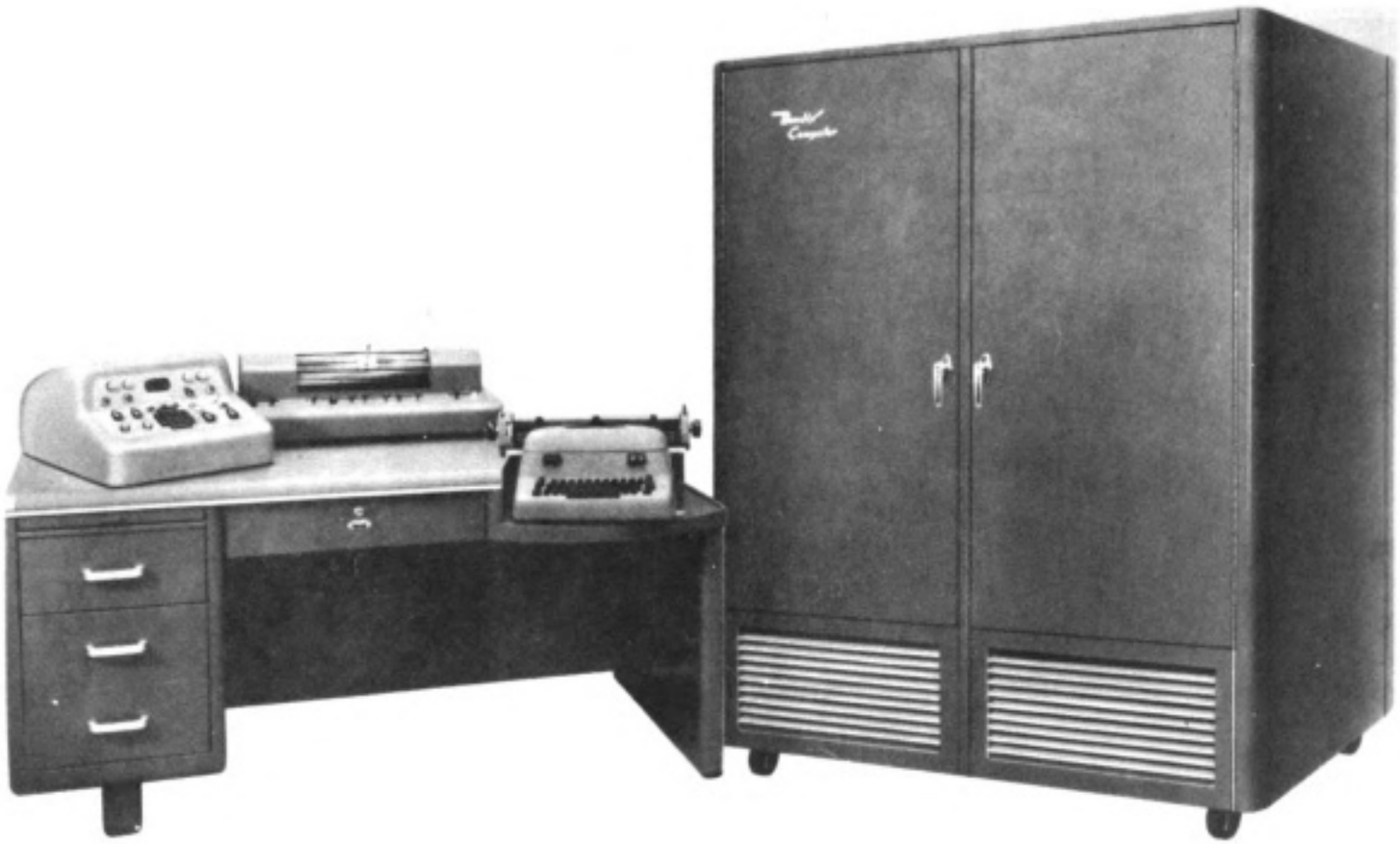
BENDIX D 12

Bendix D12 Digital Differential Analyzer

MANUFACTURER

Computer Division, Bendix Aviation



Picture by Rome Air Development Center, Griffiss Air Force Base

APPLICATIONS

Manufacturer
Solution of differential equations

Government Sample
Griffiss Air Force Base
General scientific

NUMERICAL SYSTEM

Internal number system Binary coded decimal
Decimal digits per word 8
Arithmetic system Fixed point
Number range -5.0000000 to +4.9999999

As this system is a digital differential analyzer, usual digital computer instructions are not used. The computer employs a semi-fixed program.

ARITHMETIC UNIT

Manufacturer

	Microsec
Add Time (exclud. stor. access)	43

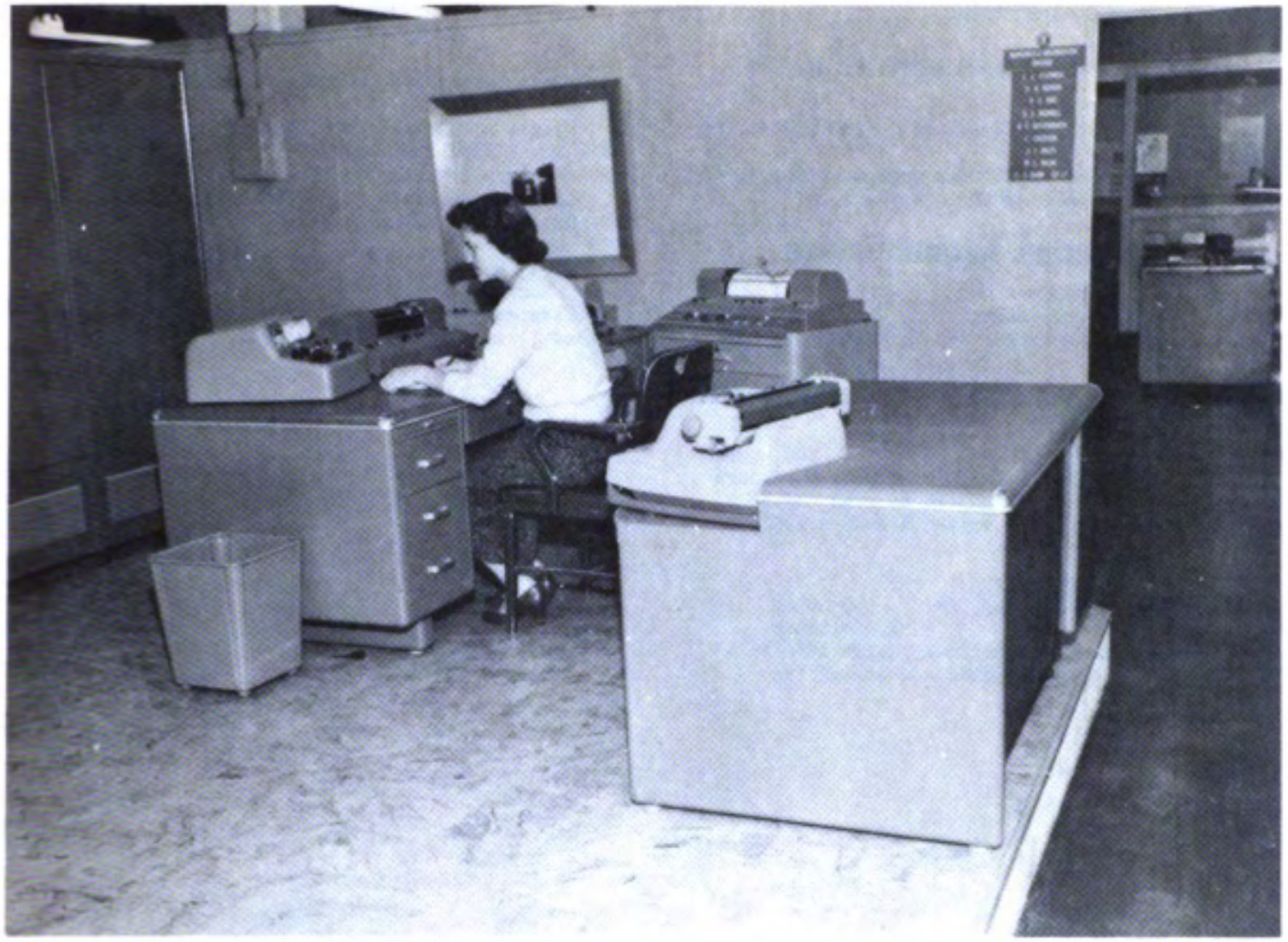
Construction Vacuum tubes
Basic pulse repetition rate 200 Kc/sec
Arithmetic mode Serial
Timing Synchronous
Operation Sequential

Decimal digits are treated serially, whereas their binary codes are held in parallel.

STORAGE

Media	Words	Binary Digits
Magnetic Drum	650	22,000

Access times are not relevant because of the fixed program.



Picture by Rome Air Development Center, Griffiss Air Force Base

Government Sample
Griffiss Air Force Base
This system has 60 integrators.

