United States Patent Application Publication	20250262648
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	JI; Moon Young

CLEANER FOR AN IONIZER, OPERATING METHOD THEREOF AND IONIZER CLEANING SYSTEM

Abstract

A cleaner for an ionizer may include a communication interface, a cleaning member, a driver and a controller. The communication interface may be configured to communicate information with the ionizer. The cleaning member may be moved along a wire of the ionizer to remove and collect particles. The driver may be configured to drive the cleaning member. Further, the driver may recognize a starting of the cleaning member from a beginning spot of the wire, an arriving of the cleaning member at an ending spot of the wire, or a returning of the cleaning member to the beginning spot of the wire. The controller may control whole operations of the cleaner. The whole operations of the cleaner may include identifying states including the driving of the ionizer through the communication interface, removing the particles on the wire by driving the cleaning member through the driver, etc.

Inventors: **JI; Moon Young (Gyeonggi-do, KR)**

Applicant: **SK hynix Inc.** (Gyeonggi-do, KR)

Family ID: **1000008586935**

Appl. No.: **19/201889**

Filed: **May 07, 2025**

Foreign Application Priority Data

KR	10-2021-0020422	Feb. 16, 2021
KR	10-2021-0126519	Sep. 24, 2021

Related U.S. Application Data

parent US division 17565196 20211229 parent-grant-document US 12325051 child US 19201889

Publication Classification

Int. Cl.: **B08B1/12** (20240101); **B03C3/74** (20060101); **B08B5/04** (20060101); **B08B15/00** (20060101)

U.S. Cl.:

CPC **B08B1/12** (20240101); **B08B5/04** (20130101); **B08B15/007** (20130101); B03C3/743 (20130101); B03C2201/04 (20130101)

Background/Summary

CROSS-REFERENCES TO RELATED APPLICATION [0001] This application is a divisional of U.S. patent application Ser. No. 17/565,196 filed on Dec. 29, 2021, which claims priority under 35 U.S.C. § 119(a) to Korean Patent application number 10-2021-0020422, filed on Feb. 16, 2021, and Korean Patent application number 10-2021-0126519, filed on Sep. 24, 2021, in the Korean Intellectual Property Office, which are incorporated herein by reference in their entirety.

BACKGROUND

1. Technical Field

[0002] Various embodiments may generally relate to a cleaner for an ionizer, an operating method thereof, and an ionizer cleaning system. More particularly, various embodiments may relate to a cleaner for an ionizer that may be capable of performing an automatic cleaning operation with improved cleaning efficiency to maintain the ionizer with an optimal state, an operating method thereof and an ionizer cleaning system.

2. Related Art

[0003] Recently, an electrostatic generated in various equipment such as semiconductor equipment may cause deterioration, fires, etc., of the equipment due to a foreign substance such as for example a charged dust particle. Thus, various ionizers may be applied to the various equipment.

[0004] The ionizer may apply cations or anions, which may be generated by discharging a high voltage, to an object to neutralize the object having a polarity opposite a polarity of the electrostatic, thereby removing the electrostatic.

[0005] In order to maintain a capacity of the ionizer, it may be required to cleanly maintain the ionizer.

[0006] The ionizer may be classified into a bar type, a nozzle type and a wire type in accordance with formation structures of a region where ions may be generated.

[0007] The wire type ionizer may be manually cleaned using a cleaner by a worker. The wire may be cut in cleaning the wire type ionizer.

[0008] Further, additional time and endeavor of the worker may be required to manage the ionizer. Moreover, when the ionizer is cleaned while operating the ionizer, the quality of the object may deteriorate.

SUMMARY

[0009] Embodiments of the invention provide a cleaner for a wire type ionizer that may have improved cleaning efficiency.

[0010] Embodiments of the invention also provide a method of operating the above-mentioned cleaner.

[0011] Embodiments of the invention still also provide an ionizer cleaning system.

[0012] In one embodiment, a cleaner for an ionizer may include a communication interface, a cleaning member, a driver and a controller. The communication interface may be configured to

communicate information with the ionizer. The cleaning member may be moved along a wire of the ionizer to remove and collect particles. The driver may be configured to drive the cleaning member. Further, the driver may recognize a starting of the cleaning member from a beginning spot of the wire, an arriving of the cleaning member at an ending spot of the wire, or a returning of the cleaning member to the beginning spot of the wire. The controller may control whole operations of the cleaner. The whole operations of the cleaner may include identifying states including the driving of the ionizer through the communication interface, removing the particles on the wire by driving the cleaning member through the driver, etc.

[0013] In one embodiment, an ionizer cleaning system may include a wire type ionizer and a cleaner. The ionizer may generate cation or anion to an object. The cleaner may be moved along the wire of the ionizer to remove particles. The cleaner may include a communication interface, a cleaning member, a driver and a controller. The communication interface may be configured to communicate information with the ionizer. The cleaning member may be moved along a wire of the ionizer to remove and collect particles. The driver may be configured to drive the cleaning member. Further, the driver may recognize a starting of the cleaning member from a beginning spot of the wire, an arriving of the cleaning member at an ending spot of the wire, or a returning of the cleaning member to the beginning spot of the wire. The controller may control whole operations of the cleaner. The whole operations of the cleaner may include identifying states including the driving of the ionizer through the communication interface, removing the particles on the wire by driving the cleaning member through the driver, etc.

[0014] In one embodiment, according to a method of operating a cleaner for an ionizer, when a clean beginning signal may be generated, whether a driving of the ionizer may be stopped or not may be identified. When the driving of the ionizer may be stopped, a cleaning member may be driven. The cleaning member may be moved from a beginning spot of the wire to the beginning spot of the wire via an ending spot of the wire to remove particles from the wire. The cleaning of the cleaning member may be terminated. A drive request signal may then be transmitted to the ionizer. Cleaning data obtained in cleaning the ionizer may be collected and analyzed.

[0015] In one embodiment, an ionizer cleaning system may include a plurality of ionizers, a plurality of cleaners and a clean management server. Identification information (ID) may be allotted to the ionizers, respectively. The cleaners may be detachably installed at the ionizers, respectively. Identification information (ID) may be allotted to the cleaners. The clean management server may control the ionizers and the cleaners. The clean management server may identify states including the driving of the ionizer. The clean management server may drive the cleaner based on the states of the ionizer to remove particles on a wire of each of the ionizers.

