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ELECTROSTATIC GENERATOR

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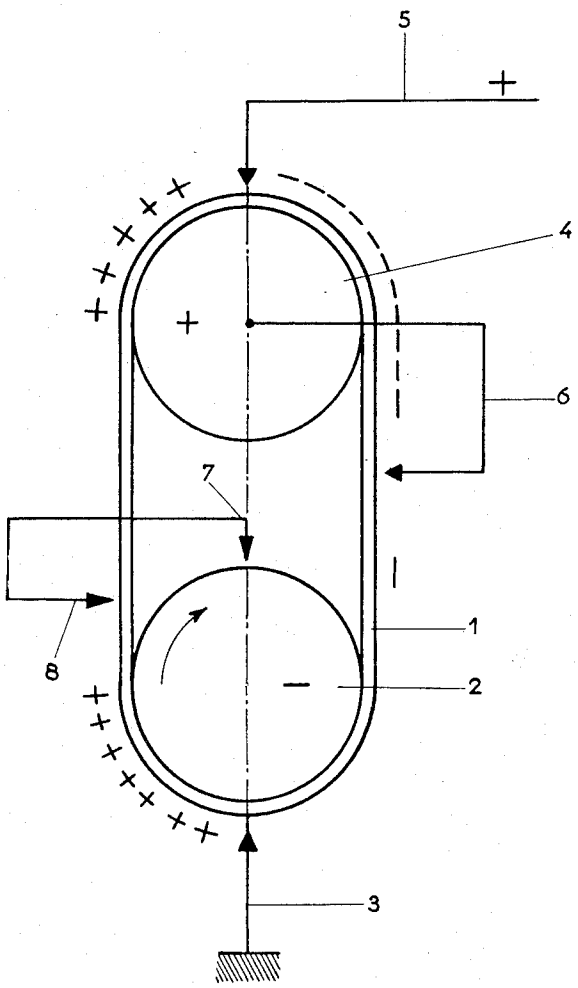

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ELECTROSTATIC GENERATOR

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This invention relates to generating apparatus and more particularly to an apparatus for stabilizing the operation of an electrostatic generator.

As is well known, in certain types of electrostatic generators there is provided a pair of spaced-apart energizing means, customarily in the form of pulleys, which are interconnected by an endless belt or other suitable conveyor. Upon the rotation of the pulleys, charges appear thereon under the action of the friction between the pulleys and the belt. Each pulley is provided with an ionizing member in spaced relationship with the belt. The charged pulleys serve as inductors to energize the ionizing members such that the members charge the belt through influence. The charge received by the belt from one of the ionizing members is conveyed to the other member, which functions as the output terminal of the generator.

The polarity of the charges on the energizing pulleys, and hence the polarity of the generator, is determined by various parameters and particularly by the characteristics of the contacting sufaces of the pulleys and the belt. However, even in cases in which information is available as to particular electrical properties of the materials used for the contacting surfaces, difficulties have been encountered in the provision of an electrostatic generator having an output of predetermined polarity. These difficulties arise primarily because of changes in the frictional effects between the pulleys and the belt which result from the adsorption of ambient gases or vapors.

For certain types of materials, particularly in cases in which the materials used for the pulleys are of different electrical conductivity, the polarity at the output of the generator may be accurately established. As an illustration, for a belt of a material such as natural rubber, for example, if one of the pulleys is of an electrically conductive material and the other is of substantially non-conductive material, the charges on the conductive pulley are of positive polarity, as is the generator output, while the non-conductive pulley is charged negatively.

In many self-energizing generators of the type employed heretofore, the charges one the pulleys exhibited a tendency to build up and were limited only by the dielectric rigidity of the ambient gas inside which the generator operated. The build-up of charges on the pulleys produced a fluctuation in the potential difference between each pulley and its corresponding ionizing member. As a result, with a generator load of substantially constant impedance, the current intensity and voltage applied to the load exhibited similar fluctuations, and the operation of the generator was highly unstable.

One general object of this invention is to provide a new and improved generator of the electrostatic type.

More specifically, it is an object of this invention to provide a self-energizing electrostatic generator having a stabilized output of predetermined polarity.

Another object of this invention is to provide an electrostatic generator which is economical to manufacture and thoroughly reliable in operation.

