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IONIZATION TYPE VOLTAGE CHARGING DEVICE

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Fig. 1.

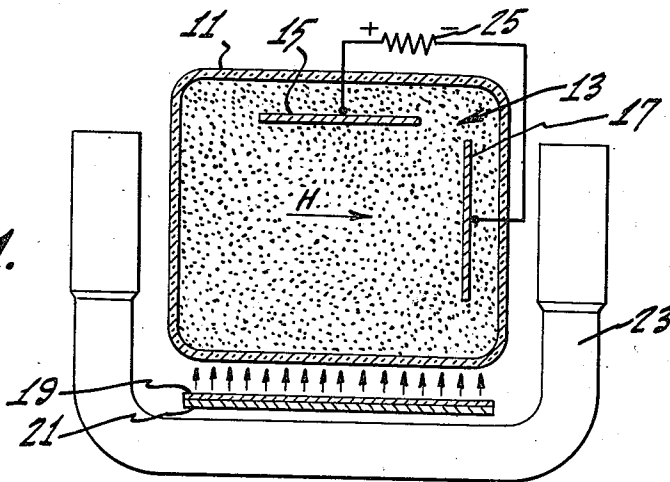


Fig. 2.

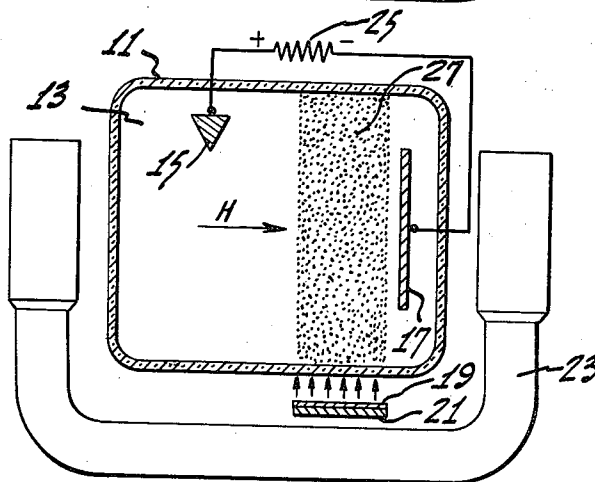
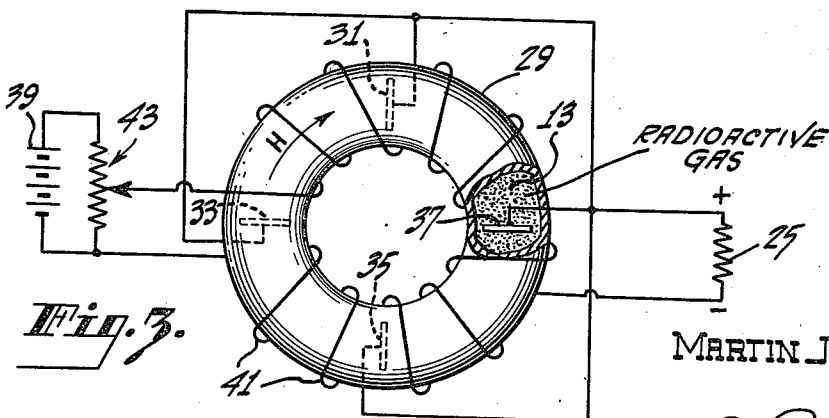


Fig. 3.

RADIOACTIVE GAS

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IONIZATION TYPE VOLTAGE CHARGING DEVICE

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6 Claims. (Cl. 310—3)

This invention relates to converting the energies of nuclear and other high energy radiations into electrical energy and more particularly to an improved ionization type voltage charging device or generator.

Heretofore ionization type voltage charging devices have been devised in which the differential mobilities or differential rates of diffusion of the particles of an ionized medium are utilized to achieve voltage charging. These particles comprise electrons and positive ions produced, for example, by subjecting an ionizable medium to high energy radiation. A collector electrode immersed in the medium receives both an electron and an ion current. For ordinary gases the electron current is several hundred times the positive ion current. Thus the electrode charges to a negative potential relative to the potential of the medium and becomes increasingly more negative until a stable point is reached wherein the magnitudes of the electron current and the ion current are equalized. By placing a second electrode in the ionized medium, different in size and/or shape from the first electrode, a different negative potential is derived. The net potential difference between the electrodes may then be utilized to supply energy to a load circuit.

According to the instant invention, the operation and efficiency of devices fabricated in accordance with the principles outlined above is greatly improved by utilizing a magnetic field to control the relative magnitudes of electron and positive ion currents collected by each electrode immersed in the medium. A further feature of the invention is directed to selectively ionizing a portion of the ionizable medium. By ionizing only a portion of the medium in a region adjacent one of the electrodes, it will be shown that some free electrons tending to flow toward and be collected by the remaining electrode attach to molecules of the medium and form relatively slow moving negative ions. Collection of such ions rather than more mobile electrons enhances the net output voltage developed between the electrodes.

An object of the invention is to provide improved methods of and means for utilizing the energy of high energy radiations.

