July 10, 1956 M. POINT 2,754,433

ELECTROSTATIC MACHINE GENERATING DIFFERENT POTENTIALS

Filed March 7, 1955 4 Sheets-Sheet 1

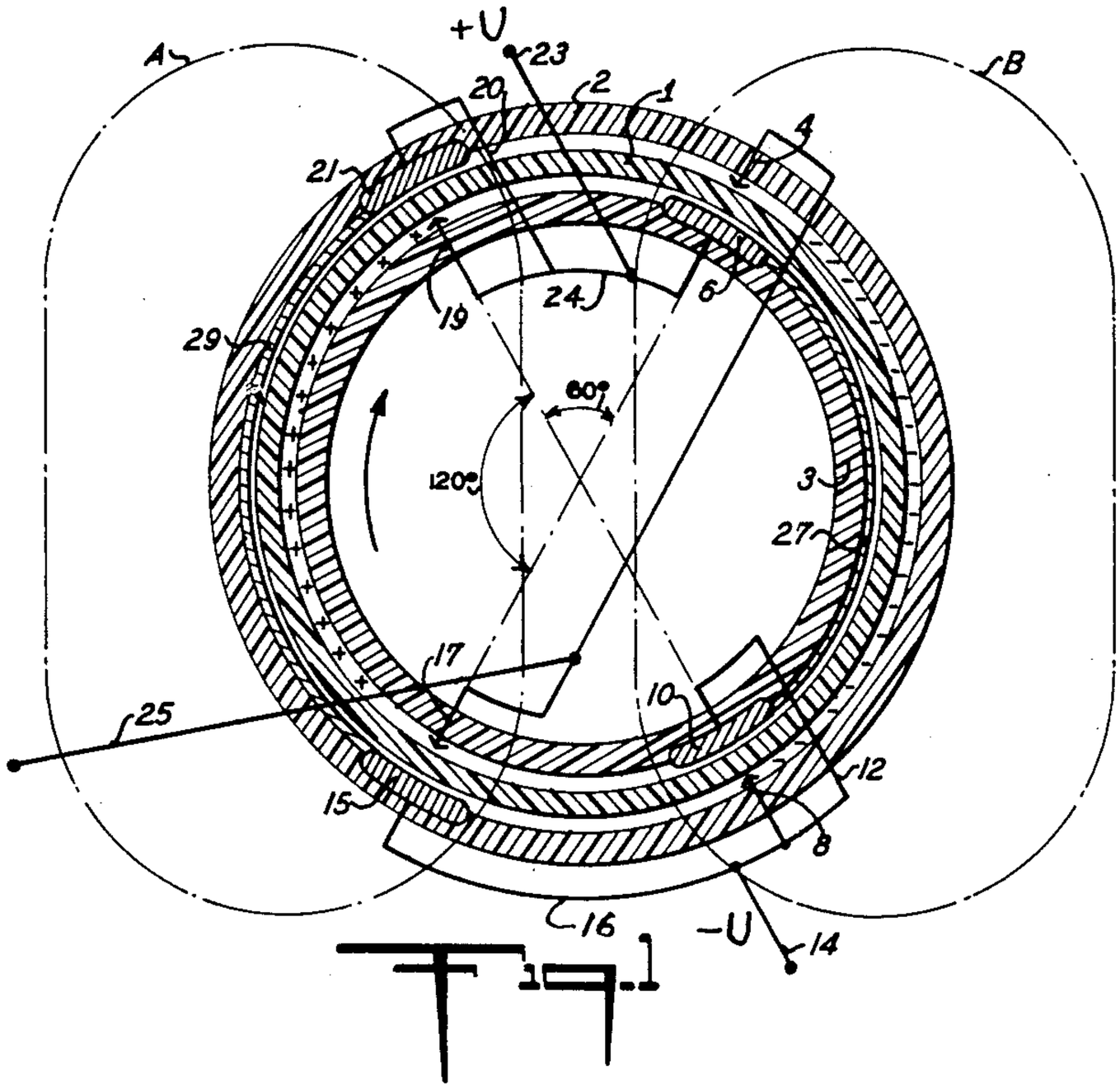


FIG 1

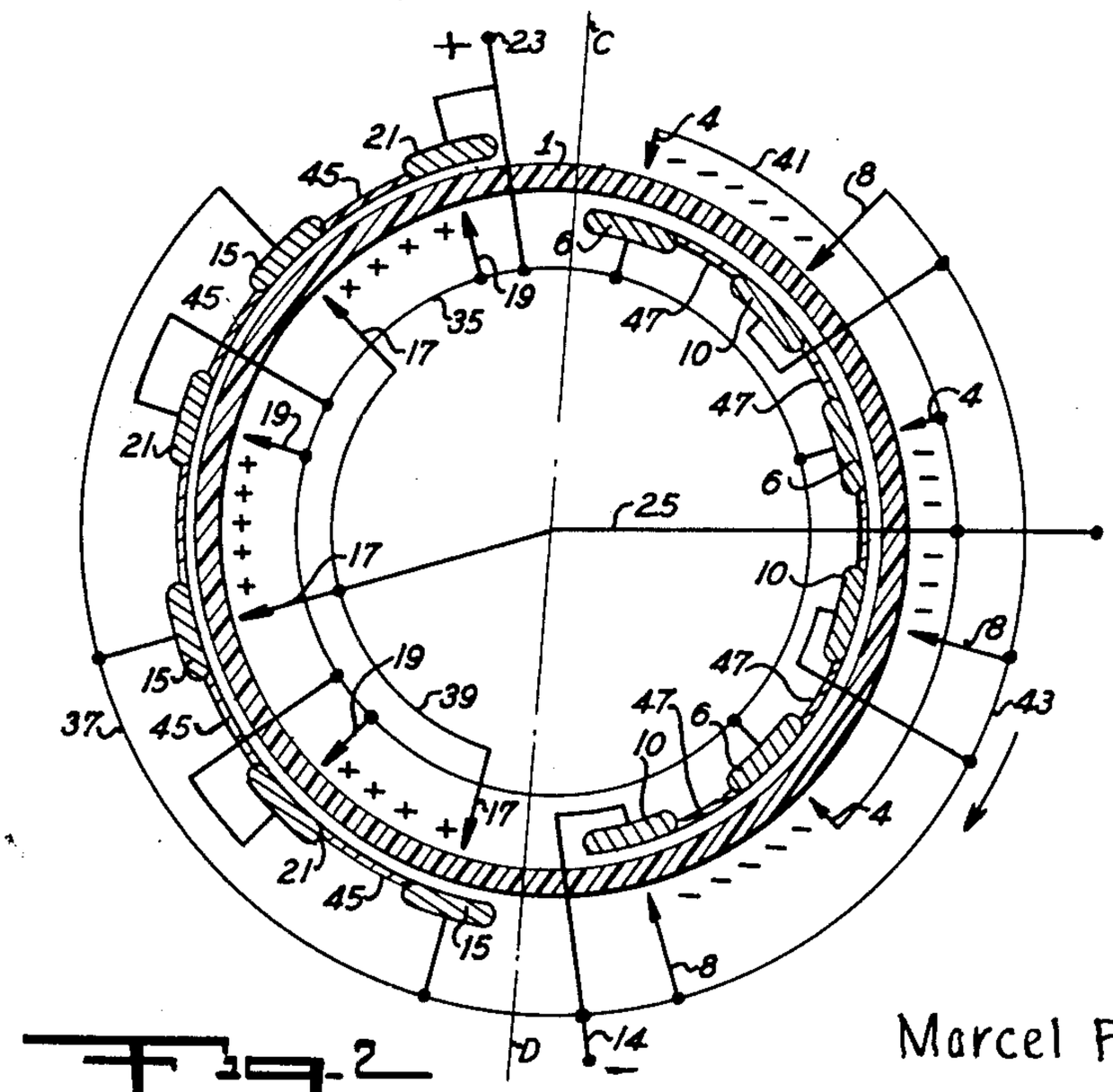


FIG 2

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ELECTROSTATIC MACHINE GENERATING DIFFERENT POTENTIALS

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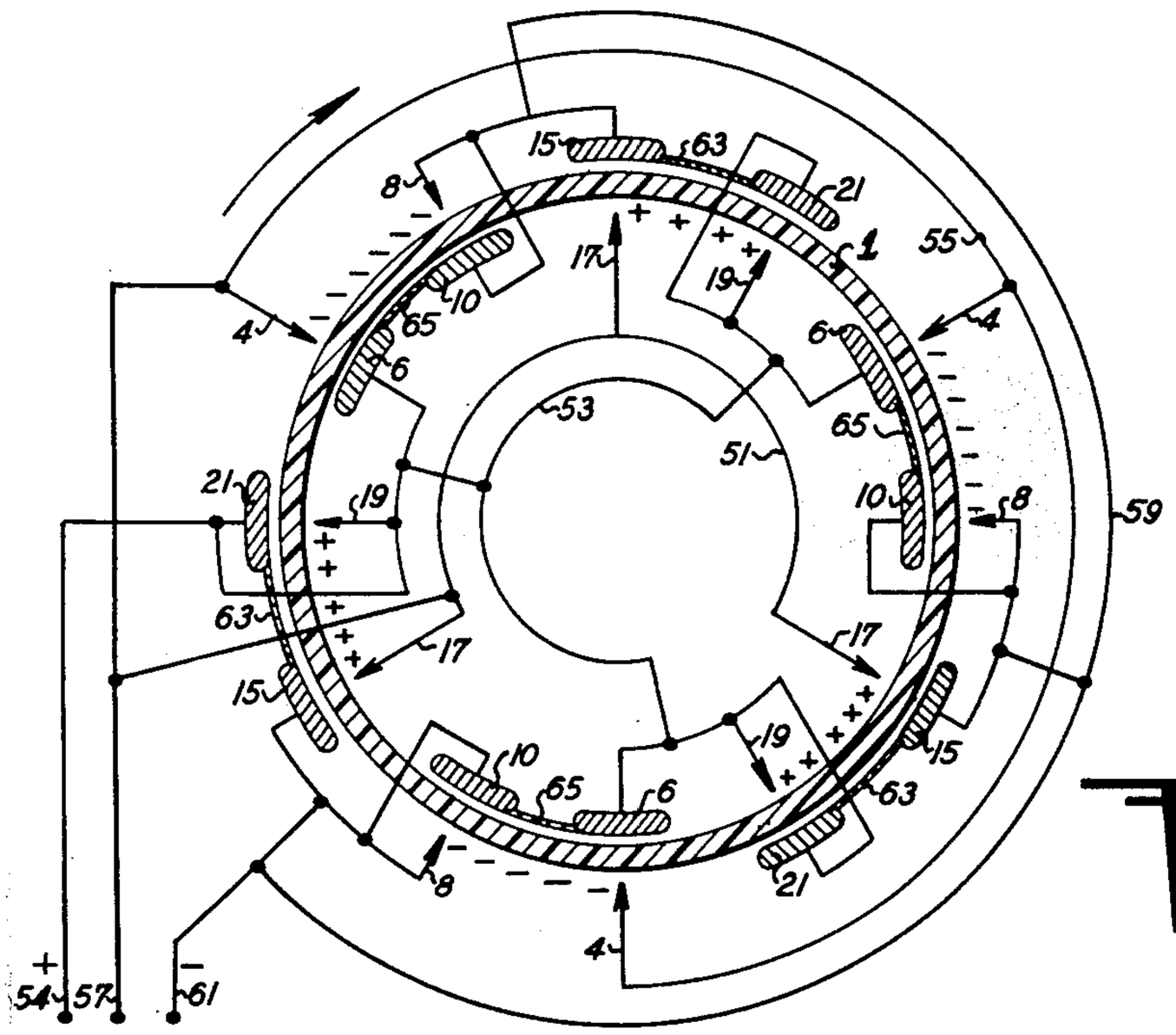


