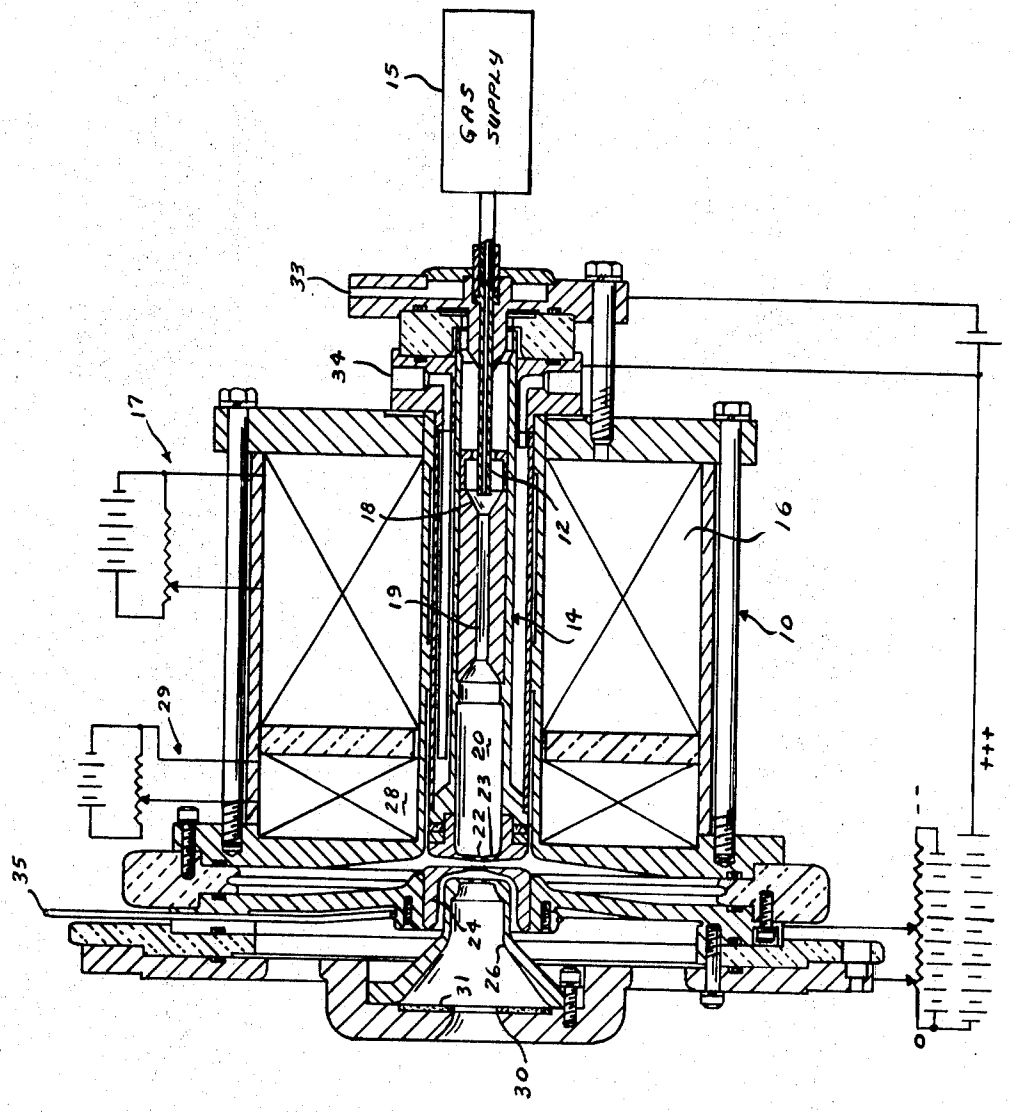
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HIGH YIELD ION SOURCE

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HIGH YIELD ION SOURCE

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ABSTRACT OF THE DISCLOSURE

A gas such as hydrogen or a mixture of gases is supplied to an arc region to produce an ion stream. A first magnet to provide optimum ionization in the arc region. An enlarged space is provided near the exit aperture of the diode structure to provide low energy secondary electrons to provide space charge neutralization. A second adjustable magnet operated in an aiding sense to the first magnet is provided near the enlarged space near the exit aperture which, because of the space charge neutralization, can be adjusted to provide greatly increased yields with focusing being maintained within the desired limits.

