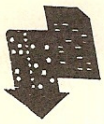

NCR Series 500

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NCR Series 500

A visible record computer for the smaller commercial organisation

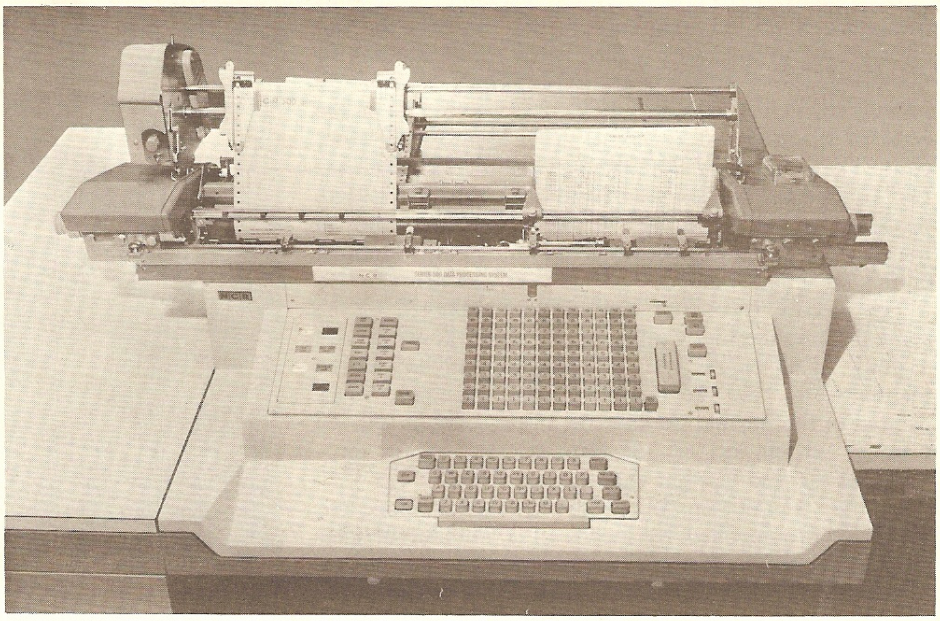
The smaller business is frequently discouraged from acquiring a computer by the impression that the change from conventional accounting methods to computer procedures is too complicated. NCR claims that the characteristics of the Series 500 computer, particularly the straightforward method of programming, simplify such a transition. One of the most important features of the Series 500 computer is that it can record information on, and read data from, magnetic ledger cards. Moreover, information recorded on these cards is also shown in visible form. In addition, the computer can be equipped with peripheral devices for handling input and output data in various forms. So far, 15 Series 500 computers have been installed and, according to NCR, systems are currently being delivered at the rate of one a week

THE gap that formerly existed between keyboard accounting machines and small computers has, during the past year or so, been virtually closed. In two respects the machines that have come to fill this gap are similar, in that they all have the ability to perform calculations electronically, and information is entered directly by means of a keyboard. Moreover, a number of these machines are capable of storing a program internally, a characteristic which, perhaps, more than any other, classifies them as computers.

A machine which falls into this category is the NCR Series 500 computer. As far as NCR is concerned, the basic assumptions* underlying the introduction of the Series 500 computer are first, that many existing users of keyboard accounting machines, and also prospective users of data processing equipment, are very often deterred from acquiring a computer for the simple reason that they consider them too complicated. At the same time, NCR realises that a number of smaller and medium-sized organisations are prepared to establish electronic data processing systems (even to the extent of installing a small computer) if the transition from conventional accounting machine methods to computer procedures can be undertaken without difficulty. Another factor which has been taken into account is the fact that many businesses, particularly in the commercial sector, rely on visible records in order to administer their accounting procedures. To meet this requirement, the NCR 500 is designed to record information on magnetic

*See "Magnetic Ledger Systems", *Data Processing*, November/December, 1966.