[0016] According to various embodiments, the wire type ionizer may be automatically cleaned by the cleaner, not manually cleaned using a cleaner by a worker to improve cleaning efficiency of the ionizer.

[0017] Further, a cleaning history of the ionizer may be stored and managed. The cleaning of the ionizer may be controlled and a cleaning cartridge may be exchanged for a new one based on the cleaning history to maintain the ionizer having optimal state.

[0018] Furthermore, the cleaner may remove the foreign substance on the wire along a predetermined rail to prevent the wire from being damaged.

[0019] Moreover, the cleaning may be performed after operation stages of the ionizer to prevent damages of the ionizer due to the cleaning.

[0020] Further, the cover frame may be configured to safely protect the ionizer and the cleaner, to prevent the inflow of foreign particles from outside and to effectively remove residual(s) around the wire thereby preventing the wire from being damaged.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above and another aspects, features and advantages of the subject matter of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[0022] FIG. **1** is a view illustrating an ionizer cleaning system in accordance with example embodiments;

[0023] FIG. **2** is a block diagram illustrating a cleaner in accordance with example embodiments;

[0024] FIGS. **3** to **6** are views illustrating operations of a cleaner in accordance with example embodiments;

[0025] FIG. **7** is a flow chart illustrating a method of operating a cleaner in accordance with example embodiments;

[0026] FIG. **8** is a detailed flow chart illustrating the method in FIG. **7**;

[0027] FIGS. **9**A, **9**B and **10** are views illustrating an ionizer cleaning system in accordance with example embodiments;

[0028] FIG. **11** is a block diagram illustrating a cleaner in accordance with example embodiments;

[0029] FIG. **12** is a block diagram illustrating an ionizer cleaning system in accordance with example embodiments;

[0030] FIG. **13** is a view illustrating an ionizer cleaning system in accordance with example embodiments;

[0031] FIG. **14** is a front view diagram illustrating an ionizer cleaning system in accordance with example embodiments;

[0032] FIG. **15** is a side view illustrating an ionizer cleaning system in accordance with example embodiments; and

[0033] FIG. **16** is a rear view illustrating an ionizer cleaning system in accordance with example embodiments.

DETAILED DESCRIPTION

[0034] Various embodiments of the present invention will be described in greater detail with reference to the accompanying drawings. The drawings are schematic illustrations of various embodiments (and intermediate structures). As such, variations from the configurations and shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, the described embodiments should not be construed as being limited to the particular configurations and shapes illustrated herein but may include deviations in configurations and shapes which do not depart from the spirit and scope of the present invention as defined in the appended claims.

[0035] The present invention is described herein with reference to cross-section and/or plan illustrations of idealized embodiments of the present invention. However, embodiments of the present invention should not be construed as limiting the inventive concept. Although a few embodiments of the present invention will be shown and described, it will be appreciated by those of ordinary skill in the art that changes may be made in these embodiments without departing from the principles and spirit of the present invention.

[0036] FIG. **1** is a view illustrating an ionizer cleaning system in accordance with example embodiments, and FIG. **2** is a block diagram illustrating a cleaner in accordance with example embodiments.

[0037] Referring to FIG. **1**, an ionizer cleaning system **10** may include an ionizer **100** and a cleaner **200**.

[0038] The ionizer **100** may have a wire type structure configured to generate cations or anions to direct toward an object and which may neutralize the object.

[0039] The cleaner **200** may move along a wire **120** of the ionizer **100** to remove a foreign substance (particles) such as for example particles from the ionizer **100**.

[0040] The cleaner **200** may be disposed at a body **110** of the ionizer **100**. The cleaner **200** may move backward and forward along the wire **120** disposed under the body **110** and spaced apart from the body **110**.
[0041] Ions may be generated from the wire **120** of the ionizer **100**. When a foreign substance may be adhered to the wire **120** or a white powder may be generated at the wire **120**, a corona discharge for generating the ions may not be desirably generated. Thus, the wire **120** in one embodiment would be maintained as a clean state to generate the desirable corona discharge.
[0042] The cleaner **200** may automatically clean the wire **120** with a minimum influence on a driving of the ionizer **100** so that the wire **120** may be maintained as an optimal state.
[0043] Referring to FIG. **2**, the cleaner **200** may include a communication interface **210**, a display **220**, a memory **230**, a cleaning member **240**, a driver **250** and a controller **260**.
[0044] The communication interface **210** may be interfaced with the ionizer **100** to transmit and receive information to and from the ionizer **100**.
[0045] The display **220** may display all information with respect to operations of the cleaner **200**. The information may include a history of cleaning, automatic clean information, a replacement time of a cleaning cartridge, a replacement history of the cleaning cartridge, a number of times that the cleaning member **240** cleans the wire **120**, etc.
[0046] The cleaning history may include at least one of a time of a cleaning operation of the cleaner **200**, an automatic or manual operation of the cleaning operation, a time of the cleaning operation, data of the cleaning operation, a total number of times that the cleaning operation is performed, a number of times that the cleaning operation is performed after replacement of the cleaning cartridge, etc., based on drive information of the cleaning member **240**. When automatic cleaning conditions including an automatic cleaning time, an automatic cleaning period, etc., may meet, the cleaner **200** may automatically perform the cleaning operation in the automatic mode. Further, the cleaner **200** may automatically perform the cleaning operation in the manual mode by inputting a command of the cleaning operation by a user.
[0047] When an alarm is made for the replacement time of the cleaning cartridge, the alarm may include additionally displaying a number of times that the cleaning cartridge operates as well as the replacement time of the cleaning cartridge.
[0048] The memory **230** may store information with respect to the cleaner **200**.
[0049] The cleaning member **240** may move along the wire **120** of the ionizer **100** to remove and collect the foreign substance.
[0050] When the cleaning member **240** may be on a standby state not to perform the cleaning operation, the cleaning member **240** may be placed in a region where the cleaning member **240** may not interrupt the ion generation of the ionizer **100**. For example, the region may be positioned outside the wire **120**.
[0051] The cleaning member **240** may include a cleaning cartridge **241**, a third detection sensor **244** and a dust collector **245**.
[0052] FIGS. **3** to **6** are views illustrating operations of a cleaner in accordance with example embodiments.
[0053] Referring to FIGS. **1**, **3**, **4** and **5**, the cleaner **200** may further include a driving rail **270** detachably disposed at one end of the ionizer **100**. The driving rail **270** may be substantially in parallel with the wire **120** of the ionizer **100**. The driving rail **270** may function such that a cleaning brush **241-2** of the cleaning member **240** is in contact with the wire **120** while the cleaning member **240** is operating.
[0054] Referring to FIGS. **3** to **5**, the cleaning member **240** may be connected to the driving rail **270** at one end of the ionizer **100**. During the cleaning member **240** may move along the driving rail **270**, the wire **120** may be inserted into a space between a first body **241-1***a* and a second body **241-1***b*.
[0055] Referring to FIGS. **5** and **6**, the cleaning cartridge **241** may include the first and second

