

Nov. 21, 1950

D. CHARLES
ION GENERATORS

2,530,859

Filed June 17, 1947

2 Sheets-Sheet 1

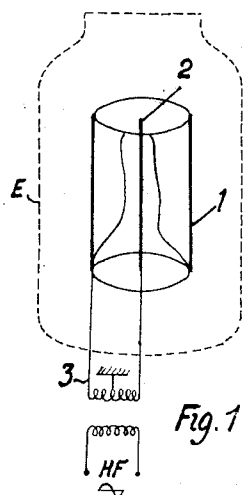


Fig. 1

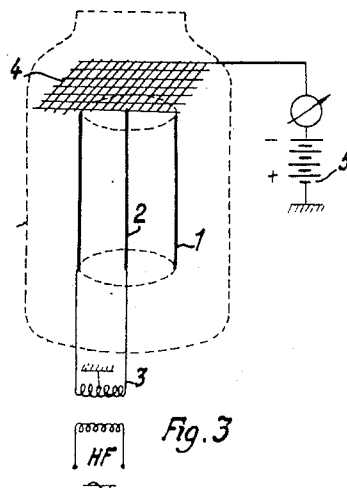


Fig. 3

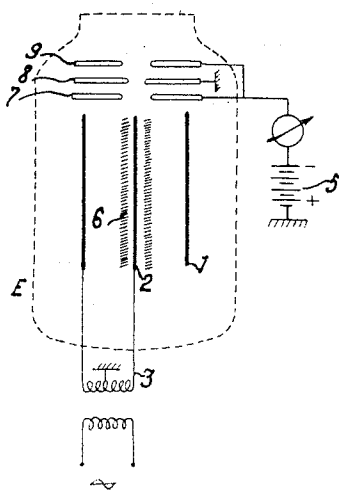


Fig. 4

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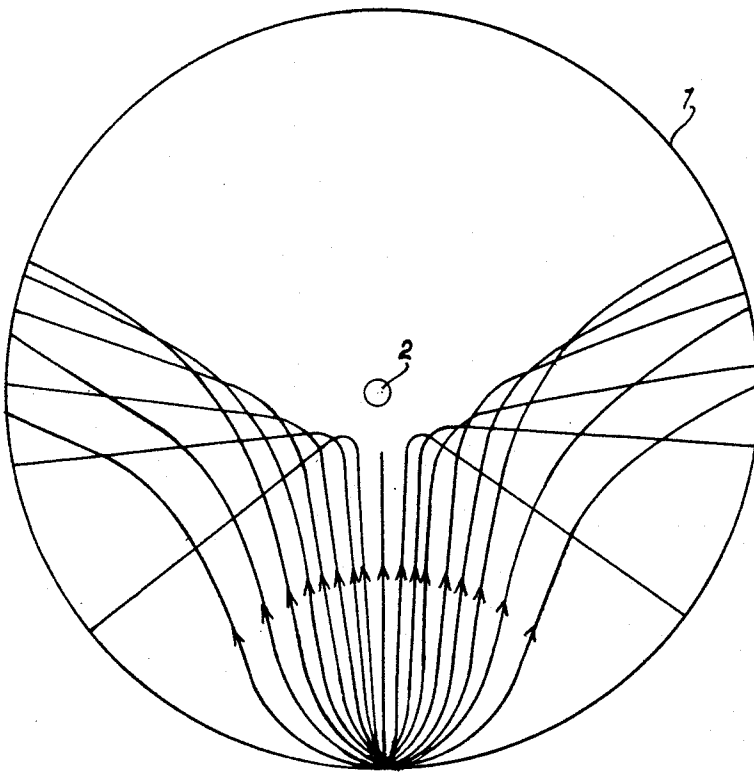


Fig. 2

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UNITED STATES PATENT OFFICE

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ION GENERATORS

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7 Claims. (Cl. 250—84)

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The most usual method of obtaining ions consists in causing a beam of electrons to act on gaseous molecules. In order that the output in ions shall be sufficient, one has to pass the beam of electrons into a gas having a substantial pressure in order to increase the probability of the ionizing shocks.

On the other hand the ions are generally utilized in an enclosure the vacuum of which is very high which compels one to maintain in communication with each other two receptacles, the one containing a gas at a relatively high pressure (the enclosure within which the ions are produced) and the other one a gas of very low pressure (the enclosure in which the ions are utilized). This is attained either by causing the two enclosures to communicate with each other through a hole of very small area which has the disadvantage that it limits the current of ions to a very small value, or by allowing the two enclosures to communicate widely with each other but by pumping very quickly into one of the enclosures while gas is supplied to the other one constantly. The main defect of the latter method is that the consumption in the amount of gas is often prohibitive.

The present invention relates to an arrangement for the production of ions by which the drawbacks of the methods above referred to are avoided, this being attained by acting not on the gas pressure, that is to say on the density of the molecules to be ionized, but on the probability of the ionizing electronic shocks.

