# GENERAL ELECTRIC COMPANY

# DATA COMMUNICATIONS PROCESSOR

# DESCRIPTION

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## 1. GENERAL

1.01 This section describes the General Electric Company Data Communications Processor.

1.02 This section is intended to provide testroom personnel with a better understanding of customer-owned and maintained equipment which may serve as the message handling and switching medium for teletypewriter (TTY) networks. Specific network applications for various customers utilizing a processor will be described in various sections following Section 312-110-000.

## 2. SYSTEM CONCEPT

2.01 The processor is intended to provide a centralized control for various teletypewriter messages between common carrier communication facilities. A wide variety of communication facilities can be used with the processor, including private line TTY, Wide Area Telephone Service (WATS), Teletypewriter Exchange Service (TWX), Direct Distance Dialing (DDD), and private line telephone.

2.02 The processor can receive and transmit digital data in any of the standard codes and at transmission rates up to 2400 bits per second. The system will automatically convert codes, speeds, and formats. Both direct and multiple address input/output capability is provided.

2.03 The processor can provide message switching between remote locations, store and update data supplied by remote locations, and respond to inquiries from remote locations. The system combines the capability of real-time and batch-processing of data. Priority is given to on-line processing with batch-processing being performed during the times that full capability is not required for on-line processing.

2.04 Automatic message accounting aids in the prevention of lost messages. The system regulates traffic, acknowledges receipt of messages, and assigns sequence numbers for message accounting and message retrieval purposes.

2.05 Fig. 1 illustrates a typical telegraph message switching center configuration. The system is composed of three major functional groups: the communications processor, which performs the data processing; the computer peripheral equipment, which is used for input/output functions; and the supervisory position, which is used to monitor and control the operation.

2.06 The operation of the switching center is automatically controlled by the stored program. Each message contains a destination code which specifies the remote station or stations.

2.07 The supervisory terminal normally provided consists of a send/receive teletypewriter. This terminal is used as a message intercept position for incorrectly routed or formatted messages. The terminal is also used to notify the supervisor of line malfunctions and to print out periodic status reports on the switching center operation.

2.08 The detailed operation of each system will be developed according to individual system requirements, such as routing, service and control codes, format, number of lines and remote ter-

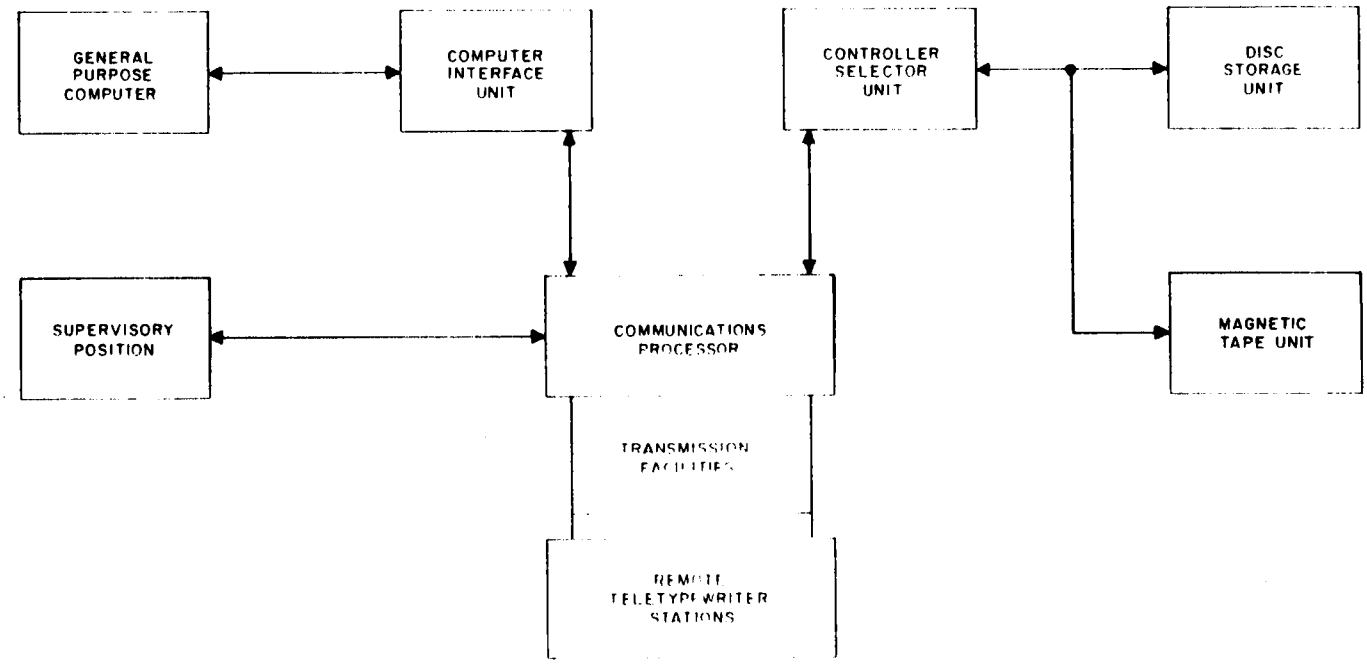


**Fig. 1 — Typical Switching Center**

minals, and many other overall system operational requirements.