INPUT

Media	Speed
Paper Tape	6 dig/sec

OUTPUT

Media	Speed
Typewriter	10 dig/sec
Graph Plotter	20 dig/sec, 100 steps/inch

Government Sample
Griffiss Air Force Base
This system has a teletype punch and a visual CRT display.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	700
Tube types	6
Crystal diodes	2,200
Separate cabinets	2

CHECKING FEATURES

Fixed
Overflow in addition
Prescribed code as a result of addition

POWER, SPACE AND WEIGHT

Manufacturer

Power, computer	7.5 KW
Power, air cond.	105 cu. ft. 25 sq. ft.
Weight, computer	2,000 lbs.

A desk is provided in addition to the computer console proper.

PRODUCTION RECORD

Manufacturer
The Bendix D-12 is no longer in production and is manufactured only when a customer's needs can be met by no other equipment. The DA-1 used with the G-15D General Purpose Computer System is based on the D-12 and uses the memory of the G-15D for combined GPC and DDA operation. The DA-1, while low-priced, is therefore equipped with 108 integrators

and 108 constant multipliers.

COST, PRICE AND RENTAL RATE

Manufacturer

Approximate cost of basic system $55,000, including one graph plotter unit.

Approximate cost of additional equipment $8,035 for unit for interconnecting two computers.

PERSONNEL REQUIREMENTS

Government Sample

Griffiss Air Force Base

System requires 1 engineer and 2 operators.

RELIABILITY AND OPERATING EXPERIENCE

Manufacturer

Good time	500 hours
Attempted to run time	600 hours
Operating ratio (Good/Attempted to run)	0.83

Acceptance test of first system 1 August 1954

Government Sample

Griffiss Air Force Base

Average error free running time	40 hours
Good time	1,000 hours

Above figures based on period 15 March 1956 to 1 November 1956. System passed acceptance test 15 March 1956.

INSTALLATIONS

Products Division, Bendix Aviation Corporation, Mishawaka, Indiana

Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio

Redstone Arsenal, Huntsville, Alabama

Lockheed Aircraft Company, Marietta, Georgia

Griffiss Air Force Base, Rome, New York

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The system is unusually easy to code and operate, since it is a fixed code machine.

BENDIX G 15

Bendix G 15 General Purpose Computer

MANUFACTURER

Bendix Computer Division
Bendix Aviation Corporation

Picture by Bendix Aviation Corporation

APPLICATIONS

Manufacturer
General scientific computation.

Government Sample
Illinois State Highway Division
Planning, design and construction of state highways on a G-15A System.

Michigan State Highway Department
Road and bridge design problems on a G-15A System.

Industrial Sample
Bendix Aviation Corporation Radio Division
Scientific calculation on a G-15A System.

Bendix Aviation Corporation Research Laboratories Division
Preparation of control tapes for numerically controlled machine tools as well as general computation is performed on a G-15C.

Lockwood, Kessler and Bartlett, Incorporated
Earthwork volumetric computations, structural design, aerial triangulation adjustment, traverse closures and adjustments, traffic count compilation and analysis.

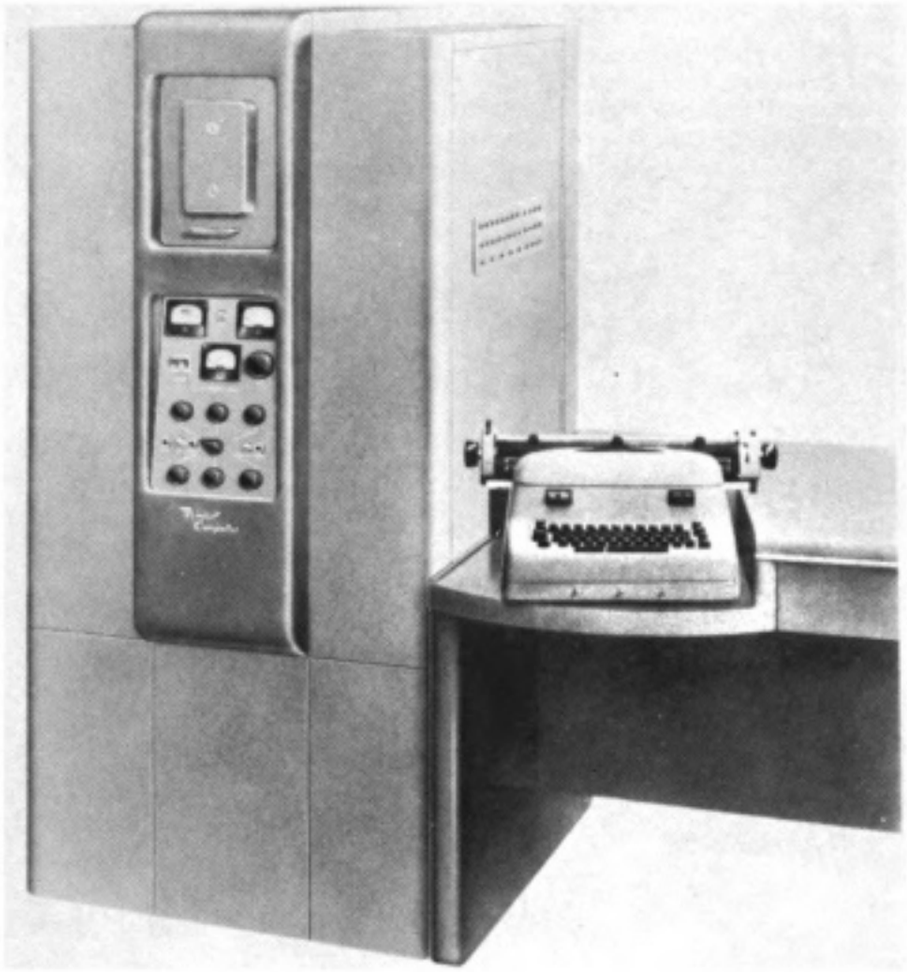
NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	28 + sign
Binary digits per instruction	29
Instructions per word	1
Instructions decoded	1,300
Arithmetic system	Fixed point
Instruction type	Modified two address
Number range	$(1 - 2^{-28})$ to - 1

There are 57 digits plus sign per word when operating on a double precision basis. Micro-programming is used, resulting in a large number of instructions.

Industrial Sample
Bendix Aviation Corporation Radio Division
Basic routines on the G-15A System permit use of machine as a floating point single address computer. Fifty instructions are decoded on this system.

Bendix Aviation Corporation Research Laboratories Division
Second address on G-15C specifies location of next



Picture by Bendix Aviation Corporation

command.

ARITHMETIC UNIT

	Single Precision Microsec	Double Precision Microsec
Add time	540	810
Mult time	16,000	33,000
Div time	16,000	33,000
Construction	Vacuum tubes and recirculating registers on magnetic drum for storage of arithmetic elements.	
Arithmetic mode	Serial	
Timing	Synchronous	
Operation	Sequential	

Multiplication of arbitrary precision is possible: 540 microseconds/digit of multiplier plus 270 microseconds command access time, is required. All times given in above table include minimum access to command. There are two accumulators, one single length and one double length. The two's complement system of arithmetic is used.

Industrial Sample
Bendix Aviation Corporation Radio Division
The model G-15A demonstrates the following characteristics:

1. Operation Time	Incl. Stor. Access Microseconds	Exclud. Stor. Access Microseconds
a. Add	15,000 (Med Access Lines)	300 (Sngl. prec.)
	900 (Fast Access Lines)	600 (Dbl. prec.)
b. Mult	32,400 (Med Access Lines)	17,400 (Sngl. prec.)
	18,000 (Fast Access Lines)	34,800 (Dbl. prec.)
c. Div	32,400 (Med Access Lines)	17,400 (Sngl. prec.)
	18,000 (Fast Access Lines)	34,800 (Dbl. prec.)

Items in first column are for single precision.

STORAGE

Media	Words	Digits	Microsec Access
Magnetic Drum	2,160	62,640	14,500
Magnetic Drum	16	464	540

Above access time entries are average values. Second line entry in above table is for the fast access storage.

Picture by Bendix Aviation Corporation

INPUT

Media	Speed
Paper Tape (Photoelectric)	250-300 sexadec char/sec
Card Punch (IBM 026)	17 sexadec char/sec
Magnetic Tape	430 sexadec char/sec

Input-output operations proceed without interrupting computation.

OUTPUT

Media	Speed
Card Punch (IBM 026)	11 sexadec char/sec
Typewriter	8 sexadec char/sec
High Speed Punch	60 sexadec char/sec
Low Speed Punch	17 sexadec char/sec
Magnetic Tape	430 sexadec char/sec

Input-output operations proceed without interrupting computation.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	180 tube packages
Crystal diodes	300 diode packages
Transistors	Plug-in etched circuit packages

Industrial Sample
Bendix Aviation Corporation Radio Division
Approximately 400 tubes and 3,000 crystal diodes compose the G-15A System.
Bendix Aviation Corporation Research Laboratories Division
Primary tube type for the G-15C System is the 5967.