The principle of the invention consists in causing each electron to traverse, in an enclosure where there is a low pressure, a complex trajectory which is as long as possible in a time that is as short as possible in such a manner as to increase in spite of the small density of the gaseous molecules the probability of producing ionizing shocks.

There are different ways by which this principle can be carried into effect. Figures 1, 2, 3 and 4 of the accompanying drawings illustrate by way of example simple arrangements which give excellent results.

Referring first of all to Fig. 1, reference character 1 designates a metal cylinder surrounding a thin rod 2 arranged along its axis, the whole being placed in an enclosure E in which there is a low pressure. Between the cylinder and the rod there is produced a difference of alternating potential of very high frequency by means of a winding 3 into which there is induced a current of high frequency. The electrons which rise for

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example on the cylinder will then sweep the whole of the interior thereof provided that the frequency that is chosen is such that the transit time between the cylinder and the rod is equal to the period of the oscillations.

Indeed, if one traces the trajectories of these electrons, so-called resonance electrons, by taking into consideration the different initial velocities, one obtains a diagram such as illustrated in Fig. 2. It will be seen that the electrons which issue from a point of the cylinder playing the part of the cathode with directional speeds of different values form a sheet which fills up a large portion of the inner space of the cylinder. It follows therefrom that if the cylindrical cathode emits over the whole of its surface there is obtained in its interior an intersection of trajectories and an extremely large electronic stream. The number of the ionizing shocks will therefore be very high.

To give an example: For a cylindrical cathode of 30 mm. diameter and a central filament of 1 mm. diameter the favorable frequency is of the order of 100 megacycles. Experience shows on the other hand that even for a gas pressure of the order of 10^{-7} mm. of mercury a slight luminescence is visible which is a sure sign of ionization; and for a pressure of the order of 10^{-6} mm. of mercury the luminescence becomes very intense.

According to the invention in order that the whole of the cylinder shall be emitting it is constituted by a metal or an alloy having a high power of secondary emission. In these conditions the first electrons formed by the high frequency excitation traces of gas bombard the cylinder by following trajectories such as shown in Fig. 2; at the points of the impact new electrons are started which in their turn bombard the cylinder following trajectories analogous to the preceding ones; and so on until the whole of the surface of the cylinder is emitting. One thus finally obtains an ion generator of the cold cathode type with secondary emission.

The extraction of the ions is then effected in a very simple manner. Since there is no accelerating tension for the ions, which cannot follow the high frequency oscillations, these ions have no tendency to run towards the cathode; it suffices therefore to place at the end of the cylinder a grid maintained at a potential slightly negative relatively to the average potential of the electrodes to collect the ions. Such a grid is shown at 4 in Fig. 3, which grid is polarized by a generator 5.

The extraction of the ions may also be effected according to the invention by means of a focussing lens which makes use of the fact that the maximum ionizing zone is cylindrical around the central electrode. Referring to Fig. 4, this shows the zone 6 of maximum ionization and 7, 8 and 9 an electronic lens with three diaphragms biased by the source 5.

In all the arrangements the regulation of the intensity of the electronic beam is effected by acting either on the frequency or on the value of the high frequency tension applied to the electrodes.

I claim:

1. In an arrangement for the generation of ions in an enclosure of low gas pressure constituting the enclosure of utilization of the ions, comprising two electrodes disposed in said enclosure at least one of which is an electron emitter, a source of very high frequency connected across said electrodes for applying an alternating electric field between them, and means for collecting the ions, all of said means being disposed in the same enclosure.

2. An arrangement for the generation of ions as set forth in claim 1, wherein the period of the alternating field is substantially equal to the transit time of the electrons between the two electrodes.

3. An arrangement for the generation of ions as set forth in claim 1, wherein one of the electrodes completely surrounds the other.

4. An arrangement for the generation of ions as set forth in claim 1, wherein one of the electrodes is in the form of a cylinder and the other in the form of a stem disposed in the axis of said cylinder.

5. An arrangement for the generation of ions as set forth in claim 1, wherein one of the elec-

trodes is in the form of a metal cylinder having a high power of secondary emission.

6. An arrangement for the generation of ions in an enclosure of low gas pressure constituting the enclosure of utilization of the ions, comprising means of electron emission in this enclosure, means for their collection in the vicinity of one end of the said cylinder and transversely thereto, means for elongating the trajectories of the electrons between the points of emission and the points of collection, a grid maintained at a slightly negative potential in relation to the potential of the means of emission and of collection and disposed in the same enclosure, and a circuit of utilization of the ions connected with this grid.

7. An arrangement of ions in an enclosure of low gas pressure constituting the enclosure of utilization of the ions, comprising means of electron emission in this enclosure, means of their collection, means for elongating their trajectories between the points of emission and the points of collection, an electronic lens disposed in the same enclosure so as to channel the ions produced by the shocks of the electrons against the gaseous molecules, and a circuit of utilization of the ions connected with said lens.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,197,079	Penning	Apr. 16, 1940
2,285,622	Slepian	June 9, 1942
2,334,356	Salzberg et al.	Nov. 16, 1943