bodies **241-1***a* and **241-1***b* and the cleaning brush **241-2**. The first body **241-1***a* may be formed at one side of the wire **120** during the cleaning member **240** may move along the wire **120**. The second body **241-1***b* may be formed at the other side of the wire **120** during the cleaning member **240** may move along the wire **120**. Thus, the first and second bodies **241-1***a* and **241-1***b* may face each other to cover the wire **120** for example in a perpendicular direction to a longitudinal direction of the wire **120** and may be spaced apart from each other. The cleaning brush **241-2** may be formed on an inner surface of each of the first and second bodies **241-1***a* and **241-1***b* to remove the foreign substance on the wire **120**.

[0056] The cleaning cartridge **241** may be detachably connected to a pedestal **242**. Thus, the cleaning cartridge **241** may be replaced with a new one in accordance with the replacement time by a use degree of the cleaning cartridge **241**, or arbitrarily replaced with a new one.

[0057] Additionally, the cleaning member **240** may further include the pedestal **242** and a collecting container **243** connected to the cleaning cartridge **241**.

[0058] The pedestal **242** may be arranged under the first and second bodies **241-1***a* and **241-1***b*. The pedestal **242** may include a collecting hole H formed at a region between the first and second bodies **241-1***a*and **241-1***b*.

[0059] The collecting container **243** may be arranged under the pedestal **242** to collect the foreign substance through the collecting hole H.

[0060] The collecting container **243** may be detachably connected to a lower portion of the pedestal **242**. Thus, the worker may detach the collecting container **242** from the pedestal **242** to manually remove the foreign substance.

[0061] The third detection sensor **244** may be configured to detect a weight of the foreign substance collected in the collecting container **243**.

[0062] Referring to FIGS. **5** and **6**, the third detection sensor **244** may be positioned under the collecting container **243** to detect the weight of the foreign substance collected in the collecting container **243**. The position of the third detection sensor **244** may be changed into other positions at which the weight of the foreign substance collected in the collecting container **243** may be detected.

[0063] Referring to FIG. **5**, the cleaning member **240** may further include the dust collector **245**. The dust collector **245** may be connected to the collecting container **243**. The dust collector **245** may inhale the foreign substance collected in the collecting container **243**. The dust collector **245** may then discharge the inhaled foreign substance to an outside of the ionizer **100**. Thus, the foreign substance may be moved through a duct between the collecting container **243** and the dust collector **245**.

[0064] The dust collector **245** may perform a dust collecting operation including inhaling the foreign substance and discharging the foreign substance. When the cleaning member **240** is returned to a beginning spot of the wire **120**, the cleaning member **240** may operate to detect the foreign substance in the collecting container **243**, or determine that the weight of the foreign substance collected in the collecting container **243** is no less than a predetermined reference weight.

[0065] Referring to FIG. **5**, the cleaning member **240** may move along the wire **120** during the cleaning operation. In various embodiments, the cleaning cartridge **241**, the pedestal **242**, the collecting container **243**, the third detection sensor **244** and the dust collector **245** may move along the wire **120**.

[0066] The driver **250** may be configured to drive the cleaning member **240**. The driver **250** may detect that the cleaning member **240** starts moving from a beginning spot of the wire **120**, reaches an ending spot of the wire **120** or returns to the beginning spot of the wire **120**.

[0067] Referring to FIG. **2**, the driver **250** may include a first driving motor **251**, a first detection sensor **253**, a second detection sensor **255** and a driving processor **257**.

[0068] The driving motor **251** may be configured to drive the cleaning member **240**.

[0069] The first detection sensor **253** may be positioned at the beginning spot of the wire **120** to detect that the cleaning member **240** starts moving from and returns to the beginning spot of the wire **120**.
[0070] The second detection sensor **255** may be positioned at the ending spot of the wire **120** to detect that the cleaning member **240** reaches the ending spot of the wire **120**.
[0071] At least one of first and second detection sensors **253** and **255** may be a position sensor including at least one of a contact type sensor and a non-contact type sensor.
[0072] In one embodiment, the first detection sensor **253** may be positioned at the beginning spot of the wire **120** and may be positioned outside a path of the wire **120** more than the cleaning member **240** to detect that the cleaning member **240** starts moving from and returns to the beginning spot according to approach and recession of the cleaning member **240**. This principle may also be applied to the second detection sensor **255**.
[0073] Alternatively, the first detection sensor **253** may be positioned at the beginning spot of the wire **120** and may be positioned inside the path of the wire **120** more than the cleaning member **240** to detect that the cleaning member **240** starts moving from and returns to the beginning point by sensing the cleaning member **240** passing thereby. This principle may also be applied to the second detection sensor **255**.
[0074] The driving processor **257** may be configured to drive and stop the driving motor **251** in accordance with the controls of the controller **260**. The driving processor **257** may transmit the driving information of the cleaning member **240** including the cleaning time, a return time, etc., obtained based on the detection information provided from the first and second detection sensors **253** and **255**.
[0075] The driving processor **257** may transmit the driving information of the cleaning member **240** during the cleaning operation may be performed as well as after the cleaning operation may be performed.
[0076] The controller **260** may identify operational states of the ionizer **100** including the driving of the ionizer **100** through the communication interface **210**. The controller **260** may drive the cleaning member **240** through the driver **250** to control the whole operations including removing the foreign substance on the wire **120**.
[0077] The controller **260** may identify the cleaning time of the cleaning member **240** through the driving information of the cleaning member **240**. The controller **260** may compare the identified cleaning time with a reference cleaning time. When the identified cleaning time may be greater than the reference cleaning time, the controller **260** may determine the cleaning member **240** to be abnormal.
[0078] For example, the cleaning time of the cleaning member **240** may be an amount of time that the cleaning member **240** moves from the beginning spot to reach the ending spot, that the cleaning member **240** moves from the beginning spot to the ending spot and returns to the beginning spot from the ending spot, or that the cleaning member **240** returns from the ending spot to the beginning spot.
[0079] When information that the cleaning member **240** reaches the ending spot is not transmitted to the controller **260** in a first reference time after detecting that the cleaning member **240** starts moving from the beginning spot, the controller **260** may determine the cleaning member **240** to be abnormal. Further, when return information of the cleaning member **240** to the beginning spot is not transmitted to the controller **260** in a second reference time after receiving information of the cleaning member **240** from the beginning spot to the ending spot, the controller **260** may also determine the cleaning member **240** to be abnormal.
[0080] The controller **260** may generate and manage the cleaning history including at least one of the date of the cleaning operation of the cleaner **200**, an automatic or manual cleaning operation, a cleaning time, data of the cleaning operation, a total number of times that the cleaning operation is performed, a number of times that the cleaning operation is performed after replacement of the

