(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 230 922 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
23.08.2023 Bulletin 2023/34

(21) Application number: **21886755.4**

(22) Date of filing: **26.10.2021**

(51) International Patent Classification (IPC):
F24F 7/007 *(2006.01)* ***F04F 5/04*** *(2006.01)*
A62B 13/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
A62B 13/00; F04F 5/04; F24F 7/007

(86) International application number:
PCT/KR2021/015096

(87) International publication number:
WO 2022/092761 (05.05.2022 Gazette 2022/18)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **26.10.2020 KR 20200139493**
13.10.2021 KR 20210136047

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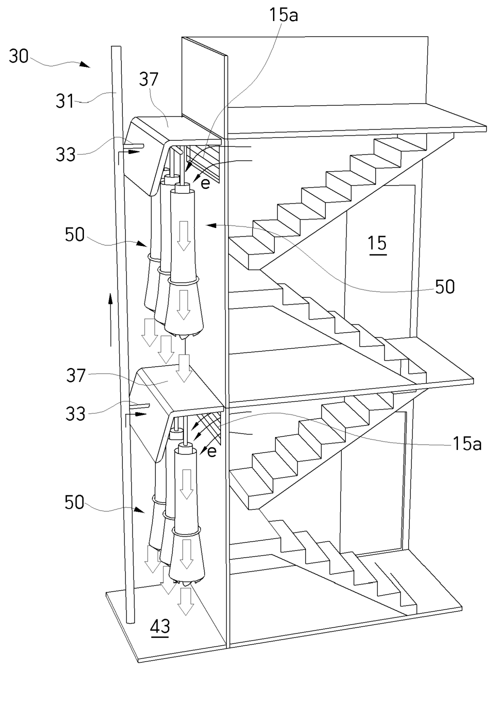
(54) **INTAKE-TYPE SMOKE REMOVAL SYSTEM**

(57) The present invention relates to an intake-type smoke removal system. The intake-type smoke removal system discharges gas flowing into a smoke removal zone to the outside of the smoke removal zone and includes a vacuum-generating multistage Venturi configured to allow water provided from the outside to pass therethrough, the vacuum-generating multistage Venturi being configured to generate negative pressure based on the Venturi effect while the water passes therethrough to suck the gas in the smoke removal zone, mix the sucked gas with the water, and discharge the gas mixed with the water.

FIG. 5



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Description

[Technical Field]

[0001] The present invention relates to a smoke removal system installed in a building, and more particularly, to an intake-type smoke removal system that quickly sucks smoke and toxic gas created in the event of a fire, mixes the smoke and toxic gas with water, and then removes the smoke and toxic gas mixed with the water, thereby preventing smoke from being diffused to a preset smoke removal zone, a fire room (living room), and hallways, stairs, and the like that are escape routes, preventing inflows of smoke and toxic gas, and minimizing human casualties.

[Background Art]

[0002] Various firefighting facilities are mandatorily installed in most of buildings built recently, and the firefighting facilities meet criteria prescribed in the enhanced building firefighting law. These firefighting facilities include fire extinguishing facilities, smoke discharge facilities, smoke removal (control) facilities, alarm facilities, evacuation facilities, firefighting water facilities, and facilities related to fire extinguishing processes. The basic purpose of the firefighting facility is, of course, to minimize damage to lives and property due to fires by detecting a fire early, protecting or evacuating people in the building, and enabling the people to extinguishing the fire at the initial time of the fire.

[0003] Among the above-mentioned various facilities, the smoke removal (control) facility is a positive-pressure facility. For example, the smoking removal (control) facility serves to blow air into each floor in the event of a fire to make internal pressure of an escape route in a building higher than pressure of toxic gas, thereby blocking an inflow of smoke and toxic gas into the escape route, and preventing escapers from being suffocated. While the smoke discharge facility refers to a facility that discharges toxic gas out of the building, the smoke removal facility is to block and maintain the toxic gas to prevent the toxic gas from entering the building.

[0004] That is, the smoke removal (control) facility is a type of firefighting facility. The smoke removal (control) facility detects smoke or the like created at the initial time of a fire, discharges the smoke in the fire room (living room), prevents smoke from spreading to hallways, stairs, and the like that are evacuation pathway, thereby protecting residents from smoke and allowing the residents to be evacuated safely. Further, the smoke removal (control) facility controls smoke and discharges smoke to the outside (fire smoke ventilation) to enable firefighters to extinguish the fire.

[0005] Depending on installation locations, the smoke removal (control) facilities may be classified into a smoke removal (control) facility for a living room and a smoke removal (control) facility for a staircase room and ancillary room. However, these smoke removal (control) facilities are almost identical in technology.

[0006] The smoke removal (control) facility for a living room includes an air supply blower and an air discharge blower to discharge smoke and heat in a living room in which a fire occurs. The air supply blower supplies air larger in amount than gas discharged by the air discharge blower to enable evacuation and fire extinguishing operations. In addition, the smoke removal (control) facility for a staircase room and ancillary room makes internal pressure in the staircase room and ancillary room (hereinafter, referred to as a 'smoke removal zone') higher than pressure in the living room to prevent smoke from entering the living room, thereby protecting the escapers from toxic gas.

[0007] Meanwhile, the smoke removal (control) facility for a staircase room and ancillary room in the related art supplies outside air into the smoke removal (control) zone by using a control air blower and a vertical air duct. That is, the smoke removal (control) facility prevents the inflow of smoke into the smoke removal (control) zone by increasing pressure by supplying air into the smoke removal (control) zone through a smoke removal damper by using an air blower installed in a basement or on a roof. However, because the smoke removal (control) facility cannot perform a normal function in case that the pressure is discharged to the outside of the control zone (through a window, an entrance, or an exit), the control zone, the hallway, the stair, and the like are filled with smoke and toxic gas, which suffocates the escapers. The fact that the smoke removal (control) facility has the above-mentioned great problem and is already useless has been known from various types of news reports, official field experiments, and inspections.

[0008] FIGS. 1 and 2 are views for explaining a problem with the smoke removal (control) facility in the related art.

[0009] As illustrated, an air duct 11 is provided between a residential space 13 and a smoke removal (control) zone 15 of a building 10. The air duct 11 is a vertical duct installed in a common duct (not illustrated) and guides upward air supplied from a lower fan 17 in a basement. Malfunction in which the air flowing through the air duct is excessively introduced through a smoke removal damper 15a installed in a smoke removal (control) hallway 15, a stair, or the like in each floor has been known from several field experiments and inspections. This malfunction excessively increases pressure in the smoke removal zone, such that the pressure is higher than an allowable value, which causes a great problem in that the elderly, as well as the healthy adult men, cannot open a door in the residential space 13 and cannot be evacuated.

[0010] In case that a window 15c or an entrance or exit 15e in the smoke removal (control) zone 15 is opened, the internal pressure of the smoke removal (control) zone cannot be increased as if the vehicle tire is punctured. For this reason, the internal pressure of the smoke removal zone does not increase no matter how much air is supplied by the blower fan 17.

[0011] In addition, various additional devices are applied to seal or isolate the smoke removal (control) zone 15, the hallway, the stair, and the like, but ventilation is never performed in a normal condition when the hallway, the stair, and the like are completely sealed. In midsummer, a temperature in the smoke removal (control) zone 15 is raised to a high temperature of 40°C or higher, and the clothes are soaked in sweat during an elevator waiting time, which causes many adverse effects such as inconvenience of residents (especially children, the elderly, and the disabled).

[0012] There is an acute need for a technology to always make a real living space pleasant in any season regardless of whether the smoke removal (control) zone is sealed and to reduce a lethal dose of various types of toxic gas to a safe range or less by maximally ensuring a safe escape passageway and an escape time and maximally removing deadly poisonous gas or the like such as hydrogen chloride (HCL) and hydrogen cyanide (HCN) fatal to a human body from the escape passageway to save even one person's life in the event of a fire.

