move into the particle processing module 300 and other modules connected thereto.

**[0114]** When there is a separate blower at a place where the dismantling processes are performed, the blower may be used. That is, when there is no blower that forms a flow of air into the module of the air purification apparatus 101 at the workplace, the blowing module 500 may be detachably coupled with other modules to form a flow of air so that the air in the place may be introduced thereto.

**[0115]** Specifically, the blowing module 500 may be connected to the adsorption outlet 403 of the adsorption chamber 401 by a third flow path 830. The blower 510 may be operated by the third flow path 830, and a flow of air may be formed by the rotational force of the blower 510 so that air may move to the pre-processing chamber 110, the filter chamber 201, and the adsorption chamber 401. In other words, while the air was passing through the pre-processing chamber 110, the filter chamber 201, and the adsorption chamber 401, harmful gases and aerosol-type radioactive substances in the air may have been processed.

**[0116]** In addition, the blowing module 500 according to an embodiment of the present disclosure may further include a blowing transfer unit 570.

**[0117]** The blowing transfer unit 570 may be formed as a wheel to move the blowing module 500 according to changes in the workplace.

**[0118]** The air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may further include a control module 600.

**[0119]** As shown in FIG. 5, the control module 600 may include a battery 610, an environment detection unit 620, an alarm unit 630, and a control transfer unit 670.

**[0120]** The battery 610 may provide power. The battery 610 may provide power to the blowing module 500 or other electronic devices required for the processes even in the special working environment for dismantling a nuclear power plant.

**[0121]** The environment detection unit 620 may collect information on a working environment. To be specific, the environment detection unit 620 may collect information on the concentration of radioactive substances or harmful substances in a place in which the control module 600 is located.

**[0122]** The information collected by the environment detection unit 620 may be transmitted to the alarm unit 630. The alarm unit 630 may notify a worker of the level of risk identified by the information collected by the environment detection unit 620 by an alarm. The alarm unit 630 may notify the worker of a danger in the working environment based on visual or auditory information.

**[0123]** The alarm unit 630 may be operated when values identified by the information collected by the environment detection unit 620 is greater than or equal to a set reference value.

**[0124]** Specifically, a controller (not shown) may be installed in the control module 600, and the controller may receive the information from the environment detection unit 620 and operate the alarm unit 630. The controller may determine whether to operate the alarm unit 630 by comparing the values identified by the information from the environment detection unit 620 with a preset reference value for each step.

**[0125]** For example, the controller may determine the level of risk in a worker's working environment based on the information collected by the environment detection unit 620 and the preset reference value for each step to control the alarm unit 630 to operate differently depending on the level of risk.

**[0126]** The control transfer unit 670 may enable the control module 600 to move. For example, the control transfer unit 670 may be a wheel.

**[0127]** Accordingly, it may be possible that a worker moves the control module 600 to a desired position.

**[0128]** In detail, it may be possible that the worker responds to any dangerous situation by locating the control module 600 in the place where the worker carries out the dismantling processes to receive information on the place including information on risks.

**[0129]** The control module 600 of the present disclosure may further include a display unit 640.

**[0130]** The display unit 640 may output the information collected by the environment detection unit 620 or information on the state of the battery 610. Therefore, a worker may recognize the information on the working environment or the information on the state of the battery 610 based on the information output by the display unit 640.

**[0131]** With the features described above, the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure may be capable of effectively reducing particles or aerosol-type radioactive substances contained in dust generated during the process of dismantling a nuclear power plant.

**[0132]** In addition, in the air purification apparatus 101 according to an embodiment of the present disclosure, it may be possible that a plurality of modules are detachably coupled to each other so that a module is selected and used according to the needs in the working environ-

ment for dismantling a nuclear power plant.

**[0133]** Furthermore, since the plurality of modules may include a transfer unit for movement, it may be possible to move the air purification apparatus 101 for reducing radioactive substances close to a place in which the processes are performed to efficiently process dust generated therein.