The NCR Series 500 computer can be equipped with a wide range of peripheral units for handling input/output data



Incorporated in the console are two main groups of keys—a purely numeric keyboard and, below it, a standard typewriter keyboard

ledger cards from which it can be automatically read, as required. Thus not only has a user the benefit of auxiliary storage facilities similar, in a limited way, to those provided by magnetic tape, but he also has a printed record of the transactions which have occurred, shown in visible form, on the magnetic ledger card. In addition to the facilities for reading and recording data on magnetic ledger cards, the NCR Series 500 computer can be equipped with peripheral devices for handling input and output data. These include paper tape and punched card readers and punches, and a line printer.

Basic configuration

The basic configuration comprises a console and a processor. Incorporated in the console are a keyboard, a printer capable of handling continuous stationery, and facilities for handling magnetic ledger cards. In layout the keyboard can be thought of as being divided into two areas, an upper area housing a numeric keyboard on each side of which are various control keys, and a lower area comprising an electric typewriter keyboard and associated control keys. The numeric keyboard has 12 rows of keys, each row containing nine keys numbered 1 to 9. Both program instructions and working data can be entered on the numeric keyboard. On the left of the numeric keyboard are seven control lights which, when illuminated, indicate to the operator various conditions on the machine. Of these, two are associated with magnetic ledger card operations, one—a "full card" light, being illuminated when the last line (on the card) on which an entry can be made is reached. The other control light, when illuminated, indicates that the processor is ready to read information from a magnetic ledger card. Also situated on the left of the numeric keyboard is a group of control keys including a "paper tape feed" key; a "reset" key which enables the instruction being executed to be interrupted and forces the processor into the halt condition; and a "KIE"—keyboard instruction entry key. The KIE key is used mainly to initiate automatic program loading. After pressing this key, program instructions are entered and fed into consecutive storage locations. The 500 is also equipped with six "start keys" designated 00, 01, 02, 03, 04 and 07. These are used to initiate program instructions when the

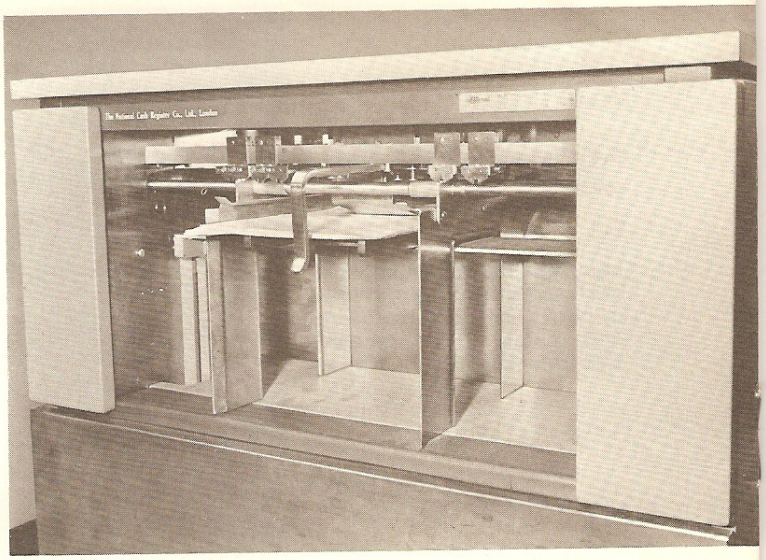
NCR SERIES 500 COMPUTER CHARACTERISTICS

Data representation: binary coded decimal; numbers—4 bits; alphabetical characters—8 bits.
Mode of operation of arithmetic unit: series/parallel.
Typical times for arithmetical operations:
+ and − 11·29 milliseconds,
× and ÷ 130·68 milliseconds.
Word length: 12 decimal digits.
Type of instruction: four address.
Main store: Ferrite core store of 4,800 decimal digits.
Auxiliary store: magnetic ledger cards which have a maximum storage capacity of 216 or 432 digits.
Data input: direct entry via keyboard,
data read from a magnetic card in 4 seconds,
punched cards read at 100 a minute,
punched paper tape read at 50, 400, 600, or 650 characters a second depending on the type of reader used.
Data output: console prints data at up to 20 numeric or 8 alphanumeric characters a second; line printer—numeric data printed at up to 125 lines a minute, alphanumeric information printed at up to 62 lines per minute; magnetic card—data recorded on one side of a card in 4 seconds; cards punched at a speed of 25 columns a second by serial card punch, 100 cards punched in one minute by parallel card punch; 5-channel paper tape—information punched at 30 characters a second or at 120 characters a second depending on the type of punch used.
Capital cost: basic system comprising a console and processor costs £15,770. A large configuration including a wide range of peripheral units costs up to £45,000.