cleaning cartridge, etc., based on drive information of the cleaning member **240**. The cleaning history may be stored in the memory **230**. The data of the cleaning operation may include cleaning results including the normal operation and the abnormal operation.

[0081] When the predetermined automatic cleaning conditions is satisfied or the manual cleaning command is inputted, the controller **260** may drive the cleaning member **240** through the driving processor **257** to clean the wire **120**. The manual cleaning command may function as to perform the cleaning operation by the cleaning member **240** in accordance with a selection of a specific cleaning button by the worker regardless of the automatic cleaning condition.

[0082] The controller **260** may set the automatic cleaning condition including at least one of an automatic cleaning date, an automatic cleaning period, lapsed dates after the latest cleaning operation, a cleaning operable state including an operation stop state of the ionizer **100**, etc.

[0083] When the cleaning cartridge **241** is to be replaced according to a replacement period or a number of times that the cleaning member **240** operates reaches a threshold number that the cleaning cartridge **241** is to be replaced according to the driving information of the cleaning member **240** and replacement information of the cleaning cartridge **241**, the controller **260** may make an alarm of the replacement time of the cleaning cartridge **241**.

[0084] The replacement information of the cleaning cartridge **241** may include a replacement history of the cleaning cartridge **241** including replacement dates.

[0085] The controller **260** may drive or stop the ionizer **100** in accordance with the driving of the cleaning member **240**. When the ionizer **100** is not driven, the controller **260** may drive the cleaning member **240** through the driving processor **257**.

[0086] FIG. **7** is a flow chart illustrating a method of operating a cleaner in accordance with example embodiments.

[0087] Referring to FIG. **7**, in step S**101**, a cleaning operation beginning signal is generated. In step S**103**, the cleaner **200** determines whether the ionizer **100** operates or not.

[0088] When the predetermined automatic cleaning condition is satisfied, or the manual cleaning command may be inputted, the cleaning operation beginning signal may be generated.

[0089] When the ionizer **100** may not be driven, in step S**105**, the cleaner **200** may drive the cleaning member **240**.

[0090] The cleaner **200** may perform the cleaning operation by moving the cleaning member **240** from the beginning spot of the wire **120** in the ionizer **100** and by returning the cleaning member **240** to the beginning spot of the wire **120** via the ending spot of the wire **120** to remove the foreign substance on the wire **120**.

[0091] Here, the cleaner **200** may perform the dust collecting operation to discharge the collected foreign substance to the outside of the ionizer **100**.

[0092] In one embodiment, when the cleaning member **240** is returned to the beginning spot of the wire **120**, the cleaning member **240** may operate, the foreign substance may be detected in the collecting container **243**, or the weight of the foreign substance collected in the collecting container **243** may be no less than the predetermined reference weight, the cleaner **200** may perform the dust collecting operation to discharge the collected foreign substance to the outside of the ionizer **100**. The cleaner **200** may collect related data including error data, operational results, etc., generated in the dust collecting operation. The related data may be used for analyzing the states of the cleaner **200**.

[0093] In step S**107**, when the cleaner **200** is moved along the wire **120** to complete the cleaning operation, the cleaning operation may then be stopped. Here, the cleaner **200** may be stopped due to the abnormal operation of the cleaning member **240**.

[0094] In step S**109**, the cleaner **200** transmits the drive beginning request signal to the ionizer **100**.

[0095] In step S**111**, the cleaner **200** collects and analyzes the data generated in the cleaning operation.

[0096] In one embodiment, the cleaner **200** may generate the cleaning history including at least one

of the date of the cleaning operation of the cleaner **200**, an automatic or manual cleaning operation, a cleaning time, data of the cleaning operation, a total number of times that the cleaning operation is performed, a number of times that the cleaning operation is performed after replacement of the cleaning cartridge, etc.

[0097] The cleaner **200** may collect the operational states of the ionizer **100**.

[0098] In various embodiments, generating the cleaning history and collecting the operational states of the ionizer **100** may be changed by the worker.

[0099] The cleaner **200** may output the alarm message indicating at least one of the operation error of the cleaning member **240**, the replacement time of the cleaning cartridge **241** and the operation error of the ionizer **100** based on the cleaning history and the operational states of the ionizer **100**.

[0100] The above-mentioned steps S**109** and S**111** may be necessarily changed into each other by the worker.

[0101] Further, the step S**111** may not be limited to be performed after the cleaning operation. For example, data, which may be collected in real time, among the data generated in the cleaning operation may be received and analyzed. The control signal may be generated in real time based on the analyzed data to collect and analyze the data in real time.

[0102] FIG. **8** is a detailed flow chart illustrating the method in FIG. **7**.

[0103] Referring to FIG. **8**, in step S**201**, the cleaning operation beginning signal is generated. In step S**203**, the cleaner **200** determines whether the ionizer **100** operates or not.

[0104] When the ionizer **100** may not be driven, in step S**205**, the cleaner **200** may drive the cleaning member **240**.

[0105] In step S**207**, the cleaner **200** detects whether the cleaning member **240** has started moving from the beginning spot or not.

[0106] Although not depicted in drawings, when the cleaner **200** may detect that the cleaning member **240** has started moving from the beginning spot, the cleaner **200** may check a first cleaning time elapsed from the detected time. That is, the first cleaning time may be an amount of time from when the cleaning member **240** starts moving to a current time.

