ABSTRACT

German literature on power transformers is covered from 1888 (first book on transformers published anywhere, just three years after patenting transformers), up to most recent publications issued in 2019. The purpose of the compilation of published books on power transformers is to give a historical summary on the topic, which may also be useful to other specialists in their research.

KEYWORDS

calculation, construction, design, DIN, historical development, power transformers, testing, VDE

Books on power transformers in German – Part I

A bibliography 1888 – 1914

Preface

P. Ramachandran has been compiling a bibliography of transformer books in various languages for over half a century, referring to the transformer books in his home library. In 2020, he invited Vitaly Gurin to clarify and supplement the list of books on power transformers in German. The latter significantly expanded the initial version of the bibliography manually referring to the relevant websites [1-10].

Books in the bibliography are grouped in the chronological order by year. The

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start date of the bibliography is 1888 (the first book on transformers published anywhere, just three years after patenting transformers), covering the period up to 2019.

For each year, books are listed in alphabetical order by the name of the first author. The full names of the authors or their abbreviations, as well as the location of the name (before or after the last name) in the bibliography, are indicated as on the cover or on the title page of the book. In those cases when the photo or scan of the book was not available, the names of the authors were taken from the available bibliographic cards of the books and placed in front of the surname.

The description of the book is given in this order: author, the title of the book, edition number, the name of the publisher, the city where the book was published, number of pages, and the year.

If the book has been published only once, the edition number is not indicated. When a book has been published repeatedly and the names of the publisher, city, and / or the number of pages coincide, the latter are not indicated. In those cases when, unfortunately, not all editions were found, only the found editions are indicated.

The book titles are indicated in italics in the original language (German). In the parentheses is the the book title in English. All other data is also translated into English.

A few of the most important books are provided with brief authors' comments (framed).

1888

F. Uppenborn, *Geschichte der Transformatoren* (History of the transformers), de Gruyter, Munich - Leipzig, Pages 60, 1888; Reprint 2019; Reprint 2020 [11]

Figure 1. History of the transformers, F. Uppenborn

For a few of the most important books, brief authors' comments are provided

QUOTE: *"As we wish to write of those discoveries which led up to the invention of the transformer, we must go back to a time, old as compared with the modern development of electrotechnics. For the starting-point of our observations we shall take Faraday, who, like Newton in mechanics, led the way in the domain of electricity, and whose name stands in the most intimate relations with all inventions for the mechanical production of the electric current, and therefore with the later development of electrotechnics".*

1831 FARADAY uses in his experiments a circuit that fundamentally differs little from a transformer: a closed iron ring with two windings.

1856 S. A. VARLEY produces a transformer with a closed, divided iron circuit and the first jacket transformer, and invents the disc coil winding.

1887 GISBERT KAPP (1852-1922) creates the basic work for the theory of the transformer. The names "Kern-transformator" and "Manteltransformer" come from him. Unfortunately, we did not find this work by G. Kapp, but we are sure that it was included in his book in 1895 (see in section 1894 - 1895).

1889 M. V. DOLIVO-DOBROWOLSKY (1862-1919) invents the three-phase transformer with magnetic interlinking (German patent No. 56359 dated 29 August, 1889).

1894 - 1895

Clarence Paul Feldmann, *Wirkungsweise, Prüfung und Berechnung der Wechselstrom-Transformatoren / für die Praxis bearb.; Teil 1* (Mode of operation, testing and design of the AC transformers / for practice edit.; Part 1), Leiner, Leipzig, Pages XII+228, 1894; Reprint Nabu Press, Pages 538, 2014; Reprint Forgotten Books, Pages 534, 2018; Reprint Wentworth Press, Pages 536, 2018 [12]

Clarence Paul Feldmann, *Wirkungsweise, Prüfung und Berechnung der Wechselstrom-Transformatoren / für die Praxis bearb.; Teil 2* (Mode of operation, testing and design of the AC Transformers / for practice edit.; Part 2, Leiner, Leipzig, 1895

CLARENCE FELDMANN (1867-1941) studied electrical engineering at TD Darmstadt, worked at Ganz & Co in Hungary, and was a professor of electrical engineering at Darmstadt and Delft. He was the president of the Dutch Electrotechnical Committee (1912-1940), and the first Dutch president of the IEC (1927-1930).

