Feb. 21, 1939. S. FAGERBERG 2,148,064

HIGH VOLTAGE GENERATOR

Filed Jan. 14, 1937

Fig. 1.

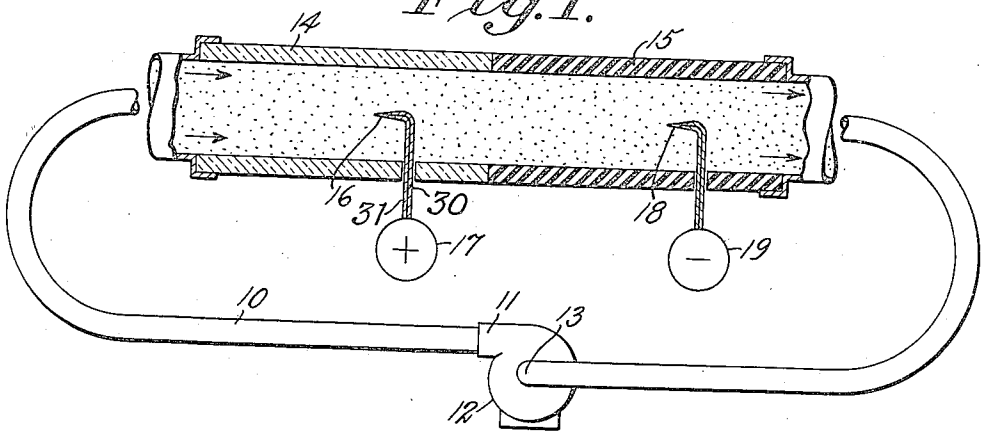


Fig. 2.

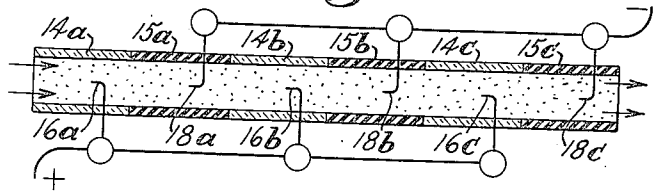
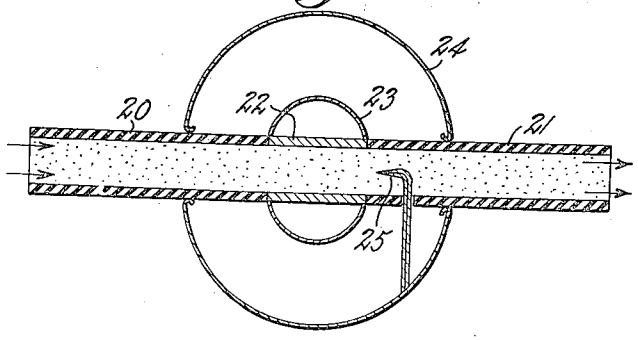


Fig. 3.



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HIGH VOLTAGE GENERATOR

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12 Claims. (Cl. 171—328)

My invention relates to an improved method and apparatus for the production of electric current having an extremely high potential.

It is well known that static electric charges may be produced by friction between members made of different material. Each material has a certain property, which may be termed friction-electrical property. In accordance with my invention electrical charges are produced by passing a stream of finely divided material carried by a current of gas in frictional contact with at least two different materials having different friction-electrical properties. Thus, charges of different polarity and/or quantity are produced by the friction of the particles with the different materials. Consequently, if the friction-electrical properties of the two materials differ widely, a large production of charge is obtained. Preferably, but not necessarily, one of the materials has a positive friction-electrical property while the other has a negative friction-electrical property.

The production of electric charges is further increased in accordance with my invention by employing what may be termed an influence effect, as will appear more in detail later.

Further objects and advantages of the invention will be apparent from the following description considered in connection with the accompanying drawing which forms a part of this specification and of which:

Fig. 1 is a more or less diagrammatic cross-sectional view of one embodiment of my invention;

Fig. 2 is a similar view of a second embodiment; and

Fig. 3 is a similar view of a third embodiment.

Referring more particularly to Fig. 1, reference character 10 designates a conduit connected to the exhaust 11 of a blower 12. The other end of conduit 10 is connected to the intake 13 of the blower whereby a closed circulatory system is provided. A portion of conduit 10 consists of a tubular member 14 and an adjacent portion consists of a tubular member 15. The materials of which members 14 and 15 are made have different friction-electrical properties. As shown, member 14 is of glass, while member 15 is made of hard rubber. Disposed within tubular member 14 is an electrode 30 made of a material having good conductivity and formed with a point 16 facing, for example, the flow to the tubular member. The electrode, other than the point 16, is covered with insulating material 31. Electrode 30 is connected to a conductor 17 disposed outside of the tubular member. A similar electrode 18 is disposed within tubular member 15 and is connected to a conductor 19.

