ECHO PULSES IN YTTRIUM IRON GARNET

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We present results of experiments aimed at observing echo pulses in an axially magnetized ferrite parallelepiped, and indicating that the observed effect is nonlinear.

A single-crystal yttrium iron garnet was used in the experiments ($4\pi M_s$ = 1750 G, $2\Delta H \sim 1$ Oe). The sample was in the form of a parallelepiped measuring 5.0 x 1.0 x 1.0 mm. The experimental mock-up is shown schematically in Fig. 1. The microwave signals were fed

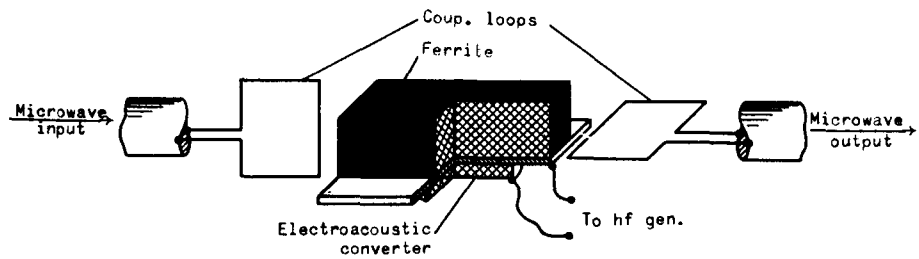

Fig. 1. Experimental mock-up

and picked-off by coupling loops comprising continuations of the internal conductors of coaxial cables. To prevent the unhindered microwave signal from flowing directly from the input to the output, the loop planes were mutually perpendicular. The experiments were made at 1 GHz and the microwave-signal peak power ranged from fractions of a milliwatt to hundreds of milliwatts. This power range is apparently beyond threshold. The ferrite sample was glued to a brass plate, on the opposite side of which was secured an electroacoustic converter to apply lateral elastic oscillations to the ferrite. The magnetizing field was directed along the largest axis of the parallelepiped. The microwave magnetic field, as seen from Fig. 1, was transverse to the magnetizing-field direction.

The results of the experiments are shown in Fig. 2. When the magnetizing field is varied from 350 to 370 Oe, echo pulses are observed in addition to the exciting microwave pulse. The observed echo-pulse duration does not depend on the duration of the exciting pulse (if the latter exceeds 1 μsec) and amounts to approximately 1 μsec. The echo-pulse delay time, reckoned from the trailing edge of the exciting pulse, does not change when the duration of the latter is varied from 1 to 20 μsec. Self-modulation oscillations were observed on the top of the exciting pulse [1].

The delay time depends on the peak power of the exciting pulse, rising from 1 to 4 μsec as the power is multiplied 50-fold. For each fixed excitation-power level, the dependence of the delay time on the magnetizing field coincides qualitatively with the similar dependence observed in experiments on the excitation of magnetostatic pulses [2,3]. The delay time of the first echo pulse changes from 1 to 4 μsec when the magnetizing field changes by less than 1 Oe.

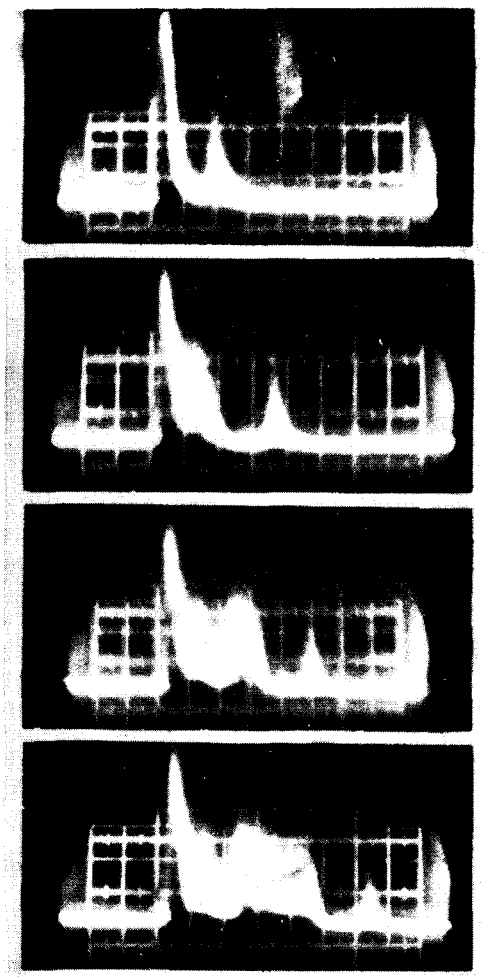

Fig. 2. Oscillograms illustrating the independence of the echo-pulse duration of the duration of the input pulse, and the shift of the echo pulse when the duration of the input pulse following its trailing edge is varied. Each division of the horizontal scale is 1 μsec.

The observed echo pulses are strongly influenced by lateral elastic hf signals (f = 300 kHz). By properly choosing the frequency of the external signal, the amplitude of the first echo pulse can be increased by 10 - 15 dB. If also the microwave pulse repetition period is a multiple of the external-signal period, then the observed echo signal is not modulated; if exact multiplicity is not maintained, amplitude modulation is produced, seen on the oscilloscope screen as a "smearing" of the echo pulse.

A number of the observed characteristics (range of magnetization fields in which the echo pulses are observed, strong dispersion, character of dependence of the delay time on the magnetizing field) are similar to those of magnetostatic echo pulses [2,3], but other characteristics (independence of echo-pulse duration of the duration of the exciting pulse, shift of echo pulse with change in duration of the exciting pulse following its trailing edge) are unusual. It is possible that the anomalous behavior of the observed echo signals is due to the same causes as the nonstationary delayed re-emission [4]. Favoring this assumption, beside some common features of the characteristics, is also the fact that the electromagnetic radiation [4] observed from the ferrite under the influence of lateral pulsed elastic oscillations contained in a series of electromagnetic-radiation "peaks" delayed relative to the trailing edge of the elastic-oscillation pulse. The delay time of these "peaks," reckoned from the trailing edge, was independent of the duration of the elastic pulse.

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E R R A T A

Article by F. V. Lisovskii and Ya. A. Monosov, "Echo Pulses in Yttrium Iron Garnet," (Vol. 5, No. 1, p. 3).

An additional experimental investigation of the phenomena described in the article has revealed that the observed "anomalies" in the behavior of the magnetostatic echo pulses (the independence of the echo-pulse duration of the exciting-pulse duration, the displacement of the echo pulse behind the trailing front of the exciting pulse, dependence of the delay time on the peak power of the exciting pulse) are produced not by the properties of the ferrite, but by the lack of suitable protection of the receiver against overload by the exciting pulse. Therefore the echo pulses described in the paper should be regarded as ordinary magnetostatic pulses, the initial sections of which could not be observed as a result of receiver overlad.