Aug. 12, 1958 B. G. E. STIFF 2,847,586

ELECTROSTATIC ACCELERATOR

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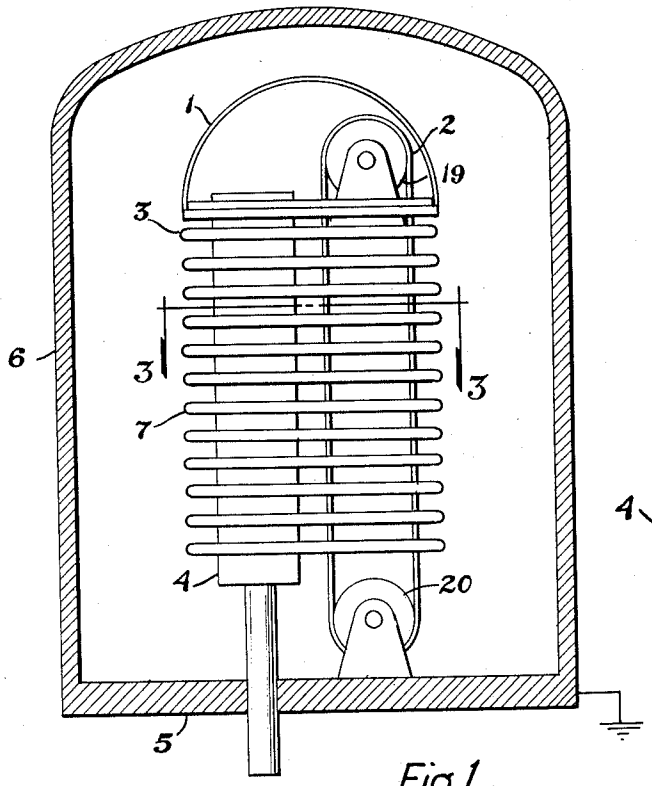