[Disclosure]

[Technical Problem]

[0013] The present invention has been made in an effort to solve the above-mentioned problems, and an object of the present invention is to provide an intake-type smoke removal system that may minimize human casualties by preventing smoke and toxic gas for moving into a smoke removal zone in the event of a fire, implement air purification in an interior even in a situation in which no fire occurs, and prevent contaminants from being discharged in an industrial site that discharges contaminants.

[Technical Solution]

[0014] As a means for achieving the above-mentioned object, there is provided an intake-type smoke removal system, which discharges gas flowing into a smoke removal zone to the outside of the smoke removal zone, the intake-type smoke removal system including: a vacuum-generating multistage Venturi configured to allow water provided from the outside to pass therethrough, the vacuum-generating multistage Venturi being configured to generate negative pressure based on the Venturi effect while the water passes therethrough to suck the gas in the smoke removal zone, mix the sucked gas with the water, and discharge the gas mixed with the water; a water supply unit configured to supply the water to the vacuum-generating multistage Venturi; and a nozzle configured to spray the water, which is supplied through the water supply unit, into the vacuum-generating multistage Venturi.

[0015] In addition, the vacuum-generating multistage Venturi may be installed in a common duct that communicates with the smoke removal zone of each floor through a through-path, and the water supply unit may include: a water supply pump configured to pump the water; a main water supply pipe configured to guide the water, which is pumped by the water supply pump, to the vacuum-generating multistage Venturi; and a branch pipe connected to the main water supply pipe, extending to an inlet part of the vacuum-generating multistage Venturi, and connected to the nozzle.

[0016] Further, the vacuum-generating multistage Venturi may be provided as a plurality of vacuum-generating multistage Venturis disposed to be spaced apart from one another vertically, and a blocking guide plate may be provided between the vacuum-generating multistage Venturis to prevent water sprayed from the upper vacuum-generating multistage Venturi from striking the lower vacuum-generating multistage Venturi.

[0017] In addition, the intake-type smoke removal system may further include: a mixing conduit extending vertically and configured to accommodate the vacuum-generating multistage Venturi and the blocking guide plate and guide downward a mixture of gas and water discharged from the vacuum-generating multistage Venturi.

[0018] Further, the vacuum-generating multistage Venturi may include: a spray pipe having an upper end at which the nozzle is provided, the spray pipe being configured to discharge the water sprayed from the nozzle; and a Venturi casing configured to surround the spray pipe and guide downward the water sprayed through the spray pipe, the Venturi casing having a shape having a diameter that increases downward.

[0019] In addition, the spray pipe may include: a first spray pipe coupled to the nozzle and having an inlet port through which water and gas are simultaneously introduced, and an outlet part through which the water mixed with the gas is discharged; a second spray pipe configured to accommodate the first spray pipe and having an inlet port through which gas is sucked, and an outlet part through which the introduced gas and the water mixed with the gas discharged from the first spray pipe are mixed and discharged; and mixing blades may be formed in the outlet parts of the first and second spray pipes and mix the introduced water and gas by allowing the introduced water and gas to collide with each other.

[0020] In addition, the Venturi casing may include: a fixed pipe configured to accommodate the second spray pipe and having an inlet port provided at an upper end thereof so that gas is sucked through the inlet port; a rotary pipe rotatably installed at a lower end of the fixed pipe; and impeller blades positioned inside the rotary pipe and configured to rotate the rotary pipe by receiving kinetic energy from water while colliding with the sprayed water.

[0021] Further, an accommodation groove may be formed at a lower end of the fixed pipe, extend in a circumferential direction, and have a predetermined cross-sectional shape in the circumferential direction, and a bent insertion end portion may be formed at an upper end of the rotary pipe, supported by being inserted into the accommodation groove, and configured to be slidable in the circumferential direction while being kept inserted into the accommodation groove.

[0022] In addition, the intake-type smoke removal system may further include: an oilless solid lubrication coating or a ring-shaped bearing installed between the bent insertion end portion and the accommodation groove.

[0023] In addition, the intake-type smoke removal system may further include: a water supply pump configured to reuse water discharged through the mixing conduit.

[Advantageous Effects]

[0024] The intake-type smoke removal system of the present invention configured as described above forms a negative pressure in the event of a fire, suctions surrounding smoke and toxic gas, and then mixes the same with water to discharge the mixture to the outside, thereby preventing smoke and toxic gas from moving to a smoke removal zone and minimizing human casualties.

[0025] In addition, even in a situation where there is no fire, various airborne pollutants such as indoor yellow dust or fine dust are suctioned and removed to purify the indoor air. Furthermore, the present invention not only can be used in industrial sites such as coal storage yards, cement factories, construction sites, oil refineries, steel mills and shipyards that emit dust, oil vapors, or toxic chemicals, but also can be used as an air purifier for agricultural and fisheries purposes or military purposes.

[Description of Drawings]

[0026]

FIGS. 1 and 2 are views for explaining a problem with a facility in the related art that controls smoke and discharge the smoke to the outside (fire smoke ventilation) .

FIGS. 3 and 4 are views for explaining a basic structure of and a method of operating an intake-type smoke removal system according to an embodiment of the present invention.

FIGS. 5 and 6 are views illustrating a configuration of the intake-type smoke removal system according to the embodiment of the present invention.

FIGS. 7A to 7C are views for explaining a structure of a vacuum-generating multistage Venturi illustrated in FIG. 5.

[Best Mode]

[0027] Hereinafter, one embodiment according to the present invention will be described in more detail with reference to the accompanying drawings.

[0028] An intake-type smoke removal system of the present invention may quickly suck smoke and toxic gas created in the event of a fire, mix the smoke and toxic gas with water, and then discharges the smoke and toxic gas mixed with the water to the outside, thereby preventing inflows of smoke and toxic gas into a preset smoke removal zone and minimizing human casualties.

[0029] That is, the intake-type smoke removal system may quickly suck smoke and toxic gas created in the event of a fire, mix the smoke and toxic gas with water, and then remove the smoke and toxic gas mixed with the water, thereby preventing smoke from being diffused to a preset smoke removal zone, a fire room (living room), and hallways, stairs, and the like that are escape routes, preventing inflows of smoke and toxic gas, and minimizing human casualties.

[0030] The intake-type smoke removal system has a structure that sucks high-temperature smoke and toxic gas, which is expanded by heat and has high pressure, mixes the smoke and toxic gas with water. The intake-type smoke removal system removes gaseous and liquid particulate-based toxic gas by dissolving and diluting the toxic gas in water and cools the toxic gas. The intake-type smoke removal system removes solid particulate-based soot and ultra-fine dust by using physical adsorption.

[0031] The present invention may be variously applied to fields such as subway stations, underground facilities, underground parking lots, various types of multi-use facilities, smoke removal from various types of tunnels, removal of various types of industrial solid particulate-based ultra-fine dust, facilities for removing military gas, liquid particulate-based gas, solid particulate-based gas, various types of chemical substances, and toxic gas, commercial facilities, hospitals, agricultural-livestock sterilization, defense equipment, and adsorption and removal of gaseous and liquid particulate-based offensive odor substances.

[0032] FIGS. 3 and 4 are views for explaining a basic concept of and a method of operating an intake-type smoke removal system according to an embodiment of the present invention, and FIGS. 5 and 6 are views illustrating a configuration of the intake-type smoke removal system according to the embodiment of the present invention in more detail.

[0033] As illustrated, an intake-type smoke removal system 30 according to the present embodiment includes a mixing conduit 43, a plurality of vacuum-generating multistage Venturis 50, a blocking guide plate 37, a water supply unit, and a nozzle 51. The smoke removal system 30 of the present embodiment is positioned between a residential space 13 and a smoke removal zone 15 in a building 10.

[0034] In general, a vertical common duct (no reference numeral) may be provided between the residential space 13 and the smoke removal zone 15 of the building, and the smoke removal system 30 of the present embodiment may be installed in the common duct. The common duct does not isolate the residential space 13 and the smoke removal zone 15. Of course, persons in the residential space 13 may move to the smoke removal zone 15.