**[0134]** Hereinafter, with reference to FIGS. 1 and 3, an operation of the air purification apparatus 101 and 102 for reducing radioactive substances according to an embodiment of the present disclosure will be described.

**[0135]** A worker may identify the type of a process required for dismantling a nuclear power plant. When the process for dismantling the nuclear power plant is the cutting of metal, the worker may select the pre-processing module 100 in which the bag filter is installed. Alternatively, the worker may select the cyclone-type pre-processing module 100 when the process for dismantling the nuclear power plant is the cutting of concrete.

**[0136]** Next, the worker may determine whether there is any available equipment in a place where the dismantling of the nuclear power plant is performed.

**[0137]** The worker may determine whether all of the filter module 200, the adsorption module 400, the blowing module 500, and the control module 600 are necessary or there are any other devices that can replace them in the place.

**[0138]** The worker may move the module 100, 200, 400, 500, and 600 suitable for the working environment to the place where the process is to be performed and then connect the pre-processing module 100 and the selected module.

**[0139]** Specifically, the pre-processing module 100 and the filter module 200 may be connected by the first flow path 810. In addition, a suction unit 700 may be connected to one side of the pre-processing module 100. The suction unit 700 may include a suction passage 710 connected to the pre-processing inlet 112 of the pre-processing module 100 and a suction nozzle 720 connected to the suction passage 710. That is, through the suction nozzle 720, dust containing particles or aerosol-type radioactive substances generated by the process may be introduced into the air purification apparatus 101 for reducing radioactive substances.

**[0140]** In that case, the worker may open the dampers installed in the modules 100, 200, 400, 500, and 600 to allow air to move between the modules during the process.

**[0141]** The worker may operate the blower 510 or a blower at the place to form a flow of air and then carry out the process for dismantling a nuclear power plant such as the cutting process.

**[0142]** After completing the process, the worker may close the dampers installed in the modules 100, 200, 400, and 500 and then separate each module to move it to another workplace or a place for their storage. In this case, it may be possible to effectively prevent a situation where particles or aerosol-type radioactive substances remaining inside the modules are discharged to the outside to threaten the safety of the worker.

**[0143]** In addition, since each module of the air purification apparatus 101 for reducing radioactive substances may be movable, it may be possible to manufacture the air purification apparatus 101 in a compact size.

**[0144]** Hereinafter, with reference to FIG. 2, an operation of the filter module 200 of the air purification apparatus 101 for reducing radioactive substances according to an embodiment of the present disclosure will be described.

**[0145]** A worker may grasp the difference between a pressure at the front and a pressure at the rear of the first filter 210 based on the pressure gauge 283. In detail, when the controller is installed, it may be possible to determine whether the first filter 210 is clogged due to dust based on the information from the pressure gauge 283.

**[0146]** The worker may determine that the first filter 210 is contaminated by dust when a pressure greater than or equal to a preset reference value is sensed based on the information from the pressure gauge 283. That is, the worker or the controller may determine a time point to operate the fluid ejection unit 250.

**[0147]** When it is determined that the first filter 210 has been clogged by contamination due to dust, the worker may connect the fluid supply member 251 to the distribution pipe 253 so that fluids may be sprayed from the rear of the first filter 210 through the spray nozzle 252 and the dust in the first filter 210 may be removed. Specifically, when the controller is installed, it may supply fluids from the fluid supply member 251 to the spray nozzle 252 for the fluids to be sprayed.

**[0148]** The process of removing dust in the first filter 210 may be performed while the air purification apparatus 101 is in operation or when its operation has been completed.

**[0149]** When it is determined based on the information from the pressure gauge 283 that the process of removing dust in the first filter 210 has been completed, the worker may stop the fluids from being sprayed through the spray nozzle 252 by the fluid supply member 251. When the controller is installed, it may stop the supply of fluids from the fluid supply member 251 to the spray nozzle 252. That is, information on pressure that appears when the process of removing dust in the first filter 210 is completed may have been preset in the controller.

