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Kondo et al.

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[54] **ION SOURCE DEVICE HAVING CONTROL MEANS FOR REDUCING FILAMENT CURRENT BELOW ITS STARTING VALUE**

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[52] **U.S. Cl.**.....**315/74**, 315/107, 315/DIG. 5

[51] **Int. Cl.**.....**H01j 33/00**

[58] **Field of Search**.....315/107, 106, 74, DIG. 5; 313/197, 198

[56] **References Cited**

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[57] **ABSTRACT**

An ion source device of the Duoplasmatron type has a current reduction resistor in the filament circuit thereof for reducing the filament current during steady state operation thereof, and a relay adapted to normally short-circuit both terminals of the current reduction resistor, which relay is energized by a current flowing through an intermediate electrode circuit so as to open both of these terminals of the resistor thereby making it possible to reduce the steady state filament current.

6 Claims, 2 Drawing Figures

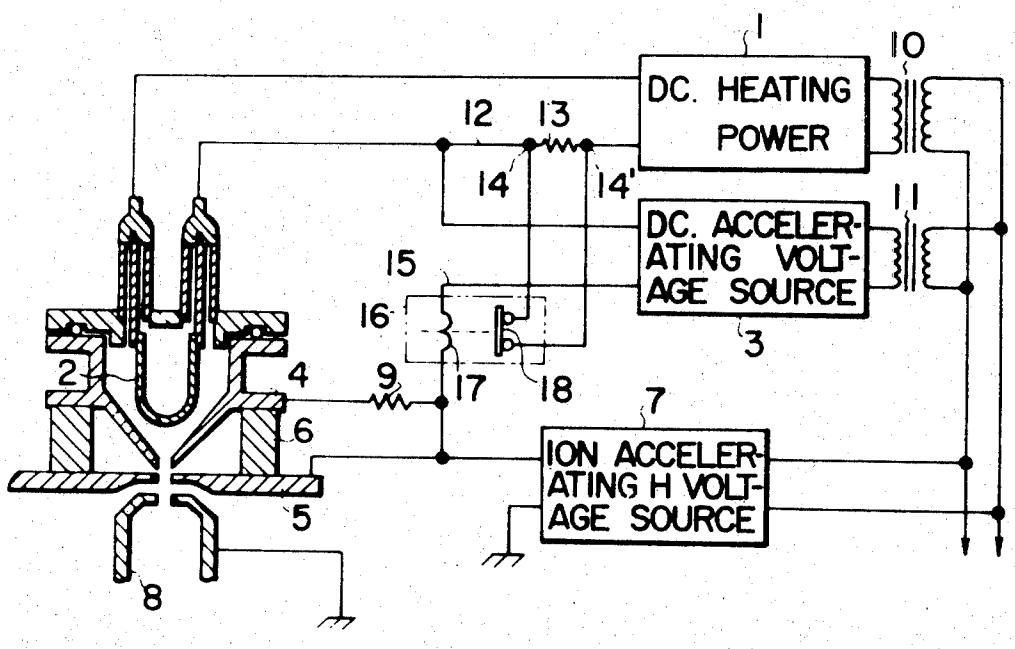


FIG. 1

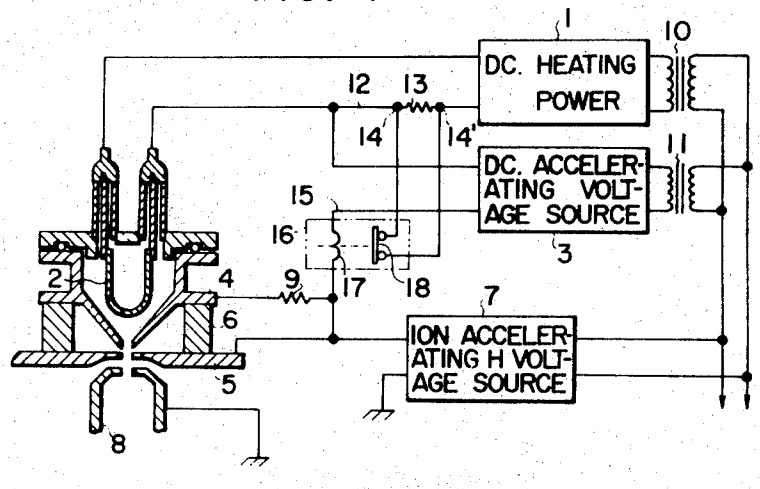
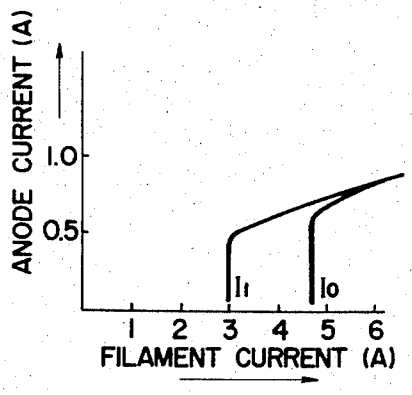


FIG. 2



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ION SOURCE DEVICE HAVING CONTROL MEANS FOR REDUCING FILAMENT CURRENT BELOW ITS STARTING VALUE

This invention relates to an ion source device for an ion microanalyzer and the like and, more particularly, to an ion source device of the Duoplasmatron type having means for reducing the filament current during steady state operation thereof.

