Conclusion

A device for high-speed plotting, printing or both has been described. The device is intended specifically for the high-speed recording of the output of computers used for the processing of missile ballistic data, but is actually a general purpose data recording device, and has capabilities for recording data consistent with the greatest digital computer capacity presently available. Results obtained from the feasibility model indicate that this device is capable of substantially advancing the art of high-speed recording of digital computer outputs.

Reference


H. R. Roberts: What is the operational meaning of "100 points per second?" Is not "points speed" meaningless?

Dr. Epstein: The machine plots 300 points per second at the spacing of 50 points to the inch. There are 30 pins, each pin represents one channel. If, during each scan, each of the pins were pulsed once, it would give 30 points along the graph. Since with the machine cycling ten times a second, the plot is derived at a rate of 300 points per second. However, during the plotting time, if a point is recorded at every available printing position across the paper, the recording is accomplished at the rate of 25,000 times a second for each of the 30 points, or at the rate of 750,000 points per second.

Discussion

J. L. Hill (Remington Rand Univac Corporation): Are the blocking oscillator transformers on the wheel or are the high voltage leads carried through the slip rings?

Dr. Epstein: The blocking oscillators are not on the wheel. The shielded cable from the secondary of the blocking oscillator is fed through the slip ring and hence to the wheel.

M. Weinberg (Monroe Calculating Machine Company): How do you prevent the fields produced by the gearing from introducing errors in the computer?

Dr. Epstein: A different embodiment of the electrographic recording technique was tested recently at the Signal Corps Engineering Laboratory for noise measurements. The noise which is produced by the printing technique and the associated equipment in this particular device was very small, below the noise level of the receivers in some of the tests.

R. B. Bonney (Electronic Engineering Company of California): How many vacuum tubes are used to drive the writing points for the complete matrix?

Dr. Epstein: The total machine has 38 tubes, of which 15 are used for the 30 printing pins in the head.

N. Newby (Bell Telephone Laboratories): What coating is used on the paper, and what minimum delay is possible between charging the paper and inking?

Dr. Epstein: The coating on the paper is a high resistivity resin, and depending upon the electrical surface and various other characteristics of the coating, the delay between charging the paper and inking can be either milliseconds or years.

J. R. Roberts: Is not "points speed" meaningless?

Dr. Epstein: The machine plots 300 points per second at the spacing of 50 points to the inch. There are 30 pins, each pin represents one channel. If, during each scan, each of the pins were pulsed once, it would give 30 points along the graph. Since with the machine cycling ten times a second, the plot is derived at a rate of 300 points per second. However, during the plotting time, if a point is recorded at every available printing position across the paper, the recording is accomplished at the rate of 25,000 times a second for each of the 30 points, or at the rate of 750,000 points per second.

M. B. Stad (Remington Rand Corporation): Was the large-diameter disc shown in the slide the actual recorder, or an additional wheel?

Dr. Epstein: The actual wheel circumference is 5 times 10 inches, roughly 50 inches; the diameter is roughly 17 inches. The other wheel you are referring to is the optical synchronizing wheel. In other words, there are two synchronizing wheels, one for synchronizing pulses for printing at each of the 500 positions, and then there is an additional wheel to provide the stop and start scan pulses.

A Transistorized Transcribing Card Punch


The RCA (Radio Corporation of America) BIZMAC Transistorized Transcribing Card Punch described in this paper provides a means for converting large volumes of data stored on magnetic tape in the Bizmac code into characters punched on electronic accounting machine cards using the IBM (International Business Machines Corporation) code. This output device will transcribe information at the rate of 150 cards per minute, and provides accuracy control features to assure correct data punching. The functional operation of the transcribing card punch is compatible with the Bizmac system and with general punched-card system requirements as well.

The device consists of two packages. The electronic circuits are housed in racks which permit rapid access to vertical mounting panels for servicing. Plug-ins are used throughout, and a simple transistor circuit element which performs all the logical functions is employed. The results of a review of punching methods, coupled with a requirement for easy replacement of parts, guided the mechanical design of the card transport and punch mechanisms. There are placed in a separate cabinet with removable covers. Input and output hoppers are at a convenient height. Design emphasis was primarily directed toward obtaining a high degree of accuracy control in a device with maximum functional flexibility.

Functional Description

Input messages to the Transcribing Card Punch are received from a BIZMAC magnetic tape station through seven channels. Character rates of 10 to 30 kc are acceptable. The Transcribing Card Punch requires that messages from magnetic tape be of fixed field format. BIZMAC alphanumeric characters and the eight punctuation marks which have IBM 407 punch equivalents are translated and punched on cards. The six BIZMAC punctuation marks which do not have IBM equivalents are translated as blank columns on the cards. All BIZMAC control symbols such as start message, item separator, and end message, are eliminated during translation and do not create blank columns.

