tions cited report work done up to 1946 in a number of widely scattered countries but mostly in greater America. (The reviewer has failed to find any references to papers published in Scandinavia, France or Italy. Is this because interest in the root-forming powers of chemicals has not yet been aroused in these countries?) Most of the reports are no more than a few pages long. Few of them can be considered as making, by themselves, solid contributions to scientific knowledge; but, read with other texts (for example, the appropriate chapters in Went and Thimann's "Phytohormones" (1937), and in "Hormones and Horticulture" (1947), by Avery *et al.*), the information collectively contained in them, assembled as it has been by Prof. Thimann and Miss Behnke, may well assist in the design of future experiments by plant physiologists who, working on ideas derived from those of Sachs and Beyerinck, seek to unravel the complexities of reacting systems which are competent to produce lateral and adventitious roots.

Up to the present, in this field practical control has outdistanced intellectual control. For the physiologist there may therefore be too little about too much in this book; but gardeners and foresters will find in it a mine of information to guide them in their efforts to establish the conditions which will, with surety, accelerate the rooting of cuttings from ornamental plants or from herbs, shrubs and trees of economic importance. The authors give accounts, ingeniously condensed, of five thousand trials on nearly four hundred genera, with species, varieties and hybrids of *Rhododendron*, *Prunus*, *Pinus*, *Picea*, *Citrus* and *Rosa* among those most used. In these trials, observations have been made of the influence on powers of quick rooting (taking a week or two) or of slow rooting (taking up to a year or more) exerted by one or more of twenty-one synthetic chemicals and sixteen commercial auxins (only one of British manufacture) applied in a variety of ways (basal dipping, coating, etc.) to different kinds of cutting (leafy and leafless softwood or hardwood, leaf, leaf-bud, etc.). Clearly the authors have disseminated much helpful and stimulating information.

M. Thomas

SERVOMECHANISMS

Theory of Servomechanisms

Edited by Prof. Hubert M. James, Nathaniel B. Nichols and Assoc. Prof. Ralph S. Phillips. (Massachusetts Institute of Technology; Radiation Laboratory Series, No. 25.) Pp. xiv + 375. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 5 dollars.

IT is appropriate that one of the first major works to be published on the theory of servomechanisms is a product of Massachusetts Institute of Technology. The contributions during the past few years of both the M.I.T. Servomechanisms Laboratory and Radiation Laboratory to the theory and practice of automatic control are well known and highly respected by specialists in the subject, and this book, which is volume 25 in the Radiation Laboratory Series, will be welcomed universally. Notwithstanding the fact that there are ten contributing authors, the editors have arranged the mass of new material at their disposal admirably, and continuity in the development of the main ideas is maintained throughout. Several chapters include hitherto unpublished work. For example, a chapter is devoted to the conditions for stability of filter networks and control systems which are actuated by intermittent data; to the reviewer's knowledge no previous quantitative studies of these important systems have been undertaken.

The authors have been influenced in their treatment of the servo problem by modern electric filter design theory and communication engineering techniques. This is no doubt due to the nature of the servo design problem with which they were concerned during the War, namely, the design of automatic following radar equipment. In the development of such equipment the major problem is to minimize the effect of spurious misalignment signals, a problem which is analogous to that of increasing 'signal to noise' ratio in a communications system. An interesting method of dealing with such a situation is described by Prof. Phillips in Chapter 7. If the input 'noise' is assumed to be purely random and optimum performance of the system is assumed when the value of the root mean square error is a minimum, the method shows how optimal values for the control parameters can be obtained without the necessity of deriving the roots of high-degree characteristic equations; the method is illustrated by numerical examples.

The introductory chapter by Prof. Getting is excellent both in its conciseness and quality; it is, in fact, the best short introduction to the basic philosophy of servo system design known to the reviewer. Another valuable feature is the chapter devoted to the study of the behaviour of typical elements used in the design of control systems, such as error measuring devices, servo motors, power amplifiers and gear trains.

The chapter on general design principles introduces the Nyquist stability criterion, the concept of 'equalization' (for example, stabilization) of servo loops, and an elegant application of the attenuation (expressed in decibels) – log frequency and phase – log frequency diagrams to illustrate the frequency response characteristics of a control system and their use in the important problem of controller synthesis. In order to exemplify the power of these new theoretical techniques, a typical radar tracking control system is analysed in detail and, as a second example, the design of a low-power servo system incorporating a two-phase induction motor is discussed.

In view of the authoritative nature of the book it is perhaps somewhat disappointing that it is devoted exclusively to linear systems, especially since it is becoming increasingly clear that non-linear effects such as backlash in gear trains, static friction, saturation of amplifiers, resilience in shafts, etc., constitute the most important factors which limit the performance of modern servo systems. Admittedly, the difficulty of handling such problems is considerable and probably justifies their omission.

A minor criticism concerns the introduction of the problem of designing a manual control system in the last chapter. Despite considerable advances in the design of manual controls, it is unlikely that the transfer function of a human operator will be known with any accuracy for a considerable time to come. The assumption that an operator in tracking a target turns a handwheel at a rate proportional to the error which existed, say, 0·3 sec. previously, cannot be substantiated by experiment and can be misleading.

A. Porter