DATA PROCESSING EQUIPMENT ENCYCLOPEDIA

Electronic Devices

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FIRST EDITION

About the Publisher . . .

THE FOUNDERS of Gille Associates, Inc. began research on their first data processing information service in 1950. The first resultant information publication was titled *The Punched Card Annual.* This was the first regularly published national reference on data processing systems.

It was *The Annual* that first introduced many users of punched card equipment to electronic systems including business computers.

Since that time Gille Associates has continued to lead the way in making available the newest data processing information in the most usable forms.

These now include:

DATA PROCESSING — a monthly magazine

DATA PROCESSING ANNUAL — a reference guide

HANDBOOKS — case studies for eight industry groups and on eight application subjects

COMPUTER APPLICATIONS — case studies on specific computers

EQUIPMENT ENCYCLOPEDIA — detailed descriptions and specifications for all office data processing equipment

PREFACE

THE PROBLEMS involved in the selection of data processing equipment are many. Too often the significant questions go unanswered because the selectors must devote so much of their time to the finding of reliable information. The specifications of available equipment is but one of the areas in which time is lost in trying to find facts. The myriad of models precludes the possibility of any one person knowing all the answers, and complete dependence upon a few of the manufacturers for these facts gives one at best a limited scope. This *Encyclopedia* cannot present enough information to provide *all* answers on equipment, but it can and does provide facts to reduce equipment under consideration to a minimum number of models.

The value of the *Encyclopedia* is in its presentation of data on a *factual* basis. The publication is not under the control of any manufacturer or distributor of data processing equipment; findings are published solely in the interests of the readers. One is assured of reports which are unbiased and authoritative, reports in which he can place the utmost confidence.

Before any major decision can be made regarding the acquisition, installation, improvement, or retirement of computing equipment, first hand technical information must be obtained concerning the characteristics, availability, cost, operational problems, capability and useful life of available systems. Efficient management requires that the experiences of others be exploited wherever such exploitation is beneficial. The computing and data processing field is a dynamic one. The present trend in design is toward higher speeds, increasing reliability, and solid state electrical components. Nevertheless, only existing or readily available equipment may be utilized for the immediate solution of commercial data processing problems. Persons in the data processing field are continuously seeking the answers to many questions: Can present procedures used in a given organization be accomplished by automatic computing and data processing equipment? Will investment in such equipment reduce costs, provide improved service, conserve manpower, or save time? When shall existing computing equipment be modified, supplemented, or replaced? Of all available equipment, what type of system is best suited for the solution of a given problem or a given group of problems? Is the maximum possible return being obtained from a given investment in computing equipment? Does a given problem require specially built equipment or is a solution to be found with commercially available standard equipment? Should computing equipment be rented or purchased? Each of these questions demands that a large body of technical language be available before answers can be given.

Scope of data covered

Only equipment on which objective, verified information could be found is included in the *Data Processing Equipment Encyclopedia.* Items omitted from this printing for lack of sufficient information will be carried in the quarterly supplements, together with newly released items. It is the intention of the editors to include all significant equipment which is commercially available and which meets established criteria for one of the two volumes.

The criterion for inclusion in Volume I on electomechanical equipment is that the equipment be usable in the preparation or semi-automatic handling of data. Generally, this has meant that an item must fall into one of the sections of the volume *(see table of contents),* and the item must be connected with the use of punched cards, punched paper tape, or continuous form paper. Other sections will be included in supplements as they become significant.

Volume II is not limited to commercially available data processing systems, but includes some systems which are of historical interest. A system must include input, output, control, arithmetic units, and storage; however, it need not be a general purpose machine; special purpose systems are included when there is wide interest in them. *(Foreign computer systems are included only where sufficient information on them is available.)* No screening of computers by size has been done; and no minimum size is required for inclusion; externally-programmed machines are also covered.

Among the items not included in Volume II are analog computers and separate computer-system components, such as storage units, arithmetic registers, input-output units, converters, and recorders. These components are included only when they belong to one or more data processing systems.

Format

Information in Volume I is organized to facilitate comparison of similar pieces of equipment, entries are alphabetical by name of section; the section on a particular type of machine contains the detailed description of all machines of the type, and a comparison of the machines in summary form. The detailed description of the machine includes definition of the machine's functions, itemization of included and optional operating features, specific models if any, and the machine's specifications. The attempt has been to give the same set of specifications on all machines in a section, and to give these figures in the same units for ease of comparison.

In Volume II, information is entered alphabetically by name of the computing system; usually, this name is the same as the manufacturer's, but there are exceptions. Each system description includes data on the general type of machine system; numeric system used; storage used and in what sizes; input and output devices; checking circuitry; and auxiliary devices. Remarks are added when necessary. Following the description of the system is a table of prices, power requirements, and physical characteristics of the system's components. In many entries a block diagram indicating the average configuration of the system has been included.

Information included in the detailed descriptions of the data processing systems is brought together in tabular form for comparison purposes in Appendices A and B. An analysis and interpretation of the data accompanies the tables. It is recommended that the tables be used only for comparison purposes, and that data on a specific system be taken *only* from that system's description, since the tabular data, out of context, can be misleading.

The index of manufacturers and glossary of terms are included to give further reference value to the *Data Processing Encyclopedia.* The index to the contents of each volume is provided as a cross-reference for aid in finding any particular piece of equipment.

We wish to specifically acknowledge the cooperation of Martin H. Weik, Jr., author of Ballistics Research Laboratories report number 1115, *A Third Survey of Domestic Electronic Digital Computing Systems,* 1961, from whom we have obtained source material.

For some of the photographs used we are indebted to:

Rome Air Development Center, Griffiss Air Force Base; Iowa State University; U. S. Army; Underwood Corporation, Electronic Computer Division; Bureau of the Census; ITT Laboratories; J. H. Maddocks; Librascope Division, General Precision, Incorporated; Magnetics Division, Idaho Maryland Mines Corporation; Ramo Wooldridge Division, Thompson Ramo Wooldridge, Incorporated; National Bureau of Standards; Computer Control Company, Incorporated; Burroughs Corporation; and Michigan Bell Telephone Company.

Without the cooperation of the manufacturers of data processing equipment, this *Encyclopedia* would have been impossible; we are grateful for the willingness they showed in giving us the information we requested. We also owe a great deal to the many users of this equipment who have given us verification of data throughout the *Encyclopedia.*

EDITORIAL FOREWORD

THE INFORMATION contained in the two volumes of this Encyclopedia was obtained from many sources. The foremost of these sources were the equipment manufacturers, who generously met our numerous requests for detailed specifications and other material. Many publications of the federal government were examined in our quest for basic data. The tabular and reference information available to us in these and other publications contributed materially to a more complete survey of equipment for the data processing field than has heretofore been published. This was our primary goal in embarking on the long months of effort needed to publish the Equipment Encyclopedia.

From the voluminous, scattered and often confusing literature which describes data processing equipment, we believed factual, objective information could be distilled into one reliable reference source. This intensive editorial effort has resulted in the reduction of these data to a common set of specifications which makes a considerable amount of comparison feasible.

Extensive revision was required of much of the data obtained from the government, the manufacturers, and in pamphlets, brochures, books, reports, and articles produced by scores of individuals, business corporations, educational institutions and consultants, Although these continued revisions delayed the initial edition of the Equipment Encyclopedia, the material herein presented is the most up to date available anywhere. Optional updating supplements will present revised information at least every three months between editions and more often if necessary.

As in any publication containing essentially statistical information, errors are sure to be found. Every effort has been taken to minimize these errors and we trust that any occurring are minor. Correction of any errors will also be included in the optional updating supplements.

We are grateful to the many who helped make this encyclopedia possible, even though space precludes enumerating them individually by name.

Alan D. Meacham
Editor

CONTENTS

MICR EQUIPMENT

OPTICAL SCANNING DEVICES

A HISTORY OF CALCULATORS AND COMPUTERS

FROM THE ABACUS to present electronic digital computers every improvement in calculating devices has come in response to the need for faster and more efficient means of counting — releasing man from burdensome figuring and leaving him free to create and evaluate. The pictures that follow describe some of the earliest calculators. One major difference in these machines, from the present computers, is that now data can be fed into the computer systems by high speed input such as magnetic tape, and the results can be accumulated, reported, and even evaluated to some extent at high speed by several output devices. The early calculating machines were hand-operated.

The "Abacus" is the earliest known calculator. It stands alone as the one calculator of the ancients that is still used for counting today. Though five thousand years old the abacus is still popular in many parts of the world. Interesting contests have been staged to compare speeds of the abacus and operator with modern computer systems. There can of course be no reasonable comparison.

Period 1600-1900

Several persons are credited with advancing in the art of calculation and machines during this period. John Napier, a mathematician and co-inventor of logarithms, devised a computing rod device to simplify multiplication. Napier's rods were widely used during the seventeenth century.

Blaise Pascal in the period from 1647 to 1653 developed the first real calculating machine. It was based on the abacus, and had stylus-operated figure wheels so geared that a complete revolution of any wheel advanced the wheel to the left one number. This machine was limited to addition and subtraction.

About 1673, Gottfried Leibnitz designed a machine to perform multiplications by repeated additions. The machine was not completely reliable but the "stepped reckoner" principle which Leibnitz devised was continued in other multiplication machines.

The Arithmometer by Thomas de Colmar was developed around 1820. This first commercially practical calculating machine used the Leibnitz "stepped reckoner" principle.

Charles Babbage — difference engines

The South Kensington Science Museum exhibits the early calculating machine built by Charles Babbage (1792-1871). This is considered the forerunner of the modern computer, because Babbage's experiments laid down some of its principles. This machine was called a Difference Engine No. 1.

It often happens that a pioneer in science or engineering who has little effect on progress awakens more public interest than those whose work has far-reaching results. Charles Babbage (1792-1871) was such a person in the field of all-purpose digital computers. His machines were well-known more than a century ago but were later almost forgotten. Only when the work of Charles Babbage had been solved by other means did writers draw attention to the fact that he had clearly visualized the modern computer.

Finding many inaccuracies in tables of logarithms, Babbage devoted his life, his substantial income, and his thinking to make a machine which could calculate such tables. He was intent on making a machine that would build tables by the method of differences. Babbage's Difference Engine No. 1 was partially assembled in 1833 and is still in working order. The whole engine and his revisions for the Difference Engine No. 2 were never completed, primarily because Charles Babbage was constantly thinking of improvements and could not settle on a finished computer. The ideas for his Engine No. 2 led to a more effective machine called the "Analytical Engine" which was in effect a universal digital computer. Work on the Analytical Engine was continued after Charles Babbage's death, and it is now a museum curio.

The historical calculators 1930-1945

It was in this period that the first automatic calculators were developed. Most data processing people designate calculators as machines dealing with punched card input and calculations punched on the same card. Early definition of calculators were actually "multiplying punches." Machines prior to this time were only able to add and subtract figures — then multiplying and division were added.

The period 1945-1949

The first large scale computers were developed in university laboratories. The earliest, the ENIAC, came from the University of Pennsylvania. Europe's first computer, the EDSAC, came from the laboratories of Cambridge University in England. At this time the computers worked on scientific calculations.

The developments of 1950-1955

Most activity in the period from 1950 to 1955 centered around government and scientific use of computers. This was a true trial and error period, and many computers were built for a specific job. Changes in construction occurred frequently. Many "one of a kind" computers were used. Some favorable results were the ideas for present computer design, and some realization of the programming (or machine instruction) problem.

The activities of 1956-1960

This period was marked by the greatest advances in computer design, and considerable experimental use of computers for commercial applications. For example, the largest computer system in commercial use was installed in 1959 by an automobile manufacturer. In 1960 that same company began the replacement of the largest commercial computer with a newer system produced by the same equipment company. The newer computer system is more reliable, uses core storage and has completely transistorized circuitry. It requires less power, dissipates less heat, takes far less space, operates at higher speed and costs less.

The manufacturers, with heavy research budgets, developed computer systems which behaved better in the period between 1956 and 1960. Furthermore, more new computers and auxiliary computer equipment, both for on-line and off-line operation, were announced during this time than will probably ever be presented again.

The pioneer users in these years also found better ways to use the computer systems and improved techniques for instructing the computer. Major developments along this line are many, but a few should serve to demonstrate the users' findings. Magnetic tape was found to be the most desirable input-output to the larger computers, because magnetic tapes were the fastest and most reliable of all input-output devices. Magnetic tape began to replace long-standing master punched card files. Many skeptics felt this could not be done; others have demonstrated the many advantages of replacing master punched card files with magnetic tape files. A few reasons for this development should be sufficient to explain this trend: first, there is never any data "out-of-file"; second, there is no costly clerical handling of individual records; and third, magnetic tape records require two (2) file cabinets or less to equal the capacity of twenty punched card files. There are many other advantages to magnetic tape records.

The pioneers in this period developed many improvements in communication "by machine language" with the computers. Today there are several instruction media which reduce the efforts to tell the computers what to do. Programming has been simplified by first, a better understanding of computer behavior and second, a number of standardized programming or instruction methods. COBOL (Common Business Oriented Language), for example, is only one of these standardized computer instruction techniques. It can be said that, if the present pace of computer development continues, the overall performance of data processing systems will soon be increased more than one hundred times. The technology of computer systems for utilization and control is contributing most to this increase. Call it "know-how" if you like, but the better understanding of what a computer can do, and how it can best be used for business applications represents a highlight in the history of data processing systems. The pioneer users, often through trial and error, accomplished much ground work in this area from 1956 to 1960. These findings are of great importance and are available to future planners.

The period from 1956 to 1960 included the major conversion in construction from vacuum tube components to transistors, diodes, and magnetic cores. More improvements are to come in this area.

Computers today — time reduction

Computers are today solving problems for scientists that could not previously be accomplished because of the *time required.* Computers are fast. A comparative time required table illustrates this point:

The calculation of density and velocity of air at mesh points on an aircraft wing section, requiring 8,000,000 operations per solution.

Method	Time Required
Pencil and Paper	15 years
Desk Calculator	80 weeks
Early IBM 701 Computer	2 minutes
Intermediate Computer IBM 704	30 seconds
Intermediate Computer IBM 709	25 seconds
Current Computer IBM 7090	5 seconds

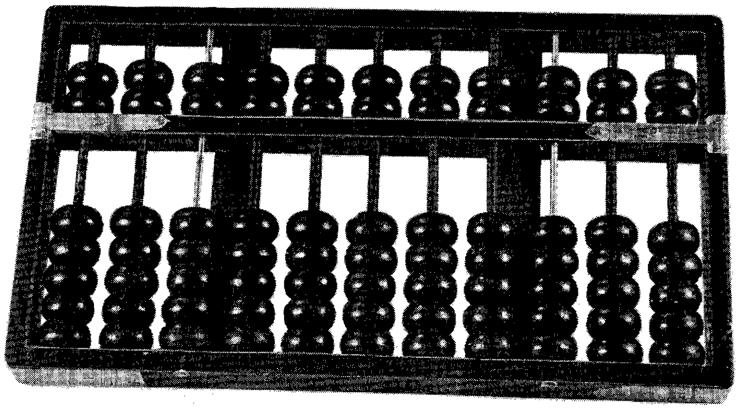
Another computer speed comparison was recently reported by the Navy on a relatively large computer. In this instance, one of the "world's first electronic computers, MARK I, was built for the Navy in the early 1940's. The machine was needed because people could no longer do what had to be done fast enough. The computer — when properly used — could. The MARK I has been operating for 17 years, three shifts a day. Now the Navy is installing a computer, the LARC, which is capable of performing every operation that MARK I did over the last 17 years in just 45 minutes." Speed, then, is a major element in the development of computers for today's requirements.

Data processing computers, and computer systems, are still in their infancy. The accomplishments of the period 1961 to 1970 will mark the greatest development in this fledgling industry. These problems will be resolved:

1. How to make a computer behave better; 2. How to talk to, or instruct, the computers with ease; and 3. How to put together a balanced computer system to fit the demands of business. These are not simple problems. The manufacturers and the pioneer users of computers readily agree that the decade ahead will be, historically, a most significant period.

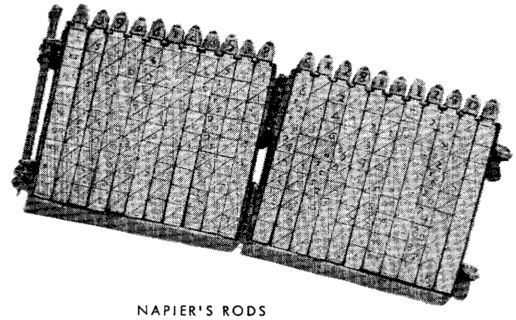
HIGHLIGHTS IN THE STORY OF THE CALCULATOR

From the Abacus to the Electronic Computer, every improvement in calculating devices has come in answer to the need for faster and more efficient means of counting.... releasing man from needless figuring and leaving him free to create.



ABACUS
c. 1200 ("Suan-pan") China

Calculator of antiquity which historians trace vaguely to Egypt, India and **Mesopotamia**

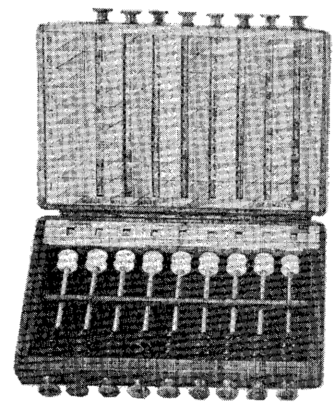


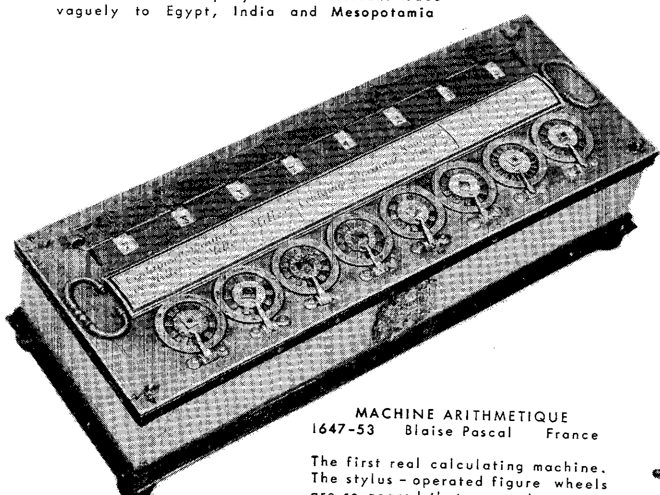
NAPIER'S RODS
1617 John Napier Scotland

Mathematician and co-inventor of logarithms, Napier devised these computing rods to simplify multiplication. They were widely used **during the seventeenth century.**

POCKET CALCULATOR
c. 1800 **France**

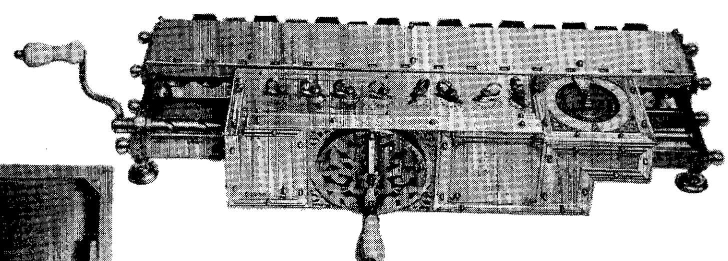
Combination of Chinese **Abacus** and mechanized Napier's **rods.**





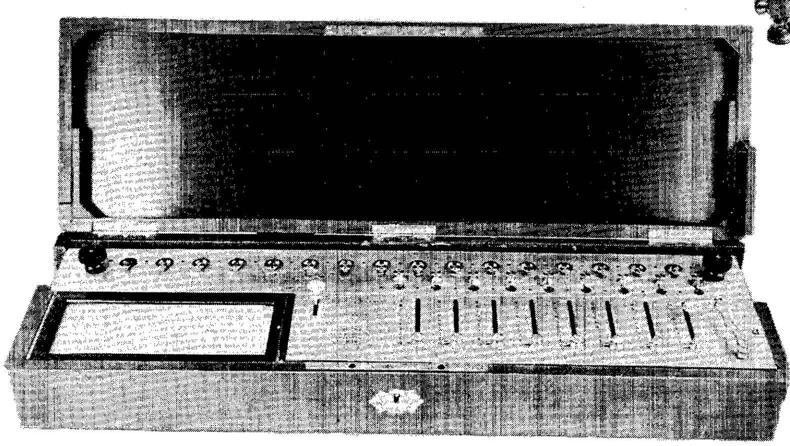
MACHINE ARITHMETIQUE
1647-53 Blaise Pascal France

The first real calculating machine. The stylus - operated figure wheels are so geared that a complete revolution of any wheel advances the **wheel to the left one number. It is limited to addition and subtraction.**



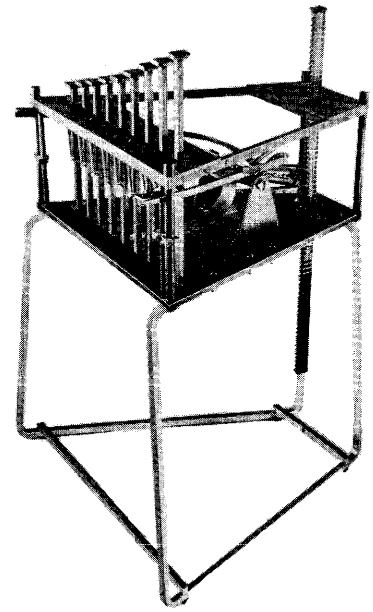
RECHENMASHINE
1673 Gottfried Leibnitz Germany

Designed to perform multiplication by rapidly repeated addition. The mechanism was not completely reliable, but the "stepped reckoner" principle which Leibnitz devised was used in the Thomas and other calculators.



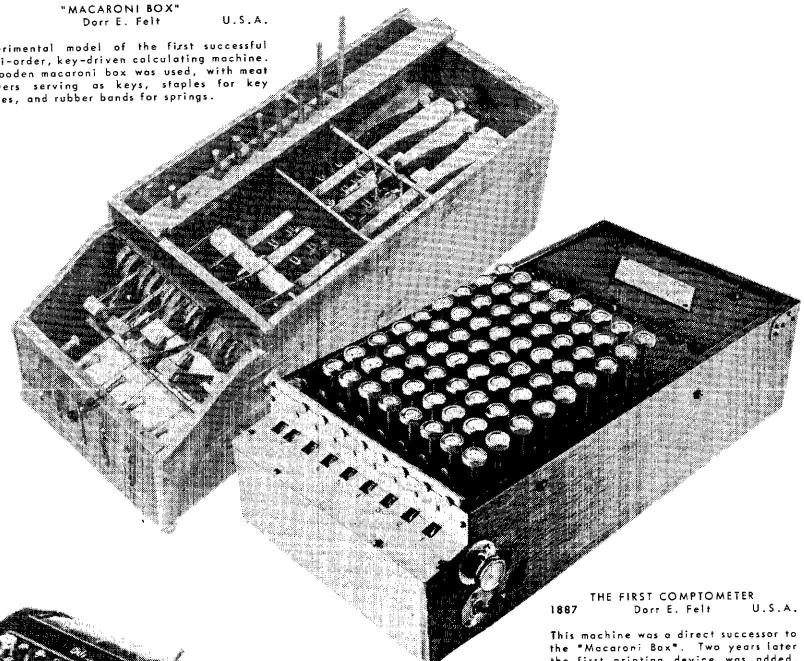
ARITHMOMETER
1820 Thomas de Colmar France

This first commercially practical calculating machine used the Leibnitz "stepped reckoner" principle. Its manufacture was made possible by the new machine methods of the Industrial Revolution.



"MACARONI BOX"
1885 Dorr E. Felt U.S.A.

Experimental model of the first successful multi-order, key-driven calculating machine. A wooden macaroni box was used, with meat skewers serving as keys, staples for key guides, and rubber bands for springs.

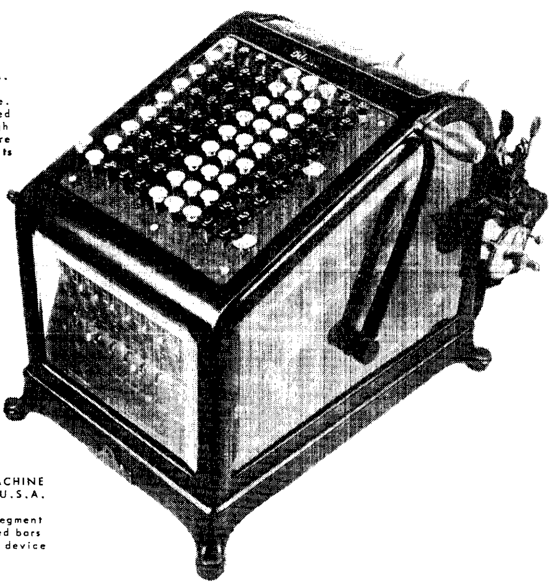


THE FIRST COMPTOMETER
1887 Dorr E. Felt U.S.A.

This machine was a direct successor to the "Macaroni Box". Two years later the first printing device was added.

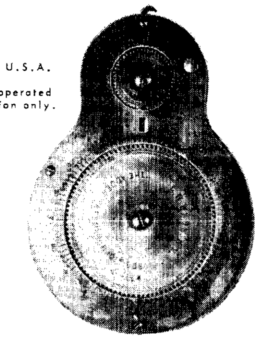
CALCULATOR
1850 Parmalee U.S.A.

The first keyboard adding machine. Readings are taken from the calibrated vertical shaft which is raised through the top of the case when the keys are depressed. Only one column of digits can be added at one time.



THE ADDER
1868 Webb U.S.A.

A pocket size stylus - operated counter useful for addition only.

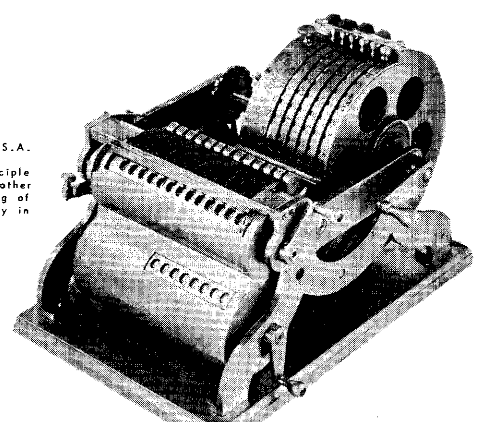


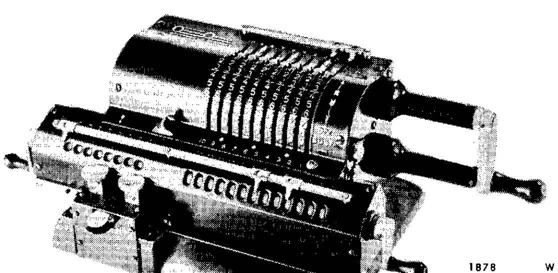
BURROUGHS ADDING AND LISTING MACHINE
1890 W.S.Burroughs U.S.A.

This machine operates on the rocking segment principle and employs a series of pivoted bars with toothed racks at either end, and a device for printing.

BALDWIN
1872-75 F.S.Baldwin U.S.A.

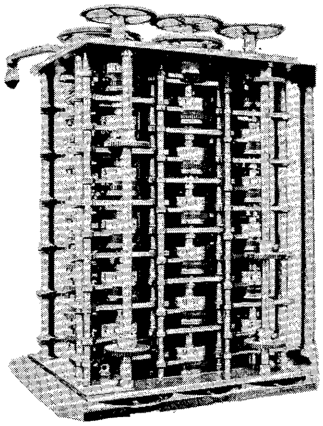
The Baldwin variable-cogs principle was incorporated into numerous other makes. This marked the beginning of the calculating machine industry in the United States.





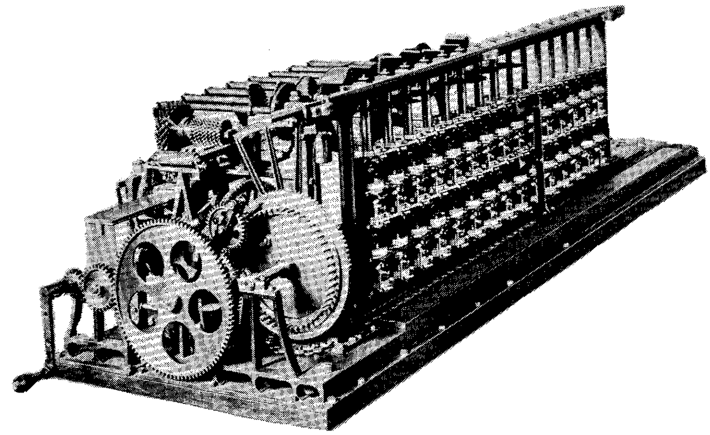
ODHNER
1878 W. T. Odhner Sweden

The principle was basically the same as that of the Baldwin, and was used in many different makes of European manufacture including the Brunsviga.



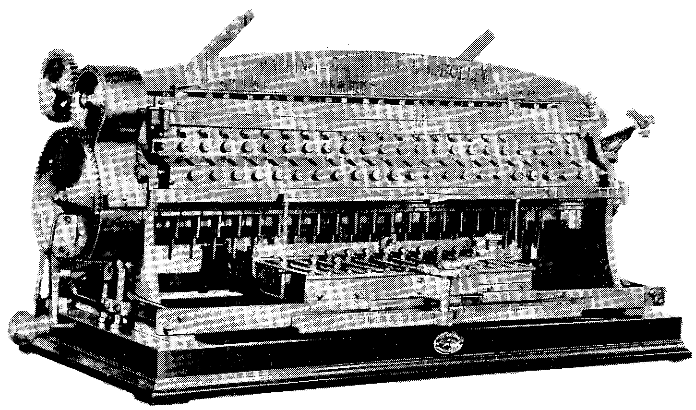
DIFFERENCE ENGINE
1823-33 Charles Babbage England

The idea for a Difference Engine that would compute mathematical tables, such as logarithms, was first conceived by Babbage in 1812. After twenty years of labor financial difficulties compelled him to stop work and the machine was never completed.



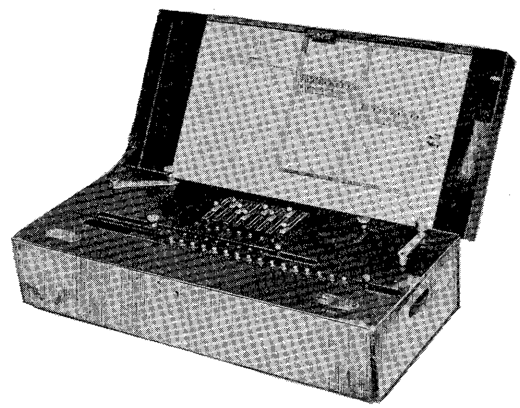
THE SCHEUTZ DIFFERENCE ENGINE
1834-53 Sweden

George Scheutz, aided by his son, was more fortunate than Babbage, in that he completed his Difference Engine. Patterned after the Babbage machine, he built several models and finally perfected one which was used to compute and print English Life Tables.



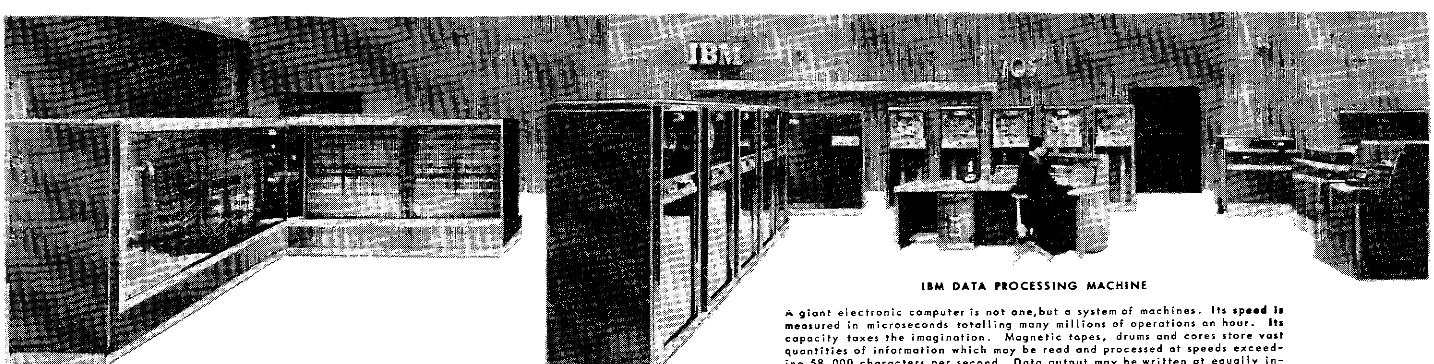
MACHINE A CALCULER
1889 Leon Bollee France

The first calculating machine to perform multiplication by the direct method and not by repeated addition. It was never produced commercially because of Bollee's greater interest in racing automobiles.



THE MILLIONAIRE
1892 Otto Steiger Switzerland

The first successful multiplying machine. Using tongued multiplication plates similar to those invented by Bollee, the Millionaire was more compact and enjoyed wide sale.



IBM DATA PROCESSING MACHINE

A giant electronic computer is not one, but a system of machines. Its speed is measured in microseconds totalling many millions of operations an hour. Its capacity taxes the imagination. Magnetic tapes, drums and cores store vast quantities of information which may be read and processed at speeds exceeding 58,000 characters per second. Data output may be written at equally incredible speed on magnetic tapes or printed at a rate of 1,000 lines a minute.

Computers

INTRODUCTION TO ELECTRONIC DATA PROCESSING EQUIPMENT

THE MODERN ELECTRONIC COMPUTER is a new and complex device which, in common with other major inventions, has arisen out of a definite need and stimulated an ever widening circle of potential uses. The very real need which was met by the development of electronic computers was that of a means to accomplish the massive scientific calculations of the present era beginning in World War II, in fields such as nuclear physics, meteorology, oceanography, and missiles. The use of computers has since been expanded throughout almost the entire breadth of business data processing and into the social sciences, notably linguistics and economics.

In the business field, there is much evidence to show a depth of computer usage which is impressive in its own right. Information retrieval projects, simulation, critical path scheduling and gaming are some examples; among others which might be cited are new concepts of central computer installations linked to field offices through new data transmission equipment.

Similarity of electronic computers

A considerable array of computing and related equipment is available, and is being augmented constantly by newer machines. Yet, all of the computers in this volume are remarkably similar in their organization, consisting of input equipment (such as card readers, paper tape readers, magnetic tape units, and console keyboards) used to get instructions and data into the machine; a central processor (in some cases, more than one), containing some sort of data storage device (a magnetic drum, a group of vacuum tubes, an array of magnetic cores, or the like), circuitry to perform arithmetic operations (chiefly variations of pure addition), and control circuitry to interrogate and implement the instructions held in storage; and output devices (such as card punches, paper tape punches, magnetic tape units, and line printers) to get the results out of the central processor.

Programming

The task of programming a general purpose, digital electronic computer is also much the same, regardless of the specific machine involved. In general, the steps involved include a painstaking study of a present system, the overall design of a new system, the exploding of the resulting general flow chart into more and more detailed block diagrams, the coding of the blocks into either a primary or pseudo machine language, and exhaustive testing of the program against both theoretical and real data. These steps often require many weeks or months of effort, depending on the complexity and size of the task and the abilities of the programmers.

Effects on organization

Another aspect of electronic computers which is relatively common, regardless of the specific machine, is the effect of the computer on the organization. Since the costs of a new computer installation are considerable, there is an incentive to try for a maximum utilization of the machine's capabilities. Because the computer's storage capacity, operational speed, and logical capabilities are much greater than any previous device, the quest for maximum utilization leads to an abandonment of the piecemeal, applications approach, common to punched card operations, in favor of a systems approach. Since the systems approach usually involves most facets of a company's operations, a certain amount of reorganization and realignment of tasks often occurs.

Logical operations

Mention was made earlier of the logical capabilities of electronic computers. In essence, this means that a computer can compare two numbers and find whether the first is greater than, equal to, or less than the second; or can examine the result of an operation to determine whether it is plus, zero, or minus. Only a few milliseconds or microseconds are needed to perform such a logical operation. Stated in this way, it all seems simple and unimpressive. Indeed, one of the features of computer programming is the need to combine very simple operational steps into a complex routine which accomplishes the desired end result in the most efficient manner. The power of a simple logical operation is not alone in the operation itself, but in the fact that the result may in turn be examined to determine which of two or more different instructions will be performed next by the computer. Thus, the results of logical operations serve as switches which control the path the computer takes as it processes the data.

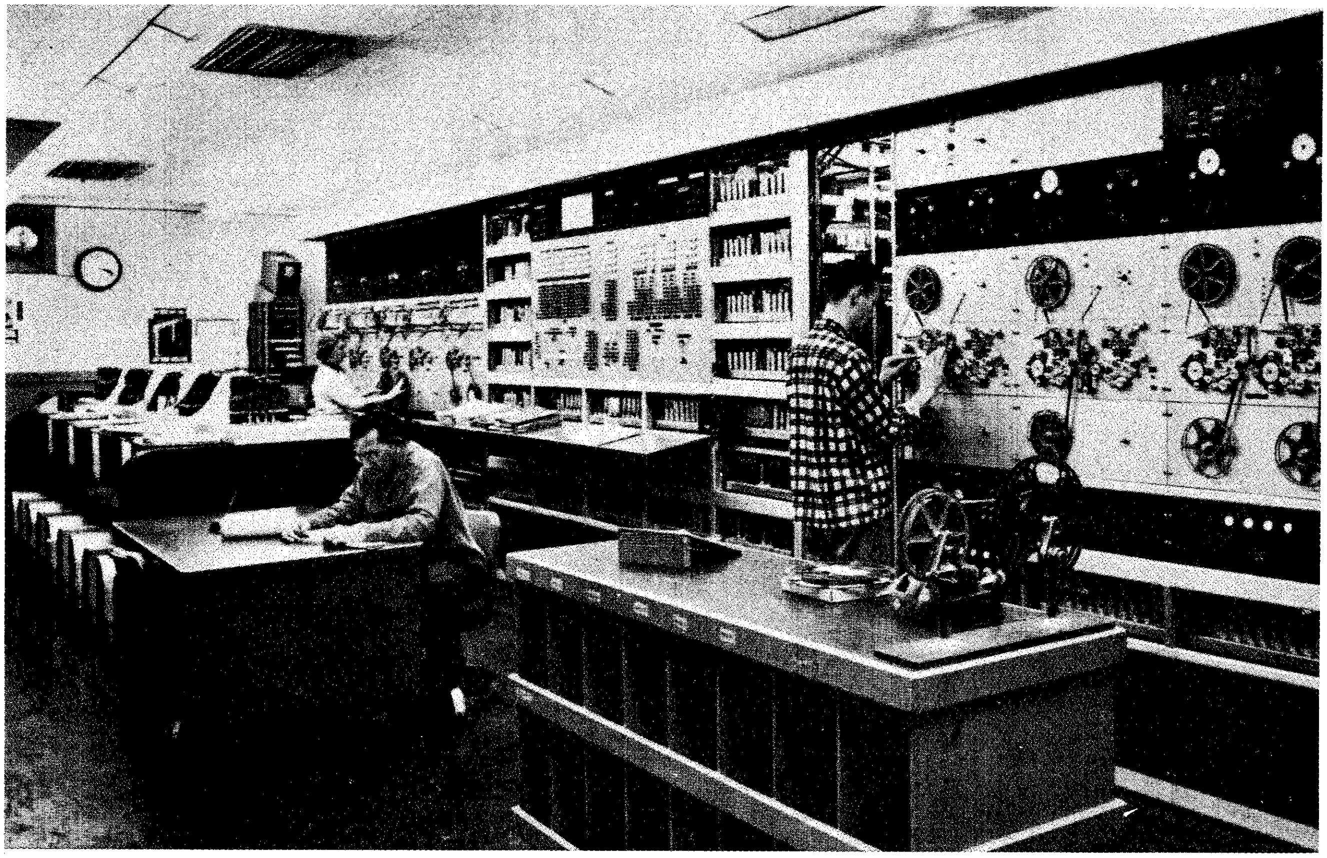
An example

As an example of the use of a logical operation, let us assume that an order processing, inventory control, and billing system has been designed for a computer. When a customer places an order, one of the questions which should be asked is whether or not he is a satisfactory credit risk. This can be done by deciding what the maximum amount of credit will be that he is allowed at any one time. We might say that the credit limit for our hypothetical customer is $1,000. When we receive an order from him, then, we want to know whether the new credit balance (what he owed us before plus what he is ordering now) exceeds $1,000.

We know the computer can add, so arriving at his new credit balance will be easy. To check this against his credit limit, the computer would find the limit data ($1,000) in his master account record and compare it to the new balance. If the latter were $1,000 or less, the result of the comparison might be a zero balance, a plus balance, an "equal" switch setting, a "greater than" switch setting, or some other predictable machine state, depending on the machine and the programming method used; and a subsequent instruction, investigating this machine state, might send the computer off along a path which will process the order. If the new balance has exceeded the $1,000 limit, the machine state following the logical operation will be different, and the computer can be sent into a different part of the program — one which, for instance, prints out all the necessary information for a review of the customer's credit history.

While this is a kindergarten-level example of a logical operation, it does indicate the great versatility of the electronic computer. It is this versatility, even more so than speed of operation, which is making the greatest impact of the computer on the business and scientific world, and which holds the most challenging promise for the years to come.

ADEC HARVARD UNIVERSITY



ADEC was an early (January, 1951), one-of-a-kind magnetic drum computer using magnetic tape input and output. It was used by the U. S. Navy for ballistics and other scientific calculations and was a vacuum-tube type computer. ADEC was dismantled in 1957.

SYSTEM COMPONENTS

General

Numeric Characters Per Word: 16 plus sign.
Character Code: Binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 30 kilocycles.

Central processor

Operation: Sequential, fixed point.
Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	4.4
Multiply:	13.2

Checking features: Dual tape writing; character validity check; parity check on instruction words.

Memory

Four magnetic drums of varying capacities and speeds are used for storage of (1) constants; (2) variables, (3) ten to twenty words per access, and (4) instructions. Total memory capacity on these four drums is 8,350 sixteen decimal digit words.

INPUT MEDIA

Input is by magnetic tape at five words per second. Eight tape units are used.

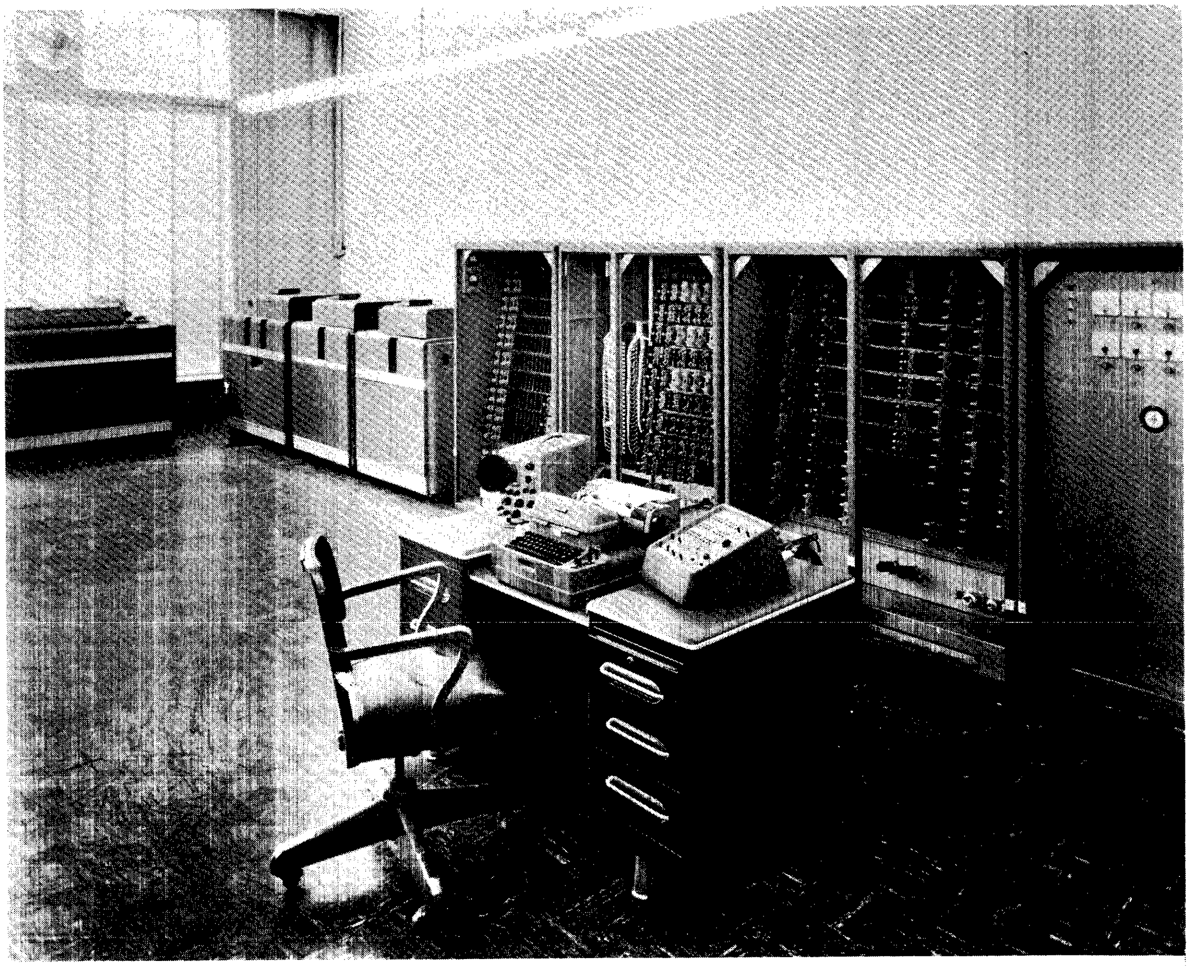
OUTPUT MEDIA

Output is by magnetic tape at five words per second. Off-line printing from these tapes is available. Eight tape units are used.

PROGRAMMING

General: ADEC uses a three-address type instruction. Instructions are stored separately from problem data. An instruction tape preparation machine automatically inserts certain subroutines.
Instructions:
Number of instructions per word: 1.
Number of digits per instruction: 16 (decimal).
Total number of operation codes: 13.

ALWAC III-E EL-TRONICS, INCORPORATED



THE BASIC ALWAC III-E SYSTEM consists of the central processor and a control console (comprising a control panel, a Flexowriter, and an oscilloscope display unit). The basic system may be expanded by the addition of a magnetic tape buffer unit, up to 16 magnetic tape units, a punched card input-output system, and an off-line printing system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 32 bits plus sign.
Numeric Characters Per Word: 8 hexadecimal (equivalent to more than 9 decimal).
Alphabetic Characters Per Word: 5
Character Code: 6-bit binary coded decimal (alphabetics).
4-bit hexadecimal (numerics).
Timing: Synchronous.
Pulse Repetition Rate: 67 kilocycles.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory):

	Time (milliseconds) Fixed point
Add: 555555 to 555555	1.6
Multiply: 555555 by 5555	17.0
Divide: 3086108025 by 5555	18.0

Access time: 4.25 milliseconds (working storage).
8.50 milliseconds (general storage).

Checking features:

Automatic checking of all block transfers to and from memory.
Overflow alarm.
Zero divisor alarm.

Registers

A register: 32 bits plus sign—holds the results of arithmetic operations.

B register: 32 bits plus sign—extension of A register for use in double-length work; can also be addressed and used independently.

D register: 32 bits plus sign—holds multiplicand and divisor; can also be addressed independently.

E register: 16 bits—used as index register and to expedite automatic address modification.

Memory

The basic magnetic drum memory has a storage capacity of 4,096 words. An optional model with a capacity of 8,192 words is available. Four rapid access working storage channels of 32 words each are standard.

Control panel

This unit contains switches and indicators by which the operator can control the various machine functions and observe the contents of the main registers. Associated with the control panel is an oscilloscope display unit which is used to display the contents of any register or word location on the magnetic drum.

INPUT MEDIA

Magnetic tape buffer

This unit serves as an intermediate storage and control device for information which is transferred between the central processor and the magnetic tape units.

Magnetic tape unit

Maximum number per system: 16.
Packing density: 175 characters per inch.
Number of channels: 7.
Record length: Fixed, 32 words.
Record gap: 0.2 inches.
Tape speed: 120 inches per second/21,000 characters per second.
Rewind time: 1 minute (approx.).
Start-stop time: 10 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
  Composition: Mylar.
  Length: 2,300 feet.
  Width: ½ inch.
Error detection: Even parity check for each character.

Flexowriter

This unit is similar to an electric typewriter with paper tape reader and punch attachments. It is used as direct input-output to the system. The paper tape reader, paper tape punch, and typing element operate at a rate of 10 characters per second.

Punched card input-output system

This system consists of a card converter unit, a card read-punch unit, and an accounting machine. The card converter is used to translate and transfer information between the card read-punch unit and the central processor or between the central processor and the accounting machine. The card read-punch unit reads and punches 80-column cards at the rate of 100 cards per minute. Editing and format control is provided by a plugboard in the card read-punch unit. The read-punch unit is available in two models. The standard model provides simultaneous read and compute and simultaneous punch and compute. The dual model provides simultaneous reading and punching while computing. Available as an optional feature is the ability to read multiple punches in each card column and convert these punches into their binary equivalents. The accounting machine can be used as an on-line printer or as a conventional off-line accounting machine.

Punched paper tape input-output system

This system consists of a paper tape read-punch unit and a paper tape buffer. The paper tape reader is a photoelectric device which reads six level punched paper tape at the rate of 200 characters per second and introduces the data directly into the central processor. The paper tape buffer provides for simultaneous reading and punching while computing. The paper tape punch converts the output of the central processor to six level punched paper tape at the rate of 60 characters per second.

OUTPUT MEDIA

Magnetic tape, punched cards, punched paper tape, and flexowriter

As previously described.

AUXILIARY COMPONENTS

Off-line printing system

This system consists of a printer buffer, a magnetic tape unit, and a 150 line per minute or a 600 line per minute line printer. Editing and format control are provided through plugboards.

PROGRAMMING

General: The ALWAC III-E uses a single address type of instruction.

Instructions:

Number of instructions per word: 2 (capable of 3 or 4 nonaddress instructions).
Number of digits per instruction: 4.
Total number of operation codes: 90.

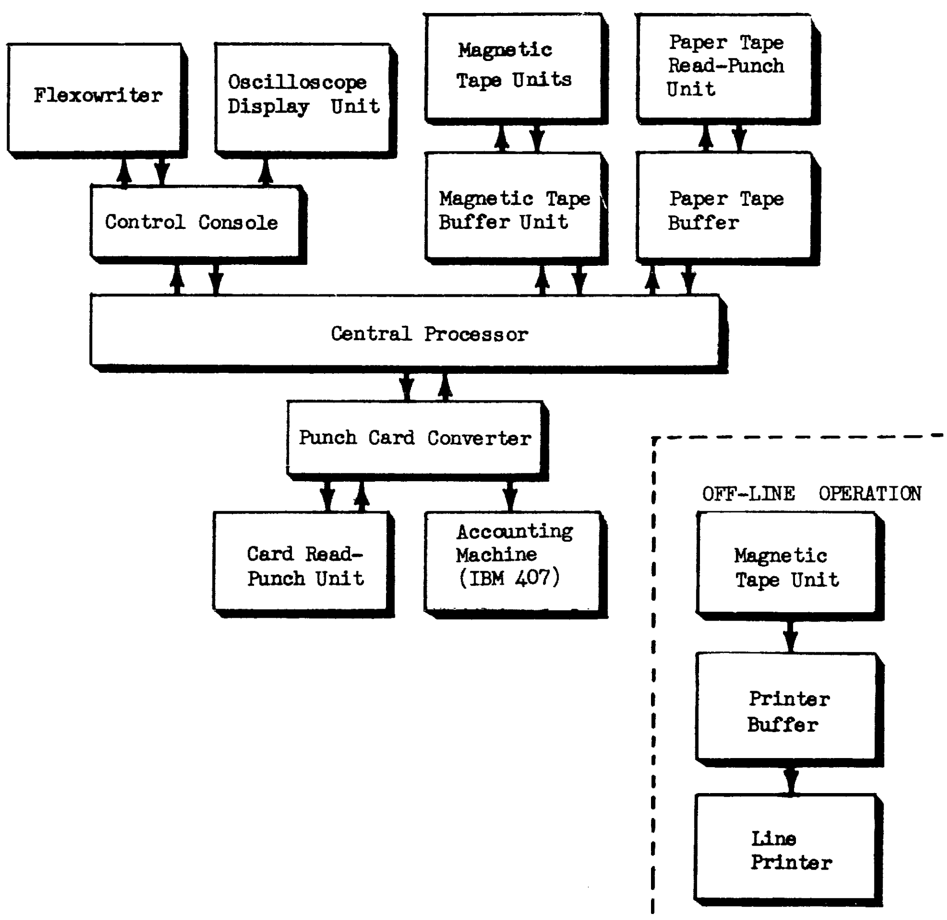
Instruction word format

1—8	9—16	17—24	25—32	Sign
Operation	Address	Operation	Address	
◄ First command ►		◄ Second command ►		

Cost, Power Requirements, and Physical Characteristics

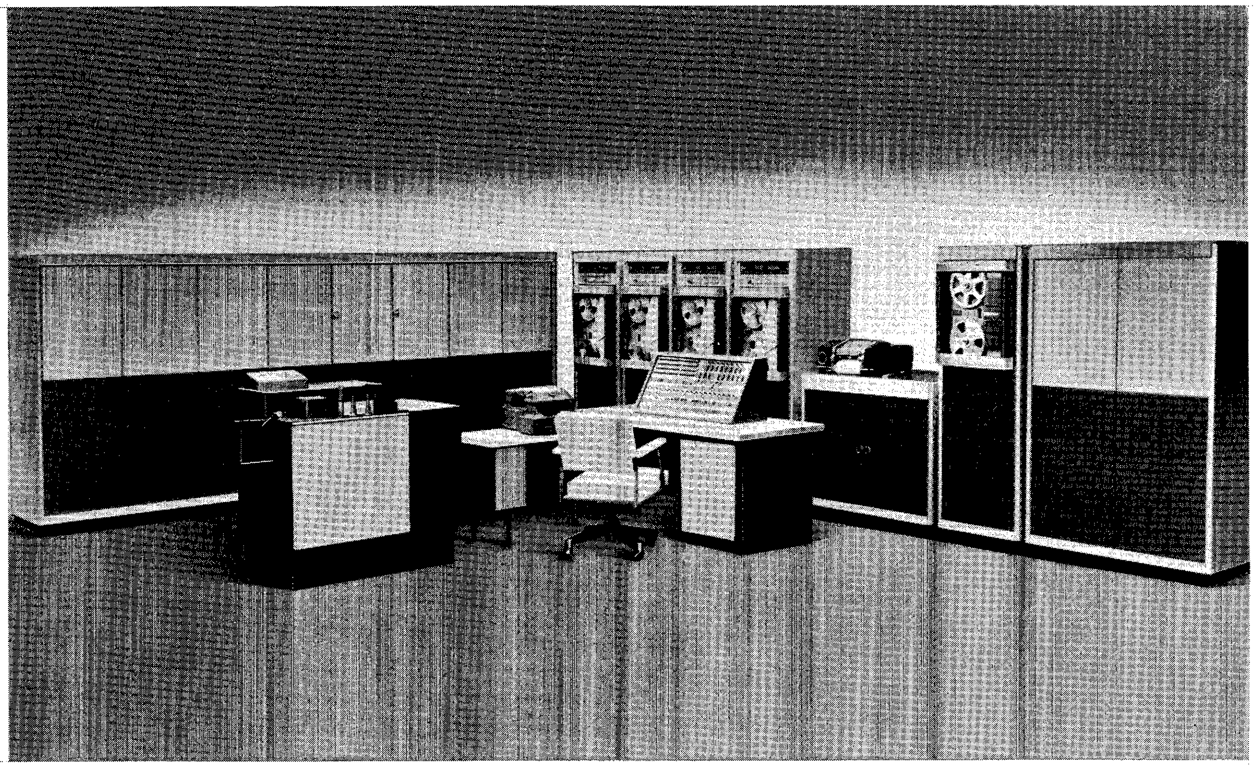
Item	Rent/mo.	Purchase	Maintenance (*)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Central Processor with 4,096 word memory	$2,510	$73,000		136x29x68	2,690	5.0	23,000
Central Processor with 8,192 word memory	2,660	79,000		136x29x68	2,690	5.0	23,000
Magnetic Tape Buffer	580	21,000		37x29x68	650	2.5	8,500
Magnetic Tape Unit	550	18,000		24x29x68	550	2.0	3,800
Punched Card Input-Output System (Standard)	650	24,750		40x29x68	600	6.0	20,500
Punched Card Input-Output System (Dual)	950	33,000		40x29x68	600	6.0	20,500
Punched Paper Tape Input-Output System (Including)				36x19x38	175	0.3	875
Paper Tape Read-Punch	290	10,950					
Paper Tape Buffer	750	26,200					
Printer Buffer	1,890	76,000		55x29x67	875	6.0	26,000
Line Printer	1,100	39,950		36x29x48	2,555	1.2	5,000

* Maintenance included in rental price. Separate maintenance contract available for purchased equipment.



BLOCK DIAGRAM OF ALWAC III-E

A-M 900 ADDRESSOGRAPH-MULTIGRAPH CORPORATION



THE A-M SERIES 900 is a medium-to-large size system designed primarily for large volume file maintenance operations. It consists of a central processor with magnetic core memory and control console, and input-output devices handling magnetic tape, punched cards and punched paper tape. The system employs solid-state circuitry.

SYSTEM COMPONENTS

General

Character Code: Binary coded decimal.
Timing: Simultaneous read-write-compute.

Central processor

Checking features: Internal checking is programmed.

Memory

Magnetic core storage is used for data only, and is available in modules of 360, 1,024 and 1,600 positions.

Control console

The console includes display and indicator lights, and a supervisory typewriter which is used for error type-out and manual entry of data into the system.

INPUT MEDIA

Principal means of both input and output is magnetic tape. Punched card and punched paper tape readers are also available.

Magnetic tape units

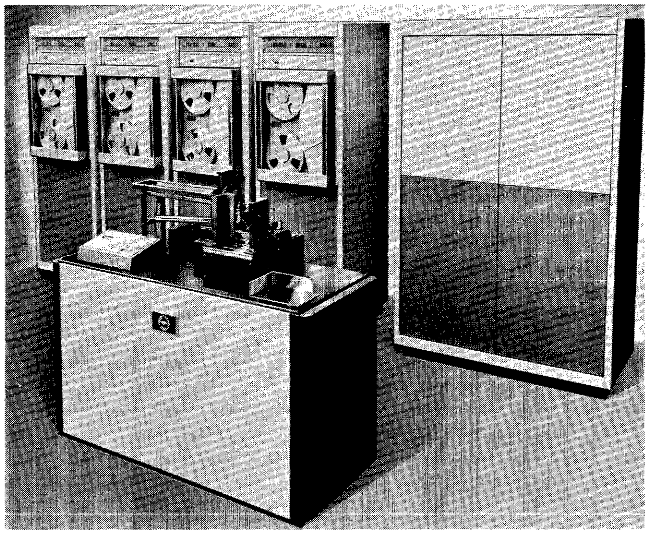
Maximum number per system: Indeterminate. Up to twelve units may read into or write from the main memory simultaneously.
Packing density: 300 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 75 inches per second/22,500 characters per second, and 150 inches per second/45,000 characters per second.
Rewind time: 2,400 feet per minute.
Physical characteristics of tape:
Composition: Mylar.
Length: 2,400 feet.
Width: ½ inch.
Error detection: Longitudinal and vertical parity checks; read following write.

Punched card reader

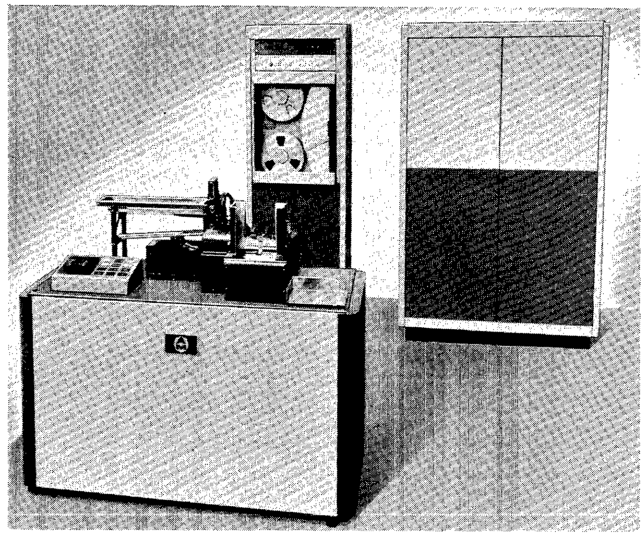
This unit operates at 500 cards per minute, and may be associated with the magnetic core memory for direct, on-line entry from punched cards, or with a magnetic tape unit for off-line conversion at higher speeds from punched cards to magnetic tape.

Paper tape reader

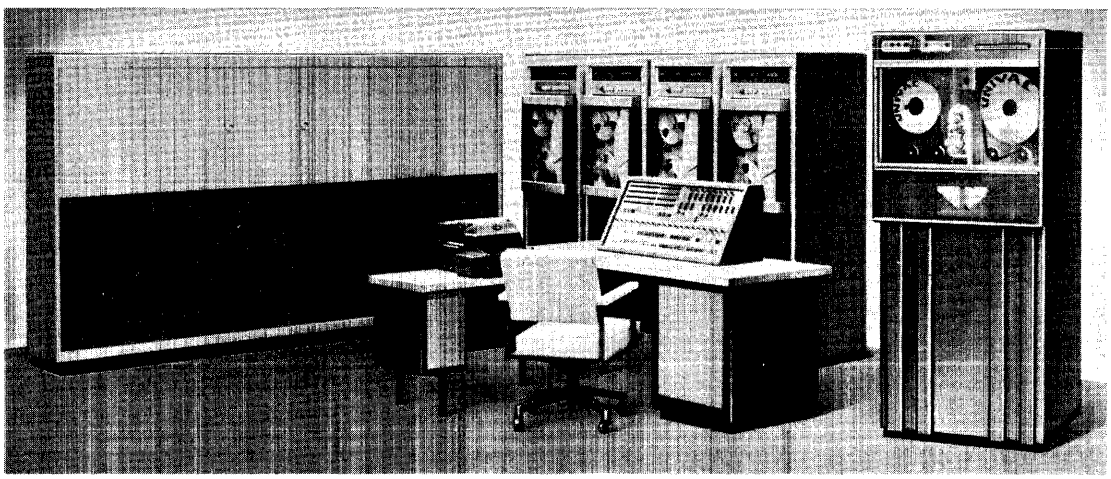
This is a separate unit which is capable of reading five- to eight-channel tape on-line.



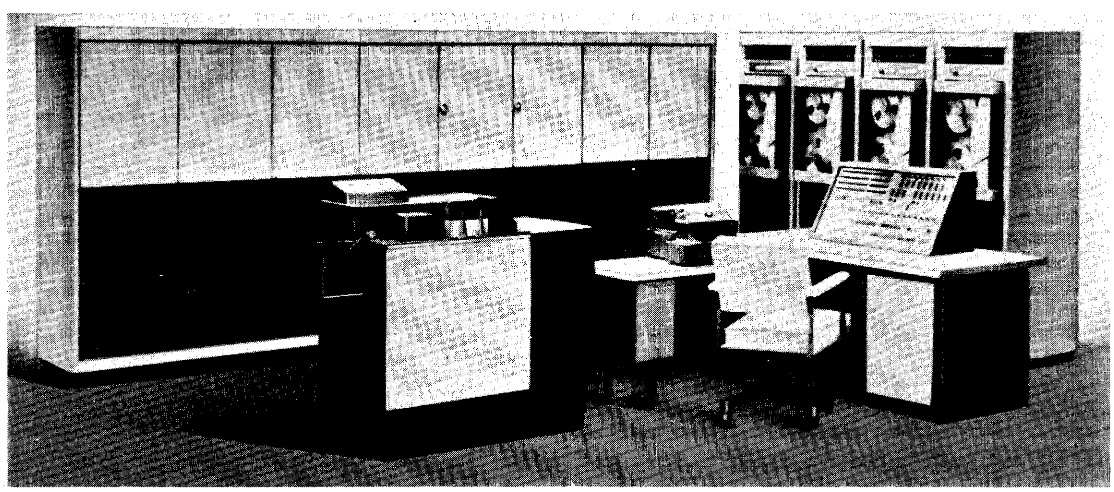
CARD TO MAGNETIC TAPE CONVERTER



CARD TO MAGNETIC TAPE EDITOR-CONVERTER MODEL 941



MAGNETIC TAPE EDITOR-CONVERTER MODEL 942



ELECTRONIC FILE PROCESSOR MODEL 943

Electric typewriter

Part of the control console, the electric typewriter may be used for manual entry of data into core storage.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Electric typewriter

As previously described.

AUXILIARY COMPONENTS

Line printer

This unit is available off-line for printing from magnetic tape at 900 lines per minute. Line character capacity may be 48, 72, or 120 characters. The printer is plugboard controlled, utilizes its own magnetic core storage, and performs editing and reordering functions.

Multi-stylus serial printer

This is an off-line unit used to prepare names and addresses of up to six lines at the rate of 45,000 names and addresses per hour.

Card to magnetic tape converter

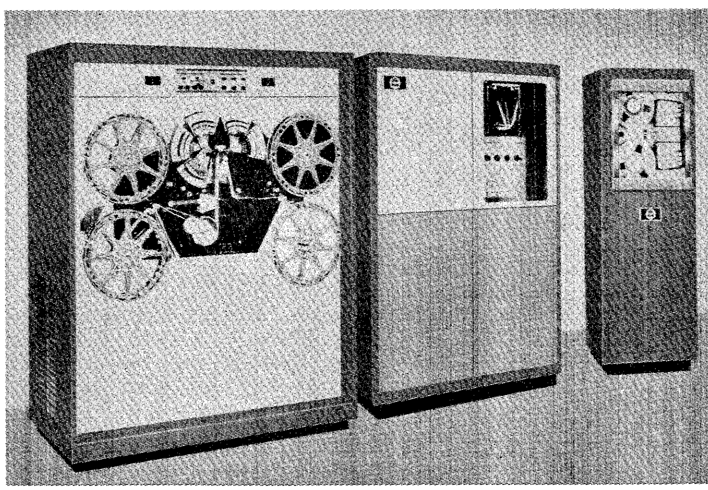
Conversion is performed off-line with this unit at up to 1,000 cards per minute.

Magnetic tape to magnetic tape converter

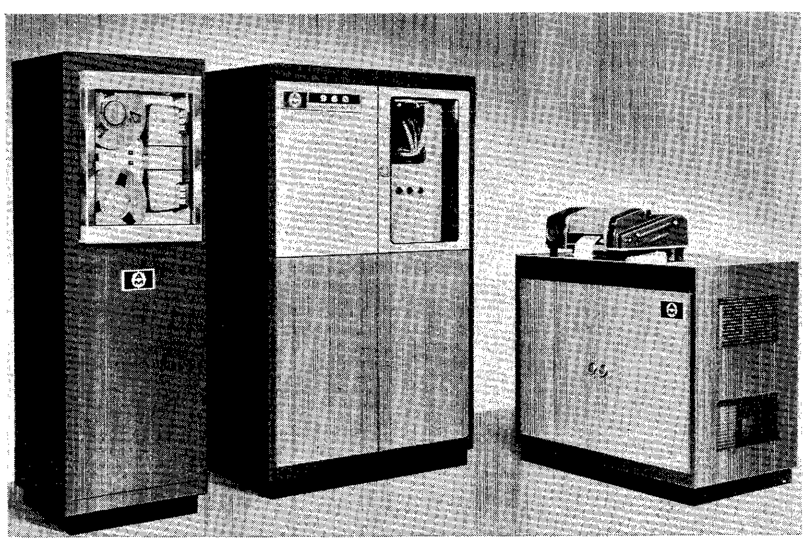
The A-M Magnetic Tape Editor-Converter converts output tapes from other electronic data processing systems to a form compatible with A-M Electronic Printers and the central processor.

PROGRAMMING

General: All programming of the A-M 900 is by externally-wired plugboard.

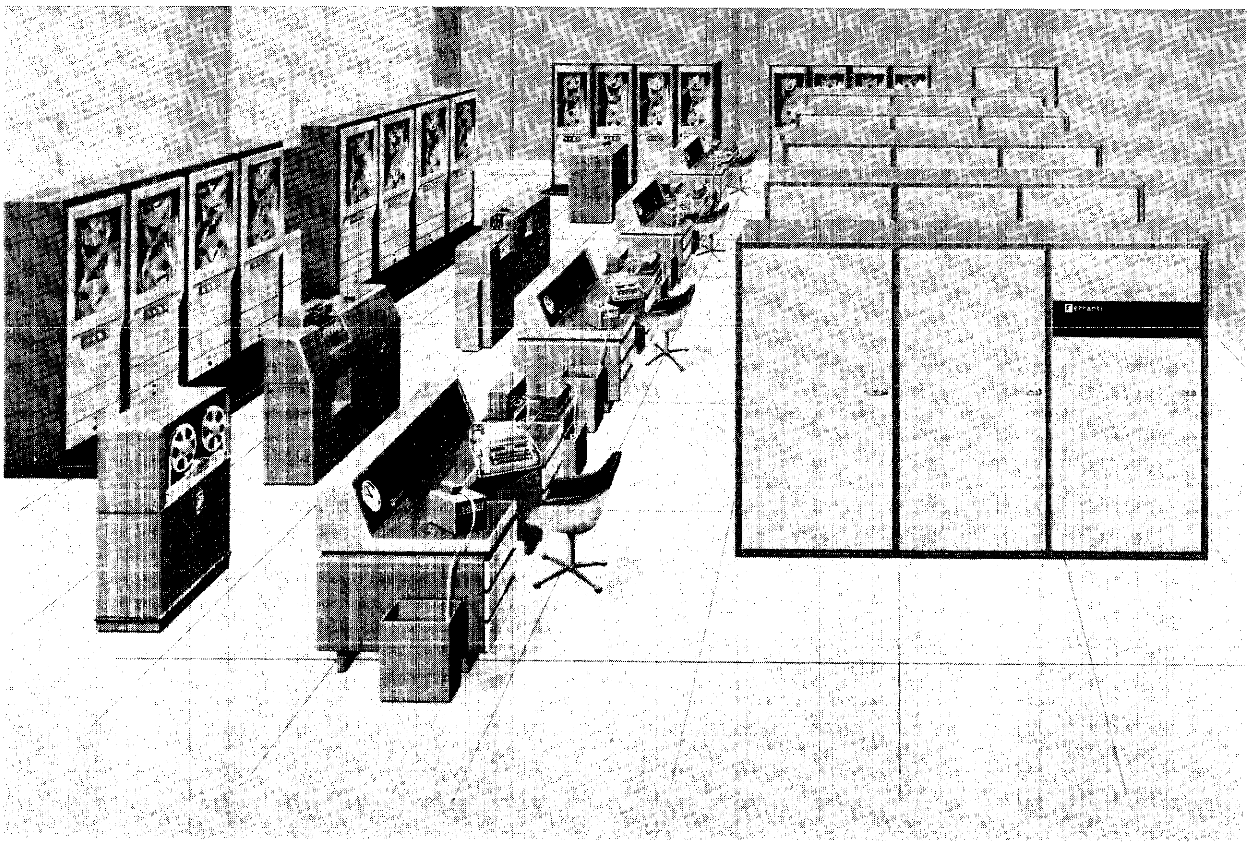


MULTI-STYLUS SERIAL PRINTER MODEL 950



HIGH SPEED LINE PRINTER MODEL 960

ATLAS FERRANTI ELECTRIC, INC.



ATLAS is a very large, transistorized, general purpose computing system, used for both scientific and business applications.

SYSTEM COMPONENTS

General

Word Length: 48 bits.
Character Code: Alphanumeric, 6 bits per character.

Central processor

Operation: Parallel; fixed and floating point.
Computation speed:

	Average time (milliseconds) Fixed point and floating point
Add:	.0011
Multiply:	.0035
Divide:	.0060

Access time: Main memory, 2 microseconds; special subroutine store, .2 microseconds.

Registers

128 index registers.

Memory

Magnetic core: This comprises the main memory, and is available in any capacity from 16,394 words, in modules of 4,096 words.

Magnetic drum: Any number of 24,576-word capacity magnetic drums may be used.

Fixed store: This special memory section is constructed of ferrite rods and has a minimum capacity of 4,096 words. It is used to store subroutines.

Magnetic disk storage can be attached.

The address system provides for up to 2,000 words, located in the core, drum, and fixed stores.

INPUT/OUTPUT MEDIA

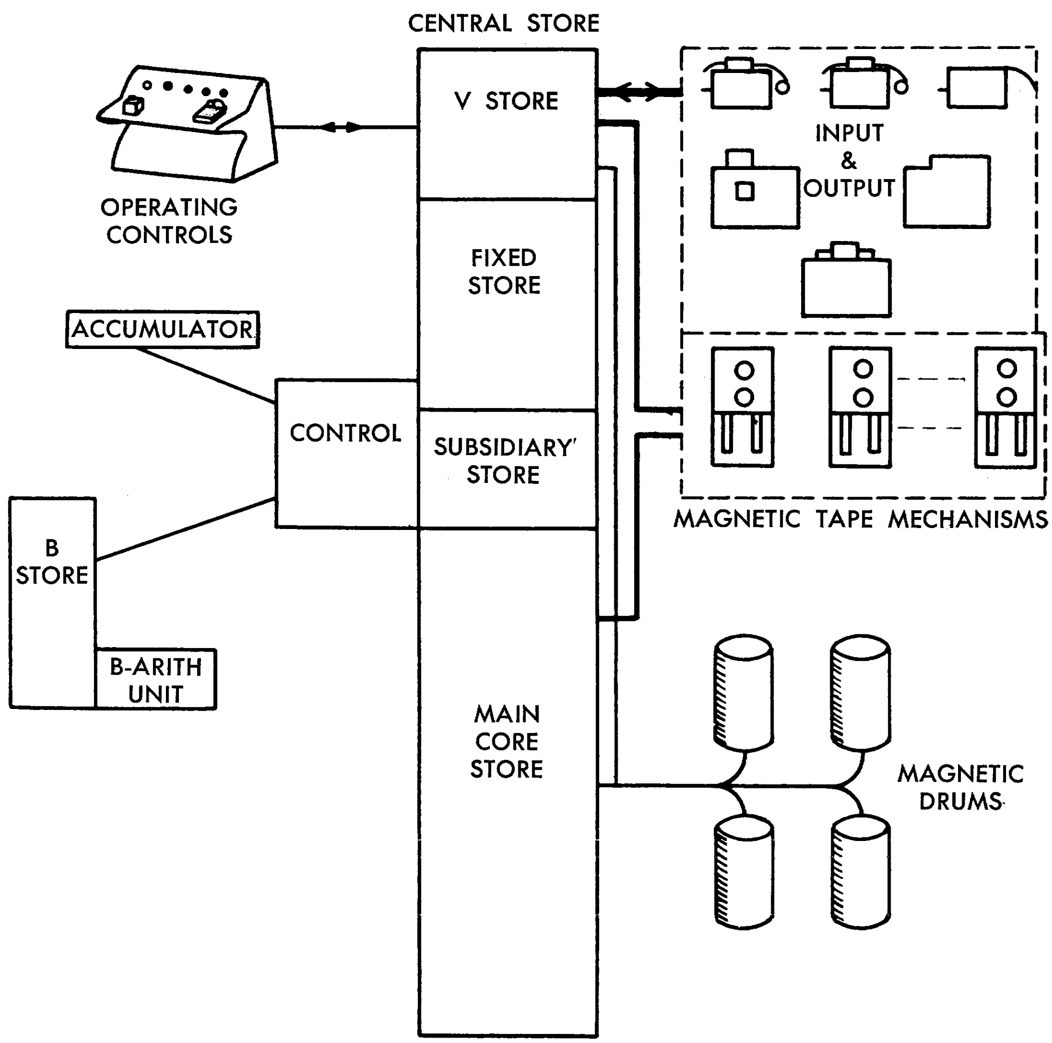
Magnetic tape units

Maximum number per system: 32 (up to eight control units, each with as many as four Ampex FR-300 tape units).
Packing density: 300 digits per inch on each of 12 information channels.
Number of channels: 16.
Tape speed: 11 microseconds per word.
Tape width: 1 inch.

Also available to the system can be any number of any type input or output unit, including punched card readers and punches, paper tape readers and punches, and line printers.

PROGRAMMING

Including subroutine instructions, there are over 300 instructions used with the ATLAS computer. About 200 of these instructions are concerned with a prepackaged "Extracode" system held in the fixed (ferrite rod) store. The machine provides time-sharing through a priority system.



BLOCK DIAGRAM OF ATLAS

AVIDAC ARGONNE NATIONAL LABORATORY

AVIDAC is one of several general scientific machines patterned after the early IAS (Institute for Advanced Study) computer. It is of vacuum tube construction and is designed for paper tape input and output.

SYSTEM COMPONENTS

General

Word Length: 40 bits.
Character Code: binary.
Timing: Asynchronous.

Central processor

Operation: Parallel, fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.05
Multiply:	1.60
Divide:	1.60
Access time:	.035

Checking features: All codes must contain coded check routines as an operational policy at this installation (optional).

Memory

Media: electrostatic (CRT).
Words: 512.
Digits: 40 per word.
Access: 35 microseconds.

INPUT MEDIA

Paper tape reader (Ferranti), at 200 characters per second.

OUTPUT MEDIA

Paper tape punch, at 30 characters per second.

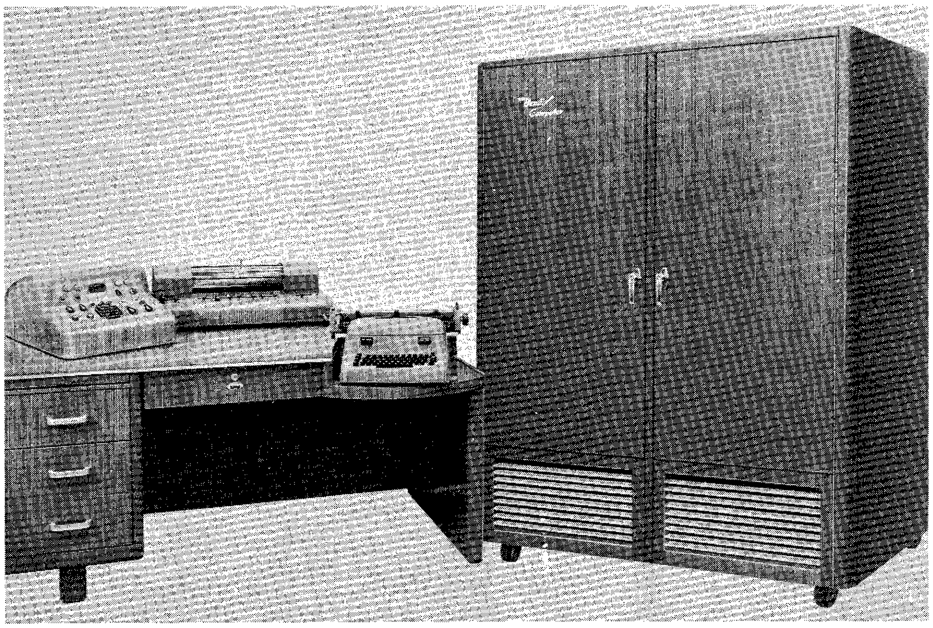
PROGRAMMING

General: AVIDAC uses a one-address type instruction.

Instructions:

Number of instructions per word: 2.
Number of digits per instruction: 20.

BENDIX D-12 BENDIX CORPORATION



THE BENDIX D–12 is a digital differential analyzer of vacuum-tube construction. It is no longer in production except by special order. Arithmetic mode is serial.

SYSTEM COMPONENTS

General

Word Length: 8 decimal digits.
Character Code: Binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 200 kilocycles per second.

Central processor

Operation: Sequential.
Computation speed: Add time (excluding storage access) is 43 microseconds.
Checking features: Overflow in addition. Prescribed code as a result of addition.

Memory

The system uses magnetic drum storage with a capacity of 22,000 binary digits (650 words). Access times are not relevant because of the fixed program. The system has 60 integrators.

INPUT MEDIA

Input is by paper tape, at 6 digits per second, and by manual entry through a typewriter keyboard. A curve follower attachment, with input at 20 digits per second, may also be used.

OUTPUT MEDIA

Output is by typewriter, at 10 digits per second, and by paper tape, also at 10 digits per second. A graph plotter also is used, with output at 20 digits per second (100 steps/inch).

AUXILIARY COMPONENTS

Graph plotter

Twenty digits per second, 100/inch.

PROGRAMMING

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

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
D-12 Processor Console, and One Graph Plotter Unit (basic system)	$55,000			125 cu. ft.	2,000	7.5	

BENDIX G-15 BENDIX CORPORATION

THE BASIC G-15 SYSTEM consists of the central processor, an alphanumeric or numeric electric typewriter, a photoelectric paper tape reader, and a paper tape punch. The basic system can be expanded by the addition of up to four magnetic tape units, a second photoelectric paper tape reader, a punched card coupler, a universal code accessory, a digital differential analyzer, and a graph plotter. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, single precision 29 bits, double precision 58 bits.
Numeric Characters Per Word:
  Single precision: 7 plus sign.
  Double precision: 14 plus sign.
Alphabetic Characters Per Word: 3.5.
Character Code:
  Numeric: Pure binary.
  Alphabetic: 8 bits per character.
Timing: Synchronous.
Pule Repetition Rate: 107 kilocycles.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point (double precision)
Add: 555555 to 555555	1.08
Multiply: 555555 by 5555	20.79
Divide: 3086108025 by 5555	13.77

Average access time:
  Fast access storage: 0.54 milliseconds.
  General storage: 14.5 milliseconds.

Checking features:

Operation check: By means of a single command, words representing a block of tape input are added together when they are written on the memory drum. The resulting sum, called a check sum, may then be compared to the sum computed when the tape was prepared.

Program check: Breakpoints which halt computation may be added to, or removed from, any portion of the program, at the option of the operator. In addition, the machine may be operated manually to single cycle through a program.

Registers

One register holding one word, 29 bits.

Three registers holding two words, 58 bits each.

Memory

A magnetic drum is used for internal storage. The drum is divided into general access storage and fast access storage. The general access storage has a 2,160 word capacity in 20 channels of 108 words each. The fast access storage has a 16 word capacity in 4 channels of 4 words each.

Control panel

This unit contains controls and indicators for monitoring the entire system and is mounted on the main frame. The alphanumeric typewriter occupies a separate desk and controls the system operation as well as providing one form of input-output.

INPUT MEDIA

Magnetic tape unit (MTA-2)

Maximum number per system: 4.
Packing density: 57 characters per inch.
Number of channels: 6.
Record length: Variable—4 to 108 words per block, 1 to 3,000 blocks per file.
Record gap: ½ inch.
Tape speed: 7.5 inches per second/430 characters per second.
Rewind time: 16 minutes.
Start-stop time: 5 milliseconds:
Change tape time: 2 minutes (approx.).
Physical characteristics of Tape:
  Composition: Mylar.
  Length: 3,600 feet.
  Width: ½ inch.
Error detection: Block summation of tape record compared against sums obtained at time of writing.

Photoelectric paper tape reader

This unit is a part of the main frame. The unit reads 5-channel punched tape at a rate of 250 characters per second. The photoelectric reader enters information into a 108 word channel on the magnetic drum which is addressable by the computer program.

High speed photoelectric paper tape reader (PR-2)

This unit reads information from 5-, 6-, or 7-channel punched tape at a rate of 400 characters per second. The number of channels desired is specified at the time the unit is ordered.

Alphanumeric electric typewriter

This unit manually enters commands or data into the system. The typewriter prints alphanumeric output from the central processor at the rate of 8 characters per second.

Numeric electric typewriter

This unit manually enters commands or data into the system. The typewriter prints numeric output from the central processor at the rate of 11 characters per second.

Punched card coupler (CA-1)

This unit provides compatibility between the G-15 and either one or two IBM 026, 80-column card reader-punch units. Cards are read at a rate of 17 characters per second and punched at a rate of 11 characters per second.

Punched card coupler (CA-2)

This unit provides compatibility between the G-15 and from one to three commercially available 80-column card reader-punch units or tabulators. Information is read at a rate of 100 cards per minute or printed at the rate of 100 lines per minute on the tabulator. Information is punched at a rate of 100 cards per minute. The CA-2 accepts mixed alphabetic and numeric characters as well as special characters.

OUTPUT MEDIA

Magnetic tape, electric typewriters, and card couplers

As previously described.

Paper tape punch

The paper tape punch is a part of the main frame. This unit punches 5-channel code in paper tape at a rate of 17 characters per second.

AUXILIARY COMPONENTS

Universal code accessory (AN-1)

This unit provides compatibility between the G-15 and external data processing equipment. The AN-1 accepts numeric or alphabetic input in any code of eight bits or less per character and enters the information directly into the computer memory. A special conversion routine translates the input language into the internal language of the G-15. After the information is processed, the AN-1 permits the results to be read out in numeric or alphabetic form to external data processing equipment.

Digital differential analyzer (DA-1)

This unit provides the G-15 with the facilities of simple programming for the solution of differential equations.

Graph plotter (PA-2)

This unit is an incremental plotter which provides graphical output directly from the computer or from accessory DA-1. Maximum paper size is 12 by 18 inches. Normal plotting speed is 20 increments per second.

PROGRAMMING

General: The G-15 uses a modified two address type of instruction.

Instructions:

Number of instructions per word: 1.

Number of digits per instruction:

9 machine language.

7 intercom programming system.

Total number of operation codes: 71.

Instruction word format

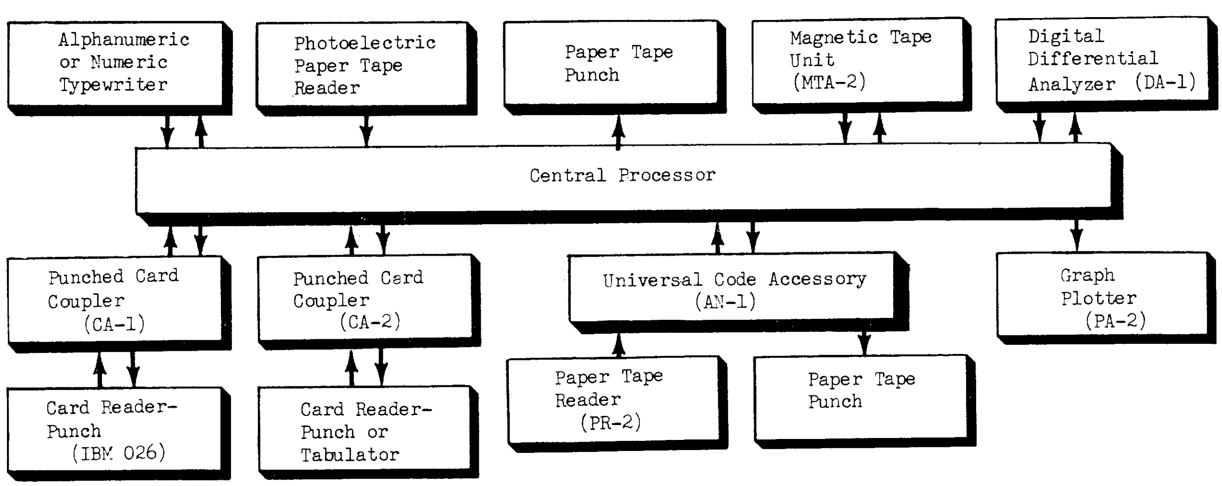
TT	NN	C	SS	DD

SSTT—DDTT—Data addresses.
NN—Address of next command.
C—Nature of operation.

Cost, Power Requirements, and Physical Characteristics

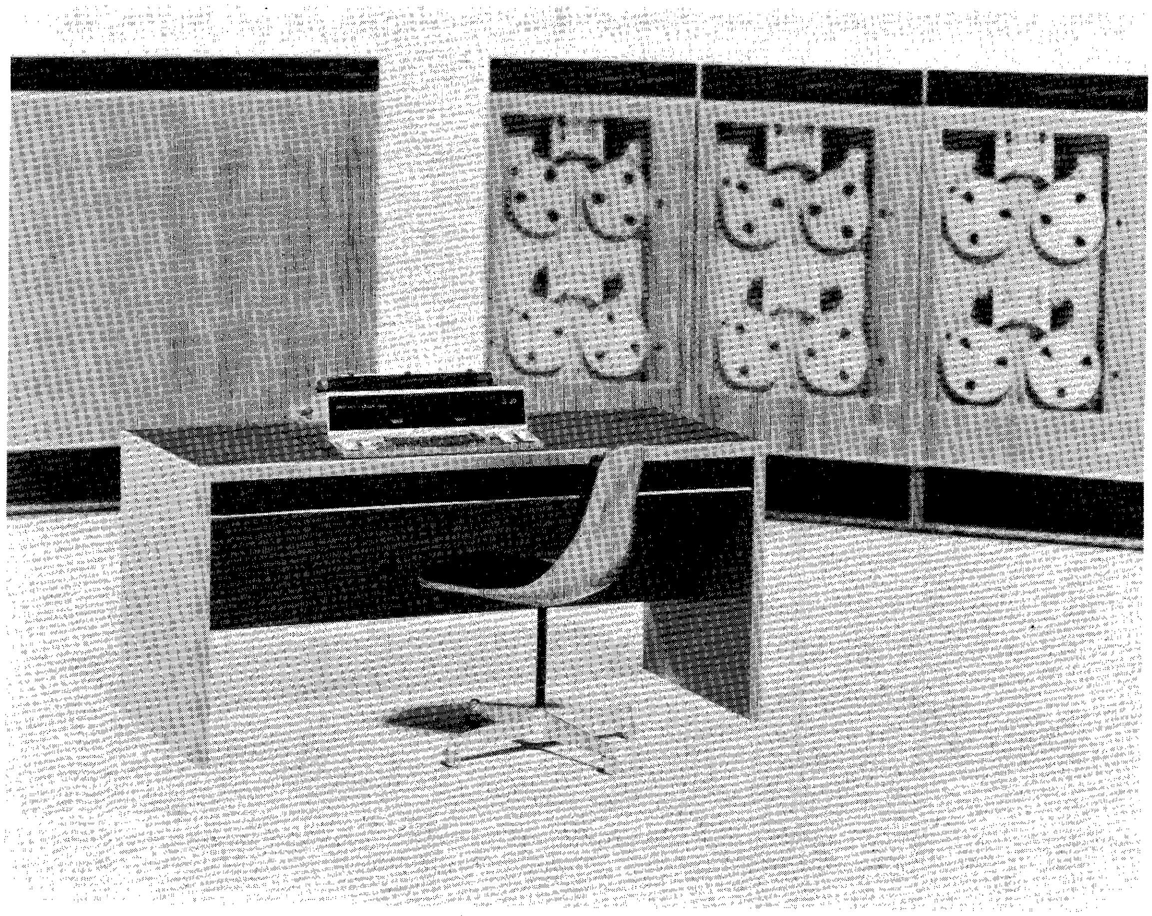
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
G-15 Central Processor, including photo-electric paper tape reader, paper tape punch, spare parts, and diode package test equipment.							
With Alphanumeric typewriter	$1,530	$51,000	$500/mo.	32x27x61	965	4.4	14,300
With Numeric typewriter	1,485	49,500	500/mo.	32x27x61	965	4.4	14,300
MTA-2 Magnetic Tape Unit	270	6,800	50/mo.	22x24x60	175	0.7	2,200
CA-1 Numeric Punched Card Coupler	100	2,530	No charge	18x26x4	20	(2)	1,150
CA-2 Alphanumeric Punched Card Coupler	585	19,500	175/mo.	22x29x60	500	2.5	8,500
PR-2 High Speed Photoelectric Paper Tape Reader	130	4,350	35/mo.	24x22x19	150	(2)	500
AN-1 Universal Code Accessory	450	11,250	150/mo.	28.5x60x31	300	1.17	2,500
DA-1 Digital Differential Analyzer	550	13,700	100/mo.	24x22x60	300	1.36	4,450
PA-2 Graph Plotter	75	1,800	No charge	Desk top	15	(2)	290

1 No charge for maintenance on leased equipment.
2 Power from G-15 Central Processor.



BLOCK DIAGRAM OF BENDIX G-15

BENDIX G 20 BENDIX CORPORATION



THE BENDIX G 20 is a transistorized general purpose computing system utilizing magnetic core storage and buffered input and output. The system is available in modular units including, in addition to the central processor, card and printer couplers, control consoles, magnetic tape units, punched card equipment, paper tape equipment, and high speed printers.

