

**THE LIBRARY OF ELECTRICAL
SCIENCE, VOLUME SIX:
POLYPHASE ELECTRIC CURRENTS
AND ALTERNATE-CURRENT
MOTORS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649676590

The Library of Electrical Science, Volume Six: Polyphase Electric Currents and Alternate-Current Motors by Silvanus P. Thompson & Nikola Tesla

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

www.triestepublishing.com

SILVANUS P. THOMPSON & NIKOLA TESLA

**THE LIBRARY OF ELECTRICAL
SCIENCE, VOLUME SIX:
POLYPHASE ELECTRIC CURRENTS
AND
ALTERNATE-CURRENT MOTORS**

The Library of Electrical Science

VOLUME SIX

**POLYPHASE
ELECTRIC CURRENTS
AND ALTERNATE-CURRENT MOTORS**

BY

SILVANUS P. THOMPSON, D.Sc., B.A., F.R.S.

PRINCIPAL OF AND PROFESSOR OF PHYSICS IN THE CITY AND GUILDS OF
LONDON TECHNICAL COLLEGE, FINSBURY

WITH A CHAPTER ON ELECTRICAL COMMUNICATION WITH THE PLANETS

By NIKOLA TESLA



HARVARD UNIVERSITY

LIBRARY

KF1226

NEW YORK
P. F. COLLIER & SON

1902

PREFACE.

WHEN the course of four Lectures on the subject of Poly-phase Currents, delivered by the author at the Technical College, Finsbury, in the autumn of 1894, was completed, representations were made by persons who had attended the Lectures, and by others, to induce him to publish them in permanent form.

In preparing the lectures for the press a good deal of matter has been added. No attempt has been made either to preserve the colloquial form of the discourses or to give to them any pretence to literary style. They are put together in their present shape for the use of students and engineers, and introductory matter has been added to make the relations of polyphase currents to ordinary single-phase currents more clear. In all this work the author has been aided by Mr. Miles Walker, whose assistance is willingly acknowledged, and on whom the task of reducing to written form much of the work has devolved. The graphic method of treating monophase motors, on pp. 165 to 169, is due to Mr. Walker.

The author is also indebted to various firms and designers for valuable information afforded as to recent progress and modern types of machine, and he desires to express his thanks

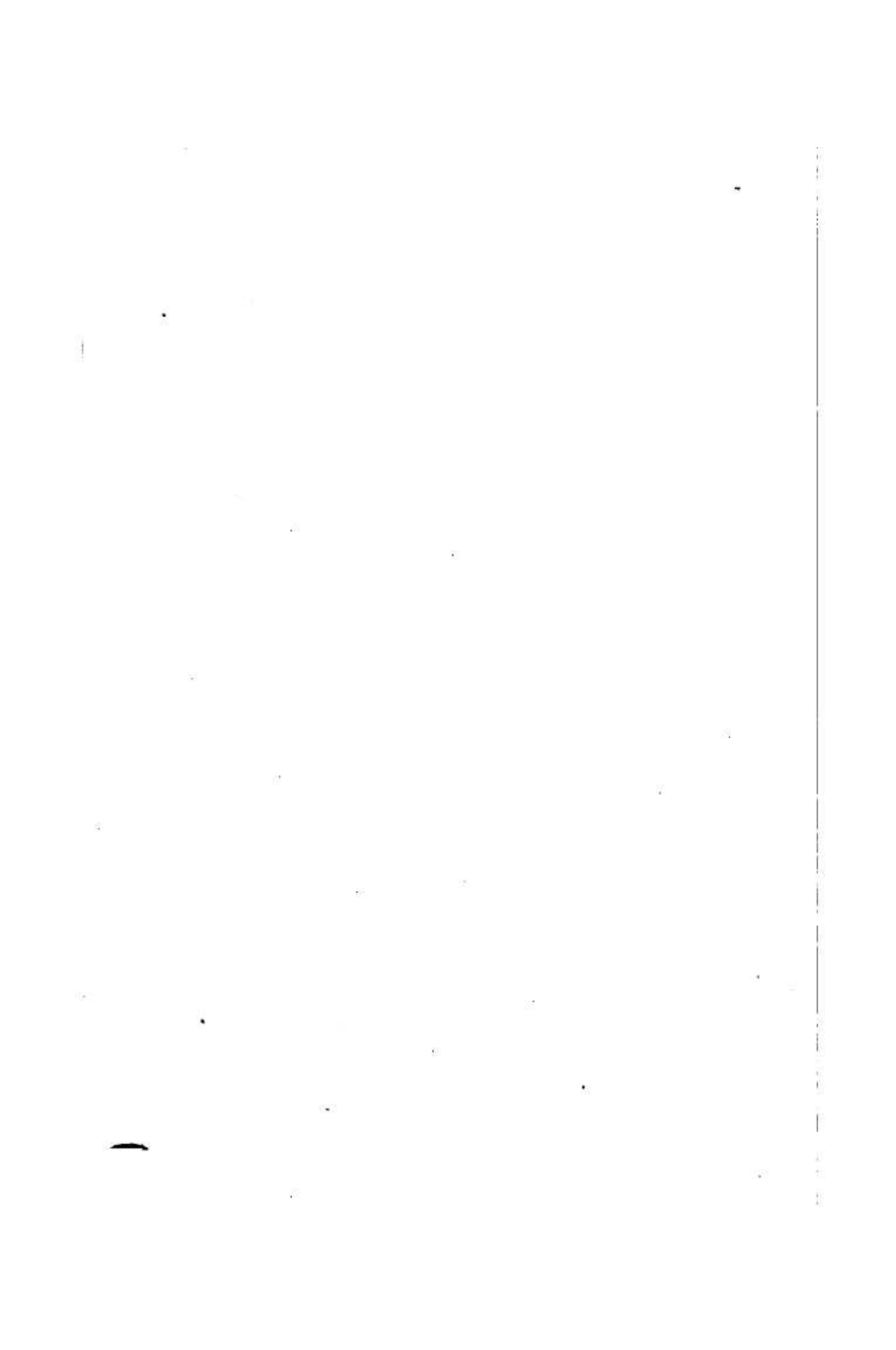
to the following: the Allgemeine Elektrizitäts-Gesellschaft, of Berlin; the Helios Company, of Cologne; the Elektrizitäts-Aktiengesellschaft (Messrs. Schuckert & Co.), of Nürnberg; the Oerlikon Maschinen-Fabrik (and to Mr. Emil Kolben) of Zürich; and most of all to Brown, Boveri & Co. (and to Mr. C. E. L. Brown), of Baden, Switzerland.