A plugboard is incorporated to permit data rearrangement and character insertion. Specifically, the plugboard provides the three following functions: (1) The formation from magnetic tape can be rearranged in any sequence on the cards. (2) Control symbols can be overpunched into the same card column with numeric punches. (3) Fixed data may be


The authors wish to acknowledge the contributions of J. R. Palmer, R. F. Bov, H. H. Cramer, and J. O'Donnell on this project.

From the collection of the Computer History Museum (www.computerhistory.org)
punched as required. The plugboard wiring used for punching is duplicated for checking purposes.

Logical Operation

A block diagram of the transcribing card punch is shown in Fig. 1. Three messages are in process at any one time. One is being read-in while the second is being punched and the third is being checked. The operation will be described by following one message through a complete machine cycle.

1. Read-in Cycle: During this time, the temporary storage is erased and connected to the tape station. The tape is started, a complete message is read into the temporary storage, and the tape is stopped. This provides almost one complete card cycle of 400 milliseconds for read-in. At the end of this cycle, the temporary storage sector containing the message just read in is switched to the punch channels.

2. Punch Cycle: Throughout the course of the punch cycle, the information is read from the temporary storage into the BIZMAC to IBM coder. The output of the coder is fed to a 12-channel electronic commutator which is synchronized with the card advance. The commutator sequentially selects the output channel from the coder corresponding to the row to be punched. From the commutator the serial data is sent to the shift register which converts the information from serial to parallel form. All 80 bits of information are read out simultaneously through the plugboard into a second shift register. This shift register converts information from parallel to serial form and its output is routed into a single channel comparator. In the meantime, the temporary storage containing the original information has been switched from the punch channel to the check channel. The information in the temporary storage is translated again, by a second BIZMAC to IBM coder, into 12-channel IBM code. Another 12-channel commutator selects and routes the correct channel to the comparator to be checked with the information read back from the brushes.

It can be seen that the temporary storage contains three sections which are switched cyclically around the read-in, punch, and check channels. Three messages, one being read in, another being punched, and another being checked, are in process simultaneously.

A high degree of accuracy is maintained during transcription by reading back the data punched on the card and comparing it with the original message which is retained in the transcribing card punch memory. A duplicate BIZMAC to IBM coder is used in this operation. The sequence of start message and end message symbols is monitored to insure that all messages are punched in their entirety. In addition, input information is checked for parity prior to translation.

3. Check Cycle: During the check cycle, the card is read, one row at a time, by 80 brushes and the information relayed through the plugboard into a second shift register. This shift register converts information from parallel to serial form and its output is routed to the comparator. In the meantime, the temporary storage containing the original information has been switched from the punch channel to the check channel. The information in the temporary storage is translated again, by a second BIZMAC to IBM coder, into 12-channel IBM code. Another 12-channel commutator selects and routes the correct channel to the comparator to be checked with the information read back from the brushes.

Mechanical Design

Fig. 2 shows the card handling mechanism. Construction features were incorporated to facilitate operation and servicing. As shown in Fig. 2, the top rollers, punch mechanism, and magnetic structure can be raised for easy access. Rapid replacement of machine parts is realized via unitized construction. The punch and solenoid assembly can be removed from the frame of the card mechanism as a unit. A spare punch or solenoid assembly can be quickly installed and the unit replaced with only minor field adjustments. The punches and associated holding magnets were designed to give maximum life while operating at 150 cards per minute.

To begin operation, blank cards are placed into the input hopper where they are held above the continuously reciprocating picker knife by solenoid operated plungers. When the solenoid is energized, the plungers are retracted, lowering the cards onto the picker knife and permitting them to be fed, nines edge first, into the mechanism.

The cards are moved intermittently, one row at a time, and are momentarily stopped while each row is punched. The intermittent drive action, which approaches a sinusoidal form during the card advance cycle to minimize impact.

Fig. 3 illustrates the knee-action punch mechanism. With no current applied to the solenoid, shown to the right of the knee-action mechanism, the solid line drawings show the action resulting when the continuously driven eccentric, shown at the top of the figure, operates in synchronism with the card advance mechanism. No punching occurs with the solenoid de-energized, but at the start of each punch cycle, shown on the left side of the drawing, the solenoid armature is returned to the solenoid proper.
When the eccentric is at the “top” position, the solenoid, if energized, is required to move no mechanical mass, but simply to prevent the knee from bending. This requires relatively little force. A dotted representation of the mechanism on the down cycle with the solenoid energized for punching is shown on the right side of the figure.

Two advantages of this mechanical design are noteworthy. The solenoids, which actuate punching, are required to merely hold the linkage during its punching stroke. Thus, the actuation time of the punch is limited only by the energizing time of the solenoid coil. Secondly, the manner in which the intermittent drive is obtained permits smooth card acceleration.