SYSTEM COMPONENTS

General

Word Length: 32 binary digits plus 1 parity bit.
Numeric Characters: 8 decimal digits plus sign.
Alphabetic Characters Per Word: 4.
Character Code: Binary.
Timing: Synchronous.

Central processor

Operation: Concurrent.
Computation speed: (Excluding storage access).

	Average time (milliseconds) Fixed point
Add:	.007
Multiply:	.049
Divide:	.098

Access time: 8.4 microseconds.

Checking features: Checking features include parity check in central processor (to and from memory), parity check on all input-output equipment, and parity check, parity bit recorded, and automatic read immediately after writing.

Registers

Registers and B boxes include memory locations used as index locations (Index Registers), interrupt and control registers, and a fixed point exponent register.

Memory

Magnetic core memory is in modules of 4,096 words each. One to eight modules (32,768 words) may be used. Each word is 33 bits long including a parity bit. Four alphanumeric characters, or a one-word precision number, occupy a word. A one-word precision number is comprised of 8 decimal digits and sign in fixed point, or, in floating point, 6 decimal digits and sign for the mantissa and 2 decimal digits and sign for the exponent. Access time is 8.4 microseconds. A word may be used for computation after 5.6 microseconds; there is an additional 2.8 microsecond wait before the memory is again available.

Control console

The operator can initiate, monitor, and control operations from the CC-10 Control Console, which includes a set of indicator lights for monitoring purposes, and a full-keyboard typewriter for entering input data and printing output information. All characters on the keyboard, both upper and lower case, alphabetic, numeric, and algebraic, can be entered or typed out. Type-out is at the rate of about 10 characters per second.

INPUT MEDIA

MT-10 magnetic tape transport

Read-write speed: 60,000 eight-bit characters per second.
Search speed: 120,000 characters per second.
Rewind speed: 120,000 characters per second.
Start and stop time: 5 milliseconds, maximum.
Tape length: 3,600 feet.
Tape width: 1 inch.
Number of channels: 10 (8 for information, 1 for parity check, 1 for block indication).

PT-10 paper tape station

Read speed: 500 characters per second.
Stop time: 1 character.
Number of channels: 8.

OUTPUT MEDIA

MT-10 magnetic tape transport

As previously described.

PT-10 paper tape station

As previously described.
Punch speed: 100 characters per second.

LP-10 high speed line printer

Characters per line: 72.
Characters per inch: 10.
Lines per inch: 6.
Lines per minute: 600.

LP-11 high speed line printer

Characters per line: 120.
Characters per inch: 10.
Lines per inch: 6.
Lines per minute: 600.

AUXILIARY COMPONENTS

MM-10 additional memory module

From one to seven of these core modules of 4,096 words each may be attached to the central processor. In programming, these auxiliary memory blocks are indistinguishable from the initial 4,096 words of internal memory.

MC-10 memory communication module

The MC-10 consists of an MM-10 memory module with facilities for direct connection to, and control of, a separate communication line, permitting multiple concurrent inputs to, and outputs from, main memory.

TC-10 magnetic tape control unit

The TC-10 can control up to four MT-10 tape transports all of which may be searching for specific blocks of information, in either forward or reverse direction, at any given time.

CP-10 card and printer coupler

Three line printer and card handling devices may be connected through a communication line to the central processor by a CP-10 unit. One LP-10 line printer may be attached, and two IBM card reader/punching units.

CP-11 card and printer coupler

The CP-11 is similar to the CP-10 except that it allows coupling of an LP-11 line printer in place of the LP-10.

CB-10 control buffer

By use of the CB-10, information may be sent from one system element to another, and modified in transit if desired, without passing through the central processor. The CB-10 contains 1,024 characters of magnetic core storage and can transfer information to and from the central processor at 143,000 eight-bit characters per second.

PROGRAMMING

General: The Bendix G 20 uses a single address type of instruction.

Instructions:

Number of instructions per word: 1.

Number of digits per instruction: 32 binary digits plus 1 parity bit.

Total number of operation codes: 63 for central processor.

Instruction word format

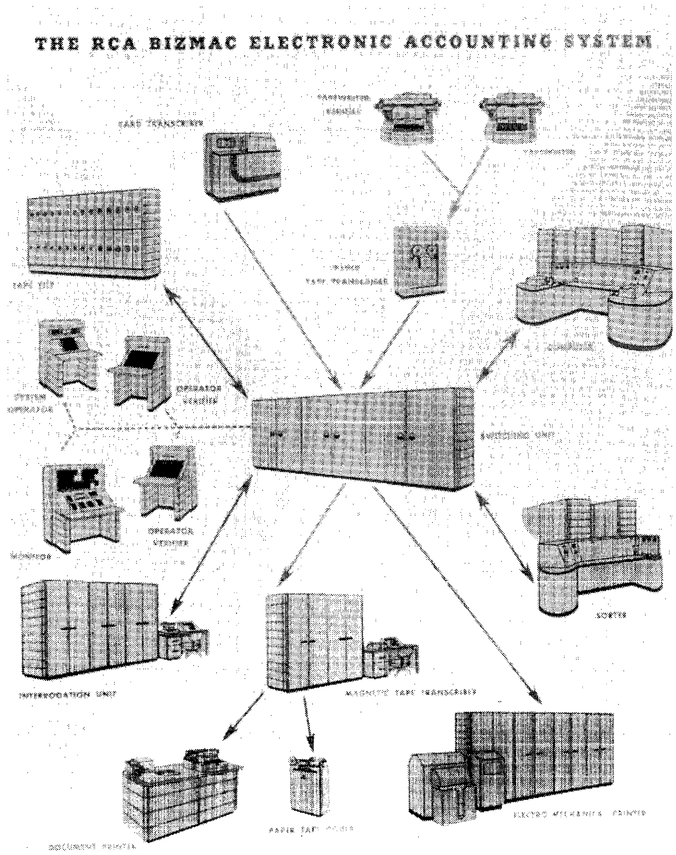
Flags	Mode code	Operation code	Index	Base Address
31-30	29-28	27-21	20-15	14-0

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
G-20 Central Processor	$6,500	$290,000	$1,210	66x28x64	2,000	2.5	....
CC-10	300	10,000	45	64x30x28	400	0.2	....
MT-10 Magnetic Tape Transport	855	28,500	120	24x28x64	700	2.0	....
CP-10 Card and Printer Coupler	675	22,500	95	24x28x64	800	1.0	....
CP-11 Card and Printer Coupler	825	27,500	115	24x28x64	1,000	1.3	....
LP-10 Line Printer	860	28,700	120	36x28x64	1,000	1.2	....
LP-11 Line Printer	2,050	68,300	285	54x28x64	1,500	1.8	....
CB-10 Control Buffer	1,500	50,000	210	24x28x64	600	0.8	....
PT-10 Paper Tape Station	525	17,500	75	24x28x64	400	0.7	....

[1] Maintenance costs are monthly for purchased equipment.

BIZMAC — RADIO CORPORATION OF AMERICA



THE RCA BIZMAC is a large-scale computing system of both vacuum-tube and magnetic core construction. The system features a large complex of magnetic tape input-output stations and interrogation points.

SYSTEM COMPONENTS

General

Word Length: Variable.
Numeric Characters: Variable.
Alphabetic Characters Per Word: Variable.
Character Code: Octal.
Timing: Synchronous for computer; asynchronous for tape operation.
Pulse Repetition Rate: 500 kc.

Central processor

Operation: Fixed point; primarily serial.

Computation speed: Execution time is variable depending on the number of significant characters in the operands. Basic formulas are:

Add: 120 + 40c microseconds (c equals number of characters in longest operand).

Multiply: 160 + 288N + 145MN microseconds (M equals number of digits in multiplicand; N equals number of digits in multiplier).

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

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

Checking features: Checking features include parity bits, dual addition comparison, tape sequence checks, echo tape, writing check, dual tape writing (on fourteen-channel tape), program control, arithmetic overflow, instruction verification, and a Computer Stop-Rollback Switch that permits a control transfer and repetition of a number of types of operations resulting in errors.

Memory

Media	*Digits*	*Access (microseconds)*
Magnetic core	4,096	20
Magnetic drum	18,000	5,120

Random access to any character in core storage.

Control console

The control consoles include monitor print-out via on-line typewriter.

INPUT MEDIA

Magnetic tape units

Maximum number per system: 182 in use at one installation.
Packing density: 125 characters per inch.
Number of channels: 14 (dual recording).
Record length: Variable.
Tape speed: 1,700 words (10,000 characters) per second, forward or reverse.
Length: 2,400 feet.

Paper tape units

Input is also available by paper tape at 400 characters per second.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Output is also available by monitor print-out (via on-line typewriter).

AUXILIARY COMPONENTS

Card transcriber (card to magnetic tape)

375 cards per minute.

Typewriter and Verifier (keyboard to magnetic tape)

Manual keyboard speed.

Paper tape transcriber (paper to magnetic tape)

200 characters per second.

Electromechanical printer (off-line)

300 or 600 lines per minute, 120 characters per line.

Magnetic tape transcriber (magnetic to paper tape)

20 characters per second.

Trancoder (magnetic tape to teletype tape)

50 characters per second.

Document printer (paper tape to typewriter)

10 characters per second.

Transcribing card punch (magnetic tape to card)

150 characters per minute.

Interrogation unit (magnetic tape to typewriter)

4 minutes per inquiry (average).

PROGRAMMING

General: BIZMAC uses a three-address instruction format.

Instructions:

Number of instructions per word: 3.
Number of digits per instruction: 8 BIZMAC characters.
Total number of operation codes: 24 basic codes, plus variation characters, bring the total number of operations to 140.

Instruction word format

Operation	Variation	Addresses		
		A	B	C
B	B	BB	BB	BB

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Complete BIZMAC System, including:	....	$4,500,000	$514,000/yr.	2,600 cu. ft.	26,500	274	....
1 Central Processor							
3 File Maintenance Computers							
1 Interrogation Unit							
182 Tape Stations							
1 System Control Unit							
1 Card Transcriber							
1 Paper Tape Transcriber							
2 High Speed Printers							
1 Transcribing Card Punch							
3 Document Printers							
10 Flexo-writers							

BURROUGHS 205 BURROUGHS CORPORATION

THE BASIC 205 SYSTEM consists of the central processor, control console (including high speed paper tape reader), a high speed paper tape punch, tape control unit and up to ten magnetic tape units. The basic system may be expanded by the addition of a Cardatron (punched card) control unit, any combination of seven input and output units with a card reader for each input unit and a card punch or line printer for each output unit, a floating point control unit, a punched card converter, an external switching unit, an output selector switch, and an electric typewriter. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 44 bits.
Numeric Characters Per Word: 10 plus sign.
Alphabetic Characters Per Word: 5 (two numerics for one alphabetic).
Character Code: 4-bit binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 140 kilocycles.

Central processor (205)

Operation: Serial, fixed point; floating point optional.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	1.92
Multiply: 555555 by 5555	8.82
Divide: 3086108025 by 5555	10.08

Average access time:
Main storage: 8.5 milliseconds.
Fast access storage: 0.85 milliseconds.

Checking features: Forbidden combination and parity checks.

Registers

A register: 11-digit word—holds the results of arithmetic operations.

B register: 4-decimal digits—expedites address modification and tally.

C register: 10 digits—holds the instruction being executed and sequential counter.

D register: 11-digit word—passes data to and from the drum—holds one operand in arithmetic operations.

R register: 10-decimal digits—an extension of the A register, used in multiplication and division.

Memory

The magnetic drum storage is divided into 24 bands. Twenty bands, each containing 200 words, comprise the main storage of 4,000 words. The fast access storage consists of 4 bands, each containing 20 words.

Control panel

This unit is a part of the control console and contains controls and indicators for operation of the system. Indicators display the contents of all registers.

INPUT MEDIA

Tape control unit (547)

This unit is under the control of the central processor. It provides power for and controls the Datareaders (548) and/or the Datafiles (560) connected to it. Any combination of ten units may be connected to the control unit.

Datareader (548)

This unit is a reel-type magnetic tape storage device.
Maximum number per system: Any combination of Datareaders and Datafiles up to a total of ten units.
Packing density: 200 characters per inch (100 characters per inch per lane at 2 lanes per tape width).
Number of channels: 12 (6 per lane at 2 lanes per tape width).
Record length: Fixed, 20 words.
Record gap: 0.3 inch.
Tape speed: 60 inches per second/6,000 characters per second.
Rewind time: 4.2 minutes.
Start-stop time: 6 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
Composition: Mylar.
Length: 2,500 feet.
Width: ¾ inch.
Error detection: Vertical parity check on each character and longitudinal parity check on each block.

Datafile (560)

This unit is a bin-type storage device which includes a tape drive for 50 separate magnetic tapes, each 250 feet in length. A movable read-write head can select any one addressed tape.
Maximum number per system: Any combination of Datareaders and Datafiles up to a total of ten units.
Packing density: 200 characters per inch (100 characters per inch per lane at 2 lanes per tape width).
Number of channels: 12 (6 per lane at 2 lanes per tape width).
Record length: Fixed, 20 words.
Record gap: 0.3 inch.
Tape speed: 60 inches per second/6,000 characters per second.
Start-stop time: 6 milliseconds.
Physical characteristics of tape:
Composition: Mylar.
Length: 250 feet per tape.
Width: ¾ inch.
Error detection: Vertical parity check on each character and longitudinal parity check on each block.

Console keyboard

This unit is a decimal keyboard and is used for manual input into the central processor.

High speed paper tape reader

This unit is a part of the control console. It reads punched paper tape at a rate of 540 characters per second and transfers the data to the central processor.

Electric typewriter (458) with typewriter control (446)

This unit, a Flexowriter, provides hard copy or punched paper tape output from the central processor. The attached paper tape reader may be used for input to the central processor. The paper tape reader, the typing element, and the paper tape punch each operate at the rate of 10 characters per second. Typewriter Control (446) controls output format.

Cardatron control unit (506)

This unit governs the activity of the individual input and output units connected to it and thereby controls the activity of all punched card machines, and line printer. Input and output units may be in any combination up to a total of seven units. The control unit is under the control of the central processor.

Input unit (507)

This unit controls an 80-column punched card reader (IBM 089 or 523). This information from the card is stored within the input unit on a small magnetic drum. On a command from the control unit the information is transferred to the central processor via the control unit.

OUTPUT MEDIA

Tape control unit, datareader, and datafile

As previously described.

Cardatron control unit

As previously described.

Electric typewriter

As previously described.

High speed paper tape punch (466)

This unit punches out information from the central processor at a rate of 60 characters per second.

Output unit (508)

This unit controls an 80-column card punch (IBM 523). Information from the central processor is routed to this unit through the Cardatron control unit. It is then converted into card codings and stored on a small magnetic drum, from which it is available to the card punch.

Output unit (509)

This unit controls a line printer (IBM 407 or 419) and operates in the same manner as the Output Unit (508).

AUXILIARY COMPONENTS

Floating point control unit (360)

This unit provides the central processor with a separate set of commands for floating point computations.

Punched card converter (500)

This unit permits the central processor to accept information from a card reader (IBM 517 or 523) or transfer information to a card punch (IBM 514, 517, 523, or 528) or a line printer (IBM 402, 407, or 416).

External switching unit (421)

This unit provides a means of controlling the card punch or printer connected to the punched card converter.

Output selector switch (420)

This unit, in conjunction with the external switching unit, permits the computer program to select either punched or printed output.

PROGRAMMING

General: The 205 uses a single address type of instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10 plus sign.
Total number of operation codes: 69.

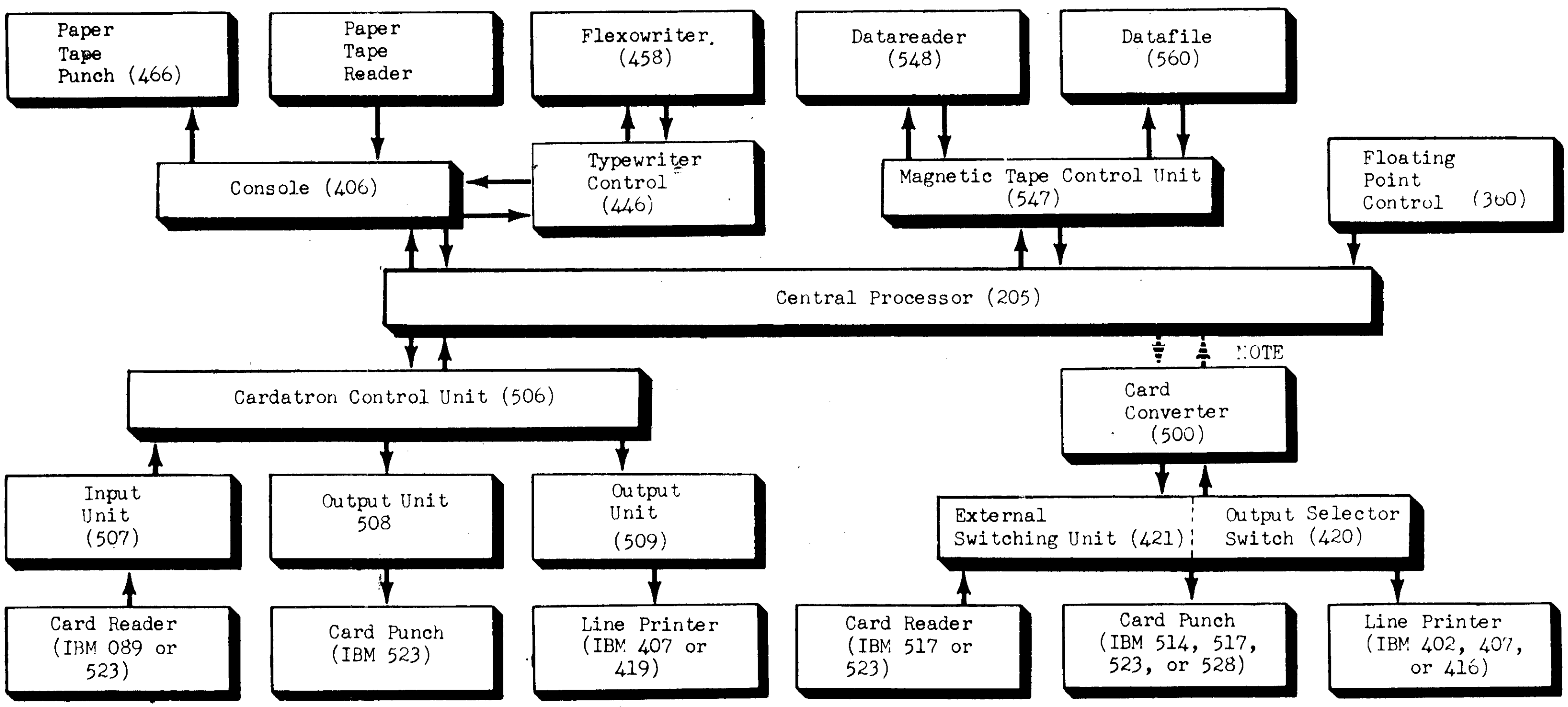
Instruction word format

Sign	Control	Operation code	Operand address
1 digit	4 digits	2 digits	4 digits

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva (2)		Heat dissipation B.t.u./hr.
205 Central Processor	$3,900	$135,000		144x28x75	3,175	15.0	1.5	56,100
406 Control Console (including high speed photoelectric paper tape reader and paper tape punch 466)	490	14,210		76x31x44	550	(3)		(3)
547 Tape Control Unit	875	28,000		38x28x78	600	3.8		12,900
548 Datareader	425	13,500		21x28x69	500	3.8	1.2	4,100
560 Datafile	825	25,000		78x32x52	650		1.0	3,400
458 Electric Typewriter (including Typewriter Control 446)	231	7,695		18x22x38	248	(3)		(3)
506 Cardatron Control Unit	770	31,000		41x28x78	850	3.0	0.5	11,900
507 Input Unit	560	22,500		36x28x78	750	2.2	0.5	9,200
508 Output Unit	660	26,300		41x28x78	800	2.8	0.5	11,200
509 Output Unit	690	27,550		41x28x78	800	2.8	0.5	11,200
500 Punched Card Converter	567	18,625		64x28x69	1,044	3.4	3.5	23,500
420 Output Selector Switch	155	4,375		24x17x13	100	(3)		(3)
421 External Switching Unit	105	2,890		24x17x13	100	(3)		(3)
360 Floating Point Control Unit	725	21,200		33x28x78	750	2.4		2,200

1 Maintenance included in rental price. Separate contract provided for purchased equipment.
2 First vertical row shows power applicable to 208/230 volt, 3 phase, 60 cycle, 4-wire supply. Second vertical row is applicable to 115 volt, single phase, 60 cycle, 3-wire supply. Both power supplies are required.
3 Included in Central Processor.



Note: A 205 system can accommodate only one punched card system, either a Card Converter System or a Cardaton System.

BLOCK DIAGRAM OF BURROUGHS 205

BURROUGHS 220 BURROUGHS CORPORATION

THE BASIC 220 SYSTEM consists of the central processor, control console, tape control unit and up to ten magnetic tape units, memory control unit, core storage unit, high speed paper tape reader, and high speed paper tape punch. The basic system may be expanded by the addition of a Cardatron (punched card) system, a supervisory printer, and a high speed printer system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 44 bits plus sign.
Numeric Characters Per Word: 10 plus sign.
Alphabetic Characters Per Word: 5 (two numerics for one alphabetic).
Character Code: 4-bit binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 200 kilocycles.

Central processor (220)

Operation: Series—Parallel, fixed or floating point.
Computation speed: (program and operands are in memory).

	Time (milliseconds) *Fixed point*	*Floating point*
Add: 555555 to 555555	0.185	0.215
Multiply: 555555 by 5555	1.500	1.200
Divide: 3086108025 by 5555	3.980	4.070

Access time: 0.01 milliseconds.
Checking features:
Forbidden combination.
Nonexistent address.

Registers

A register: 11-digit word—stores one of the operands as well as the result of an arithmetic operation.
R register: 11-digit word—an extension of the A register.

D register: 11-digit word—buffers all input to the central processor.

B register: 4 digits—expedites address modification.

C register: 10 digits—contains the instruction being performed.

P register: 4 digits—contains the address of the next instruction to be executed.

IB register: 11-digit word—buffer between core storage and arithmetic and control circuits.

E register: 4 digits—contains the address in core memory to which access is being made.

S register: 4 digits—holds address where computer will stop while debugging.

Memory

The basic magnetic core memory has a capacity of 2,000 words. This is expandable to 10,000 words by the addition of 1,000-word units. Five thousand words of memory can be contained in one core storage unit. Another core storage unit is added to hold additional units. A memory control unit is required to control the transfer of information between the core storage unit and the central processor.

Control panel

This unit is a part of the control console and contains controls and indicators for control of the system. The status of ten control switches may be tested by the computer program.

INPUT MEDIA

Magnetic tape control unit (550)

This unit controls any combination of magnetic tape units and/or Datafiles up to a total of ten units.

Magnetic tape unit (551)

This unit is a reel-type magnetic tape storage device.
Maximum number of units: Any combination of magnetic tape units and/or Datafiles up to a total of ten units.
Packing density: 416 characters per inch (208 characters per inch per lane at 2 lanes per tape width).
Number of channels: 12 (6 per lane at 2 lanes per tape width).
Record length: Variable—10 to 100 words.
Record gap: 0.2 inch (approx.).
Tape speed: 120 inches per second/25,000 characters per second.
Rewind time: 4.2 minutes.
Start-stop time: 5 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
- Composition: Mylar.
- Length: 3,500 feet.
- Width: ¾ inch.

Error detection:
- Parity check.
- Digit count—word count check.

Datafile (556)

This unit is a bin-type magnetic tape storage device which includes a tape drive for 50 separate magnetic tapes, each 250 feet in length. A movable read-write head can select any one addressed tape.
Maximum number of units: Any combination of Datafiles and/or magnetic tape units up to a total of ten units.
Packing density: 416 characters per inch (208 characters per inch per lane at 2 lanes per tape width).
Number of channels: 12 (6 per lane at 2 lanes per tape width).
Record length: Variable—10 to 100 words.
Record gap: 0.2 inch (approx.).
Tape speed: 120 inches per second/25,000 characters per second.
Start-stop time: 5 milliseconds.
Physical characteristics of tape:
- Composition: Mylar.
- Length: 250 feet per tape.
- Width: ¾ inch.

Error detection:
- Parity check.
- Digit count—word count check.

Console keyboard

This unit is a decimal keyboard and is used for manual input into the central processor.

High speed paper tape reader (440)

This unit reads 7-channel punched paper tape at a rate of 1,000 characters per second. Start time is less than 5 milliseconds and the reader will stop with the last character read still under the reading head. Up to ten of these units may be connected to the system.

Cardatron control units (510 and 511)

These units contain the circuitry to govern the activity of the individual input and output units connected to them and thereby control the activity of all punched card equipment and line printer. Input and output units may be connected in any combination up to a total of seven units.

Input unit (512)

This unit controls an 80-column punched card reader (IBM 087). Cards are read at a rate of 240 cards per minute. Information from the cards is stored within the input unit on a small magnetic drum. On a command from the control unit the information is transferred to the central processor via the control unit. Under certain conditions 480 cards per minute may be read.

OUTPUT MEDIA

Magnetic tape control unit, magnetic tape unit, and datafile

As previously described.

Cardatron control units

As previously described.

Output unit (513)

This unit controls an 80-column card punch (IBM 523) or a 120 character per line printer (IBM 407). Information from the central processor is translated into appropriate card or line printer coding and is stored within the output unit on a small magnetic drum, from which it is available to the card punch or line printer. Punching rate is 100 cards per minute and printing rate is 150 lines per minute.

Supervisory printer (465)

This unit prints out information from the central processor at a rate of ten characters per second. It will also print out information from its associated paper tape reader at a rate of ten characters per second.

High speed paper tape punch (470)

This unit punches 7-channel paper tape at a rate of 60 characters per second. Up to ten of these units may be connected to the system.

AUXILIARY COMPONENTS

High speed printer control (271)

This unit provides controls for a High Speed Printer (272).

High speed printer (272)

This unit prints out information at rates up to 1,225 alphanumeric or 1,550 all-numeric lines per minute, 120 characters per line. It may be used, on-line with the central processor, or off-line with one or two magnetic tape units.

PROGRAMMING

General: The Burroughs 220 uses a single address type of instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10 plus sign.
Total number of operation codes: 94.

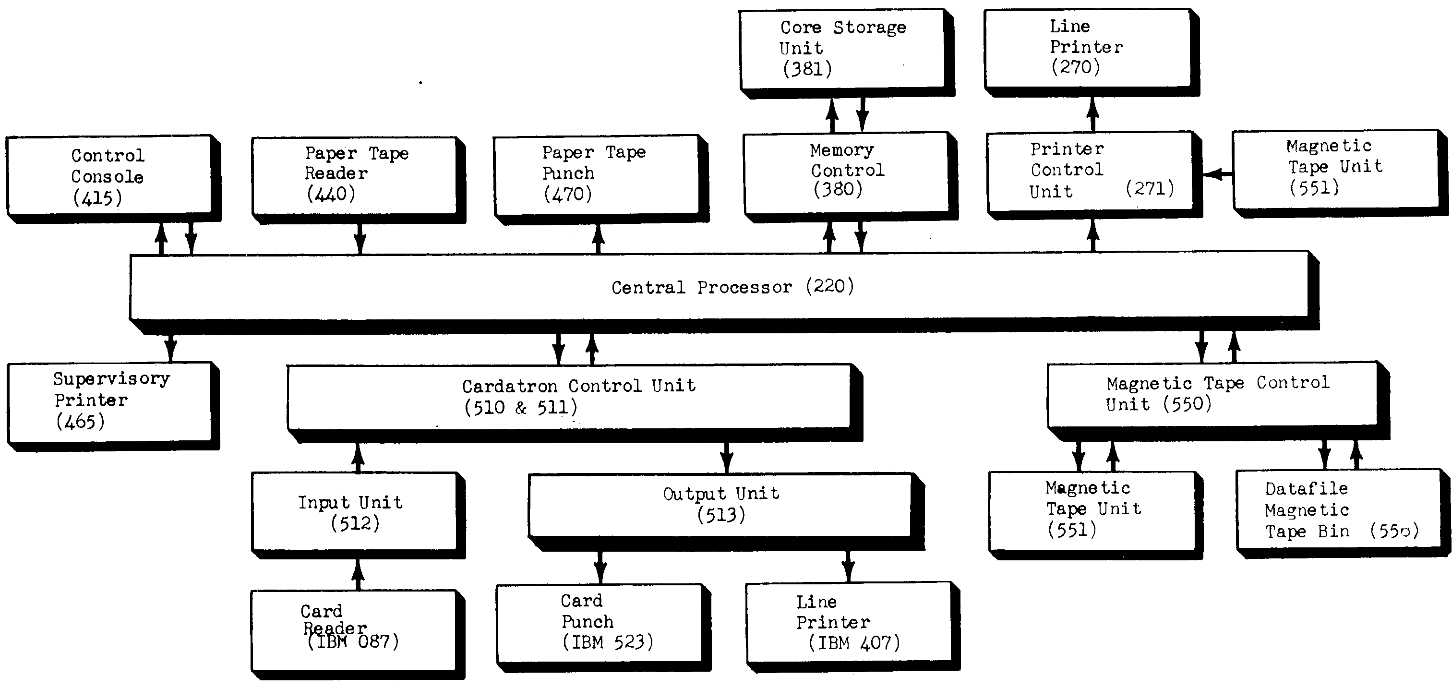
Instruction word format

Sign	Control	Operation code	Operand address
1 digit	4 digits	2 digits	4 digits

Cost, Power Requirements, and Physical Characteristics

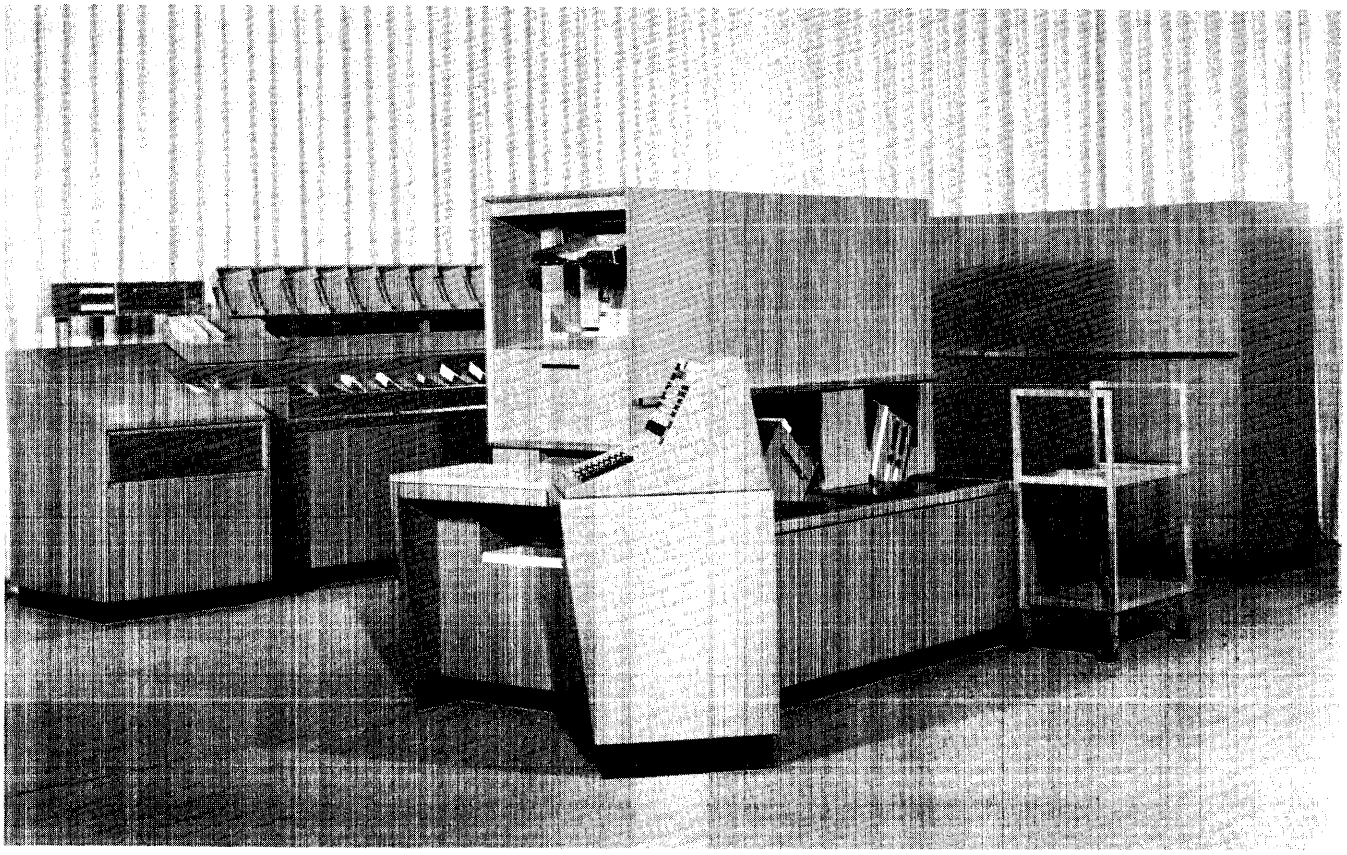
Item	Rent/mo.	Purchase	Maintenance (*)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Central Computer, consisting of—	$7,800	$320,000					
220 Central Processor				156x30x76	2,850	8.30	41,000
380 Memory Control Unit				52x29x76	780	6.20	15,000
381-1 Core Storage Unit				79x29x76	710		22,800
415 Control Console				78x18x29	500	0.10	340
465 Supervisory Printer				23x36x47	300	0.60	2,040
440 High Speed Paper Tape Reader				23x23x47	290	0.70	2,380
400 Power Control				40x30x76	800	1.10	
401 Power Supply				54x30x76	1,500		34,000
550 Magnetic Tape Control Unit	1,200	45,000		53x29x76	850	2.50	18,700
551 Magnetic Tape Unit	635	21,450		28x31x52	650	5.33	13,600
556 Datafile	1,475	49,500		86x36x57	1,300	3.0	9,200
470 High Speed Paper Tape Punch	100	3,400		23x23x47	190	0.25	1,020
Cardatron System, consisting of—	2,735	107,200					
510 and 511 Cardatron Controls				80x29x75	1,550	3.12	4,500
512 Input Unit				40x29x75	750	1.56	9,500
513 Output Unit				40x29x75	750	1.56	9,800
271 High Speed Printer Control	3,950	144,000		60x31x76	2,000	4.00	16,000
272 High Speed Printer	2,255	84,550		56x36x57	1,200		

* Maintenance included in rental price. Separate maintenance contract available for purchased equipment.



BLOCK DIAGRAM OF BURROUGHS 220

BURROUGHS B 251 VRC BURROUGHS CORPORATION



A TYPICAL BASIC B251 VRC (Visible Record Computer) system consists of a central processor, record processor, sorter-reader, and card reader.

SYSTEM COMPONENTS

General

Word Length: 13 digits, including sign.
Character Code: Binary coded decimal.

Central processor

Operation: Fixed point.
Computation speed:

	Average time (milliseconds) Fixed point
Add: 10 digits (5's) to 10 digits (5's)	2.31
Multiply: 10 digits (5's) by 10 digits (5's)	22.71
Divide: 10 digits (5's) by 10 digits (5's)	16.02

Access time: 10 microseconds.

Memory

Thirty words of magnetic core memory are supplied with each B251 system, but this can be expanded to 100 words in increments of ten words each.

Control Console

The control console provides the operator with system indicators and alarms, and with a keyboard which may be used for manual entry of data into the machine.

INPUT MEDIA

Input to a basic system is by magnetically encoded documents, at 1,500 documents per minute; ledger cards with magnetic strips, at 180 per minute; and punched cards, at 100 cards per minute.

OUTPUT MEDIA

Output is by ledger cards with magnetically encoded strips, at 180 per minute, and by the Records Processor Printer, which prints 160-character lines at the rate of 200 lines per minute.

AUXILIARY COMPONENTS

B101 sorter-reader

The B101 sorts checks and other magnetic ink encoded paper documents at a maximum rate of 1,560 minimum-sized checks per minute, and also serves as a basic input unit to the B251. The B101 may be used off-line, under patch board control, or on-line under control of the B251 central processor.

Records processor

This unit of the B251 is used for processing of magnetically-encoded ledger cards, which are automatically fed and compared with transaction documents in the Sorter-Reader and updated, when required, by the central processor.

PROGRAMMING

General: Punched Mylar program tapes are used to control the B251 system. Instructions are punched into these tapes, which are mounted on up to 12 tape readers. When all 12 instruction tape readers are used, capacity is over 2,500 instructions. The B251 uses a three-address type instruction.

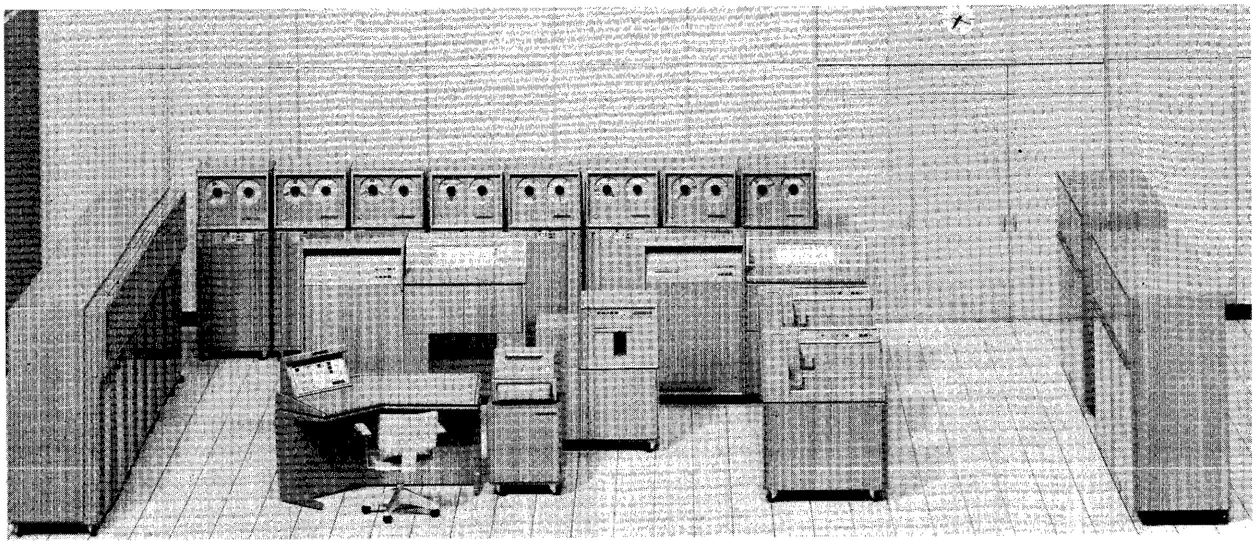
Instructions:

Number of digits per instruction: 12 (maximum).
Total number of operation codes: 22.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
B251 VRC Basic System	$3,975	$217,400	----------	----------	----------	15	----------

BURROUGHS B 5000 BURROUGHS CORPORATION



THE MINIMUM B 5000 Information Processing System consists of the central processor; a system control console with an associated keyboard and message printer; one memory module; one input-output channel; one storage drum; and a card reader. A typical system, in addition to the above, might include six magnetic tape units, a card punch, and a line printer. The system can be expanded to a maximum of two central processors; eight memory modules; four input-output channels; two storage drums; sixteen magnetic tape units; two high-speed card readers; two line printers; and a card punch. Solid state circuitry is used throughout the system.

An unusual characteristic of the B 5000 system is its new concept of modularity. The equipment capabilities of the system can be increased or altered at any time through the addition or replacement of any component, without reprogramming. Because of the independence of the program from the configuration of equipment on which it is being run, any B 5000 program can be run on any B 5000 system, so long as minimum input and output requirements are met.

SYSTEM COMPONENTS

General

Word Length: Fixed, 48 bits plus parity check.

Character Code: Alphanumeric—eight six-bit binary coded decimal characters per word; numeric—thirteen octal digits per word (equivalent to eleven or twelve decimal digits) with common notation for both fixed and floating point.

Timing: Synchronous; one megacycle clock rate.

Central processor

Operation: The B 5000 operates in two distinct states, normal and control. Internal processing of programs is carried on in the normal state. The processing enters the control state in order to perform input-output operations, supervise the execution of multiple programs, interpret all interruptions of system operation, and assign component and memory functions. While in the control state, the processor operates under the direction of the Master Control Program, a special set of automatic handling routines designed by the manufacturer and permanently recorded on the storage drum.

In either the normal or control state, the processor may operate in the word mode or in the character mode. Each of these modes utilizes the available arithmetic and control registers in a different manner and has its own set of commands. Arithmetic functions are generally carried out in the word mode. Numerical quantities upon which arithmetic operations are to be performed are represented in octal notation. Since a common notation is used for both fixed and floating point numbers, it is possible to perform calculations involving integers and floating point numbers without conversion. Computation in the word mode is carried out in parallel by word. The character mode is designed to facilitate the manipulation of data within the system. Input and output formating, editing, comparison, conversion and internal transfers of data are basic functions of the character mode. Addition or subtraction of decimal quantities can also be accomplished. Execution of commands is done serially by character in this mode.

Two levels of program execution are possible, program level and sub-routine level. Special sub-routine operators automatically preserve and restore register contents and transfer control between levels.

Computation speed: Due to the internal logic of the processor and the various ways in which data required for computation can be obtained from memory, average execution times for complete arithmetic processes cannot be obtained. The execution times shown assume that both operands are contained in the appropriate registers:

	Execution time (milliseconds)
Add:	.003
Multiply:	.086
Divide:	.150
Access time:	.003

Registers

The operation of the registers differs from conventional computers because of the manner in which arithmetic processes are handled. Machine logic is based upon the concept of a stack, consisting of two registers and an associated area of memory. All arithmetic operations involve the contents of the two stack registers. The stack provides for temporary storage of information upon which calculations will be performed and automatically feeds and empties the associated registers. Index registers as such are not required, since the machine logic provides multiple level variable indexing ability *(See page 55).*

Memory modules

The memory module is a coincident current, magnetic core type, with a random access time of 3 microseconds per word and a memory cycle time of 6 microseconds. Information can be stored indefinitely without regeneration. Each of the 4,096 words contains 48 bits of information plus a parity bit. A 49-bit information buffer register permits data to be transferred in parallel between the module and either the central processor or the input-output channels.

One to eight memory modules can be included in a system, providing primary storage for programs and data. Independence of modules facilitates multiple and parallel processing. The central processor may access a memory module while the module is engaged in communication with input-output devices.

Console

The console is the operations center of the system and contains control switches and indicator lights which provide the operator with a convenient supervisory center. Next to and considered a part of the console control center are the message printer and keyboard, to furnish the communication link between the system and the operator. The console also contains the system switching facilities, the interrupt circuitry, the system synchronization equipment, the power controls and the interval timer. This timer provides a regular interval time interrupt, to permit the logging of running time for all programs.

INPUT AND OUTPUT MEDIA

Input-output channels

An input-output channel handles the flow of information in one direction at a time between any memory module and any input-output unit attached to the system. From one to four channels may be included in a system. Their number determines the number of simultaneous input-output operations that can be carried on concurrent with internal program execution. Since any input-output operation utilizes the first available channel, no reprogramming is required if more channels are added to a system.

Transfer of data between memory modules and input-output units is accomplished through a 48-bit buffer register in the input-output channel. Transfers between the input-output units and the buffer register are by character, six bits at a time. Transfers between memory and the buffer register are by word, 48 bits at a time. Data being transferred may be either alphanumeric or binary.

Storage drum

The storage drum is a high-speed, on-line storage device providing rapid access to program segments, subroutines and large blocks of data. Transfers of data between the storage drum and memory modules take place through an input-output channel, independent of processor activity. The basic B 5000 system requires one storage drum and a second may be added. Each can contain 32,768 words, a word consisting of 48 information and 6 longitudinal parity bits. Each word is independently addressable. The drum rotates at a rate of 3,600 r.p.m. and has a read-write speed of 8.1 microseconds per character. Average access time to a word on the drum is 8.5 milliseconds, or 18.5 milliseconds if changing bands.

The storage drum is included in the system primarily to provide storage for the Master Control Program and its related utility routines, the compilers, and for programs being executed. The Master Control Program and its adjuncts will require one-half of the drum, which will be made permanently unavailable to the program, except for reading, by means of manual lockout switches. The drum will contain the Master Control Program at the time it is turned over to a user.

Magnetic tape unit

Auxiliary storage for the B 5000 system is provided by magnetic tape units, 16 of which can be included in any system. These units are capable of reading forward or backward, writing, back spacing, rewinding and erasing magnetic tape. Tape reels will hold up to 3,600 feet of magnetic tape, ½ inch in width. Data may be represented on tape in binary or single-frame alphanumeric code and even or odd parity may be selected programmatically. Tape format is compatible with IBM Model 729 II and 729 IV tape units.

Data may be stored in two densities, either 200 or 555.5 frames per inch. One frame contains either six binary bits or one six-bit alphanumeric character. Tape speed is 120 inches per second, for a transfer rate of 24,000 low density characters or 66,600 high density characters per second. Packing density is selected manually. Tape is rewound at a speed of 340 inches per second or 2.1 minutes per reel. Start or stop time is less than 5 milliseconds and there is a gap between records of ¾ inch. Record length is variable. Complete error detection facility is provided by read following write and by character and longitudinal parity checking.

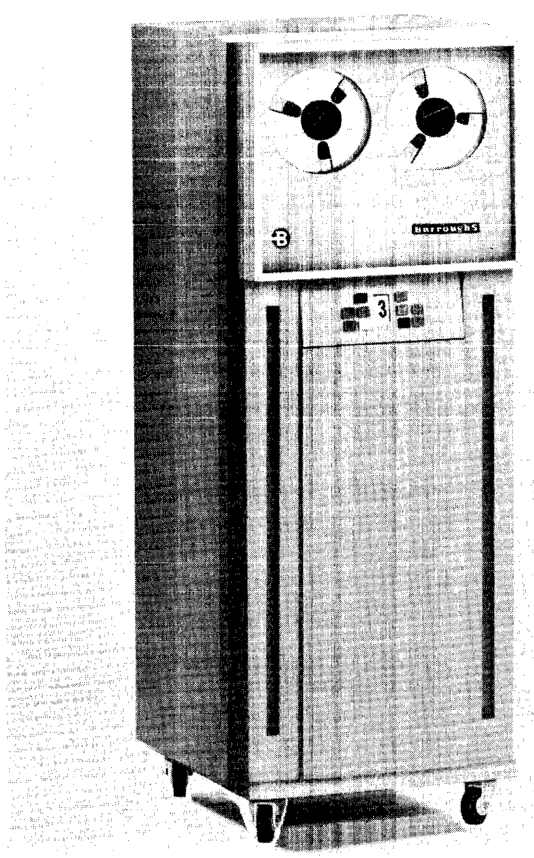
Card readers

Two models of card readers are available. One reader must be included in a system and two may be included. Model B 122 reads 80-column cards at the rate of 200 per minute. Model B 124 reads 51-, 60-, 66- or 80-column cards at the rate of 800 cards per minute. Cards may be standard or postcard thickness. Each model reads photoelectrically in serial fashion and has an immediate-access clutch to eliminate clutch access time. Card data may be represented in standard tabulating card code or straight binary code. Invalid card codes are sensed and indicated to the system. Hopper and stacker hold 500 cards on the Model B 122 and 2,400 cards on Model B 124. Both allow addition or removal of cards during operation.

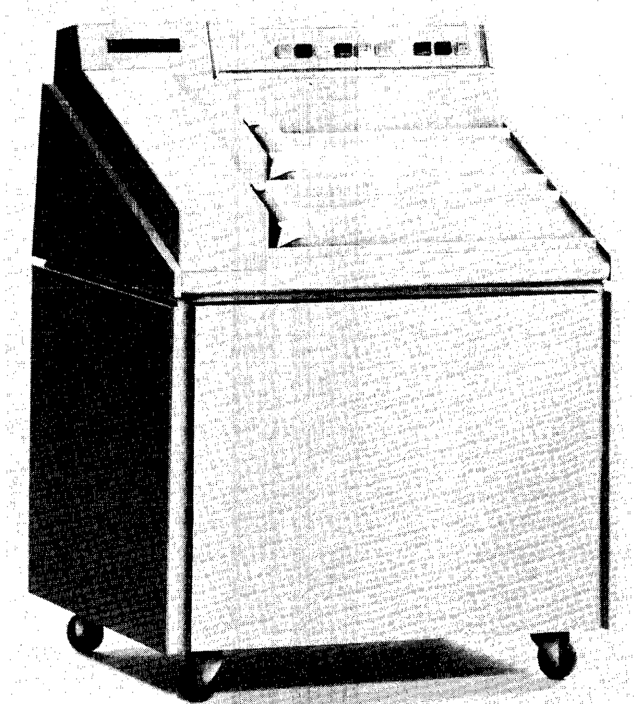
Line printer

The line printer operates at 650 lines per minute. There are 120 print positions per line, with 63 characters plus a blank available for each position. Ten alphanumeric characters per inch are printed horizontally and vertical line spacing of six or eight to the inch may be selected. Continuous forms ranging from 5 to 20 inches in width and up to a maximum of 22 inches in length can be accommodated. Form spacing is controlled by a punched vertical format tape which is contained in the printer and actuated by the processor.

A 120-position buffer register is filled before a line is printed, so that most of the printing operation is buf-



MAGNETIC TAPE UNIT



CARD READER

fered from the input-output channel. Access to a print cycle is immediate. Print checking consists of a parity check when characters are read into or out of the print buffer. Drum synchronization is checked by means of the drum position counter to assure that the drum position and timing circuits agree.

Card punch

The card punch will feed, punch, check and stack 80-column cards in both standard and postcard thicknesses at the rate of 100 cards per minute. An immediate-access clutch is provided. Functional controls are located on the plugboard and on the operator's control panel. Double-punch and blank-column detection units are available in groups of 20 as optional devices. Both hopper and stacker can hold 800 cards.

Keyboard and message printer

The keyboard and message printer provide communication between the operator and the Master Control Program. The keyboard is similar to a typewriter, containing 26 alphabetic characters, 10 numeric characters and 3 special characters. The message printer prints 600 characters per minute, a character at a time. Sixty-three characters may be printed. The printer records all information initiated at the keyboard, as well as that transmitted by the Master Control Program, thus providing a permanent record of operations.

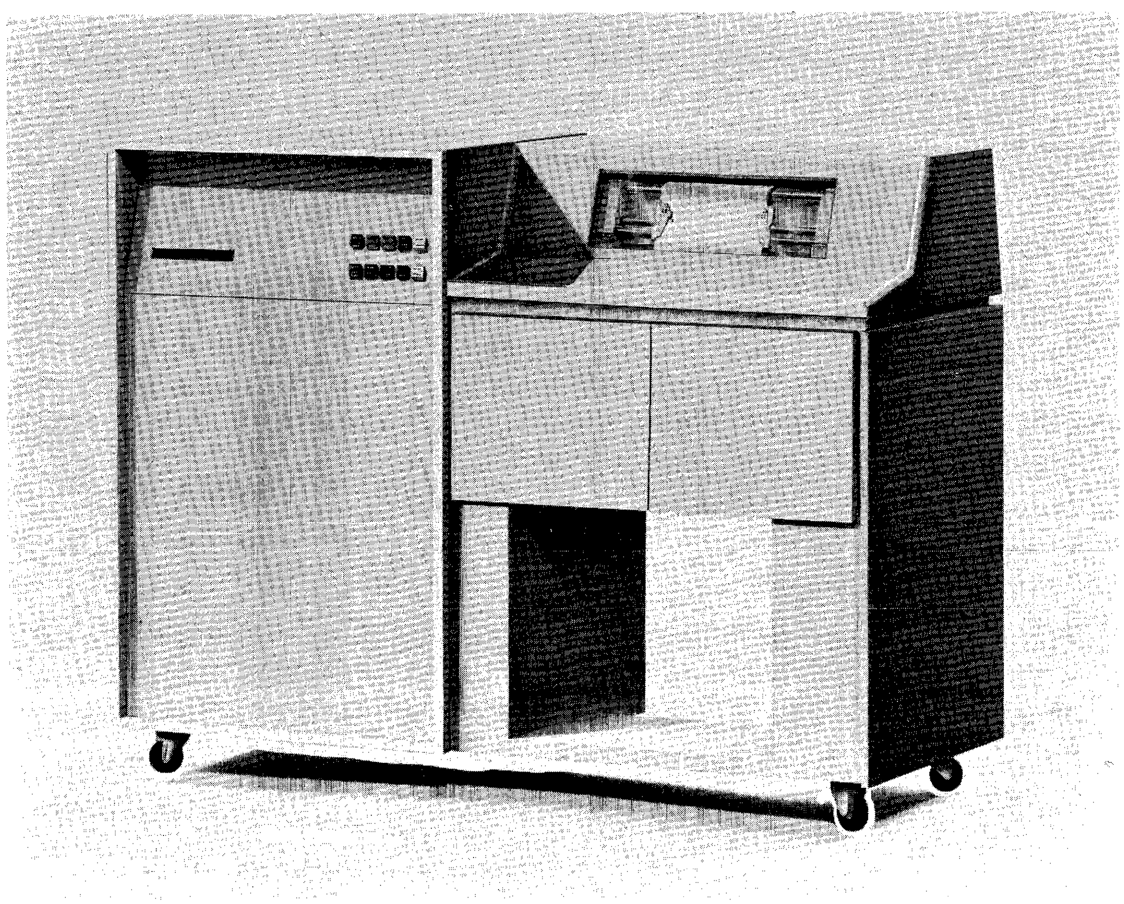
AUXILIARY COMPONENTS

Plotter

The Model 201 Tally Digital Plotter may be attached to the system in order to provide an immediate visual display of computed results. It plots up to 8 points per second with selected symbols or up to 20 points per second with random symbols.

PROGRAMMING

The programming system of the B 5000 differs radically from conventional computers. Advanced internal logic techniques such as the use of Polish notation, memory stacks, indirect addressing and comprehensive interrupts provide for high compilation speeds and efficient object programs. More than ninety basic machine commands are included, with many subcommands. The instruction unit is the program syllable, consisting of twelve bits. Four of these are contained in a single computer word.



LINE PRINTER

Although machine language coding is possible, users are encouraged to write their programs in a problem language based on ALGOL and COBOL. Compilation is accomplished and complete program control over input-output operations, external files, and error conditions is established under the Master Control Program, which also directs the operation of the program in the production phase, minimizing the role of the operator. The Master Control Program and its associated compilers and utility routines are inscribed on the drum prior to delivery to the user, making it an integral and permanent part of the system.

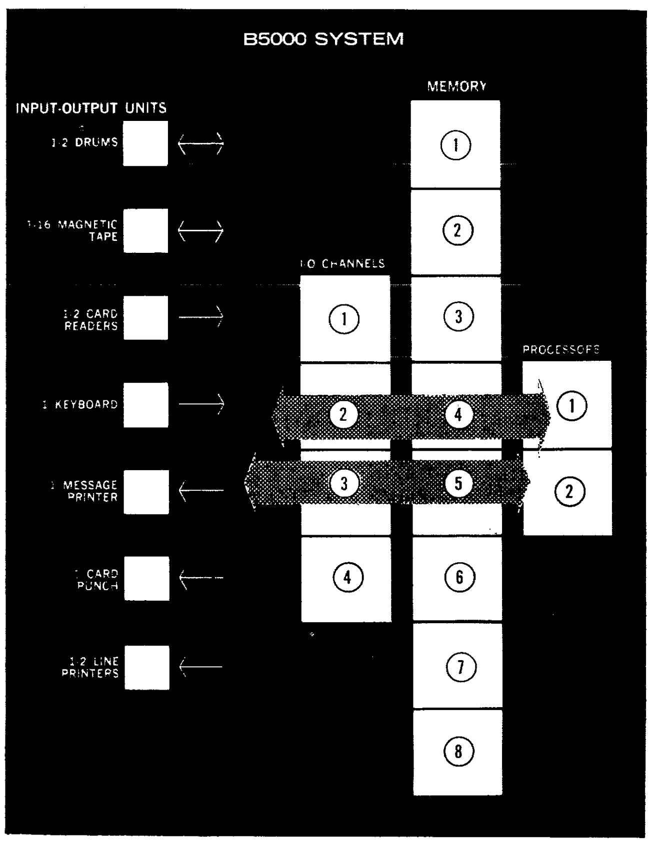
Cost, Power Requirements, and Physical Characteristics

Model	Description	Lease per Month	Purchase	Maintenance per month[1]	Dimensions inches l x w x h	Power kva	Heat dissipation B.t.u./hr.
B 5280	Processor Module A[2]	$6,400	$265,600	$180	96x29x74	.65	2,070
	System Console				23x22x44		
	Message Printer and Keyboard				23x23x43	.65	2,070
B 5281	Processor Module B	4,500	186,750	105	96x29x74	.65	2,070
B 5282	Input-Output Channel	2,250	93,375	80	([3])	.32	1,035
B 460	Memory Module	1,250	51,875	45	([3])	.16	518
B 430	Storage Drum	1,700	70,550	50	70x29x67	1.08	3,450
B 124	Card Reader	400	16,600	100	30x17x41	1.08	3,450
B 122	Card Reader	220	9,130	45	38x29x49	.36	1,139
B 321	Line Printer	1,200	49,800	185	76x29x55	3.24	10,350
B 303	Card Punch	450	18,675	65	40x29x48	1.40	4,485
B 422	Magnetic Tape Unit	800	33,200	125	27x29x67	3.24	10,350

[1] For systems in which age of central processor is less than 36 months.

[2] Includes system console, message printer and keyboard, memory exchange, input-output exchange, system synchronizer, automatic interrupt control, internal timer, power control and power supply.

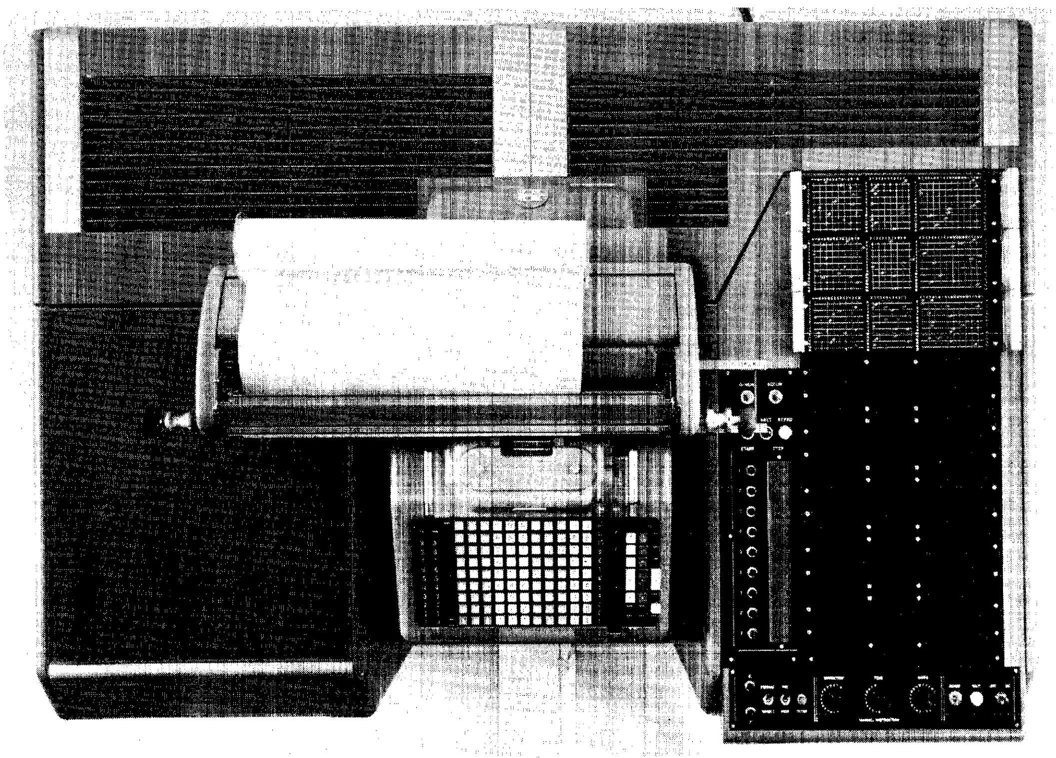
[3] Housed in processor modules.



REGISTERS

Register	Bits	Function in Word Mode	Function in Character Mode
Arithmetic/source register	48	Arithmetic register, top of stack.	Source register, containing eight six-bit characters from source string being edited.
Arithmetic/destination register	48	Arithmetic register, second level of stack.	Destination register, containing six-bit characters of edited data to be stored in destination area.
Program address registers	17	Contain address and position of next program syllable to be executed.	Contain address and position of next literal-operator pair to be executed.
Program register	48	Contains one word of program, which is treated as four 12-bit program syllables.	Contains one word of program, which is treated as four 12-bit literal-operator pairs.
Intermediate storage register	39	Provides a 39-bit extension of the arithmetic registers for certain operations such as multiply or divide and furnished temporary storage of other register contents.	Provides temporary storage of other register contents as required.
Memory address register	15	Contains address of memory location associated with arithmetic/source register when memory access is registered.	Contains address of memory location from which the source string is being obtained.
Reference address register	9	Contains base address which converts relative addresses contained in program to absolute memory locations.	Used as counter.
Stack address register	15	Contains address of next memory location to be assigned to stack.	Contains address of memory location in which destination string is being stored.
Intermediate address register	15	Provides control over stack for entry or exit from sub-routine level.	Provides for storage of registers for entry or exit from nesting.
Count register	6	Counts number of bits transfers between arithmetic registers.	Counts number of repetitions of an operator.
Character/bit address registers	12	Contain address of bits and/or characters within the arithmetic/source register, to permit operations on the character or bit levels.	Same as word mode.
Interrupt register	36	Provides the Master Control Program with notification of exceptional conditions, such as input-output channel availability, error and overflow conditions and program communication requirements.	Same as word mode.

BURROUGHS E103 BURROUGHS CORPORATION



THE E103 is a semi-automatic decimal digital computer. The central computer is housed in a single desk-sized cabinet on which a keyboard-printer is mounted, and on which the control panel is located. The optional paper tape and card adjuncts are separately housed.

OPERATING FEATURES

Input

Punched tape, punched card and direct keyboard entry. Multiple tape units, card units or combination of both.

Output

Two print cycles per second (24 digits per second); nine separate controls to provide complete flexibility for printing data on hard copy journal, duplicating masters, front fed forms and ledger sheets. Punched tape or punched card output available.

Number system

Decimal; word length of 12 digits (plus sign).

Data storage

220-word magnetic drum; 10 mechanical accumulators; all can be split to provide maximum of 460 words.

Program storage

Program stored by pin settings in 8 removable pinboard units; pins can be dropped through marked holes in paper templates; templates provide permanent program storage; instructions may also be read from optional tape or card input unit.

Programming

Machine language of 29 single-address instructions; 128 program steps; 2 automatic address-modification counters with programmed limits; unconditional and 2 conditional transfer instructions.

Speed

Addition and subtraction at 20 per second, multiplication and division at 4 per second (including access times). Buffering of input and output units permits continuous data processing.

Optional punched paper tape input

Single and multiple punched paper tape units read data and/or instructions from 5-, 6-, 7-, or 8-channel tape at 20 characters per second. Random data can be read from tape or tapes and sequenced or accumulated into programmed memory units and/or sequenced into output tape.

Optional punched card input

Read data and/or instructions from standard 80-column punched cards at 20 or 17 characters per second.

Optional punched paper tape output

Punch data and instructions into 5-, 6-, 7-, or 8-channel tape at speeds up to 10 digits per second.

Optional punched card output

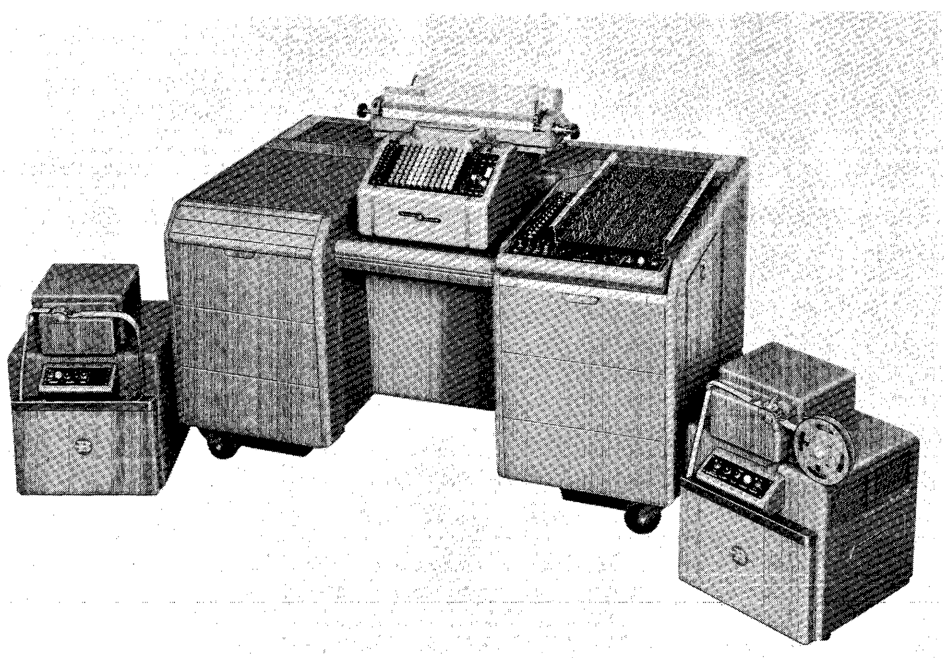
Punch numeric data at a rate of 17 or 20 characters per second into standard 80-column punched cards.

Address modification and selection

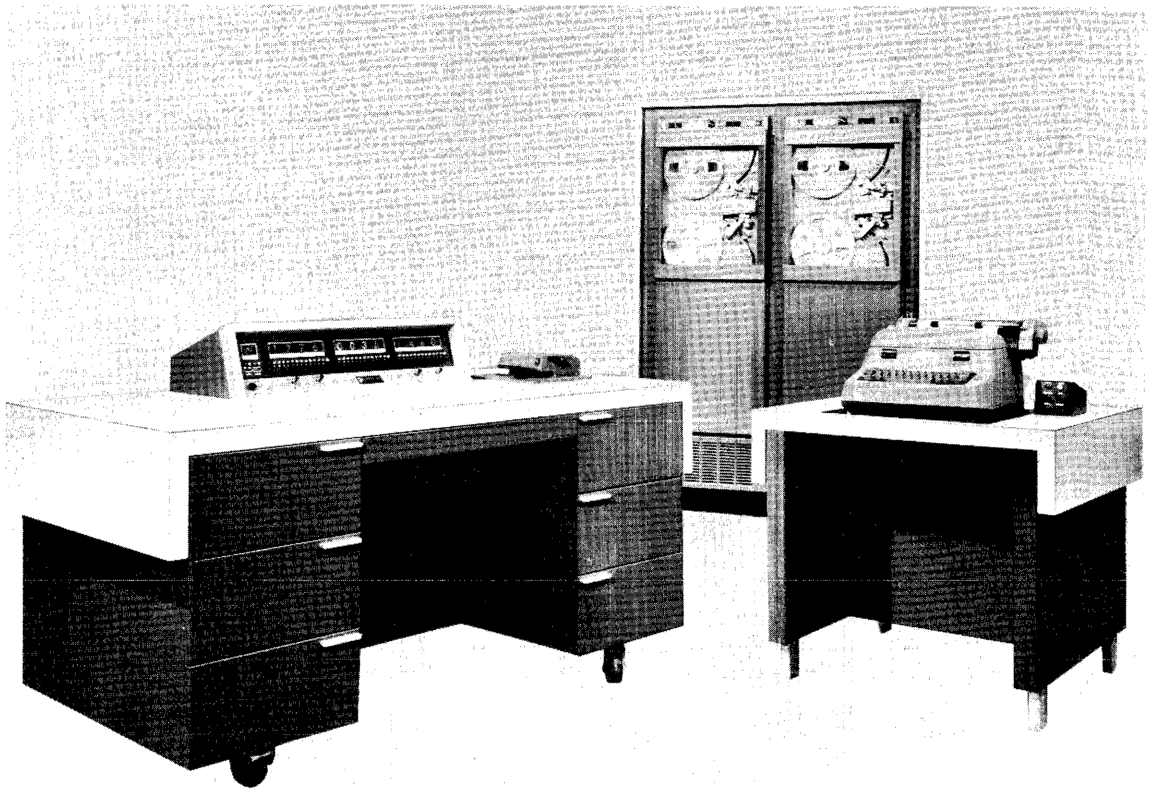
Any of the 220 cells of memory can be addressed in any one or combination of the following methods: 1. direct programmed address, 2. address selection keys, 3. value of amount listed on the keyboard or entered from tape or card and 4. automatic counting switches.

SPECIFICATIONS

Height	5 ft.
Floor Space	
Desk Unit	3 ft. 3 in. x 2 ft. 6 in.
All Units	10 ft. x 10 ft.
Current	
First Source	115 Volts, 60 Cycle, Alternating
Second Source	230 Volts, 60 Cycle, Alternating
Speed	Add Time, 50 milliseconds
Net Weight	Approx. 1,500 lbs.



CONTROL DATA 160 CONTROL DATA CORPORATION



THE CONTROL DATA 160 is a desk sized solid-state general purpose computer with 4,096 words of magnetic core storage. Input-output media for the 160 may be punched cards, paper tape, or magnetic tape. In addition, a console typewriter may be used for input and output, and a line printer is available. The 160 may be used independently or in conjunction with the Control Data 1604 large scale computer.

SYSTEM COMPONENTS

General

Word Length: 12 binary digits.
Character Code: Binary.
Timing: Asynchronous.

Central processor

Operation: Sequential, fixed point.
Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.0128
Multiply:	programmed
Divide:	programmed

Access time: 6.4 microseconds.

Registers

Z register: 12 bits
P register: 12 bits
A register: 12 bits
B register: 12 bits
S register: 12 bits
F register: 6 bits
Adder: 12 bits

Memory

The 160 has 4,096 words of magnetic core storage, each word consisting of 12 bits. Access time is 6.4 microseconds.

Console

The register display on the desk-console shows register contents in Arabic numerals.

INPUT MEDIA

Punched cards

1,300 cards per minute.

Paper tape

350 characters per second.

Magnetic tape units

Maximum number per system: 20.
Packing density: 200 characters per inch.
Number of channels: 7.
Record gap: ¾ inch.
Tape speed: 75 or 150 inches per second: 15,000 or 30,000 characters per second.
Physical characteristics of tape:
- Composition: Mylar.
- Length: 3,600 feet.
- Width: ½ inch.

OUTPUT MEDIA

Paper tape

60 characters per second.

Printer

500 or 1,000 lines per minute.

Magnetic tape units

As previously described.

PROGRAMMING

General: The 160 uses a single-address type of instruction.

Instructions:
- Number of instructions per word: 1.
- Number of digits per instruction: 12 binary digits.
- Total number of operation codes: 63.

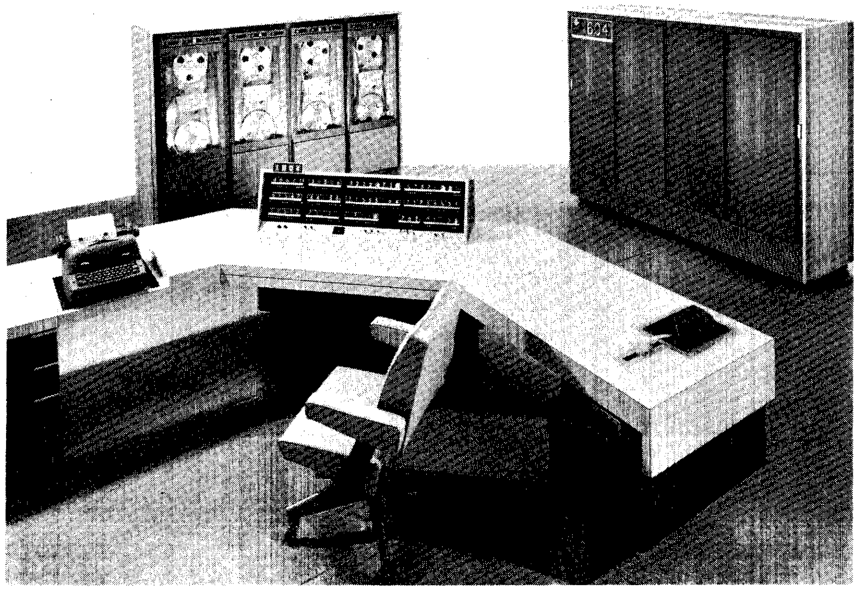
Instruction word format

Function	Address
6 bits	6 bits

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
160 Computer	$1,500	$60,000			700	0.7	

CONTROL DATA 1604 CONTROL DATA CORPORATION



THE BASIC CDC 1604 SYSTEM consists of the central processor; a control console with an associated paper tape reader, paper tape punch, and electric typewriter; and a magnetic tape subsystem consisting of four magnetic tape units and a magnetic tape synchonizer. The basic system may be expanded by the addition of up to five magnetic tape subsystems and an input-output adapter with its associated IBM input and output equipment. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 48 bits.
Numeric Characters Per Word: 14.
Alphabetic Characters Per Word: 8.
Character Code: Numerics, pure binary; alphabetics, 6-bit binary coded decimal.
Timing: Basically asynchronous (some functions performed in a synchronous mode).
Pulse Repetition Rate: 2.5 megacycles.

Central processor

Operation: Parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add: 555555 to 555555	0.0142
Multiply: 555555 by 5555	0.0380
Divide: 3086108025 by 5555	0.0724

Access time: 0.0064 milliseconds.

Checking features: All internal checking is programed.

Registers

A register: A 48-bit subtractive accumulator used in most arithmetic operations.

Q register: A 48-bit register used to assist the A register in the more complicated arithmetic operations.

B register: Six 15-bit index registers used for address modification.

Program control register: A 48-bit register which holds an instruction word while the two instructions contained in it are executed.

Program address counter: A 15-bit register used to advance by one the addresses of the instructions being executed.

Memory

The magnetic core storage is available in three models: 8,192; 16,384; and 32,768 word capacities. Each model is divided into two modules which are used and referenced alternately. The storage cycles of the two modules overlap one another in the execution of a program and result in an effective cycle time of less than 0.0064 milliseconds.

Control panel

This unit is a part of the control console and contains controls and indicators for control of the system. Indicators display the contents of all operational registers. Switches associated with these indicators provide a means of manually inserting data into the registers.

INPUT MEDIA

Magnetic tape subsystem (1607)

This unit consists of four magnetic tape units and their associated synchronizer unit. The synchronizer unit is connected directly to an input and an output channel of the central processor and contains the control circuitry for addressing each of the four magnetic tape units independently. The subsystem is contained in a single cabinet and up to six subsystems may be connected directly to the central processor.

Magnetic tape unit

Maximum number per system: 24 (4 per subsystem).
Packing density: 200 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 150 inches per second/30,000 characters per second.
Rewind time: 3.2 minutes.
Physical chacateristics of tape:
  Composition: Mylar or acetate.
  Length: 2,400 feet.
  Width: ½ inch.
Error detection: Each character is checked for parity; read following write.

Paper tape reader

This unit is a part of the control console and photoelectrically reads 7 level punched paper tape at a rate of 350 characters per second.

Electric typewriter

This unit, a modified IBM electric typewriter, is a part of the control console. The keyboard may be used to enter data into the system, and the printer may be used to print out data from the system.

OUTPUT MEDIA

Magnetic tape subsystem (1607)

As previously described.

Paper tape punch

This unit is a part of the control console and punches 7-level paper tape at a rate of 60 characters per second.

Electric typewriter

As previously described.

AUXILIARY COMPONENTS

Adapter (1605)

This unit is a signal converting device that provides the capability of operating any of the following IBM input-output equipment on-line with the central processor.

Card Reader (IBM 714) with Control Unit (IBM 759).
Line Printer (IBM 717) with Control Unit (IBM 757).
Card Punch (IBM 722) with Control Unit (IBM 758).
Magnetic Tape Unit (IBM 727) with Synchonizer Unit (IBM 754).

PROGRAMMING

General: The CDC 1604 uses a single address type of instruction.

Instructions:

Number of instructions per word: 2
Number of digits per instruction: 24 bits (8 octal digits).
Total number of operation codes: 62.

Instruction word format

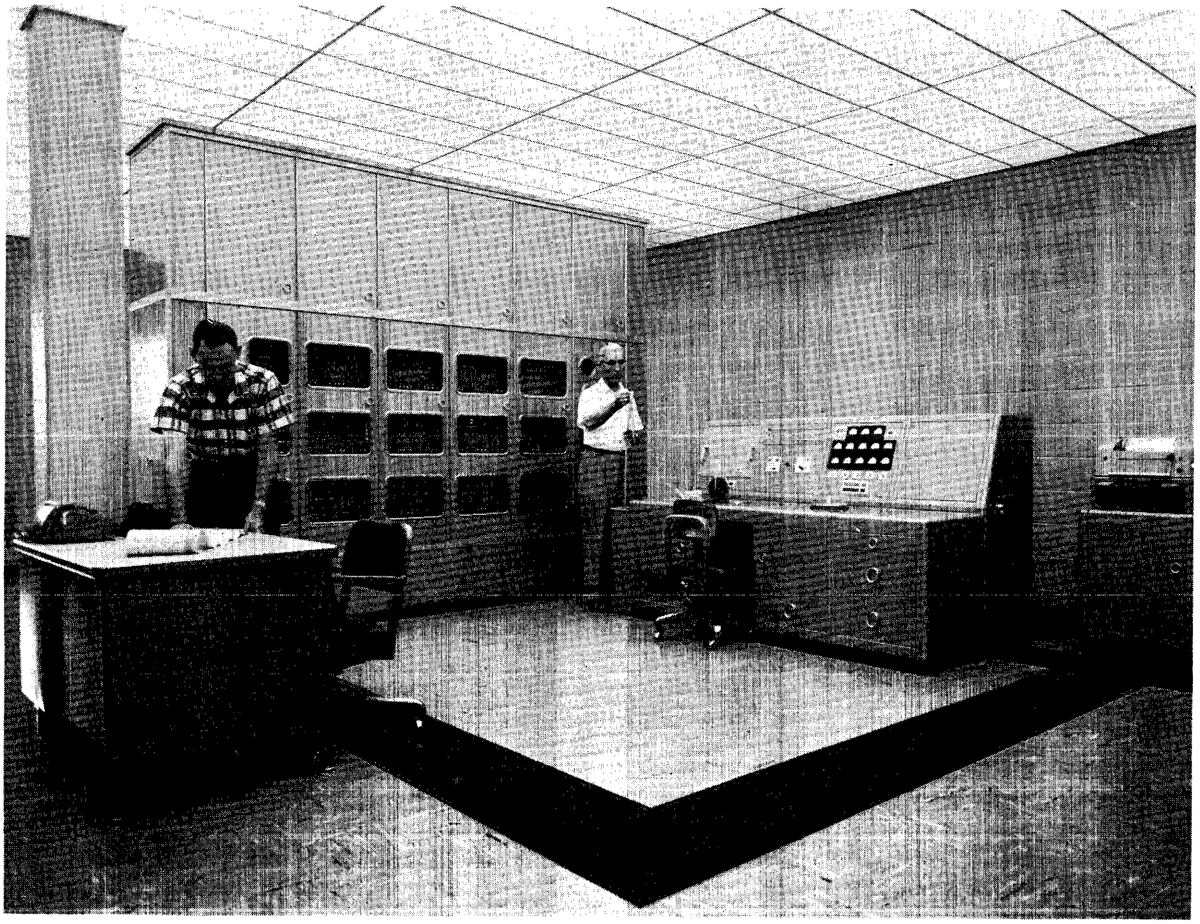
Op code	Index desig.	Address	Op code	Index desig.	Address
XX	X	XXXXX	XX	X	XXXXX
◄ Upper instruction ►			◄ Lower instruction ►		

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs	Power kva	Heat dissipation B.t.u./hr.
1604 Central Processor, with 8,192 word memory	$22,500	$700,000	....	90x24x66	2,200	5.00	13,700
Operators Console, with Electric Typewriter & Paper Tape Reader-Punch	(2)	(2)	....	156x29x30	1,100	1.25	3,413
1607 Magnetic Tape Subsytem	5,050	145,000	....	90x24x66	2,200	5.00	13,700
1605 Adapter	2,050	70,000	....	48x30x29	650	2.50	6,850
Floating Point Option	(2)	50,000	....	(2)	(2)	(2)	(2)
1604 with 16,384 word memory	25,000	780,000	....	(2)	(2)	(2)	(2)
1604 with 32,768 word memory	30,000	940,000	....	(2)	(2)	(2)	(2)

[1] Resident engineer on site. $17,500 per annum for complete system.
[2] Included in 1604.

CYCLONE IOWA STATE UNIVERSITY



CYCLONE is a vacuum-tube, general purpose digital computer patterned after the ILLIAC computer at the University of Illinois. It consists of a central processor with a CRT memory, a console with indicator lights and switches, and input-output units. CYCLONE was built by Iowa State University, Ames, Iowa, and is not available commercially.

SYSTEM COMPONENTS

General

Word Length: 40 binary digits.
Character Code: Binary.
Timing: Asynchronous.

Central processor

Operation: Sequential, fixed point (fractional base).
Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.10
Multiply:	.99
Divide:	1.20

Access time: 30 microseconds (average).
Checking features: Fixed: Division error. Optional: CRO on memory read amplifier; single order execution; step-wise gating within single order execution.

Registers

Registers include an accumulator register, a multiplier-quotient register, an operand register, and an order register.

Memory

CYCLONE utilizes electro-static tube storage with a capacity of 1,024 words (40,960 digits) and an average access time of 30 microseconds. This memory is to be replaced by a 64-word magnetic core output buffer and a 16,380-word magnetic core main memory.

INPUT MEDIA

Input is currently by 5-level punched paper tape, at 300 characters per second. Two IBM 726 magnetic tape units are to be added to the system for improved input and output.

OUTPUT MEDIA

Output is by 5-level punched paper tape, at 60 characters per second, and by a 10 character per second Teleprinter unit.

PROGRAMMING

General: CYCLONE uses a single-address programming system.

Instructions:

Number of instructions per word: 2.

Number of digits per instruction: 20 binary digits.

Total number of operation codes: 112 (to be increased to 152 when modifications are completed).

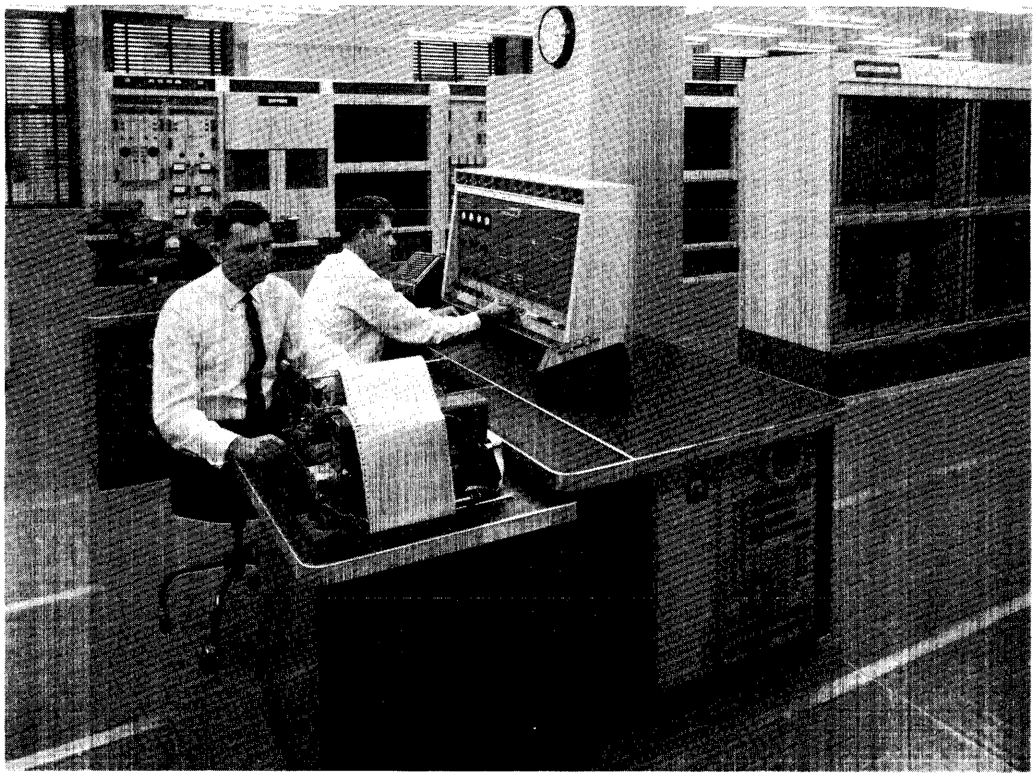
Instruction word format

Basic Operation	Variant	Address	Basic Operation	Variant	Address
4	4	12	4	4	12

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
CYCLONE Central Processor				400 cu. ft.	5,000	19	

DATAmatic 1000 MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



THE BASIC DATAmatic 1000 SYSTEM consists of the central processor (consisting of a read-write unit, a control unit, an arithmetic unit, a magnetic core storage unit, and an input-output buffer unit), a control console, a Flexowriter, from 4 to 8 magnetic file (tape) units, and a variety of off-line input-output devices and auxiliary equipment. The basic system may be expanded by the addition of an auxiliary central processor, a magnetic core storage unit, a file reference unit, a file switching unit, and up to a maximum of 100 magnetic file units. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 52 bits.
Numeric Characters Per Word: 12 (11 plus sign for arithmetic operations).
Alphabetic Characters Per Word: 8.
Character Code: 6-bit binary coded decimal, alphabetic.
4-bit binary coded decimal, numeric.
Timing: Synchronous.
Pulse Repetition Rate: 2.2 megacycles.

Central processor (1000)

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory.

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.230
Multiply: 555555 by 5555	1.000
Divide: 3086108025 by 5555	1.760

Access time: 0.01 milliseconds (approx.).

Checking features: Automatic checking of all data transfers, arithmetic operations, order and memory selection, and magnetic tape safe conditions.

Error correcting feature: The system incorporates an automatic error correcting network, referred to as "Orthotronic Control," which provides the facility of correcting erroneous information obtained from magnetic tape.

Registers

7 addressable one-word registers:

Control register: Used to store each order during the time the order is being performed.

Output buffer register: Contains the first word which will be written on tape by the next instruction.

Extractor register: Contains the constant used for the extraction that is performed in the transfer and select orders.

Selection register: Contains the Transfer and Select instruction and the Internal Select instruction during and after their execution.

Remainder register: Used to store the low order product of a multiplication after it has been modified by rounding.

Sentinal register: A special register used in transfer and select, comparison, and multiplication operations.

Current order register: Used to store the address of the order being executed.

Memory

The basic magnetic core memory has a capacity of 2,000 words. An additional unit may be used to increase memory capacity to 4,000 words.

Control panel

This unit is a part of the control console (1090) and provides a means of controlling and monitoring operation of the system.

INPUT MEDIA

Note: Direct input-output to and from the central processor is obtained only through the use of magnetic tape. Conversions to and from punched cards, punched paper tape, etc. must be accomplished off-line.

Auxiliary central processor (1052, 1054, etc.)

This unit may be connected to the read-write unit of the central processor. It contains the switching circuitry necessary for connecting up to a maximum of 100 magnetic file units directly to the central processor.

File switching unit (1170)

This may be connected to the auxiliary central processor or the read-write unit of the central processor. It provides greater flexibility with which the magnetic file units may be connected to the various conversion media groups. The file switching unit can accommodate up to three magnetic file units and provides connections for an input unit, an output unit, and/or a file reference unit. It also permits the substitution of one of the magnetic file units connected to it for one of the magnetic file units connected to the central processor.

Magnetic file unit (1100)

Maximum number per system: 100.
Packing density: 230 bits per inch.
Number of channels: 31.
Record format: Fixed, 62 words.
Record gap: None (interlaced recording system).
Tape speed: 100 inches per second/60,000 numeric or 40,000 alphanumeric characters per second.
Rewind time: 5.5 minutes.
Start-stop time: 6.5 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
  Composition: Mylar.
  Length: 2,700 feet.
  Width: 3 inches.
Error detection: Weight count (4 bits per word).

File reference unit (1150)

This unit, with its associated Flexowriter, provides a means of obtaining information stored on magnetic tape without disturbing the operation of the central processor. The stored information is obtained through the use of the Flexowriter keyboard or paper tape reader for interrogating the file, and by printing out the desired information on the Flexowriter. This operation is performed off-line.

Punched card input system (1200)

This system consists of a punched card input converter and a card reader. The system converts the data contained on 80-column punched cards to magnetic tape at the rate of 900 cards per minute. A plugboard is used for format control.

Paper tape input system (1600)

This system consists of a paper tape input converter and a paper tape reader. The system converts the data contained on 5, 6, 7, or 8 level punched paper tape to magnetic tape at the rate of 1,000 characters per second.

Flexowriter

This unit is similar to an electric typewriter with paper tape reader and punch attachments. The paper tape reader, paper tape punch, and typing element operate at a rate of 10 characters per second. The Flexowriter is used to obtain a typed record of all information requested from or inserted into the system at the control console.

OUTPUT MEDIA

Magnetic file system

As previously described.

Output converter (1300)

This unit converts data contained on magnetic tape into a form suitable for actuating a printer adapter (1310) or a card punch adapter (1320). Editing and format flexibility are provided through control panels.

Printer adapter (1310)

This unit connects to the output converter (1300). The adapter actuates a line printer which operates at the rate of 150 lines per minute, 120 characters per line.

Card punch adapter (1320)

This unit connects to the output converter (1300). The adapter actuates an 80-column card punch which operates at the rate of 100 cards per minute.

Output printing system (1400)

This system consists of an output printing converter and a line printer. The system converts data contained on magnetic tape to printed form at the rate of 900 lines per minute, 120 characters per line.

Paper tape output system (1500)

This system consists of a paper tape output converter and a paper tape punch. The system converts data contained on magnetic tape to 5, 6, 7, or 8 level punched paper tape at the rate of 60 characters per second.

Flexowriter

As previously described.

PROGRAMMING

General: The DATAmatic 1000 uses a three address type of instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 12.
Total number of operation codes: 33 (67 variations).