Another object of the invention is to provide improved methods of and means for generating electrical energy.

Another object of the invention is to provide improved methods of and means for utilizing the differential mobilities of free electrons and ions to achieve voltage charging.

A further object of the invention is to provide an improved ionization type voltage charging device.

A still further object of the invention is to provide a more efficient ionization type voltage charging device.

Another object is to provide an improved radioactive radiation detector.

The invention will be described in detail with reference to the accompanying drawing in which:

Figure 1 is a schematic diagram of a first embodiment of an ionization type voltage charger, according to the invention;

Figure 2 is a schematic diagram of a second embodi-

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ment of the invention and in which selective ionization is employed; and

Figure 3 is a schematic diagram of a further embodiment of the invention.

Similar reference characters are applied to similar elements throughout the drawing.

Referring to the drawing, Figure 1 shows a voltage charging device or generator which comprises a non-magnetic envelope 11 containing an ionizable medium 13 (such as argon gas, hydrogen gas, helium, etc.) having a low coefficient of electron attachment. Also contained in the envelope 11 and mounted in a spaced relation in the medium are a pair of electrically conductive plane electrodes 15 and 17 having their respective axes preferably normal to each other. External to the envelope 11 a source 19 providing cold high energy emission is mounted on a support 21. For the ensuing description it will be assumed that the source material is strontium⁹⁰, a beta particle emitter. It is emphasized, however, that any source material may be utilized which produces radiations capable of ionizing the gas 13. For example, materials which produce X-rays, deuterons, positrons, protons, fission fragments, neutrons, ultra-violet rays, or cosmic rays are satisfactory and may be employed either separately or in combination to ionize the gas.

Initially the electrodes 15 and 17 and the gas 13 are at the same potential. However, beta particles radiated by the source 19 collide with the gas molecules to ionize the gas and produce ion pairs comprising free electrons and positive ions. Since the electron current normally is several hundred times the ion current each electrode, 15 and 17, charges to a negative potential and continues to charge negatively until a negative potential is reached at which the free electrons comprising the electron current are repulsed at such a rate that the electron and positive ion currents flowing to each electrode are equalized.

Ordinarily, if electrodes 15 and 17 are similarly sized and/or shaped, the voltages to which the electrodes charge are equal hence there is no net output voltage developed. The directional flow of the charged particles (i. e., electrons and positive ions), however, may be controlled in accordance with one feature of the invention by subjecting the ionized medium to the effects of a magnetic field. This magnetic field may be produced by any convenient means such as by a permanent magnet 23. The magnetic field is oriented such that the magnetic lines of force are aligned parallel to one electrode, in the present example the electrode 15, and normal to the remaining electrode 17. Thus, in instances in which it may be necessary to utilize electrodes having substantially the same surface area, it will be seen that the magnetic field controls the electron and positive ion current flow such that electrode 17 receives a much greater than normal number of electrons and charges to a potential substantially more negative than the negative potential to which electrode 15 charges. The ratio of electron diffusion in the direction of the magnetic field force lines compared to electron diffusion in a direction transverse thereto may be as large as 1000 to 1, hence an appreciable net output voltage is developed. The energy of this electric potential may then be expended in a suitable load circuit 25.

Referring to Figure 2 of the drawing, a preferred embodiment of the invention is shown. In this instance the net output voltage developed between electrodes 15 and 17 is enhanced by utilizing collector electrodes having materially different geometries. The point-plane arrangement illustrated is one of a number of possible configurations which are suitable. The point electrode 15 (for the moment neglecting the directional current control effects of the magnetic field) charges to a less negative voltage than does the plane electrode 17. This is true because a smaller negative charge on electrode 15

will repel an approaching electron and cause it to miss electrode 15. The same negative charge on the larger area electrode 17 may not prevent the electron from landing thereon. Since the control of the magnetic field is such that more electrons are directed to electrode 17 than are directed to electrode 15, it will be seen that electrode 17, as shown, preferably possesses the greater surface area for electron collection. If the converse condition were true, i. e. the configurations of electrodes 15 and 17 were transposed, the useful output voltage developed by the instant apparatus would be appreciably less.

According to a further feature of the invention the net output voltage developed by the apparatus of Figure 2 may be further enhanced by selective ionization of the gaseous medium 13. This is effected by proportioning and positioning the radiation source 19 to ionize only a portion of the gas 13. In order that the useful output voltage be enhanced rather than diminished the ionization region 27 is selected to be adjacent electrode 17. As described above the free electrons and positive ions produced by the ionization flow toward both electrodes. Since electrode 17 is closely adjacent region 27, free electrons and positive ions flowing thereto are readily collected. However, electrons flowing toward electrode 15 have a relative longer distance to traverse within the envelope before collection. A portion of these electrons collide with and attach to gas molecules in the un-ionized regions in the envelope 11. This electron attachment reduces the number of free electrons flowing toward electrode 15 and causes the formation of a corresponding number of relatively slowly moving negative ions. Since the mobility of the negative ions thus formed is considerably less than that of free electrons, it is seen that electrode 15 charges negatively at a slower rate thereby increasing the net output voltage derived. While electron attachment is desired for the reasons described above, an ionizable medium having a low coefficient of electron attachment is preferred. If a high coefficient of electron attachment gas is used, although electrode 15 charges to a potential less negative than before, electrode 17 also charges to a less negative voltage whereby the potential difference between electrodes 15 and 17 is reduced rather than enhanced. Also, to further improve the operation of the device, the material from which electrode 17 is formed preferably is different from the material of electrode 15, the material from which electrode 17 is formed having a greater affinity for electron collection (i. e., the work function of electrode 17 is lower than the work function of electrode 15).