Fig. 1

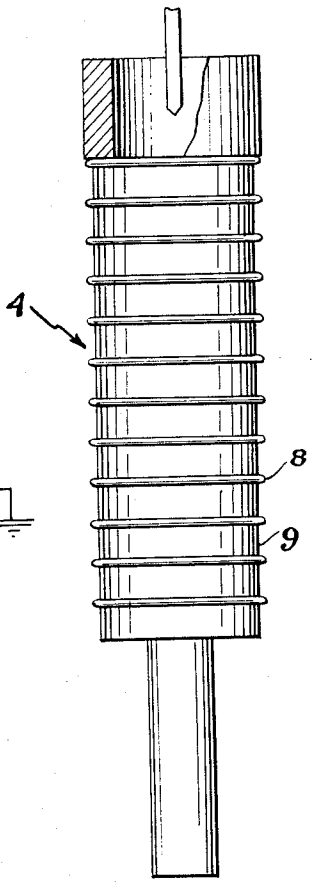

Fig. 2

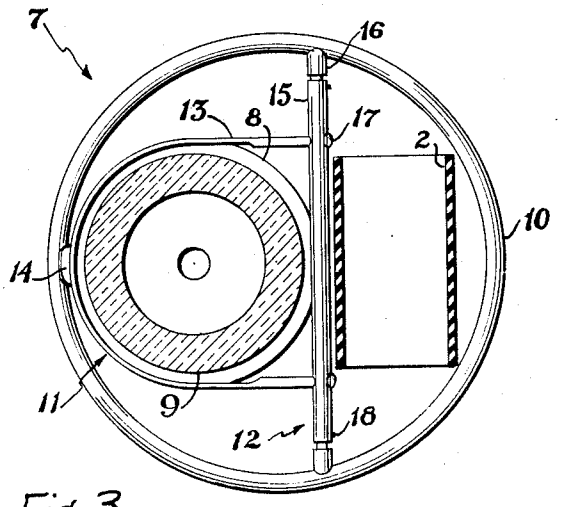

Fig. 3

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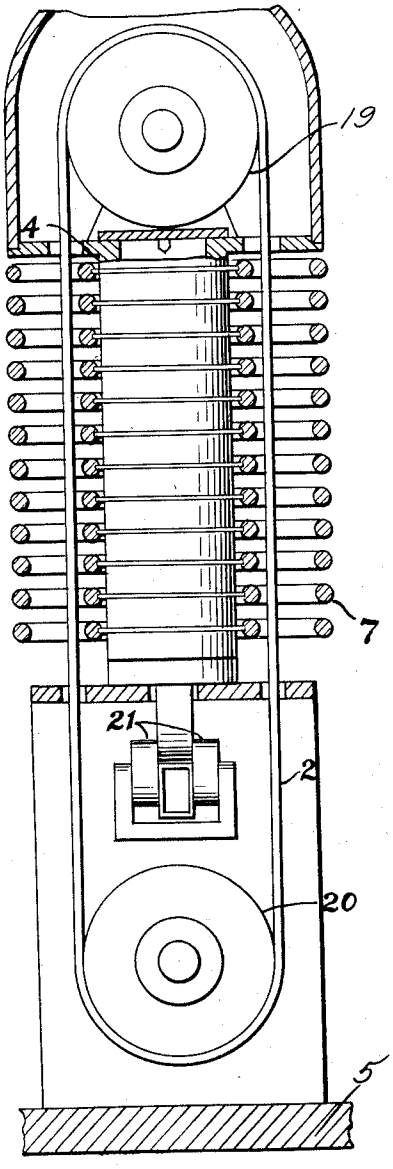

FIG. 4.

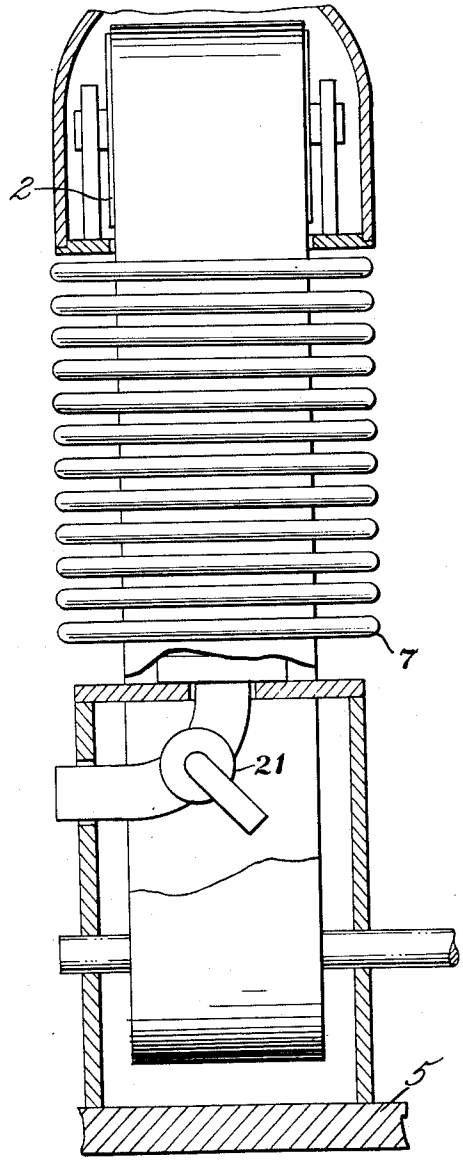

FIG. 5.

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ELECTROSTATIC ACCELERATOR

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Application February 29, 1956, Serial No. 568,470

4 Claims. (Cl. 310—5)

This invention relates to charged-particle accelerators, and in particular to a compact device for accelerating charged particles by means of the high voltage generated by an electrostatic belt-type generator.

Electrostatic belt-type generators are well-known in the particle-acceleration art and are described, for example, in the United States patent to Robert J. Van de Graaff, No. 1,991,236, dated February 12, 1935, and in the United States patent to John G. Trump, No. 2,252,668, dated August 12, 1941. In such generators, electric charge is deposited on a rapidly moving endless belt and carried physically by the belt to the high-voltage terminal, where it is removed by a charge collector. Similarly, the descending run of the belt may have charge of opposite polarity deposited on it within the terminal which is physically carried down to ground potential, where it is removed in like fashion. The high-voltage terminal is supported upon a column which must also insulate the high-voltage terminal electrically. The column may be entirely of insulating material, but usually comprises a series of equipotential planes separated by insulators which are cemented to the equipotential planes so that the entire assembly forms a rigid and strong column. For greater compactness, the generator may be housed in a tank which is filled with a suitable insulating gas under pressure.