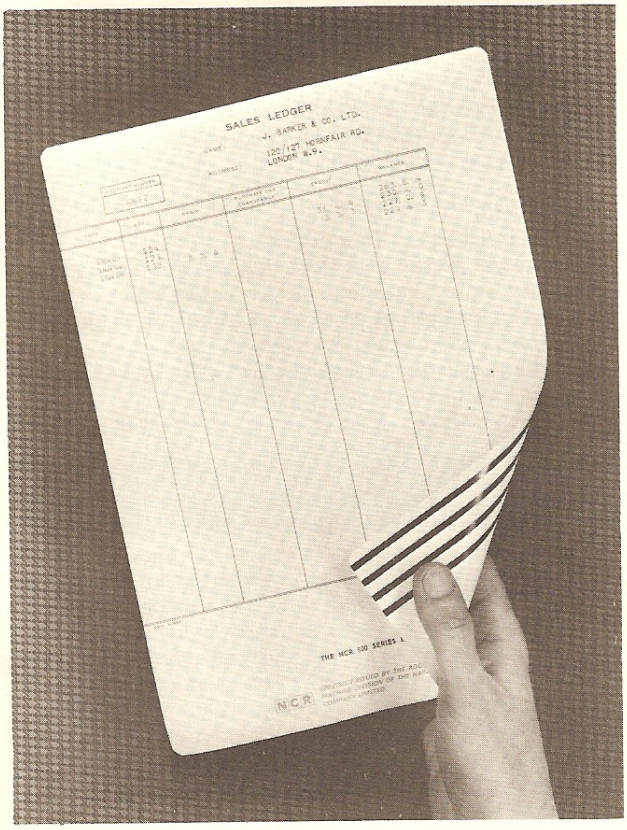
computer is in the halt state. Such instructions are always held in locations (called cells) corresponding to the designations of the start keys. Thus, to call the instruction in cell 02, start key 02 is pressed. On the right of the numeric keyboard are a number of other control keys including a "resume program" bar which has two functions. On the one hand it is used to initiate processor operations after a "halt" instruction, and on the other it initiates processor operations after manual entries have been made.

The electric typewriter keyboard is arranged in the standard layout and, by utilising the "shift" key, provides a range of 48 characters. Information can be entered manually on the keyboard of the typewriter and printed in the normal manner or, if required, it can be printed automatically under the control of the processor at a speed of eight characters a second.

On the Series 500 computer the movement of the carriage can be controlled by means of a number of keys situated on the right of the numeric keyboard, or automatically by program instructions. However, when operating in either of these modes, the actual positioning of the carriage is effected by control stops. These stops, which are located in pre-determined positions on a bar situated in front of the carriage, are fitted with different selection control plates depending on the type of function required. For example, a plate used for controlling the movement of paper differs from a plate used for tabulation operations. The carriage is equipped with selector levers and plungers which, when they come into contact with the control stops, initiate the requisite instruction. The 500 has the ability to print information over a width of 26 inches. Moreover, more than one type of document, including a magnetic ledger card, can be accommodated in the document carriage simultaneously. This means, of course, that an invoice (in continuous form), statement, and sales ledger and sales journal can be produced concurrently.