[0035] Further, in the present description, the residential space 13 is a space in which persons using the building 10 are mainly positioned. For example, if the building is an office building, the residential space 13 is an office, a meeting room, or a restaurant. Also, if the building is an apartment or officetel, the residential space is a space for each family.

[0036] The smoke removal zone 15 may be a hallway, a staircase room, or other ancillary rooms that the persons use when escaping from the building in an emergency situation. Because the smoke removal zone is a passageway through which the persons in the building pass or are evacuated in the event of a fire, for example, smoke or toxic gas should not enter the smoke removal zone.

[0037] The intake-type smoke removal system 30 according to the present embodiment is disposed outside the smoke removal zone 15 and communicates with the smoke removal zone 15 of each floor through a smoke removal damper 15a. For example, in case that negative pressure is formed in the mixing conduit 43, air in the smoke removal zone 15 is sucked into the mixing conduit 43. The smoke removal damper 15a connects the inside and outside of the smoke removal zone 15.

[0038] As a result, the intake-type smoke removal system 30 of the present embodiment is installed outside the smoke removal zone 15 and enables escape or evacuation through the smoke removal zone by discharging gas, which is introduced into the smoke removal zone in the event of a fire, to the outside of the smoke removal zone. A rescue requester, who escapes from the residential space 13 in the event of a fire, may move to the smoke removal zone 15 and then safely escape to the outside of the building.

[0039] Meanwhile, the mixing conduit 43 is a vertically extending pipe. The mixing conduit 43 accommodates the vacuum-generating multistage Venturi 50, the blocking guide plate 37, and the water supply unit and moves downward a mixture of gas and water discharged from the vacuum-generating multistage Venturi 50.

[0040] The water discharged from the mixing conduit 43 may be separately collected and treated as sewage. In some instances, the water may be collected in a separate water tank, purified, and then be circulated and reused. That is, the water discharged through a lower portion of the mixing conduit 43 is separately collected and treated as sewage, or the water is collected in the water tank, purified, circulated to an intake-type smoke removal facility for removing smoke and toxic gas, and then reused, which makes it possible to save water. The shape of the mixing conduit 43 may be changed as much as needed. Further, a main water supply pipe 31 may be separately disposed outside the mixing conduit 43.

[0041] The water supply unit serves to supply water to each of the vacuum-generating multistage Venturis 50 and includes a water supply pump 39, the main water supply pipe 31, and a branch pipe 33.

[0042] The water supply pump 39 serves to move the water upward through the main water supply pipe 31 by pumping the water supplied from the outside. The water supplied from the outside may be firefighting water supplied from a fire engine or water stored in a separate water tank. Alternatively, the water supplied from the outside may be service water.

[0043] The main water supply pipe 31 is a pipe extending vertically upward and extends up to an uppermost floor of the building. The branch pipe 33 is a pipe connected to the main water supply pipe 31 and extending to each of the vacuum-generating multistage Venturis 50. The water, which flows upward through the main water supply pipe 31, is introduced into the branch pipe 33 and supplied to the vacuum-generating multistage Venturi 50. An extension end portion of the branch pipe 33 reaches a center of an upper end of the vacuum-generating multistage Venturi 50 and is coupled to the nozzle 51. The nozzle 51 is a nozzle embedded with a swirl inducer. The nozzle 51 sprays water at high speed in a vortex effect pattern, such that the nozzle 51 sprays downward, at high speed, the water passing through the branch pipe 33 to an inlet port 53a of a first spray pipe 53 to be described below. The shape of the swirl inducer may be variously implemented as much as needed as long as the swirl inducer may form a spiral stream line.

[0044] By the negative pressure, the water sprayed into the vacuum-generating multistage Venturi 50 by the nozzle 51 sucks high-temperature smoke and toxic gas with increased pressure such as smoke, toxic gas dust, fine dust, soot, various types of non-combustion flammable gas, heat, and the like created in the event of a fire, and the gas is mixed with the water. Liquid particulate-based toxic gas is removed by being dissolved and diluted in the water, solid particulate-based soot and various types of ultra-fine dust generated in industrial sites are removed by physical adsorption, and the gas mixed with the water is discharged downward. Hydrogen cyanide (HCN) and hydrogen fluoride (HF), which are water soluble toxic gas created in the event of a fire, are infinitely dissolved in water, hydrogen chloride (HCl) is dissolved in water significantly well, and phosgene ($COCl_2$), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon dioxide (CO_2), and the like are easily dissolved in water.

[0045] Meanwhile, the vacuum-generating multistage Venturi 50 serves to allow the water, which is supplied through the branch pipe 33, to pass therethrough and generate negative pressure based on the Venturi effect while the water passes therethrough, thereby sucking the gas in the smoke removal zone 15, mixing the sucked gas with water, and discharging the gas mixed with the water. That is, as illustrated in FIG. 5, the vacuum-generating multistage Venturi 50 sucks the gas in the smoke removal zone 15 in the direction of the arrow e, mixes the gas with water, and then discharges downward the gas mixed with the water.

[0046] Further, in the present embodiment, three vacuum-generating multistage Venturis 50 are applied in parallel for each floor. The number of vacuum-generating multistage Venturis 50 applied for each floor may be changed as much as needed.

[0047] The blocking guide plate 37 is a plate-shaped member installed between the vacuum-generating multistage Venturis 50 positioned vertically. For example, the blocking guide plate 37 prevents the water, which is sprayed downward from the upper vacuum-generating multistage Venturi, from striking the lower vacuum-generating multistage Venturi. The water passing through the vacuum-generating multistage Venturi 50 collides with the blocking guide plate 37, flows in the direction of the arrow g in FIG. 5, and then falls.

[0048] Another function of the blocking guide plate 37 is to guide gas, which is extracted through the smoke removal damper 15a, and allow the gas to smoothly move to an inlet portion, i.e., an upper end of the vacuum-generating multistage Venturi 50. In other words, the blocking guide plate 37 guides the extracted gas so that the gas is quickly sucked into the vacuum-generating multistage Venturi 50 without scattering upward. The structure of the blocking guide plate 37 may be changed as much as needed as long as the blocking guide plate 37 may perform the above-mentioned function.

[0049] FIGS. 7A to 7C are views for explaining a structure of the vacuum-generating multistage Venturi 50 illustrated in FIG. 5.

[0050] As illustrated, the vacuum-generating multistage Venturi 50 has a three-stage structure including the first spray pipe 53, a second spray pipe 55, and a Venturi casing 57. According to the embodiment, the vacuum-generating multistage Venturi 50 may be manufactured to have four or more stages.

[0051] The first spray pipe 53 is a cylindrical duct having the inlet port 53a provided at an upper end thereof, and an outlet part 53e provided at a lower end thereof. The nozzle 51 is fixed to the upper end of the first spray pipe 53. The water sprayed from the nozzle 51 flows downward while passing through the inlet port 53a of the first spray pipe 53. A plurality of mixing blades 53b is formed at a lower side of the first spray pipe 53.

[0052] The mixing blade 53b collides with the water flowing downward so that the water is uniformly mixed with the gas. The gas is introduced through the inlet port 53a by the negative pressure formed in the vacuum-generating multistage Venturi 50.

[0053] The mixing blades 53b are portions made by cutting lower portions of the first spray pipe 53 at equal intervals in parallel in a longitudinal direction and then folding the lower portions uniformly inward. The water passing through the first spray pipe 53 has a vortex effect pattern as the water collides with the mixing blades 53b and is mixed with gas.

[0054] The second spray pipe 55 is a duct that accommodates the first spray pipe 53 therein. A length of the second spray pipe 55 is approximately twice the length of the first spray pipe 53. However, the length of the second spray pipe 55 may be changed. An interval between an inner surface of the second spray pipe 55 and an outer peripheral surface of the first spray pipe 53 is maintained by a connection struts 54. The connection struts 54 are disposed at predetermined intervals in a circumferential direction of the first spray pipe 53 and supports the second spray pipe 55.