**2.09** The following is a listing of major functions performed by the communications processor.

(a) Message Accumulation — Messages are assembled and routed under program control.

(b) Message Distribution — Messages are distributed under program control.

(c) Automatic Multipoint Private Line Control (Party Line) — Polling and selection of stations on the line is accomplished under program control.

(d) In-Transit Storage — Storage is provided for message queueing.

(e) Journal Storage — Storage is provided for recording message journals.

(f) Intercept Storage — Storage is provided for messages for stations closed due to limited time of operation, station malfunction, etc.

(g) Message Accounting — Journal storage can be processed during off hours or low activity periods to provide daily status reports and data for network study.

(h) Traffic Analysis — The number of messages per line per station per day can be counted. The reports generated can then be typed out at the supervisory position. Such items as average message length, number of multiple message broadcasts, and operator errors in formatting may be included in the reports.

(i) Multiple Message Broadcast — Individual messages can be routed to more than one remote station as designated by the routing indicators.

(j) Automatic Restart — System is capable of automatically restarting itself in case of power failure or program malfunction.

(k) Supervisory System Monitoring — One Automatic Send-Receive (ASR) and a Receive Only (RO) teletypewriter are used for system monitoring. Headers of misrouted messages can be printed out and corrected. The

supervisor can send service messages to open or close out stations and/or to send data to intercept storage.

(l) Trunk Line Connections — Trunk lines to other switching centers can be provided for communication with remote terminals of other switching centers.

(m) Format Conversion — The order of spacing data from the incoming order to the desired outgoing order can be changed.

(n) Error Control — A variety of error detection and correction schemes can be used. Operator error codes can be recognized and a recovery or restart procedure set up for that message. The processor can be programmed to control the format of a message and notify the operator of any format errors. Also, transmission errors can be recognized through echoplex retransmission. Parity check of codes and block parity checks can be used.

(o) Alternate Routing of Messages — Supervisory changes in routing on a temporary basis in case of line or terminal outage is possible. Programmed automatic alternate routing is also possible.

(p) Priority Messages — Messages may contain a priority level code that can be recognized by the processor program. Thus, priority messages or data can be handled before routine administrative messages.

## 3. DESCRIPTION OF BASIC EQUIPMENT USED IN THE MESSAGE SWITCHING SYSTEM

### A. Communications Processor

**3.01** The communications processor (Fig. 2) controls the input/output flow of data and manipulates the data as necessary. Buffers are used to connect the communications facilities and computer equipment to the communications processor.

**3.02** The communications processor contains a core memory, power supply, control and working registers, buffer selector, paper tape reader, and operator control panel.

**3.03** The magnetic core memory stores program instructions, alphanumeric information, and binary data. Standard memory units are available in sizes of 4,096; 8,192; and 16,384 words. Each word consists of 18 bits.

**3.04** The buffer selector is an important functional element of the processor. Low-speed information flow between the communications processor and external equipment is through buffers connected to the buffer selector. All units directly connected to the buffer selector will be referred to as buffers. The buffer selector contains one hundred twenty-eight (128) channels numbered 0 to 127.

**3.05** The normal flow of data in the communications processor occurs as shown in Fig. 3. The routing programs are periodically interrupted to allow the scan program to take bits from the bit buffers to form characters in memory. When a character is formed, it is transferred over to another area of memory where the program accumulates characters into words. The words are accumulated into blocks of variable lengths and then transferred to the disc storage unit, where the queue, journal, intercept, and in-transit storage areas are established under program control.

**3.06** Upon receipt of the message header, the program determines the destination, which outgoing line is to be used for retransmitting the message, and whether or not there is a queue for that line. If the line is available and there is no queue, the processor can start transmitting the message to the destination before the end-of-message is received. If a line is not immediately available, the message is placed in queue storage to be transmitted in queue sequence.

**3.07** The processor has as standard equipment a 300-cps photoelectric paper tape reader and a bin containing a 300-foot loop of paper tape. Paper tape may be read under program control in two modes: continuous mode at 300 cps or step mode up to 50 cps. Five- to eight-level tape may be read in the unit, but normally only eight-level tape will be used.

