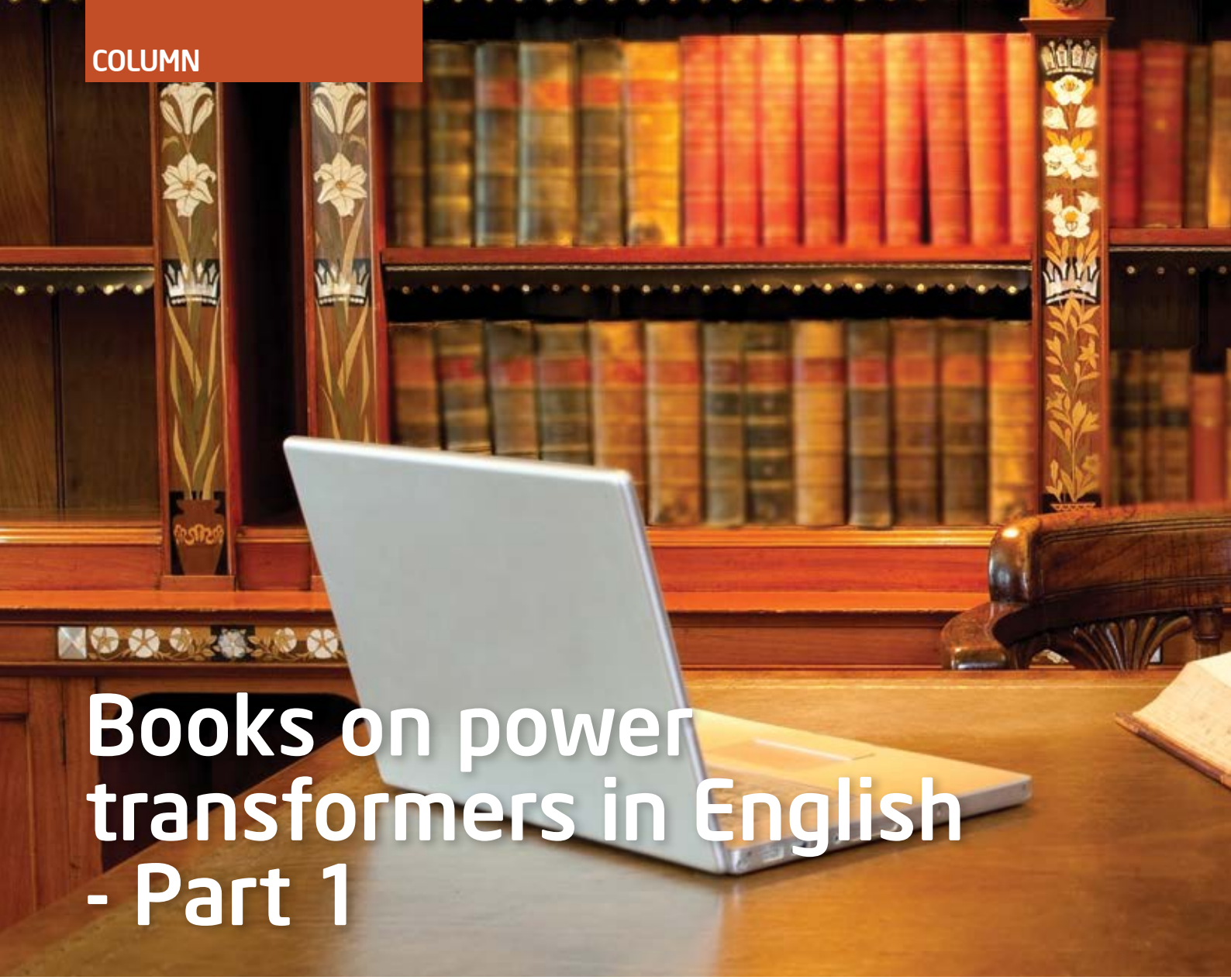


Books on power transformers in English - Part 1

ABSTRACT

This article presents a comprehensive historical review of the literature on power transformers, spanning from 1885, when the transformers were patented, up until the end of the 19th century. Tracing the evolution of knowledge surrounding transformers during this pivotal period, the article delves into the works of notable authors and key advancements in understanding and utilizing transformers, as well as the respective electrical engineering technologies in the early days.

