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Apparatus for Producing Ions

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WPI Class of 1908

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APPARATUS FOR PRODUCING IONS

Filed July 16, 1926

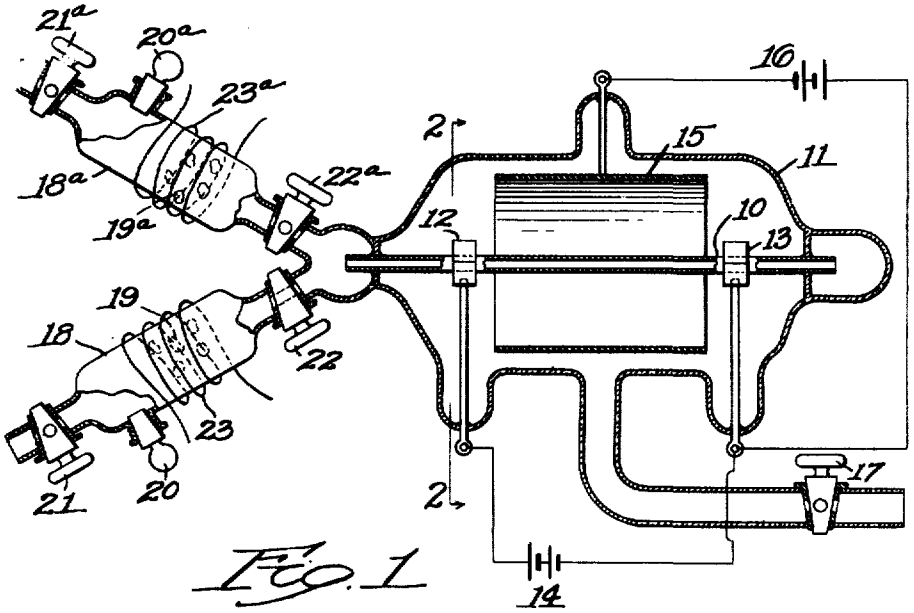


Fig. 1

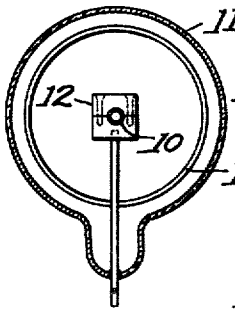
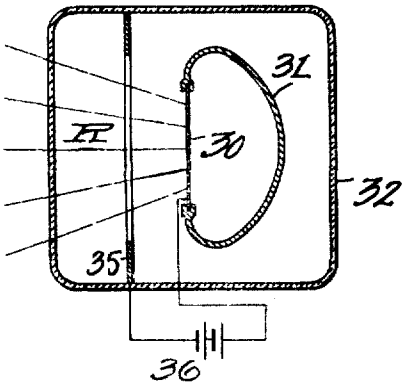


Fig. 2

Fig. 3



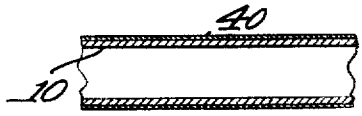


Fig. 4

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UNITED STATES PATENT OFFICE

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APPARATUS FOR PRODUCING IONS

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This invention relates to apparatus having electrodes which emit ions consisting of charged atoms or molecules, or groups of atoms and molecules, rather than electrons.

One important object of my invention is to provide an apparatus of this general type so designed that it may be continuously operated and that the supply of non-ionized material may be replenished without interrupting the operation of the apparatus.

Another object of the invention is to provide apparatus wherein a substance in the non-ionized state may be introduced at one side of a relatively thin electrode, or an electrode having a relatively thin wall portion, into which electrode or wall portion said material penetrates and from which it is finally liberated as ions at the other side thereof.

My invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

Two forms of the invention are shown in the drawings in which

Fig. 1 is a horizontal sectional view through one form of my improved apparatus;

Fig. 2 is a vertical sectional view, taken along the line 2—2 in Fig. 1;

Fig. 3 is a sectional elevation of a modified construction; and

Fig. 4 shows a further slight modification.

Referring to Figs. 1 and 2 in which a tubular electrode is employed, I have shown the electrode as preferably consisting of a thin platinum tube 10 mounted in a glass casing 11 and provided with terminals 12 and 13 through which a heating current may be supplied to the electrode 10 from a battery 14. This electrode acts as an anode and is advantageously employed in obtaining positive ions from the alkali metals such as potassium. The casing 11 also encloses a cathode which may be of any suitable form such as the hollow brass cylinder 15 which is shown in the drawings. A definite difference in potential between the anode 10 and the cathode 15 is maintained by a suitable current generator such as a battery 16. A stop cock 17 is provided through which the casing 11 may be exhausted.

In the preferred form of my apparatus, I have also provided one or more supply chambers 18, 18ª, each containing a portion of the metal 19 to be ionized, which may be introduced into the chamber by removing a stopper 20. The supply chamber may then be exhausted through a stop cock 21, after which communication with the electrode 10 in the casing 11 may be established by opening a second stop cock 22.

A heating coil 23, or any other convenient source of heat, is provided for vaporizing the metal 19 and the metallic vapor thus formed is conducted through the stop cock 22 to the inside of the platinum tube or electrode 10, where it is taken up by the platinum which it gradually penetrates, finally being liberated therefrom in the form of positive ions at the charged outer surface of the platinum tube.

By using a second supply chamber 18ª, the apparatus may be operated continuously as long as desired, without interrupting the operation thereof or substantially changing the degree of vacuum in the casing 11.

