

Description

This invention relates to apparatus for discharging static electricity from a body, and finds application in the discharge of static electricity from a human body.

In many industrial fields, damage can result from the discharge of static electricity from a human body to equipment or components. In certain industries such as the petrochemical and munition industries, the result of such a discharge can be an explosion which not only threatens equipment, but human life. In other industries such as the electronics industry, the discharge of static electricity from a person's body to equipment or components results in damage to that equipment. This is particularly true if the equipment contains MOS components. In the case of the petrochemical and munition industries, very stringent procedures are followed in attempting to avoid the discharge of static electricity which could result in a spark causing an explosion. In the electronic industry, procedures such as grounding the workers are implemented to eliminate such discharges. These procedures are difficult to maintain and at times are ineffective due to worker forgetfulness or the difficulty of eliminating static electricity. The problem with grounding workers is that it limits the mobility of the workers. Also, problems arise from workers forgetting to attach their ground wire to the designated terminal.

Portable ion generating devices are generally known - see EP-A-0 209 706.

According to this invention there is provided apparatus as claimed in claim 1.

An embodiment of the invention provides apparatus for dissipating the static electric charge on a human body directly into the air without requiring a solid or liquid electrical connection to a ground point. Elements in the apparatus cause a volume of air near the body to be ionized and the flow of air ions away from the body is used to discharge static electricity on the body below a safe potential.

Advantageously, the apparatus provides for the body being at either a negative or a positive potential with respect to ground. The apparatus uses buried electrodes to minimize the electrical arcing problem and yet allows the ions to be sufficiently excited so as to discharge the static electricity from the body.

Advantageously, the electric power for the apparatus is provided by self-contained solar cells which are capable of producing the necessary electrical current from ambient light.

Brief Description of the Drawing

FIG. 1 illustrates the discharge unit capable of being worn on the wrist of a person;

FIG. 2 illustrates a side view of the discharge unit of FIG. 1;

FIG. 3 illustrates a top view of the discharge unit of FIG. 1.

Detailed Description

FIG. 1 illustrates the apparatus for discharging static electricity from a human body. The unit illustrated in FIG. 1 is designed to be worn on the wrist; however, it would be obvious to one skilled in the art that other arrangements could be derived so that this unit could be positioned on other portions of the body. The unit illustrated in FIG. 1 consists of discharge unit 100 and solar unit 102 both connected to wrist strap 103. The wrist strap 103 is of a conductive material such as a metal expansion band similar to those worn on a wrist watch or fabricated out of a material rendered conductive by metal threads or conductive impregnation as is done in conventional wrist straps through which workers are electrically grounded to their work benches. Solar unit 102 comprises two sub-units each capable of producing the necessary voltage and current. It would be obvious to one skilled in the art that solar unit 102 could be replaced by batteries with the necessary electrical circuits to generate the required voltage. Discharge unit 100 uses electrical power from solar unit 102 to discharge static electricity from the wearer of the apparatus by generating air ions and then allowing the static electricity to dissipate by the flow of ions to a ground point through the air.

Discharge unit 100 is shown as a side view in FIG. 2. The two sub-units of solar unit 102 are illustrated as power supplies 206 and 207. The human body can either be positive or negative with respect to ground, and discharge unit 100 allows for this possibility by the utilization of two power supplies each at a different polarity from the human body which is connected to discharge unit 100 via metal body contact 205. Power supply 206 places embedded positive electrode 202 at a positive potential with respect to the body. This potential of power supply 206 can advantageously be 1500 volts. The negative terminal of power supply 206 is connected to contact 205 via conductor 210, and the positive terminal of power supply 206 is connected to electrode 202 via conductor 211. Similarly, power supply 207 places embedded negative electrode 201 at a negative potential with respect to the body. This potential advantageously can also be 1500 volts. The positive terminal of power supply 207 is connected to contact 205 via conductor 213, and the negative terminal of power supply 207 is connected to electrode 201 via conductor 212. The embedded electrodes are in a horizontal plane with respect to each other sepa-

rated by region 214. The embedded electrodes are enclosed in a plastic insulation so as to prevent arcing through region 214, which would create a sparking hazard, and to allow the creation of ion distributions 203 and 204 which occupy the space above embedded electrodes 202 and 201, respectively. The relative positioning of the embedded electrodes is illustrated in a top view in FIG. 3.