**3.08** The communications processor contains a control panel designed to serve both operator and maintenance functions. The operator

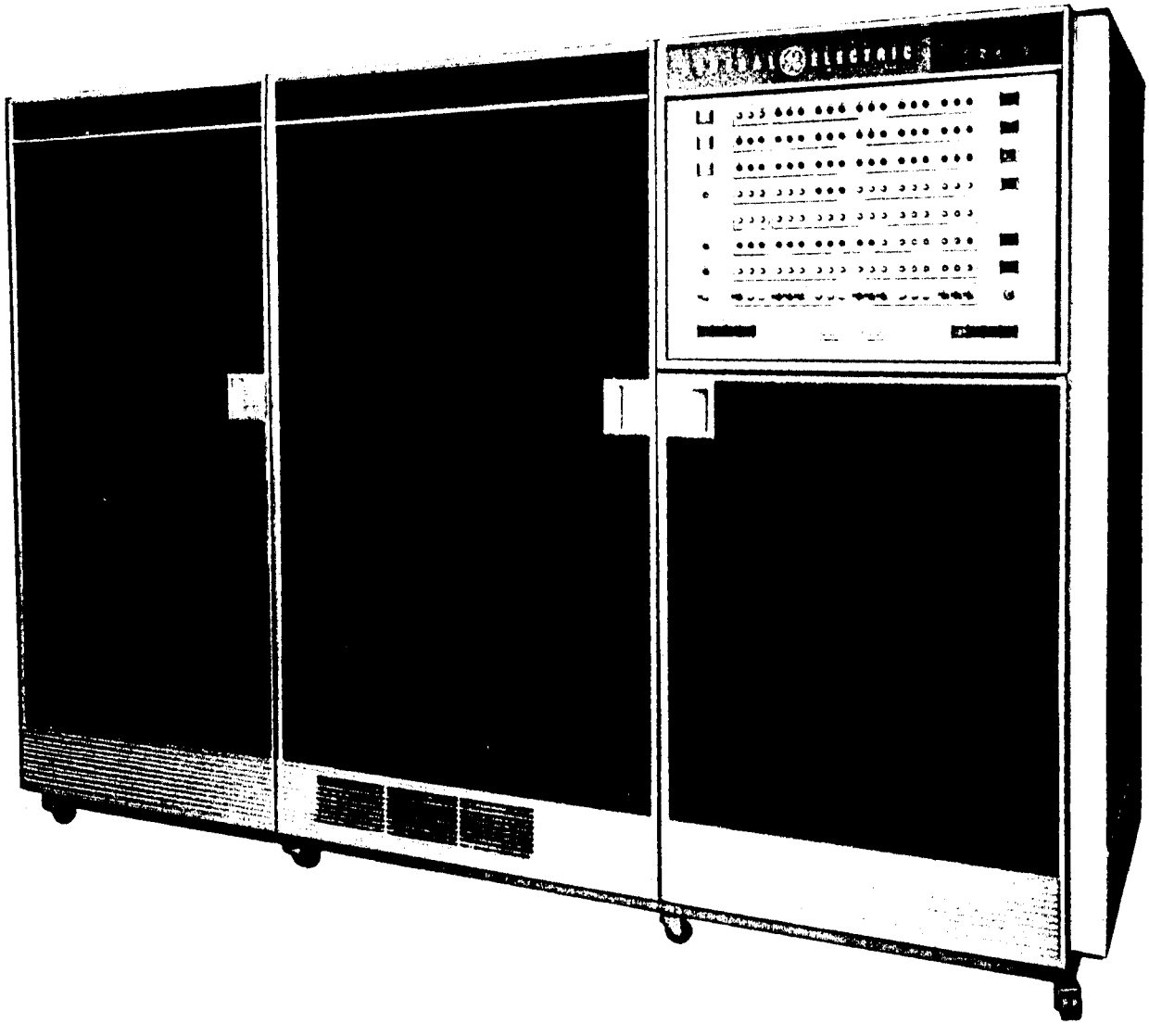

Fig. 2 — Communications Processor

functions are at a minimum, however, since the processor is designed to operate without direct operator control via the control panel. Once the program is running, most control functions will be initiated from the supervisory position keyboard/printer.

**3.09** The control panel provides means for the supervisor to start the program and check that the operate/maintenance, COUNT P, COUNT Q, HALT, MODE SELECT, and BUZZER switches are all in the correct position. The start-up sequence is: power on, check all the above switches, and operate the MANUAL LOAD switch. This enters the program from the paper tape reader. When the paper tape reader stops, the CONTINUOUS switch is operated. The program is now running and all other control functions will be initiated from the supervisory position.

**3.10** The other switches are not used normally by the supervisor. They are for maintenance, troubleshooting, and program purposes.

