June 9, 1942. J. SLEPIAN 2,285,622

ION SOURCE

Filed June 14, 1940

Fig. 1.

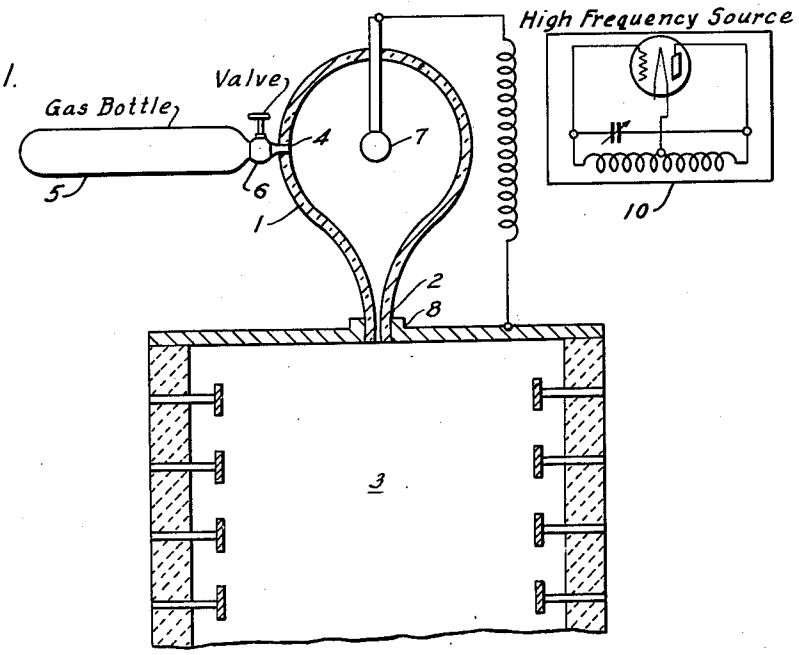
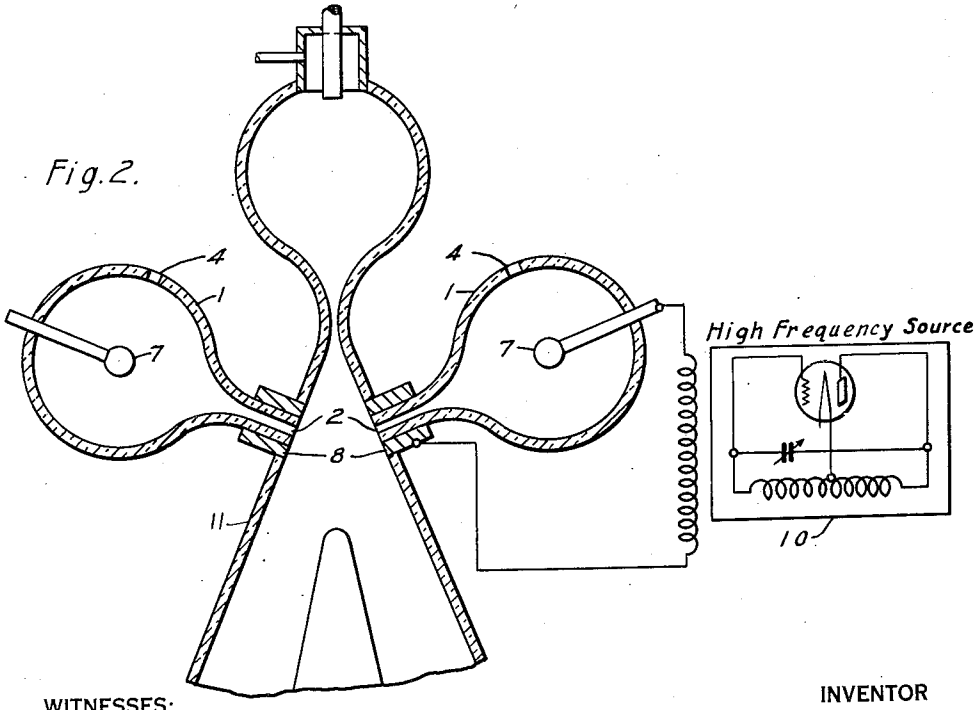


Fig. 2.



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ION SOURCE

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8 Claims. (Cl. 250—84)

My invention relates to an ion generator, and particularly to means for increasing the efficiency of such generators.

In the operation of certain devices, it is desirable to have a source of high energy ions for use in the operation of the device. Such ions have heretofore been produced by means of so-called ion sources in which an ionizable gas is subjected to an electric discharge, and the ions so generated are passed through a capillary tube into the utilizing device. In the heretofore known ion generators, a large proportion of the ions produced contact with the walls of the generator and are lost, while only a few pass through the capillary opening where they may do useful work.

According to my invention, the ionizing discharge is caused to take place within the capillary opening where it ionizes a stream of gas passing through the opening which carries substantially all of the ions thus generated into the space where they can do useful work. The ion generator according to my invention comprises a suitable discharge vessel constructed of insulating material having a capillary opening through which a suitable ionizable gas flows into the working space. A suitable electrode is provided within the generator chamber, and a second electrode is provided in capacitive relation to the insulating material forming the capillary discharge tube. A high frequency discharge is then maintained between the two electrodes so that the discharge flows through the capillary and ionizes the gaseous medium passing therethrough.

It is, therefore, an object of my invention to provide a high efficiency ion generator.

It is a further object of my invention to provide an electron generator in which the ions are generated in a gaseous medium as they flow from the generator.