CHECKING FEATURES

Fixed
Critical signals are available at the test panel.
Optional
Marginal check voltages. Test programs.

POWER, SPACE AND WEIGHT

Power, computer	3.8 KVA
Space, computer	30.5 cu. ft. 6 sq. ft. 32" deep by 27" wide by 61" high
Weight, computer	850 lbs.
Capacity, air cond.	Internal forced air

PRODUCTION RECORD

	G-15A	G-15C	G-15D
Produced	18	1	2
In production	-	-	25
Operating	18	1	2
On order	-	-	8
Delivery time	3 to 6 Months		

COST, PRICE AND RENTAL RATE

	Price
G-15 General Purpose Computer, including the following: G-15A- - - - G-15D- - - -	$44,800 $49,500
Typewriter for Input, Output and control Paper Tape Input and Output (punch and photoelectric reader) Spare parts and Package test equipment Installation at customer's location Library of Sub-routines Operating and Maintenance Manuals Training Courses in Programming, Operation and Maintenance Material and Workmanship Warranty of One year	
MTA-2 Magnetic Tape Unit. Up to four units, each with 300,000 word storage, may be used.	6,800
AN-1 Alphanumeric Paper Tape Input and Output Accessory	6,900
DA-1 Digital Differential Analyzer	13,700
PA-1 Graph Plotter, for use with DA-1	1,800
PFA-1 Graph Plotter/Follower for use with DA-1	5,700
PTP-1 Paper Tape Output Punch (60 char/sec.)	3,240
CA-1 Punched Card Input-Output Converter	1,245

Prices are f.o.b. Los Angeles and are subject to change without notice.

	Monthly Lease Rate
G-15A General Purpose Computer, including the following:	$1,350
Typewriter for Input, Output and control Paper Tape Input and Output (punch and photoelectric reader) Installation of customer's location Maintenance Service Library of Sub-routines Programming and Operating Manuals Training Courses in Programming and Operation	
G-15D General Purpose Computer	1,485

Will operate with DA-1 Accessory, to provide for combined digital computer and digital differential analyzer use. Some materials and services are included as with G-15A.

MTA-2 Magnetic Tape Unit. Up to four units, each with 300,000 word storage, may be used with either G-15A or G-15D.	270

Accessories for use with G-15D only

AN-1 Alphanumeric Paper Tape Input and Output	280
CA-1 Punched Card Input-Output Converter	50
DA-1 Digital Differential Analyzer	550
PA-1 Graph Plotter, for use with DA-1	75
PFA-1 Graph Plotter/Follower for use with DA-1	230
PTP-1 Paper Tape Output Punch (60 char/sec.)	130

Rates are f.o.b. Los Angeles and are subject to change without notice.

LEASE POLICY

Minimum Lease Period: One year.
Add 50% to prices for each shift of use over one.
Rates do not include taxes or transportation.
Purchase Option: 35% of previously paid rental charges may be applied to purchase, with limit of 60% of current purchase price.

Tube-package tester, diode package tester, 10% of all plug-in packages included with rental or sales price. An oscilloscope is furnished with a rental installation.

PERSONNEL REQUIREMENTS

Manufacturer

Daily Operation	Engineers
1-8 Hour shift	0.5

Government Sample

Michigan State Highway Department

Though system is not yet in production, 1 engineer and 1 technician-operator are utilized.

Industrial Sample

Bendix Aviation Corporation Radio Division

Three 8-hour shifts require 5 engineers on this system.

Bendix Aviation Corporation Research Laboratories Division

	No. of Engineers	No. of Tech-Operators
One 8-hour shift	1	1
Two 8-hour shifts	1	2
Three 8-hour shifts	1	3

RELIABILITY AND OPERATING EXPERIENCE

Manufacturer

90-98% good time reported by all installations.
Anything below 90% is abnormal.
110 hours of error free operation on 24 hour shifts with unattended operation at night reported by one installation.

Government Sample

Michigan State Highway Department

Average error free running period	80 hours
Good time	156 hours
Attempted to run time	160 hours
Operating ratio (Good/Attempted)	0.975

Figures based on period from 1 December 1956 to 1 January 1957.

Industrial Sample

Humble Oil and Refining Company

The Bendix G-15A System has been found to be a very reliable and satisfactory medium speed computer.

FUTURE PLANS

Government Sample

Michigan State Highway Department

The G-15A System will be used for highway earthwork estimates, traversing, and bridge design problems.

Industrial Sample

Bendix Aviation Corporation Radio Division

A digital differential analyzer is to be attached to the G-15A System.

INSTALLATIONS

Bonneville Power Administration, 1001 N.E. Lloyd Boulevard, Portland, Oregon

Humble Research Center, 3120 Buffalo Speedway, Houston, Texas

Eclipse Pioneer Division, Bendix Aviation Corporation, Teterboro, New Jersey

Fellows Gear Shaper Company, 78 River Street, Springfield, Vermont

Dr. Harry D. Huskey, 2655 Buena Vista Way, Berkeley 8, California

Massachusetts Institute of Technology, Naval Supersonic Laboratory, 560 Memorial Drive, Cambridge 39, Massachusetts

Bendix Research Laboratories, Bendix Aviation Corporation, 4855 Fourth Avenue, Detroit 1, Michigan

Bendix Radio Division, Bendix Aviation Corporation, East Joppa Road, Baltimore 4, Maryland

Eastman Kodak Company, Hawk-Eye Works, 20 Avenue E, Rochester, New York

E. I. DuPont de Nemours & Company, Pioneering Research Laboratory, Experimental Station, Wilmington 98, Delaware

Michigan State Highway Department, 8th Floor, Mason Building, Lansing, Michigan

Illinois Division of Highways, Department of Public Works and Buildings, Springfield, Illinois

New York Naval Shipyards, 29th Street and 3rd Avenue, Brooklyn 32, New York (2 systems)

ADDITIONAL FEATURES AND REMARKS

Manufacturer

Three methods may be used to program the G-15D general purpose computer. Each offers distinct advantages to the user, depending upon the type of problems which he wishes to solve and the experience of his programming personnel.

1. A standard set of 54 commands may be used to program any problem suitable for solution by a general purpose computer. The speed and efficiency of these commands is further increased by their adaptability to modification for block operations, double precision arithmetic, and other functions.
2. For the experienced programmer, the micro-coding technique enables commands to be "custom built" from individual components. As many as 1,300 different commands are possible using the micro-coding system.
3. For those with little or no experience and for problems in which programming time is an important factor, the INTERCOM 101 interpreter-compiler system is used. INTERCOM 101 offers a one-address, floating point, decimal programming system with 8 B registers.

The G-15D general purpose computer with the supplementary DA-1 digital differential analyzer combines the wide applicability of the general purpose computer with the simple programming for the solutions of linear and nonlinear differential equations characteristic of the digital differential analyzer. When used as a combination machine it is a new and powerful tool for solving the problems of engineering and automatic control.

The differential analyzer incorporates many features of the Bendix Model D-18 DDA. These include coding which is simplified to the bare essentials, improved stability and accuracy made possible by ternary transfer of incremental information, improved performance of servo and adder units, and the facility for efficient use of tabular empirical functions. The DA-1 has 108 intergretors and 108 constant multipliers.

The DA-1 and G-15D use the same memory and operate as a single, complete, synchronized device.

Industrial Sample

Bendix Aviation Corporation Radio Division

"Intercom", an efficient simplified coding system using interpretive codes for programming.

Command conversion program to convert from decimal to binary machine code.

A flexible command structure designed to facilitate a floating point system.

Bendix Aviation Corporation Research Laboratories Division

Standard coding is of micro-programming tape.

Automatic coding routines which accept greatly simplified commands are available.

Computation simultaneous with input or output materially increases speed of computation.