[0107] In step S**209**, the cleaner **200** determines whether the cleaning member **240** has arrived at the ending spot or not.

[0108] In step S**211**, when the cleaning member **240** has not reached the ending spot, the cleaner **200** determines whether the first cleaning time is greater than a first reference time or not.

[0109] When the first cleaning time is greater than the first reference time, in step S**213**, the cleaner **200** may determine the cleaning member **240** to be abnormal to generate the error message. Processes after step S**219** may then be performed.

[0110] In contrast, when the first cleaning time is greater than the first reference time, the cleaner **200** may repeat the process in step S**209**.

[0111] When the cleaning member **240** arrives at the ending spot, in step S**215**, the cleaner **200** may determine whether the cleaning member **240** returns to the beginning spot or not.

[0112] Although not depicted in drawings, when the cleaner **200** detects that the cleaning member **240** has reached the ending spot, the cleaner **200** may check a second cleaning time. The second cleaning time may be an amount of time from when the cleaning member **240** starts moving and returns from the ending spot to a current time. Alternatively, the second cleaning time may be an amount of time from when the cleaning member **240** reaches the ending spot to the current time.

[0113] When the cleaning member **240** is not returned to the beginning spot, in step S**217**, the cleaner **200** determines whether the second cleaning time is greater than a second reference time or not.

[0114] When the second cleaning time is greater than the second reference time, in step S**213**, the cleaner **200** may determine the cleaning member **240** to be abnormal to generate the error message. Processes after step S**219** may then be performed.

[0115] In contrast, when the second cleaning time is not greater than the second reference time, the

cleaner **200** may repeat the process in step S**215**.
[0116] When the cleaner **200** detects the return of the cleaning member **240** to the beginning spot, in step S**219**, the cleaning operation is stopped.
[0117] In step S**221**, the cleaner **200** requests and may transmit a drive beginning signal to the ionizer **100**.
[0118] In step S**223**, the cleaner **200** collects and analyzes the data generated in the cleaning operation.
[0119] In various embodiments, the steps S**221** and S**223** may be necessarily changed into each other by the worker.
[0120] When the ionizer **100** may operate in step S**203**, an error message including corresponding reason may be generated in step S**225**. Then, step S**223** may be performed.
[0121] When it is not detected that the cleaning member **240** starts moving from the beginning spot in step S**207**, the cleaner **200** may generate the error message including the abnormal operation of the cleaning member **240**. The processes after step S**219** may then be performed.
[0122] FIGS. **9**A, **9**B and **10** are views illustrating an ionizer cleaning system in accordance with various embodiments, and FIG. **11** is a block diagram illustrating a cleaner in accordance with example embodiments.
[0123] Referring to FIG. **11**, a cleaner **200** may include a communication interface **210**, a display **220**, a memory **230**, a cleaning member **240**, a dust collector **245**, a driver **250** and a controller **260**.
[0124] The communication interface **210** may be interfaced with the ionizer **100** to transmit and receive information to and from the ionizer **100**.
[0125] The display **220** may display all information with respect to operations of the cleaner **200**. The information may include a history of cleaning, automatic clean information, a replacement time of a cleaning cartridge, a replacement history of the cleaning cartridge, a number of times that the cleaning member **240** cleans the wire **120**, etc.
[0126] The cleaning history may include at least one of a time of a cleaning operation of the cleaner **200**, an automatic or manual operation of the cleaning operation, a time of the cleaning operation, data of the cleaning operation, a total number of times that the cleaning operation is performed, a number of times that the cleaning operation is performed after replacement of the cleaning cartridge, etc., based on drive information of the cleaning member **240**.
[0127] When an alarm is made for the replacement time of the cleaning cartridge, the alarm may include additionally displaying a number of times that the cleaning cartridge operates as well as the replacement time of the cleaning cartridge.
[0128] The memory **230** may store information with respect to the cleaner **200**.
[0129] The cleaning member **240** may move along the wire **120** of the ionizer **100** to remove and collect the foreign substance. That is, the cleaning cartridge **241** may make contact with the wire **120** to release the foreign substance from the wire **120**. The released foreign substance may then be collected in the collecting container **243**.
[0130] The cleaning member **240** may include a cleaning cartridge **241** and a third detection sensor **244**.
[0131] Referring to FIGS. **9**A and **9**B, the cleaning cartridge **241** may include first and second bodies **241-1***a* and **241-1***b* and a cleaning brush **241-2**. The first body **241-1***a* may be formed at one side of the wire **120** during the cleaning member **240** may move along the wire **120**. The second body **241-1***b* may be formed at the other side of the wire **120** during the cleaning member **240** may move along the wire **120**. Thus, the first and second bodies **241-1***a* and **241-1***b* may face each other to cover the wire **120** for example in a perpendicular direction to a longitudinal direction of the wire **120** and may be spaced apart from each other. The cleaning brush **241-2** may be formed on an inner surface of each of the first and second bodies **241-1***a* and **241-1***b* to remove the foreign substance on the wire **120**.
[0132] Additionally, the cleaning member **240** may further include the pedestal **242**, a collecting

