

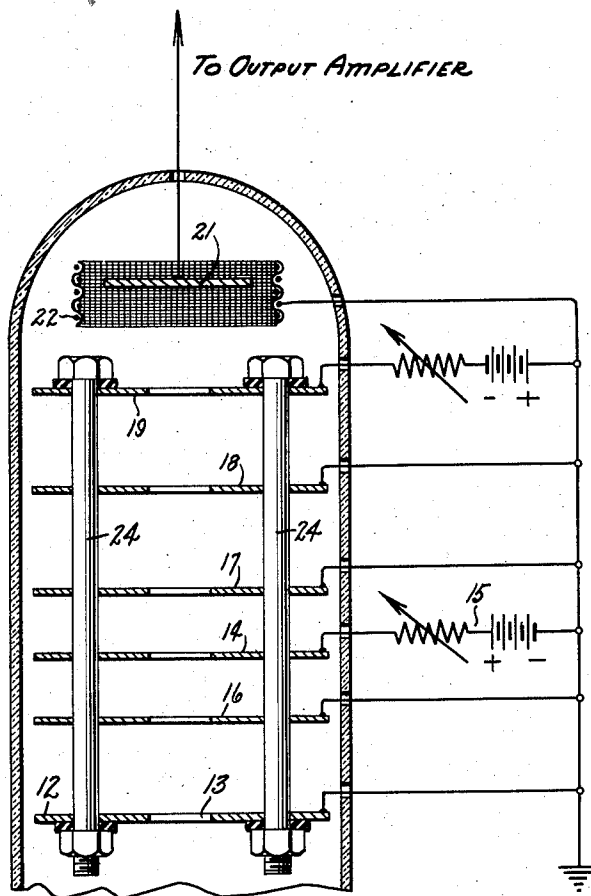
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VARIABLE RESOLVING SLIT COLLECTOR FOR MASS SPECTROMETER

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VARIABLE RESOLVING SLIT COLLECTOR FOR MASS SPECTROMETER

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This invention relates to mass spectrometers.

The performance of a mass spectrometer is dependent on the width of a slit situated in front of the detector and usually termed the "resolving slit." The width of this slit partly determines the resolving power of the instrument since the narrower the slit the greater is the resolution of the instrument.

The main object of the invention is to provide means whereby the effective width of the slit may be varied from positions external of the instrument.

According to the present invention the versatility of a mass spectrometer is increased by the use of an electrostatic resolver located in front of the detector, which resolver comprises a plurality of similar slit apertured diaphragms disposed along the path of the ion beam and means for applying an adjustable steady potential between said diaphragms so as to produce an electrostatic field whereof the cross-sectional width effective to pass the ion beam may be varied by varying said applied steady potential.

According to a preferred embodiment a slit apertured diaphragm is maintained at a potential which is positive with respect to similar slit apertured diaphragms preceding it and following it along the path of the ion beam so as to produce an electrostatic lens, whereof only the central cross-sectional part is effective to pass the ion beam and the width of which central part may be varied by adjusting the potential of said positive diaphragm relative to the preceding and succeeding diaphragms.

In carrying out the invention the electrostatic lens so formed preferably operates in conjunction with a limiting slit which is, in effect, a further slit diaphragm maintained at earth potential and located between the electrostatic lens and the detector. In such a case varying the potential of the centre diaphragm of the electrostatic lens varies the focal length of the lens. Such a variation of the focal length enables the cross-sectional width effective to pass the beam to be varied over a range determined by the design of the lens, the separation between the lens and limiting slit, and the width of the limiting slit.

According to one such specific embodiment of the invention the resolver comprises first an entrance slit which is a slit apertured diaphragm 12 located in front of the lens and having a slightly narrower slit 13, then the electrostatic lens which comprises a mid-diaphragm 14 which is insulated and connected to an adjustable positive potential source 15, together with a pair of earthed diaphragms 16 and 17 located in front of and after the high voltage diaphragm; these last two diaphragms may be kept at earth potential. Following the electrostatic lens is the limiting slit 18, above referred to, then a further slit diaphragm 19 maintained at a small negative potential which acts as an electron suppressor, and finally a collector disc 21 which is surrounded by a tubular earthed screen 22.

The effect of the electron suppressor 19 is to reduce

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the number of secondary electrons, caused by positive ion bombardment, which arrive at, or escape from the collector 21. The screen 22 around the collector is a metal partition which reduces interaction between the detector circuit and the high voltage supply.

It will be appreciated that normal construction methods may be employed and the diaphragms may be carried on axially extending supporting rods 24, which can pass through apertures in the diaphragms in cases in which it is not desired to make electrical connection.

As an example of carrying out the invention it was found that when operating the spectrometer with a 2000-volt ion beam the effective width of the resolving slit could be varied between the limits 0.010" and 0.040" by varying the voltage on the centre diaphragm of the electrostatic lens between 1360 and 1950 volts. In such a case the electron suppressor could be, for example, of 250 volts.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An ion collector assembly for a mass spectrometer comprising a collector electrode adapted to be disposed in an ion beam path comprising a multiplicity of ion groups of different mass-to-charge ratio, a variable focus electrostatic lens assembly positioned along the ion beam path ahead of said collector electrode to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate the collector electrode and said electrostatic lens assembly, and means for adjusting the focal length of said electrostatic lens assembly whereby only selected ones of said ion groups pass through said beam limiting aperture to said collector and the remaining ones are intercepted by said diaphragm.