The circuit comprised of conduit 10 and blower 12 is charged with a quantity of finely divided particles, for instance lycopodium powder. On operation of blower 12 this powder is circulated by means of the current of gas produced by the blower through the closed circuit. In passing through tubular members 14 and 15 a certain portion of this powder comes in frictional contact with the inner walls of these tubular members. The particles which pass in frictional contact with tubular member 14 are given a negative charge of $-Q_{f1}$. Tubular member 14 thus is given a similar positive charge, that is $+Q_{f1}$. The negatively charged particles are carried along to within the tubular member 15 where, due to the friction against the inner walls of the rubber tube, the particles are now given a positive charge of $+Q_{f2}$, and give off to the member 15 their original negative charge of $-Q_{f1}$ and also produce in the member 15 a negative charge of $-Q_{f2}$. The particles discharged from tubular member 15 carry with them the positive charge $+Q_{f2}$ which they give off to the tubular member 14 when they again come in frictional contact with this member. Thus, after the device has been operated a short time the tubular member 14 has received a positive electrical charge of $+(Q_{f1}+Q_{f2})$ and the tubular member 15 has received a similar but negative charge of $-(Q_{f1}+Q_{f2})$.

The above is on the assumption that the same particles take part in the frictional contact with both tubes. Of course, in practice this is not strictly so inasmuch as all of the particles do not contact the tubes, some passing through the center of the channel without touching the sides and some touching the sides of one tubular member but not the sides of the other. However, tests have shown that very considerable charges may be imparted to the tubular members.

Both the glass and rubber being non-conductors, it is not possible to take the charges accumulated thereon directly from these members. For this purpose electrodes 16 and 18 are provided.

It will be understood that each particle which comes in frictional contact with tubular members 14 and 15 imparts a small charge to these members. The charges imparted by the individual charges build up on these members and when the positive charge on the inner surface of member 14 has assumed a sufficient density

there then occurs, due to the influence of this positive charge, a negative point discharge from the point of the electrode 16 toward the member 14, whereby the conductor 17 is charged positively. In travelling from the electrode to the member 14 the ions cross the current of particles and a large part of the negative ions is added to the particles. In this way there is obtained a negative charge on those particles which have not come into contact with the tubular member 14 and which therefore have not received any frictional charge. This second manner of charging the particles is therefore effected entirely by influence effect, in connection with which the frictional charges on the walls of the tubular members serve only as auxiliary charges. To the pure frictional charge of the systems there must therefore be added the influence charge $+Q_1$. The charge present on tubular member 14 is thus $+(Q_{11}+Q_{12}+Q_{11}+Q_{12})$ and the charge on tubular member 15 is of the same quantity, but of negative polarity.

The device is thus very effective for the production of high potential currents. It is self-exciting and the individual current electrodes always have the polarity determined by the selection of the friction surfaces and of the material which constitutes the finely divided particles.

In order to increase the amount of current which may be taken from the apparatus, the number of tubular members may be increased. As shown in Fig. 2, there are provided three tubular members 14*a*, 14*b* and 14*c* made of glass and three tubular members 15*a*, 15*b* and 15*c* made of rubber. Electrodes 16*a*, 16*b* and 16*c* are connected in parallel, while the electrodes 18*a*, 18*b* and 18*c* are likewise connected in parallel.

As friction surfaces in the circuit there can be used metals or any other conductors or semiconductors. In such event it is of course necessary that the different sections be separated from each other by intermediate insulating members.

When using conductive frictional surfaces, the electrical charges produced thereon may be conducted therefrom merely by connecting an electrical conductor thereto and hence it is not necessary to provide electrodes. However, if this were done the influence effect would not be obtained. To obtain this effect the apparatus shown in Fig. 3 may be employed. In this embodiment the tubular members 20 and 21 are made of insulating material, while the tubular member 22 is an electric conductor. A corona protection device 23, for instance, in the form of a metal sphere, surrounds tubular member 22, and may be termed an auxiliary conductor. Auxiliary conductor 23 is enclosed in a metallic main conductor 24 to which is electrically connected the metallic electrode 25 disposed in the path of flow of the finely divided particles.

In operation, the tubular member 22 is first charged by the friction of the particles. The difference in potential produced in this manner between auxiliary conductor 23 and main conductor 24 causes a point discharge at the electrode 25, which charges by influence the finely divided particles passing between the electrode and member 22.