BACKGROUND OF THE INVENTION

As is well known, an ion source device of the Duoplasmatron type is used in an ion microanalyzer Hitherto, such an ion source device has been constructed so that the value of the minimum steady state filament current for maintaining the discharge which occurs therein is larger than that of the starting filament current for causing initiation of said discharge.

However, since an ion current flows in the filament of said ion source device, it is possible to maintain the discharge even if the value of the minimum steady state filament current is less than that of the starting filament current. Therefore, it is apparent that in such conventional devices the steady state filament current has an unnecessarily large value and thus the life of the filament therein becomes very short.

SUMMARY OF THE INVENTION

An object of this invention is to provide means for making it possible to reduce the steady filament current in an ion microanalyzer of the type described.

This invention is characterized in that a current reduction resistor is inserted in the filament heating circuit and switching means is arranged so as to short-circuit both terminals of the reduction resistor. With a view to function, when said discharge occurs, the switching means is energized by a current flowing through an intermediate electrode circuit which causes both terminals to open so that the filament current flows through the current reduction resistor and the steady state filament current for maintaining discharge is reduced.

This and other objects, advantages and features of the present invention will become more apparent from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic circuit diagram indicating an embodiment of this invention.

FIG. 2 shows the relationship between filament current and anode current in an ion source device.

DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. 1, a filament 2 is connected to a d. c. heating power source 1 which provides heater current thereto, and a d. c. accelerating voltage source 3 is connected between an intermediate electrode 4 and the filament 2 so as to accelerate electrons emitted from said filament.

A magnet 6 made of ferrite is disposed between said intermediate electrode 4 and an anode 5 so as to insulate these elements and to concentrate the electrons in the space therebetween. A gas having a constant quantity is supplied to a space adjacent to said intermediate electrode 4 by proper means (not shown) and ionized as a result of discharge occurring due to impingement with said electrons.

An ion accelerating high voltage source 7 is connected between said anode 5 and an extractor 8 so that the ions are extracted therefrom by said extractor 8 and further are introduced into an ion microanalyzer (not shown) so that the ions are directed to a speciment in a known manner. Moreover, a resistor 9 is inserted in said intermediate electrode circuit.

Both secondary windings of the insulating transformers 10 and 11 are connected to the respective inputs of the power sources 1 and 3, and both primary windings thereof are connected to an a. c. power source (not shown).

In the ion source device as above-described, there is a relationship between the filament current and the anode current as shown in FIG. 2. As is apparent from said relationship, even if the minimum steady filament current I_1 is less than the starting filament current I_0, discharge caused to occur once can be maintained.

According to this invention, in order to attain a reduction in the steady filament current, a current reduction resistor 13 and a relay 16 having an exciting coil 17 and a contact 18 are disposed in the system, in addition to the above-described elements. The current reduction resistor 13 is inserted in the filament circuit 12, the exciting coil 17 is inserted in an intermediate electrode circuit 15 and the contact 18 is selectively connected between the terminals 14 and 14′ of the reduction resistor 13 to provide an open or short-circuit therebetween. Further, relay 16 is adapted to normally short-circuit both terminals 14 and 14′ of the reduction resistor 13 when a current does not flow through the circuit 15, namely, the contact 18 is a so-called "break" contact which remains closed when the relay 16 is not energized.

Now, when the filament current whose value is larger than that of said starting filament current is applied to said filament 2, a discharge begins. As a result of said discharge, the current flows through the circuit 15 and energizes the relay 16, so that the contact 18 opens and the filament current flows through the reduction resistor 13. Consequently, the value of the filament current becomes less than that of the starting filament current. The contact 19 is kept in the open state during further operation of the ion source device.

According to this invention, since it is possible to reduce the filament current during steady state operation of said ion source device, the life of the filament can be extended remarkably as compared with the prior art.

While we have shown and described one embodiment in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to a person skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

We claim:

1. In an ion source device for an ion micro-analyzer and the like comprising

a filament for emitting electrons,

an intermediate electrode for accelerating said electrons emitted from said filament,

a heating power source connected in circuit to said filament for supplying a filament current to said

filament at a starting value necessary to initiate a gaseous discharge in the space adjacent said intermediate electrode,

a first voltage source connected between said filament and said intermediate electrode,

anode means for accelerating ions produced in the space adjacent said intermediate electrode,

a magnet disposed between said intermediate electrode and said anode for concentrating said ions, and

an extractor of said ions and a second voltage source connected between said extractor and said anode,

the improvement which comprises filament current control means responsive to a discharge current flowing from said first voltage source to said intermediate electrode for reducing and maintaining said filament current at a lesser value than said starting value, which lesser value is still sufficient to maintain said discharge.

2. The combination defined in claim 1, wherein said filament current control means includes switching means for selectively increasing the resistance of said filament circuit in response to detection of said discharge current.

3. The combination defined in claim 1, wherein said magnet is made of an electrical insulating material and is disposed in contact with said intermediate electrode and said anode.

4. The combination defined in claim 1, wherein said filament current control means includes a current reduction resistor connected in series between said filament and said heating power source, and switching means normally short-circuiting said current reduction resistor for removing said short-circuit in response to said discharge current, so as to reduce said filament current in the steady operating state of said device.

5. The combination defined in claim 4, wherein said switching means includes a movable switch contact normally connected across said current reduction resistor and an operating winding connected between said first voltage source and said intermediate electrode for actuating said movable switch contact when energized by current flow.

6. The combination defined in claim 5, wherein said magnet is made of an electrical insulating material and is disposed in contact with said intermediate electrode and said anode.

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