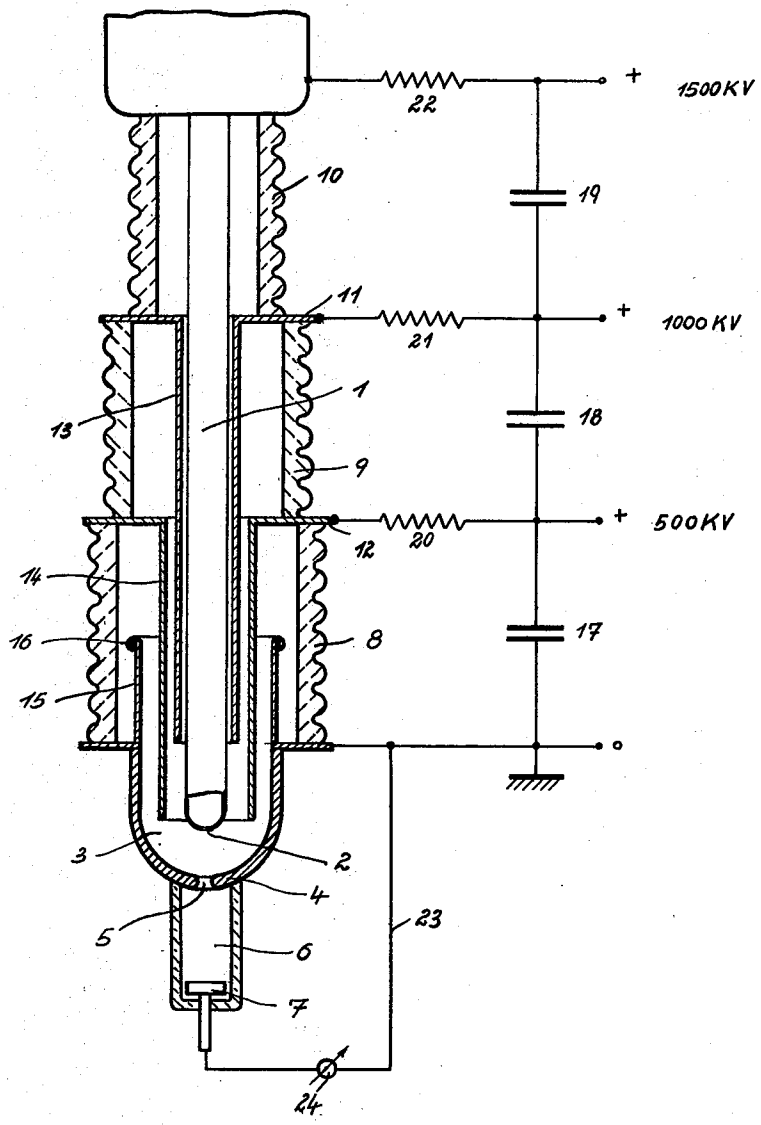
Nov. 4, 1941. W. SCHÜTZE 2,261,569

DEVICE FOR PRODUCING RAPIDLY FLYING IONS

Filed April 22, 1939



Inventor
Werner Schütze
by Knight Bros
Attorneys

Patented Nov. 4, 1941 2,261,569

UNITED STATES PATENT OFFICE

2,261,569

DEVICE FOR PRODUCING RAPIDLY FLYING IONS

Werner Schütze, Berlin-Pankow, Germany, assignor to "Fides Gesellschaft für die Verwaltung und Verwertung von gewerblichen Schutzrechten mit beschränkter Haftung," Berlin, Germany, a corporation of Germany

Application April 22, 1939, Serial No. 269,451
In Germany April 23, 1938

6 Claims. (Cl. 250—84)

This invention relates to improvements in electric discharge devices for producing ions or ion rays of high velocity. In such discharge devices, the ions are produced in a gas-filled discharge chamber whence they pass through a narrow aperture into a highly evacuated portion of the discharge vessel where they are accelerated by a high voltage while flying towards the acceleration electrode. The acceleration electrode (cathode) has an aperture through which part of the ions pass into the operating space proper where they are caused to act, for instance, on a substance to be treated.

The high voltage required between the electrodes of the accelerating discharge gap for attaining the high ion speeds often desired, causes considerable difficulty as regards the insulation of the electrodes. Attempts have been made to accelerate the ions gradually, i. e. in several steps, by using a series of several acceleration electrodes. However, the amount of rapid ions obtained in this manner is, as a rule, relatively small. The output of rapid ions may be somewhat increased by reducing the spacing between the accelerating electrodes and arranging them in series relation at the smallest possible intervals.