Instruction word format

Memory designator	Operation code	Address A	Address B	Address C	Weight count
X	XX	XXX	XXX	XXX	X

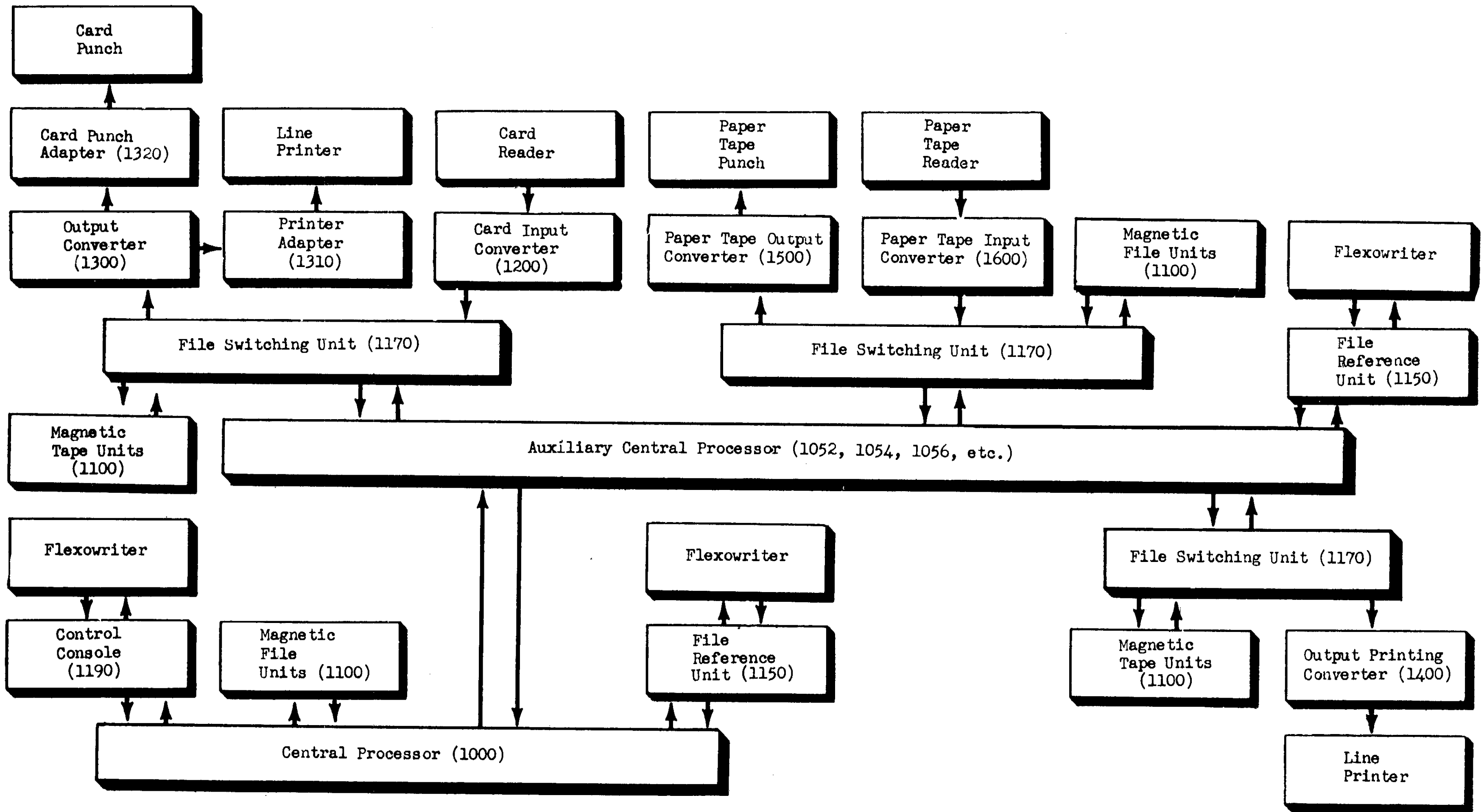
Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1000 Central Processor, including	$21,500	$985,000	$73,875				
a. Control Console				134x78x55	1,500	1.5	5,123
b. Arithmetic Unit				286x31x87	7,200	7.5	25,613
c. Control Unit				286x31x87	7,200	7.5	25,613
d. Core Storage Unit				286x31x87	7,350	8.0	27,300
e. Buffer Units				384x133x87	12,600	18.0	61,500
f. Read-Write Unit				255x31x87	7,000	5.0	17,075
1100 Magnetic File Unit	1,350	60,000	4,500	108x34x78	1,900	4.0	13,660
1150 File Reference Unit	1,075	50,000	3,750	60x34x38	400	1.5	5,123
1170 File Switching Unit	190	9,600	720	41x31x42	750	0.0	0,000
1200 Card Input System, including	3,325	185,000	13,875			7.0	23,905
a. Input Converter				237x31x87	6,315		
b. Card Reader				42x90x54	2,500		
1300 Output System, including	1,800	100,000	7,500			8.5	29,000
a. Output Converter				222x31x87	6,260		
b. Printer				71x31x57	2,915		
1310 Printer Adapter	200	13,000	975	7x21x9	35	(2)	(2)
1320 Card Punch Adapter, including	35	1,900	143			(2)	(2)
a. Unit 1				5x17x3	6		
b. Unit 2				3x14x3	5		
1400 Output Printing System, including	4,300	215,000	16,125			6.5	22,198
a. Output Converter				275x31x87	3,750		
b. Printer				58x32x52	600		
1500 Paper Tape Output System	1,775	92,300	6,923	109x31x87	2,370	3.3	819
1600 Paper Tape Output System	1,775	92,300	6,923	(3)	(3)	(3)	(3)
1052 Auxiliary Central Processor (Two Magnetic File Units)	2,220	100,000	7,500	(3)	(3)	(3)	(3)
1054 Auxiliary Central Processor (Four Magnetic File Units)	3,900	175,000	31,125	(3)	(3)	(3)	(3)
1056 Auxiliary Central Processor (Six Magnetic File Units)	5,500	250,000	18,750	(3)	(3)	(3)	(3)
1058 Auxiliary Central Processor (Eight Magnetic File Units)	6,600	295,000	22,125	(3)	(3)	(3)	(3)

1 Maintenance included in rental price. Maintenance price shown is per annum charge for purchased equipment.

2 Included in Output System (1300).

3 Information not available at this time.



NOTE: All input/output converters and file reference units operate off-line and are electrically connected to the central processor for switching purposes only.

BLOCK DIAGRAM OF DATAMATIC 1000

DIANA LABORATORY FOR ELECTRONICS, INCORPORATED

GENERAL DESCRIPTION

DIANA is a large-scale, general purpose digital computer employing both vacuum tube and solid state construction. Its chief characteristic is the availability of up to 330 magnetic file drums, with a capacity of 2,500,000 numeric characters each, for large random-access processing.

SYSTEM COMPONENTS

General

Word Length: Variable.
Numeric Characters: Variable.
Character Code: Binary coded decimal.
Timing: Synchronous (except file drums).
Pulse Repetition Rate: 150 kilocycles.

Central processor

Operation: Sequential and concurrent, fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.56
Multiply:	3.14
Divide:	4.83

Access time: 34 microseconds, to core storage; 11 milliseconds, to high-speed drum; 197 milliseconds, to file drum.

Checking features: Single bit errors are detected in all information and control paths except in the arithmetic unit. This includes input-output paths, and all data on the addressed file drum track.

Dual (parallel) arithmetic unit. If this unit is not included, arithmetic operations can be program-checked.

Registers

Product register: 12 digits plus sign.

Multiplier register: 12 digits plus sign.

Multiplicand register: 12 digits plus sign.

Transfer registers (12): Magnetic core, 10 alphanumeric characters each.

Memory

Internal working storage (OAST) consists of 200 to 10,000 positions of magnetic core storage. Average access time is 34 microseconds.

A high-speed magnetic drum is used for input-output buffering. This drum has a capacity of 6,000 characters, rotates at 100 revolutions per second, and has an average access time of 11 milliseconds.

The main data storage in the DIANA system consists of a maximum of 330 magnetic file drums, each with a capacity of 1,875,000 alphanumeric characters or 2,500,000 numeric characters. Access speed is 197 milliseconds.

INPUT MEDIA

Input to DIANA is by paper tape, at 300 characters per second; by keyboard, at manual speeds; and by punched cards, at 100 cards per minute. Magnetic tape may also be used as input, primarily to the random-access file drums. Their function in the DIANA system is to hold non-current data and provide duplicate security storage.

OUTPUT MEDIA

Output is by paper tape, at 60 characters per second; by line printer, at 150 lines per minute; and by punched cards, on-line typewriter, cathode ray tube viewer, and magnetic tape.

PROGRAMMING

General: DIANA is a two-address, stored program machine.

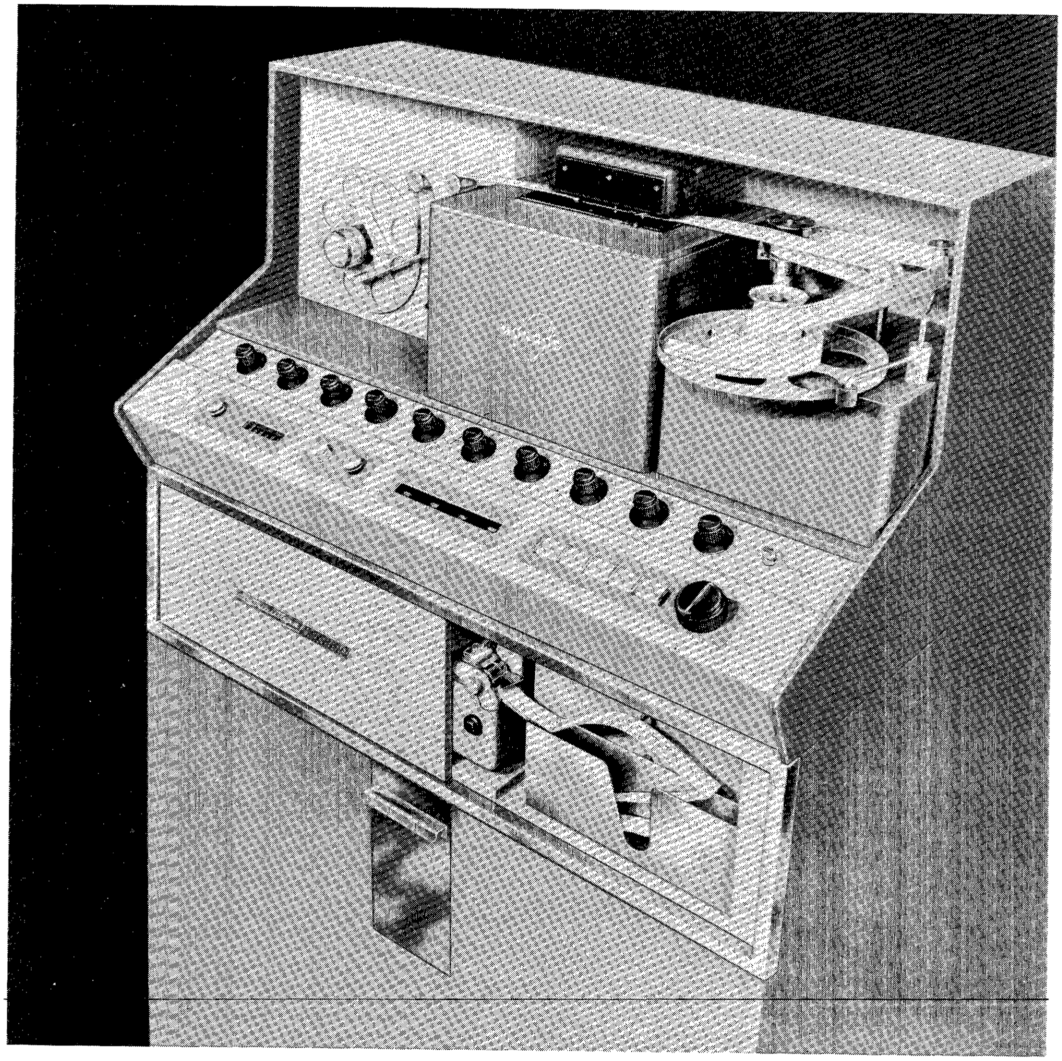
Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10 decimal digits.
Total number of operation codes: 20.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
DIANA Computer				12,000 cu. ft.	20,000	90	

DISTRIBUTAPE MONROE CALCULATING MACHINE COMPANY



THE DISTRIBUTAPE is a small, externally-programmed special purpose computer, designed to sort and summarize unit record data from punched paper tape. The DISTRIBUTAPE consists of a high-speed paper tape reader; a control console; an output paper tape perforator; and a processor section containing an arithmetic and logic unit, magnetic drum storage unit, and associated power units.

SYSTEM COMPONENTS

General

Word Length: 11 decimal digits plus sign.
Character Code: Binary.
Timing: Synchronous.

Central processor

Operation: Sequential, fixed point.
Checking features: Checking features include a paper tape parity check, a proof total balance check, and an instruction code sequence check.

Registers

Four fast-access registers are used for arithmetic operations and input data transfer.

Memory

The DISTRIBUTAPE has a magnetic drum storage unit with a capacity of 1,000 words. Drum rotation is 3,600 revolutions per minute, and average access time is eight milliseconds.

Control console

DISTRIBUTAPE console controls include:
Power switch
Tape start-stop buttons
Program selector

Total accumulator clear button
Transaction count reset button
Address controls.

INPUT MEDIA

Input to the Distributape is by punched paper tape, at 235 characters per second.

OUTPUT MEDIA

Paper tape punch-out is at the rate of 17 characters per second. A printing interpreter and accumulator is used for off-line conversion from paper tape to written copy.

PROGRAMMING

General: Programming of the DISTRIBUTAPE computer is controlled in part by instructions contained in input tapes, and in part by control switches.

Instructions:

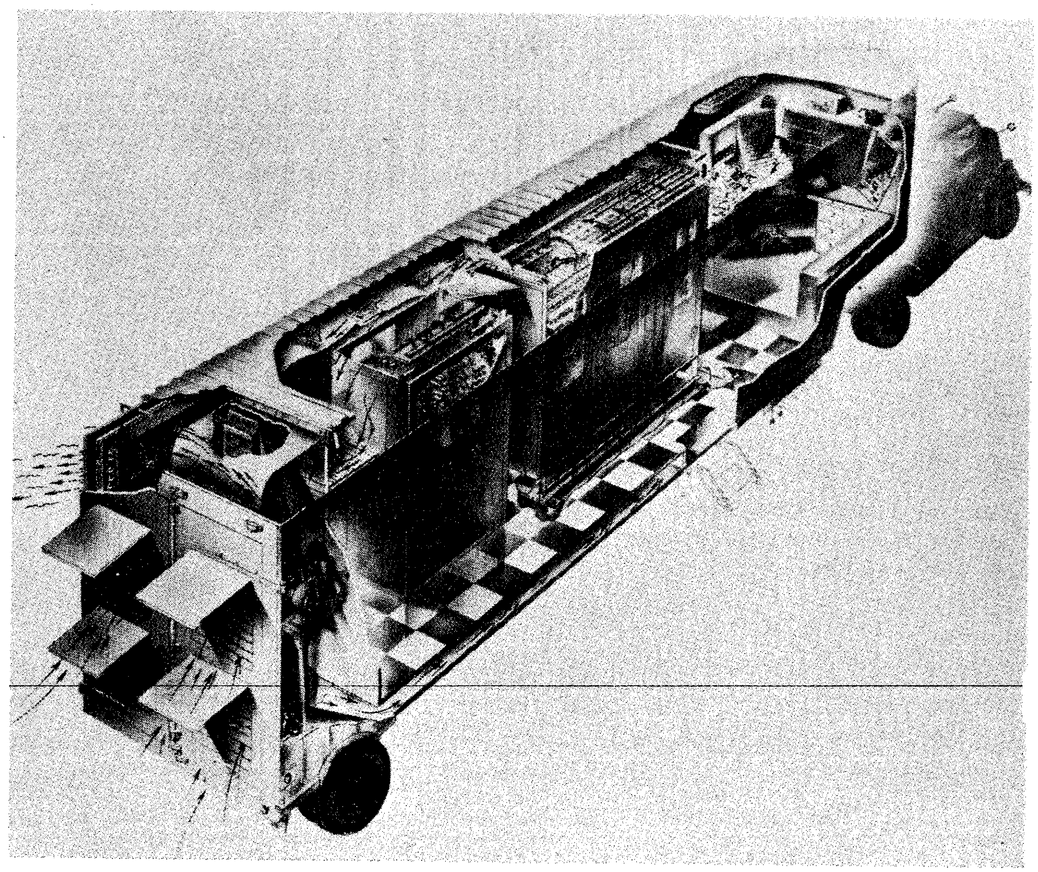
Number of instructions per word: 1.
Number of digits per instruction: 10.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
DISTRIBUTAPE Computer and Model 135 Printer	$1,250	$43,500	(1) $2,000/yr.	32½x35x55	580	2	----------

1 For customer-owned machines. Service is included in rental price.

DYSEAC NATIONAL BUREAU OF STANDARDS



GENERAL DESCRIPTION

DYSEAC is a trailer-housed general purpose digital computer which can be used for simulation and real-time control. Major elements in construction are vacuum tubes and crystal diodes. Included in the system are a central processor with mercury delay line memory, a control console, and magnetic wire and paper tape input-output units.

SYSTEM COMPONENTS

General

Word Length: 45 binary digits plus check bit.
Character Code: Binary.
Timing: Synchronous.
Pulse Repetition Rate: One megacycle per second.

Central processor

Operation: Fixed point; sequential except concurrent input-output-compute.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.192 to 1.536
Multiply:	2.304 to 3.648
Divide:	2.304 to 3.648

Access time: 48 to 384 microseconds.

Checking features: Fixed: Odd-even parity check on storage. Optional: Error detection print-out or program branch.

Registers

Registers in DYSEAC include three fast-access word registers, and two counter-registers used for program sequencing.

Memory

DYSEAC storage consists of mercury delay lines with a capacity of 512 words (24,576 digits) and an access time of 48 to 384 microseconds. There is provision in the system for up to 4,096 words of high-speed memory.

Control console

A control console is part of the DYSEAC system, and includes indicator lights, switches, and an on-line typewriter for data entry and error and memory type-out.

INPUT MEDIA

DYSEAC input is by means of a manual keyboard; paper tape reader, at 10 characters per second; and by magnetic wire, at 3,500 digits per second.

OUTPUT MEDIA

Output is by typewriter (Flexowriter), at 10 alphanumeric characters per second; by paper tape punch, at 60 characters per second; by CRT display, at 2,000 words per second; and by magnetic wire, at 3,500 digits per second.

PROGRAMMING

General: DYSEAC is a three-address stored program machine.

Instructions:

Number of instructions per word: 1.

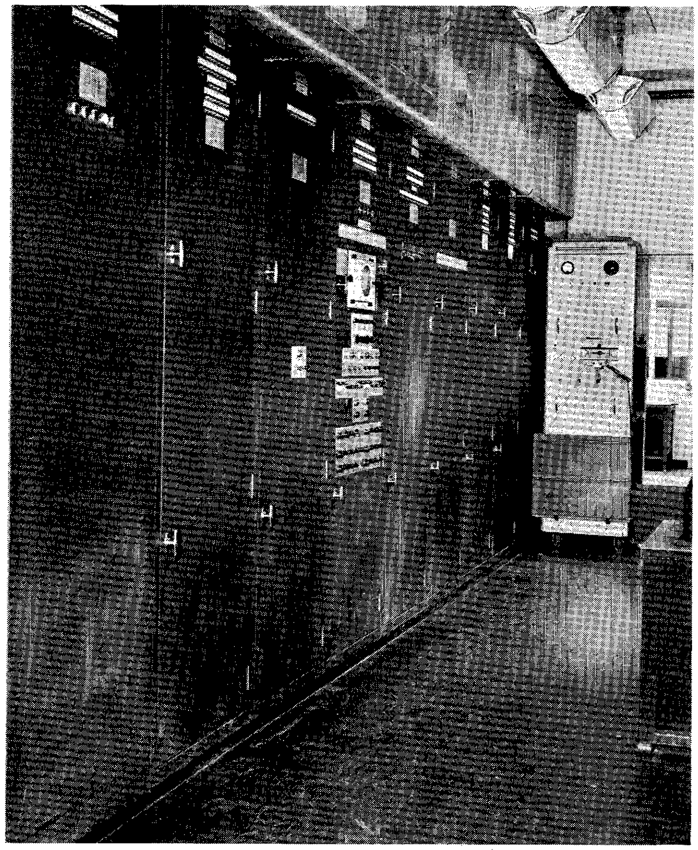
Number of digits per instruction: 45 binary digits plus check bit.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Complete DYSEAC System, including Control Console, Central Processor, and Input-Output Units				270 cu. ft.	(1)	20	

[1] DYSEAC is housed in two trailer vans, the loaded combined weight of which is 20 tons. A 12-ton van houses the computer system; an 8-ton van carries power supplies.

EDVAC MOORE SCHOOL OF ELECTRICAL ENGINEERING



EDVAC is a general purpose scientific digital computer of vacuum tube construction. First placed in operation in 1949, it consists of a central processor with both mercury delay line and magnetic drum storage, a magnetic tape system, and other input-output units.

SYSTEM COMPONENTS

General

Word Length: 44 binary digits.
Character Code: Binary.
Timing: Synchronous.
Pulse Repetition Rate: 1 megacycle per second.

Central processor

Operation: Sequential, floating and fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.864
Multiply:	2.880
Divide:	2.930

Access time: 48 to 384 microseconds for mercury delay line; 17 milliseconds for magnetic drum.

Checking features: Dual arithmetic units halt machine on unequal result comparison; unused commands halt machine; paper tape reader error detection; address halt.

Registers

EDVAC contains four rapid access word registers.

Memory

Memory devices in EDVAC include a mercury delay line storage, with a capacity of 1,024 words and an access time of 48 to 384 microseconds, and a 4,608-word capacity magnetic drum, with an access time of 17 milliseconds.

INPUT MEDIA

Photoelectric paper tape reader

78 words per second. 5-channel tape is used.

Punched card reader (IBM)

146 cards (8 words per card) per minute.

Magnetic tape units

Maximum number per system: 7.
Packing density: 112 characters per inch.
Number of channels: 8.
Record length: Variable, from 2 to 1,024 words.
Record gap: 1½ inches.
Tape speed: 75 inches per second.
Start/stop time: 3 milliseconds.
Physical characteristics of tape:
  Composition: Red Oxide.
  Length: 1,250 and 2,500 feet.
  Width: ⅝ inch.

OUTPUT MEDIA

Paper tape perforator

30 words per minute.

Teletypewriter

30 words per minute.

Card punch

125 cards (1,000 words) per minute.

Magnetic tape units

As previously described.

PROGRAMMING

General: EDVAC is a four-address, stored program computer.

Instructions:
  Number of instructions per word: 1.
  Number of digits per instruction: 44 binary digits.
  Total number of operation codes: 16.

Instruction word format

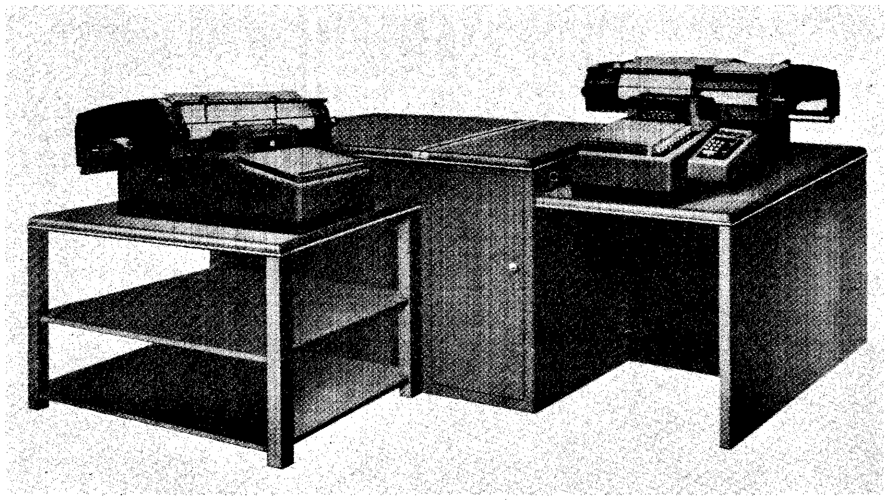
Operation	Address	Address	Address	Address
(4)	(10)	(10)	(10)	(10)

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
EDVAC Basic System	....	\$467,000 ([1])	....	([2])	17,300	52	....

[1] Approximate cost.
[2] 490 square feet of floor space are required.

ELECOM 50 UNDERWOOD CORPORATION



THE ELECOM 50, now out of production, is a small, desk-sized business computer of vacuum tube construction, utilizing keyboard and paper tape input-output and magnetic drum storage.

SYSTEM COMPONENTS

General

Word Length: 10 decimal digits plus sign.
Numeric Characters: 10.
Character Code: Decimal.
Timing: Synchronous.
Pulse Repetition Rate: 67 kilocycles per second.

Central processor

Operation: Sequential, fixed point.
Computation speed: (Excluding storage access):

	Average time (milliseconds) Fixed point
Add:	.65
Multiply:	39.0

Access time: 33 milliseconds to main drum storage; 325 microseconds to rapid access drum.

Registers

Three rapid-access registers are provided on a magnetic drum having an access time of 325 microseconds. Each register has a capacity of one word (10 decimal digits and sign).

Memory

Main memory in the ELECOM 50 is a magnetic drum, with an access time of 33 milliseconds. Capacity of the drum is 100 words (1,000 decimal digits).

INPUT MEDIA

Input to the computer is by keyboard, at manual speed, and by punched paper tape, at 20 digits per second.

OUTPUT MEDIA

Output is by punched paper tape, at 2 digits per second, and by two printers operating in parallel at 10 characters per second.

PROGRAMMING

General: ELECOM 50 may be programmed by means of interchangeable program tapes holding up to 2,400 program steps.

Instructions:

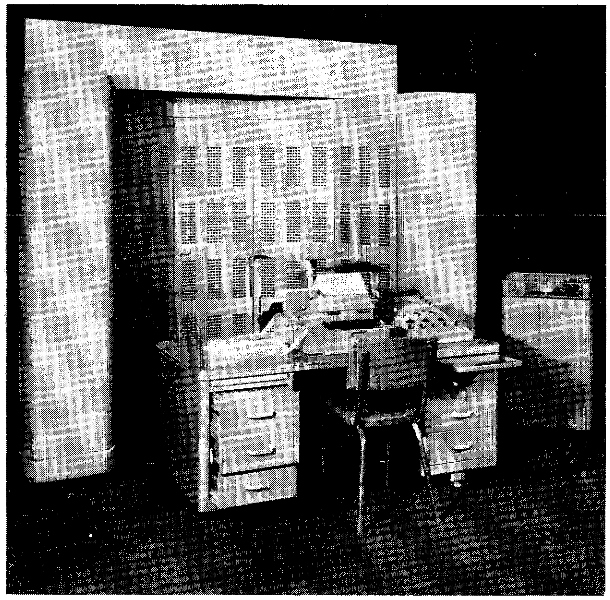
Total number of operation codes: 42 plus combinations.

Cost, Power Requirements, and Physical Characteristics

Item		Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
ELECOM 50 Basic System	....	\$600 (1)	\$22,500 (2)	....	50 cu. ft.	750	2	....

[1] As of June, 1957.
[2] Approximate.

ELECOM 100 UNDERWOOD CORPORATION



THE ELECOM 100, which is no longer in production, is a small-scale computer of vacuum tube construction, designed for engineering and scientific applications. The system utilizes both magnetic drum and magnetic tape storage.

SYSTEM COMPONENTS

General

Word Length: 30 binary digits.
Character Code: Binary.
Timing: Synchronous (magnetic drum); asynchronous (magnetic tape).
Pulse Repetition Rate: 100 kilocycles per second.

Central processor

Operation: Sequential, fixed point.

Computation speed: 25 to 50 operations per second may be performed, including drum storage access.

Checking features: Checking features include overflow indication and halt; "out of synchronism" for tape and halt; and engineering diagnostic tests.

Memory

ELECOM 100 memory consists of a 512-word magnetic drum, with an access time of 20 milliseconds, and magnetic tape with a capacity of 60,000 words. A 64-word block transfer of data between tape and drum requires approximately two seconds.

INPUT MEDIA

Input to ELECOM 100 is by keyboard, at manual speed, and by punched paper tape, at 7.5 octal digits per second.

OUTPUT MEDIA

Output is by on-line typewriter at 7.5 characters per second.

PROGRAMMING

General: The ELECOM 100 computer uses a three-address type of instruction.

Instructions:

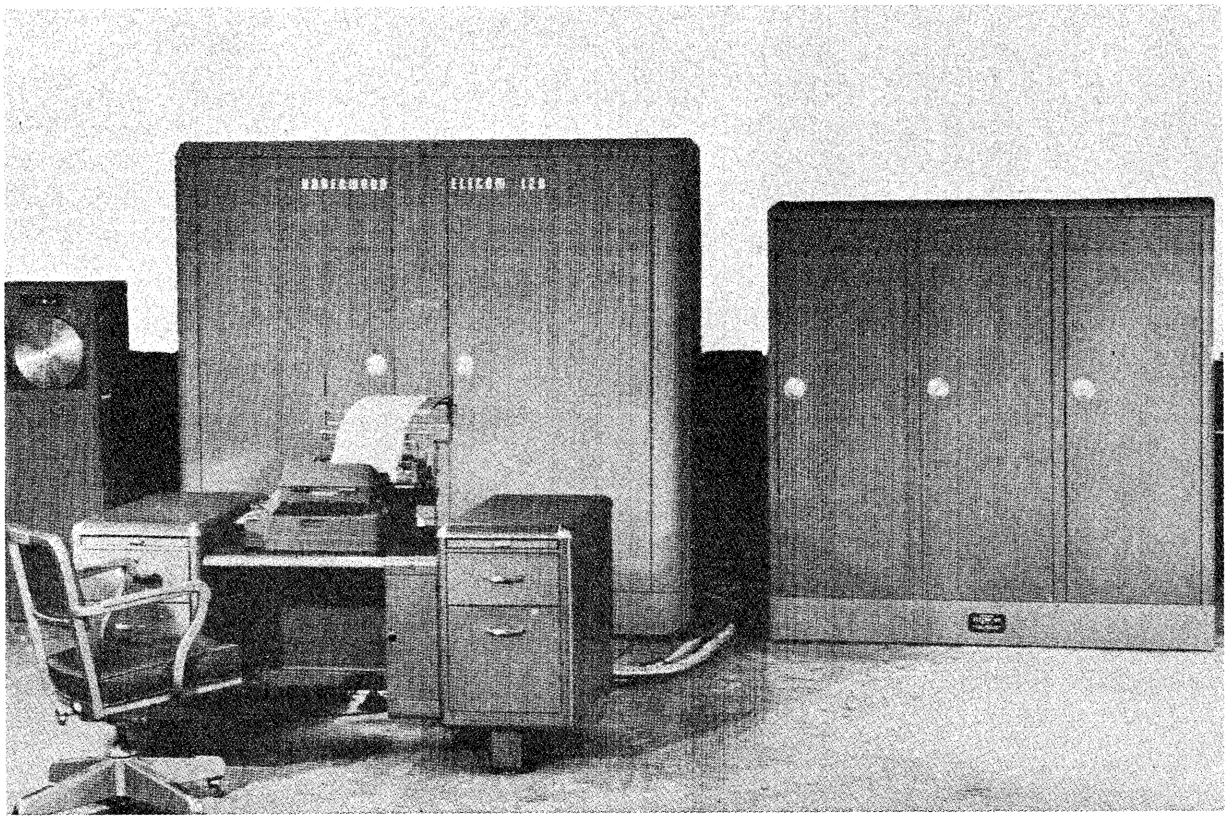
Number of instructions per word: 1.
Number of digits per instruction: 30 binary digits.
Total number of operation codes: 8.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
ELECOM 100 Basic System	(1)	$60,000 (2)		1,200 cu. ft.		3.5	

1 No longer in production.
2 Approximate.

ELECOM 120 MINNEAPOLIS HONEYWELL REGULATOR COMPANY



THE ELECOM 120 is a small to medium sized computer of vacuum-tube construction. It utilizes magnetic drum storage, and was designed to accommodate engineering and scientific applications.

SYSTEM COMPONENTS

General

Word Length: 8 decimal digits plus sign.
Numeric Characters: 8 plus sign.
Character Code: Binary.
Timing: Synchronous.
Pulse Repetition Rate: 105 kilocycles per second.

Central processor

Operation: Sequential, fixed floating point.

Computation speed: (Excluding storage access):

	Average time (milliseconds) Fixed point
Add:	.33
Multiply:	18.30
Divide:	18.70

Access time: 8.3 milliseconds to main drum storage.

Checking features: Checking features include internal check for forbidden pulse combinations; check of drum-writing operations; and parity check on tapes with automatic re-read.

Registers

The ELECOM 120 includes three rapid access registers, each with a capacity of one word.

Memory

The basic ELECOM 120 system uses two magnetic drums. The main storage drum has a capacity of 1,000 to 10,000 eight-digit words, and an average access time of 8.3 milliseconds. A small fast-access drum has a capacity of 10 to 100 words, and an average access time of 1.67 milliseconds.

Control desk

A control desk is provided in the basic ELECOM 120 system, and includes an on-line typewriter for entry of data into the computer and for error and result typeout.

INPUT MEDIA

Input to the ELECOM 120 is by typewriter, at manual speed and at eight characters per second; by paper tape reader (optional), at eight to 400 characters per second; and by magnetic tape at 400 characters per second. One magnetic tape unit is provided as part of the basic system; control circuits are also included for additional units.

OUTPUT MEDIA

Output is by on-line typewriter, at eight characters per second; punched paper tape (optional), at eight or 60 characters per second; and by magnetic tape, at 400 characters per second.

PROGRAMMING

General: ELECOM 120 uses a two-address type of instruction.

Instructions:

Number of instructions per word: 1.

Number of digits per instruction: 10.

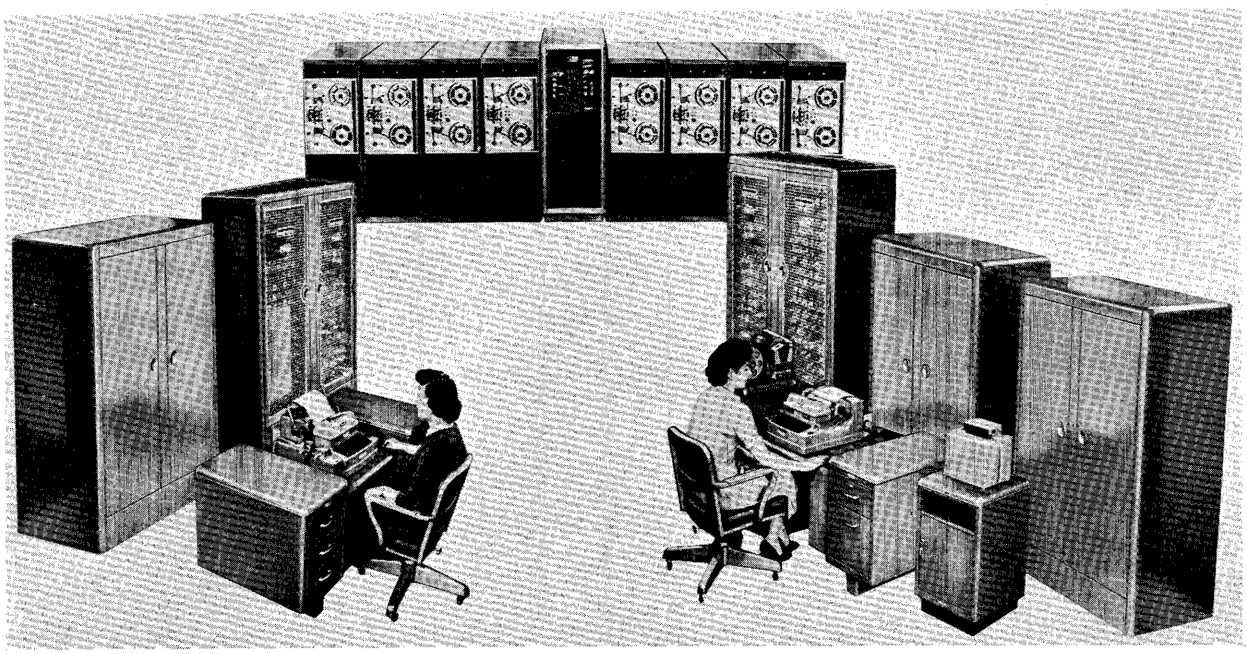
Total number of operation codes: 33.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
ELECOM 120 Basic System, With Control Desk and One Magnetic Tape Unit	(1) $3,500	(2) $97,000	(3)	200 cu. ft.	3,500	5 to 7	

1 System is no longer in production.
2 Approximate.
3 Maintenance is included in monthly rental.

ELECOM 125 & 125 FP UNDERWOOD CORPORATION



THE ELECOM 125 is a small-to-medium sized computer system of vacuum tube construction. It utilizes a magnetic drum storage and magnetic tape input. The ELECOM 125 FP is a File Processor designed for use with the 125 computer. Designed for business applications, the 125 FP performs search, collate, and sort operations as an adjunct to the 125 central processor.

SYSTEM COMPONENTS

General

Word Length: 10 decimal digits plus sign.
Numeric Characters: 10.
Character Code: Decimal.
Timing: Synchronous.
Pulse Repetition Rate: 132 kilocycles per second.

Central processor

Operation: Sequential, fixed point (floating point optional).

Computation speed: (excluding storage access)

	Average time (milliseconds) Fixed point
Add:	.33
Multiply:	18.30
Divide:	18.70

Access time: 8.3 milliseconds to main magnetic drum.

Checking features: Checking features include internal check for forbidden pulse combination; parity tape check with automatic re-read; and, on the 125 FP, parity check on all data transfers.

Registers

The ELECOM 125 and the 125 FP have three rapid access registers, each with a capacity of one word (10 decimal digits and sign). Two four-digit index registers are also included as standard equipment.

Memory

Both ELECOM models have a main magnetic drum memory, with a capacity of 4,000 to 10,000 words and an average access time of 8.3 milliseconds, and a fast access magnetic drum, with a capacity of 50 to 100 words and an average access time of 1.67 milliseconds. The ELECOM 125 FP has a 100-word acoustic delay line.

Control desks

The 125 computer and 125 FP file processor each have a control desk containing an on-line typewriter for entry of data into the system and for typed output from the system.

INPUT MEDIA

Input is by the following media:

Typewriter (standard), at manual speed and at eight characters per second.
Paper tape (standard), at eight characters per second.
Paper tape (optional), at 400 characters per second.
Magnetic tape (standard), at 6,000 characters per second.
Punched cards (optional).

OUTPUT MEDIA

Output is by the following media:

Typewriter (standard), at eight characters per second.
Paper tape (standard), at eight characters per second.
Paper tape (optional), at 60 characters per second.
Magnetic tape (standard), at 6,000 characters per second.
Punched cards (optional).
On-line printer (IBM 407 — optional).

PROGRAMMING

General: The ELECOM 125 uses a two-address type of instruction.

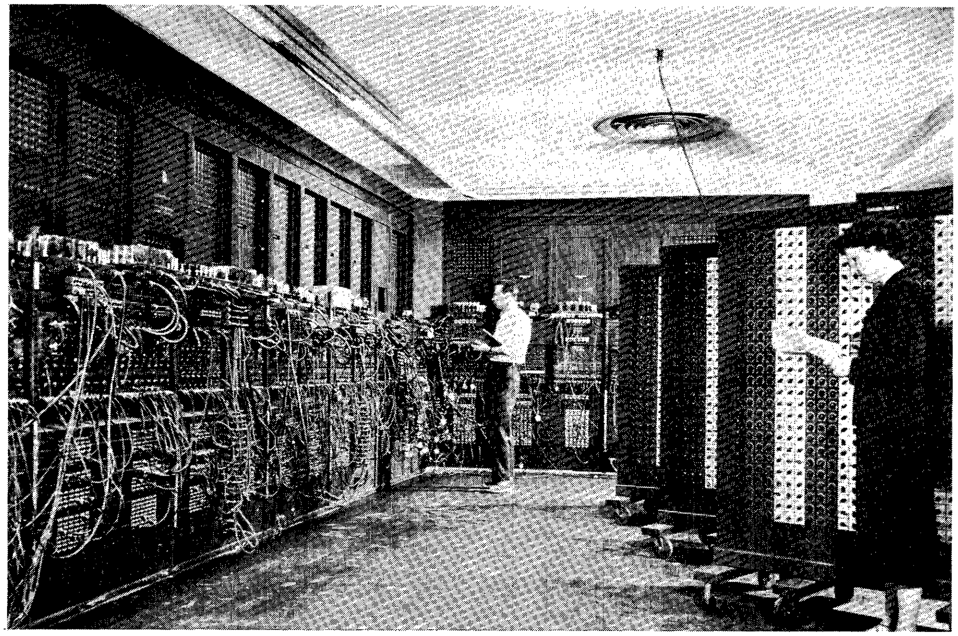
Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10.
Total number of operation codes: 36.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
ELECOM 125 Computer	$4,185	$155,000		400 cu. ft.	4,000	5 to 7	
ELECOM 125 FP File Processor	2,295	85,000		200 cu. ft.		7	

ENIAC MOORE SCHOOL OF ELECTRICAL ENGINEERING



ENIAC, the first large scale general purpose digital electronic computer, was placed in operation for demonstration purposes in 1946, at the Moore School of Electrical Engineering, University of Pennsylvania, and was installed the following year at the Ballistic Research Laboratories, United States Army Ordnance Corps. It consisted of a central processor, containing 18,000 vacuum tubes and 1,500 electromechanical relays, and eighty-column card reading and punching apparatus.

SYSTEM COMPONENTS

General

Numeric Characters Per Word: 10 plus sign.
Timing: Synchronous.
Pulse Repetition Rate: 100 kilocycles.

Central processor

Operation: Parallel, fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	0.2
Multiply:	0.2
Divide:	2.8
Access time:	0.1

Checking features: All internal checking was programmed.

Registers

ENIAC contained twenty ten-position accumulators, which served for both memory and arithmetic unit.

Memory

Up to 200 digits of data were stored in vacuum tubes. Instruction store was through electromechanical switches and plugboards.

INPUT MEDIA

Problem data was fed into ENIAC via eighty-column punched cards. Instructions were manually set in switches and wiring.

OUTPUT MEDIA

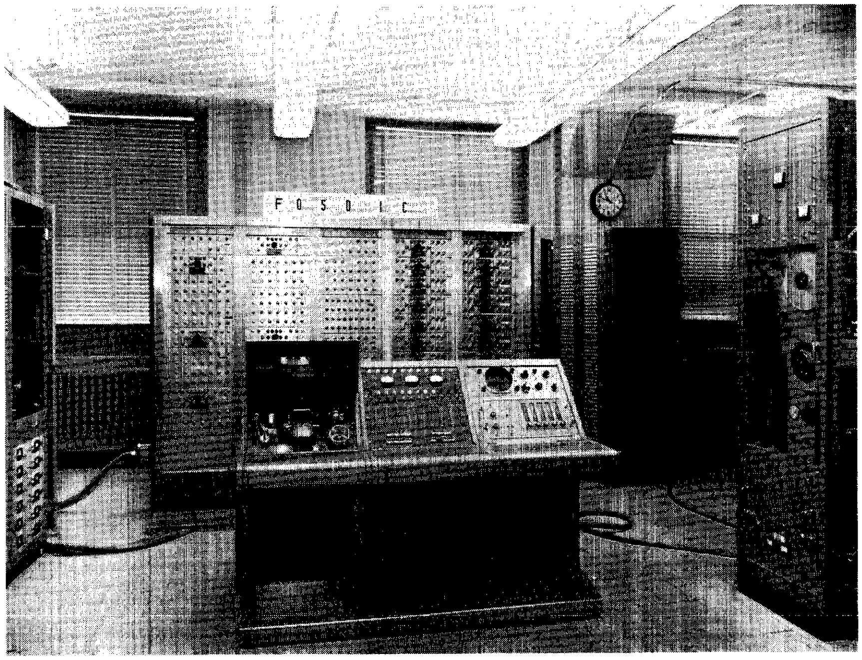
Output was by punched card, for subsequent off-line listing.

PROGRAMMING

General: ENIAC used a single address type of instruction.

Instructions: 94 two-digit instructions were available for programming ENIAC. Sequencing and storage of instructions was accomplished through external wiring and switches.

FOSDIC NATIONAL BUREAU OF STANDARDS



FOSDIC is used for reading and conversion of microfilm copies of Decimal Census Schedules (position marked documents) to magnetic tape, for subsequent computer input. FOSDIC consists of a Scan Unit, of conventional vacuum tube construction; a Program Control Unit, constructed of solid state components mounted on printed circuit boards; a control console; and input-output devices.

SYSTEM COMPONENTS

General

Word Length: Variable.
Character Code: Binary coded decimal.

Central processor

Checking features: Numerous scan, magnetic tape and program interlocks are used plus sprocket and parity checking on magnetic tape output.

Memory

FOSDIC contains temporary fast storage by means of flip-flops.

Control console

The control console contains a microfilm (roll) reading device for input to the system, and indicator lights and switches used for operator control of the system.

INPUT MEDIA

Input to FOSDIC is by microfilm (roll) reader, at two to four frames per second. The reader utilizes flying spot tube scanning.

OUTPUT MEDIA

Output from FOSDIC is via magnetic tape, at up to 2,376 characters per second, the speed depending on the amount of document information converted. Magnetic tape format is UNIVAC compatible, 100 pulses per inch, in 720-character blocks in fixed format.

PROGRAMMING

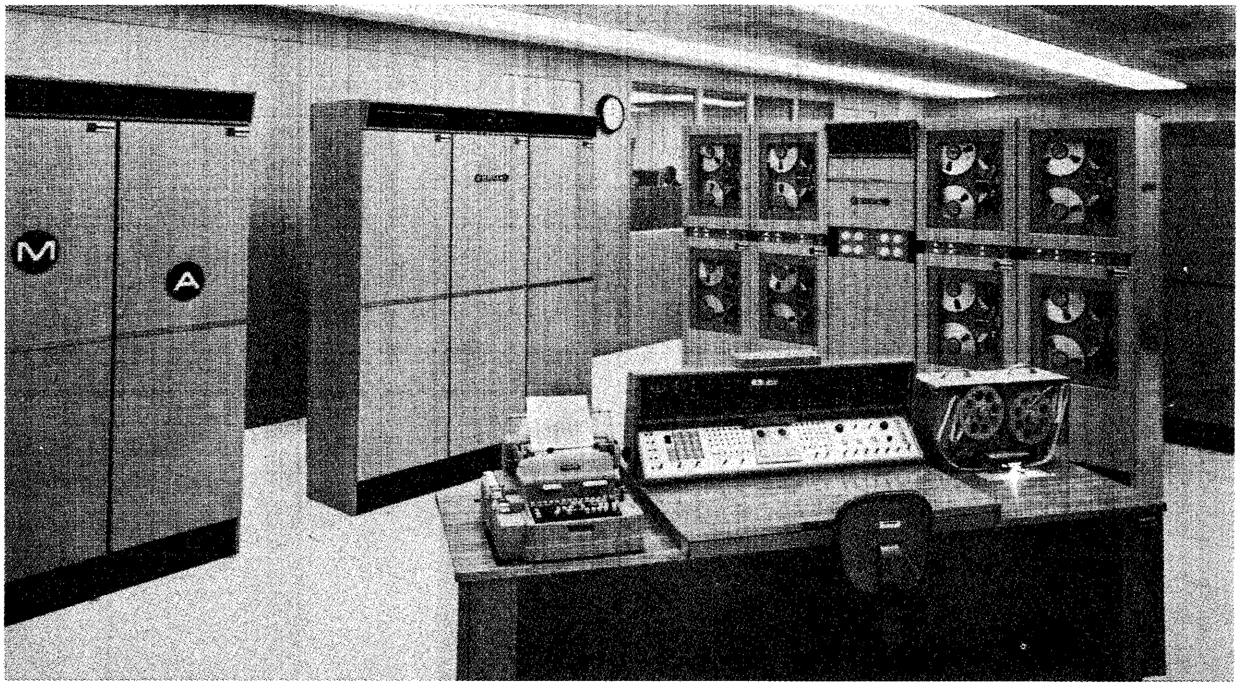
General: FOSDIC is plugboard controlled.
Instructions: Total number of operation codes: 45.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
FOSDIC Basic System		$126,000 (1)		3,000 cu. ft.		5	

[1] Approximate development cost.

GE 100 ERMA GENERAL ELECTRIC COMPANY



THE GE 100 ERMA is a large scale, transistorized, general purpose digital computer with a particular configuration of peripheral equipment which enables it to perform demand deposit accounting and other banking applications. It employs 4,000 words of magnetic core storage, a monitoring and control console, magnetic tape handling equipment, paper tape photoreader and punch, magnetic ink encoded document handling equipment, and line printer.

SYSTEM COMPONENTS

General

Word Length: 6 decimal digits.
Numeric Characters: 6.
Alphabetic Characters Per Word: 3.
Character Code: Binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 250 kilocycles per second.

Central processor

Operation: Concurrent, fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.064
Multiply:	.550
Divide:	1.200

Access time: 32 microseconds.

Checking features: Internal checking is performed on all operations by the Modulo-3 method. A two-way parity check is performed in all magnetic tape operations.

Registers

N Location of next instruction.
M Input and output memory transfer.
J Memory buffer.
I Contains current instruction.
R Accumulator.
L Used with R for double length word operations.
B Address portion on instruction.
P Peripheral buffer.

Memory

The GE 100 memory is magnetic core with a capacity of 4,000 words and an access time of 32 microseconds.

Control console

The console of the GE 100 contains indicator lights and switches, and an on-line console typewriter which may be used for both manual input and typed output. A paper tape reader is attached to the console typewriter.

INPUT MEDIA

Magnetic tape units

Maximum number per system: 8.

Packing density: 250 characters per inch.
Number of channels: 11.
Record gap: 1 inch.
Tape speed: 60 inches per second; 30,000 decimal digits per second.
Start/stop time: 4.5 milliseconds.
Rewind time: Maximum 4½ minutes for 3,600 foot reel.

MICR document handler

This 12-pocket unit is used off-line for sorting magnetically encoded documents, and is also used for on-line input from these documents to the GE 100 central processor. While in use on-line, the central processor may be utilized to determine and signal the disposition of documents to sorting pockets in the document handler. Reading magnetic type font E-13B, the document handler operates at a speed of 750 documents per minute. An input of 1,500 documents per minute can be achieved through use of two document handlers operating on-line, simultaneously, under central processor control.

Paper tape

200 characters per second.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Punched tape

60 characters per second.

Console typewriter

10 characters per second.

Hi speed self editing printer (off-line)

Numeric lines per minute: 900.
Alphanumeric lines per minute: 600.
Characters per line: 120.

AUXILIARY COMPONENTS

Off-line printers

PROGRAMMING

General: The GE 100 ERMA uses a single-address type of instruction. Some automatic subroutines are built-in.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 6.

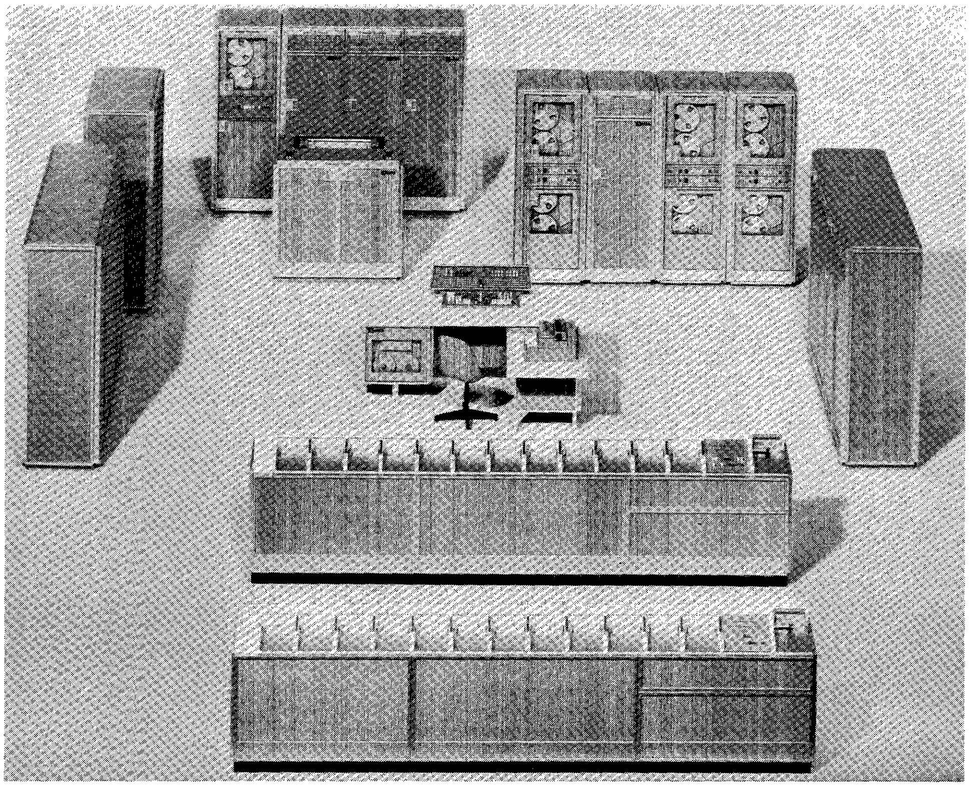
Instruction word format

Sign / Designator	Operation Code		Operand Address			
Mod						
3						

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
GE 100 ERMA Central Processor and Power Supply				101x28x76			
Control Console				84x70x42			
Paper Tape Photoreader							
Document Handler				180'x36x38			
Document Reader							
Magnetic Tape Transport							
30 KC							
50 KC				(123x28x76			
Magnetic Tape Controller				(8 tapes))			
30 KC							
50 KC							
Card Reader				27x28x45			
Paper Tape Punch				27x28x45			
72-Column Printer				27x28x46			
Computer-Edited Printer				50x29x54			
Self-Editing Printer				50x29x54			
Re-entry Printer				50x29x54			
					10,000	22	82,900

GE 210 GENERAL ELECTRIC COMPANY



THE GE 210 is a large scale, transistorized, general purpose digital computer consisting of a central processor with magnetic core storage, a monitoring and control console, magnetic tape handling equipment, MICR magnetic encoded document handling equipment, punched card and paper tape units, and line printers. The GE 210 was developed from the GE 100 ERMA processor.

SYSTEM COMPONENTS

General

Word Length: 6 decimal digits.
Numeric Characters: 6.
Alphabetic Characters Per Word: 3.
Character Code: Binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 250 kilocycles per second.

Central processor

Operation: Concurrent, fixed point.

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.064
Multiply:	.550
Divide:	1.200

Access time: 32 microseconds.

Checking features: Internal checking is performed on all operations by the Modulo-3 method. A two-way parity check is performed on all magnetic tape operations.

Registers

N Location of next instruction.
M Input and output memory transfer.
J Memory buffer.
I Contains current instruction.
R Accumulator.
L Used with R for double length word operations.
B Address portion of instruction.
P Peripheral buffer.

Memory

The GE 210 memory is a magnetic core unit with a capacity of 4,000 or 8,000 words (24,000 or 48,000 digits) and an access time of 32 microseconds per word.

Control console

The console of the GE 210 contains indicator lights and switches, and an on-line console typewriter which may be used for both manual input and typed output. A paper tape reader is attached to the console typewriter.

INPUT MEDIA

Magnetic tape unit

Maximum number per system: 13.
Packing density: 250 alphanumeric characters or 500 decimal digits per inch.
Number of channels: 11.
Record gap: 1 inch.
Tape speed: 60 or 100 inches per second; 30,000 or 50,000 decimal digits per second.
Start/stop time: 4.5 milliseconds.
Rewind time: Maximum of 4½ minutes for 3,600 foot reel.
Physical characteristics of tape:
Composition: Mylar.
Length: 1,200, 2,400, or 3,600 feet.
Width: ¾ inch.

MICR document handler

This 12-pocket unit is used off-line for sorting magnetically encoded documents, and is also used for on-line input from these documents to the GE 210 central processor. While in use on-line, the central processor may be utilized to determine and signal the disposition of documents to sorting pockets in the document handler. Reading magnetic tape font E-13B, the document handler operates at a speed of 1,200 documents per minute. An input of 2,400 documents per minute can be achieved through use of two document handlers operating on-line, simultaneously, under central processor control.

MICR document reader

The document reader (two pockets) also reads E-13B type font at 1,200 documents per minute, and is used for input to the central processor in cases where document sorting is not required.

Other GE 210 input includes paper tape, at 200 or 500 characters per second; punched cards, at 400 or 1,500 cards per minute; and manual entry via the console typewriter.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Paper tape

60 characters per second.

Console typewriter

10 characters per second.

Four high-speed printers:

72-column printer (on-line)

Numeric lines per minute: 1,200.
Alphanumeric lines per minute: 600.
Characters per line: 72.

Computer-edited printer (on or off-line)

Numeric lines per minute: 1,000.
Alphanumeric lines per minute: 1,000.
Characters per line: 120.

Self-editing printer (on or off-line)

Numeric lines per minute: 900.
Alphanumeric lines per minute: 600.
Characters per line: 120.

Re-entry printer (on or off-line) (Gothic and E-13B fonts)

Lines per minute, Gothic: 1,000.
Lines per minute, E-13B: 500.

AUXILIARY COMPONENTS

Off-line printers

PROGRAMMING

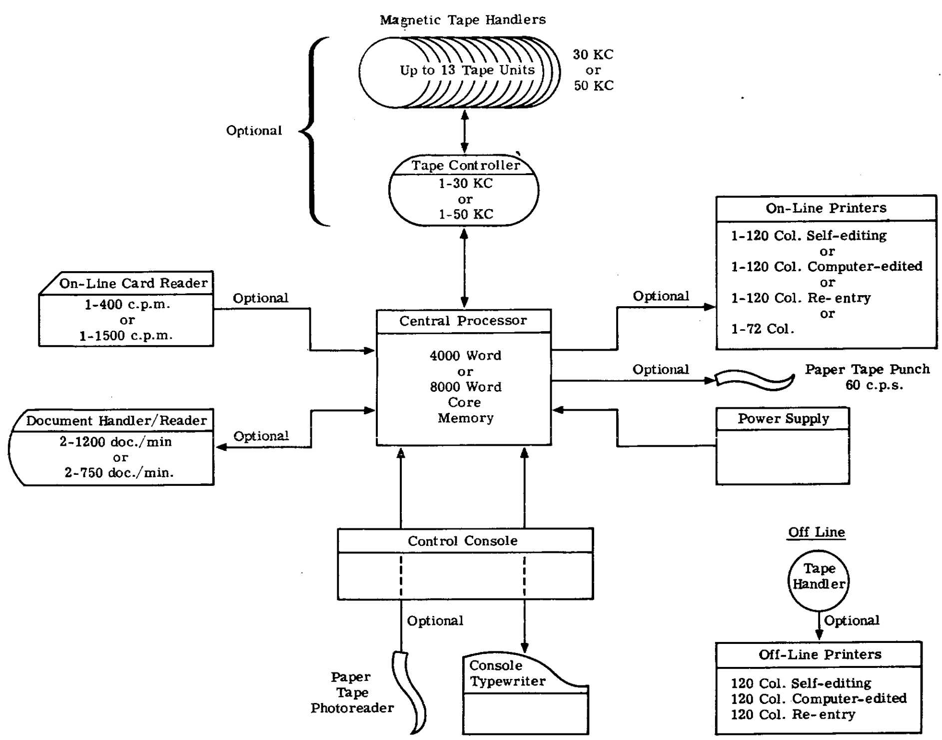
General: The GE 210 uses a single-address type of instruction. Some automatic subroutines are built-in.
Instructions:
Number of instructions per word: 1.
Number of digits per instruction: 6.
Total number of operation codes: 124.

Instruction word format

<table>
<tr><td>Sign</td><td colspan="2" rowspan="2">Operation Code</td><td colspan="4" rowspan="2">Operand Address</td></tr>
<tr><td>Designator</td></tr>
<tr><td>Mod</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>3</td></tr>
</table>

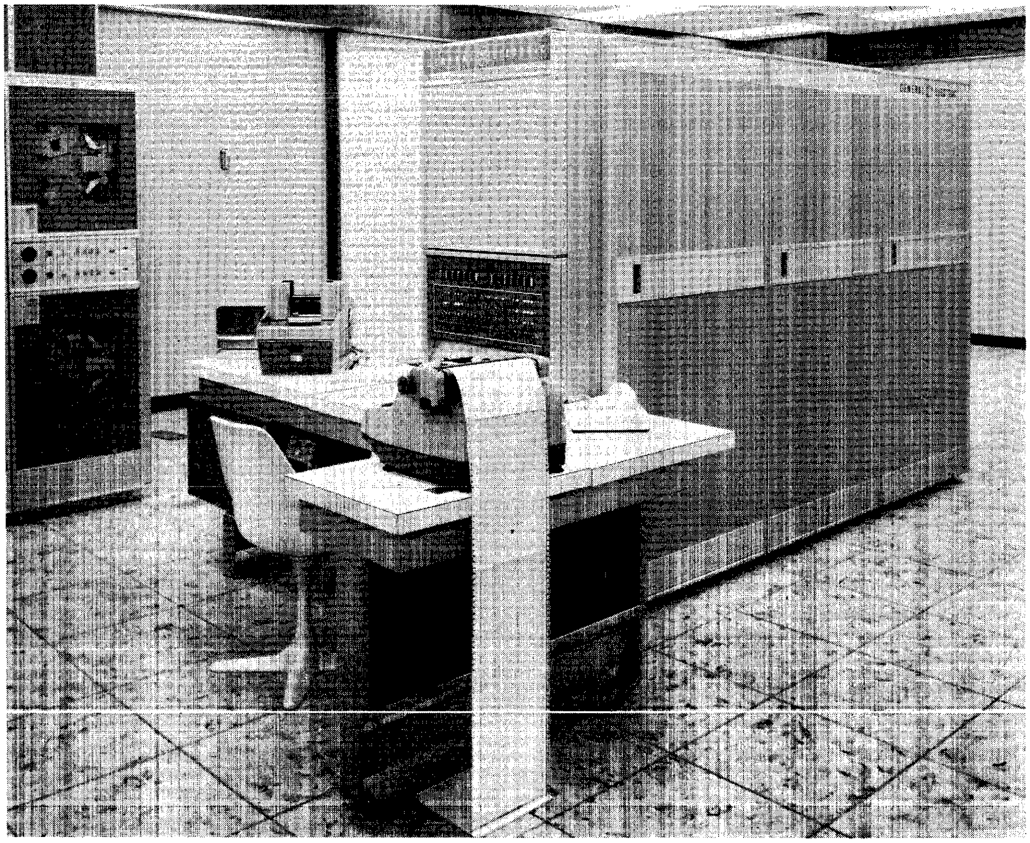
Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
GE 210 Central Processor and Power Supply				101x28x76			
Control Console				84x70x42			
Paper Tape Photoreader							
Document Handler				151x36x38			
Document Reader							
Magnetic Tape Transport							
30 KC							
50 KC				123x28x76			
Magnetic Tape Controller				(8 tapes)			
30 KC							
50 KC							
Card Reader				27x28x45			
Paper Tape Punch				27x28x45			
72-Column Printer				27x28x46			
Computer-Edited Printer				50x29x54			
Self-Editing Printer				50x29x54			
Re-entry Printer				50x29x54			
					10,000	22	82,900



BLOCK DIAGRAM OF GE 210

GE 225 GENERAL ELECTRIC COMPANY



THE GE 225 is a general purpose digital computer utilizing transistor and magnetic core components. It consists of a central processor, control console, and a complete line of input-output units. All inputs and outputs are buffered. An auxiliary arithmetic unit is available, permitting input from all types of peripheral equipment, computing, additional computing, and output to all types of peripheral equipment — all to operate simultaneously. Dual instructions are provided to perform arithmetic, card reading, card punching, magnetic tape reading and writing, in both the decimal and binary modes.

SYSTEM COMPONENTS

General

Word Length: 19 binary digits plus sign plus parity bit.
Numeric Characters: 5.
Alphabetic Characters Per Word: 3.
Character Code: Binary or binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 250 kilocycles per second.

Central processor

Operation: Sequential, fixed point (floating point optional). Input-output is concurrent with computing.

Computation speed: (Program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.036
Multiply:	.225
Divide:	.450

Access time: 18 microseconds to magnetic core.

Checking features: Parity check of all information transfers; horizontal and vertical parity checks on magnetic tape.

Registers

The GE 225 includes the following registers:

- A An accumulator
- Q Used for double-length operations
- M Memory location
- N Output register for typing, paper tape I/O
- I Instruction register

B Memory buffer (holds data during arithmetic operations)

P Instruction counter

Also included are three registers for automatic instruction modification. 96 index registers are optional.

Memory

The GE 225 utilizes magnetic core memory with capacities of 4,096, 8,192, or 16,384 words (the equivalent of 20,480 to 81,920 decimal digits or 12,288 to 49,152 alphanumeric characters). Access time to core storage is 18 microseconds per word. Random access disk files are also available with capacities equivalent to 640 million alphanumeric characters or more than one billion decimal digits. Average access is 133 milliseconds.

Control console

Included in the GE 225 control console are register display lights, indicator lights, power switches, status lights, 20 program control switches, and a console typewriter.

INPUT MEDIA

Magnetic tape units

Maximum number per system: 64.
Packing density: 200 or 555.5 characters per inch.
Number of channels: 7.
Record gap: ¾ inch.
Tape speed: 75 to 112 inches per second (15,000 to 62,500 characters per second).
Physical characteristics of tape:
Composition: Mylar.
Length: 1,200 or 2,400 feet.
Width: ½ inch.

Document sorter (12 pockets) and document reader (2 pockets)

These units read MICR encoded documents at 1,200 documents per minute. For a full description, see entry under GE 210.

Paper tape reader

Reads five-, six-, seven-, or eight-channel paper tape at 1,000 characters per second.

Card reader

The photoelectric card reader reads binary or Hollerith codes at 400, 1,000, or 2,000 cards per minute.

OUTPUT MEDIA

GE 225 output is by magnetic tape, at 15,000 up to 62,500 characters per second; punched cards, at 100 or 200 cards per minute (binary or Hollerith codes); five-, six-, seven-, or eight-channel paper tape, at 110 characters per second; high-speed printer, at 667 or 1,000 alphanumeric lines per minute (120 characters per line); console typewriter, at 10 characters per second; and data transmitter-receiver unit, at 60 to 150 characters per second.

AUXILIARY COMPONENTS

High-speed printer

May be operated off-line.

Re-entry printer

May be operated off-line.

PROGRAMMING

General: The GE 225 uses a single-address type of instruction. "Gecom" compiler available, which uses English language statements.

Instructions:

Number of instructions per word: 1.
Total number of operation codes: 134.

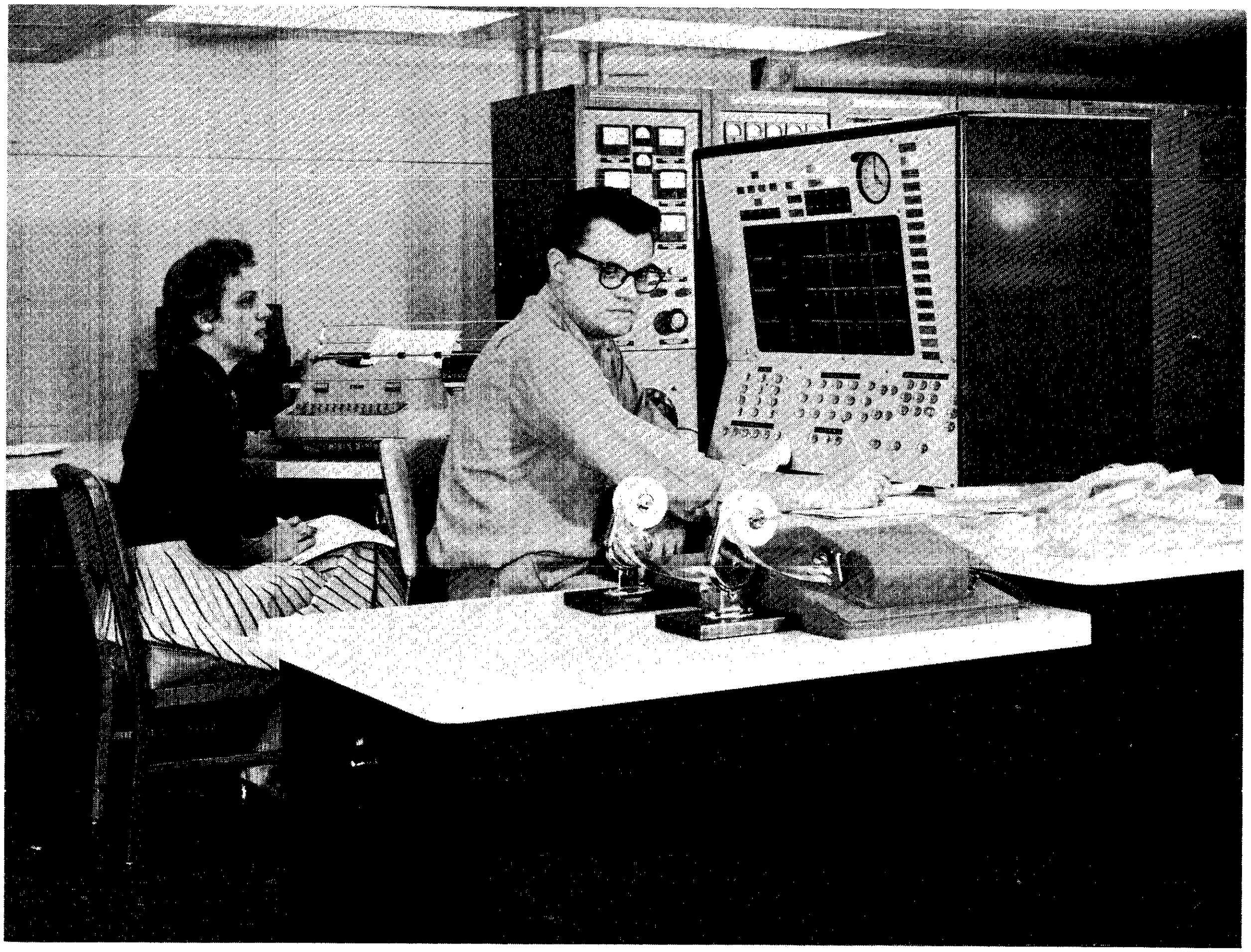
Instruction word format

bits 0 – 4	5 – 6	7 — 19
Op Code	XX	Operand Address

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
GE 225 Central Processor				117x32x76	1,800	2.4	8,190
Console, Typewriter, Card Reader				88x48x30	300		
Card Punch				41x26x50	800	1.0	3,413
High-Speed Printer				75x32x76	1,400	3.0	10,200
Tape Controller				40x32x76	550	1.1	820
Two Magnetic Tape Units				29x32x76	600	1.8	6,210
Document Handler				15′x36x38	2,100	4.0	8,100
Disk File				84x36x50	1,500	4.0	8,200

GEORGE ARGONNE NATIONAL LABORATORY



GEORGE is composed of two arithmetic units, a fixed point unit and a floating point unit. Each has its own word length and instruction code. The two arithmetic units work concurrently with a single memory.

REGISTERS AND B-BOXES:

Fixed and floating point arithmetic registers.

Four high-speed floating point registers.

Sixteen high-speed index registers and any memory locations.

An index of significance is carried with each floating point number and is corrected with each operation as to the number of bits which are still significant.

ARITHMETIC UNIT

	Excluding storage access (microseconds) Fixed point	Floating point
Add:	7	3
Multiply:	485	26
Divide:	595	27

Arithmetic mode: Parallel.

Timing: Asynchronous.

Operation: Concurrent.

Checking features: Parity on input, output and core memory. Complete redundancy and dropout error. Correction on wide magnetic tapes.

STORAGE

Magnetic core

Number of words: 4,096.
Number of digits: 42 bits per word.
Access: 7.5 microseconds.

Wide magnetic tape

Number of words: 400,000.
Number of digits: 42 bits per word.
Maximum number of units that can be connected to the system: 4.
Channels or tracks on the tape: 42.
Tape speed: 43 inches per second.
Physical properties of tape:
Width: 2 inches.
Length of reel: 1,200 feet.
Composition: Mylar sandwich.

Tape has fixed blocks of 128 words. The time per block is 70 milliseconds, including start, read or write, and stop. Tape may be searched for a particular block while the computer is computing.

INPUT MEDIA

Paper tape (two readers)

1 000 alphanumeric characters per second.

Narrow magnetic tape

15,000 alphanumeric characters per second.

Keyboard

Manual speed.

OUTPUT MEDIA

Paper tape

60 alphanumeric characters per second.

Narrow magnetic tape

15,000 alphanumeric characters per second.
Buffered 16 microsecond tieup for computer.

On-line printer

72 columns; 600 lines per minute.
Buffered 28 microseconds tieup for computer.

Console typewriter

10 characters per second.

Cathode ray tube

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Number of binary digits per word: 40 or 80.
Number of binary digits per instruction: 20 to 100.
Number of instructions per word: Variable.
Arithmetic system:

Floating Point	Fixed Point
Sign + 62-bit fraction	Sign + 39-bit fraction
Sign + 10-bit power	20-bit positive integers

Six-bit index of significance.
Instruction type: Modified two-address for fixed point. Variable zero through four-address for floating point.

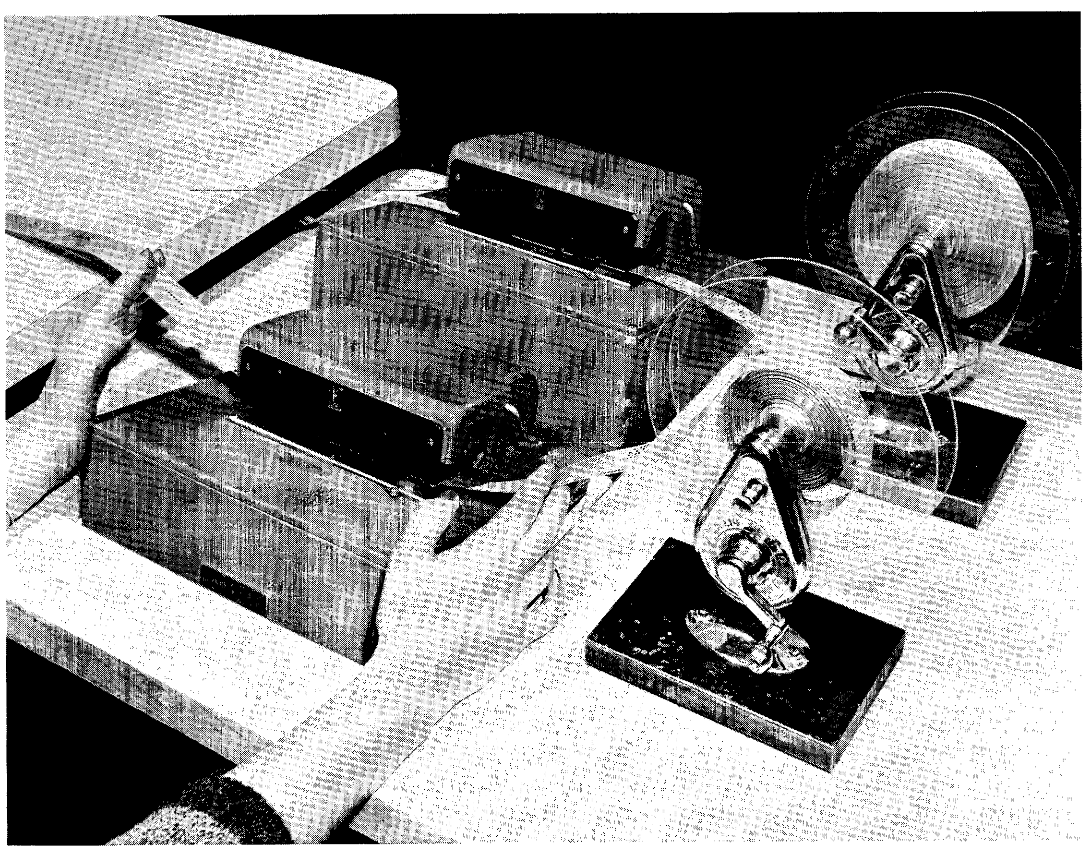
Instruction word format

B-Address	Order	Tag	A-Address
0 — 11	12 — 19	20 — 27	28 — 39

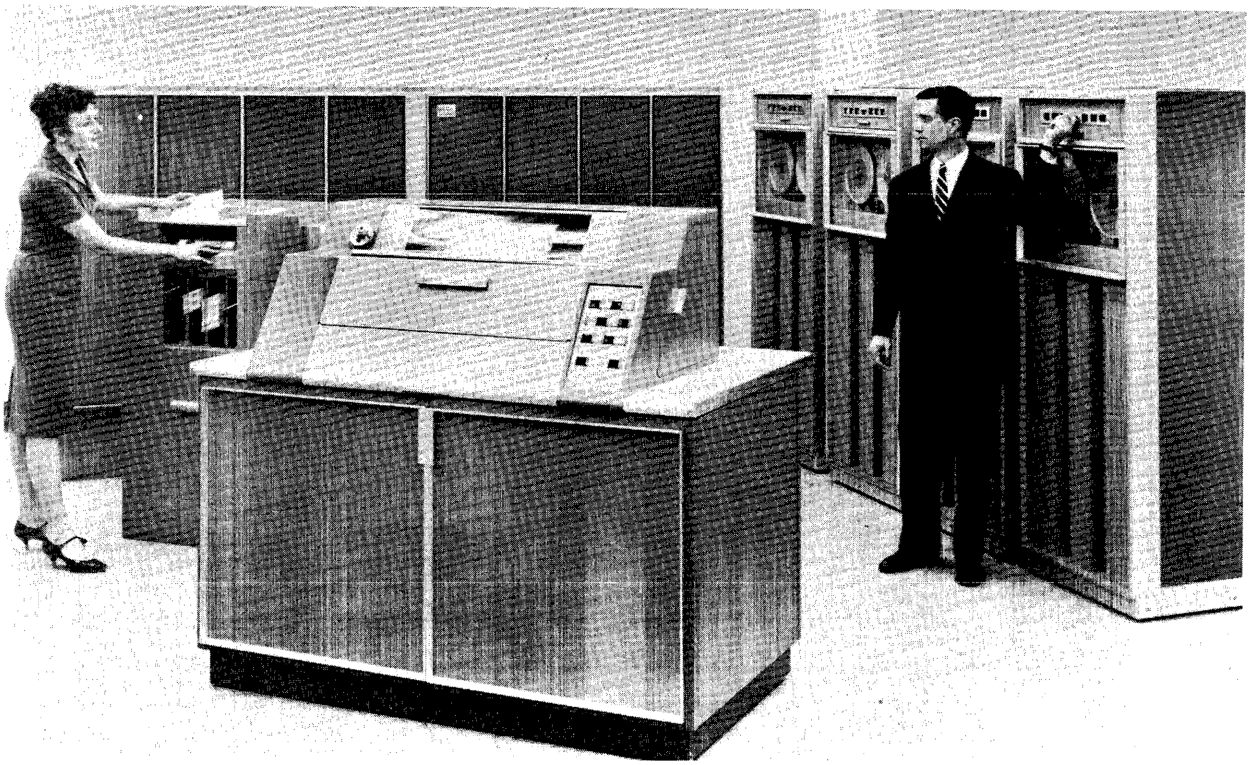
Order	A-Address	B-Address	C-Address	D-Address
0 — 19	20 — 39	40 — 59	60 — 79	80 — 99

Automatic built-in subroutines: Square root on floating point.

Automatic coding: GAR — George Assembly Routine (with Macro-instructions).



HONEYWELL 400 MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



THE HONEYWELL 400 consists of a central processor to which a basic array of input-output units is attached. Constructed of solid-state components, this small scale basic system includes the central processor, four magnetic tape units, one high-speed card reader, and a high-speed line printer.

SYSTEM COMPONENTS

General

Word Length: 44 binary digits plus sign plus check bits.
Numeric Characters: 11 decimal digits and sign.
Alphabetic Characters Per Word: 8.
Character Code: Binary and binary coded decimal.
Timing: Synchronous.

Central processor

Operation: Concurrent, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.120
Multiply:	2.000
Divide:	5.070

Access time: 24 microseconds.

Checking features: Verification of all data transmission, arithmetic processes, address modification, memory selection, and central processing. Orthotronic correction of tape data (regeneration of missing bits through built-in mathematical subroutines); marginal checking for preventive maintenance; echo checking on printer; parity checking on all data transmissions.

Registers

Three index registers.

Memory

The Honeywell 400 central processor contains a magnetic core storage unit with a capacity of 1,024 words (about 10,000 characters), expandable to 4,096 words. Access time is 12 microseconds.

Control console

The Honeywell 400 control console contains indicator lights, breakpoint switches, and console typewriter.

INPUT MEDIA

Magnetic tape units

Maximum number per system: 8.
Packing density: 800 decimal digits per inch.
Number of channels: 10.

Record length: Variable.
Record gap: ⅔ inch.
Tape speed: 120 inches per second.
Transfer rate: 64,000 alphabetic or 96,000 decimal characters per second.
Rewind speed: 360 inches per second.
Start-stop time: 3.5 milliseconds.
Physical characteristics of tape:
Composition: Mylar.
Length: 2,400 feet.
Width: ¾ inch.

Input also may be by punched cards, at 240 or 650 cards per minute; paper tape, at 200 or 1,000 characters per second; or console typewriter at manual speeds.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Punched cards

100 or 250 cards per minute.

Printer

900 lines per minute, 120 characters per line.

Paper tape

60 characters per second.

Console typewriter and up to 47 inquiry typewriters

10 characters per second.

AUXILIARY COMPONENTS

Off-line printer, with magnetic tape input

900 lines per minute. 120 characters per line.

PROGRAMMING

General: The Honeywell 400 uses a three-address type of instruction.

Instructions:
Number of instructions per word: 1.
Number of digits per instruction: 48 bits.
Total number of operation codes: 45 plus subroutines.

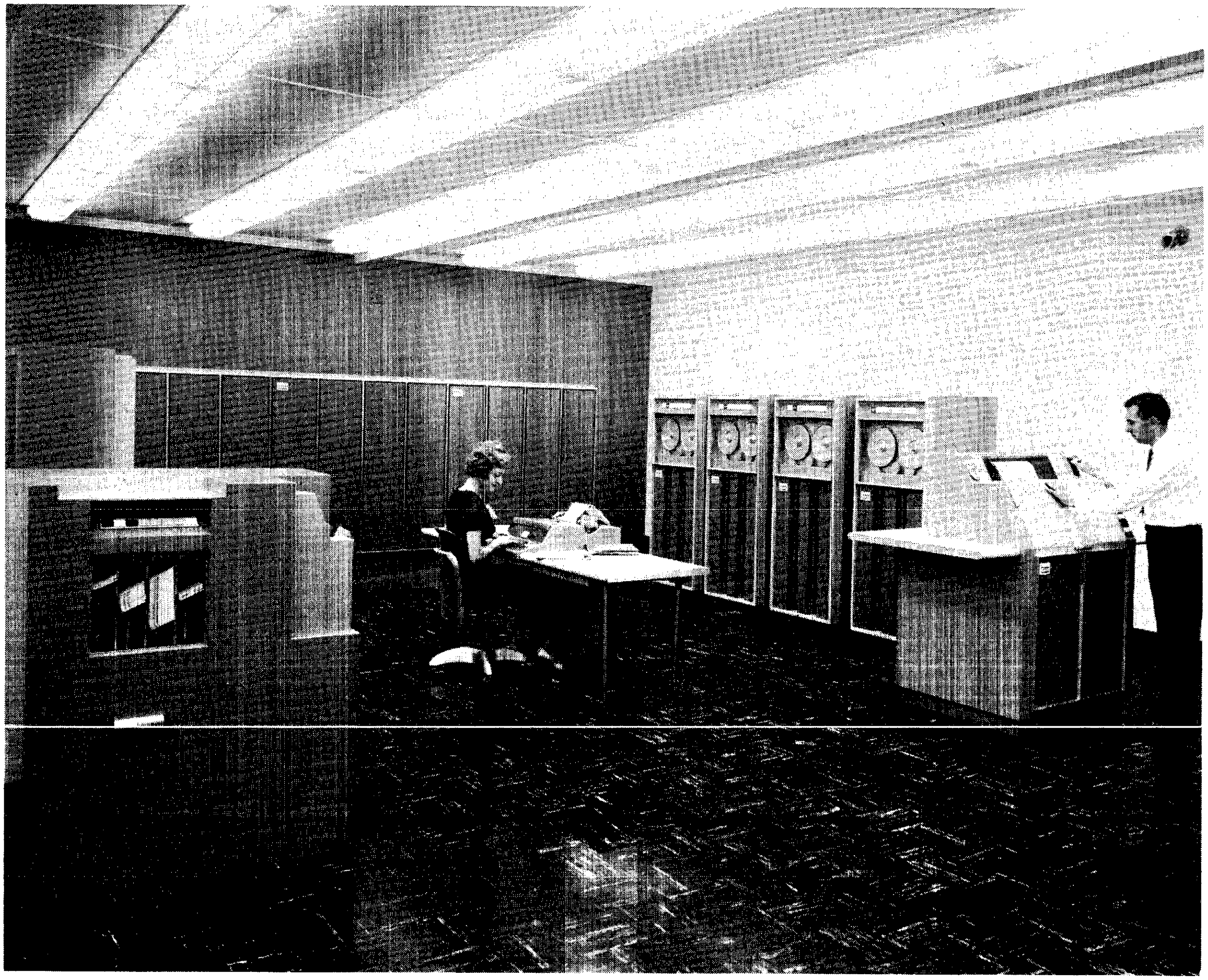
Instruction word format

Index	Operation Code	Address A	Address B	Address C
6 bits	6 bits	12 bits	12 bits	12 bits

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
H-400 Central Processor (401) Maint. Panel	$8,660-20,000	$389,775-900,000		116x30x73	2,800	3.0	17,758
401P Power Unit				72x24x73	1,600	6.5	6,147
401C Console				60x30x36	350	0.7	1,708
400E Off-Line Printing Conf.						6.3	21,913
404 Magnetic Tape Unit				33x29x68	1,250	2.8	8,538
408-8 Printer Control				35½x30x73	800	1.0	5,520
422-3 High-Speed Printer				80x36x57	1,600	2.5	7,855
402-2 Addit. Memory (2,048 words)				20x30x73	200	0.4	1,708
404 Magnetic Tape Unit				28x29x68	1,250	2.8	8,538
405 Magnetic Tape Swtg. Unit				20x30x73	175	0.4	1,366
409/425-2 High-Speed Paper Tape Reader and Control				61x36x58	750	2.5	6,830
410/426-1 Standard-Speed Paper Tape Punch and Control				61x36x58	600	1.0	2,732
422-3 High-Speed Printer				80x36x57	1,600	2.5	7,855
423-2 High-Speed Card Reader				58x30x58	1,500	1.6	4,372
424-2 High-Speed Card Punch				29x35x42	900	1.0	2,732

HONEYWELL 800 MINNEAPOLIS-HONEYWELL REGULATOR COMPANY



THE HONEYWELL 800 is a medium scale, general purpose digital computer of solid-state construction. It consists of a central processor with magnetic core memory, a control console, a magnetic tape system, and other input-output units. The magnetic tape system incorporates error detection and correction through a regenerative process.

SYSTEM COMPONENTS

General

Word Length: 54 bits (44 binary digits, 6 checking bits, and 4 sign bits).
Numeric Characters: 11 and sign.
Alphabetic Characters Per Word: 8.
Character Code: Binary and binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 1.33 megacycles per second.

Central processor

Operation: Concurrent, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.024
Multiply:	.162
Divide:	.450

Access time: 6 microseconds.

Checking features: Verification of all data transmission, arithmetic processes, address modification, memory selection, and central processing. Orthotronic correction of tape data (regeneration of missing bits through built-in mathematical subroutines); marginal checking for preventive maintenance; echo checking on printer; parity checking on all data transmissions.

Registers

64 Index registers
8 Mask index registers
32 Input-output control registers
32 Sequencing and history registers
96 Special registers
8 Automatic subroutines
16 Internal control registers
Accumulator register
Low order product-quotient register
Mask constant storage register
Program control register
Machine control register

Memory

Honeywell 800 memory is a magnetic core unit with a capacity of 4,096 to 32,768 words. Access time is six microseconds.

Control console

The control console on the Honeywell 800 contains indicator lights, switches, and a console typewriter used for manual input, error typeout, and inquiry typeout.

INPUT MEDIA

Magnetic tape units

Maximum number per system: 64.
Packing density: 800 decimal digits per inch.
Number of channels: 10.
Record length: Variable.
Record gap: ⅔ inch.
Tape speed: 120 inches per second.
Transfer rate: 64,000 alphabetic or 96,000 decimal characters per second.
Rewind speed: 360 inches per second.
Start-stop time: 3.5 milliseconds.
Physical characteristics of tape:
Composition: Mylar.
Length: 2,400 feet.
Width: ¾ inch:

Input also may be by punched cards, at 240 or 650 cards per minute; paper tape, at 200 or 1,000 characters per second; or console typewriter at manual speeds.

OUTPUT MEDIA

Magnetic tape units

As previously described.

Punched cards

100 or 250 cards per minute.

Printer

900 lines per minute, 120 characters (160 positions) per line.

Paper tape

60 characters per second.

Console typewriter and up to 47 inquiry typewriters

10 characters per second.

PROGRAMMING

General: The Honeywell 800 uses a three-address type of instruction.

Instructions:
Number of instructions per word: 1.
Number of digits per instruction: 48 bits.
Total number of operation codes: 70.

Instruction word format

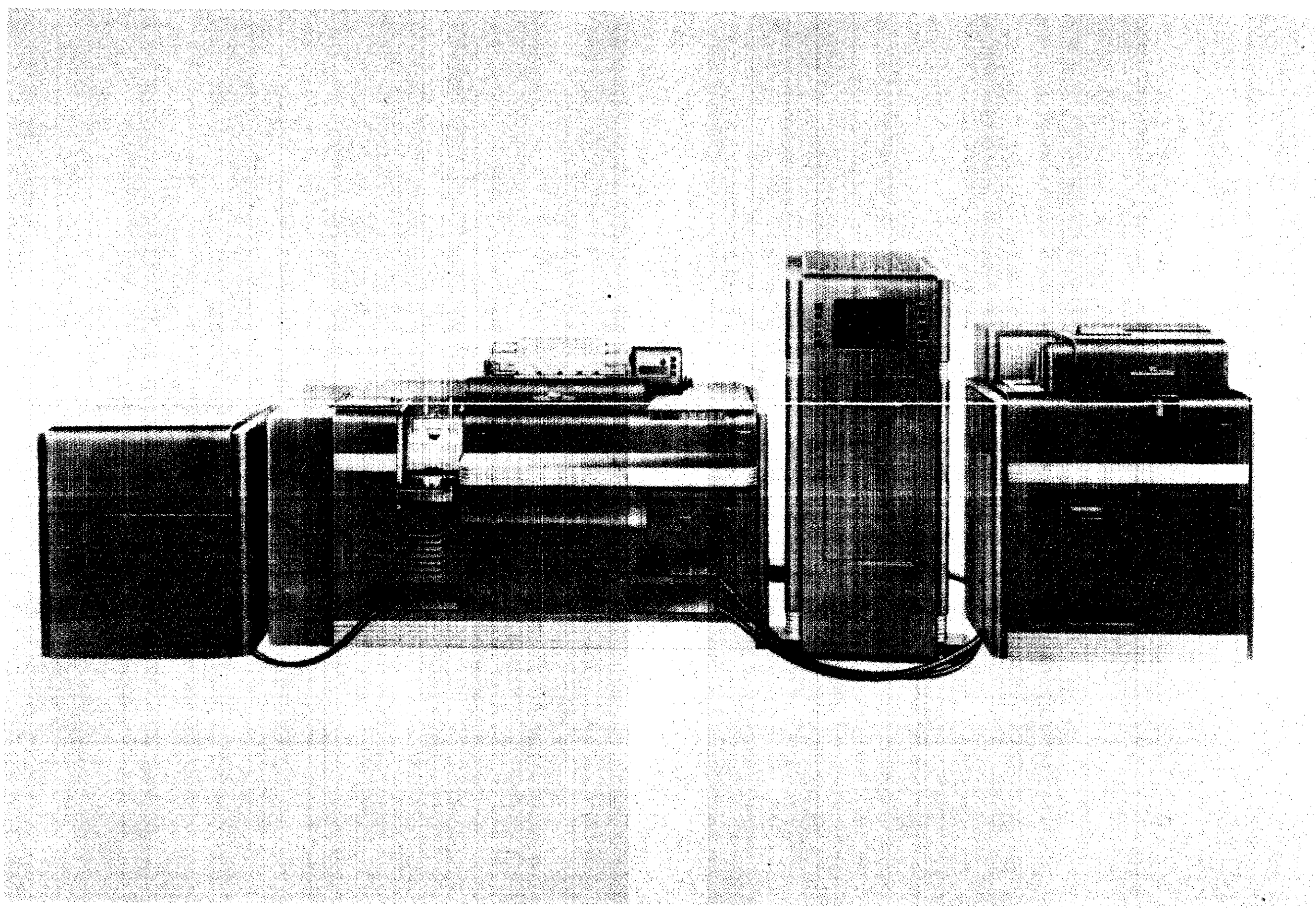
Operation Code	Address A	Address B	Address C
12 bits	12 bits	12 bits	12 bits

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
H-800 Central Processor	$22,000-80,000	$990,000-3,600,000		217x30x73	5,200	3.3	22,320
Console				93x30x36	200		
Power Unit				108x34x73	3,320	32.6	20,640
Tape Control (803)				50x30x73	1,200	2.0	6,840
Magnetic Tape Unit (804)				28x29x68	800	12.0 (6@2.0)	32,784 (6@5,464)
Printer - Card Reader - Card Punch Control (811)				84x30x73	2,000	1.0	10,440
High-Speed Printer (822-3)				64x37x55	600	2.5	6,820
High-Speed Card Reader (823-2)				58x28x58	1,500	1.7	4,774
High-Speed Card Punch (824-2)				29x35x42	900	1.5	4,092

IBM CARD-PROGRAMMED CALCULATOR

INTERNATIONAL BUSINESS MACHINES CORPORATION



THE CPC is no longer in production but approximately 1,000 were delivered and operative. It is actually composed of several machines which are connected by electrical cables. The accounting machine, either IBM 412 or IBM 418 normally reads from punched card the data to be calculated and the codes that instruct the machine what calculations to perform. The data is held in storage devices in the various machines. The storage unit (IBM 941) increases the capacity of the machines so that it handles large problems.