FIG. 2

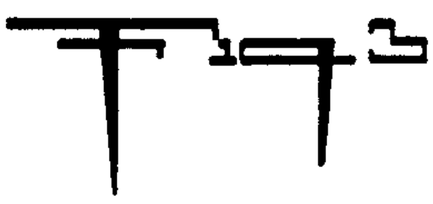

FIG. 3

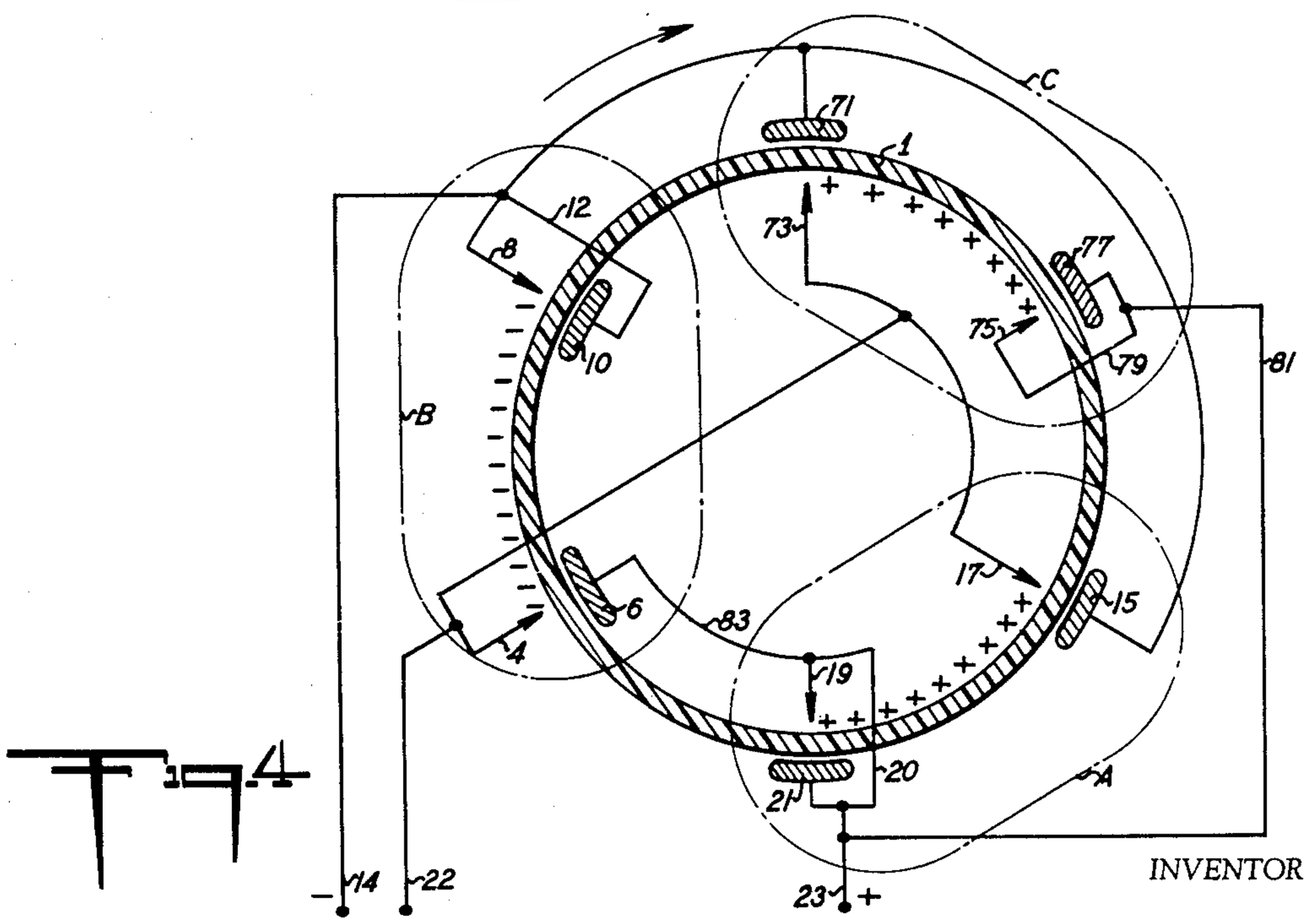


FIG. 4

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ELECTROSTATIC MACHINE GENERATING DIFFERENT POTENTIALS

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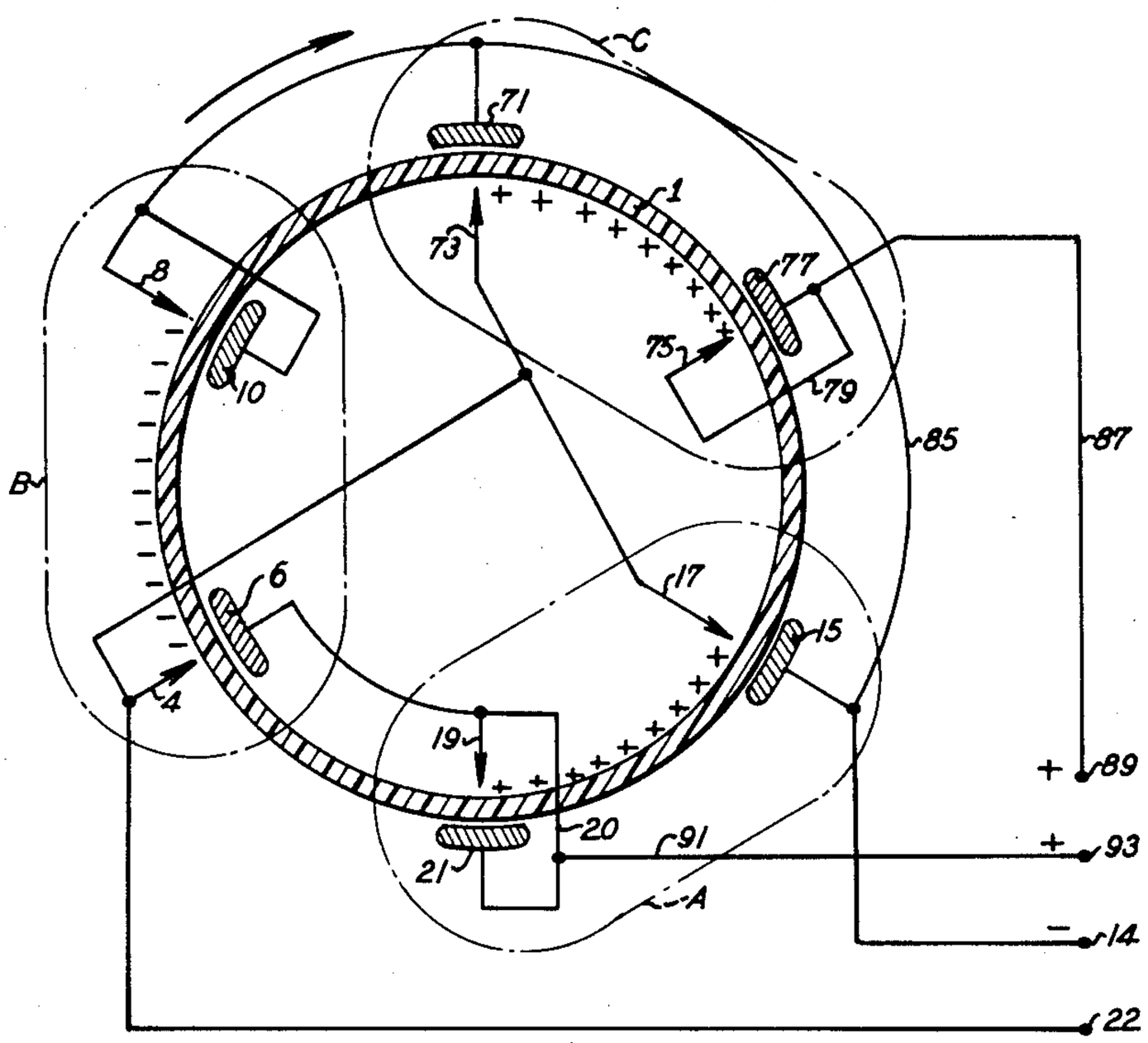


