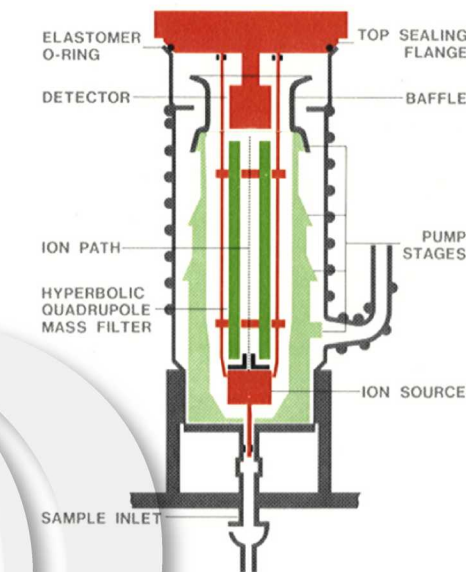


Agilent/Hewlett Packard has had a rich history in the area of mass spectrometry. The company started to design quadrupole mass filters for GC/MS applications in the early 1970's. The 5930A was the first Hewlett Packard mass spectrometer introduced in 1971 for use as a general-purpose laboratory instrument.

A truly revolutionary approach in the industry was taken by Hewlett Packard with the introduction of the first "bench-top" GC/MS, the Model 5992A. It was introduced in 1976 in Florence, Italy and was radical in design. The concept developed by Ned Kuypers was refined in several generations to become the standard of the industry. Not only was it a bench-top instrument, but it also placed the quadrupole mass filter inside the diffusion pump.



HP 5992B/93B Diffusion Pump and Analyzer Assembly
Cross Section.



Design Considerations

The gas chromatograph was integrated with the mass spectrometer from the inception of the design. Up until this time, existing chromatographs had been retrofitted to existing mass spectrometers. Designing the two instruments into one package provided an opportunity to eliminate many of the problems associated with interfacing them. The mass analyzer, high-vacuum system and electronics card cage were mounted above the GC oven so that the ion source was immediately above the GC oven. As capillary GC columns had not yet come into use, packed columns with their higher flow rates required a molecular separator and MS isolation valve which were conveniently positioned between the top of the GC oven and the ion source to minimize the length of the GC/MS transfer line. The hyperbolic quadrupole mass filter was eight inches in length and delivered ions to a continuous dynode electron multiplier. The entire source, mass filter and detector assembly was mounted on a single upper flange which used atmospheric pressure to seal the vacuum system.

The hardware design unique. The mass analyzer was surrounded by and built into the center of a newly designed diffusion pump. This approach offered several advantages including:

- lower cost due to compactness and fewer parts
- faster evacuation of minimum volume vacuum envelope
- the entire source, analyzer, and detector assembly operated in a controlled temperature gradient environment provided by the surrounding diffusion pump boiler and heated vapor zones
- only one high vacuum flange were no bolts or metal gaskets, thus minimizing leaks
- pump down and venting automatic minimizing operator involvement

The entire structure featured simple electrical connections and a minimum of mechanical parts.

HP5992 Specifications

HP 5700A Gas Chromatograph

- Microprocessor control of injection port and oven programming
- **Column Oven:** -50°C to 350° (Upper limit 280° with membrane separator installed.)
- **Oven Temperature Programmer:** 0.125 to 16°/minute in 0.125°C steps
- **GC/MS Interface:** Membrane separator supplied. Jet separator available as an option.

Mass Spectrometer

- **Mass Range:** 10 to 800 amu
- **Resolution:** Unit resolution throughout mass range
- **Sensitivity:** One ng methyl stearate injected on column will yield a spectrum with a signal-to-noise ratio 10:1 or better at the molecular ion (298.3) when scanned at 190 amu per second.
- **Scan Rate:** 620, 330, 190, and 100 amu per second from high to low mass
- **Ion Source:** Dual rhenium filaments at 70eV ionizing energy with patented Turner-Kruger lense to focus ions into the mass filter
- **Detector:** Continuous dynode electron multiplier
- **Mass Filter:** Hyperbolic quadrupole rods 203mm long
- **Signal Amplifier:** Field Effect Transistor (FET) logarithmic preamplifier with 5 decades dynamic range
- **Vacuum System:** Four-stage water-cooled diffusion pump with 150 liters/second pumping speed for helium. Direct drive mechanical pump at 50 liters/minute.

Data System

The HP 5992A was an integrated microprocessor controlled GC/MS instrument. The control terminal consisted of the HP 9825A Calculator with 16K of 16 bit words of memory and the HP 9866B Thermal Line Printer. A tape cartridge held the master system software and programs were supplied in either binary format or in secured Hewlett Packard Programming Language (HPL), the programming language of the HP 9825A Calculator. The 5992A was also the first GC/MS to be supplied with AUTOTUNE capability. Scientific Instruments Division (SID)-HPL was the language used for AUTOTUNE and operating the GC/MS for chemical analysis. AUTOTUNE adjusted the ion source elements, amu gain, and amu offset to achieve specified performance based on perfluorotributylamine ions at 69, 219 and 502. A communications interface option was offered permitting users to communicate with various computer timeshare networks. This allowed users to link the system through a phone line to help identify unknown spectra by searching libraries available from commercial timeshare services.

While critics predicted some technical problems with the design, the 5992 set the expectations of the market and was destined to be a big success. This was corroborated by the very broad-based acceptance of the HP 5992A which reached an installed base of many hundreds of instruments spanning many markets.

