# IBM 704

International Business Machines Type 704 Electronic
Data Processing Machine

Picture by International Business Machines Corporation

## APPLICATIONS

Manufacturer
Commercial, scientific, and engineering data
processing.

Government Sample
Army Ballistic Missile Agency
Missile design and development activities.
Industrial Sample
Aerojet-General Corporation
Scientific, rocket engine manufacture activity.
General Dynamics Corporation, Convair Division
Engineering, aircraft manufacture activity.
General Electric Aircraft Gas Turbine Division
Engineering and scientific problems.
General Electric Company, Lynn Computations
Scientific, engineering and business applications.
General Motors Corporation, Research Staff
General scientific computation.
Glenn L. Martin Company
Engineering computation.

Midwestern Universities Research Association
Research with especial reference to high energy
physics, accelerator design and the application of
computers to problems concerned therewith.
North American Aviation
Engineering, computing and data processing.
Standard Oil Company of California
Mathematical computation and data processing.
United Aircraft Corporation
The United Aircraft Corporation provides a central
computing facility located at the Research Depart-
ment for the solution of engineering and research
problems.  It services the three UAC Divisions:
Pratt and Whitney Aircraft, Sikorsky Aircraft, and
Hamilton Standard which are engaged in the design
and manufacture of aircraft engines, helicopters,
propellers and other aircraft equipment.  Two Type
704 systems are utilized.
University of California Radiation Laboratory
Scientific problems.
Westinghouse Electric Corporation
Engineering.

IBM 704
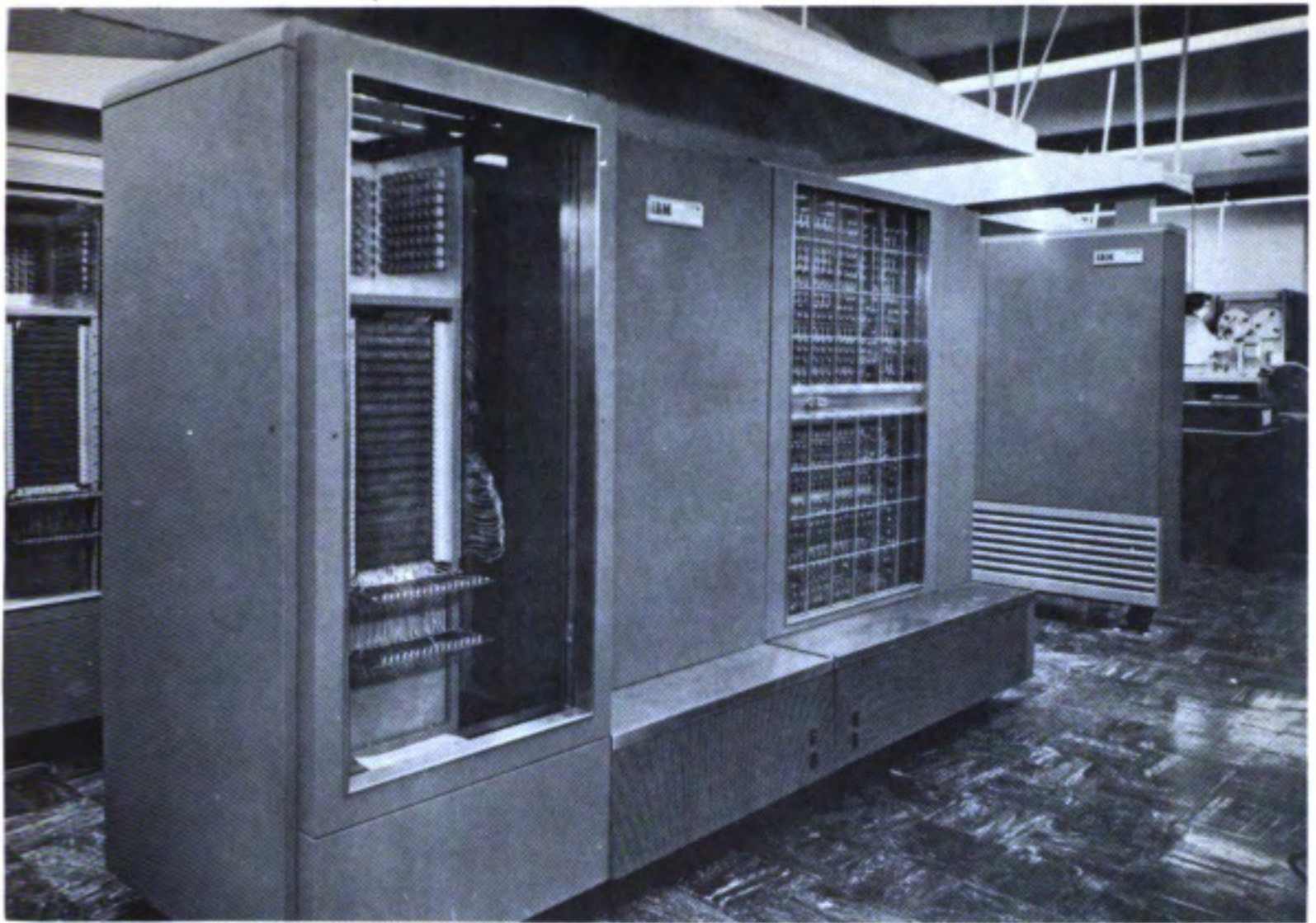
Picture by University of California Radiation Laboratory, Livermore