**[0150]** Even when electricity supply is not smooth at a place for dismantling a nuclear power plant, it may be possible that the fluids required for removing dust in the first filter 210 are manually supplied by worker so that the first filter 210 may be purified, thereby increasing its lifespan.

**[0151]** With the features described above, it may be possible to purify the first filter 210 of the filter module 200 of the air purification apparatus 101 according to an embodiment of the present disclosure by spraying fluids thereto. Therefore, it may be possible to effectively solve the problem of having to take the first filter 210 out of the

filter chamber 201 for its replacement and purification because of the pressure inside the filter chamber 201 rising when the first filter 210 is clogged with dust.

**[0152]** The present invention may be summarized as follows: The embodiments of the present disclosure relate to an air purification apparatus disposed in a workplace for dismantling a nuclear power plant. The air purification apparatus for reducing radioactive substances includes a particle processing module that processes dust containing particles or aerosol-type radioactive substances, a first transfer unit that enables the particle processing module to move, a first damper positioned on one side of the particle processing module and selectively blocking the inflow and discharge of dust, and a second damper positioned on the other side of the particle processing module and selectively blocking the discharge of dust that has passed through the particle processing module.

**[0153]** Although the embodiments of the present disclosure have been described with reference to the accompanying drawings, it is to be understood by a person having ordinary skill in the technical field to which the present disclosure belongs that the present disclosure may be embodied in other specific forms without changing the technology or essential characteristics thereof.

**[0154]** Therefore, it should be understood that the embodiments described above are illustrative in all respects and not restrictive. In addition, the scope of the present disclosure and the detailed description above are consistent with the claims set forth below, and all variations or modifications derived from the meaning, the scope, and equivalents of the claims should be construed as being included in the scope of the present disclosure.

## Claims

1. An air purification apparatus (101; 102) for reducing radioactive substances, comprising:

   a particle processing module (300) that processes dust containing particles or aerosol-type radioactive substances;
   a first transfer unit (370) that enables the particle processing module (300) to move;
   a first damper (191) positioned on one side of the particle processing module (300) and selectively blocking the inflow and discharge of dust; and
   a second damper (292) positioned on the other side of the particle processing module (300) and selectively blocking the discharge of dust that has passed through the particle processing module (300).

2. The air purification apparatus (101; 102) of claim 1, wherein the particle processing module (300) includes:

   a pre-processing module (100) for reducing radioactive substances contained in dust; and
   a filter module (200) for reducing radioactive substances contained in the dust that has passed through the pre-processing module (100).

3. The air purification apparatus (101; 102) of claim 2, wherein the pre-processing module (100) includes:

   a pre-processing chamber (110);
   a pre-processing filter (120) installed inside the pre-processing chamber (110) to filter radioactive substances contained in dust; and
   a pre-processing collection unit (130) installed in a lower portion of the pre-processing chamber (110) to collect particles contained in dust.

4. The air purification apparatus (102) of claim 2 and/or 3,
   wherein the pre-processing module (100) includes:

   the pre-processing chamber (110);
   a pre-processing inclined portion (150) that is formed in the pre-processing chamber (110) and guides dust introduced into the pre-processing chamber (110) to move with a swirling flow so that particles contained in the dust are separated therefrom.

5. The air purification apparatus (101; 102) of claim 3 and/or 4,
   wherein the filter module (200) includes:

   a filter chamber (201) into which dust that has passed through the pre-processing chamber (110) is introduced;
   a first filter (210) inclined toward a lower portion of the filter chamber (201) in the filter chamber (201);
   a second filter (220) spaced apart from the first filter (210) in the filter chamber (201);
   a fluid ejection unit (250) for ejecting fluids toward the first filter (210) so that dust in the first filter (210) is removed therefrom;
   a filter chamber inclined unit (230) that is more contiguous to the first filter (210) than to the second filter (220) and is disposed to protrude outwardly in an inclined shape on a portion of a lower surface of the filter chamber (201); and
   a chamber collection unit (240) disposed under the filter chamber inclined unit (230) and capable of collecting materials separated from the first filter (210).