container **243** and first and second guides **246***a* and **246***b*. The pedestal **242** may be connected to the cleaning cartridge **241**.
[0133] Referring to FIG. **9**B, the pedestal **242** may be arranged under the first and second bodies **241-1***a* and **241-1***b*. The pedestal **242** may include a collecting hole H formed at a region between the first and second bodies **241-1***a* and **241-1***b*.
[0134] The collecting container **243** may be arranged under the pedestal **242** to collect the foreign substance through the collecting hole H.
[0135] Referring to FIGS. **9**A and **10**, the first guide **246***a* may have one surface configured to make contact with an upper surface of the pedestal **242**, and the other surface configured to make contact with a first rail **281***a* when the cleaning member **240** may operate. The other surface of the first guide **246***a* may move along the first rail **281***a*.
[0136] Referring to FIGS. **9**A and **10**, the second guide **246***b* may have one surface configured to make contact with the upper surface of the pedestal **242**, and the other surface configured to make contact with a second rail **281***b* when the cleaning member **240** may operate. The other surface of the second guide **246***b* may move along the second rail **281***b*.
[0137] Referring to FIG. **9**A, the third detection sensor **244** may be configured to detect the weight of the foreign substance collected in the collecting container **243**.
[0138] Referring to FIG. **9**A, the cleaning member **240** may move along the wire **120** during the cleaning operation. In various embodiments, the cleaning cartridge **241**, the pedestal **242**, the collecting container **243**, the third detection sensor **244** and the first and second guides **246***a* and **246***b* may move along the wire **120**.
[0139] The dust collector **245** may be connected to the collecting container **243**. The dust collector **245** may inhale the foreign substance collected in the collecting container **243**.
[0140] The dust collector **245** may perform a dust collecting operation including inhaling the foreign substance and discharging the foreign substance. When the cleaning member **240** is returned to a beginning spot of the wire **120**, the cleaning member **240** may operate to detect the foreign substance in the collecting container **243**, or determine the weight of the foreign substance collected in the collecting container **243** may be no less than a predetermined reference weight.
[0141] Referring to FIG. **10**, the cleaner **200** may further include a driving rail including the first rail **281***a* and the second rail **281***b*. The first and second rails **281***a* and **218***b* may be detachably disposed at one surface of the ionizer **100**. The first and second rails **281***a* and **281***b* may function as to contact the cleaning brush **241-2** of the cleaning member **240** with the wire **120** during the cleaning member **240** may operate.
[0142] As shown in FIG. **10**, the first and second rails **218***a* and **281***b* may be arranged on the lower surface of the body **110** of the ionizer **100**.
[0143] The driver **250** may be configured to drive the cleaning member **240**. The driver **250** may detect that the cleaning member **240** starts moving from a beginning spot of the wire **120**, reaches an ending spot of the wire **120** or returns to the beginning spot of the wire **120**.
[0144] Referring to FIG. **11**, the driver **250** may include a first driving motor **251**, a fourth detection sensor **258***a*, a fifth detection sensor **258***b*, a sixth detection sensor **258***c*, a seventh detection sensor **258***d* and a driving processor **257**.
[0145] The driving motor **251** may be configured to drive the cleaning member **240**.
[0146] The fourth and fifth detection sensors **258***a* and **258***b* may be positioned at the beginning spot of the wire **120** adjacent to the first and second rails **281***a* and **281***b* to detect that the cleaning member **240** starts moving from and returns to the beginning spot of the wire **120**.
[0147] The sixth and seventh detection sensors **258***c* and **258***d* may be positioned at the ending spot of the wire **120** adjacent to the first and second rails **281***a* and **281***b* to detect that the cleaning member **240** reaches the ending spot of the wire **120**.
[0148] At least one of the fourth to seventh detection sensors **258***a*, **258***b*, **258***c* and **258***d* may be a position sensor including at least one of a contact type sensor and a non-contact type sensor.

[0149] The driving processor **257** may be configured to drive and stop the driving motor **251** in accordance with the controls of the controller **260**. The driving processor **257** may transmit the driving information of the cleaning member **240** including the cleaning time, a return time, etc., obtained based on the detection information provided from the fourth to seventh detection sensors **258***a*, **258***b*, **258***c* and **258***d*. The driving processor **257** may transmit the driving information of the cleaning member **240** during the cleaning operation may be performed as well as after the cleaning operation may be performed.
[0150] The controller **260** may identify states of the ionizer **100** including the driving of the ionizer **100** through the communication interface **210**. The controller **260** may drive the cleaning member **240** through the driver **250** to control the whole operations including removing the foreign substance on the wire **120**.
[0151] FIG. **12** is a block diagram illustrating an ionizer cleaning system in accordance with various embodiments,
[0152] The ionizer cleaning system in one embodiment may include elements substantially the same as or similar to the elements illustrated with reference to FIGS. **1** to **11**. Thus, any further illustrations with respect to the same elements may be omitted herein for brevity.
[0153] Further, cleaner **200** in one embodiment may be applied to the cleaners in FIGS. **1** and **9**.
[0154] Referring to FIG. **12**, an ionizer cleaning system **30** may include a plurality of ionizers **100***a*, **100***b*, **100***c*, . . . , a plurality of cleaners **200***a*, **200***b*, **200***c*, . . . , and a cleaning management server **300**.
[0155] Identification information may be allotted to each of the ionizers **100***a*, **100***b*, **100***c*, ...
[0156] The cleaners **200***a*, **200***b*, **200***c*, . . . , may be detachably disposed at the ionizers **100***a*, **100***b*, **100***c*, ... Identification information may be allotted to the cleaners **200***a*, **200***b*, **200***c*, ...
[0157] The cleaning management server **300** may control the ionizers **100***a*, **100***b*, **100***c*, etc., and the cleaners **200***a*, **200***b*, **200***c*, etc. The cleaning management server **300** may check the drive states of the ionizers **100***a*, **100***b*, **100***c*, etc. The cleaning management server **300** may drive the cleaners **100***a*, **100***b*, **100***c*, etc., based on the drive states of the ionizers **100***a*, **100***b*, **100***c*, etc., to remove the foreign substance from the wire **120**.
[0158] The functions of the cleaning management server **300** may be substantially the same as or similar to the functions of the controller illustrated with reference to FIGS. **1** to **10**. The cleaning management server **300** may further include a function for wholly managing the ionizers **100***a*, **100***b*, **100***c*, etc., and the cleaners **200***a*, **200***b*, **200***c*, etc.
[0159] Signals may be transmitted between the ionizers **100***a*, **100***b*, **100***c*, etc., and the cleaners **200***a*, **200***b*, **200***c*, etc., based on the identification information allotted to the ionizers and cleaners when the cleaning management server **300** may totally manage the ionizers **100***a*, **100***b*, **100***c*, etc., and the cleaners **200***a*, **200***b*, **200***c*, etc.
[0160] In example embodiments, a cleaner for an ionizer and an ionizer cleaning system may further include a cover frame **400**.
[0161] The cover frame **400** may be configured to receive the ionizer **100** and a part of the cleaner **200**. The cover frame **400** may cover the wire **120** to prevent the wire **120** from being damaged. The cover frame **400** may prevent foreign substances from infiltrating into the ionizer **100** and thereby prevent foreign matter such as for example fuzz balls from being generated in the ionizer **100**, thereby preventing the wire **120** from being damaged. Further, after the reciprocal operation of the cleaner **200**, the cover frame **400** may provide a storage space for storing trapped foreign substances.
[0162] FIG. **13** is a view illustrating an ionizer cleaning system in accordance with example embodiments, FIG. **14** is a front view diagram illustrating an ionizer cleaning system in accordance with example embodiments, FIG. **15** is a side view illustrating an ionizer cleaning system in accordance with example embodiments, and FIG. **16** is a rear view illustrating an ionizer cleaning system in accordance with example embodiments.

