(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
24 April 2008 (24.04.2008)

PCT

(10) International Publication Number
WO 2008/048019 A1

(51) International Patent Classification:
G21K 1/14 (2006.01)

(21) International Application Number:
PCT/KR2007/004974

(22) International Filing Date: 11 October 2007 (11.10.2007)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
10-2006-0100506 16 October 2006 (16.10.2006) KR

(71) Applicant *(for all designated States except US)*: **SUNJE HITEK CO., LTD.** [KR/KR]; 700-18, Mora-dong, Sasang-gu, Pusan 617-080 (KR).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **LEE, Dong-Hoon** [KR/KR]; 106-2301 Daerim 1-cha Apartment, 25-tong 8-ban, 1396, Joa-dong, Haeundae-gu, Pusan 612-755 (KR). **KIM, Sang-Hyo** [KR/KR]; 102-402 Dongwonbora Apartment, 490, Namcheon-dong, Suyeong-gu, Pusan 613-010 (KR). **JUNG, Yong-Chul** [KR/KR]; 102-601 Woosin Apartment, 102-601 Woosin Apartment, Pusan 617-755 (KR). **KIM, Jae-Yeol** [KR/KR]; 203 Yoosung Villa, 361-8, Gaya-1-dong, Pusanjin-gu, Pusan 614-805 (KR). **SHIM, Seung-Ook** [KR/KR]; 405-405 Danggam Ddranchae Apartment, Buam-3-dong, Pusanjin-gu, Pusan 614-093 (KR). **LEE, Won-Dae** [KR/KR]; 4-503 Royal Apartment, Sajik-2-dong, Dongnae-gu, Pusan 607-764 (KR). **KIM, Mu-Ho** [KR/KR]; A-202 Hanju Villa, 358-22, Eobang-dong, Gimhae-si, Gyeongsangnam-do 612-917 (KR). **RYU, Jong-Jin** [KR/KR]; 904 Jangwon Apartment, Hwamyeong-dong, Buk-gu, Pusan 616-120 (KR). **KIM, Hyun-Soo** [KR/KR]; 601 Hanna Villa, Eobang-dong, Gimhae-si, Gyeongsangnam-do 621-916 (KR).

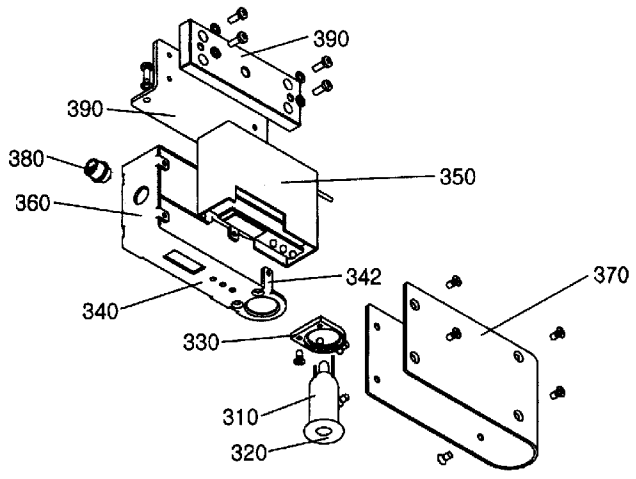
(74) Agent: **KIM, Sung-Soo**; Room No. 1133 Opian, 1258, Sanggye-dong, Nowon-gu, Seoul 139-838 (KR).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,

[Continued on next page]

(54) Title: AN IONIZER USING SOFT X-RAY AND A METHOD FOR REMOVING ELECTRIC CHARGES OF A CHARGED BODY



(57) Abstract: This invention relates to an ionizer using soft X-ray comprising a head unit that generates soft X-ray in order to remove electric charges of a charged body by +/- ions or electrons generated from the gas in the air ionized by the soft X-ray, and a control unit to control at least one of the head unit, wherein said head unit comprises, a protective case consisting of a D-shaped side unit, and a D-shaped cover unit combined to said side unit and forming a housing space; an X-ray tube housed within said protective case and having an output window that emits soft X-ray generated when the electrons collide with the target; a flange unit thermally and electrically connected to said output window and forming a front end of said X-ray tube, supporting said output window, and radiating the heat generated from said target to outside of the X-ray tube by contacting with the front portion of said side unit of the protective case; a high voltage generation unit housed in said protective case and supplying high voltage to said X-ray tube; and a flange coupler fixing said X-ray tube to said front portion of said side unit of the protective case.

WO 2008/048019 A1

ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

Description

AN IONIZER USING SOFT X-RAY AND A METHOD FOR REMOVING ELECTRIC CHARGES OF A CHARGED BODY

Technical Field

[1] This invention relates to an ionizer using soft X-ray and a method for removing electric charges of a charged body. More specifically, this invention improves structural defects of previous ionizers using soft X-ray, with easy external heat radiation which is necessary for decreasing size of the ionizer using soft X-ray, easy and simple construction, and stable support.

Background Art

[2] As a prior art, there is a Japanese Patent Application No. H08-256780 (X-ray generator), whose structure is shown in figure 1. In this art, the flange portion (18) formed on the front end of the X-ray tube (8) is interposed between two supporting plates (5, 24) in order to fix the X-ray tube to the protective case. However, the ionizers adopting this art have not become practical, because they have problems like complex process of construction, electrically and thermally incomplete contact between the flange portion and the protective case.

[3] As another prior art, there is an ionizer whose structure is shown in figure 2. However, it has similar problems as the prior art in figure 1.

Disclosure of Invention

Technical Problem

[4] To solve said problems of prior arts, this invention aims to provide an ionizer using soft X-ray which has high thermal conductivity, simple structure so that it can be easily constructed, have increased stability and improved function of shielding X-ray.

[5] Other purposes and merits of this invention will become clear upon reading the detailed explanation and referring to the attached drawings.

Technical Solution

[6] A preferred embodiment of an ionizer using soft X-ray (hereafter called "ionizer") according to this invention comprises,

[7] a head unit that generates soft X-ray in order to remove electric charges of a charged body by +/- ions or electrons generated from the gas in the air ionized by the soft X-ray, and a control unit to control at least one of the head unit,

[8] wherein said head unit comprises,

[9] a protective case consisting of a □-shaped side unit, and a □-shaped cover unit combined to said side unit and forming a housing space;

[10] an X-ray tube housed within said protective case and having an output window that

emits soft X-ray generated when the electrons collide with the target;

[11] a flange unit thermally and electrically connected to said output window and forming a front end of said X-ray tube, supporting said output window, and radiating the heat generated from said target to outside of the X-ray tube by contacting with the front portion of said side unit of the protective case;

[12] a high voltage generation unit housed in said protective case and supplying high voltage to said X-ray tube; and

[13] a flange coupler fixing said X-ray tube to said front portion of said side unit of the protective case,

[14] wherein said flange coupler has thermal and electrical conductivity, has a through hole as large as the flange unit so that the periphery of the flange unit can be fixed by the raised spot formed inside of said through hole, and wherein said flange coupler and said flange unit form one surface when they are coupled.

