IX. ATOMIC BEAMS*

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A. USE OF VARIABLE-CAPACITANCE DIODE FREQUENCY MULTIPLIER AS X-BAND POWER SOURCE

The use of semiconductor variable-capacitance diodes as high-ratio frequency multipliers is being investigated. Such devices have immediate application in cesium-beam atomic clocks, for which X-band power sources of fractions of a milliwatt are needed. Several multiplier circuits that multiply from 100 mc to 9000 mc in one jump have been constructed. The best of these circuits, a quarter-wave line at 100 mc which drives a variable-capacitance diode mounted in an X-band waveguide cavity, gave an output power of 200 μw for an input power of 500 mw at 100 mc.

A 100-mc transistor power amplifier is now being constructed to drive the multiplier circuit. The present design, now being tested, uses two 2N500 transistors in a class C push-pull circuit for the output stage, driven by two 3N37 tetrodes.

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B. A CARBON MONOXIDE CLOCK

We propose to do an electric deflection molecular-beam experiment to measure the energy difference of the J = 0, J = 1, v = 0 rotation states of carbon monoxide as a function of electric field. This line will be used as an "electric" clock in part of the laboratory program of the intercomparison of clocks that use different force fields. The present experiment will afford a comparison with the cesium frequency standard to one part in 10^9.

The carbon monoxide line has the following nice properties: high frequency – 115,270.56 ± .25 mc, as measured by Gilliam, Johnson, and Gordy (1) by microwave spectroscopy; high intensity – at liquid-air temperature approximately one-fifth of the molecules are in the two lowest rotation states, the vapor pressure is approximately 100 mm, and there is no nuclear splitting. These factors, considering the geometry of the apparatus, should give a signal intensity of "flopped" molecules of the order of 10^{12} molecules per second. Another property is small field dependence. For $\Delta J = 1$, $\Delta m = 0$ there is negligible magnetic-field dependence. The electric-field dependence is of the order of $10^{-2}\,\mathscr{E}^2$ cps for $\mathscr{E}$ in volts/cm.

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The difficulty, aside from problems of generation of a monochromatic 2.6-mm wave and detection of the beam, is that there may be Stark broadening of the line by near collisions with the residual gas molecules in the transition region.

At the present time we have generated, but not stabilized, approximately 10^{-7} watt of 2.6-mm power. We have assembled an electron-bombardment detector with an efficiency of 1/50 but have no measurements of the signal-to-noise ratio of the CO beam against the N_2 and residual CO background in the vacuum.

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References

1. O. R. Gilliam, C. M. Johnson, and W. Gordy, Microwave spectroscopy in the region from 2 to 3 millimeters, Phys. Rev. 78, 140 (1950).