2. An ion collector assembly for a mass spectrometer comprising a collector electrode adapted to be disposed in an ion beam path comprising a multiplicity of ion groups of different mass-to-charge ratio, a variable focus electrostatic lens assembly positioned along the ion beam path ahead of said collector disc electrode to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate the collector electrode and said electrostatic lens assembly, and means for supplying an adjustable value steady potential of a magnitude less than the ion accelerating voltage to the electrostatic lens assembly for controlling the focal length thereof to thereby control the effective size of the ion beam impinging on said collector whereby only selected ones of said ion groups pass through said beam limiting aperture to said collector and the remaining ones are intercepted by said diaphragm.

3. An ion collector assembly for a mass spectrometer including a collector electrode adapted to be disposed in the ion beam path of a mass spectrometer which beam comprises a multiplicity of ion groups of different mass-to-charge ratio, a variable focus electrostatic lens assembly comprising a plurality of apertured diaphragms disposed along the ion beam path to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate said collector and said electrostatic lens assembly, and means for applying an adjustable value steady potential of a magnitude less than the ion accelerating voltage between the diaphragms of said electrostatic lens assembly for controlling the focal length thereof to thereby control the cross-sectional width of the apertures in said diaphragms effective to pass the ion beam whereby only selected ones of said ion groups pass through said beam limiting aperture to said collec-

tor and the remaining ones are intercepted by said diaphragm.

4. An ion collector assembly for a mass spectrometer including a collector electrode adapted to be disposed in the ion beam path of a mass spectrometer which beam comprises a multiplicity of ion groups of different mass-to-charge ratio, a variable focus electrostatic lens assembly comprising a plurality of apertured diaphragms disposed along the ion beam path to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate said collector and said electrostatic lens assembly, and means for applying an adjustable value steady state positive potential of a magnitude less than the ion accelerating voltage to one of the diaphragms of said electrostatic lens assembly for controlling the focal length of the lens assembly to thereby control the cross-sectional width of the apertures in said diaphragms effective to pass the ion beam whereby only selected ones of said ion groups pass through said beam limiting aperture to said collector electrode and the remaining ones are intercepted by said diaphragm.

5. An ion collector assembly for a mass spectrometer comprising a collector electrode adapted to be disposed in an ion beam path comprising a multiplicity of ion groups of different mass-to-charge ratio, a first diaphragm positioned along the ion beam path and having an entrance slit therein for accommodating the ion beam, a variable focus electrostatic lens assembly comprising three apertured diaphragms aligned along the ion beam path intermediate the collector and said first diaphragm to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate the collector and said electrostatic lens assembly, and means for applying an adjustable value steady potential of a magnitude less than the ion accelerating voltage between the diaphragms of said electrostatic lens assembly for controlling the focal length thereof to thereby control the cross-sectional width of the apertures in said diaphragms effective to pass the ion beam whereby only selected ones of said ion groups pass through said beam limiting apertured diaphragm to said collector and the remaining groups are intercepted by said diaphragm.

6. An ion collector assembly for a mass spectrometer comprising a collector electrode adapted to be disposed in an ion beam path comprising a multiplicity of ion groups of different mass-to-charge ratio, a first diaphragm positioned along the ion beam path and having an entrance slit therein for accommodating the ion beam, a variable focus electrostatic lens assembly comprising three apertured diaphragms aligned along the ion beam path intermediate the collector and said first diaphragm to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm posi-

tioned along the ion beam path intermediate the collector and said electrostatic lens assembly, means for connecting said first diaphragm, said beam limiting diaphragm and the two end diaphragms of said electrostatic lens assembly to a source of reference potential, and means for applying an adjustable value steady state positive potential of a magnitude less than the ion accelerating voltage to the middle one of the three aligned diaphragms of said electrostatic lens assembly for controlling the focal length of the lens assembly to thereby control the cross-sectional width of the apertures in said diaphragms effective to pass the ion beam whereby only selected ones of said ion groups pass through said beam limiting apertured diaphragm to said collector and the remaining ones are intercepted by said diaphragm.

7. An ion collector assembly for a mass spectrometer comprising a collector electrode adapted to be disposed in an ion beam path comprising a multiplicity of ion groups of different mass-to-charge ratio, a first diaphragm positioned along the ion beam path and having an entrance slit therein for accommodating the ion beam, a variable focus electrostatic lens assembly comprising three apertured diaphragms aligned along the ion beam path intermediate the collector and said first diaphragm to control the degree of convergence of the ion groups constituting said beam, a beam limiting apertured diaphragm positioned along the ion beam path intermediate the collector and said electrostatic lens assembly, means for connecting said first diaphragm, said beam limiting diaphragm and the two end diaphragms of said electrostatic lens assembly to a source of reference potential, means for applying an adjustable value steady state potential of a magnitude less than the ion accelerating voltage to the middle one of the three aligned diaphragms of said electrostatic lens assembly for controlling the focal length of the lens assembly to thereby control the cross-sectional width of the apertures in said diaphragms effective to pass the ion beam whereby only selected ones of said ion groups pass through said beam limiting apertured diaphragm to said collector and the remaining ones of said paths are intercepted by said beam limiting diaphragm, and a suppressor diaphragm having an aperture therein for accommodating the ion groups passing through said beam limiting apertured diaphragm and an adjustable value steady state negative potential supplied thereto positioned intermediate the collector disc and the beam limiting diaphragm.

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