

**ELEMENTARY LECTURES  
ON ELECTRIC DISCHARGES,  
WAVES AND IMPULSES,  
AND OTHER TRANSIENTS**

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Elementary Lectures on Electric Discharges, Waves and Impulses, and Other Transients by  
Charles Proteus Steinmetz

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## PREFACE TO THE SECOND EDITION.

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SINCE the issue of the first edition, in 1911, our knowledge of transients has greatly increased, and many of the phenomena, especially those of double energy transients and compound circuits, have been observed and studied on transmission systems to a considerable extent, and have corroborated the oscillographic records given in the previous edition.

Considerable work has been done on momentary short circuits of alternators, and the variable component of the self-inductive reactance recognized as a transient reactance resulting from the mutual induction of the armature with the field circuit.

Especially in the field of sustained or continual, and of cumulative oscillations, a large amount of information has been gathered. The practical importance of these continual and cumulative oscillations has been strongly impressed upon operating and designing engineers in recent years, usually in the most disagreeable manner by the destruction of high power, high voltage transformers. A chapter on these phenomena has therefore been added in the second edition.

CHARLES P. STEINMETZ, A.M., Ph.D.

*February, 1914.*



## PREFACE TO THE FIRST EDITION.

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IN the following I am trying to give a short outline of those phenomena which have become the most important to the electrical engineer, as on their understanding and control depends the further successful advance of electrical engineering. The art has now so far advanced that the phenomena of the steady flow of power are well understood. Generators, motors, transforming devices, transmission and distribution conductors can, with relatively little difficulty, be calculated, and the phenomena occurring in them under normal conditions of operation predetermined and controlled. Usually, however, the limitations of apparatus and lines are found not in the normal condition of operation, the steady flow of power, but in the phenomena occurring under abnormal though by no means unfrequent conditions, in the more or less transient abnormal voltages, currents, frequencies, etc.; and the study of the laws of these transient phenomena, the electric discharges, waves, and impulses, thus becomes of paramount importance. In a former work, "Theory and Calculation of Transient Electric Phenomena and Oscillations," I have given a systematic study of these phenomena, as far as our present knowledge permits, which by necessity involves to a considerable extent the use of mathematics. As many engineers may not have the time or inclination to a mathematical study, I have endeavored to give in the following a descriptive exposition of the physical nature and meaning, the origin and effects, of these phenomena, with the use of very little and only the simplest form of mathematics, so as to afford a general knowledge of these phenomena to those engineers who have not the time to devote to a more extensive study, and also to serve as an introduction to the study of "Transient Phenomena." I have, therefore, in the following developed these phenomena from the physical conception of energy, its storage and readjustment, and extensively used as illustrations oscillograms of such electric discharges, waves, and impulses, taken on industrial electric circuits of all kinds, as to give the reader a familiarity