Coronal discharge electrodes 208 and coronal discharge electrodes 209 are utilized to assist in the formation of the ion distribution layers. These coronal discharge electrodes are illustrated in FIG. 3 as comprising pairs but one skilled in the art can readily see that there could be a plurality of these discharge electrodes and that they could have different physical configurations. Consider the operation of discharge electrodes 208. The function of these electrodes is to create negative ions for the negative air ion distribution 203 above embedded positive electrode 202. Discharge electrodes 208 accomplish this by injecting electrons into the air molecules resulting in negative air ions which are attracted to embedded positive electrode 202 through electrostatic attraction. Discharge electrodes 209 function in a similar manner but adsorb electrons from the air molecules resulting in positive ions which are attracted to the embedded negative electrode 201 and are thus added to positive air ion distribution 204.

The make-up of the ion distributions above both electrodes is described with respect to embedded positive electrode 202. The distribution of negative ions in ion distribution 203 is in two different layers of ions associated with the positive electrode 202. The layer of ions immediately adjacent to the surface is called the Stern layer. The ions of this layer are held to the charged surface by a combination of electrostatic attraction and specific adsorption forces. The thickness of this layer is assumed to be about equal to the ionic diameter of the adsorbed ions. The second layer of ions is the Gouy layer. The ions in the Gouy layer are acted upon only by electrostatic forces and thermal motions. The net charge density of the diffused ion atmosphere of the Gouy layer decreases exponentially with the distance from the Stern plane. The ions in the Stern layer are tightly held to the surface of the plastic insulation by the embedded positive electrode 202 and the adsorption forces. However, the ions in the Gouy layer have what is known as a plane of shear above which they are reasonably free to move horizontally with respect to embedded positive electrode 202. The positive ions in positive air ion distribution 204 have a similar distribution.

Since the ions in the Gouy layer of both ion distributions 203 and 204 are free to move in the horizontal direction with respect to their respective

embedded electrodes 202 and 201, the ions in both Gouy layers drift towards region 214. The movement of the ions in the distribution layers is caused by the electrostatic attractions that the ions have for ions of the opposite polarity. As the ions move towards region 214, ions of the same polarity as the human body are expelled from the appropriate embedded electrode and flow through plastic grill 200 into the air to an external ground point. For example, if the body is at a positive potential with respect to ground, the positive ions will flow through plastic grill 200. The remaining ions entering region 214 are combined with each other to form air molecules. Since the embedded electrodes are in plastic insulation, there can be no arcing across region 214; hence, the rate of recombinations is at a near steady state within region 214. The continuous flow of ions is desirable to prevent space charges from building up around the coronal discharge electrodes, thus preventing the formation of ions by the coronal discharge electrodes. In the above example, the negative ions are combined with positive ions within the region 214; however, a greater number of positive ions is being added to positive air ion distribution 203 to make up for the loss of positive ions out of the discharge unit 100 via plastic grill 200.

Claims

1. Apparatus for the static electric discharge of a body and which is worn on the body, comprising a pair of electrodes (201,202), a conductive body contact means (205) for making an electrical contact with said body, a first voltage means (207) connecting the negative terminal of said first voltage means to a first one of said electrodes and the positive terminal of said first voltage means to said conductive body contact means, CHARACTERISED IN THAT said pair of electrodes is insulation-embedded in a common horizontal plane, and said apparatus comprises a second voltage means (206) connecting a positive terminal of said second voltage means to a second one of said embedded electrodes and a negative terminal of said voltage means to said conductive body contact means, a first set of discharge electrodes (208) connected to said first one of said embedded electrodes for generating negative air ions in the vicinity of said second one of said embedded electrodes thereby creating a distribution of negative ions (203) in the vicinity of said second one of said embedded electrodes, a second set of discharge electrodes (209) connected to said second one of said embedded electrodes for generating positive ions in the vicinity of said first one of said



rated by region 214. The embedded electrodes are enclosed in a plastic insulation so as to prevent arcing through region 214, which would create a sparking hazard, and to allow the creation of ion distributions 203 and 204 which occupy the space above embedded electrodes 202 and 201, respectively. The relative positioning of the embedded electrodes is illustrated in a top view in FIG. 3.

Coronal discharge electrodes 208 and coronal discharge electrodes 209 are utilized to assist in the formation of the ion distribution layers. These coronal discharge electrodes are illustrated in FIG. 3 as comprising pairs but one skilled in the art can readily see that there could be a plurality of these discharge electrodes and that they could have different physical configurations. Consider the operation of discharge electrodes 208. The function of these electrodes is to create negative ions for the negative air ion distribution 203 above embedded positive electrode 202. Discharge electrodes 208 accomplish this by injecting electrons into the air molecules resulting in negative air ions which are attracted to embedded positive electrode 202 through electrostatic attraction. Discharge electrodes 209 function in a similar manner but adsorb electrons from the air molecules resulting in positive ions which are attracted to the embedded negative electrode 201 and are thus added to positive air ion distribution 204.

