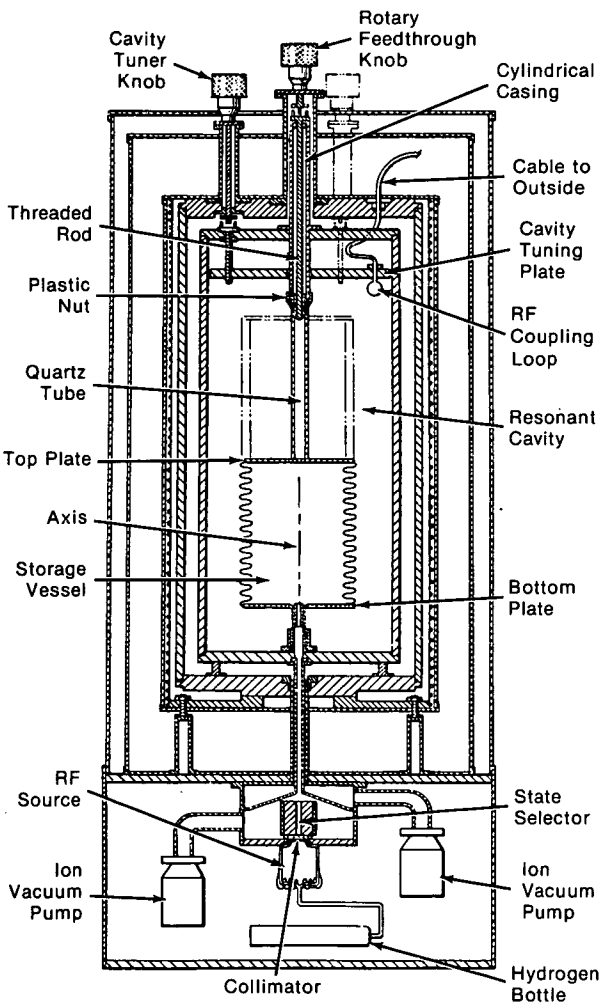
NASA TECH BRIEF

Goddard Space Flight Center

Variable-Volume Atomic Storage Vessel for Hydrogen Masers

The problem:

Atomic or molecular storage vessels (or bulbs) are used in measurements of atomic frequency standards. One important application is in hydrogen masers. The vessel, which is placed in the resonant cavity, is used to measure frequency deviations of excited atoms interacting with the inner vessel wall. This so-called wall-shift phenomenon is directly proportional to the vessel inner-surface-area/volume ratio. Measurements are made by changing this ratio and observing the corresponding change in frequency deviation. The ratio is varied by changing the vessel volume. With currently used methods, however, it is difficult to change the vessel volume without altering the inner surface area. As the result, the measurements are often inaccurate.



Atomic Storage Vessel in Hydrogen Maser

The solution:

A newly-developed atomic storage vessel that is incorporated in a hydrogen maser has a precisely adjustable volume. Its inner surface area remains constant with the changing volume.

How it's done:

The illustration shows a hydrogen maser which includes the new variable-volume vessel. The vessel, which is located in the maser cavity, is made from cylindrical, convoluted flexible bellows which can be expanded or contracted along the cylinder axis vertically. The bottom plate of the vessel is attached to a stationary support, while the top plate is designed to move up and down.

The top plate is attached to a quartz tube. Inside, the upper portion of this tube includes a plastic nut that is fixed in position and is adapted to receive a threaded rod. The threaded rod is enclosed in a hollow cylindrical casing and can be rotated by a spring-loaded rotary feedthrough.

The vessel volume is changed by depressing the rotary feedthrough to rotate the threaded rod. As the rod is rotated through the plastic nut, it either raises or lowers the top plate. The bellows volume is changed according to the direction of rotation. The vessel volume is derived by measuring the length of its vertical axis.

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Molecular hydrogen is supplied into the vessel from a bottle through an RF source which dissociates the molecules and forms a beam of atomic hydrogen. The beam is collimated and passes through a state selector into the vessel. The state selector magnetically defocuses low-energy-state atoms which are removed by ion vacuum pumps. The higher-energy, microwave-state atoms are passed into the vessel.

Microwave oscillations occur at the hydrogen hyperfine transition due to simulated emission of radiation if the beam flux is sufficiently high. The resulting signal is measured through an RF coupling loop that is connected to the outside by a cable. The wall shift is measured by varying the vessel volume and observing the corresponding changes in the signal frequency.

Note:

Requests for further information may be directed to:

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Reference: TSP75-10248

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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Categories: 03 (Physical Sciences)
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