Claims

[Claim 1]

A device for managing a fine particle concentration of a target region by supplying charges to the target region, the device comprising:

a container configured to store liquid;

at least one nozzle configured to output the liquid;

a pump configured to supply the liquid from the container to the at least one nozzle;

a power supply configured to supply power to the device; and

a controller configured to ~~su~~apply ~~the~~ a negative voltage ~~charges~~ to ~~the target region through~~ the at least one nozzle by using the power supply such that:

a) electrical field between the at least one nozzle and surrounding terrain feature where the device is installed can be formed and

b) electrons can be supplied to the target region in open space through the at least one nozzle,

wherein the electrons are ~~controller is configured to, by using the power~~ supply~~y~~ied by providing negatively~~, output~~ charged droplets through the at least one nozzle,

wherein the negatively charged droplets are provided by:

a) applying ~~a~~ the negative voltage equal to or greater than a first reference value to the at least one nozzle, and

b) ~~form space charge in the target region by~~ supplying the stored liquid from ~~charges to~~ the container to ~~target region through~~ the at least one nozzle~~charged droplets~~,

wherein the electrons supplied ~~controller is configured~~ to ~~output~~ the ~~charged droplets, charge~~ target region induce, the fine

particles in the target region ~~through the~~to be negatively charged ~~droplets, and provide electric force in a direction away from the device to the charged fine particles through the formed space charge~~,

wherein the ~~electric force provided to the~~negatively charged fine particles~~—~~, the electrons and the negatively charged droplets form a spatial ~~is at least partially provided by~~ electric field having a non-uniform charge density between the at least one nozzle and the surrounding terrain feature where the device is installed, and

whereby the negatively~~formed by~~ charged~~s~~ ~~supplied to the target region, and~~

~~wherein the~~ fine particles in the target region in the open space are forced by:

a) ~~charged with~~ the electrical field formed by the at least one nozzle, and

b) ~~same polarity as~~ the spatial electric field formed by the electrons, the negatively ~~supplied~~ charged~~s~~ droplets and ~~by~~ the negatively~~supplied~~ charged~~s~~ fine particles

such that the negatively charged fine particles are pushed outwards from the device.

[Claim 2]

The device of claim 1,

wherein the controller is configured to, by supplying ~~a charged substance~~the electrons to the target region in the open space for more than a predetermined time period, maintain the spatial ~~ce~~ electric field formed by the electrons, the negatively charged droplets and the negatively charged fine particles for more than the predetermined time period ~~such that the charged fine particles are removed by receiving the electric force and moving in a ground direction.~~

~~**[Claim 3]**~~

~~The device of claim 1,~~

~~wherein the controller is configured to supply negative charges to the target region by using the power supply, and the controller is configured to release negatively charged droplets through the at least one nozzle by applying a negative voltage to the at least one nozzle using the power supply.~~

~~**[Claim 4]**~~

~~The device of claim 1,~~

~~wherein the controller is configured to form negative space charge in the target region by supplying charges to the target region through the at least one nozzle using the power supply, and~~

~~wherein the electric force provided to the fine particles is at least partially provided by electric field by the negative space charge.~~

~~**[Claim 5]**~~

~~The device of claim 1,~~

~~wherein the controller is configured to provide electric force~~

~~including a component directed to a ground to the fine particles in the target region by using the power supply.~~

[Claim ~~6~~3]

The device of claim 1,

wherein the controller is configured to determine ~~apply power equal to or greater than~~ the first reference value ~~determined~~ by considering a predetermined effective radius to the at least one nozzle by using the power supply, and

wherein the predetermined effective radius is a distance to a point at which the fine particles concentration decreases to a reference ratio within a reference time period.

[Claim ~~7~~4]

The device of claim 1,

wherein the controller is configured to ~~apply a voltage equal to or greater than~~ determine the first reference value ~~determined~~ to output a current from 10μA to 10mA through the at least one nozzle ~~to the at least one nozzle by using the power supply~~.

[Claim ~~8~~5]

The device of claim 1,

wherein the controller is further configured to control the negative~~apply a~~ voltage applied ~~equal to or less than a second reference value~~ to the at least one nozzle to be equal to or less than~~by using~~ the second reference value~~power supply~~, wherein the second reference value is determined to prevent direct discharge of a charge from the nozzle.

[Claim ~~9~~6]

A device for managing a fine particle concentration of a target region by supplying charges to the target region, the device comprising:

a container configured to store liquid;

at least one nozzle configured to output the liquid;

a pump configured to supply the liquid from the container to the at least one nozzle;

a power supply configured to supply power to the device; and

a controller configured to apply a negative voltage to the at least one nozzle by using the power supply such that:

a) electrical field between the at least one nozzle and surrounding terrain feature where the device is installed can be formed, and

b) electrons can be supplied ~~a charged substance~~ to the target region in an open space through the at least one nozzle ~~by using the power supply~~; and

a particle dispersion unit configured to provide non-electric force to ~~the charged substance~~ near the nozzle,

wherein the electrons are supplied by providing negatively charged droplets through the at least one nozzle,

wherein the negatively charged droplets are provided ~~controller is configured to,~~ by

~~using the power supply, output charged droplets through the at least one nozzle by~~a) applying ~~a~~ the negative voltage equal to or greater than a first reference value to the at least one nozzle, and

b) ~~form space charge in the target region by~~ supplying the stored liquid from the container to the at least one nozzle~~charges to the target region through the charged droplets~~,

wherein the electrons supplied to the target region induce the ~~controller is configured to provide electric force in a direction away from the device to charged~~ fine particles ~~charged by the charges supplied to~~in the target region ~~through the space~~to be negatively charged,

wherein the negatively charged fine particles, the electrons and the negatively charged droplets form a spatial electric field having a non-uniform charge density between the at least one nozzle and the surrounding terrain feature where the device is installed, and

whereby the negatively charged fine particles in the target region in the open space are forced by:

a) the electrical field formed by the at least one nozzle,

b) the spatial electric field formed by the electrons, the negatively charged droplets and the negatively charged fine particles, and

c) the non-electric force provided by the particle dispersion unit

such that the negatively charged fine particles are pushed outwards from the device.