Gisbert Kapp, *Dynamomaschinen fur Gleich- und Wechselstrom und Transformatoren* (Dynamo machines for direct and alternating current and transformers), J. Springer und Oldenbourg, Berlin-Munchen, Pages VIII+331, 1894; Ed.2.0, J. Springer, Berlin, Pages 374, 1897; Ed.3.0, Pages 326, 1907; Ed.4.0, Pages 620, 1904

Gisbert Kaap, *Transformatoren fur Wechelstrom und Drehstrom, Eine Darstellung ihrer Theorie, Konstrukzion und Anwendung* (Transformers for AC and DC current, a representation of their theory, construction and application), J. Springer, Berlin, Pages 206, 1895; Ed.2.0, Pages 282, 1900; Ed.3.0, 1907; Reprint Ed.2.0 on Demand, Pages 296, 2019

GISBERT KAPP was educated as an electrical engineer in Vienna. Then he moved to Birmengen. He developed the basics of calculating and designing dynamo machines and transformers. In 1904-1919, he headed the Department of Electrical Engineering at the University of Birmingham. In 1909, he was elected the president of the Institution of Electrical Engineers.

Heinrich Kratzert, *Grundriss der Elektrotechnik : Für den praktischen Gebrauch, für Studierende der Elektrotechnik und zum Selbststudium T. 2: Transformatoren, Akkumulatoren, elektrische Beleuchtung und Kraftübertragung mit besonderer Berücksichtigung der elektrischen Eisenbahnen* (Basics of electrical engineering: For practical use, for students of electrical engineering and for self-study T. 2: Transformers, accumulators, electrical lighting and power transmission with special consideration of the electri-

Figure 2. A three-phase transformer

cal railways), Deuticke, Leipzig, Pages VIII+346, 1895; Ed.2.0, Pages XI+464, 1903 [13]

1900

Franz Sallinger, *Transformatoren* (Transformers), de Gruyter, Berlin, Pages 112, 1900; Series: Sammlung Göschen 952 (Series: Göschen Collection 952), de Gruyter, Berlin, Pages 112, 1927 [14, 15]

1901

G. Dettmar, *Normalien zur Prüfung von elektrischen Maschinen und Transformatoren* (Standard parts for testing electrical machines and transformers), Springer, Berlin, Pages 52, 1901

GEORG DETTMAR (1871-1950) was an active participant in the creation and development of standards for electric machines, transformers, and other electrical equipment and electrical installations. This first of his books was the beginning of the standardisation of the VDE. Dettmar's norms and books on their explanation are constantly improved and repeatedly published and reprinted (see, for example, the years 1914 and 1930 in this bibliography). He was the Secretary General of the VDE (1905-1921). He was called the "father of electrical engineering."

The first Electrotechnical Association was founded in 1879 by Werner von Siemens and the imperial postmaster General Heinrich von Stefan. It was the first association in the world that dealt with all areas of electrical engineering.

After the emergence of new electrical engineering associations in Germany, their delegates founded the Association of German Electrical Engineers in 1893 (abbreviated as: VDE). Since then, the VDE has become the most important representative body for electrical engineering in Germany and one of the largest associations in Europe.

The first complete book of VDE standards was published in 1904.

1831 Faraday discovered electromagnetic induction, 1856 A. Varley perfected transformer design, 1888 F. Uppenborn the first book on transformers - Geschichte der Transformatoren (History of the transformers)

1902 -1904

J. L. la Cour, *Theorie der Wechselströme und Transformatoren (=Die Wechselstromtechnik ; Bd. 1)* (Theory of alternating currents and transformers (= AC technology; Vol. 1). [Hrsg. E. Arnold], Springer, Berlin, Pages 425, 1902

J. L. la Cour, *Die Transformatoren: Ihre Theorie, Konstruktion, Berechnung und Arbeitsweise (=Die Wechselstromtechnik ; Bd. 2)* (The transformers: Their theory, construction, design and method of operation (= AC technology; Vol. 2), [Hrsg. E. Arnold], J. Springer, Berlin, Pages 404, 1904; Ed.2.0, Pages 450, 1910; Unchanged reprint, 1923; Ed.3.0 (with F. Faye-Hansen), Pages 699, 1936