Where an electrostatic belt-type generator is used to accelerate charged particles, an evacuated acceleration tube, such as that disclosed in the United States patent to Robert J. Van de Graaff and William W. Buechner, No. 2,517,260, dated August 1, 1950, is positioned between the high-voltage terminal and ground, so that an electric field is produced within the acceleration tube whereby charged particles may be accelerated from one end of the tube to the other. While in certain embodiments of the invention hereinafter described the use of such an acceleration tube is preferred, the invention is not limited to such an acceleration tube or to any other particular type of acceleration tube. The acceleration tube is usually supported within the column so as to lie alongside the belt.

The invention comprehends an electrostatic particle accelerator wherein the acceleration tube itself provides the mechanical support for the high-voltage portions of the apparatus, thereby simplifying the construction of the column by eliminating the supporting members thereof which have hitherto been thought necessary. In accordance with one embodiment of the invention, the acceleration tube provides the mechanical support not only for the high-voltage terminal but also for the series of equipotential planes; and, in this embodiment, the insulators which hitherto have been cemented between the equipotential planes are eliminated. In accordance with another embodiment of the invention, greater compactness is achieved by positioning the acceleration tube centrally and supporting the belt so that it travels around the tube; in this embodiment, means may be provided for deflecting the accelerated beam of charged particles so that it misses the belt and other intervening obstructions.

The invention may best be understood from the following detailed description thereof, having reference to the accompanying drawings, wherein:

Figure 1 is a somewhat diagrammatic view in vertical central section of an electrostatic particle accelerator embodying the invention;

Figure 2 is a side elevation of the acceleration tube of the electrostatic accelerator of Figure 1;

Figure 3 is a sectional view along the line 3—3 of Figure 1;

Figure 4 is a somewhat diagrammatic view in vertical central section of a portion of an electrostatic particle accelerator embodying a modification of the invention; and

Figure 5 is a side elevation of the apparatus of Figure 4.

Referring to the drawings, and first to Figure 1 thereof, the electrostatic accelerator therein shown comprises a hollow high-voltage terminal 1 to which electric charge is conveyed in the conventional manner by an endless belt 2. The high-voltage terminal 1 is supported upon a terminal plane 3 which in turn is supported upon an acceleration tube 4 which, in addition to serving as the sole mechanical support for the electrostatic accelerator, also functions as the vacuum tube in which charged particles are accelerated to high energy by the electric field which is created therein by the electric charge accumulated on the high-voltage terminal 1. The acceleration tube 4 is supported upon a base plate 5, which is at ground potential and to which a tank 6 is bolted. The tank 6 surrounds the entire electrostatic accelerator, and is filled with a suitable gas under pressure for the purpose of insulating the high voltage portions of the electrostatic accelerator.

In order to control the voltage gradients which are produced by the electric charges on the terminal 1 and on the belt 2, equipotential planes 7 are provided between the terminal 1 and the base plate 5. Such equipotential planes 7 are commonly used in electrostatic accelerators, but since, in accordance with the invention, the acceleration tube 4 provides the sole mechanical support for the accelerator, the equipotential planes 7 must have a special construction.

Referring now to Figures 2 and 3, in addition to Figure 1, each equipotential plane 7 is supported upon an electrode 8 of the acceleration tube 4, which comprises the usual multiplicity of alternating electrode disks 8 and insulating rings 9, as is described in detail in the aforementioned patent to Van de Graaff and Buechner. Each equipotential plane 7 need support only its own weight, and so its construction may be simple; and, in the embodiment of the invention shown in Figure 3, each equipotential plane 7 is readily removable. Each equipotential plane 7 comprises an outer ring 10, a connecting member 11, and a cross-bar 12.