[15] In this invention, it is preferable that each of said head unit further comprises a timer to display cumulative used time of said ionizer.

[16] In this invention, it is preferable that the side unit, cover unit of the protective case, and the target are made of conductive materials, have ground potentials and thermal conductivities.

[17] In this invention, it is preferable that said control unit comprises

[18] a means of choice to choose the head unit; and

[19] a display window to display cumulative used time of chosen head unit by linking with the timer in the head unit.

[20] In this invention, it is preferable that said control unit has functions of alarm, interlock, remote control, input and output of control signal of the power source of the controller.

[21] In this invention, it is preferable that the head unit and the control unit are connected by a flexible tube when the head unit is installed outside of the protective case, wherein said flexible tube houses a high voltage cable that connects the head unit and the power control unit in order to protect the high voltage cable from external impact or vibration, and wherein said flexible tube allows the user to bend the head of said head unit at an arbitrary angle toward a charged body, and wherein the flange coupler is not used in this case.

[22] In this invention, it is preferable that an RMS (Remote monitoring system) to monitor a number of ionizers remotely with one personal computer is adopted.

[23] In this invention, it is preferable that the connector of said control unit adopts a single connector form.

[24] This invention preferably further comprises a bracket for attaching said ionizer to the ceiling or the wall which consists of a □-shaped bracket unit to fix said head unit

horizontally or vertically by screws; and

[25] a reinforcing plate connected with one outer surface of said □-shaped bracket unit by screws and fixes said head unit by screws, wherein said □-shaped bracket unit is fixed to the ceiling or the wall by anchor bolts.

[26] In this invention, it is preferable that the area which said flange coupler contacts with said side unit of the protective case can be set up from necessity.

[27] In this invention, it is preferable that a space for the body of the X-ray tube is prepared beside said high voltage generation unit inside said side unit of the protective case.

[28] In this invention, it is preferable that said X-ray tube is fixed and supported by the means that fixes said flange coupler to said side unit of the protective case.

[29] In this invention, it is preferable that said control unit has a function of alarming to inform when the term of use of said head unit has expired or to be expired soon.

[30] In this invention, it is preferable that an apparatus for shielding which has a hole for irradiation is placed on the side unit of the protective case on which the output window exists, so that various ionizing ranges and X-ray irradiation types including circle, square and ellipse can be obtained according to the shape of the hole and the distance to the output window.

[31] A preferred embodiment of a method for removing electric charges of a charged body according to this invention is characterized in removing electric charges of a charged body by ionizing elements or materials near the charged body by irradiating soft X-ray having wavelengths in the range of 1~5Å generated from the soft X-ray tube that has a target with a predetermined target voltage and target current, and uses beryllium window evaporated with silver(Ag).

[32] In this invention, it is preferable to remove electric charges by generating soft X-ray having main wavelengths in the range of 3.5~4.5Å under the circumstance that the anode voltage is under 10kV.

Advantageous Effects

[33] Various advantages can be expected according to work of this invention.

[34] First, more economical installation is possible because shielding is easier and stability is increased by using beryllium window evaporated with silver as the target material.

[35] Second, faster heat transferring is possible because the area which the flange contacts with the protective case can be increased easily by using the flange coupler.

[36] Third, constructing and manufacturing is easier because the interposing in the prior art is unnecessary.

Brief Description of the Drawings

[37] Figure 1 is a structural diagram of an ionizer using soft X-ray according to a prior art.

[38] Figure 2 is a structural diagram of an ionizer using soft X-ray according to another prior art.

[39] Figure 3 is a structural diagram of an ionizer using soft X-ray according to a preferred embodiment of this invention.

[40] Figure 4 presents characteristic curves showing the relation between the value of ion current multiplied by square of distance and the neutralization distance when tungsten or silver is used as the target material and the anode voltage is 9.5kV, 10kV, 10.5kV.

[41] Figure 5 presents curves showing generated soft X-ray radiation doses (Sv) per wavelength when tube current is 100□, anode voltage is 6~13kV, and silver is used as the target material.

[42] Figure 6 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when tungsten or silver is used as the target material, anode voltage is 9.48kV, and tube current is 0.240mA.

[43] Figure 7 presents curves showing the relation between the neutralization distance and the ion current when tungsten or silver is used as the target material, anode voltage is 10.5kV, and tube current is 0.240mA.

[44] Figure 8 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when tungsten or silver is used as the target material, anode voltage is 10.5kV, and tube current is 0.240mA.

[45] Figure 9 presents curves showing the relation between the neutralization distance and the ion current when tungsten or silver is used as the target material, anode voltage is 10kV, and tube current is 0.2382mA.

[46] Figure 10 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when tungsten or silver is used as the target material, anode voltage is 10kV, and tube current is 0.2382mA.

[47] Figure 11 presents curves showing the relation between the neutralization distance and the ion current when tungsten or silver is used as the target material, anode voltage is 9.48kV, and tube current is 0.240mA.

[48] Figure 12 is a diagram showing the state when the flange unit and the flange coupler of the ionizer using soft X-ray according to this invention are coupled.

[49] < Explanation about important part of drawings >

[50] 310: X-ray tube

[51] 320: flange unit

[52] 330: flange coupler

[53] 340: front portion of the side unit of the protective case

[54] 350: high voltage generation unit

[55] 360: side unit of the protective case

[56] 370: cover unit of the protective case

[57] 380: connector

[58] 390: bracket

Best Mode for Carrying Out the Invention

[59] Now referencing the attached drawings, we make an explanation about the structure and characteristics of this invention. The features of the ionizer using soft X-ray according to this invention are as follows.

[60] 1. The structure of supporting X-ray tube and transferring heat

[61] The head unit of the ionizer in this invention has a structure as shown in figure 3 to improve the structure of supporting X-ray tube and transferring heat.

[62] In this invention, a protective case consists of a □-shaped side unit (360) and a □-shaped cover unit (370) connected by screws, and forms a space in it. An X-ray tube (310) having output window emitting soft X-ray generated when the electrons collide with the target, and a high voltage generation unit (350) supplying high voltage to said X-ray tube are housed in the space. The protective case and the target are made of conductive materials, and have ground potentials and thermal conductivities. The ionizer is attached to the ceiling or the wall by a bracket (390) that consists of a □-shaped bracket unit and a reinforcing plate.

