BENDIX D 12
Bendix D12 Digital Differential Analyzer

MANUFACTURER
Computer Division, Bendix Aviation

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

Add Time (excl. stor. access) Microsec 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
Magnetic Drum

Words Binary Digits
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
  - 6 dig/sec

- **Paper Tape**

**OUTPUT**

- **Media**
  - Speed
  - 12 dig/sec

- **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.
- **2 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 106 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

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
command.

**ARITHMETIC UNIT**

<table>
<thead>
<tr>
<th>Single Precision</th>
<th>Double Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add time</td>
<td>540 Microsec</td>
</tr>
<tr>
<td>Mult time</td>
<td>16,000</td>
</tr>
<tr>
<td>Div time</td>
<td>16,000</td>
</tr>
</tbody>
</table>

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 microsec/digit of multiplier plus 270 microsec 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:


<table>
<thead>
<tr>
<th>Time</th>
<th>Microseconds</th>
<th>Microseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Add</td>
<td>15,000</td>
<td>500 (Sngl. prec.)</td>
</tr>
<tr>
<td></td>
<td>900 (Fast Access Lines)</td>
<td>600 (Dbl. prec.)</td>
</tr>
<tr>
<td>b. Malt</td>
<td>32,400</td>
<td>17,400 (Sngl. prec.)</td>
</tr>
<tr>
<td></td>
<td>18,000 (Fast Access Lines)</td>
<td>34,800 (Dbl. prec.)</td>
</tr>
<tr>
<td>c. Div</td>
<td>32,400</td>
<td>17,400 (Sngl. prec.)</td>
</tr>
<tr>
<td></td>
<td>18,000 (Fast Access Lines)</td>
<td>34,800 (Dbl. prec.)</td>
</tr>
</tbody>
</table>

Items in first column are for single precision.

**STORAGE**

<table>
<thead>
<tr>
<th>Media</th>
<th>Words</th>
<th>Digits</th>
<th>Access Microsec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Drum</td>
<td>2,160</td>
<td>62,640</td>
<td>14,500 540</td>
</tr>
<tr>
<td>Magnetic Drum</td>
<td>16</td>
<td>464</td>
<td>540</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Tape (Photoelectric)</td>
<td>250-300 sexadec char/sec</td>
</tr>
<tr>
<td>Card Punch (IBM 026)</td>
<td>17 sexadec char/sec</td>
</tr>
<tr>
<td>Magnetic Tape</td>
<td>430 sexadec char/sec</td>
</tr>
</tbody>
</table>

Input-output operations proceed without interrupting computation.

OUTPUT

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card Punch (IBM 026)</td>
<td>11 sexadec char/sec</td>
</tr>
<tr>
<td>Typewriter</td>
<td>8 sexadec char/sec</td>
</tr>
<tr>
<td>High Speed Punch</td>
<td>60 sexadec char/sec</td>
</tr>
<tr>
<td>Low Speed Punch</td>
<td>17 sexadec char/sec</td>
</tr>
<tr>
<td>Magnetic Tape</td>
<td>430 sexadec char/sec</td>
</tr>
</tbody>
</table>

Input-output operations proceed without interrupting computation.

CIRCUIT ELEMENTS ENTIRE SYSTEM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes</td>
<td>180 tube packages</td>
</tr>
<tr>
<td>Crystal diodes</td>
<td>300 diode packages</td>
</tr>
</tbody>
</table>

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.
Weight, computer           32" deep by 27" wide by 61" high
Capacity, air cond.        850 lbs.

Internal forced air
PRODUCTION RECORD

<table>
<thead>
<tr>
<th></th>
<th>G-15A</th>
<th>G-15C</th>
<th>G-15D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced</td>
<td>18</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>In production</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Operating</td>
<td>18</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>On order</td>
<td>-</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Delivery time</td>
<td>3 to 6 Months</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COST, PRICE AND RENTAL RATE

- **G-15 General Purpose Computer,** including the following:
  - 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

<table>
<thead>
<tr>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-15A</td>
</tr>
<tr>
<td>G-15C</td>
</tr>
<tr>
<td>G-15D</td>
</tr>
<tr>
<td>$44,800</td>
</tr>
<tr>
<td>$49,500</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Daily Operation</th>
<th>Engineer Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government Sample</td>
<td>Michigan State Highway Department</td>
<td>1-8 Hour shift 0.5</td>
</tr>
<tr>
<td>Average system is not yet in production, 1 engineer and 1 technician-operator are utilized.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Sample</td>
<td>Bendix Aviation Corporation Radio Division</td>
<td>3-8 hour shifts require 5 engineers on this system.</td>
</tr>
<tr>
<td>Bendix Aviation Corporation Research Laboratories Division</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of</th>
<th>No. of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineers</td>
<td>Tech-Operators</td>
</tr>
<tr>
<td>One 8-hour shift</td>
<td>1</td>
</tr>
<tr>
<td>Two 8-hour shifts</td>
<td>1</td>
</tr>
<tr>
<td>Three 8-hour shifts</td>
<td>1</td>
</tr>
</tbody>
</table>

RELIABILITY AND OPERATING EXPERIENCE

Manufacturer
90-95% 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
Buena 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

Bonnerie Power Administration, 1001 N.E. Lloyd Boulevard, Portland, Oregon
3. For those with little or no experience and for problems in which processing time is an important factor, the INTERCOM 101 interpreter-computer 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 interpreters 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 26 October 1955.
Picture by U. S. Department of Interior, Bonneville Power Administration
**APPLICATIONS**

Manufacturer  
General purpose computer.