[0163] Elements in FIGS. **13** to **16** may have functions substantially the same as or similar to the functions of the elements in FIGS. **1** to **12**. Thus, any further illustrations with respect to the same elements may be omitted herein for brevity.
[0164] Further, the cover frame **400** may be applied to the cleaners in FIGS. **1** and **9**.
[0165] Referring to FIGS. **13** to **16**, the cover frame **400** may include a body container **410** and a wire container **430**.
[0166] The body container **410** may have a receiving space configured to receive the body **110** of the ionizer to protect the body **110** of the ionizer. The body container **410** may receive parts of the cleaner **200** such as the communication interface **210**, the memory **230**, etc. The display **220** may be installed on an outer surface of the body container **410**. In example embodiments, the body container **410** may have a hexahedral structure formed by a plurality of protection panels, not limited thereto. For example, the body container **410** may have a tubular shape including an opened lower surface. The tubular shape may have a circular cross-section, an elliptical cross-section, a polygonal cross-section, etc.
[0167] The wire container **430** may be arranged under the body container **410**. The wire container **430** may have a receiving space configured to receive and protect the wire **120**, the cleaning member **240**, the driver **250**, the controller **260**, the driving rail **270**, etc. of the ionizer. The wire container **430** may have one opened surface, or two or more opened surfaces to allow for circulation of air. Further, the user may verify the condition of the receiving space of the wire container **430** through the opened surface(s). The wire container **430** may have a downwardly slanted surface, not limited thereto. For example, the wire container **430** may include a tubular shape having a circular cross-section, an elliptical cross-section, a polygonal cross-section, etc.
[0168] The first and second bodies **241**-**1***a* and **241**-**1***b*, the pedestal **242**, the collecting container **243** and the first and second guides **246***a* and **246***b* in the cleaning member **240** may have the shape illustrated in FIG. **13**, configured to be received in the wire container **430**. Further, the first and second rails **281***a* and **281***b* (for the movements of the first and second guides **246***a* and **246***b*) may be arranged over the wire **120**. The first and second rails **281***a* and **281***b* may be contained in the wire container **430**.
[0169] At least one ion discharge hole **439** may be formed through the wire container **430**. The cations and the anions, which may be generated by the discharge of the wire **120** by applying the high voltage to the wire **120** from the power supply, may flow from the wire container **430** through the ion discharge hole(s) **439**. The power supply may provide the ionizer **100** and the cleaner **200** with the power.
[0170] The cover frame **400** may further include a dust container **450** arranged at one side of the body container **410** and the wire container **430**. The dust container **450** may be configured to have a dust collector **451**.
[0171] The dust collector **451** may have a storage space configured to store the foreign substances trapped after completing the cleaning operation of the cleaner **200**. The dust collector **451** may receive air flow from the wire container **430** which may contain foreign substances formerly residing in the wire container **430**. The dust collector **451** may separate the foreign substances from the air flow by trapping the foreign substances so that the wire may no longer be exposed to those foreign substances removed from the wire container **430**. The dust collector **451** may then collect the foreign substances. Particularly, external air may be supplied into the wire container **430** through an air passage **453** to generate an air entraining foreign substances therein. The dust collector **451** may receive the air with the foreign substances. The dust collector **451** can function to collect the foreign substances from the air flow and store the foreign substances away from the wire **120**.
[0172] The dust collector **451** may include an air intake passage. The intake passage may be connected to at least one intake duct. The intake duct may be arranged in the wire container **430** with the wire **120**. A vacuum pump may be connected to the intake duct to draw the air with the

foreign substances through the intake duct. The intake duct may also be connected to an air passage to intake the air including the foreign substances. The vacuum pump may be controlled by a controller. After operating a pneumatic pump, the vacuum pump may then be operated.

[0173] The dust collector **451** may include a filter configured to separate the foreign substances from the air flow. The dust collector **451** may include an exhaust hole configured to discharge the air without the foreign substances.

[0174] The dust collector **451** may be detachably installed at the dust container **450** to remove the foreign substances collected in the dust collector **451**.

[0175] The dust collector **451** may be connected to the collecting container **243**. Thus, foreign substances in the collecting container **243** may be removed from the dust container **451**.

[0176] The dust collector **451** may further include a particle detection sensor. The particle detection sensor may be installed at the exhaust hole of the dust collector **451** to detect a concentration of the foreign substances. The particle detection sensor may then transmit the detected concentration of the foreign substances to the controller **260**. When the detected concentration of the foreign substances is beyond a set value, the controller **260** may control the display **220** to display a discharge signal on the display **220**, thereby alerting the user to remove the foreign substances from the dust collector **451**.

[0177] The ionizer cleaning system of example embodiments may include various air supply configurations.

[0178] For example, as shown in FIG. **13**, the air passage **453** may be formed at an upper portion of the body container **410**. The air passage **453** may be connected to the air duct **455** protruded from the dust container **450** to supply the air to an upper space or a lower space of the cleaning member **240**. The body container **410** may include an air hole **411** connected with the air passage **453** through the air duct **455** to discharge the air into the wire container **430** through the air passage **453**. The at least one air hole **411** may be formed between the driving rails **281***a* and **281***b*.

[0179] In order to intake the air with the foreign substances into the dust collector **451**, the controller **260** may control the supply of the air through the air passage **453** so that the air may be supplied after removing the foreign substances from the wire **120** by the cleaning member **240**. The air duct **455** may be connected to a pneumatic pump controlled by the controller **260**. When the air with the foreign substances enters into the dust collector **451**, the controller **260** may stop the wire **120**.

[0180] The at least one air hole **411** may be formed through an upper surface of the wire container **430**. The air hole **411** may be connected to the air passage **453** to supply the air from the air passage **453** into the wire container **430**. Further, the air hole **411** may apply a pneumatic pressure to the cations and the anions, which may be generated by the discharge of the wire **120** by applying the high voltage to the wire **120**, to propel the cations and the anions through an ion exhaust hole **439**. The air hole **411** may be connected to the intake duct so that the air with the foreign substances in the wire container **430** may pass through the air hole **411**.

