TUESDAY, MAY 16, 1961
SESSION 3: FERRITES

9:00 AM - 12 NOON
CHAIRMAN: FRANK REGGIA
DIAMOND ORDNANCE FUZE LAB
WASHINGTON, D. C.

3.5 OCTAVE BANDWIDTH UHF/L BAND CIRCULATOR*

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Nonreciprocal ferrite devices—in particular, low-loss circulators—are increasingly difficult to realize at the lower microwave and UHF frequencies. Previous low-loss S-band and L-band circulators used a high-density magnesium manganese ferrite with aluminum substitution (General Ceramics R-6). Measurements show that the loss of R-6 in broad-band circulators increases rapidly when the operating frequency is decreased below 1100 Mc. Therefore, a new material is required for UHF application.

Two new aluminum-substituted yttrium-iron-garnet (YIG) compositions were obtained that combined low saturation magnetization (400 and 300 gauss), narrow line width, reasonable Curie temperature, and low dielectric-loss tangent. The 300 gauss material had a line width of 50 oersteds, a dielectric loss tangent of .0016 and a Curie temperature of 125°C. The magnetic loss at 1200 Mc as a function of applied magnetic field for R-6, unsubstituted YIG, and the 400 gauss substituted YIG are compared in Fig. 1 Reverse magnetic loss measurements of the 300 and 400 gauss materials at 900 Mc are compared in Fig. 2. The 300 gauss material shows a low loss dip below resonance that is broader than that of the 400 gauss material and which extends to lower frequencies. The 300 gauss material is the most suitable for application in broad-band UHF circulators and isolators.

A broad-band UHF/L band four-port phase-shift-type circulator was developed that operated over a 2 to 1 frequency range. Insertion loss was 1 db or less from 660 to 1320 Mc (with constant magnetic field) and 0.5 db or less from 800 to 1150 Mc with a minimum isolation of 20 db and an average SWR of 1.15 (Figure 3). A very compact and favorable circulator package design was evolved. It employed, two alumina loaded strip-transmission lines, a broadband coaxial magic tee of novel design, and a broad-band 90° hybrid and three-quarter-wave Techebyscheff transformers.

Isolator measurements down to 200 Mc showed reverse-to-forward magnetic-loss ratios of 36 at 600 Mc and 12 at 300 Mc using the same structure as used for the circulator which was designed for optimum performance at higher frequencies.

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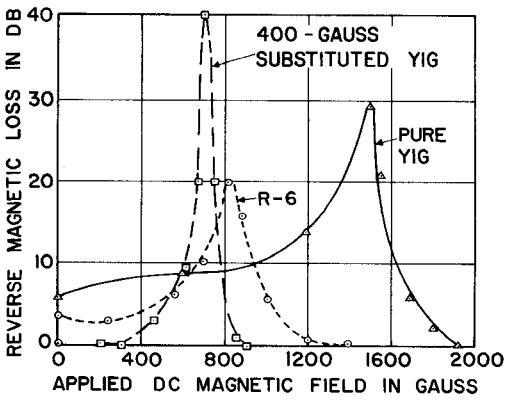

Figure 1 - Comparison of Magnetic Loss (1200 Mc).

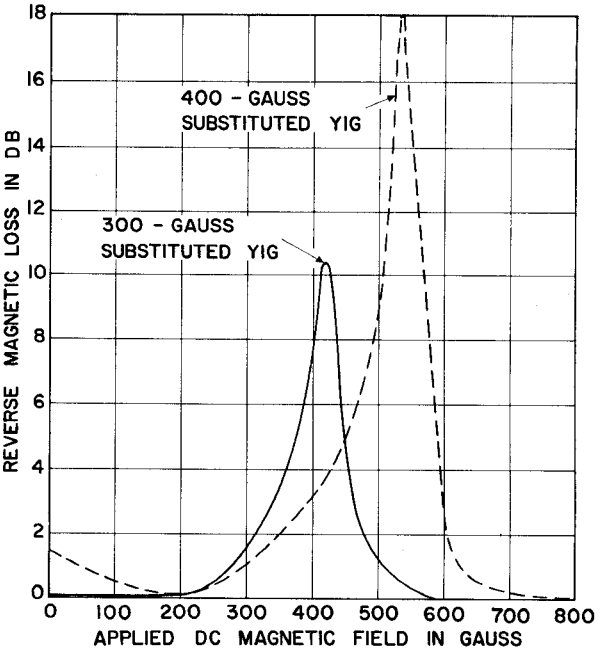

Figure 2 - Comparison of Magnetic Loss (900 Mc).

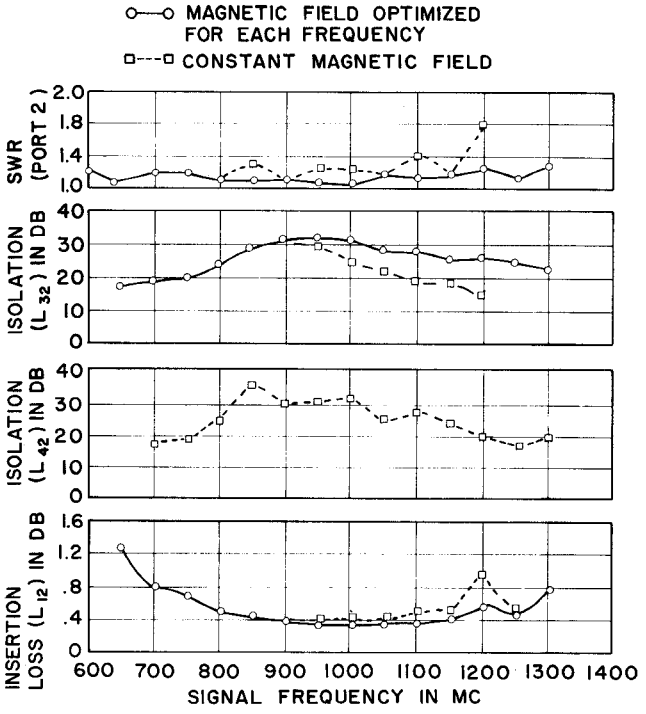

Figure 3 - Performance Data for UHF/L Band Circulator.