[0055] An inlet port 55c is provided at an upper end of the second spray pipe 55, and an outlet part 55e is provided at a lower end of the second spray pipe 55. The inlet port 55c is a passageway through which ambient gas is sucked. In addition, the outlet part 55e is a passageway through which the gas introduced through the inlet port 55c and the gas-water mixture (the fluid made by mixing water and gas) sprayed from the first spray pipe are mixed and discharged.

[0056] A plurality of mixing blades 55b is also provided at the lower end of the second spray pipe 55. The mixing blades 55b are portions made by cutting lower portions of the second spray pipe 55 at predetermined intervals in the longitudinal direction and then folding the cut portions inward. The mixture of gas and water, which passes through the second spray pipe 55, is mixed once again while colliding with the mixing blades 55b.

[0057] The Venturi casing 57 accommodates the first and second spray pipes 53 and 55 and guides downward the water that is sprayed while passing through the first and second spray pipes. The Venturi casing 57 has a shape having a diameter that increases downward.

[0058] The Venturi casing 57 includes a fixed pipe 58 and a rotary pipe 59. The fixed pipe 58 is a duct fixed to the second spray pipe 55 through connection struts 56. The rotary pipe 59 is a downward expandable duct rotatably mounted at a lower end of the fixed pipe 58.

[0059] An inlet port 57a, through which the gas is sucked, is provided at an upper end of the fixed pipe 58, and a support portion 58a is provided at the lower end of the fixed pipe 58. The support portion 58a is a portion that supports the rotary pipe 59 so that the rotary pipe 59 may rotate about an axis. The support portion 58a is formed by bending the lower end of the fixed pipe 58. The support portion 58a provides an accommodation groove 58b that has a predetermined cross-sectional shape in a circumferential direction of the fixed pipe 58 and is opened inward.

[0060] The rotary pipe 59 is a duct in which a diameter of a lower end thereof is larger than a diameter of an upper end thereof. The rotary pipe 59 has a bent insertion end portion 59a formed at the upper end thereof. The bent insertion end portion 59a is a portion made by bending the upper end of the rotary pipe outward. The bent insertion end portion 59a is supported by being inserted into the accommodation groove 58b. In addition, the bent insertion end portion 59a may slide in the circumferential direction while being kept accommodated in the accommodation groove 58b.

[0061] In particular, bearings 59e are mounted on upper and lower portions of the bent insertion end portion

59a. The bearings 59e serve to reduce friction between the bent insertion end portion 59a and the accommodation groove 58b. The rotary pipe 59 smoothly rotates while being kept supported on the support portion 58a by the bearings 59e.

[0062] In addition, impeller blades 59g are installed inside the rotary pipe 59. The impeller blades 59g are blades disposed spirally. The impeller blades 59g serve to rotate the rotary pipe 59 about the axis in a direction indicated by the arrow k by receiving kinetic energy from the water while colliding with the sprayed water.

[0063] In particular, the water sprayed from the nozzle 51 rapidly becomes moisture vapor by high-temperature heat of smoke and toxic gas. The water is vaporized and expanded in volume by about 1,700 or more times at 100°C, 2,400 or more times at 260°C, and 4,200 or more times at 650°C at 1 atm.

[0064] In the event of a fire, high-temperature smoke and toxic gas increase pressure in an upper layer in an indoor space while being consistently moved upward to and collected in the upper layer. The smoke and toxic gas (non-combusted flammable gas and black smoke) with increased pressure are spread toward a location with low pressure. When the smoke and toxic gas reach a predetermined critical point within about three minutes, the smoke and toxic gas are ignited by radiant heat and cause a flash-over phenomenon, such that the fire is further diffused toward the periphery. The temperature of the high-temperature smoke and toxic gas in the upper layer may be raised to 600 to 900°C or higher by radiant heat.

[0065] A flow velocity further increases when a volume of a fluid passing through an inside of a flow field is increased instantaneously by high-temperature heat. Therefore, a fluid with a high velocity, i.e., a fluid mixture, in which moisture vapor, gas, and water are complicatedly mixed, may further increase a suction force by rapidly decreasing pressure in the vacuum-generating multistage Venturi 50 on the basis of the Venturi principle. This is because vaporization and expansion may be induced in a state in which the pressure in the vacuum-generating multistage Venturi 50 is decreased to be lower than 1 atm and the temperature is lower than 100°C, and a rate of vaporization and expansion is further increased in a state of low pressure, which further increases a spray flow velocity.

[0066] As a result, the fluid is sprayed at high speed in the Venturi by the vaporization and expansion of the fluid mixture, such that a suction force for sucking smoke and toxic gas is greatly increased. This is the principle on which the gas created in the event of a fire is sucked into the vacuum-generating multistage Venturi 50.

[0067] With the operation of the vacuum-generating multistage Venturi 50, among the gases passing through the vacuum-generating multistage Venturi 50 in the smoke removal system of the present embodiment, liquid particulate-based toxic gas is dissolved or diluted in water, solid particulate-based soot, ultra-fine dust, and the like are physically adsorbed, and hot heat and expanded moisture vapor are cooled by the water.

[0068] The gas created in the event of a fire is a substance created when a combustible substance is combusted. The gas is a complex mixture having a high temperature and containing very sticky solid particulates, droplet particles such as liquid tar, atomized vapor, and gaseous molecules. The toxic gas is dissolved or diluted in water and then discharged to the outside while flowing toward the lower portion of the mixing conduit 43.

[0069] While the present invention has been described above in detail with reference to the specific embodiments, the present invention is not limited to the embodiments but may be variously modified by those skilled in the art without departing from the technical spirit of the present invention.

Claims

1. An intake-type smoke removal system, which discharges gas flowing into a smoke removal zone to the outside of the smoke removal zone, the intake-type smoke removal system comprising:

   a vacuum-generating multistage Venturi configured to allow water provided from the outside to pass therethrough, the vacuum-generating multistage Venturi being configured to generate negative pressure based on the Venturi effect while the water passes therethrough to suck the gas in the smoke removal zone, mix the sucked gas with the water, and discharge the gas mixed with the water;
   a water supply unit configured to supply the water to the vacuum-generating multistage Venturi; and
   a nozzle configured to spray the water, which is supplied through the water supply unit, into the vacuum-generating multistage Venturi.

2. The intake-type smoke removal system of claim 1, wherein the vacuum-generating multistage Venturi is installed in a common duct that communicates with the smoke removal zone of each floor through a through-path, and
   wherein the water supply unit comprises:

   a water supply pump configured to pump the water;
   a main water supply pipe configured to guide the water, which is pumped by the water supply pump, to the vacuum-generating multistage Venturi; and
   a branch pipe connected to the main water supply pipe, extending to an inlet part of the vacuum-generating multistage Venturi, and connected to the nozzle.

3. The intake-type smoke removal system of claim 2, wherein the vacuum-generating multistage Venturi is provided as a plurality of vacuum-generating multistage Venturis disposed to be spaced apart from one another vertically, and
wherein a blocking guide plate is provided between the vacuum-generating multistage Venturis to prevent water sprayed from the upper vacuum-generating multistage Venturi from striking the lower vacuum-generating multistage Venturi.

4. The intake-type smoke removal system of claim 3, further comprising:

   a mixing conduit extending vertically and configured to accommodate the vacuum-generating multistage Venturi and the blocking guide plate and guide downward a mixture of gas and water discharged from the vacuum-generating multistage Venturi.

5. The intake-type smoke removal system of claim 1, wherein the vacuum-generating multistage Venturi comprises:

   a spray pipe having an upper end at which the nozzle is provided, the spray pipe being configured to discharge the water sprayed from the nozzle; and
   a Venturi casing configured to surround the spray pipe and guide downward the water sprayed through the spray pipe, the Venturi casing having a shape having a diameter that increases downward.