This second supply chamber 18ª contains a supply of potassium or other alkali metal 19ª, which may be placed therein by removing the stopper 20ª. Air may be exhausted from the chamber 18ª through the stop cock 21ª and communication with the casing 11 is established by opening the stop cock 22ª, all as previously described. A separate heating coil 23ª is also preferably provided. By using the supply chambers 18 and 18ª alternately, the operation of the apparatus may be continued indefinitely, fresh metal being placed in one supply chamber while the other chamber is operatively connected to the casing 11 and electrode 10.

This advantage of continuous operation of the apparatus herein described is not possessed by the apparatus heretofore commonly used, in which the electrodes consist of filaments or wires which are covered with a coating of a chemical compound or combination of elements which contain the substance to be

ionized. Such electrodes, when exhausted of ionizable material, must be replenished with a fresh coating of the chemical point or mixture, which replenishment necessitates a complete interruption of the operation of the apparatus.

A particular advantage of my invention, as herein described, lies in the fact that ions of a material having a low boiling point may be discharged from the electrode at a much higher temperature than could be employed if the ionizable substance were merely coated or deposited on the outer surface of the electrode. This higher temperature greatly decreases the proportion of uncharged atoms which will be emitted from the electrode.

While the apparatus shown and described in Figs. 1 and 2 has been found very satisfactory, the essential features of my invention may be embodied in substantially different form. In Fig. 3, I have shown the continuously acting electrode as made in the form of a thin plate or sheet 30 mounted in one side of a tubular support 31 within a vacuum casing 32. Heating of this thin plate electrode may be obtained by concentrating radiant energy R upon the electrode instead of by the use of electric current.

The cathode 35 may be of any suitable form connected electrically with the anode 30 through a battery 36. A continuous supply of metal to be ionized may be provided for the purpose shown in Fig. 3 by the use of one or more supply chambers (not shown) as in the previous form. The potassium vapor or other material supplied to the tube 10 (Fig. 1), or to the casing 31 (Fig. 3), may supplied at either high or low pressure as may be desired.

The partition or wall of the electrode may consist of more than one layer of material. Thus the platinum tube 10 in Figs. 1 and 2 may be covered on the outside with a coating of metal or chemical compounds such as is indicated at 40 in Fig. 4 and such as has been previously used for coating electrodes. One such material is potassium oxide which is preferably used when potassium is the metal to be ionized. This arrangement has the advantage that the ions are liberated at a comparatively low temperature compared with that required when a simple metallic electrode is used and it also has the advantage that the covering material does not become exhausted as in the usual form of apparatus but is apparently replenished from within the tube or behind the plate from the metallic vapor supplied thereto.

While the apparatus has been particularly described as applied to the production of positive ions, many features thereof are also applicable to the production of negative ions.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed otherwise than as set forth in the claims, but what I claim is:—

1. Apparatus for continuously producing ions comprising a vacuum casing, a cathode in said casing, an electrode mounted in said casing and having a relatively thin wall portion, and means to continuously supply ionizable material at one side of said wall portion, the ions to be liberated at the opposite side of said wall portion after penetrating through the material thereof, and means for replenishing said ionizable material from time to time during the continued operation of the machine.

2. Apparatus for continuously producing positive ions comprising a vacuum casing forming an outer cathode chamber, a tubular metallic electrode mounted within said casing and forming an inner vapor receiving chamber separated by the metallic wall of said tubular electrode from said outer chamber, said electrode being, a cathode in said casing, adapted to be heated and to be maintained at a definite potential, and means separate and additional to said tubular electrode effective to continuously supply metallic vapor to the inside of said tubular electrode.

3. Apparatus for continuously producing positive ions comprising a vacuum casing, a cathode in said casing, a tubular metallic electrode in said casing adapted to be heated and to be maintained at a definite potential, and means to continuously supply metallic vapor to the inside of said tubular electrode, said latter means comprising a supply chamber having a valved connection with said tubular electrode and having provision for filling and exhausting said chamber while shut off from said electrode.

4. Apparatus for continuously producing positive ions comprising a vacuum casing, a cathode in said casing, a tubular metallic electrode in said casing adapted to be heated and to be maintained at a definite potential, and means to continuously supply metallic vapor to the inside of said tubular electrode, said latter means comprising a pair of supply chambers each having a valved connection with said tubular electrode and each having provision for filling and exhaustion of said chamber while shut off from said electrode, said chambers being alternately operable during the continued operation of said electrode.

5. Apparatus for continuously producing ions comprising a vacuum casing, a cathode in said casing an electrode mounted in said casing and having a relatively thin wall portion, and means to continuously supply ionizable material at one side of said wall portion, the ions produced from said ionizable material on one side of said wall portion being thereafter liberated at the opposite side of said wall portion after penetrating through

the thickness and substance of said wall portion of said electrode, said electrode also having a coating of additional ionizable material applied to the liberating surface thereof.

6. Apparatus for continuously producing positive ions comprising a vacuum casing, a cathode in said casing, a tubular metallic electrode in said casing adapted to be heated and to be maintained at a definite potential, and means to continuously supply metallic vapor to the inside of said tubular electrode, said latter means comprising a supply chamber having a valved connection with said tubular electrode and having provision for filling and exhausting said chamber while shut off from said electrode, and also having provision for vaporizing the metallic ionizable material contained within said supply chamber.

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