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## NUMERICAL SYSTEM

| | |
|---|---|
| Internal number system | Binary |
| Binary digits per word | 36 |
| Binary digits per instruction | 36 |
| Instructions per word | 1 decrement field |
| Instructions decoded | 86 |
| Instructions used | 86 |
| Arithmetic system | Floating point, fixed point, and logical arithmetic |
| Instruction type | One address |

Number range $\quad$ Fixed point $-(2^{35}-1) < n < (2^{35}-1)$

$\qquad$ Floating point $-10^{38} < n < 10^{38}$

Industrial Sample
General Dynamic Corporation
Number range is $\pm$ 34, 359, 738, 367
University of California Radiation Laboratory
Floating point operation is 8 bit exponent excess 128 and 27 bit fraction plus sign. Fixed point is 35 bit magnitude plus sign. The single address instruction word contains an 11 bit command, 3 bit tag and 15 bit ADR. Index instruction is sign plus 2 bit command, 15 bit decrement, 3 bit tag and 15 bit ADR.

## ARITHMETIC UNIT

| Time | Fixed Point Microsec | Floating Point Microsec |
|---|---|---|
| Add (exclud. stor. access) | 12 | 72 |
| Mult (exclud. stor. access) | 228 | 192 |
| Div (exclud. stor. access) | 228 | 204 |
| Construction | Vacuum tubes, magnetic cores, transistors | |
| Rapid access word registers | 3 index | 2 arithmetic |
| Basic pulse repetition rate | 1 Mc/sec | |
| Arithmetic mode | Parallel | |
| Timing | Synchronous | |
| Operation | Sequential and concurrent | |

A sign is provided for the floating point exponent. Add and multiply times include access to instruction. Floating-point divide time is 24 microseconds if dividend fraction is zero.

Industrial Sample
General Dynamics Corporation, Convair Division
Operation times including storage access, operating fixed point, are 24, 240, and 240 microseconds, for add, multiply and divide, respectively. Diode switching circuits are used in the arithmetic unit.

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Picture by University of California Radiation Laboratory, Livermore

## STORAGE

| Media/Words | Access Microsec |
|---|---|
| Magnetic Core, 8,192 | 12 to any word (10 decimal digits equivalent and sign) |
| Magnetic Drum, 8,192 or 16,384 | 12,000 average access to first word, 96 per word for subsequent words. Of the 96 per word, 36 are available for further computation. |
| Magnetic Tape, 900,000 bin. words per tape. 540,000 bin. coded dec. and alphanumeric words per tape. Up to 10 tapes. | Time to accelerate magnetic tape to write status (75 inches per sec.) from standstill is 10,000 of which 7,000 are available for further computation. Time to write subsequent words is 400 each, of which 336 is available for further computation. Time to accelerate magnetic tape to read status (75 inches/sec.) from standstill is 10,000 of which 3,000 are available for further computation. Time to read subsequent words is 400 each, of which 288 are available for computation. Magnetic tape unit can rewind 2,400 feet of tape in 1.2 minutes. |

Provision has been made in addressing and indexing system to increase main frame storage up to 32,768 words of magnetic core when made available by manufacturer.

Industrial Sample

General Dynamics Corporation, Convair Division
Storage consists of one 4,096 word core unit, one 8,192 word drum unit and one 900,000 word tape unit.

General Electric Aircraft Gas Turbine Division
Storage has up to 7 tape units attached.

General Motors Corporation, Research Staff
Storage has 8,192 words of magnetic core, 8,192 words of magnetic drum, 900,000 and 540,000 words binary and binary-coded-decimal words in 8 tape units. Word length may be considered to be 10 decimal digits equivalent plus sign.

Westinghouse Bettis Atomic Power Division
System utilizes 4,096-word magnetic core, 8,192-word drum, ten IBM type 727 magnetic tape units, and a 262,144-word magnetic drum.

## INPUT

| Media | Speed |
|---|---|
| Punched Card Reader | 150 or 250 cards per minute. Cards are 80 column. |
| Magnetic Tape | If magnetic tape is alphanumeric: 15,000 char/sec. If magnetic tape is pure binary: |

Picture by University of California Radiation Laboratory, Livermore

25,000 **decimal** equivalent digits per second.
See STORAGE, Magnetic Tape.

Card to Magnetic Tape. (Independent operation) — 250 80-column cards per minute. Cards must be in decimal alphanumeric code. Tape is written in binary coded decimal alphanumeric code and simultaneously checked.

290 or 177 millisec are available between cards for computation. Time to convert the worst case of decimal to binary (floating-point word) and check conversion is 7 millisec per word. Therefore, all conversion in one 80 column card can take place between the reading of successive cards.

Industrial Sample

General Dynamics Corporation, Convair Division
Magnetic tape reading speed is 2,500 words/sec after tape is in motion.