KEYWORDS

literature, history, review, electromagnetic induction, historical evolution, transformer design

Transformers, as we see them today, developed through the efforts of several engineers and scientists for more than half a century, from 1831 when Michael Faraday discovered electromagnetic induction to 1885 when Ganz engineers patented transformers and used that term for the improved AC electric converters that they developed. Since 1885, tens of books have been published in English, exclusively describing the selection, application, design, manufacturing, testing, or operation and maintenance of transformers. At the fag end of the nineteenth century, there was great interest in electric power and equipment for its generation, distribution, and utilization, and engineers were keen to learn about this new technology. Several books were published on this subject during this period. Ten books were published on transformers alone during the fifteen years from 1885 until 1900. Details of these ten books are covered in this column.

1889

F. Uppenborn, *History of the Transformer*, E & F. N. Spon, 125, Strand, London, England & New York, 60 pages, 1889. Price 3 shillings. Translated from German. Reprint available from Kessinger Publishing, Montana. [Online], available at https://archive.org/details/historyoftransfo00upperich

History of the Transformer **was first published in German in 1888, just 3 years after the patenting of the transformer by Ganz in Budapest**

Friedrich Uppenborn (1859-1907) was the editor of the "Zentralblatt für Elektrotechnik" and the head of the electrotechnical testing station at Munich. This book, *History of the Transformer*, was first published in German in 1888, just 3 years after the patenting of the transformer by Ganz in Budapest. This English translation came out in 1889, probably the first English-language book published on Transformers.


HISTORY

OF

THE TRANSFORMER.

BY

F. UPPENBORN,

TRANSLATED FROM THE GERMAN.

E. & F. N. SPON, 125, STRAND, LONDON.
NEW YORK: 12, CORTLANDT STREET.
1889.

In the preface to the book, the author explained its purpose was to give the correct history of the evolution of the transformer from August 29, 1831, when Faraday discovered electromagnetic induction, until Carl Zipernowsky, Max Deri, and Otto T. Blathy of Budapest applied for a patent for the transformer on March 6, 1885 (patent No. 40414). He felt this was necessary as several distorted versions of the invention of the transformer were appearing in technical journals of the time. He thought it necessary to show the truth by studying all the patents that finally resulted in the patent for transformers.

All discoveries and patents related to secondary generators (the term used at the time, later came to be known as transformers) since Michael Faraday discovered electromagnetic induction in 1831 are explained in the book. These early works and patents finally led to the aforementioned patent for the transformer in 1885.

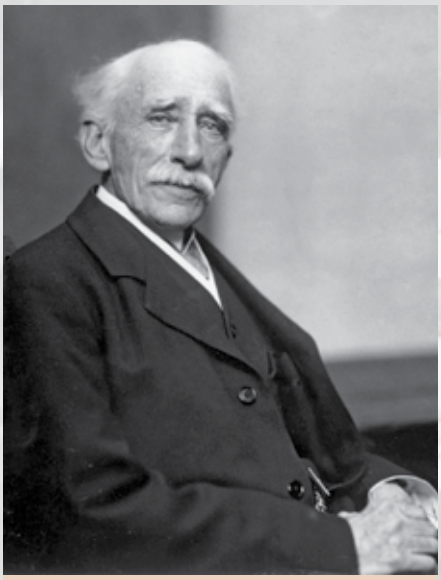
Sir John Ambrose Fleming, the inventor of right-hand rule in electromagnetics, authored a notable two-volume book on the transformers in 1889: *The Alternate Current Transformer in Theory and Practice*

John Ambrose Fleming, *The Alternate Current Transformer in Theory and Practice, Vol. 1: Induction of Electric Currents*, The Electrician Printing & Publishing Co. Ltd, London

1st edition, 1889, 487 pages; 2nd edition, 1892, 500 pages; 4th edition, 500 pages; 5th issue, 1894, 540 pages; new edition, 1896, 641 pages D. Van Nostrand; 3rd edition, 1900, [Online], available at https://www.amazon.com/Alternate-Current-Transformer-Theory-Practice/dp/1143275128

John Ambrose Fleming, *The Alternate Current Transformer in Theory and Practice, Vol. 2: The Utilization of Induction Currents*, The Electrician Printing & Publishing Co. Ltd, London

