United States Patent

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[33] **Japan**
[31] **44/72604 and 44/105851**

[54] **SURGE REDUCTION RESISTORS BETWEEN A HIGH-VOLTAGE SOURCE AND AN ELECTRON MICROSCOPE ELECTRON GUN**
3 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **250/49.5 A,** 307/93, 317/61.5, 328/259, 338/21

[51] **Int. Cl.** **H01j 37/26**

[50] **Field of Search** ..... 250/49.5 R, 49.5 A; 307/93; 315/291; 317/61.5; 328/259; 338/21, 216

[56] **References Cited**

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ABSTRACT: A resistance for adjusting the bias voltage is provided in a high voltage source, a high DC voltage being applied to the resistance, and the high DC voltage and bias voltage are applied to the filament and Wehnelt electrode, respectively, of an electron gun in an electron microscope through a high-voltage cable including two core lines whose resistance value is high enough to reduce surge voltage.

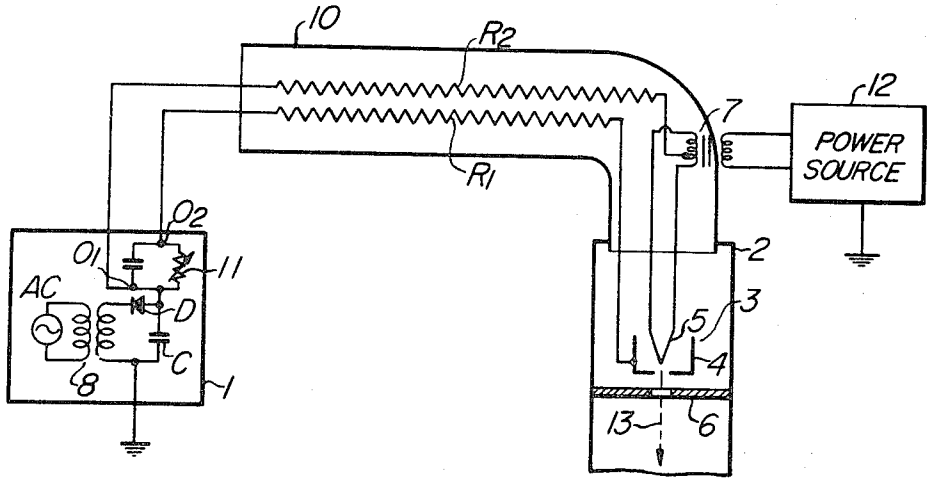


FIG. 1

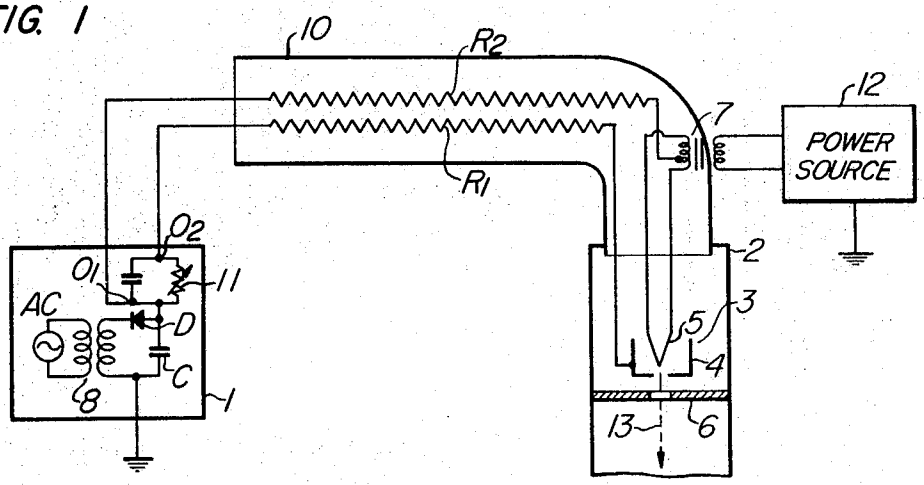


FIG. 2

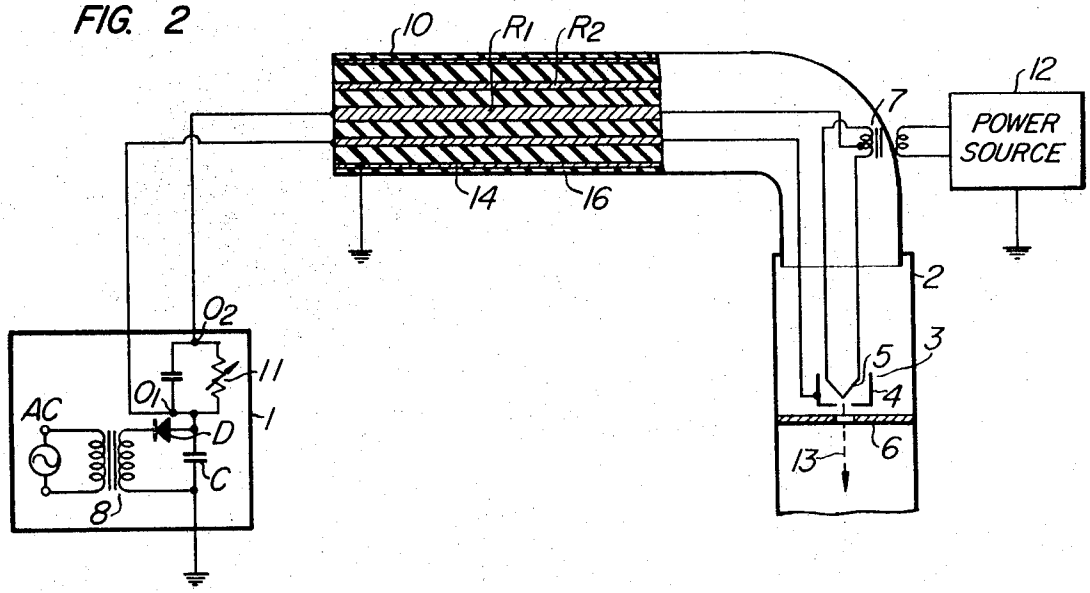
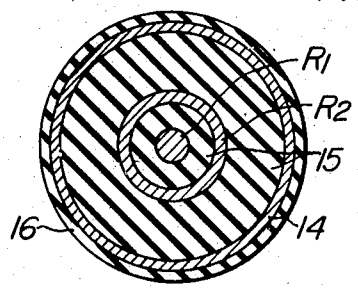


FIG. 3



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SURGE REDUCTION RESISTORS BETWEEN A HIGH-VOLTAGE SOURCE AND AN ELECTRON MICROSCOPE ELECTRON GUN

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to improvements in the structure of apparatus for supplying a high DC voltage and a bias voltage to an electron gun in an electron microscope and the like.

2. Description of the Prior Art

As is commonly known, the accelerating voltage in modern electron microscopes is generally higher than 1 million volts, and thus it is common practice to dispose the high-voltage source and the electron microscope independently of each other and to connect them by means of a high-voltage cable in view of the desired simplicity of manipulation, the problem of disturbance with respect to the electron beam, the simplification of the structure and other problems.