Referring to Figure 3, a further embodiment of the invention is shown. The ionizable medium 13 in this example is contained within a hollow electrically conductive non-magnetic toroid 29 and comprises a radioactive gas such as tritium which is capable of self-ionization. Also contained within the toroid 29 and immersed in the medium 13 are a plurality of disk shaped electrodes 31, 33, 35, and 37. These disk shaped electrodes are insulated from the toroid and are disposed at different angular positions around the toroid. A magnetic field is produced having magnetic lines of force within the toroid transverse to the disks by supplying current from a source 39 to a coil 41 wound about the toroid. The magnetic field strength may be controlled by some suitable means such as a potentiometer 43 in shunt with the source 39.

The apparatus shown in Fig. 3 operates substantially in accordance with the principles described hereinbefore with respect to the devices of Figs. 1 and 2. Because of its radioactive nature the gas 13 ionizes and produces free electrons and positive ions. Under the control of the magnetic field, these charged particles are collected in different amounts by the inner surface of the toroid 29 and by the disk electrodes 31, 33, 35, and 37. The disks preferably are connected together and charge to a potential different from the potential to which the toroid

charges. The net output voltage again may be utilized to supply current and energy to a desired load or utilization circuit. For purposes of simplicity only four disks have been illustrated as immersed within the medium. It will be recognized however that any number of such collector electrodes may be employed, the number of electrodes used depending, for example, on the dimensions of the toroid, the particular gas used, and the pressure of the gas. Also, it is pointed out that, if desired, selective ionization may be employed to further improve the operation and efficiency of the instant device.

If the apparatus described with reference to either Figures 1, 2, and 3 of the drawing is to be utilized as a radiation detector, it will be apparent that the sources of high energy radiations of Figures 1 and 2 may be omitted or the radioactive gas (tritium) of Figure 3 may be replaced with a suitable non-radioactive gas and ambient radiations used to provide charging. In the event that the apparatus is to serve as a voltage source, it may be desirable to place the source materials illustrated in Figures 1 and 2 within the envelope, for example, supporting it on one of the collector electrodes.

The instant invention thus comprises improved ionization type voltage charging devices, generators, or radiation detectors. The utilization of a magnetic field for controlling the directional flow of charged particles toward differently oriented collector electrodes greatly enhances the differential voltage obtainable therefrom. Also, the feature of selective ionization further improves the operation and efficiency of the device. While the radiation sources have been illustrated as comprising films or coatings it will be recognized that these sources may assume various other forms.

What is claimed is:

1. Apparatus for primarily generating electrical energy comprising, an envelope containing an ionizable gaseous medium, a pair of spaced electrodes immersed in said medium, said electrodes having axes normal to each other, a source of high energy radiation positioned to continuously ionize only a portion of said gaseous medium to produce a copious supply of free electrons and positive ions in a region adjacent one of said electrodes, means for producing a magnetic field for directing different quantities of said free electrons and positive ions to said electrodes to establish a direct-current electric potential therebetween, and means for utilizing the electric energy of said potential.

2. Apparatus as claimed in claim 1 wherein said electrodes immersed in said medium have different surface areas.

3. Apparatus as claimed in claim 1 wherein one of said electrodes is mounted within said envelope transverse to the lines of force of said magnetic field and the other of said electrodes is aligned in the direction of said lines of force.

4. Apparatus as claimed in claim 3 wherein said copious supply of free electrons and positive ions is produced in a region adjacent said transverse electrode.

5. Apparatus as claimed in claim 1 wherein one of said electrodes is a point electrode and the other of said electrodes is a plane electrode.

6. Apparatus for primarily generating electrical energy comprising, an ionizable medium capable of self-ionization, a pair of spaced electrodes each having a longitudinal axis, said electrodes being positioned in said medium so that the longitudinal axis of one electrode of said pair is transverse to the longitudinal axis of the other electrode of said pair, and means for impressing a magnetic field on said ionizable medium wherein the lines of force of said magnetic field are parallel to only one of said axes and a direct-current electric potential is established between said spaced electrodes.

References Cited in the file of this patent

UNITED STATES PATENTS

2,520,603	Linder	Aug. 29, 1950
2,548,225	Linder	Apr. 10, 1951
2,555,116	Coleman	May 29, 1951
2,696,564	Ohmart	Dec. 7, 1954

OTHER REFERENCES

A New Electric Battery, published in The Electrician,
Vol. 10, page 497, dated October 31, 1924.