[63] A flange unit (320) is thermally and electrically connected to the output window, forms a front end of the X-ray tube (310), supports the output window, and radiates the heat generated from said target to outside of the X-ray tube by contacting with a front portion (340) of said side unit of the protective case. A flange coupler (330) has thermal and electrical conductivity, has a through hole as large as the flange unit (320) so that the periphery of the flange unit can be fixed by the raised spot formed inside of said through hole. The flange coupler (330) and the flange unit (320) form one surface when they are coupled. The area which said flange coupler (330) contacts with said front portion (340) of the side unit of the protective case can be set up from necessity. The X-ray tube (310) is fixed and supported by the screws that fix said flange coupler (330) to said side unit (360) of the protective case.

[64] Figure 12 is a diagram showing the state when the flange unit and the flange coupler in this invention are coupled. Like this, this invention produces a superior heat transferring effect compared with prior arts, because the area of the protective case which the flange unit of the X-ray tube contacts with becomes substantially larger by fixing and coupling the flange coupler to the flange unit. In addition, the ionizer in this invention has a simple structure, can be constructed easily, and can support the X-ray

tube stably by fixing the flange coupler to the protective case by screws without adop ting the complex structure as interposing which is used when attaching the flange to the protective case in the prior art.

[65] 2. Evaporation of silver(Ag)

[66] General ionizer using soft X-ray in the prior art removed electric charges by generating soft X-ray having main wavelengths in the range of 1~2Å under the cir- cumstance that the anode voltage is under 9~11kV with beryllium window evaporated with tungsten. However, as a result of the experiment by the applicant with beryllium window evaporated with silver (Ag), it was discovered that the amount of ion current which is required for ionizing is almost the same as in the prior art, while the main wavelengths of the soft X-ray is in the range of 3.5~4.5Å under the circumstance that the anode voltage is 9.5kV. Moreover, radiation doses were only half of the amount in the prior art. Now we make a detailed description of the result of the experiment.

[67] Figure 4 shows decrease of ion current according to the distance when beryllium window evaporated with tungsten or silver is used as the target material and the anode voltage is 9.5kV, 10kV, 10.5kV. When silver is evaporated, we expected ionizing effect at long distance would be inferior, because the main wavelengths (3.5~4.5Å) are longer than the wavelength (1~2Å) generated when tungsten is evaporated as in the prior art. However, we can see that the decrease of ion current according to the distance is almost the same in reality. We guess this is because of the long distance ionizing effect by the bremsstrahlung (l.5~2.5Å) generated in addition to the main wavelengths when silver is evaporated. Because generated X-ray radiation doses are smaller than when tungsten is used, the target using beryllium window evaporated with silver has many merits like increased stability, easy shielding, and better economical efficiency, while the ionizing effect according to the distance is maintained as before.

[68] Figure 5 presents curves showing the relation between the main wavelengths of soft X-ray and generated soft X-ray radiation doses of corresponding wavelength when tube current is 100□, anode voltage is 6~13kV, and beryllium window evaporated with silver is used as the target material. It is shown that as the anode voltage gets higher the soft X-ray of the same wavelength is generated more, the soft X-ray of 0.425nm (4.25Å) is generated the most in this example, most of the soft X-rays have wavelengths of 1~5Å. In the figure, unit of the vertical axis is generated soft X-ray radiation doses (Sv) per wavelength. The tube current here means the current by the electrons moving to the inner target of the soft X-ray tube when the anode voltage is given.

[69] Figure 6 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 9.48kV, and tube

current is 0.240mA. It is shown that generated soft X-ray radiation doses are smaller for the same distance when silver is evaporated. This means that using silver is safer and it can shield X-ray more easily.

[70] Figure 7 presents curves showing the relation between the neutralization distance and the ion current when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 10.5kV, and tube current is 0.240mA. The ion current when silver is used is a little smaller for the same distance. However, considering the time of ionization according to the ion current (ion current maintaining the time to drop ±1000V to ±100V within 0.5 seconds: 150~240nA), substantial efficiency of ionization is the same.

[71] Figure 8 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 10.5kV, and tube current is 0.240mA. When silver is used, generated soft X-ray radiation doses are smaller for the same distance, which shows that using silver is safer and it can shield X-ray more easily.

[72] Figure 9 presents curves showing the relation between the neutralization distance and the ion current when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 10kV, and tube current is 0.2382mA. The ion current when silver is used is a little smaller for the same distance. However, considering the time of ionization according to the ion current (ion current maintaining the time to drop ±1000V to ±100V within 0.5 seconds: 150~240nA), substantial efficiency of ionization is the same.

[73] Figure 10 presents curves showing the relation between the neutralization distance and generated soft X-ray radiation doses when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 10kV, and tube current is 0.2382mA. When silver is used, generated soft X-ray radiation doses are smaller for the same distance, which shows that using silver is safer and it can shield X-ray more easily.

[74] Figure 11 presents curves showing the relation between the neutralization distance and the ion current when beryllium window evaporated with tungsten or silver is used as the target material, anode voltage is 9.48kV, and tube current is 0.240mA. The ion current when silver is used is a little smaller for the same distance. However, considering the time of ionization according to the ion current (ion current maintaining the time to drop ±1000V to ±100V within 0.5 seconds: 150~240nA), substantial efficiency of ionization is the same. The difference in this case is smaller than other cases. From this fact, we can see that the generated amount of ion current is almost the same when the anode voltage is low.

[75] The fact that we can see from the result of the above experiment is as follows.

[76] First, generated amount of ions is almost the same when the voltage is low.

[77] Second, dangerousness is much more reduced and shielding is easier compared to prior ionizers, while the efficiency of ionization is similar.

[78] Third, having 3.5~4.5Å as the main wavelengths and 1.5~2.5Å as the bremsstrahlung wavelengths in this invention, the ionizer of this invention is useful for ionization for both long distance and short distance. Main wavelengths in the range of 3.5~4.5Å are useful for short distance ionization, and bremsstrahlung wavelengths in the range of 1.5~2.5Å are useful for long distance ionization. Accordingly, this invention is very economical because one ionizer can be used both as long distance ionization and short distance ionization. In addition, the overall efficiency of ionization is expected to be improved.

[79] Meanwhile, a Japanese Patent No. 2951477 fixed the range of main wavelengths as 2~20Å without defining the target material. However, this is not credible because it simply claims specific numerical value without considering a number of actual factors (for example, target material, anode voltage, tube current, etc.) and it is not based on any experimental foundation.

[80] 3. Improved functions of controller

[81] Compared to prior ionizers, a lot of functions of the ionizer using soft X-ray according to this invention were improved. They are arranged in Table 1 below. Table 1 illustrates a set up table of the functions of the ionizer using soft X-ray according to this invention. In this example, 10 functions can be set up. Improved functions of controller in the ionizer according to this invention are as follow.