General Electric Aircraft Gas Turbine Division
Tapes may be prepared as a peripheral operation.

General Electric Company, Lynn Computations
Plastic magnetic tape unit reading speed is 4,200 words/minute.

General Motors Corporation, Research Staff
System utilizes punched card reader at 250 cards/min. and magnetic tape at 15,000 binary coded decimal char/sec or 25,000 equivalent decimal digits if straight binary. Cards to magnetic tape conversion proceeds at 250 80-column cards/min. (alphanumeric only) as an independent operation.

## OUTPUT

| Media | Speed |
|---|---|
| Punched Card Recorder | 100 cards/min., 24 words/card (binary). 342 millisec computing time available/card (binary and decimal). |
| Line Printer (Wheel type) | 150 lines/min. 72 characters/line. 322 millisec computing time available/card. |
| Cathode Ray Tube Display | 8,300 data points/second. 7 in. tube for photos. 21 in. tube for visual. |
| Magnetic Tape | If magnetic tape is to be written in alphanumeric or binary coded decimal code: 15,000 characters/second. If magnetic tape is to be written in binary digits: 25,000 decimal equivalent digits/sec. |
| Magnetic Tape to 80-column card | 100 cards/min. Punched characters are automatically internally checked by unit. |
| Magnetic Tape to Printer Line | 150 lines/min. (Wheel printer). 120 alphanumeric characters/line. |

IBM 704

Picture by General Motors Corporation

1,000 lines/minute at 60 characters/line (wire matrix printer).

Industrial Sample

General Dynamics Corporation, Convair Division
System utilizes printer 150 lines/min. and 120 char/line, card punch 100 cards/min., and magnetic tape at 2,500 words/sec after tape is in motion.

General Electric Aircraft Gas Turbine Division
System utilizes line printer, cards and magnetic tapes.

General Electric Company, Lynn Computations
System utilizes direct print, direct cards and plastic magnetic tape.

General Motors Corporation, Research Staff
System utilizes punched card, line and printer, magnetic tape. Magnetic tape to cards and tape to printer conversion is performed as an independent operation.

Glenn L. Martin Company
System utilizes printer, punch and tape.

University of California Radiation Laboratory
System utilizes magnetic tape, cards, printer and CRT. The cathode ray tube output speed is 140 microseconds/point. A Univac Hi-speed printer was adapted to 704 tapes at 600 lines/min.

Westinghouse Bettis Atomic Power Division
System utilizes on-line printer, cards and magnetic tape.

## CIRCUIT ELEMENTS ENTIRE SYSTEM

Industrial Sample

General Dynamics Corporation, Convair Division
System has 147,456 magnetic cores, 15 separate cabinets, and tube types used are the 5965, 5687, 6211, 12AY7, 5998, 6072, 6350.

General Motors Corporation, Research Staff
System has approximately 160,000 magnetic cores, 16 separate cabinets including main frame, card machines, power cabinets, 2 core storage units, and 6 tape and synchronizing units. The card to tape, tape to card and tape to printer converters each have 3 separate cabinets.

University of California Radiation Laboratory
Approximate circuit component complement is:

| | |
|---|---|
| Tubes | 5,000 |
| Crystal diodes | 10,001 |
| Magnetic cores | 295,168 |
| Tube types | 5965, 6211, 5687, 12AY7, 5998 are basic types. |
| Separate cabinets | 20 |

## CHECKING FEATURES

Manufacturer
Magnetic Tape -- Horizontal and vertical parity bit check for each tape row and column.

Line Printer -- Echo checking for each printed character.

Card to Magnetic Tape -- checks magnetic tape as above. Checks card.

Tape to Printer -- Checks magnetic tape as above. Echo checking for each printed character.

Tape to Card -- Same as above. Punched card is checked.

Arithmetic and Logical Unit -- Overflow in accumulator. Two extra positions are on left side of accumulator so that overflow is not lost. Divide check if $|Dividend| \geqslant |Divisor|$. Machine can operate in trapping mode for checking flow of the problem to assist in program checking.

### Industrial Sample

General Dynamics Corporation, Convair Division Provisions are made for exponent overflow and underflow plus divide check.

General Motors Corporation, Research Staff In addition to the above, system has off-line check of redundancy bits on a written tape.

Westinghouse Bettis Atomic Power Division System utilizes lateral and longitudinal redundancy check on magnetic tape, check of sum to and from tape and drums and echo check to printer. All of these are used during input-output operations only.

## POWER, SPACE AND WEIGHT

Manufacturer

|  | Weight (lbs.) | KVA |
|---|---|---|
| Main Frame | 2,850 | 40.3 |
| Punch Card Recorder | 530 | 0.7 |
| Line Printer (Wheel type) | 2,795 | 3.1 |
| Magnetic Drum | 1,480 | 10.4 |
| Magnetic Core Frame | 2,425 | 6.4 |
| Cathode Ray Tube Display Unit |  | 2.4 |
| Power Frame No. 1 | 2,810 | 5.8 |
| Power Frame No. 2 | 2,810 | 5.8 |
| Power Distribution Unit | 1,230 | 1.2 |
| Magnetic Tape Unit | 900 | 2.5 |
| Magnetic Tape Control Unit | 1,636 | 6.0 |

Power Factor: $.65 < \cos \theta < .7$

Space occupied: Machine including 10 tape units: $3,000 \text{ ft}^2$. Customer Engineering requirements: $400 \text{ ft}^2$. Air conditioning, overall, approximately 40 tons.