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

**NUMERICAL SYSTEM**

<table>
<thead>
<tr>
<th>Arithmetic system</th>
<th>Fixed point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction type</td>
<td>Three address</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Variation</th>
<th>Addresses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A B C B B B B</td>
</tr>
</tbody>
</table>

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.
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 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 N = No. of digits in multiplicand and 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-stating 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
Operation Asynchronous for tape operation
Sequential by character
Concurrent by 7 bits forming the character.

STORAGE

<table>
<thead>
<tr>
<th>Media</th>
<th>Digits</th>
<th>Microsec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Core</td>
<td>8,192</td>
<td>20/char</td>
</tr>
<tr>
<td>Magnetic Drum</td>
<td>32,736</td>
<td>5,120</td>
</tr>
<tr>
<td>Magnetic Tape</td>
<td>Indefinite</td>
<td>5,000</td>
</tr>
</tbody>
</table>

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.
### INPUT

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card Transcriber</td>
<td>400 cards/min</td>
</tr>
<tr>
<td>(Card to Magnetic Tape)</td>
<td></td>
</tr>
<tr>
<td>Tapewriter and Verifier</td>
<td>5,000 strokes/hour</td>
</tr>
<tr>
<td>(Key to Paper Tape)</td>
<td></td>
</tr>
<tr>
<td>Paper Tape Transcriber</td>
<td>200 char/sec</td>
</tr>
<tr>
<td>(Paper to Magnetic Tape)</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electromechanical Printer</td>
<td>600 lines/min</td>
</tr>
<tr>
<td>Magnetic Tape Transcriber</td>
<td>20 char/sec</td>
</tr>
<tr>
<td>(Magnetic to Paper Tape)</td>
<td></td>
</tr>
<tr>
<td>Trancoder</td>
<td>50 char/sec</td>
</tr>
<tr>
<td>(Magnetic Tape to Teletype Tape)</td>
<td></td>
</tr>
<tr>
<td>Document Printer</td>
<td>9 char/sec</td>
</tr>
<tr>
<td>(Paper Tape to Typewriter)</td>
<td></td>
</tr>
<tr>
<td>Transcribing Card Punch</td>
<td>150 char/min</td>
</tr>
<tr>
<td>(Magnetic Tape to Card)</td>
<td></td>
</tr>
<tr>
<td>Interrogation Unit</td>
<td>4 min/inquiry</td>
</tr>
<tr>
<td>(Magnetic Tape to Typewriter)</td>
<td>(average)</td>
</tr>
</tbody>
</table>
| 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

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes</td>
<td>5,000</td>
</tr>
<tr>
<td>Tube types</td>
<td>12</td>
</tr>
<tr>
<td>Crystal diodes</td>
<td>14,500</td>
</tr>
<tr>
<td>Magnetic cores</td>
<td>28,700</td>
</tr>
</tbody>
</table>

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:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes</td>
<td>30,000</td>
</tr>
<tr>
<td>Crystal diodes</td>
<td>70,000</td>
</tr>
<tr>
<td>Magnetic cores</td>
<td>35,000</td>
</tr>
<tr>
<td>Transistors</td>
<td>200</td>
</tr>
<tr>
<td>Separate cabinets</td>
<td>470</td>
</tr>
</tbody>
</table>

### 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
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 assure 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
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
Ordinance 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
Ordinance 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. Mainte-
anance personnel furnished under contract with RCA.

RELIABILITY AND OPERATING EXPERIENCE

Government Sample
Ordinance 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
Ordinance 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
Ordinance Tank-Automotive Command
Detroit 9, Michigan
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 inter-
connection 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 oper-
ations.
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 subrou-
tines.
Ability to write on tape while computing or reading
(Stimultaneous 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.
TRANSDUCER (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
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.

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 $-10(1-10^{-11}) \leq n \leq +10(1-10^{11})$

ARITHMETIC UNIT

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

<table>
<thead>
<tr>
<th>Media</th>
<th>Words</th>
<th>Microsec Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Drum</td>
<td>220</td>
<td>8,500 Avg</td>
</tr>
<tr>
<td>Paper Tape</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INPUT

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard</td>
<td>Manual</td>
</tr>
<tr>
<td>Paper Tape</td>
<td>0.5 sec to read</td>
</tr>
</tbody>
</table>

OUTPUT

<table>
<thead>
<tr>
<th>Media</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printer (Selasmat)</td>
<td>24 dec dig/sec</td>
</tr>
<tr>
<td>Paper Tape</td>
<td>0.53 sec to punch</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Daily Operation</th>
<th>Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-8 Hour shift</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2-8 Hour shifts</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3-8 Hour shifts</td>
<td>1</td>
</tr>
</tbody>
</table>

- 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, 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.