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COMPONENTS HANDBOOK

Edited by

JOHN F. BLACKBURN

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COMPONENTS HANDBOOK

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Foreword

THE tremendous research and development effort that went into the development of radar and related techniques during World War II resulted not only in hundreds of radar sets for military (and some for possible peacetime) use but also in a great body of information and new techniques in the electronics and high-frequency fields. Because this basic material may be of great value to science and engineering, it seemed most important to publish it as soon as security permitted.

The Radiation Laboratory of MIT, which operated under the supervision of the National Defense Research Committee, undertook the great task of preparing these volumes. The work described herein, however, is the collective result of work done at many laboratories, Army, Navy, university, and industrial, both in this country and in England, Canada, and other Dominions.

The Radiation Laboratory, once its proposals were approved and finances provided by the Office of Scientific Research and Development, chose Louis N. Ridenour as Editor-in-Chief to lead and direct the entire project. An editorial staff was then selected of those best qualified for this type of task. Finally the authors for the various volumes or chapters or sections were chosen from among those experts who were intimately familiar with the various fields, and who were able and willing to write the summaries of them. This entire staff agreed to remain at work at MIT for six months or more after the work of the Radiation Laboratory was complete. These volumes stand as a monument to this group.

These volumes serve as a memorial to the unnamed hundreds and thousands of other scientists, engineers, and others who actually carried on the research, development, and engineering work the results of which are herein described. There were so many involved in this work and they worked so closely together even though often in widely separated laboratories that it is impossible to name or even to know those who contributed to a particular idea or development. Only certain ones who wrote reports or articles have even been mentioned. But to all those who contributed in any way to this great cooperative development enterprise, both in this country and in England, these volumes are dedicated.

L. A. DuBRIDGE.

Preface

THIS volume is intended primarily as a companion and reference work for Vols. 18 through 23 of the Radiation Laboratory Series. It contains data on a number of classes of electrical and electronic components which are of principal interest to the designer of receiving and test equipment. In so far as possible it emphasizes the components which were developed by or under the sponsorship of the Radiation Laboratory, or were of primary importance in its work. In order to avoid a one-sided presentation, however, this material has been supplemented with other data so that in most cases an individual chapter approximates a survey of current practice in its particular field.

The title "Components Handbook" is undoubtedly too inclusive for the volume as published, since the circumstances under which it was written have unfortunately prevented the inclusion of chapters on several important classes of components and have also had some effect on the contents of those that were included. The most serious omission is probably that of fixed condensers. Chapters were also projected on air-core inductors, on mechanical components, and on several other subjects. Credit is due the authors who contributed to these chapters; the omission of their work was due neither to any faults of the work itself nor to a lack of interest in the subject matter, but solely to the fact that the termination of the Office of Publications caused these chapters to be left out. Their omission is a serious if unavoidable defect.

The completeness of coverage of a particular field depends in large measure upon the amount of time which the individual author was able to devote to it. The necessity for the immediate acceptance of postwar jobs, usually far from Cambridge, made it impossible for most of the authors to check their work in final manuscript form. In such cases the editor hopes that the collation and condensation of the original drafts have not resulted in serious errors of fact or in undue distortion of the presentation.

In order to make the volume useful both to the academic research worker and to the engineer in the industrial laboratory the editor has tried in most cases to combine the generalized "survey-of-a-field" form

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with a reasonable amount of specific data, largely in tabular form. For discussions of the accuracy and balance of several of the chapters indebtedness is expressed to their authors or to others equally familiar with the subjects. These discussions have considerably improved the book.

It is a pleasant task to record appreciation of the help of the many people, both in the Office of Publications of the Radiation Laboratory and outside, who have had a hand in the preparation of this volume. The lack of space prevents the listing of names, but this omission has been rectified as far as possible by the inclusion of credit lines to sources outside the Laboratory and by the following list of sources of the individual sections.

In a book such as this one it is difficult to apportion credit fairly because many of the chapters are the result of a process of synthesis and rearrangement that left little of the original reactants. The names listed at the heads of the chapters are those of authors who are responsible for major portions of those chapters; a somewhat more detailed list of credits follows: O. Abbiati, Secs. 12-9 through 12-11; F. N. Barry, Chap. 14; P. F. Brown, Secs. 5-1 and 5-2; F. E. Dole, Chap. 8; G. Ehrenfried, Chap. 2 and Secs. 3-14, 3-15 and parts of Secs. 3-9 and 3-10; M. D. Fagen, Secs. 1-1 through 1-11, 3-1 through 3-8, and part of Sec. 3-11; S. Frankel, Secs. 5-3 through 5-5; S. N. Golembe, parts of all sections of Chap. 4; W. F. Goodell, Jr., Secs. 10-1 through 10-16; E. A. Holmes, III, Chap. 9; M. M. Hubbard, Secs. 12-5, 12-6, 12-8, and 12-12; M. M. Hubbard and P. C. Jacobs, Jr., Secs. 12-3, 12-4, and 12-7; H. B. Huntington, Chap. 7; H. E. Kallman, Sec. 1-12 and Chap. 6; T. B. Morse, Chap. 11.

The volume editor is responsible for the remainder of the book and for numerous interpolations in the texts of some of the authors above. For advice and for miscellaneous data in connection with these interpolations, credit is due to a number of members of the Radiation Laboratory, including the following: H. F. Brockschmidt and D. N. Summerfield, for data on engine-driven generator sets in Secs. 12-3, 12-4, and 12-5; C. E. Foster, for reviewing Chaps. 10 and 13 and for additional data for these chapters; C. E. Foster and E. R. Perkins, for original rough draft of Chap. 10; M. M. Hubbard, for reviewing Chaps. 4, 11, and 12; J. M. McBean, for data on the electronic line-voltage stabilizer of Sec. 12-13; R. J. Sullivan, for reviewing Chap. 8, and for additional data; C. A. Washburn, for data on high-voltage power-supply transformers of Sec. 4-3, and for data on M-1060 regulator tube in Sec. 14-2.

It may seem invidious to single out an individual for credit when so many have helped, but the editor cannot refrain from expressing gratitude to Mr. F. N. Barry, who performed the laborious task of compiling the tables of receiving tubes and who wrote the accompanying text for Chap. 14. Most of this work was done after his termination from the

PREFACE

Laboratory and his acceptance of another job, and at considerable personal sacrifice.

The editor is also deeply indebted to Mrs. Barbara D. Côté for her faithful and efficient services as editorial and production assistant, and to his wife, Harriet, for aid in typing and proofreading.

JOHN F. BLACKBURN.

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