none of these gives the impression that they will get off the ground. Of the two papers on cryogenic stores the first is little more than a series of design specifications, without any details as to how they were determined. However, the second, and the last in the book, is a very good paper by Burns and his colleagues from R.C.A., giving a clear account of their particular storage system.

Reviewing this book more than two years after the Symposium has made me query whether it is time that someone did something to speed up the publication of information of this nature; for it loses so much of its impact if it fails to have rapid dissemination. Would, in fact, a simple paperback edition have speeded up the process? Nevertheless the problem of large capacity storage is, as far as I know, a long way from a satisfactory solution, and it is always useful for those interested in using or designing this type of store to have at their disposal a collection of papers that show what other workers in the field have done in the past.

G. H. PERRY.

Digital Techniques. By D. W. DAVIES, 1963; 158 pages. (London: *Blackie & Sons Ltd.* 30s.)

This book provides an introduction to many of the methods used to handle digital information which, although originally developed for digital computers, are becoming increasingly used in other applications such as data transmission, machine tool control, and instrumentation.

Chapter 1 gives a brief account of the essentials of a digital system, including methods of gathering data, and the magnitude of errors. Chapter 2 discusses the collection of data in binary and decimal form, the use of code plates, code discs, optical and magnetic digitizers, a simple analogue to digital convertor, and the need to use cyclic codes or redundant tracks to avoid reading ambiguities. The rule for translating cyclic binary to normal binary code is given, but without logical equations or a block diagram of a system which could perform the operation.

Chapter 3 deals with the design of "and" "or" and "inverting" gates, and bistable and counting circuits, and illustrates their performance by truth tables. Their practical realization using transistors, diodes and thermionic valves is described in Chapter 4. Current-steering or long-tailed pair circuits using valves and transistors, direct-coupled transistor logic, non-saturating transistor circuits, and tunnel-diode/resistor logic are mentioned briefly. The treatment of saturated transistor circuits on p. 52 may mislead by including the relation $i_c = \beta i_b$, and could be made more instructive by including a diagram of the collector characteristics of the transistor, showing the load line, and the linear, cutoff and saturation regions. Again on p. 59, the discussion of direct-coupled logic could be condensed if a diagram superimposing the collector and input characteristics of a suitable transistor were given, and in Fig. 4.23 a much simpler "and" gate can be constructed by merely connecting two transistors in series, each base being connected to one of the inputs.

Chapter 5 describes circuits which include reactive elements, such as monostable multivibrators, delay lines, blocking oscillators, square-loop magnetic core circuits and core-transistor circuits. A simple description of a coincident-current core store is given, but there is no mention of recent developments such as partial flux switching and other methods of selection. On p. 76 the common-base current gain of a transistor is designated as β instead of α, and on p. 75 the field and flux equations could be presented in a simpler form by using the M.K.S. system of units.

Binary counting circuits using valves and transistors, and methods of connecting them to produce decade counters are described in Chapter 6. Although three methods are described, these all require a delay element, and circuits which include only logical inter-connections, which are preferred for high-speed decade counters, are not mentioned. The alternative decimal gas-filled and beam-deflection counters are described briefly, but no mention is made of "auto-transfer" operation, or single-pulse gas-filled tubes, and their maximum counting speed is now 1 Mc/s, not 100 Kc/s as quoted on p. 98.

The use of punched cards, punched paper tape, and magnetic tape for the long-term storage of data and for changing its transmission rate is described in Chapter 7, which includes photographs and descriptions of paper-tape readers and magnetic-tape decks, and some discussion of RZ, NRZ and phase modulation schemes for digital magnetic recording. The clear advantage of the phase modulation system when transformer-coupled heads are used is, however, omitted.

Chapter 8 is concerned with the various printing and display devices such as lamp and gas-filled indicators, xerographic and matrix printers, electric typewriters, and X-Y plotting tables. The general principles of machine-tool control by digital signals are also mentioned briefly.

The final chapter mentions some topics in system design, including the selection of the number of digits to be encoded, their rate of transmission and some of the logical problems which may be encountered. These are illustrated in relation to a bi-directional counting system, and a digital magnetic-tape unit.

The treatment is generally expository rather than analytical, and few of the circuit diagrams give component values, so that the book will disappoint students interested in the design of digital circuits. A particular fault is the failure to discuss operating speed, which is an important factor in any digital system. Bearing in mind the present state of the art, it might be better to omit all circuits involving thermionic valves in order to devote more space to transistor circuits, and their response times.

It is also most surprising to find in a book on digital techniques no mention of Boolean algebra as a means of describing and manipulating logical operations. Any student of digital systems will encounter this notation in nearly all textbooks and periodicals, and an introduction to it would surely be more useful than, for example, the description of lamp display devices, or the mechanism of high-speed printers.

Many manufacturers now produce standard logical blocks which may be inter-connected to form large and complex digital systems with facilities for producing high power outputs to operate tape punches, fluid valves, etc., and which may easily be modified or extended. These are now widely used in industrial control systems and one would expect to find them mentioned.

In view of the omissions mentioned above, the book could be recommended only as an introductory text for electrical engineering students of degree level, to be followed by a fuller treatment of logical algebra and the design of digital circuits. It would, however, be suitable for less academic courses, or for civil, mechanical or chemical engineers who encounter digital instrumentation and wish to obtain some knowledge of the principles involved.

J. C. CLULEY.