In accordance with this invention it is possible to use alternating metallic and insulating surfaces. It should be borne in mind that the alternating members need not have opposite friction-electrical properties but that it is only necessary that their friction-electrical properties be different in order that different potentials shall be produced. However, in order to obtain the best results the alternating members should be selected in such a manner that their friction-electrical properties differ as much as possible. Hence, it is usually preferable to choose one member having a positive property and the other member having a negative property.

In general, especially where it is a question of obtaining very high voltages, it is also advisable to surround or screen the charge reversing parts of the system with metallic surfaces of spherical or other suitable form. It has been found desirable to arrange all joints which have little dielectrical strength and which lie between adjoining parts of the gas conduit, within such protecting and screening devices, inasmuch as the strong electrical field between the individual screens may have disadvantageous results on the transmission of the electricity, or may result in break-down or spark-over voltages.

Certain parts of the gas circuit, which must consist of insulating material for the reason that they serve at the same time as supports for the apparatus, may advantageously be provided with impact surfaces directed toward the current of finely divided particles, which surfaces are made of material having friction-electrical properties such that the particles coming into contact with these surfaces are given charges of the same polarity as that which they carry in this part of the gas circuit. This is also true with respect to the blower 12.

While I have shown and described several more or less specific embodiments of my invention, this has been done for purposes of illustration only and the scope of my invention is not to be limited thereby, but is to be determined by the appended claims viewed in the light of the prior art.

What I claim is:

1. In a device for producing high potential electric current, means defining a path of flow, means for producing flow of finely divided particles through said path, at least two members made of materials having different friction-electrical properties disposed so as to be contacted serially by said particles passing through said path, whereby said members are charged at different potentials as a result of frictional contact with said particles, and means for collecting the charges at different potentials from said members.

2. A device as described in claim 1 in which the materials of said members have friction-electrical properties of different polarity.

3. In a device for producing high potential electric current, means defining a path of flow, said means including at least two serially arranged tubular members made of materials having different friction-electrical properties, means for producing a flow of finely divided particles through said path and in frictional contact with said members, whereby said members are charged at different potentials as a result of frictional contact with said particles, and means for collecting the charges at different potentials from said members.

4. A device as described in claim 3 in which the materials of said tubular members have friction-electrical properties of different polarity.

5. A device as described in claim 3 in which the materials of said tubular members are non-conductors of electricity.

6. A device as described in claim 3 in which the materials of said tubular members are conductors of electricity, and electrical insulating means separating said members.

7. In a device for producing high potential electric current, means defining a path of flow, means for producing a flow of finely divided particles through said path, at least two members made of materials having different friction-electrical properties disposed so as to be contacted serially by said particles passing through said path, whereby said members are charged at different potentials as a result of frictional contact with said particles and electrodes disposed in the neighborhood of said members and in the path of flow of said particles for collecting the charges at different potentials from said members.

8. In a device for producing high potential electric current, means defining a path of flow, said means including at least two serially arranged tubular members made of materials having different friction-electrical properties, means for producing a flow of finely divided particles through said path and in frictional contact with said members, whereby said members are charged at different potentials as a result of frictional contact with said particles and electrodes disposed centrally within said tubular members and in the path of flow of said particles for connecting the charges at different potentials from said members and for imparting charge to said particles by an influence effect.

9. In a device for producing high potential electric current, means defining a closed path of flow, means for circulating finely divided particles through said path, at least two members made of materials having different friction-electrical properties disposed so as to be contacted serially by said particles, whereby said members are charged at different potentials as a result of frictional contact with said particles, and means for collecting the charges from said members.

10. In a device for producing high potential electric current, means defining a path of flow, said means including a plurality of serially arranged tubular members, adjacent members being made of different materials and alternate members being made of the same material, said different materials having different friction-electrical properties, means for producing a flow of finely divided particles through said path and in frictional contact with said members, whereby adjacent members are charged at different potentials and alternate members are charged at the same potential, and means for collecting the charges from said members, the means for collecting the charges from members made of the same material being electrically connected in parallel.

11. In a device for producing high potential electric current, means defining a path of flow, means for producing a flow of finely divided particles through said path, said means including a tubular metallic member and tubular insulating members on either side of said metallic member, an auxiliary conductor in the form of a metal sphere surrounding and electrically connected to said tubular metallic member, a main conductor surrounding and spaced from said auxiliary conductor, and an electrode disposed in the path of flow of said particles and electrically connected to said main conductor.

12. That improvement in the art of generating high potential electric current which includes flowing a stream of finely divided particles in frictional contact with at least two different materials having different friction-electrical properties, and collecting the charges thereby imparted to said materials.

SVEN FAGERBERG.