6. The intake-type smoke removal system of claim 5, wherein the spray pipe comprises:

   a first spray pipe coupled to the nozzle and having an inlet port through which water and gas are simultaneously introduced, and an outlet part through which the water mixed with the gas is discharged;
   a second spray pipe configured to accommodate the first spray pipe and having an inlet port through which gas is sucked, and an outlet part through which the introduced gas and the water mixed with the gas discharged from the first spray pipe are mixed and discharged, and
   wherein mixing blades are formed in the outlet parts of the first and second spray pipes and mix the introduced water and gas by allowing the introduced water and gas to collide with each other.

7. The intake-type smoke removal system of claim 6, wherein the Venturi casing comprises:

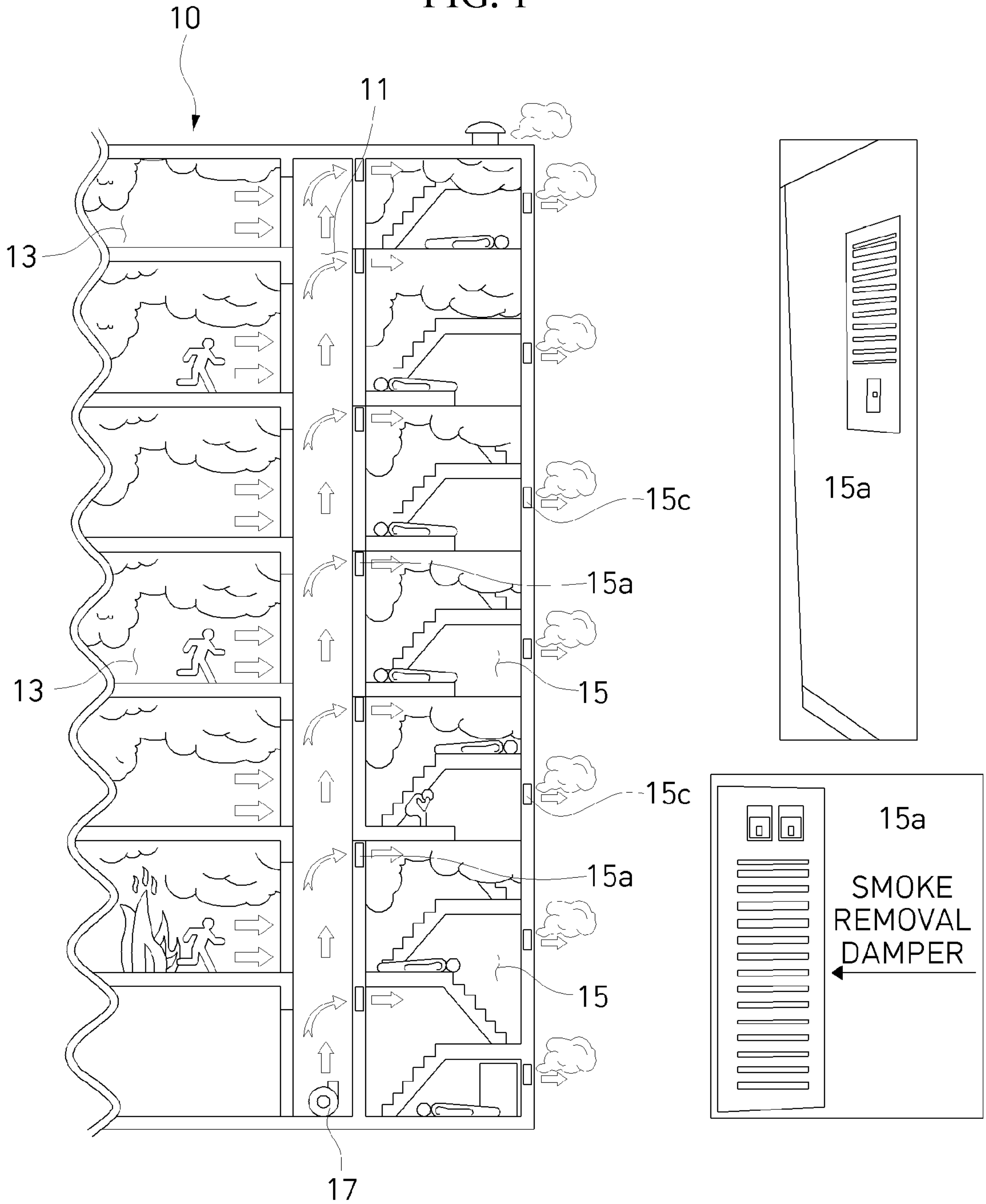
   a fixed pipe configured to accommodate the second spray pipe and having an inlet port provided at an upper end thereof so that gas is sucked through the inlet port;
   a rotary pipe rotatably installed at a lower end of the fixed pipe; and
   impeller blades positioned inside the rotary pipe and configured to rotate the rotary pipe by receiving kinetic energy from water while colliding with the sprayed water.

8. The intake-type smoke removal system of claim 7, wherein an accommodation groove is formed at a lower end of the fixed pipe, extends in a circumferential direction, and has a predetermined cross-sectional shape in the circumferential direction, and
wherein a bent insertion end portion is formed at an upper end of the rotary pipe, supported by being inserted into the accommodation groove, and configured to be slidable in the circumferential direction while being kept inserted into the accommodation groove.

9. The intake-type smoke removal system of claim 8, further comprising:
an oilless solid lubrication coating or a ring-shaped bearing installed between the bent insertion end portion and the accommodation groove.

10. The intake-type smoke removal system of claim 4, further comprising:
a water supply pump configured to reuse water discharged through the mixing conduit.

