Book Reviews

Large-Capacity Memory Techniques for Computing Systems. Edited by Marshall C. Yovits, 1962; 440 pages. (New York: *The Macmillan Company* $11.00. London: *Macmillan Company New York*, 75s.)

This book consists of an edited version of the papers presented at the Symposium of the same name, which was held in Washington D.C. May 23–25 1961 and sponsored by the Information Systems Branch of the Office of Naval Research.

The object of the Symposium, it was claimed, was to focus attention on new ideas, research and development which could lead to novel computer memories capable of storing very large amounts of information. The 30 papers, which are now collected within 440 pages, were all invited by a committee, under the Chairmanship of Marshall C. Yovits, that was set up for this purpose.

In the preface to the book Marshall C. Yovits has made it clear that the term "large capacity" has deliberately been left vague, on the grounds that the techniques rather than the operational capability are of interest. However, it is stated that it is hoped that stores with a capacity of hundreds of millions of bits if not billions of bits will eventually result. Furthermore these should have access times commensurate with the fastest computing system now on the horizon.

The thing that struck me when taking a first glance at the book, was the sequence in which the papers were arranged. I appreciate the difficulties with the number of overlapping techniques but I can see no reason for the only two papers on cryogenic memories to be placed No. 20 and No. 30. I think that in addition to the normal contents list a simple cross-reference table would have been a great help in finding one's way around the various techniques.

The first two papers deal with what are probably the two most important topics of any storage system, i.e. access techniques and organization. The first of these two papers I found disappointing and I passed rapidly to the second. This paper, by Ledley, dealt with the organization of large-capacity memory systems, and was reporting work supported by the Symposium organizers, and it so happened that this was the longest paper in the collection. Nevertheless the paper does a very useful job of work in covering simple, complex and indirect addressing, also list co-ordinate and both simple and complex contenting. 36 references are included but, as is pointed out, this is rather misleading, for literature on the organization of stores is sparse. However, I think the author has done his best to improve this situation. In conjunction with this contribution it is worth reading the paper by Goldberg and Green which covers some of the practical approaches to stores whose items are retrieved on a basis of content rather than location.

As may be expected at a symposium of this type, photographic storage was well to the fore. The Bell semi-permanent store is described in a paper by Hoover and Haugk, and there are three papers on optical selection systems for photographic stores. Brian and Focht of Philco go into details of the problem of positioning the spot of a C.R.T. so as to locate the required address accurately. The other two papers are based on a continuously rotating mirror to scan a photographic plate, and the use of a matrix-controlled electroluminescent screen to position the light spot. A completely new approach to photo storage is given in a paper "The Photochromic Microimage Memory" by staff from the National Cash Register Co. A photochromic coating is used to replace the normal photographic emulsion. This photochromic coating consists of a molecular dispersion of reversible light-sensitive dyes that produce a high resolution grain-free material. A reduction capability of 200/1 is claimed and, as is pointed out, with this reduction the contents of 40,000 filing cabinets can theoretically be reduced to a single cabinet.

Two papers on large-capacity document storage are included; these cover the Magnaview and the IBM systems. In the case of Magnaview, both photo and magnetic storage are combined.

There are six papers on various aspects of magnetic recording. A paper by Angel describes the N.C.R. M.C.R.A.M. (Magnetic Card Random Access Memory) which is in fact now in full production. There is a group of three papers from IBM covering three aspects of magnetic disc recording. The first covers the problems involved in the preparation of the disc and the magnetic material, the second covers transducers and amplifiers, and the third covers the air-lubrication slider bearing for controlling the space between the transducers and the magnetic material. The other two papers on magnetic recording deal with novel ways of reading and recording. The paper on reading is based on the use of the Kerr magneto-optical effect for detecting the direction of magnetization along the preferred axis of small areas of a continuous thin magnetic film, which can be deposited on either a drum or a disc. There is only a summary of the paper on a novel method of recording. The proposal is to use an electron beam to raise a small area of a magnetic film beyond its Curie point. If the film was pre-magnetized normal to its surface then, when the small heated area is cooled, it will reverse its direction of magnetization. This is the necessary consequence of the fact that minimum magnetic energy requires flux closures through the temporarily non-magnetic area.

In addition to the above there are four other papers based on the use of thin magnetic films; one of these, by Fuller and Robinstein, considers the high density of magnetic domains that are possible in thin magnetic films, and goes on to consider ways that this may be utilized for large capacity files. A paper by Meier and Kolk of N.C.R. describes the fabrication and use of a cylindrical thin magnetic film memory element, and Howard *et al.* report on the results of their investigation of woven-screen memory techniques. Finally a paper by Bittmann covers the more conventional flat plate type of thin magnetic film store.

There is only one paper based on the use of ferrite, and this is in the form of long hollow extended cylinders. These are aligned and subsequently cut to form ring cores. A density of 50 per inch is claimed.

There are three papers, in addition to those on photo storage, on changeable permanent stores. Two of these are by Japanese authors and both use the presence or absence of holes in a metal plate to represent "1" and "0". The difference between the papers is that in one case the presence or absence of holes is sensed by the variation of inductance, and in the other by the difference in capacity. The third paper on this topic uses small permanent magnets arranged on a card to represent the binary digits, and the presence or absence of these is sensed by the switching of a nearby "twistor".

The book contains papers making the cases for ferro-electric, phosphor and electron spin echo phenomena, but

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.