This second volume of the five-volume *«Die Wechselstromtechnik»*, is devoted to the theory, calculation and design of transformers. The five volumes were popular and withstood several editions in the first quarter of the twentieth century. One of the authors, Swiss electrical engineer ENGELBERT ARNOLD (1856 - 1911), became a leading engineer in Orlikon in 1891, and in 1896 he founded and was the first professor at the Electrotechnical Institute, and then rector of the TH Karlsruhe. His assistant, JENS LASSEN DE LA COUR (1976-1956), a Danish engineer, was the Technical Director of ASEA from 1907-1914.

Leitfaden für die Uebungen im Laboratorium. 2.Tel. Experimentelle Untersuchung der Wechselstromgesetze, der Vorgänge in Wechselstromkreisen und der Transformatoren (Guide for laboratory exercises. 2. Tel. Experimental investigation of AC laws, processes in AC circuits and transformers), Technischen Hochschule Karlsruhe, Pages 109, 1904 [16]

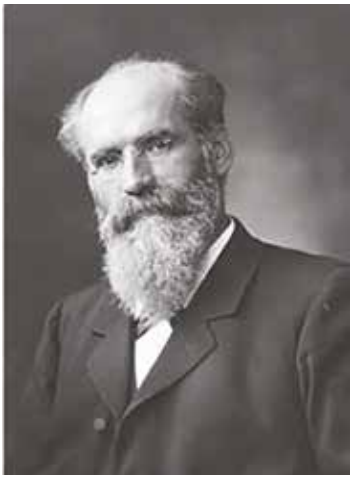

Figure 3. Arnold Engelbert

W. Winkelmann, *Entwerfen von Weckselstrommaschinen und Transformatoren. Vorträge* (Design of wake-up current machines and transformers. Lectures), Hannover, Pages 90, ca 1903

1907

Friedrich Weickert, *Prüfung elektrischer Maschinen und Transformatoren* (Testing of electrical machines and transformers), M. Janecke, Hannover, Pages 119, 1907; Ed.2.0, M. Janecke, Leipzig, Pages 188, 1917; Ed.3.0, 1922

Figure 4. Testing of electrical machines and transformers, Friedrich Weickert

Wilhelm Winkelmann, *Transformatoren und Asynchronmotoren : Ihre Wirkungsweise, Berechnung und Konstruktion* (Transformers and asynchronous motors: Their mode of operation, design and construction), M. Janecke, Hannover, Pages 136, 1907; Reprint 2018 [17, 18]

Ernst Schulz, *Die Krankheiten elektrischer Maschinen. Darstellung der Störungen und Fehler an Genaratoren, Motoren und Transformatoren und ihre Abhilfe, für den praktischen Gebrauch der Installateure, Monteure und Maschinenwärter* (The diseases of electrical machines. Presentation of malfunctions and faults in generators, motors and transformers and their remedies, for the practical use of installers, fitters and machine attendants), M. Janecke, Hannover, Pages 95,1905; Ed.2.0, 1907; Ed.4.0, Leipzig, Pages 107, 1917; Ed.9.0, 1942; Ed.10.0, 1944

1908

Karl Pichelmayer, *Handbuch der Elektrotechnik. Fünfter Band: Dynamobau. Berechnen und Entwerfen der elektrischen Maschinen und Transformatoren* (Electrical engineering manual. Fifth volume: Create a dynamo. Calculation and design electrical machines and transformers), Hirzel, Leipzig, Pages 745, 1908

VDE, *Normalien für Bewertung und Prüfung von elektrischen Maschinen und Transformatoren: Normalien für die Bezeichnung von Klemmen bei Maschinen, Anlassern, Regulatoren und Transformatoren. Normale Bedingungen für den Anschluss von Motoren an* öffentliche *Elektrizitätswerke. Normalien für die Verwendung von Elektrizität auf Schiffen* (Standard parts for evaluation and testing of electrical machines and transformers: Standard parts for the designation of terminals on machines, starters, regulators, and transformers. Normal conditions for connecting motors to public power plants. Standards for the use of electricity on ships), Springer, Berlin, Pages 44, 1908; Classic Reprint, Forgotten Books, Pages 78, 2018 [19]

In 1917, the standard Committee on General Mechanical Engineering (DIN) was founded in Berlin. This committee represents technical bodies, technical associations and companies from mechanical engineering, electrical engineering, precision engineering, shipbuilding, etc.