The calculations are performed in the electronic calculator, which is an IBM 605 Calculating Punch. Upon completion of the calculations, results are printed in report form on the accounting machine, and/or punched into cards by the calculator punch unit.

The majority of these machines are now used for engineering and scientific calculations. The CPC use is for sequential step to solve problems.

ARITHMETIC UNIT

	Excluding Storage access (microseconds)
Add:	760 (average)
Multiply:	13,180 (average)
Divide:	15,480 (average)

Construction: Vacuum tubes.
Rapid access word registers: 4.
Basic pulse repetition rate: 50 kc.
Arithmetic mode: Parallel.
Timing: Synchronous.
Operation: Sequential.
Checking features: Checking may be performed through control panel wiring.

STORAGE

Electronic tubes

Number of words: 9.
Number of digits: 37.
Access: 760 microseconds.

Accumulator (Mech.)

Number of words: 6.
Number of digits: 80.
Access: 400,000-800,000 microseconds.

Mechanical

Number of words: 48.
Number of digits: 480.
Access: 400,000-1,200,000 microseconds.

INPUT MEDIA

Card Reader

100-150 cards per minute.

OUTPUT MEDIA

Printed record

100-150 lines per minute.

Summary punch

50 cards per minute.

PROGRAMMING

Internal number system: Binary coded decimal.
Decimal digits per word: 3 or 5.
Arithmetic system: Fixed point.
Instruction type: One- or two-address.
Number range: Dependent upon programming.

System detail

Speed: 2174 additions or subtractions per second; 86 multiplications and divisions per second.

Input:

IBM 412 Alphabetical Accounting Machine A-1
IBM 418 Numeric Accounting Machine A-1
IBM 941 Auxiliary Storage Unit
IBM 605 Electronic Calculating Unit
IBM 527 Punch Unit

The 941 provides supplemental storage for 16 10-digit signed numbers.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
412	$760			75x43x49	2,643	6.7	3,620
418	710			75x43x49	2,643	6.7	3,620
605	615			53x33x58	1,522	33.1	19,450
527	250			40x26x50	760	3.1	2,190
941	200			32x26x37	561	1.4	595

IBM STRETCH INTERNATIONAL BUSINESS MACHINES CORPORATION

IBM STRETCH CLASS COMPUTER SYSTEMS, at times referred to as IBM 7030, are built to order under contract for business firms and government agencies. The system has a solid-state componentry employing transistors, and other advanced devices, and sells in a price range upward of $10,000,000. STRETCH systems are marketed on a special basis under which the principal elements will be purchased, while other components may be either purchased or leased.

An example of capacity illustrates the capability and design of the 7030: it is seventy-five (75) times more powerful than a large-scale IBM 704 and yet can be installed in the same floor space.

The STRETCH may be used for engineering development, scientific research, real time processing and control, logistics, procurement and supply, production scheduling and control, and other volume applications.

Overlap operation: The STRETCH, one of the largest computer systems built, is frequently referred to as performing "overlap" operations. This "overlap" of input-output device actions, internal storage in several units, and disk storage designates simultaneous operation, parallel operation, and the ability to run and interrupt several programs concurrently. The unit and conditions peculiar to the STRETCH class systems which provide these features are:

1. Use of an input EXCHANGE,
2. Multiprogramming,
3. Simultaneous operation of all central processor sections,
4. A "look-ahead' device,
5. The "priority interrupt" device,
6. Eight (8) to thirty-two (32) channel storage bus control for independent and overlap action.

Arithmetic unit

	Including Storage access (microseconds)	Excluding Storage access (microseconds)
Add	N/A—Overlapped	1.38 to 1.50
Multiply	N/A—Overlapped	2.48 to 2.70
Divide	N/A—Overlapped	9.00 to 9.90

Timing given for floating point. Precise time unknown. Design incomplete.

Construction (Arithmetic unit only):

Transistors: Approximately 200,000 for complete system.

Magnetic Cores: Special index core storage and exchange memory.

Arithmetic mode: Serial and parallel.

Index arithmetic unit, 24 bits in parallel; Parallel 48 or 96 bit arithmetic for floating point; Serial binary or decimal integer arithmetic (1 to 8 bits in parallel). Note that instructions address words, fields, or bits for arithmetic operations.

Timing: Asynchronous.

System is asynchronous for input-output devices, central processing unit operation, including instruction preparation, memory operation and execution.

Operation: Concurrent.

Additional features of operation: The high degree of overlapped and asynchronous operation, together with two new devices, the instruction processor and look-ahead, not only permit concurrent operation of input-output and external storage devices with the central processing unit, but also several operations are carried on concurrently within the CPU, i.e., instructions and data may be fetched simultaneously from core storage while other instructions are being prepared for processing and while previously prepared instructions are being executed.

Solid state construction is used throughout. Automatic error checking and correction and automatic maintenance scanning and recording facilitates trouble-shooting.

Checking features: Checking features include single error correction and double error detection on all information transfers between core storage and the central processing unit, disk synchronizer and exchange, parity checking within the CPU and also in all I/O units, and residue checking of all arithmetic operations in parallel arithmetic unit.

Connective operations including automatic tests and counts allow facile programmed testing of data in the system with various parity and checking features contained within the data.

A unique error scanning and recording device automatically records the entire machine state, should malfunction occur.

STORAGE

Magnetic core

Number of words: 16,384 to 262,144.
Number of decimal digits: 262,144 to 4,194,304.
Microseconds: 0.5 to 2.18.

Magnetic disk

Number of words: 2,097,152 to 67,108,864.
Number of decimal digits: 33,554,432 to 1,073,741,824.
Microseconds: 0— 215,000.

Magnetic core storage unit modules may each operate independently and simultaneously due to an interleaving of addresses within the modules and the operation of the instruction processor and look-ahead. With as many as four modules each of which may be referenced simultaneously, an effective core storage cycle of ½ microsecond may be realized for data and similarly with six modules, two for instructions and four for data permit up to 2,000,000 instructions and 2,000,000 data words to be referenced each second, giving an effective storage cycle of ½ microsecond for both instructions and data.

Magnetic tape

Number of units that can be connected: 256 units.
Number of characters per linear inch: 200 to 556 characters per inch.
Channels or tracks on the tape: 6 tracks per tape.
Blank tape separating each record: ¾ inch.
Tape speed: 112.5 inches per second.
Transfer rate: 22,500 or 62,500 characters per second.
Start time: 7.3 milliseconds.
Stop time: 7.3 milliseconds.
Physical properties of tape:
Width: ½ inch.
Length of reel: 2,400 feet.
Composition: Mylar.

INPUT MEDIA

Punched cards

1,000 cards per minute.

Multiple card readers may be included in the system operating simultaneously.

Magnetic tapes

Eight per channel.

62,500 characters per second.

Up to eight magnetic tape units may be in simultaneous operation (one per channel).

Typewriter, keys switches

Manual speed.

Keyboard, switches, and keys are part of operator's console which functions like I/O devices. Multiple consoles may be attached for simultaneous operation.

Input-output devices are all controlled by the exchange, an asynchronously and concurrently operating component of the system. The exchange may have from eight to 32 channels, each of which permits the simultaneous operation of its input-output device through appropriate control units.

OUTPUT MEDIA

Magnetic tapes

Eight per channel.
62,500 characters per second.

Punched cards

250 cards per minute.

High-speed printer

600 lines per minute.

Typewriter

Direct digital display, lights.

PROGRAMMING

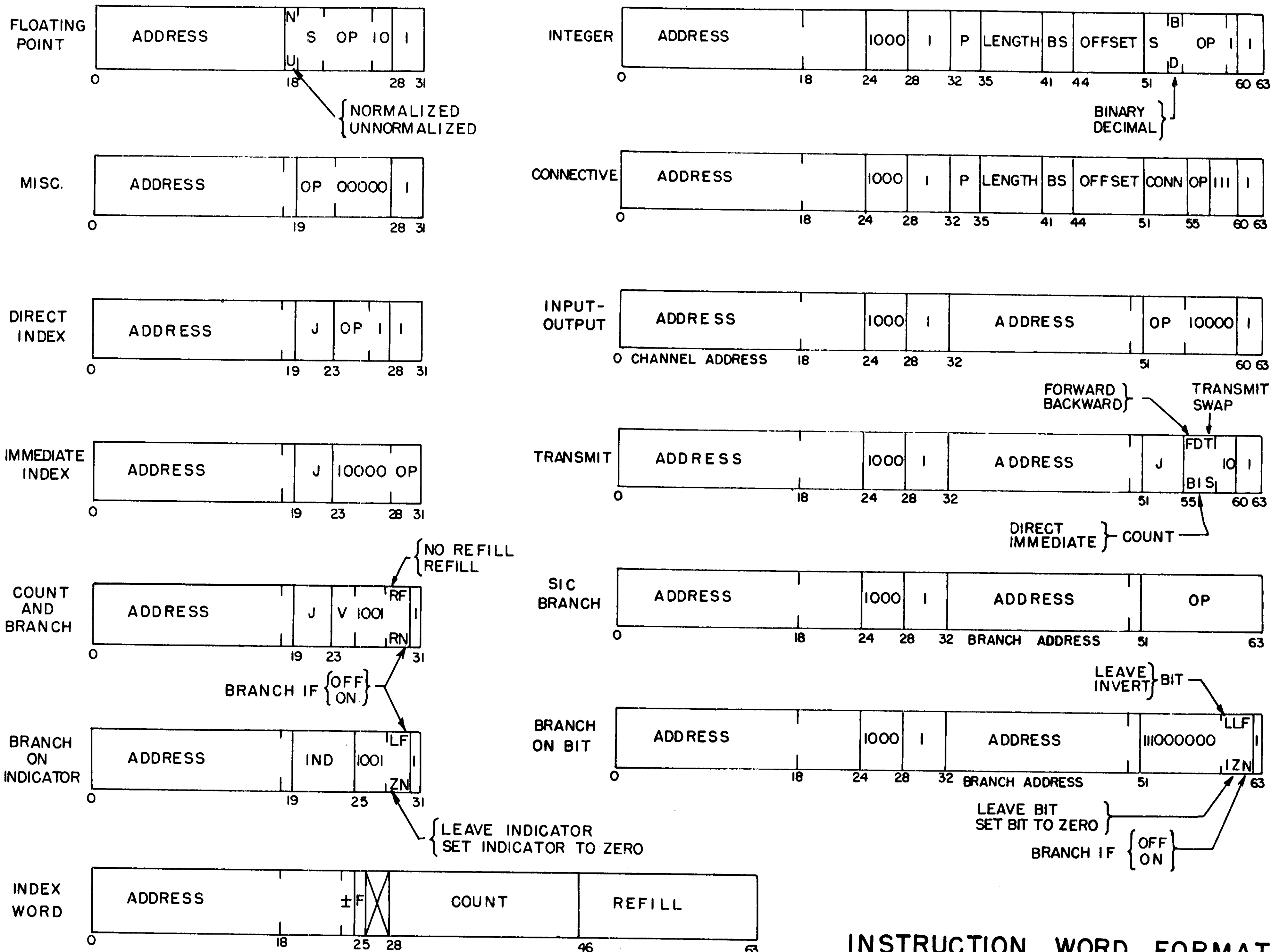
Internal number system: Binary and decimal.
Binary and decimal digits per word: 64 bits or 16 digits.
Binary digits per instruction: 32 or 64.
Instructions per word: One or two.
Instructions decoded: 154 basic.
Arithmetic system: Fixed and floating point Binary and Decimal Integer Arithmetic for variable length fields.
Instruction type: One and two address.
Automatic built-in subroutines:
- Square Root
- Radix Conversion
- Transmit
- Swap
- Automatic subroutine-entry codes
- Automatic priority processing through interruption system.
- Multiply and Add operation for both floating point and integer arithmetic.

Automatic coding:
- STRAP I
- 704-709-7090 Simulator
- STRAP II
- 704-709 Simulation
- SMAC (MACRO Generator)
- SMCP (master control program)
- FORTRAN

Registers and B-boxes:
- 16 index registers
- 20 addressable special registers
- Special addressable registers include:

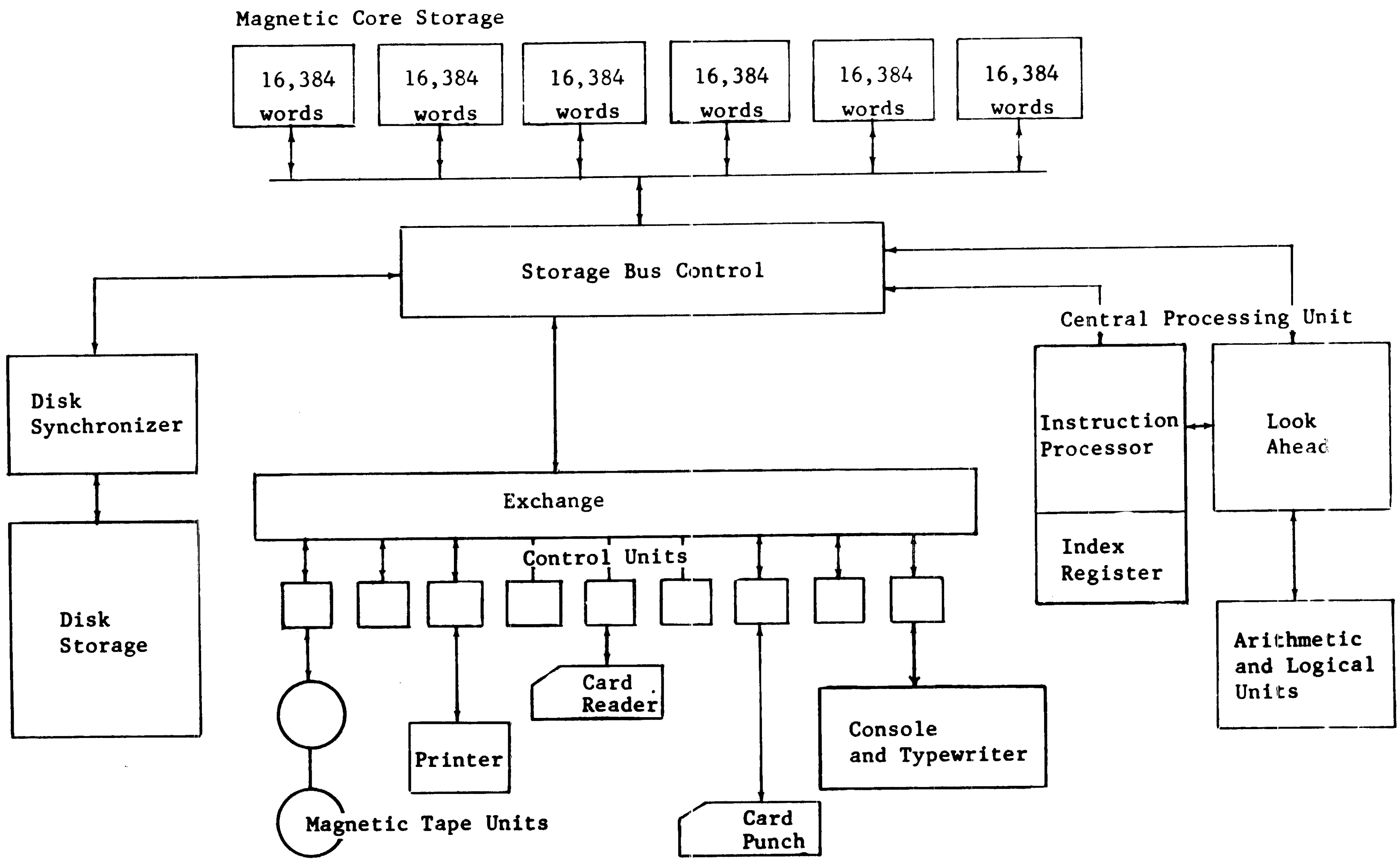
Interval timer Elapsed time clock	Function through interrupt system to provide elapsed time and time of day indication.
Interruption address	Base address of interrupt system fix-up routines.
Upper boundary Lower boundary Boundary control bit	Enable protection of areas of main core store to facilitate multiprogramming ability.
Maintenance bits	
Channel address	
Other CPU	
Left zeros count	
All ones count	
Left half of accumulator	
Right half of accumulator	
Accumulator sign	
Indicators Mask Remainder Factor Transmit	Set by interrupt system or programmer to provide flexibility in interrupt handling.

A variety of modifiers apply to different instruction classes and lead to a total of 2,975 individual operations e.g., there are two transmit instructions, TRANSMIT and SWAP. Two modifiers, count forward or backward, and immediate or direct address of count value, give a total of eight transmit orders.

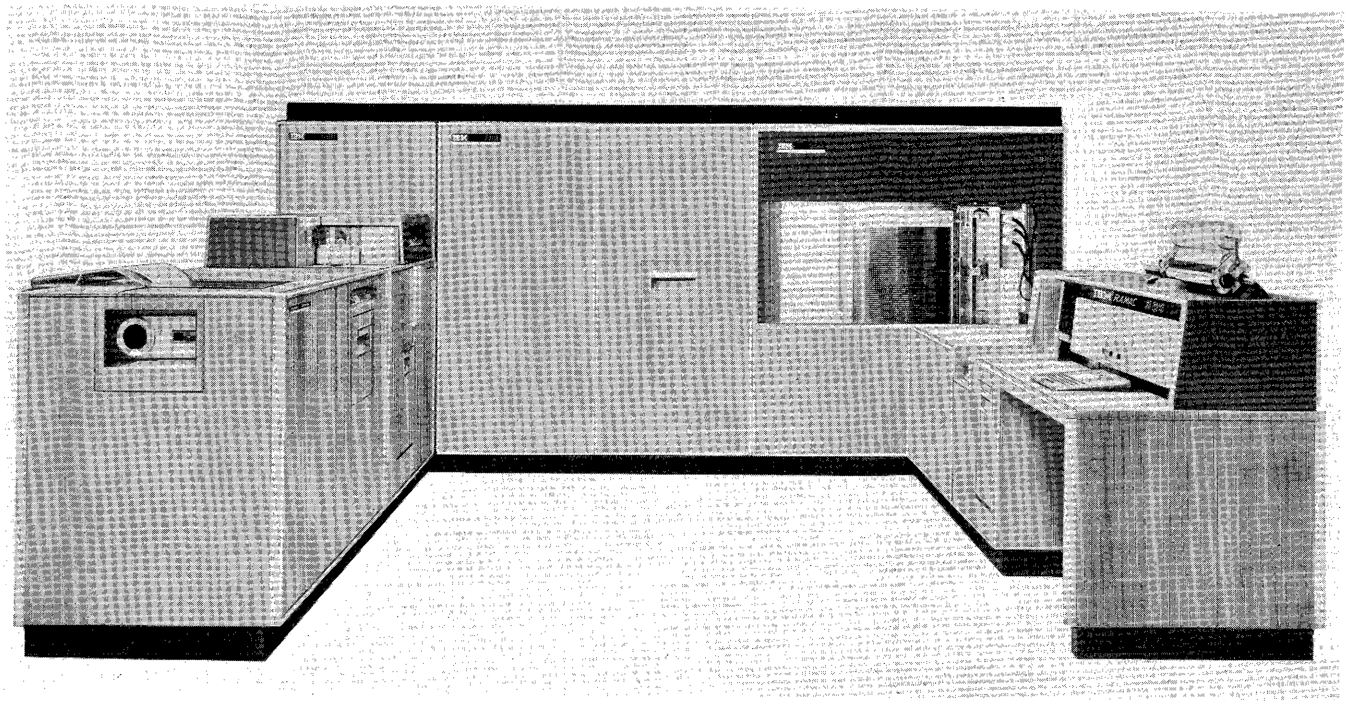


INSTRUCTION WORD FORMAT

BLOCK DIAGRAM OF IBM STRETCH



IBM 305–RAMAC INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC IBM 305 RAMAC (Random Access Method of Accounting and Control) consists of the central processor, magnetic disk storage unit, card punch, output printer, and control console with associated typewriter keyboard, typewriter printer, and card reader. The basic system may be expanded by the addition of a second magnetic disk storage unit, a punched paper tape reader, an accounting machine, and a remote printing station. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Variable within 100 digits.
Numeric Characters Per Word: Variable (limit of 100).
Alphabetic Characters Per Word: Variable (limit of 100).
Character Code: Binary coded decimal.
Timing: Synchronous.

Central processor (305)

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	60
Multiply: 555555 by 5555	90
Divide: 3086108025 by 5555	180

Average access time (drum): 5 milliseconds.

Checking features: Characters are checked for validity at various points throughout the system and after an operation or transfer.

Registers

The registers are tracks on the magnetic drum:

Punch and printer output: 1 track. Separate output tracks optionally available.

Type output: 1 track.

Input: 1 track.

Arithmetic: 2 tracks.

Memory

The magnetic drum is divided into 29 tracks each having a capacity of 100 characters. Four additional tracks optionally available.

Control panel

This unit is a part of the control console and contains controls and indicators for control of the system.

INPUT MEDIA

Typewriter keyboard

This is a part of the control console and is used for manual input to the system.

Card reader

This unit is a part of the control console. It reads 80-column cards at a rate of 125 cards per minute (max.) and transfers the data to the input track of the magnetic drum.

Magnetic disk storage unit (350)

This unit contains 50 metallic disks coated with magnetic material on each side. The disks are 24 inches in diameter, are evenly spaced on the same vertical shaft, and rotate at 1,200 revolutions per minute. This unit is available in two models having different recording densities.

Maximum number of disk units: 2.

Disks per unit: 50.

Tracks per disk: 100 or 200.

Sectors per track: 10.

Characters per sector: 100.

Total addressable locations: 50,000 or 100,000 per unit.

Total character storage: 5,000,000 or 10,000,000 per unit.

Access time: Minimum—150 milliseconds, maximum 800 milliseconds (access time is a function of total access arm movement required, that is, track-to-track movement on same disk, low access time: track-to-track movement on different disks, higher access time.)

Address: Information in the disk storage is located by a five-digit address which specifies the disk, track, and sector. This address must be placed in the address register by a program instruction.

OUTPUT MEDIA

Typewriter printer

This unit is a part of the control console. It prints out data from the system at a rate of 10 characters per second. A plugboard establishes format control for the typewriter printer.

Card punch (323)

This unit punches 80-column cards at the rate of 100 cards per minute under control of the program. The data are taken from the output track of the magnetic drum. Format control is provided by a plugboard on the punch.

Output printer (370)

This unit prints out data from the output track of the magnetic drum. Horizontal spacing is 10 characters per inch, and a total of 80 characters per line may be printed. Vertical spacing is six lines per inch. To print an 80-character line and return the carriage requires approximately two seconds. Shorter lines are printed in less time. Format control is provided by a plugboard on the printer. Vertical line spacing is controlled by a 12-channel punched paper tape. Line spacing and skipping occur at a rate of 25 lines per second.

Magnetic disk storage unit (350)

As previously described.

AUXILIARY COMPONENTS

Additional access arms

One additional access arm per disk unit allows overlapping of seek operations.

Remote printing station (381)

This unit consists of a typewriter printer and an inquiry keyboard. A maximum of four units may be connected to the system. The remote printing station duplicates some of the operations normally associated with the control console so far as typing of output data and inquiries to the file are concerned.

Paper tape reader (382)

This unit is a mechanical paper tape reader that will read 5-, 6-, 7-, or 8-channel punched paper tape at a rate of 20 characters per second. The data read from tape are transferred to the input track of the magnetic drum.

Accounting machine (407)

The printing element of this unit operates on-line with the central processor and prints out data at a rate of 150 lines per minute, 120 characters per line. The unit may be used off-line as a conventional punched card accounting machine. Card reading rate is 150 cards per minute.

PROGRAMMING

General: The 305 RAMAC has no operation codes, as such. Transfer and arithmetic operations are controlled by a stored program. This program is modified by logical decisions made through control panel wiring. The instruction word, composed of 10 characters, is designed to transfer a specified number of characters from one location to an arithmetic unit, a comparison hub, an input-output track, or another memory location.

Instruction word format

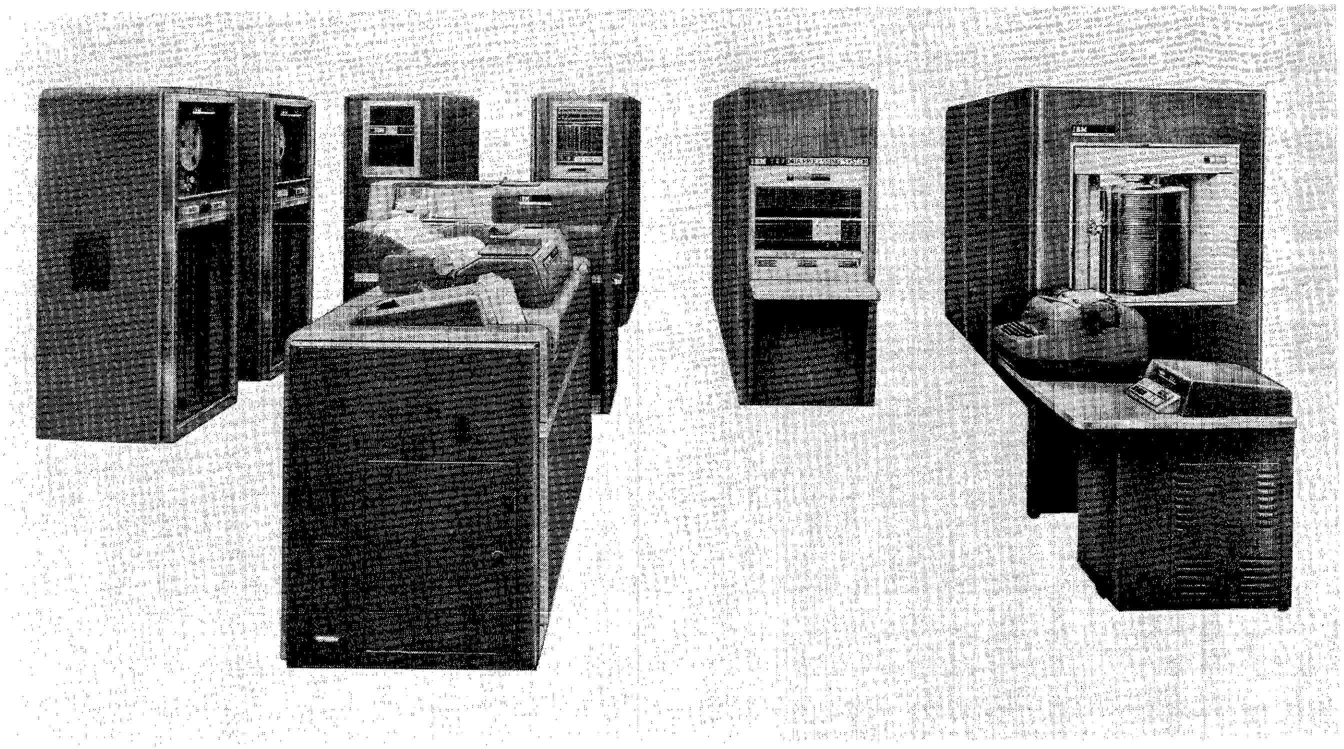
From			To			No. characters		Control code	
Track	Position		Track	Position					
X	9	9	Y	9	9	0	0	A	1

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
305 Central Processor	$1,250	$68,000	$142.00	62x32x73	1,945	(2)	28,270
380 Control Console (including typewriter keyboard and printer, and card reader)	400	28,400	42,75	62x32x47	1,015	(2)	1,350
350 Magnetic Disk Storage Unit (5,000,000 characters)	650	34,500	113.00	65x32x73	1,730	4.0	8,100
350 Magnetic Disk Storage Unit (10,000,000 characters)	1,075	57,000	224.00	65x32x73	1,730	4.0	8,100
323 Card Punch	225	12,250	15.25	44x32x51	760	(2)	2,500
370 Printer	350	22,100	79.50	57x32x47	985	(2)	900
381 Remote Printing Station	75	3,775	6.50	48x29x36	256	(2)	....
382 Paper Tape Reader	250	13,000	19.50	39x32x36	419	(2)	....
340 Power Unit	325	24,700	15.50	32x32x73	1,810	12.6	6,830
407 Accounting Machine Model R1	1,000	51,000	166.00	72x31x51	2,555	(2)	7,500
407 Accounting Machine Model R2	1,025	52,750	196.00	74x31x51	2,555	(2)	7,500

1 On purchased machines only. Based on age of machines in months (0-36 month rate shown).
2 Included in 340.

IBM 650 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC IBM SYSTEM consists of the central processing unit with associated console, a card read-punch unit, and an accounting machine (card reader and line printer). The basic system may be expanded by the addition of any combination of card readers, card punches, and accounting machines up to a maximum of three input units and three output units. The system may further be expanded by the addition of a control, buffer, and switching unit, a magnetic tape control unit, up to six magnetic tape units, up to four magnetic disk storage (RAMAC) units, up to ten inquiry stations, a paper tape input system, an alphabetic unit, and a tape data selector system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 10 digits plus sign.
Numeric Characters Per Word: 10.
Alphabetic Characters Per Word: 5 (two numerics for one alphabetic).
Character Code: 7-bit biquinary (arithmetic operations).
2 out of 5 bits (internal storage).
Timing: Synchronous.
Pulse Repetition Rate: 125 kilocycles.

Central processor (650)

Operation: Serial, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	1.44
Multiply: 555555 by 5555	6.72
Divide: 3086108025 by 5555	12.48

Access time: 0.096 to 4.800 milliseconds.

Checking features:
- Internal validity check.
- Card feed check.
- Accumulator overflow.

Registers

Accumulator: 20 digits plus sign, each half addressable. Holds the results of arithmetic operations.

Distributor: 10 digits plus sign. Passes data between the accumulator and internal storage, addressable.

Program: 10 digits, nonaddressable.

Indexing: Optional, three accumulating registers of four digits each, addressable.

Memory

The magnetic drum memory is available in two models, 2,000 words or 4,000 words.

Control panel

This unit is mounted on the central processor main frame. It contains indicators which can display the contents of various registers, the switches for step-by-step operation, insertion of data, address selection and selection of operation modes.

INPUT MEDIA

Control, buffer and switching unit (653)

This unit is required if magnetic tapes or magnetic disk storage (RAMAC) units are to be utilized. It may contain any combination of the following equipment:

1. High speed magnetic core storage, 60 word capacity.
2. Control circuitry for magnetic tape and RAMAC utilization.
3. Floating point circuitry.
4. Three indexing accumulators.

Note: Items 1 and 2 are required for magnetic tape or RAMAC utilization; Items 3 and 4 are optional equipment.

Magnetic tape control unit (652)

This unit provides control for the magnetic tape units, RAMAC units and inquiry stations. It also provides power for the magnetic tape units.

Magnetic tape unit (727)

Maximum number per system: 6.
Packing density: 200 characters per inch.
Number of channels: 7.
Record length: Variable, to 60 words.
Record gap: ¾ inch.
Tape speed: 75 inches per second/15,000 characters per second.
Rewind time: 1.2 minutes.
Start-stop time: 10 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
  Composition: Mylar, acetate, or durexcel.
  Length: 2,400 feet.
  Width: ½ inch.
Error detection: Parity check for each character and for each record.

Magnetic disk storage unit (355)

This unit contains 50 metallic disks coated with magnetic material on each side. The disks are 24 inches in diameter, are evenly spaced on the same vertical shaft, and rotate at 1,200 revolutions per minute. There are three independent access arms. Each arm is forked and carries two read-write heads, one for each side of the disk. This unit is available in two models having different recording densities.

Maximum number per system: 4.
Disks per unit: 50.
Tracks per disk: 200 or 400.
Digits per track: 600.
Total addressable locations: 10,000 or 20,000 per unit.
Total digit storage: 6,000,000 or 12,000,000 per unit.
Access time:
  Intertrack seek on same disk — 175 milliseconds, average.
  Interdisk seek — 600 milliseconds, average.

Card read-punch unit (533)

This unit reads or punches 80-column cards under the control of the central processor. Reading rate is 200 cards per minute and punching rate is 100 cards per minute. Validity check of reading and read following punch are used for error detection.

Card read-punch unit (537)

This units reads or punches 80-column cards at a rate of 155 cards per minute. It reads a card; checks the card reading and transfers the data to the central processor; allows a time delay for processing; punches the output of the central processor into the same card; and checks the punched data.

Card reader (543)

This unit reads 80-column cards under the control of the central processor. Reading speed is 250 cards per minute. Validity check of reading is used for error detection.

Accounting machine (407)

This unit operates on-line with the central processor and reads 80-column punched cards at a rate of 150 cards per minute. The printing element of the unit operates independently of the card reader element and prints out data at a rate of 150 lines per minute, 120 characters per line. The 407 may be used off-line as a conventional punched card accounting machine.

Inquiry station (838)

This unit, a modified electric typewriter, provides the facility for interrupting (but not disrupting) the central processor to permit inquiry into any record in internal storage or disk storage. The inquiry can effect record alteration as well as enabling status inquiries.

OUTPUT MEDIA

Control, buffer and switching unit, magnetic tape control unit, magnetic tape unit, and magnetic disk storage unit

As previously described.

Card read-punch units (533 and 537)

As previously described.

Card punch (544)

This unit punches 80-column cards under control of the central processor. Punching speed is 250 cards per minute. Cards are read following punching for error detection.

Inquiry station (838)

As previously described.

Accounting machine (407)

As previously described.

AUXILIARY COMPONENTS

Tape data selector (774)

This unit permits the off-line selection and rearrangement of data for printing and/or punching. It permits the search for a control word in a particular position of a record in a tape file. When the record containing the control information is found, the record may be rearranged, then printed or punched.

Auxiliary alphabetic unit (654)

This unit permits increasing the alphabetic input-output capacity of the system to a maximum of 80 characters.

Paper tape input adapter

This unit permits the use of the paper tape reader element of a paper tape to card converter (IBM 46 or 47) as input to the system. An adapter is required for each converter. A total of three adapters may be connected.

Paper tape to card converter (46 or 47)

The paper tape reading element of this unit is used as direct input (through the input adapter) to the central processor. It reads 5 or 8-level punched paper tape at a rate of 20 characters per second.

PROGRAMMING

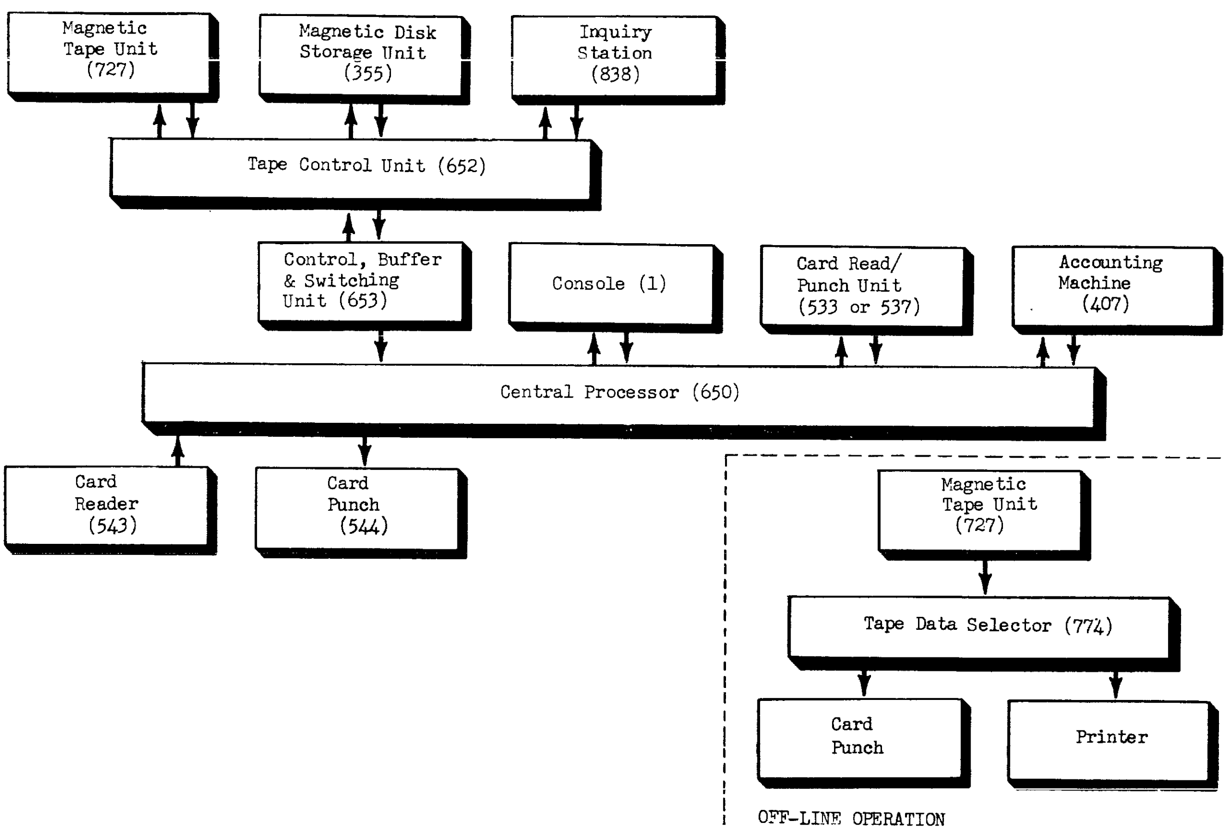
General: The 650 uses a one plus one type of instruction which specifies one of the operands and also the address of the next instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10 plus sign.
Total number of operation codes: 96.

Instruction word format

OP code		Data address				Instruction address				Sign
10	9	8	7	6	5	4	3	2	1	0



BLOCK DIAGRAM OF IBM 650

Cost, Power Requirements, and Physical Characteristics

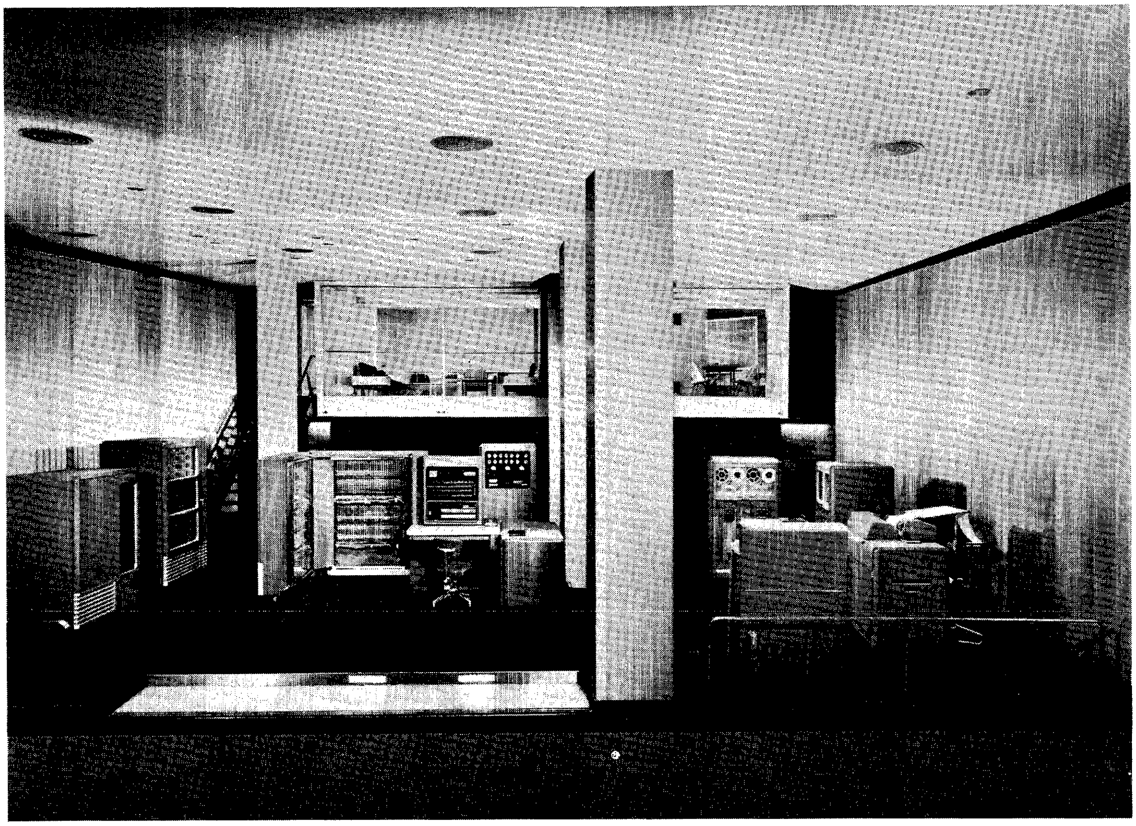
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
650 Central Processor Model 2 (2,000 word memory)	$2,400	$115,000	$276.00	62x30x71	1,996	(2)	35,100
650 Central Processor Model 4 (4,000 word memory)	3,250	150,000	282.00	62x30x71	1,996	(2)	35,100
655 Power Unit Model 1	800	42,400	51.00	62x30x71	2,972	17.7	14,300
653 Control, Buffer, and Switching Unit Model C3	1,975	108,650	117.00	62x30x71	2,872	12.0	31,100
652 Magnetic Tape Control Unit (for magnetic tapes only) Model A1	1,050	50,400	58.25	62x30x71	2,235	5.0	16,600
727 Magnetic Tape Unit	550	18,200	158.00	30x29x69	950	2.2	4,100
355 Magnetic Disk Storage Unit (RAMAC) Model 1	975	62,200	194.00	62x30x71	2,090	4.6	12,700
355 Magnetic Disk Storage Unit (RAMAC) Model 2	1,500	74,800	306.00	62x30x71	2,090	4.6	12,700
533 Card Read-Punch Unit	550	25,000	52.75	59x25x49	1,295	(2)	1,500
537 Card Read-Punch Unit	700	40,000	53.50	59x25x50	1,230	(2)	2,500
543 Card Reader	325	14,650	29.25	29x35x42	615	(2)	1,680
407 Accounting Machine Model C2	1,035	52,750	196.00	72x31x51	2,625	1.8	6,060
838 Inquiry Station	175	7,500	28.00	37x29x37	240	0.2	650
544 Card Punch	475	20,250	31.50	29x35x42	810	(2)	1,360
654 Auxiliary Alphabetic Unit Model 2	585	35,500	29.50	62x30x71	2,500	3.3	8,500
Paper Tape Input Adapter	215	11,300	9.75	(3)	(3)	(3)	(3)
46 Paper Tape to Card Converter	135	6,050	30.25	31x28x39	350	2.0	1,300
774 Tape Data Selector System—							
774-1 Tape Data Selector	2,200	128,000	161.00	63x32x67	2,300	(4)	23,000
774-2 Tape Data Selector	2,300	137,000	173.00	63x32x67	2,300	(4)	23,000
774-3 Tape Data Selector	2,400	146,000	185.00	63x32x67	2,300	(4)	23,000
407B1 Accounting Machine	875	45,000	129.00	73x31x51	2,620	1.8	5,630
407B2 Accounting Machine	910	46,750	134.00	73x31x51	2,620	1.8	5,630
407B3 Accounting Machine	995	51,000	156.00	73x31x51	2,620	1.8	5,630
408B1 Accounting Machine	1,130	66,300	178.00	73x34x56	2,730	2.6	6,000
408B2 Accounting Machine	1,165	68,400	184.00	73x34x56	2,730	2.6	6,000
408B3 Accounting Machine	1,250	73,500	200.00	73x34x56	2,730	2.6	6,000
519-6 Document Originating Machine	210	9,550	50.75	53x25x50	1,180	1.5	4,090
519-7 Document Originating Machine	195	9,100	50.50	53x25x50	1,180	1.5	4,090
747 Power Supply (TDS)	500	29,200	17.00	44x32x67	2,000	15.0	5,900

[1] On purchased machines only. Based on age of machines in months (0-36 month rate shown).

[2] Included in 655.

[3] Information not available at this time.

[4] Included in 747.



THE IBM 701 is the original system of the 700 series, and while it is used for business data processing as well as engineering and scientific application, the 701 is most often associated with the IBM 704 and 709. The arithmetic unit is constructed of approximately 4,000 vacuum tubes and 12,800 diodes. Magnetic core storage, up to 147,456 cores, were also available with later models. The 701 systems are no longer in production, and are available for new orders only when released by present users.

SYSTEM COMPONENTS

General

Word Length: 18 or 36 per data word (see instructions).
Timing: Synchronous.

Central processor

Operation: Mode is parallel and operation is sequential.

Computation speed:

	Incl. Access (microseconds)	Excl. Access (microseconds)
Addition or Subtraction:	60 or 36	48 or 24
Multiplication:	456	444
Division:	456	444

Checking features: The following checking features are found in the 701 systems:

Tapes (727): Longitudinal and transverse parity check.

Line Printer: Echo checking for each character.

Card Reader: Double reading of cards.

Card Punch: Checks columns for double punch and blank column.

Arithmetic and logical units: Overflow, divide check, and parity checks.

Registers

The 701 has three (3) arithmetic registers, accumulator, multiplier-quotient and memory register.

Memory

Magnetic core

Number of words: 4,096.
Number of digits: 40,960.
Access: 12 microseconds.

Magnetic drum

Number of words: 8,192 or 16,384.
Access: 50,000 microseconds.

Magnetic tape

Number of words: Up to 900,000.
Access: 10,000 microseconds serially.

Console

The console of the 701 is an extension of the Central Processing Frame.

INPUT MEDIA

Card reader

150 cards per minute.

Magnetic tape (726)

6,000 characters per second or 10,000 digits per second.

Magnetic tape (727)

15,000 characters per second or 25,000 digits per second.

Card to magnetic tape

250 cards per minute.

OUTPUT MEDIA

Card punch

100 cards per minute.

Line printer

150 lines per minute.

Cathode ray tube

8,300 points per second.

Magnetic tape (726)

6,000 characters per second.

Magnetic tape to card

100 cards per minute.

Magnetic tape to printer

150 lines per minute.

AUXILIARY EQUIPMENT

Through the medium of magnetic tape, any 700 series (and 7000 series) system may be used in conjunction with practically any input-output devices manufactured on an off-line basis. One auxiliary, or subsystem is associated with the 700 series computers, and is known as a 774 Tape Data Selector. This 774 subsystem consists of a 727 Tape Unit, a 774 Tape Data Selector, a 747 Power unit, and an output unit which can be a modified 407 or 408 or 519.

PROGRAMMING

General: Fixed binary arithmetic, with exception shown below. Thirty-three (33) basic instructions.

Instructions:

Number of instructions per word: 2.

Number of digits per instruction: 18.

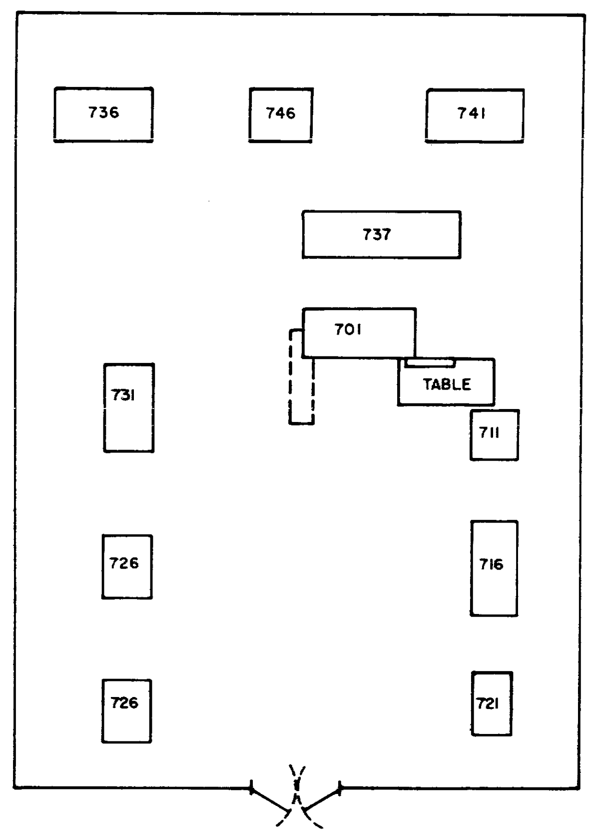
Instruction word format

±	Operation	Operand
0	1 — 5	6 — 17

Symbolic routines and floating point interpretive codes are available. One user reports use of two interpretive systems, Speed Co and ACOM. Speed Co is a three (3) address code while ACOM is two (2) address. Both provide for floating point arithmetic, transcendental functions, input-output operations, B-boxes, and tracing, all of which aid in coding and checkout.

Another user has a general purpose system called FLOP, a contraction of Floating Octal Point. FLOP converts the 701 into an entirely different machine which operates in a "floating octal" basis, but also permits all the normal 701 operations to be executed in fixed binary. The floating octal operations performed by FLOP use are add, subtract, multiply, divide (all with real or complex numbers). Logarithms, sines, and square roots are also performed with the FLOP approach. This technique was developed in order to obtain a minimum of elapsed time from when a new problem enters the department to when the answers are obtained.

One 701 system has been modified to allow asynchronous digital data to fill the entire storage unit at one time, based on indirect analog original data.



IBM 701 TYPICAL INSTALLATION LAYOUT

Cost, Power Requirements, and Physical Characteristics

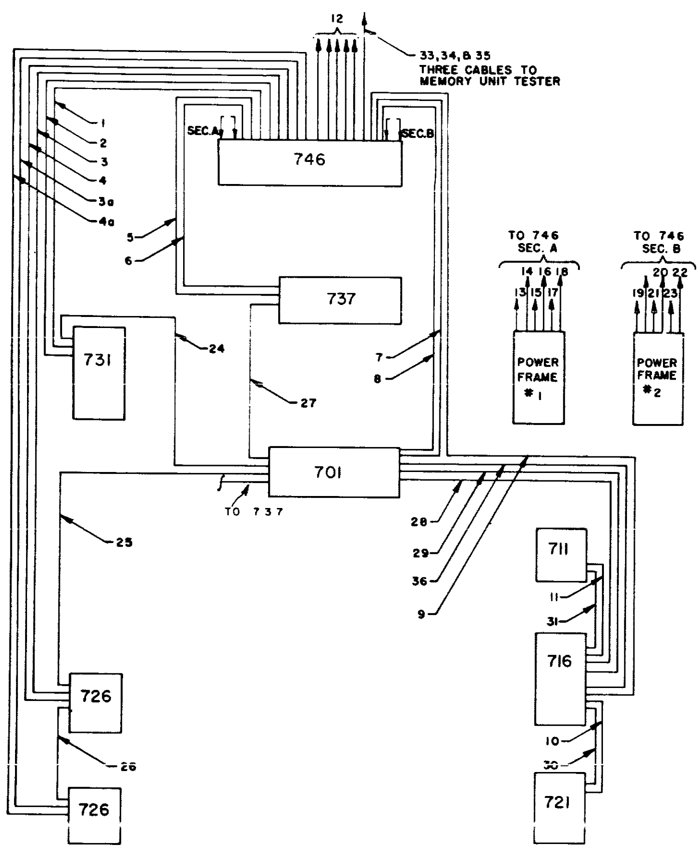
Unit	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
						(3)	(4)
701 Central Processing	$5,000	$230,000	(1) (2)	72x37x66	3,050	37.4	95,500
711 Card Reader	400	16,350		32x30x32	500	0.7	1,700
716 Printer	1,200	54,200		59x30x47	1,910	3.1	7,850
721 Card Punch	600	25,000		40x26x50	650	3.5	9,000
726 Magnetic Tape	850	42,100		39x32x63	1,370	4.6	11,400
727 Magnetic Tape	550	18,200		31x29x69	950	2.3	4,100
731 Magnetic Drum	1,400	87,450		55x31x67	1,700	9.9	25,200
736 Power Supply #1	1,000	57,400		61x34x65	2,400	5.8	14,700
737 Magnetic Core	3,700	192,400		105x31x64	1,620	6.4	16,400
740 CRT Recorder	2,450	96,000		37x28x52	790	2.4	6,140
741 Power Supply #2	1,000	57,400		61x34x65	3,250	5.8	14,700
746 Power Distribution	1,100	52,000		41x34x65	1,110	1.2	3,000
747 Power				44x32x67	2,000	15.0	5,900
753 Tape Control	2,350	80,000		60x32x67	2,280	6.0	9,200
774 Tape Data Selector				63x32x67	2,300		23,000
780 CRT Display	400	16,000		28x24x22	270		

[1] Monthly rental includes customer service and parts. Since tihs machine is no longer in production, the Base Purchase price is used in computing a discounted purchase price based on the age of the installed system. A published discount schedule is available from IBM Corp.

[2] Typical 701 system rentals are: a. $21,500 per month, and b. $17,220 per month.

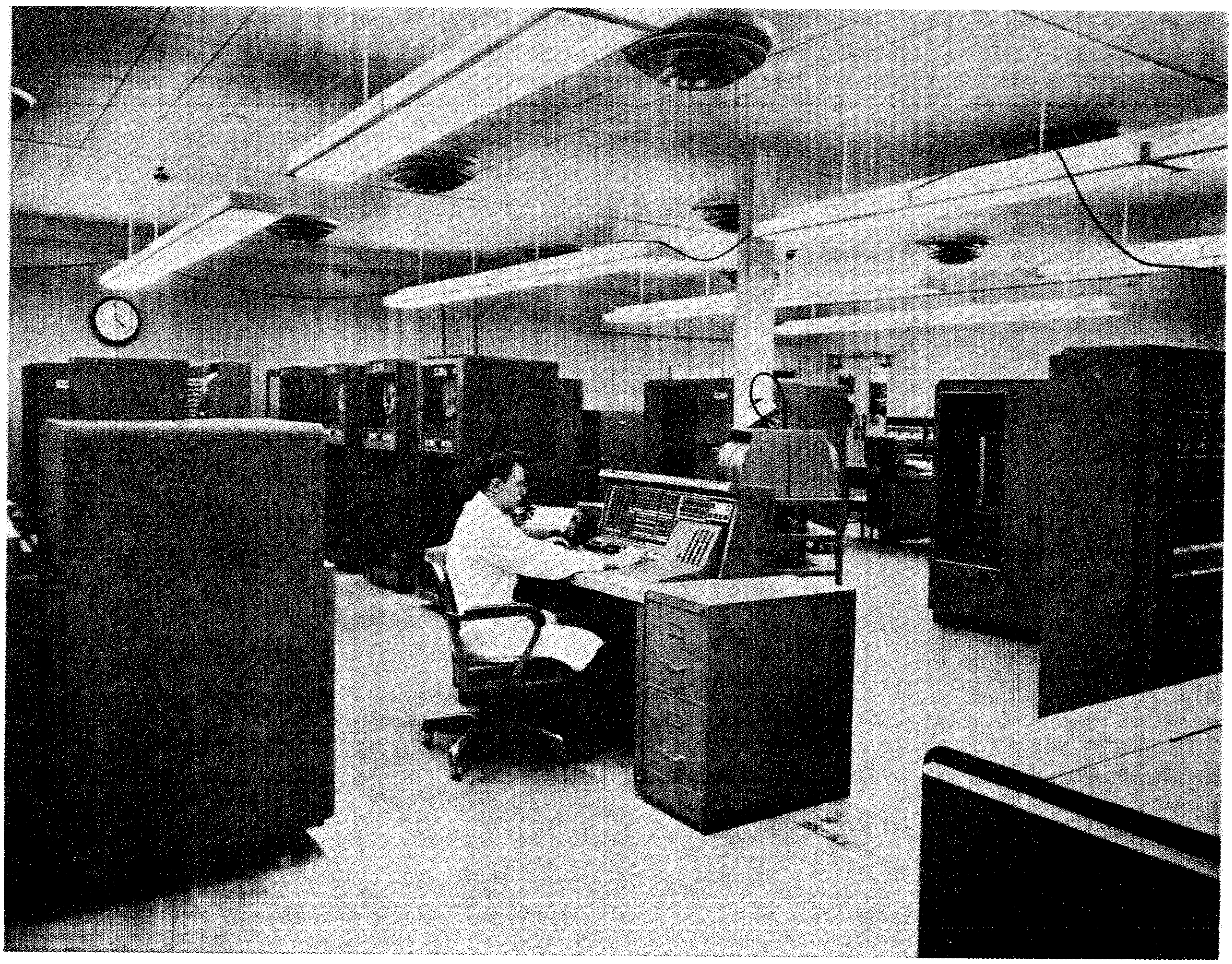
[3] Total power requirement of the typical 701 system is 84.0 kva, but varies from 87.6 kva to 136 kva in actual installations.

[4] Both air conditioning and humidity control are required by manufacturer. The 701 units are internally cooled by air-circulating blowers in most units. Air intakes vary slightly from one unit to another, but in general, is through the bottom and also through louvers along the bottom edge. One inch dust filters are included at each air intake. Warm air exhausts from the top of each unit. Manufacturer has physical planning engineers to assist in site preparation of all 700 series systems, as well as all others.



BLOCK DIAGRAM OF IBM 701

IBM 702 INTERNATIONAL BUSINESS MACHINES CORPORATION



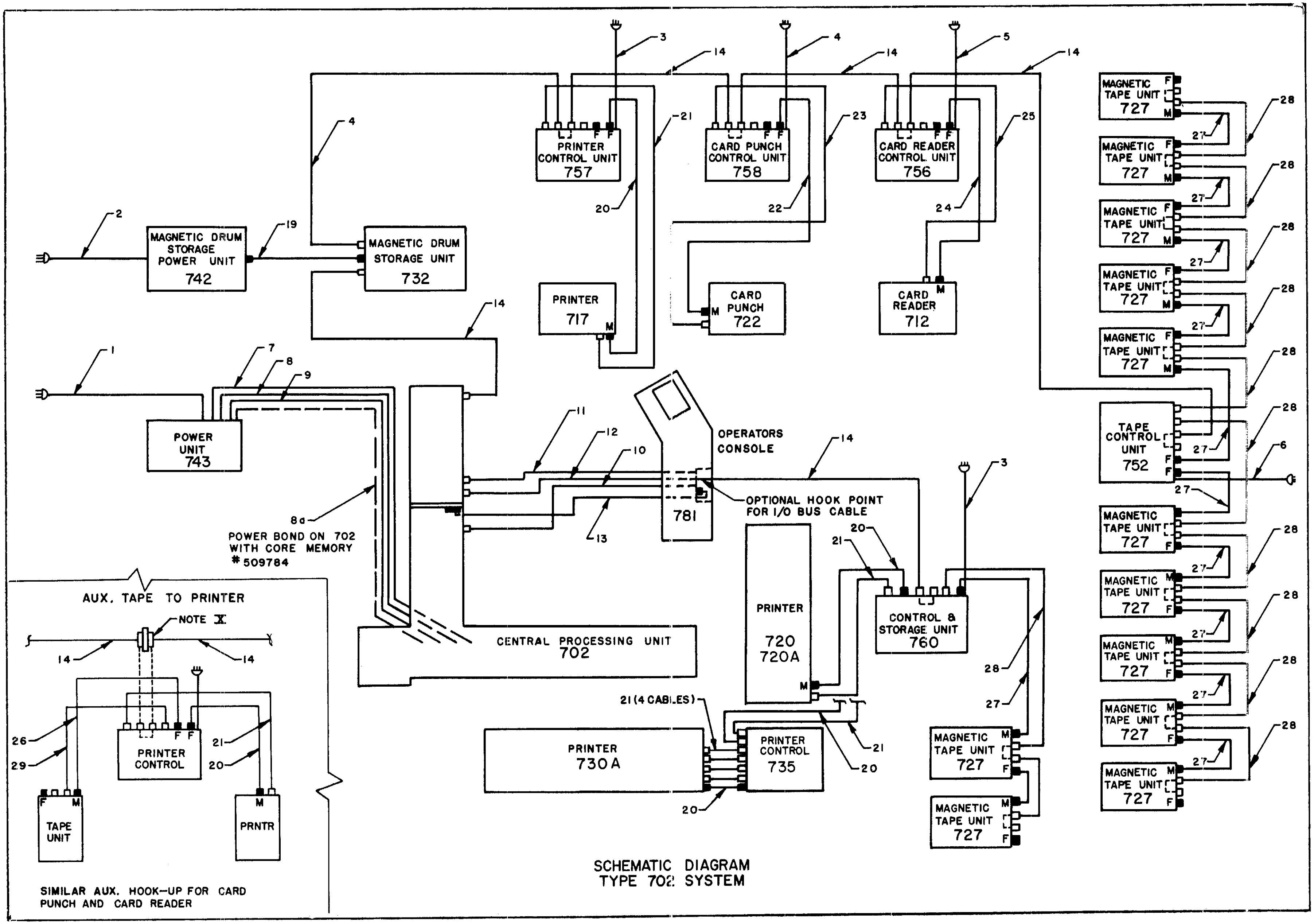
THE 702 SYSTEMS are general purpose computers for commercial as well as scientific applications.

The 702 is a data processing system designed primarily to fill the requirements of business for the handling of large amounts of data at electronic speeds. Several design features contribute substantially to the efficient processing of data, such as the ability to handle variable size numeric and alphabetic fields.

All operations of the 702 are controlled through the stored program of single-address type.

702 systems are no longer in production; about fifteen (15) were built. Combinations of units in the 702 system vary greatly, however, an average pattern might be one 702 central processor, two 712 card readers, two 722 card punches, two 717 printers, 12 727 magnetic tape units, and one 732 magnetic drum. Control and power units are associated with these units. Average 701 system cost, one shift, is $30,200.

The 702 is the forerunner of the 705 and 705 III in the IBM 700 series. Later similar models in the IBM 7000 series are the 7070, 7074, and 7090.



SCHEMATIC DIAGRAM
TYPE 702 SYSTEM

SYSTEM COMPONENTS

General

Word Length: Variable.
Character Code: Binary coded decimal and alphabetical.

Central processor

Computation speed:

	Excluding Access time (microseconds)
Addition and Subtraction:	23
Multiplication (6 × 6):	1,418
Division:	1,863

Checking features:

Instructions: During execution of an instruction, a character code error, an invalid operation part transfer, or an operation part interpretation may be detected and indicated.

Machine: The "machine check indicator" is turned on when a character code error is detected during the execution of all instructions involving read from accumulator storage or memory. "Read-write" checks on the transmission of data from input units to memory. "Read-write" also checks data transmission to output units, from drum, tape units, memory, storage units and typewriter.

Printer-Punch: This indicator reflects any error when information is punched in a card or when printed on a printer.

Overflow: The overflow check indicator is turned on during an add or subtract operation when the number of digits in the result is greater than the number of digits in the longer of the original fields. An overflow is indicated as a result of a round off operation if the carryover is made out of the highest order position of the original accumulator storage field.

Sign: This indicator turns on when a field addressed by an arithmetic instruction does not have a plus or minus zoning over the right hand digit.

Other checks: Odd-even redundancy; longitudinal-redundancy on magnetic tape; normal operation may be with internal error detection set to stop and corrective action to be taken by console operator.

The arithmetic unit is constructed of vacuum tubes, crystal diodes and magnetic cores, and operates serially by binary coded decimal characters and parallel by bit.

STORAGE

Magnetic core

Capacity: 10,000.
Access in microseconds: 17.0.

Magnetic drum

Capacity: 60,000.
Access in microseconds: 8,120 + 40 N.
Magnetic drum has 300 sections of 200 characters each. (N = number of characters).

Magnetic tape

Capacity: 5,760,000.
Access in microseconds: 10,140 + 67 N.
Number of tape units that can be connected: 10.

INPUT MEDIA

A maximum of nine (9) of the storage and input-output devices in any combination may be incorporated in the 702 system.

Magnetic tape units

Card readers

250 cards per minute.

Operator's console

Manual speed.

Off-line equipment

OUTPUT MEDIA

Magnetic tape units

Card punch

100 cards per minute.

Line printers

150, 500, 1,000 lines per minute.

Console typewriter

Magnetic drum

25,000 characters per second.

Tape data selector

See description under IBM 701.

Subsystems

1401, 1410.

PROGRAMMING

General: Interval number system is binary coded decimal and alphabetical; variable digits per word and fixed point or floating point arithmetic. It is possible to have both variable field and variable record length.

Instructions:

Number of instructions per word: No words.

Number of digits per instruction: 5.
Total number of operation codes: 32 basic.

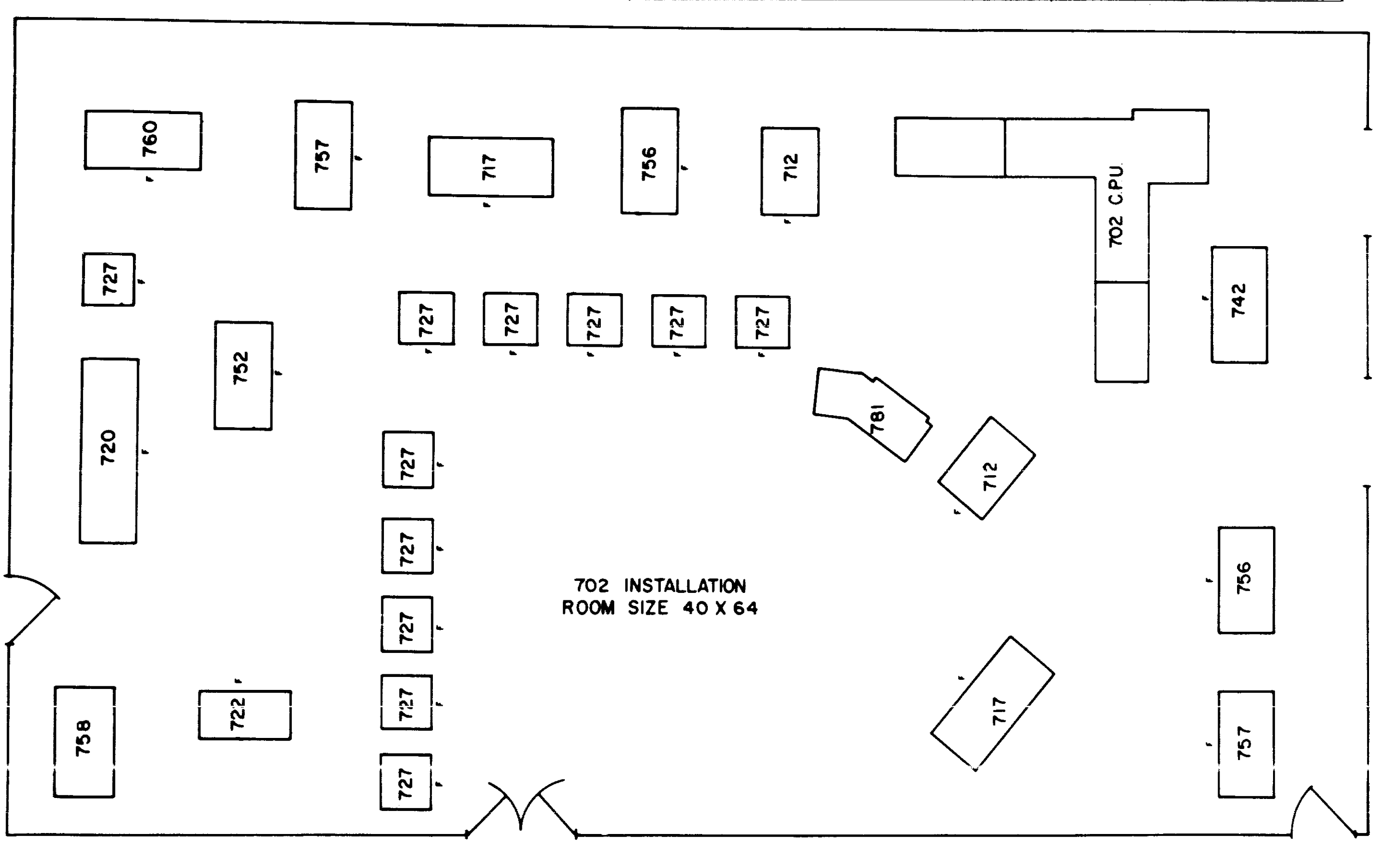
Instruction word format

X	X	X	X	X
Operation	Address			

Automatic built-in subroutines include store for print. Automatic coding consists of the Autocoder.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
						([3])	([4])
702 Central Processor #1	$6,900	$358,800	([1]) ([2])	152x172x65	5,110	29.3	66,760
712 Card Reader	750	36,800		47x33x54	1,080		9,220
717 Printer	1,400	55,000		71x33x49	2,260		14,000
720 Printer #1	1,400	56,900		78x30x91	1,600	2.8	10,000
722 Card Punch	800	43,300		52x26x50	1,220		6,830
727 Magnetic Tape	500	18,200		31x29x69	950	2.3	4,100
730 Printer #2	3,900	210,500		106x38x56	2,400	2.7	7,000
732 Magnetic Drum	2,300	113,000		65x32x67	1,850		17,400
735 Printer Control	600	32,500		63x31x71	1,300	3.3	11,000
742 Magnetic Drum Power	500	26,500		44x32x61	1,760	12.5	5,460
743 Power Supply	1,000	52,000		65x32x68	3,450		3,920
752 Tape Control	550	28,600		60x32x67	2,280	6.0	9,200
756 Card Reader Control	300	18,000		60x32x67	2,100	9.5	7,850
757 Printer Control	650	44,000		60x32x67	2,160	14.5	13,700
758 Card Punch Control	600	36,000		60x32x67	2,170	12.3	13,660
760 Control and Storage #1	2,500	111,000		63x32x67	2,790	10.0	24,000
781 Console				71x28x44	560		1,710



THE BASIC IBM 704 consists of a central processor with associated control console, a magnetic core storage unit, a magnetic tape control unit, up to ten magnetic tape units, a card reader, a card punch, and a line printer. The basic system may be expanded by the addition of magnetic core storage units, one or two magnetic drum storage units, and a tape data selector system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 36 bits.
Numeric Characters Per Word: 11 (pure binary).
Alphabetic Characters Per Word: 6 (binary coded decimal).
Character Code: Pure binary.
Timing: Synchronous.
Pulse Repetition Rate: One megacycle.

Central processor (704)

Operation: Parallel, fixed or floating point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) *Fixed point*	*Floating point*
Add: 555555 to 555555	0.072	0.132
Multiply: 555555 by 5555	0.288	0.252
Divide: 3086108025 by 5555	0.288	0.264

Access time: 0.012 milliseconds.

Checking features: All internal checking is initiated by programming.

Registers

AC register: Accumulator. 37 bits plus sign.

MQ register: Multiplier—Quotient Register. 35 bits plus sign.

Instruction register: 18 bits.

Storage register: 36 bits. Acts as a buffer between core memory and the central processor.

Instruction location counter: 12, 13, or 15 bits (function of memory size).

Index registers: Three registers, each having a capacity of 12, 13, or 15 bits (function of memory size).

Memory

Tha basic magnetic core storage for the system has a capacity of 4,096 words. Additional core storage units are available which will increase core storage capacity to 8,192 or 32,768 words.

Control panel

This unit is a part of the central processor main frame. It contains controls and indicators for control of the system. Indicators display the contents of all registers.

INPUT MEDIA

Magnetic tape control unit (753)

This unit (one per system) supplies power to and controls from one to ten magnetic tape units.

Magnetic tape unit (727)

Maximum number per system: 10.
Packing density: 200 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 75 inches per second/15,000 characters per second.
Rewind time: 1.2 minutes.
Start-stop time: 10 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
  Composition: Mylar or acetate.
  Length: 2,400 feet.
  Width: ½ inch.
Error detection:
  Binary coded decimal—even parity check, horizontal and vertical.
  Binary—even parity check horizontal, and odd parity check vertical.

Card reader (711-2)

This unit reads any 72 selected columns of 80-column cards at a rate of 250 cards per minute. Format may be rearranged by plugboard.

OUTPUT MEDIA

Magnetic tape system

As previously described.

Card punch (721)

This unit punches any 72 selected columns of 80-column cards at a rate of 100 cards per minute. Format may be rearranged by plugboard.

Line printer (716)

This unit prints out information at a rate of 150 lines per minute. A maximum of 120 characters may be printed per line. "Echo Checking" is used for error detection.

AUXILIARY COMPONENTS

Magnetic core storage unit (737 or 738)

These units are available with capacities of either 4,096 or 32,768 words. Two of the 4,096 word units may be used at one time. This provides a configuration with a capacity of 8,192 words.

Magnetic drum storage units (733)

These units (a maximum of two) may be added to the system to increase memory capacity. Each unit consists of two magnetic drums, each with a capacity of 4,096 words, for a total of 8,192 words per drum unit.

Tape data selector (774)

This unit, in conjunction with associated equipment, permits the off-line selection and rearrangement of data for printing and/or punching. It permits the search for a control word in a particular position of a record in a tape file. When the record containing the control information is found, the record may be rearranged, then printed or punched.

PROGRAMMING

General: The IBM 704 uses a single address type of instruction.

Instructions:
  Number of instructions per word: 1.
  Number of bits per instruction: 36.
  Total number of operation codes: 86.

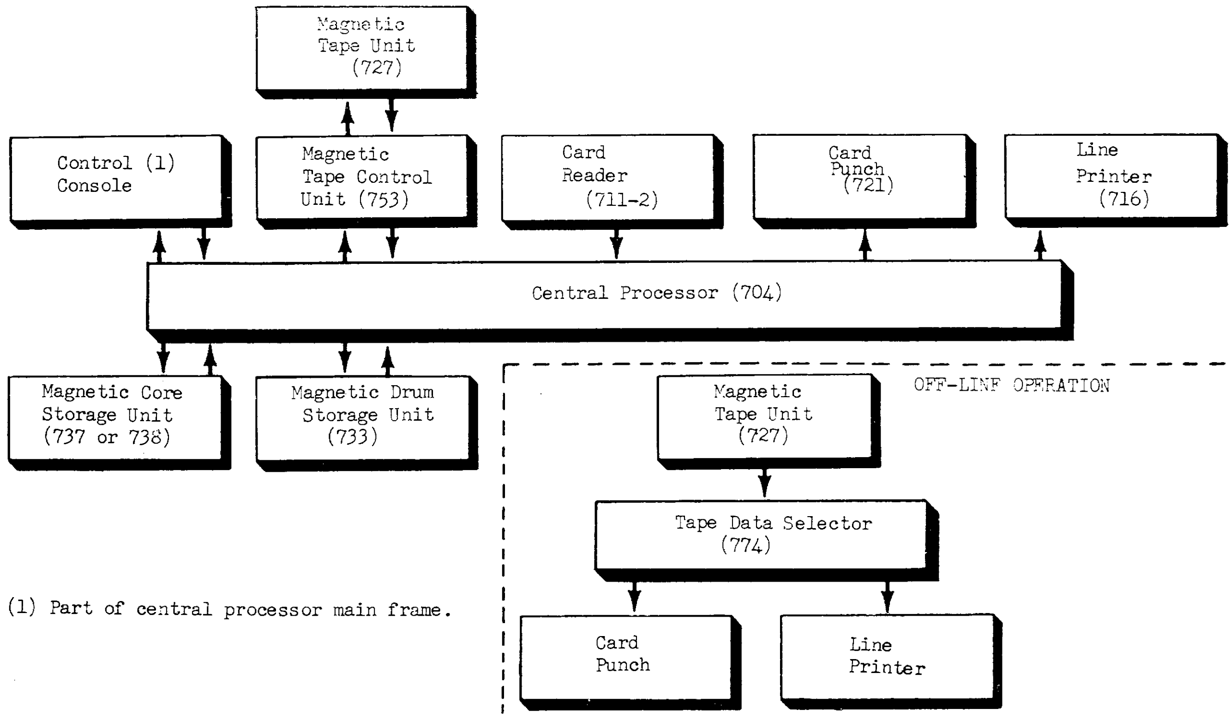
Instruction word format

Type A Instruction

Sign	OP code		Decrement	Index tag	Address
S	1	2	3—17	18-20	21—35

Type B Instruction

Sign	Not used		Op code	Not used	Index tag	Address
S	1	2	3—11	12—17	18—20	21—35



BLOCK DIAGRAM OF IBM 704

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
704 Central Processor	$9,700	$450,000	$1,439.00	72x37x66	3,150	40.3	109,800
711-2 Card Reader	800	32,000	94.25	32x30x32	560	0.7	1,700
716 Printer	1,200	54,200	173.00	59x30x47	1,910	3.1	7,850
721 Card Punch	600	25,000	92.75	40x26x50	670	3.5	9,000
727 Magnetic Tape Unit	550	18,200	158.00	29x31x69	950	2.3	4,100
733 Magnetic Drum Unit	2,900	110,000	372.00	55x31x67	1,930	10.4	25,200
737-1 Core Storage Unit	3,700	192,400	197.00	105x31x64	1,620	6.4	16,400
738-1 Core Storage Unit	19,700	940,000	960.00	159x95x64	4,000	23.4	60,500
753 Tape Control Unit	2,350	80,000	335.00	60x32x67	2,240	6.0	9,200
736-2 Power Frame #1	1,100	57,200	97.25	61x34x65	2,380	5.8	14,700
741 Power Frame #2	1,400	72,800	66.50	61x34x65	3,030	5.8	14,700
746-2 Power Distribution Unit	1,400	72,800	42.00	41x34x65	1,170	1.2	3,000
746-3 Power Distribution Unit (for 738)	1,300	67,600	42.00	41x34x65	1,170	1.2	3,000
774 Tape Data Selector System (2).							

[1] On purchased machines only. Based on age of machines in months (0-36 month rate shown).

[2] For components of the Tape Data Selector System see IBM 650 chart.

IBM 705-1 & IBM 705-2 INTERNATIONAL BUSINESS MACHINES CORPORATION

THE BASIC 705-1 SYSTEM consists of the central processor, operator's console, magnetic tape units and tape control units, card reader and control, card punch and control, printer and control, and power supply. The basic system may be expanded by the addition of tape record coordinators, a tape data selector system, magnetic drums, and high speed printers. The use of a tape record coordinator rather than a tape control unit permits overlapping of reading, writing and computing. Vacuum tubes are the principal electronic elements of the system.

SYSTEM COMPONENTS

General

Word Length: Variable.
Numeric Characters Per Word: Variable, limited by memory size only.
Alphabetic Characters Per Word: Variable, limited by memory size only.
Character Code: Binary coded decimal (6 bits plus check bit).
Timing: Synchronous.
Pulse Repetition Rate: 1 megacycle.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.272
Multiply: 555555 by 5555	0.816
Divide: 3086108025 by 5555	5.151

Access time: 0.017 milliseconds.

Checking features:

Automatic checking of all input-output.

Character code check for internal data movement.

Miscellaneous internal checks.

Registers

Accumulator: 256 positions. Can hold result of any arithmetic operation.

Auxiliary storage units: Fourteen 16-position and one 32-position registers. Used for addition, subtraction and comparisons.

Memory address: 4 positions.

Operation: 1 position.

Memory address counter 1: 4 positions. Contains last position addressed in core.

Memory address counter 2: 4 positions. Contains last position addressed in core for read and receive instructions.

Memory

The magnetic core memory has a capacity of 20,000 characters.

Control panel

This unit is a part of the operator's console and contains indicators, switches and keys. It is used to indicate errors; determine the status of machine circuits, registers, and counters; determine the contents of memory and accumulator storage; and to revise the contents of memory.

INPUT MEDIA

Control units

Any combination of control units up to a maximum of nine units may be used with the system. These units are: tape control unit (754), tape record coordinator (777), printer control (757), control and storage (760), card reader control (759), and card punch control (758).

Tape control unit (754)

This unit supplies power to and controls from one to ten magnetic tape units.

Tape record coordinator (777)

This unit supplies power to and controls from one to eight magnetic tape units. It acts as a buffer and contains 1,024 positions. It permits the overlapping of reading, writing, and computing.

Control and storage (760-1 or 760-2)

This unit serves as a buffer for one or two magnetic tape units and for a high speed printer (720-2 or 730-2).

Magnetic tape unit (727)

Maximum number of units: 10 for one tape control unit (754), 8 for one tape record coordinator (777) or 2 for one control and storage (760).

Packing density: 200 characters per inch.

Number of channels: 7.

Record length: Variable.

Record gap: ¾ inch.

Tape speed: 75 inches per second/15,000 characters per second.

Rewind time: 1.2 minutes.

Start-stop time: 10 milliseconds.

Change tape time: 1½ minutes (approx.).

Physical characteristics of tape:

Composition: Mylar, acetate, or durexcel.

Length: 2,400 feet.

Width: ½ inch.

Error detection: Even parity check, horizontal and vertical.

Card reader (714)

This unit, together with the card reader control (759), reads 80-column punched cards at a rate of 250 cards per minute. Dual reading and comparison of readings are used as an accuracy check. The data read are transferred to the central processor or to a magnetic tape unit (off-line).

Keyboard

This unit is a part of the operator's console. Alphabetic and numeric keys are used for input of data or instructions to the central processor.

OUTPUT MEDIA

Magnetic tape and control units

As previously described.

Card punch (722)

This unit, together with the card punch control (758), punches 80-column cards at a rate of 100 cards per minute. It receives its data from the central processor or from a magnetic tape unit (off-line).

Typewriter

This unit is a part of the operator's console and may be used to print out data from the central processor at a rate of 10 characters per second.

Printer (717)

This unit, together with the printer control (757), prints out data from the central processor at a rate of 150 lines per minute, 120 characters per line. It may also be used off-line with magnetic tape units.

Printer (720-2)

This unit, together with the control and storage (760-1), prints out data from the central processor at a rate of 500 lines per minute, 120 characters per line.

It may also be used off-line with magnetic tape units.

Printer (730-2)

This unit, together with the control and storage (760-2) and printer control (735), prints out data from the central processor at a rate of 1,000 lines per minute, 120 characters per line. It may also be used off-line with magnetic tape units.

Printer control (735)

This unit is used only with the printer (730-2). It is connected between the control and storage (760-2) and the printer.

AUXILIARY COMPONENTS

Tape data selector (774)

This unit permits the off-line selection and rearrangement of data for printing and/or punching. It permits the search for a control word in a particular position of a record in a tape file or the search for a control word anywhere within a record in a tape file. When the record containing the control information is found, the information in the record may be rearranged, then printed or punched.

Magnetic drum storage unit (734)

These units, up to a total of 30, can be added to the system to increase the memory capacity. Each drum has a capacity of 60,000 characters, divided into 300 addressable sections. Drum access time is 8 milliseconds.

PROGRAMMING

General: The 705-1 uses a single address type of instruction.

Instructions:

Number of instructions per word: Not applicable.
Number of digits per instruction: 5.
Total number of operation codes: 35.

Instruction word format

Op. code	Address
X	XXXX

THE IBM 705-2 is identical to the IBM 705-1 except that the 705-2 magnetic core memory capacity is 40,000 characters, double the capacity of the 705-1.

Central processor (705-2)

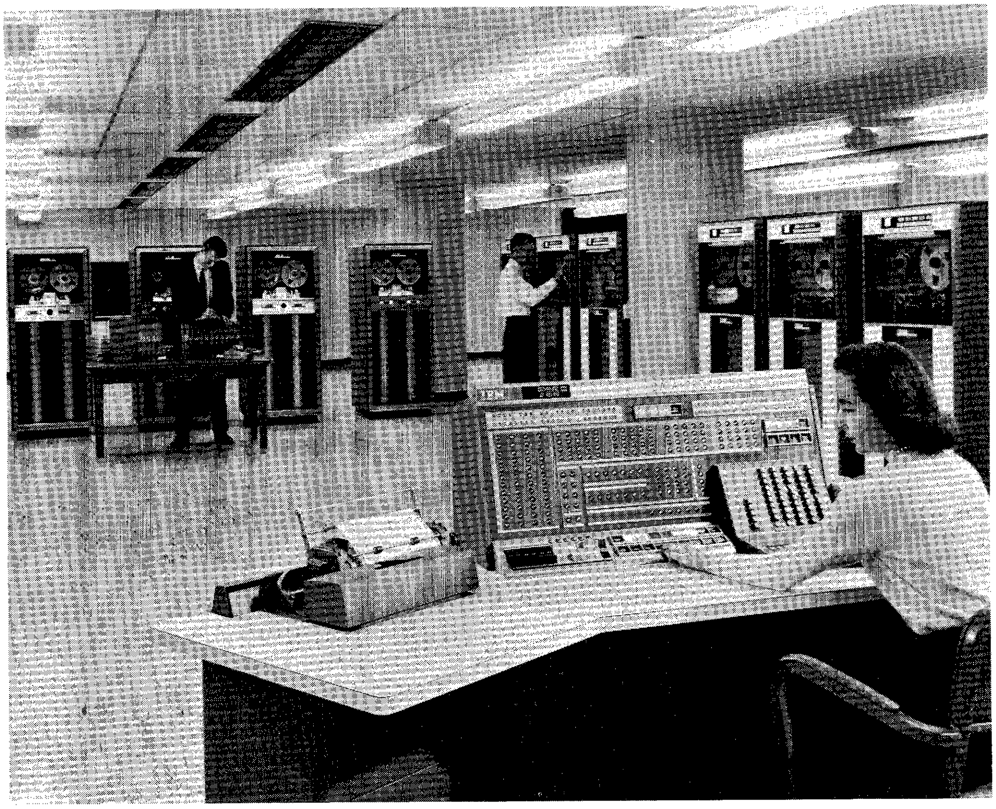
Monthly rental: $14,150.
Purchase price: $590,000.
Monthly maintenance charge on purchased machine: $1,668.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
705-1 Central Processor	$11,650	$500,000	$1,377.00	152x182x65	5,110	(2)	70,250
782 Operators' Console and Typewriter	1,000	52,000	49.25	71x28x44	620	(2)	1,710
754 Tape Control Unit	1,500	78,000	99.00	60x32x67	2,360	6.3	9,660
777 Tape Record Coordinator	3,400	156,000	361.00	63x32x67	3,120	11.0	34,000
760 Control and Storage	2,500	111,000	486.00	63x32x67	2,790	12.0	23,000
727 Magnetic Tape Unit	550	18,200	158.00	31x29x61	950	2.3	4,100
759 Card Reader Control	900	45,000	78.50	60x32x67	2,160	10.0	8,250
714 Card Reader	1,500	64,450	276.00	47x33x54	1,150	(3)	9,680
758 Card Punch Control	600	36,000	68.50	60x32x67	2,170	12.3	13,660
722 Card Punch	800	43,300	147.00	52x26x50	1,220	(4)	6,830
757 Printer Control	650	44,000	88.75	60x32x67	2,160	14.5	13,700
717 Printer	1,400	55,000	225.00	71x33x49	2,260	(5)	14,000
720-2 Printer	1,900	93,000	503.00	94x38x61	1,750	3.9	11,320
735 Printer Control	600	32,500	111.00	63x31x71	1,300	4.4	14,900
730-2 Printer	3,900	210,500	799.00	106x38x56	2,400	3.1	9,800
734 Magnetic Drum Storage Unit	2,300	90,000	360.00	65x32x67	1,850	(6)	17,400
744 Magnetic Drum Power Supply	500	21,500	24.50	44x32x67	1,530	13.2	5,460
745-1 Power Unit	1,200	62,400	24.50	65x32x68	3,580	30.7	4,060
774 Tape Data Selector System (7).							

1 On purchased machines only. Based on age of machines in months (0-36 month rate shown).
2 Included in 745-1.
3 Included in 759.
4 Included in 758.
5 Included in 757.
6 Included in 744.
7 For components of Tape Data Selector System see IBM 650 chart.

IBM 705-3 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC 705-3 SYSTEM consists of the central processor, an operator's console, a data synchronizer unit, up to ten magnetic tape units, a card reader with associated card reader control, a card punch with associated card punch control, and a line printer with associated printer control. The basic system may be expanded by the addition of a core storage unit, up to 30 magnetic drum storage units, a maximum of six data synchronizer units with one to ten magnetic tape units per data synchronizer, line printers with associated control and storage units, and a tape data selector system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Variable.
Numeric Characters Per Word: Variable (limited by memory size only).
Alphabetic Characters Per Word: Variable (limited by memory size only).
Character Code: Binary coded decimal (6 bits plus check bit).
Timing: Synchronous.
Pulse Repetition Rate: One megacycle.

Central processor (705-3)

Operation: Serial, fixed point.
Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.1916
Multiply: 555555 by 5555	0.6104
Divide: 3086108025 by 5555	3.7582

Access time: 0.013 milliseconds.

Checking features:
Automatic checking of all input-output.
Character code check for internal data movement.
Miscellaneous internal checks.

Registers

Accumulator: 256 positions. Can hold result of any arithmetic operation.

Auxiliary storage units: Fourteen 16-position and one 32-position registers. Used for additions, subtractions and comparisons.

Memory address register: 4 positions.

Memory address counter No. 1: 4 positions. Contains last position addressed in core.

Memory address counter No. 2: 4 positions. Contains last position addressed in core for read and receive instructions.

Instruction counter: Contains the memory address of the right hand digit of the instructions.

Storage select register: Contains the address of the working storage unit being utilized for the operation.

Select register: Contains the address of the last device selected.

Character register No. 1: Contains the most recent character read from memory.

Character register No. 2: Contains the most recent character read out of storage.

Memory

The basic magnetic core memory has a capacity of 40,000 characters. An additional core storage unit with a capacity of 40,000 characters may be added to the system for a total of 80,000 characters of core storage.

Control panel

This unit is a part of the control console and contains indicators, switches and keys. It is used to indicate errors; determine the status of the machine circuits, registers and counters; determine the contents of memory and accumulator storage; and to revise the contents of memory.

INPUT MEDIA

Data synchronizer unit (767)

This unit is used to control and synchronize the flow of data between the central processor and the magnetic tape units. A maximum of six data sychronizer units may be used with the system. If magnetic tape units (729-3) are used, a maximum of four data synchronizer units may be operated simultaneously. If only magnetic tape units (729-1) are used, all six data synchronizer units may operate simultaneously.

Magnetic tape unit (729-1)

Maximum number of units: 5 per data synchronizer unit.
Packing density: 200 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 75 inches per second/15,000 characters per second.
Rewind time: 1.2 minutes.
Start-stop time: 10 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
Composition: Mylar, acetate, or durexcel.
Length: 2,400 feet.
Width: ½ inch.
Error detection: Even bit check, horizontal and vertical. Two-gap read-write head which reads characters as they are written on tape and immediately checks them for validity.