The following information was received too late to be included in the above outline:

U. S. Department of Interior, Bonneville Power Administration

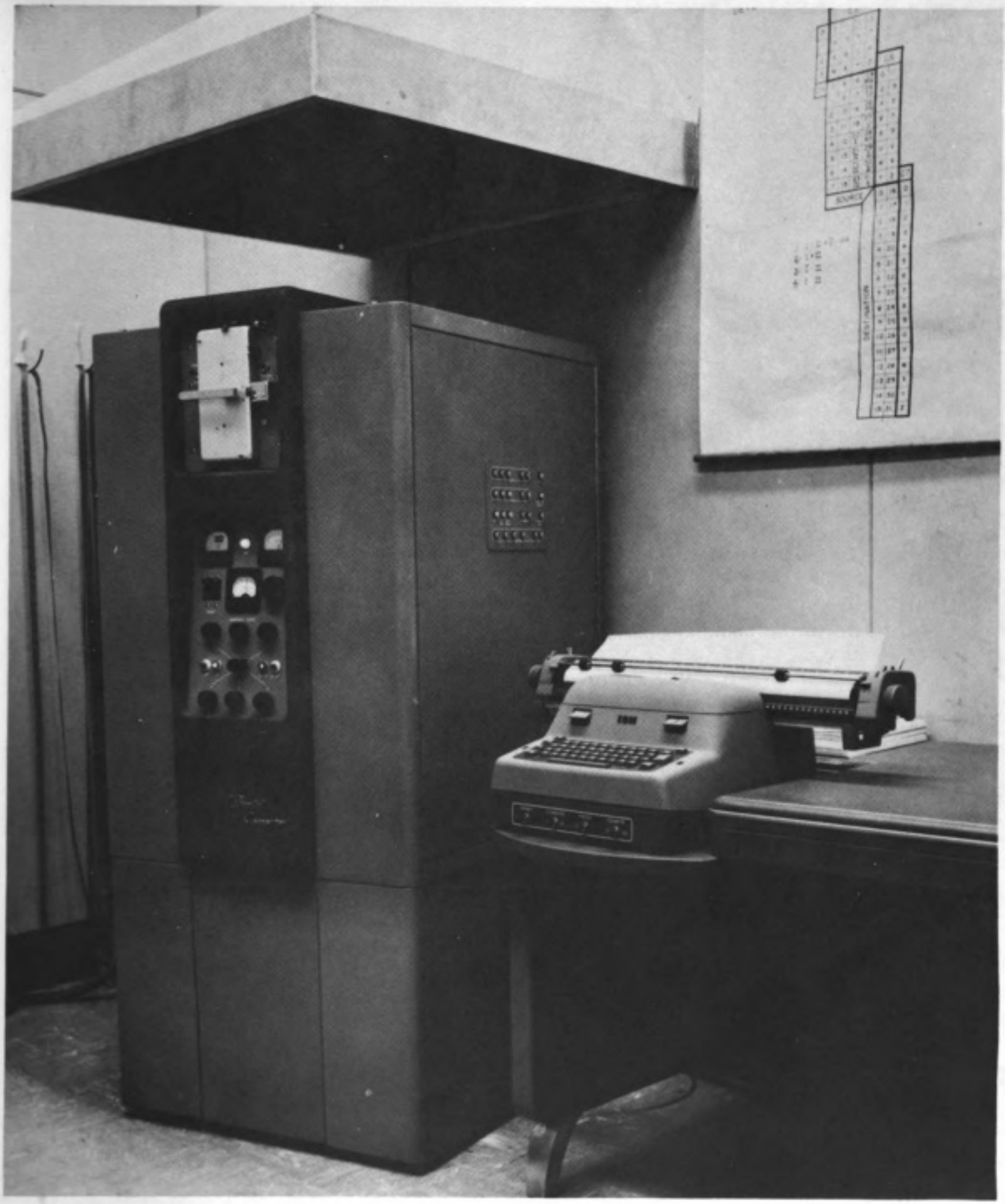
The system is utilized for the solution of power plant operation problems. Use of the computer has been limited to solutions of hydroelectric plant operation problems. Some consideration is being given toward the use of external magnetic tape storage in order to operate on more than one plant or group of plants automatically in order to speed up the program and eliminate operator intervention.

The magnetic drum is approximately 12 inches in diameter, 4 inches wide, and rotates at 1,800 rev/min.

System price was $45,000.

Two engineers are assigned for programming, operation, and maintenance.

System was accepted 28 October 1955.



Picture by U. S. Department of Interior, Bonneville Power Administration

BIZMAC

Radio Corporation of America BIZMAC System

MANUFACTURER

Radio Corporation of America

Picture by Ordnance Tank-Automotive Command

APPLICATIONS

Manufacturer
General purpose computer.

Government Sample
Ordnance Tank-Automotive Command
Business type data processing, stock management, requirements forecasting and cataloging.

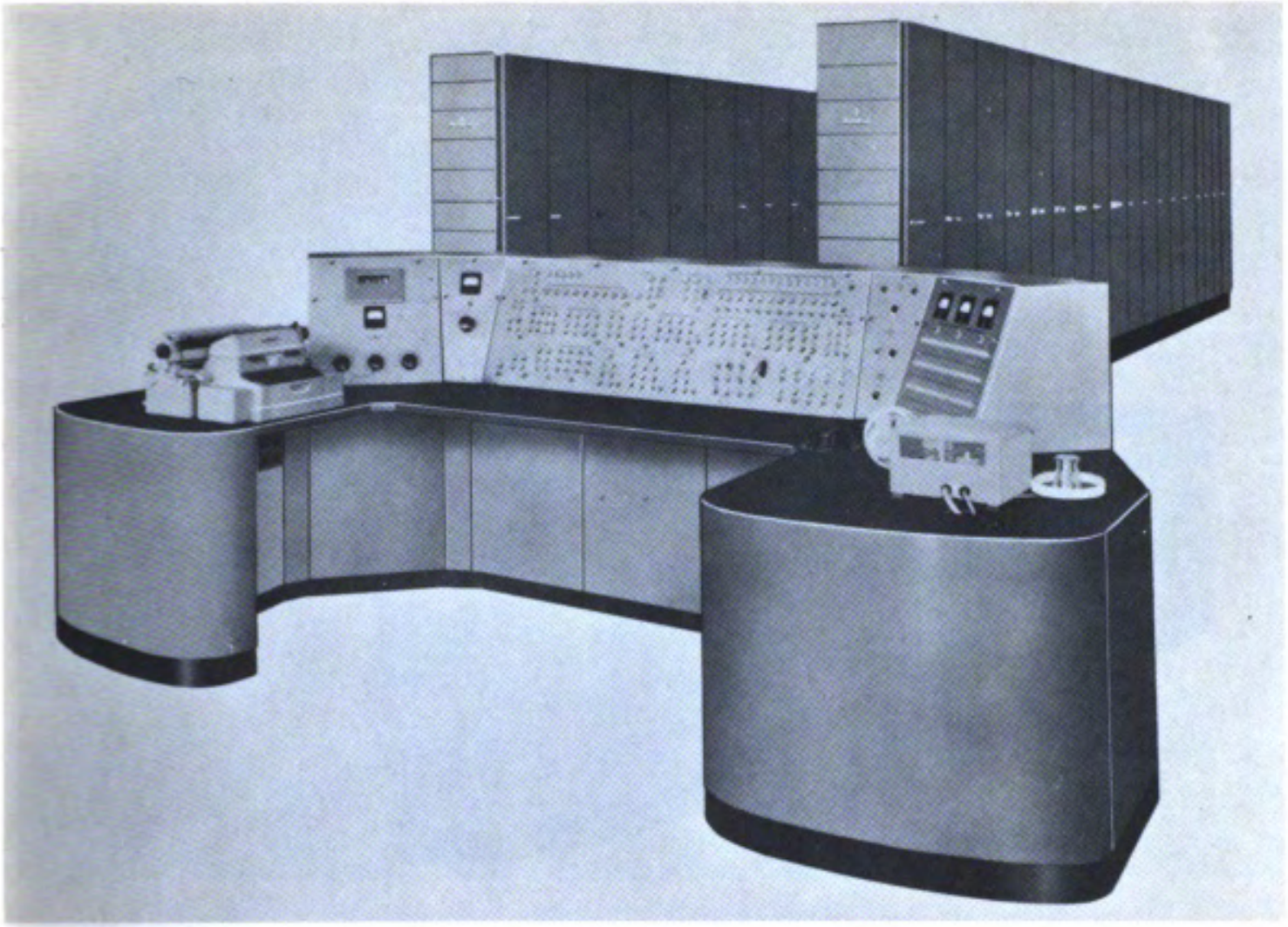
NUMERICAL SYSTEM

Arithmetic system	Fixed point
Instruction type	Three address

Data are organized in the RCA BIZMAC System in the following manner:
Seven bits (6 information + 1 parity) comprise one BIZMAC character (63 characters including ten decimal digits, 26 letters, control symbols, and miscellaneous symbols). A variable number of related characters preceded (on the left) by a control symbol comprises an item (corresponding to a word).
A group of related items enclosed by control symbols is a message (for handling as a unit on tape).
An instruction consists of eight BIZMAC characters interpreted as follows:

Operation	Variation	Addresses		
		A	B	C
B	B	BB	BB	BB

There are twenty-four basic operations which may be varied by the variation character to obtain approximately 140 distinct combinations.
The computer may perform decimal and binary arithmetic operations. Operands are completely variable in length. A 32-character operand limitation is necessary in decimal addition and subtraction where an end-around carry is possible and in multiplication where the multiplicand is also restricted in the same manner.



COMPUTER - Picture by Radio Corporation of America

ARITHMETIC UNIT

In arithmetic operations, the three addresses are used to specify the High Speed Memory locations of the least significant characters of the operands and the result. Execution time for each of these instructions is variable depending on the number of significant characters in the operands. Control symbols as well as space symbols to the left of operands cause the operations to end. The following timing formulae are available:

ADDITION TIME is given by 120 + 40C microseconds, where C equals number of characters in longest operand. This is the formula for addition with positive operands. Formula time is increased when the zero suppression or automatic left justification option is desired or if there is an end-around-carry.

