CHAPTER II

ANTENNAS

Electric Circuit Theory and Electromagnetic Theory.—In order to understand the behavior of antennas and of electric circuits at ultra-high frequencies, it is essential to recognize that phenomena of a vastly more general nature are involved than are encountered in conventional electric networks. Attention is seldom called to the fact that electric-circuit theory which proceeds from Kirchhoff's laws is a highly specialized form of a more general theory. In some respects, the situation is like that in mechanics, in which the simple law of gravitation due to Newton may be looked upon as a special case of a more general law formulated in the theory of relativity. Much as Newtonian mechanics is adequate for the mechanical engineer, ordinary electric-circuit theory is accurate for the requirements of electrical power engineering and for many requirements in communications. But even as Newton's laws of motion are inadequate in dealing with atomic phenomena and some astronomical problems, so ordinary electric-circuit theory fails when applied to antennas and to most circuits that are to be used at ultra-high frequencies. The reason is that the conditions that limit the generality of Newton's laws on the one hand, or the theorems of electric-circuit theory on the other, are not satisfied. For those who have assumed that Kirchhoff's laws are perfectly general, a series of surprises is in store. They may, in fact, feel like Alice when the Red Queen was annoyed by her reluctance to believe "six impossible things before breakfast." But presently they may return through the Looking Glass and discover that they have been living in the one-dimensional Wonderland of electric-circuit theory and that Nature is as simple as this suggests only in sufficiently small spaces.

It is difficult to understand the structure of general electromagnetism without first learning the appropriate symbolism, that of mathematics. But if one is willing to accept some things on faith and to meet others with an open, perhaps even an adventurous