

Picture by U. S. Naval Research Laboratory (Official United States Navy Photograph)

APPLICATIONS

Scientific problems

NUMERICAL SYSTEM

Internal number system	Binary
Binary digits per word	45
Binary digits per instruction	21
Instructions per word	2
Instructions used	31
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-1 < n < 1$

ARITHMETIC UNIT

	Microsec
Add time (exclud. stor. access)	3
Mult time (exclud. stor. access)	520-790
Div time (exclud. stor. access)	660-790

Construction
 Rapid access word registers
 Arithmetic mode
 Timing
 Operation

Vacuum tubes
 6
 Parallel
 Asynchronous
 Sequential, with concurrent recording

STORAGE

Media	Words	Microsec Access
Electrostatic (CRT)	1,024	10
Magnetic Drum	1,536	8,340 (avg)

A total of 115,200 binary digits of storage.
 A new 30 rps magnetic drum of 8,192-word capacity will be installed.
 1 to 256 word blocks may be transferred from drum to CRT and vice versa.

INPUT

Media	Speed
Paper Tape (Ferranti Mk II)	200 char/sec
Magnetic Tape	300 char/sec

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Magnetic Tape	300 char/sec
Typewriter (Flexowriter)	10 char/sec

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	2,000
Tube types	4
Crystal diodes	20,000
Different kinds of plug-in units	8
Separate cabinets	4

CHECKING FEATURES

Fixed
Automatic comparison of all transfers between registers.

Optional
Automatic comparison of all transfers between the arithmetic section and the storage section.

POWER, SPACE AND WEIGHT

Power, computer	25 KW
Space, computer	800 cu ft 100 sq ft
Power, air cond.	15 KW
Capacity, air cond.	20 Tons

Air conditioning is for computing system and working area.

PRODUCTION RECORD

Number produced	1
Number in current operation	1

PERSONNEL REQUIREMENTS

Two technicians are required for one 8-hour shift.

INSTALLATIONS

U. S. Naval Research Laboratory
Washington 25, D. C.

ADDITIONAL FEATURES AND REMARKS

Flexowriters are used in parallel, each typewriter giving the results of a separate problem simultaneously.

Centralized operating area by placing photoelectric tape reader, high speed punch, and Flexowriter adjacent to control console.

M-G set to replace electronic power supply.

NCR CRC 102 A

National Cash Register Company
Model CRC 102A

MANUFACTURER

National Cash Register Company



Picture by U. S. Army Chemical Center

APPLICATIONS

General purpose scientific applications

Government Sample

Chemical Warfare Laboratories, U. S. Army

Chemical Center

Scientific

U. S. Naval Ordnance Test Station (China Lake)

Data reduction general purpose

Holloman Air Development Center (ARDC)

Trajectory calculations, heat transfer problems, solution of various kinds of linear simultaneous equations and other algebraic equations.

U. S. Air Force School of Aviation Medicine

Biometrics

NUMERICAL SYSTEM

Internal number system Binary

Binary digits per word 42 (One for timing)

Binary digits per instruction	41
Instructions per word	1
Instructions decoded	27
Instructions used	27
Arithmetic system	Fixed point
Instruction type	Three address
Number range	$-(1-2^{-36})$ to $(1-2^{-36})$

ARITHMETIC UNIT

Government Sample

Chemical Warfare Laboratories, U. S. Army Chemical Center

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	19,900	7,400
Mult time	37,500	25,000
Div time	38,500	25,800
Construction		300 Vacuum tubes 4,000 Diodes
Rapid access word registers		8



Official Photograph U. S. Naval Post Graduate School

Basic pulse repetition rate 100 Kc/sec
 Arithmetic mode Serial
 Timing Synchronous
 Operation Sequential
 The speed can be increased by a factor of 8 when a buffer is used.

STORAGE

Government Sample
 Chemical Warfare Laboratories, U. S. Army Chemical Center

Media	Words	Microsec Access
Magnetic Drum	1,024	12,500 (avg)
Magnetic Tape	112,800/reel	6,000

Up to 7 tape units may be used with one computer.
 Magnetic drum rotates at 40 rev/sec.