MULTIPLICATION TIME is given by 160 + 288N + 145MN microseconds, where M = No. of digits in multiplicand N = No. of digits in multiplier.

The constants 288 and 145 in the above formula are average times for reading out characters, and repetitive additions are determined by the magnitude of the digits in the multiplier.

Division is programmed, and the time varies with the type of division program used, as well as with the characteristics of the operands.

The timing formulae shown above include instruction-staticizing time as well as transfer-of-data time to and from the memory.

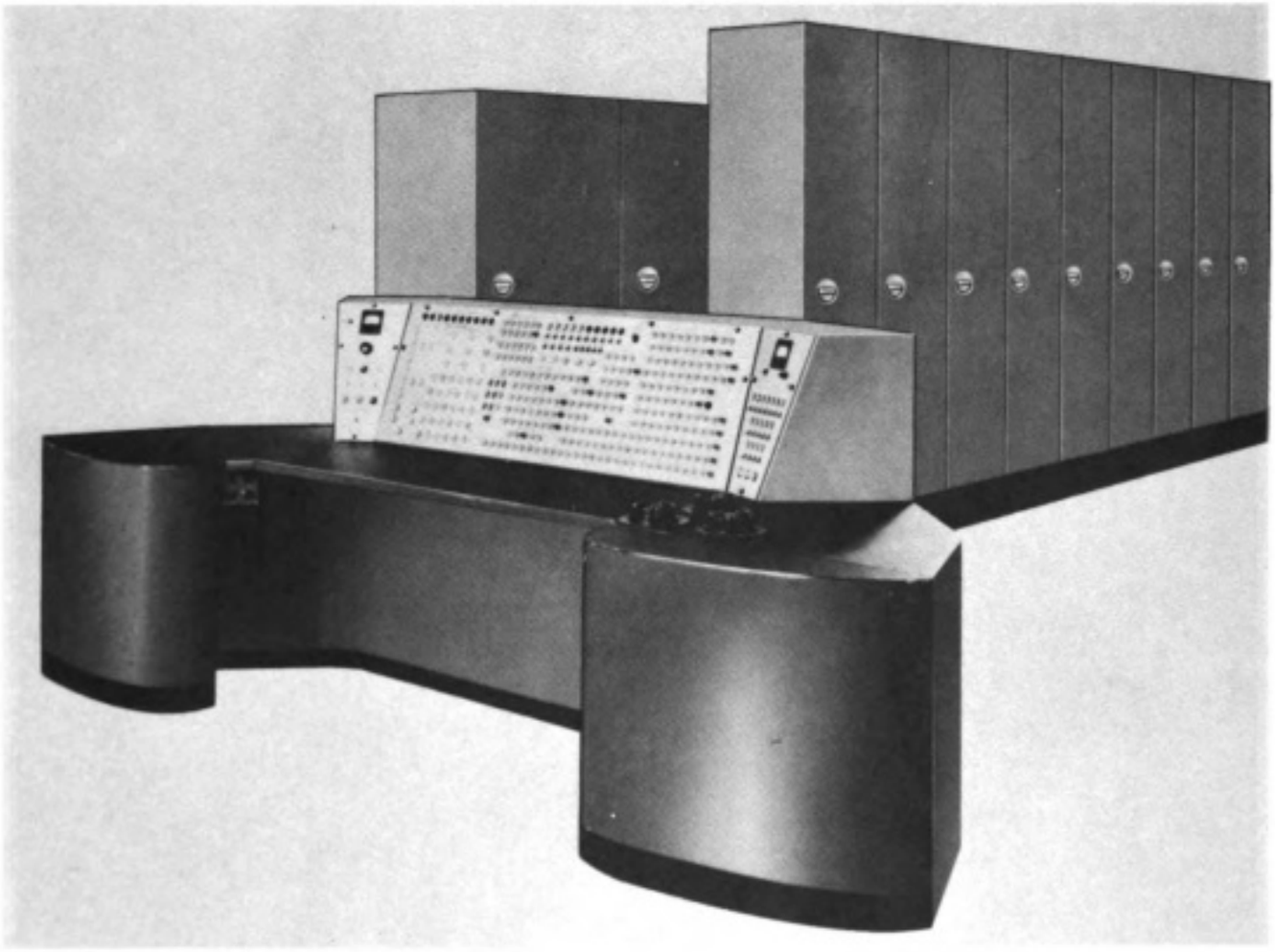
Basic construction of the arithmetic unit is vacuum tube-diode. There are no programmed rapid access registers outside of the 8,192-character High Speed Memory. Basic pulse-repetition rate is 500 KC throughout the Computer. Arithmetic operations are primarily serial although pairs of characters (one from each operand) are read from memory in parallel.

Construction	Magnetic cores and vacuum tubes
Timing	Synchronous for the computer Asynchronous for tape operation
Operation	Sequential by character Concurrent by 7 bits forming the character.

STORAGE

Media	Digits	Microsec Access
Magnetic Core	8,192	20/char
Magnetic Drum	32,736	5,120
Magnetic Tape	Indefinite	5,000

Random access to any character in core storage. Characters may be transferred between magnetic drum storage in blocks of 4 or 8 at 80 microseconds per block.



SORTER - Picture by Radio Corporation of America

INPUT

Media	Speed
Card Transcriber (Card to Magnetic Tape)	400 cards/min
Tapewriter and Verifier (Key to Paper Tape)	5,000 strokes/hour
Paper Tape Transcriber (Paper to Magnetic Tape)	200 char/sec

Inputs to all data processing equipment via magnetic tapes are at 10,000 characters/sec with blanks eliminated by variable word length. Direct paper tape input to the computer is at 400 characters/sec.

OUTPUT

Media	Speed
Electromechanical Printer	600 lines/min
Magnetic Tape Transcriber (Magnetic to Paper Tape)	20 char/sec
Trancoder (Magnetic Tape to Teletype Tape)	50 char/sec
Document Printer (Paper Tape to Typewriter)	9 char/sec
Transcribing Card Punch (Magnetic Tape to Card)	150 char/min
Interrogation Unit (Magnetic Tape to Typewriter)	4 min/inquiry (average)

With the exception of monitor print (via on-line typewriter) the output of all high-speed data processing equipment is magnetic tape: 10,000 characters per second with blanks eliminated by variable word length.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	5,000
Tube types	12
Crystal diodes	14,500
Magnetic cores	28,700

The above figures are for the Computer only. System figures depend on exact equipment complement.

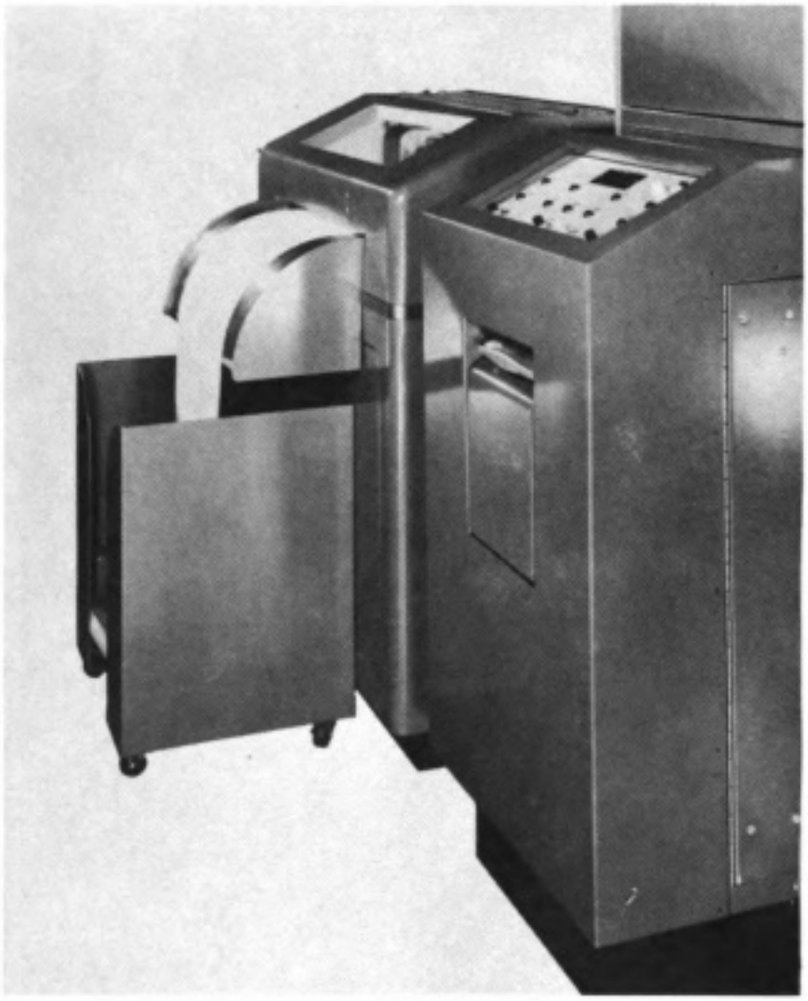
Government Sample
Ordnance Tank-Automotive Command
System has the following complement:

Tubes	30,000
Crystal diodes	70,000
Magnetic cores	35,000
Transistors	200
Separate cabinets	470

CHECKING FEATURES

Parity

The BIZMAC code is designed in such a fashion that each character of information contains a redundant parity bit for even parity checking. The various devices in the system contain hardware for extensive



ELECTROMECHANICAL PRINTER - Picture by Radio Corporation of America

utilization of this feature. In the Computer, information circulating internally or transferred to and from tape is checked for parity.