In one preferred embodiment of the invention, auxiliary ionizing means is operatively associated with at least one of the pulleys or other energizing means of the generator. This ionizing means serves to limit the charge carried by the associated pulley to substantially reduce fluctuations in the current intensity and voltage at the

generator output. In certain particularly good arrangements, the auxiliary ionizing means is interposed between an electrically conductive pulley adjacent the output ionizing member and an oppositely charged portion of the endless belt.

In some advantages embodiments, the generator also is provided with additional auxiliary ionizing means which is effective to limit the charge on the pulley adjacent the input ionizing member. The arrangement is such that a substantially constant potential appears at the generator output.

The present invention, as well as further objects and advantages thereof, will be understood more clearly and fully from the following description of one illustrative embodiment, when read with reference to the accompanying drawing, in which the single figure is a schematic representation of a self-energizing electrostatic generator in accordance with the invention.

Referring to the drawing, there is shown an endless belt **1** which is fabricated from natural rubber or other suitable non-conductive material. The belt **1** is trained around two pulleys **2** and **4** which are positioned one above the other in spaced-apart relationship and serve as the energizing means for the generator. The pulley **2** is substantially non-conductive and illustratively is fabricated from polyethylene, vinyl chloride or other insulating material. The pulley **4**, on the other hand, is formed of metal and is highly conductive.

Positioned in spaced juxtaposition with the insulating pulley **2** is an input ionizing member **3**. The ionizing member **3** is maintained in a stationary position with respect to the pulley **2** and is at ground potential. The member **3** is arranged in close proximity with the outer surface of the portion of the belt **1** in contact with the pulley **2**.

In a similar manner, an output ionizing member **5** is disposed in close proximity with the outer surface of the belt portion in contact with the conductive pulley **4**. The member **5** is arranged in spaced relationship with the pulley **4** and is suitably insulated with respect to ground. As will be understood, the member **5** serves as the output terminal of the generator and is arranged for connection to the desired load (not shown).

In operation, the non-conductive pulley **2** is continuously rotated in a clockwise direction, as viewed in the drawing, to similarly rotate the belt **1** and the metal pulley **4**. As the pulleys rotate, the pulley **2** is charged with a negative potential while the pulley **4** is charged positively. The charged pulleys serve as inductors and respectively energize the ionizing members **3** and **5**. The input ionizing member **3** cooperates with the belt **1** to load the belt with positive charges, through influence, and the upwardly directed reach of the belt conveys these charges to the output ionizing member **5**. The ionizing member **5** collects the poistive charges and also produces negative charges, again through influence, on the downwardly directed belt reach moving away from the member **5** toward the member **3**. The positive charges on the member **5** establish the positive output potential of the generator.

In the use of the various components described thus far, the positive potential on the metal pulley **4** exhibits a tendency to build up more or less continuously until the dielectric rigidity of the air or other gas surrounding the generator breaks down. Thus, the difference in potential between the pulley **4** and the output ionizer **5** tends to increase until a momentary arc appears therebetween. As a result, the voltage between the pulley and the output ionizer fluctuates to produce unstable oscillations in the output voltage of the generator.

The instability of the generator output is augmented by somewhat similar fluctuations in the potential difference

between the negatively charged pulley 2 and the input ionizer 3. Because the ionizer 3 is at ground potential, the adverse effect of the build-up of charges on the pulley 2 is not as substantial as that resulting from the charges building up on the pulley 4. For many types of electrostatic generators, however, the charge build-up on the pulley 2 has a substantial effect on the generator's instability.

In order to limit the positive charges carried by the metal pulley 4, there is provided an auxiliary ionizing member 6 in the form of a conductor. One end of the member 6 is electrically connected to the pulley 4, while the other end is maintained in spaced relationship with a portion of the apparatus having a substantially lower potential. Thus, in the illustrated embodiment, the free end of the member 6 is in spaced juxtaposition with the downwardly directed reach of the belt 1. As indicated heretofore, this reach carries negative charges from the pulley 4 to the pulley 2. The potential difference between the pulley 4 and the downwardly directed belt reach is substantially greater than that between the pulley and the output ionizer 5.