1st edition, 1889, 507 pages; 1892, 641 pages; 1893, D. Van Nostrand Co., London; 2nd edition, 600 pages, 1894, [Online], available at https://www.amazon.co.uk/Alternate-Current-Transformer-Theory-Practice/dp/1270718169



Sir John Ambrose Fleming (1849-1945) was a Professor of Electrical Engineering at University College, London, from 1884, the first electrical engineering professor in the UK. He was also a member of the Royal Institution of Great Britain. Dr Fleming, who worked with James Maxwell and Thomas Edison, is known more for the invention of the first thermionic valve or vacuum tube (the start of electronics) and the right-hand rule used in Physics. His right-hand rule is taught globally in schools and colleges in lectures on electromagnetism. He can be described as the father of modern electronics as his invention of the vacuum tube heavily influenced modern-day electronics and reshaped telecommunications. He designed the radio transmitter with which the first transatlantic radio transmission was made. However, in the 19th century, he was most famous for his book on AC transformers, which was widely read, just like the J&P transformer book in the 20th century, both classics from London, UK.

Fleming's book *The Alternate Current Transformer in Theory and Practice* was published by The Electrician Press, London, in 1889. The Electrician was the first journal of electrical engineering – a weekly journal of telegraphy, electricity, and applied chemistry, published in London, UK, from 1861 until 1952.

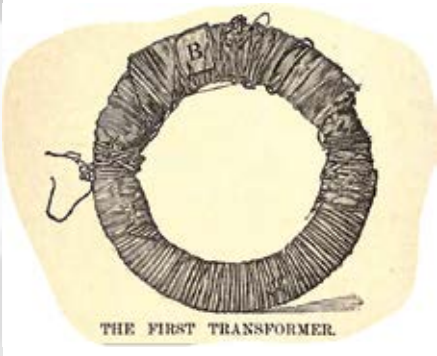
Volume 1 covered the induction of electric currents, and Volume 2 was devoted to the utilization of induced currents, i.e., electric machines and transformers. There was a huge interest in the last decade of the 19th century in AC electric power generation/utilization, and these volumes attracted a lot of interest, as seen in the following press notes published in The Electrician. Several reprints and editions were brought out within a short period. Dr Fleming thoroughly revised the content based on the latest studies on the subject.

"It would be very difficult to pick out from amongst the electrical literature of the past ten years any work which marks, as emphatically as does Dr Fleming's book, how the practical problems of the day have compelled electrical engineers to advance in their knowledge of theoretical science. It is a book which the electrical engineer of the present and the future alike will read - he of the present if he can; he of the future, because he must," so wrote prof. Silvanus P. Thompson in The Electrician about Volume 1 of this book.

"In reviewing the first volume of this work we found much to admire and praise, much to raise high expectations for the volume which was to follow. These expectations have by no means been disappointed. The new volume is in many ways of even greater interest than its predecessor," prof. Silvanus P. Thompson wrote, again in The Electrician, about Volume 2.

In the preface to the 1896 edition of Volume 1, Dr. Fleming wrote: "In the seven years which have elapsed since the first Edition (1889) of this Treatise was pub-

Volume 1 covered the induction of electric currents, and Volume 2 was devoted to the utilization of induced currents, i.e., electric machines and transformers



The iron ring, which had insulated primary and secondary coils, wound on it, with which Faraday discovered magneto-electric induction. Photographed from the original, preserved in the Museum of the Royal Institution (Frontispiece of Volume I of the book)

minals and fuses. The transformer roughly resembles a water-wheel, and can be rolled about easily when set on edge. On the top plate are fixed porcelain discs, which carry the primary and secondary fuses, which are short slips of fusible metal contained in glass tubes. The transformers are made in various sizes, to transform down generally to 105 and 52 volts, and each secondary circuit has three terminals by which 105 volts can be taken off for incandescence lamps, and 52 volts for arc lamps. The transformers are made in four sizes as follows :—

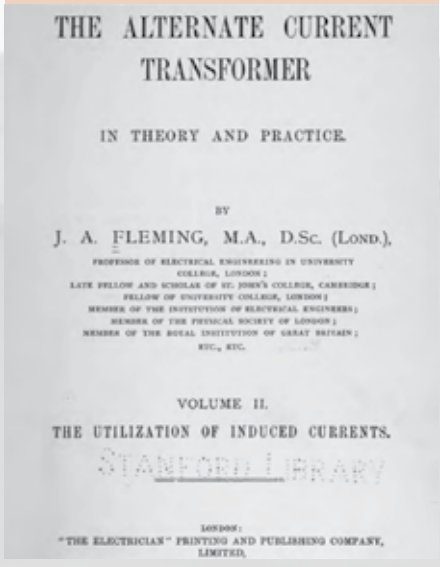
Gaulard Transformers.