[82] Table 1

Number	Function (Connector name)	Number of pins	Prior Art	This Invention	Description of Function	Description of Operation
1	OUTPUT 1~4	5	0	0	Connecting head.	
2	INTERLOCK	2	0	0	Inputting external interlock. START should be pushed in prior art.	START/STOP is applied automatically or manually when external interlock is inputted.
3	REMOTE	2	0	0	Inputting external remote.	START/STOP when external remote is inputted.
4	INDICATOR	2	0	0	Confirming head ON/OFF status.	Confirming head ON/OFF status.
5	ALARM	2	X	0	Outputting alarm status.	
6	INTERLOCK OUT	2	X	0	Outputting external interlock signal.	Outputting while interlock.
7	REMOTE OUT	2	X	0	Outputting external remote signal.	Outputting while remote.
8	POWER ON/OFF	2	X	0	Outputting power ON/OFF	Outputting signal according to power input status
9	POWER TYPE (AC)		100 ~ 240V	100 ~ 240		
10	CONNECTOR TYPE		Individual connector	Single connector		

[83] First, this invention added function of outputting signals of Alarm, Interlock, Remote, Controller Power outside.

[84] Second, the flexible tube disclosed in the applicant's another Korean Patent Application No. 10-2005-32535 "A Flexible Soft X-ray Ionizer" can be applied to this invention. That is, another embodiment of an ionizer using soft X-ray according to this invention comprises a head unit generating soft X-ray, a soft X-ray protect unit shielding the leak of the soft X-ray from said head unit, and a power control unit supplying control signal and control voltage to the head unit, wherein the head unit is located outside of the soft X-ray protect unit, a high voltage cable that connects the head unit and the power control unit is protected from external impact or vibration, and it is possible to use the flexible tube which allows the user to bend the head of said head unit at an arbitrary angle toward a charged body.

[85] Third, an RMS (Real monitoring system) can be applied to this invention. The RMS is a system which can monitor a number of ionizers in the field conveniently with one PC prepared in the field. The RMS is explained in detail in the applicant's another Korean Patent Application No. 10-2005-32534 "A Bar Type Ionizer".

[86] The details of 10 functions above are as follows.

[87] The connector name (corresponds to the function) of Function 1 is OUTPUT 1~4,

number of pins is 5, and this function is connecting the head. This function was also used in a prior art.

[88] The connector name of Function 2 is INTERLOCK, number of pins is 2, and this function is inputting external interlock signal. When a worker enters a shielding room in which ionizers are installed, operation of ionizers needs to be stopped for the safety of the worker. If the door of the shielding room is opened by the external interlock signal, operation of ionizers is stopped automatically. If the door is closed again, operation of ionizers is started only when the START button is pushed. Accordingly the worker can be safe. However, in some working environments, operation of ionizers should be started automatically when the door of the shielding room is closed, and this requirement can be satisfied by a circuit modification. This function was also used in a prior art.

[89] The connector name of Function 3 is REMOTE, number of pins is 2, and this function is inputting external remote signal. START/STOP function is applied when the external remote signal is inputted. This function was also used in a prior art.

[90] The connector name of Function 4 is INDICATOR, number of pins is 2. This function is confirming head ON/OFF status, which was also used in a prior art.

[91] The connector name of Function 5 is ALARM, number of pins is 2, and this function is outputting alarm status, which was not used in a prior art.

[92] The connector name of Function 6 is INTERLOCK OUT, number of pins is 2, and this function is outputting external interlock signal. This function is outputting while interlock is operating, which was not used in a prior art.

[93] The connector name of Function 7 is REMOTE OUT, number of pins is 2, and this function is outputting external remote signal. This function is outputting while operation is remote, which was not used in a prior art.

[94] The connector name of Function 8 is POWER ON/OFF, number of pins is 2. This function is power ON/OFF, and outputs signal according to the power input status, which was not used in a prior art.

[95] The connector name of Function 9 is POWER TYPE (AC). 100~240 volt is used as a prior art.

[96] The connector name of Function 10 is CONNECTOT TYPE. Single connector is used in this invention while individual connector was used in a prior art.

[97] This invention may be modified and embodied in various forms, and it has been described and illustrated herein with reference to a specific embodiment thereof. However, it should be understood that this invention is not limited to the particular form as described above, and that this invention includes all modifications, equivalents and substitutes within the spirits and scope of this invention as defined in the "claims" attached hereto.

[98]

[99]

Claims

[1] An ionizer using soft X-ray and having a head unit that generates soft X-ray in order to remove electric charges of a charged body by +/- ions or electrons generated from the gas in the air ionized by the soft X-ray, and a control unit to control at least one of the head unit,
said head unit comprising,
a protective case consisting of a □-shaped side unit, and a □-shaped cover unit combined to said side unit and forming a housing space;
an X-ray tube housed within said protective case and having an output window that emits soft X-ray generated when the electrons collide with the target;
a flange unit thermally and electrically connected to said output window and forming a front end of said X-ray tube, supporting said output window, and radiating the heat generated from said target to outside of the X-ray tube by contacting with the front portion of said side unit of the protective case;
a high voltage generation unit housed in said protective case and supplying high voltage to said X-ray tube; and
a flange coupler fixing said X-ray tube to said front portion of said side unit of the protective case,
wherein said flange coupler has thermal and electrical conductivity, has a through hole as large as the flange unit so that the periphery of the flange unit can be fixed by the raised spot formed inside of said through hole, and wherein said flange coupler and said flange unit form one surface when they are coupled.

[2] The ionizer as set forth in claim 1, wherein each of said head unit further comprises a timer to display cumulative used time of said ionizer.

[3] The ionizer as set forth in claim 1, wherein the side unit, cover unit of the protective case, and the target are made of conductive materials, have ground potentials and thermal conductivities.

[4] The ionizer as set forth in claim 1, wherein said control unit comprises
a means of choice to choose the head unit; and
a display window to display cumulative used time of chosen head unit by linking with the timer in the head unit.

[5] The ionizer as set forth in claim 1, wherein said control unit has functions of alarm, interlock, remote control, input and output of control signal of the power source of the controller.

[6] The ionizer as set forth in claim 1, wherein the head unit and the control unit are connected by a flexible tube when the head unit is installed outside of the protective case, and wherein said flexible tube houses a high voltage cable that

connects the head unit and the power control unit in order to protect the high voltage cable from external impact or vibration, and wherein said flexible tube allows the user to bend the head of said head unit at an arbitrary angle toward a charged body, and wherein the flange coupler is not used in this case.

[7] The ionizer as set forth in claim 1, wherein an RMS (Remote monitoring system) to monitor a number of ionizers remotely with one personal computer is adopted.