### Industrial Sample

General Dynamics Corporation, Convair Division System requires 69.6 KW, 96.4 KVA, 872.9 cu. ft., 169.2 sq. ft. (combined 15 separate frames). System weighs 25,320 lbs. and utilizes 60 Tons of air conditioning.

General Electric Aircraft Gas Turbine Division System occupies 1,500 sq. ft. A 150-Ton air conditioning unit was installed to service two machines.

General Electric Company, Lynn Computations System requires 60 KVA, occupies 36,000 cu. ft. and 3,400 sq. ft. Area is 60 by 60 to 70 by 12 ft. The air conditioner occupies approximately 27,000 cu. ft. and 1,600 sq. ft. Area is 40 by 40 by 14 to 22 ft. System requires 40 Tons of air conditioning, the unit is capable of 50 Tons with 100% stand-by capacity.

General Motors Corporation, Research Staff Computer requires 71 KW, 101.4 KVA, 0.7 PF. The three peripheral units are extra. The system occupies 13,500 cu. ft., 1,350 sq. ft. plus 9,000 cu. ft. and 900 sq. ft. for 3 peripheral units. The system weighs 25,590 lbs. The air conditioner occupies 4,000 cu. ft. and 400 sq. ft. 72 Tons of air

conditioning are available, approximately half of capacity is used on the average. Three 7-1/2-Ton units are for peripheral units and two 25-Ton units are for the computer.

Glenn L. Martin Company System requires 100 KVA and 2,500 sq. ft. 60 Tons of air conditioning is utilized.

University of California Radiation Laboratory Computer requires 77 KW, 149.2 KVA, 0.65 PF. Area occupied is 3,000 sq. ft. and computer weighs 30,000 lbs. Air conditioning occupies 2,000 sq. ft. and has a 60-Ton capacity.

Westinghouse Bettis Atomic Power Division Computer requires 160 KW, 210 KVA, 0.76 PF. Central machine room is 2,450 sq. ft.

## PRODUCTION RECORD

| Produced | 36 |
|---|---|
| Operating | 31 |
| On order | 75 (Estimate) |
| Delivery time | Special |

## COST, PRICE AND RENTAL RATE

Machine Purchase and Rental Policy
Purchase Plan
Direct Purchase (Ownership Plan)

Equipment currently being manufactured will be offered for sale. This plan will include installation of the machines; warranty; trade-in provisions of purchased IBM equipment; and maintenance by one of the following methods: (Contracts for the sale of new machines and the maintenance of machines will be proposed to the General Services Administration for use by the Federal Government).

Annual maintenance agreement contract with IBM.
Repair and maintenance service on a time and material basis from IBM.
User service own equipment.
Services other than IBM.

Options

For the user who prefers to lease IBM equipment with an option to purchase, IBM makes available a lease-purchase option for a two-year period.

Rental Rates Applicable to Purchase Price.

When a customer with an option agreement to purchase exercises his option, a percentage of the rentals paid on that machine, including extra shift charges, up to the effective date, will be credited against the purchase price of the machine. In the case of the type 704 the percentage of rental allowance against purchase depends upon the individual components comprising the system. For example: 704 - 55%; 711 and 721 - 40%; 733 - 60%; 737 or 738 - 60%

Other Plans

IBM offers to sell, beginning January 1, 1957, any IBM punched card and/or electronic data processing machines which are at that time installed with its customers or may be installed at any time prior to July 25, 1958. This offer will continue as to any machine only so long as it is installed, and will terminate on July 25, 1958.

Rental Plans

For the user who prefers to lease, IBM continues to offer its equipment under its traditional machine service agreement, or in the case of the Federal Government, the provisions as specified in the GSA contract or separate contract.

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# Rental Periods

Equipment on a lease basis under the traditional machine service agreement is for a period of one year. In the case of the Federal Government, the purchase order covering the fiscal year will apply.

# Other Policies Regarding Purchase Price and Rental Rates.

Other than standard commercially available equipment, special equipment will be manufactured or modified by IBM by separate contracts through its Military Products Division or Special Engineering Product Division. Purchase price and rental rates in these cases will be negotiated for each individual case.