Transistorized Circuits

The basic circuit chosen to meet the logic requirements of the BIZMAC Transcribing Card Punch is shown in simplified form in Fig. 4. It is known as a two-input resistor gate. This element provides not only the gating function, but signal amplification and standardization as well, all with one transistor. The circuit has proved a very powerful logical element since any number of stages may be directly cascaded to synthesize any logical array. The logic designer is no longer concerned with the problem of inserting signal re-standardizing and amplifying elements such as pulse amplifiers. Indeed, few pulses are required in machines using these d-c circuits. The avoidance of pulses is in itself a substantial step forward for the logic designer. More importantly perhaps, the maintenance man in the field may now employ rather simple d-c testing techniques. Both the logic designer and maintenance man find their work simplified since they must learn only one simple, though very flexible, logic element. Due to this new simplicity, errors in logic design have been sharply reduced.

Referring to Fig. 4 then, observe that if either input is lowered to ground potential, current will flow through the base of the transistor, turning it on and raising the output to plus 6 volts. Hence, for negative going signals, assumed to be standard information signals, the element acts like an OR gate followed by an inverter. Fig. 4 shows this logical representation of the element. If only one input is used, then element functions as a simple power amplifier-inverter.

Notice that when, and only when, both inputs are at plus 6 volts, the output will be at ground. Thus, another logical representation may be used, the AND function. Since this requires positive signals and the normal signals are negative, we indicate this by showing logical inverters at the input of the AND gate to denote that NOT signals are required. In this operation, the element may also be looked upon as a double inhibit gate.

The capacitors shown across the input resistors of the circuit of Fig. 4 are used to speed up circuit operation. Their primary purpose is to quickly rid the transistor of the stored charge which accumulates in the base region when the transistor is “bottomed.”

Typical signal delays of 0.2 microsecond per stage are obtained when elements are connected in series. The output resistor of each element can absorb 10 milliamps from the stages it drives, and 1.6 millamps are required by each gate input. Hence, up to six gate
The 18,000-ohm resistor is used to supply leakage currents when the transistor is off. The RCA Transistorized Transcribing Card Punch uses this element, packaged four per plug-in, for all except specialized logic functions like shift registers.

It is necessary to provide for the flip-flop or storage function and Fig. 5 shows how two basic elements may be connected to produce a flip-flop. Typical unloaded waveform forms are also shown. Such a flip-flop may be set and reset at a 1-megacycle rate, although such speeds are seldom required by input or output devices.

It is important that time delay or pulse forming circuits be available to the logic designer. An accurate time delay or pulse forming one-shot multivibrator is easily built using transistors. The one-shot chosen as the “standard” transistor delay element is shown simplified in Fig. 6. This circuit is designed so that large changes in supply voltages or transistor parameters do not appreciably affect the output pulse width.

The Transcribing Card Punch requires storage for the data to be punched and also for the data read from the checking station. Shift registers are applicable since in the former case serial to parallel conversion is required and in the latter case, parallel to serial conversion. Magnetic elements were considered, but a transistor shift register was finally chosen since it is more easily understood by maintenance personnel, costs being approximately equal.

Transistors have proved capable of handling much of the medium power applications in digital computer work.

**Discussion**

C. Kagan (Western Electric Company): Reference has been made to application of this unit with BIZMAC Systems. Is RCA prepared to produce data-processing equipment such as this and BIZMAC or is this merely an exposition of RCA developmental work?

Mr. Propster: As far as is known, RCA intends to stay in the computer business.

A. Krell (Remington Rand Univac): Please describe in more detail the temporary storage.

Mr. Propster: The temporary storage consists of, in effect, three storage sections. The sections are switched cyclically, in order to allow three cards to be in process at any one time.

M. J. DiCarlo-Cottone (Bell Telephone Laboratories): If I understood correctly, a duplicate plugboard is used for checking. Why is not echo pulse circuitry utilized?

Mr. Propster: When you try to punch a card, it is all very well to energize the punch, but for one reason or another, it may, for example, stick and not punch, or, even though punched, the hole may not be readable. It was felt that it would be better to check that the card is readable, rather than that the punch was energized or that the punch had moved. By the way, there is not a duplicate plugboard; there is one plugboard with duplicate wiring on that plugboard.

C. K. Vanderhoof (Prudential Insurance Company): What check is made that the data has been accurately transcribed from tape to card?

Mr. Propster: There is a parity check on the data coming from tape, so that loss of a single bit in any character will turn up as an error.

B. Jenkins (Computing Devices of Canada): What is the indication if the card has been punched incorrectly?

Mr. Propster: The card with the error is rejected, together with the cards that have already been fed and are in the mechanism, so that we get 3 or 4 cards in a reject pocket and the machine stops. Appropriate indications are made of the kind of error that stopped the machine.

Mr. Lippel (IBM): What is your procedure for error correction?

Mr. Propster: Let us suppose first that it is a transient error of one sort or another. There is a button to be pushed which backs up the magnetic tape the appropriate number of messages, the machine then restarts and a second attempt is made to go through without error. However, if it is a machine failure and not a transient error, it will be necessary for corrective maintenance of the machine.