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ELECTRONIC INSTRUMENTS

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First Edition

NEW YORK · TORONTO · LONDON
McGRAW-HILL BOOK COMPANY, INC.
1948

ELECTRONIC INSTRUMENTS

THE MAPLE PRESS COMPANY, YORK, PA.

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.

ELECTRONIC INSTRUMENTS

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Preface

THE title of the present volume, *Electronic Instruments*, carries with it the implied adjective "some." The specific kinds of electronic instruments which are treated are *electronic analogue computers, instrument servomechanisms, voltage and current regulators*, and *pulse test equipment.* Aside from the common denominator indicated by the title, these four types of equipment share claims as important adjuncts to many modern radar systems.

It has been the object of the authors to present both theoretical background and practical details of these instruments as they were known to the radar engineer. However, the authors believe firmly that radar applications of these devices represent only a very small part of their field of utility. An attempt has been made to emphasize the sort of information which the authors felt would have been most helpful to them when they were required to solve problems in the fields represented by this volume.

The preservation of the material of this volume was made possible through the foresight of I. I. Rabi and L. A. DuBridge, who appointed a committee consisting of L. J. Haworth, G. E. Valley, and B. Chance to consider the scope and content of a series of books on the general subject of electronic circuits. Volumes 17 to 22 of the present series are the result of the committee's survey. At the termination of hostilities an intensive writing program, under the leadership of L.N. Ridenour, was put into effect. Because of the rapid dissolution of the Radiation Laboratory, an accelerated writing schedule, using as many authors as possible, was unavoidable. Even with such a policy many authors made real sacrifices in giving up or postponing positions and fellowships in order to complete their contributions. The combination of accelerated schedules and divided efforts has regrettably resulted in discontinuities in the scope and treatment of the material covered, and in many cases has led to historical study inadequate for the proper assignment of credit for developments reported.

At the termination of the Radiation Laboratory Office of Publications, some of the writing, much of the editing, and all of the proofreading of the present volume still remained to be done. Credit for the

completion of this volume belongs in a large degree to the General Precision Laboratory Inc., of Pleasantville, N.Y. This Laboratory generously permitted one of the technical editors of the present volume to devote a large fraction of his time over a period of many months to the project, and made available extensive secretarial and drafting assistance. In addition, much of the manuscript was read and criticized by other members of the staff. Credit is due the many authors who assisted in the checking of proofs long after they had left the employ of the Radiation Laboratory.

Many of the developments described in this volume are contributions from laboratories in the United Kingdom. It is a pleasure to acknowledge the unstinting support of these British laboratories, and especially of Telecommunications Research Establishment (TRE). Through their generosity, several experts have visited this country and have contributed much useful information to this and other volumes of the Radiation Laboratory Series. Our gratitude for this international cooperation is due Sir Robert Watson Watt, W. B. Lewis, B. V. Bowden, F. S. Barton, F. C. Williams, and N. F. Moody, and their associates.

Background material on which parts of this volume are based was contributed by H. S. Sack of Cornell University.

The preparation of manuscript and drawings would have been impossible without the help of the production department under C. Newton; the Technical Coordination Group, under Dr. Leon Linford; the typing pool, under M. Dolbeare and P. Phillips; and the drafting room, under Dr. V. Josephson. The authors wish to acknowledge the invaluable help of the following editorial assistants, production assistants, and secretaries: Louise Rosser, Nora Van Der Groen, Joan Brown, Helene Benvie, Teresa Sheehan, Joan Leamy, Barbara Davidson, and Helen Siderwicz, all of the Radiation Laboratory, and Mary Pollock, Nora Applegate, and Gordon Clift of General Precision Laboratory.

THE AUTHORS.

CAMBRIDGE, MASS.,
October, 1946.

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