No.	Output in watts.	Weight in kilogrammes.	Commercial efficiency at full load as given by makers.
1.	1,875	70	92·5 per cent.
2.	3,750	110	94·5 "
3.	7,500	180	95·5 "
4.	15,000	290	96·8 "

The energy loss in magnetizing the iron is stated to be 5·5, 3·5, 2·5, and 1·5 per cent. respectively at full load in the No. 1, 2, 3, and 4 sizes, and the energy loss in the copper is put at 2 per cent. The primary coils are wound to receive current at 900, 1,800, 2,700, and 3,600 volts respectively in the four sizes, and to transform it down to 105 and 52 at the chief and intermediate terminals on the secondary circuit. The relation between commercial efficiency to the corresponding load on the secondary circuit in watts is given by the efficiency curve, as shown in Fig. 10.

Page 133 of Vol. 2: The utilization of Induction Currents – J. A. Fleming

lished, the study of the properties and applications of alternating electric currents has made enormous progress. At the outset the aim of the author was to collect, and present in a form suitable for students, a general statement of the facts and principles of electromagnetic induction, and the manner in which these are applied in the design and construction of the Induction Coil and Transformer. At that time most of the practical information on the subject was embedded in technical journals and original papers. Confident that alternating electric currents would play a very important part in the evolution of the electrical industry, the author believed that service would be rendered to engineering students by an attempt, even if an imperfect one, to place a brief systematic treatise on the subject of the Alternating Current Transformer within reach. The result, so far, has justified the belief."


THE ALTERNATE CURRENT TRANSFORMER

IN THEORY AND PRACTICE.

BY

J. A. FLEMING, M.A., D.Sc. (Lond.),

VOLUME II.

THE UTILIZATION OF INDUCED CURRENTS.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LIMITED.

Seven chapters of Haskins's book cover theoretical considerations, mathematical formulae, evolutional history of transformers, constructional details, and service conditions

The contents of the first volume were covered in six chapters: Historical Introduction (from the times of Faraday), Electromagnetic Induction, The Theory of Simple Periodic Currents, Mutual and Self-induction, Dynamic Theory of Induction and the last chapter, Induction Coil and Transformer.

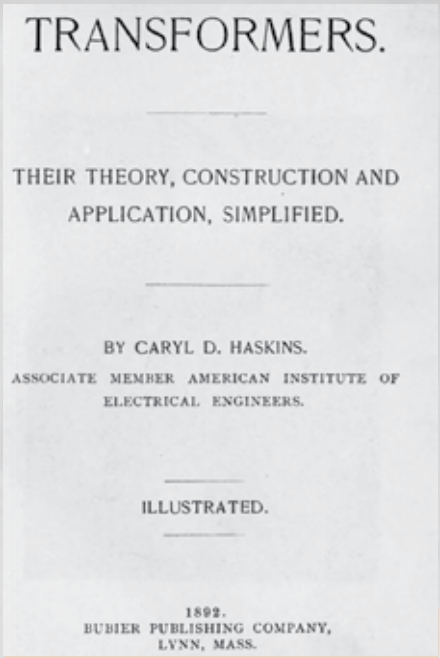
Volume 2 of the book had five chapters: The Historical Development of Induction Coil and Transformers, The Distribution of Electric Energy by Transformers, Alternate Current Electric Station Generators, The Construction and Action of Transformers, and the last chapter, Other Practical Uses of Transformers (included in this chapter were, for example, welding transformers).