FIG. 5

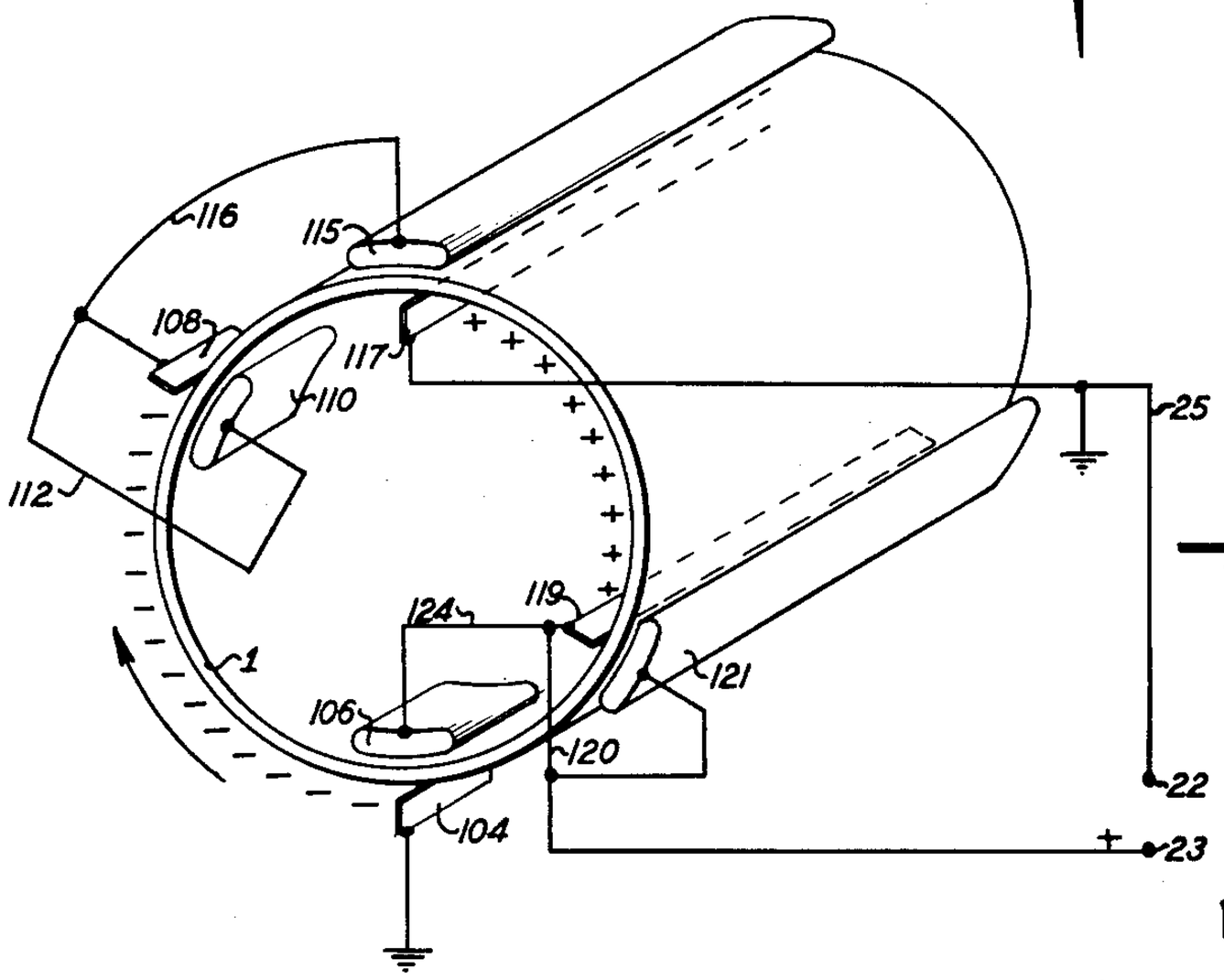


FIG. 6

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ELECTROSTATIC MACHINE GENERATING DIFFERENT POTENTIALS

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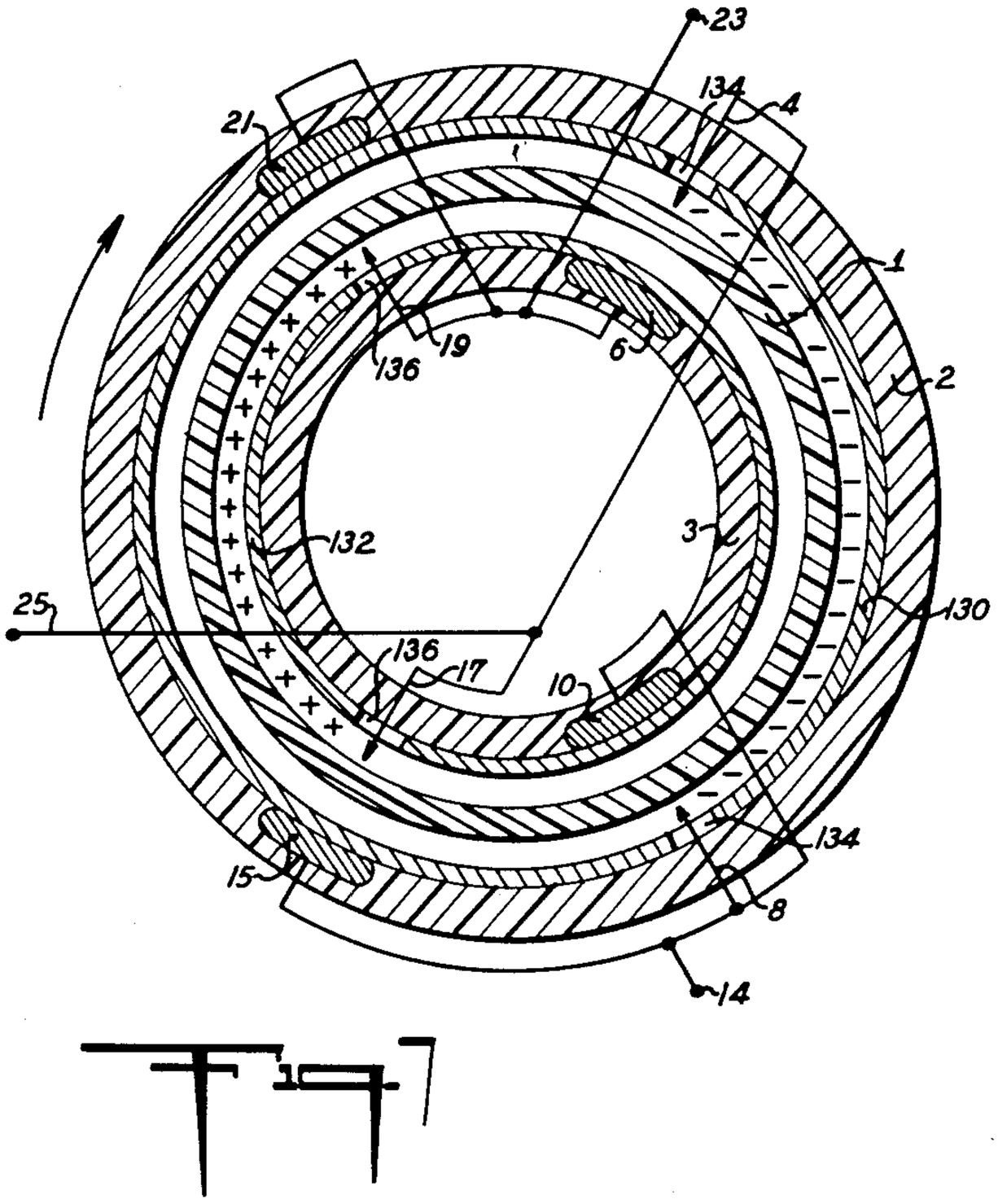