Heretofore, a bias resistance has been disposed in the vicinity of the electron gun in electron microscopes in order to adjust the bias voltage applied to the Wehnelt electrode of the electron gun. The prior art arrangement described above has involved the danger that the bias resistance may be damaged by a surge voltage generated as a result of a discharge occurring in the electron gun. Further, the disposition of such a part in the vicinity of the electron gun has been undesirable in that the structure of the apparatus becomes complex resulting in handling difficulties.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to prevent the bias resistance from being destroyed by the surge voltage.

Another object of the present invention is to prevent the undesirable destruction of the bias resistance by employing a high-voltage cable including a plurality of core lines whose resistance value is high enough to quickly reduce the surge voltage.

A further object of the present invention is to provide a high-voltage cable of the kind described above which has a distributed capacitance so as to give the high-voltage cable an additional function of eliminating the ripple component in the high DC voltage supplied from a high-voltage source.

In accordance with the present invention which attains the above objects, there is provided an apparatus for supplying high voltage from a high-voltage source to an electron gun in an electron microscope and the like which comprises a high-voltage source having a high DC-voltage-producing means and a variable bias resistance connected to said high DC-voltage-producing means for producing an adjustable bias voltage; a high-voltage cable including at least two core lines therein, the impedance of each said core line being larger than the surge impedance; and an electron beam device having an electron gun composed of a filament, a Wehnelt electrode and an anode, said filament being connected to said high DC-voltage-producing means through one of said two core lines and said Wehnelt electrode being connected to said bias resistance through the other of said two core lines.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of an embodiment of the present invention.