Further objects and advantages of my invention will be apparent from the following detailed description taken in conjunction with the accompanying drawing, in which:

Figure 1 is a schematic illustration of an electron generator shown applied to an ion accelerating device; and

Fig. 2 is a similar illustration showing a plurality of ion generators applied to an electric generating device.

In the illustrative embodiment of my invention according to Fig. 1, the ion generator comprises a hollow chamber 1 made of suitable insulating material, such as glass or quartz, and having an outlet capillary tube of relatively small size which communicates with the suitable working passage herein illustrated as an ion accelerator or so-called atom-smasher 3. A small inlet passage or so-called leak 4 is provided in the side walls of the generator chamber 1, and a suitable ionizing gas, which may be air, hydrogen, argon, etc., is introduced through this leak 4, so that there is a flow of ionizable gas through the capillary outlet tube 2 into the working chamber 3 to which ions are to be supplied. If a gas other than air is to be utilized as the working medium, a suitable container 5 controlled by any suitable valve 6 may be connected to the leak 4 in the generating chamber 1. In any event, the flow of gas through the leak 4 is controlled to provide sufficient pressure in the generator chamber 1 to cause a flow of the gaseous medium through the capillary tube 2. A suitable discharge electrode 7 is placed within the generator chamber 1, and a second electrode 8 is placed in capacitive relation to the external portion of the capillary tube 2; preferably, this second electrode 8 being formed as a collar tightly surrounding the capillary tube 2.

The capillary tube 2 is constructed of an insulating material of high dielectric strength, such as quartz, and is made of a minimum thickness to increase the capacitive discharge effect of the second electrode 8. A suitable high-frequency source 10 is connected to these two electrodes 7 and 8 to produce a high-frequency discharge through the capillary opening 2. This discharge ionizes the gas flowing through the capillary 2; the ions being carried along by the flowing gas so that substantially all are carried into the working space and but a few lost to the wall of the capillary itself.

In the embodiment according to Fig. 2, a plurality of ion generators are shown connected to an electric generator 11 in which gases of combustion are expanded to low pressure and high velocity and then ionized as they pass into the working chamber of the generator. Because of the large number of ions required in the electric generator, I prefer to utilize a plurality of such ion generators.

While it is indicated above that I may use any suitable ionizing gas, I prefer to use deuterium (heavy hydrogen) as the ionizable medium where neutrons are desired to effect nuclear transformations.

In general, the formula for determining the constants of the various portions of the gener-

ator is as follows: i=capacity in farads × applied voltage × 2π frequency; the capacity=

$$\frac{Ac}{4\pi d}\times 10^{-12}$$

whene A is the area in square centimeters of the active surface of the capillary electrode 8; c is the dielectric constant of the capillary material; and d is the diameter in centimeters of the capillary opening 2.

Assuming that one milliampere of current is required and selecting a capillary wall thickness of one millimeter and applied voltage of 10,000 volts, then

$$10^{-3}=\frac{At}{2\pi d}\times 10^{-12}\times 10{,}000\times 2\pi F$$

F=12,500 cycles.

While for purposes of description I have shown and described a specific embodiment of my invention, it will be apparent that changes and modifications can be made therein without departing from the spirit of my invention or the scope of the appended claims.

I claim as my invention:

1. An ion generator for supplying high energy ions to a low pressure ion consuming device comprising a vitreous chamber, a source of heavy hydrogen connected to said chamber, a capillary tube outlet of dielectric material connecting said chamber to the consuming device, an electrode in said chamber, an electrode adjacent said outlet and a source of high frequency power connected to said electrodes for producing a high frequency discharge through said outlet.

2. An ion source comprising a chamber of insulating material, a tubular outlet of capillary dimensions, said tubular outlet being constructed of dielectric material, a source of ionizable gas connected to said chamber to cause a flow of gas through said outlet, an electrode in said chamber, an electrode surrounding said outlet, and means for producing a high frequency discharge between said electrodes to ionize the gas passing through said outlet.

3. An ion generator comprising a chamber of insulating material, a tubular outlet of small cross section area, said tubular outlet being constructed of insulating material, means for causing a flow of ionizable gas outward through said tubular outlet, an electrode in said chamber, an electrode in capacitive relation to said outlet, and means for producing a high frequency discharge between said electrodes for ionizing the gas flowing through said tubular outlet.

4. An ion generator comprising an insulating chamber, a tube of insulating material forming a tubular discharge opening in said chamber, means for introducing an ionizable gas into said chamber at sufficient pressure to insure the gas flowing through said discharge opening, an electrode external to said discharge opening, an electrode in said chamber and a source of high frequency power connected to said electrodes for producing a high frequency discharge for ionizing the gas passing through said discharge opening.

5. An ion generator for producing ions for use external to the ion generator comprising a chamber composed of insulating material, a leak in the side wall of said chamber to admit ionizable fluid thereto, a capillary tube of insulating material forming an outlet from said chamber and means for producing a high frequency discharge for ionizing the fluid passing through said capillary outlet.

6. An ion generator comprising a chamber, means for admitting gas into said chamber, a capillary tube of insulating material forming an outlet for permitting gas to flow from said chamber and means for ionizing the gas passing through the capillary tube.

7. An ion generator comprising a chamber, means for admitting gas into said chamber, a capillary tube of dielectric material forming an outlet for permitting gas to flow from said chamber, and high frequency discharge means for ionizing the gas passing through the capillary tube.

8. An ion generator comprising a capillary tube of insulating material, means for causing a flow of ionizable gas through said capillary tube and high frequency discharge means for ionizing the gas passing through said capillary tube.

JOSEPH SLEPIAN.