Adder Comparison

The adder forms two sums (the second by using complements of the operands). These sums must be equal, or comparator alarms are registered.

Tape Checks

Input checks are provided to assure that the proper sequence of control symbols is sensed (marking the beginning and end of messages). The first character read in is checked to see that it is one of three permissible control symbols.

An output check is provided by an echo signal, which is used to determine that writing on tape has properly taken place.

Dual recording on magnetic tape is provided. Fourteen channel tape permits the duplicate storage of each bit.

Program Control

Checks are provided to insure that instructions are properly located, that drum switching is correctly completed, and that the flow of basic machine cycles is correct.

Instruction Characteristics

Facilities which are present for use in programs include a verify instruction for data comparison, and an overflow alarm usable with decimal arithmetic instructions.

Computer Stop-Rollback Switch

This device is used to reduce manual intervention when certain types of errors are detected: parity, adder comparison, programmed verify and overflow, control-symbol sequence incoming from tape. When the switch is in the rollback position a transfer of control will be made automatically to a specific drum line, permitting attempts to repeat the affected operation.

General

Only a partial listing of checking features is presented above. The RCA BIZMAC System makes extensive use of hardware checks to insure the proper operation of the system as a whole. Many of the checks are implicit in the design (e. g. no erase while reading) or explicit in special circuits (e. g. parity checking).

POWER, SPACE AND WEIGHT

Power, computer	37.2 KW	50.9 KVA
Power, air cond.	5.0 KW	7.5 KVA
Space, computer	2,600 cu. ft.	325 sq. ft.
Space, air cond.	1,200 cu. ft.	100 sq. ft.
Weight, computer	26,500 lbs.	
Capacity, air cond.	15 Tons	

Government Sample
Ordnance Tank-Automotive Command

Power, entire system	360 KW
Power, air cond.	500 KW

REMOTE PRINTER - Picture by Radio Corporation of Americ

Space, entire system	252,000 cu. ft.	18,000 sq. ft.
Weight, entire system	500,000 lbs.	
Capacity, air cond.	250 Tons	

PRODUCTION RECORD

Produced	3
Operating	3
Delivery time	16 Months

COST, PRICE AND RENTAL RATE

Approximate cost of basic system $1,300,000.
System is available on a purchase basis only.

Government Sample
Ordnance Tank-Automotive Command
Approximate cost of entire system is $4,200,000.

PERSONNEL REQUIREMENTS

Daily Operation	Tech or Operators
1-8 Hour shift	3

Maintenance services available through RCA Service Company by contract.

Government Sample
Ordnance Tank-Automotive Command
Approximately 19 persons are employed, per shift, for system operation not including maintenance or programming. A total of 38 persons are required for two shift operation. A total of 33 technicians are required for engineering and maintenance. Maintenance personnel furnished under contract with RCA.

RELIABILITY AND OPERATING EXPERIENCE

Government Sample
Ordnance Tank-Automotive Command

Good time	653.8 Hours
Attempted to run time	774.3
Operating ratio (Good/Attempted to run)	0.845

Figures based on period 25 November 1956 to 26 January 1957.
Acceptance test November 1955.

FUTURE PLANS

Government Sample
Ordnance Tank-Automotive Command
Acquisition of the following is planned:
One magnetic tape to punched card converter
One random access memory
One additional computer

INSTALLATIONS

Government Sample
Ordnance Tank-Automotive Command
Detroit 9, Michigan

TYPEWRITER - Picture by Radio Corporation of America

Industrial Sample
Radio Corporation of America
Data Center
Camden, New Jersey

Associated Merchandising Corporation
Higbee Department Store
Cleveland, Ohio

ADDITIONAL FEATURES AND REMARKS

All equipment items in the RCA BIZMAC System are designed to accommodate actual data lengths.

All equipment items in the RCA BIZMAC System are designed to permit equipment integration, i. e. central operation of all equipment including interconnection of Tape Stations and operating devices. This means of integration permits parallel operation of equipment items on "tight" schedule basis.

A separate equipment item, the Sorter, is provided to rearrange information on magnetic tape. It is provided to sort, merge and extract said information with provision for variations of these basic operations.

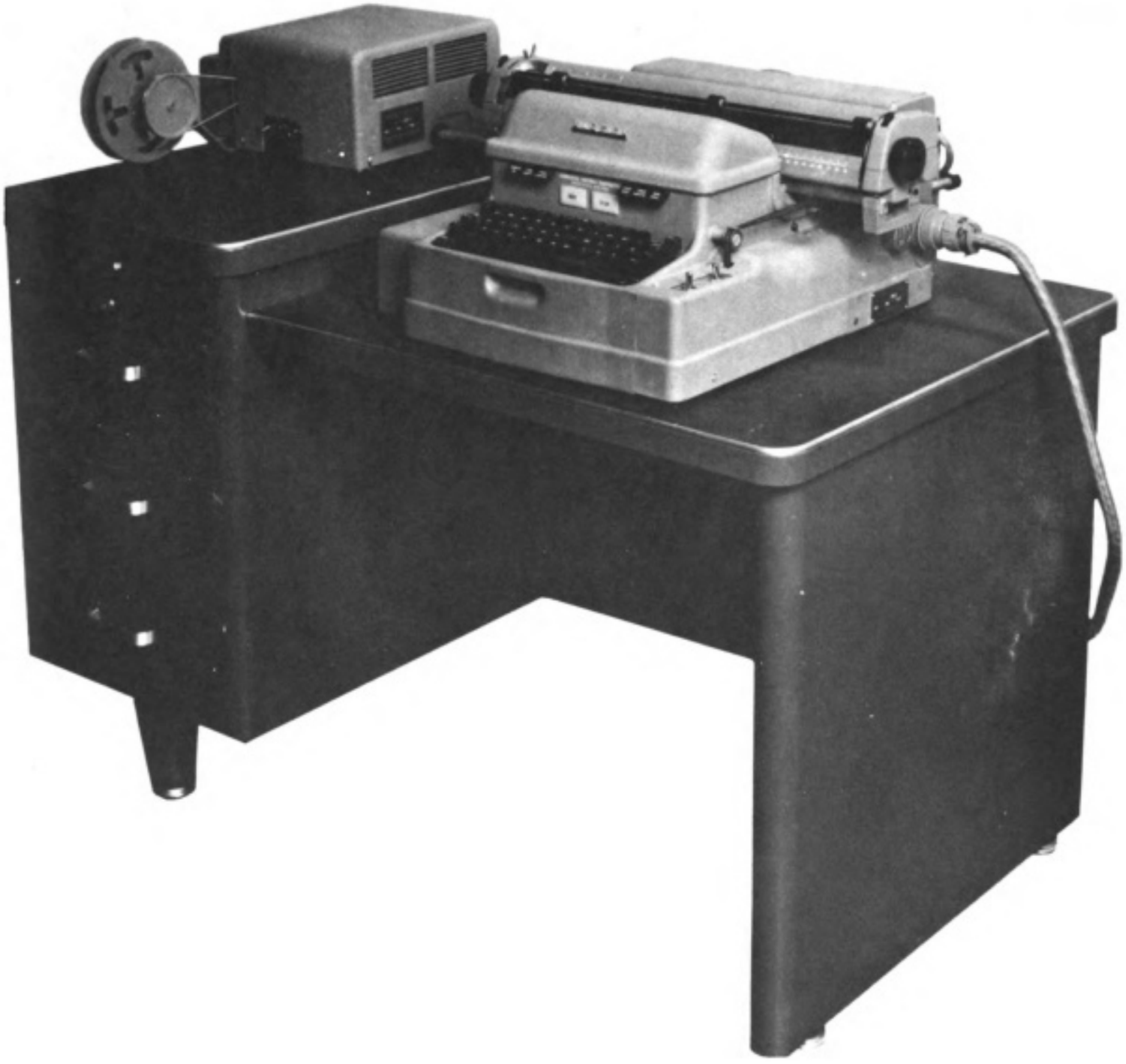
A separate equipment item, the Interrogation Unit, is an optional part of the system. It is a search and print-out device which permits prompt access to any message stored on any Tape Station within the RCA BIZMAC System.