Upon the build-up of positive charges on the pulley 4, current flows through the auxiliary ionizing member 6 and is carried by an effluvia across the spark gap between the free end of the member 6 and the negatively charged reach of the belt 1. This current is effective to limit the potential of the pulley 4, and hence the potential at the output ionizer 5, such that the fluctuations in the current intensity and output voltage of the generator are substantially reduced.

In cases in which it is advantageous to also limit the potential of the insulating pulley 2, there is provided a second auxiliary ionizing member 7 which likewise is in the form of a conductor. One end of the ionizing member 7 is in spaced but close proximity with the negatively charged pulley 2 to define a spark gap therebetween. The member 7 includes an ionizing portion 8 at its opposite end which is arranged in spaced juxtaposition with a portion of the apparatus having a potential substantially different from that of the pulley 2. As an illustration, in the illustrated embodiment the ionizing portion 8 is spaced from the upwardly directed positive reach of the belt 1, although in other good arrangements the portion 8 is connected directly to ground.

As the negative potential on the pulley 2 tends to increase, arcing occurs across the gap between the pulley and the adjacent end of the ionizing member 7 and also across the gap between the ionizing portion 8 of the member 7 and the negative reach of the belt 1. A current path is thereby established between the pulley and the belt which serves to limit the build-up of charges on the pulley. The arrangement is such that, for a generator load of constant impedance, the current intensity and voltage at the ionizer 5 is substantially constant, and any fluctuation in the generator output is eliminated.

Because of the non-conductive characteristics of the material for the pulley 2, coupled with the highly conductive characteristics of the material for the pulley 4, the output potential at the ionizing member 5 is of positive polarity. In cases in which a negative generator output is desired, the ionizing member 3 is suitably insulated from ground and serves as the output ionizer of the generator. The ionizing member 5, on the other hand, is connected to ground and is effective to transmit negatively directed electrostatic charges to the belt 1. In this latter situation, the auxiliary ionizers 6 and 7 again enable a substantial reduction in the fluctuations of the output voltage to provide stable operation.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. In an electrostatic generator, in combination, first and second energizing means in spaced-apart relationship with each other, a conveyor movable along a predetermined path between said energizing means for establishing a positive charge on said first energizing means and a negative charge on said second energizing means, a pair of ionizing means disposed along said path respectively adjacent said first and second energizing means, one of said ionizing means cooperating with said conveyor for applying electrostatic charges thereto and the other of said ionizing means cooperating with said conveyor for receiving said electrostatic charges, and auxiliary ionizing means operatively associated with at least one of said energizing means for limiting the charge established thereon, said auxiliary ionizing means being positioned along said path subsequent to the ionizing means adjacent said at least one energizing means in the direction of movement of said conveyor.

2. In an electrostatic generator, in combination, means including a first energizing member of electrically conductive material and a second energizing member of substantially non-conductive material in spaced-apart relationship with each other, a conveyor extending between said first and second members, a pair of ionizing means respectively adjacent said members, one of said ionizing means cooperating with said conveyor for applying electrostatic charges of one polarity thereto and the other of said ionizing means cooperating with said conveyor for receiving said charges and for applying electrostatic charges of the opposite polarity thereto, whereby one of said members is charged with a potential different from that of the other member, and auxiliary ionizing means operatively associated with at least one of the charged energizing members and including a point electrode cooperating with an oppositely charged portion of said conveyor for limiting the potential of said at least one member.

3. In an electrostatic generator, in combination, energizing means including a first pulley of electrically conductive material and a second pulley of substantially non-conductive material in spaced-apart relationship with each other, an endless belt movable along a predetermined path between said pulleys for conveying electrostatic charges therebetween, a pair of ionizing means disposed along said path respectively adjacent said first and second pulleys, one of said ionizing means cooperating with said belt for applying electrostatic charges thereto and the other of said ionizing means cooperating with said belt for receiving said charges, said other energizing means forming an output terminal for said generator, whereby said first pulley is charged with a potential of positive polarity and said second pulley is charged with a potential of negative polarity, and auxiliary ionizing means separate from said output terminal and interposed between said first pulley and said belt for limiting the positive potential of said first pulley, said auxiliary ionizing means including a point electrode positioned along said path subsequent to the ionizing means adjacent said first pulley in the direction of movement of said belt.