[0181] As shown FIGS. **14** to **16**, the air passage **453** may be formed at one side of the dust container **450**. The air may be supplied to the upper space of the cleaning member **240** through the air passage **453** into the dust container **450**.

[0182] A door may be installed for the dust container **450**. The dust collector **451** in the dust container **450** may be moved through the door to remove the foreign substances from the dust collector **451**. The dust collector **451** without the foreign substances, may then be moved into the dust container **450** through the door.

[0183] For cleaning the wire, the cleaning member may be moved between the beginning spot of the wire to the ending spot of the wire and then back to the beginning spot of the wire, foreign substances may be removed from the wire. The air may then be supplied to the position adjacent to the wire, i.e., the receiving space of the wire container, to generate the air with the foreign substances in the receiving space. The air with the foreign substances may be collected in the dust

collector. The foreign substances in the dust collector may then be removed from the dust container **450** by use of the door discussed above.

[0184] In cover frame **400** of example embodiments, the wire container **430** may be detachably connected to the body container **410** to repair and maintain the wire **120**. The wire container **430** may include a front cover **431** and a rear cover **433**.

[0185] The front cover **431** may be integrally installed at a lower portion of a front surface of the body container **410**. The rear cover **433** may be detachably installed at a lower portion of a rear surface of the body container **410**. Alternatively, the front cover **431** may be detachably installed at the lower portion of the front surface of the body container **410**. The rear cover **433** may be integrally installed at the lower portion of the rear surface of the body container **410**.

[0186] Referring to FIG. **16**, the rear cover **433** configured to form the wire container **430** may include a fixing protrusion **435**. The fixing protrusion **435** may be formed at both sides of an upper portion of the rear cover **433**. A first connection hole C**1** may be formed through the fixing protrusion **435**. At least one threaded protrusion may be formed at the rear cover **433**. The body container **410** may include a fixing groove FH formed at a lower portion of a rear surface of the body container **410**, and a second connection hole C**2** formed through the fixing groove FH. The fixing protrusion **435** may be inserted into the fixing groove FH of the body container **410**. A fixing member B such as a bolt may be threaded into the first connection hole C**1** and the second connection hole C**2** to fix the upper portion of the rear cover **433** to the lower surface of the body container **410**. The threaded protrusion of the rear cover **433** may be inserted into a fixing groove F formed at the lower surface of the front cover **431** to combine the rear cover **433** with the front cover **431**.

[0187] The rear cover **433** may include a first fixing groove and a first fixing hole. The first fixing groove may be formed at both ends of the upper portion of the rear cover **433**. The first fixing hole may be formed at one side of the upper portion of the rear cover **433**. The rear cover **433** may further include a fixing block **437**. At least one fixing protrusion may be formed at the lower surface of the rear cover **433**. The body container **410** may include a second fixing groove and a second fixing hole corresponding to the first fixing groove and the first fixing hole, respectively. A fixing groove F may be formed at the lower surface of the front cover **431**. Thus, after installing the rear cover **433** at the lower surface of the body container **410**, the fixing block **437** may be inserted into the first fixing groove and the second fixing groove. A fixing member B such as a bolt may be threaded into the first fixing hole and the second fixing hole to fix the upper portion of the rear cover **433** to the lower portion of the body container **410**. The fixing protrusion of the rear cover **433** may be inserted into the fixing groove F of the front cover **431** to fix the rear cover **433** to the front cover **431**. The two fixing members may be used at the upper portion and the lower portion of the fixing block **437**, not limited thereto. For example, each of the two fixing members may be used at the upper portion of the lower portion of the fixing block **437**, respectively.

[0188] Therefore, the rear cover **433** may be readily detached from the wire container **430** for repair or inspection of wire **120**.

[0189] The functions of the cleaning management server **300** may be substantially the same as or similar to the functions of the controller illustrated with reference to FIGS. **1** to **16**. The cleaning management server **300** may further include a function for wholly or in part managing the ionizers **100***a*, **100***b*, **100***c*, etc., and the cleaners **200***a*, **200***b*, **200***c*, etc.

[0190] The above described embodiments of the present invention are intended to illustrate and not to limit the present invention. Various alternatives and equivalents are possible. The invention is not limited by the embodiments described herein. Nor is the invention limited to any specific type of semiconductor device. Another additions, subtractions, or modifications are obvious in view of the present disclosure and are intended to fall within the scope of the appended claims.

Claims

1. An ionizer cleaning system comprising: a wire type ionizer including a wire configured to generate cations or anions for directing toward an object; a cleaner moving along the wire to remove a foreign substance, wherein the cleaner comprises: a communication interface configured to transmit/receive information to/from the ionizer, and a cleaning member configured to move along the wire to remove and collect a foreign substance gathered on the wire; a driver configured to: drive the cleaning member, and detect that the cleaning member starts moving from a beginning spot of the wire, reaches an ending spot of the wire or returns to the beginning spot of the wire; and a controller configured to: determine whether the ionizer is operating or not through the communication interface, and control the driver to drive the cleaning member for the cleaning member to remove the foreign substance on the wire by the cleaning member.

2. The ionizer cleaning system of claim 1, wherein the driver comprises: a driving motor configured to drive the cleaning member; a first detection sensor positioned at the beginning spot of the wire to detect that the cleaning member starts moving from or returns to the beginning spot; a second detection sensor positioned at the ending spot of the wire to detect that the cleaning member reaches the ending spot; and a driving processor configured to drive and stop the driving motor under control of the controller and to transmit to the controller driving information, which includes a cleaning time and a returning time obtained from detection information provided from the first and second detection sensors, and wherein each of the first and second detection sensors comprise a position sensor including at least one of a contact type sensor and a non-contact type sensor.

3. The ionizer cleaning system of claim 1, further comprising a) a cover frame including a body container and b) a wire container configured to receive and protect the ionizer and the cleaner.

4. The ionizer cleaning system of claim 3, wherein the cover frame further comprises a dust collector installed at the body container and coupled to the wire container to collect and store the foreign substance.

5. The ionizer cleaning system of claim 4, wherein the cover frame further comprises at least one air passage configured to supply an external air into the wire container, the external air supplied to the wire container through the air passage generates an air flow including the foreign substance in the wire container, and the dust collector collects the foreign substance from the air flow.