The magnetic ledger card reader can be adjusted to accommodate ledger cards with differing dimensions



Bonded to the back of each magnetic ledger card are four mylar strips on which data can be recorded

Magnetic ledger cards

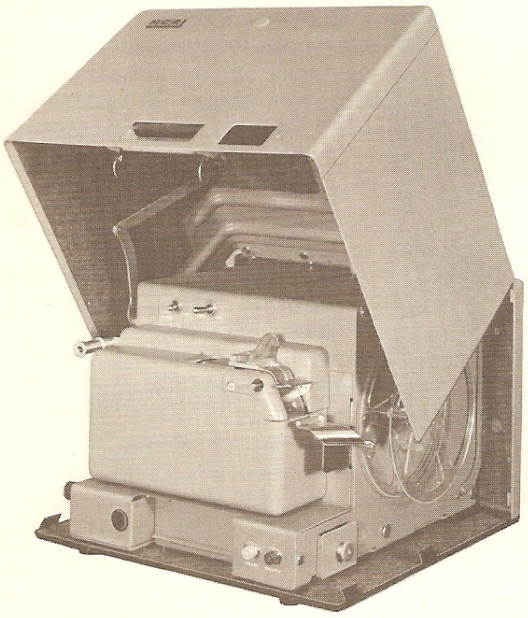
Magnetic ledger cards can be handled by the NCR 500 computer in two ways, by feeding the cards manually, one-by-one, into the right-hand side of the document carriage where each card is fed past a read/write head, or by making use of an automatic magnetic ledger card reader—a separate unit, which is capable of reading cards at speeds of up to 2,500 an hour. The size of a ledger card may vary, but must not exceed 16 inches in width (although cards of a special construction up to 20 inches in width can be accommodated), and 15 inches in length. The amount of digital and visual information which can be recorded on a card is, in fact, determined by its length. For instance, a card measuring ten inches in length has a capacity of 111 digits (recorded magnetically) and 36 lines of printed data, excluding heading information, whereas a card 15 inches in length can store 216 digits and accommodate 66 lines of printed data. In general, a magnetic ledger card has, for example, the capacity to store all the payroll details relating to an employee. Digital information is recorded on four vertical strips of Mylar tape which are bonded onto the back of the card. However, if required, cards having eight strips can be provided thus increasing the storage capacity to 432 digits. Once a card has been placed in the document carriage, all the subsequent operations of reading, recording and printing, with the exception of the entry of new data on the keyboard, are performed under the control of the program.

The automatic magnetic ledger card reader comprises a separate unit which is connected directly to the Series 500 computer. Various sizes of card can be handled by the reader. And where different sizes are used adjustments are made, by the operator, to the reading unit, feed bin and output bin to accommodate them. However, cards fed through the reader on a specific run must be of the same size. Owing to the facilities it provides, the reader is particularly useful in accounting procedures where statistics, analyses and trial balance are required. Also the device can be used as an auxiliary store, information being derived from individual cards during the course of an accounting operation.

The console is connected by cable to the processor which contains a storage unit, arithmetic unit and control unit. The storage unit comprises a ferrite core store which is divided into four areas, referred to as "planes" (designated 0, 2, 4 and 6) each containing 100 storage positions. Each of the positions, or cells, has a capacity of 12 digits. Thus the store, which is used to hold both working data and program instructions, has a total capacity of 4,800 decimal digits. Associated with the main store is a buffer store which is used to hold information, temporarily, before it is transferred to a line printer or card punch. The buffer is also used when an "expand" instruction is executed. When such an instruction is called, the relevant data are transferred to the buffer and are expanded into alpha format. Thus 12 digits would be expanded into 24 digits which are then transferred into two adjacent cell locations. The control unit incorporates an instruction register and a memory register. While a program is being run, instructions are transferred, one at a time, from their cell locations in the main store into the instruction register. In other words as one instruction is completed it is replaced by the next instruction. Since the computer's main store is divided into four planes it is necessary to indicate which are used during the execution of each instruction. This function is performed by the memory register. In brief, because the address system of the 500 is discussed later, the plane numbers corresponding to the addresses are derived from each instruction as it arrives in the memory register. For example, in an ADD instruction the plane locations of the two factors to be added, and the plane location where the result is to be stored are held in the memory register, while the actual addresses, showing the cell locations, are stored in the instruction register. However, these plane settings can be modified, if required, by means of an SMR (set memory register) instruction which would indicate which plane is to be used in place of that shown in the original ADD instruction.