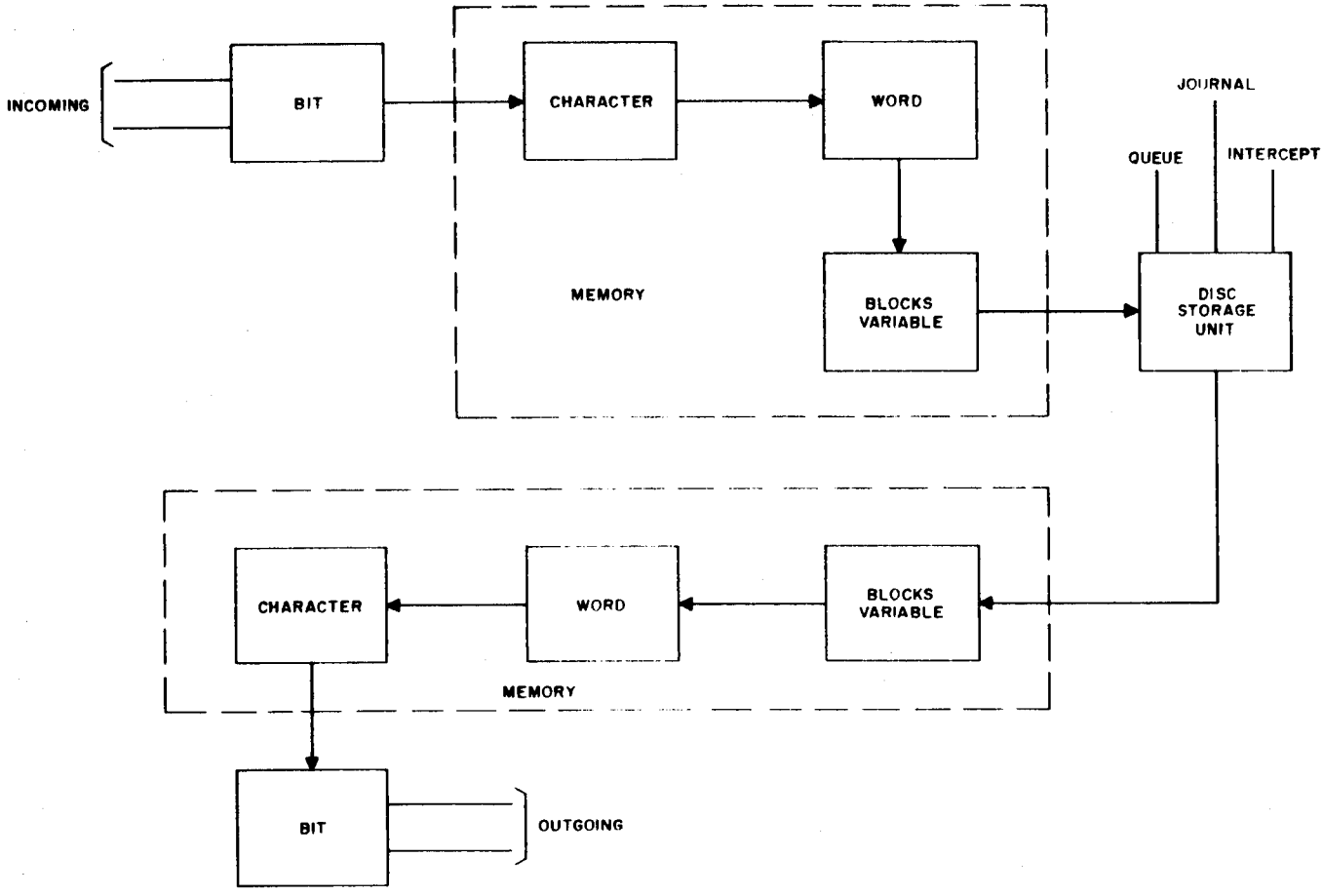


**Fig. 3 — Communications Processor Data Flow — Functional Block Diagram**

**B. Input/Output Buffers**

**3.11** The input/output buffers permit direct attachment of the communications processor to digital subsets or teletypewriter line relays which change signals to and from those required for communication transmission. Digital subsets are required on both ends of a voice-grade transmission facility.

**3.12** The four standard buffer units vary primarily in size of buffer storage. These are:

(a) The bit buffer — buffers one bit.

(b) The character buffer — buffers one character (5, 6, 7, or 8 bits).

(c) The word buffer — buffers one word (20 bits or less) of information.

The choice of buffer depends upon the transmission rate and the unit on the other end of the line. The bit buffer can operate with either a teletypewriter line relay or a digital subset. The character buffer and word buffer operate with a digital subset only.