INPUT

Manufacturer	Media	Speed
	Flexowriter	Typing Speed
	Punched Paper Tape	10 char/sec
	Magnetic Tape	1.6 char/millisecond

Government Sample
 Chemical Warfare Laboratories, U. S. Army Chemical Center

Media	Speed
Flexowriter	Typing Speed
Punched Paper Tape	10 char/sec

Manufacturer	Media	Speed
	Magnetic Tape	64 words/sec
	U. S. Naval Ordnance Test Station (China Lake)	
	Media	Speed
	Punched Paper Tape	10 char/sec
	IBM Cards	50 cards/min IBM 523 (modified)

U. S. Air Force, School of Aviation Medicine

Manufacturer	Media	Speed
	Flexowriter	Typing speed
	Punched Paper Tape	10 char/sec
	IBM Cards	50 or 100 cards/min

OUTPUT

Manufacturer	Media	Speed
	Magnetic Tape	600 char/sec
	Flexowriter	10 char/sec
	Punched Paper Tape	10 char/sec

Government Sample
 Chemical Warfare Laboratories, U. S. Army Chemical Center

Media	Speed
Magnetic Tape	64 words/sec
Flexowriter	10 char/sec
Punched Paper Tape	10 char/sec

U. S. Naval Ordnance Test Station (China Lake)		
Media	Speed	
Flexowriter	10 char/sec	
Punched Paper Tape	10 char/sec	
IBM Cards	50 cards/min	IBM 523 (modified)

U. S. Naval Postgraduate School
A digital point is used, which operates independently of computer. No conversion is necessary for plotting. The plotter is manufactured by the California Computer Products Corporation.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Manufacturer	
Tubes	400
Tube types	12
Crystal diodes	8,000

Government Sample
Chemical Warfare Laboratories, U. S. Army Chemical Center
Tube types used include 12AT7, 12BE7, 6BQ7, 5687, 5963, 6080, 5881, and 6AN5. System utilizes 265 tubes and 6,000 diodes and consists of operators console, computer proper, and magnetic tape unit.

CHECKING FEATURES

Manufacturer
Duplicate recording on magnetic tape
"Overflow alarm"
"No command" alarm

POWER, SPACE AND WEIGHT

Manufacturer	
Power, computer	7.7 KW
Weight, computer	2,700 lbs

Government Sample
Chemical Warfare Laboratories, U. S. Army Chemical Center
Computing system occupies 135 cu ft, air conditioner 48 cu ft. The computing system weighs 3,400 lbs, air conditioner weighs 12,000 lbs. The capacity of the air conditioner is 6 Tons.

U. S. Naval Ordnance Test Station (China Lake)
System operates a 230v +5% line, liberates 35,000 BTU/hour. Computer occupies 72 cu ft and 12 sq ft (Dimensions are 30 by 59 by 73 inches).

PRODUCTION RECORD

Produced	16
Operating	16

COST, PRICE AND RENTAL RATE

Government Sample
School of Aviation Medicine, Randolph Air Force Base
Approximate cost of system \$80,000.
Chemical Warfare Laboratories, U. S. Army Chemical Center
Approximate cost of basic system \$70,000
Approximate cost of additional equipment \$25,000
Rental rates of basic system \$ 3,400/month

PERSONNEL REQUIREMENTS

Government Sample
Chemical Warfare Laboratories, U. S. Army Chemical Center
One 8-hour shift requires 1 engineer and 1 technician-operator.

U. S. Naval Ordnance Test Station (China Lake)
One 8-hour shift requires 1 engineer, 2 programmers and 1 "open shop" personnel.

School of Aviation Medicine, Randolph Air Force Base
One 8-hour shift requires 1 engineer and 1 technician-operator.

Industrial Sample
Gulf Research and Development Company
Central computing section consists of 1 engineer, 1 operator, 1 secretary-librarian, and 5 administrative, numerical analysis and programming personnel, for slightly more than an 8-hour shift.

RELIABILITY AND OPERATING EXPERIENCE

Government Sample
Chemical Warfare Laboratories, U. S. Army Chemical Center

Good time	3,380 hours
Attempted to run time	5,200
Operating ratio (Good/Attempted to run)	0.65
Figures based on period	2.5 years
Acceptance test	June 1954

U. S. Naval Ordnance Test Station (China Lake)
Average error-free running period 80 hours
Operating ratio (Good/Attempted to run) 0.90
Figures based on period 1 January 1955 to 10 November 1956.
Acceptance test 1 June 1954.

FUTURE PLANS

Government Sample
School of Aviation Medicine, Randolph Air Force Base
Planning the acquisition of magnetic tape storage unit in order to overcome storage limitations.