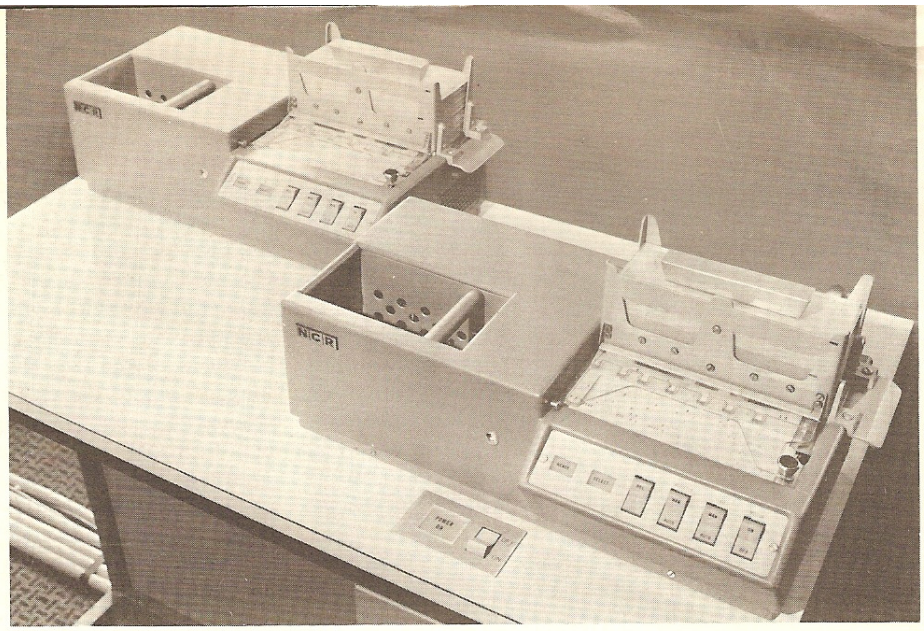
Cell locations

An important feature of the 500 computer is the economical manner in which information can be packed in a cell location. For example, the following payroll data, a clock number (four digits), department number (two digits), cost code (three digits), and a job number (three digits) may be held, on a magnetic ledger card, in four separate words each having an end of word code to distinguish its boundary. Four such items of data can, in fact, be held on a magnetic ledger card as one word, and can thus be stored in one cell—090—occupying positions 12 to 1 respectively. If during the course of a run, any part of this information is needed the required portion can be accessed and transferred to another cell by using an "insert" instruction and a "shift and copy" instruction. For instance, if the department number which occupies positions 7 and 8 of cell 090 is to be used, the insert instruction is used to transfer these two digits into the new cell while the shift and copy instruction is used to position the digits in the required section of the new cell, the contents of cell 090 remaining unchanged.



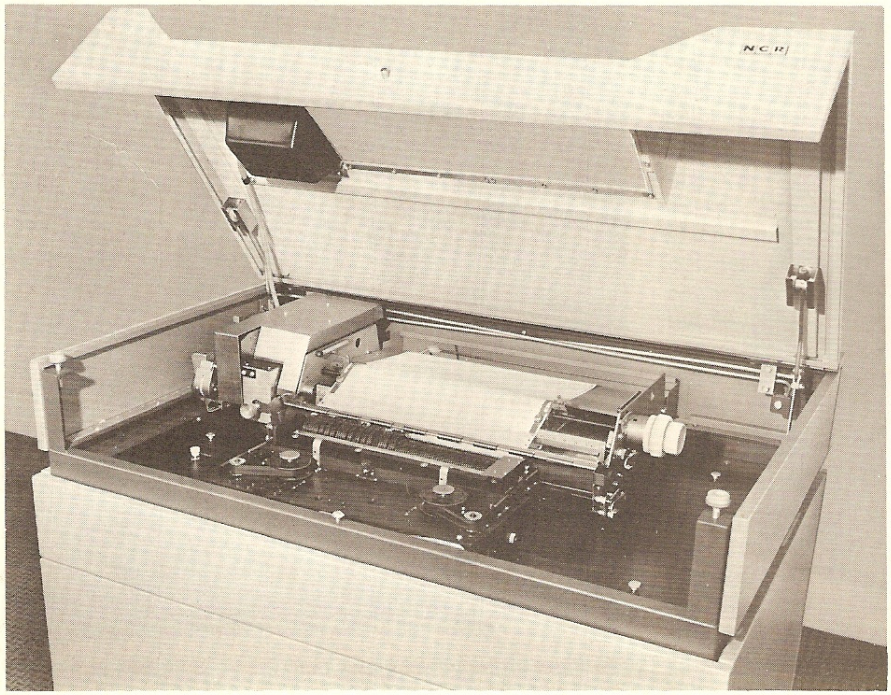
Output data can be punched into paper tape at a speed of 30 characters per second