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United States Patent Office

2,754,433

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2,754,433

# ELECTROSTATIC MACHINE GENERATING DIFFERENT POTENTIALS

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Application March 7, 1955, Serial No. 492,493

Claims priority, application France March 8, 1954

20 Claims. (Cl. 310—6)

This invention relates to electrostatic influence machines of the type having a conveyor of insulating material which conveys charges on a face thereof that are produced by an electric field transverse to the face and discharges these charges to a collector which may be connected to a load terminal. The invention particularly relates to an electrostatic machine of this type in which a rotor rotatable on an axis provides a wall of insulating material concentric with the axis adjacent a face of which an exciter ionizer and a collector ionizer are disposed in spaced relation to each other along the wall about the axis of rotation. An exciter inductor is disposed at the opposite side of the wall from the exciter ionizer to develop with respect to this exciter ionizer the requisite electric field for making conductive the fluid medium, usually a gas, in the space between the ionizer and the adjacent face of the conveyor for conducting ions to this surface to be conveyed thereby to the collector ionizer.

In such machines, in order to develop the requisite excitation field, a source of potential is required for maintaining a sufficient potential difference between the exciter inductor member and the exciter ionizer. This source of potential may be an independent source continuously supplying this potential but the provision of this source of potential often involves undesirable restrictions particularly when it is desired to provide an automatic machine and one which is self-exciting. In electrostatic machines utilizing an insulating conveyor, because the space between the ionizers and the face of the conveyor initially is non-conductive when this space is filled with a dielectric material such as a gas, these machines are not self starting and it is necessary to provide means for initially making the space between the exciter ionizer and the conveyor conductive. This may be accomplished by developing across the exciter inductor and the exciter ionizer a sufficient potential, or it may be accomplished by providing a radioactive element adjacent the ionizer for making the gaseous space conductive, as disclosed in the application of Roger Morel, Serial No. 465,395, filed October 28, 1954.

The machine of the invention is of the general form disclosed in the French Patent No. 1,051,430, published January 15, 1954, and in the corresponding U. S. application Serial No. 321,351, filed November 19, 1952. In the electrostatic generator of the patent and the application a cylindrical conveyor of insulating material is supported for rotation on an axis and is provided with an exciting inductor member and a screen inductor member in spaced relation about the axis and adjacent a given face of the conveyor wall. In opposed relation to the respective inductor members at the opposite side of the conveyor wall are exciter and collector ionizers. The collector ionizer is connected to the inductor member opposite to which it is disposed and to a load terminal. The exciter ionizer is connected to ground or similar capacity at a reference potential and the exciter inductor



is maintained at a predetermined potential by suitable means.

In the application Serial No. 465,395 a plurality of sets of inductor and ionizer members functioning in the manner referred to are associated with a single cylindrical conveyor of insulating material, the collector ionizer of one set being connected to the exciter inductor member of another set so that each set as a generator serves to excite the other set to function as a generator. In the electrostatic machine of the application Serial No. 465,395 the charges all are conveyed by the conveyor on the same face of the conveyor wall.

It is an object of the invention to provide an electrostatic machine of the type disclosed in the U. S. applications referred to in which the essential parts for generating the electrostatic charge are disposed for securing improved electrostatic conditions.

It is another object of the invention to provide an electrostatic machine having two or more sections which are mutually exciting and in which advantage is taken of the insulating character of the conveyor for improving the insulated relation with respect to each other of parts that are at different potentials and polarities.

It is another object of the invention to provide a multiple section machine in which selected sections may develop charges at different potentials or different polarities and at least one other section may serve as an exciter section for those selected sections.

It is another object of the invention to provide a multiple section electrostatic generating machine in which the mechanical arrangement of as many parts as possible is such that parts that are at the same polarity are disposed at the face of the conveyor which carries the charges of this same polarity.

In order to accomplish the objects of the invention and other objects which will be understood from the description to follow, the inductor members of two sections of the electrostatic machine are disposed at opposite faces of the insulating conveyor wall. Correspondingly, the ionizers which respectively cooperate with these inductor members are disposed in the two sections at opposite faces of the conveyor wall. Thus, in a given section in which the exciter inductor member and the screen inductor member are disposed, for example, in spaced relation to and adjacent the outer face of a conveyor wall extending about and rotating on an axis of rotation and in spaced relation to each other about the axis, the exciter ionizer and the collector ionizer are respectively disposed at the inner face of the conveyor wall. If the exciter inductor member of this given section is maintained at a negative potential and the exciter ionizer is connected to ground, positive ions will be conducted to the conveyor at the inner face of the wall and will be carried thereby to the collector ionizer which may be connected to a load terminal at positive potential, this collector ionizer preferably being connected to the screen inductor member disposed in opposed relation thereto at the opposite side of the wall so that this screen inductor is charged at the positive potential. This given section of the machine with its set of inductor members and ionizers, therefore, operates in the same manner as disclosed in the two U. S. applications above referred to.

In a second section of the machine in accordance with the invention the exciter inductor member and the screen inductor member are disposed in spaced relation to each other about the axis and adjacent and in spaced relation to the conveyor wall at the inner face thereof, the corresponding exciter ionizer and collector ionizer being disposed at the outer face of the wall. The set of inductor members and ionizers in this second section is disposed in spaced relation about the axis from the set of the first section. The exciter inductor of this second section is con-

nected to the collector ionizer of the first section so as to be charged at a positive potential, and the exciter ionizer of this second section may be connected to ground, so that negative charges are conducted through the exciter ionizer of this second section to the outer face of the conveyor wall and are collected from this outer surface by the collector ionizer of this second section which preferably is connected to the screen inductor of the second section and to a second load terminal at a negative potential. This second collector ionizer also is connected to the exciter inductor of the first section for charging this exciter inductor at a negative potential.

It will be understood from the description of the arrangement just given by way of example that in the two sections, in accordance with the invention, only positive ions are conveyed by the conveyor at the inner face thereof and only negative ions are conveyed at the outer face of the conveyor. It also will be understood that the two ionizers that are disposed at the inner face of the conveyor are at positive potentials and that the exciter inductor of the second section which is disposed adjacent this inner face also is at a positive potential. Similarly, the ionizers of the second section that carry negative charges and the exciter inductor of the first section that is charged at a negative potential are disposed at the outer face of the conveyor. The only parts which are at a different polarity from that of the charges at the respective faces of the conveyor are the screen inductors. As will be more clearly understood from further description, the screen inductors may be disposed at a substantial distance from the conductive parts that are of different potential. Moreover, the parts that are at different potential and are disposed in relatively close relation are separated by the insulating material of the conveyor, so that they are insulated with respect to each other from electric discharge therebetween.

The number of sections which may be utilized at each face of the conveyor is limited only by the dimensions of the conveyor and of the different parts of the sections. These sections, moreover, may be variously connected as to terminals, reference potential and mutual excitation. In general in each section the exciter ionizers, the collector ionizers and the exciter inductors that are disposed at the same face of the conveyor wall all will have the same polarity or will be at potentials all above or below a reference potential. The screen inductors that are disposed adjacent this same face will have the opposite polarity, or will be at potentials respectively below or above the reference potential. Each excifer inductor member that is disposed adjacent a given face of the conveyor wall preferably is connected to a screen inductor member disposed at the opposite face of the conveyor wall, this screen inductor member being connected to the collector ionizer that is disposed in opposed relation to this screen inductor member.

The distribution and spacing about the axis of rotation of the ionizers, and of the inductors which respectively are disposed at the opposite face of the wall from the ionizer, may be determined as a function of the difference of potential between the different members. The screen inductors at a given face of the conveyor in one section may be disposed in sufficiently spaced relation to the ionizer of the next section to insure only that discharge therebetween does not take place.

The invention takes advantage of the feature disclosed in the application Serial No. 321,351 in providing a slightly conductive or high resistivity material connecting the inductor members in each section that are disposed adjacent the same face of the conveyor wall in order that the field which exists between these inductor members shall be maintained at a controlled gradient which may be a smooth or a constant gradient of potential and so as to limit discharge or corona effect at the edges of the respective inductor members, particularly at the edges that are disposed toward each other.