The BIZMAC Computer has definite operating advantages:

Random composition - read-in.
Random composition - write-out.
Full algebraic decimal add, subtract and multiply and binary add and subtract using variable length operands are possible.
Magnetic tape and drum memory storage of programs with automatic program input from drum memory.
Automatic rollback function to permit correction of transient errors.
Three address instruction code with operating variations provided per instruction.
Addressable character extract.
Linear-time-dependent transfer of data.
Automatic zero suppression.
Specific instruction provision for handling subroutines.
Ability to write on tape while computing or reading (Simultaneous Write Instruction).
High speed paper tape input of 400 characters per second.
Fifteen addressable universal tape trunks, each can be used either as an input or output trunk.
Ability to read into High Speed Memory in compressed data form. (Linear Read).

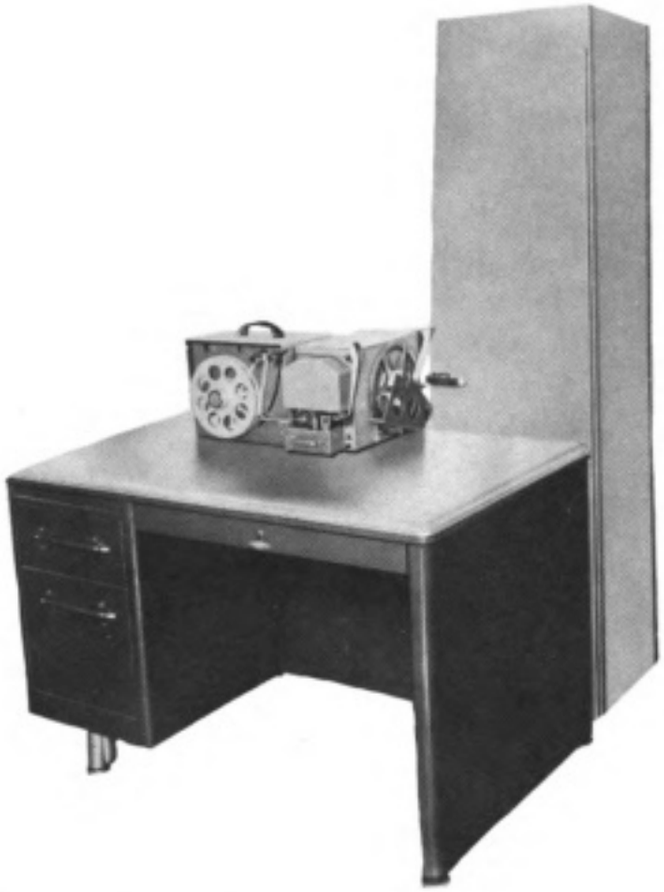
Government Sample
Ordnance Tank-Automotive Command

Advantages of system include:
Centralized control of entire system
Specialized sorters and collators
Reference tapes permanently mounted on stations



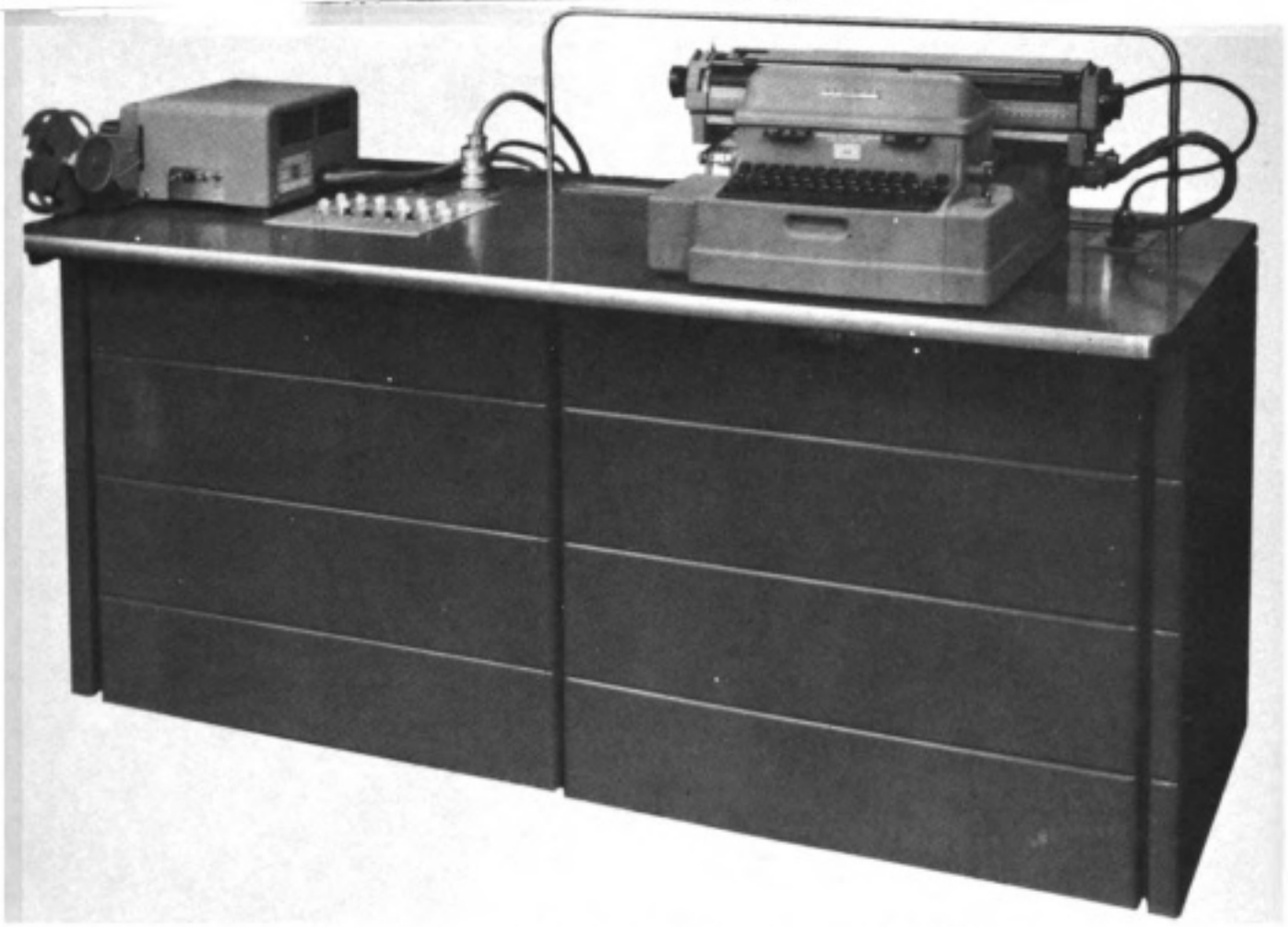
TAPEWRITER & VERIFIER (Key to Paper Tape) - Picture by Radio Corporation of America

Automatic tape station switching
Variable data length within individual item, variable item length, variable items per message to minimize storage.



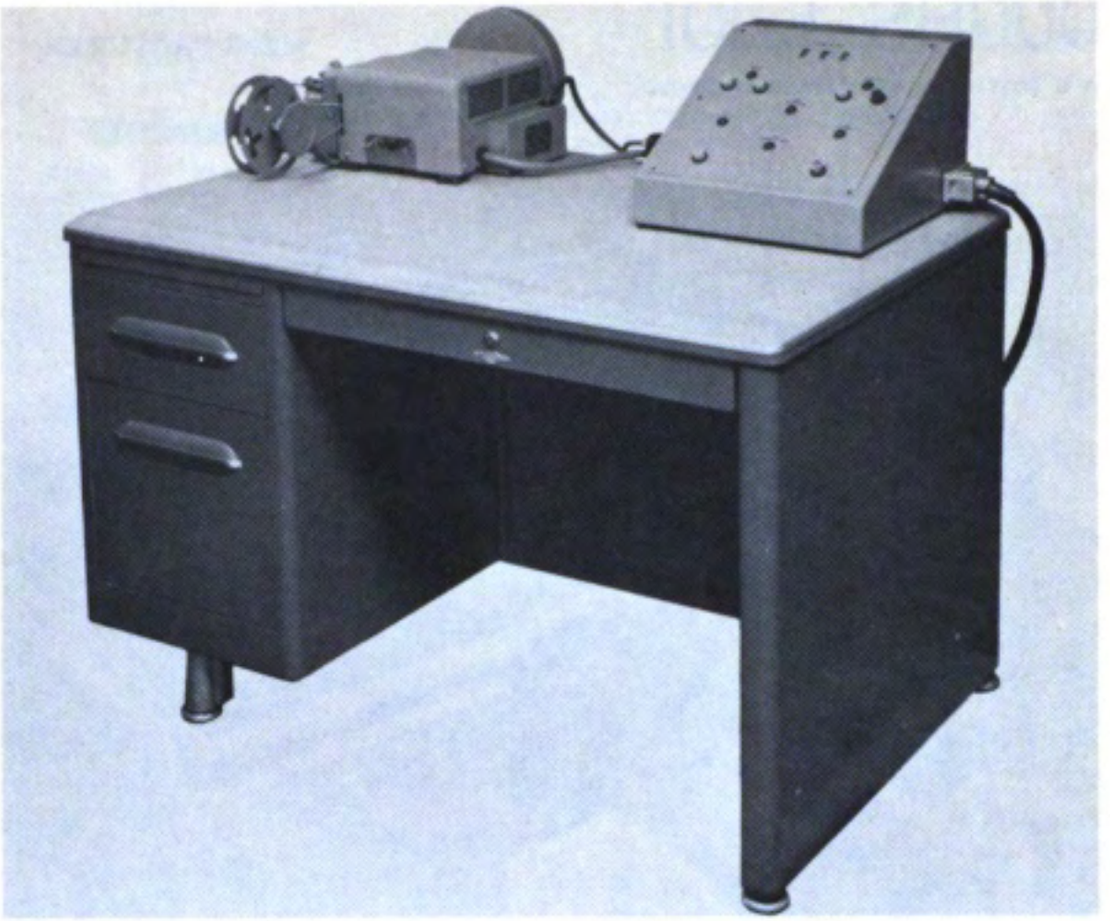
TRANSCODER (Magnetic Tape to Teletype Tape) - Picture by Radio Corporation of America