The make-up of the ion distributions above both electrodes is described with respect to embedded positive electrode 202. The distribution of negative ions in ion distribution 203 is in two different layers of ions associated with the positive electrode 202. The layer of ions immediately adjacent to the surface is called the Stern layer. The ions of this layer are held to the charged surface by a combination of electrostatic attraction and specific adsorption forces. The thickness of this layer is assumed to be about equal to the ionic diameter of the adsorbed ions. The second layer of ions is the Gouy layer. The ions in the Gouy layer are acted upon only by electrostatic forces and thermal motions. The net charge density of the diffused ion atmosphere of the Gouy layer decreases exponentially with the distance from the Stern plane. The ions in the Stern layer are tightly held to the surface of the plastic insulation by the embedded positive electrode 202 and the adsorption forces. However, the ions in the Gouy layer have what is known as a plane of shear above which they are reasonably free to move horizontally with respect to embedded positive electrode 202. The positive ions in positive air ion distribution 204 have a similar distribution.

Since the ions in the Gouy layer of both ion distributions 203 and 204 are free to move in the horizontal direction with respect to their respective

embedded electrodes 202 and 201, the ions in both Gouy layers drift towards region 214. The movement of the ions in the distribution layers is caused by the electrostatic attractions that the ions have for ions of the opposite polarity. As the ions move towards region 214, ions of the same polarity as the human body are expelled from the appropriate embedded electrode and flow through plastic grill 200 into the air to an external ground point. For example, if the body is at a positive potential with respect to ground, the positive ions will flow through plastic grill 200. The remaining ions entering region 214 are combined with each other to form air molecules. Since the embedded electrodes are in plastic insulation, there can be no arcing across region 214; hence, the rate of recombinations is at a near steady state within region 214. The continuous flow of ions is desirable to prevent space charges from building up around the coronal discharge electrodes, thus preventing the formation of ions by the coronal discharge electrodes. In the above example, the negative ions are combined with positive ions within the region 214; however, a greater number of positive ions is being added to positive air ion distribution 203 to make up for the loss of positive ions out of the discharge unit 100 via plastic grill 200.

Claims

1. Apparatus for the static electric discharge of a body and which is worn on the body, comprising a pair of electrodes (201,202), a conductive body contact means (205) for making an electrical contact with said body, a first voltage means (207) connecting the negative terminal of said first voltage means to a first one of said electrodes and the positive terminal of said first voltage means to said conductive body contact means, CHARACTERISED IN THAT said pair of electrodes is insulation-embedded in a common horizontal plane, and said apparatus comprises a second voltage means (206) connecting a positive terminal of said second voltage means to a second one of said embedded electrodes and a negative terminal of said voltage means to said conductive body contact means, a first set of discharge electrodes (208) connected to said first one of said embedded electrodes for generating negative air ions in the vicinity of said second one of said embedded electrodes thereby creating a distribution of negative ions (203) in the vicinity of said second one of said embedded electrodes, a second set of discharge electrodes (209) connected to said second one of said embedded electrodes for generating positive ions in the vicinity of said first one of said



embedded electrodes thereby creating a positive air ion distribution (204) in the vicinity of said first one of said embedded electrodes, and a recombination region (214) of a predetermined width between said first and second ones of said embedded electrodes whereby the ions from said negative and positive air ion distributions horizontally move under electrostatic attraction from each other to said recombination region releasing ions of the same polarity of said body into the air to flow away from the embedded electrodes into the surrounding air thereby resulting in the removal of static electricity from said body.

2. Apparatus as claimed in claim 1 wherein said first and second voltage means are solar cell units (102) for producing electricity from ambient light.
3. Apparatus as claimed in claim 1 or 2 comprising a conductive wrist strap (103) connected to said conductive body contact means thereby allowing the apparatus to be worn on the wrist of a human body.