1892

C. D. Haskins, *Transformers: Their Theory, Construction and Application, Simplified*, Bubier Publishing Co., Lynn, Mass., 150 pages, 1892, New Ed. 1923. [Online], available at https://www.abebooks.com/Transformers-Theory-Construction-Application-Simplified-Haskins/30357903045/bd

Caryl Davis Haskins (1867-1911) was a member of the American Institute of Electrical Engineers. He wrote in the preface. "I have endeavoured in the following pages to treat of the transformer and its action in such a manner as to render the work of especial value to the central station electrician, the student, and the investigator,…"

Seven chapters of the book cover induction and distribution by alternating current, theoretical considerations (like regulation, Foucault Current, hysteresis, and leakage), mathematical formulae, evolutional history of transformers,


TRANSFORMERS.

THEIR THEORY, CONSTRUCTION AND APPLICATION, SIMPLIFIED.

BY CARYL D. HASKINS.

ASSOCIATE MEMBER AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

ILLUSTRATED.

1892.
BUBIER PUBLISHING COMPANY,
LYNN, MASS.

constructional details, and service conditions. The last chapter covers details of various makes of transformers made in the US, such as Ferranti, National, Slattery, Stanley, Thomson-Houston, and Westinghouse.

On page 63, the book reads: "Transformers are sold as a mere commercial article and lighting companies order dozens of them, as a cook might a dozen eggs"

Appendices cover transformers for special purposes such as high voltage (10 kV), "Hedgehog", welding, Direct Current, station, and constant current transformers. The last one covers Underwriters' rules for Secondary Genera-

Rober Willsher Weekes's book was the first book exclusively on the design of transformers, with two chapters covering design details of various transformer models

tors or Converters. In the US, the term transformer was not popular then, and the secondary generator was more in circulation. These rules stipulated requirements for installation, operation, protection, and safety to be followed by users when operating transformers in residences. This was an extract from the Rules and Regulations adopted by the New England Insurance Exchange and the Boston Fire Underwriters' Union for electric lighting, as in force then.

Here are some interesting quotes from the book: "The per cent of loss (at full load) in the average transformer of today varies from about 10 to 15 per cent in very small, to 3 to 5 per cent in large converters. It is probably easier to design a transformer of, say 10,000 watts capacity, with an efficiency of about 97.5%, than a 250 watts converter (the term used in Europe for transformer) with an efficiency of 90%" (page 54).

"Transformers are sold as a mere commercial article and lighting companies order dozens of them, as a cook might a dozen eggs" (page 63).

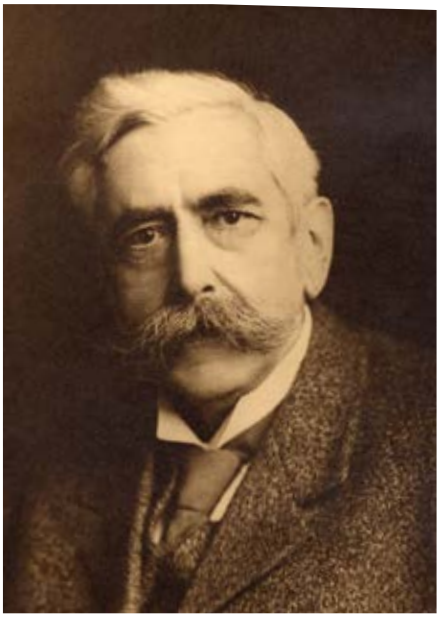
1893

Rober Willsher Weekes, *The Design of Alternate Current Transformers*, Biggs & Co., 139-140, Salisbury Court, London, 120 pages, 1893, new ed. 1923, [Online], available at https://books.google.com.ua/books/about/The_Design_of_Alternate_current_Transfor.html?id=5EYYAAAAYAAJ&redir_esc=y

This was the first book exclusively on the design of transformers. In two chapters, design details of various transformer models are given. All were 2400/100 V single-phase transformers used for lighting residences.

Gisbert Kapp, *Dynamos, Alternators and Transformers*, Biggs & Co., London, 493 pages, 1893, [Online], available at https://openlibrary.org/works/OL1093558W/Dynamos_alternators_and_transformers

Gisbert Kapp (1852-1922) was an Austrian-English electrical engineer, first Chair of Electrical Engineering at the University of Birmingham, and became the president of the Institution of Electrical Engineers in 1909. He introduced the Kapp's triangle, or Kapp's diagram - a phasor diagram used to determine the voltage drop on the transformer.