INTERROGATION UNIT (Magnetic Tape to Typewriter) - Picture by Radio Corporation of America



DOCUMENT PRINTER (Paper Tape to Typewriter) - Picture by Radio Corporation of America

CARD TRANSCRIBER (Card to Magnetic Tape) - Picture by Radio Corporation of America



MAGNETIC TAPE TRANSCRIBER (Magnetic to Paper Tape) - Picture by Radio Corporation of America

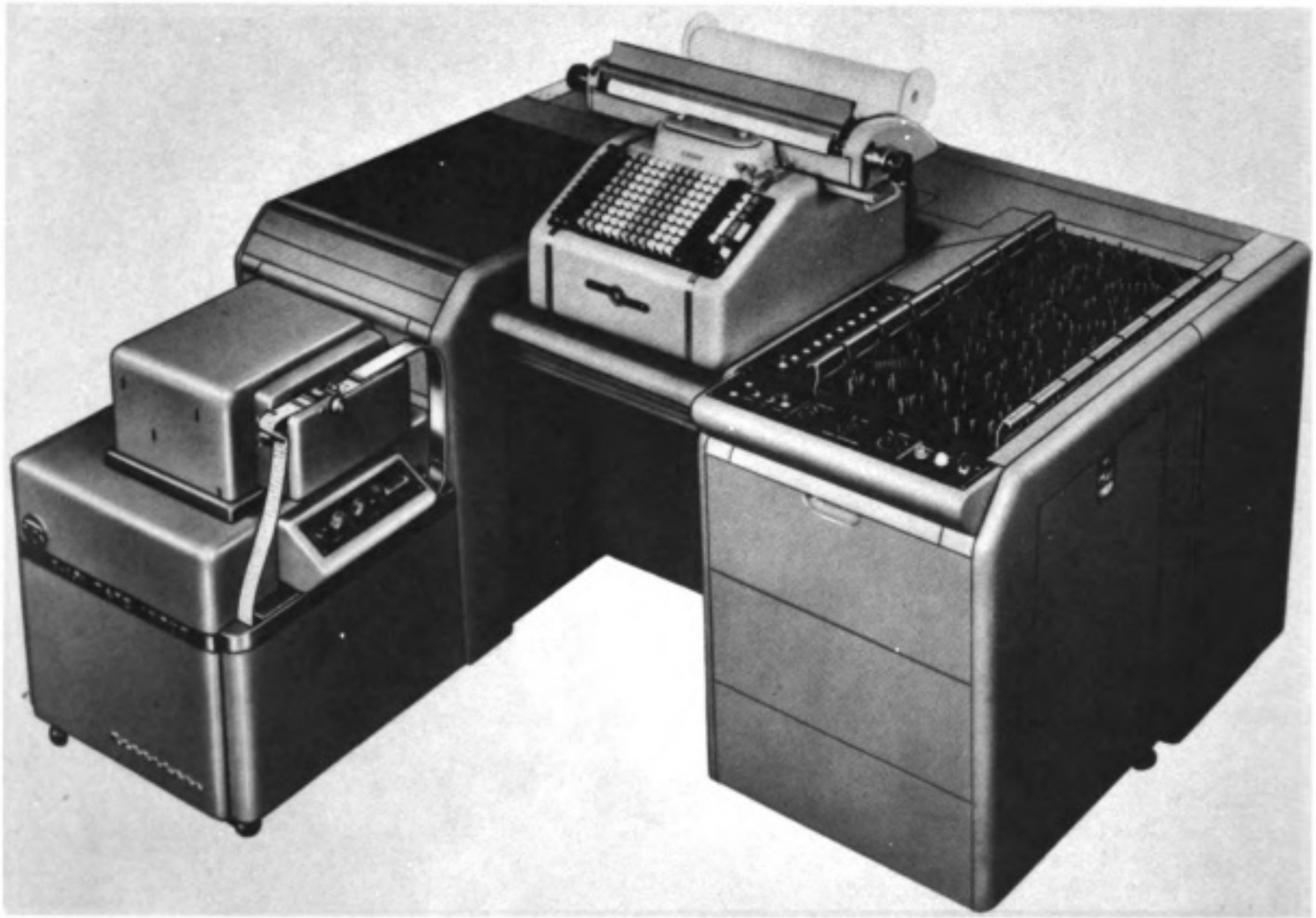
PAPER TAPE TRANSCRIBER (Paper to Magnetic Tape) - Picture by Radio Corporation of America

BURROUGHS E 101

Burroughs Series E Desk-size Electronic Digital Computer

MANUFACTURER

Burroughs Corporation
ElectroData Division



Picture by Burroughs Corporation

APPLICATIONS

Manufacturer
Scientific and business

Government Sample
Army Ordnance Corps, Frankford Arsenal
Along with other systems the E101 is being utilized in the following fields:
Field Service National Stock Accounting
Fire control instruments
Cage accounting
Production control
Payroll accounting
Internal arsenal accounting including fiscal
Budget, property and cost accounting
Scientific computations in the field of fluid dynamics, interior ballistics theoretical physics and certain aspects of nuclear physics.

Industrial Sample
The First National City Bank of New York
Banking procedures.

United Aircraft Corporation
Solution of engineering and research problems.

NUMERICAL SYSTEM

Internal number system	Pulse coded decimal
Decimal digits per word	12 plus sign
Decimal digits per instruction	3
Instructions per word	1
Instructions decoded	27
Instructions used	27
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-10(1-10^{-11}) \leqslant n \leqslant +10(1-10^{11})$

ARITHMETIC UNIT

	Microsec
Add time (includ. stor. access)	50,000
Mult time (includ. stor. access)	250,000
Div time (includ. stor. access)	250,000
Construction	Vacuum tubes and diodes

Arithmetic mode	Serial
Timing	Synchronous
Operation	Sequential

STORAGE

Media	Words	Microsec Access
Magnetic Drum	220	8,500 Avg
Paper Tape		

INPUT

Media	Speed
Keyboard	Manual
Paper Tape	0.5 sec to read

OUTPUT

Media	Speed
Printer (Sensimatic)	24 dec dig/sec
Paper Tape	0.33 sec to punch

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	160
Crystal diodes	1,800
Separate cabinets	3

CHECKING FEATURES

Plug-in circuitry
Marginal voltage checking
Internal program checking

POWER, SPACE AND WEIGHT

Power, computer	3 KW
Space, computer	Desk-size
Weight, computer	1,800 lbs

PRODUCTION RECORD

Produced	61
In production	20
Operating	61
On order	20
Delivery time, approx.	2 Months

COST, PRICE AND RENTAL RATE

Approximate cost of basic system $38,000
Approximate cost of additional equipment $10,000
Approximate rental rate of basic system $ 1,000/month
Approximate rental rate of additional equipment $200/month

PERSONNEL REQUIREMENTS

Daily Operation	Manufacturer Engineers
1-8 Hour shift	1
2-8 Hour shifts	1
3-8 Hour shifts	1

Service on a service call basis

Industrial Sample
New York University
System is maintained by manufacturer. System is used by various persons in the College of Engineering, who do their own operating.

RELIABILITY AND OPERATING EXPERIENCE

New York University
Average error-free running period 35 hours
Acceptance test 5 January 1956
University of Rochester
Acceptance test 1 April 1956

INSTALLATIONS

Government Sample
Army Ordnance Corps Frankford Arsenal
Philadelphia 37, Pennsylvania
Industrial Sample
All-American Engineering Company
Wilmington, Delaware

Boeing Airplane Company
Seattle, Washington

The Dow Chemical Company
Texas Division

The First National City Bank of New York
55 Wall Street
New York 15, New York

New York University
University Heights
New York 53, New York

United Aircraft Corporation, Research Department
East Hartford 8, Connecticut (3 systems)

University of Rochester
Computing Center
Rochester 20, New York

ADDITIONAL FEATURES AND REMARKS

Picture shows optional punched tape input unit.