| Type | Model | Description | Monthly Charge (Incl Maint.) | Purchase Price (Complete) | Monthly Maintenance Charges for prime shift Age 0-36 mos. (Contracted) | Additional Monthly Use and Maintenance Charges Per Additional Shift (40 hour work week) |
|---|---|---|---|---|---|---|
| 704 | 1 | Central Processing Unit with Floating Point Arithmetic | $ 9,700.00 | $523,800.00 | $2,414.50 | $965.75 |
| 736 | 2 | Power Frame No. 1 * | 1,100.00 | 57,200.00 | 87.50 | 35.00 |
| 741 | 2 | Power Frame No. 2 * | 1,400.00 | 72,800.00 | 63.75 | 25.50 |
| 746 | 2 | Power Distribution Unit * | 1,300.00 | 67,600.00 | 38.75 | 15.50 |
| 711 | 2 | Punched Card Reader (200 CPM) | 800.00 | 52,000.00 | 173.25 | 173.25 |
| 716 | 1 | Alphabetic Printer (150 LPM-120 char) | 1,200.00 | 78,050.00 | 325.00 | 325.00 |
| 721 | 1 | Punched Card Recorder (200 CPM) | 600.00 | 39,000.00 | 162.50 | 162.50 |
| 727 | 1 | Magnetic Tape Unit (200 bits/in. 15,000 alphanum char/sec) | 550.00 | 29,800.00 | 243.00 | 243.00 |
| 753 | 1 | Tape Control Unit | 2,500.00 | 140,250.00 | 525.75 | 210.30 |
| 733 | 1 | Magnetic Drum Unit (8,192 words) | 3,100.00 | 167,400.00 | 488.25 | 195.25 |
| 733 | 2 | Magnetic Drum Unit (Add'l 8,192 words) | 3,500.00 | 189,000.00 | 551.25 | 220.50 |
| 737 | 1 | Magnetic Core Storage Unit (4,096 words) | 4,000.00 | 208,000.00 | 303.00 | 121.25 |
| 737 | 2 | Magnetic Core Storage Unit (Add'l 4,096 words) | 3,200.00 | 193,000.00 | 273.25 | 109.25 |
| 738 | 1 | Magnetic Core Storage Unit (32,000 words) | 20,000.00 | 1,040,000.00 | 1,500.75 | 600.25 |
| 740 | 1 | CRT Output Recorder (7,000/sec) | 2,700.00 | 162,000.00 | 227.50 | 91.00 |
| 780 | 1 | Display Unit (7,000/sec.) | 150.00 | 8,700.00 | 71.50 | 28.75 |

*All of these units are required for each 704 System.

Auxiliary tape-to-card, tape-to-printer and card-to-tape components.

| Type | Model | Description | Monthly Charge (Incl Maint.) | Purchase Price (Complete) | Monthly Maintenance Charges for prime shift Age 0-36 mos. (Contracted) | Additional Monthly Use and Maintenance Charges Per Additional Shift (40 hour work week) |
|---|---|---|---|---|---|---|
| 714 | 1 | Card Reader (2,500 CPM) | 1,500.00 | 97,500.00 | 396.75 | 158.75 |
| 759 | 1 | Card Reader Control Unit | 900.00 | 54,000.00 | 133.00 | 53.25 |
| 717 | 1 | Printer (150 LPM - 120 char.) | 1,200.00 | 73,950.00 | 338.75 | 338.75 |
| 757 | 1 | Printer Control Unit | 600.00 | 36,000.00 | 150.00 | 60.00 |
| 722 | 1 | Card Punch (100 CPM) | 750.00 | 44,400.00 | 223.25 | 223.25 |
| 758 | 1 | Card Punch Control Unit | 300.00 | 18,000.00 | 82.50 | 33.00 |
| 720 | 1 | Printer (500 LPM - 120 char.) | 1,400.00 | 74,200.00 | | |
| 760 | 1 | Printer Control and Storage Unit | 1,850.00 | 111,000.00 | 485.75 | 194.25 |

## Machine Operating Policy
### Service Contracts for Purchasers.
### IBM Maintenance Agreement.

The IBM Maintenance Agreement offers purchasers maintenance and repair service on a flat-rate annual basis for a 40-hour work week plus additional charges for use of machines for regular overtime and additional shifts. See table above for maintenance charges. Charges are based on the age of the machine in months: 0-36, 37-72, 73-108.

### Warranty

Machines are covered by a 12-month warranty providing for exchange of defective parts. In addition, the warranty provides for service at no charge for the first three months of this period. The 12-month warranty period providing exchange of defective parts will be reduced in direct proportion to the amount of usage exceeding 40 hours per week.

### Services performed

Services rendered will include periodic preventive maintenance, cleaning, oiling and emergency repair.

### Time and Material Maintenance Services.

Service on a time and material basis is service on a per-call basis, without a contract. IBM charges an hourly rate for time spent for service and a retail price for parts used.

### Maintenance by the Customer.

Customers may send their employees to the IBM Service Engineering Training School on a payment of tuition. IBM will sell IBM manufactured parts and tools. Testing equipment will also be sold, if not available commercially. Parts catalogs and customer engineering manuals will be available for purchase by the customer.

### Service Arrangements for Renters.

All existing services to lease customers will prevail. However, full maintenance and repair services will be based on a 40-hour work week for Electronic Data Processing Machines, and all uses beyond the normal working hours will be subject to maintenance charges for the average number of hours in excess of forty hours per week. A GSA contract

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covering IBM's EDPM equipment is being proposed and when issued will specify the terms and conditions of services in detail for the Federal Government.

Arrangements for Parts and Replacements.