[Claim ~~10~~7]

The device of claim ~~9~~6,

wherein the particle dispersion unit is configured to provide the non-electric force by spraying an electrically neutral substance near the at least one nozzle~~to the charged substance~~.

~~**[Claim 11]**~~

~~The device of claim 9,~~

~~wherein the controller is configured to form the space charge in the target region by supplying the charged substance through the at least one nozzle using the power supply.~~

~~**[Claim 12]**~~

~~The device of claim 11,~~

~~wherein the at least one nozzle includes one end from which the charged droplets are released, and~~

~~wherein the controller is configured to provide the non-electric force in a direction away from the one end to the charged substance near the one end by using the particle dispersion unit such that a density of the space charge near the one end is at least partially reduced.~~

[Claim ~~13~~8]

The device of claim ~~9~~6,

wherein the particle dispersion unit includes at least one air nozzle configured to spray~~ing~~ a gas, and is configured to spray the gas in a direction away from the at least one nozzle ~~to the charged substance~~.

[Claim ~~14~~9]

A method for managing a concentration of fine particles in a target region by using a device being located at a predetermined distance from a ground and supplying ~~charges~~ electrons to the target region,

wherein the device comprises a container configured to store

liquid, at least one nozzle configured to output the liquid, a pump configured to supply the liquid from the container to the at least one nozzle, a power supply configured to supply power and a controller configured to ~~su~~apply ~~the charges~~a negative voltage to ~~the target region through~~ the at least one nozzle by using the power supply,

the method comprising:

applying, by the controller, ~~a~~ the negative voltage equal to or greater than a first reference value to the at least one nozzle ~~by using the power supply~~;

supplying, by the controller, the liquid to the at least one nozzle by using the pump;

outputting, by the controller, negatively charged droplets through the at least one nozzle by using the power supply and the pump, ~~and forming space charge in~~such that the electrons are supplied to the target region ~~by supplying the charges to the target region through the charged droplets~~in an open space; and

~~charging, by the controller,~~inducing the fine particles in the target region to br negatively~~through the~~ charged ~~droplets, and providing,~~ by the ~~controller,~~supplied electron~~sic~~,

wherein the negatively charged ~~force at least partially including a component directed away from the device to the~~ fine particles the electrons and the negatively charged droplets form a spatial electric field having a non-uniform charge density between the at least one nozzle and the surrounding terrain feature where the device is installed, and

whereby the negatively charged fine particles in~~charged with the same polarity as the supplied charges by the charges supplied to~~ the target region ~~through~~ in the open space are forced by:

a) the electrical field formed by the at least one nozzle and

b) the spatial electric field formed by the electrons, the negatively charged droplets and the negatively charged fine particles

such that the negatively charged fine particles are pushed outwards from the device.

~~**[Claim 15]**~~

~~The method of claim 14,~~

~~wherein the providing, by the controller, the electric force to the fine particles includes forming electric field between the ground and the device in the target region by forming the space charge in the target region, and providing the electric force to the fine particles through the formed electric field.~~

[Claim ~~16~~10]

The method of claim ~~14~~9, wherein the method further comprises:

maintaining~~, by the controller, by supplying~~ to output the negatively charged ~~substance~~ droplets to the target region for more than a predetermined time period~~, the space charge for more than the predetermined time period such that the charged fine particles are removed by receiving the electric force and moving in a ground direction~~.

~~**[Claim 17]**~~

~~The method of claim 14,~~

~~wherein the controller is configured to form negative space charge in the target region by supplying negative charges to the target region through the at least one nozzle using the power supply, and~~

~~wherein the electric force provided to the fine particles is at least partially provided by electric field by the negative space charge.~~

[Claim ~~18~~11]

The method of claim ~~14~~9,

wherein the device further comprises a particle dispersion unit configured to provide non-electric force to ~~the charged substance~~near the at least one nozzle, and

wherein the method further comprises providing, by the controller, non-electric force to ~~the charged substance~~ near ~~one end of~~ the at least one nozzle such that negatively charged fine particles in the target region are also forced by the provided non-electric force~~at which the droplets are generated in a direction away from the one end by using the particle dispersion unit~~.

~~**[Claim 19]**~~

~~The method of claim 18,~~

~~wherein the providing the non-electric force further comprises providing the non-electric force by spraying an electrically neutral substance to the charged substance.~~

~~**[Claim 20]**~~

~~The method of claim 18,~~

~~wherein the supplying, by the controller, the charges to the target region comprises forming space charge that forms electric field in the target region by supplying, by the controller, the charges to the target region, and~~

~~wherein the providing, by the controller, the non-electric force further comprises providing, by the controller, non-electric force including a component directed away from the one end to the charged substance to reduce a distribution density of the space charge near the one end.~~

[Claim 12]

The method of claim 9,

wherein the first reference value is determined by considering a predetermined effective radius, and

wherein the predetermined effective radius is a distance to a point at which the fine particles concentration decreases to a reference ratio within a reference time period.

[Claim 13]

The method of claim 9,

wherein the first reference value is determined to output a current from 10μA to 10mA through the at least one nozzle.

[Claim 14]

The method of claim 9, further comprising:

controlling the negative voltage applied to the at least one nozzle to be equal to or less than the second reference value, wherein the second reference value is determined to prevent direct discharge of a charge from the nozzle.