A full Bibliography of the subject of Polyphase Currents and Induction Motors has been appended at the end of the volume.

S. P. T.

CONTENTS.

CHAPTER	PAGE
I. POLYPHASE GENERATORS.....	1
II. COMBINATIONS OF POLYPHASE CURRENTS.....	43
III. PROPERTIES OF ROTATING MAGNETIC FIELDS.....	69
IV. EARLY DEVELOPMENT OF ROTARY-FIELD MOTORS..	84
V. STRUCTURE OF POLYPHASE MOTORS.....	111
VI. ELEMENTARY THEORY OF POLYPHASE MOTORS....	134
VII. ANALYTICAL THEORY OF POLYPHASE MOTORS.....	146
VIII. MONOPHASE MOTORS.....	158
IX. MISCELLANEOUS ALTERNATE-CURRENT MOTORS....	170
X. POLYPHASE TRANSFORMERS.....	176
XI. MEASUREMENT OF POLYPHASE POWER.....	187
XII. NOTES ON DESIGN OF POLYPHASE MOTORS.....	190
XIII. MECHANICAL PERFORMANCE OF POLYPHASE MOTORS	197
XIV. SOME EXAMPLES OF MODERN POLYPHASE MOTORS..	210
XV. DISTRIBUTION OF POLYPHASE CURRENTS FROM STATIONS.....	217
 APPENDIX	
I. BIBLIOGRAPHY.....	225
II. SCHEDULE OF BRITISH PATENTS ON POLYPHASE MOTORS.....	242
INDEX.....	245
 <hr style="width: 10%; margin: auto;"/>	
PLATE I. TWO-PHASE, SIX HORSE-POWER MOTOR	263
" II. THREE-PHASE, ONE HUNDRED HORSE-POWER MOTOR.....	265



POLYPHASE

ELECTRIC CURRENTS AND ALTERNATE- CURRENT MOTORS.

CHAPTER I.

POLYPHASE GENERATORS.

INTRODUCTORY REMARKS.

No apology is needed for devoting special attention at the present time to the subject of polyphase electric currents. There seems to be no doubt that in the problem of the electric transmission of power a very important part will, in the future, be played by alternating currents combined in systems of two or three different phases. Already a number of examples exist; and some very large works are now in course of construction. The undoubted advantages possessed by polyphase systems over either (*a*) continuous current systems, or (*b*) ordinary single-phase alternate currents, for the special service of power transmission, are beyond question; but it remains to be seen how far the complications thereby inevitably introduced are, in practice, sufficiently great to militate against polyphase distribution for the purpose of general electric lighting supplies.

The comparative novelty of polyphase methods, and the circumstance that the greater part of that which has already been achieved has been done in foreign countries, are reasons why the topic should receive some attention from English engineers.

In these pages the subject will be dealt with under the following subdivisions:—Generators for Polyphase Currents; the Properties of the Rotatory Magnetic Field, with some account of its historical development; the Theory, Construction and Performance of Polyphase Motors; the Theory and Construction of Motors operated by ordinary single-phase Alternate Currents; together with some account of Polyphase Transformers, and of the measurement of power in polyphase systems.

ALTERNATE CURRENTS.

It will be assumed at the outset that we are already acquainted with the general principles of alternate-currents, and with the general features¹ of alternators or alternate-current generators.

Nevertheless, a recapitulation of the main points about alternate currents may be useful as a preliminary.

Faraday's discovery of the induction of currents in wires by moving them across a magnetic field, so as to cut the

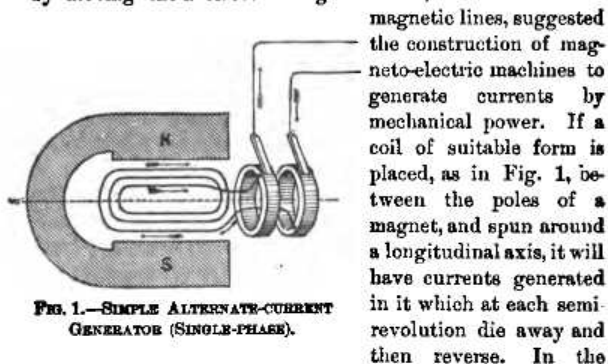


FIG. 1.—SIMPLE ALTERNATE-CURRENT GENERATOR (SINGLE-PHASE).

magnetic lines, suggested the construction of magneto-electric machines to generate currents by mechanical power. If a coil of suitable form is placed, as in Fig. 1, between the poles of a magnet, and spun around a longitudinal axis, it will have currents generated in it which at each semi-revolution die away and then reverse. In the figure the coil of wire is supposed to be so spun that the upper portion comes towards the observer. In that case, the

¹ For a simple outline of the subject see Chapters IX. and X. of the 1894 edition of the author's *Elementary Lessons in Electricity and Magnetism*; or, for a fuller account, consult the author's larger treatise on *Dynamo-electric Machinery*.