6. The air purification apparatus (101; 102) of claim 5, wherein the first transfer unit (370) includes:

a pre-processing transfer unit (170) installed in the pre-processing chamber (110); and
a filter transfer unit (270) installed in the filter chamber (201).

**7.** The air purification apparatus (101; 102) of claim 5 and/or 6, further comprising:

a third damper (192) installed on the other side of the pre-processing chamber (110) to selectively block the discharge of dust that has passed through the pre-processing chamber (110) while the first damper (191) is installed on one side of the pre-processing chamber (110); and
a fourth damper (291) installed on one side of the filter chamber (201) to selectively block the inflow of dust into the filter chamber (201) and the discharge of dust therefrom while the second damper (292) is installed on the other side of the filter chamber (201).

**8.** The air purification apparatus (101; 102) of any one or more of claims 2 to 7, further comprising
an adsorption module (400) including:

an adsorption chamber (401) into which dust that has passed through the filter module (200) is introduced;
an adsorption filter (410) disposed inside the adsorption chamber (401) to process harmful gases contained in the dust;
a fifth damper (491) installed on one side of the adsorption chamber (401) to selectively block the inflow of the dust into the adsorption chamber (401) and the discharge of the dust therefrom; and
a sixth damper (492) installed on the other side of the adsorption chamber (401) to selectively block the discharge of the dust that has passed through the adsorption chamber (401).

**9.** The air purification apparatus (101; 102) of claim 8, further comprising
a blowing module (500) forming a flow of air so that dust is introduced into the adsorption module (400) or the particle processing module (300).

**10.** The air purification apparatus (101; 102) of any one or more of claims 1 to 9, further comprising
a control module (600) including:

a battery (610) capable of providing power;
an environment detection unit (620) collecting information on a working environment;
an alarm unit (630) for providing an alarm to a worker based on the information from the environment detection unit (620); and
a control transfer unit (670) for mobility.