FIG. 2 is a diagrammatic view of another embodiment of the present invention.

FIG. 3 is an enlarged schematic sectional view of one form of the coaxial high-voltage cable employed in the embodiment shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a high DC voltage source 1 includes a high-voltage transformer 8, a diode D, a condenser C, an AC power source AC and a variable bias resistance 11. A high DC voltage generated by the high DC voltage source 1 appears at a terminal 0_1. A column 2 of an electron microscope contains

therein an electron gun 3 which comprises a filament 5, a Wehnelt electrode 4 and an anode 6. The high DC voltage is applied to the variable bias resistance 11 so that a desired bias voltage appears at a terminal 0_2 by suitably adjusting the bias resistance 11.

A high-voltage cable 10 includes two core lines R_1 and R_2 whose resistance value is high enough to reduce the surge voltage. The core line R_1 connects the output terminal 0_2 of the bias resistance 11 with the Wehnelt electrode 4, while the core line R_2 connects the terminal 0_1 with the neutral point n of a bushing transformer 7. The bushing transformer 7 is built in the high-voltage cable 10 in the vicinity of the electron gun 3. A power source 12 supplies heating power to the filament 5 through the bushing transformer 7 to cause emission of an electron beam from the filament 5. The electron beam 13 emitted from the filament 5 varies depending on the bias voltage applied to the Wehnelt electrode 4 and can therefore be controlled by adjusting the bias resistance 11. The core lines R_1 and R_2 have a resistance value which is about 10 times the surge impedance of the order of 50 to 100 ohms. However, due to the fact that the bias resistance 11 has a resistance value of the order of several 10 megohms, the resistance value of the core line R_1 does not adversely affect the adjustment of the bias voltage.

It will be readily seen that the above arrangement provides many advantages. One advantage of the above arrangement is that the bias resistance 11 and other parts in the high-voltage source 1 are prevented from being damaged by the surge voltage generated due to discharge within the electron gun because the surge voltage is quickly reduced by the core lines R_1 and R_2. Another advantage resides in the fact that, since the bias resistance and other parts are not disposed in the vicinity of the electron gun 3, the high-voltage cable 10 and the electrodes in the electron gun 3 can be integrally combined to provide an apparatus which is very compact in construction and can be easily handled.

Another embodiment of the present invention shown in FIG. 2 is generally similar to that shown in FIG. 1 except that it employs a coaxial high-voltage cable as shown in FIG. 3. Referring to FIGS. 2 and 3, coaxial core lines R_1' and R_2' serve the same purpose as that served by the core lines R_1 and R_2 shown in FIG. 1. A conductive member 14 surrounds the coaxial core lines R_1' and R_2', and a uniform capacitance Cs is distributed between the conductive member 14 and the coaxial core lines R_1' and R_2'. Reference numerals 15 and 16 designate layers of electrically insulating material. The conductive member 14 is grounded, and the capacitance Cs has a value of the order of 200 to 1,000 pf.

With an arrangement as shown in FIG. 2, it is also possible to quickly reduce the surge voltage generated due to discharge in the electron gun. According to this embodiment, a low-pass filter is formed by the resistance of the coaxial core lines and the distributed capacitance Cs so that the ripple component contained in the high DC voltage delivered from the high-voltage source 1 can be naturally removed. Therefore, the filter frequently employed heretofore is unnecessary.

We claim:

1. Apparatus for supplying high voltage from a high-voltage source to an electron gun in an electron microscope and the like comprising a high-voltage source having high DC-voltage-producing means and a variable bias resistance connected to said high DC-voltage-producing means for producing an adjustable bias voltage; a high-voltage cable including at least two core lines therein, the impedance of each said core line being larger than the surge impedance; and an electron beam device having an electron gun composed of a filament, a Wehnelt electrode and an anode, said filament being connected to said high DC-voltage-producing means through one of said two core lines and said Wehnelt electrode being connected to said bias resistance through the other of said two core lines.

2. Apparatus according to claim 1, wherein said high-voltage cable comprises at least two coaxial core lines.

3. Apparatus according to claim 2, wherein said coaxial core lines are covered by a conductive member.