On the other hand, we can easily find many places where the authors show exceptional care. In discussing the hydrolysis of bicarbonate ion, they point out that either of the simplifying assumptions made in calculating the pH gives an answer far different from the experimental value. By any standards this text should join the highest rank of its kind. The content of the book reveals a mastery of the subject, and the style in which it is written reveals the beauty. The typography is excellent, but the thin paper will probably not stand hard use.

ROBERT EPPLE

*Brown University*

***Electric contacts.*** Ragnar Holm. Stockholm: Almquist & Wiksells, 1946. Pp. xvi + 398. (Illustrated.) 45:-.

Electric contacts have an important role in modern living. However, the physical principles of contact phenomena have not been correlated fully with experimental data. Present knowledge is confined largely to well-guarded production techniques and empirical formulas that the industry has amassed. This book is an attempt to describe in general terms the physics of contacts and to develop fundamental formulas in agreement with data taken by the author and colleagues over a period of some 20 years.

As noted in the text, the book was written while the author was a physicist in the Research Laboratory of the Siemens Works in Berlin, one of the outstanding industrial laboratories on the continent between the first and second World Wars. Translation of the book into English introduced some minor errors in spelling and terminology, but these in no sense lessen its technical value.

The style used by the writer is a balance of thoroughness and clarity. He begins with a complete list of symbol definitions and a qualitative résumé of the major conceptions used throughout the work. Such an introduction is necessary, because many of the symbols and terms used either have not received universal recognition or are used here to introduce new concepts, e.g. "constriction resistance" and "coherer action."

Stationary contacts are considered in Part I. The general theory of contact surfaces and contact resistance is treated in some detail. This is followed by a theoretical analysis of the interrelation between electric potential differences, temperature gradients, and impedance in contacts. The role of electrodynamic and electrostatic forces is outlined. The influence of pressure and tarnish films on contact resistance is carefully described. Tables and plates are interspersed that in the main confirm, but at times are not in full agreement with, the theory. The author goes to some lengths to point out that in many instances only the results of preliminary investigations are available, and that more detailed research is necessary before useful formulas can be evolved.

Part II is a study of sliding contacts. The concept of friction and its effect on contact resistance is treated in considerable detail. The relative physical properties of several combinations of contact materials are presented in detailed tabular form with a commentary on the observations.

Part III begins anew with a survey of the short switch arc, including a study of the VI-relationship, bouncing, oxidation, arc duration, and methods of quenching and suppression. The physics of contact erosion and transfer of matter are very clearly presented with substantiating data.

Part IV, a retrospect, is purely historical. Going back to the early experiments of Franklin and Leyden, it traces the evolution of the concept of contact resistance to the present day. A very complete author and literature index is included.

As a whole, the book is written on a plane that will qualify it as a reference text for graduate students in electrical engineering or as a handbook for industrial design engineers. Some parts of the text, printed in brevier, are intended primarily for the physicist and afford a prolific ground for the selection of problems for fundamental and applied research.

MERLE H. BRAGDON

*Naval Ordnance Laboratory,*
*White Oak, Silver Spring, Maryland*

***Servomechanism fundamentals.*** Henri Lauer, Robert Lesnick, and Leslie E. Matson. New York-London: McGraw-Hill, 1947. Pp. xi + 277. (Illustrated.) $3.50.

The fundamental principles of servomechanisms are so presented in this book as to require a minimum background in mathematics and physics. A chapter on the fundamentals of mechanics and electricity is included, and the necessary differential equations are presented and solved in detail by classical methods. Thus, considerable review of the necessary background material is provided in the book itself.

The fundamental servo control system is developed, and its essential components are pointed out. These components are an error-detecting device which compares the actual output quantity with a given input requirement, and a controller embodying the necessary amplifiers and motors to cause the output to correspond to the input requirement. The need for damping and stabilizing devices is also pointed out. The more common error-detecting devices such as synchros are discussed fully, and several examples of servo systems are given.

The transient response of various typical servomechanisms is studied by means of classical differential equations. First, a system with a proportional controller whose only damping is the viscous friction of the output member is considered. This system has the disadvantage of a steady-state error if the input is a constant velocity. This undesirable error is found to be absent if all the damping is produced in the controller by means of an additional effort proportional to the rate of change of error. Systems with error-rate damping and combined damping are then studied. Networks for producing this error-rate stabilization are also discussed. Elimination of the steady-state error by means of integral control is then discussed, and systems with integral control are studied. Networks for producing integral control are also included.

The response of servo systems to a sinusoidal input function is mentioned in various places in the text, and a chapter near the end of the book gives an introduction to the frequency response or transfer function analysis. Nyquist's stability criterion is stated, and various plots of the transfer function are given. This chapter serves as an introduction to the more advanced treatises using this method of analysis.

Although the book has many excellent solved examples and one chapter treats typical design calculations, it is felt that its value as a textbook would be increased by the addition of a number of well-chosen problems.

F. CARLIN WEIMER

*Ohio State University*