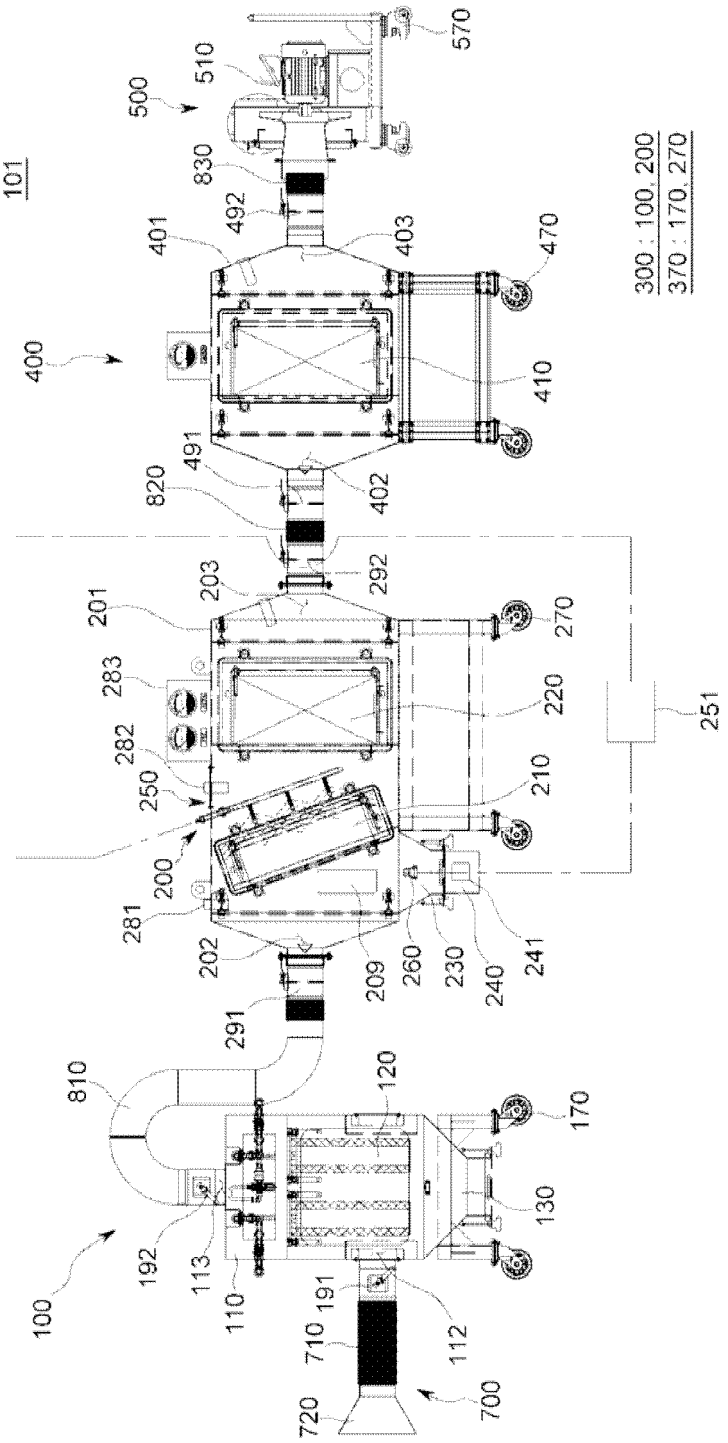
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FIG.1