**3.13** System considerations limit operating speed of the bit buffer lines to the standard rates of 45, 50, 56.25, 66.2, 72.6, 75, 110, and 150 bits per second. The rate is established per module with a timing connector plug. The selected bit rate will apply to all the bit buffer channels physically located in a module. If more than one bit rate is used in a system, the different bit-rate lines would be terminated in separate bit buffer unit modules using a timing connector plug set for the bit rate of that module. More than one code level may be used within a bit buffer unit

module. The program recognizes different code levels in use in the same system.

**3.14** The maximum number of lines which can operate simultaneously is dependent upon the bit rate in use in the system, the volume of traffic, and other factors. The slower the transmission rate, the higher the number of remote stations that can be handled simultaneously.

**3.15** A bit buffer is able to echo what is received (Fig. 4). This is controlled by activating the appropriate instruction and therefore is under program control. When echoing, the bit received by the receive section is retransmitted over the transmit portion of the full-duplex line. In this way a terminal device with error control capability can verify what was received by the processor (actually, what is received by the terminal device). Whenever a bit buffer channel is set up for echoing, the transmitting section is locked out so that the bit ordinarily in the transmit data buffer cannot interfere with what is being sent back to the terminal device.

**3.16** The usual equipment at the transmitting end is a keyboard printer send/receive unit. The information is transmitted in the normal manner, but the printer does not print a hard copy as a direct result of the transmission. The transmitted signals are received by the receive section of a bit buffer and immediately transmitted back to the page printer of the transmitting terminal. Thus, the printed information indicates the number of possible errors involved in the transmission of the message.

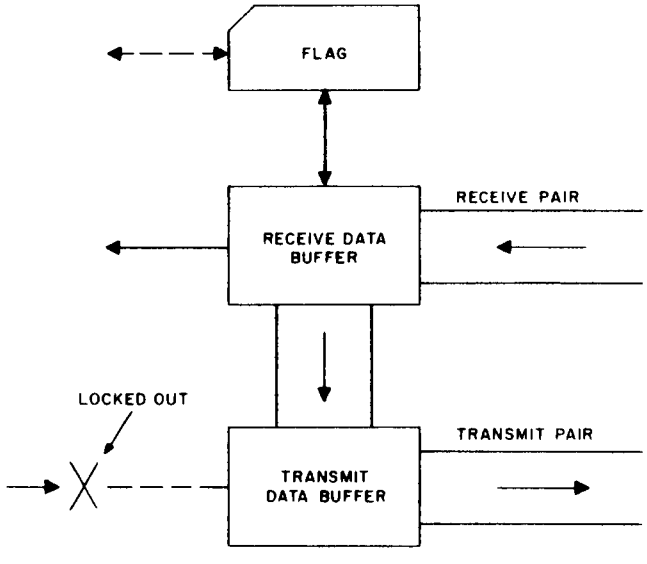


**Fig. 4 — Bit Buffer Echoplex Mode**

**3.17** This technique quickly shows whether or not the lines are working properly and, in the case of an administrative message, whether or not it is possible to read through the errors. If the errors are too numerous the transmitting terminal can take appropriate action. If the transmission contains important numerical data where the numbers must be correct, the transmitting station again can immediately verify that the transmission was satisfactory.

### C. The Computer Interface Unit

**3.18** For those systems requiring a combination data communication-information processing system, a Computer Interface Unit (CIU) is provided. This unit permits attaching a data communication processor to a General Electric 215, 225, or 235 General Purpose Computer. With this combination, the processor is responsible for the communications portion of the system, while the computer is responsible for the data processing portion.

### D. Magnetic Tape System

**3.19** The magnetic tape systems provide:

(a) Compact storage of a high volume of data in computer language. The data then can be entered directly into GE-200 series computers for processing (inter-computer compatibility).

(b) Storage for variable length records on the tape.

(c) A means for entering data generated by the computer into a processor for transmission to a remote terminal.

**3.20** The magnetic tape system (Fig. 5) consists of one to four magnetic tape controllers, each capable of directing from one to eight magnetic tape handlers.

