VI. MOLECULAR BEAMS*

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A. CESIUM BEAM TUBE INVESTIGATION

During the past quarter, measurements of the frequency stability of the cesium atomic clock that was described in Quarterly Progress Report No. 69 (page 17) were made.

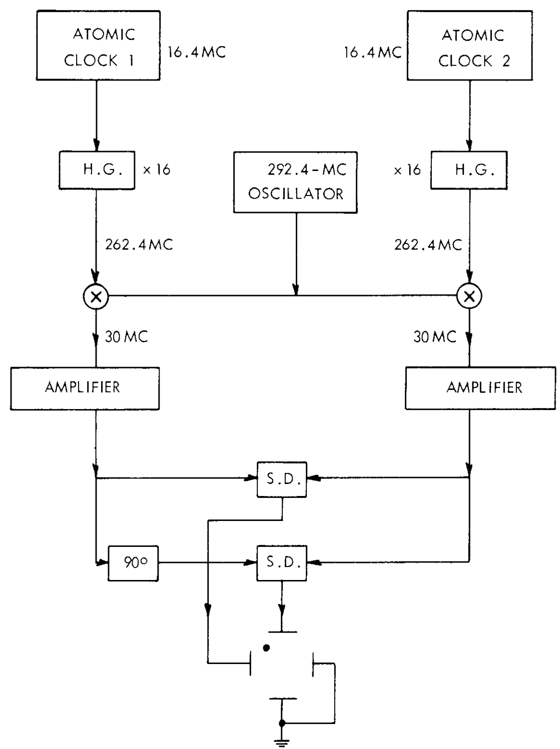

Fig. VI-1. Stability measurement system.

The system shown in Fig. VI-1 was used for these measurements. The 16.4-mc outputs of two identical clocks drive the harmonic generators which take the sixteenth harmonic. The resulting 262.4-mc signals are then mixed down to 30 mc by means of a common 292.4-mc local oscillator. Two synchronous detectors 90° out of phase provide a means of observing the instantaneous phase difference (or beat) between the two clocks. The

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visual display consists of a dot on the oscilloscope which describes one complete circle for every sixteenth of a cycle of phase change at 16.4 mc. To check the stability, a record is kept of the variations in the time that it takes for some arbitrary number of complete cycles of the dot to occur. To permit measurements to be made unattended, an automatic data-recording system has been devised.

Measurements made on the system described above have shown that the stability of the clocks falls far short of the results that might be expected on the basis of the tests of the electronic apparatus described in Quarterly Progress Report No. 69 (pages 20 and 21). Since the instability must be caused by a component that would not influence the results of these electronics tests, it is probably caused by changes in the characteristics of the beam tubes themselves and, to some extent, by the modulators.[1] The variations in question consisted of a daily frequency fluctuation between the two clocks which was very closely correlated with the changes in the differential temperature between the two clocks during the course of a 24-hour period. A peak-to-peak variation of 3 parts in 10^{11} corresponded to a 10°F temperature change. Part of this variation was traced to the effect of temperature upon the 16.4-mc crystal oscillator and was eliminated by providing much more loop gain at very low frequency. However, an error of 2 parts in 10^{11} is still to be accounted for, and determination of the cause will be a major concern of the work during the next quarter.

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References

1. See Fig. III-2, Quarterly Progress Report No. 69, Research Laboratory of Electronics, M.I.T., April 15, 1963, p. 18.