VARIABLE RESOLVING-SLIT COLLECTOR FOR
MASS SPECTROMETER

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Application September 24, 1954, Serial No. 458,069
Claims priority, application Great Britain
September 30, 1953
7 Claims. (Cl. 250—41.9)

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 to the instrument.

According to the present invention the versatility of
a mass spectrometer is increased by the use of an electro-
static resolver located in front of the detector, which
resolver comprises a plurality of similar slit aperture
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 aperture
diaphragm is maintained at a potential which is positive
with respect to similar slit aperture diaphragms pre-
ceding 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 vary-
ing the potential of the centre diaphragm of the electro-
static 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 separa-
tion 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 aperture 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 dia-
aphragms 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 sup-
pressor, and finally a collector disc 21 which is sur-
rounded by a tubular earthed screen 22.

The effect of the electron suppressor 19 is to reduce
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-
volttion 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
case the electron suppressor could be, for example,
of 250 volts.

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 aperture diaphragm posi-
tioned along the ion beam path intermediate the collect-
ator 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 electrode 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 electro-
static 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 aperture diaphragm positioned
along the ion beam path intermediate the collector elec-
trode and said electrostatic lens assembly, and means for
supplying an adjustable value steady potential of a magni-
tude less than the ion accelerating voltage to the electro-
static 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
one of said ion groups pass through said beam limiting aperture to said collector electrode 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 aperture diaphragm positioned along the ion
beam path intermediate said collector and said electro-
static lens assembly, and means for applying an adjust-
able 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 electrostatic lens assembly 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 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.

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 positioned along the ion beam path intermediate the collector and said electrostatic lens assembly, and 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 diaphragms 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 to the positioned intermediate the collector disc and the beam limiting diaphragm.

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