[8] The ionizer as set forth in claim 1, wherein the connector of said control unit adopts a single connector form.

[9] The ionizer as set forth in claim 1, wherein the ionizer further comprises a bracket for attaching said ionizer to the ceiling or the wall which consists of a □-shaped bracket unit to fix said head unit horizontally or vertically by screws; and a reinforcing plate connected with one outer surface of said □-shaped bracket unit by screws and fixes said head unit by screws, and wherein said □-shaped bracket unit is fixed to the ceiling or the wall by anchor bolts.

[10] The ionizer as set forth in claim 1, wherein the area which said flange coupler contacts with said side unit of the protective case can be set up from necessity.

[11] The ionizer as set forth in claim 1, wherein a space for the body of the X-ray tube is prepared beside said high voltage generation unit inside said side unit of the protective case.

[12] The ionizer as set forth in claim 1, wherein said X-ray tube is fixed and supported by the means that fixes said flange coupler to said side unit of the protective case.

[13] The ionizer as set forth in claim 1, wherein said control unit has a function of alarming to inform when the term of use of said head unit has expired or to be expired soon.

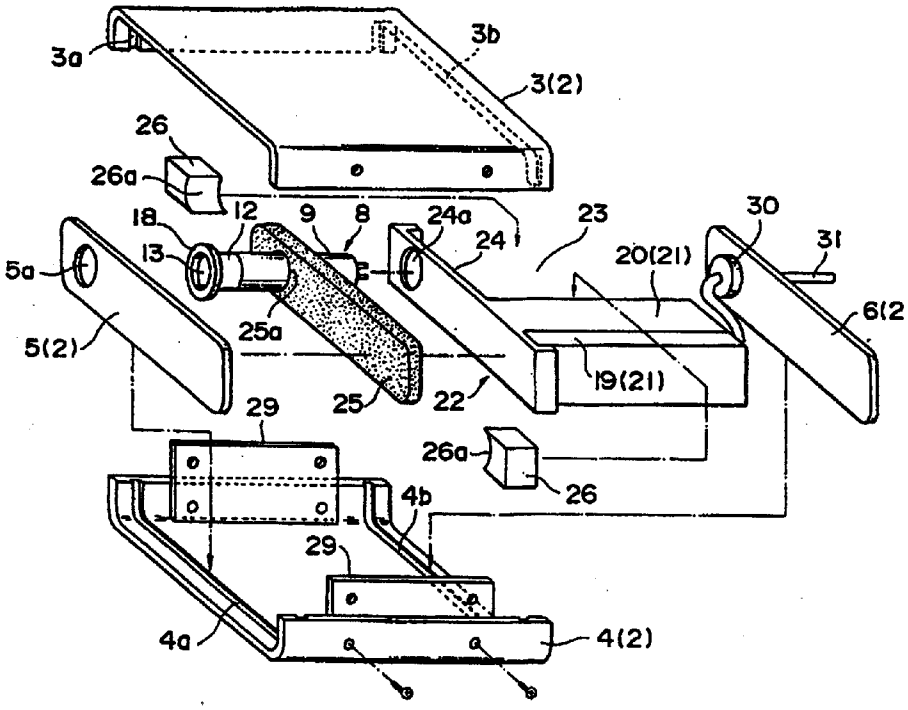
[14] The ionizer as set forth in claim 1, wherein an apparatus for shielding which has a hole for irradiation is placed on the side unit of the protective case on which the output window exists, so that various ionizing ranges and X-ray irradiation types including circle, square and ellipse can be obtained according to the shape of the hole and the distance to the output window.

[15] A method for removing electric charges of a charged body characterized in removing electric charges of a charged body by ionizing elements or materials near the charged body by irradiating soft X-ray having wavelengths in the range of 1~5Å generated from the soft X-ray tube that has a target with a pre-determined target voltage and target current, and uses beryllium window evaporated with silver (Ag).

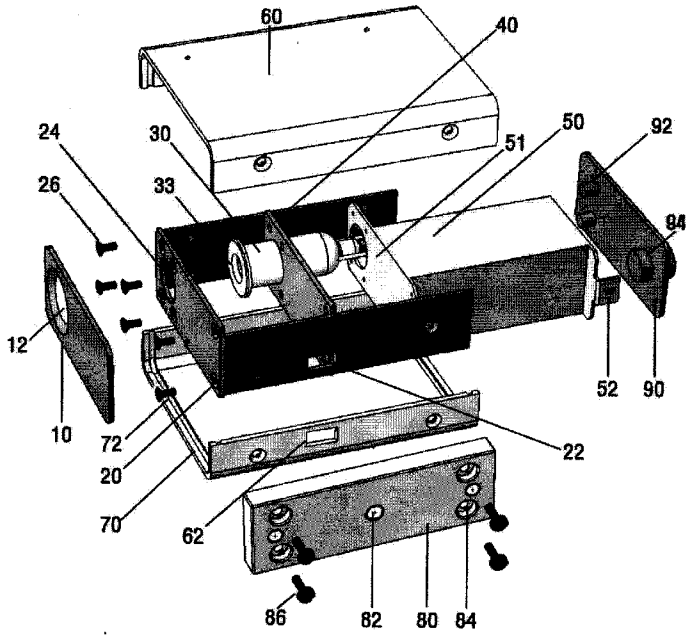
[16] The method for removing electric charges of a charged body as set forth in claim 15, characterized in removing electric charges by generating soft X-ray having

main wavelengths in the range of 3.5~4.5Å under the circumstance that the anode voltage is under 10kV.

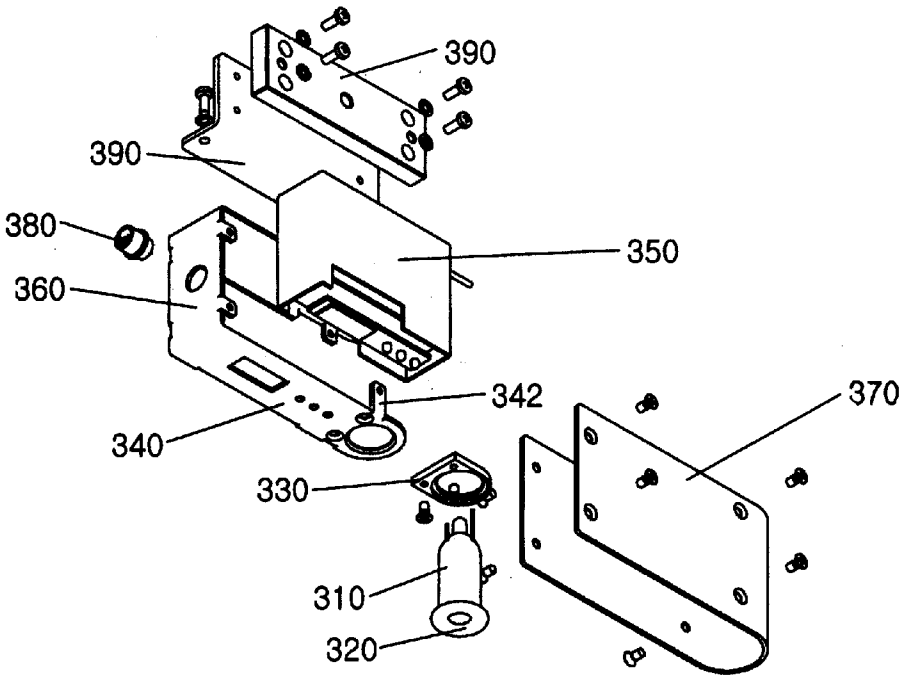
[Fig. 1]