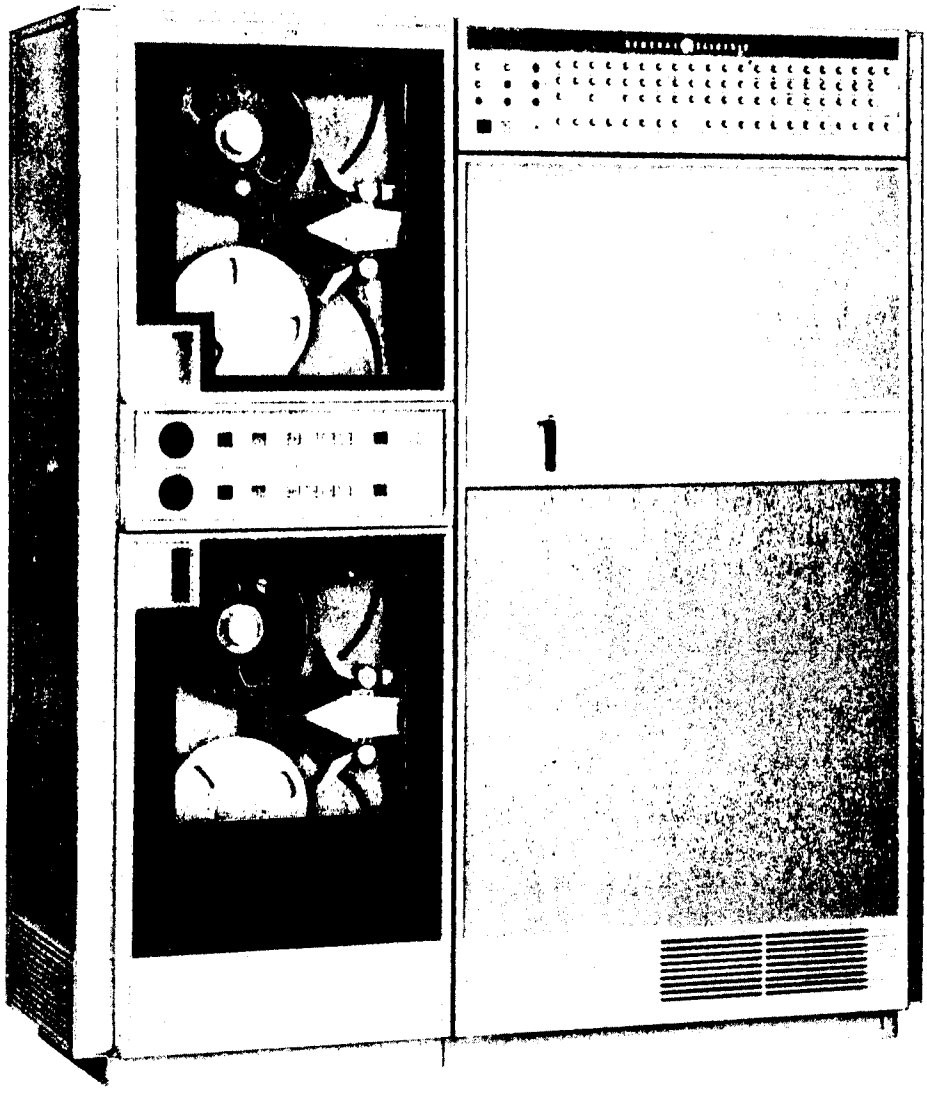

Fig. 5 — Magnetic Tape Controller and Handlers

**3.21** The magnetic tape controller links the data communications processor and tape handlers. Tape instructions are transmitted by the data communications processor through one of the channels of the controller selector to a magnetic tape controller.

**3.22** The magnetic tape controller performs the following functions:

(a) Provides logic for selecting the magnetic tape handler and for reading, writing, and rewinding the magnetic tape.

(b) Monitors the flow of data between tape handlers and memory.

(c) Initiates and times the starting and stopping of the selected tape handler.

(d) Detects the end-of-record, end-of-tape, and end-of-file conditions.

(e) Ensures reliability for the magnetic tape subsystem through its error-checking circuitry.

### E. Disc Storage Unit

**3.23** The disc storage unit subsystem (Fig. 6) is made up of the controller, the disc storage unit, and an electronics cabinet. One controller can be connected to a system and is capable of controlling up to four units. The controller communicates with the data communications processor through a channel of the controller selector. A dual access controller is available as an option.

**3.24** Each disc storage unit provides a capacity of 98,304 records of 64 words each, providing storage of 18.8 million alphanumeric characters, or more than 34 million numeric digits. As storage requirements increase, other units can be added.

**3.25** Each disc storage unit consists of 16 circular magnetic data discs. Each disc is coated on both sides with a ferrous oxide recording material, thus providing 32 recording surfaces. Each side of a disc is divided into an inner zone and an outer zone. Each zone consists of 128 circular tracks, providing a total of 256 recording tracks on each side of a disc.