Magnetic tape unit (729-3)

Maximum number of units: 5 per data synchronizer unit.
Packing density: 555 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 112.5 inches per second/62,500 characters per second.
Rewind time: 1 minute.
Start-stop time: 7.5 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape: Same as magnetic tape unit (729-1).
Error detection: Same as magnetic tape unit (729-1).

Card reader (714)

This unit, together with card reader control (759), reads 80-column punched cards at a rate of 250 cards per minute and transfers the data to the central processor or to an off-line magnetic tape unit.

Keyboard

This unit is a part of the operator's console. Alphabetic and numeric keys are used for input of data or instructions to the central processor.

OUTPUT MEDIA

Magnetic tape system

As previously described.

Card punch (722)

This unit, together with the card punch control (758), punches 80-column cards at a rate of 100 cards per minute. It receives its data from the central processor or from an off-line magnetic tape unit.

Line printer (717)

This unit, together with the printer control (757), operates on line from the central processor or off-line from a magnetic tape unit (727) at a rate of 150 lines per minute, 120 characters per line.

Control and storage (760-1 or 760-2)

This unit serves as a buffer for one or two magnetic tape units (727) and for the line printers (720-2 or 730-2).

Line printer (720-2)

This unit, together with the control and storage (760-1), operates on-line from the central processor or off-line from a magnetic tape unit (727) at a rate of 500 lines per minute, 120 characters per line.

Line printer (730-2)

This unit, together with the control and storage

(760-2) and printer control (735), operates on-line from the central processor or off-line from a magnetic tape unit at a rate of 1,000 lines per minute, 120 characters per line.

Printer control (735)

This unit is used only with the printer (730-2). It is connected between the control and storage unit (760-2) and the printer.

Typewriter printer

This unit is a part of the operator's console and may be used to print a portion of memory at a rate of 10 characters per second.

AUXILIARY COMPONENTS

Tape data selector (774)

This unit permits the off-line selection and rearrangement of data for printing and/or punching. It permits the search for a control word in a particular position of a record in a magnetic tape file (729-1). When the record containing the control information is found, the record may be rearranged, then printed or punched.

Additional core storage unit (739)

This unit is a magnetic core storage unit with a capacity of 40,000 characters. It may be added to the system to increase the core storage capacity to 80,000 characters.

Magnetic drum storage unit (734)

These units, up to a total of 30, can be added to the system to increase memory capacity. Each has a capacity of 60,000 characters, divided into 300 addressable sections. Drum access time is eight milliseconds.

PROGRAMMING

General: The 705-3 uses a single address type of instruction.

Instructions:

Number of instructions per word: Not applicable.
Number of digits per instruction: 5.
Total number of operation codes: 48.

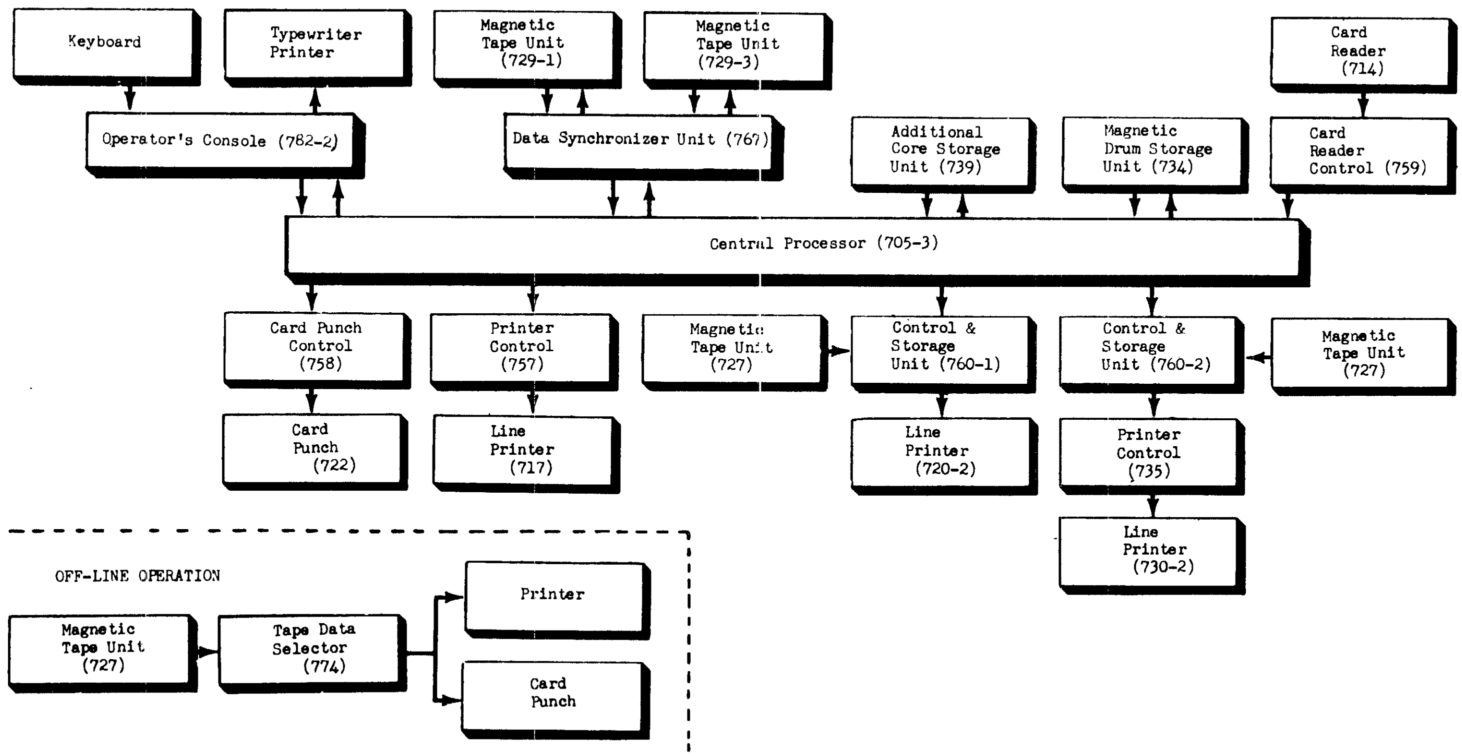
Instruction word format

Op. code	Address
X	XXXX

Cost, Power Requirements, and Physical Characteristics

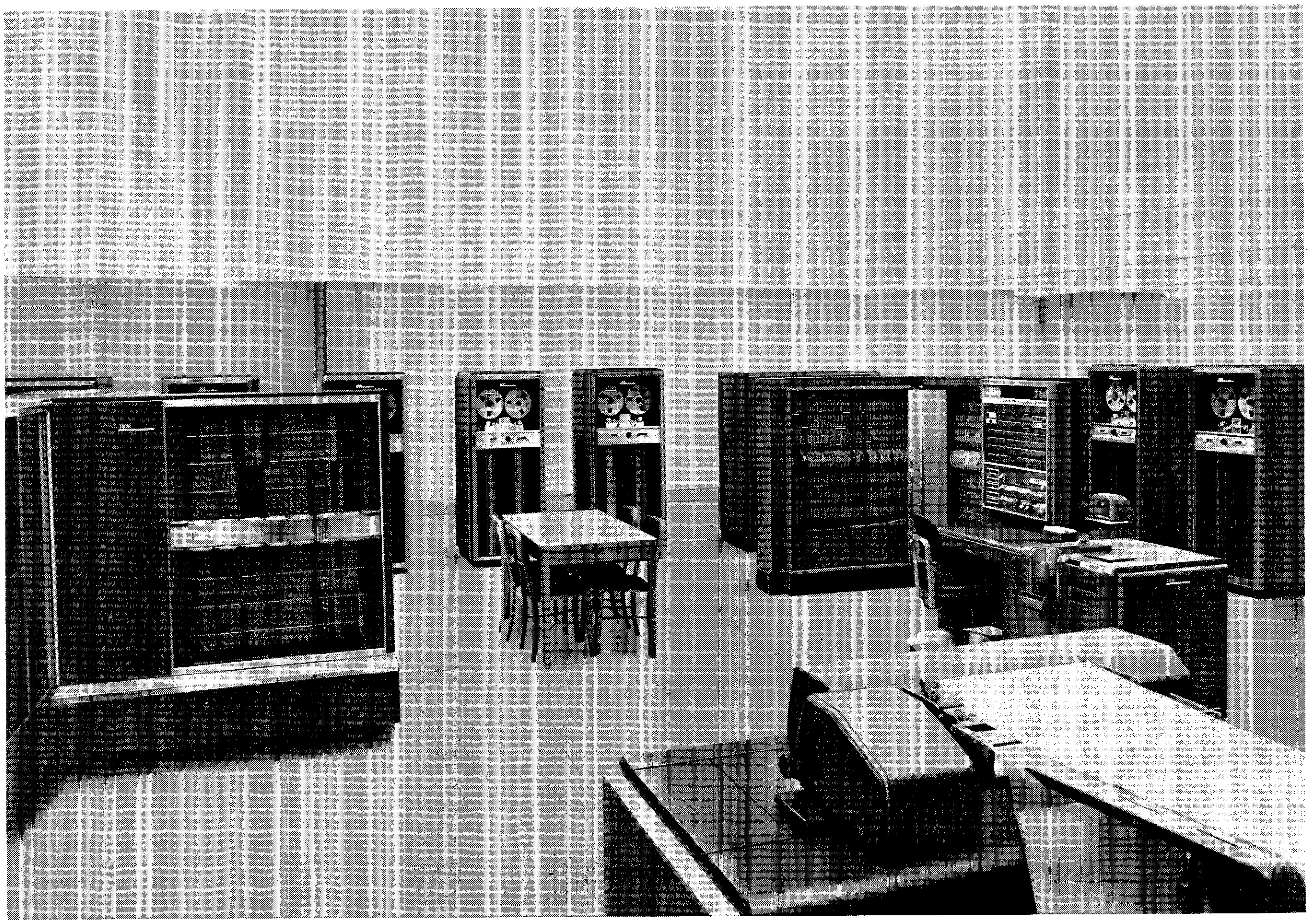
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
705-3 Central Processor	$15,000	$788,000	$969.00	184x182x65	5,570	(2)	103,870
782-2 Operator Console and Typewriter	1,100	58,000	49.25	81x30x57	660	(2)	1,710
767 Data Synchronizer	3,500	200,000	111.00	64x34x68	1,500	11.30	29,350
760 Control and Storage	2,500	111,000	486.00	63x32x67	2,790	12.00	23,000
729-1 Magnetic Tape Unit	700	27,500	202.00	31x29x69	950	2.30	4,100
729-3 Magnetic Tape Unit	900	48,500	191.00	34x29x69	1,200	1.14	3,220
759 Card Reader Control	900	45,000	78.50	60x32x67	2,160	10.00	8,250
714 Card Reader	1,500	64,450	276.00	47x33x54	1,150	(3)	9,680
758 Card Punch Control	600	36,000	68.50	60x32x67	2,170	12.30	13,660
722 Card Punch	800	43,000	147.00	52x26x50	1,220	(4)	6,830
757 Printer Control	650	44,000	88.75	60x32x67	2,160	14.50	13,700
717 Printer	1,400	55,000	225.00	71x33x49	2,260	(5)	14,000
720-2 Printer	1,900	93,000	503.00	94x38x61	1,750	3.90	11,320
735 Printer Control	600	32,500	111.00	63x31x71	1,300	4.40	14,900
730-2 Printer	3,900	210,500	799.00	106x38x56	2,400	3.10	9,800
734 Magnetic Drum Storage Unit	2,300	90,000	360.00	65x32x67	1,850	(6)	17,400
744 Magnetic Drum Power Supply	500	21,500	24.50	44x32x67	1,530	13.20	5,460
745-2 Power Unit	1,500	100,000	24.50	65x32x68	3,795	41.00	4,500
739 Additional Core Storage	6,000	340,000	272.00	104x32x64	1,800	5.50	13,430
748 Data Synchronizer Power Supply	700	53,000	4.50	48x24x65	1,600		4,500
774 Tape Data Selector System (7)							

1 On purchased machines only. Based on age of machines in months (0-36 month rate shown).
2 Included in 745-2.
3 Included in 759.
4 Included in 758.
5 Included in 757.
6 Included in 744.
7 For components of Tape Data Selector System see IBM 650 chart.



BLOCK DIAGRAM OF IBM 705-3

IBM 709 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC 709 consists of the central processor with associated control console, a magnetic core storage unit, a data synchronizer unit, two tape control units with up to eight magnetic tape units per control unit, a card reader, a card punch, and a line printer. The basic system may be expanded by the addition of a magnetic core storage unit, one or two magnetic drum storage units, one or two data synchronizer units, up to four tape control units with up to eight magnetic tape units per control unit, and a tape data selector system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 36 bits.

Numeric Characters Per Word: 11 (pure binary).

Alphabetic Characters Per Word: 6 (binary coded decimal).

Character Code: Pure binary.

Timing: Synchronous internal, asynchronous for input-output.

Pulse Repetition Rate: One megacycle.

Central processor (709)

Operation: Parallel, fixed or floating point.

Computation speeds: (program and operands are in memory).

	Time (milliseconds) Fixed point	Time (milliseconds) Floating point
Add: 555555 to 555555	0.072	0.132
Multiply: 555555 by 5555	0.144	0.156

Divide: 3086108025 by 5555 .... 0.288 0.264
Access time: 0.012 milliseconds.

Checking features: All internal checking is initiated by programming.

Registers

AC register: Accumulator. 37 bits plus sign.

MQ register: Multiplier—Quotient Register. 35 bits plus sign.

Instruction register: 18 bits.

Storage register: 36 bits. Acts as a buffer between core storage and the central processor.

Instruction location counter: 12, 13, or 15 bits (function of memory size).

Index registers: Three registers, each having a capacity of 12, 13 or 15 bits (function of memory size).

Sense indicator register: 36 bits. Sense indicator instructions treat the bits of this register as switches which may be logically manipulated or tested, either singly or in groups.

Memory

The basic magnetic core memory for the system has a capacity of 4,096 words. Additional core storage units are available which will increase core storage capacity to 8,192 or 32,768 words.

Control panel

This unit is a part of the central processor main frame. It contains controls and indicators for control of the system. Indicators display the contents of all registers.

INPUT MEDIA

Data synchronizer unit (766)

This unit controls the input-output units (tape control units, card reader, card punch, and printer) connected to the system. It serves as a link between core storage and the input-output units. Up to three data synchronizers may be used with the system. Each data synchronizer may control two tape control units, plus one card reader, plus one card punch, plus one printer.

Tape control unit (755)

This unit will control up to eight magnetic tape units. It serves as a link between the tape units and the data synchronizer unit. (*Note:* Two tape control units are required when SHARE programs are to be utilized).

Magnetic tape unit (729-1)

Maximum number per system: 48 (8 per control unit).
Packing density: 200 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 75 inches per second/15,000 characters per second.
Rewind time: 1.2 minutes.
Start-stop time: 10 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
- Composition: Mylar or acetate.
- Length: 2,400 feet.
- Width: ½ inch.

Error detection:
- Binary coded decimal—even parity check, horizontal and vertical.
- Binary—even parity check horizontal, and odd parity check vertical.
- Two-gap read-write head which reads characters as they are written on tape and immediately checks them for validity.

Card reader (711-2)

This unit reads 72 selected columns of 80-column cards at a rate of 250 cards per minute. Format may be rearranged by plugboard.

OUTPUT MEDIA

Magnetic tape

As previously described.

Card punch (721)

This unit punches any 72 selected columns of 80-column cards at a rate of 100 cards per minute. Format may be rearranged by plugboard.

Line printer (716)

This unit prints out information at a rate of 150 lines per minute. A maximum of 120 characters may be printed per line. "Echo checking" is used for error detection.

AUXILIARY COMPONENTS

Magnetic core storage unit (737 or 738)

These units are available with capacities of either 4,096 or 32,768 words. Two of the 4,096 word units may be used at one time. This provides a configuration with a capacity of 8,192 words.

Magnetic drum storage units (733)

These units (a maximum of two) may be added to the system to increase memory capacity. Each unit consists of two magnetic drums each with a capacity of 4,096 words, for a total of 8,192 words per drum unit.

Tape data selector (774)

This unit, in conjunction with associated equipment, permits the off-line selection and rearrangement of data for printing and/or punching. It permits the search for a control word in a particular position of a record in a tape file. When the record containing the control information is found, the record may be re-arranged, then printed or punched.

PROGRAMMING

General: The IBM 709 uses a single address type of instruction.

Instructions:

Number of instructions per word: 1.
Number of bits per instruction: 36.
Total number of operation codes: 189.

Instruction word format

Type A Instruction

OP			D	T	Y
S	1	2	3 — 17	18 — 20	21 — 35

Type B Instruction

OP				I	NU	T	Y
	0	0					
S — 1 — 2 — 11				12 — 13	14 — 17	18 — 20	21 — 35

Type C Instruction

OP				C	T	Y
	0	0				
S — 1 — 2 — 9				10 — 17	18 — 20	21 — 35

Type D Instruction

(Used in conjunction with the sense indicators, 0-17 or 18-35. Position S is used to denote whether the left (0-17) or the right (18-35) indicators are to be used by the instruction.)

OP				NU	R
	0	0			
S — 1 — 2 — 11				12 — 17	18 — 35

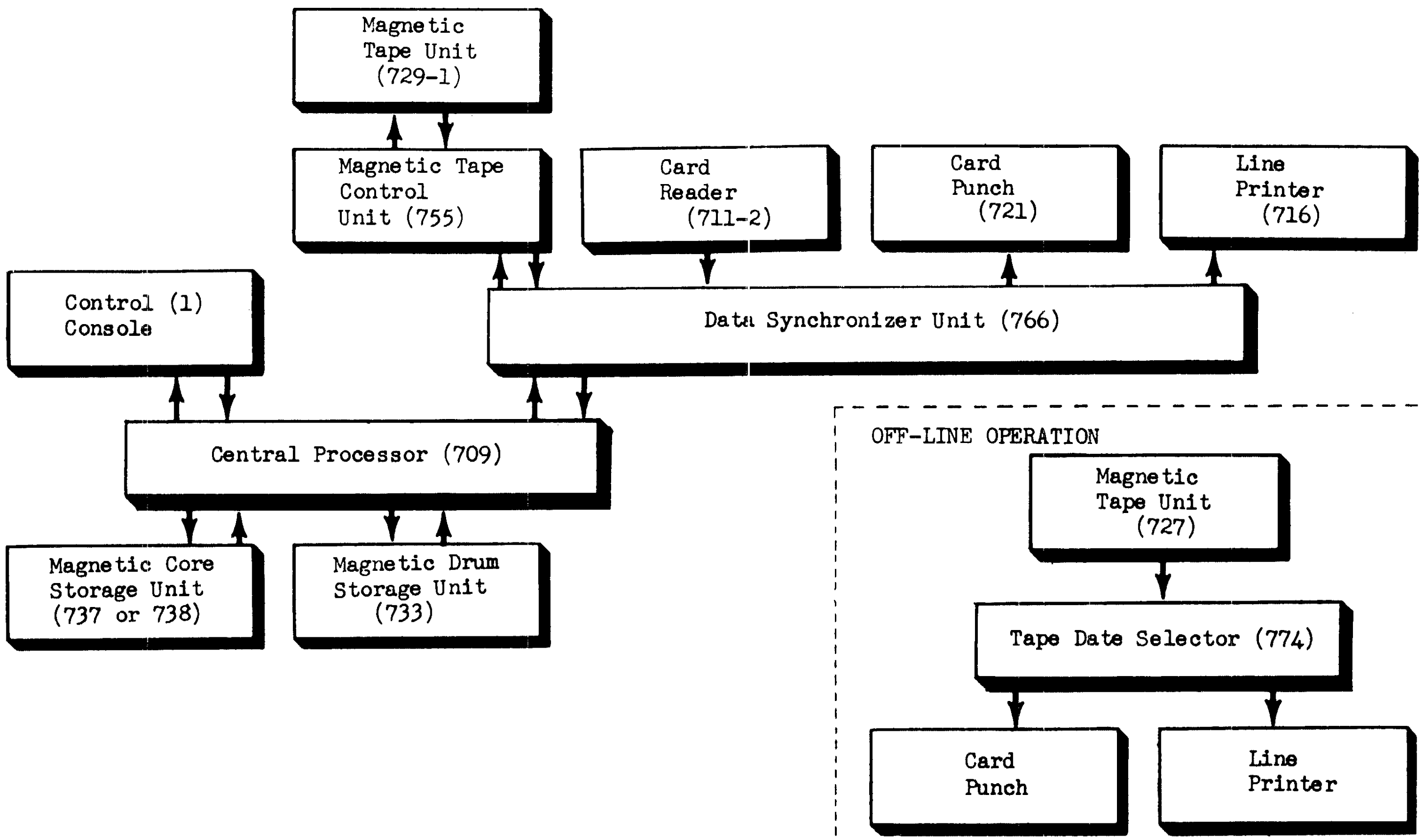
OP —Operation Code.
D —Increment.
T —Index Register Tag.
Y —Address.
I —Specify Indirect Addressing.
NU—Not Used.
C —Count.
R —Control Field.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
709 Central Processor	$10,000	$500,000	$1,456.00	72x37x66	3,150	40.3	109,800
711-2 Card Reader	800	32,000	94.25	32x30x32	560	0.7	1,700
716 Printer	1,200	54,200	173.00	59x30x47	1,910	3.1	7,850
721 Card Punch	600	25,000	92.75	40x26x50	670	3.5	9,000
729-1 Magnetic Tape Unit	700	27,500	202.00	29x31x69	950	2.2	4,100
733 Magnetic Drum Unit	2,900	110,000	372.00	55x31x67	1,930	10.4	25,200
737-3 Core Storage Unit	3,700	192,400	238.00	105x31x64	1,620	6.4	16,400
738-1 Core Storage Unit	19,700	940,000	960.00	159x95x64	4,000	23.4	60,500
755 Tape Control Unit	1,500	90,000	207.00	60x32x67	2,250	6.0	9,200
766 Data Synchronizer	3,600	190,000	498.00	63x32x67	3,500	14.0	38,100
736-2 Power Frame #1	1,100	57,200	97.25	61x34x65	2,380	5.8	14,700
741 Power Frame #2	1,400	72,800	66.50	61x34x65	3,030	5.8	14,700
746 Power Distribution Unit #2	1,400	72,800	42.00	41x34x65	1,170	1.2	3,000
746 Power Distribution Unit #3	1,300	67,600	40.00	41x34x65	1,170	1.2	3,000
774 Tape Data Selector System (2)							
740 CRT Recorder	2,450	96,000	215.00	37x28x52	790	2.4	6,140
780 CRT Display	400	16,000	54.00	28x24x22	270		

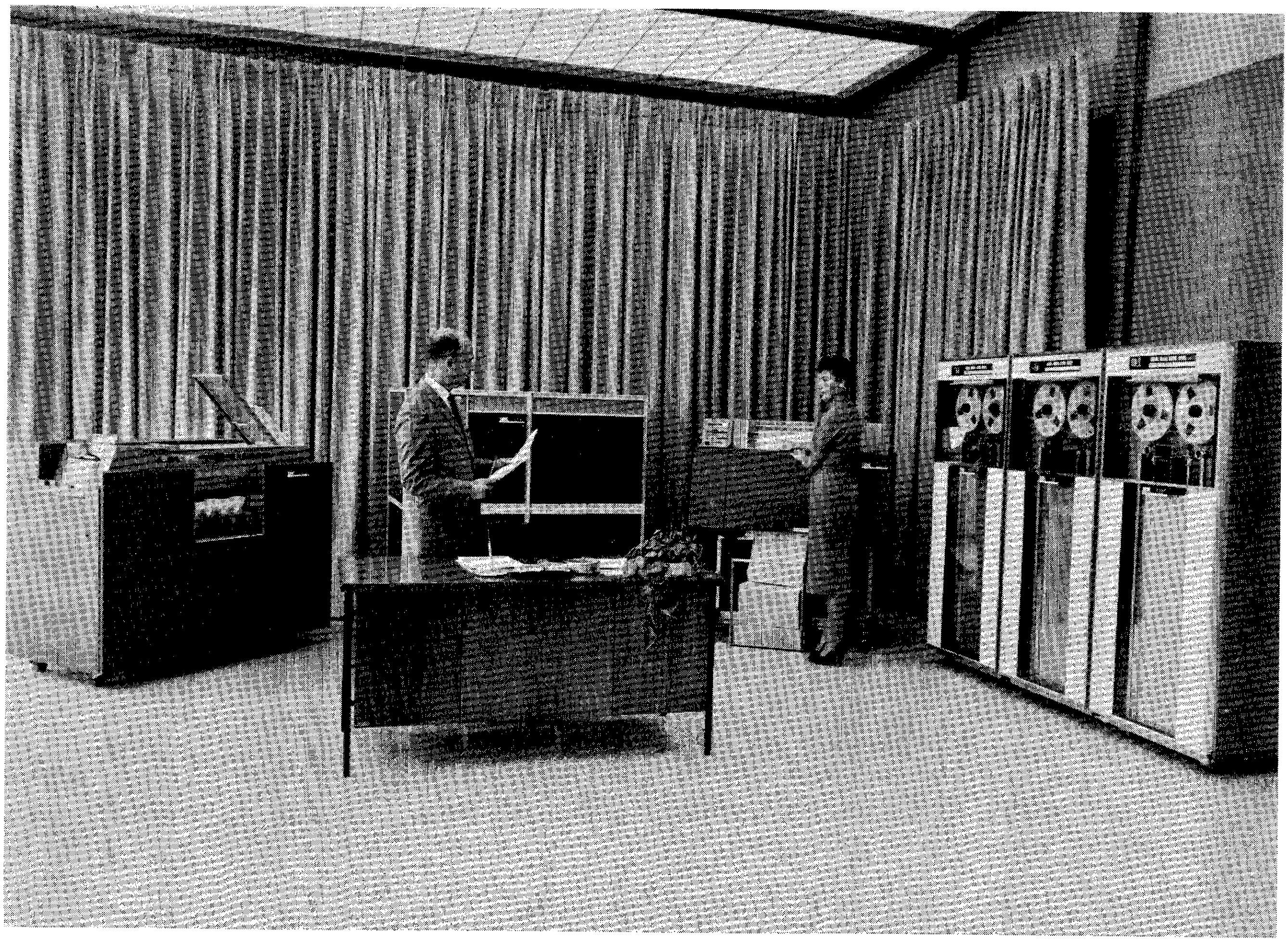
[1] On purchased machines only. Based on age of machine in months (0-36 month rate shown).

[2] For components of the Tape Data Selector System, see IBM 650 chart.



BLOCK DIAGRAM OF IBM 709

IBM 1401 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC IBM 1401 consists of a central processor, a high speed card read-punch unit, and a high speed printer. The basic system may be expanded by the substitution of a larger core storage unit, and the addition of a magnetic tape adapter with up to six magnetic tape units. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Variable.

Numeric Characters Per Word: Variable, limited by memory size only.

Alphabetic Characters Per Word: Variable, limited by memory size only.

Character Code: Binary coded decimal (6 bits plus parity bit).

Timing: Synchronous.

Pulse Repetition Rate: 83 kilocycles.

Central processor (1401)

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point Programmed	Direct (optional)
Add: 555555 to 555555	0.264	0.264
Multiply: 555555 by 5555	12.000	2.256

Divide: 3086108025 by 5555 .... 20.000 5.772

Access time: 0.012 milliseconds.

Checking features: Parity, validity, and hole count checks.

Registers

A address register: Contains the storage location of the data in the (A) portion of an instruction.

B address register: Contains the storage location of the data in the (B) portion of an instruction.

I address register: Contains the storage location of the next instruction character to be used by the stored program.

Memory

The basic magnetic core memory has a capacity of 1,400 character locations. Optional models are available with capacities of 2,000 and 4,000 character locations. All charater locations are addressable.

Operator's panel

This unit is a part of the central processor main frame. It contains controls and indicators for monitoring operation of the system. Indicators display the contents of all registers. The contents of any storage location can be displayed. Switches are available to alter the contents of any storage location.

INPUT MEDIA

Card read-punch unit (1402)

This unit provides the system with simultaneous punched card input-output. It has two card feeds; a read feed operating at a maximum of 800 cards per minute and a punch feed operating at a maximum of 250 cards per minute. The card reading element uses dual reading and comparison of readings as an accuracy check. In the card punch element, a reading station follows the punching station for accuracy checking. There are five radial type stackers in the read-punch unit. Two of the stackers are assigned to the reader and two are assigned to the punch. The fifth stacker can be used by either unit but it must be assigned by the program to either one or the other during any one run.

Magnetic tape adapter

This unit is physically located in the central processor main frame. The adapter is utilized to synchronize and control the flow of information between the internal storage and the magnetic tape units. Up to six magnetic tape units, either IBM 729-2 or 729-4, may be connected to the adapter. All of the tape units used with a specific system must be of the same model and have the same packing density.

Magnetic tape unit (729-2)

Maximum number of units: 6.

Packing density: 200 or 556 characters per inch.

Number of channels: 7.

Record length: Variable.

Record gap: ¾ inch.

Tape speed: 75 inches per second/15,000 or 41,667 characters per second.

Rewind time: 1.2 minutes.

Start-stop time: 10.8 milliseconds.

Change tape time: 1½ minutes (approx.).

Physical characteristics of tape:

Composition: Mylar.

Length: 2,400 feet.

Width: ½ inch.

Error detection: Parity check, horizontal and vertical. Two-gap read-write head which reads characters as they are written on tape and immediately checks them for validity.

Magnetic tape unit (729-4)

Maximum number of units: 6.

Packing density: 200 or 556 characters per inch.

Number of channels: 7.

Record length: Variable.

Record gap: ¾ inch.

Tape speed: 112.5 inches per second/22,500 or 62,500 characters per second.

Rewind time: 0.9 minutes.

Start-stop time: 7.3 milliseconds.

Change tape time: 1½ minutes (approx.).

Physical characteristics of tape:

Same as tape unit (729-2).

Error detection: Same as tape unit (729-2).

OUTPUT MEDIA

Card read-punch unit and magnetic tape system

As previously described.

High speed printer (1403)

This unit is a chain type printer which prints at a rate of 600 lines per minute, 100 or 132 characters per line. There are 48 printable characters, 26 alphabetic, 10 numeric, and 12 special symbols. Vertical spacing is either 6 or 8 lines per inch (manually selected by the operator). With a single speed carriage, skip line speed is 33 inches per second. With a dual speed carriage, skip line speed is 75 inches per second, after the eighth line has been skipped.

AUXILIARY COMPONENTS

Print control

This feature provides 100 or 132 nonaddressable extra positions of core storage and is used to increase processing speed in applications where printing volume is high. Data to be printed is moved by the PRINT instruction from the printing area of core storage to the Print Control area. On the completion of this transfer, normal program execution is resumed while the Print Control area sets up the print mechanism.

Printer buffer

This unit is electrically inserted between the central processor and the printer. It provides the capability of simultaneous printing and card reading.

PROGRAMMING

General: Basically, the 1401 uses a two address type of instruction.

Instructions:

Number of instructions per word: Not applicable.
Number of digits per instruction: Variable, 1 to 8.
Total number of operation codes: 33.

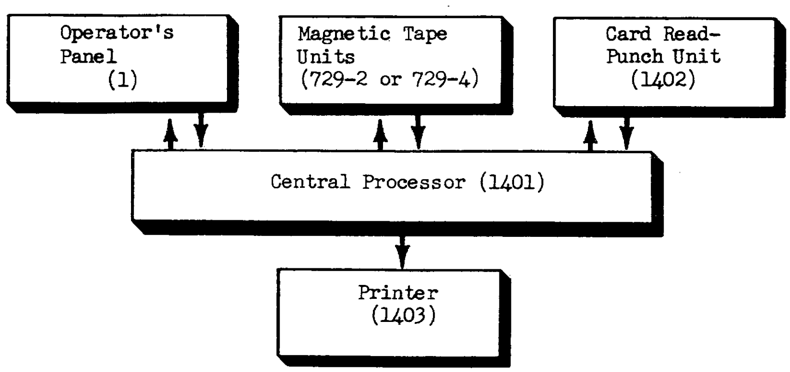
Typical instruction word format

OP code	A address	B address
X	XXX	XXX

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1401 Central Processor (Basic model)	$1,200	$70,500	$47.50	29x31x58	980	(2)	3,000
1401 Central Processor (Fully expanded model	2,680	107,250	81.50	58x31x58	1,825	(2)	15,100
1402 Card Read-Punch Unit	550	24,800	45.00	58x30x46	1,300	8.0	6,200
1403 High Speed Printer Model 1	725	30,300	172.00	48x29x54	850	(2)	4,100
1403 High Speed Printer Model 2	775	30,800	187.00	48x29x54	850	(2)	4,100
729-2 Magnetic Tape Unit	700	27,500	202.00	29x33x69	1,200	1.5	3,900
729-4 Magnetic Tape Unit	900	48,500	191.00	29x33x69	1,200	1.5	3,900

1 For purchased equipment only. Based on age of equipment in months (0-36 month rate shown).
2 Included in 1402.



BLOCK DIAGRAM OF IBM 1401

THE 1410 extends the range of intermediate computers for commercial use. Transition from the 1401 to the 1410 requires a minimum system development cost, since programs are compatible. The 1410 comes in card, magnetic tape, RAMAC and RAMAC tape models. With five (5) RAMAC disk storage units, the 1410 can store 100 million characters of information for in-line processing.

Shown is an expanded RAMAC 1410 system. The operator, in foreground, is seated at the 1415 console. From left to right in background are the 1403 printer, the 1402 card read punch, the 1411 processing unit and the 1011 paper tape reader.

The other operator is standing in front of the 1412 magnetic character reader used with the 1410 in banking applications. To her right are a 1405 disk storage unit, a 7330 magnetic tape unit and two (2) 729 magnetic tape units. The 1410 can handle a total of twenty tape units. The 1410, as the 1401, has significant use as subsystems with large-scale computer systems.

SYSTEMS COMPONENTS

Word Length: Variable.
Numeric Characters Per Word: Variable limited by memory size only.
Alphabetic Characters Per Word: Variable.
Character Code: Binary coded decimal six (6) bits plus parity bit.
Timing: Synchronous.
Pulse Repetition Rate: 83 kilocycles.
Decimal Digits/Instruction: 1 to 12.

The 1410 systems are available in three basic component arrangements:

1410 Card system,
1410 Tape system, and
1410 RAMAC system.

1411 processing unit

Operations that can be performed are addressing, program control, arithmetic logic, indexing, general data, input-output and checking. There are three (3) models with 10,000, 20,000, and 40,000 positions of core storage. The character cycle is 4.5 microseconds. The following registers are used in this 1410 system.

Instruction address register: Is a five (5) character register, and the address read into it specifies the initial address of an instruction in core storage.

A-Address register: Accepts a five (5) character address that specifies the storage location of the first A-field character involved in the operation.

B-Address register: Accepts a five (5) character address that specifies the storage location of the first B-field character involved in the operation.

Op register: Is a one (1) character register that stores the operation code of the instruction in process.

I/0 channel select register, unit select register, and unit number register: These accept the hundredths, tens, and unit positions of the x-control field that designates an I/0 device. The hundreds position specifies the data transmission channel; the tens position specifies the I/0 device; and the units position specifies the number of that device, such as tape drive three

There are fifteen (15) indexing registers of five (5) characters each.

1414 input-output synchronizers

Model 1 provides controls for 729 II or IV Magnetic Tape input-output.

Model 2 controls 7330 Magnetic Tape input-output.

Up to ten (10) Magnetic Tape units may be installed on a single channel with one 1414 synchronizer. One additional 1414 Model 1 and/or Model 2 is available for dual channel operation thereby permitting a maximum of twenty (20) magnetic tape units.

Model 3 controls and buffers card reading, card punching and report printing.

1405 disk storage

Model 1 has 10,000,000 alphameric character capacity consisting of 25 disks, 200 tracks per disk and each track containing ten 200-character records.

Model 2 has 20,000,000 alphameric character storage consisting of 50 disks, 200 tracks per disk, and each track containing ten 200-character fixed length records. As many as five (5) 1405 disk storage units may be installed. One (1) access arm is standard per unit, and two additional arms per unit are optional.

1415 console

Contains operational controls, visual displays and operator communication with system and provides automatic logging, display of all storage registers and contents of core storage. Console typewriter provides for inquiry, program check and restart procedures.

INPUT-OUTPUT

1402 card read-punch, model 2

Unit reads 800 cards per minute, punches 250 cards per minute, and can be independently operated. Design includes high capacity file feed, five (5) radial non-stop stackers, automatic checking.

1403 printer

This unit is the new chain printer that prints 600 lines per minute; 48 characters spaced 10 per inch with high speed spacing and forms skipping. Model 1 has 100 print positions per line and Model 2 has 132 print positions per line.

Other input-output media

Three magnetic tape units may be used with the 1410 system and up to 20 tape units can be installed in the system.

729 II Magnetic Tape unit provides an information transmission rate of 41,667 characters per second or, with low density, 15,000 characters per second.

729 IV Magnetic Tape unit provides an information transmission rate of 62,500 characters per second or, with low density, 22,500 per second.

7330 Magnetic Tape unit provides an information transmission rate of 20,000 characters per second or, with low density, 7,200 characters per second. Unit is compatible with both 729 units.

AUXILIARY EQUIPMENT

1011 paper tape reader

Unit reads both chad and chadless tape at 500 characters per second from 5- to 8-channel, and accepts reel, strip or center roll feeding.

1412 magnetic character reader

Unit reads and sorts magnetically inscribed documents at a maximum rate of 950 documents per minute, provides direct input to the 1411 processing unit, with all operations under control of 1410 stored program.

PROGRAMMING

General: The 1410 system uses a two-address type of instruction, with variable decimal digits words and decimal digit instructions 1 to 12.

Instruction word format

<table>
<tr><th>Op. Code</th><th>A-or I-Address</th><th>B-Address</th><th>d-Character</th></tr>
<tr><td rowspan="3">X</td><td>XXXXX</td><td rowspan="3">XXXXX</td><td rowspan="3">X</td></tr>
<tr><td>x-control field</td></tr>
<tr><td>XXX</td></tr>
</table>

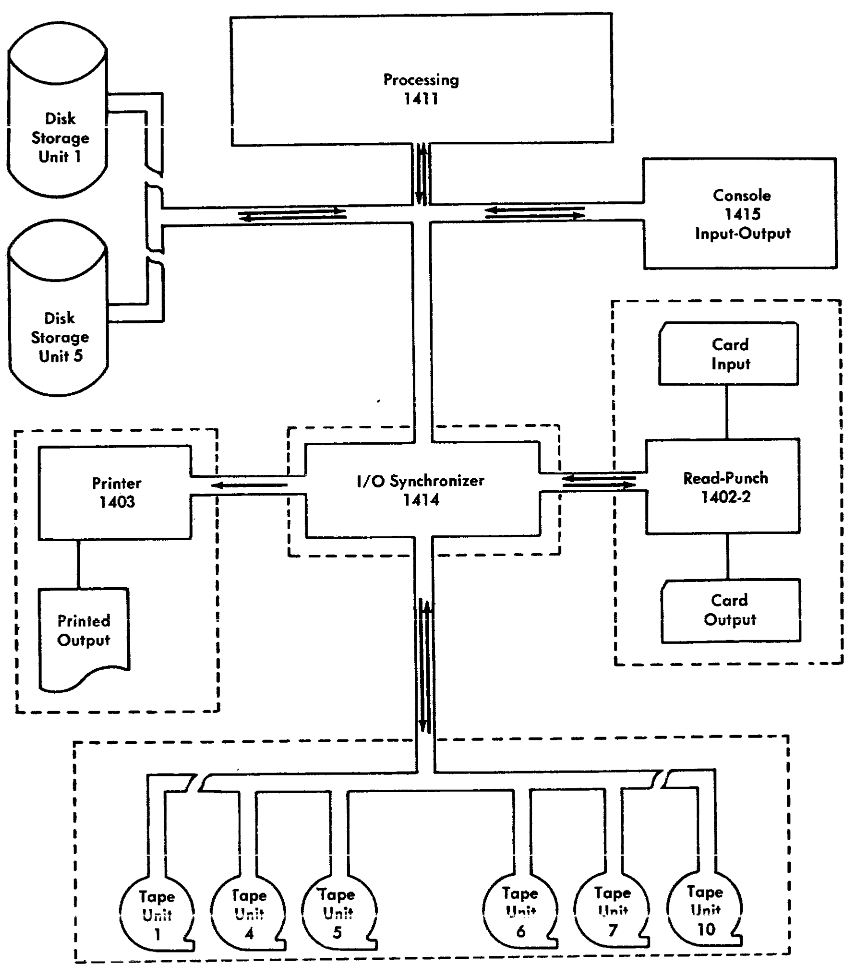
Programs and routines to aid in testing and machine operation are:

- Autocoder
- Basic Autocoder
- Tape Sort Routine
- RAMAC Tape Sort Routine
- Tape Merge Routine
- Utility Programs
- RAMAC File Organization System
- FORTRAN
- Report Program Generator, and Input-Output Control System

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1402-2 Card Read Punch	$615	$27,050	(2)	58x31x46	1,400		5,600
1403-1 Printer	725	30,300		48x29x54	850		4,100
1403-2 Printer	775	30,800		48x29x54	850		4,100
1405-1 Disk Storage	965	36,000		61x30x70	2,090	5.3	2,600
1405-2 Disk Storage	1,515	48,500		61x30x70	2,090	5.3	2,600
1411-1 Processing	3,800	174,500		146x31x70	2,800	14.0	18,000
1411-2 Processing	4,550	202,500		146x31x70	2,800	14.0	18,000
1411-3 Processing	5,400	235,000		146x31x70	2,800	14.0	18,000
1414-1 I/0 Synchronizer	975	43,500		38x31x70	600		2,130
1414-2 I/0 Synchronizer	500	24,900		38x31x70	600		1,825
1414-3 I/0 Synchronizer	675	30,375		38x31x70	600		2,560
1415-1 Console	250	11,500		70x29x44	300		940
729 II Magnetic Tape	700	27,500		29x34x69	1,200	1.5	3,520
729 IV Magnetic Tape	900	48,500		29x34x69	1,200	1.5	3,520
7330-1 Magnetic Tape	450	19,000		29x31x58	640	1.0	3,415
1011-1 Paper Tape Reader	500	20,000					
1412 Magnetic Character Reader	2,000	83,100					

1 Maintenance is provided in monthly rental.
2 Several adapters, etc. are required in various combinations of the 1410 system units.



BLOCK DIAGRAM OF IBM 1410

IBM 1620 INTERNATIONAL BUSINESS MACHINES CORPORATION

THE IBM 1620 is a compact, transistorized computer which handles the formula encountered in solving engineering and scientific problems in industry. System is used for solutions of problems in petroleum, public utilities, optics, general manufacturing, civil and general engineering, and electronics. Features of this unit are the 20,000-digit magnetic core storage, and the Card Read Punch input-output unit.

SYSTEM COMPONENTS

General

Word Length: Character addressable, decimal.
Character Code: Binary coded decimal digits.
Pulse Repetition Rate: 20 microsecond cycle rate.

Central processor

Operation: The 1620 consists of two modular units, a central processing unit and a paper tape reader-punch.

Computation speed:

	Including Storage access (microseconds)
Addition or Subtraction	960 (10 digits)
Multiplication:	17,700 (10 digits)
Division:	16,800
Access time:	20

The 1620 is a two (2) address system and times given alone include access time to the two (2) operands and the storing of the result. Divide time includes loading dividends. In the arithmetic and logical unit, addition, subtraction and multiplication are accomplished by table look-up method in core storage. Division is accomplished by subroutine or optional direct divide feature.

Checking features: Odd bit parity check of input, output, and internal manipulations of data.

Table look-up arithmetic is used, with the table stored in main memory of magnetic cores.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation: Sequential.

The magnetic core storage of 20,000 to 60,000 digits is individually addressable and can be made immediately available for processing. All data placed into the system is recorded in core storage as decimal digits; alphabetic and special characters are handled automatically, with each being stored as two decimal digits.

The 1623 core storage, models 1 and 2, allow expansion of the initial 20,000 core storage unit. Model 1 furnishes an additional 20,000 positions, and model 2 an additional 40,000 positions. Addressing remains direct with the additional storage:

Basic system positions	00000-19999
With Model 1	00000-39999
With Model 2	00000-59999

Control console

The console is an integral part of the central processing unit and provides communication with the 1620 system. It consists of a console panel with lights, keys, switches and a typewriter.

The console is used to:

1. Instruct the machine manually.
2. Display machine and program status indicators.
3. Display the contents of storage and registers.
4. Place data and instructions in storage.
5. Revise the contents of storage.
6. Alter machine functions.
7. Correct errors.
8. Provide a log of manual operations.

The console panel displays the contents of registers by means of small incandescent lights. The lights represent the digit present in each position of a register and the on-off condition of internal check indicators.

Control keys are used to perform manual operations. Signal lights associated with the control keys visually indicate a specific condition of the computer.

Four program switches are provided on the console, for manual control of branching where interrogated by the stored program.

The console typewriter is an input-output unit for direct input of data and instructions into storage. The console typewriter provides print-out of storage data as specified by the program. Continuous forms may be used and line spacing may be set for single, double, or triple spacing. Special line spacing is also available.

INPUT MEDIA

1621 paper tape reader

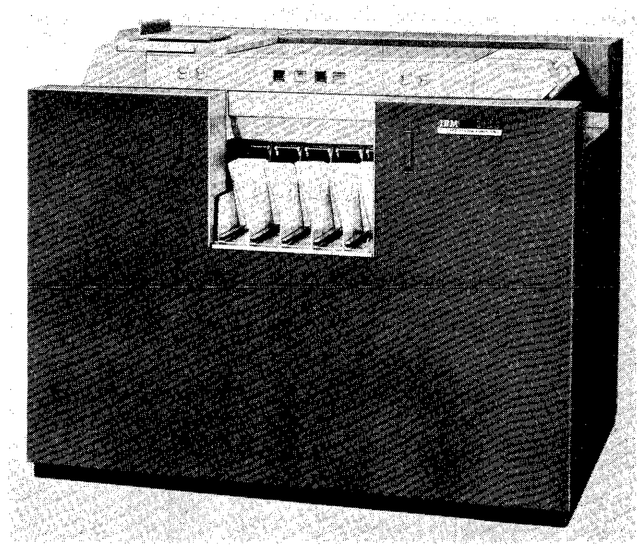
Reads standard eight-track alphameric characters photoelectrically at a rate of 150 per second. The characters are read from the tape serially, converted to internal digit code, and transmitted to 1620 storage. The eight-track tape used is one inch wide and the 1621 has a maximum reel capacity of 1,000 feet of tape. The 1621 can feed tape in the center of the reel, in strip form, or from reel to reel.

Typewriter

A modified electric typewriter which makes a hard copy record of data introduced into the system. See Console.

1622 card read punch

Reads 80-column cards at a rate of 250 cards per minute and punches 125 cards per minute. Input and output is buffered, allowing data transfer in either



1622 CARD READ PUNCH

numerical or alphabetic mode to or from 1620 core storage in 3.4 milliseconds. The remainder of the read or punch cycle is available for processing. The 1622 has independent operating keys, lights, and power switches.

Feeding is from opposing ends toward the center where five (5) radial non-stop unloading stackers receive cards. The two (2) stackers near each feed are used for that side of the machine; the first is the normal stacker, and the second is for error selection. The center stacker use is unidentified at this time.

OUTPUT MEDIA

921 paper tape punch typewriter

1622 card read punch

See above.

AUXILIARY COMPONENTS

IBM 1622 card read punch

Reads 250 cards per minute and punches 125 cards per minute. The 1622 has a synchronizer for both input and output, and allows complete overlap of reading, computing, and punching. This unit has independent control of each feed by stored program, automatic conversion when reading or punching alphameric data, and automatic checking of reading and punching. Also, has five (5) radial type, non-stop stackers and pocket selection.

Direct Division feature #47 is optional and allows for 56 divisions per second in terms of ten (10) digits by five (5) digits. Another optional feature is indirect addressing, #493 which provides a means of address modification that allows a saving of program instructions and compute time when the same address appears in multiple instructions. It also is useful for subroutine linkage.

PROGRAMMING

General: The 1620 uses a 12-digit instruction divided into three parts (a two-digit operation code and two five-digit addresses). This double address reduces the number of instructions needed to perform an operation and simplifies programming.

For example, one instruction will locate, add, and store the sum of two numbers, or branch to a subroutine area and store an address for return from the subroutine. The operation code consists of two digits, 00 through 99, that instruct the computer to perform a specific operation.

Variable length fields permit data to be fixed or varied in length depending on the problem. Data can be addressed as digits, fields, or records.

Instructions:

Number of digits per instruction: 12 fixed length.

Total number of operation codes: 36.

Instruction word format

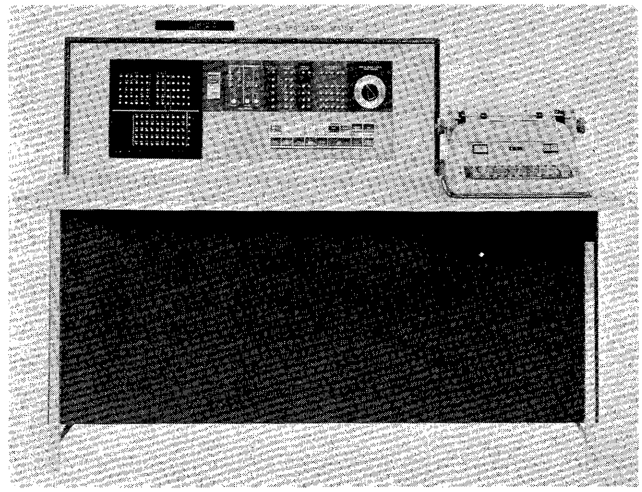
Operation	P Address	Q Address
1 — 2	3 — 7	8 — 12

Symbolic programming, FORTRAN, and a program library can be used on the 1620 system.

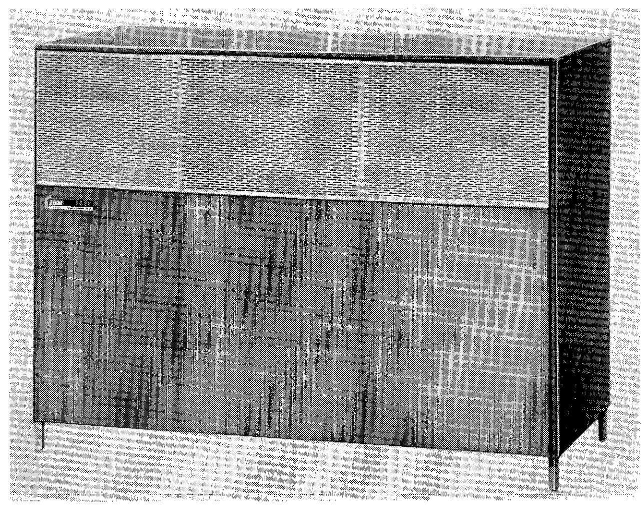
Symbolic programming provides for the use of symbolic operation codes and addresses in the preparation of programs.

FORTRAN, a mathematical language, automatically compiles into the machine program and can be used in conjunction with other IBM systems.

The program library has efficient programs for all common mathematical functions. Utility routines are available to aid in program testing.



1620 CENTRAL PROCESSOR

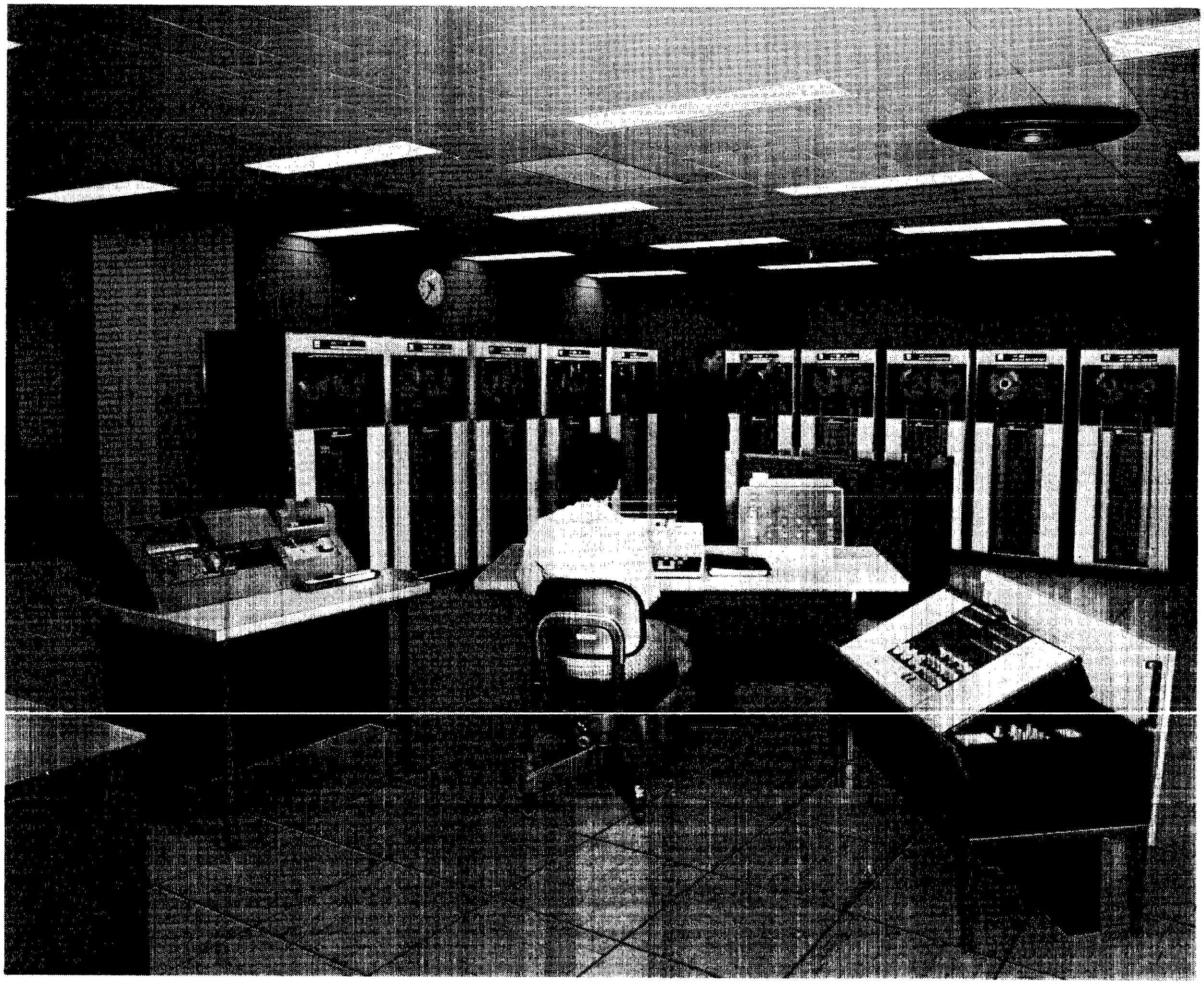


1623 CORE STORAGE

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Comments	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1620 Central Processor	$1,375	$64,000		63x44x44	1,210		10,000
1621 Paper Tape Reader	200	9,100		31x26.5x44	350		
1622 Card Read Punch	625	30,500		57.5x30x45.5	1,305		5,000
1623-1 Core Storage	800	39,500	20,000 Positions	61x27x44.5	830		2,000
1623-2 Core Storage	1,275	62,400	40,000 Positions	61x27x44.5	915		3,000
961 Paper Tape Punch	25	1,400		Included in 1621			
47 Automatic Divide	55	2,400					
493 Indirect Addressing	25	1,150					

IBM 7070 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE BASIC IBM 7070 consists of an arithmetic and program control unit, a control console, a magnetic core storage control unit, a magnetic core storage unit, an input-output synchronizer unit, an input-output control unit, a card reader, and a card punch. The basic system may be expanded by the substitution of a larger core storage unit, by the addition of a tape control unit, up to 12 magnetic tape units, a magnetic disk storage control unit with up to 4 magnetic disk storage (RAMAC) units, and up to 10 inquiry stations, as well as multiple card readers, card punches, and line printers. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 10 digits plus control digit.

Numeric Characters Per Word: 10 plus sign.

Alphabetic Characters Per Word: 5 plus sign (two numerics for one alphabetic).

Character Code: Binary; two-out-of-five bits.

Timing: Asynchronous logic, sychronous input-output.

Pulse Repetition Rate: 250 kilocycles.

Central processor

Operation: Parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.168

	Time (milliseconds) Fixed point
Multiply: 555555 by 5555	0.708
Divide: 3086108025 by 5555	2.220

Access time: 0.006 milliseconds.

Checking features: Self-checking 2-out-of-5-bit character code. Validity checks on all internal transfers of data.

Registers

Index registers: 99 addressable (10 digits plus sign) registers located in core storage.

Arithmetic register: A ten digit plus sign register used as intermediate storage during arithmetic operations.

Auxiliary register: A ten digit plus sign register used to hold one of the operands during arithmetic operations.

Accumulators: 3 registers used to hold the operands and the results of arithmetic operations.

Priority register: Used to hold the address of the next machine instruction to be executed in the main program after finishing an automatic priority processing operation.

Address register: Used to hold the address of the next machine instruction to be executed.

Program register: Used to hold the instruction word while the instruction itself is being executed.

Memory

The basic magnetic core memory (7301-1) has a capacity of 5,000 words. The core storage control unit (7602) is used in conjunction with the core storage unit. Six models of the core storage control unit are available to provide switching and control for different input-output configurations. An optional core storage unit having a capacity of 9,900 words may be used in place of the smaller memory unit.

Control panel

This unit is a part of the control console and contains the indicators and controls necessary for operation and control of all units.

INPUT MEDIA

Tape control unit (7604)

This unit is utilized to synchronize and control information flow between the high speed memory control and the tape units and/or disk storage units. Either of two tape control units may be used with the system. One unit (7604-1) provides two independent, simultaneously-operating data channels, which may each have up to six magnetic tape units attached. The other unit (7604-2) provides one data channel which may have up to six magnetic tape units attached. Each data channel can be utilized by the disk storage units. Magnetic tape units (729-2 and 729-4) may be connected to the tape control unit in any combination up to a total of six tape units per data channel.

Magnetic tape unit (729-2)

Maximum number per system: Any combination of tape units (729-2 or 729-4) up to a total of 12 units.
Packing density: 200 or 556 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 75 inches per second/15,000 or 41,667 characters per second.
Rewind time: 1.2 minutes.
Start-stop time: 10.8 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
Composition: Mylar.
Length: 2,400 feet.
Width: ½ inch.
Error detection: Parity check, horizontal and vertical. Two-gap read-write head which reads characters as they are written on tape and immediately checks them for validity.

Magnetic tape unit (729-4)

Maximum number per system: Any combination of tape units (729-2 or 729-4) up to a total of 12 units.
Packing density: 200 or 556 characters per inch.
Number of channels: 7.
Record length: Variable.
Record gap: ¾ inch.
Tape speed: 112.5 inches per second/22,500 or 62,500 characters per second.
Rewind time: 0.9 minutes.
Start-stop time: 7.3 milliseconds.
Change tape time: 1½ minutes (approx.).
Physical characteristics of tape:
Same as tape unit (729-2).
Error detection: Same as tape unit (729-2).

Input-output synchronizer unit (7603-3)

This unit contains the synchronizing circuits for the printer and the punched card equipment. This unit is available in 27 different models for different input-output configurations.

Input-output control unit (7600-1)

This unit is used in conjunction with the input-output synchronizer unit. It serves as the synchronizer storage for the printer and the punch card equipment and contains the circuitry for the synchronizer timing and control. It also contains all the timing and control circuitry for the control console.

Magnetic disk storage control unit (7605-1)

This unit provides the control circuits for connecting up to four disk storage units to the system. Connection of a disk storage unit to one of the two data channels of the magnetic tape control unit is effected in this unit. Only one disk storage unit may operate on a data channel at one time.

Magnetic disk storage (RAMAC) unit (7300)

This unit contains 50 metallic disks coated with magnetic material on each side. The disks are 24 inches in diameter, are evenly spaced on the same vertical shaft, and rotate at 1,200 revolutions per minute. There are three independent access arms. Each arm is forked and carries two read-write heads, one for each side of the disk. This unit is available in 2 models having different recording densities.
Maximum number of units: 4.
Disks per unit: 50.
Tracks per disk: 200 or 400.
Digits per track: 600.
Total addressable locations: 10,000 or 20,000 per unit.
Total digit storage: 6,000,000 or 12,000,000 per unit.
Access time:
- Intertrack seek, adjacent track on same disk — 105 milliseconds (max.).
- Intertrack seek, nonadjacent track on same disk — 235 milliseconds (max.).
- Interdisk seek — 850 milliseconds (max.).

Error detection:
- Comparing the actual position of an access arm with the desired position.
- Character code check (2-out-of-5).
- Comparing the information written on the disk with the information transferred from core memory.

Card reader (7500-1)

This unit is the primary input for the system. It mechanically senses 80-column punched cards (alphanumeric information) at a rate of 500 cards per minute. Three reading operations are performed; the first two sense and arrange the format and the third is used for data input to the system. The card stacker is a vacuum operated, drum type and can offset selected cards. Data can be arranged by plugboard wiring.

Electric typewriter

This unit is associated with the control console and provides the following services:
1. Prints out the contents of any addressable location upon command.
2. Provides the facility to enter or modify instructions and/or data.
3. Automatically creates a complete record of all console actions which may affect the program.
4. Prints messages under control of the stored program.
5. Automatically writes a record of all machine halts, as they occur.

OUTPUT MEDIA

Magnetic tape

As previously described.

Magnetic disk storage

As previously described.

Card punch (7550-1)

This unit punches 80-column cards (alpha-numeric information) at a rate of 250 cards per minute. Card reading is performed immediately following the punching for an accuracy check. The card stacker is a vacuum operated, drum type and can offset selected cards. Data can be arranged by plugboard wiring.

Line printer (7400-1)

This unit prints out information at a rate of 150 lines per minute, 120 characters per line during each print cycle. Eighty of these characters may come from core storage and the others may be emitted through plugboard control. Format is arranged by plugboard wiring and a 12-channel program tape.

Electric typewriter

As previously described.

AUXILIARY COMPONENTS

Inquiry station (7900)

Up to ten inquiry stations may be connected to a system. The inquiry station is provided with one input-output, format-selecting program tape. Each program tape provides three input-output formats. The operator may select any one of these three formats for input. The computer may select any of the formats for output. Inquiry is limited to 10 words of which one is a control word. For input this word is automatically provided by the program tape. On output the control word is provided by the computer. Inputs and outputs are typed at a maximum rate of 10 characters per second.

PROGRAMMING

General: The IBM 7070 uses a single address type of instruction.

Instructions:
- Number of instructions per word: 1.
- Number of digits per instruction: 10 plus sign.
- Total number of operation codes: 200.

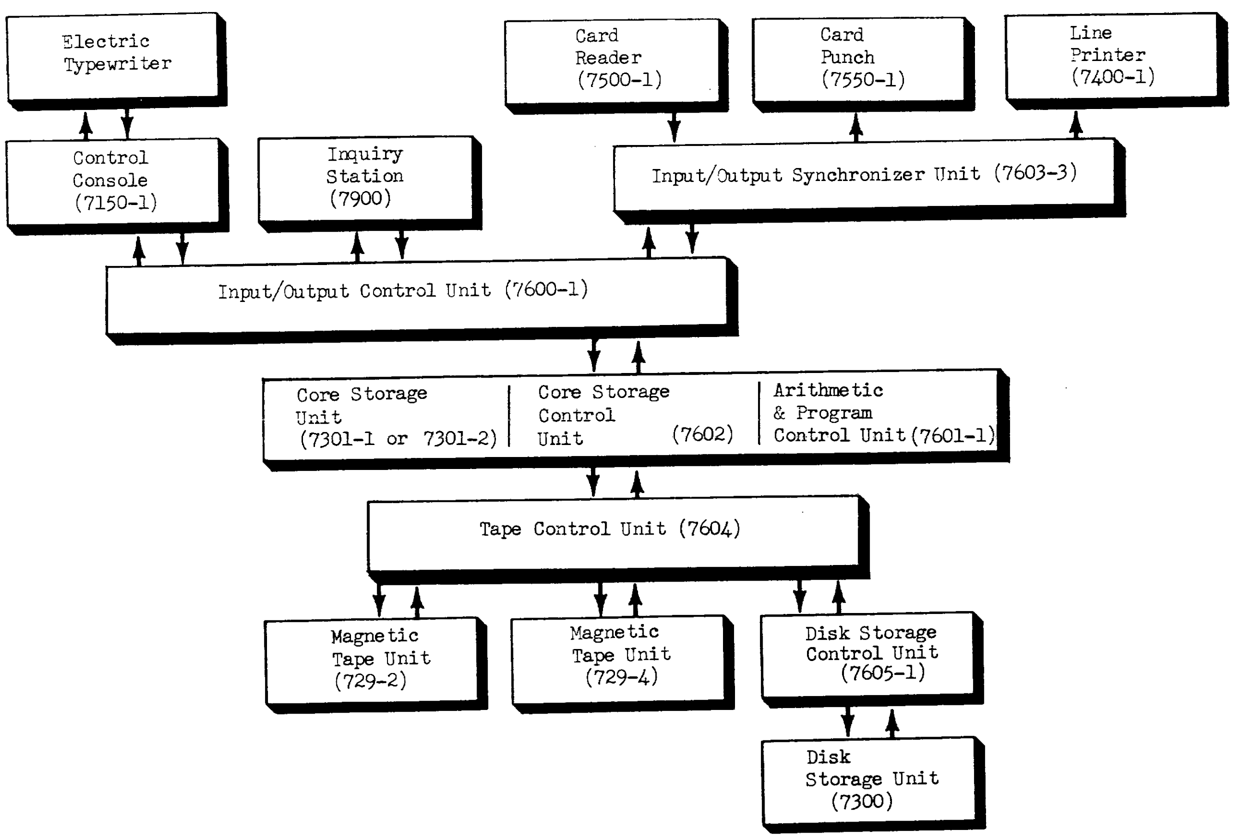
Instruction word format

Operation			Indexing word		Field definition		Address			
Sign	0	1	2	3	4	5	6	7	8	9

Cost, Power Requirements, and Physical Characteristics

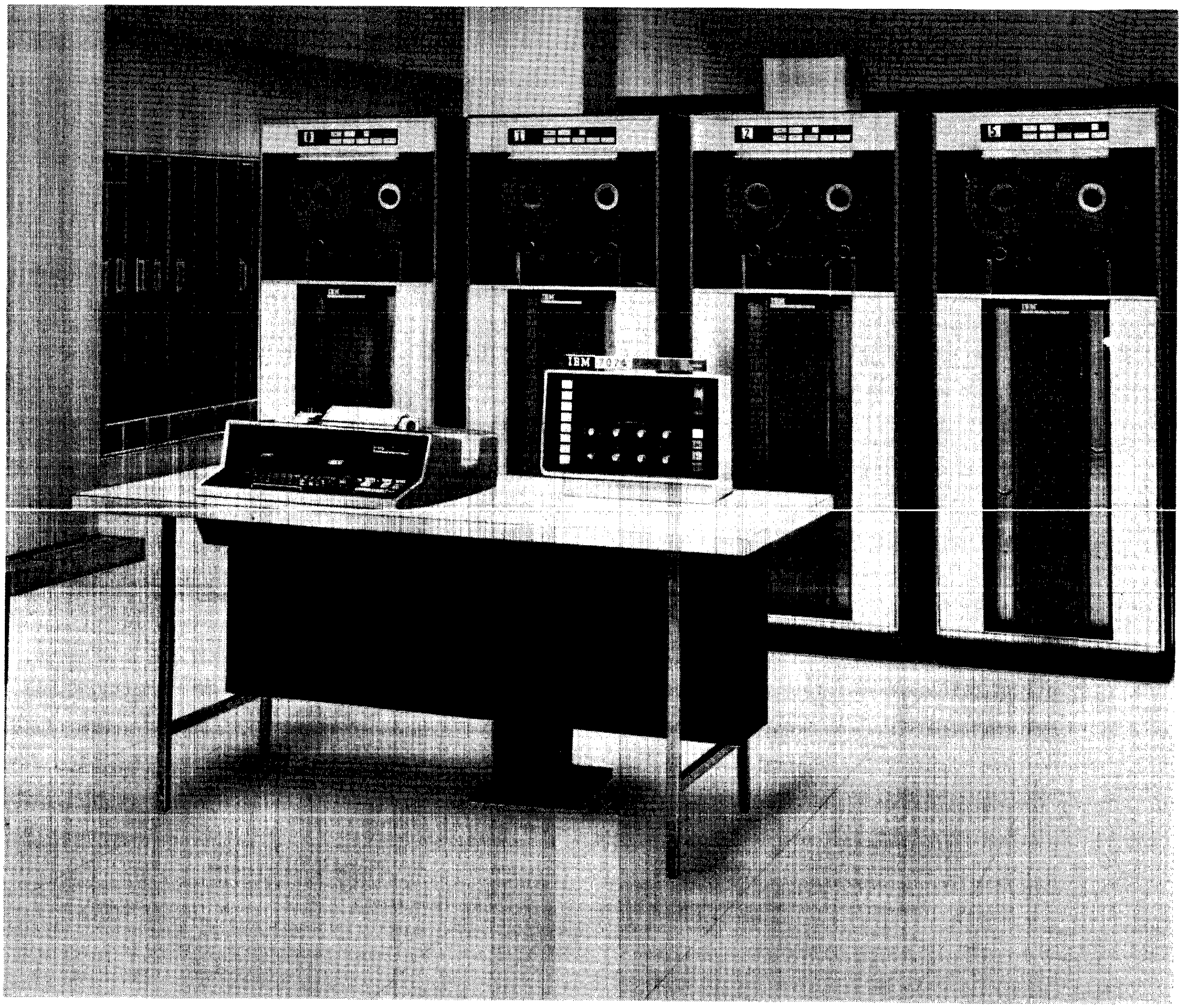
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
7150-1 Console	$ 300	$13,050	$15.50	66x33x40	350	.02	800
7301-1 Core Storage Unit	3,500	160,000	31.25	29x56x69	2,200	1.4	6,500
7600-1 Input-Output Control Unit	1,400	63,000	41.00	29x56x69	2,200	0.9	5,500
7601-1 Arithmetic and Program Control Unit	3,000	138,100	87.50	29x56x69	2,200	0.4	4,400
7602-2 Core Storage Power and Control Unit	2,000	92,650	37.25	29x56x69	2,100	0.4	2,600
7603-3 Input-Output Synchronizer Unit	1,350	62,050	31.25	29x56x69	2,200	0.9	5,400
7604-1 Tape Control Unit	2,700	122,550	86.75	29x56x69	2,200	0.3	4,200
7605-1 Magnetic Disk Storage Control Unit	3,900	174,000	36.75	29x56x69	1,600	0.3	2,000
7300-1 Magnetic Disk Storage (RAMAC) Unit	975	62,200	194.00	62x30x71	2,000	3.7	9,100
7300-2 Magnetic Disk Storage (RAMAC) Unit	1,500	74,800	306.00	62x30x71	2,000	3.7	9,100
7400-1 Line Printer	950	41,500	40.50	60x31x49	1,600	1.7	4,800
7500-1 Card Reader	400	18,000	44.75	29x35x43	1,000	1.5	4,400
7550-1 Card Punch	550	24,600	36.75	29x35x43	800	1.7	4,800
7900-1 Inquiry Station	250	10,300	26.75	48x30x29	200	0.2	600
729-2 Magnetic Tape Unit	700	27,500	202.00	29x33x69	1,200	1.5	3,900
729-4 Magnetic Tape Unit	900	48,500	191.00	29x33x69	1,200	1.5	3,900

[1] For purchased equipment only. Based on age of equipment in months (0-36 month rate shown).



BLOCK DIAGRAM OF IBM 7070

IBM 7074 INTERNATIONAL BUSINESS MACHINES CORPORATION



THE 7074 Data Processing System is one of seven advanced solid-state computers manufactured by this company. It has expandable modular component. Any IBM 7070 can be converted in the field to a 7074 by replacement of three 7070 modules with two 7074 components.

Like the 7070, the 7074 has punched card, magnetic tape, or card-tape-RAMAC combinations. Other features of both the 7070 and the 7074 are automatic priority processing; automatic simultaneous read, write and compute; scatter read or write in magnetic tape operations; and a comprehensive, fully compatible program library.

The following comparison of processing speeds indicates the major difference between the 7070 and 7074 systems:

Processing Speed Comparison in Milliseconds			
Type Operation	Digits	7070	7074
Fixed Point:			
Add/Subtract:	6 + 6	.060	.001
Multiplication:	10 × 5	.610	.043
Division:	5 digit quotient	1.750	.070
Logical Decisions:		.036	.004
Floating Point:			
Add/Subtract:	8 + 8	.212	.016
Multiplication:	8 × 8	1.019	.060
Division:	5 digit quotient	2.57	.096

The 7074 is roughly six times faster internally, two times faster on through-put, and 10 to 20 times faster in scientific computing.

Core storage access time on the 7074 is four microseconds, and the core-to-core transmission rate is 1,250,000 digits per second.

SYSTEM COMPONENTS

General

Only the changes in the 7074 are reported here, the balance of components are identical to those reported for the 7070 system.

7104 high-speed processor

This unit replaces the 7601 unit in the 7070 system. The 7104 performs arithmetic, logical and other programming operations, and has high-speed circuitry, high-density circuit packaging, full parallel arithmetic, and circuits for control of 7301 Core Storage, models 3 and 4. The following 7104 models are available based on the number of magnetic tape channels desired:

Model		Tape Channels
7301	Model 1	for card-only systems
	Model 2	1
	Model 3	2
	Model 4	3
	Model 5	4

Optional high-speed Floating Decimal Arithmetic is available which allows the 7074 system to perform arithmetic operations on numbers having a wide range of values and written in floating decimal form.

7301 core storage, models 3 and 4

These models have four microsecond memory cycles for the 7074 system, and may be field changed from the 7301, model 1, and 7301, model 2, of the 7070 system respectively.

Model 3 — 5,000 words
Model 4 — 9,990 words

7602, core storage control, model 6

One 7602, model 6 is required with each 7074 system.

See page 147 for schematic diagram of 7070 and 7074 systems.

AUXILIARY EQUIPMENT

The IBM 1401 Tape System relieves the 7074 (and the 7070) system of many processing functions. See report on 1401 Systems.

Other units that may operate auxiliary with the 7070 or 7074 system are:

714 Card Reader with 759 Card Reader Control
722 Card Punch with 758 Card Punch Control
774 Tape Data Selector with 519, 407, or 408
720 Printer with 760 Control and Storage, Model 1
730 Printer with 760 Control and Storage, Model 2
717 Printer with 757 Printer Control
7765 Paper Tape to Magnetic Tape Converter

PROGRAMMING

Programming Languages and Systems:

Autocoder

Simplifies coding, eliminates most sources of coding errors.

Input-output control system

Provides macro-instructions for all basic input-output functions.

SPOOL system

Automatically schedules and executes SPOOL operations concurrently with other programs.

FORTRAN

A mathematical language for programming scientific applications.

Programs written in FORTRAN and FOR TRANSIT for other systems can be assembled for the 7070.

Sort and merge

Full flexibility for any application.

As fast and efficient as custom-made programs.

Report generator

Generalized program permitting report preparation from any tape file containing the basic data.

Utility programs

A library of programs to simplify machine operation and aid in program testing.

Instruction word format

Operation			Indexing Word		Field Definition		Address			
Sign	0	1	2	3	4	5	6	7	8	9

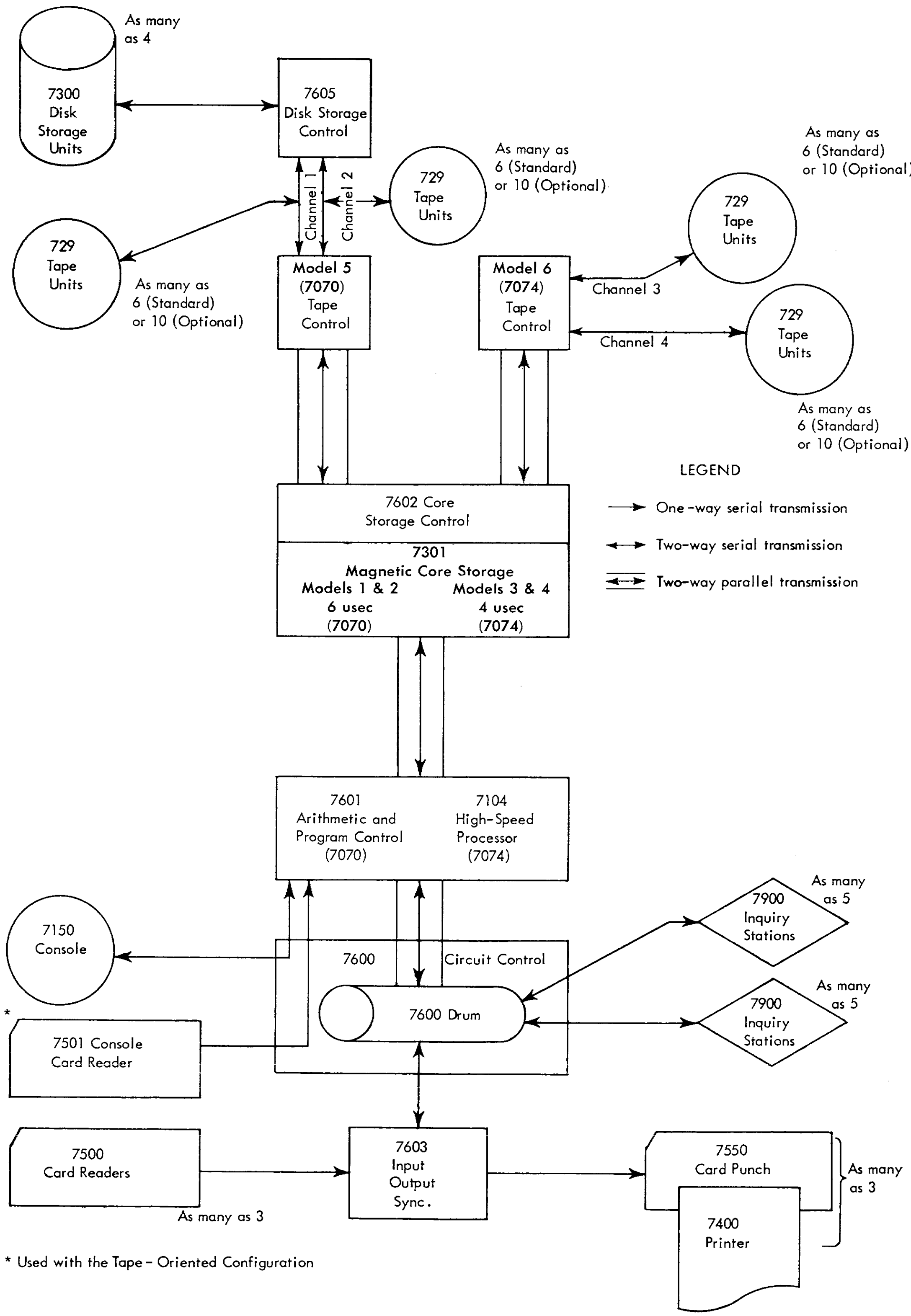
Cost, Power Requirements, and Physical Characteristics

Unit	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
729II M. T. Unit	$700	$27,500	(1)	29x33x69	1,160	1.62	3,900
729IV M. T. Unit	900	48,500		29x33x69	1,160	1.62	3,900
7150 Console Control	300	13,050		66x33x40	350	.02	800
7300-1 Disk Storage	975	62,200		62x30x71	2,000	3.7	9,100
7300-2 Disk Storage	1,500	74,800		62x30x71	2,000	3.7	9,100
7400 Printer	950	41,500		60x31x49	1,600	1.7	4,800
7500 Card Reader	400	18,000		29x35x43	1,000	1.5	4,400
7501 Console Card Reader	75	3,700		29x33x39	200	0.3	800
7550 Card Punch	550	24,600		29x35x43	800	1.7	4,800
7600-1 Input-Output Control	1,400	63,000		29x56x69	2,000	0.4	5,500
7600-2 Input-Output Control	800	33,000		29x56x69	2,000	0.9	5,500
7603-1 Input-Output Synchronizer	1,000	46,050	(2)	29x56x69	2,000	0.9	5,400
7603-2 Input-Output Synchronizer	1,300	59,250					
7603-3 Input-Output Synchronizer	1,350	62,050					
7603-4 Input-Output Synchronizer	1,650	75,250					
7603-5 Input-Output Synchronizer	2,000	91,250					
7603-6 Input-Output Synchronizer	1,700	78,050					
7603-7 Input-Output Synchronizer	1,600	72,450					
7603-8 Input-Output Synchronizer	1,950	88,450					
7603-9 Input-Output Synchronizer	2,300	104,450					
7604-1 Tape Control	2,700	122,500		29x56x69	2,000	0.3	4,200
7604-2 Tape Control	1,850	94,000		29x56x69	2,000	0.3	4,200
7605-1 Disk Store Control	3,900	174,000		29x56x69	1,600	0.3	2,000
7900 Inquiry Station	250	10,300		48x30x29	200	0.2	600
7104-1 High-Speed Processor*	7,300	313,000	(3)				
7104-2 High-Speed Processor	7,400	317,000	(3)				
7104-3 High-Speed Processor	7,500	321,000	(3)				
7104-4 High-Speed Processor	7,700	329,000	(3)				
7104-5 High-Speed Processor	7,800	333,000	(3)				
7602-1 Core Storage Control	1,200	49,400		29x68x69	1,800	0.4	1,900
7301-3 Core Storage*	4,700	208,600	(3)	29x68x69	2,300	1.4	6,600
7301-4 Core Storage	8,000	334,000	(3)	29x68x69	1,500	1.4	6,600

1 Maintenance and parts included in rental prices.

2 See chart explaining Models of 7603 Input-Output Synchronizer. The typical 7074 system requires 29.14 KVA of power. The average system price: monthly rental, $29,300; purchase, $1,284,350.

3 These units, the 7104 and the 7301 in the several shown capacities, provide the increased power of the 7074 system. See breakdown specification on preceding pages.



BLOCK DIAGRAM OF IBM 7074

IBM 7080 INTERNATIONAL BUSINESS MACHINES CORPORATION

A GENERAL PURPOSE COMPUTER designed for both commercial and scientific applications. System will process IBM 705 I, II, or III programs unaltered, and can be expanded to 160,000 positions of core storage. Complete solid-state construction.

SYSTEMS COMPONENTS

General

Internal data representation: Seven-bit coded decimal.
Alphanumeric character/words: Variable data field length.
Single address instructions: Five character.
Read and interpret time, instructions: 2.18 microseconds.
Timing: Synchronous and asynchronous.

Central procesor

Operation: Simultaneous core-to-core transmission, reading, writing, and computing; core-to-core transmission at rate of 1,146,000 characters per second; automatic built-in subroutines include an interrupt system, a store-for-print, and a concurrent transmit.

Computation speed: (program and operands are in memory).

	Time (microseconds) Fixed point
Additions or Subtractions: 6 digits	12.8
Multiplications: 6 × 6 digits	140
Divisions: 20 ÷ 20 digits	210
Logical decision per second:	303,000

STORAGE

IBM 7305 central storage and input-output control has centralized control for two or four input-output channels; all channels can be used simultaneously; contains an accumulator, auxiliary storage, channel auxiliary storage — for priority processing — and communications storage, each consisting of 256 character positions.

IBM 7302 core storage has 2.18 microsecond cycle rate in either of two models:

Model 1 — 160,000 alphameric characters, or
Model 2 — 80,000 alphameric characters.

Media	*Number of characters*	*Access (microseconds)*
Core	40,000; 80,000; 160,000	2.18
Core (fast registers)		1.09

Magnetic tape

Number of units that can be connected: 50 units.
Number of characters per linear inch: 200 or 556.
Channels or tracks on tape: Seven.
Blank tape separating each record: 0.75 inch.
Tape speed: 75 or 112.5 inches per second.
Transfer rate: 15,000, 22,500, 41,667, 62,500 characters per second.
Start-stop time: 10.8 or 7.3 milliseconds.
Length of tape reel: 2,400 feet.

Console

IBM 7153 Console has visual display of binary coded decimal and digits; a keyboard for data entry and instruction execution, and for manually initiated interrupt; load button for simplified program looking. Typewriter with an output rate of 600 alphameric characters per minute.

INPUT-OUTPUT MEDIA

One or two IBM 7621 Tape Control units may be used per system, and each unit is associated with two input-output communication channels. Ten magnetic tape units — Types 729 II or 729 IV — may be used with each channel.

The IBM 7622 Signal Control provides for use of any ten (10) additional input devices shown in Chart II page 150

OFF-LINE SYSTEM COMPONENTS

Card to tape

IBM 714 Card Reader. 250 cards per minute.
IBM 1401 Tape System. 800 cards per minute.

Tape to card

IBM 722 Card Punch.
IBM 774 Tape Data Selector with IBM 519. 100 cards per minute.
IBM 1401 Tape System. 250 cards per minute.

Tape to printer

IBM 717 Printer. 150 lines per minute.
IBM 774 TDS with IBM 407, 408, or 409. 150 lines per minute.
IBM 720 Printer — Model 2. 500 lines per minute.
IBM 1401 Tape System. 600 lines per minute.
IBM 730 Printer — Model 2. 1,000 lines per minute.

Paper tape to magnetic tape

IBM 7765 Converter. 150 characters per second.

Tele-transmission

IBM 65 Card-to-Card.
IBM 1001 Card-to-Card.
IBM 7701 Magnetic Tape-to-Tape.

PROGRAMMING

Several program languages and systems are available:

1. Autocoder III — An advanced language to simplify programming by providing macro-instruction format and field definition. A library of these pretested macro-instructions is available.
2. FORTRAN — A program language in which problems are stated in symbolic form resembling that of ordinary mathematics.
3. Decision Making — A language which expresses a program decision by sentence-type statements, that can be used with other available language to extract items for processing.
4. File Maintenance and Report/File Writing — A special language for programming report preparation and summaries, and for updating tape files.
5. Input-Output Package — This system facilitates use of simultaneous read/write/transmit/process feature of the IBM 7080.
6. 7080 Processor — Phase I connects a program written in any language or combination to Autocoder III. Phase II is a ready-to-run machine language program. The processor also permits use of future language such as the IBM Commercial Translator.
7. Utility Programs — A library of service programs available individually or as part of an integrated test system.
8. Sort-Merge — Generalized programs equally as efficient and fast as custom-designed programs.

Instruction word format

Operation	Address with Zone Bits as indicators

CHART 1

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
7102 Arithmetic Logic	$14,500	$685,000	([1])	56x30x69	2,200	0.9	
				56x20x69	1,800		
				56x20x69	1,800		
7153 Console	1,500	25,000		91x58x44	1,100		
7302-1 160,000 Core Storage	17,500	840,000		56x30x69	2,150		9,560
7302-2 80,000 Core Storage	10,000	480,000		56x30x69	2,150		9,560
7305-1 Central Store 1/0 Control 2	7,300	345,000		56x30x69	2,200		9,850
7305-2 Central Store 1/0 Control 4	8,400	395,000		56x30x69	2,200		9,850
7621 Tape Control[1]	3,300	147,000		56x30x69	2,730		
7800 Power Convert[1]	700	25,000		56x30x69	1,800	32.0	
7801 Power Control[1]	900	35,000		56x30x69	1,200		
729 II Magnetic Tape	700	27,000		29x31x69	950	1.6	3,900
729 IV Magnetic Tape	900	48,500		29x31x69	950	1.6	3,900

[1] The rental rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176th of 40%. A maintenance contract is available for a purchased system at rates per a published schedule.

A typical IBM 7080 System: Purchase price, $2,200,000; rental, monthly, $48,000.

CHART 2

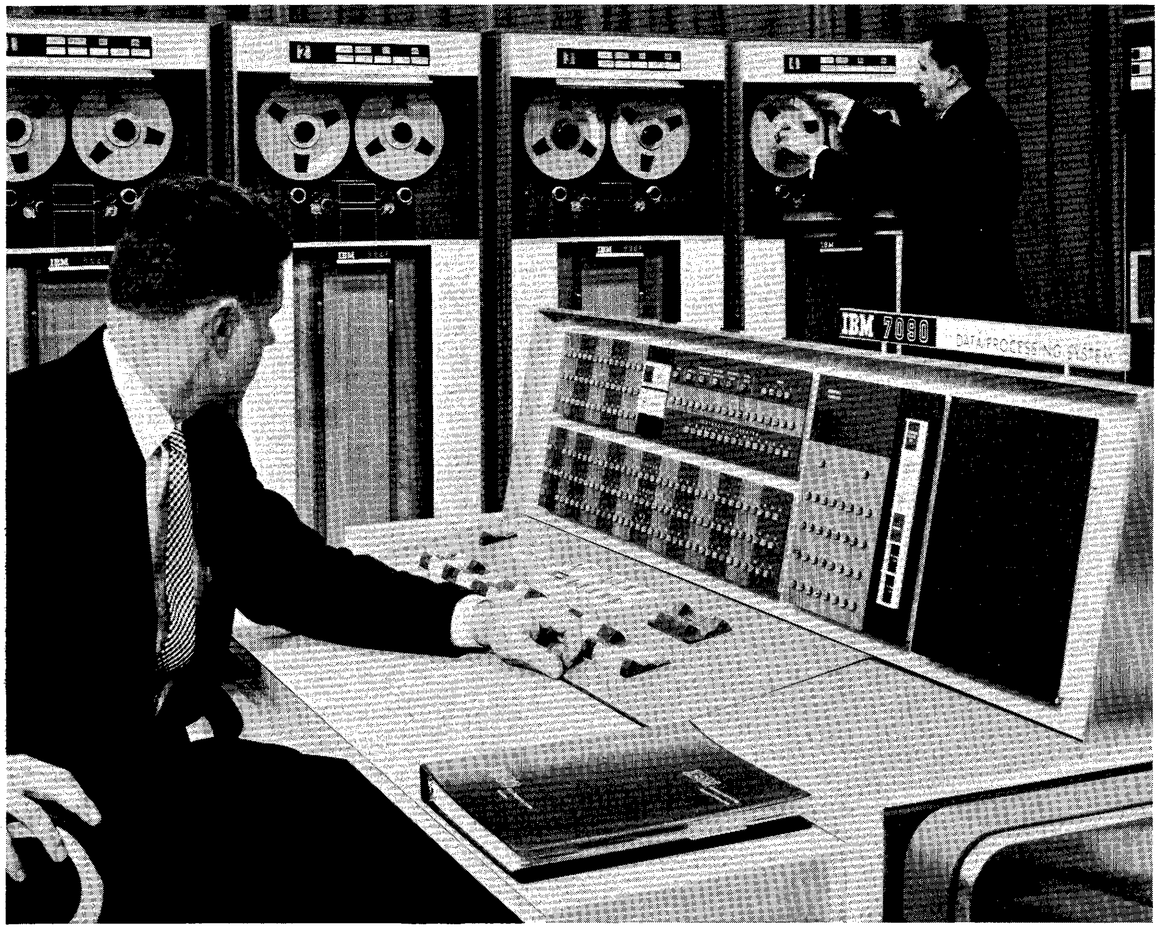
IBM 7622 Signal Control Units

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
7622 Signal Control[1]	$1,500	$26,000		35x33x58	900	3.2	9,000
744 Magnetic Drum Control				44x32x67	1,530	13.2	5,460
734 Magnetic Drum Storage 1-1				65x32x67	1,850		17,400
754 Magnetic Tape Control				60x32x67	2,350	6.3	9,660
727 Magnetic Tape 1-10				29x31x69	950	2.3	4,100
757 Printer Control				60x32x67	2,160	38.5	13,700
717 Printer 1-1				71x33x49	2,260		14,000
758 Punch Control				60x32x67	2,170	12.3	13,660
722 Card Punch 1-1				52x25x50	1,220		6,830
759 Reader Control				60x32x67	2,160	10.0	8,250
714 Card Reader 1-1				47x33x54	1,150		9,680
760 Control				63x32x67	2,790	10.0	24,000
727 Magnetic Tape 1-2				29x31x69	950	2.3	4,100
720-2 Printer 1-1				97x37x61	1,600	2.3	10,000
735 Control				63x31x71	1,300	3.3	11,000
730-2 Printer 1-1				109x37x61	1,900	1.0	4,000
747 Control				44x32x69	2,000	15.0	5,900
407 Printer 1-1				73x31x51	2,620		5,630
408 Printer 1-1				73x34x56	2,730		6,000
409 Printer 1-1				73x32x56	2,990		6,000
519 Punch 1-1				53x25x49	1,180		4,090
777 M.T. Control 1-8							

[1] The rental rates include customer engineering maintenance and parts and cover the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176th of 40%. A maintenance contract is available for a purchased system at rates per a published schedule.