A compact punched paper tape reader operates at a speed of 50 characters a second



A Series 500 computer system can be equipped with two punched card readers

The two instructions mentioned in the previous example constitute part of the basic repertoire of instructions used with the 500 Series computer. In all there are 20 basic instructions although a certain number of these have one or more related commands which increase the number of instructions to 42. The 500 Series computer employs a four address system, a feature which enables a single instruction to become a series of related instructions. For example, a single "print" instruction can cause the contents of the whole store to be printed. Each instruction is identified by a single mnemonic description which is used merely for reference. An instruction comprises 12 digits which have the following significance. Two digits are used to indicate the basic command, for instance 17 denotes ADD. This is followed by a single digit which serves as a modification code for the basic command. A further digit is used as a register select modifier which, depending on its designation controls the plane location of the addresses by selecting or ignoring the memory register settings. The remaining part of the instruction consists of four addresses each comprising two digits. The first two digits constitute the A address and indicate the first cell location to be used in the instruction. The next two digits are the B address denoting the second cell location to be used. However, in some instructions, the B address portion is used to define a limit for incrementing the A address in the instruction register. The A and B address are followed by two further digits called the C address which, again, may define various functions. It may be used to indicate the cell address to receive the result of a calculation, it could contain the address of an alternative instruction which is to be obeyed depending on the result of a test instruction, or it may act as a



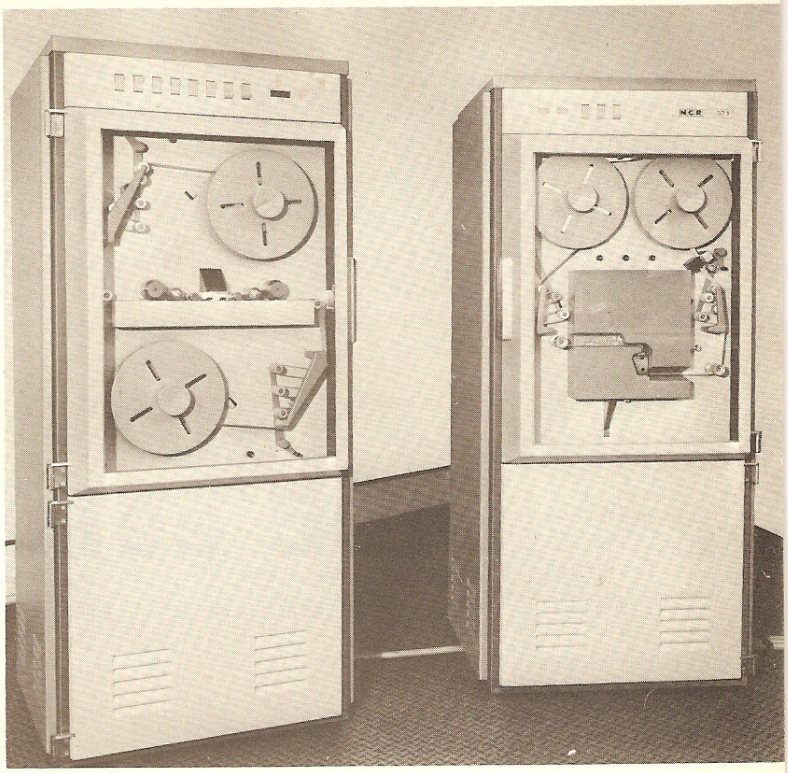
If a considerable volume of printed output data is required a line printer can be included in the computer configuration

modifier to the command. The last two digits define the cell location of the next instruction to be executed. This is known as the "NI"—next instruction address.