INSTALLATIONS

Government Sample
Holloman Air Development Center (ARDC) (2)
Holloman Air Force Base, New Mexico

School of Aviation Medicine
Randolph Air Force Base, Texas

Chemical Warfare Laboratories
U. S. Army Chemical Center, Maryland

U. S. Naval Ordnance Test Station
China Lake, California

Industrial Sample
A. V. Roe, Ltd.,
Malton, Ontario, Canada

Great Lakes Pipe Line Company
Kansas City, Missouri

Gulf Research and Development
P. O. Drawer 2038
Pittsburgh 30, Pennsylvania

Polytechnic Institute of Milan
Milan, Italy

Royal Canadian Air Force
Edmonton, Alberta, Canada

Sandia Corporation
Albuquerque, New Mexico

Standard Oil Company of California
California

The National Cash Register Company
Dayton, Ohio

The National Cash Register Company
Hawthorne, California

Industrial Sample
Gulf Research and Development Company

Auxiliary equipment consists of:
2 NCR 126 Magnetic Tape Units.
Two Flexowriters, each capable of serving as the input-output device for the computer. A third Flexowriter, not modified, for input-output functions.
One 514 IBM Reproducing Punch, modified for use as an output device.

A photoelectric paper tape system based upon a Ferranti reader has been constructed.

Two more one-word recirculating registers have been made addressable, making them correspond roughly to the accumulator and Q-register of a typical one-address computer. Necessary changes have been made to permit the availability of information arising in one instruction for the next succeeding one. These changes permit more frequent achievement of minimum access times, save storage space and simplify certain matters for the programmers.

29 instead of the standard 25, instructions are decoded. Some of these are, or have been made into, multiple instructions. One additional transfer instruction provides a subroutine link and requires only a blank word at the end of the subroutine in addition to the instruction in the main program.

Automatic (i.e. without reference to the drum) conversion during filling of paper tape, from coded-decimal to binary fractions with round off at the least significant (36th) binary digit has been built in. Conversion is controlled by single bit in fill instructions or tape character. Time of execution, 8ms per word, is not apparent at present, since it is performed between time of reading adjacent characters from tape.

Automatic conversion, during the print instruction, from binary to decimal-coded fractions is available, as well as round-off at any decimal-coded digit position.

Additional Government Samples
U. S. Postgraduate School
Monterey, California

ADDITIONAL FEATURES AND REMARKS

Government Sample

Holloman Air Development Center (ARDC)

Two systems have been in use since 1955. Additional input/output equipment includes 3 magnetic tape units (NCR 128), and 1 summary card punch (IBM 525).

Chemical Warfare Laboratories, U. S. Army Chemical Center

The three-address system permits ease of programming and coding not present in one or two address systems.

Additional features include: Bit positions available in the structure of commands for flagging internal addresses for automatic coding and repositioning of programmed routines. Logic designed such that automatic links to and from subroutines are accomplished easily. Large storage capacity and three-address commands. Tape unit searches independently of the computer, once the block address is set up. High speed paper tape input reader. A visual display of the control register while computing and when idle. All logical diodes accessible, diodes are of clip-in type, plug-in units replaceable for repair.

U. S. Naval Postgraduate School

The system is used primarily for the education of the officers in the Engineering School. Other computer time after normal training hours is used by government agencies in the Monterey area on a non-interference basis.