3a
3b
3(2)
26
26a
18
12
9
8
24a
24
23
30
31
5a
13
20(21)
6(2
5(2)
25a
19(21)
29
25
22
26a
26
4b
29
4a
4(2)

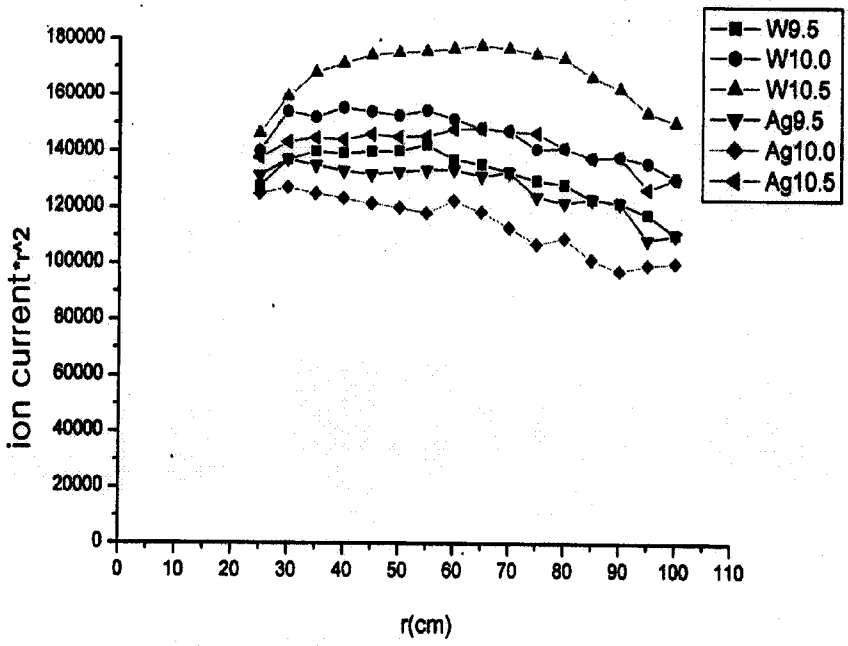
[Fig. 2]


60
40
24
30
51
50
92
26
33
94
12
52
90
10
72
22
20
70
62
86
82
80
84

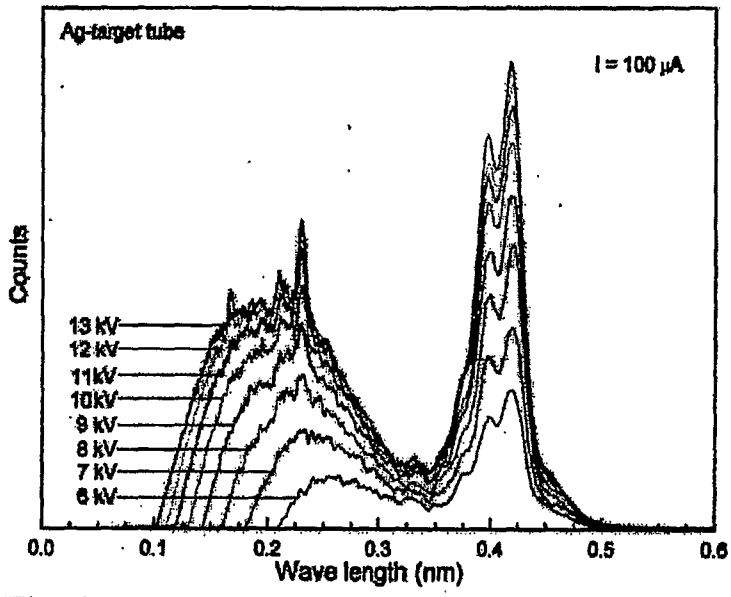
[Fig. 3]


390
390
380
350
360
342
370
340
330
310
320

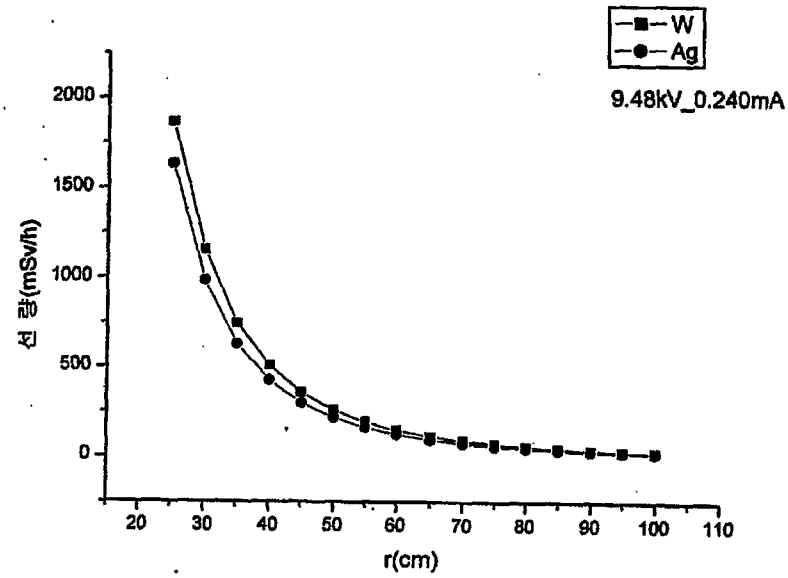
[Fig. 4]


W9.5
W10.0
W10.5
Ag9.5
Ag10.0
Ag10.5
ion current*r^2
r(cm)
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
0
10
20
30
40
50
60
70
80
90
100
110