The invention will be understood further from the description to follow taken in connection with the drawings in which

Fig. 1 shows diagrammatically a section transverse to the axis of rotation of a generator having an annular conveyor rotatable on this axis and providing two generating sections.

Fig. 2 shows schematically in transverse section a generator having a rotatable conveyor and providing six sections, three sections of the same polarity being disposed in successive relation to each other at each side of a median plane.

Fig. 3 shows schematically in transverse section a generator having a rotatable conveyor and providing six sections in which the sections of opposite polarity are in interspersed relation to each other about the axis of rotation.

Fig. 4 shows schematically in transverse section a generator having a rotatable conveyor and comprising three sections two of which operate at a polarity opposed to the polarity of the third section.

Fig. 5 shows schematically a transverse section of a generator having a rotatable conveyor and providing three sections two of which operate at a polarity opposed to that of the third section, connections being provided to terminals at different potentials.

Fig. 6 shows schematically in perspective a generator having a rotatable cylindrical conveyor and providing two sections one of which utilizes one face of the conveyor and the other utilizes only a part of the other face of the conveyor.

Fig. 7 shows schematically in transverse section a generator similar to that of Fig. 1 in which annuli of high resistivity material are supported on the two stafors.

In order to simplify the drawings, the stator or stators which support the inductor members and the ionizers and other conductive parts as well as the material of high resistivity referred to above are omitted, except in Figs. 1 and 7. These parts may be supported mechanically in the manner disclosed in the application Serial No. 321,351, or by other suitable means.

In Fig. 1 the conveyor 1 of insulating material in the form of an annular wall, which may be a hollow cylinder, is supported for rotation on the axis of the annulus in the direction of the arrow. In Fig. 1 the generator provides sections A and B, as indicated in broken outline, operating at opposite polarities. Adjacent and in spaced relation to the outer face of the conveyor the ionizing element 4 of section B is disposed in opposed relation to the exciter inductor member 6 disposed adjacent the inner face of the conveyor 1. In spaced relation along the conveyor wall about the axis collector ionizer 8 of section B is disposed adjacent and in spaced relation to the outer surface of the conveyor wall and in opposed relation to screen inductor member 10 at the inner surface of the conveyor wall. The collector ionizer 8 is connected electrically to the screen 10 by connection 12 and is connected also to the load terminal 14 of section B and to exciter inductor member 15 of the section A of the generator. This exciter inductor member 15 and the exciter ionizer 17 in opposed relation thereto at the inner face of the wall are disposed on the same diameter as the ionizer 4 and the inductor member 6 of section B in the embodiment of Fig. 1. In section A, the collector ionizer 19 is disposed at the inner face of the conveyor wall on the same diameter as the collector ionizer 8 and the screen 10. The screen inductor member 21 of section A also is disposed on this diameter at the outer surface of the conveyor 1 and is connected by connection 20 to the collector ionizer 19 and to the exciter inductor member 6 of section B, as well as to the load terminal 23 of section A.

The exciter ionizers 4 and 17 in the embodiment of Fig. 1 are connected together and may be connected by the connection 25 to ground or to a body at a reference potential. For simplicity of explanation in the descrip-

tion of the embodiments of the invention as shown in the drawings, the connections corresponding to the connection 25 of Fig. 1 will be assumed to establish a connection to ground potential so that the exciter inductor member and the screen inductor member will be at opposite polarities.

Charges induced from ground by the inductor **6** through the ionizer 4 and conducted to the outer face of the conveyor 1 are carried by the conveyor at the outer face thereof to the collector ionizer **8** and are delivered to the load terminal 14 and to the screen inductor member **10**, as well as to the exciter inductor member 15 of section A. Charges conducted from ground to the inner face of the conveyor 1 through the ionizer **17** under the influence of the inductor 15 are carried by the conveyor to the collector ionizer 19 and are delivered to the output terminal 23 and to the screen inductor member **21** of section A, as well as to the exciter inductor **6** of section B. Thus, when either the exciter inductor member **6** or the exciter inductor member **15** is brought by any suitable means initially to a potential relative to the ground potential, in the embodiment being described, such that a field of sufficient strength is developed between the inductor member 6 or 15 and the corresponding ionizer 4 or 17, through which field the conveyor **1** moves, ions will be conducted to the corresponding face of the conveyor and carried thereby to the collector ionizer of that section of the generator. It will be understood that by this operation each section will begin to excite the other section so that after a time sufficient potential is built up on the respective exciter inductors to effect mutual excitation of the sections of the generator.

It also will be noted in the particular embodiment of Fig. 1 that only positive charges are carried at the inner face of the conveyor in section A of the generator and only negative charges are carried by the outer face of the conveyor in section B. The only members that are disposed at a given face of the conveyor that are different in polarity from all the other members at the given face are the screen inductors **10** and **21** which through the respective connections **12** and **20** are brought to the same potential and polarity as the collector ionizers in opposed relation to which they are disposed. It will be understood, however, from the general description given above that the distance between the screen inductor members 10 or 21 and the respective ionizers **17** or **4** disposed at the same side of the conveyor as the respective screen inductor members may be such as to prevent discharge between these parts of the machine.

It also will be understood that for the most part the conveyor 1 of insulating material is disposed between parts that are not greatly spaced apart and are at opposite polarities or at different potentials. If the exciter inductors of sections A and B respectively are considered to be maintained at $-U$ and $+U$ potentials relative to their respective ionizers that are at ground potential in the embodiment described, the difference of potential between the ionizer 17 and the ionizer **19** of section A will be U and the difference of potential between the exciter inductor member 15 and the screen inductor member **21** of section A will be 2U. The difference of potential between the ionizer **19** of section A and the inductor **6** of section B is zero. The difference of potential between the ionizer 4 of section B and the inductor member **21** of section A is U. Corresponding differences of potential occur in section B with respect to the ionizers **4** and **8**, the inductors 6 and 10, the ionizer **8** and the inductor **15**, and the ionizer 17 and the inductor **10**.

As shown in Fig. 1 sufficient spacing of the conductive parts may be secured in a typical case by disposing the four ionizers and their corresponding inductor members at the extremities of the two diameters forming angles of 60° between the ionizers of one section and those of another, the angular spacing of the ionizers as well as of the corresponding inductors in each section being 120°.

In each section the two inductor members are connected by an arcuate member **27**, **29** of slightly conductive or of high resistivity material in order to establish a smooth gradient of potential, 2U in the embodiment of Fig. 1, between the two inductor members **15**, **21** of section A and between the two inductor members **6**, **10** of section B.

In the electrostatic generator of Fig. 1, as well as in the other embodiments to be described hereinafter, the parts shown merely diagrammatically in these figures may be disposed within a casing containing a dielectric fluid medium within which the generator operates. Although other fluid mediums may be used, preferably this medium will be a gas under pressure sufficient to develop a high dielectric strength and may have other characteristics desirable for electrostatic generation.

In the embodiment of Fig. 2 an electrostatic machine comprising six sections is shown. With respect to a diametral plane CD the structure of Fig. 2 provides three sections developing charges of positive potential in the portion of the machine at the left hand of the plane and three sections developing negative potential in the portion at the right hand of the plane. In the left hand portion six inductor members are disposed in spaced relation to each other circumferentially about the axis adjacent and in spaced relation to the outer face of the conveyor wall **1** of insulating material. Alternate inductor members **15** are exciter inductor members. The intermediate inductor members **21** are screen inductor members. The exciter inductor members are disposed in opposed relation to exciter ionizers **17** disposed at the opposite face of the wall **1** and in adjacent spaced relation thereto. Collector ionizers **19** also are disposed adjacent and in spaced relation to this opposite face of the wall and in opposed relation to the respective screen inductor members **21**. The disposition of each exciter inductor member **15** relative to the next adjacent screen inductor member **21** and the disposition of the corresponding exciter ionizers **17** and collector ionizers **19** are the same as the elements with corresponding reference numerals in Fig. 1.

As in Fig. 1 also the collector ionizers **19** are connected to the respective screen inductor members **21**, and these collector ionizers are all connected together by a conductor **35** which is connected to the load terminal **23** at positive potential. The exciter inductor members **15** are all connected together by the conductor **37** and connected to the other terminal **14** of the generator at negative potential. The exciter ionizers **17** are all connected together by conductor **39** and connected through conductor **25** to a terminal which may be connected to a body at a reference potential, as in Fig. 1.