A typical IBM 7080 System: Purchase price, $2,200,000; rental, monthly, $48,000.



THE IBM 7090 SYSTEM is designed and used for scientific and commercial data processing, real time flight control, safety and impact prediction calculations, and message processing.

Features include compatibility with IBM 704 and 709 systems, several programming code sets and fast memory. The system has overlap of input-output operations with low memory interference rate, and automatic interrupt facilities permitting I/0 devices to interrupt main programs as required. Special features and attachments are: cathode ray tube pictorial output, clocks, extended precision arithmetic, direct data I/0 devices, and others.

Speed

Average execution times for instructions (including storage reference) are:

	(microseconds) Fixed point	(microseconds) Floating point
Add or Subtract	4.8	16.8
Multiply	38.	34.
Divide	48.	43.2

All logical operations are at a speed of 4.8 microseconds.

SYSTEMS COMPONENTS

Central processor unit — 7100

The 7100 contains the arithmetic and stored program control circuits for the 7090 system. Computation is performed in parallel, using a 36-bit fixed word length.

Instructions are provided to simplify the conversion of decimal or other coded input-output. Over 200 operational instructions are provided, including fixed-point arithmetic, floating point arithmetic, logical operations on information in registers and storage, control and testing, input-output, shifting, and numerous indexing operations.

Other instructions are provided for number system conversion and automatic table look-up operations, facilitating compiling, interpretation, variable length multiplication and division. Thirty-six (36) internal sense indicators allow program flexibility, indirect addressing, and automatic floating-point overflow-underflow trap.

Control for independent data transmission is provided, permitting concurrent data transmission without logical interference with the computer.

Arithmetic section: This section of the Central Processing unit consists of a storage register, an accumulator register, and a multiplier-quotient register, each with a capacity of 35 bits and sign, and a 36-bit sense indicator register. The accumulator register has two (2) overflow positions. The accumulator and multiplier registers are coupled when multiplying or dividing to store a 70-bit signed product or dividend. They may also be coupled to shift information left or right.

Index registers: Three index registers provide automatic indexing, and make possible automatic address modification and loop control within programs. Each register has 15 positions.

Automatic priority processing: The data channel trap feature gives the programmer a tool with which to control input-output operations. The data channel signals the Central Processing unit upon completion of an input-output operation or an error condition. The program may then provide for further input-output operation without complex timing conditions, or proceed to a connective action.

Checking features:

Magnetic tape: Horizontal and vertical parity check while reading and writing. Verification of tape writing by two-gap head, and dual level sensing.

Line printers: Echo checking for each character printed on the 717, 407, 408, and 409 printers.

Arithmetic and logical units: Accumulator overflow check, divide check on fixed point division, floating point overflow and underflow check, and data channel tape check.

Core storage — 7302

The 7302 has 32,768 words of high-speed core storage. Random access to any of the 36-bit words requires 2.4 microseconds, including the time to execute a complete read and rewrite cycle. All storage locations are directly addressable.

Console control — 7151

This is a separate unit containing indicators, switches, keys and register displays. Information in any storage location or register can be displayed and/or changed by manual insertion through the entry keys and switches.

Multiplexor — 7606

The 7606 accomplishes all data switching necessary to store data in core storage in the 7090 Data Processing System. Data channels and the Central Processing Unit transmit all data to and from core storage through the 7606. A maximum of eight (8) 7607 Data Channels may be attached to the 7606.

Data channels — 7607, models 1 and 2

The 7607 contains the control circuits, registers and counters to provide simultaneous and independent transfer of information between input-output units and core storage via the 7606 Multiplexor in the 7090 Data Processing System. At least one (1) is necessary for each system and a maximum of eight (8) can be attached to the 7090 system. Each channel has a 36-bit shift register and a 36-position data register which transfers data to or from core storage through the Multiplexor in a 36-bit parallel operation. There are two (2) models of the 7607:

On Model 1 up to ten (10) magnetic tape units may be attached. Tape units 729 II or 729 IV may be intermixed with no address restrictions. This model also will handle three (3) card units. (711 Card Reader, 716 Printer, and 721 Card Punch.)

Model 2 performs the same functions for tape units as the Model 1 but no on-line card units can be attached.

All data channels can operate simultaneously and concurrently with computation, with no logical interference. A channel may be reading or writing at any time, regardless of the operation of other channels; however, only one (1) input-output unit per channel may be in independent operation.

After an input-output unit and its associated data channel have been selected by an instruction of the stored program, control of the data transfer between input-output units is relegated to the 7607. Associated with each data channel are counters, registers, and control and test circuits to permit it to operate independently of the Central Processor unit. However, synchronous or asynchronous intervention, control, or supervision of the data channels can be obtained by instructions in the program. The 7607 rate of operation is controlled by the rate of operation of the input-output units attached to it. 2.4 microseconds are required to transfer a 36-bit word of data between any data channel and core storage.

Data channel console — 7617

This unit provides for greater input-output flexibility between the 7090 system and the operator. It can be located up to 50 feet from the Data Channel unit. Several operations can be performed by this console:

1. Data transmission.
2. Non-data tape.
3. Loading.
4. Storing.

Power converter 7608 and control 7618

The units of the 7090 system convert power from 60 cycle AC to well-regulated 400 cycle AC, and complete the system.

INPUT-OUTPUT MEDIA

Magnetic tape unit — 729 II or magnetic tape unit — 729 IV

Up to eighty (80) can be used with the 7090 data processing system. Transistorized 729 II units provide large capacity input-output for storage of data or programs in the 7090 system. Tape can be read in a forward direction; dual-density feature allows reading or writing at either 15,000 or 41,667 characters a second under stored program control. Recording density is then either 200 or 556 characters to the linear inch. Other features are identical to those of the 729 I Magnetic Tape units previously described.

Magnetic Tape units, 729 IV, are transistorized, high-speed, large capacity input-output for storage of data or programs. Tape, which may be read or written in a forward direction, has dual-density feature for reading or writing at either 22,500 or 62,500 characters a second. Recording density is either 200 or 556 characters to the linear inch. Other features are identical to those of the 729 III tape units previously described. Both 729 II and 729 IV can be intermixed in the 7090 with no address restrictions.

Card reader — 711

Cards are read into the machine in parallel at a rate of 250 cards per minute from a hopper with a capacity of 800 cards. Feeding mechanism has two sets of 80-column reading brushes. Any 72 columns of a card can be selected through a wired program to read into core storage as two 36-bit words. The cards can be in binary code or in any other code, which is translated into binary code by the computer.

Printer — 716

The 7607 Data Channel Model 1 provides functional controls for the 716 and a mixed program is also used. Printing speed is 150 lines a minute, with 120 printing positions each having 72 characters for printing digits 0-9, 26 letters, and 11 special characters. A check of the numerical portions of all characters printed is made by comparing the print wheel echo impulse against the information sent to the 716 Printer. A line of printing is spaced ten characters to the inch with a maximum width of 12″. Line spacing is 6 or 8 lines-to-the-inch, single spaced. Single and double line spacing, and form skipping, is controlled by the wired program.

Card punch — 721

Cards are punched in parallel at a maximum rate of 100 cards per minute, and information can be punched into the desired card columns in binary, decimal, or other codes established by programming. Seventy-two (72) columns can be punched from computer control at one time. The 721 Card Punch contains 80 punch brushes, and can be used off-line for gangpunch operations.

AUXILIARY COMPONENTS

Card-to-tape — BCD or binary data

250 cards per minute with the IBM 714 Card Reader with column binary feature.*

800 cards per minute with the IBM 1401 Tape System with column binary feature.**

Tape-to-card

100 cards per minute with the IBM 722 Card Punch.*

100 cards per minute with the IBM 774 TDS and IBM 519.*

250 cards per minute with the IBM 1401 Tape System (BCD or binary with the column binary feature).**

Tape-to-printer

150 lines per minute with the IBM 717 Printer.*

150 lines per minute with the IBM 774 TDS and IBM 407, 408 or 409.*

500 lines per minute with the IBM 720 Printer, model 2.*

600 lines per minute with the IBM 1401 Tape System.**

1,000 lines per minute with the IBM 730 Printer, model 2.*

**Used with IBM 727 or 729 I Magnetic Tape Units.*
***Used with IBM 729 II or IV Magnetic Tape Units.*

PROGRAMMING

Share 709 (SOS) is the main programming method for the 7090 Data Processing System. It is composed of four distinct parts:

1. Share compiler assembler translator (SCAT).
2. The program testing and correcting system.
3. The input-output system.
4. The MOCK Donald control system.

Fortran, Formula Translation System, may also be used with the 7090 system.

Instruction word format

OP Code	Flag	Tag	Address
S1 — 11	12 — 13	12 — 21	22 — 35

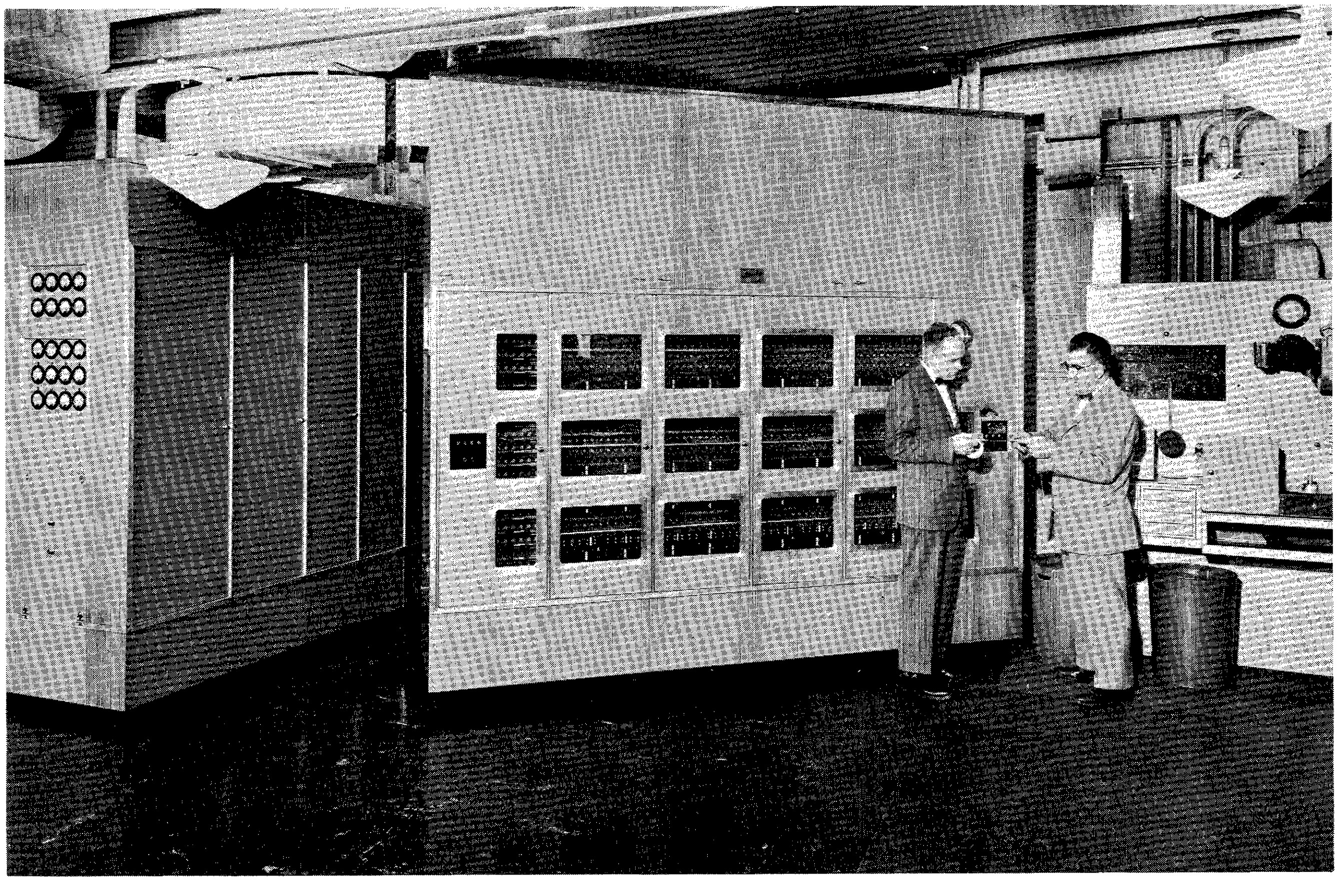
Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
7100 Central Processing	$16,975	$707,500	(1)	60x56x69	4,450	3.18	7,240
7302 Core Storage	19,800	950,000		56x30x69	2,450	8.03	19,400
7151 Console Control	1,225	61,700		60x41x44	650	.71	1,570
7606 Multiplexor	3,900	156,300		56x30x69	1,500	.73	1,550
7607-1 Tape and Card Data Channel	4,500	208,400		56x30x69	2,290	.153	3,590
7607-2 Tape Data Channel	3,500	169,900		56x30x69	2,290	.153	3,590
7617 Data Channel Console	225			30x17x30	110		
711-2 Card Reader	800	32,000		32x30x32	560		2,600
721 Card Punch	600	25,000		40x26x50	670		3,070
716 Printer	1,200	54,200		59x30x47	1,910	5.4	7,150
729 II Magnetic Tape	700	27,500		29x31x69	950	1.6	3,900
729 IV Magnetic Tape	900	48,500		29x31x69	950	1.6	3,900
7608 Power Converter	1,600	60,000		61x29x58	1,680	8.69	19,800
7618 Power Control	1,600	60,000		50x30x69	1,150	.20	500

[1] The rental rates include customer engineering maintenance and parts, for the first 176 hours a month the system is in use. Each hour of use thereafter is subject to a rate of 1/176th of 40%. A maintenance contract is available for purchased equipment at rates per a published schedule.

A typical IBM 7090 System: Purchase price, $2,898,000; rental, monthly, $63,500.

ILLIAC UNIVERSITY OF ILLINOIS



ILLIAC (Illinois Automatic Computer) is a large scale, general purpose digital computer of vacuum tube construction. Input to the system is by paper tape; output is by paper tape page printer, and cathode ray tube.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	93	40
Multiply:	665-865	620-820
Divide:	950	900

Construction: Vacuum tubes.
Rapid access word registers: 6.
Arithmetic mode: Parallel.
Timing: Asynchronous.
Operation: Sequential.

The figures for operation time including storage access include the access time for the operand and prorated access for the instruction.

STORAGE

Electrostatic (CRT)

Words: 1,024.
Digits: 40,960.
Access: 18 to 36 microseconds.

Magnetic drum

Words: 12,800.
Digits: 512,000.
Access: 1,280 to 16,900 microseconds.
Instructions for drum access require 40 binary digits

with 14 binary digit addresses. This address specifies the location of the word desired. Subroutines are employed for block transfers between drum and electrostatic storage.

INPUT MEDIA

Punched paper tape

300 characters per second.

Five-hole teletype tape is used. Numerical data is read with a four-hole code. Alphanumeric data employs a five-hole code and a special instruction.

OUTPUT MEDIA

Punched paper tape

60 characters per second.

Page printer

10 characters per second.

Cathode ray tube

500 points per second.

A teletype BRPE Punch is used. The CRT has a 256 x 256 raster.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 40.
Binary digits per instruction: 20.
Instructions per word: 2.
Instructions decoded: 112.
Instructions used: 62.
Arithmetic system: Fixed point.
Instruction type: One-address.

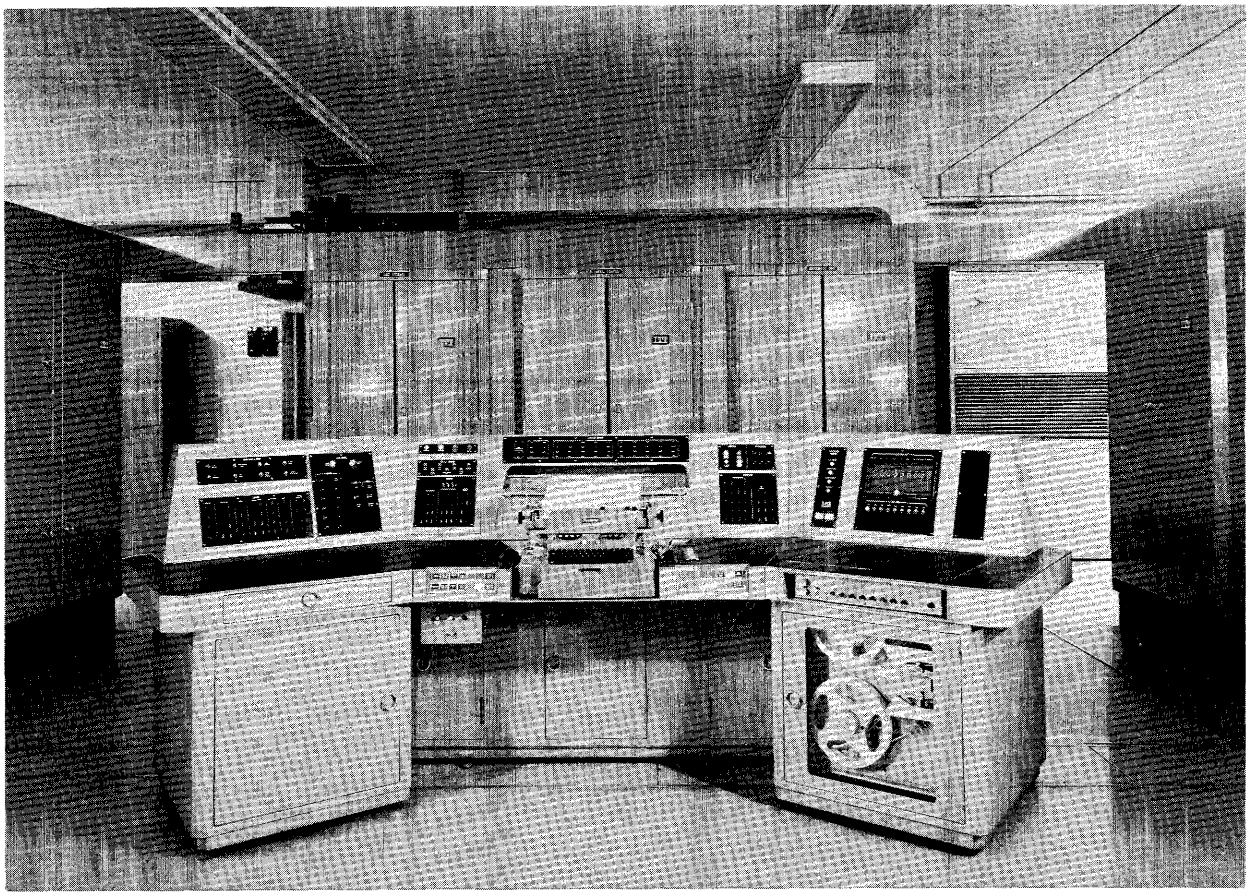
The 20 digits (half of a word) for the instruction are divided so as to utilize eight digits for the instruction type (command digits), 10 digits for the address, and two digits are unused spares.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kw	Heat dissipation B.t.u./hr.
ILLIAC Computer (basic system)		$300,000 (1)		700 cu. ft.	4,000	27.2	

[1] Approximate.

ITT BANK LN PROC. ITT FEDERAL LABORATORIES



CONSTRUCTION AND DAILY MAINTENANCE of magnetic tape file for personal loan operation of third largest U. S. bank, processing of daily inputs and answering of inquiries to this file, print-out of all customer mailings and of numerous internal reports.

Additional features and remarks

Outstanding features include transistorization, large processing capacity at medium speed, will maintain 600,000 loans up-to-date daily, about 10^9 bits of data accessible at all times, inquiries answered in less than 20 seconds each, at rate of 20 per minute and simultaneous operation of 12 tape functions, computer processing, and printing. Additional system advantages are that it combines on-line processing and off-line processing by the same equipment. A large data file is in ready access.

Future plans

Further applications to banks, reservations, credit cards, and other commercial and government systems.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	170	170
Multiply:	680-10,710	680-10,710
Divide:	Programmed	

The figures are for the arithmetic unit only, excluding the control. The number of cores includes storage and central control.

Arithmetic mode: Parallel-Serial.

Timing: Synchronous.

"Synchronous" refers to internal logic circuits; however, operation of central section is simultaneous with various in-out operations, the latter proceeding asynchronously with the former.

Operation: Bits of a digit in parallel. Digits of a word sequential.

Checking features: Sign redundancy, Mod 3 check in several places (arithmetic, bus, output, tape). Parity check on punched tapes and printer data.

Registers

Registers and B-boxes include a high and low accumulator, a distributor, an in-out register, and an instruction register.

The system is designed for operating both off-line and on-line, and at the same time. It can simultaneously compute, read tape, write tape, search on several tapes, print (on- or off-line), and answer inquiries.

STORAGE

Magnetic tape

Number of words: 22 x10^6.
Number of decimal digits: 264 x 10^6.
Access: 20,000,000 microseconds.

Magnetic drum

Number of words: 10,000.
Number of decimal digits: 120,000.
Access: 9,000 microseconds.

Magnetic core

Number of words: 100.
Number of decimal digits: 1,200.
Access: 6 microseconds.

Core buffers

Number of words: 300.
Number of decimal digits: 3,600.
Access: 12 microseconds.
Number of units than can be connected: 108.
Number of characters per linear inch of tape: 300.
Channels or tracks on the tape: 22.
Blank tape separating each record: 0.03 inch.
Tape speed: 100 inches per second.
Transfer rate: 30,000 characters per second.
Start time: 2 milliseconds.
Stop time: 2 milliseconds.
Average time for experienced operator to change reel:
No reels (bin type). Tape exchange is 60 seconds.
Physical properties of tape:
Width: 1 inch.
Length of tape in bin: 450 feet.
Composition: Mylar sandwich.

The 108 units is an arbitrary design goal, not an actual limitation.

The 0.03-inch inter-record gap is an interleaved recording. The opposite-direction record serves as a gap.

INPUT MEDIA

Magnetic tape (ITTL bin transports)

30,000 digits per second.

Paper tape (Potter 907)

600 characters per second.

Paper tape (Flexo reader)

10 characters per second.

Keyboard (Flexo, inquiry)

Manual speed.

OUTPUT MEDIA

Magnetic tape (ITTL bin transports)

30,000 digits per second.

High-speed printer (Shepard w/ITTL electronics)

20 lines per second.

Typewriter (Flexowriter)

10 characters per second.

Punched tape (Flexo punch)

10 characters per second.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Decimal digits per word: 12 plus sign.
Decimal digits per instruction: 12.
Instructions per word: 1.
Instructions decoded: 85.
Arithmetic system: Fixed point.
Instruction type: One-address (modified).

Modified single-address (Alpha and Delta, i.e., operand and next instruction address.)

Instruction word format

<table>
<tr><td>+ and check</td><td>1</td><td>2</td><td>3</td><td></td><td></td><td></td><td>7</td><td>8</td><td></td><td></td><td></td><td>12</td></tr>
<tr><td></td><td colspan="2">OP CODE</td><td colspan="5">DELTA
Next instruction</td><td colspan="5">Operand
(or alternate next instruction, or special)</td></tr>
</table>

Automatic built-in subroutines include a sort command, a sequence command, and a merge command.

Automatic coding includes SCP, a Symbolic Conversion Program (One-to-One Compiler for Symbolic Address and Op Codes), and MARK II, a utility system.

Cost, price and rental rates

The computer, drum printer system, tape system (18 transports) rents at $17,000 to $20,000 per month.

Thirty-six additional tape transports, and seven inquiry channels rents at an additional $10,000 to $15,000 per month.

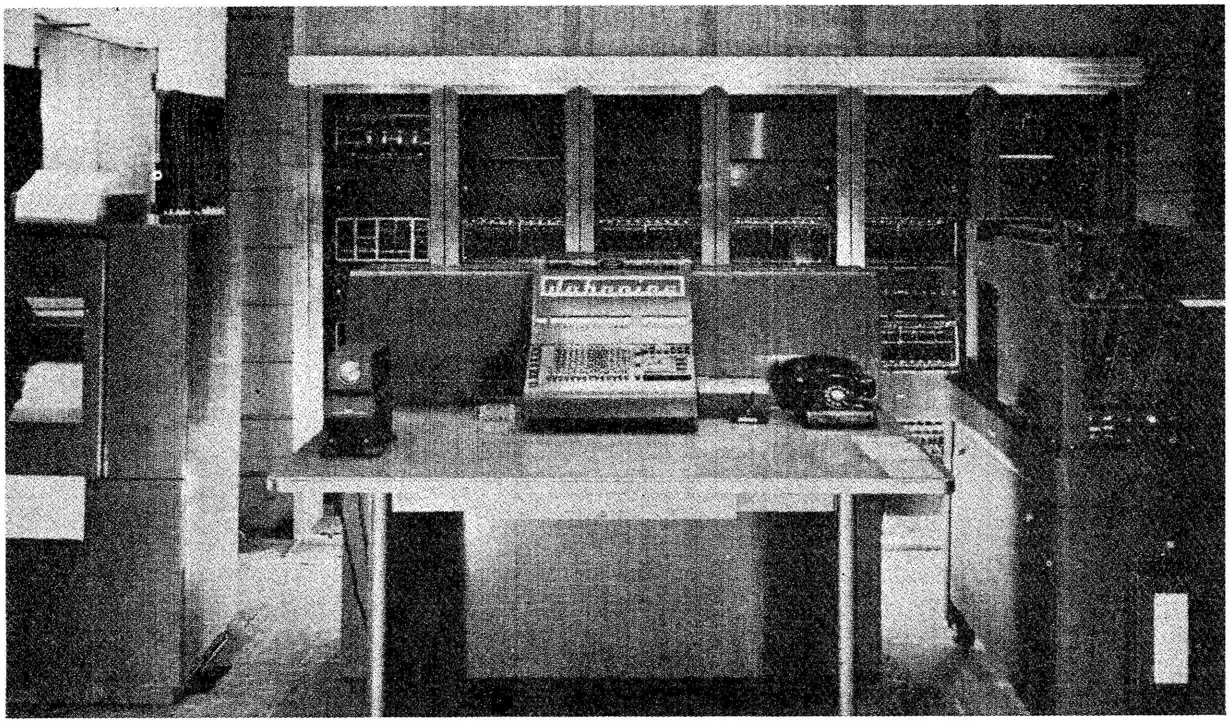
Maintenance is contracted to Federal Electric Company at about $6,000 per month.

Power, space, weight, and site preparation

Power, computer: 6 kw.
Area, computer: 80 sq. ft.
Room size, computer: 900 sq. ft.
Weight, computer: 4,000 lbs.

Site preparations include a separate power main, a regulator, and floor ducts. Area air conditioning only.

JOHNNIAC THE RAND CORPORATION



THIS SYSTEM was designed and is owned and operated by the Rand Corporation.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	25	10
Multiply:	400	385
Divide:	400	385

Construction: Vacuum tubes and transistors.

Rapid access word registers: Four.

Arithmetic mode: Parallel.

Timing: Asynchronous.

Operation: Sequential.

Addition is concurrent with store cycle. Multiply and divide times are maximum. The transistorized logical adder has a full carry time of 1.5 microseconds.

Checking features: Manual marginal testing is performed.

STORAGE

Magnetic core

Words: 4,096.
Digits: 40 per word.
Access: 15 microseconds.

Magnetic drum

Words: 12,288.
Digits: 40 per word.
Access: 17,000 microseconds.

Drum access time is average access to first word. Sixty microseconds are required for each succeeding address in same channel.

INPUT MEDIA

Card reader

240 cards per minute.

An IBM collator is used. Both primary and secondary feeds are used.

OUTPUT MEDIA

Card punch

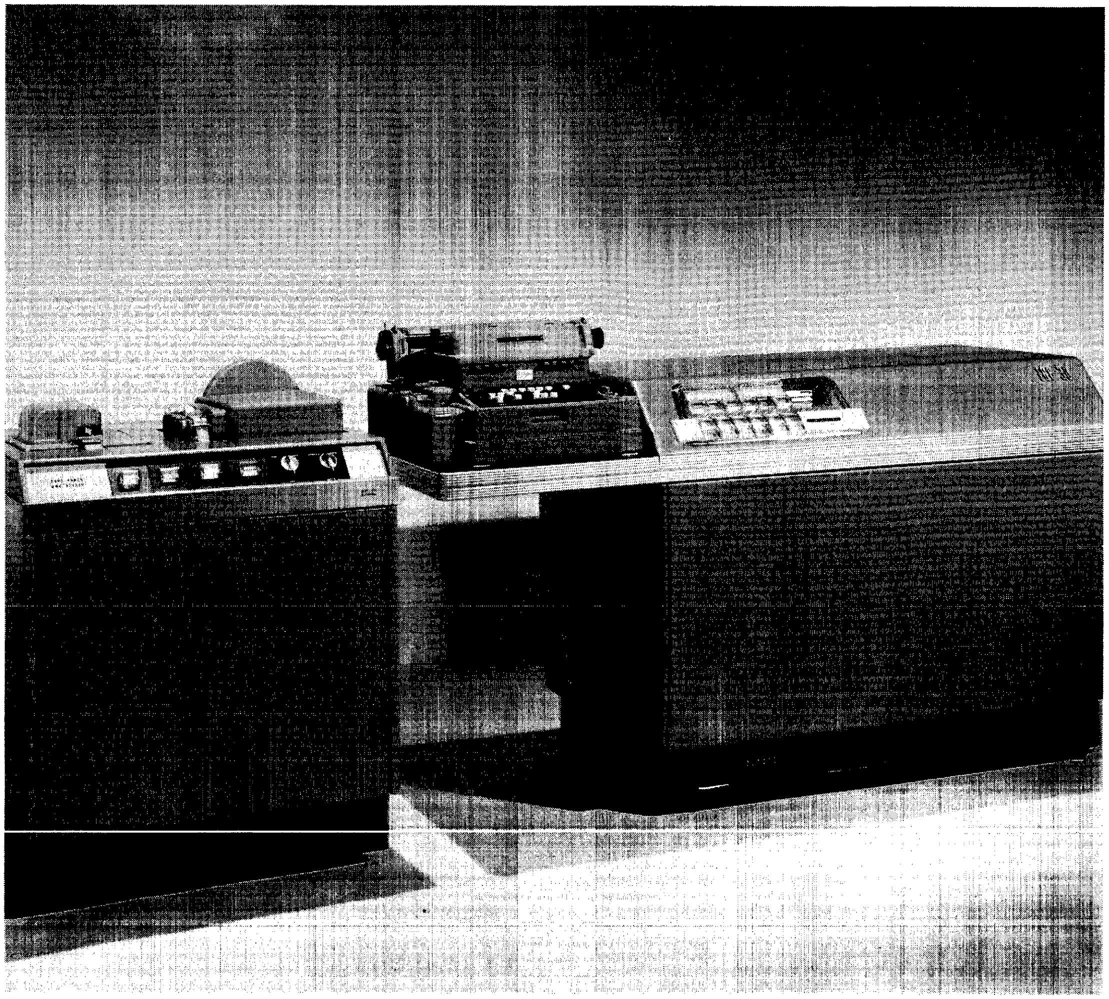
100 cards per minute.

Printer (ANelex)

1,200 lines per minute.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 40.
Binary digits per instruction: 20.
Instructions per word: 2.
Instructions decoded: 128.
Instructions used: Approximately 85.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: Numerically less than unity.
Negative numbers are presented as complements.



THE BASIC LGP-30 SYSTEM consists of a computer unit and a Flexowriter with associated paper tape reader and paper tape punch. The basic system may be expanded by the addition of a high-speed paper tape read-punch unit, a punch card control unit with associated IBM 024 or 026 keypunch, and an off-line X-Y plotter system. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 32 bits including sign and spacer bit.
Numeric Characters Per Word: 9.
Alphabetic Characters Per Word: 5.
Character Code:
  Numeric: Pure binary.
  Alphabetic: 6-bit binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 120 kilocycles.

Computer unit

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	2.26
Multiply: 555555 by 5555	17.60
Divide: 3086108025 by 5555	17.60

Access time: 2 to 15 milliseconds.

Checking features: No mathematical checking features are inherent in the electronic circuitry; however, there is an automatic stop on overflow thus preventing the loss of the significant portion of an operation.

Registers

Accumulator—one word.
Instruction—one word.
Control counter—one word.

Memory

The LGP-30 uses a magnetic drum memory which has a capacity of 4,096 words in the main memory and three 1-word recirculating registers for fast access. Drum speed is 4,000 revolutions per minute.

Control panel

The control panel provides switches and indicators for control of the system. An oscilloscope on the panel displays the contents of the three registers.

INPUT MEDIA

Flexowriter

This unit is similar to an electric typewriter with paper tape reader and punch attachments. It is used as direct input-output for the system. The paper tape reader, paper tape punch, and typing element operate at a rate of 10 characters per second.

OUTPUT MEDIA

Flexowriter

As previously described.

AUXILIARY COMPONENTS

Paper tape read-punch unit (342)

This unit consists of a high-speed photoelectric paper tape reader and a mechanical paper tape punch. The unit will read 5-, 7-, or 8-level paper tape at the rate of 200 characters per second and punch 5-, 7-, or 8-level paper tape at the rate of 20 characters per second.

X-Y plotter system (347)

This system consists of an X-Y plotter, a motorized paper tape reader, and a punched paper tape converter. It is used off-line for graphic depiction of one independent variable in terms of another. Input is provided by punched paper tape through the 20 character per second reader. The converter accepts digital information and converts it to corresponding analog signals for use in controlling the plotter. Operating speed of the plotter is 80 points per minute.

Paper tape reader (341)

This unit photoelectrically reads punched paper tape at a rate of 200 characters per second. Data are read directly into the computer memory.

Edge punched card attachment

This unit may be attached to the Flexowriter to provide the capability of reading edge punched cards.

Punch card control unit (321)

This unit provides the capability of using an IBM 024 or 026 keypunch as input to the system.

PROGRAMMING

General: The LGP-30 uses a single address type of instruction.

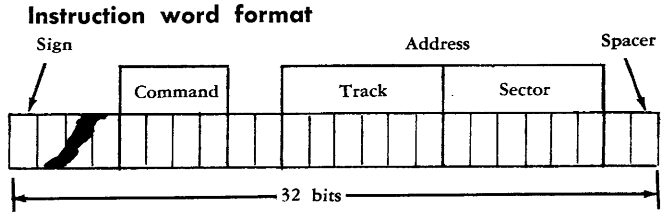
Instructions:

Number of instructions per word: 1.

Number of bits per instruction: Twelve bits representing the operand address and four bits representing the instruction.

Total number of operation codes: 16.

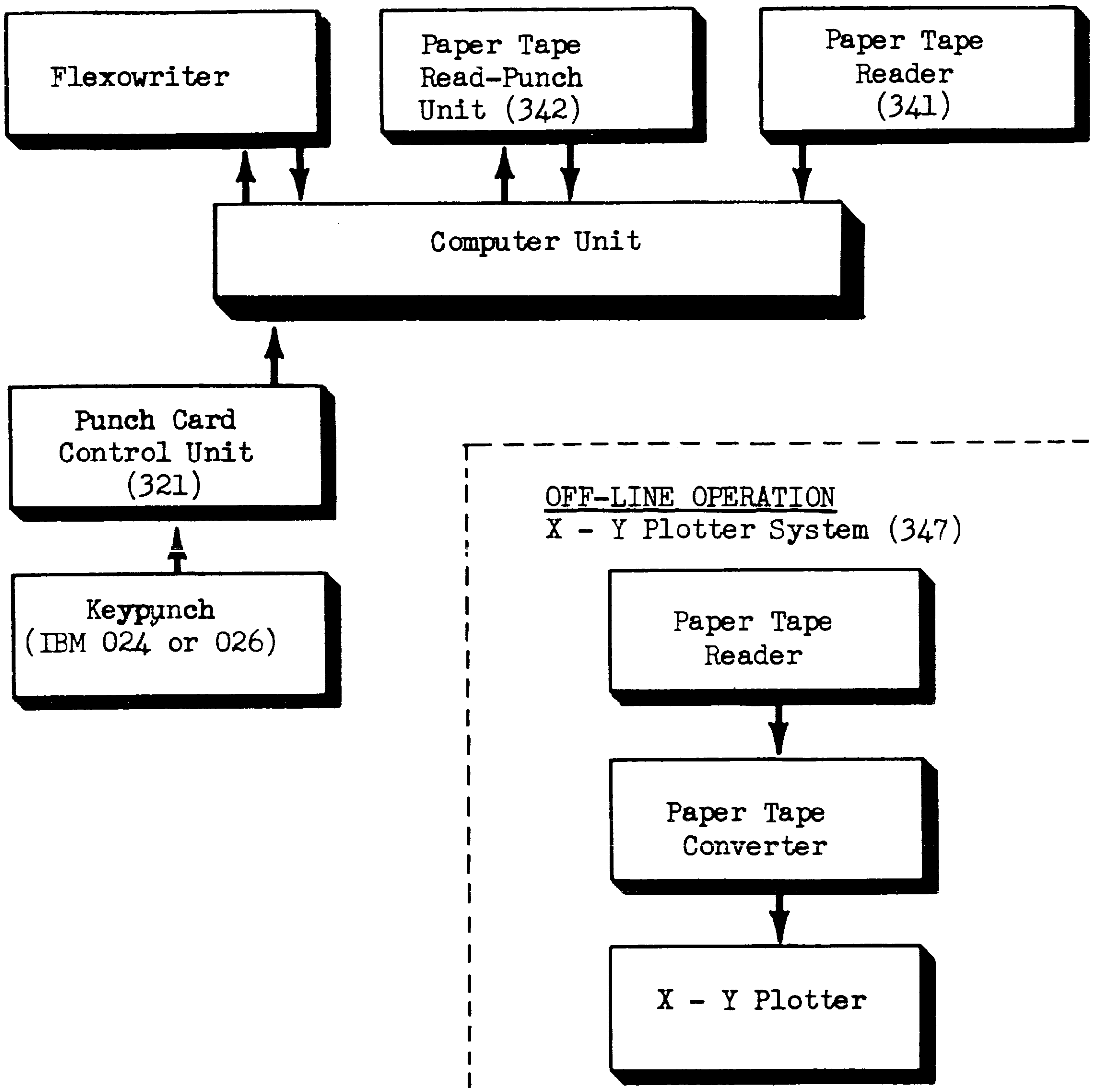
Instruction word format



Cost, Power Requirements, and Physical Characteristics

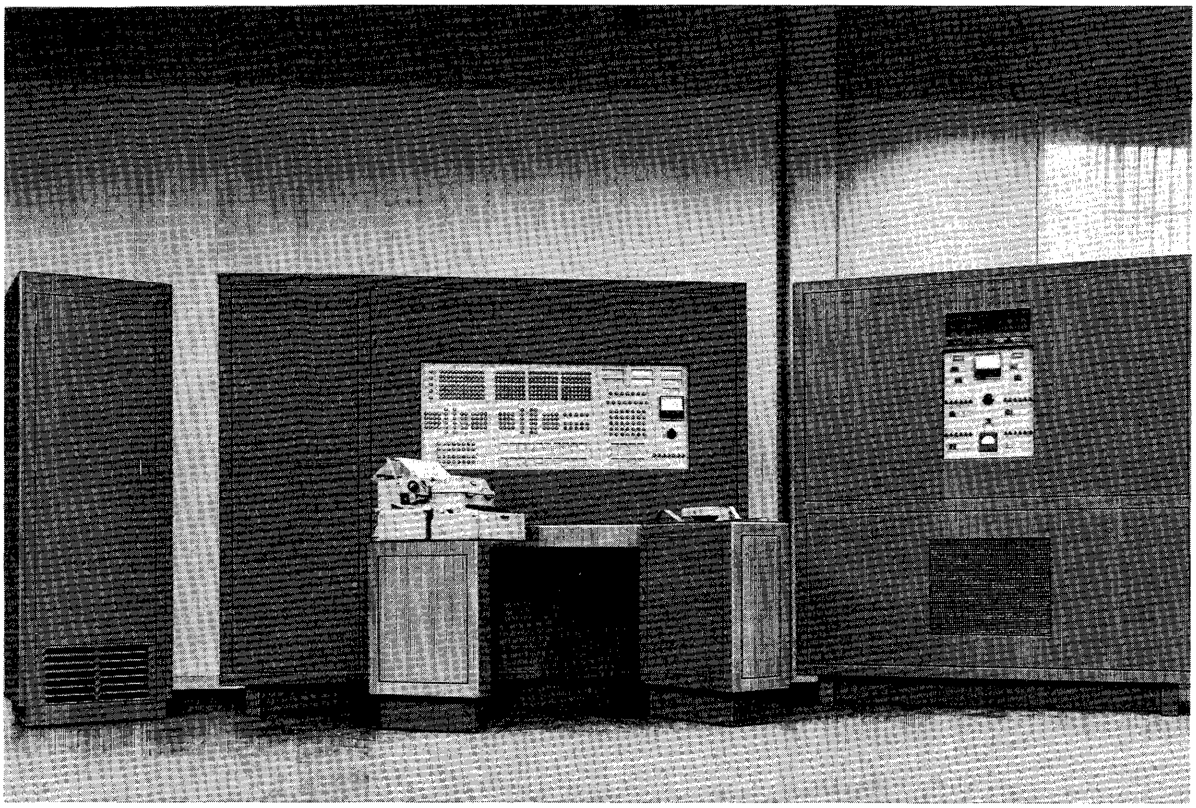
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power watts	Heat dissipation B.t.u./hr.
LGP-30 System, including							
Computer Unit and Flexowriter	$1,100	$43,500		44x26x33	800	1,500	5,000
342 Paper Tape Read-Punch Unit	265	6,360		22x27x30	150	(2)	(2)
341 Paper Tape Reader	200	4,800		22x27x30	100	(2)	(2)
321 Punched Card Control Unit	100	(3)		(4)	(4)	(4)	(4)
347 X-Y Plotter System, (including)	300	(3)				(2)	(2)
Paper Tape Reader				11x12x7	15		
Paper Tape Converter				11x19x21	75		
Plotter and Recorder				16x19x16	60		
Edge Punched Card Attachment for Flexowriter	15	175		(2)	(2)	(2)	(2)

[1] Maintenance included in rental cost. Maintenance contract for purchased equipment—$1,750 per annum plus parts.
[2] Included in computer unit.
[3] Can be purchased by special arrangements.
[4] Physically located in IBM 026.



BLOCK DIAGRAM OF LGP-30

LIBRASCOPE AIR TRAFFIC GENERAL PRECISION INCORPORATED



THIS SYSTEM meets general purpose data processing requirements where high speed, large capacity random inquiry files are required and large numbers of different types of input-output systems are connected. Specifically, it is designed for on-line, real time use in the control of air traffic. Some functions are those of flight plan breakdown, conflict prediction, conflict resolution, flow prediction, flight strip preparation and updating, flight plan updating.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	32	22 Max.
Multiply:	366	356 Av.
Divide:	380	370 Av.

Construction: (Arithmetic unit only)
Transistors, 3,000.
Arithmetic mode: Serio-parallel.
Timing: Synchronous.
Operation:
Serial by alphanumeric character.
Parallel by bit.

Checking features: Checking features include parity on all registers, and all information exchanges between units. A dual adder is used in the arithmetic unit. Complete checking is performed.

STORAGE

Core memory

Number of words: 4,000.
Number of digits: 32,000.
Access: 10 microseconds.

Magnetic drum

Number of words: 256,000.
Number of digits: 2,032,000.
Access: 16,000 microseconds.

Magnetic tape — multiple FR 300 units

Number of units than can be connected: 32.
Number of characters per linear inch: 200.
Channels or tracks on the tape: 7.
Blank tape separating each record: ½ inch.
Tape speed: 75-150 inches per second.

Transfer rate: 30,000 characters per second.
Start time: 3 milliseconds.
Stop time: 3 milliseconds.
Physical properties of tape:
Width: ½ inch.
Length of reel: 2,400 feet.
Composition: Oxide on paper or plastic.

INPUT MEDIA

Flexowriter

10 characters per second.

Photo reader

330 characters per second.

Teletype via buffer

10 characters per second. 12 multiplexed channels.

Keyboard via display console

15,000-20,000 characters per second. 30 multiplexed channels.

Data link

50 characters per second. Four multiplexed channels.

Analog-digital conv. from radar

50 characters per second. Two multiplexed channels.

Inter computer via buffer

200,000 characters per second. One multiplexed channel.

OUTPUT MEDIA

Flexowriter

10 characters per second.

Teletype via buffer

10 characters per second. Seven multiplexed channels.

Charactron via display console

15,000-20,000 characters per second. 30 multiplexed channels.

Flight strip via display console

15,000-20,000 characters per second. 30 multiplexed channels.

Flight strip punch and printer

10 characters per second. 12 multiplexed channels.

Data link

30 characters per second. Seven multiplexed channels.

Analog-digital conv. to radar trackers

30 characters per second. Two multiplexed channels.

Inter computer via buffer

200,000 characters per second. One multiplexed channel.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Binary coded decimal digits per word: 8.
Binary coded decimal digits per instruction: 8.
Instructions per word: 1 (includes field specification).
Instructions decoded: 31.
Arithmetic system: Fixed point (Magnitude plus sign).
Instruction type: One-address.

Instruction word format

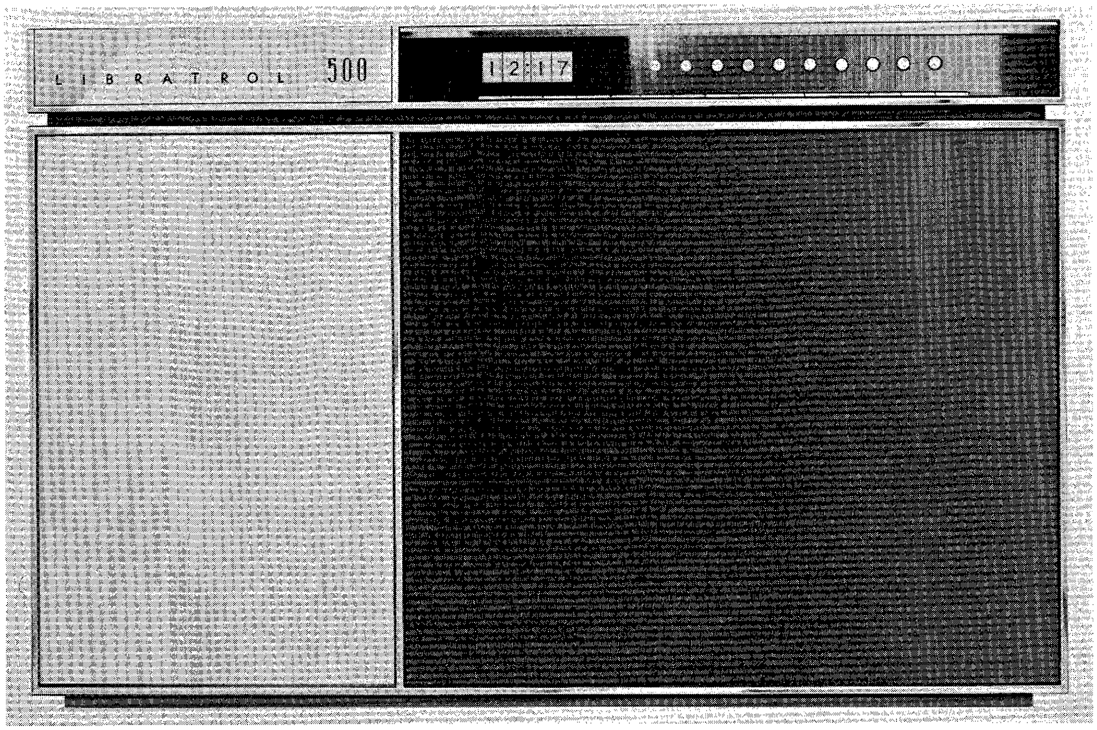
—	C	X	Y	M	M	M	M
Not used	Command	Field Specif.		Operand Address			

Automatic built-in subroutines include an error mode, entered by detection of an error. It interrupts program, stores instruction address, and R register contents.

Power, space, weight

Power, computer: 3 Kw.
Area, computer: 23 sq. ft.
Weight, computer: 3,000 lbs.
Air conditioner is internal.

LIBRATROL 500 GENERAL PRECISION INCORPORATED



GENERAL PURPOSE COMPUTING where computing equipment must communicate directly with equipment external to the computer, via digital inputs or via voltage inputs.

General purpose computing where computing equipment must send control signals to equipment external to the computer.

Examples of applications are quality control for both continuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation (data acquisition, logging and calculation).

Registers include counter register, accumulator, and instruction register.

ARITHMETIC UNIT

	Including Storage access (microseconds)	Excluding Storage access (microseconds)
Add:	7,750 (Mean access)	250
	23,000 (Mean access)	15,000
	23,000 (Mean access)	15,000

Arithmetic mode: Serial.
Timing: Synchronous.
Operation: Sequential.

Though operation is listed as being sequential, the input system of the LIBRATROL 500, since it is independent of the computing portion of the machine, is capable of inputting information while calculation is proceeding concurrently.

STORAGE

Manufacturer:

Magnetic drum (main)

Number of words: 4,096.
Number of digits: 126,976.

Magnetic drum (buffer)

Number of words: 64.
Number of digits: 1,984.
Access time is variable between 500 and 15,000 microseconds.
Magnetic tape will be developed.

Frankford Arsenal:

Magnetic drum

Number of words: 4,096.
Number of digits: 31 binary.
Access: 9,000 microseconds (average).

Public Service:

Magnetic drum

Number of words: 4,096.
Number of digits: 32 binary.

INPUT MEDIA

Analog

60 samples per second.

Digital

60 characters per second.

Paper tape

10 or 60 characters per second.

Typewriter

10 characters per second.
Above items are standard.

OUTPUT MEDIA

Paper tape

10 characters per second.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 30 bits plus sign.
Binary digits per instruction: 4.
Instructions per word: 1.
Integrated system.
Instructions decoded: 16.
Arithmetic system: Fixed point.
Floating point is programmable.
Instruction type: One-address.

0	1 12	13 16	17 18	19 24	25 30	31	Sp
Sign		Instruction		Track	Sector		Spacer

A complete set of compiler and utility programs are available.

Cost, price and rental rates

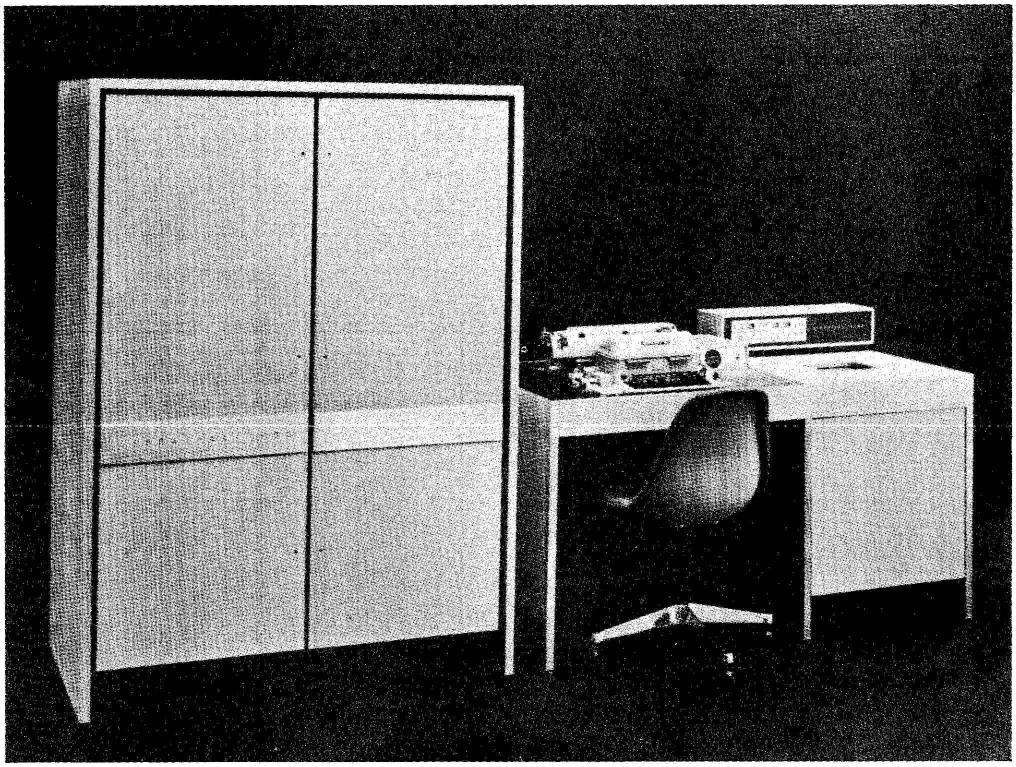
Manufacturer:

	Cost
1 Libratrol 500 Computer with 120 input channels and analog to digital converter	$84,500

Power, space, weight

Power, computer: 2.5 Kw.
Volume, computer: 49 cu. ft.
Area, computer: 13.7 sq. ft.
Room size: 24 sq. ft.
Weight, computer: 1,000 lbs. (nominal).

LIBRATROL 1000 GENERAL PRECISION INCORPORATED



THIS SYSTEM is intended for general purpose computing, where computing equipment must communicate directly with equipment external to the computer via digital or voltage (analog) inputs and where computing equipment must develop control signals to equipment external to the computer. Examples of applications are quality control for both continuous and batch production processes-real time, process control for both continuous and batch processes, and equipment test stand instrumentation — data acquisition, logging, and calculations.

Additive index register and double length accumulator.

Lower accumulator can be made to operate on eight words at a time.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	1,000	250
Multiply:	17,000	16,250
Divide:	17,000	16,250

Arithmetic mode: Serial.
Timing: Synchronous.
Operation. Sequential.

Though operation is listed as being sequential, the input system of the L-1000, since it is independent of the computing portion of the machine, is capable of receiving information while calculation is proceeding concurrently.

STORAGE

Magnetic drum (main)

Number of words: 8,000.
Number of digits: 256,000.
Access: 250 microseconds.

Magnetic drum (buffer)

Number of words: 64.
Number of digits: 2,016.
Access: 250 microseconds.

Magnetic tape

Number of units that can be connected: 64.
Magnetic tape is a future development.

INPUT MEDIA

Analog

60 samples per second (2,000 samples per second optional).

Digital

60 characters per second (standard).

Paper tape

10 or 60 characters per second (standard).

Typewriter

10 characters per second (standard).

OUTPUT MEDIA

Paper tape

60 characters per second (optional).

Typewriter

10 characters per second (standard).

Control (analog or digital)

120 characters per second (standard).

Line printer

300 characters per second (optional).

PROGRAMMING AND NUMERICAL SYSTEM

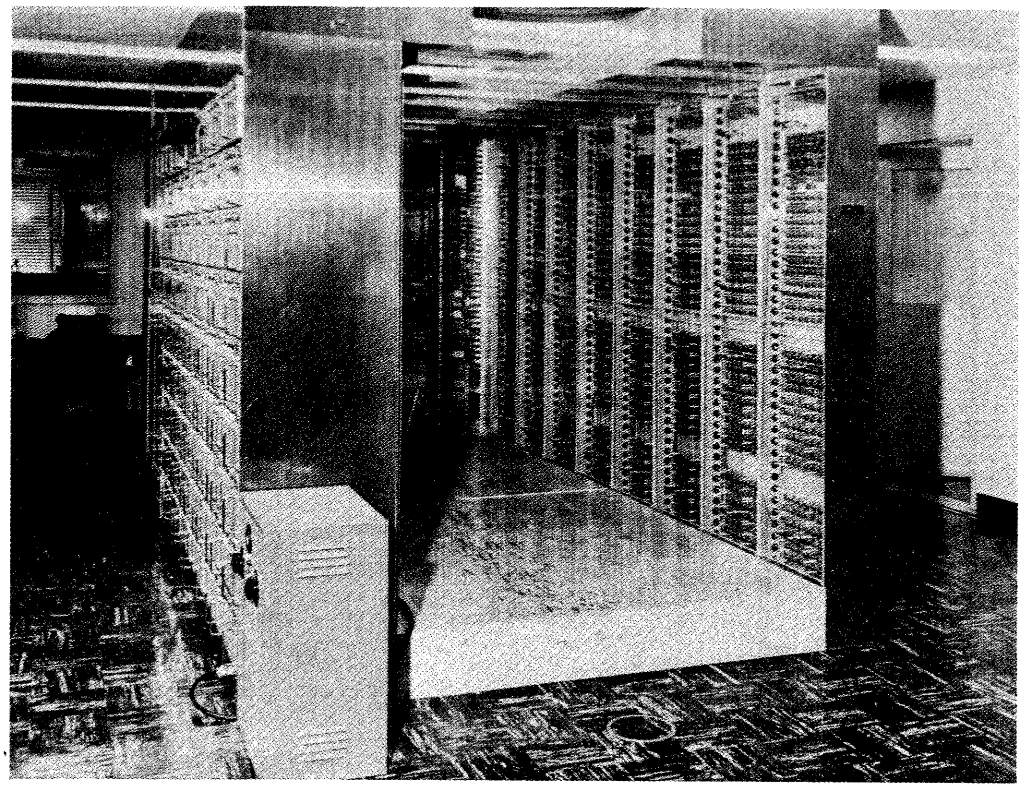
Internal number system: Binary.
Binary digits per word: 32.
Binary digits per instruction: 5.
Instructions per word: 1.
Instructions decoded: 32.
Arithmetic system: Fixed point.
Floating point is programmable.
Instruction type: Two-address.

Instruction word format

	Operand Address		Next Inst. Address		
S1 – 4	5 – 11	12 – 17	18 – 24	25 – 30	31
Command	Track	Sector	Track	Sector	Address Modify Flag

A complete set of compiler and utility programs are available.

MANIAC II UNIVERSITY OF CALIFORNIA



LOCATED AT Los Alamos, N. M., the system is used for studies in automatic programming, symbolic manipulations (e.g., algebra, differential calculus), mathematics, esp. combinatorial and algebraic transformations, Monte Carlo, crystallography, and general applied mathematics.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Multiply:	180 avg.	180 avg.
Divide:	300 avg.	300 avg.

Arithmetic mode: Parallel.

Timing: Asynchronous.

Operation: Sequential.

Checking features: Parity check on electrostatic storage and magnetic tape.

Load sums for identification
(+) Exponent spill
Overflow
(−) Exponent spill

STORAGE

Cathode ray tube (barrier grid)

Number of words: 12,288.
Number of binary digits per word: 49.
Access: 15 microseconds (average).

Magnetic cores

Number of words: 4,096.
Number of binary digits per word: 49.
Access: 2.4 microseconds.

Magnetic tape

Number of units that can be connected: 3.
Number of characters per linear inch of tape: 300.
Channels or tracks on the tape: 1.
Blank tape separating each record: 6 inches.
Tape speed: 60 inches per second.
Transfer rate: 18,000 characters per second.
Start time: 25 milliseconds.
Stop time: 30 milliseconds.
Average time for experienced operator to change reel of tape: 60 seconds.
Physical properties of tape:
 Width: 0.25 inch.
 Length of reel: 1,200 feet.
 Composition: 1½ mil mylar sandwich.
Two physical tracks on tape combine to form a single information channel.

INPUT MEDIA

Magnetic tape

270 words per second.

Paper tape

250 characters per second.

Keyboard

Manual speed.

OUTPUT MEDIA

Magnetic tape

270 words per second.

Printer

77,400 characters per second (maximum).

Punch

60 characters per second.

Electric typewriter

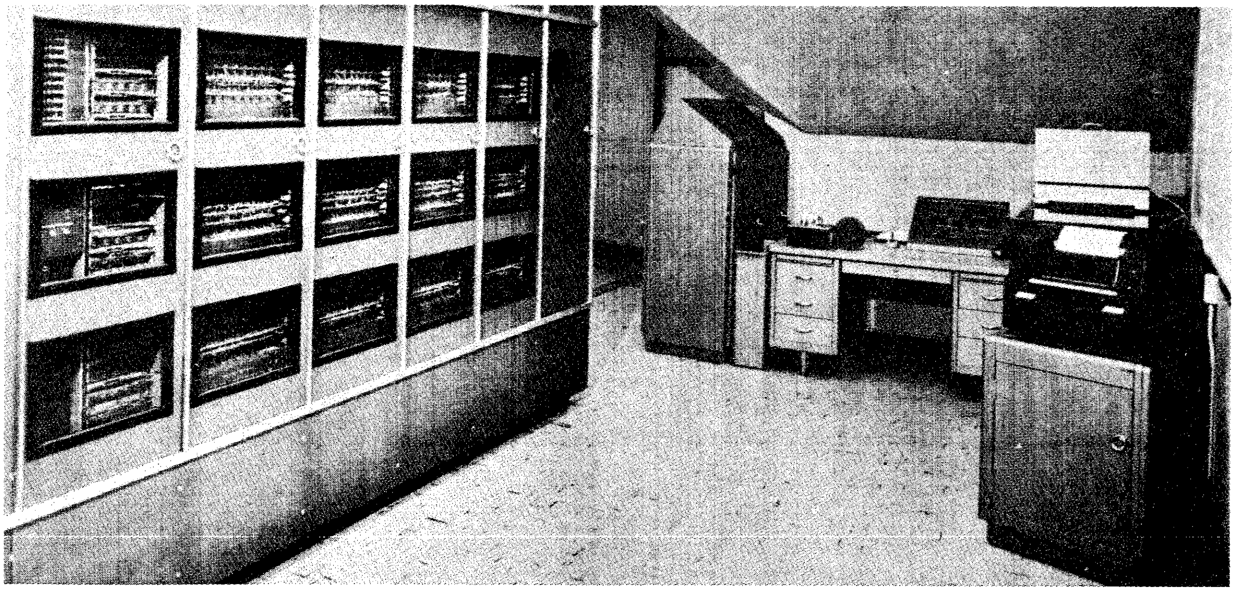
10 characters per second.
Printer speed is 900 lines per minute.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
MANIAC II (basic system)		$350,000 (1)		1,000 cu. ft.		37	

[1] Approximate cost.

MISTIC MICHIGAN STATE UNIVERSITY



MISTIC is a general purpose digital computer of vacuum tube construction, but containing a 16,384-word magnetic core memory unit.

ARITHMETIC UNIT

Operation:

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	100	80
Multiply:	1,000	980
Divide:	1,100	1,080

Construction: (Arithmetic unit only)

	Quantity
Vacuum tubes type 5844	580
Vacuum tubes type 7044	236
Vacuum tubes type 5670	120

Arithmetic mode: Serial.

Checking features: Division algorithm automatically checks for overflow and division by 0.

STORAGE

Magnetic core

Number of words: 16,384.
Digits per word: 40 binary.
Access: 20 microseconds.

INPUT MEDIA

5-Level photodiode paper tape

300 characters per second.

Cards

200 cards per minute.

Above speeds are maximum. Card decoding is programmed so that input is 100 cards per minute for most applications.

OUTPUT MEDIA

Paper tape

60 characters per second.

Teletypewriter

10 characters per second.

Cards

100 cards per minute, maximum.
Cards are program decoded.
CRT output is under construction.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Number of binary digits per word: 40.
Number of binary digits per instruction: 20.
Number of instructions per word: 2.
Total number of instructions decoded: 186, of which 139 are unique.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: -1 to $+(1-2^{-39})$.

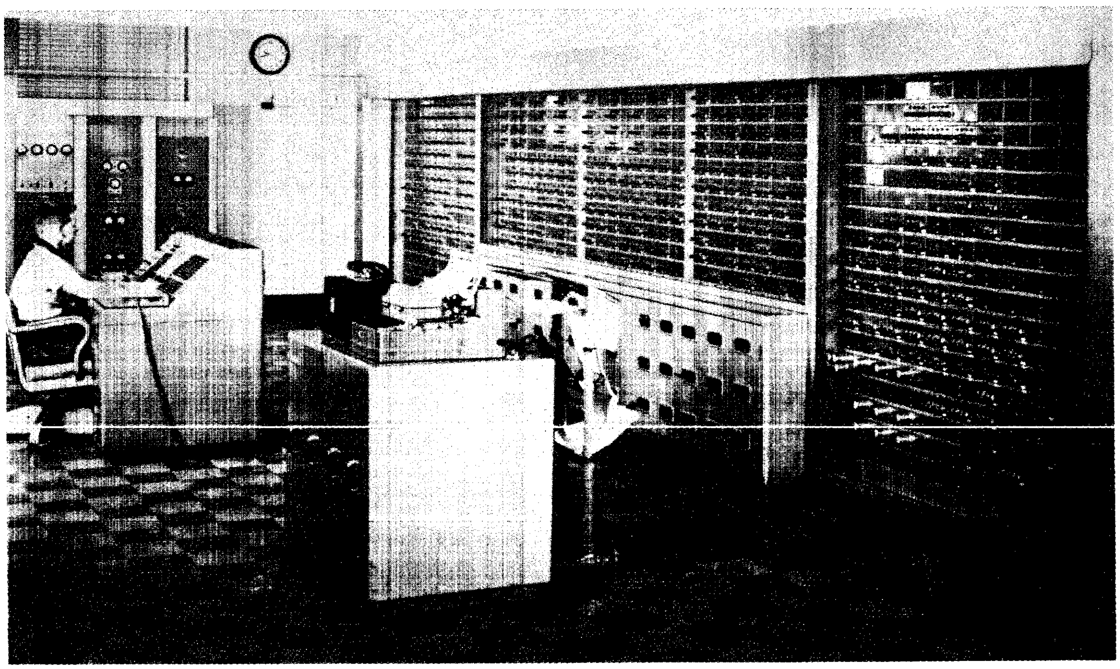
Instruction word format

Order		Address	Order		Address
Type 4 bits	Variant 4 bits	12 bits	Type 4 bits	Variant 4 bits	12 bits

Two 40-bit shifting registers and one 40-bit fixed register for arithmetic operations.

Two separate two-bit registers will hold a bank address for 16,384 word core memory, one register each for operands and instructions.

NAREC U. S. NAVAL RESEARCH LABORATORY



GENERAL PURPOSE scientific calculation and data processing.

Outstanding features include a special console, which displays the contents of core memory address and information registers and permits direct manual read and write to core memory locations.

Unique system advantages include computation monitored from control console without loss of time to stop computer at desired location or instruction in many different ways in order to facilitate program and machine checking. Instruction code and layout is very simple to use and remember, yet is extremely powerful and flexible.

Flexowriters are used in parallel to print results of several problems simultaneously. A centralized operating area consists of photoelectric tape readers, high-speed punch, Flexowriter and core memory console adjacent to main control console.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	22	6
Multiply:	300-600	same (approx. range) = 450
Division:	575-725	same (approx. range) = 650

Division = 10 per digit (excluding access) for numerator = 0.

Construction: (Arithmetic unit only).

	Quantity
Vacuum tubes type 5687	600
Vacuum tubes type 5670	600
Vacuum tubes type 6AN5	100
Total	1,300
Transistors	0
Crystal diodes	16,000

Arithmetic mode: Parallel.

Timing: Asynchronous:

Operation: Sequential.

Input-output is partially concurrent.

Checking features: Automatic comparison bit by bit of all transfers between registers in arithmetic and control sections by means of two 48-bit comparator registers.

Magnetic tape system will have conventional parity checks and sense instructions.

Registers

Seven 48-bit parallel registers in arithmetic section, including one adder and one inverter of which two are directly programmable.

One 48-bit parallel register in control section.

One 16-bit parallel register in control section (program counter).

One 48-bit serial-parallel output buffer register.

Two 48-bit multiple use comparator registers.

One 48-bit core memory information register.

One 14-bit core memory address register.

Two 48-bit and one 16-bit manual switch registers.

STORAGE

Magnetic core

Number of words: 16,384.
Number of digits: 786,432.
Memory cycle time: 8 microseconds.

Magnetic drum

Number of words: 8,192.
Number of digits: 393,216.
Maximum drum access: 33,333 microseconds.

Magnetic tape

Number of units that can be connected: 16.
Number of characters per linear inch: 600.
Each line across the tape contains two characters of eight bits each.
Packing density: 300 lines per inch.
Channels or tracks on the tape: 16.
Blank tape separating each record: .75 inch.
Tape speed: 120 inches per second.
Transfer rate: 72 KC characters per second.
Start time: 3 milliseconds.
Stop time: 2 milliseconds.
Physical properties of tape:
Width: 1 inch.
Length of reel: 2,400-3,600 feet.
Composition: Mylar.

The above information on magnetic tape is preliminary only, as definite plans are now being formulated.

The tape system should be installed in the NAREC by July, 1961.

INPUT MEDIA

Magnetic tape

120 inches per second.

Paper tape

25-100 inches per second.

Dual speed photoelectric reader at 250 and 1,000 characters per second using mylar-aluminum foil and paper tape.

OUTPUT MEDIA

Paper tape

60-110 characters per second.

High and medium speed paper tape punches.

Magnetic tape

120 inches per second.

Line printer

Line Printer will be installed by July, 1961.

Speed of 600-1,200 lines per minute is anticipated.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 48.
Binary digits per instruction: 24.
Instructions per word: 2.
Instructions decoded: 44.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: -1 to $+1$.

Instruction word format

Address				Order	
4	4	4	4	4	4

Half-word, six four-bit sexadecimal characters.

Automatic built-in subroutines include punched tape input and output routines and variable length data transfer instructions (two-address).

Automatic coding includes floating point interpretive routines, containing standard mathematical subroutines as basic instructions.

Cost, price and rental rates

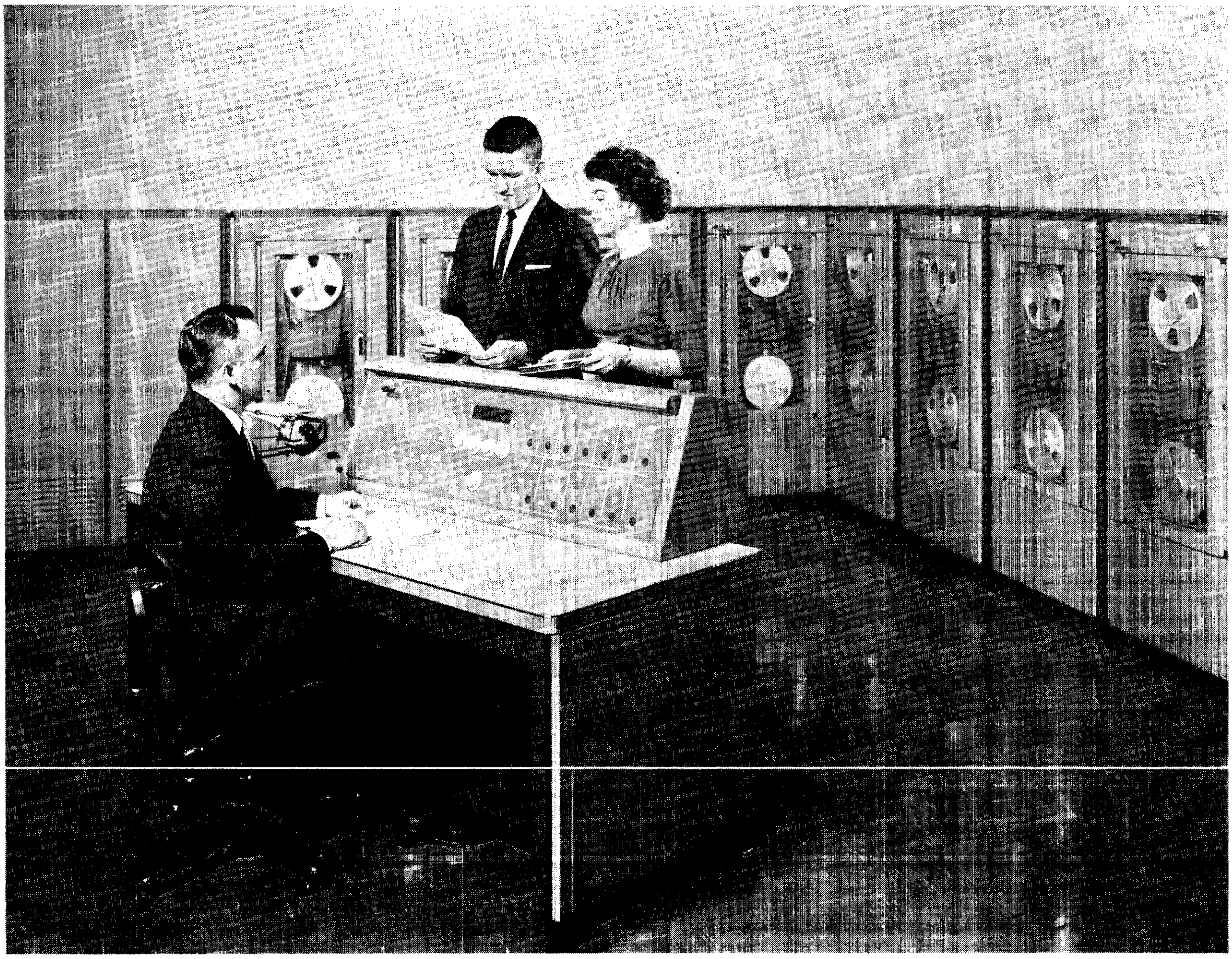
Total system cost approximately $1,500,000.

Power, space, weight, and site preparation

Power, computer: 25 kw.
Power, air conditioner: 15 kw.
Volume, computer: 1,000 cu. ft.
Area, computer: 125 sq. ft.
Room size, computer: 30 ft. x 80 ft.
Capacity, air conditioner: 25 tons.
Weight, computer: 5,000-10,000 lbs.

Site preparation included concrete trenches in floor for power wiring and coaxial cables. Power includes both M-G sets and electronic power supplies.

NCR 304 THE NATIONAL CASH REGISTER COMPANY



THE BASIC NCR 304 consists of the central processor, control console with associated typewriter printer, magnetic tape controller, magnetic tape units, and high speed punched card reader. The basic system may be expanded by the addition of a high speed paper tape reader, paper tape punch, high speed line printer, universal converter, and printer converter. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 60 bits.

Numeric Characters Per Word: 10 at six bits each or 15 at four bits each (packed).

Arithmetic operations cannot be performed on packed words.

Alphabetic Characters Per Word: 10.

Character Code: Binary coded decimal.

Timing: Central processor—synchronous; other equipment—asynchronous.

Pulse Repetition Rate: 400 kilocycles.

Central processor (304)

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.60
Multiply: 555555 by 5555	2.46
Divide: 3086108025 by 5555	3.36

Access time: 0.06 milliseconds per operand, including checking.

Checking features: Check character in each word (a word has 10 characters plus check character).

Registers

Ten addressable index registers.

Sequence control register: Contains the address of the next instruction to be executed.

Memory buffer register: Information is entered into, or accessed from, the memory through this register.

Shift register: Used for many functions, i.e., partial word operation.

Input-Output register: A buffer register for input-output for peripheral devices.

Tally register: Various instructions store certain information pertinent to the instructions in this register.

Accumulator: Used in all arithmetic operations.

Memory

The basic magnetic core memory has a capacity of 2,400 words. An alternate 4,800 word memory is available. The 2,400 word memory may be expanded to 4,800 words by a field change.

Control panel

This unit is a part of the control console and contains controls and indicators for control of the system.

INPUT MEDIA

Magnetic tape controller (330-1)

This unit serves as a control and buffer for up to eight magnetic tape units. A total of eight controllers may be connected to the system. Search, copy, and rewinds of tape are independent of the central processor.

Magnetic tape unit (332-1)

Maximum number per system: 64.
Packing density: 200 characters per inch.
Number of channels: 8.
Record length: Variable—10 to 100 words.
Record gap: None—automatic repositioning of tape.
Tape speed: 150 inches per second/30,000 characters per second.
Rewind time: 3.2 minutes.
Start-stop time: 4 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
  Composition: Plastic—(mylar).
  Length: 3,600 feet.
  Width: ½ inch.
Error detection: Odd parity bit for each character, odd parity character for each record. Tape writing is followed immediately by tape reading which is then checked by the tape controller for accuracy.

High speed paper tape reader (360)

This unit is a photoelectric tape reader which operates at a rate of 1,800 characters per second. Five, six, seven, or eight channel tape, in any code, may be read. (This unit is supplied to read three codes. One code will be the 7-channel code used by the console typewriter printer. At time of order, customer will select any two additional optional codes.) The code to be read is selected by means of a selector switch. This unit utilizes dual character reading for error detection. Upon receipt of a stop order, tape is stopped before the next character reaches reading position. Full parity checking (on checkable codes) is accomplished during reading. This unit operates on-line to the central processor or off-line to the universal converter.

High speed punched card reader (380)

This unit is a photoelectric card reader which reads at the rate of 1,500 cards per minute. It can be supplied to read 80-column or 90-column cards, and will correct for any punch slippage in the cards. This unit utilizes dual reading for error detection. It operates on-line to the central processor or off-line to the universal converter.

Typewriter printer (351)

This unit has a standard typewriter keyboard plus additional special symbols. It is equipped with a paper tape reader and punch. Information can be entered directly into the central processor or taken directly from the central processor. The unit can type only, type and punch, or punch only. Paper tape being read or punched is in the 7-channel 304 typewriter code. Typing, reading, and punching are performed at a rate of 10 characters per second.

OUTPUT MEDIA

Magnetic tape system

As previously described.

Typewriter printer

As previously described.

Paper tape punch (370)

This unit punches paper tape at a rate of 60 characters per second in 5-, 6-, 7-, or 8-channel tape, any code. (This unit is supplied to punch two codes. One code will be the 7-channel code used by the console typewriter printer. At time of order, customer will select one additional optional code.) The code to be punched is selected by means of a selector switch. Full parity checking (on checkable codes) is accomplished during punching. This unit operates on-line from the central processor or off-line from the universal converter.

High speed line printer (340)

This unit prints 120 characters per line at a rate of 600 lines per minute of alpha-numeric information or 750 lines per minute of numeric information. Skip line speed is 4,200 lines per minute. Vertical format control is by means of a plastic loop and a stored character in the first word of a record. Columnar rearrangement can be achieved by use of a plugboard. Minimum form width is 4 inches and maximum width is 22 inches. There are 56 character symbols which can be printed. An original and five copies can be produced. This unit operates on-line from the central processor and off-line from the universal converter or printer converter.

AUXILIARY COMPONENTS

Universal converter (320)

This unit is used entirely off-line to convert from magnetic tape to the line printer, magnetic tape to punched cards, magnetic tape to punched paper tape, punched cards to magnetic tape and punched paper tape to magnetic tape.

Printer converter (322)

This unit is used entirely off-line to convert from magnetic tape to the line printer.

Card punch (IBM 523)

This unit is used with the universal converter to produce 80-column punched cards at a rate of 100 cards per minute.

PROGRAMMING

General: The NCR 304 uses a 3-address type of instruction. It will operate on either partial or whole word operands.

Instructions:

Number of words per instruction: 2 (for all except 3 instructions).

Number of digits per instruction: 20 (for 2-word instructions).

Total number of operation codes: 38 (114 by using variation designator V).

Instruction word format

9	8	7	6	5	4	3	2	1	0

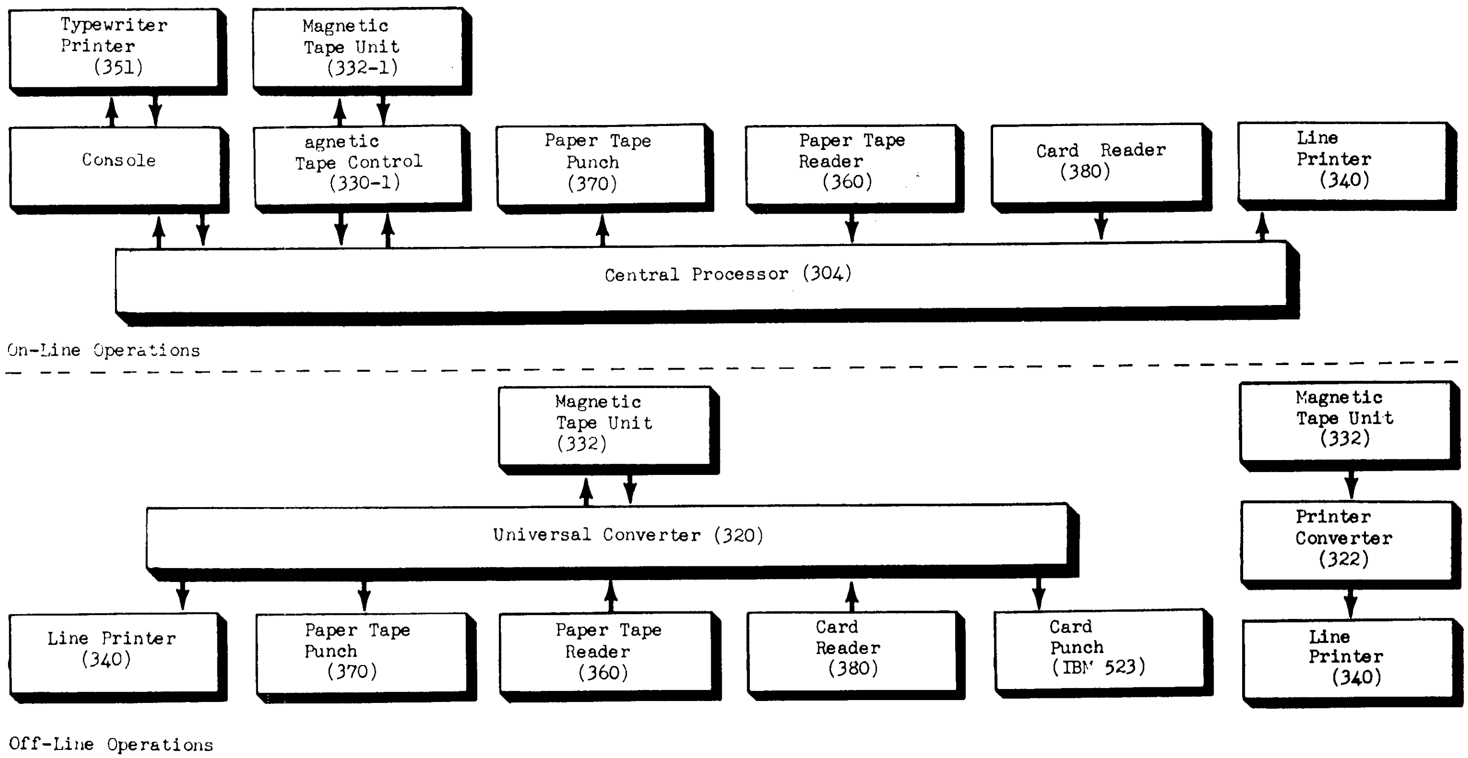
OP	A				B		C
V	M	S	R	A1-Ar	B1-Br		C1-Cr

OP—Operation to be performed.
A —Memory address of first operand.
B —Memory address of second operand.
C —Memory address where result of operation performed is to be stored.
V —*(a)* Designates a variation in the operation to be performed.
(b) The algebraic sign of V controls "self-linking".
M —Specifies the level of Automonitoring if Automonitoring is desired. (Used mainly for code checking and debugging.)
S —Designates which of the addresses A, B, or C, or any combination thereof, are to be modified by an Index Register.
R —Specifies the Index Register which is to be used to modify addresses A, B, or C, or any combination thereof.
A1—Ar: Specifies the length and position of field of first operand.
B1—Br: Specifies the length and position of field of second operand.
C1—Cr: Specifies the length and position of field for result.

Cost, Power Requirements, and Physical Characteristics

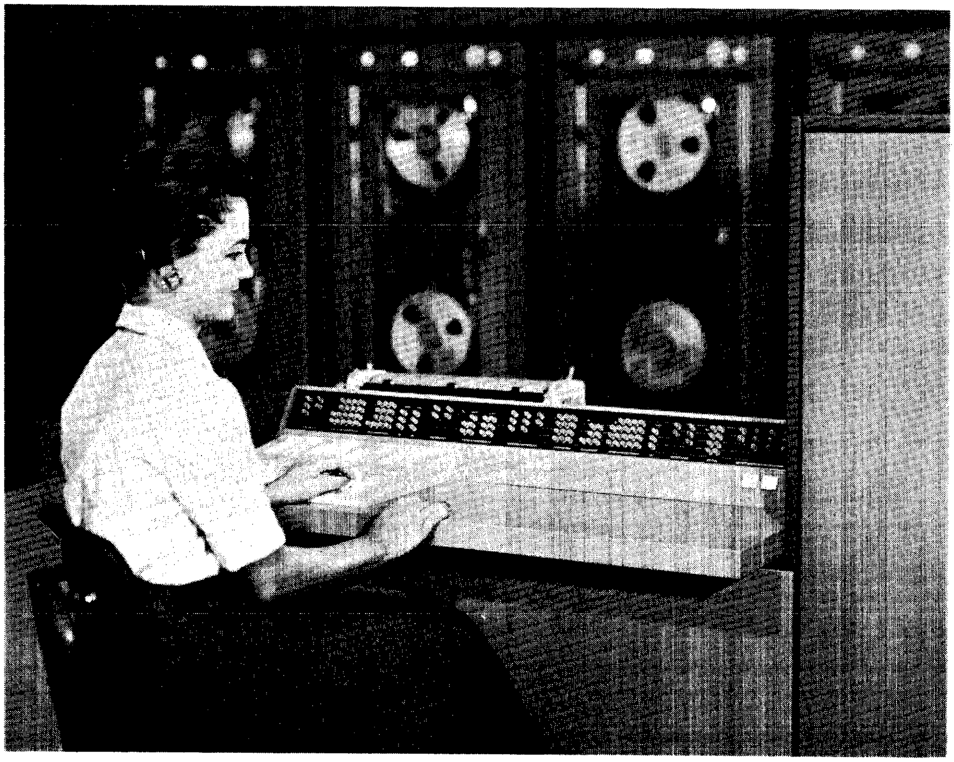
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
304-2 Central Processor	$7,640	$366,600		142x22x60	3,150	10.4	20,000
304-4 Central Processor	8,750	420,000		142x22x60	3,150	10.4	20,000
Control Console (including type-writer printer)	(2)	(2)		58x34x30	600	1.3	3,000
330-1 Magnetic Tape Controller	2,320	111,000		86x22x60	1,300	5.0	11,000
332-1 Magnetic Tape Unit	550	26,300		30x22x60	400	1.7	4,000
360 High Speed Paper Tape Reader	680	32,800		50x22x60	950	3.9	9,000
380 High Speed Punched Card Reader	650	31,100		63x33x42	1,000	6.4	16,500
351 Typewriter Printer	70	3,400		28x30x30	250	0.2	300
370 High Speed Paper Tape Punch	370	17,800		30x22x60	350	2.3	5,000
340 High Speed Line Printer (3 units):	2,590	124,300					
Buffer Unit				58x22x60	700	5.8	11,000
Thyratron Unit				60x22x60	950	8.1	15,000
Mechanical Unit				38x73x42	750		
320 Universal Converter	2,630	126,000		86x22x60	1,300	6.6	13,500
322 Printer Converter	940	45,000		30x22x60	500	3.1	6,000

1 Maintenance included in rental price. Maintenance charge for purchased equipment is 5½ percent per annum of purchase price.
2 Included in 304.



BLOCK DIAGRAM OF NCR 304

NCR 315 THE NATIONAL CASH REGISTER COMPANY



THE NATIONAL 315 SYSTEM is a compact, modular, electronic data processing system, expandable so that it can be applied as a small scale system or built up to one with large scale capacities.

The 315 System is designed for processing business data and provides the proper balance of components and data handling instructions. It also can handle engineering and scientific problems.

In the National 315 System, solid state devices are used throughout. It is completely transistorized, with ferrite core memory units. The use of magnetic cards in removable and mailable cartridges permits high-speed random access or in-line processing. Since multiple cartridges can be on-line at the same time, sequential or batch processing may also be performed, retaining the old file while creating the new.

Also available as part of the National 315 configuration can be magnetic tapes. Either magnetic card files or magnetic tapes can be employed, or both are available on the same system.

Registers and B-boxes include 32 Index Registers of 5 digits each and 32 Jump Registers of 5 digits each. This includes automatic storage of 3 different link addresses. The Sequence Control Register (Instruction Counter) is completely addressable. Automatic input-output tallies are used.

The entire system capable of any degree of polysynchronous operation, wherein any designated collection of peripheral units may each *Demand* program attention whenever appropriate. Demand interrupt is subject to a simple, flexible system of priorities, and to master control which may forbid interrupt altogether whenever desired.

SYSTEM COMPONENTS

Central processor

Operation: Concurrent and polysynchronous.

Operating speeds:

Cycle time: 6 microseconds.

Add time: 36 microseconds.

Multiply time: 900 microseconds (average).

Sort time (for 10,000 120-digit items): magnetic tape — 4 handlers — 5.6 minutes.

Checking features: Complete parity checking throughout the entire system. Internal checks continually monitor the accuracy of the system and guard against incipient malfunction. Typical are the parity and inadmissible character tests . . . automatic read-back of magnetic tape and magnetic cards as the information is being recorded . . . the electronic tests which precede each use of magnetic tape or magnetic cards to ensure that the operator has not inadvertently set switches improperly. These internal, automatic tests are supplemented by the TEST instruction which may be programmed to ensure proper setup of certain units prior to their use. Console switches are designed to protect against inadvertent or improper use, and interlocks are provided on peripheral units to guard against operator error.

COMPONENTS

Central computer

315 Electronic Data Processor with Console.
316 Modular Magnetic Core Memory Units.

Magnetic tape file system

332-202 Magnetic Tape Handler (24 and 40KC).
332-203 Magnetic Tape Handler (24, 40 and 60 KC).

Magnetic card file system

353 Card Random Access File.

Input devices

362-3 Paper Tape Reader.
393-1 Punched Card Reader.
402 Buffered Magnetic Character Sorter.

Output devices

340-3 High-Speed Line Printer.
371-3 Paper Tape Punch.
354 Card Punch Buffer.

General organization

1. Alpha-numeric and numeric data representation.
2. Minimum 4000 alpha-numeric or 6000 decimal digits of Magnetic Core Main Memory.
3. Additional memory units up to 120,000 digits.
4. 12-bit word structure — two alpha-numeric, or three numeric digits.
5. Solid state construction.
6. Automatic checking of all data transfers.
7. Special error detection circuitry.
8. Modular construction.
9. 64 special registers used as Index, Link, Jump, and Sequence Registers.

Instruction format

1. Single-address plus "double-stage" instructions.
2. Variable-length operands—ability to specify number of words.
3. Index registers for address modification.
4. Built-in monitoring features.
5. Self-linking facility.
6. Automatic unit interrupt facility under program control.