In a known discharge tube of the last-mentioned type, the electrodes are supported by concentrical sheet metal cylinders of different lengths which are provided with flanges at the ends away from the electrode. These flanges hold the electrodes in proper position with respect to one another, with the aid of tubular insulators placed between the flanges. When applying very high voltages in such tubes, there is still considerable difficulty as regards insulation.

An object of the invention is to reduce the above-mentioned difficulties of properly insulating the acceleration means of a discharge device for producing rapid ions. Another more particular object is to provide a discharge device of the type here in point, which is puncture-proof at extremely high acceleration voltages, for instance above 1000 kv., while maintaining an economic output of rapid ion rays. An object, in conjunction with the foregoing, is to provide an economically operating high-voltage discharge tube for producing ions of high speed, which tube is of simple construction and composed of relatively few parts of convenient dimensions.

According to the invention, a single high-voltage discharge gap of a tube for producing rapid ions has its anode and cathode insulated from each other by several preferably cylindrical insulators which are separated from one another by circular sheet metal plates. These circular plates, which are impressed with suitable voltages, are associated with sheet metal cylinders which extend inside the insulator towards the cathode and have such diameters that each cylinder lies substantially in the equipotential surface corresponding to its voltage. In this manner it is possible to attain a puncture-proof tube even at very high total voltages above 1000 kv.

In the accompanying drawing is shown diagrammatically in sectional elevation a tube according to the invention. The ions are produced inside the gas-filled discharge chamber 1 (anode) which is closed except for a narrow aperture 2 through which the ions pass into the highly evacuated acceleration chamber 3. Well-known gas supply and evacuating means (not shown) may be provided to maintain the anode chamber 1 and the acceleration chamber 3 in gas-filled and evacuated condition, respectively. The electrode 4 is impressed, with respect to the anode 1, with a negative voltage of, for instance, 1500 kv. When the ions pass through the evacuated discharge chamber 3, they are accelerated and leave this chamber through an aperture 5 at a very high velocity. An extension 6 which is secured to the tube in a vacuum-tight manner forms the operating chamber proper wherein the rapid ion rays are utilized, for instance, for treating a substance placed on the electrode 7.

The electrodes 1 and 4 are insulated from each other by means of three insulators 8, 9, 10. These insulators are separated from one another by metallic sheets 11 and 12 which have preferably a circular form. The anode 1 is impressed, for instance, with a voltage of 1500 kv., the sheet 11 with a voltage of 1000 kv., and the sheet 12 with a voltage of 500 kv., these voltages being positive and referring to the zero potential of the grounded electrode 4.

The sheets 11 and 12 are associated with sheet metal cylinders 13 and 14 respectively which are arranged inside the space hermetically closed by the insulators and extend in the downward direction. A cylindrical sheet metal part 15, having a beaded edge 16, forms an extension of the electrode 4. Between the cathode 1 and the sheet metal part 15 prevails a potential difference of 1500 kv. The position of the cylindrical sheet metal parts 13 and 14 is so chosen that each coincides with the equipotential surface between parts 1 and 15 which correspond to the voltage with which the cylinder is impressed. Owing to the logarithmic potential drop between the anode

1 and the sheet metal part 15 (electrode 4), the distances between the individual cylindrical sheet metal bodies are of course not equal. It may also be convenient to arrange the sheet metal cylinders in such a manner that they do not extend to an equal distance from the cathode 4, but to choose the inner cylinders somewhat shorter than the outer one, as is illustrated in the drawing.

The drawing also shows a suitable electric connection for operating the tube. The total voltage of 1500 kv. between the anode and the cathode is subdivided by condensers 17, 18 and 19 into steps of 500 kv. each. Protective resistances 20, 21, 22 are arranged between the terminals of the condensers and the terminals of the discharge vessel. A conductor 23 connects the screen or electrode 7 with the ground point of the high voltage source in order to dissipate the charge of electrode 7 effected by the ions. An ammeter 24 inserted in conductor 23 allows measuring the effective ion output utilized at the electrode 7.

What is claimed is:

1. In a discharge device for producing ions of high velocity, in combination, an anode unit forming a source of ions, a cathode for accelerating the ions emitted from said anode, a plurality of insulators arranged in series relation between said anode and said cathode, said insulators consisting of tubular cylindrical bodies and forming a wall portion of a vacuum vessel containing said anode unit, said cathode comprising a cup-shaped conductive body and a conductive flange secured to said body and to the nearest of said insulators, said body and flange forming another wall portion of said vacuum vessel, circular metal plates arranged between said insulators and extending radially with respect to said vacuum vessel, each of said plates separating two adjacent insulators from each other, means for applying progressively graduated voltages to said anode, plates, and cathode respectively, totalling in a high acceleration voltage effective between said anode and cathode, and metal cylinders associated with said plates respectively and surrounding said anode, all of said cylinders having different diameters respectively, the diameters being graduated in accordance with said voltages, and each of said cylinders extending from its appertaining plate towards said cathode substantially in conformity with the equipotential surface corresponding to the voltage of said plate.