FIG. 1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SMOKE
REMOVAL
DAMPER

FIG. 2

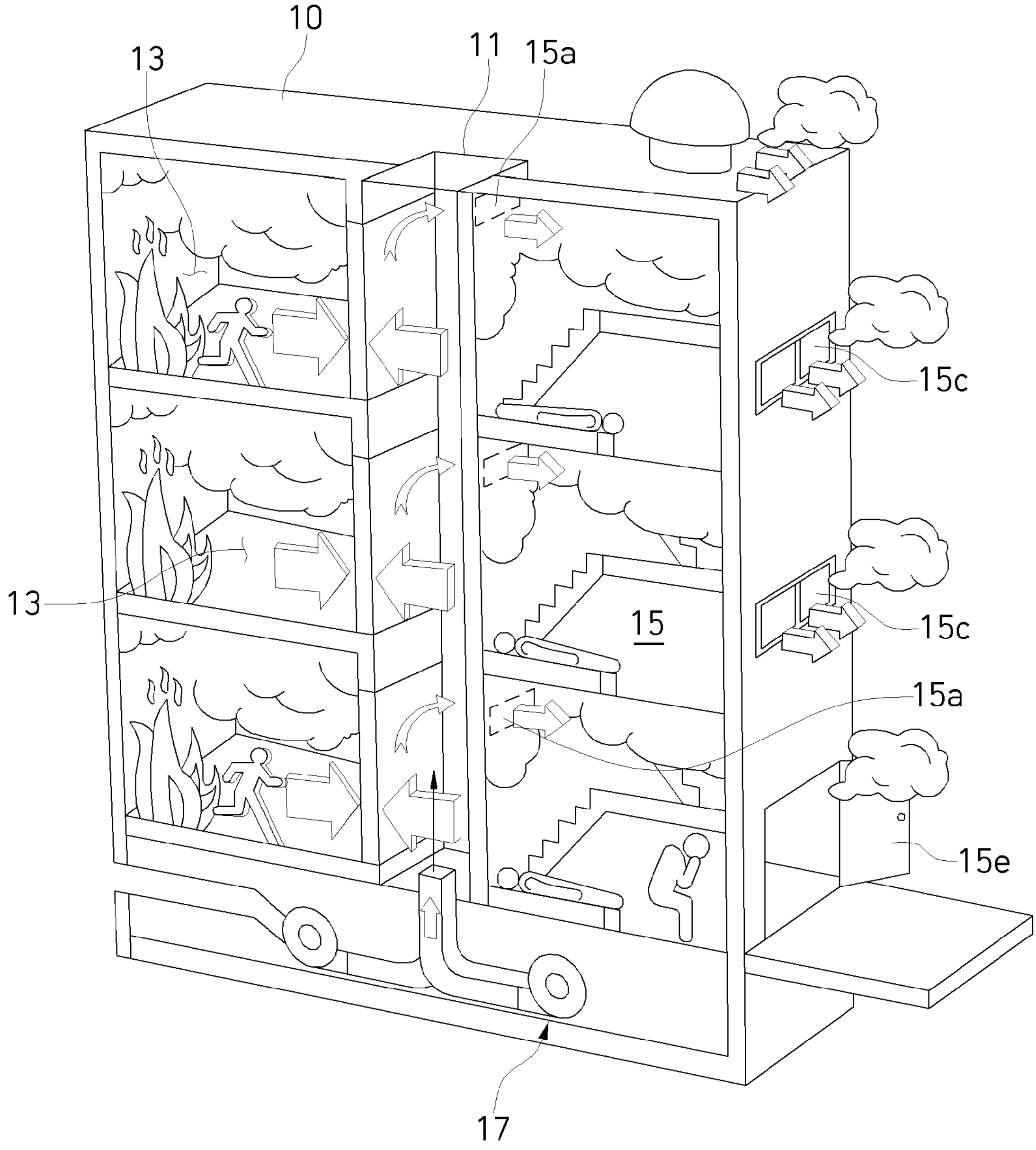

FIG. 3

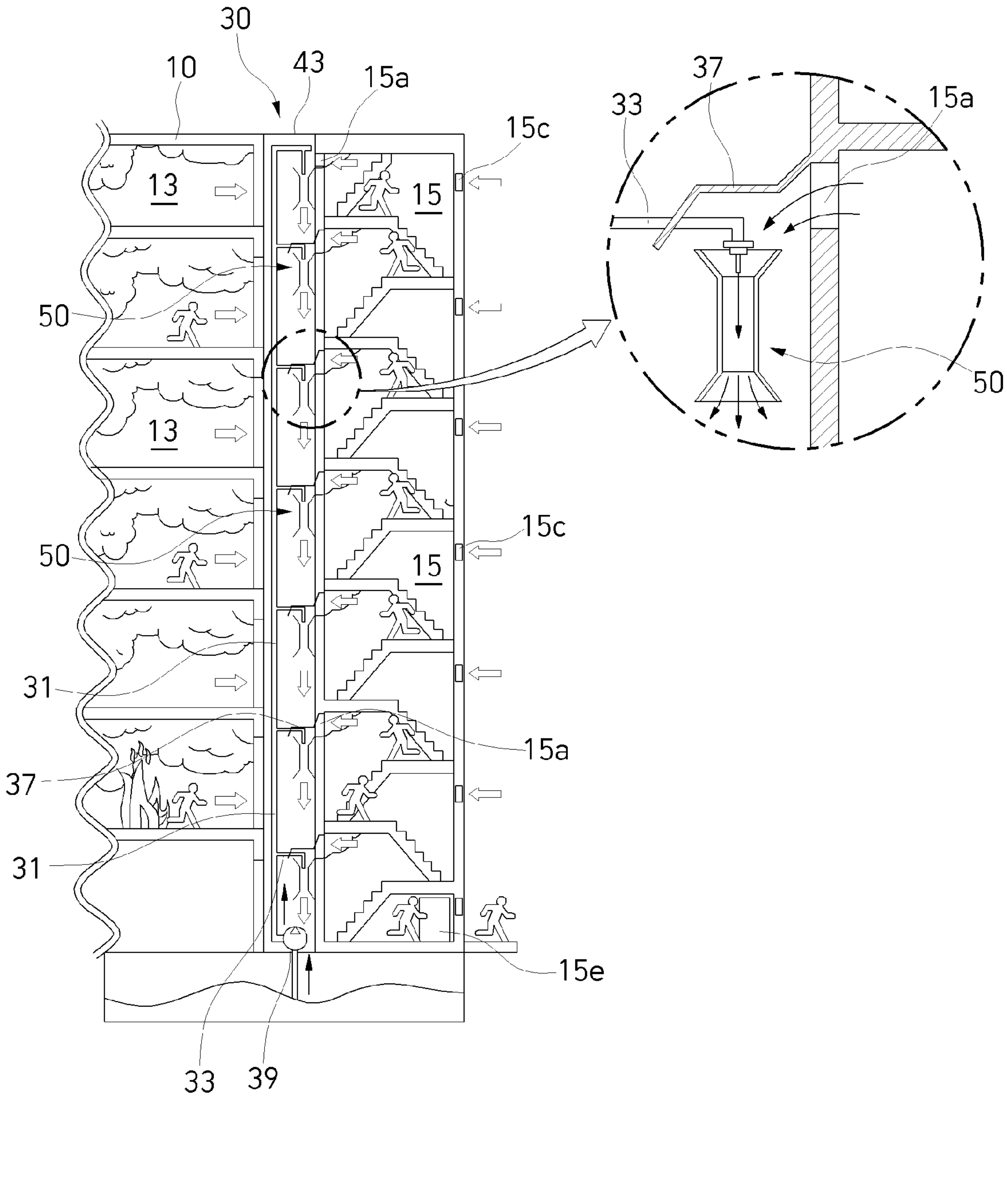
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FIG. 4

