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Spangler

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[54] **ION MOBILITY STORAGE TRAP AND METHOD**

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[52] **U.S. Cl.** **250/287**; 250/282

[58] **Field of Search** 250/287, 282, 250/292, 281

[56] **References Cited**

U.S. PATENT DOCUMENTS

Re. 34,000	7/1992	Syka et al. .	
2,939,952	6/1960	Paul et al. .	
2,950,389	8/1960	Paul et al. .	
3,699,333	10/1972	Cohen et al. .	
4,390,784	6/1983	Browning et al. .	
4,540,884	9/1985	Sptafford et al. .	
4,736,101	4/1988	Syka et al. .	
4,855,595	8/1989	Blanchard	250/287
4,882,484	11/1989	Franzen et al. .	
4,975,577	12/1990	Franzen et al. .	
5,028,777	7/1991	Franzen et al. .	
5,170,054	12/1992	Franzen .	
5,180,914	1/1993	Davis et al.	250/287
5,200,614	4/1993	Jenkins .	
5,283,436	2/1994	Wang .	
5,291,017	3/1994	Wang et al.	250/292
5,331,157	7/1994	Franzen .	
5,338,931	8/1994	Spangler et al. .	
5,386,113	1/1995	Franzen et al. .	
5,420,424	5/1995	Carnahan et al.	250/287
5,468,958	11/1995	Franzen et al. .	
5,569,917	10/1996	Buttrill, Jr. et al. .	
5,576,540	11/1996	Jolliffe	250/292
5,693,941	12/1997	Barlow et al.	250/292
5,714,755	2/1998	Wells	250/292

OTHER PUBLICATIONS

J.O. Hirschfelder, C.F. Curtiss and R.B. Bird, "Molecular Theory of Gases and Liquids," Wiley: New York, 1954, table of contents and chap. 3, sec. 10f(pp. 222–225).

E.A. Mason and H.W. Schamp, "Mobility of Gaseous Ions in Weak Electric Fields," Annals of Physics (NY), vol. 4, 1958, pp. 233–270.

U. von Zahn, "Monopole Spectrometer, a New Electric Field Mass Spectrometer," Review of Scientific Instruments, vol. 34, No. 1, 1963, 1–4.

M.H. Studier, "Continuous Ion Source for a Time–of–Flight Mass Spectrometer," Review of Scientific Instruments, vol. 34, No. 12, 1963, 1367–1370.

E.A. Mason, H. O'Hara and F.J. Smith, "Mobilities of Polyatomic Ions in Gases: Core Model," Journal of Physics B: Atomic and Molecular Physics, vol. 5, 1972, 169–176.

R.F. Bonner, G. Lawson and J.F.J. Todd, "Ion–Molecule Reaction Studies with a Quadrupole Ion Storage Trap," International Journal of Mass Spectromety and Ion Physics, vol. 10, 1972/1973, 197–203.

J.H. Schummers, G.M. Thomson, D.R. James, I.R. Gatland and E.W. McDaniel, "Mobilities and Longitudinal–Diffusion Coefficients of Mass–Identified Positive Ions in Carbon Monoxide Gas," Physical Review A, vol. 7, No. 2, 1973, 683–688.

E.C. Horning, M.G. Horning, D.I. Carroll, I.Dzidic and R.N. Stillwell, "New Picogram Detection System Based on a Mass Spectrometer with a, External Ionization Source at Atomspheric Pressure," Analytical Chemistry, vol. 45, 1973, 936–943.

(List continued on next page.)

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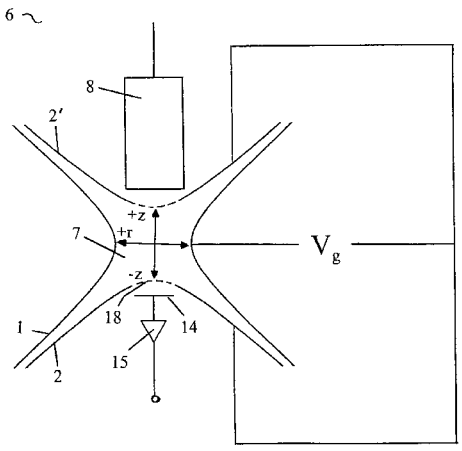
[57] **ABSTRACT**

An apparatus and method to separate and store ions by exploiting mobility characteristics of the ions. A sample is introduced into a trap volume and ionized. The ions are separated according to their mobility characteristics by applying an electric field to the trap volume. The ions thus migrate to equilibrium positions in the trap volume due to a difference in mobilities and to changes in the electric field. The ions may be sequentially scanned from the trap by changing the electric field. The identity of ions within the trap may then be determined.

75 Claims, 46 Drawing Sheets