At the right of the diametral plane in Fig. 2 the exciter ionizers 4 are disposed adjacent and in spaced relation to the outer face of the conveyor wall **1** and the exciter inductor members **6** are disposed adjacent and in spaced relation to the inner face of this wall and in opposed relation to the respective ionizers **4**. All of the ionizers **4** are connected together by the conductor 41 and are connected also to the conductor **25** connected to the reference potential. All of the exciter inductors **6** are electrically connected together by the conductor **35** which also connects all of these inductor members to all of the collector ionizers **19** of the portion of the generator at the left hand of the diametral plane, Fig. 2. The intermediate screen inductors **10** are connected to the respective collector ionizers **8** which are all electrically connected together by the conductor **43** which also connects these ionizers to the terminal **14** of the machine and to the exciter inductor members **15** of the portion of the machine at the left of the diametral plane. Each set composed of an exciter inductor member **6**, **15** and the next adjacent screen inductor member **10**, **21** in the direction of rotation of the conveyor, together with the ionizer elements respectively in opposed relation to these exciter and screen inductor members, constitutes a sec-

tion of the machine similar to the sections A and B described in connection with Fig. 1, these sections, however, being connected in parallel to each other in each portion of the machine at the left and at the right of the diametral plane in Fig. 2.

It will be understood that, in accordance with the description above given in connection with Fig. 1, the difference of potential between an exciter inductor member **15** and an adjacent screen inductor member **21** will be 2U when the terminals of the machine respectively are at +U and —U potentials. The distance circumferentially about the axis of rotation between an exciter inductor member **15** and a screen inductor member **21** must be sufficient to prevent discharge through the dielectric material between these two inductor members. In order to minimize the concentration of the charge on the edges of the inductor members that are disposed toward each other and to provide a controlled or a constant gradient of potential therebetween, arcuate portions **45** of high resistivity material extending between adjacent inductors **15, 21** are provided adjacent the outer face of the conveyor **1** and similar arcuate portions **47** of high resistivity material are disposed adjacent the inner face of the conveyor and connected between adjacent exciter and screen inductor members **6, 10**.

It will be understood also from the description given in connection with Figs. 1 and 2 that, whereas in the embodiment of Fig. 1 section B developing charges at a negative polarity on the outer face of the conveyor **1** is successive in the direction of rotation of the conveyor to Section A which develops charges at positive potential at the inner face of the conveyor, in the embodiment of Fig. 2 three sections at the left hand of the diametral plane all develop positive charges at the inner face of the conveyor **1** and are connected in parallel to the output terminal **23**. At the right of the diametral plane and in succession three sections develop charges of negative potential at the outer surface of the conveyor. The alternation of polarity in Fig. 2 occurs between the two portions of the generator at the two sides of the diametral plane and not in successive sections of the generator each constituted by a set of exciter and screen inductor members with exciter and collector ionizers respectively in opposed relation thereto.

It will be understood further in connection with the embodiment of Fig. 2 that the inductor members disposed adjacent and in spaced relation to the two faces of the conveyor may be supported by stators similar to the stators **2** and **3** shown in Fig. 1 which also may support the ionizers adjacent and in spaced relation to the respective surfaces of the conveyor. These stator members are omitted in the drawing of Fig. 2 in order to avoid complication.

Fig. 3 shows an electrostatic generator providing six sections circumferentially spaced about the axis of rotation of the conveyor **1**, each section being similar to a section of Fig. 1. In the embodiment of Fig. 3, the inductor members of adjacent sections are disposed adjacent opposite faces of the conveyor wall the same as in Fig. 1, so that the inductor members of alternate sections are disposed at the same face of the wall. Ionizers respectively associated with the inductor members are disposed in opposed relation to the respective inductor members and at the opposite side of the wall therefrom as is required in an electrostatic generator of this type utilizing a conveyor providing a wall of insulating material.

In Fig. 3 the exciter inductor members and the screen inductor members disposed respectively adjacent and in spaced relation to the inner and outer faces of the conveyor wall carry reference numerals the same as in Fig. 1. The ionizers corresponding to the respective exciter inductor members and to the respective screen inductor members also carry reference numerals the same as in the two sections A and B of the generator of Fig. 1. The exciter inductor members **17** are all connected together by the conductor **51**. The collector ionizers **19** are all connected together by the conductor **53**, these collector ionizers being connected to the respective screen inductors **21** and to the exciter inductor members **6** of the next section in the direction of rotation of the machine as shown by the arrow in Fig. 3. These collector ionizers **19** in Fig. 3 also are connected to the terminal **54** of the machine at positive potential. Similarly, the exciter ionizers **4** are all connected together by the conductor **55** which is connected to the terminal **57** at a reference potential or ground. The collector ionizers **8** all are connected together by the conductor **59** and connected to the terminal **61** of the machine at negative potential.



In the embodiment of Fig. 3 as in the embodiments of Figs. 1 and 2 the charges of two different polarities, or of two different potentials with respect to the reference potential, are carried at opposite faces of the conveyor wall **1**. At each face all of the elements are at polarity or potential corresponding to the charges carried on this face, except the screen inductor members which are at a different potential and may be of opposite polarity to the charges carried on the face adjacent to which it is disposed. The difference of potential between an exciter inductor member **15, 6** and the screen inductor member **21, 10** of the same section may be 2U if the terminals **54** and **61** of the machine respectively are at +U and —U potentials, the terminal **57** being at ground potential.

As in the embodiment of Fig. 1, in Fig. 3 arcuate portions **63** and **65** of high resistivity material in each section connect the exciter and screen inductor members **15, 21** and **6, 10** in order to provide a smooth gradient of potential between these inductor members and to prevent discharge from the edges thereof through the dielectric medium, such as a gas under pressure, in which the generator operates.

Fig. 4 shows an electrostatic generator having two sections A and B which correspond to sections A and B of Fig. 1. In these sections respectively positive charges and negative charges are produced on the inner and outer faces of the conveyor **1** of insulating material rotating in the direction of the arrow about an axis of rotation. In this embodiment the reference numerals of Fig. 1 are applied to the respective inductor members and ionizers in sections A and B. As in Fig. 1 the collector ionizer **19** collecting positive charges is connected to the load terminal **23** at positive potential and to the screen inductor member **21** by the conductor **20**. The collector ionizer **19** also is connected to the exciting inductor member **6** of section B. The exciter ionizer **4** of section B is connected to a terminal **22** at the reference potential or ground. The collector ionizer **8** of section B collecting negative charges is connected to the screen inductor member **10** by the conductor **12** and is connected to the terminal **14** at negative potential as in Fig. 1.

In the embodiment of Fig. 4 a third section C is shown in which an exciter inductor member **71** is disposed adjacent and in spaced relation to the outer face of the conveyor wall **1** in spaced relation circumferentially about the axis in the direction of rotation of the conveyor from the collector ionizer **8** of section B. In opposed relation to the exciter inductor member **71** adjacent and in spaced relation to the inner face of the wall the exciter ionizer **73** is disposed which is connected to the reference potential terminal **22** and to the exciter ionizers **17** and **4** respectively of sections A and B. Section C also is provided with a collector ionizer **75** disposed adjacent and in spaced relation to the inner face of the conveyor wall and in spaced relation about the axis in the direction of rotation from the ionizer **73**. Screen inductor member **77** is disposed in opposed relation to the collector ionizer **75** adjacent and in spaced relation to the outer face of the wall and is connected to the ionizer **75**

by conductor **79**. The collector ionizer **75** and the screen inductor member **77** are connected by conductor **81** to terminal 23 at positive potential.

The two sections A and C of the generator of Fig. 4 thus operate in the same manner in parallel and at the same polarity. The generator of section B operates as the exciter for both sections A and C, and both sections A and C operating in parallel serve to excite section B, the charges being conducted through the conductor **83** to the exciter inductor member **6** of section B.

Fig. 5 shows a machine having three sections A, B and C with the inductor members and the corresponding ionizers of these sections arranged in the same manner as in Fig. 4. As in Fig. 4, section B develops negative charges at the outer face of the conveyor wall **1** for excitation of sections A and C and the sections A and C develop positive charges at the inner face of the conveyor for delivery to the terminals and for excitation of section B.

In Fig. 5, however, four terminals of the machine are shown. One of these terminals **22** may be connected to the reference potential or the ground in order that the exciter ionizers **4**, **73** and **17** that are connected together and to the terminal **22** may function in the same manner as in Fig. 4. In Fig. 5 also the collector ionizer 8 is connected to the screen inductor **10** in opposed relation thereto and also is connected through the connector 85 to the exciter inductor members **71** and **15** respectively in Sections C and A and to the terminal **14** at negative potential. The collector ionizer **75** connected to the screen inductor **77** by the conductor **79** is connected through the conductor **87** to a terminal **89** of the machine at positive potential. The collector ionizer **19** connected by the conductor **20** to the screen inductor **21** is connected by the conductor **91** to a separate terminal **93** also at positive potential. Within the scope of the invention the positive potentials of the terminals **89** and **93** may be different from each other and this difference may be determined by the design of the machine with respect to the exciter potentials of the inductors **71** and **15** and the respective increases of potential as the conveyor conveys the charges from the respective ionizers **73** and **17** to the respective collector ionizers **75** and **19**.