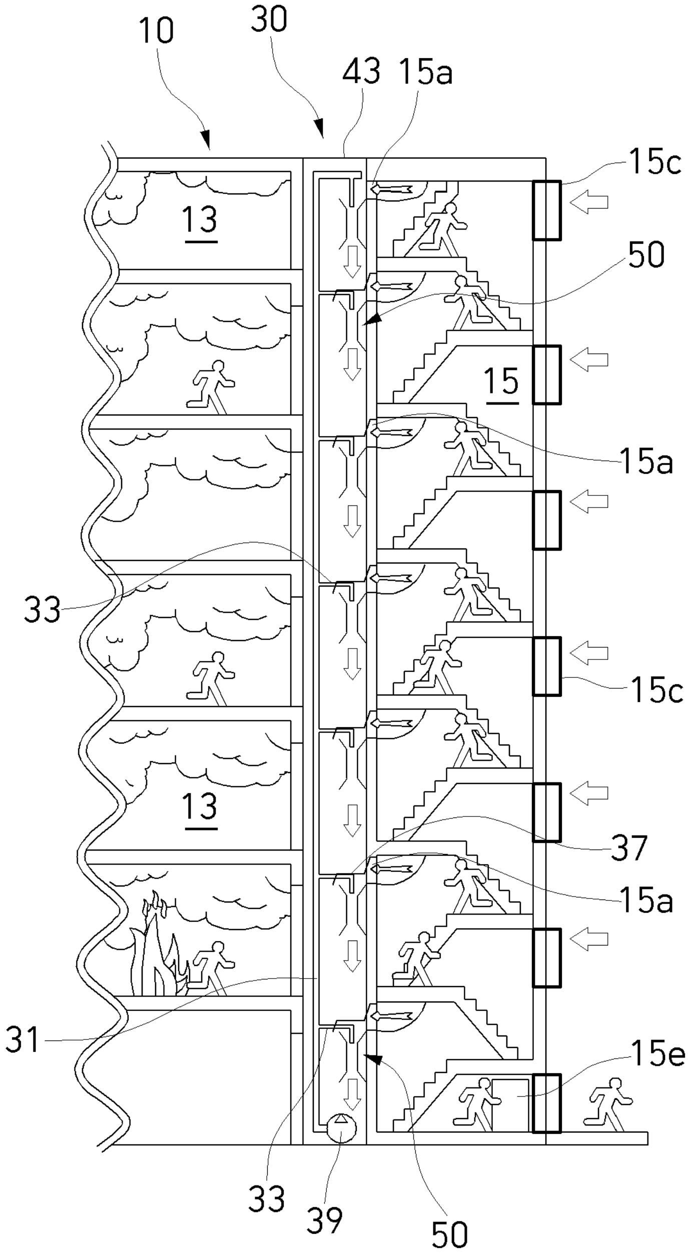

FIG. 5

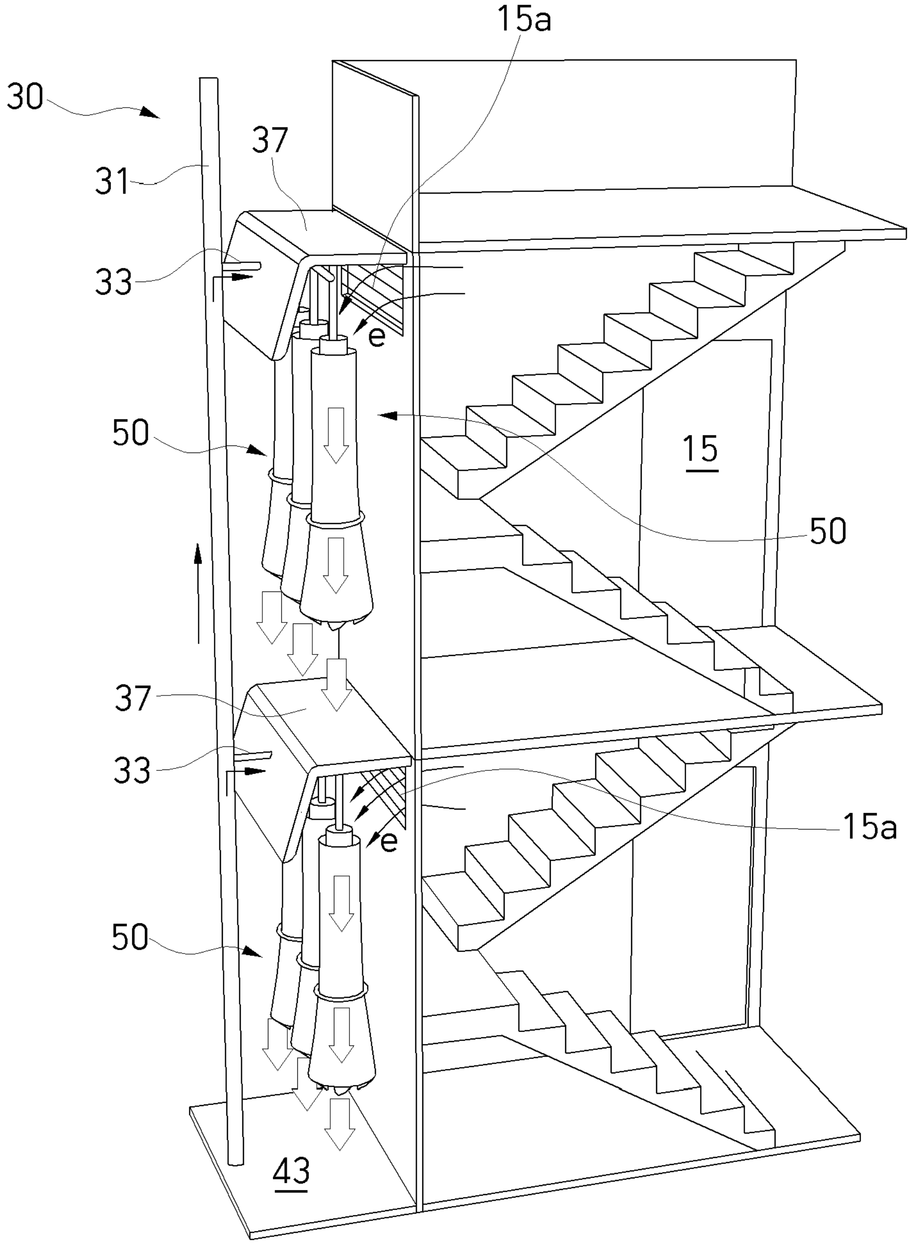

FIG. 6

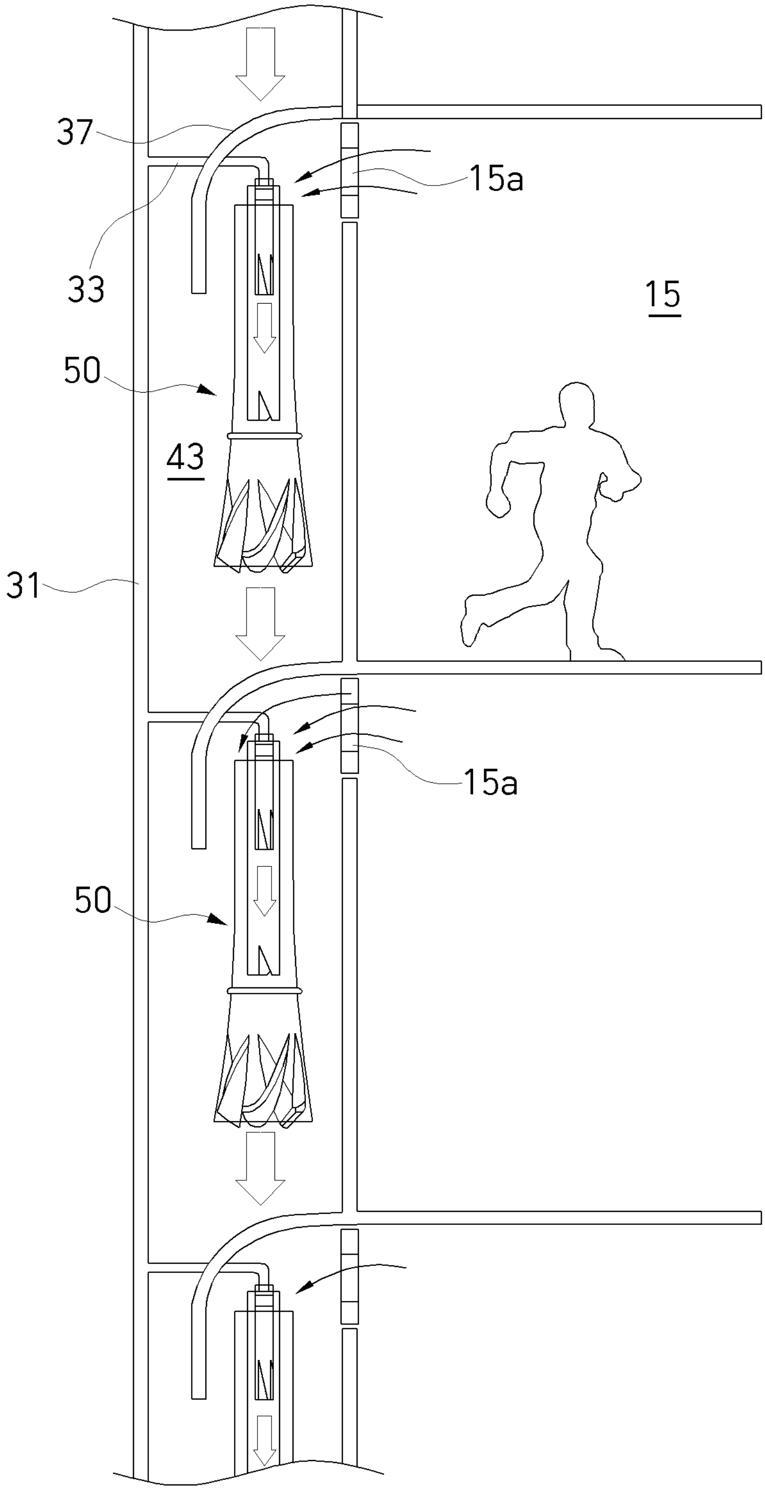

FIG. 7A

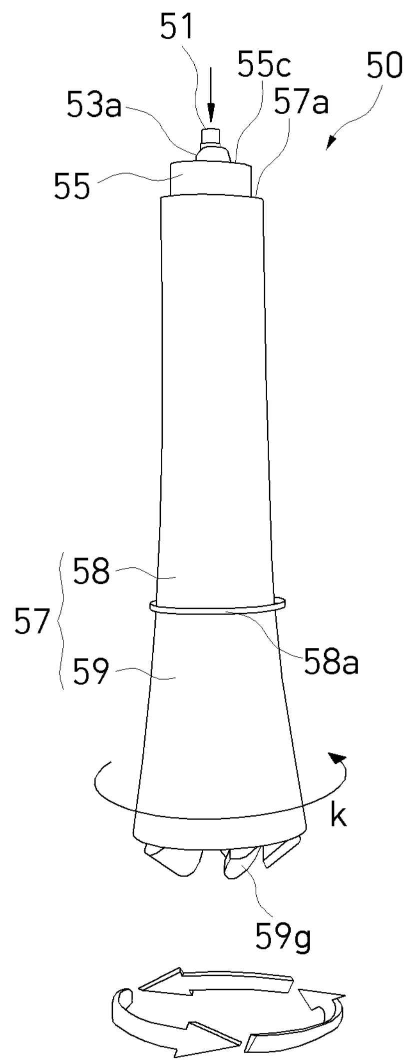

FIG. 7B

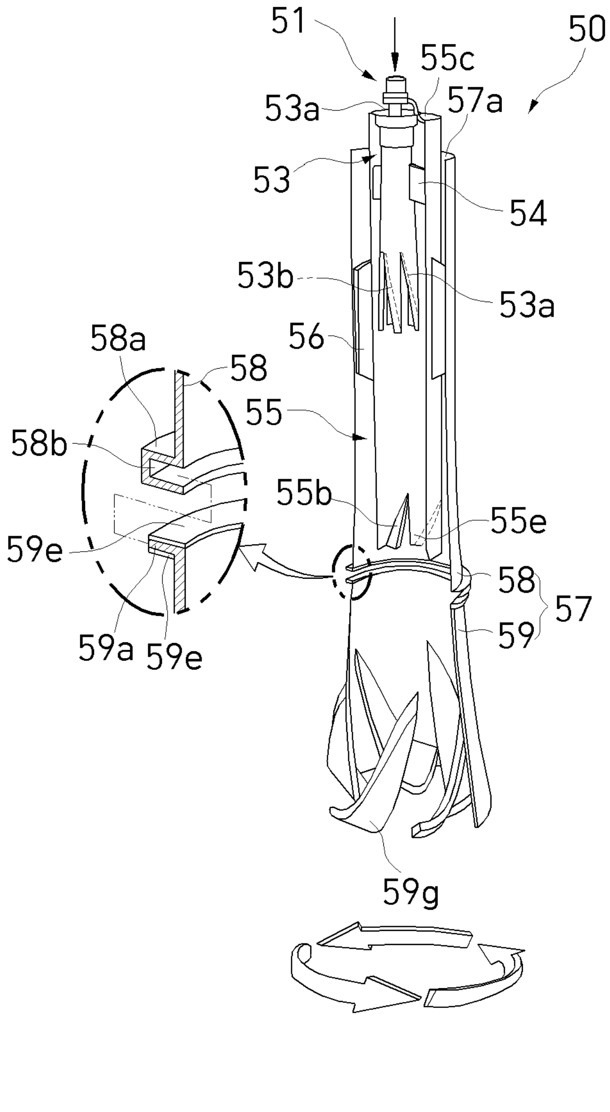
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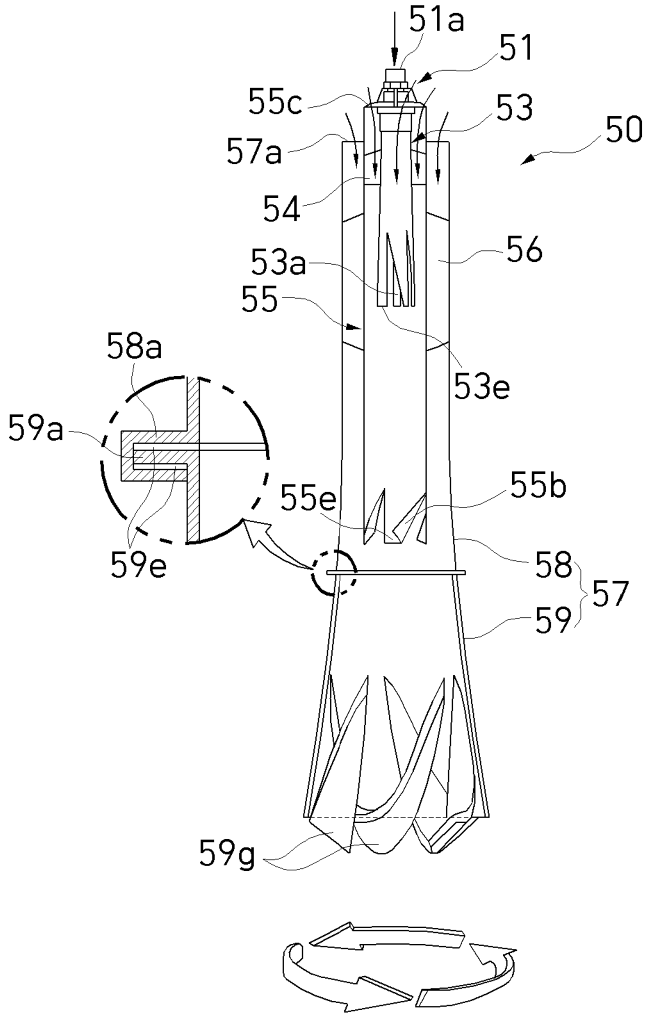
FIG. 7C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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/015096

A. CLASSIFICATION OF SUBJECT MATTER

F24F 7/007(2006.01)i; **F04F 5/04**(2006.01)i; **A62B 13/00**(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 7/007(2006.01); A62C 2/00(2006.01); A62C 2/06(2006.01); A62C 35/58(2006.01); A62C 35/68(2006.01); E04F 17/02(2006.01); F24C 15/20(2006.01)

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

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 제연구역(smoke removal zone), 용해(dissolution), 혼합(mixing), 다단 벤츄리관 (multiple venturi pipe), 노즐(nozzle)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2014-0002970 A (KIM, Sung Woo et al.) 09 January 2014 (2014-01-09) See paragraphs [0017], [0019] and [0030]-[0053] and figure 7.	1,5
Y		2
A		3-4,6-10
Y	KR 10-1662267 B1 (DONG HWA E&C CO., LTD.) 05 October 2016 (2016-10-05) See paragraphs [0038]-[0044] and figure 1.	2
Y	KR 20-2007-0001065 U (KIM, Chang Hwan) 04 October 2007 (2007-10-04) See paragraph [0032] and figure 1.	2