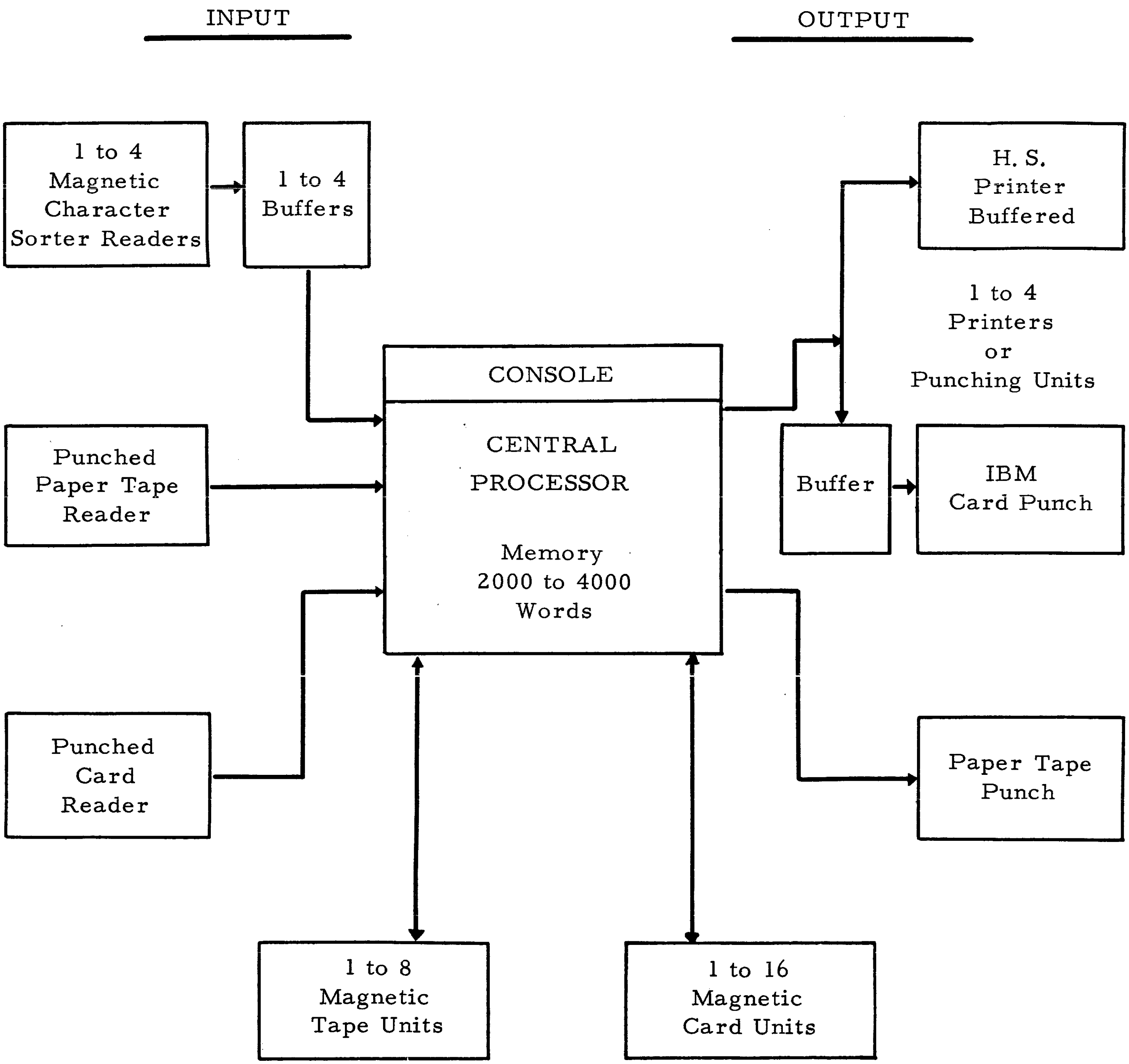
Console

General characteristics:

1. Complete monitoring of entire system.
2. Binary coded decimal display of main memory address.
3. Complete indication of cause of error halt.
4. Direct printout of desired information on console printer.
5. Program modification facility.
6. Single cycle operation ability.
7. Provides facility for entire system monitoring by one person.
8. Eight option switches.
9. Human engineering principles of design.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance mo.	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
315-1 Basic Processor	$1,300	$82,500	$160	105x24x52	1,325	3.0	
315-2 Basic Processor	1,400	90,000	170				
315-3 File Processor	1,400	95,000	180				
315-4 Bank File Processor	1,500	95,000	190				
316-1 2,000 Word Memory	650	37,500	20	43x24x52	500	1.0	
316-2 5,000-Word Memory	1,100	55,000	20				
316-3 10,000-Word Memory	1,600	75,000	20				
332-202 40kc Magnetic Tape	700	27,500	200	30x24x60	400	1.6	
332-203 60kc Magnetic Tape	900	36,000	200				
340-3 Printer and 357-1 Buffer	1,425	72,500	260	80x24x52	1,000	2.5	
354-1 Card Punch Buffer	450	25,000	30	43x24x52	600		
355-1 Sorter Buffer	450	23,500	30				
362-371 Paper Tape Reader-Punch	450	15,000	50			1.0	
383-1 Punched Card Reader	450	20,000	100				
402 Magnetic Character Sorter	1,700	62,000	460			6.0	
353-1 Magnetic Card	950	38,000	30			0.5	



BLOCK DIAGRAM OF NCR 315

NCR 315 THE NATIONAL CASH REGISTER COMPANY

THIS SYSTEM is designed to handle all types of accounting records, reports, and statistics, paper tape sorting (Direct and Sequential), engineering calculations, and linear programming problems (Limited to 10 x 15 matrix or less).

ADDITIONAL FEATURES AND REMARKS

Features include magnetic ledger cards, accounting machine printer, four-address system, internally stored program, decimal coding, and desk size. The unique Magnetic Ledger Card which combines visible, auditable, historical information posted on the front, with machine language encoded on the back. Up to 200 characters of information pertaining to each account can be stored on the back of each card. The magnetic ledger philosophy provides unlimited external storage facility and immediate random access to a complete, up-to-date historical record.

ARITHMETIC UNIT

	Including Storage access (microseconds)
Add:	11,000
Multiply:	250,000
Divide:	400,000

Above times are "worst case." Because of the four-address system, command times all include access and storage.

Arithmetic unit is constructed of 48 cores, with transformers and diodes.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation: Sequential.

Checking features: Among the fixed checking features are a five-bit parity check, reader and punch check, power supply tolerances auto check, a print-out check, and ledger card read-write failure indicators are used. Test points are available on all logical circuits.

STORAGE

Core

Number of words: 200.
Number of digits: 2,400.
Access: 22 microseconds per bit.

Magnetic ledger cards

Number of digits: 200.
Access: 220 characters per second.
Variable word length on magnetic cards.

INPUT MEDIA

Paper tape (photoelectric)

400 characters per second.

Punched card (IBM 024 or 026)

18 characters per second.

Magnetic ledger card

220 characters per second.

Speed of reading and writing depends on card length. The average is 1.5 to 2.0 seconds.

Console keyboard (standard)

The Magnetic Ledger Card is a standard ledger card with standard visible posted information on the front and strips of magnetic tape on the back capable of storing up to 200 digits of information pertaining to that account.

OUTPUT MEDIA

Paper tape

17 characters per second.

Punched card

18 characters per second.

Magnetic ledger cards

Same as input.

Accounting machine printer

1,200 characters per minute.

The Accounting Machine type printer is completely programmable both horizontally and vertically. It will accommodate continuous forms, journals, cut forms, and ledger cards all simultaneously, if desired and has all accounting machine checking, comparing, and accumulating features.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Decimal digits per word: 12.
Decimal digits per instruction: 12.
Instructions per word: 1.
Instructions decoded: 27.
Arithmetic system: Fixed point.
Instruction type: Four-address.
Number range: From -1×10^9 to $+ 9 \times 10^9$.

Instruction word format

Instruction	Mode	Address A Operand	Address B Operand	Address C Modification	Address D Next Instruction

Two decimal digits each.

Automatic built-in subroutines include block transfer, and sum and add pairs of numbers. Variable block instructions perform some functions similar to B-boxes.

Cost, price and rental rates

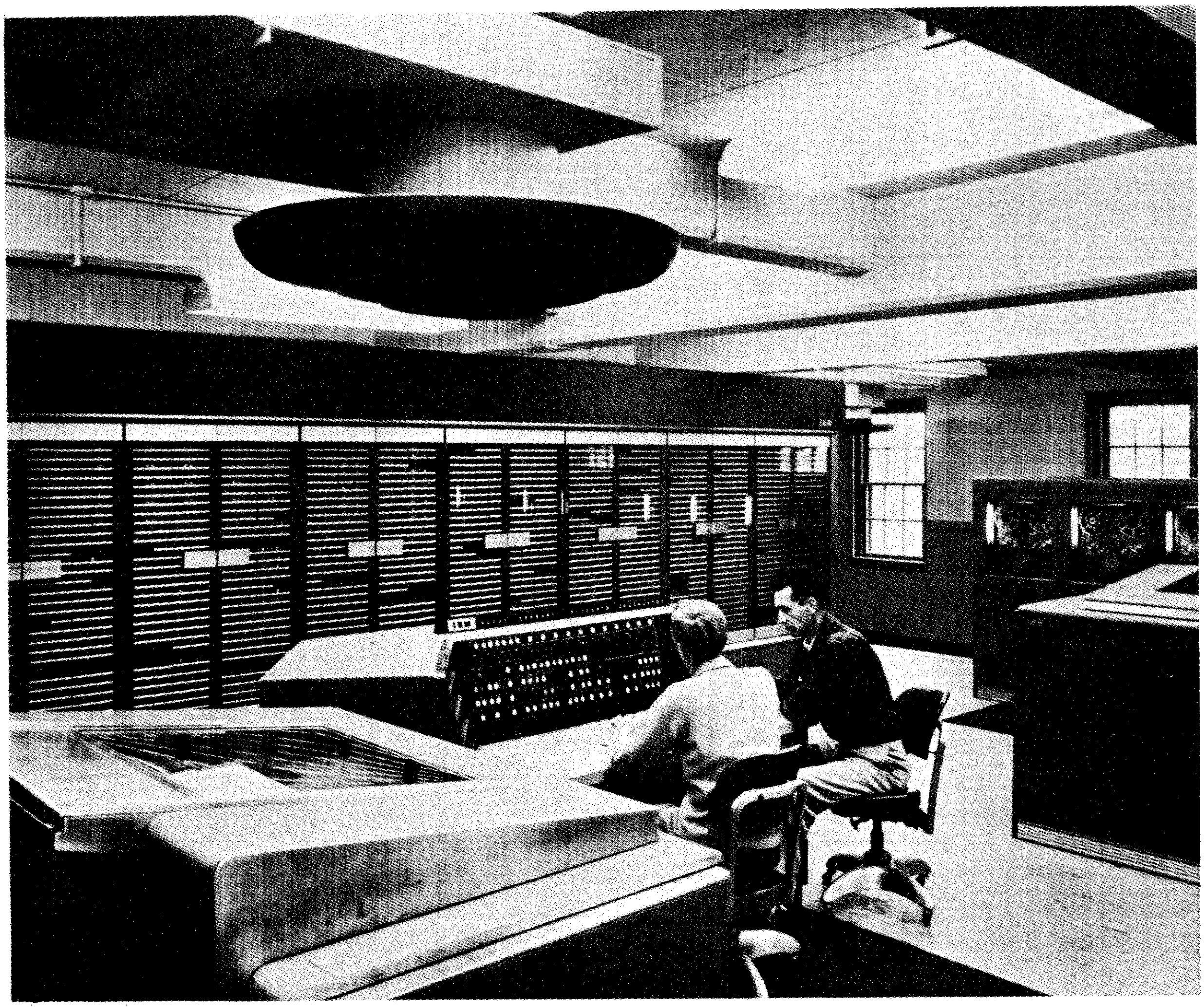
	Price	Monthly Rental
Basic System:		
390-3 Console and Central Processor	\$56,300	\$1,395
361-1 Paper Tape Reader	10,000	250
461-2 Tape Recorder	1,735	50
Additional Equipment:		
381-1 Punched Card Reader Coupler	2,250	60
468-1 Punched Card Coupler	815	27
417 Paper Tape Rewinder-Splicer	1,215	30
361-2 Paper Tape Reader		

Maintenance service is included in the rental price.

Power, space weight, and site preparation

KVA computer: 4.8 KVA, 1 phase, 240v.
Room size: 10 ft. x 15 ft.
Weight, computer: 1,000 lbs.
1,500 lbs., total.

NORC INTERNATIONAL BUSINESS MACHINES CORPORATION



GENERAL SCIENTFIC CALCULATION in ordnance research, development and testing. Primary effort has been devoted to scientific computation, including satellite surveillance data reduction, orbital computation, missile ballistics, reactor design, war game simulation. A small portion of the time is spent on business type data reduction and computation.

ARITHMETIC UNIT

	Excluding Storage access (microseconds)
Add:	15
Multiply:	31
Divide:	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.

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.

STORAGE

Magnetic core

Number of words: 20,000.
Number of decimal digits: 16 per word.
Access: 8 microseconds.

Magnetic tape

Number of words: 40,000,000.
Access: Variable.

The core memory was built by Daystrom Instrument Corp. and installed in March 1960. Original memory was 2,000 word Williams CRT System with same word size and access time. The magnetic tape system can read or search forward and backward and write forward.

PROGRAMMING AND 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.

INPUT MEDIA

Magnetic tape (8)

70,000 decimal digits per second.

Keyboard

Manual speed (serial).

Eight tape units are in service. The packing density on magnetic tape is 500 characters per inch, the linear speed is 140 inches per second. 0.5 inch tape is used.

OUTPUT MEDIA

Magnetic tape (8)

70,000 decimal digits per second.

Mechanical printers (2)

150 lines per minute 407 mechanisms.

CRT-Microfilm printer and plotter

15,000 characters per second.

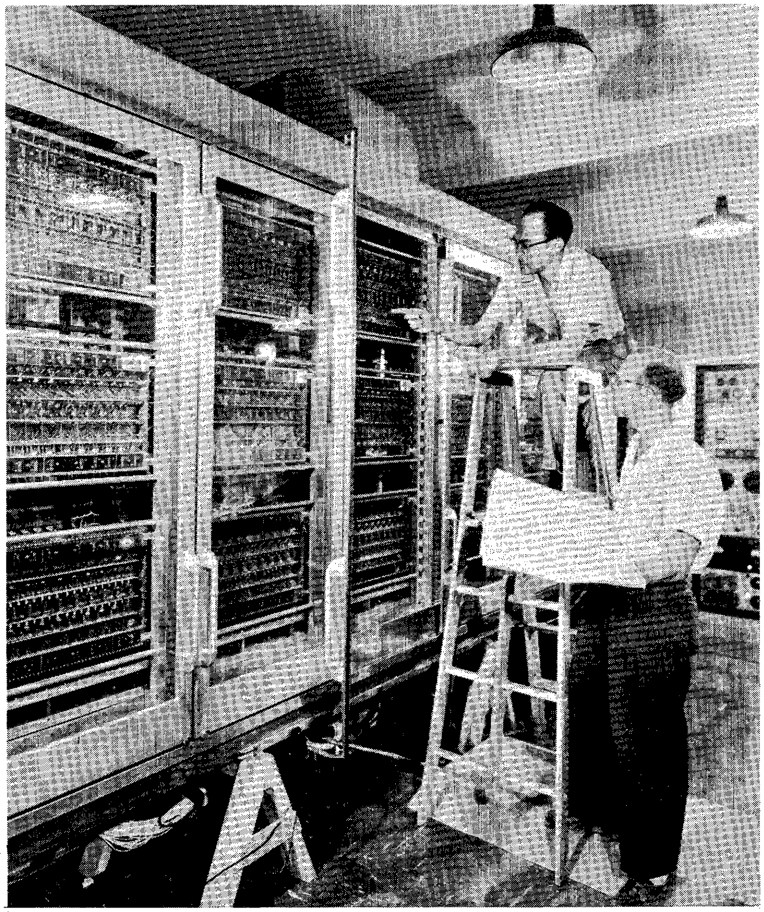
Built by Stromberg Carlson; user Charactron CRT; installed in 1958.

Cost, price and rental rates

$2,500,000 is the cost of the machine as above described (without core memory and CRT printer) plus Card-Tape-Card Converter.

Additional costs were the Core Memory at $500,000 and the CRT Printer at $200,000. Total for the system is $3,200,000.

ORACLE OAK RIDGE NATIONAL LABORATORY AND ARGONNE NATIONAL LABORATORY, JOINTLY



USE AND APPLICATION has been primarily as a research and development tool for numerical analysis, programming techniques, and problems in physics, chemistry, engineering and biology. Methods have been developed for solving linear equations, matrix inversions, computing eigenvalues and vectors of matrices, solution of reactor problems involving ordinary and partial differential equations. Monte Carlo techniques have been designed and applied to problems in health physics and shielding. Many "one of a kind" problems are solved which involve methods mentioned above as well as function evaluation, interpolation and statistical analysis. In the last few years much effort has gone into data processing, data handling and reduction. System is a large scale and general purpose computer.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	70	8
Multiply:	370-590	Slightly less
Divide:	590	Slightly less

Construction: (Arithmetic unit only). Arithmetic unit is constructed of vacuum tubes, transistors, and diodes. Type 2N43 transistors and type 1N68 and 1N191 diodes are used.

Arithmetic mode: Serial.

Timing: Synchronous in storage and asynchronous in arithmetic.

Operation: Sequential concurrent in magnetic tape hunting operations.

Checking features: Word parity on memory, word parity on magnetic tape, character parity on paper and magnetic tape.

Registers

Accumulator, quotient and storage registers.

STORAGE

Cathode ray tube

Number of words: 2,048.

Access: 18 microseconds.

Magnetic tape

Number of words: 3×10^6.

Access: 50,000 microseconds per block.
Four handlers: 128 words per block.
Number of units that can be connected: 4.
Number of characters per linear inch: 170.
Channels or tracks on the tape: 42.
Blank tape separating each record: 1 inch.
Tape Speed: 47 inches per second.
Transfer rate: 8,000 characters per second.
Start time: 5 milliseconds.
Stop time: 5 milliseconds.
Average time for experienced operator to change reel: 30 seconds.
Physical properties of tape:
Width: 2 inches.
Length of reel: 1,000 feet.
Composition: .003″ Mylar base, .001″ Oxide coating.

INPUT MEDIA

Paper tape (Ferranti)

200 characters per second.

OUTPUT MEDIA

Photographic curve plotter

2,000 characters per second.
Used for point plotting also. Characters are series of points.

Console typewriter

10 characters per second.
Not normally used for output.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 40.
Binary digits per instruction: 8.
Instructions per word: 2.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: -39.
-1 to $+(1-2^{-39})$.

Instruction word format

Order	Break Point	Address
8	1	11

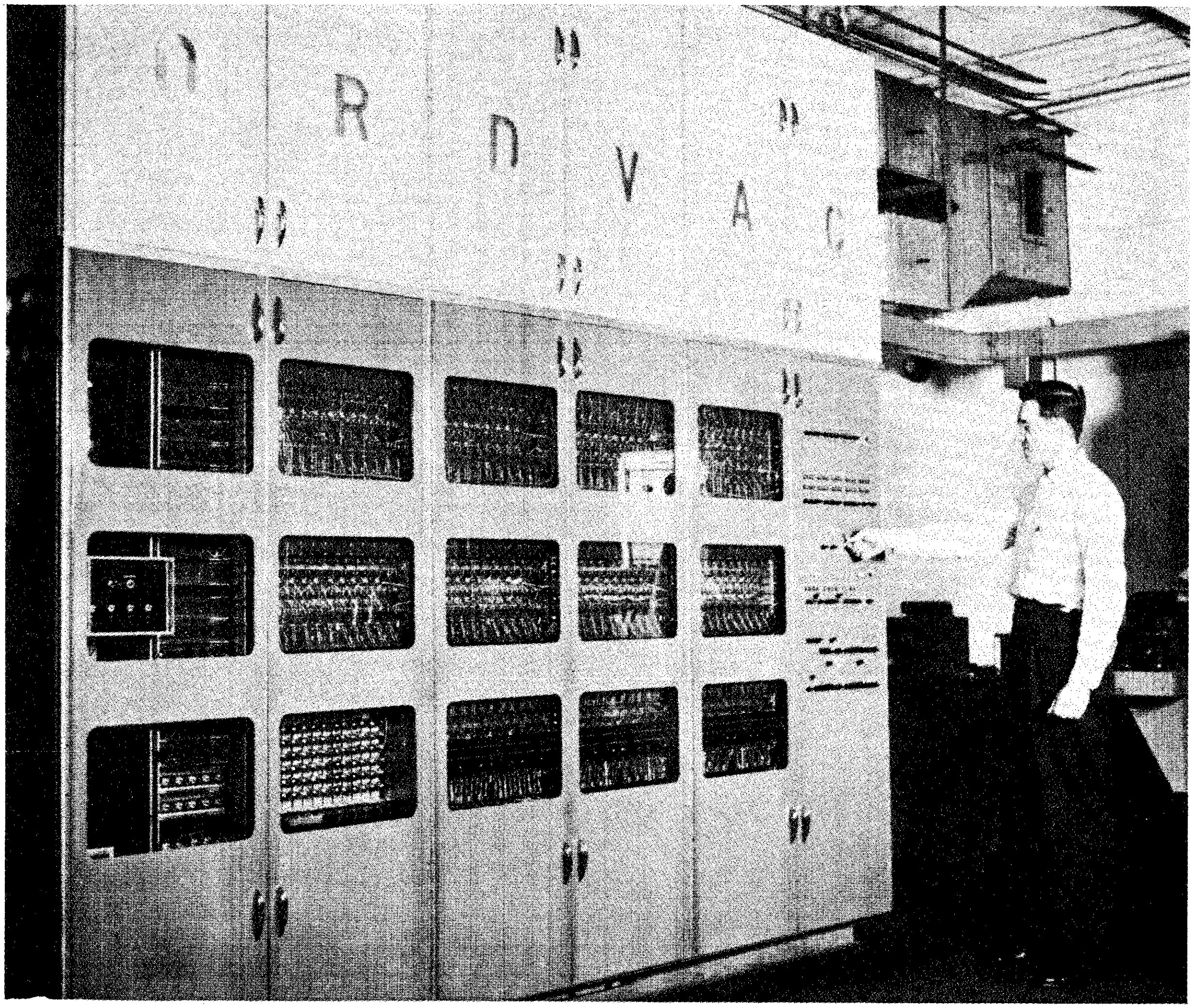
Power, space, weight, and site preparation

Power, computer: 75 kw 0.9 pf.
Room size: 60 ft. x 60 ft.

Cost, price and rental rates

Arithmetic Unit, Memory Unit, Magnetic Tape Unit, Input-Output and Console. Total, $250,000.

ORDVAC UNIVERSITY OF ILLINOIS



EXTERIOR BALLISTICS PROBLEMS such as high altitudes, solar and lunar trajectories, computation for the preparation of firing tables and guidance control data for Ordnance weapons, including free flight and guided missiles.

Interior ballistic problems, including projectile, propellant and launcher behavior, e.g. physical characteristics of solid propellants, equilibrium composition and thermodynamic properties of rocket propellants, computation of detonation waves for reflected shock waves, vibration of gun barrels and the flow of fluids in porous media.

Terminal ballistic problems, including nuclear, fragmentation and penetration effects in such areas as explosion kinetics, shaped charge behavior, ignition, and heat transfer.

Ballistic measurement problems, including photogrammetric, ionospheric, and damping of satellite spin calculations, reduction of satellite doppler tracking data, and computation of satellite orbital elements.

Weapon systems evaluation problems, including antiaircraft and anti-missile evaluation, war game problems, linear programming for solution of Army logistical problems, probabilities of mine detonations, and lethal area and kill probabilities of mine detonations, and lethal area and kill probability studies of missiles.

ARITHMETIC UNIT

Arithmetic mode: Parallel.

Basic pulse rate: Not pulse controlled.

Add time (basic addition by arithmetic unit): 14 microseconds.

Multiply time (excl. storage access): 700 microseconds.
Divide time (excl. storage access): 700 microseconds.

The total add time, including transfer to final register, is 50 microseconds. None of the above figures include access to storage.

Construction: (Arithmetic unit only). Transistorized on printed circuit plug-in boards, using 1,000 Type 2N128 transistors.

Timing: Asynchronous.

Operation: Parallel.

STORAGE

Magnetic core

Words: 4,096.
Digits: 163,840 bits.
Access: 15 microseconds:

Magnetic drum

Words: 10,032.
Digits: 401,280 bits.
Access: 80,000 microseconds/48 words.

Magnetic drum purchased from ERA Division of Sperry Rand, Incorporated. The track selector for the magnetic drum has been transistorized. Magnetic core storage unit purchased from Telemeter Magnetics, Incorporated. Both above storage units adapted to ORDVAC and installed by Ballistic Research Laboratories personnel.

INPUT MEDIA

Teletype tape (5-hole)

2.5 words per second.

Punched cards

40 words per second (binary), 8 words per second (decimal).

Ferranti high-speed paper tape reader

20 words per second (binary).

Magnetic tape

300 words per second.

The special purpose one inch wide magnetic tape system for transferring telemetered data to ORDVAC has six information tracks and three control tracks.

OUTPUT MEDIA

Teletype page printer

0.4 word per second.

Teletype tape

0.4 word per second.

Punched cards

40 words per second (binary), 8 words per second (decimal).

Transistorized magnetic core contents display.

Cost, price and rental rates

Rental rates for additional equipment $648.57 per month.

The additional rented equipment is:

IBM Punch	$83.32	per month
IBM Reader	82.50	per month
IBM Reproducer	122.50	per month
IBM Tabulator	360.25	per month

Approximate cost of basic system $600,000.

Power, space, weight, and site preparation

Power consumption, computer: 40 kw.
Power consumption, core memory: 15 kw.
Power consumption, magnetic drum: 6 kw.
Air conditioning, computer: 15 tons.
Air conditioning, core memory: 7.5 tons.
Air conditioning, magnetic drum: 3 tons.
Space, computer: 630 cu. ft., 80 sq. ft.
Weight, computer: 3,000 lbs.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 40.
Instructions per word: 2.
Instruction type: One-address.
Binary digits in operation code: 6 or 9.
Binary digits in address: 12 or 10.
Instructions used: 55 or 72.
Arithmetic system: Fixed point.

Instruction word format

Left Instruction			Right Instruction		
6 Order	2 Unused*	12 Address	6 Order	2 Unused*	12 Address
	20 Bits		20 Bits		

*One bit will be used to differentiate floating point numbers from fix point numbers.

Rapid access word registers: 3.

Sexadecimal representation is used externally.

Negative numbers are handled as two complements.

Floating point operation may be programmed.

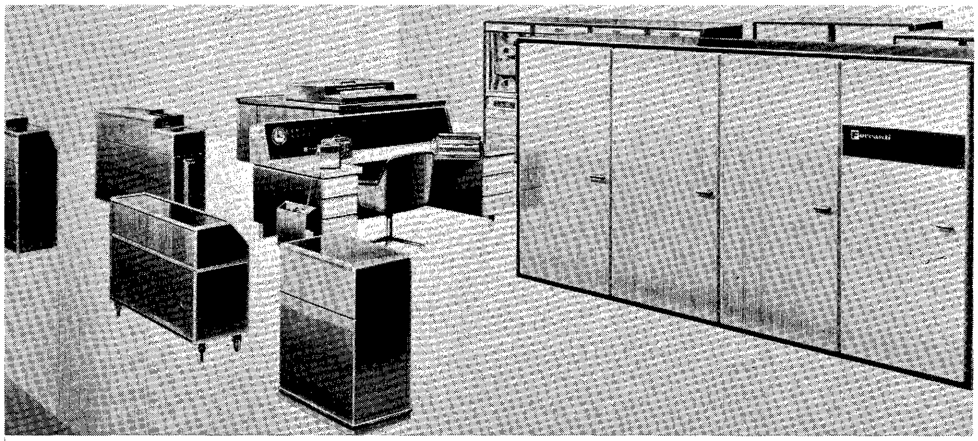
Dual code: ORDVAC operates on a dual code basis. The codes are, on a two instructions per word basis, i.e. 20 digits per instruction:

Code A — 1,024 words of storage:
- 9 digit, command
- 1 digit, spare
- 10 digit, address

Code B — 4,096 words of storage:
- 6 digit, command
- 2 digit, spare
- 12 digit, address

This system permits utilization of routines developed previous to the 4,096-word operation change over.

ORION FERRANTI ELECTRIC, INCORPORATED



ORION is a medium-to-large scale general purpose digital computer system of solid state construction. The ORION system consists of a central processor with magnetic core memory and time-sharing capabilities, a control console, a magnetic tape subsystem, and other input-output units.

SYSTEM COMPONENTS

General

Word Length: 48 binary digits.
Numeric Characters: 14.
Alphabetic Characters Per Word: 8.
Character Code: Binary.
Timing: Asynchronous.
Pulse Repetition Rate: 500 kilocycles per second.

Central processor

Operation: Semi-parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Average time (milliseconds) Fixed point
Add:	.064
Multiply:	.064 to .200
Divide:	.100 to .300

Registers

ORION contains 225 index registers in magnetic core storage.

Memory

The main ORION memory unit is magnetic core, and has a capacity of 4,096 to 16,384 words. Auxiliary storage is provided by one or more magnetic drums having a capacity of 16,384 words per drum and an access time of 12 milliseconds.

Control console

The ORION control console contains a paper tape reader, a character printer, and indicator lights and switches.

INPUT MEDIA

Any available input equipment may be used in the ORION system, including:

Magnetic tape units (Ampex FR 300)

Read-write speed — 90,000 characters per second (up to 64 tape units possible).

TR 5 photoelectric paper tape readers

300 characters per second.

TR 7 photoelectric paper tape readers

1,000 characters per second.

Punched card readers

Up to 600 cards per minute.

OUTPUT MEDIA

Any available output equipment may be used in the ORION system, including:

Magnetic tape units

As previously described.

Paper tape punches

10, 33, 60, and 300 characters per second.

Card punches

100 cards per minute.

Console printer

10 characters per second.

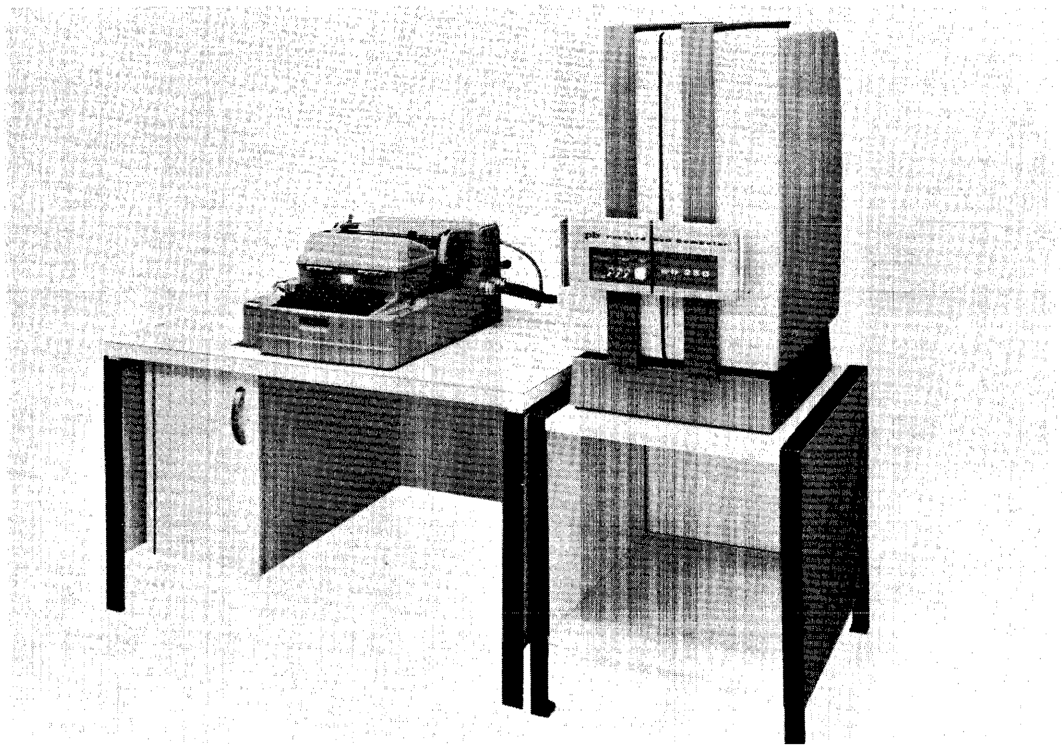
Line printers

100 and 3,000 lines per minute.

PROGRAMMING

General: ORION may be programmed with either three-address, modified two-address, or unmodified two-address instruction. Microprogramming and time-sharing are possible.

PACKARD BELL 250 PACKARD BELL COMPUTER CORPORATION



THE PB is a high-speed digital computer designed to be used for general purpose computing and as a system component for on-line, real-time, data handling.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	108 Avg.	12
Multiply:	372 Avg.	276 (max.)
Divide:	348 Avg.	252 (max.)

Arithmetic mode: Serial.
Timing: Synchronous.
Operation: Sequential or non-sequential.

The PB 250 operates at a clock frequency of 2 Mc giving a word time of 12 microseconds. The arithmetic unit is completely serial in operation as is the magnetostrictive delay line memory.
delay line memory can be expanded from the basic 1808 words in one to 256- word increments to 15,888 words by the addition of plug-in units. The magnetostrictive

Checking features: All operations involving the memory are parity checked. Checking is also done in the assembly program and in the subroutine.

STORAGE

Magnetostrictive delay line

Number of words: To 15,888.
Number of bits: To 349,536.
Access: 1540 microseconds average.

Magnetic core

Number of words: To 16,384.
Number of bits: To 360,448.

Magnetic tape

Number of units that can be connected: 6.
Number of characters per linear inch of tape: 200.
Channels or tracks on the tape: 7.
Blank tape separating each record: 0.75 inch.
Tape speed: 5, 10 inches per second.
Transfer rate: 1 or 2 Kc per second.
Start time: 3 milliseconds.
Stop time: 1.5 milliseconds.
Physical properties of tape:
Width: ½ inch.
Length of reel: 2500 feet.

INPUT MEDIA

Flexowriter

10 six- or 8-bit characters per second.

Paper tape

300 six- or eight-bit characters per second.

Magnetic tape

2000 seven-bit characters per second.

Serial

Two Mc bit, 83.3 KC word rate.

Thirty control inputs used with the transfer on external signal command are also available for control applications.

Operations grouping

COMMAND STRUCTURE			
OP Code 6 bits	Address 13 bits	Sequence tag 1 bit	Index tag 1 bit

A and B Registers: One-word registers, programmed independently or combined for multiplication, division, square root, and double precision operations.

C Register: For multiplication, division, tally, and control.

OUTPUT MEDIA

Flexowriter

10 six- or eight-bit characters per second.

High-speed paper tape punch

110 six- or eight-bit characters per second.

Magnetic tape

2,000 seven-bit characters per second.

High-speed serial

Two Mc bit, 83.3 KC word rate.

The high-speed (2 Mc) input and output is through a 2 Mc external shift register which can be loaded or unloaded in serial or parallel from equipment such as A to D, D to A converters, shaft encoders, etc.

Input and output can also be made through an eight-bit character buffer which is used for Flexowriter, Paper Tape, and Magnetic Tape input and output. For example, an adapter card which connects our Model M3 A to D converter directly to the character buffer is available. Thirty-two control output lines are available for use with the Pulse to Specified Unit command for control applications.

Both punched card and line printing equipment will be available by mid 1961.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 21 plus sign.
Binary digits per instruction: 22.
Instructions per word: 1.
Instructions decoded: 63.
Arithmetic system: Fixed point.
Floating point by subroutine.
Instruction type: One-address (Modified).
Number range: 6 decimal digits.

Instruction word format

22 15	14	13 8	7 3	2	1
Sector Number	Sec Tag	Op Code	Line Number		Index Tag

An index register may be loaded to modify line number of address. (The contents of the index register replaces line number of all instructions where a tag is specified.)

A single instruction can shift the memory location of a specified number of words by one address position thus eliminating the need for address modification while maintaining optimum programming.

Optimum programming is provided for by provision for relative addressing for next instruction.

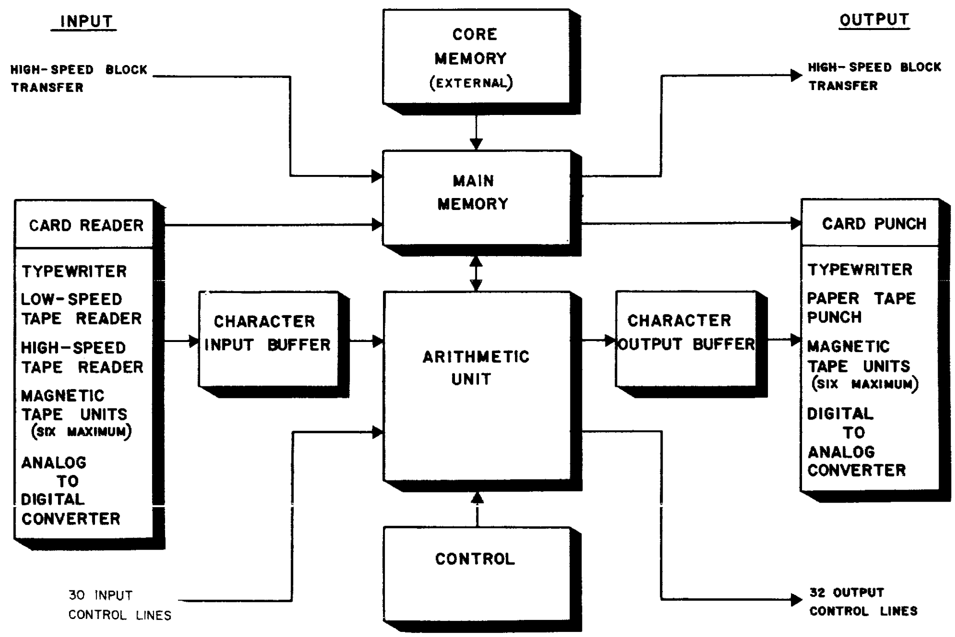
Automatic built-in subroutines include square root and gray-to-binary conversion.

Cost, price and rental rates

Model Number	*Item*	*Sale Price*	*Monthly Lease Price*
PB 250	Computer with Flexowriter and 2320-word memory.		
	PB 250-T in Free-Standing Case	$40,500	$1,230
	PB 250-R for Rack Mounting	39,500	1,200
	PB 250-R with Shelf and Slides for Rack Mounting Flexowriter	39,900	1,210
MSR-1	Memory Module (up to 256 words)	1,200	40
MTU-1	Magnetic Tape Unit	14,750	445
HSR-1	Paper Tape Reader (300 characters per second)	7,500	230
HSP-1	Paper Tape Punch (110 characters per second)	4,950	155
MX-1	Memory Extension Chassis	1,000	35
MT-1-250	Module Tester (less oscilloscope)	3,000	....
SK-1	Spare Parts Kit	3,100	....
RR-1	Rack	500	....
PBS-1	Computer Stand	250	....
PBD-1	Desk	500	....
	Six Additional Signal Input Lines (max. three sets)	300	10
FX-1R	Flexowriter (with Shelf and Slides for Rack Mounting)	4,900	150
FX-1T	Flexowriter (for Table Mounting)	4,500	140
PS-8	Battery Power Supply when included instead of a-c supply	1,500	45
HSB-1	Buffer Register	4,750	....

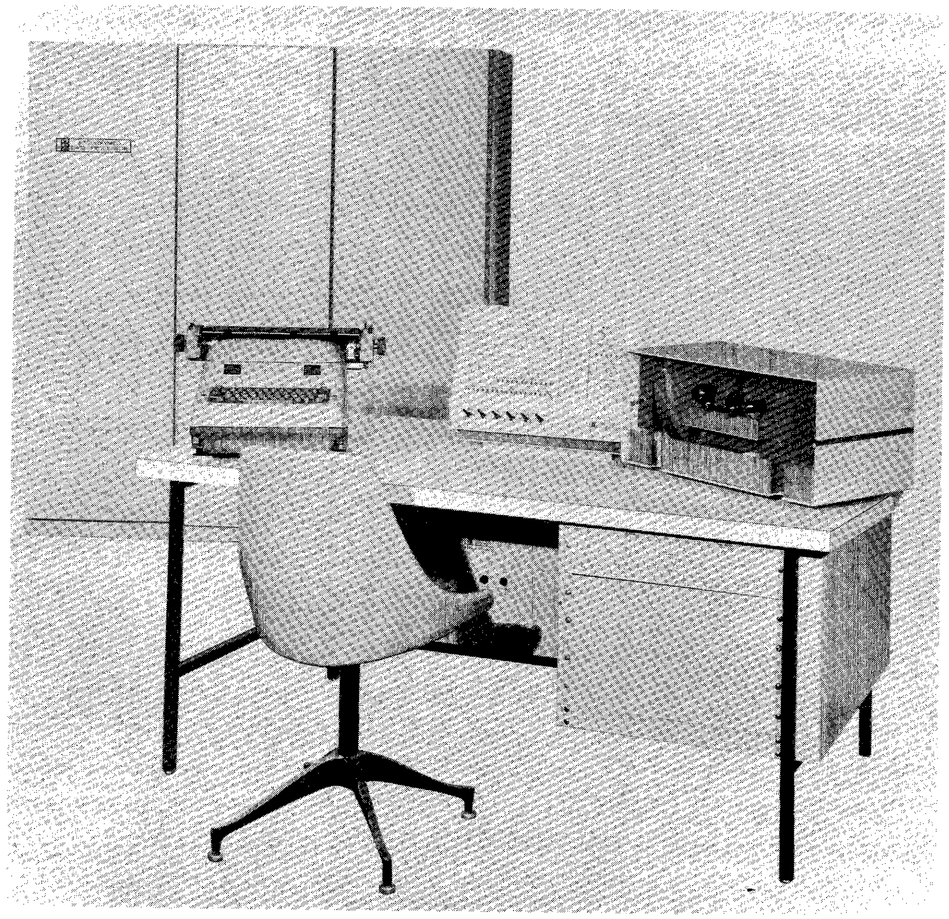
Power, space, weight, and site preparation

Power, computer: 0.1 Kw.
Volume, computer: 7 cu. ft.
Area, computer: 2.8 sq. ft.
Weight, computer: 110 lbs.



BLOCK DIAGRAM OF PACKARD BELL 250

PDP 1 & PDP 3 DIGITAL EQUIPMENT CORPORATION



THE PDP-1 AND PDP-3 are stored program, general purpose digital computers. They are single address, single instruction machines operating in parallel on 36-bit numbers. The PDP-3 features multiple step indirect addressing and has a main memory which makes 511 registers available as index registers. The main storage is magnetic core modules of 4096 words each.

SYSTEM COMPONENTS

Central processor

Operating times of PDP-3 instructions are normally multiples of the memory cycle of five microseconds. Two cycle instructions refer twice to memory and thus require 10 microseconds for completion. Examples of this are add, subtract, deposit, load, etc. One cycle instructions do not refer to memory and require five microseconds. Examples of the latter are the jump instructions, the skip instructions, and the operate group. The operating times of variable cycle instructions depend upon the instruction. For example, the operating time for a shift or rotate instruction is 5 + 0.2N microseconds, where N is the number of shifts performed. The operating times for multiply and divide are functions of the number of ones in the multiplier and in the quotient, respectively. Maximum time for multiply is 25 microseconds. This includes the time necessary to get the multiply instruction from memory. Divide takes 90 microseconds maximum.

In-Out Transfer instructions that do not include the optional wait function require five microseconds. If the in-out device requires a wait time for completion, the operating time depends upon the device being used.

If an instruction includes reference to an index register, an additional five microseconds is required. Each step of indirect addressing also requires an additional five microseconds.

The Equipment Frame is approximately six feet high and two feet deep. The length is a function of the amount of optional features included. The Central Processor requires a length of five and one-half feet. The power cabinet is 22 inches long. A memory cabinet is 32 inches long and will hold three memory modules (12,288 words per cabinet). Memory cabinets may be added at any time.

Magnetic tape units require 22 inches per transport. A tape unit cabinet may be connected as an extension of the Equipment Frame or may be a free-standing frame.

The Central Processor and memory together require 30 amperes of 110 volts single phase 60 cycle ac. Each inactive tape transport requires two amperes and the one active transport requires 10 amperes.

Computation speed:

	(microseconds)
Addition:	10
Multiplication:	25 (Max.)
Division:	90 (Max.)
Transfer time:	5

Registers

There are four registers of 36-bit length.

Memory Buffer: The Memory Buffer is the central switching register. The word coming from or going to memory is retained in this register. In arithmetic operations it holds the addend, subtrahend, multiplicand, or divisor. The left six bits of this register communicate with the Instruction Register. The address portion of the Memory Buffer Register communicates with the Index Adder, the Memory Address Register, and the Program Counter. In certain instructions, the address portion of the control word does not refer to memory but specifies variations of an instruction, thus, the address portion of the Memory Buffer is connected to the Control Element.

Accumulator: The Accumulator is the main register of the Arithmetic Element. Sums and differences are formed in the Accumulator. At the completion of multiplication it holds the high order digits of the product. In division it initially contains the high order digits of the dividend and is left with the remainder.

The logical functions AND, inclusive OR, and exclusive OR, are formed in the Accumulator.

Carry Storage Register: The Carry Storage Register facilitates high-speed multiply and is properly part of the Accumulator.

In-Out Register: The In-Out Register is the main path of communication with external equipment. It is also part of the Arithmetic Element. In multiplication it ends with the low order digits of the product. In division it starts with the low order parts of the dividend and ends with the quotient.

The In-Out Register has a full set of shifting properties (arithmetic and logical).

There are three registers of 15-bit length which deal exclusively with addresses. The design allows for expansion to 18 bits. These registers are:

Memory

Memory Addressing: The Memory Address Register holds the number of the memory location that is currently being interrogated. It receives this number from the Program Counter, the Index Adder or the Memory Buffer.

Program Counter: The Program Counter holds the memory location of the next instruction to be executed.

Index Adder: The Index Adder is a 15-bit ring accumulator. The sum of an instruction base address, Y, and the contents of an index register, C(x), are formed in this register. This register holds the previous content of the Program Counter in the "jump and save Program Counter,' jps, instruction. The Index Adder also serves as the step counter in shift, multiply, and divide.

The Control Element contains two six-bit registers and several miscellaneous flip-flops. The latter deal with indexing, indirect addressing, memory control, etc. The six-bit registers are:

Instruction Register: The Instruction Register receives the first six bits of the Memory Buffer Register during the cycle which obtains the instruction from memory (cycle zero). This information is the primary input to the Control Element.

Program Flags: The six Program Flags act as convenient program switches. They are used to indicate separate states of a program. The program can set, clear, or sense the individual flip-flops. The program can also sense or make the state "All Flags ZERO." They can also be used to synchronize various input devices which occur at random times.

Three toggle switch registers are connected to the Central Processor.

Test Address: The 15 Test Address Switches are used to indicate start points and to select memory registers for manual examination or change.

Test Word: The 36 Test Word Switches indicate a new number for manual deposit into memory. They may also be used for insertion of constants while a program is operating by means of the operate instruction.

Sense Switches: The six Sense Switches allow the operator to manually select program options or cause a jump to another program in memory. The program can sense individual switches or the state "All Switches ZERO."

Console

The photograph is of a PDP-1 which is an 18-bit version of the PDP-3.

The console is a desk approximately seven feet long. It contains the controls and indicators necessary for operation and maintenance of the machine. A cable connects the Console to the Equipment Frame.

INPUT-OUTPUT MEDIA

Paper tape reader

The Paper Tape Reader of the PDP-3 is a photoelectric device capable of reading 300 lines per second. Six lines form the standard 36-bit word when reading binary punched eight-hole tape. Five-, six- and seven-hole tape may also be read.

Paper tape punch

The standard PDP-3 Paper Tape Punch has a nominal speed of 20 lines per second. It can operate in either the alphanumeric mode or the binary mode.

Typewriter

The Typewriter will operate in the input mode or the output mode.

OPTIONAL INPUT-OUTPUT MEDIA

The PDP-3 is designed to accommodate a variety of input-output equipment. Of particular interest is the ease with which new, and perhaps unusual, external equipment can be added to the machine. Optional inout devices include Cathode Ray Tube Display, Magnetic Tape, Real Time Clock, Line Printer and Analog to Digital Converters. The method of operation of PDP-3 with these optional devices is similar to the standard input-output equipment.

Magnetic tape

The system consists of tape units connected to the PDP-3 through a tape control (TC). This tape is read or written in IBM 7291 format. Two hundred characters, each having six bits plus a parity bit, are written on each inch of tape and the tape moves at 75 inches per second. The tape control has the job of connecting a specific unit to the PDP-3 and is a switch. It also has the function of controlling the format of information that is read or written on tape.

Cathode ray tube display

The PDP-3 Cathode Ray Tube Display is useful for presentation of graphical or tabular information to the operator. It uses a 16-inch round tube with magnetic deflection.

An additional display option is a Light Pen. By use of this device the computer is signaled that the operator is interested in the last point displayed. Thus the program can take appropriate action such as changing the display or shifting operation to another program.

Real time clock

A special input register may be connected to operate as a Real Time Clock. This is a counting register operated by a crystal controlled oscillator. The clock can be reset to zero by manual operation. A toggle switch interlock prevents an accidental reset. The state of this counter may be read at any time by the appropriate In-Out Transfer instruction.

Line printer

A 72-column Anelex printer and control are available as an option for PDP-3. The control contains a one-line buffer.

PROGRAMMING

General: An assembly program, FRAP-3, and a compiler program, DECAL, are available with several utility programs.

Instruction word format

Op. Code		Index Address		Operand Address
0 - 5	6 - 8	9 — 17	18 - 20	21 — 35

Magnetic tape storage

Up to five magnetic tape units with control unit. Multiple lengths of 600 feet with maximum 3,000 feet per reel. Full reel takes 175,000 to 270,000 39-binary-digit words, or 2,000,000 alphanumeric characters. Search time is 24 16-word or 19 32-word sections per second. Read-write time is 41 to 53 milliseconds. Buffer has 32 39-binary-digit words. Tape buffer transfer speed is 41-53 milliseconds.

INPUT MEDIA

Punched card readers

65-column card — 200 per minute.
80-column card — 120 per minute.

Punched paper tape reader

300 characters per second.

OUTPUT MEDIA

Card punches

65-column card — 100 per minute.
80-column card — 100/120 per minute.

Paper tape punch

60 or 300 characters per second.

Line printer

150 lines per minute (102 characters).
100 lines per minute (100 characters).
Card units and line printer output may be on-line or off-line from magnetic tape converter.

Teleprinter

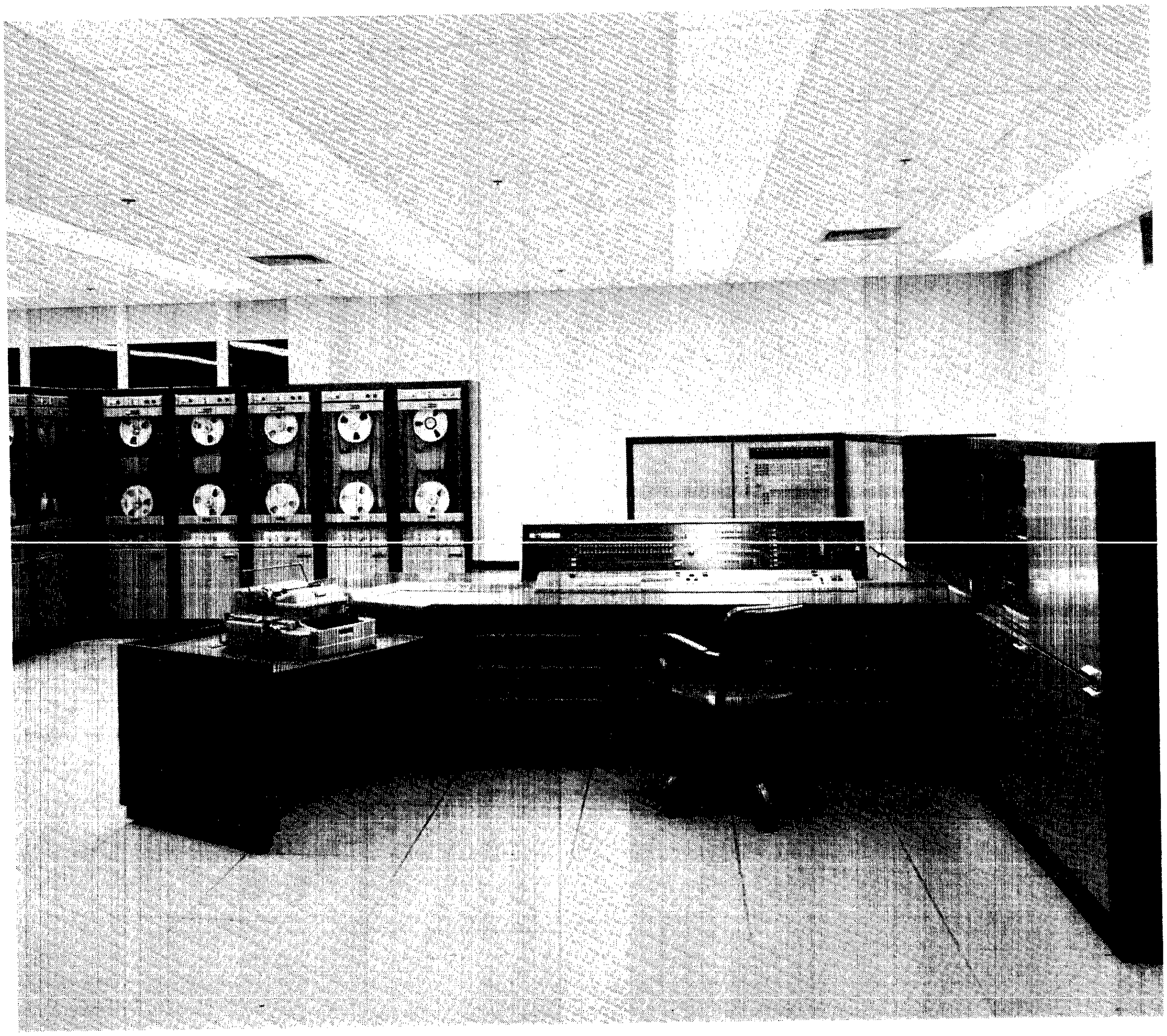
10 characters per second.

AUXILIARY COMPONENTS

Maximum number of input-output devices:
Paper tape system: 2 tape readers, 6 punches.
Card system: 2 readers, 2 punches and 2 printers.

Average purchase price: $278,000.

PHILCO 2000 PHILCO CORPORATION



THE BASIC PHILCO 2000 SYSTEM consists of the central processor, a control console, a Flexowriter, an input-output processor with up to 16 magnetic tape units, a universal buffer-controller, a punched card system, a punched paper tape system, and a high speed printing system. The basic system may be expanded by the addition of up to a maximum of 256 magnetic tape units and over 400 other input-output devices. Up to eight magnetic drum control units with up to four magnetic drum storage units per control unit may also be connected to the system. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 48 bits.
Numeric Characters Per Word: 15.
Alphabetic Characters Per Word: 8.

Character Code: Numerics, pure binary; alphabetics, 6-bit binary coded decimal.
Timing: Asynchronous.

Central processor (210)

Operation: Parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.0150
Multiply: 555555 by 5555	0.0503
Divide: 3086108025 by 5555	0.0530

Access time: 0.010 milliseconds.

Checking features: Command fault, arithmetic overflow.

Registers

Program registers: Four.
PR register: Retains the selected pair of instructions.
PA register: Contains the address of the next sequential pair of instructions.
MA register: Contains the address of the memory location accessed.
JA register: Contains the address of the instruction following the last jump instruction.

Arithmetic registers: Three.
A register: Accumulator, 48 bit.
D register: D Data, 48 bit.
Q register: Multiplier—Quotient, 48 bit.
Index registers: Eight to thirty-two, optional, in groups of eight.

Memory

The basic magnetic memory unit has a capacity of 4,096 words. This capacity may be expanded to a total of 32,768 words.

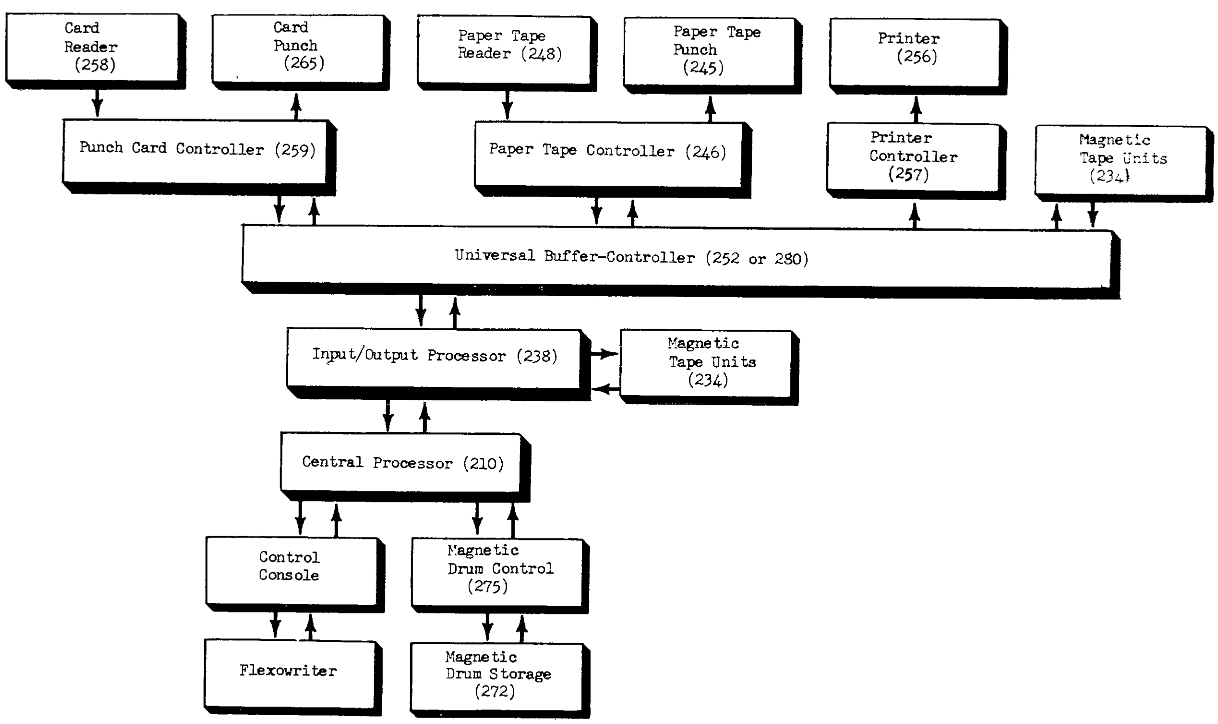
Control panel

This unit contains switches and indicators for control of the system.

INPUT MEDIA

Input-output processor (238)

This unit is under control of the central processor and contains circuitry for the control of up to 16 magnetic tape units and up to 4 universal-buffer-controllers (which control all input-output systems except magnetic tape). This unit permits simultaneous transmission between four magnetic tape units and the central computer, concurrent with processing, while four printer, punched card, and paper tape operations take



BLOCK DIAGRAM OF PHILCO 2000

place.

Magnetic tape unit (234)

Maximum number per system: 16 per I-O processor (256 using 16 I-O processors).
Packing density: 375 characters per inch (recorded in pairs for a total of 750 characters per inch).
Number of channels: 16 (two tracks of 8 channels each).
Record length: Fixed, 1,024 characters.
Record gap: 0.9 inch.
Tape speed: 120 inches per second/90,000 characters per second.
Rewind time: 3.2 minutes.
Start-stop time: 5 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
- Composition: Mylar base.
- Length: 3,600 feet.
- Width: 1 inch.

Error detection:
- Recording is immediately read and checked.
- Parity bit for each character.
- Horizontal and vertical parity characters for each block.
- Sprocket bit check.
- Block marks on flawless areas of tape.

Universal buffer—Controller (252 and 280)

This unit is an on-line or off-line buffer storage and control unit for punched card, printer, and paper tape systems. It also controls two magnetic tape units, off-line, for conversion operations. The universal buffer-controller (252) contains pushbuttons which switch the controller or an associated magnetic tape unit from on-line to off-line or vice versa. The universal buffer-controller (280) performs this switching automatically under program control. Up to seven input-output systems, including the two magnetic tape units, may be connected to each buffer-controller. Four buffer-controllers may be connected to each input-output processor.

Card control unit (259)

This unit is under control of the universal buffer-controller and contains circuitry for control of the card read and punch units. Format and editing control is determined by the card control unit which includes read and punch plugboards, and editing symbols in the data.

Card reader (258)

This unit reads 51- or 80-column punched cards at a rate of 2,000 cards per minute.

Paper tape control unit (244)

This unit is under control of the central processor and contains circuitry for control of the paper tape reader and the paper tape punch.

Paper tape reader (245)

This unit reads 5- or 7-channel punched paper tape at a rate of 1,000 characters per second. Reading is accomplished photoelectrically and tape speed is 100 inches per second.

Flexowriter

This unit operates in conjunction with the control console. It is similar to an electric typewriter with paper tape reader and punch attachments. It is used to insert data into the central processor or print out data from the central processor. The printing, paper tape reading, and paper tape punching is accomplished at a rate of 10 characters per second.

Magnetic drum control unit (275)

This unit is under control of the central processor and contains circuitry for control of up to four magnetic drum storage units. Up to eight drum controllers may be incorporated in a system.

Magnetic drum storage unit (272)

This unit has a capacity of 32,768 words, in eight bands of 4,096 words each. The average access time to any word on the drum is 17 milliseconds and the time required to transfer one word to core memory is 0.016 milliseconds.

OUTPUT MEDIA

Magnetic tape, magnetic drum, flexowriter, and universal buffer-controller

As previously described.

Card punch unit (265)

This unit punches 80-column cards at a rate of 100 cards per minute.

Paper tape punch (248)

This unit punches 5- or 7-channel paper tape at a rate of 60 characters per second.

High speed printing system (250)

This system prepares printed copy at the rate of 900 lines per minute, 120 characters per line. Vertical format is controlled by editing symbols and a perforated paper tape loop. Horizontal format is controlled by editing symbols and a plugboard.

PROGRAMMING

General: The Philco 2000 system uses a single address type of instruction.

Instructions:

Number of instructions per word: 2.

Number of digits per instruction: 24 bits.

Total number of operation codes: 225 (including 59 floating point codes).

Instruction word format

1	3-5	10-12	1	7	bits
S	N	V	F	C	
Address			Command		

a. 7 bit C field defines command.

b. F, or function bit, modifies command (e.g. specifies fixed or floating point mode for arithmetic).

c. V, or variable field, may be an address, a number, or an index register modifier.

d. N specifies index register number.

e. S bit specifies index register use.

f. The size of N and V are determined by the number of index registers in a system. The V field is 15 bits if there are no index registers. The N field is not required in such a case.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase [1]	Maintenance [2]	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
210 Central Processor, including	$12,500					3.447	11,720
a. Arithmetic and Control Section				109x34x44	2,100		
b. Control Console and Typewriter Section				36x34x36	300		
c. Power Supply and Distribution Section				32x19x58	1,000		
1000 Floating Point Control	700			(3)	(3)	(3)	(3)
1011 Index Registers (Block of 8) (Additional Block of 8 Registers)	600			(3)	(3)	(3)	(3)
2204 Core Storage Unit (4,096 words)	4,200			90x19x58	1,900	1.164	3,958
2208 Core Storage Unit (8,192 words)	8,100			159x19x58	2,300	1.739	5,913
2216 Core Storage Unit (16,384 words)	15,900			159x19x58	3,750	2.978	10,252
2232 Core Storage Unit (32,768 words)	28,000			281x19x58	6,650	4.217	14,337
234 Magnetic Tape Unit	650			23x24x66	500	1.024	3,482
235 Input-Output Processor	1,900			61x19x58	1,150	0.678	2,297
236 Input-Output Processor (2 simultaneous)	4,100			61x19x58	1,150	0.919	3,125
237 Input-Output Processor (3 simultaneous)	5,350			119x19x58	2,250	1.160	3,944
238 Input-Output Processor (4 simultaneous)	6,600			119x19x58	2,250	1.160	3,944
272 Magnetic Drum Unit	1,600			45x39x58	1,800	0.725	2,465
275 Magnetic Drum Control Unit	2,900			33x19x58	700	1.345	4,573
240 Paper Tape System, including	2,200			61x19x58	800		
244 Paper Tape Control				(4)	(4)	0.276	938
245 Paper Tape Reader				(4)	(4)	0.900	3,128
248 Paper Tape Punch				(4)	(4)	0.250	850
260 Punched Card System, including	2,400						
259 Card Control				61x19x58	1,000	1.500	5,100
258 Card Reader				68x19x49	650	1.050	3,600
265 Card Punch				40x26x51	747	0.900	3,100
250 Printer System, including	2,700						
257 Printer Control				90x19x58	1,600	2.300	7,820
256 Printer				49x42x58	2,000	4.600	15,640
252 Universal Buffer Controller	1,350			61x19x58	1,000	0.700	2,400
280 Universal Buffer Controller Unit	1,850			61x19x58	1,000	0.700	2,400

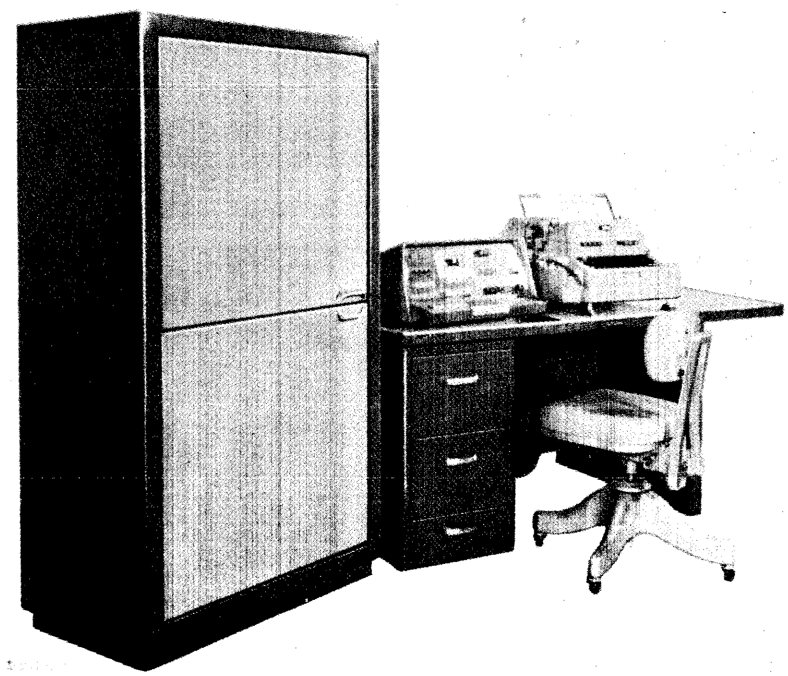
[1] Purchase price will be furnished by the manufacturer upon request.

[2] Maintenance included in rental price. Separate maintenance contract available for punchased equipment.

[3] Included in 210.

[4] Included in 240.

PHILCO 3000 PHILCO CORPORATION



THE PHILCO 3000 is a solid-state general purpose digital computer for programmed control and computation applications. A single cabinet houses computer, memory, console and power supply. The computer will accept and transmit control impulses from and to external devices. Elements which might effect a potentially explosive atmosphere are hermetically sealed. The computer may be controlled from the console, a remote console, or a Flexowriter input-output unit.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	924	132
Multiply:	4,224	2,772
Divide:	4,224	2,772

Construction: (Arithmetic unit only).

Transistors: 1,300.

Condenser-diodes: 4,000.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation: Sequential.

Checking features: Parity check is made on all word transfers to and from the drum. An optional safety device is a control switch which removes write capability for ½ drum capacity to protect program storage.

STORAGE

Magnetic drum

Number of words: 8,064-16,256.
Number of binary digits: 177,408 to 357,632.
Access: 8,448 microseconds.

Magnetic drum

Number of words: 4.
Number of binary digits: 88.
Access: 264 microseconds.

The drum has 64 tracks for recording information — 63 tracks for general storage; one rapid-access revolver loop. The general storage tracks contain 128 words of data, the revolver loop four words.

INPUT MEDIA

Punched paper tape (Flexowriter)

10 characters per second.

Console keyboard

External shift register

162 kilocycles/second.

Available with serial input to the accumulator at the basic clock frequency using control signals from external input source.

OUTPUT MEDIA

Paper tape and page (Flexowriter)

10 characters per second.

Cathode ray tube

Two register display.

External shift register

162 kilocycles/second.

Provides serial output of the accumulator at the basic clock frequency with control signals to external device.

PROGRAMMING

Internal number system: Binary.
Binary digits per word: 20 + sign + parity.
Binary digits per instruction: 20.
Instructions per word: 1.
Instructions decoded: 16 basic, expandable to over 60.
Arithmetic system: Fixed point.
Instruction type: One-address or 1 + 1 at option.

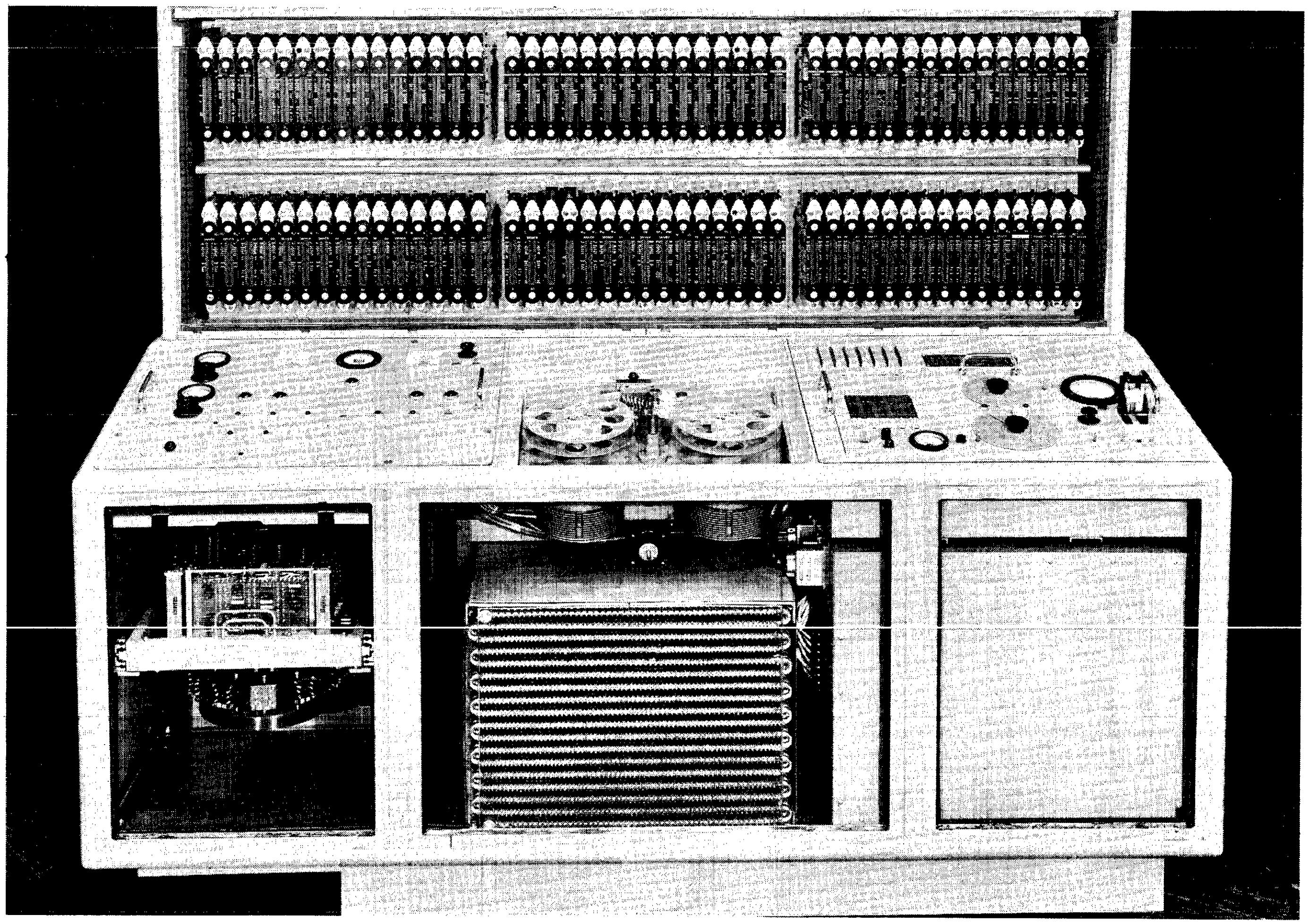
Instruction word format

21 — 15	14 — 8	7 — 1	0
Track	Sector	Command	Sign

When bit number 1 is set equal to 0, a single address instruction is interpreted. When bit 1 is set equal to 1, a 1 + 1 address instruction is interpreted.

Automatic built-in subroutines include a square root command.

QUAC NORTHROP CORPORATION



SPECIAL PURPOSE, medium-speed magnetic drum digital computer, which computes information to be recorded on magnetic tape for the XSM-62 Guidance System.

Console size: 39 in. x 79 in. x 69 in.
Console weight: 2,700 lbs.
Power consumption: 6,000 watts.
Includes: Cooling equipment,
Integral test equipment.

Memory

Disc type drum coated with magnetic dispersion.
Speed: 3,600 rpm.
Three delay lines of 864 pulses each.
One marks channel containing 64 equally spaced pulses.
One clock channel containing 1,152 pulses.

OPERATING CHARACTERISTICS

Clock rate 67.120 kc.
Operates at eight times real time.
80 memory iterations per second.
Solves Newton's forward interpolation equation to approximate third degree curves.
48 words of 18 pulses each.

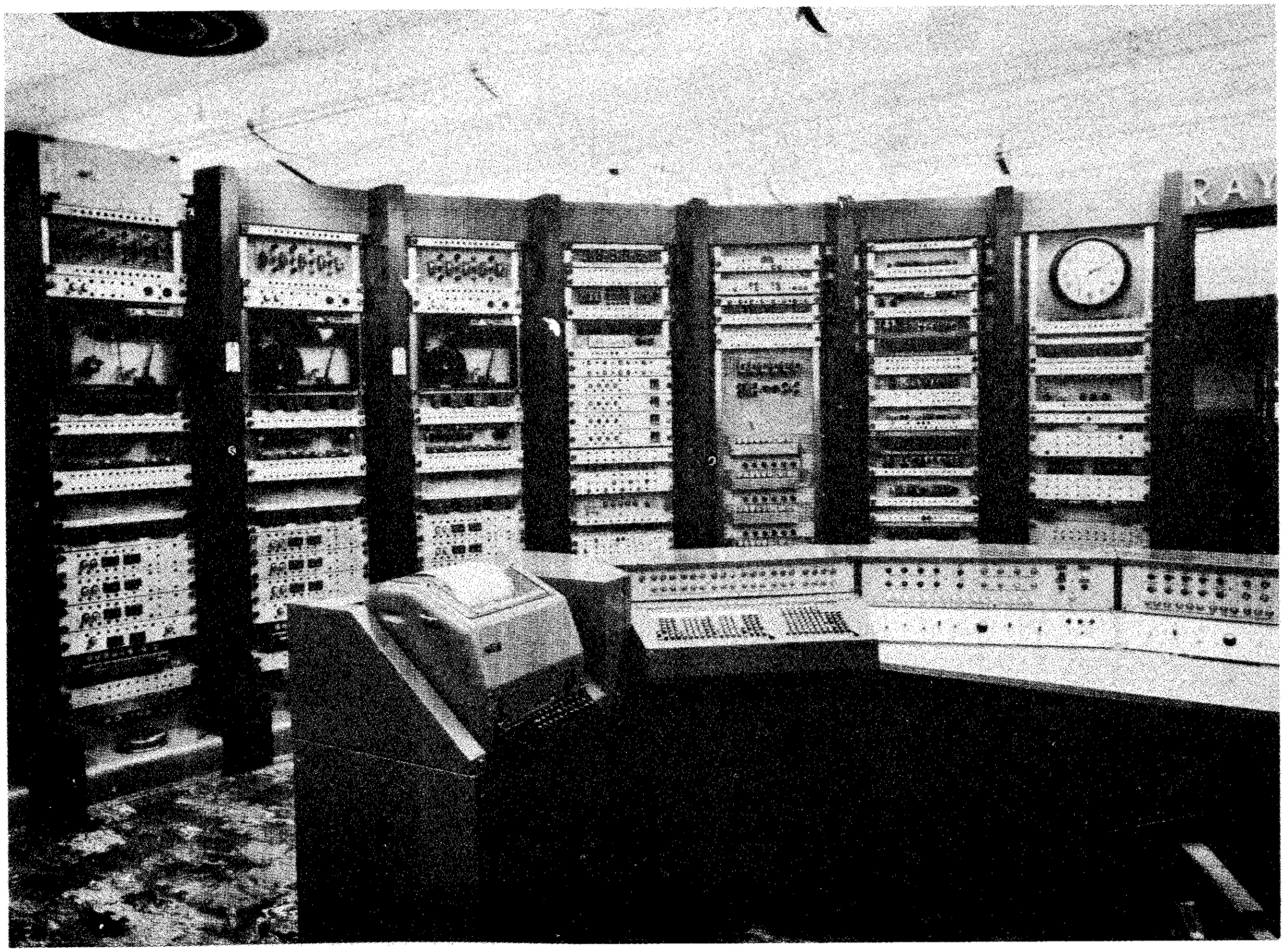
INPUT MEDIA

Brush read paper tape.

OUTPUT MEDIA

27 output channels whose pulse lengths are phantastron controlled.

RAYDAC RAYTHEON COMPANY



GENERAL PURPOSE scientific computations and data reduction.

ARITHMETIC UNIT

	Including Storage access (microseconds)	Excluding Storage access (microseconds)
Add:	134-1,280	48
Multiply:	296-1,440	210
Divide:	470-1,620	380

Construction: Vacuum tubes.

Rapid access word registers: 12.

Basic pulse repetition rate: 3.77 Mc/second.

Arithmetic mode: Parallel.

Timing: Synchronous.

Operation: Sequential.

The cycle time is dependent upon storage access and operation times. Bistable devices used in RAYDAC are not balanced circuits, such as bistable multivibrators, but are regenerative pulse stretching circuits which are not dependent on balance, nor sensitive to component value or supply voltage.

Checking features: Fixed. Fully automatic built-in self-checking on arithmetic operations, transfer, selection and control. Each word carries a four-bit check number calculated from the word, which is recalculated and checked after transfers. For arithmetic check, a five-bit check number is calculated for each operand and result and appropriate checks are calculated using the five-bit check numbers.

STORAGE

Acoustical delay line

Words: 2,176.
Digits: 78,336.
Access: 19-305 microseconds.

Magnetic tape

Words: 400,000.
Digits: 14,400,000.
Access: 19-4 minutes.

Acoustic medium is Mercury. Thirty-two words are stored in each of 64 305-microsecond delay paths.

Information is stored on tape in blocks of 32 words. Blocks are addressable at random through the use of optical address markings on the tape.

INPUT MEDIA

Keyboard

14 words per minute.

Magnetic tape

400 words per second.

High-speed input equipment under development will permit direct entry from paper tape at 200 frames per second, IBM cards at 240 cards per minute and from magnetic tapes prepared in the field.

OUTPUT MEDIA

Typewriter

Five digits per second.

Magnetic tape

400 words per second.

Output equipment under development will permit printing at 150 lines per minute, punching 100 IBM cards per minute, and plotting 20 points per second.

NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 30 plus one sign bit plus four-bit check tag plus one blank.
Binary digits per instruction: 54 plus two sign bits plus two four-bit check tags plus eight blanks.
Instructions per word: One-half.
Arithmetic system: Fixed and floating point mode.
Instruction type: Four-address.
Number range: -1 to $+1$.

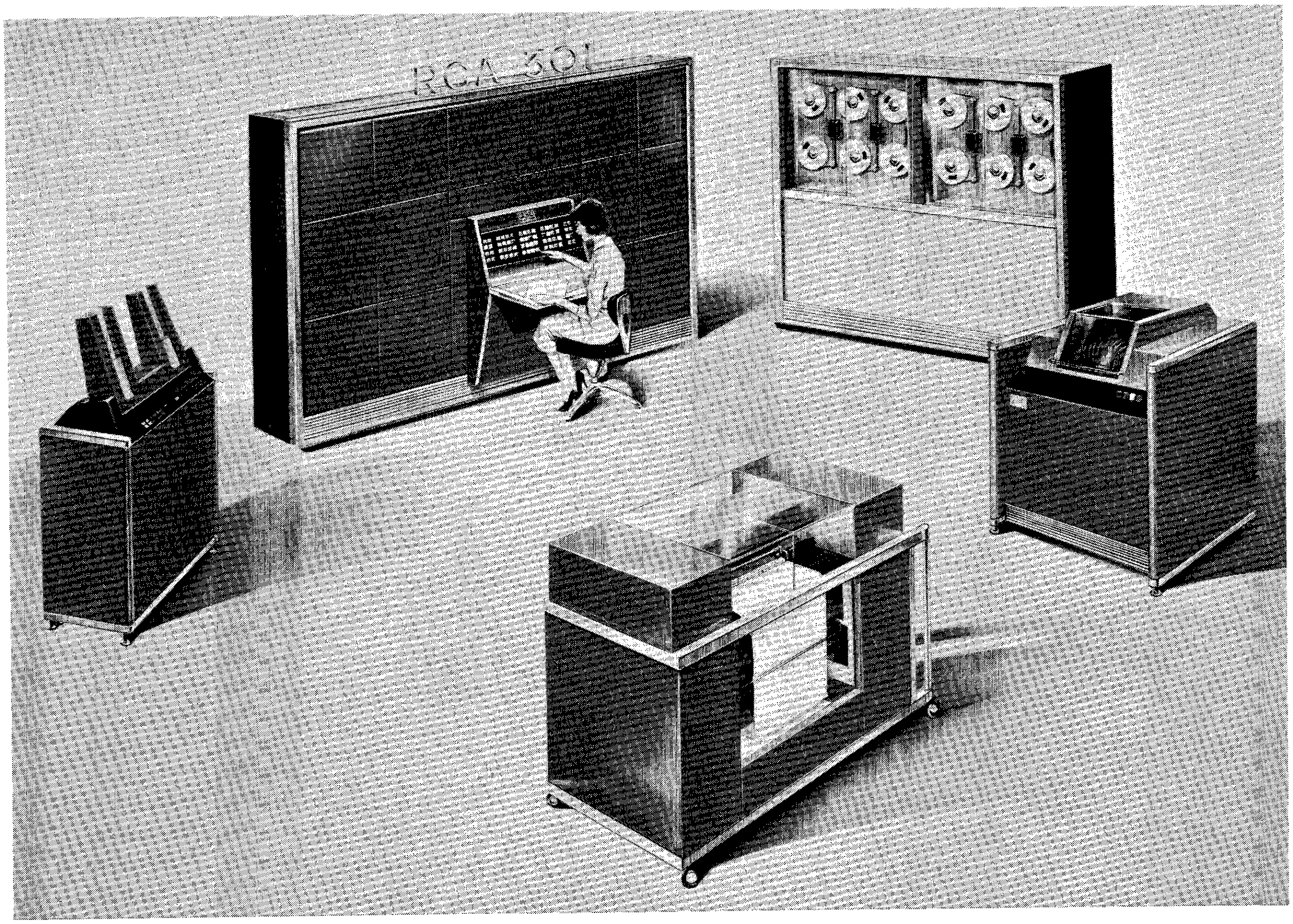
The arithmetic unit has built-in floating point operations. The standard mode of operation is fixed point. The arithmetic unit also has built-in double precision addition and subtraction.

Cost, price and rental rates

Approximate cost of basic system: $3,000,000.
Approximate cost of additional equipment:
Input-output equipment is under development: $300,000.
Main storage No. 2 (1,024 words): $25,000.

Power, space and weight

Power, computer: 30 kw.
Space, computer, 17,600 cu. ft., 1,760 sq. ft.
Area, computer: 44 ft. by 40 ft.



THE COMPUTER is a general purpose, digital, stored program, transistorized machine consisting of high speed storage, program control, a control panel, and a power supply.

The program control unit contains circuitry for the interpretation and execution of the instructions. The high-speed storage unit is a magnetic core, decimally addressed, random-access device which provides the storage for data and programs. Memory cycle time is seven microseconds. The basic unit contains 10,000 or 20,000 alphanumeric characters. The control panel contains the controls and indicators necessary for the operation and maintenance of the computer.

The power supply unit supplies power for operation of the control panel, the high-speed storage, and the program control, and standard voltages for the control of the input-output equipment. Transistor and diode logic techniques are employed throughout the system.

ARITHMETIC UNIT

Add time (decimal), including instruction acquisition: 210 microseconds.

Programmed multiply time, average: 7,800 microseconds.

Transfer instruction: 126 microseconds.

Compare: 56 to 161 microseconds.

Basic cycle time: 7 microseconds.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation: Concurrent.

Above times assumes six-character fields.

Multiply time assumes average multiplier digit is five.

STORAGE

Magnetic core

Number of characters: 20,000.

Access: 7 microseconds.

Record file

Number of characters: 4,608,000 per file.

Access: 4.25 microseconds.

The number of words of storage is variable due to variable word length. The Record File is random access. Up to five files may be used. Access to files is simultaneous.

Magnetic tape

Access: 381 microseconds (Hi Data tape).
Number of units that can be connected: 12.
Number of characters per linear inch of tape: 250.
Channels or tracks on the tape: 1.
Blank tape separating each record: Inter-block gaps equal approximately one inch.
Tape speed: 30 inches per second.
Transfer rate: 7,500 characters per second.
Start time: Up to 20 milliseconds.
Stop time: Not exactly established (overlaps computation).
Average time for experienced operator to change reel: 45 seconds.
Physical properties of tape:
Width: ½ inch.
Length of reel: 1,200 feet.
Composition: Mylar.

The 580 tape station, with tape adaptor, records 222 characters per inch at 100 inches per second. The 581 tape station, with tape adaptor, records at 333 characters per inch at 100 inches per second.

INPUT MEDIA

Punched paper tape

100 or 1,000 characters per second.

Punched cards

600 cards per minute.

Magnetic tape

See magnetic tape.

Record file

2,500 characters per second (transfer rate).

OUTPUT MEDIA

Punched paper tape

100 or 300 characters per second.

Punched cards

100 or 200 cards per minute.

Magnetic tape

See magnetic tape.

Record file

2,500 characters per second (transfer rate).

Hi-speed printer

1,000 lines per minute (120 characters per line).

CHECKING FEATURES

Accuracy control is accomplished on the RCA 301 by the following methods:

Punch card control – model 315

The cards are automatically read after punching.

On-line printer control – model 316

Signals are returned to the printer control module from the On-Line Printer, so that corrective measures can be taken whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motors off
Power supply off

Record file control – model 317

Any of the following conditions will cause the computer to stop:

Incorrect parity of address sent to Record File
Non-verified write information
Record file not following command
Incorrect parity of information being read

Hi-data tape group control – models 318 and 319

Monitors the write-verify check, the address-verify parity check, the operability, and the response to commands of the Hi-Data Tape Group.

Processor – models 303 and 304

Program Control: The following conditions will stop computer operations:

Incorrect parity in memory address register
Incorrect parity in memory register
Incorrect parity in operation register
Incorrect parity in N register
Incorrect parity in N R (repeat) register

Input-Output: Any of the following conditions will stop computer operation:

Device not operable or not responding to applicable computer command
Parity error in data received from input device
Non-verification of data sent to an output device

Paper tape reader – punch control – model 311

The computer is caused to stop whenever any of the following conditions occur:

Failure to receive a write-verify pulse
Incorrect parity of information being read
Characters in a gap space
Reader not following command
Punch not following command

Card reader control – model 314

The card is read at two stations and a hole count check is made. An error will stop the computer, and the Card Reader.

Paper tape reader-punch – model 321

The information received at the punch is checked;

and when parity is correct, a write verify pulse is returned to the Paper Tape Reader-Punch Control.

Card reader — model 323

Each card is read twice to permit an accuracy check.

On-line printer — model 333

Signals are sent to the Computer so that corrective measures may be taken which cause the Printer operation to stop whenever any of the following conditions occur:

Low paper supply
Ribbon failure
Printer motor off
Printer in non-operable condition

Card punch — model 334

The cards are read after punching to permit an accuracy check of the punched data.

Record file — model 361

Parity check is performed on the information to be written and on the address received from the Record File Control for the selection of records.

Hi-data tape group — model 381

Automatic stop of tape at end of reel
Write lockout
Write verify
Address verify
Operable indication

Record file mode control — model 391

Parity checks of data and address are performed.

Simultaneous mode control — model 392

Parity checks are performed on SOR and M registers. An error will stop the computer. However, the other modes will complete their operation before they stop.

580/581 adaptor — model 393

The write-verify pulse is received when the write head current is of correct parity. Operability and response to commands are also checked.

PROGRAMMING

General: Automatic coding aids are: RCA Narrator and COBOL. General purpose programs are: distribution sorting, trace, memory dump, I/O service routine, RCA 301 Intepreter.

Instructions:

Number of instructions per word: Variable.
Number of digits per instruction: 10 RCA 301 characters.
Total number of operation codes: 40.
Two-address instruction.

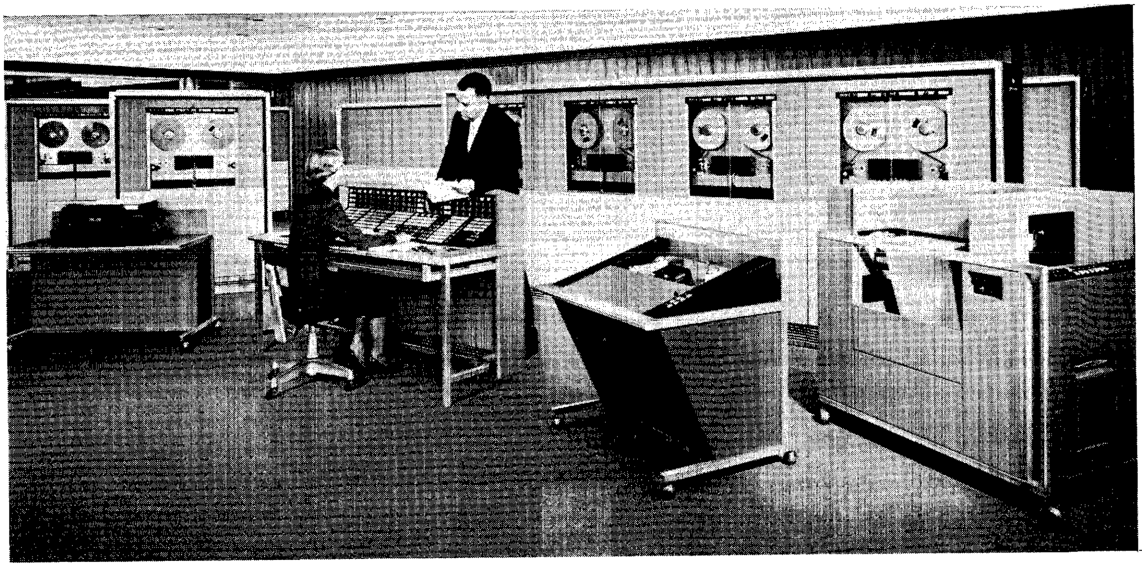
Instruction word format

1	1	4	4
Operation Code	N Character	A Address	B Address

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Card System:	$2,350	$196,000	(1)	825 sq. ft.		32.2	
623 Card Reader	350	15,850					
314 Card Reader Control	130	6,900					
634 Card Punch	200	8,900					
315 Card Punch Control	275	13,750					
361 Record File	300	14,900					
317 Record File Control	125	6,250					
632 Printer	700	32,200					
316 Printer Control	150	7,850					
303 Processor (10,000 ch.)	1,750	89,400					
301 System Components:							
301 Processor (20,000 ch.)	2,350	112,900					
321 Paper Tape Reader Punch	170	7,800					
311 Paper Tape Control	120	5,900					
381 Hi Data Tape - 6 Stations	1,520	74,900					
318 Hi Data Control	375	17,900					
391 Mode Control (RF)	690	32,800					
329 Simult. Mode Control	590	27,900					
393 Tape Station Adaptor	320	15,900					

[1] Service agreements available.