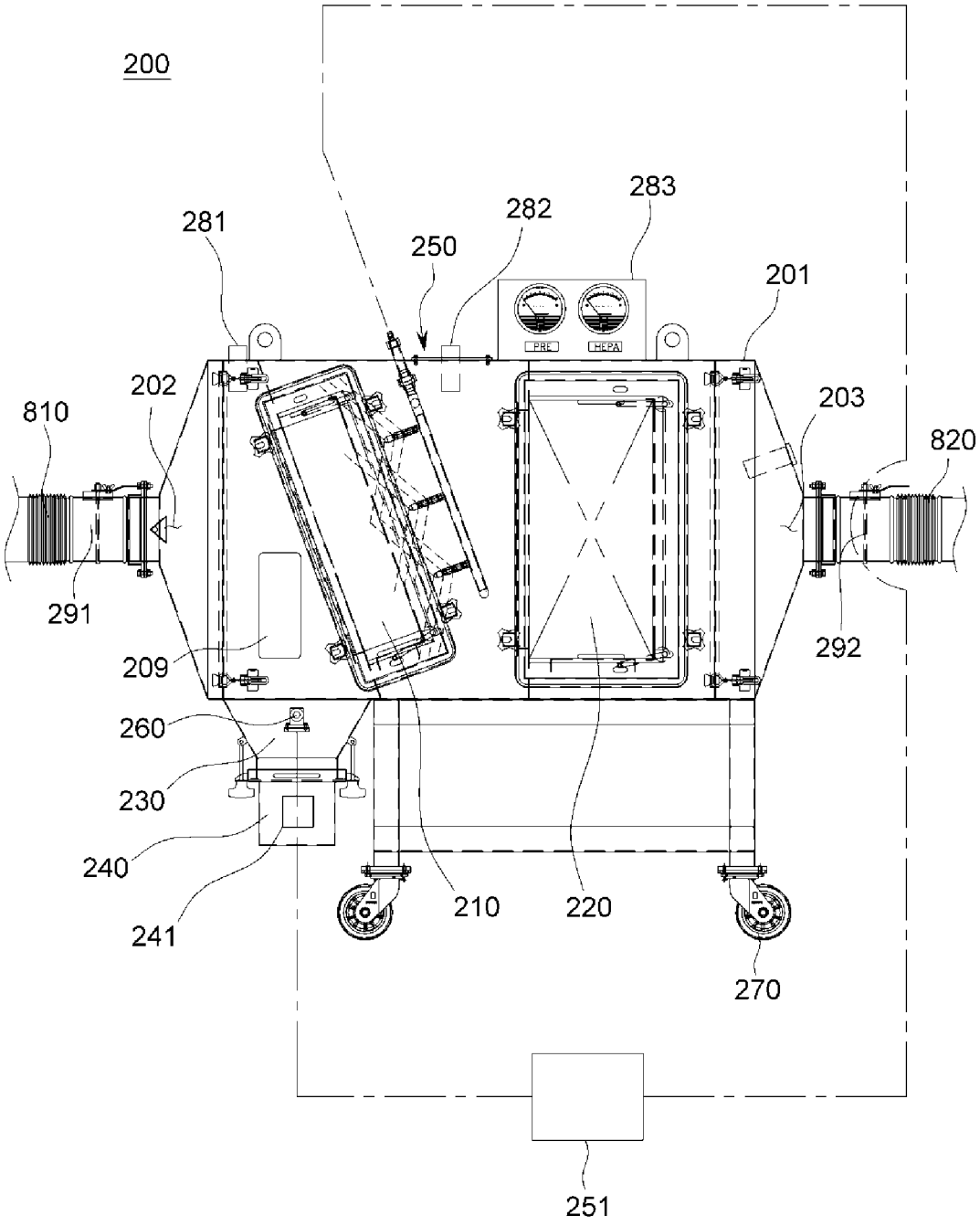
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FIG.2