4. In an electrostatic self-energizing generator, in combination, energizing means including a metal pulley and a pulley of insulating material in spaced relationship with each other, a non-conductive endless belt operatively inter-connecting said pulleys for conveying electrostatic charges therebetween, first ionizing means in juxtaposition with the portion of said belt adjacent said insulating pulley for applying positive charges to said belt, second ionizing means in juxtaposition with the portion of said belt adjacent said metal pulley for receiving said positive charges from said belt and for applying negative charges thereto, said metal pulley being charged with a positive potential and said insulating pulley being charged with a negative potential, and auxiliary ionizing means connected to said metal pulley and in spaced proximity with

the negatively charged portion of said belt for limiting the positive potential of said metal pulley.

5. An electrostatic self-energizing generator of the character set forth n claim 4, in which said auxiliary ionizing means and said negatively charged portion of said belt define a spark gap therebetween to provide a current path between said metal pulley and said belt.

6. In an electrostatic self-energizing generator, in combination, first and second energizing means in spaced relationship with each other, a conveyor interconnecting said energizing means for conveying electrostatic charges therebetween, first ionizing means in juxtaposition with the portion of said conveyor adjacent said first energizing means for applying positive charges to said conveyor, second ionizing means in juxtaposition with the portion of said conveyor adjacent said second energizing means for receiving said positive charges and for applying negative charges to said conveyor, said first energizing means being charged with a negative potential and said second energizing means being charged with a positive potential, first auxiliary ionizing means operatively associated with said first energizing means and defining a first spark gap with the positively charged portion of said conveyor for enabling current flow between the negative first energizing means and said positively charged portion, to thereby limit the negative potential of said first energizing means, and second auxiliary ionizing means operatively associated with said second energizing means and defining a second spark gap with the negatively charged portion of said conveyor for enabling current flow between the positive second energizing means and said negatively charged portion, to thereby limit the positive potential of said second energizing means.

7. In an electrostatic self-energizing generator, in combination, energizing means including an electrically conductive pulley and a pulley of insulating material in spaced relationship with each other, an endless belt operatively interconnecting said pulleys for conveying electrostatic charges therebetween, first ionizing means in juxtaposition with the portion of said belt adjacent said insulating pulley for applying positive charges to said belt, second ionizing means in juxtaposition with the portion of said belt adjacent said conductive pulley for receiving said positive charges and for applying negative charges to said belt, said conductive pulley being charged with a positive potential and said insulating pulley being charged with a negative potential, first auxiliary ionizing means interposed between said conductive pulley and the negatively charged portion of said belt for limiting the positive potential of said conductive pulley, and second auxiliary ionizing means interposed between said insulating pulley and the positively charged portion of said belt for limiting the negative potential of said insulating pulley.

8. In an electrostatic self-energizing generator, in combination, energizing means including a metal pulley and a pulley of insulating material in spaced relationship with each other, a non-conductive belt movable along a predetermined path between said pulleys for conveying electrostatic charges therebetween, first ionizing means disposed along said path in juxtaposition with the portion of said belt adjacent said insulating pulley for applying positive charges to one of the reaches of said belt, second ionizing means disposed along said path in juxtaposition with the portion of said belt adjacent said metal pulley for receiving said positive charges from said one belt reach and for applying negative charges to the other reach of said belt, said metal pulley being charged with a positive potential and said insulating pulley being charged with a negative potential, first auxiliary ionizing means connected to said metal pulley and including a portion positioned along said path subsequent to said second ionizing means in the direction of movement of said belt and in spaced proximity with said negatively charged reach for limiting the positive potential of said metal pulley, and second auxiliary ionizing means for limiting the negative potential of said insulating pulley, one portion of said second auxiliary ionizing means being in spaced proximity with said insulating pulley and another portion being positioned along said path subsequent to said first ionizing means in the direction of movement of said belt and in spaced proximity with said positively charged reach.

9. An electrostatic self-energizing generator of the character set forth in claim 8, in which the said portion of said first auxiliary ionizing means and the negatively charged reach of said belt define a spark gap therebetween to provide a current path between said metal pulley and said negatively charged reach.

10. An electrostatic self-energizing generator of the character set forth in claim 9, in which said second auxiliary ionizing means enables the flow of current between said insulating pulley and the positively charged reach of said belt, to reduce the negative potential of said insulating pulley.

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