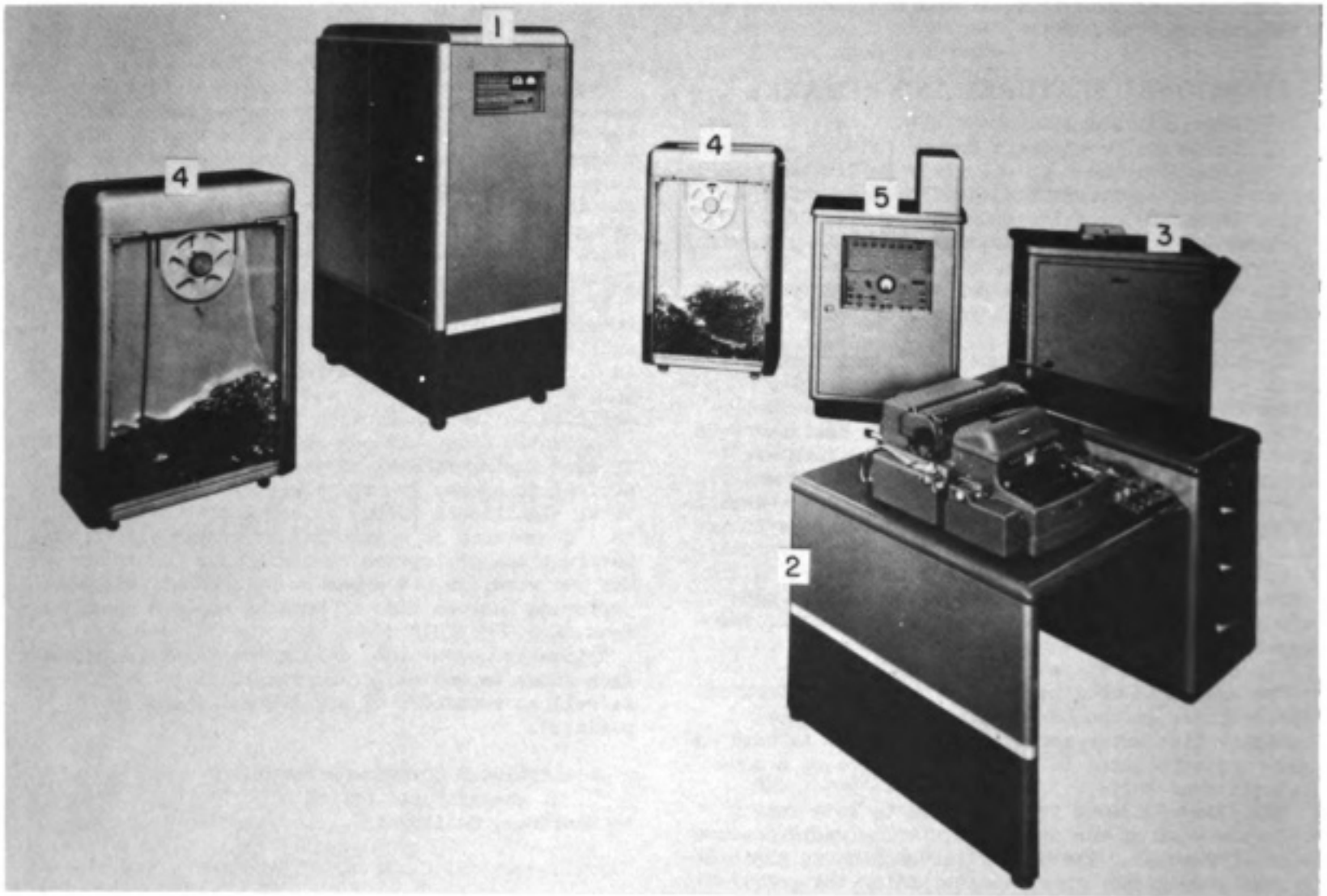
The plotter output is considered to be a very valuable part of the system permitting rapid observation of results. The binary information is plotted directly on graph paper, thus avoiding the problem of converting to decimal. The plotter has three plotting symbols.

NCR 102 D

National Cash Register Company
Model 102D Electronic Data Processing System

MANUFACTURER

National Cash Register Company



Picture by the National Cash Register Company

APPLICATIONS

General purpose scientific application

NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits per word	9 plus 6 bin dig/word
Binary digits per instruction	42
Instructions per word	1
Instructions decoded	27
Arithmetic system	Fixed point
Instruction type	Three address
Number range	or $-(1-10^{-9})$ to $+(1-10^{-9})$ $-(1-2^{-36})$ to $+(1-2^{-36})$

ARITHMETIC UNIT

	Incl. Stor. Access Microsec	Exclud. Stor. Access Microsec
Add time	7,800	4,000
Mult time	21,100-49,100	15,000
Div time	21,100-53,200	15,500
Construction		Vacuum tubes
Rapid access word registers		8
Basic pulse repetition rate		100 Kc/sec
Arithmetic mode		Serial
Timing		Synchronous
Operation		Sequential

STORAGE

Media	Words	Digits	Microsec Access
Magnetic Drum	1,024	43,008	12,500(avg)
Magnetic Tape	102,000/reel	918,000/reel	



Picture by the National Cash Register Company

INPUT

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
Paper Tape (Photo-electric)	200 char/sec
Magnetic Tape	600 char/sec
Keyboard (Flexowriter)	Manual
Punched Cards	4,000 char/min

OUTPUT

Media	Speed
Paper Tape (Flexowriter)	10 char/sec
High Speed Punch	60 char/sec
Magnetic Tape	600 char/sec
Punched Cards	4,000 char/min

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	425
Tube types	15
Crystal diodes	8,500

CHECKING FEATURES

Duplicate recording on magnetic tape
 "Overflow" alarm
 "No command" alarm

POWER, SPACE AND WEIGHT

Power, computer	7.7 KW
Space, computer	250 sq ft
Weight, computer	2,700 lbs

COST, PRICE AND RENTAL RATE

Approximate cost of basic system	\$65,000
Approximate cost of additional equipment	
Magnetic Tape Unit Model 126	\$16,000
High Speed Reader Model 160	9,500
High Speed Punch Model 170	5,000
Flexowriter	2,900
Rental rates of basic system	\$ 2,400/month
Rental rates of additional equipment	
High Speed Reader Model 160	\$ 275/month
High Speed Punch Model 170	220/month
Flexowriter	150/month

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
One 8-Hour shift	1	1
Two 8-Hour shifts	1	2
Three 8-Hour shifts	1	3



Picture by the Georgia Institute of Technology, Engineering Experiment Station, Rich Electronic Computer Center

