<Note>

Nuclear Quadrupole Resonance Spectrometer for N^{14} Resonance

Much of the pure quadrupole resonance studies have been made using marginal oscillators and Zeeman modulation. Disadvantages of these techniques were pointed out elsewhere(1,2). Especially in the cases of N^{14} resonances where the resonance frequency is low and asymmetry parameter is high, the high L/C ratio to sustain the oscillation affects Q of the tank circuit and the efficiency of modulation decreases. Frequency modulation by means of silicon voltage variable capacitors is simpler in instrumentation and superior in modulation efficiency than Zeeman modulation.

In practice, the incidental amplitude modulation which causes bad drift in baselines and swamp the amplifier-detector system.

The efforts to compensate this spurious signal were made in the Knight's high level oscillator(3) by means of bidirectional square wave modulation(4), and in the Robinson's low level oscillator by direct application of compensating signal of the proper phase and amplitude into the grid of the first rf amplifier tube(2).

This note is concerned to combination of low level operation, frequency modulation with varicaps and use of difference amplifier to reduce the effect of incidental amplitude modulation. The modification of Robinson's original circuit presently employed is shown in Fig. 1.

To avoid the large modulation field around the tank circuit, V-39E is used for both modulation and sweeping of the rf frequency. The oscillator is followed by an AF amplifier then a difference amplifier. The difference amplifier consisted of a 12AX7 tube and one section of another 12AX7 used in the cathode circuit terminating at −300 volts supply. The effective cathode impedance of this amplifier is about 10M ohms. Thus the common mode rejection ratio is rather high. The phase of the compensating signal is adjusted via precision phase shifter employing two steps of the resistance capacitance phase shifter(5), consisting of ganged 100K ohm-10 turn helipot, and substraction circuit built by using a Philbrick K2-X operational amplifier. Two narrow band amplifiers, similar to that of Jennings(6) with 280 cps twin-T made somewhat more stable by addition of stronger cathode degeneration, follow in cascade. The gain arround the feedback loop of single section is 3×10^3 corresponding to a Q of 750(9). The overall gain of this narrow band amplifier system is 8×10^5 at 280 cps. The output of the narrow band amplifier is rectified by means of a Schuster's(8) switching type phase-sensitive detector.

It should be pointed out that the compensation procedure is not so critical as those of Dutcher et al(2), and easily achieved by making the indicating voltage of the compensation monitoring meter, attached to the narrow band amplifier, minium.

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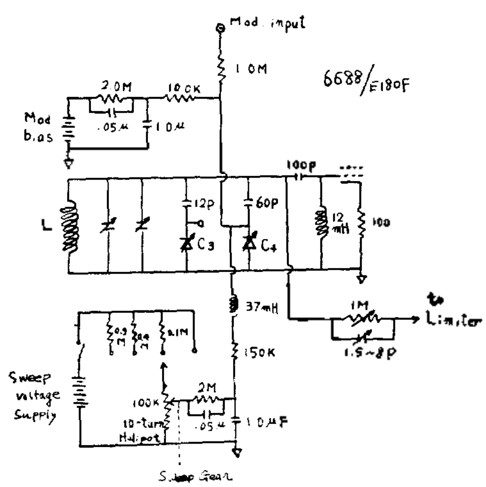

Fig. 1. Modified tank circuit of low level oscillator.
L: Specimen coil, inside diameter 1.5cm, consisted of 20 turns of No. 17 copper wire.
C_3, C_4: Pacific Semiconductor Type V-15 and V-39E, respectively.

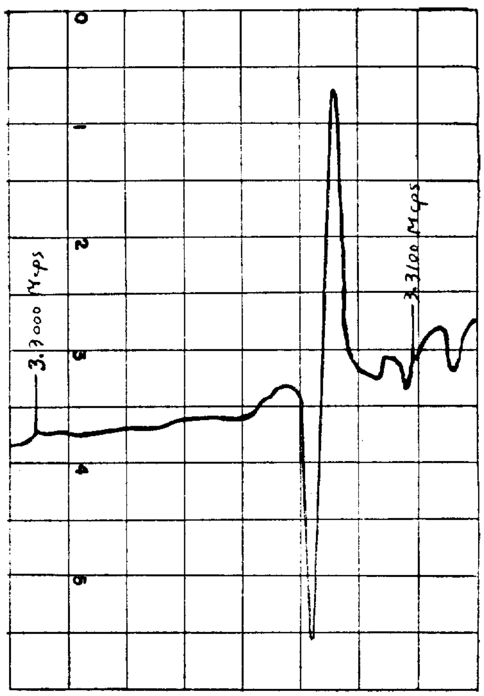

Fig. 2. Pure quadrupole resonance of N^{14} in $(CH_2)_6N_4$ at 22°C, the resonance frequency being 3.3076 Mcps. The R-C integrating circuit preceding the recorder has a time constant of 2 seconds.

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Q. Won Choi and Czae-Myungzoon

Department of Chemistry, Seoul National University, Seoul Korea