

ELECTROMAGNETIC THEORY.

BY

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VOLUME II.

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PREFACE TO VOL. II.

FROM one point of view the present volume consists essentially of a detailed development of the mathematical theory of the propagation of plane electromagnetic waves in conducting dielectrics, according to Maxwell's theory, somewhat extended. From another point of view, it is the development of the theory of the propagation of waves along wires. The connection of the two subjects was thoroughly explained in Chapter IV. of Volume I., which should be understood. But on account of the important applications, ranging from Atlantic telegraphy, through ordinary telegraphy and telephony, to Hertzian waves along wires, I have usually preferred to express results in terms of the concrete voltage and current, rather than the specific electric and magnetic forces belonging to a single tube of flux of energy. The translation from one form to the other is quite easy, when understood. As far as space would permit, I have tried to develop the theory as thoroughly as possible, considering every kind of wave, and including the calculation of the waves produced by multiple reflections. Even the theory of the latest kind of so-called wireless telegraphy (Lodge, Marconi, etc.) has been somewhat anticipated, since the waves sent up the vertical wire are hemispherical, with their equatorial bases on the ground or sea, which they run along in expanding. (*See* § 60, Vol. I.; *also* § 393 in this volume.) The investigations are based upon those in my "Electrical Papers," with considerable extensions. My old predictions relating to skin conduction, and to the possibilities of long-distance telephony have been abundantly verified in advancing practice; and my old predictions relating to the behaviour

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of approximately distortionless circuits have also received fair support in the quantitative observation of Hertzian waves along wires. The reader need not therefore fear that he may be muddling himself over fantastic theories void of practical significance, whatever the scienticulist may say.

The mathematical methods employed are those which have proved themselves to me by practice to be those best suited to obtaining new results and advancing natural knowledge. The general idea is to make the differential equations themselves perfectly definite, so that the differential equation of a problem is actually its full solution, the operational or differential solution, though it may not be in obvious quantitative form. The process of algebrisation, or conversion from differential to algebraical form admitting of numerical treatment is, of course, very important. Though it may be easy when the proper way of treatment has been found, yet there has been a good deal of exploring work which makes no appearance.

In Chapter VIII. I have given a condensed account of my researches on generalised differentiation and series, a subject that grows naturally out of the operational way of working. Although I think this subject has a large future, yet I must warn the reader that there is no pretence of logical rigour, and that much of the matter was rejected some years ago by persons who ought to be good judges.

The several appendices relate to electromagnetic waves in general, save the one on rational units. There is some progress to report. Of the three stages to Salvation, two have been safely passed through, namely the Awakening and the Repentance. I am not alone in thinking that the third stage, the Reformation, is bound to come.

I have good reason to be satisfied with the reception given to the first volume of this work. Nearly all parts of it, the outline of general theory, the nomenclature, the rational units, the vector analysis, and the waves and their application, have been approved in this and other countries. But I

regret that I have been able to make so little impression upon British official science as expressed by its late leader. It is true that the "K.R. law," which set such unnecessary and unwarrantable restrictions upon telephony, is not much heard of now. With advancing practice it became so ridiculously wrong (say 1,000 per cent.) that it was impossible to save appearances by any manipulation of figures. But a dangerous and alarming official error has been pressed forward, even to the extent of experimentation with the public funds. I refer to Mr. Preece's proposal to increase the capacity of telephone cables, with a view to Atlantic telephony, by bringing the twin conductors as close together as possible. It is, indeed, very true that by Mr. Preece's ingenious plan of flattening the wires on one side, and bringing the flat sides closely together, the capacity may be considerably, and even greatly increased. But it is not the working capacity that is increased, but the electrostatic capacity! Faraday knew that much.

And this blundering is so unnecessary. For if it be beneath the dignity of one who sat at the feet of Faraday and afterwards rose to be the leading authority on electrical matters (according to *Answers*), to consult the works of an insignificant person, still there are other ways. Why not ask someone else? It may be too late to consult the family doctor; but there are many young gentlemen going about who have been to technical colleges and are quite competent to give information concerning the capacity of condensers.

It is to be hoped and expected that the late important removals in the British Telegraph Department will lead to much improvement in the quality of official science. The above two examples show how much improvement has been needed. Others could be given. This volume may help.

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