The Pace of Modern Technology

In 1946, J. H. E. Griffiths published in *Nature* the first account of an experimental observation of the phenomenon of ferromagnetic resonance. Naturally enough this paper elicited little interest from electrical engineers, nor did the theoretical work of C. Kittel and D. Polder published during the next three years which gave a quantitative explanation of Griffith's experiment. Now, however, approximately eight years after Polder's rather complete theoretical paper on ferromagnetic resonance this issue of an engineering journal is devoted exclusively to the practical ramifications of this first experimental observation. Many of the devices referred to in this issue are beyond the development stage and are already in widespread use in microwave systems. Although the delay between research and development and between development and production usually seems interminably long to those most actively associated with the development of engineering devices, it appears, in retrospect at least, that in this case the progress has been almost astounding. In fact, it is illuminating to go back to the beginning of the electronic era and look at the basic experiments which led to the development of the vacuum tube in order to see how our technological timetable has been greatly compressed during the last fifty years.

Actually as early as 1725, DuFay discovered that the region surrounding a red-hot body was a conductor of electricity, but the first definitive experiments which showed conclusively that electrons could pass from a hot filament to a cold plate were performed by Edison in 1883 (158 years after DuFay's observation). Even so, it was not until 1905 that Fleming developed the diode and DeForest added a third electrode known as the grid in 1907, 24 years after Edison's experiments. If the same timetable were in effect today, the first practical engineering device based upon the phenomenon of ferromagnetic resonance would not be constructed until sometime after 1968 and this issue of the TRANSACTIONS of the PGMTT could not become a reality until most of us had retired from active engineering practice.

It is not our purpose here to account for the various factors which make this progress possible nor to imagine what our engineering specialty will be like even twenty years from now if this rate of productivity continues to increase. Instead it is sufficient merely to point out the tremendously rapid transition that has been made from fundamental physical research to engineering practice in this particular instance and to contend that this example does not represent an isolated phenomenon but more nearly describes typical creative engineering activity as it exists today. In fact, we sometimes find our profession pressing so hard upon the latest results of the solid-state physicist that engineering demand is becoming a common criterion which the experimental physicist uses to shape the course of his experiments. A natural result of this progress is that we, as engineers, are forced into ever closer alliance with physicists and physical research.

This journal reports the proceedings of a meeting held in May, 1957. That meeting covered as completely as possible the latest advances in the microwave ferrite art. Now, however, approximately six months later, newer and in some respects more exciting applications of ferromagnetic resonance than those described in this issue have been reduced to practice in many laboratories. These newer devices include: 1) harmonic generators; 2) passive microwave amplitude limiters; 3) low-noise microwave amplifiers; and 4) efficient microwave detectors which promise to cover all wavelengths from a fraction of a millimeter to several centimeters. Some of these newer devices are based on the theoretical work of H. Suhl which was first published in the October, 1956 issue of the PROCEEDINGS OF THE IRE. Most of these new devices appear practical because within the last year new materials (the ferromagnetic garnets) have been made available to us. In addition to their obvious engineering potentialities, these materials promise to give a tremendous boom to our fundamental understanding of the properties of ferromagnetic materials and thus, perhaps, give us the knowledge needed to produce a great myriad of engineering devices which we are not able even to conceive of today.

It appears evident, however, that we are only at the beginning of a tremendous revolution in high-frequency communication techniques which has been made possible by mankind's increasing knowledge of the behavior of solid-state materials. We are fortunate to be part of a profession that allows us to take part in this exciting progress.

CLARENCE LESTER HOGAN