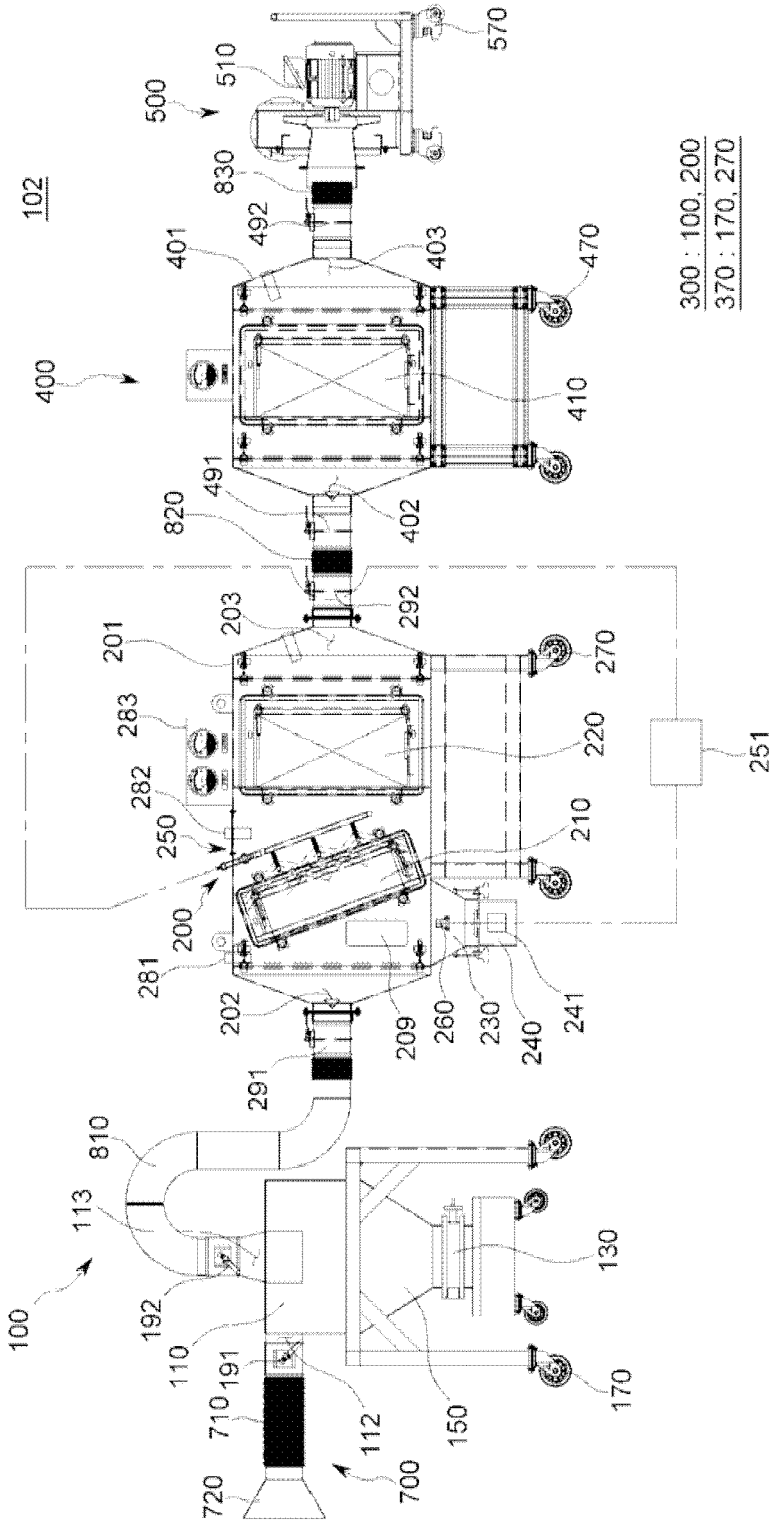
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FIG.3