INSTALLATIONS

Dow Chemical Company
Midland, Michigan

Georgia Institute of Technology
Atlanta Georgia

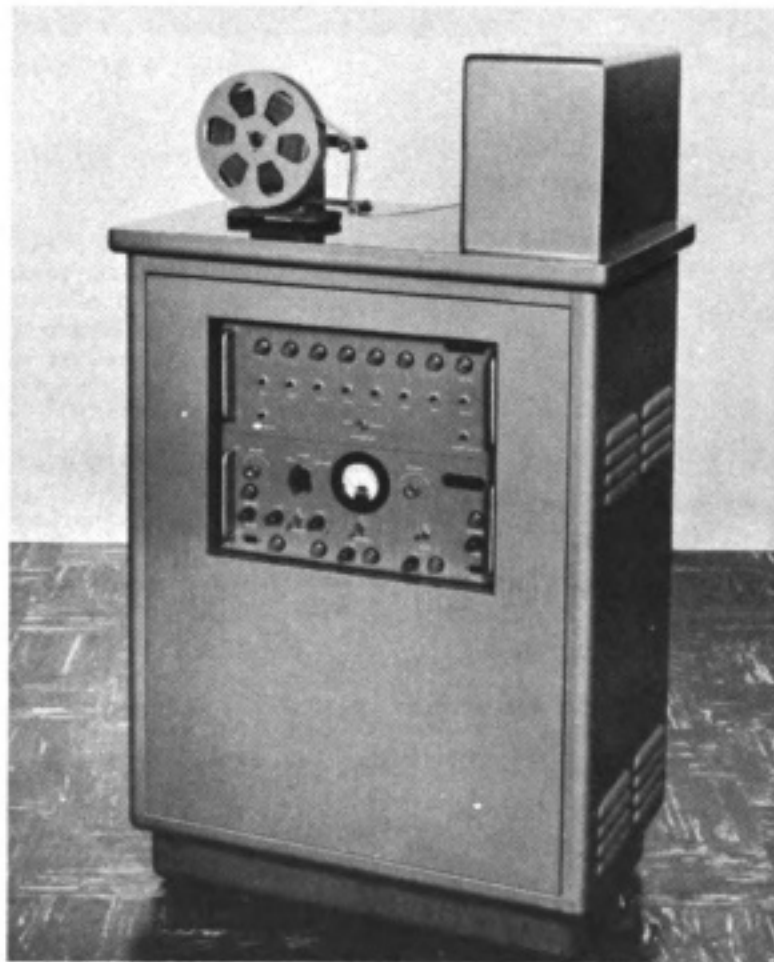
The National Cash Register Company
Dayton, Ohio

The National Cash Register Company
Hawthorne, California

ADDITIONAL FEATURES AND REMARKS

The first picture shows the components of the system, including:

1. Computer
2. Control Console
3. High Speed Paper Tape Reader
4. Magnetic Tape Units
5. High Speed Paper Tape Punch



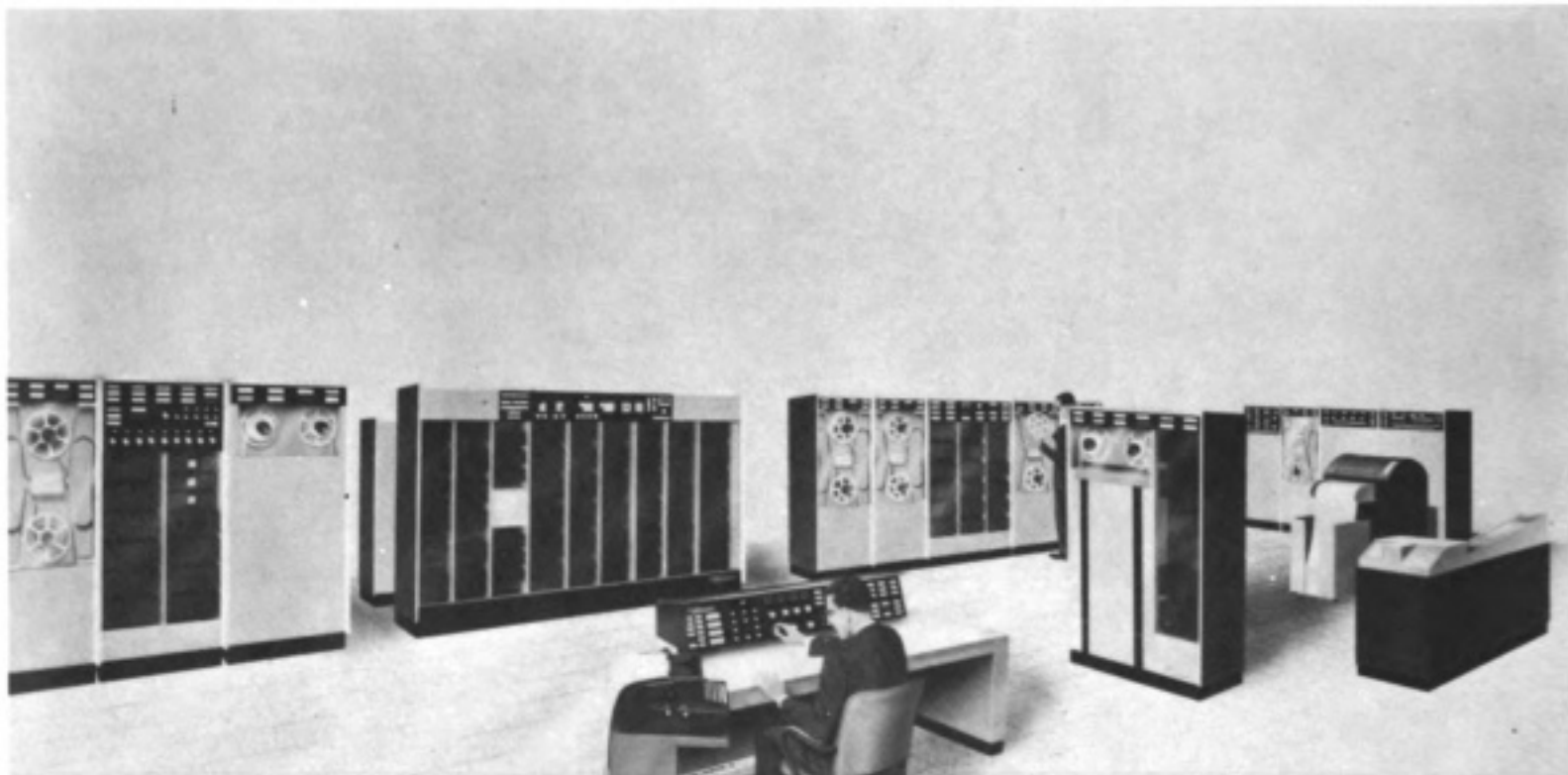
Pictures by the National Cash Register Company

NCR 304

National Cash Register Company Model 304 Electronic
Data Processing System

MANUFACTURER

The National Cash Register Company
Electronics Division and the Engineering and Product
Development Division



Picture by the National Cash Register Company

APPLICATIONS

Commercial
May be used for scientific

NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Alphanumeric characters per word	10
Instructions decoded	37 Basic instructions
Arithmetic system	Fixed point (automatic alignment)
Instruction type	Multi-address
Number range	$-(1 \cdot 10^{-10})$ to $(1 \cdot 10^{-10})$ or $-(10^{10}-1)$ to $(10^{10}-1)$

Each instruction causes the operation of a micro-programmed sub-routine. The instructions contain where relevant, the following:

Operation code and variation designator to identify operation

Variation Designator

Addresses of operands are basically 3-address

Field designators of operands include:

Limiters

Self-linking Designator

Branch Addresses

Level of automonitoring

Designation of the specific input or output device

Location of keys

Relative Address Register to be used

Fields to be relatively addressed

Each instruction may be relative to one of ten Relative Address Registers. The portions of the instruction which are to be relative are specified within the instruction.

Instructions contain from 2 to 6 words, depending upon the number of parameters.

ARITHMETIC UNIT

	Microsec
Add time (Includ. stor. access)	60 (10+R+L)
Mult time (Includ. stor. access)	60 (26+R+L+X)
Div time (Includ. stor. access)	60 (14+R+L+2Q+Y)

The following define the variables used in calculating operation times:

- R = 1 If relative addressing is required
- R = 0 If no relative addressing is required
- L = 2 If self-linking is to occur
- L = 0 If no self-linking is to occur
- X = The sum of the digits of the multiplier
- Q = The number of digits in the quotient
- Y = The sum of the digits of the quotient

Construction	Transistors and diodes
Basic pulse repetition rate	400 Kc/sec central processor character rate
Arithmetic mode	Serial by word, parallel by character
Timing	Synchronous in central processor Asynchronous to auxiliary equipment
Operation	Sequential internally Concurrent with copy or search of magnetic tape or printing.

A dual, self correcting adder/subtractor is used. The operation of Add includes the following:

- Look-up of the instruction
- Modification of the instruction by a Relative Address Register if desired
- Look-up of the operands
- Selection of the field within the operands.
- Alignment of the fields
- Addition
- Selection of the word in which the result is to be stored
- Insertion of the result into the selected field
- Check for overflow, setting overflow alarm if necessary
- Check for self-linking, performing self-linking if necessary
- Check for automonitoring, setting up for automonitoring if necessary

STORAGE

Media	Words	Digits
Magnetic Core	1,000 to 4,000	10 alphanumeric/word
Magnetic Tape	400,000	alphanumeric/tape
Magnetic Tape	600,000	numeric/tape

Access to the magnetic core storage unit is parallel by word.