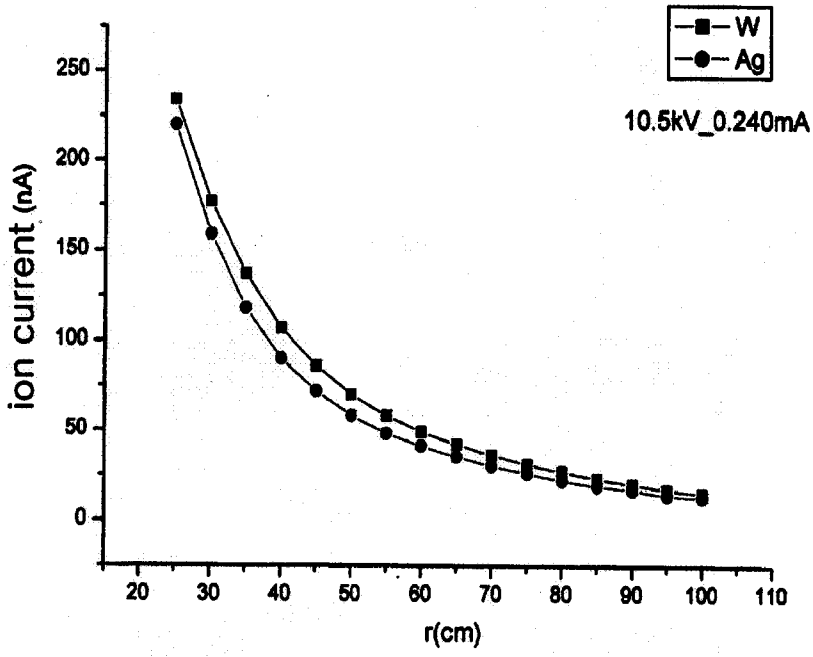
[Fig. 5]


Ag-target tube
I = 100 μA
Counts
13 kV
12 kV
11kV
10kV
9 kV
8 kV
7 kV
6 kV
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Wave length (nm)

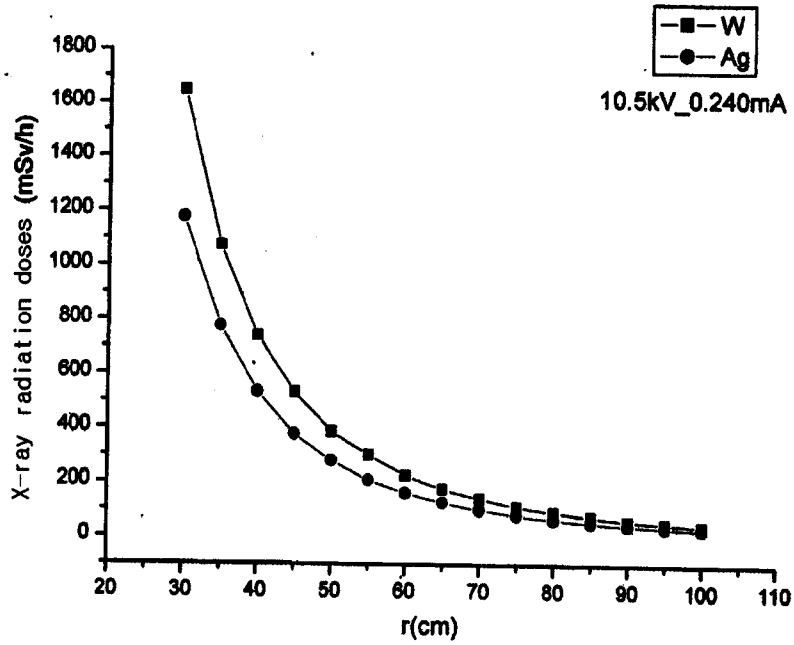
[Fig. 6]


W
Ag
9.48kV_0.240mA
선량(mSv/h)
2000
1500
1000
500
0
20
30
40
50
60
70
80
90
100
110
r(cm)

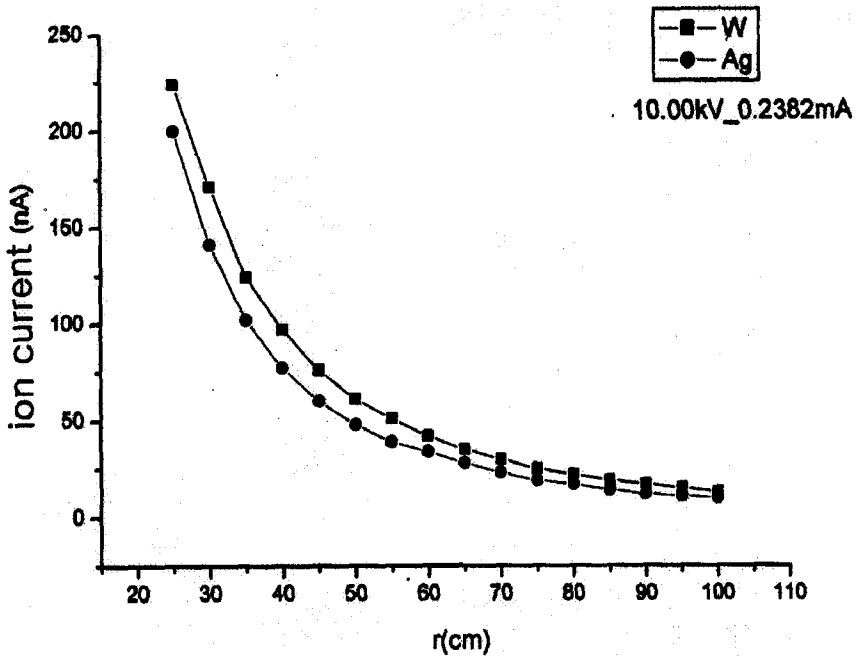
[Fig. 7]


W
Ag
10.5kV_0.240mA
ion current (nA)
250
200
150
100
50
0
20
30
40
50
60
70
80
90
100
110
r(cm)

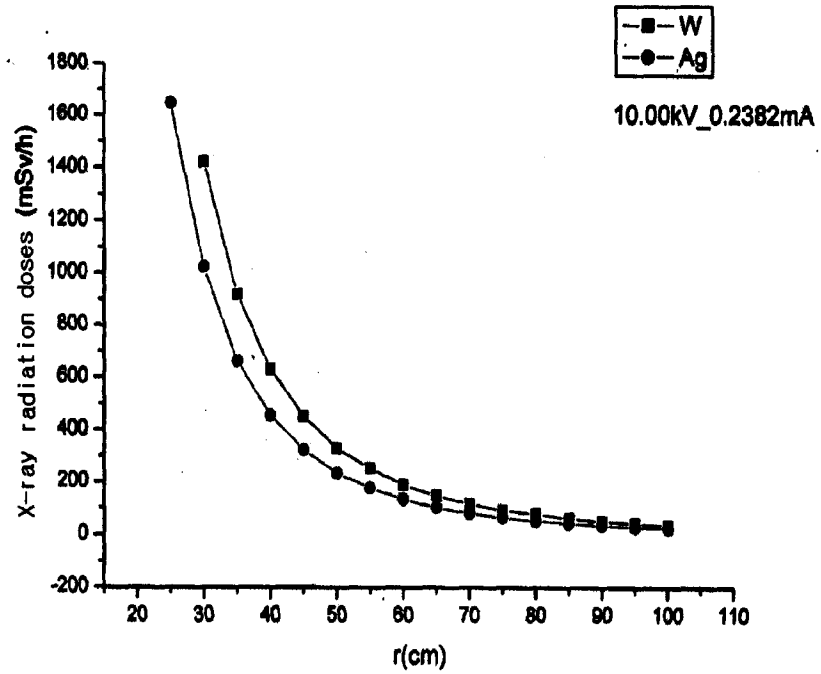
[Fig. 8]


