Editorial

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ELECTRICAL engineering as a technology necessarily embodies applications of physics, and in the microwave branch, a particularly close link exists between the two subjects of study. The phenomenal progress in microwave work has come about as a result of physicist and engineer working side by side, each making his own kind of contribution, much to the benefit of both. Cross fertilization of ideas is always profitable, and in microwaves, perhaps more than in many other things, this has had exceedingly valuable results. The engineers have discovered the need to broaden their approach to problems of the electromagnetic field and to delve much more deeply into matters concerning the behavior of electrical materials in such fields. The high frequencies involved have naturally been a dominant factor in the new work they had to do.

Prior to the advent of microwaves, which for practical purposes only really came on the scene during World War II, most electrical engineers were content to examine their guided-wave problems in terms of circuit theory, and even in the VHF part of the spectrum, that treatment sufficed for most purposes. In the microwave band, equivalent circuits still play their part, but more often field theory is required to give an intimate and precise picture of the situation. The behavior of the field at a boundary between two different media is almost always of special interest, and much of our microwave work centers around that aspect of the subject. This is not surprising when we recall that air, as the pervading medium of the space in which we live, has many excellent properties for electromagnetic wave propagation, and most of the limitations we have to accept are imposed by the various forms of guide and supporting structure introduced for the purpose of directing energy along a particular route. The commission demanded by the guide for this service is often an important consideration, and so are the losses in any associated solid dielectric. It is a salutary thought that even at low frequency, the permissible electric stress in a high-power cable is limited primarily by voids in the insulation, tending to reduce the performance to that attainable with a gas dielectric, while at high frequency, we generally try to use as little solid dielectric as possible in order to keep down the power absorbed.

Microwaves, in teaching us to think and study more particularly in terms of the electromagnetic field rather than the electric circuit, have encouraged a more unified approach to our problems, and this is perhaps the most important need today in the science of electrical engineering. The power engineer often reasons and acts from a point of view which is very different from his colleague in the radio field. Both have something of value to offer, but it is nevertheless true that the younger science tends to be more progressive and to give wider scope for challenging ideas.

How many engineers realize that the basic mechanism of the mechanical force on the conductors of the armature of a motor carrying current is the same as that of radiation pressure, and moreover, that its counterpart, the Hall effect, arises in a way which is the precise equivalent of the EMF generated in the armature? How many engineers have ever thought of the equalizer rings on a wave-wound dc machine as performing the same function as the strapping of a multicavity magnetron, or of the rotating magnetic field of a polyphase induction motor as a surface wave? How often do power engineers use, or indeed think of, the Poynting vector in relation to their calculations for power transmission, and how many of them are still inclined to visualize the power as passing through the conductors themselves? What proportion of our colleagues dealing with the design of ac machines consider the problem of the distribution of current over the cross section of conductors in terms of wave propagation and recognize that even at 50 cps the wavelength in copper is only about 5 cm? It might justly be argued that there is little of immediate practical value to be gained from any broader approach to these and similar matters, but this is a short-term view and, in the long run, one generally finds that it is from the wider horizon that the most important developments emerge. To that end, it is particularly important that teachers should do all they can to bring together in the minds of their students basic scientific ideas that are closely allied. This may encourage wider attempts at generalization, which is always difficult to achieve without losing some of the detail—detail that is sometimes of vital importance in an engineering problem. In spite of all the difficulties, the fact remains that without some further measure of unification in the teaching of electrical engineering, the growth of the subject will force the tendency toward narrow specialization to become still more pronounced. The close contact between physicist and engineer in the microwave field has broadened the outlook of both. Let us do our best to insure that the same kind of interchange is not lost between the power and the radio engineer. The great ideas on which our future so largely depends will surely come from the closest possible collaboration, and particularly from those who have the gift of a broad scientific understanding of the problems presented to them.

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