INPUT

Media	Speed
Punched Cards	1,000 cards/min
Punched Paper Tape	1,000 char/sec
Magnetic Tape	15,000 char/sec

Information from cards and paper tape may be read directly or may be converted to magnetic tape.

Off-line Conversion

An off-line converter can convert from:

Punched Cards to Magnetic Tape
Paper Tape to Magnetic Tape

Magnetic Tape to Punched Cards
Magnetic Tape to Paper Tape

Magnetic Tape to Printer

Magnetic Tape

A record on Magnetic Tape may contain 10 or more words. Multiple variable-length records may be written onto Magnetic Tape with a single acceleration. There is no inter-record gap between records on Magnetic Tape.

Multiple variable-length records may be read from Magnetic Tape with a single acceleration.

The contents of one Magnetic Tape may be read and simultaneously written onto another Magnetic Tape until a desired record is reached. The copying may be shared with computing, printing, input or output. Several copy operations may be in progress simultaneously.

All conditions which may arise during Magnetic File operations are automatically detected and identified by the Processor without programmed testing. Then a standard routine of less than 250 words will perform all tape management operations including:

- Repeat in case of error
- Repeat, or jump, on busy Tape Unit or Controller
- Indicate attempt to use locked-out tape
- Alternate Tape Units at end of tape
- Tape identification, and label-checking
- Memory dump, and rescue points
- Log of tape operations

The time-sharing ability of Magnetic Tape Copy allows for convenient file-splitting, or multi-programming of different jobs where reference to the file is for less than every record. Thus, completely independent programs can be written and checked out, then tied together with the timing interlace being performed by the equipment.

In order to improve the efficiency of Magnetic Tape operations, any quantity of numeric information may be packed from 6-bit code to 4-bit code with a single Instruction. Thus utilization of Magnetic Tape storage, and transport speed, will both be increased by 50% for numeric information.

When the packed information is brought into Memory, a single Instruction will reverse the transformation. Only that information requiring arithmetic operation need be unpacked; sorting, table lookup, and all other logical operations, can be performed on packed information.

OUTPUT

Media	Speed
Paper Tape	60 char/sec
Printer	600 lines/min, print
	4,200 lines/min, space
Magnetic Tape	15,000 char/sec

Paper tape may be punched directly by the system data processor or from magnetic tape.

Printing may be performed by the system data processor or from magnetic tape, or on a shared basis.

Punched cards may be prepared from magnetic tape by means of a converter. (See "Off-line Conversion" under "INPUT" above.)

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	0
Tube types	0

Crystal diodes	8,000
Magnetic cores	66,000 to 264,000
Transistors	4,000

The above data pertains to the Central processor only.

Separate cabinets	12 different for the entire system
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CHECKING FEATURES

Magnetic Tape

All recording on Magnetic Tape is immediately checked by re-reading at a check head placed immediately behind the write head. Checks are made for parity on each character, longitudinal parity check over each record, character count on each record and proper bounding of each record.

These same checks are carried on during reading of records.

These same checks are carried on both during reading and writing when a copy operation is in progress.

Punched Card Reader

All Cards are read twice to insure accuracy.

Paper Tape Reader

Paper Tape is read twice and codes which are checkable with parity are checked. Conversion to processor language is checked.

Paper Tape Punch

A check is made at the punching dies for parity.

Processor

All transmission from the processor to or from auxiliary equipment is checked for parity.

All transmission to or from the memory is checked for parity on each word.

All data manipulation is checked for character parity and word parity.

POWER, SPACE AND WEIGHT

Power, computer	Approximately 1 KW for Central Processor
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ADDITIONAL FEATURES AND REMARKS

Coding Features

The instructions list includes Merge, Summarize, Sift and Editing instructions. The Editing instructions have the ability to simultaneously zero suppress or check protect and split money amounts around a comma or decimal point.

The structure of each instruction is designed so that there is almost a one-to-one correspondence between the systems flow-chart and the final machine code. Thus, the housekeeping instructions are at a minimum and the need for compiling routines is eliminated.

The Class 304 system consists of ten different units. These functional units may be assembled into operable systems scaled to perform a specific purchaser's job. These different units are:

The C-304 Central computer and control with its manual console which is provided with a Flexowriter, having Printer, Transmitter, Receiver and Punching facilities.