In order to clarify the four address system further, it would be helpful to examine two commands—the "read ledger" and "write ledger" instructions in detail. For example "RDL", the read ledger command, could take the form 26/16/$\frac{4}{20}$/$\frac{4}{23}$/00/$\frac{2}{40}$/. Starting on the left, the 2 defines the plane location of the next instruction, while 6 denotes the actual command (RDL). The digit 1 is a command modifier which sets up controls for the positioning of the card in the carriage, the following 6 being a register select modifier which controls the plane location of the A, B and C address by selecting or ignoring the memory register settings. The four remaining sections of this instruction are the four addresses starting with $\frac{4}{20}$—the A address. The digit 4 denotes that the address is in plane 4, 20 indicating the first cell number which is to be loaded with data from the card. The B address which follows is also located in plane 4, 23 being the number of the last cell location into which data are to be stored. The C address in this instruction is always blank. Finally, the NI address denotes that the next instruction is in cell 40 of plane 2. The "WTL"—write ledger instruction takes much the same form as the RDL command. It could for instance be shown as 27/17/$\frac{4}{23}$/$\frac{4}{40}$/$\frac{2}{22}$/$\frac{2}{27}$/. The first two sections relate to functions similar to those described in the RDL instruction, the A and the B addresses (third and fourth sections respectively) in this example defining the first and last cell locations respectively from which data are to be encoded on the magnetic card. The C address is an "alternative" instruction (stored in cell 22 of plane 2) which is selected if the data are incorrectly encoded on the magnetic card. Again, the NI instruction defines the location of the next command. The six sections, of an instruction, comprising 12 digits in all, are thus stored in one cell location. However, the plane locations of the A, B, C and NI addresses shown in the previous examples are merely indicated for reference and are not, in fact, incorporated in the actual instruction. Another advantage of the four address system is that any cell position corresponding to blank sections of an instruction (the C address portion of the RDL instruction, for example) can be used for storing other factors. In other words a constant could, if required, be held in such a storage location.

Program storage

Programs are recorded on magnetic ledger cards, although on a larger Series 500 computer incorporating a punched tape reader, for instance, programs could be held on paper tape. A number of standard subroutines are provided and these are available, without charge, to Series 500 users. With regard to initial programming work, NCR prepares, free of charge, programs for the first two applications undertaken by a user once the scope of the applications has been mutually agreed. Any subsequent programs written by NCR are chargeable according to the size and complexity of the work involved. However, NCR provides free programming courses for users. NCR also provides help with systems analysis work prior to the installation of a Series 500 computer, and for a year after the machine has been installed.



Other peripheral devices which can be supplied include a high speed paper tape reader and a paper tape punch

A number of peripheral units which can be connected to the basic machine are available with the Series 500. These include a desk-sized paper tape reader capable of operating at a speed of 50 characters a second, a larger tape reader available in two models which operate at speeds of 400 and 600 characters a second, and a paper tape strip reader. The strip reader, which is designed for reading paper tapes which do not require rewinding, operates at a speed of 650 characters a second. A desk-sized paper tape punch is also available which perforates data at a rate of 30 characters a second. And a free standing tape punch can be supplied which operates at a speed of 120 characters a second. Punched cards can be handled by a Series 500 system. The computer can be equipped with up to two card readers which operate at 100 cards a minute. A parallel card punch can also be supplied which perforates cards at a rate of 100 a minute, while a serial card punch is available which operates at a speed of 25 columns a second, the punched data being interpreted simultaneously. If the volume of printed output data is high, a Series 500 installation can make use of a line printer which prints up to 125 lines of numeric data, or up to 62 lines of alphanumeric information, a minute. The printer is capable of printing a range of 40 characters in up to 96 print positions.

NCR has so far delivered 15 computers of the 500 Series and deliveries are now being made at the rate of one a week. In its basic configuration the NCR Series 500 computer costs approximately £15,770 while a system incorporating a paper tape punch and paper tape reader, and an automatic magnetic ledger card reader would cost about £20,500.

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