## 4. OPERATIONAL FEATURES AND CAPABILITIES

**4.01** Table A summarizes some of the features, functions, and capabilities of the system. Inasmuch as the solid state teletypewriter and data switching field of development is continually changing, various items listed may have already undergone design changes. These features are intended to serve as a broad outline of the latest

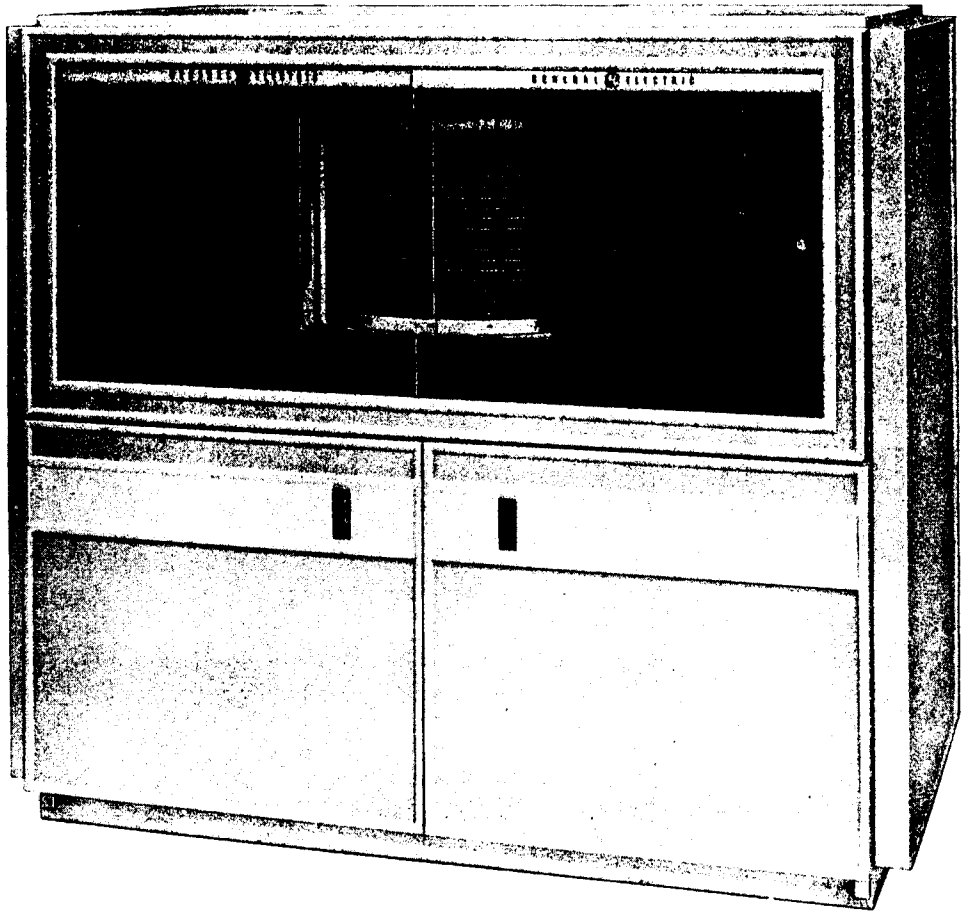

Fig. 6 — Disc Storage Unit

information available in the manufacturer's brochures as of the date of this publication.

**4.02** Because of the brevity in which Table A has been assembled, certain abbreviations used are explained in the following paragraphs. Also, some additional information is provided which is not contained in the table. Parenthetical figures correspond to the line numbers listed in Table A.

(1) ***Switching Only:***

Yes — Indicates that the system does not normally process data other than that normally associated with switching teletypewriter or data message traffic.

No — Indicates that the complete system has data processing capability in addition to switching teletypewriter and data message traffic.

(2) ***Switching Plus Data Processing Capability:***

Yes — Indicates that the system can process data in addition to switching messages and data.

No — Indicates that the system has no data processing capability.

(3) ***Bits/Sec:*** This indicates the maximum bits per second that the equipment and/or facilities will normally handle. In this area the limits are not precisely defined. The maximum in many cases is determined by intercity transmission facility capabilities or the type of equipment associated with the processor. Forty-five to sixty bits correspond to approximately 60 to 75 words per minute of 5-level teletypewriter characters. Seventy-five bits correspond to approximately 100 words per minute.

(4) ***Length of Word:*** This refers to the normal number of bits contained in a data or computer word.

(5) ***Type of Storage:*** Four types of storage are listed: ferrite core, magnetic tape, disc, and drum. These various types of storage are used for:

(a) Storing words, addresses, instructions, etc., prior to making a decision to switch.

(b) Keeping a journal of all traffic incoming and/or outgoing through a central processor.

(c) Keeping logs of message traffic being handled by a computer center.

(6) ***Computer Storage Capacity:*** This indicates the communications processor storage capacity in 18-bit words. It does not include system storage capacity.

(7) ***Capacity of Journal:*** A journal is a record either on magnetic tape or disc of traffic or data for a given length of time. This record can be for a number of days or weeks. It contains the date, message or data identification number, address, text, and signature completely as received. Means are provided for retrieving any message or block of data in accordance with some programmed instruction. The use and application of a journal will vary between customers.