Fig. 6 shows another modification of a generator having two sections similar to the embodiment of Fig. 1 in which the ionizer **104** corresponds to the ionizer **4** of Fig. 1 and the exciter inductor member **106** corresponds to the exciter inductor member **6** of Fig. 1. The ionizer 104 is connected to ground. The exciter inductor member 106 being charged at a positive potential, negative charges will be induced upon the outer face of the conveyor 1 and collected by the collector ionizer **108** in opposed relation to screen inductor **110** connected by the conductor 112 to the ionizer **108**. The collector ionizer 108 also is connected by the conductor **116** to the exciter ionizer 115 disposed adjacent the outer face of the conveyor 1 in opposed relation to the ionizer **117** at the inner face of this conveyor. The ionizer **117** is connected to ground and to a terminal **22** through the conductor 25. The exciter inductor member **115** is charged at a negative potential and charges at positive potential are induced upon the inner face of the conveyor **1** at the ionizer 117 and are carried by the conveyor to the collector ionizer **119** connected by the conductor **120** to the screen inductor **121** disposed at the outer face of the conveyor in opposed relation to the collector ionizer **119**. The collector ionizer **119** also is connected to the terminal 23 of the generator and to the exciter inductor **106** through the conductor **124**. The exciter inductor **106** thereby becomes charged at a positive potential as is requisite for inducing the negative charges at the ionizer 104 on the outer face of the conveyor **1**.

It will be apparent that the portions of the machine as thus described in connection with Fig. 6 are generally the same as the sections of the generator of Fig. 1. It will be noted, however, in the embodiment of Fig. 6 that the inductor members **115** and **121** corresponding to the inductor members of section A of Fig. 1, as well as the corresponding ionizers **117** and **119**, extend substantially for the full length parallel to the axis of rotation of the cylindrical conveyor shown in Fig. 6. The length of the inductor members **106** and **110**, however, is considerably shorter than the full length of the conveyor **1** parallel to the axis and the corresponding ionizers **104**, **108** are coextensive with these shorter inductor members **106**, **110**. Thus, in the embodiment of Fig. 6 only a portion of the length of the conveyor **1** is utilized for developing the negative charges on the outer face of the conveyor. It will be understood, however, that these shorter inductor members and ionizers are capable of developing a sufficient amount of charges to charge the inductor member 115 in order to produce at the ionizer **117** the positive charges on the inner face of the conveyor which, upon rotation of the conveyor in the direction of the arrow, are delivered to and are collected by the ionizer **119** for delivery to the load terminal **23** as well as to the exciter inductor **106** as above described.

Fig. 7 shows two sets of inductor members and ionizers arranged similarly to the embodiment of Fig. 1. In Fig. 7 reference numerals are used for various parts to indicate similar parts of the generator shown in Fig. 1. In Fig. 7, however, a continuous cylindrical wall **130** of high resistivity material is disposed immediately adjacent the inner surface of the outer stator **2** and is in electrical contact with the inner faces of the inductor members **15** and 21 disposed in recesses in the inner surface of the stator 2, these inner faces being flush with the inner surface of the stator 2. Similarly, a cylindrical wall **132** of high resistivity material is disposed immediately adjacent the outer surface of the inner stator **3** and in electrical contact with the outer faces of the inductor members **6** and 10 supported in recesses in the outer surface of this inner stator with these outer faces flush with the outer surface of the stator **3**. It will be understood in the embodiment of Fig. 7 that a potential gradient is secured along both of the arcuate extents of the walls **130** and 132 in both directions from any given inductor member to the next inductor member with which these walls respectively are in electrical contact.

It will be noted as a practical feature that in the wall 130 openings 134 are provided through which the ionizers 4 and 8 shown diagrammatically extend to a position adjacent the conveyor wall **1**. Similarly, openings **136** are provided in the wall **132** through which the ionizers **17** and 19 shown diagrammatically extend to a position adjacent the inner surface of the conveyor **1**. The openings **134** and **136** are of such size as to provide sufficient clearance between the respective ionizers and the high resistivity material so that discharge between these parts at the respective potential differences does not occur through the dielectric medium within the electrostatic machine.

Within the scope of the invention other modifications and arrangements may be made than those shown in the drawings and described above in which charges of different potentials and more specifically of opposite polarities are induced upon and conveyed by the conveyor of insulating material at the respective surfaces of the wall thereof. Other arrangements also may be made within the scope of the invention of a plurality of sections in the electrostatic generator which generate charges of different polarities or at different potentials at the two surfaces of the conveyor wall, in which generator the charges of the different sections are delivered to respective load terminals or in which some of these charges in one or more sections are delivered to an exciter inductor member or members of one or more other sections of the generator for charging the exciter inductor member or members. All such variations of the arrangements disclosed which serve the functions described are intended to be included within the scope of the invention.

I claim:

1. An electrostatic generator comprising a conveyor providing a wall of insulating material supported for movement thereof in a given direction parallel to said wall, an exciter inductor member disposed adjacent and in spaced relation to a given face of said wall, an exciter ionizer disposed in opposed relation to said inductor member adjacent and in spaced relation to the opposite face of said wall, a collector ionizer disposed adjacent and in spaced relation to said opposite face of said wall and spaced along said wall from said exciter ionizer in said direction of movement of said wall, a second exciter inductor member disposed adjacent and in spaced relation to said opposite face of said conveyor wall and spaced along said wall from said collector ionizer in said direction of movement of said wall, a second exciter ionizer disposed in opposed relation to said second exciter inductor member adjacent and in spaced relation to said given face of said wall, a second collector ionizer disposed adjacent and in spaced relation to said given face of said wall and spaced along said wall from said second exciter ionizer in said direction of movement of said wall, and means for developing predetermined potential differences between said exciter inductor members and the respective exciter ionizers disposed in opposed relation thereto for producing charges on the respective faces of said conveyor wall.

2. An electrostatic generator comprising a conveyor providing a wall of insulating material supported for movement thereof in a given direction parallel to said wall, an exciter inductor member disposed adjacent and in spaced relation to a given face of said wall, an exciter ionizer disposed in opposed relation to said inductor member adjacent and in spaced relation to the opposite face of said wall, a collector ionizer disposed adjacent and in spaced relation to said opposite face of said wall and spaced along said wall from said exciter ionizer in said direction of movement of said wall, a second exciter inductor member disposed adjacent and in spaced relation to said opposite face of said conveyor wall and spaced along said wall from said collector ionizer in said direction of movement of said wall, a second exciter ionizer disposed in opposed relation to said second exciter inductor member adjacent and in spaced relation to said given face of said wall, a second collector ionizer disposed adjacent and in spaced relation to said given face of said wall and spaced along said wall from said second exciter ionizer in said direction of movement of said wall, and means for charging said exciter inductor members at opposite polarities to develop between said exciter inductor members and the respective exciter ionizers potential differences capable of charging the respective faces of said conveyor wall with charges of opposite polarity.

3. An electrostatic generator comprising a conveyor providing a wall of insulating material supported for movement thereof in a given direction parallel to said wall, an exciter inductor member disposed adjacent and in spaced relation to a given face of said wall, an exciter ionizer disposed in opposed relation to said inductor member adjacent and in spaced relation to the opposite face of said wall, a collector ionizer disposed adjacent and in spaced relation to said opposite face of said wall and spaced along said wall from said exciter ionizer in said direction of movement of said wall, a second exciter inductor member disposed adjacent and in spaced relation to said opposite face of said conveyor wall and spaced along said wall from said collector ionizer in said direction of movement of said wall, a second exciter ionizer disposed in opposed relation to said second exciter inductor member adjacent and in spaced relation to said given face of said wall, and a second collector ionizer disposed adjacent and in spaced relation to said given face of said wall and spaced along said wall from said second exciter ionizer in said direction of movement of said wall, said second collector ionizer being connected to said first exciter inductor member for conducting charges therebetween.

4. An electrostatic generator comprising a conveyor providing a wall of insulating material supported for movement in a given direction parallel to said wall, an exciter inductor member and a screen inductor member each disposed adjacent and in spaced relation to a given face of said wall, said screen inductor member being spaced from said exciter inductor member in said direction parallel to said wall, exciter and collector ionizers disposed adjacent and in spaced relation to the opposite face of said wall and in spaced relation to each other parallel to said wall respectively in opposed relation to said exciter and screen inductor members, a second exciter inductor member and a second screen inductor member disposed adjacent and in spaced relation to said opposite face of said wall, said second screen inductor member being spaced from said second exciter inductor member in said given direction parallel to said wall, said second exciter inductor member being spaced from said collector ionizer in said given direction parallel to said wall, a second exciter ionizer and a second collector ionizer disposed adjacent and in spaced relation to said given side of said wall in spaced relation to each other respectively in opposed relation to said second exciter inductor member and said second screen inductor member, said collector ionizers respectively being connected to an exciter inductor member spaced therefrom in said given direction parallel to said wall.

