come emphasis is laid on the synthesis of ammonia. The general progress of the synthesis, including a discussion of the inherent requisites for good ammonia catalysts, is dealt with by W. G. Frankenburg on the basis of the necessary activation of the nitrogen, by chemisorptive linking of suitable bond-strength to the catalyst, in addition to the activation of the hydrogen. This is followed by a monograph by a group of chemists from the Dutch Staatsmijnen on research on the ammonia synthesis since 1940, the outstanding feature in this section being a clear exposition of the mechanism of promotion. The synthesis of methanol is discussed by G. Natta with special reference, first, to the necessary specificity of action which is required in the catalysts employed in order to avoid the formation of polymeric products, and, secondly, to the merits of particular catalysts. R. Feuge contributes a practical account of modern methods of working in the industrial hydrogenation of glyceride oils. In this, the discussion of forms of nickel catalysts alternative to kieselguhr-supported nickel prepared by the reduction of basic nickel carbonate is particularly valuable. Finally, the technical dehydrogenation of hydrocarbons in the petroleum industry is described, perhaps too briefly, by K. K. Kearby.

Considered as a whole, this volume represents a fair balance between the academic and the industrial aspects of hydrogenation. Its component articles are of a consistently high quality. It certainly stands out from the earlier volumes of the work, in particular from the point of view that chapters containing tables of largely undiscussed references to patent and other literature are absent; and Dr. Emmett is to be congratulated on assembling, within the compass of some five hundred pages, such an authoritative and internationally contributed description of catalytic hydrogenation.

E. B. Maxted

## AUTOMATIC REGULATION

### Servomechanism Analysis

(McGraw-Hill Electrical and Electronic Engineering Series.) By George J. Thaler and Robert G. Brown. Pp. xii+414. (New York and London: McGraw-Hill Book Company, Inc., 1953.) 60*s*. net.

At a time when so much is written and talked about the automation of manufacturing processes, the automatic control of aircraft, guided missiles and the like, a book is welcome which sets out to give the mathematical background for the analysis and design of servomechanisms. The present volume under review is written in a fluent and clear style and contains a great number of worked examples and of problems enabling the student to ascertain whether he has grasped the contents of the chapters he has read and to gain some experience in handling actual problems of control. A very welcome feature is a brief and sufficiently clear introduction to the theory of Laplace transformations which are used throughout the book.

As problems of electric circuits can usually be solved with not too great difficulty either directly or with the aid of analogue computers, electrical analogues are set up of mechanical, thermal, hydraulic and pneumatic systems. The book then deals with the transient analysis of servomechanisms, that is, the derivation, solution and discussion of their differential equations for determining the main criteria of performance, the speed of response, the steady-state error, the maximum overshoot and the resonant frequency for the case when changes in input or output occur. Proportional as well as derivative and integral control are dealt with.

The next chapter deals with transfer functions and their graphical representation, the transfer function being defined as the complex ratio of the output of the device to its input (p. 112). The authors seem to be not quite consistent in that a few pages later (p. 126) they call this ratio the frequency response function, while the direct transfer function is defined as the ratio between output and error, this latter being the difference between input and output. The reason for this apparent inconsistency is given on p. 140 and following.

Simplifications are made for the mathematical analysis by replacing complicated schematic drawings by equivalent block diagrams and by introducing a shorthand notation for the transfer function, representing it as the product of a constant factor $K$ and a complex factor $G$. The symbols $K$ and $G$ are replaced by $A$ and $F$ respectively if a control element is used in the feedback path. Frequency response curves and curves of direct and inverse transfer functions are given in rectangular and polar co-ordinates, respectively. Then the performance of servomechanisms is analysed from equations and plots, stability criteria are discussed at some length, a classification of the systems is given and figures of merit are defined. Only very brief chapters deal with the introduction to design and with gain adjustment. A trial-and-error method and direct methods for the gain adjustment are given.

Where gain setting alone is not sufficient for obtaining the desired values of resonant frequency and steady-state error, some kind of compensation must be applied either in the main circuit or in a parallel circuit. Series and parallel compensation are therefore dealt with at some length in the next two chapters. Then it is shown how, by the use of logarithmic co-ordinates, analysis and design may be simplified in many cases. A brief chapter deals with relay servomechanisms as these find wider and wider application. Here electromechanical relays are used for applying full power to the output when the error is excessive and to maintain it until the error is sufficiently reduced. The final chapter, dealing with the 'root-locus method', might be of particular interest, as this method claims to combine to some extent the advantages of the transient and the transfer function analysis. But, due to limitations of space, only the elements are given and the chapter is somewhat sketchy.

The authors do not claim originality for the material contained in this book, but have found in their teaching practice that the arrangement and detail of presentation are well suited for the student. This is also my impression. While the various systems of servomechanisms are treated in the text in a rather abstract manner, the student will find in the appendixes, apart from some useful tables, more detailed physical and technological descriptions of the components used, like error detectors, controllers, servomotors and compensating devices. A subject-matter index and a bibliography of 206 items complete this well-produced book. As is not uncommon in American publications, only very few references are made to British and Continental sources.

R. Neumann