BACKGROUND OF THE INVENTION

Magnetic fields have been used with ion sources for various purposes. One of these is to constrain electrons to paths along magnetic lines which results in greater ion efficiency. In these systems, focusing and shaping of the plasma front from which ions are extracted has been accomplished by the use of shaped extraction electrodes made of materials with various permeabilities. With these devices the extraction geometries are fixed.

SUMMARY OF THE INVENTION

According to this invention a second shaping magnet is provided which permits the extraction front geometry to be changed so that optimum yields and focusing may be obtained. Also a large space is provided within the anode structure together with an exit aperture scaled in size so that the fringe of the ion beam strikes the edge of the electrode to provide low energy secondary electrons. These electrons drift slowly toward the decelerating electrode and because of their slow velocity contribute to space charge neutralization. This provides better focus control and larger yields.

BRIEF DESCRIPTION OF THE DRAWING

The single figure is a partially schematic sectional view of an ion source according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is now made to the drawing which shows an ion source **10** having a hollow cathode **12** and an anode shown generally at **14**. A gas, for example a mixture of hydrogen, deuterium, tritium and helium, is supplied to the cathode **12** from gas supply **15**. A first electromagnet **16** with a variable power supply **17** acts to constrain the electrons in the region between hollow cathode **12** and the anode **14**, to paths along the magnetic field lines which results in greater ion efficiency. The ions leaving the constrictured portion **19** of anode **14** enter an enlarged electric field free volume **20** adjacent the anode exit aperture **22**. The ions are extracted through aperture **22** in the closure member **23** by means of an extractor electrode

24 and are then focused by means of a decelerating field between electrode **24** and a decelerating electrode **26**. A second electromagnet **28** supplied from a variable source **29** in an aiding relation to magnet **16** acts to shape the plasma front. A halo baffle **30** with a graphite insert **31** is provided in the output of the ion source adjacent decelerating electrode **26**. Conventional cooling is provided by supplying coolant to inlets **33**, **34** and **35**.

In the operation of the device, the gas is admitted to cathode **12** from supply **15** and is ionized by the arc discharged between the anode and cathode in the conventional manner. The magnet **16** is adjusted for optimum ionization efficiency in the arc region. The second magnet **28** is adjusted to shape the plasma front to obtain optimum yields and focusing. The enlarged electric field free volume **20** permits spreading of the ions so that some of the ions strike the closure member **23** around aperture **22** and cause the emission of low energy secondary electrons. These secondary electrons drift slowly toward the delecerating electrodes **26** and contribute to space charge neutralization. This permits greatly increased yields due to the use of the separate shaping magnet which can be adjusted to optimize yields with focus being maintained within the desired limits.

There is thus provided an ion source capable of providing variable extraction geometries and improved yields and focusing of the ion beam.

While a certain specific embodiment has been described, it is obvious that numerous changes may be made without departing from the general principles and scope of the invention.

I claim:

1. A high yield ion source for providing a high density ion beam comprising: means for providing an arc discharge, means for supplying an ionizable gas to said arc discharge; a first electromagnetic means for providing an axial magnetic field in the region of said arc discharge; means for adjusting the strength of said magnetic field for maximum ionization efficiency in the arc region; said means for providing an arc discharge including an anode having a constricted channel portion and an aperture of predetermined size through which ions may be extracted from said arc region; means including an extracting electrode for extracting a beam of ions through said apertures; means including said extracting means for electrostatically focusing the ions extracted through said aperture; means including an enlarged portion within said anode adjacent said aperture responsive to a portion of the ions within said anode for supplying secondary electrons to the ion beam leaving said aperture to thereby provide space charge neutralization within the ion beam; a second electromagnetic means, surrounding said anode adjacent said aperture, for shaping the ion beam for maximum extraction efficiency and focusing; means connected to the second electromagnetic means for adjusting the field strength of the second electromagnetic means in aiding relation to said first electromagnetic means.

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