

DISCUSSION ON "RADIO TELEGRAPHY"*

BY
G. MARCONI

Stuart Ballantine (by letter): Dr. Marconi's paper touches briefly upon the interesting phenomena of the propagation of electric waves over the earth's surface, especially viewed from the important geographical position of the antipole of a terrestrial source. Of special interest to me was his recorded opinion (evidently based upon directional observations made in the neighborhood of the antipole) that waves from certain American stations prefer to travel three-quarters of the earth's circumference rather than by the direct route of the great circle. Now this is a very surprising thing, and even marshalling all possible effects, coast-line diffraction, Heaviside layer reflection—and if you please, the relativity deflection due to the earth's east-west rotation—is hard to account for. In the absence of a fuller statement of the experimental conditions I do not see how it is possible to infer this from observations made at one or more closely located points, unless these points are located on the sea and the direction-finding apparatus itself is installed on a wooden raft. For experience with the radio direction-finder indicates with a high degree of probability that most of the permanent deviations in direction, at least in the case of an apparatus located on land, are due to diffraction and scattering by local objects, coast lines, and so on, and that these disturbances of the approximately linear propagation do not persist at distances from their foci, which are great compared with the wave length.¹ I presume that the opinion in question is not based upon those transient shifts, studied extensively by Taylor, Kinsley, Pickard, and Loughlin in this country and by Eckersley in England, which have probably no local terrestrial genesis and are for that reason more likely to cause the large deviations which have been frequently observed. The idea that the wave consistently takes any other route than that of the great circle certainly violates

* Received by the Editor, July 18, 1922.

¹ Compare Ballantine; "The Radio Compass," page 10, and following, "Year Book of Wireless Telegraphy and Telephony," London, 1921.

our physical intuition, and should be fortified by experimentally mapping the direction of the Poynting-vector along the entire course of the propagation.

The whole matter is one of great scientific fascination, and the important practical economies made possible by the antipodal rise in signal strength impart a great interest to the theoretical problem. The spreading of waves around a spherical earth has been discussed mathematically in the important papers of Rayleigh, Macdonald, Poincaré, Nicholson, Whittaker, and others, but with considerable disagreement of results, and in most cases the discussions have failed to embody such practical features as the finite conductivity of the earth and the possible influence of the Heaviside layer. The effect of the finite earth conductivity has been considered in but one case, in a paper by Rybcynski, and if we accept the experimental evidence lately submitted by Eckersley as to the existence of a super-atmospheric conducting stratum, the approximate influence of this may be treated by a method of Macdonald's² for the oscillations in simply-connected spaces. I have carried this calculation thru, assuming perfect earth conductivity, and have obtained formulas which with the complete experimentally determined attenuation law may help to fix the possible height of this reflecting layer. But in view of the great difficulty of the problem, augmented by the impossibility of taking into the mathematical equations all the practical deviations from the idealized problem, I think that practical men will welcome the experimental data promised by Dr. Marconi with considerable satisfaction. It would be especially interesting to know if Fresnel nodal-lines are discovered, and whether the vibrations conspire sufficiently to give an antipodal rise of the order of the theoretical calculations.

² Compare H. M. Macdonald; "Electric Waves," page 49 and following, Cambridge, 1902.