The connecting member 11 comprises a first part 13 and a second part 14 which is sealed to said first part 13 as by soldering, welding, or brazing, so that the connecting member 11 is a single unit. The first part 13 may comprise a length of tubing which has been bent into a generally semicircular shape and which has been slotted at its inner peripheral surface so as to receive the edge of the electrode 8. The second part 14 may comprise a small plate which has been contoured to receive the inner peripheral surface of the outer ring 10. The cross-bar 12 comprises a central tube 15 and two end-pieces 16, which slideably fit into the tube 15 and whose outer ends are contoured to the inner peripheral surface of the outer ring 10.

To affix an equipotential plane 7 to an electrode 8, the connecting member 11 is fitted onto the electrode 8, as shown in Figure 3. The connecting member 11 is then

affixed to the electrode 8 by means of the cross-bar 12, whereof the central tube 15 is slotted so as to receive the edge of the electrode 8. Thus, for example, the ends of the first part 13 of the connecting member 11 may be internally threaded to engage screws 17 which pass through apertures in the central tube 15 of the cross-bar 12. The outer ring 10 is then slipped over the acceleration tube 4 and positioned in the plane of the appropriate electrode 8. With the end-pieces 16 retracted, the cross-bar 12 is inserted into the outer ring 10. The outer ring 10 is then affixed to the connecting member 11 by extending the end-pieces 16 against the outer ring 10 and tightening the set screws 18, so that the outer ring 10 is held by the two end-pieces 16 and the second part 14 of the connecting member 11.

The other equipotential planes 7 are affixed to suitable electrodes 8 in a similar manner. It may be necessary, however, to support the terminal plane 3 upon the acceleration tube 4 in a stronger manner, using any conventional technique, such as bolting, since the terminal plane 3 may be required to support not only the terminal 1 but also the various electrical equipment which is needed at the terminal 1 in order to create charged particles and for other usual purposes. For example, the belt 2 will usually be supported upon two pulleys 19, 20, the first pulley 19 being supported within the terminal 1 upon the terminal plane 3, and the second pulley 20 being at ground.

Further compactness may be achieved by the alternative construction shown in Figures 4 and 5, wherein the acceleration tube 4 is centrally located and is surrounded by the belt 2. The beam of charged particles may be bent in a magnetic field created by suitable magnets 21, so as to clear the lower pulley 20, the belt 2, and other intervening obstructions.

Having thus described the principles of the invention, together with illustrative embodiments thereof, it is to be understood that although specific terms are employed, they are used in a generic and descriptive sense and not for purposes of limitation, the scope of the invention being set forth in the following claims.

I claim:

1. An electrostatic accelerator comprising in combination: a base plate; a high-voltage terminal assembly; a traveling charge-conveying endless belt for carrying electric charge between said high-voltage terminal assembly and said base plate; and an acceleration tube mechanically supporting said high-voltage terminal assembly upon said base plate.

2. An electrostatic accelerator comprising in combination: a base plate; a high-voltage terminal assembly; a traveling charge-conveying endless belt for carrying electric charge between said high-voltage terminal assembly and said base plate; and an acceleration tube mechanically connected between said high-voltage terminal assembly and said base plate in such a way as to provide the sole mechanical support for said high-voltage terminal assembly.

3. An electrostatic accelerator comprising in combination: a base plate; a high-voltage terminal assembly; a traveling charge-conveying endless belt for carrying electric charge between said high-voltage terminal assembly and said base plate; an acceleration tube comprising a multiplicity of alternating insulating rings and electrode disks and mechanically supporting said high-voltage terminal assembly upon said base plate; and a series of equipotential planes each of which is supported upon one of said electrode disks, whereby the voltage gradient between said high-voltage terminal assembly and said base plate is made more uniform.

4. An electrostatic accelerator comprising in combination: a base plate; a hollow electrode; a traveling charge-conveying endless belt for carrying electric charge between said hollow electrode and said base plate, said belt being supported upon at least two pulleys, the first within said hollow electrode and the second upon said base plate; and an acceleration tube mechanically connected between said hollow electrode and said base plate in such a way as to provide the sole mechanical support for said hollow electrode and said first pulley.

References Cited in the file of this patent

UNITED STATES PATENTS

2,578,908	Turner	Dec. 18, 1951
2,640,948	Burrill	June 2, 1953
2,643,341	Leland	June 23, 1953