A	KR 10-1376962 B1 (HAN SHIN CONSTRUCTION CO., LTD.) 20 March 2014. See paragraphs [0025]-[0050] and figures 2-4.	1-10

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2022	**16 February 2022**

Name and mailing address of the ISA/KR	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/015096

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102080443 A (GUOWEI, Luo) 01 June 2011 (2011-06-01) See claims 1-10 and figure 1.	1-10

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2021/015096

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2014-0002970 A	09 January 2014	AU 2012-360313 A1	21 August 2014
		AU 2017-202676 A1	11 May 2017
		AU 2017-202676 B2	29 November 2018
		BR 112014016075 A2	13 June 2017
		BR 112014016075 A8	04 July 2017
		CA 2861760 A1	04 July 2013
		CA 2861760 C	27 February 2018
		CN 104114242 A	22 October 2014
		CN 104114242 B	22 March 2017
		EP 2799117 A1	05 November 2014
		JP 2015-507500 A	12 March 2015
		JP 6211002 B2	11 October 2017
		KR 10-1168831 B1	25 July 2012
		US 2014-0352698 A1	04 December 2014
		US 9700826 B2	11 July 2017
		WO 2013-100599 A1	04 July 2013
KR 10-1662267 B1	05 October 2016	None	
KR 20-2007-0001065 U	04 October 2007	None	
KR 10-1376962 B1		None	
CN 102080443 A	01 June 2011	CN 102080443 B	25 July 2012

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