5. An electrostatic generator comprising a conveyor providing a wall of insulating material extending about and supported for rotation on an axis of rotation, an exciter inductor member disposed adjacent and in spaced relation to a given face of said conveyor wall, an exciter ionizer disposed in opposed relation to said exciter inductor member adjacent and in spaced relation to the opposite face of said wall, a collector ionizer disposed adjacent and in spaced relation to said opposite face of said wall and circumferentially spaced about said axis along said wall from said exciter ionizer in the direction of rotation of said conveyor, a second exciter inductor member disposed adjacent and in spaced relation to said opposite face of said conveyor wall and spaced circumferentially about said axis along said wall from said collector ionizer in the direction of rotation of said conveyor, said second exciter inductor member being connected to said collector ionizer for conducting charges therebetween, a second exciter ionizer disposed in opposed relation to said second exciter inductor member adjacent and in spaced relation to said given face of said wall, and a second collector ionizer disposed adjacent and in spaced relation to said given face of said wall and circumferentially spaced about said axis along said wall from said second exciter ionizer in the direction of rotation of said conveyor, said second collector ionizer being connected to said first exciter inductor member for conducting charges therebetween.

6. An electrostatic generator comprising a conveyor providing a wall of insulating material extending about and supported for rotation on an axis of rotation, a pair of exciter inductor members respectively disposed adjacent and in spaced relation to opposite faces of said conveyor wall and in spaced relation to each other circumferentially about said axis along said wall, a pair of screen inductor members respectively disposed adjacent and in spaced relation to the same faces of said wall as said exciter inductor members and in circumferentially spaced relation about said axis along said wall from the respective exciter inductor members and in interspersed relation to said exciter inductor members, exciter ionizers respectively disposed in opposed relation to said exciter inductor members at the opposite faces of said wall from the respective exciter inductor members, and collector

ionizers respectively disposed in opposed relation to said screen inductor members at the opposite faces of said wall from the respective screen inductor members, said collector ionizers respectively being connected to the exciter inductor members disposed at the same faces of said wall as the respective collector ionizers for conducting charges between said collector ionizers and the respective exciter inductor members.

7. An electrostatic generator as defined in claim 4 in which said collector ionizers respectively are connected to the screen inductor members disposed in opposed relation thereto at the opposite side of said conveyor wall.

8. An electrostatic generator as defined in claim 2 in which said exciter ionizers are connected to a body at a reference potential.

9. An electrostatic generator as defined in claim 2 in which said exciter ionizers are connected to ground and said collector ionizers respectively are connected to two terminals of the generator at opposite polarities.

10. An electrostatic generator as defined in claim 4 which comprises a member of high resistivity material extending parallel to said wall and connecting the exciter and screen inductor members that are disposed at the same face of said conveyor wall.

11. An electrostatic generator comprising a conveyor providing a wall of insulating material extending about and supported for rotation on an axis of rotation, a plurality of inductor members disposed adjacent and in spaced relation to a given face of said conveyor wall and in spaced relation to each other circumferentially about said axis along a predetermined arcuate extent of said wall, a plurality of inductor members disposed adjacent and in spaced relation to the opposite face of said wall and in spaced relation to each other circumferentially about said axis along a second predetermined arcuate extent of said wall, ionizers disposed adjacent and in spaced relation to the respective faces respectively in opposed relation to said inductor members, alternate ionizers in each of said arcuate extents along said wall being connected to a body at a common reference potential, the intermediate ionizers in each of said arcuate extents along said wall being connected respectively to the inductor members to which they are opposed, the other inductor members in the respective arcuate extents being connected to respective terminals of the generator.

12. An electrostatic generator as defined in claim 11 in which said intermediate ionizers disposed at each face of the wall are connected together and to the inductor members of the other arcuate extent along said wall that are disposed in opposed relation to ionizers that are connected to said body at said reference potential.

13. An electrostatic generator comprising a conveyor providing a wall of insulating material supported for movement in a given direction parallel to said wall, a plurality of sets of inductor members, each set having an exciter inductor member and a screen inductor member, the exciter inductor member and the screen inductor member of each set being disposed adjacent and in spaced relation to the same face of said wall with the screen inductor member spaced from the exciter inductor member in said given direction parallel to said wall, the exciter and screen inductor members of a given set being disposed at the opposite face of said wall from the exciter and screen inductor members of another set and in spaced relation to said other set along said wall in said given direction, exciter and collector ionizers for each set disposed adjacent and in spaced relation to the opposite face of said wall from the exciter and screen inductor members of said set and in spaced relation to each other along said wall respectively in opposed relation to said exciter and screen inductor members of said set, the exciter ionizers of said sets being electrically connected to a body at a reference potential, the collector ionizers of each set being connected to the exciter inductor of another set spaced therefrom in said given direction of movement of said conveyor parallel to said wall.



14. An electrostatic generator as defined in claim 13 in which the collector ionizers that are disposed adjacent each face of said wall are connected to the screen inductors respectively in opposed relation thereto at the opposite face of said wall.

15. An electrostatic generator as defined in claim 13 in which the collector ionizers that are disposed at the respective faces of said wall are connected together and to respective terminals of the generator.

16. An electrostatic generator as defined in claim 4 which comprises an additional exciter inductor member disposed adjacent and in spaced relation to a selected face of said wall and in spaced relation to said second screen inductor member along said wall in said given direction of movement thereof, an additional exciter ionizer disposed adjacent and in spaced relation to the opposite face of said wall from said additional exciter inductor member in opposed relation to said additional exciter inductor member, an additional collector ionizer disposed adjacent and in spaced relation to the same face of said wall as said additional exciter ionizer and in spaced relation thereto along said wall in said given direction of movement of said wall, an additional screen inductor member disposed adjacent and in spaced relation to said selected face of said conveyor wall in opposed relation to said additional collector ionizer, said additional collector ionizer being electrically connected to said additional screen inductor member and to said first screen inductor member and to said second exciter inductor member.

17. An electrostatic generator as defined in claim 4 which comprises an additional exciter inductor member disposed adjacent and in spaced relation to a selected face of said wall and in spaced relation to said second screen inductor member along said wall in said given direction of movement thereof, an additional exciting ionizer disposed adjacent and in spaced relation to the opposite face of said wall from said additional exciter inductor member in opposed relation to said additional exciter inductor member, an additional collector ionizer disposed adjacent and in spaced relation to the same face of said wall as said additional exciter ionizer and in spaced relation thereto along said wall in said given direction of movement of said wall, an additional screen inductor member disposed adjacent and in spaced relation to said selected face of said conveyor wall in opposed relation to said additional collector ionizer, said collector ionizers respectively being connected to the screen inductors disposed respectively in opposed relation thereto, said first collector ionizer and said additional collector ionizer being connected to a terminal of said generator at a given polarity, said second collector ionizer being connected to a terminal of said generator at the opposite polarity, said exciter ionizers being connected to a body at a reference potential.

18. An electrostatic generator as defined in claim 4 which comprises an additional exciter inductor member disposed adjacent and in spaced relation to a selected face of said wall and in spaced relation to said second screen inductor member along said wall in said given direction of movement thereof, an additional exciter ionizer disposed adjacent and in spaced relation to the opposite face of said wall from said additional exciter inductor member in opposed relation to said additional exciter inductor member, an additional collector ionizer disposed adjacent and in spaced relation to the same face of said wall as said additional exciter ionizer and in spaced relation thereto along said wall in said given direction of movement of said wall, an additional screen inductor member disposed adjacent and in spaced relation to said selected face of said conveyor wall in opposed relation to said additional collector ionizer, said collector ionizers respectively being connected to the screen inductors disposed respectively in opposed relation thereto, said first collector ionizer and said additional collector ionizer re-

spectively being connected to separate terminals of said generator at a given polarity, said second collector ionizer being connected to a terminal of said generator at the opposite polarity, said exciter ionizers of said generator being connected to another terminal of said generator.

19. An electrostatic generator as defined in claim 5 in which one of said exciter inductor members and the opposed exciter ionizer have a substantially greater extent along said wall generally parallel to the axis of rotation than the other exciter inductor member and the opposed exciter ionizer, the respective collector ionizers having a length along said wall parallel to the axis corresponding to the length of the respective exciter ionizers.

20. An electrostatic generator comprising a conveyor providing a wall of insulating material, an exciter inductor member disposed adjacent and in spaced relation to a given face of said wall, an exciter ionizer disposed in opposed relation to said inductor member adjacent and in spaced relation to the opposite face of said wall, a collector ionizer disposed adjacent and in spaced relation to said opposite face of said wall and spaced along said wall in a given direction from said exciter ionizer, a second



exciter inductor member disposed adjacent and in spaced relation to said opposite face of said conveyor wall and spaced along said wall from said collector ionizer in said direction, a second exciter ionizer disposed in opposed relation to said second exciter inductor adjacent and in spaced relation to said given face of said wall, a second collector ionizer disposed adjacent and in spaced relation to said given face of said wall and spaced along said wall from said second exciter ionizer in said direction, means for developing predetermined potential differences between said exciter inductor members and the respective exciter ionizers disposed in opposed relation thereto for producing charges on the respective faces of said conveyor wall, said conveyor wall and said inductor members being supported for movement of said conveyor wall and said inductor members relative to each other parallel to said direction along said conveyor wall, said conveyor wall and said ionizers being supported for concomitant movement of said conveyor wall and said ionizers relative to each other parallel to said direction along said wall.

No references cited.