1896

Frederick Bedell, *The Principles of the Transformer*, The Macmillan Company, New York, 400 + XII pages, 1896, [Online], available at https://www.nature.com/articles/054545a0

Frederick Bedell (1868-1958)

Gisbert Kapp, *Transformers for Single and Multiphase Current: Their Theory, Construction and Use* (translated from German) 1st edition, 241 pages, 1896; 2nd edition, Whittaker &Co, London, UK, 363 pages, 1908; 3rd edition, Pitman un-

Kapp's book *Transformers for Single and Multiphase Current: Their Theory, Construction and Use*, among other topics, covers constructional details and types of transformers made by transformer manufacturers of that time

der the Specialist's series, 391 pages, 1925, [Online], available at https://archive.org/details/transformersfors00kapprich

This is a book translated from German by the author himself, covering the theory, construction, and use of single and multiphase transformers. In the preface to the book, the author writes: "In what may be termed the literature of heavy electrical engineering, there is no lack of books on dynamos, motors, cables, and a host of auxiliary apparatus, but transformers have been somewhat neglected. The reason may possibly be that scientists have not considered it worth their trouble to investigate so seemingly simple a piece of apparatus as a transformer, whilst so much more interesting problems connected with machinery in motion remained to be solved".

Some of the topics covered are losses in transformers, types and construction of iron parts, and heating of transformers.

The book gives constructional details and types of transformers made by transformer manufacturers of that time, for example, Siemens and Halske, Berlin, Siemens Brothers & Co. London, M/s Brown Boveri & Co, Baden, Switzerland, The Electric Construction Co. Ltd, Wolverhampton, Westinghouse Electric Manufacturing Co., Pittsburgh, USA, AEG Berlin, M/s Johnson & Philips, Charlton, UK, Elektrizitats - Aktien, Schuckent & Co., Nürnberg, Elektrizitats – Aktien-Gellschaft, W.Lahmeyer & Co., Frankfurt, The Johnson & Philips, Charlton, London, The Brush Electrical Engineers, London, The Machinen fabrik, Oerlikon, Switzerland and M/s Ganz, Budapest. Popular ratings of transformers were 1-150 kW single phase and 2.5-200 kW three phase.

1897

George Adams, *Transformer Design*, Spon & Chamberlain, New York, 1st edition, 1897, 2nd edition, 1899, 75 pages https://books.google.com.ua/books/about/Transformer_Design.html?id=hIFh5_HCy7AC&redir_esc=y

This 75-page short book covers types of transformers, iron loss and copper loss calculation, effects of air gaps in the core, magnetic leakage, and power factor.

1898

Alfred Still, *Alternating currents of electricity and theory of transformers*, Whittaker & Co, London, 179 pages, 1898, [Online], available at forgottenbooks.com › download › AlternatingCurrentsof...pdf

Alfred Still was a professor of electrical design at Purdue University, USA. The author prepared the book "less from the scientist's point of view and more from an engineering standpoint." The book was limited to basic principles of single-phase transformers, ranging from magnetic, self, and mutual induction, capacitance currents, and AC principles.

Alfred Still was a professor of electrical design at Purdue University, USA, and he prepared the book "less from the scientist's point of view and more from an engineering standpoint"

Authors

P. Ramachandran started his career in transformer industry in 1966 at TELK, Kerala, a Hitachi Joint venture, in India. He worked with ABB India during 1999-2020. He has more than 50 years of experience in the design and engineering of power products including power transformers, bushings, and tap-changers. He received Bachelor of Science Degree in Electrical Engineering from the University of Kerala, India, and Master of Business Administration Degree from Cochin University, India. He is a Fellow of Institution of Engineers (India), and he represented India in CIGRE Study Committee A2 for transformers during 2002 – 2010.

Vitaly Gurin graduated from Kharkov Polytechnic Institute (1962) and graduate school at the Leningrad Polytechnic Institute. Candidate of technical sciences in the Soviet scientific system (1970). For 30 years he tested transformers up to 1.150 kV at ZTZ, including the largest one of that time in Europe, and statistically analysed the test results. For over 25 years he was the Executive Director of Trafoservis Joint-Stock Company in Sofia (the diagnosis, repair and modernisation in the operating conditions of transformers 20 – 750 kV). He has authored about 150 publications in Russian and Bulgarian, and is the main co-author of GOST 21023.