In 1970, DIN and VDE established DKE as the central agency in Germany for electrotechnical standardisation.

"In 1975, the position of the DKE was legally ensured in a "standardisation agreement" between DIN and FRG. From then onwards, DIN has become "the German Institute for Standardisation"(Deutsche Institut fur Normung = DIN)".

Hermann Zipp, *Dynamomaschinen, Elektromotoren und Transformatoren als Energieumformer (= Bibliothek der Technik und Industrien, Band 10)* (Dynamo machines, electric motors and transformers as energy converters (= Library of technology and industries, Volume 10), Moritz, Stuttgart, Pages 307, 1908 [20, 21]

1909

Gustav Benischke, *Die Transformatoren, ihre Wirkungsweise, Konstruktion, Prüfung und Berechnung* (The transformers, their mode of operation, design, testing and calculation), F. Vieweg and Sohn, Braunschweig, Pages 220, 1909 [22]

J. Herrmann, *Elektrotechnik. Einführung in die moderne Gleich- und Wechselstromtechnik. Dritter Teil: Die Wechselstromtechnik. Kurze Beschreibung der Generatoren, Transformatoren und Motoren für Wechselstrom* (Electrical engineering. Introduction to modern direct and alternating current technology. Third part: AC technology. Brief description of generators, transformers and motors for alternating current), G. J. Göschen'sche Verlagshandlung, Berlin-Leipzig, Pages 123, 1909

1911

AEG, *Wartungsanweisung für fahrbare Transformatoren* (Maintenance instructions for mobile transformers), Verlag AEG, Pages 7, 1911 [23]

1912

K. A. Schreiber, *Theorie, Berechnung und Untersuchung von Transformatoren* (Theory, calculation and study of transformers), Enke, Stuttgart, Pages 246, 1912

1913

Brown-Boveri, *Induktions-Regulatoren (Drehtransformatoren) mit selbsttätiger Steuerung* (Induction regulators (rotary transformers) with automatic control), Springer, Pages 11, 1913

Ernst Schulz, *Die elektrischen Maschinen. 2. Band: Generatoren, Transformatoren, Motoren für Wechsel- und Drehstrom. Bibliothek der gesamten Technik 214* (The electrical machines. Volume 2: Generators, transformers, AC and DA motors. General technology library 214), Ed.2.0, M. Janecke, Leipzig, Pages 102, 1913 [24]

1914

R. Bachmann, *Die thermischen Grundlagen der Ölkühlung elektrischer Apparate, insbesondere von Transformatoren. Dissertation* (The thermal basics of oil cooling of electrical apparatus, especially transformers. Dissertation), TH Dresden, 1914

G. Dettmar, *Erläuterungen zu den Normalien für Bewertung und Prüfung von elektrischen Maschinen und Transformatoren, den Normalen Bedingungen für den Anschluß von Motoren an öffentliche Elektrizitätswerke und den Normalien für die Bezeichnung von Klemmen bei Maschinen, Anlassern, Regulatoren und Transformatoren* (Guide for the evaluation and testing of electrical machines and transformers-General requirements for motors used in Electric Power grid and terminal markings for Electric Machines, Transformers, Regulators and Starters), Ed.4.0, Springer, Berlin, Pages 160, 1914 [25]

QUOTE: *"In the fall of 1899, I brought to the attention of Association of German Electrical Engineers the difficulties faced in measuring the efficiency of Generators and Motors due to the uncertainties associated with current standards. I requested Mr. Griff Kapp to set up a technical committee to investigate the matter. He readily agreed and expanded the scope of study committee to include the performance requirements of drives for trams and also to remove current differences in the permissible temperature rise limits. The unanimous response from the audience showed how timely and desirable my proposal was."*

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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.

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.