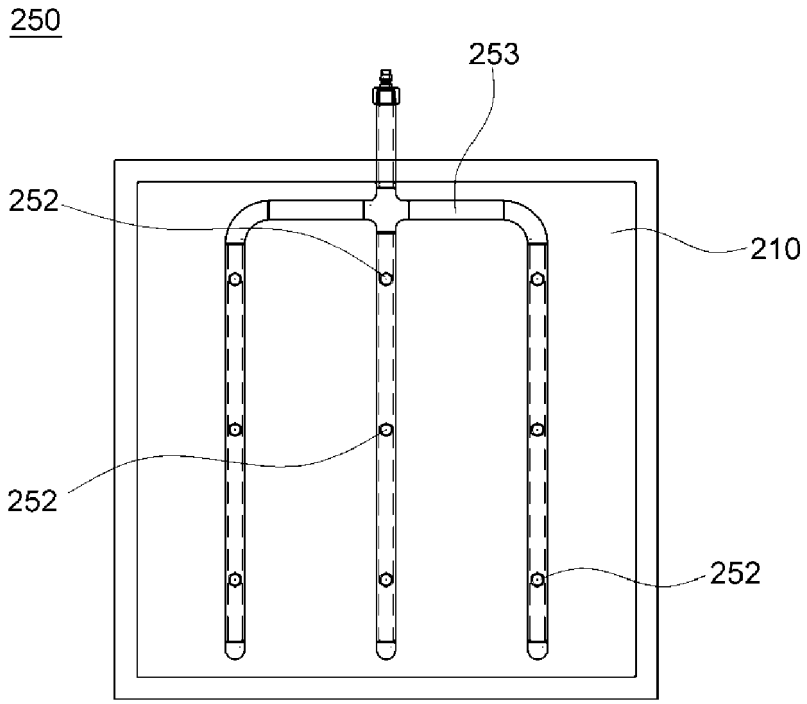


FIG.4

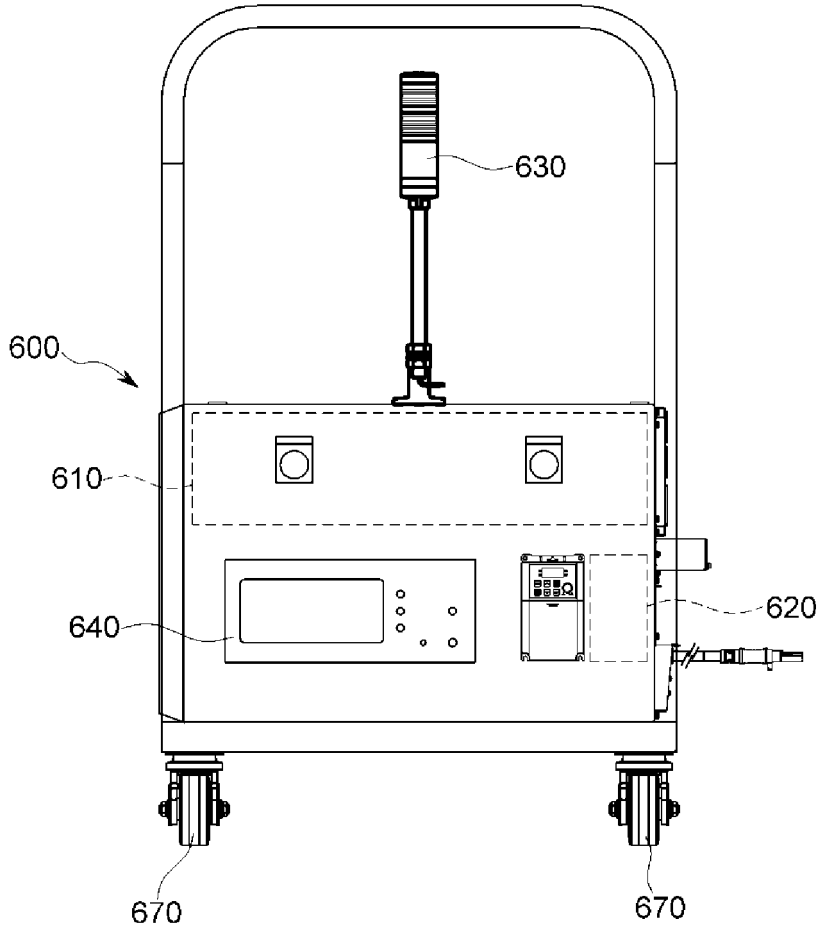


FIG.5

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# EUROPEAN SEARCH REPORT

Application Number
EP 22 20 3916

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X<br>Y<br>A | JP 2012 245498 A (SHIN NIPPON AIR TECH CO LTD) 13 December 2012 (2012-12-13)<br>* paragraphs [0014] - [0061]; claims 1-4; figures 1-17 * | 1-3,7-10<br>4<br>5,6 | INV.<br>G21F9/02<br>G21F9/04<br>G21F9/06<br>G21F9/28<br>G21F9/30 |
| Y | KR 970 007 649 B1 (CHO DONG SOO [KR])<br>15 May 1997 (1997-05-15)<br>* pages 1-10; figures 1,2 * | 4,5 | |
| X<br>Y<br>A | KR 101 518 624 B1 (KIM BO GON [KR])<br>7 May 2015 (2015-05-07)<br>* paragraphs [0004] - [0064]; claims 1-10; figures 1-8 * | 1-3,5,6,<br>9,10<br>5<br>7,8 | |

| TECHNICAL FIELDS SEARCHED (IPC) |
|---|
| G21F |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 7 March 2023 | Lohberger, Severin |

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# ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 3916

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07-03-2023

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| JP 2012245498 A | 13-12-2012 | JP 5910959 B2 | 27-04-2016 |
| | | JP 2012245498 A | 13-12-2012 |
| KR 970007649 B1 | 15-05-1997 | NONE | |
| KR 101518624 B1 | 07-05-2015 | NONE | |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82