For purchasers with a maintenance agreement contract with IBM, services will be provided to keep the machines in good working order, including replacement of unserviceable parts. Parts will be furnished on an exchange basis under which replaced parts become the property of IBM, and parts will be new or equivalent to new if new parts are not available. It will not include furnishing platens, supplies or accessories, painting or refinishing the machines, making specification changes or adding or removing accessories, attachments or other devices.

For purchasers electing to use IBM services on a time and material basis, new parts will be furnished and billed to the customer.

Customers who own and maintain their own equipment may buy repair and replacement parts from IBM.

Installation Requirements.
Outright Purchase.

Machines will be furnished and installed ready for use by the customer. All requirements, such as power, air conditioning, space, etc. are to be furnished by the customer. Transportation, rigging and draying charges are to be paid by the customer.

IBM will install machines and place them in good working order at no extra charge. Machines are covered by a 12-month warranty providing for exchange of defective parts. In addition, the warranty provides for service at no charge for the first three months of this period.

Rental

IBM will install machines and place them in good working order at no extra charge. All requirements as to space, power, air conditioning, etc. are to be furnished by the customer. Transportation, rigging, and draying charges are to be paid by the customer.

Industrial Sample

General Dynamics Corporation, Convair Division
Rental rate for basic system is $21,000/month. Additional equipment is $2,800/month. Basic system includes type 704 Analytical Control, Type 711 card reader, Type 716 Printer and Type 737 core storage. Additional equipment includes 6 tape units and one drum unit.

General Motors Corporation, Research Staff
Rental rate for basic system is $34,600/month. Card-to-Tape, Tape-to-Card, and Tape-to-Printer converters are $2,950, $1,600 and $2,350 per month, respectively.

Glenn L. Martin Company
Total rental rate for basic system is $43,000/month.

Midwestern Universities Research Association
Rental rate of basic system is $30,000/month.

University of California Radiation Laboratory
One card reader, one card punch, one set of drums, two 4,096-word magnetic core units, one tape control unit, and 7 tape units are rented at $34,370 per month for one shift. The CRT output unit is $2,850/month and the card-to-tape (plus tape unit) is $2,950/month.

## PERSONNEL REQUIREMENTS

Government Sample
Army Ballistic Missile Agency
Three 8-hour shifts require 5 engineers and 6 technician-operators. One person operates card-to-

tape and tape-to-printer equipment. Components include 4,096 word core storage, floating point arithmetic, 8,192 drum storage, 7 tape units, printer, card reader, card punch, peripheral card reader and punch.

Industrial Sample

General Dynamics Corporation, Convair Division
Approximately 40 engineers and 3, 5 and 7 technician-operators for 1, 2 and 3 shift operations, respectively, are associated with the system. This does not include people required for key punching, and standard card equipment processors.

General Electric Aircraft Gas Turbine Division
Approximately 40 engineers and 35 technician-operators are associated with the system. Machine is operated on a closed shop basis.

General Motors Corporation, Research Staff
One 8-hour shift     5 Engineers     5 Tech-Operators
Two 8-hour shifts    7 Engineers     7 Tech-Operators

Glenn L. Martin Company
One 8-hour shift     2 Engineers     3 Tech-Operators
Two 8-hour shifts    4 Engineers     6 Tech-Operators
Three 8-hour shifts  5 Engineers     9 Tech-Operators

Approximately 30-45 programmer-analysts are utilized.

Midwestern Universities Research Association
One 8-hour shift     3 Engineers     2 Tech-Operators

Standard Oil Company of California
One 8-hour shift     11 Engineers    3 Tech-Operators
to fill proposed staff on installation of system in August 1957.

University of California Radiation Laboratory
One 8-hour shift     3 Engineers     3 Tech-Operators
Two 8-hour shifts    5 Engineers     5 Tech-Operators
Three 8-hour shifts  7 Engineers     7 Tech-Operators

16 manufacturer engineers maintain two type 704 systems. 14 operators operate two 704's 24 hours/day 7 days/week.

United Aircraft Corporation Research Department
System is operated on a 24 hour six-day a week basis.

Westinghouse Electric Corporation, Analytical Department
One 8-hour shift: 21 engineers and 3 Tech-operators are associated with the system. About 100 programmers throughout Westinghouse Electric Corporation prepare work for the system. System consists of 1 magnetic core storage unit, 10 tape units, 1 drum unit, 1 tape-to-printer and 1 card-to-tape unit.

## RELIABILITY AND OPERATING EXPERIENCE

Government Sample
Army Ballistic Missile Agency
Good time                               1,454.27 hours
Attempted to run time                   1,487.79 hours
Operating ratio (Good/Attempted to run)   0.9775
Figures based on period 17 June 1956 to 1 December 1956.
Acceptance test 17 June 1956.

Industrial Sample
General Electric Aircraft Gas Turbine Division
Good time                               1,100 hours
Operating ratio (Good/Attempted to run)   0.98
Figures based on period January 1956 to September 1956.
Acceptance test January 1956.
Scheduled maintenance 13% of "on" time.
Unscheduled maintenance 3% of "on" time.

General Motors Corporation, Research Staff
Good time                               399.44 hours
Attempted to run time                   438.13 hours
Operating ratio (Good/Attempted to run)  0.912
Figures based on period 1 May 1956 to 1 October 1956
Acceptance test 1 May 1956.