(8) ***Capacity of Log:*** The log is an abbreviated copy of the journal that is stored in the same manner for a given length of time. It contains the date, message or data identification number, address, and signature. A log keeps a concise record of all message traffic through a center and can be retained for a longer period than the journal since it usually has less volume. The information required by a station on a request for rerun of certain traffic can be obtained from the log even after the journal has been destroyed. The use of a log will depend upon customer application.

(9) ***Simplex Line Capacity:*** This refers to the maximum number of communication lines that can be connected to the system. In practice, however, the practical limit of line connections will be less. The optimum number of lines depends entirely upon the application of the system. In general, as the search time and number of computations required increases, the number of practicable lines decreases.

(10) ***Handling Various TTY Speeds:*** The column indicates the standard teletypewriter speeds that the system can handle without dig-

ital subsets. The system is capable of handling various TTY speeds up to 300 bps. It is not necessary that all teletypewriters on all lines operate at the same speed, since the system is able to facilitate speed conversions.

(11) ***Type of Circuit Assurance:*** This refers to the method used to assure that the circuits are in a continually operating condition. The processor sends a specific character or code to the distant station. Upon receipt of this code, the station will generate an answer-back code. The receipt of this answer-back code by the processor indicates that the circuit is in operating condition.

(12) ***Type of Control Position:*** This refers to the type of equipment used for the manual control of the system.

(13) ***Program Change by Customer:***

Yes — Indicates that the customer can readily change the programming of the processor.

No — Indicates that the customer may require the assistance of a service representative of the equipment supplier.

(14) ***Signals Regenerated:*** This indicates that all incoming signals are reshaped and retimed at some point in the processor.

(15) ***Access Time to Storage:*** This refers to the time required to locate and start sending information stored in the processor. The access time depends largely upon application and will vary considerably.

(16) ***Trouble Analysis Arrangement:*** This indicates that diagnostic programming and processor routines are the main methods of equipment trouble analysis.

(17) ***Dual Switching Unit Provision:*** This indicates that back-up processors can be supplied to prevent downtime for maintenance and emergencies. This is referred to as a dual system.

(18) ***Automatic Message Numbering:*** This indicates that the system is capable of providing automatic message numbering if desired.

(19) ***Broadcast:*** This indicates that the processor is able to send a single message to all or many of its stations at the same time.

(20) ***Message Time Stamping:*** This indicates that the processor is capable of marking messages with time of receipt and time of delivery information.

(21) ***Trunk Hunting:*** Trunk hunting is the ability to select an alternate line to a location served by more than one line if the first or normal line is busy.

(22) ***Priority Arrangement:*** This indicates that the system is capable of handling traffic on a priority basis in accordance with the following:

Priority Pickup — Indicates that the system can accept priority traffic from an outlying station or line before it will accept routine traffic from another station.

Priority Cross Office — Indicates that priority traffic can be switched ahead of routine traffic that is already in the processor.

Priority Delivery — Indicates the processor can interrupt routine or lower priority traffic on an outgoing line in order to deliver the higher priority traffic.

**TABLE A — SUMMARY OF PROCESSOR FUNCTIONS AND CAPABILITIES**

| | SYSTEM FUNCTIONS | | SYSTEM CAPABILITIES |
|---|---|---|---|
| 1 | Switching Only | | No |
| 2 | Switching Plus Data Processing Capability | | Yes |
| 3 | Bits/Sec | | 2400* |
| 4 | Length of Word | | 18 Bits |
| 5 | Type of Storage | Ferrite Core | Yes |
| | | Magnetic Tape | Yes |
| | | Disc | Yes |
| | | Drum | No |
| 6 | Computer Storage Capacity | | 4096; 8192; or 16,384 |
| 7 | Capacity of Journal | | Not Definite |
| 8 | Capacity of Log | | Not Definite |
| 9 | Simplex Line Capacity | | 128 Lines |
| 10 | Handling Various TTY Speeds | | 60, 75, 100 wpm* |
| 11 | Type of Circuit Assurance | | Station Polling |
| 12 | Type of Control Position | | Control Panel and Teletypewriter Supervisory Position |
| 13 | Program Change by Customer | | Yes |
| 14 | Signals Regenerated | | Yes |
| 15 | Access Time to Storage | | Varies with Application |
| 16 | Trouble Analysis Arrangement | | Diagnostic Program and Routines |
| 17 | Dual Switching Unit Provision | | Yes |
| 18 | Automatic Message Numbering | | Yes |
| 19 | Broadcast | | Yes |
| 20 | Message Time Stamping | | Yes |
| 21 | Trunk Hunting | | Yes |
| 22 | Priority Arrangement | | Pickup, Cross Office, Delivery |

* Has at least this capability