W
Ag
10.5kV_0.240mA
X-ray radiation doses (mSv/h)
1800
1600
1400
1200
1000
800
600
400
200
0
20
30
40
50
60
70
80
90
100
110
r(cm)

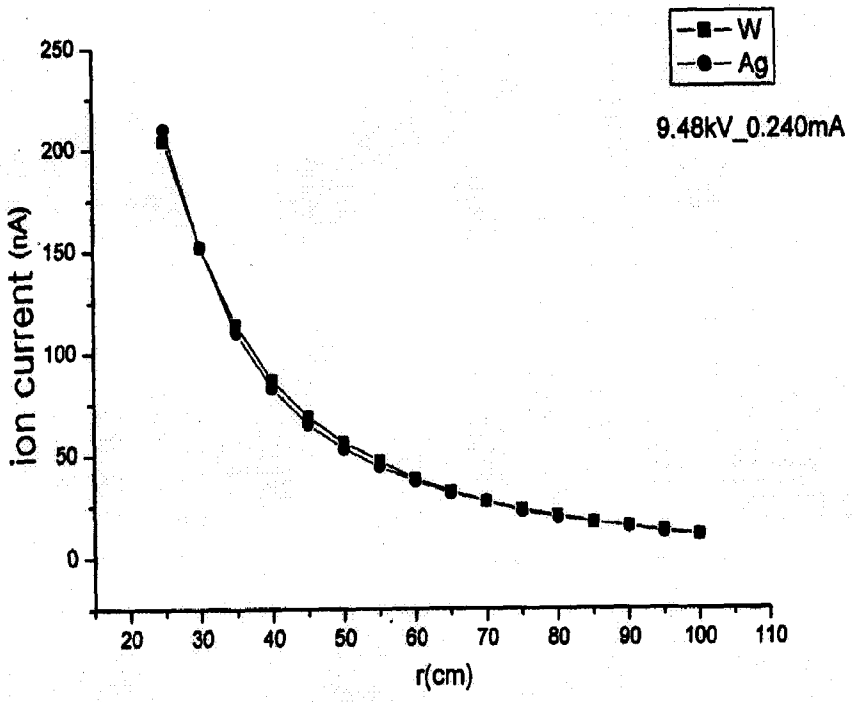
[Fig. 9]


W
Ag
10.00kV_0.2382mA
ion current (nA)
250
200
150
100
50
0
20
30
40
50
60
70
80
90
100
110
r(cm)

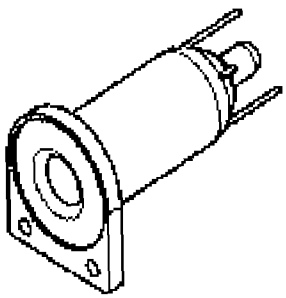
[Fig. 10]


W
Ag
10.00kV_0.2382mA
X-ray radiation doses (mSv/h)
1800
1600
1400
1200
1000
800
600
400
200
0
-200
20
30
40
50
60
70
80
90
100
110
r(cm)

[Fig. 11]


W
Ag
9.48kV_0.240mA
ion current (nA)
250
200
150
100
50
0
20
30
40
50
60
70
80
90
100
110
r(cm)

[Fig. 12]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/004974

A. CLASSIFICATION OF SUBJECT MATTER

G21K 1/14(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)

IPC 8 : G21K

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 since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKIPASS (KIPO internal) " ionizer", "x-ray"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 7126807 B2 (MIZUNO, A et al.) 24 October 2006 See figure 1 See abstract and claims	6, 15, 16 1-5, 7-14
A	US 5883934 A (UMEDA, TERUHIKO) 16 May 1996 See abstract and figure 3	1-16
A	JP 10-106463 A (HAMAMATSU PHOTONICS, CO. LTD.) 24 April 1998 See abstract and figure 1	1-16

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of 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
21 JANUARY 2008 (21.01.2008)	**21 JANUARY 2008 (21.01.2008)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

PAEK, Jin Wook

Telephone No. 82-42-481-8458

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/004974

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1 to 14 are directed to an ionizer using soft X-ray and having a head unit that generates soft X-ray in order to remove electric charges of a charged body by +/- ions.
Claims 15 and 16 are directed to a method for removing electric charges of a charged body characterized in removing electric charges of a charged body by ionizing elements or materials near the charged body by irradiating soft X-ray

The only common special technical feature throughout the whole claims is a soft X-ray tube for irradiating soft X-ray to remove electric charges of a charged body by +/- ions. However, this feature lacks novelty with respect to document US 7126807 B2 cited in this ISR.

Thus, there is no technical relationship left over the prior art among the claimed inventions, leaving the claims without a single general inventive concept.

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/004974

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US07126807	24.10.2006	EP1397030A1	10.03.2004
		EP1397030A4	01.09.2004
		KR1020040004662	13.01.2004
		US20040218315A1	04.11.2004
		US2004218315AA	04.11.2004
		US2006279897AA	14.12.2006
		US7126807BB	24.10.2006
		WO2002098188A1	05.12.2002
		WO200209818BC2	10.04.2003
US05883934	16.03.1999	JP09192209	29.07.1997
		JP10127747A2	19.05.1998
		JP10127747	19.05.1998
		JP3049542B2	05.06.2000
		JP3091907B2	25.09.2000
		JP9192209A2	29.07.1997
		US5883934A	16.03.1999
JP10106463	24.04.1998	CN1183022	27.05.1998
		CN1183022A	27.05.1998
		DE69726535T2	14.10.2004
		EP00833365A1	01.04.1998
		EP00833365B1	03.12.2003
		EP0833365A1	01.04.1998
		EP833365A1	01.04.1998
		EP833365B1	03.12.2003
		JP10106463A2	24.04.1998
		JP10106463	24.04.1998
		JP3839528B2	01.11.2006
		KR100465346B1	29.12.2004
		KR1019980025059	06.07.1998
		KR1020040089634	05.11.2004
		US05949849	07.09.1999
		US5949849A	07.09.1999