The Glenn L. Martin Company
Acceptance test 3 December 1956.
    Lockheed Aircraft Corporation, System No. 1
Average error-free running period      4     hours
Good time             1,127.38 hours
Attempted to run time        1,156.98 hours
Operating ratio (Good/Attempted to run)    0.974
Figures based on period 1 September 1956 to 1 December 1956.
Acceptance test September 1956.
    Lockheed Aircraft Corporation, System No. 2
Average error-free running period      4     hours
Good time             768.43 hours
Attempted to run time        774.26 hours
Operating ratio (Good/Attempted to run)    0.99
Figures based on period 1 April 1956 to 1 September 1956.
Acceptance test April 1956.
    Midwestern Universities Research Association
Acceptance test 1 November 1956.
    North American Aviation
Operating ratio      0.85 (Good time)
Maintenance time     0.15
    United Aircraft Corporation Research Department
Good time             2,949 hours
Attempted to run time     3,725 hours
Operating ratio          0.79
Acceptance Unit No. 1     18 January 1956
Acceptance Unit No. 2      7 August 1956
    University of California Radiation Laboratory
Average error-free running period      17.9 hours
Good time             1,006.5 hours
Attempted to run time        1,024.8 hours
Operating ratio (Good/Attempted to run)    0.983
Figures based on period September 1956 to October 1956.
Acceptance test February 1956 (First machine)
Acceptance test July 1956 (Second machine)

Average error-free running period, above, does not include satisfactory re-reads of tape and total hours based on available computing time.

## FUTURE PLANS

    Government Sample
    Army Ballistic Missile Agency
Second Type 704 System to be delivered in September 1957.
    Edwards Air Force Base, Flight Test Center
Type 704 System to be acquired in December 1957.
    Naval Ordnance Test Station, China Lake
Plan to obtain a Type 704 System.
    U. S. Naval Ordnance Laboratory
Type 704 System to be acquired in October 1957.
    Industrial Sample
    Douglas Aircraft Company, Incorporated, Santa Monica Division
Type 704 System to be acquired in July 1957.
    Douglas Aircraft Company, Incorporated, El Segundo
Type 704 is to replace Type 701 in May 1957.
    General Electric Aircraft Gas Turbine Division
Plan to increase high speed (core) storage capacity. Expect to acquire second Type 704 System during 1957.
    General Electric Company, Lynn Computations
The present 8,192-word core storage unit will be converted to a 32,768-word unit when these units are available.
    General Motors Corporation, Research Staff
Planning acquisition of:
740 CRT Display Unit. 8,300 points/sec.
500 Line/min. Printer
32,768-word Core Storage Unit

    Lockheed Aircraft Corporation, California Division
New components and modifications include:
Type 740 Cathode Ray Tube Output Recorder May 1957.
A third IBM Type 704 Electronic Data Processing System is to be acquired in November 1957.
A 32,768-word magnetic core storage unit is to be acquired in 1958.
    Gulf Research and Development Company
Planning acquisition of Type 704 or 709 System.
    Lockheed Aircraft Corporation, Missile Systems Division
An IBM 704 with 8,192-word core memory and 8,192-word drum memory is scheduled for delivery June 1, 1957 and the memory system will be changed to 32,768 words of core when available.
    New York University
Acquisition of system on a one shift rental basis expected 1 April 1957.
    University of California Radiation Laboratory
Plan to increase storage capacity to 32,768 words. Type 704 Model III (Including buffer and additional instructions to be obtained).
    Westinghouse Electric Corporation, Analytical Department
Plan to acquire one Type 704 for the Aviation Gas Turbine Division. Plan to acquire one Type 704 for the Air Arm Division. A 32,768-word core storage unit is on order for 1958.
    Westinghouse Bettis Atomic Power Division
A large auxiliary drum storage and special purpose instructions are to be added in 1957. The drum unit will store 256 blocks of 2,048 words each and read or write in 84 milliseconds per block. The core storage unit is to be increased to 16,384 words in April 1957 and to 32,768 words in July 1957.

## INSTALLATIONS

Existing and planned installations

    Government Sample
    Army Ballistic Missile Agency, Computation Laboratory, Huntsville, Alabama
    Edwards Air Force Base, Air Force Flight Test Center, California
    U. S. Naval Ordnance Test Station, Computing Branch, China Lake, California
    U. S. Naval Ordnance Laboratory, White Oak, Maryland
    National Advisory Committee for Aeronautics, Langley Field, Virginia
    Industrial Sample
    Aerojet-General Corporation, Sacramento, California
    Boeing Airplane Company, Seattle, Washington
    Douglas Aircraft Company, Incorporated, El Segundo, California
    Douglas Aircraft Company, Incorporated, Santa Monica, California
    General Dynamics Corporation, Convair Division, Fort Worth, Texas
    General Electric Company, Aircraft Gas Turbine Division, Cincinnati 15, Ohio
    General Electric Company, Schenectady, New York
    General Electric Company, Tempe, Arizona
    General Electric Company, West Lynn, Massachusetts
    General Motors Corporation, Research Staff, Detroit, Michigan
    The Glenn L. Martin Company, Baltimore 3, Maryland
    International Business Machines Corporation, 580 Madison Avenue, New York 22, New York
    Lockheed Aircraft Corporation, California Division, Burbank, California
    Lockheed Aircraft Corporation, Missile Systems Division, Sunnyvale, California