2. In a discharge device for producing ions of high velocity, in combination, an anode unit forming a source of ions, a cathode for accelerating the ions emitted from said anode, a plurality of insulators arranged in series relation between said anode and said cathode, metal plates arranged between said insulators, each plate separating two adjacent insulators from each other, means for applying graduated voltages to said anode, plates, and cathode respectively, totalling in a high acceleration voltage, sheet metal cylinders associated with said plates respectively and surrounding said anode, all of said cylinders having different diameters respectively, the diameters being graduated in accordance with said voltages, and each of said cylinders extending from its appertaining plate towards said cathode substantially in conformity with the equipotential surface corresponding to the voltage of said plate, and a cylinder of sheet iron connected with said cathode and projecting from said cathode into the interior space of the insulator next to said cathode so as to surround the outermost of said cylinders.

3. In a discharge device for producing corpuscular rays of high velocity, in combination, two spaced electrodes of different polarity, a plurality of insulators arranged in series relation between said electrodes, a plurality of metal plates arranged between said insulators, each plate separating two adjacent insulators from each other, circuit means for separately applying progressively graduated voltages to said electrodes and plates respectively, and a plurality of metal cylinders connected with said plates respectively and surrounding one of said electrodes, all of said cylinders having different diameters progressively graduated in accordance with the graduation of said voltages, and each of said cylinders extending from its appertaining plate towards said other electrode substantially in conformity with the equipotential surface corresponding to the voltage of said plate.

4. In a discharge device for producing corpuscular rays of high velocity, in combination, two spaced electrodes of different polarity, a plurality of insulators arranged in series relation between said electrodes, a plurality of metal plates arranged between said insulators, each plate separating two adjacent insulators from each other, conductor means for separately applying progressively graduated voltages to said electrodes and plates respectively, and a plurality of metal cylinders connected with said plates respectively and surrounding one of said electrodes, all of said cylinders having different diameters and lengths, the diameters being graduated in accordance with the graduation of said voltages, each of said cylinders extending from its appertaining plate towards said other electrode substantially in conformity with the equipotential surface corresponding to the voltage of said plate, the lengths of said cylinders being also graduated so that the outer cylinder approaches said other electrode to a greater extent than the inner cylinder.

5. In a discharge device for producing ions of high velocity, in combination, an anode unit forming a source of ions, a cathode for accelerating the ions emitted from said anode, a plurality of tubular insulators series-arranged between said anode unit and said cathode, circular metal plates arranged between said insulators, each plate separating two adjacent insulators from each other, conductor means separately connected with each of said anode, plates and cathode for applying graduated voltages to said anode, plates and cathode respectively so as to have the total voltage effective between said anode and cathode, and sheet metal cylinders associated with said plates respectively and surrounding said anode, all of said cylinders having different diameters progressively graduated in accordance with the graduation of said voltages, and each of said cylinders extending from its appertaining plate towards said cathode substantially in conformity with the equipotential surface corresponding to the voltage of said plate, said cylinders further having different lengths, the cylinders associated with plates more distant from said cathode having greater length than the cylinders appertaining to plates closer to said cathode, so that each inner cylinder overlaps the adjacent outer cylinder beyond the plane of the plate appertaining to said outer cylinder.

6. In a discharge device for producing ions of high velocity, in combination, an anode unit

forming a source of ions, a cathode for accelerating the ions emitted from said anode, a plurality of tubular insulators series-arranged between said anode unit and said cathode, circular metal plates arranged between said insulators, each plate separating two adjacent insulators from each other, conductor means separately connected with each of said anode, plates, and cathode for applying graduated voltages to said anode, plates, and cathode respectively so as to have the total voltage effective between said anode and cathode, and sheet metal cylinders associated with said plates respectively and surrounding said anode, all of said cylinders having different diameters progressively graduated in accordance with the graduation of said voltages, and each of said cylinders extending from its appertaining plate towards said cathode substantially in conformity with the equipotential surface corresponding to the voltage of said plate, the distance of the inner cylinders from said cathode being larger than that of the outer cylinders.

WERNER SCHÜTZE.