Patentansprüche

1. Vorrichtung zur elektrostatischen Entladung eines Körpers, die auf dem Körper getragen wird, und ein Paar von Elektroden (201, 202) aufweist, ferner eine leitende Körperkontakteinrichtung (205), die einen elektrischen Kontakt mit dem Körper herstellt, eine erste Spannungseinrichtung (207, deren negativer Anschluß mit einer ersten Elektrode und deren positiver Anschluß mit der Körperkontakteinrichtung verbunden sind, dadurch gekennzeichnet, daß das Elektrodenpaar in einer gemeinsamen horizontalen Ebene in eine Isolation eingebettet ist, daß die Vorrichtung eine zweite Spannungseinrichtung (206) aufweist, deren positiver Anschluß mit der zweiten eingebetteten Elektrode und deren negativer Anschluß mit der Körperkontakteinrichtung verbunden sind, daß ein erster Satz von Entladungselektroden (208), die mit der ersten eingebetteten Elektrode verbunden sind, negative Luftionen in der Nachbarschaft der zweiten eingebetteten Elektrode und damit eine Verteilung negativer Ionen (203) in der Nachbarschaft der zweiten eingebetteten Elektrode erzeugen, daß ein zweiter Satz von Entladungselektroden (209), die mit der zweiten eingebetteten Elektrode verbunden sind, positive Ionen in der Nachbarschaft der ersten

eingebetteten Elektrode und damit eine Verteilung positiver Luftionen (204) in der Nachbarschaft der ersten eingebetteten Elektrode erzeugen, und

daß eine Rekombinationszone (214) vorbestimmter Länge zwischen der ersten und der zweiten eingebetteten Elektrode vorgesehen ist, wodurch die Ionen aus der Verteilung negativer und positiver Luftionen sich horizontal unter gegenseitiger elektrostatischer Anziehung zu der Rekombinationszone bewegen und Ionen gleicher Polarität des Körpers in die Luft freigeben, die dann weg von den eingebetteten Elektroden in die umgebende Luft abfließen, wodurch sich eine Entfernung statischer Elektrizität von dem Körper ergibt.

2. Vorrichtung nach Anspruch 1, bei der die erste und die zweite Spannungseinrichtung Solarzelleneinheiten (102) sind, die elektrischen Strom aus dem Umgebungslicht erzeugen.
3. Vorrichtung nach Anspruch 1 oder 2 mit einem leitenden Armband (103), das mit der leitenden Körperkontakteinrichtung verbunden ist, so daß die Vorrichtung am Handgelenk eines menschlichen Körpers getragen werden kann.

Revendications

1. Appareil pour la décharge de l'électricité statique d'un corps, qui est porté sur le corps, comprenant une paire d'électrodes (201, 202), un moyen de contact corporel conducteur (205) pour établir un contact électrique avec ledit corps, un premier moyen générateur de tension (207) dont la borne négative est connectée à une première desdites électrodes et dont la borne positive est connectée audit moyen de contact corporel conducteur, caractérisé en ce que ladite paire d'électrodes est enrobée d'une matière isolante dans un plan horizontal commun, et ledit appareil comprend un second moyen générateur de tension (206) dont une borne positive est connectée à une seconde desdites électrodes enrobées et dont une borne négative est connectée audit moyen de contact corporel conducteur, un premier jeu d'électrodes de décharge (208) connecté à ladite première desdites électrodes enrobées pour engendrer des ions d'air négatifs au voisinage de ladite seconde desdites électrodes enrobées, créant ainsi une distribution d'ions négatifs (203) au voisinage de ladite seconde desdites électrodes enrobées, un second jeu d'électrodes de décharge (209) connecté à



ladite seconde desdites électrodes enrobées pour engendrer des ions positifs au voisinage de ladite première desdites électrodes enrobées, créant ainsi une distribution d'ions d'air positifs (204) au voisinage de ladite première desdites électrodes enrobées, et une région de recombinaison (214) d'une largeur prédéterminée entre lesdites première et seconde desdites électrodes enrobées, de sorte que les ions provenant desdites distributions d'ions d'air négatifs et positifs se déplacent horizontalement par attraction électrostatique en s'éloignant les uns des autres en direction de ladite région de recombinaison, libérant des ions de la même polarité du corps dans le flux d'air de manière à s'éloigner des électrodes enrobées dans l'air environnant, ce qui a pour effet d'évacuer l'électricité statique dudit corps.

2. Appareil suivant la revendication 1, dans lequel ledit premier et ledit second moyen générateur de tension sont des unités de cellules solaires (102) destinées à produire de l'électricité à partir de la lumière ambiante.
3. Appareil suivant la revendication 1 ou 2 comprenant un bracelet conducteur (103) relié audit moyen de contact corporel conducteur de manière que l'appareil puisse être porté sur le poignet d'un corps humain.