Midwestern Universities Research Association, Madison, Wisconsin

New York University, A. E. C. Computing Facility, New York, New York

North American Aviation, Incorporated, Los Angeles, California

The Rand Corporation, Santa Monica, California

Standard Oil Company of California, San Francisco, California

United Aircraft Corporation, Research Department, East Hartford, Connecticut

University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico

University of California, Radiation Laboratory, Livermore, California

Westinghouse Electric Corporation, Analytical Department 4L38, East Pittsburgh, Pennsylvania

Westinghouse Electric Corporation, Bettis Atomic Power Division, Pittsburgh, Pennsylvania

## ADDITIONAL FEATURES AND REMARKS

Manufacturer

FORTRAN (automatic formula translation), a program for automatically translating mathematical notation to optimum machine programs. Three indexing registers for automatic, address modification and cycle counting (independent of arithmetic element). Logical operations based on the full 36 bits per word. Automatic feature for setting up RETURN address for closed subroutines. Magnetic tape compatibility for the IBM 650, 701, 702 and 705 machines. Automatic floating or fixed-point operation built into hardware. IBM provides technical assistance through the 704 school in New York. Applied Science Representatives, and Special Representatives of specific industries to assist in problems relative to their industry. These services are included in the previously quoted rental rates.

Industrial Sample

General Dynamics Corporation, Convair Division System has 3 index registers, floating point and utilizes FORTRAN coding system.

General Electric Aircraft Gas Turbine Division CAGE is used for program compiling and assembly. Checkout uses trapping mode of the machine.

General Motors Corporation, Research Staff 3 index registers and 2 arithmetic rapid access word registers. Magnetic tape input and output. A Formula Translating System (FORTRAN) is to be made available.

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

Lockheed Aircraft Corporation, California Division
Application
System No. 1 is utilized for the solution of accounting and factory business problems and System No. 2 is utilized for the solution of engineering problems.
Numerical System
The total number of instructions decoded on Machine No. 2 is 113. On Machine No. 1, which does not have floating point, the number of instructions is 105. The floating point arithmetic system consists of a 27 bit fraction plus sign and an 8 bit characteristic. The one-address type A instruction has a prefix (3 bits), a decrement (15 bits), a tag (3 bits), and an address (15 bits). The floating-point number range is:

$$2^{-128} \leqslant n \leqslant 2^{127}$$

the fixed-point number range is:

$$0 \leqslant n \leqslant 131,071$$

The arithmetic unit operation times are given as follows for fixed point arithmetic:

|  | Includ. Stor. Access Microsec | Exclud. Stor. Instruc. Access Microsec |
|---|---|---|
| Add time | 24 | 12 |
| Mult time | 240 | 228 |
| Div time | 240 | 228 |

For floating-point arithmetic operations:

|  | Includ. Stor. Access | Exclud. Stor. Instruc. Access |
|---|---|---|
| Add time | 84 | 72 |
| Mult time | 204 | 192 |
| Div time | 216 | 204 |

If extent of shift is greater than 10, add 12 microseconds for each 12 additional shifts to addition time. If dividend is 0, only 36 microseconds are required for division.

The checking features in use include:
Fixed:
Accumulator overflow
Multiplier - Quotient overflow
Divide check
Read-Write check
Tape redundancy indicator
Optional:
Trapping mode
Mathematical or balancing where applicable
Power requirements are:
70 KW, 98.6 KVA, 0.718 PF.
The system weighs 25,200 lbs.
The air conditioners are:
95 by 84 by 28 in, weight 1,800 lbs, 25 Tons.
131 by 173 by 38 in, weight 3,800 lbs, 40 Tons.
There are two of the latter.
The rental rates are:
$26,000/month for System No. 1 (no floating point)and $30,000/month for System No. 2 (with floating point). For peripheral equipment and tape units, System No. 1 is $3,950/month and System No. 2 is $5,300/month.
The personnel requirements are:

| System No. 1 | Engineers | Tech-Operators |
|---|---|---|
| One 8-hour shift | 3 | 6 |
| Two 8-hour shifts | 5 | 9 |
| Three 8-hour shifts | 7 | |

The six technician-operators perform the following on the first shift:
One supervises
One schedules
One operates peripheral equipment
Two operate computer
One trainee
The three additional persons for second shift:
Two operate computer
One operates peripheral equipment
System No. 2
One 8-hour shift requires two computer operators, two peripheral equipment operators, two supporting equipment operators and 1 expediter.
Additional features of the system include the utilization of three 15-bit B-boxes and the use of the trapping mode for selective tracing on transfer instructions.

University of California Radiation Laboratory
3 index registers for ADR modification and cycle count.
Logical operations
Automatic return address setting for subroutines
Magnetic tapes compatible with peripheral card reader to printer conversion.