A system has been evolved to handle Sets which abide by the following rules: in any one Set the Unit is of fixed length and that length is a whole number of words; a special mark is used in a separate word to signify the end of the Set where the maximum number of Units are not present.

The program tackles the Set problem by use of a single index counter which can be referred to by any statement, and which is also used by certain statements specially written to handle Sets. The two groups of statements for handling Sets are outlined below; frequently the two are used together.

The first group of statements are identical to the equivalent basic statements except that the appropriate addresses are indexed by the counter in order to deal with the particular Unit to which the counter is set. The second group of statements deal with each Unit of the Set in turn, and in the same way. They are more powerful than the first group, and allow for selection of a particular Unit by comparison of any item within the Unit, or by listing pieces of data from each Unit in turn. This second group actually varies the setting of the index counter.

It is also possible to manipulate Sets with only the first group of statements by using basic statements to vary the setting of the index counter. In this way it is possible to execute particularly complex manœuvres of the Set in question.

Summary

The retrieval program has proved easy to put into use for any particular tape file. Little more is required than just forming the basic Name Table, selecting the statements required according to storage available, and compiling the source deck.

The result of each compilation is a flexible retrieval system for the tape file concerned. Very little programming effort is required to produce any particular summary, document, or other information, and only a few cards need to be punched before the job can be run on the computer. The result is that the system produces very rapid results and the required information can be available a short time after the initial request.

The current system is the development of a simple basic system, guided by the nature and frequency of the questions that have been answered. While this development will go on with each new application, a more comprehensive retrieval system to make use of an integrated set of tape files is being planned.

Book review: Parity-check codes

Low-Density Parity-Check Codes, by ROBERT G. GALLAGER, 1963; 102 pages. (Cambridge, Massachusetts: *M.I.T. Press* $4.00.)

The series of Research Monographs issued by the M.I.T. Press is a laudable effort to present in convenient form the results of research which might for a variety of reasons, be subjected to considerable delay in attaining their proper standing in technical literature. In the field of coding for error-control purposes, the literature is indeed very rich, and much of this has been collected between the covers of W. W. Peterson's "Error-correcting Codes." The two earlier monographs from the the M.I.T. Press by Wozencroft and Reiffen on "Sequential Coding" and by Massey on "Threshold Coding" may be considered as worthy extensions of Peterson's classic, and the volume under review is a welcome addition to the literature on coding.

Unlike Peterson's book, which is set out as a text-book on error-correcting codes, Gallager's volume is a revised and enlarged version of a thesis completed in 1960 for his doctorate at M.I.T., and deals with research work on an error-control technique employing low-density parity-check coders and decoders.

One result of Shannon's Noisy Channel Coding theorem is that if a channel is to be used efficiently, the coding constraint length must be made large if a satisfactory error probability is to be attained. This can be achieved with a relatively simple encoder, but with large constraint lengths the decoding function presents complexities. The author outlines how low-density parity-check coding techniques would work, and the applications in which it might prove useful, although the latter should be treated with some reserve, as they are based on the use of restricted and idealized transmission media.

The monograph consists of six Chapters, the first of which defines in general terms the basis of low-density parity check codes, and compares their efficacy as determined by computer simulation with other forms of coding. The distances between code words of low-density codes are examined in the second chapter, the results of which are applied in the next chapter to the establishment of bounds for the probability of decoding error for the Binary Symmetric Channel.

In chapter four, the author develops two decoding schemes, the second of which shows promise and which decodes from the *a posteriori* probabilities of the channel output. An analysis is given of the probability of decoding error from this "probabilistic" decoding method.

The results are extended in the next Chapter to cover multi-input channels. The final chapter summarizes the results of computer simulation of probabilistic decoding on a number of channel types, with variations of block length and code rate. Interesting comparisons are drawn between the performance of low-density codes and that of equivalent Bon-Chanduri codes. Three Appendices, enlarging on certain mathematical points in the text, and a list of 18 references complete the monograph.

This is a book for the coding specialist and is intended as a stimulus to further work on a class of codes which in certain circumstances have great potentialities for error correction.

T. A. MAGUIRE.