III. SOLID STATE PHYSICS

Prof. W. P. Allis
Prof. S. C. Brown
Prof. G. G. Harvey
Prof. L. Tisza
J. M. Goldey
J. B. Thomas

MICROWAVE STUDY OF SEMICONDUCTORS

Measurements of the carrier contribution to the dielectric coefficient of germanium are under way. The dielectric coefficient is measured at a frequency of 24,000 Mc/sec by a waveguide transmission method. Details of the circuit are shown in Fig. III-1. The bridge is balanced for a null at the detector with the sample in the circuit and then again with a blank present. Power transmission is measured with the aid of the directional couplers and suitable detectors. The measurements give the complex transmission coefficient from which one may obtain the dielectric coefficient and conductivity of the sample (1).

The carrier contribution to the dielectric coefficient is temperature-dependent through the temperature dependence of the mobility and carrier density. In the present experiment measurements are made between 200°K and 300°K. Throughout this temperature range, the carrier density for the samples used does not vary appreciably; hence, to a good approximation, changes in dielectric coefficient are the result of changes in mobility alone. One is then able to determine quite simply the effective mass of the carriers involved from the change in carrier contribution with temperature.

Measurements are being made on both n and p types of germanium with room temperature resistivities of the order of 5 ohm-cm. Three samples of each type are cut from adjacent portions of a single crystal. The samples are cut so that when they are placed in the waveguide the electric field will be along the [100], [110], and [111] crystal directions, respectively. The measurements are being made to determine whether or

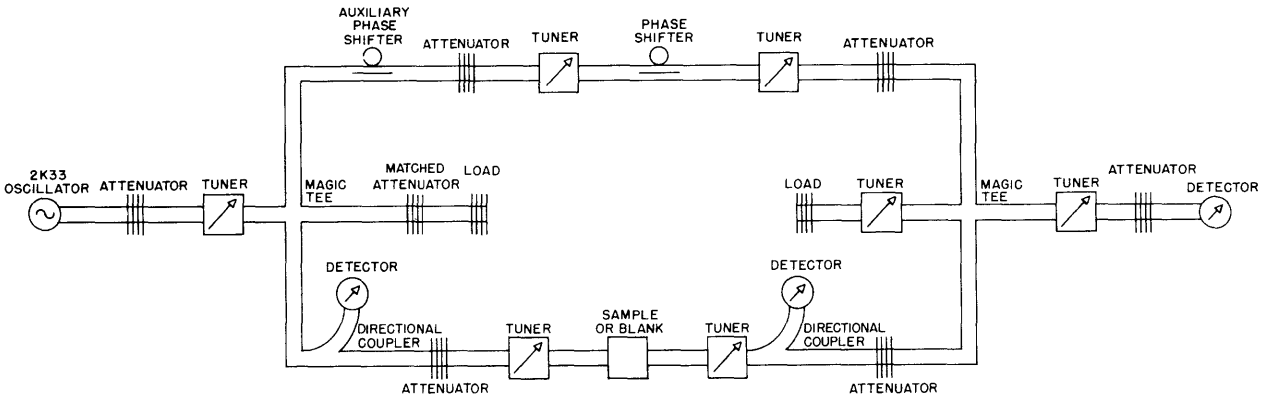

Fig. III-1
Schematic diagram of microwave bridge.

not anisotropies in the carrier contributions (caused by anisotropies in either the effective mass or collision frequency) will be observable in an experiment of this type. It is worth noting that for certain types of energy surfaces such anisotropies will not be observable in this experiment.

Measurements have been made on several samples and are in progress on the others. The results will be reported when complete.

J. M. Goldey

References

1. E. G. Montgomery, Techniques of Microwave Measurements (McGraw-Hill Book Company, Inc., New York, 1947) Chap. 10.