The class 330 Magnetic Tape Controller capable of the functional control of one and up to eight Tape Handlers.

The class 320 off-line media Converter.

The class 322 off-line Printer Controller.

The class 340 High-Speed Printer.

The class 360 High-Speed Paper Tape Reader.

The class 370 High-Speed Tape Punch.

The class 380 High-Speed Card Reader.

Off-line Flexowriter with printer conversion unit. IBM Card Punch.

From this array of different functional units a range of systems falling between a visualized minimum and maximum can be obtained.

NORC

Naval Ordnance Research Calculator

MANUFACTURER

International Business Machines Corporation



Picture by U. S. Naval Proving Ground

APPLICATIONS

General scientific calculation in ordnance research, development and testing.
 Information provided by U. S. Naval Proving Ground and the International Business Machines Corporation.

NUMERICAL SYSTEM

Internal number system	Binary coded decimal
Decimal digits per word	16
Decimal digits per instruction	16
Instructions per word	1
Instructions decoded	80
Instructions used	80
Arithmetic system	Floating or fixed point
Instruction type	Three address
Number range	10^{-43} to 10^{+31}

A number may be written as
 $\pm x.xxxxx xxxxx xxxxx \cdot 10^{xxx}$

ARITHMETIC UNIT

	Time	Microsec
Add (exclud. stor. access)		15
Mult (exclud. stor. access)		31
Div (exclud. stor. access)		227
Construction	Vacuum tubes and diodes (switching)	
Rapid access word registers	2,000	
Basic pulse repetition rate	1 Mc/sec	
Arithmetic mode	Serial	
Timing	Asynchronous	
Operation	Concurrent	

Multiplication and division are partly performed in parallel. Operation time depends on decimal indices.

STORAGE

Media	Words	Binary Digits	Microsec Access
Electrostatic (CRT)	2,000/3,600	132,000/ 237,000	8

Magnetic Tape 4,000,000 Variable

3,600 words of CRT storage are available at reduced read-around ratio. 16 decimal digits/word are stored. Magnetic tape system can read or search forward and backward and write forward.

INPUT

Media	Speed
Magnetic Tape (8)	4,000 words/sec maximum

Eight tape units are in service. The packing density on magnetic tape is 500 char/inch, the linear speed is 140 inches/sec.

OUTPUT

Media	Speed
Magnetic Tape (8)	4,000 words/sec maximum
Monitor Printer (2)	18,000 char/min
Cathode Ray Tube	Decimal Numerals (Visual)

Printing is concurrent with calculating. Characters are delivered to printers at the rate of 10,000 char/sec. Storage may be visually inspected by numerals appearing on the faces of CRT's. Tape speeds given above are the "within-block" rate. Eight magnetic tape units are in service. Off-line conversion takes place from magnetic tape to punched card.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	9,800
Tube types	20
Crystal diodes	30,000
Separate cabinets	6

CHECKING FEATURES

Fixed checks include:
Bit count modulo-4 check on each word transfer
Modulo-9 arithmetic check
Illegitimate character check
Word-length and block-length check on tape reading.

POWER, SPACE AND WEIGHT

Power, computer	168 KW
Power, air cond.	80 KW
Space, computer	3,500 Sq. ft.
Space, air cond.	740 Sq. ft.
Capacity, air cond.	76 Tons

Computer space includes maintenance area. Capacity of main frame cooling plant has been increased from 30 to 40 Tons. Room air conditioning plant capacity is 36 Tons.

PRODUCTION RECORD

Produced	1
Operating	1

COST, PRICE AND RENTAL RATE

Approximate cost of basic system \$2,500,000

PERSONNEL REQUIREMENTS

Daily Operation	Engineers	Tech and Operators
3-8 Hour Shifts	3	22

RELIABILITY AND OPERATING EXPERIENCE

Operating ratio (Good/Attempted to run) 0.86
Figures based on period January 1956 to August 1956
Acceptance test 25 February 1955.

Three to four hours of preventive maintenance is required out of twenty-four hours.

FUTURE PLANS

U. S. Naval Proving Ground
Cathode-ray tube printer, due for delivery in October 1957, will print 16,000 char/sec or plot on microfilm using rectangular coordinates.

A larger random access storage unit and a fast transcriber are being considered for acquisition.

INSTALLATIONS

U. S. Naval Proving Ground
Dahlgren, Virginia

ADDITIONAL FEATURES AND REMARKS

Speed increased by taking short cuts in case of zero operands and through the use of previous result as an operand. Provisions for addition, subtraction, and shifting of instruction words make possible programmed synthesis of instructions. A large variety of conditional program transfer instructions are available. Three address-modifier registers make possible the modification of operand addresses without changing the stored instruction. Card-tape-card conversion is used.