THE BASIC RCA 501 SYSTEM consists of the central processor (consisting of a program control unit and a tape selecting and buffer unit-A), a magnetic core storage system, a control console, a monitor printer, a photoelectric paper tape reader, and up to eight magnetic tape units. The basic system may be expanded by the use of additional magnetic tape units and controls, a magnetic drum storage system, an on-line printer, an on-line paper tape punch, an off-line punched card system and an off-line printing system. Transistors are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Variable.
Numeric Characters Per Word: Variable.
Alphabetic Characters Per Word: Variable.
Character Code: Binary coded decimal (6 bits plus sign).
Timing: Synchronous.
Pulse Repetition Rate: 400 kilocycles.

Central processor (503)

Operation: Parallel, fixed point:
Arithmetic: Serial by characters.
Transfers: Parallel by four character groups.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.420
Multiply: 555555 by 5555	6.435
Divide: 3086108025 by 5555	9.570

Access time: 0.015 milliseconds.

Checking features: Contains a complete system of wired-in checks, including the ability to perform all calculations in two different ways and check the results.

Registers

A register: Receives the A address of an instruction and, when necessary, maintains a record of the memory locations of characters being processed in the normal mode.

B register: Receives the B address of an instruction and, when necessary, maintains a record of the memory locations of the characters being processed in the normal mode.

P register: Contains the memory address of the next instruction to be executed in the normal mode.

S register: Assumes the function of the A register when an operation shifts into the simultaneous mode.

T register: Acts as a third register, when needed, in conjunction with the A and B registers, and on occasion, as an internal counter.

Accumulator: Used in all arithmetic operations.

Memory

The basic magnetic core memory unit contains 16,384 character locations. This capacity can be increased, in units of 16,384 to 262,144 character locations.

Control panel

This unit contains all operating controls and indicators for control of the system.

INPUT MEDIA

Tape selecting and buffer unit—A

This unit is a part of the central processor. It contains circuitry to switch, buffer, and control up to eight tape trunks. Each tape trunk may have connected to it a magnetic tape unit or a tape selecting and buffer unit

—B1 or B2.

Tape selecting and buffer unit—B1 (543)

This unit connects to a tape trunk of the tape selecting and buffer unit—A. It provides facilities for the connection of up to eight magnetic tape units where formerly only one could be connected.

Tape selecting and buffer unit—B2 (545)

This unit operates the same as B1 except that it requires two tape trunks of the tape selecting and buffer unit—A and provides facilities for the connection of up to 16 magnetic tape units.

Magnetic tape unit (581)

Maximum number per system, 8, expandable to 62 units by the use of tape selecting and buffer units—B1 or B2.
Packing density: 333 characters per inch (maximum).
Number of channels: 16 (dual recording of 8-channel data).
Record length: Variable.
Record gap: 0.4 inch.
Tape speed: 100 inches per second/33,333 characters per second.
Rewind time: 2.4 minutes.
Start-stop time: 3.575 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
Composition: Mylar base.
Length: 2,400 feet.
Width: ¾ inch.
Error detection: Parity check on each character; dual recording of each character.

Photoelectric paper tape reader (521)

This unit reads seven level punched paper tape at the rate of 1,000 characters per second. It is used to insert data directly into the central processor.

Card transcriber (527)

This unit is operated off-line and transcribes data from 80-column punched cards to a magnetic tape unit at the rate of 400 cards per minute. All card readings are performed twice and the results compared.

File control unit (568)

This unit is used in conjunction with the random access file (magnetic drum storage unit). Its basic function is to enable the central processor to control and to read and write information on a maximum of 12 magnetic drum storage units. The file control unit connects to the tape selecting and buffer units—A, B1, or B2 in the same manner as a magnetic tape unit.

Random access file (567)

This unit is a magnetic drum storage device which provides fast random access storage. It contains 300 tracks, each having a capacity of 5,000 alpha-numeric characters, for a total of 1.5 million characters per drum. The average random access time is 192 milliseconds.

OUTPUT MEDIA

Magnetic tape system

As previously described.

Monitor printer

This unit is similar to an electric typewriter with a paper tape punch attachment. It prints out, and/or punches seven level paper tape, from the central processor at a rate of ten characters per second.

Transcribing card punch (537)

This unit operates from an off-line magnetic tape unit. It punches 80-column cards at a rate of 100 cards per minute.

Random access file (567) and file control unit (568)

As previously described.

On-line printer (533)

This unit prints data directly from the central processor at a rate of 600 lines per minute, 120 characters per line. Format is controlled by the central processor or through a punched tape loop in the printer.

Off-line printer system

This system consists of an off-line printer (535) and a magnetic tape unit. The off-line printer operates at a rate of 600 lines per minute, 120 characters per line. Format is controlled by a plugboard and a punched tape loop.

Computer punch (512-5 and 512-7)

These units punch 5 (512-5) or (512-7) level paper tape directly from the central processor at a rate of 100 characters per second.

Computer punch (513-5 and 513-7)

These units punch 5 (513-5) or 7 (513-7) level paper tape directly from the central processor at a rate of 300 characters per second.

AUXILIARY COMPONENTS

Tapewriter (523)

This unit is a keyboard operated device for producing a punched paper tape and printing the same information on paper stock. It operates at a rate of 10 characters per second.

Tapewriter—Verifier (525)

This unit is a keyboard operated device for producing a punched paper tape and printing the same information on paper stock. It operates at a rate of 10 characters per second. This unit verifies the accuracy of the output information by comparison with a previously prepared punched paper tape.

PROGRAMMING

General: The RCA 501 uses a two-address type of instruction.

Instructions:

Number of instructions per word: Not applicable.

Number of digits per instruction: 8 RCA characters.

Total number of operation codes: 48.

Instruction word format

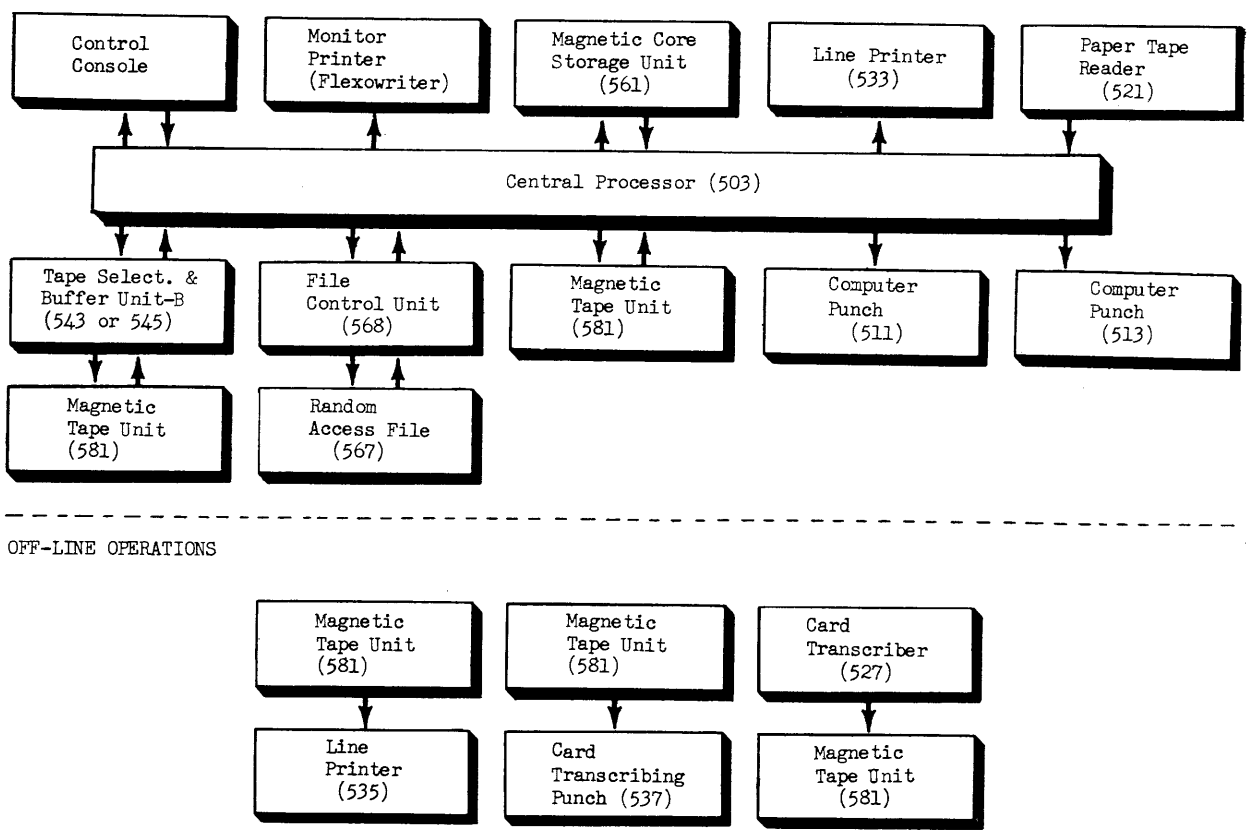
52	002572	01	017254
Operation code	A address	N-modifier	B address

This denotes 16 octal digits but actually represents 8 RCA 501 characters.

Cost, Power Requirements, and Physical Characteristics

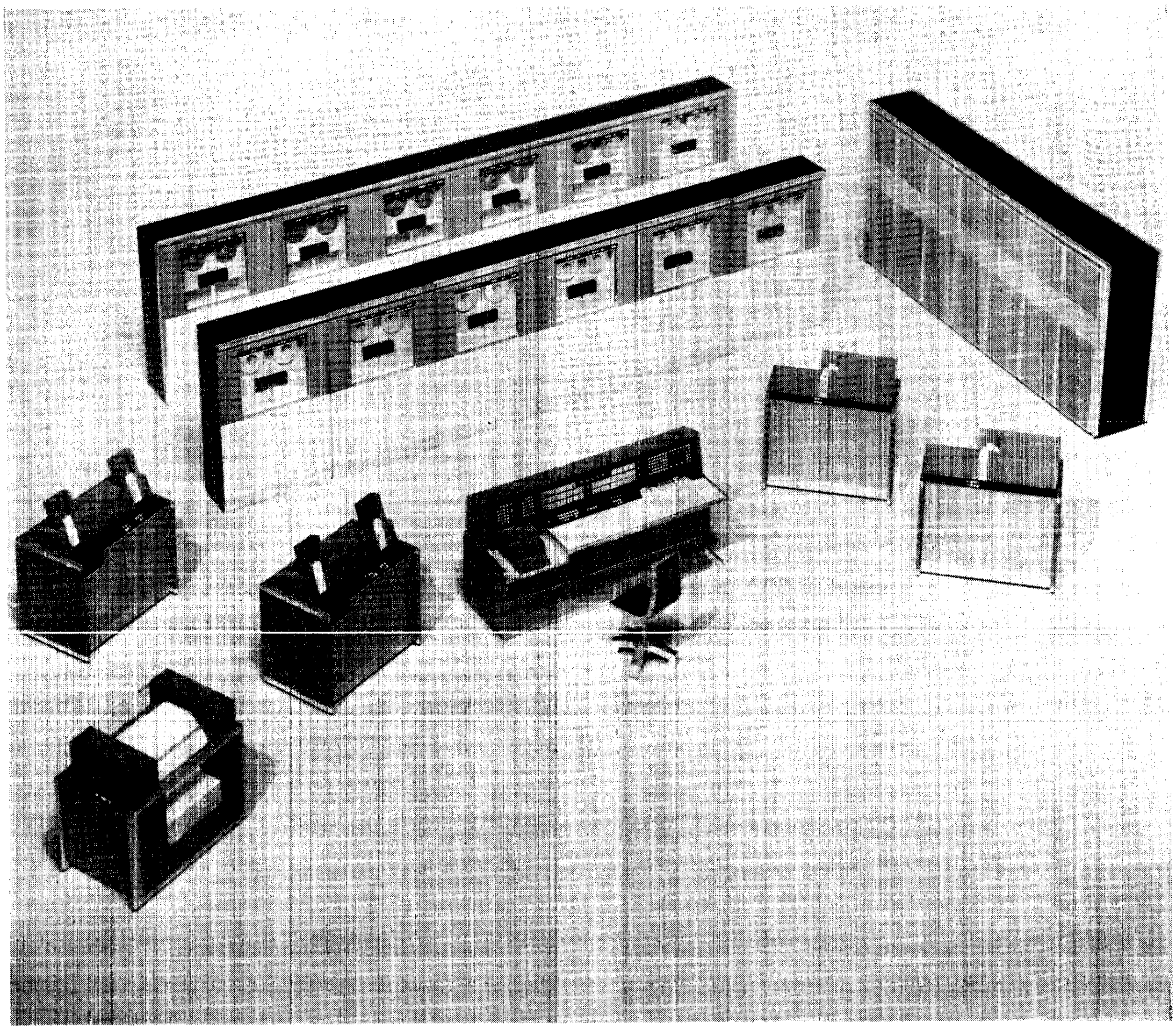
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
503 Central Processor, consisting of:	$5,400	$257,000				10.10	24,200
a. Program Control including Tape Selecting and Buffer Unit A				176x17x69	2,000		
b. Console				72x31x42	500		
c. Paper Tape Reader				40x20x46	250		
d. Monitor Printer (Flexowriter) and Table				43x29x37	250		
e. Power Supply				88x17x69	2,000		
561-1 High Speed Storage Unit (16,384 Characters)	2,400	120,000		176x17x69	1,000	4.30	10,240
561-2 High Speed Storage Unit (32,768 Characters)	3,400	177,000		176x17x69	1,000	4.30	10,240
561-3 High Speed Storage Unit (49,152 Characters)	4,400	234,000		176x17x69	1,000	4.30	10,240
561-4 High Speed Storage Unit (65,536 Characters)	5,400	291,000		176x17x69	1,000	4.30	10,240
543 Tape Selecting Unit B1	1,200	56,700		44x17x69	1,000	2.15	5,120
545 Tape Selecting Unit B2	2,400	113,400		44x17x69	1,150	2.85	6,830
581 Magnetic Tape Unit	550	29,700		44x17x69	1,000	1.30	3,750
533 On-Line Printer	1,300	60,500				4.10	11,000
a. Printer Unit				45x30x45	500		
b. Electronics Unit				44x17x69	500		
535 Electro-Mechanical Printer	3,400	170,000				6.10	16,750
a. Printer Unit				45x30x45	500		
b. Electronics Unit				88x17x69	1,000		
527 Card Transcriber	2,275	103,000				7.10	19,800
a. Card Reader				48x30x45	500		
b. Card Editor				88x17x69	1,000		
537 Transcribing Card Punch	2,965	148,300				5.00	13,600
a. Card Punch Unit				48x30x45	400		
b. Electronics Unit				73x31x72	2,000		
523 Tapewriter and Table	110	3,300		22x21x10	85	0.25	685
525 Tapewriter—Verifier	150	4,500		13x24x7	115	0.3	820
567 Random Access File	500	30,000		48x29x45	700	0.62	2,050
568-1 File Control Unit	1,375	100,000		88x17x69	1,500	4.2	11,750
597 Power Supply for 567 and 568-1	150	10,000		45x29x48	1,500	2.1	5,800
512 Computer Punch	325	13,975		30x38x60	350	0.4	1,670
513 Computer Punch	900	38,700		30x38x60	350	0.4	1,670

1 Maintenance included in rental price. Separate maintenance contract provided for purchased equipment.



BLOCK DIAGRAM OF RCA-501

RCA 601 RADIO CORPORATION OF AMERICA



THE COMPUTER is a general purpose, stored program, digital device utilizing transistor and diode circuitry. It provides high-speed storage, processing, and on-line input-output device control capabilities.

The 601 System is able to handle simultaneous routines. The number of such routines is not fixed but is a function of the speed-wait of any peripheral devices involved and the complexity of the individual routines.

In general, minimum storage capacity and complexity is required in external buffers due to maximum use of the internal memory under control of programmed routines. This permits flexible and economical input-output buffering to be achieved.

Computers may also be coupled together. This permits various multi-computer configurations to be obtained. Each computer may be oriented to some particular function, such as input-output processing, or may be completely general purpose in nature.

SYSTEM COMPONENTS

Central processor

Operation: Serial for variable length arithmetic; parallel for fixed length arithmetic; timing asynchronous; concurrent operation.

Computation speed:	(microseconds) Including Storage access
Addition or Subtraction:	9.75
Multiplication:	13.75
Division:	28.75

Arithmetic speed is variable depending on choice of both arithmetic and instruction units.

Storage

Media	*No. of Words*	*No. of Digits*	*Access (microseconds)*
Magnetic Core	32,768 Variable	523, 288-3 bit digit 393, 216-4 bit digit 262, 144-6 bit digit 196, 608-8 bit digit Number of bits per digit is optional with programmer (3, 4, 6, or 8)	0.9-1.5

Memory is in modules of 8192 words. Use of more than one module permits overlap reducing access time to 0.9 microseconds.

Word length is also completely variable if desired.

All magnetic tape units (22K, 33K, 66K) available with the 501 System are also available with the 601 in addition to that described here.

Eight-bit code is Fieldata 3.

Magnetic tape

No. of units that can be connected: 64 units.
No. of characters/linear inch: 800 chars./inch.
Channels or tracks on the tape: 10 tracks/tape.
Blank tape separating each record: 0.9 inch.
Tape speed: 150 inches/sec.
Transfer rate: 120,000/180,000 chars./sec.
Physical properties of tape:
Width: ¾ inch.
Length: 2,400 feet.
Composition: Mylar.

INPUT MEDIA

Paper tape

1,000 characters per second.

Cards

600 cards per minute.

Magnetic tape

120,000/180,000 22,222; 33,333; 66,666 characters per second.

Teletype line

Up to 50 lines per minute.

Optional time scanning unit available.

Same magnetic tapes available on the RCA 501 are also available on the RCA 601. 22K and 33K tapes are interchangeable between RCA 601, 501, 301. 66K tapes are interchangeable between RCA 601 and 501.

OUTPUT MEDIA

Paper tape

100 or 300 characters per second.

Cards

100 cards per minute.

Magnetic tape

120,000/180,000 22,222; 33,333; 66,666 characters per second.

Printer

600 lines per minute.

Up to six magnetic tapes may be read simultaneously and up to eight magnetic tapes may be written out simultaneously.

Up to eight card readers may be operated simultaneously.

Up to eight card punches may be operated simultaneously.

Up to six printers may be operated simultaneously.

On-line card readers, card punches and printers may be operated independently of program being run.

PROGRAMMING

Internal number system: Binary, binary coded decimal, alphanumeric.
Binary digits/word: 6, 8, 12, 16 or variable.
Binary digits/instruction: Variable 24 to 144.
Instructions per word: Variable size instructions from ½ word to 3 words each.
Instructions decoded: Variable over 120.
Arithmetic system: Flo point, dec and bin (optional); Fix point, dec and bin (optional); variable word length: operands limited by memory size.
Instruction type: Number of addresses is variable. One, two, three address at programmer's option.
Number range: Depends on memory size.
Instruction word format: Binary digit count.

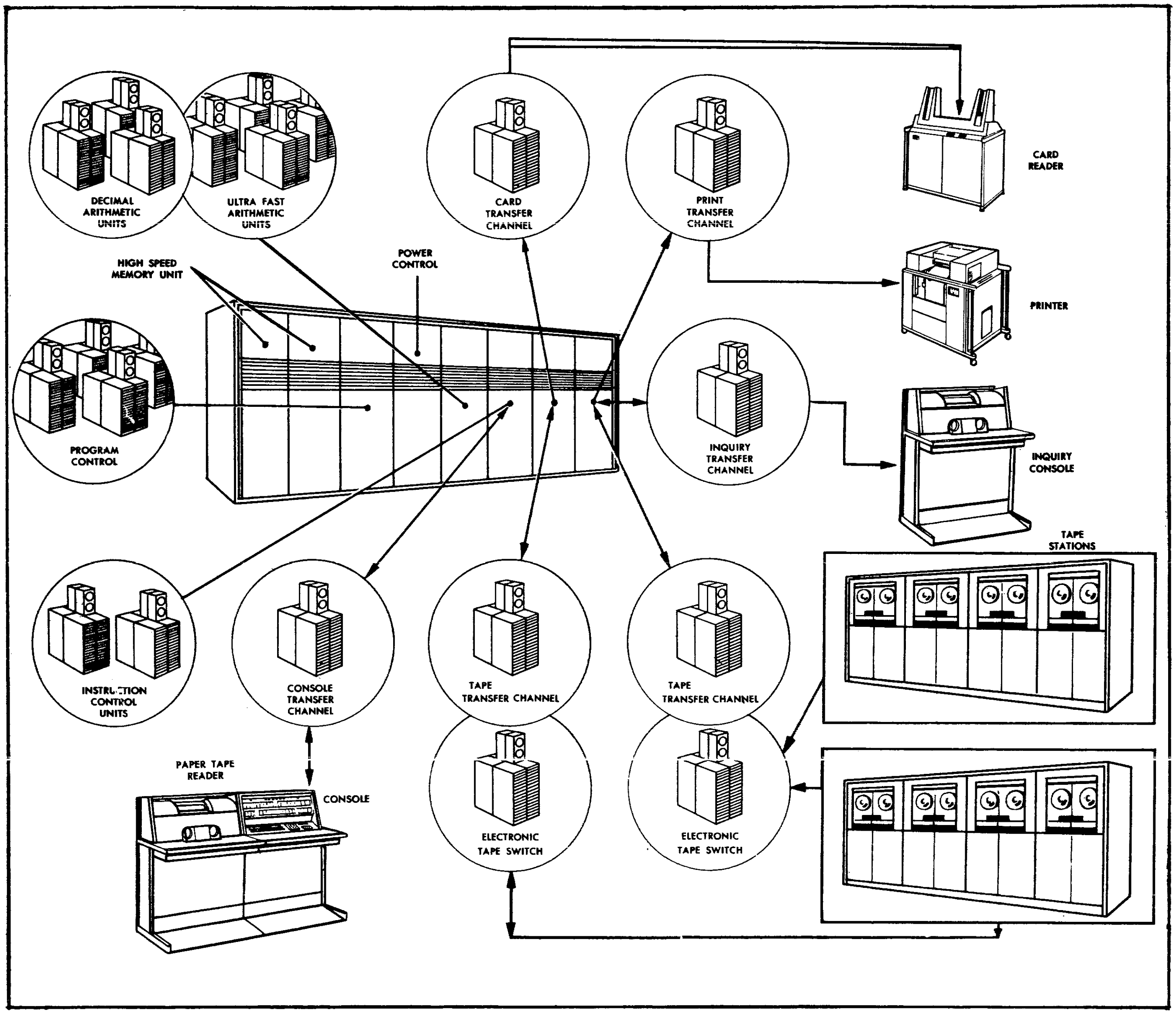
Automatic built-in subroutines are available. For example, automatic servicing of que table for input-output instructions. Calculation of weight-load of input-output devices. Sortable preparation of criteria address lists as data is read in. Several operation codes have the effect of a subroutine, i.e., code convert provides conversion from one bit structure to another.

Automatic coding includes Automatic Assembler, RCA Narrator (COBOL) and RCA ALGOL.

Registers and B-boxes include 8 address modifiers.

1/2 word	1/2 word
Address Modifier	This modifies the Address Modifier

Additional op codes can be added by the programmer



BLOCK DIAGRAM OF RCA-601

Instruction word format

1	3	6	3	3	9	3	1	3	4	1	16	3
P A R	T A G	Op. Code	D Interrupt Set-Sense Tags	ACD Assumed Address	Count Sym. Register No.	C1	P A R	T A G	Address Mod.	I N D	Half Word Add.	Char. Add.

Data Processing System— **Cost, Power Requirements, and Physical Characteristics**

Item	Rent/mo.	Purchase		Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
603 Processor (8, 192) Includes Console and Power Supply	$19,500	$839,700	1				
610 Tape Transfer Channel	580	26,100	1				
640 Tape Switch	700	31,800	2				
582 Tape Station	8,750	432,600	10				
632 On-Line Printer	700	32,200	1				
612 Print Transfer	515	23,600	1				
623 Card Reader	350	15,850	1				
613 Card Transfer	250	11,300	1				
Total	$31,345	$1,443,150					

—RCA 601—Scientific System

Cost, Power Requirements, and Physical Characteristics

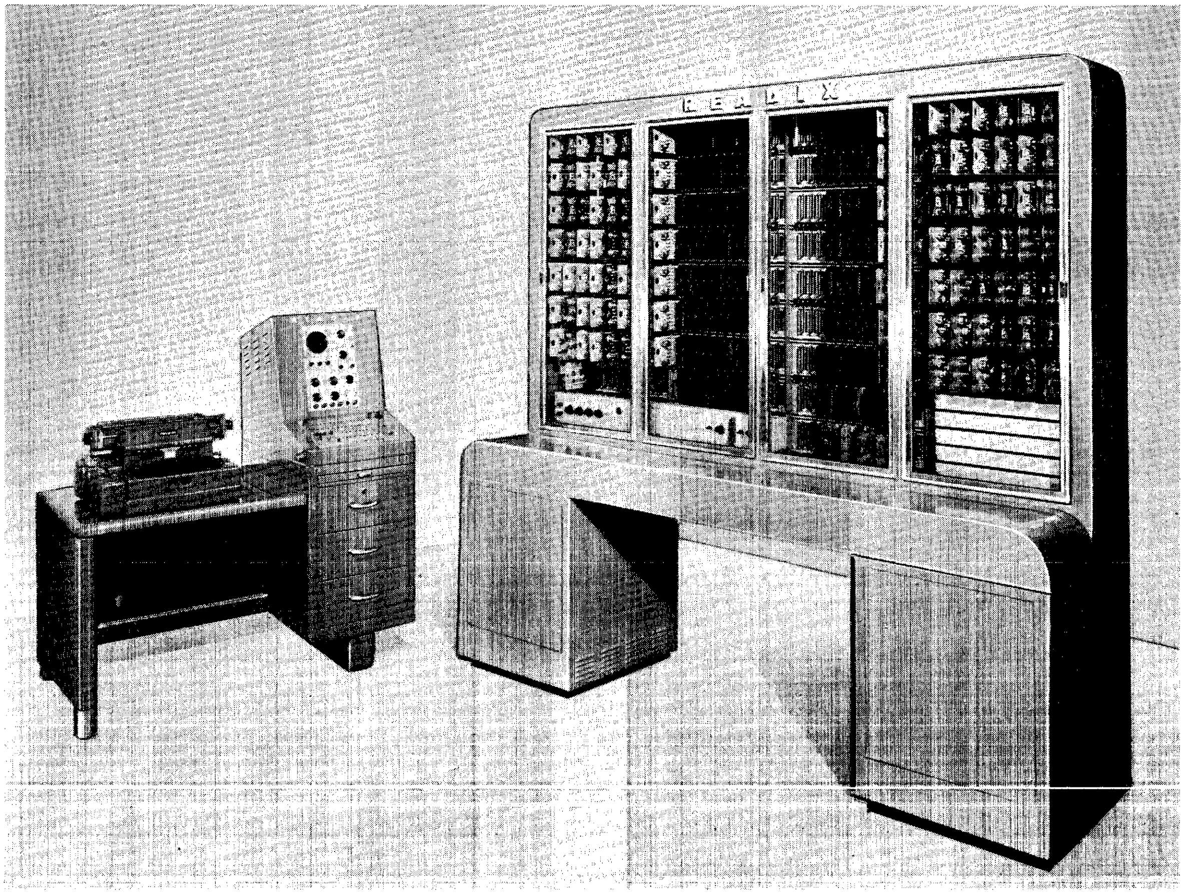
Item	Rent/mo.	Purchase		Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
604 Processor (including Hi-Speed Arithmetic, Console, Power Supply)	$22,300	$998,600	1				
661 Add. Hi-Speed Storage	6,980	314,200	1				
610 Tape Transfer	580	26,100	1				
640 Tape Switch	350	15,900	1				
580 Tape Stations	2,790	151,140	6				
632 Printer	700	32,200	1				
612 Print Transfer	515	23,600	1				
621 Paper Tape Reader	260	11,900	1				
Total	$34,475	$1,573,640					

—RCA 601—Additional Components

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Size Characters per second	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
681 Tape Station	$1,080	$56,300	120,000/ 180,000				
580 Tape Station	465	25,190	22,000				
581 Tape Station	550	29,700	33,333				
611 Tape Transfer Channel — For 681	1,670	76,800	Max. 48 T.S. Each				
641 Tape Switch — For 681	785	36,100	6 Tape Stations Each				
614 Daspan Coupler	290	13,200					
615 Extensor Scanner	565	25,500					
616 Extensor	35	1,580					
607 Inquiry Console	280	12,600					
617 Inquiry Transfer Channel	260	11,700					
634 Card Punch	200	8,900	100 Cards Per Min.				

READIX IDAHO MARYLAND MINES CORPORATION



THIS SYSTEM is designed and used for scientific computation, commercial data processing, record keeping, and data reduction.

Other applications include:

Facility Requirements
- Physical Installation
- Personal Requirements

Accounting Applications

Design of Business Systems

Inventory and Scheduling Application
- Inventory Control
- Aircraft Production Scheduling

Scientific and Engineering Applications
- Simultaneous Linear Algebraic Equations
- Characteristic Roots and Vectors
- Linear Programming
- Differential Equations
- Statistical Analysis

Techniques for Reliability
- Summary of Operating and Design Techniques
- System Design
- Circuit Design
- Maintenance

Logical Design
- Algebraic Techniques of Logical Design
- Preliminary Design Considerations
- Detailed Logical Design

The READIX medium general purpose computer, with 107 commands, is easy to learn and to program.

Unique system advantages include ease of maintenance. The READIX is most suited for scientific problems.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	440	440
Multiply:	25,000	16,000
Divide:	40,000	24,000

Arithmetic mode: Serial.

Timing: Asynchronous.

Operation: Sequential.

Checking features: Checking features include overflow, non-existent number (all decimal), non-existent instruction, non-existent address, and double decision.

STORAGE

Magnetic drum

Number of words: 4,000.
Number of digits: 40,000.
Access: 8,000 microseconds average.

Magnetic drum

Number of words: 160.
Number of digits: 1,600.
Access: 4,000 microseconds average.

Register

Number of words: 5.
Number of digits: 50.
Access: 220 microseconds average.

Magnetic tape

Number of units that can be connected: 10.

INPUT MEDIA

Flexowriter

10 characters per second.

Paper tape

60 characters per second.

Cards (IBM)

100 cards per minute.

Magnetic tape

1,000 characters per second.

OUTPUT MEDIA

Flexowriter keyboard

10 characters per second.

Paper tape

60 characters per second.

Cards (IBM)

100 cards per minute.

Magnetic tape

1,000 characters per second.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Decimal digits per word: 10 plus sign.
Decimal digits per instruction: 5.
Arithmetic system:
Floating point: Add, subtract, multiply, and divide.
Fixed point: Add, subtract, multiply, divide, and square root.
Instruction type: One-address, stored program.
Number range: Fixed $\pm (10^{10} - 1)$
Floating $\pm (10^{+49}_{-50} - 1)$

Instruction word format

1 — 2	3 — 5	6 — 7	8 — 10
Operation	Address	Operation	Address

Automatic built-in subroutines include square root.
Registers and B-boxes include four one-word arithmetic registers (S, T, U, and V) and a B-box with automatic address modification.

Cost, price and rental rates

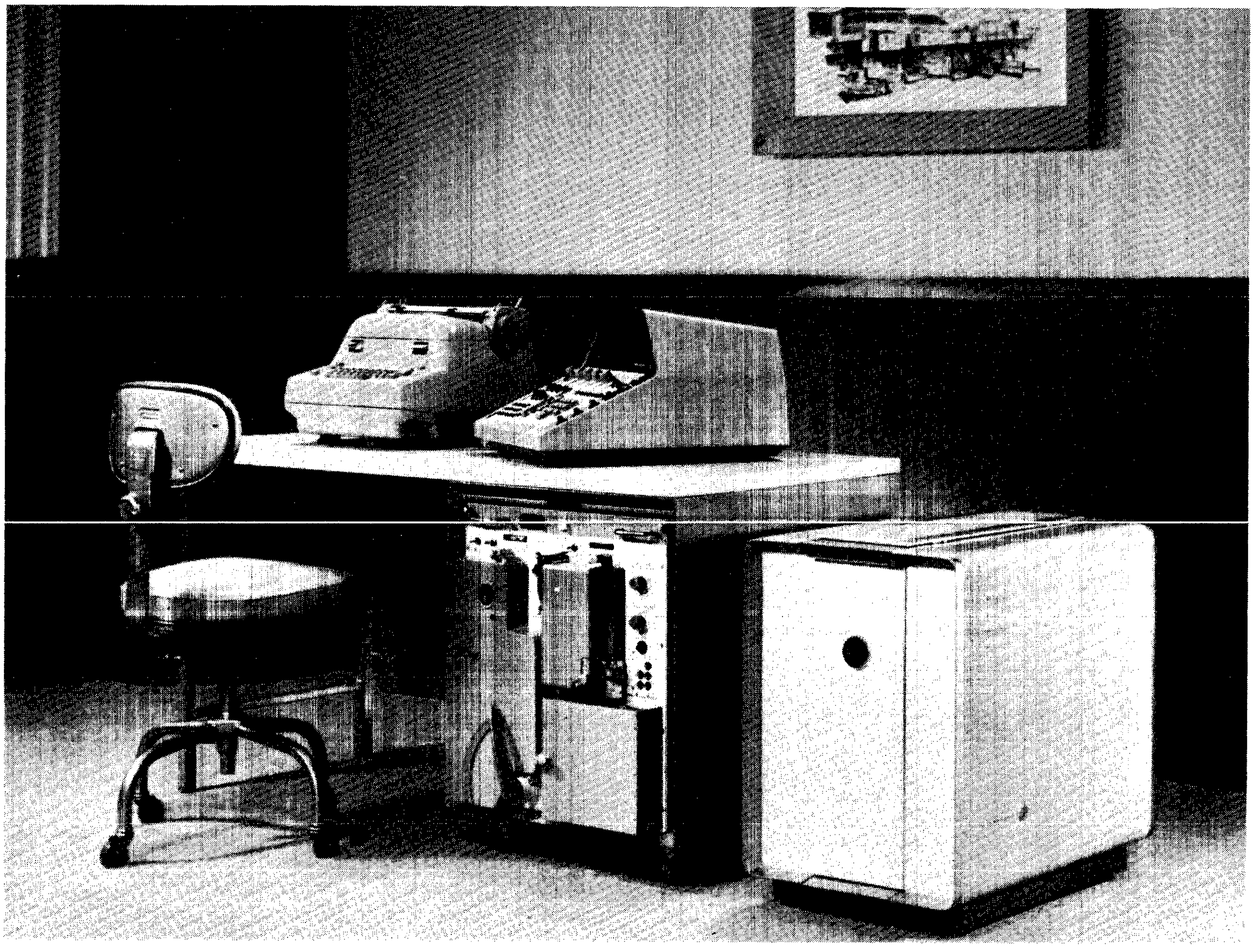
	Cost	Monthly Rental
READIX Computer (all decimal w/both fixed and floating point); 4,000-word drum; 107 instructions; desk console; Flexowriter, power supply; ventilation system; component tester	$70,000	$2,400
IBM Converter	20,000	600
Magnetic Tape	25,000	800

Service Costs:
Engineer at Installation: $12,000 per year.
On Call Service: $100 per call plus traveling expenses.

Power, space, weight, and site preparation

Power, computer: 8 Kw.
Room size: 14 ft. x 14 ft.
Weight, computer: 1,750 lbs.

RECOMP II NORTH AMERICAN AVIATION, INC.



THE RECOMP II consists of a computer unit, a control console, an electric typewriter, a paper tape reader, and a paper tape punch. Transistors are the principal electronic components.

SYSTEM COMPONENTS

General

Word Length: Fixed, 39 bits plus sign.
Numeric Characters Per Word: 12.
Alphabetic Characters Per Word: 8.
Character Code: Numerics—pure binary; alphabetics —5-bit teletypewriter code.

Timing: Synchronous.
Pulse Repetition Rate: 157 kilocycles.

Computer unit

Operation: Serial, fixed or floating point.
Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point	*Time (milliseconds)* Floating point
Add: 555555 to 555555	1.08	2.16
Multiply: 555555 by 5555	11.34	13.21
Divide: 3086108025 by 5555	11.64	13.51

Access time: 0.52 to 16.9 milliseconds.

Checking features: Echo check on typewriter output; verify mode to check contents of memory against original tape.

Registers

Five, one word—

A register: Holds the result of arithmetic operations.

R register: An extension of the A register in fixed point multiplication and division or holds exponent of floating point instruction.

B and X registers: Provide intermediate storage between memory and arithmetic register.

C register: Contains full word from which command being executed was obtained.

Memory

The magnetic disk memory has a capacity of 4,096 words in 64 channels. The general storage portion has a capacity of 4,080 words with the remaining 16 words in the high speed access portion. The five one-word registers and the permanently recorded clock signal are also on the disk.

Control panel

This unit contains all operating controls and indicators. A visual readout permits examination of the contents of any memory location and all registers except the B register. The readout also enables visual observations of commands and data entered from the decimal keyboard.

INPUT MEDIA

Decimal keyboard

Located on the control console, this keyboard provides a means for manual input of initial data and commands or modification of stored information.

Photoelectric paper tape reader

This unit reads folded punched paper tape at a rate of 400 characters per second in the standard teletypewriter code. Provision is also made for automatically verifying information stored in the computer with the input paper tape.

Electric typewriter

This unit is an on-line input-output device that operates at a rate of 10 characters per second. It may be used for input of commands or data, or for modification of stored information. It may also be used to print out the contents of memory locations and registers. The typewriter may be used in conjunction with the paper tape punch for the off-line preparation of punched paper tapes.

OUTPUT MEDIA

Electric typewriter

As previously described.

Mechanical paper tape punch

This unit punches paper tape in the teletypewriter code at a rate of 20 characters per second except when used in parallel with the typewriter. The slower speed of the typewriter is then maintained.

AUXILIARY COMPONENTS

Paper tape reader

A second paper tape reader may be used with the system and information called for intermittently or continuously.

Visual display

RECOMP II provides a special connector to which output signals may be fed for on-line operation with external interpretive devices such as X-Y plotter or a cathode-ray tube display unit.

PROGRAMMING

General: The RECOMP II uses a single address type of instruction.

Instructions:

Number of instructions per word: 2.

Number of digits per instruction: 6 (octal) plus sign bit and half-word bit.

Total number of operation codes: 49.

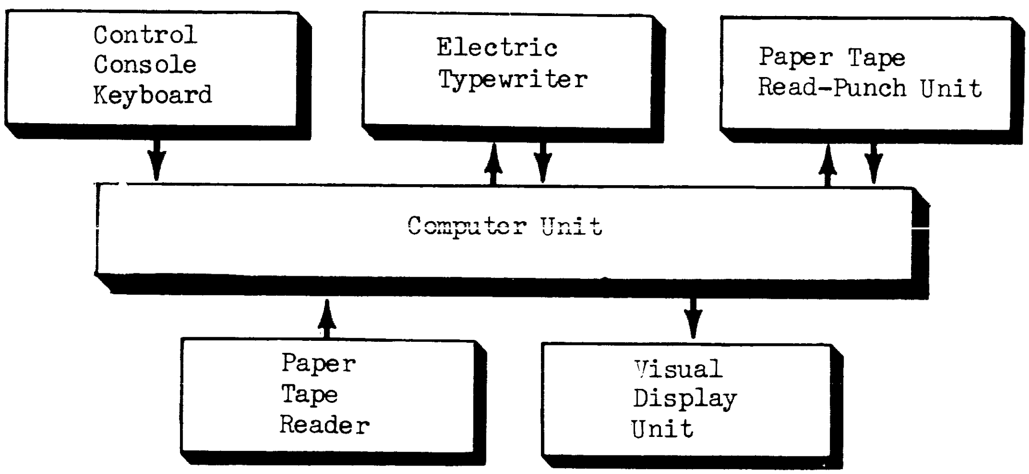
Instruction word format

S	1—6	7—12	13—18	19	20	21—26	27—32	33—38	39
Sign	Operation	Channel	Sector	Half-word bit	Sign	Operation	Channel	Sector	Half-word bit
		←— Address	—→				←— Address	—→	
←— First command				—→	←— Second command				—→

Cost, Power Requirements, and Physical Characteristics

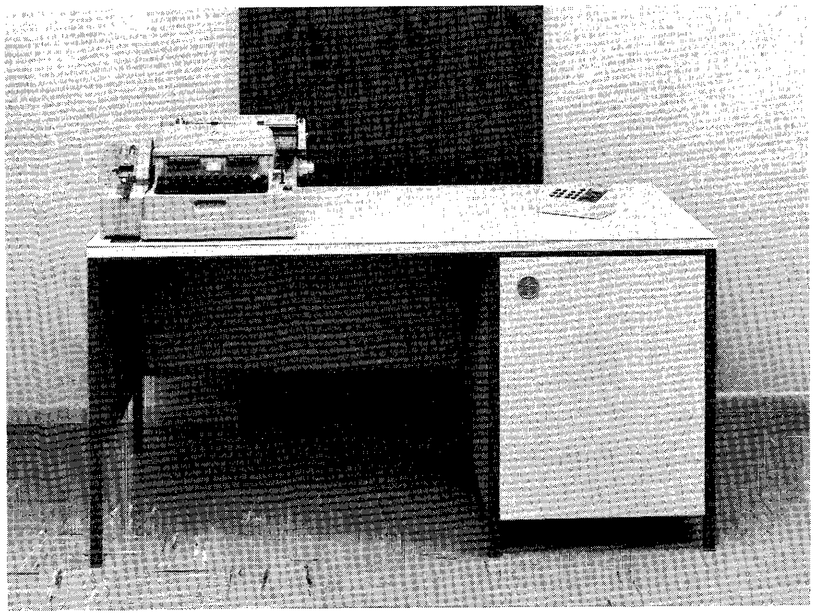
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
RECOMP II System, including	$3,000	$96,000	$5,000				
Computer Unit				21x17x23	170	0.40	1,100
Control Panel				20x16x12	32	(2)	(2)
Electric Typewriter				16x17x9	55	0.05	137
Mechanical Paper Tape Punch				14x10x24	35	0.12	330
Photoelectric Paper Tape Reader				14x10x24	35	0.35	960

[1] Maintenance included in rental price. Maintenance cost shown is for purchased equipment.
[2] Included in Computer Unit.



BLOCK DIAGRAM OF RECOMP II

RECOMP III AUTONETICS INDUSTRIAL PRODUCTS



A DESK-SIZE, general purpose digital computer. Transistorized, serial, binary, single address, internally stored program, with 32 instructions including four arithmetic instructions; 23 logical and transfer instructions; five input-output instructions. Five built-in floating point instructions are available as optional features.

Memory

Rotary magnetic disk with storage capacity of 4,096 words, each of 40-bit length including sign, plus 16 words in high-speed memory loops. Each word holds up to a 12-decimal digit number, eight alpha characters, or two program instructions.

Timing

Access time:
- Main memory: 9.3 milliseconds average.
- High-speed loops: 0.95 millisecond reading average.

Operation time:
- Fixed point, excluding access time: Add-subtract, 0.54 millisecond; multiply, 10.8 milliseconds; divide, 11.1 milliseconds.
- (Optional) Floating point, excluding access and normalization time: Add-subtract, 1.1 milliseconds (minimum); multiply, 12.4 milliseconds; divide, 12.7 milliseconds.

INPUT MEDIA

Mechanical Reader (10 char./sec.) and electric typewriter Engineering Keyboard (Flexowriter). Up to any four inputs (standard, optional, special devices) Facitape High-Speed Reader (600 char./sec. and it stops on a char.).

OUTPUT MEDIA

Electric Typewriter (Flexowriter) and paper tape punch (10 char./sec.). Up to any four outputs (standard, optional, special devices), Facitape High-Speed Punch (150 char./sec.).

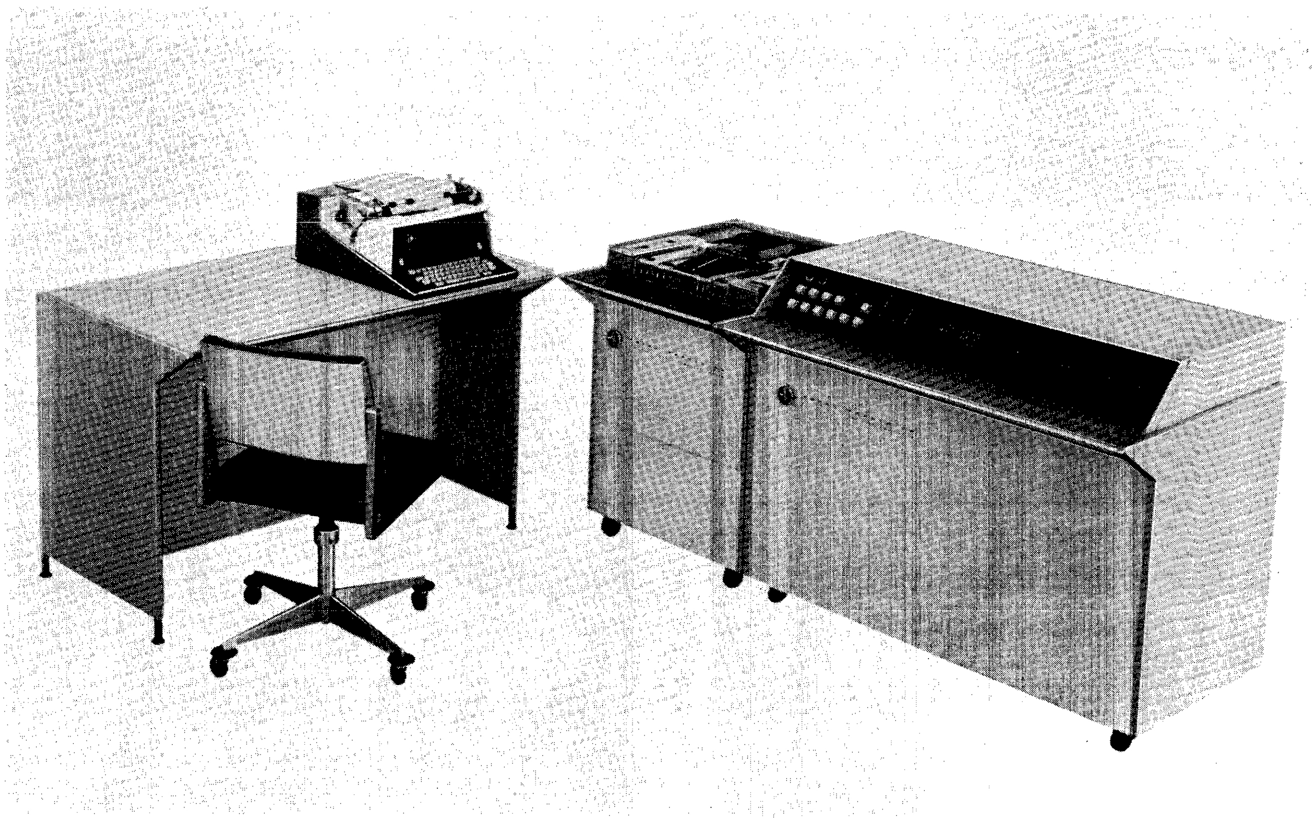
	Sale	Lease
RECOMP III — Complete Computer System including Flexowriter and Desk	$65,000	$1,495
Optional Equipment:		
Floating Point Hardware — Built-in, compacted floating point hardware	15,500	495
Facitape Console — High-speed tape reader, 600 characters per second, and high-speed tape punch, 150 characters per second	16,950	500
Three Inputs — Three additional input plugs for optional or special devices	750	25 each
Three Outputs — Three additional output plugs for optional or special devices	750	25 each

Maintenance is provided at no additional cost on leased equipment.

Power, space, weight, and site preparation

Power: 115 volts ac, 50-60 cps., 350 watts.
Weight: 250 pounds — excluding input-output equipment.
Size: 30 inches high x 30 inches deep x 60 inches long.

RPC 4000 ROYAL PRECISION CORPORATION



TYPICAL EXAMPLES of applications include engineering, e.g. flight simulation, thermal distribution, motor fuel blending, heat exchanger design, highway design, water network calculations, electric power load-flow calculations, optical ray trace, and reduction of wind tunnel test data; and business data processing, e.g. production control, payroll, accounts receivable, order analysis, financial statements, job costing, sales analysis, quality control, and operations research.

The system is fully transitorized with large memory, programming flexibility, high operating speeds, Index Register for automatic high-speed address modification, repeat execution feature, memory search of 8,000 words in 2½ to four seconds, high-speed input and output, up to 17 input-output devices (or up to 60 with minor modifications), parity checking on input, dual access and high-speed tracks, utilizes 110-220 volt current.

Registers include upper accumulator, lower accumulator, instruction, index and 8,008 memory registers.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	500	250
Multiply:	17,000	17,000
Divide:	17,000	17,000

STORAGE

Magnetic drum

Number of words: 8,008.
Number of binary digits: 32.
Average access: 8,500 microseconds.

INPUT MEDIA

Paper tape (photo electric reader)

500 characters per second.

Paper tape (tape typewriter reader)

60 characters per second.

Punched card reader

Magnetic tape

OUTPUT MEDIA

Paper tape (high-speed punch)

300 characters per second.

Paper tape (tape typewriter punch)

30 characters per second.

Tape typewriter print

12 characters per second.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 32.
Binary digits per instruction: 32.
Instructions per word: 1.
Instructions decoded: 42.
Arithmetic system: Fixed point.
Floating point can be simulated.
Instruction type: Two-address (one over one).
Number range: 9 decimal digits.

Instruction word format

Sign	Command	Operand Address	Next Instruction Address	Index Tag
S	1—4	5—17	18 —— 30	31

Automatic coding includes compilers, assemblers, and interpretative systems.

Cost, price and rental rates

Cost of Basic System

Computer (including one Tape Typewriter)	$87,500
Additional Equipment:	
Photo Electric Reader	15,000
High-Speed Punch	20,000
Tape Typewriter (off-line)	5,000

Rental for Basic System

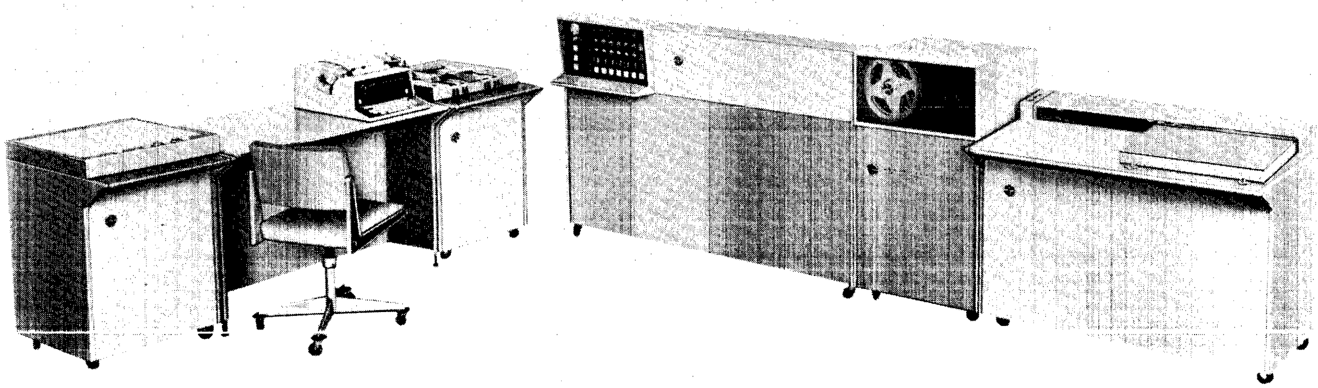
Computer (including one Tape Typewriter)	$1,750
Rental Additional Equipment:	
Photo Electric Reader	300
High-Speed Punch	400
Tape Typewriter (off-line)	150

Maintenance included in rental; service contract available for purchasers.

Power, space, weight, and site preparation

Power, computer: 0.725 Kw.
Length, computer: 46¾ inches.
Width, computer: 27 inches.
Depth, computer: 34¾ inches.
Weight, computer: 600 lbs.
Normal office power required.

RPC 9000 ROYAL PRECISION CORPORATION



THE BASIC RPC 9000 SYSTEM consists of the central processor, a tape typewriter system (consisting of an electric typewriter, a paper tape reader, and a paper tape punch) and a magnetic tape system. The basic system may be expanded by the addition of a high speed paper tape reader, a high speed paper tape punch, and a punched card reader. Transistors and magnetostrictive delay lines are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 12 characters.
Numeric Characters Per Word: 12.
Alphabetic Characters Per Word: 12.
Character Code: 6-bit binary coded decimal plus parity.
Timing: Synchronous.
Pulse Repetition Rate: 364 kilocycles.

Central processor (9010)

Operation: Serial, fixed point.

Computation speed: (programs and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.23
Multiply: 555555 by 5555	5.52
Divide: 3086108025 by 5555	8.28

Average access time: 0.8 milliseconds.

Checking features: Parity check of all data transfers within the central processor and all input/output.

Registers

(All registers are magnetostrictive delay lines.)

Arithmetic: Three 1-word delay lines used for data manipulation, testing, and arithmetic computations.

Command: A 1-word delay line used to hold and execute the current command word.

Address: A 1-word delay line used to hold and execute the current address word.

Desired Address (DAR): An 8-word delay line used to hold "key" words for which records on magnetic tape are searched.

Mask holder: An 8-word delay line used to mask or filter the contents of the desired address register.

Memory

The basic internal memory consists of nine 8-word recirculating magnetostrictive delay lines. One of these lines is used for the transfer of information within the central processor. The basic memory may be expanded by the addition of 8-word lines (in blocks of 4 lines each) up to a maximum of 48 lines.

Control panel

This unit is a part of the central processor and contains controls and indicators for control of the system. It may be used for manual input of data into the system.

INPUT MEDIA

Tape typewriter system (9500)

This system consists of a modified Royal electric typewriter, a paper tape reader, and a paper tape punch. The tape reader and tape punch are not physically attached to the typewriter but occupy a separate cabinet. The typewriter may be used for manual input or inquiry into the system or may print out data from the system at a rate of 10 characters per second. It may be used off-line, in conjunction with the paper tape system, for the preparation of punched paper tape or the conversion of punched paper tape to printed copy. When operating off-line, the speeds of the paper tape reader and punch are controlled by the typewriter. The paper tape reader is used to read data into the system at a rate of 60 characters per second. The paper tape punch is used to punch out data from the system at a rate of 30 characters per second. A seven level code is used in the system.

Magnetic tape drum (9100)

This unit utilizes a continuous loop of magnetic tape which is constantly in motion. The tape is housed in removable cartridges. The cartridges are mounted on the tape unit in the horizontal plane and the tape stands on edge. The system operates such that a record is read from tape into the central processor, is updated, and is written back on tape in the same location it originally occupied. Longer programs require more updating time and therefore a longer effective distance between the read head and the write head. This change in effective distance is achieved through a system of sprockets and idlers and is adjustable from 60 to 600 milliseconds.

Maximum number per system: 25.

Packing density: 400 characters per inch (200 characters per inch per lane at 2 lanes per tape width).

Number of channels: 16 (8 per lane at 2 lanes per tape width).

Record length: Fixed, 96 characters.

Record gap: 0.083 inch.

Tape speed: 120 inches per second/48,000 characters per second.

Change cartridge time: 2-3 minutes.

Physical characteristics of tape:

- Composition: Mylar base.
- Length: Variable—10 to 250 feet.
- Width: 35 millimeters.

Checking features: Parity check.

OUTPUT MEDIA

Tape typewriter system

As previously described.

Magnetic tape drum

As previously described.

AUXILIARY COMPONENTS

High speed paper tape reader (9410)

This unit is a photoelectric reader which reads seven level punched paper tape at a rate of 500 characters per second and enters the data into the system.

High speed paper tape punch (9440)

This unit punches data from the system into paper tape in a seven level code at a rate of 300 characters per second.

Punched card reader (9460)

This unit reads the data from 80-column punched cards at a rate of 400 cards per minute and enters the data into the system.

PROGRAMMING

General: The RPC 9000 uses a single address type of instruction.

Instructions:

Number of instructions per word: 12 instructions in a "pair" of words.

Number of digits per instruction: 2.

Total number of operation codes: 43.

Instruction word format

One word

O	O	O	O	O	O	O	O	O	O	O	O

One word

A	A	A	A	A	A	A	A	A	A	A	A

12 instructions

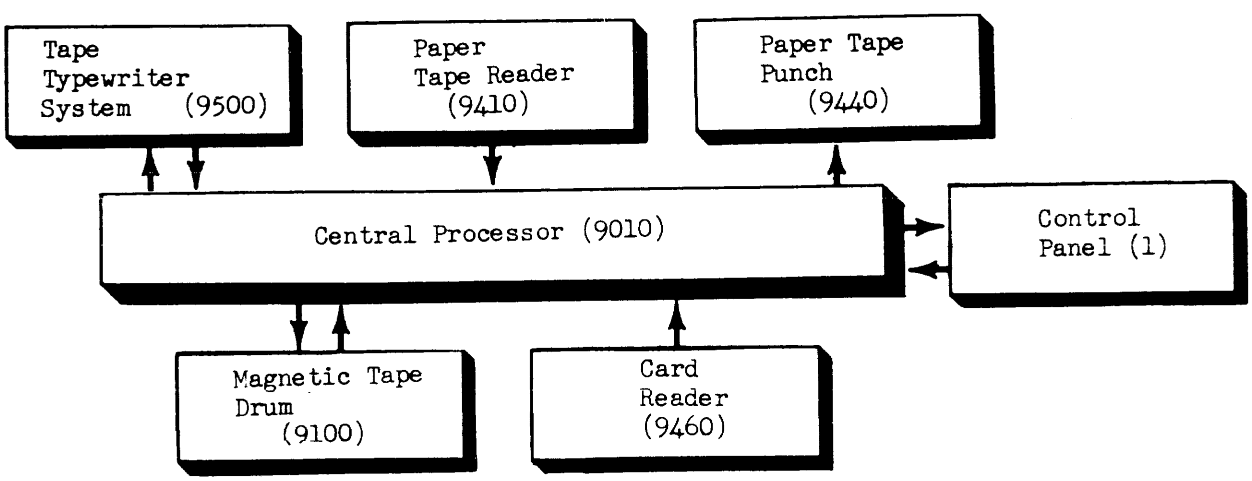
O—Operation code.

A—Address.

Cost, Power Requirements, and Physical Characteristics

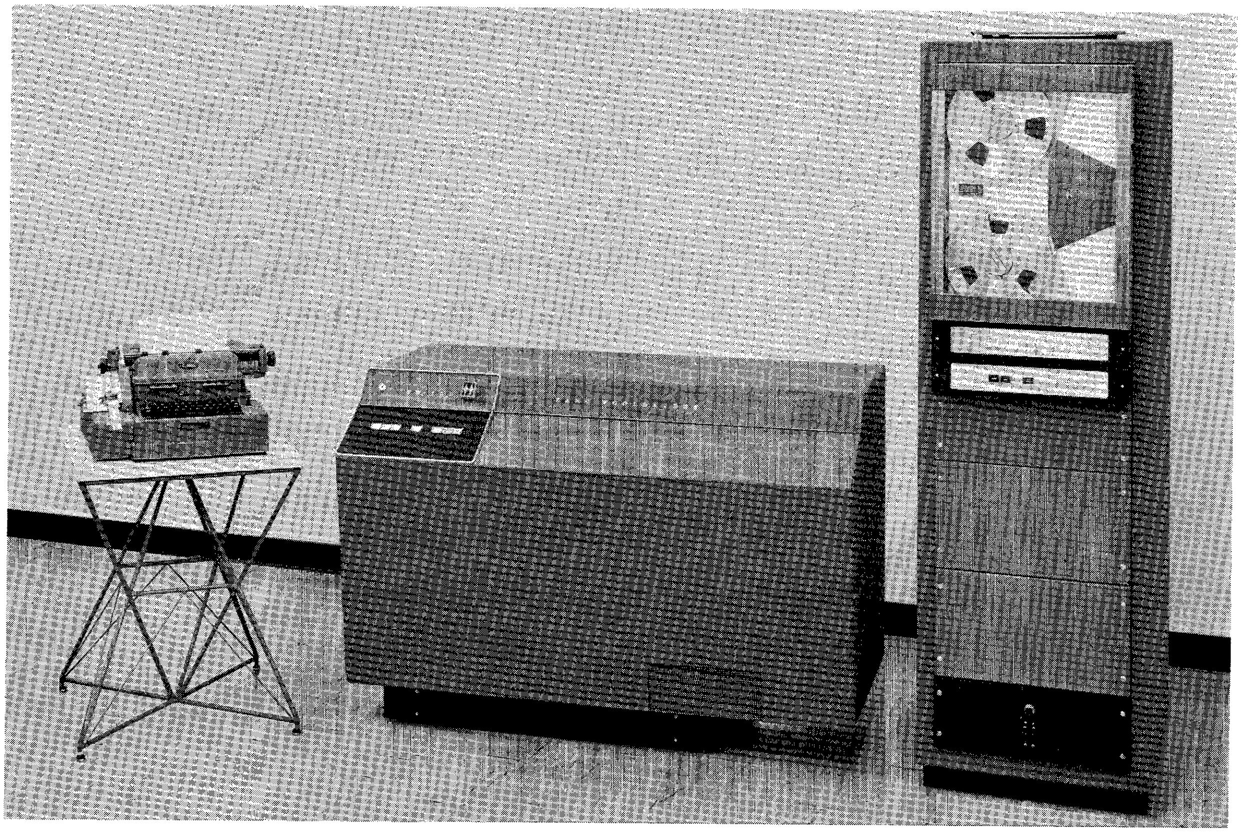
Item	Rent/mo.	Purchase (1)	Maintenance (2)	Dimensions inches l x w x h	Weight lbs.	Power watts	Heat dissipation B.t.u./hr. (4)
9010 Central Processor	$1,400			66x27x42	300	70	
9100 Magnetic Tape Drum	1,600			44x44x30	300	300	
9410 High Speed Paper Tape Reader	300			22x27x30	200	500	
9440 High Speed Paper Tape Punch	400			22x27x42	150	500	
9460 Punched Card Reader	400			22x27x30	200	400	
9500 Tape Typewriter System	150			66x27x30	300	200	
Expanded Memory (4 lines)	100			(3)	(3)	(3)	

1 Purchase price will be furnished by the manufacturer upon request.
2 Included in rental price.
3 Included in 9010.
4 Information not available at this time.



BLOCK DIAGRAM OF RPC-9000

RW 300 THOMPSON RAMO WOOLDRIDGE, INCORPORATED



AUTOMATIC, on-line, real-time uses include industrial process control, process data logging, pilot plant operation, quality control testing, electronic or electromechanical systems checkout, test stand data acquisition and data reduction. Off-line uses include general purpose computing.

The system has built-in analog-digital conversion logic. Programming is not required to store analog data in memory. System has built-in digital-analog conversion logic. Program is required only to change the output values.

A typical RW 300 reactor monitoring system includes an RW 300 Digital Control Computer as the central unit; the required analog and digital input-output equipment; standard measuring and sensing instruments such as compensated and uncompensated ion chambers and scintillometers, and pressure, temperature, and flow sensors, indicating devices; and, where desirable, control devices actuated by the computer.

In operation, the RW 300 continuously scans the instruments connected to it, converts analog and other readings to binary digital form, calculates corrections for measured values where necessary, compares these values against predetermined limits, actuates alarm and warning devices when limits are exceeded, and prints out measured and calculated data.

To insure that the protection of continuous monitoring is available without interruption, two RW 300 computers can operate in parallel (as is the case in two nuclear power station installations in France), with both machines receiving all input data and making all calculations. Only one of the computers operates the automatic typewriters, the alarm devices, and the other output devices. If that computer stops or makes a mistake, the other computer automatically takes over the output device communications.

Alternatively, the first computer might have the single function of alarm scanning, with the second computer and the tape unit used for computations, statistical correlations and trend analyses, data logging, processing of historical data read into the computer from the tape, and control of reactor and power plant variables, as well as backing up the alarm scanning computer.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	780	780
Multiply:	2,990	2,990
Divide:	3,120	3,120

Construction (Arithmetic unit only):
Transistors: Approx. 580.
Diodes: Approx. 4,000.
Arithmetic mode: Serial.
Timing: Synchronous.
Operation: Sequential.
Zero access for optimum coding.
8,330 microseconds average access for sequential coding.
Checking features: There is an optional parity bit on the Flexowriter input-output.

STORAGE

Magnetic drum

Number of words: 7,936 or 15,520.
Number of binary digits: 18 × 7,936 or 18 × 15,520.
Access: 8,330 microseconds average.
Magnetic drum contains 32 words of fast-access memory; 2,080 microseconds average.
The 8,330 microseconds average access is for general storage only.

Magnetic tape

Number of units that can be connected: 8.

National Aviation Facilities Experimental Station:

Drum

Number of words: 7,936.
Access: 830 microseconds average.

Core buffer

Number of words: 128.
Access: 215 microseconds average per 128 words.

INPUT MEDIA

Paper tape

10 characters per second; 60 characters per second optional.

Digital on-off signals

Up to 540 bits available.

Analog

Continuous up to 1,920 samples per second and 1,024 channels of input.

OUTPUT MEDIA

Automatic typewriter

10 characters per second. Several typewriters can be operated simultaneously.

Paper tape punch

10 characters per second; 60 characters per second punch optional.

Analog

Continuous up to 128.

Digital on-off signals

Up to 540 bits available.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 17 bits plus 1 sign bit.
Binary digits per instruction: 36 (2 words).
Instructions per word: One-half.
Instructions decoded: 21.
Arithmetic system: Fixed point.
Instruction type: Two-address (one plus one).

Instruction word format

Word One — Two Words — Word Two

18 — 14	13 — 1	18 — 14	13 — 1
Execution Code	Operand Address	Operation	Next Instruction Address

Automatic built-in subroutines include a program loader.

Automatic coding features include "OPUS," a routine for compiling optimum-coded computer program from sequential, symbolic listing, and "SAFARI," an assembly and interpretive program for scientific problems.

Registers include an A register (accumulator), a B register (lower accumulator), three one-word control registers, and an output-buffer register (18 bits).

Cost, price and rental rates

Manufacturer:

Price of basic computer (includes automatic typewriter and paper tape punch) is $98,000.

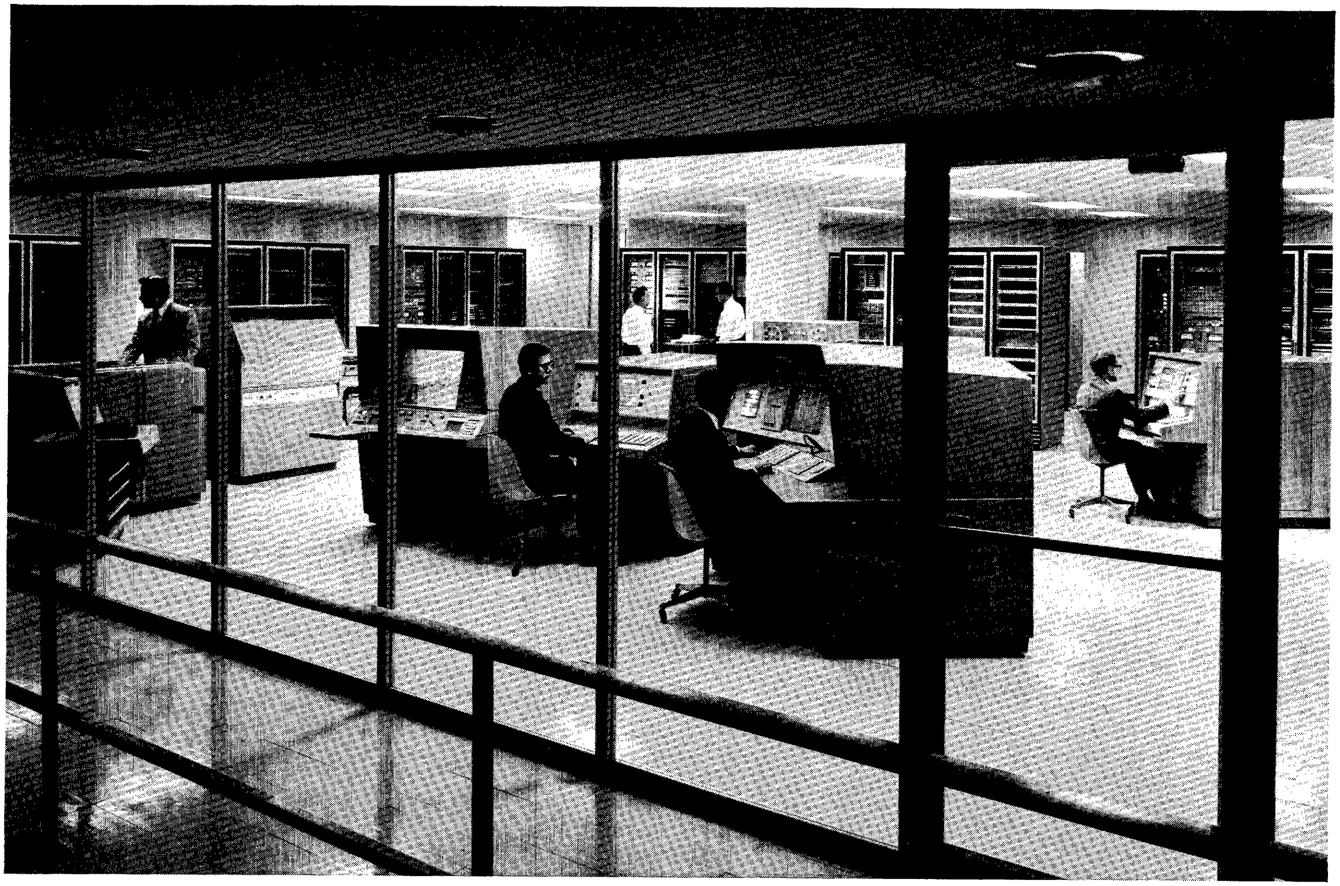
Price of input-output system (Analog), optional equipment, control console, and magnetic tape units, is available on request.

On-call maintenance contract and full-time maintenance contract are available.

Power, space, weight, and site preparation

Power, computer: 0.5 Kw., 120 volts, 60 cps.
Volume, computer: 33.5 cu. ft.
Area, computer: 11.2 sq. ft.
Room size: Small.
Weight, computer: 600 lbs.

Volume figure does not include input-output equipment.



GENERAL OR SPECIAL PURPOSE data processing and real-time, on-line, instrumentation, data processing.

Features include a multiple input-output capability, full parallel processing capability, limited only by size of the particular installation and a distributed memory and control.

Unique system advantages include expandability and flexibility. System can be a small tailored installation and then be expanded by addition of related modules to meet new or more stringent requirements. Expansion does not necessitate re-programming.

Types of service routines include:

"Dump" routines enable the programmer to obtain printed listings of the contents of computer and buffer core storage.

Drum and magnetic tape dumps.

Magnetic tape editing routine.

Program analyzer routine.

Tracing routine.

Types of scientific subroutines include:

Fixed point elementary functions — trigonometric, logarithmic, and exponential.

Fixed point numerical integration.

Binary to binary coded decimal conversion.

Interpretive multiprecision floating point abstraction.

RW 400 MODULE DESCRIPTIONS

Central exchange CX-400 and interim exchange IX-400

The IX-400 or CX-400 provides all of the communication paths between modules of the system. Its size is dependent upon the number of required paths. The interim exchange, a transistor-diode device, is adequate for small systems; for large systems the central exchange, a transfluxor device, is available. Features of the exchanges are as follows:

The exchange function at electronic speeds.

The exchange is controlled by both computer and buffer modules.

All transmission formats are standard.

Unidirectional transmission is employed.

Each exchange itself can be increased in capacity by adding more channels.

The RW 400 central or interim exchange performs a function similar to a telephone exchange. On request, it will set up a communication path between modules of the system. Several communication paths between different pairs of modules can exist at any given time; however, a request for connection to a module in use will result in a "busy" signal. It is convenient to think of the central exchange as a rectangular array of cross-points, having computers and buffers positioned along one axis, and devices to which they can connect along the other axis. Only CM 400's and BM 400's can request connections; hence these are the executive elements. RW 400 modules communicate in a standard format, and can be connected into the central exchange in an arbitrary position; however, since buffers and computers must communicate, each buffer has a position on both axes of the crosspoint array.

In its implementation the central exchange bears little resemblance to the telephone exchange. A conversation path actually consists of 37 lines in parallel, and the information rate through the exchange can be as high as 400,000 bits per second per line.

Computer module, CM 400

The CM 400 is a high-speed, general-purpose digital computer which is housed in a four-bay cabinet approximately seven feet high, eight feet wide, and two feet deep. The characteristics and capabilities of the CM 400 are described in the following paragraphs:

High-speed operations: There are 38 internal instructions for arithmetic and logical operations. The CM 400 is a parallel binary computer. The computer instruction word is 26 bits long and has two 10-bit addresses and a six-bit operation code. A typical instruction line, including both memory accesses, is 40 microseconds, an add operation is performed in 35 microseconds, and a multiply operation is performed in 80 microseconds. Five general external (input-output) instructions are provided.

The computer instructions have two addresses. The set of arithmetic instructions has been chosen in a manner to effectively provide three-address efficiency in many cases. Each of the arithmetic operations — addition, subtraction, multiplication, division, square root of a sum — occur in three modes: replace, hold and store. In the replace mode, a division operation, for example, calls out two operands — the divisor and dividend — from the addresses specified by the instruction. After completion of the operation, the quotient is stored in one of the operand locations. In the hold mode, the same process occurs except the quotient is held in the accumulator and is not stored in memory. In the store mode of division, the divisor is obtained from any address in memory but the dividend is taken as the number retained in the accumulator at the end of the preceding instruction. The quotient is then stored in the location specified by the second address of the instruction. These three modes provide practically all of the one- and two-address combinations desired for arithmetic operations. Special interpretation is made of addresses containing all zeros or all ones — the latter providing access to operands or result locations in the memory of a connected buffer module.

Memory: The CM 400 has a 1,024-word random access magnetic core memory. The read-write cycle time is 10 microseconds. Stored words are 28 bits long — 26 bits of information and two parity bits.

Interrupt capability: Automatic interrupt of a CM 400 is controlled by the masking action of an internal sense register which is under program control. Interrupts may be due to "master" computer intervention, alerting signals from external system modules, and internal conditions such as overflow. An interrupted CM 400 may be programmed to process the condition that caused the interrupt. It then returns to its normal sequence of operations at the point of interruption.

In more detail, each computer has a 20-bit sense register which permits program-controlled interruptions. Each flip-flop of this register senses an alert signal. If an alert signal becomes true and the sensing flip-flop is also true, then a program interrupt occurs. Interruption causes the computer program to next take the instruction stored in address zero. This instruction causes the program to jump to an "interrupt" subroutine. Conventional instructions are used to save the contents of the arithmetic registers and the address at which to re-enter the interrupted program. Thirteen of the twenty alert conditions can be arbitrarily assigned from external sources. The remaining conditions arise from internal sources such as overflow, "ready" or other status signals received during standard communication.

Switching capability: A CM 400 may connect itself through the central exchange to any available buffer module, tape module, tape adapter, drum module, printer module, peripheral buffer, or display buffer. Connections are made within the central exchange. All modules communicate over identical standard cables.

The system network of alert signals of the RW 400 is required in multiple computer systems to permit one computer to control the operation of other computers. It allows the system to efficiently accept infrequently occurring asynchronous input signals, and can be used to implement the timing of certain kinds of computer operation. Alert signals are extremely useful for indication of operator requests, causing prompt response to queries or modifications of console displays. If two or more occur simultaneously, the resulting interrupts are processed in a specifiable order or priority.

ARITHMETIC UNIT

	Including Storage access (microseconds)
Add:	36 (555555 + 555555)
Multiply:	80 (555555 × 5555)
Divide:	128 (3086108025 ÷ 5555)

Arithmetic unit is constructed of transistors.

Arithmetic mode: Parallel.

Timing: Synchronous.

Operation: Concurrent.

Registers

Registers include an exchange register, an instruction register, a program counter, accumulator (A), accumulator extension (B), and a sense register.

STORAGE

Magnetic core

Number of words: Variable; seven characters per word.
Access: 10 microseconds.

Magnetic drum modules

Number of words: 8,192 each; seven characters per word.
Access: 8,500 microseconds.

A variable number of drums and core units may be added. The characters are numeric.

Magnetic tape modules

Number of units that can be connected: 64.

INPUT MEDIA

Peripheral buffer

8,192 words. 3,600 rpm. 8.5 microseconds average access time.

Up to 32 input-output devices may be connected to a peripheral buffer including Flexowriters, consoles, card readers, etc.

Central exchange

35 microseconds connect speed. For direct connect of input devices to system, card read, tape read, flexo, etc.

Cards

2,000 cards per minute. Variable read format is utilized.

OUTPUT MEDIA

Typed page (Flexowriter)

10 characters per second.

Paper tape (Flexowriter)

10 characters per second.

Printer (Analex)

900 lines per minute.

Plotter

Lines: 25 increments per minute. Symbols: 50 per minute.

Card punch, etc.

The Flexowriter is modified for edge-punched cards and seven-level paper tape, read and punch. Thirty-two may be connected to one peripheral buffer.

Additional input-output devices include a display and analysis console and a data communication console.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 26 + 2 parity.
Binary digits per instruction: 26.
Instructions per word: 1.
Instructions decoded: 38.
Arithmetic system: Fixed point.
Instruction type: Two-address.

System has some three-address capability, due to special instructions.

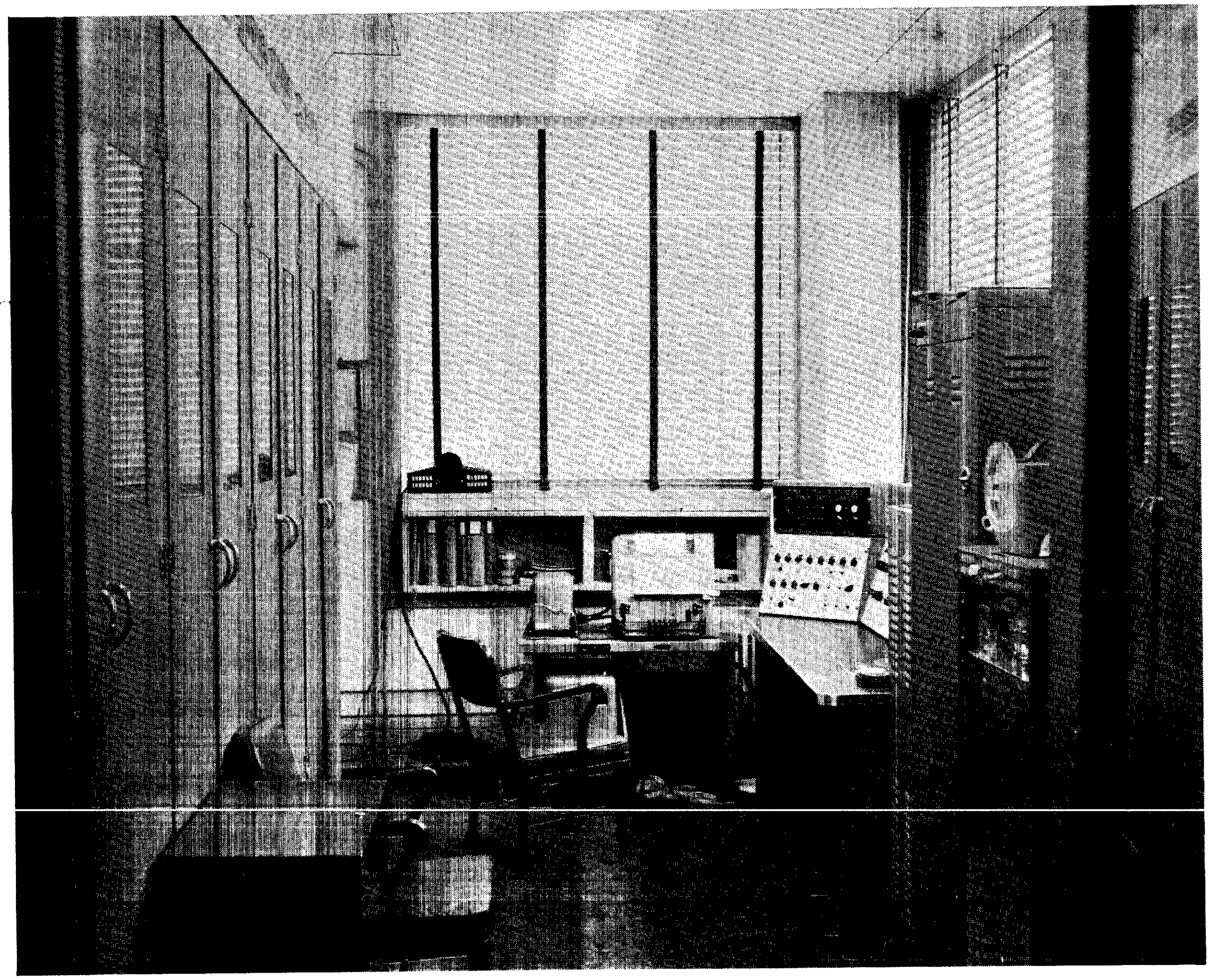
Instruction word format

26 — 21	20 — 11	10 — 1
Op Code	First Operand Address	Second Operand and Result Address

Power, space, weight, and site preparation

Size, weight and power requirements for same typical RW 400 modules. A false floor for cabling is recommended.

Item	Dimensions (feet) l.	w.	h.	Weight (lbs.)	Power (kw) Requirements	Heat Dissipation B.t.u./min.
Computer Module	8	2	7	1,800	2.665	152
Buffer Module	6	2	7	1,450	2.545	145
Tape Module	2	2	7	1,000	1.460	83
Tape Adapter	2	2	7	1,000	1.200	68
Central Exchange (large)	8	2	7	2,000	4.445	255
Central Exchange (small)	6	2	7	1,450	2.755	160
Drum Module	2	2	7	1,000	0.460	26
Printer, Elec. (large)	8	2	7	1,900	9.635	550
Printer, Mich.	2.5	3.5	2	300	9.635	550
Peripheral Buffer	8	2	7	1,800	3.925	225
Display Buffer	4	2	7	1,100	0.540	31
Flexowriter	Small			100	0.250	15
Plotter	6	4	3	1,500	1.000	57



GENERAL DATA PROCESSING, scientific calculation and engineering development. Man-machine systems studies in conjunction with analog computer.

Since SEAC is being used as a research tool rather than for computation, it is not used on a regularly scheduled basis. Training of programmers is done internally within the user groups. Available only to government agencies.

Outstanding features include a variety of auxiliary devices, automonitoring of program, ease of "talking" with the machine, and two counter registers which may be used for program sequencing and address base numbers. See DYSEAC also.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	192-1,540	48
Multiply:	2,300-3,650	2,112
Divide:	2,300-3,650	2,112

Construction: 1,200 Germanium diodes, 80 delay lines, 60 pulse transformers, 61 vacuum tubes.

Rapid access word registers: 3.

Basic pulse repetition rate: 1 megacycle per second.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation: Sequential.

Operation time varies with memory being used. Acoustic and electrostatic memory may be used together in computer.

STORAGE

Acoustic (mercury)

Number of words: 1,024.
Number of digits: 46,080.
Access: 216 microseconds (average).

Electrostatic (CRT)

Number of words: 1,024.
Number of digits: 46,080.
Access: 12 microseconds.

Magnetic tape

Number of words: 24,000.
Number of digits: 52 x 24 x 10^3 bits per unit.
Number of units that can be connected: 5.
Multi-channel tape system is under construction.

Checking features:

Fixed: Parity check for acoustic storage. Parity check for electrostatic storage.

Optional: "AUTOMONITOR" — Order by order and breakpoint monitoring of program progress available to operator by console switch setting. Address in memory, instruction being performed and its result may be printed on Flexowriter, punched paper tape, magnetic wire or tape automatically.

INPUT MEDIA

Keyboard (Flexowriter)

Manual speed (maximum 10 characters per second).

Paper tape (Flexowriter)

10 characters per second.

Paper tape (Potter)

150/600 characters per second (photoelectric).

Magnetic wire (Pierce)

65 words per second (new unit).

Magnetic tape

135 words per second (single channel).

Magnetic tape

4,500 words per second (multichannel).

Punched card

330 characters per second.

OUTPUT MEDIA

Printer (Flexowriter)

10 characters per second.

Paper tape (Flexowriter)

10 characters per second.

Paper tape (Teletype)

58 characters per second.

Paper tape (Soroban)

240 characters per second.

Magnetic wire (Pierce)

65 words per second.

Magnetic tape

135 words per second.

Magnetic tape

4,500 words per second.

Input-output word lengths are single word, eight words, or variable block up to capacity of memory with single instruction.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 44 plus sign.
Binary digits per instruction: 45.
Instructions per word: 1.
Instructions decoded: 16.
Instructions used: 16 + 2 optional (switch).
Arithmetic system: Fixed point.
Instruction type: Three- or four-address (switch).

Instruction word format

4 Address	10 bits α	10 bits β	10 bits γ	10 bits δ	4 bits operation	1 bit sign

3 Address	12 bits α	12 bits β	12 bits γ	4 bits counters	4 bits operation	1 bit sign

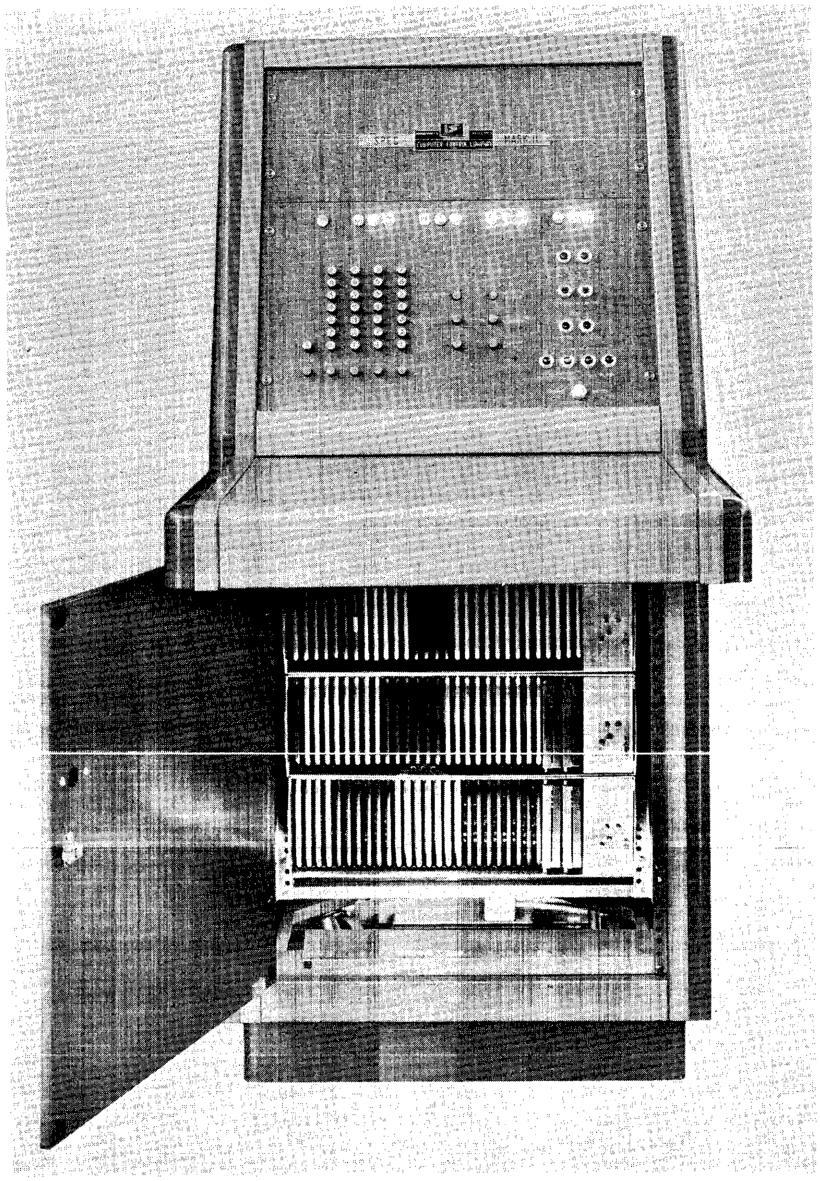
In three-address operation instruction sequencing is done by two counters which are independently sequenced by bits in the instruction. Relative programming can thus be accomplished.

Power, space, weight, and site preparation

Power, computer: 25 KVA.
Area, computer: 85 sq. ft.
Weight, computer: 3,000 lbs. (Central Machine).
Weight, air conditioner: 1,500 lbs.

Dimensions of computer are 5 x 17 feet. Air conditioner measures 77 x 31 x 56 inches. Floor space for computer control console, memories and auxiliaries is 1,386 sq. ft. Floor space for air conditioner and power supplies is 225 sq. ft.

SPEC COMPUTER CONTROL COMPANY, INCORPORATED



THIS SYSTEM is designed and used for teaching machine operation and basic programming techniques, teaching logical design, general purpose computation, the solution of differential equations, and for the rapid implementation of special logical systems.

The entire logical wiring is on removable patchboard, which facilitates quick change from general purpose computer to digital differential analyzer or utilization for logical implementation. The system allows the student or user complete freedom in logical design study without any possibility of equipment damage due to incorrect wiring.

The SPEC (stored program educational computer) is available in three models:

Mark I — General purpose computer only.

Mark II — Digital differential analyzer only.

Mark III — General purpose computer, digital differential analyzer, universal logic implementer.

Only Mark III has logical wiring on patchboard and may be converted from GPC to DDA merely by interchanging two prewired patchboards. Other arrangements of components may be accomplished by appropriate wiring of other patchboards. Components of SPEC are Computer Control Company's standard plug-in digital modules.

ARITHMETIC UNIT

	Including Storage access (microseconds)	Excluding Storage access (microseconds)
Add:	221	13

Arithmetic mode: Serial.
Timing: Synchronous.
Operation: Sequential.

STORAGE

Magnetostrictive delay line

Number of words: 128 (GPC).
Number of binary digits: 13.
Access: 208 microseconds (average).

Magnetostrictive delay line

Number of words: 20 (DDA).
Number of binary digits: 21.

GPC—General Purpose Computer.
DDA—Digital Differential Analyzer.

Four 416-bit delay lines are available, in which words of almost any length may be stored merely by making appropriate changes in the logical wiring.

INPUT MEDIA

Octal keyboard

Speed depends on operator's skill.

System input is adaptable to punched paper tape input.

OUTPUT MEDIA

Register indicator lights

For both GPC and DDA.

Analog output (for plotter)

DDA only.

Digital output (incremental for plotter)

DDA only. Up to 200 points per second.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 13.
Binary digits per instruction: 13.
Instructions per word: 1.
Instructions decoded: 8.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: $-4{,}095$ to $+4{,}095$.

Instruction word format

13	12 — 11	10 — 4	3 — 1
Sign	Unused	Address	Operation Code

The above information applies to SPEC as a general purpose computer. As a digital differential analyzer, SPEC has 20 integrators, a 21-bit word length, and is a binary, stored program machine.

Cost, price and rental rates

Mark I Model	$17,695
Mark II Model	19,195
Mark III Model	24,895

Power, space, weight, and site preparation

Power, computer: 0.06 Kw.
Area, computer: 4.52 sq. ft.
Weight, computer: 310 lbs.

SWAC NATIONAL BUREAU OF STANDARDS

GENERAL PURPOSE scientific computation, research in numerical analysis computing methods.

The National Bureau of Standards Western Automatic Computer is a medium-sized, high-speed computer with 256-word electrostatic (Williams type) memory, and an 8,192-word drum storage. The machine is described in the IRE Proceedings, Computer Issue, 1953.

Some applications of SWAC include the study of discrete variable problems. The use of diffuse surface optical model of the nucleus in the analysis of elastic scattering of charged particles by complex nuclei. The analysis of the crystalline structure of vitamin B12. Determination of many of the larger prime numbers. Valuable work on semi-groups, traffic simulation, the growth of cloud drops, counter gradient methods, queueing theory, and on correlation and factor analysis in psychology.

The SWAC is used as a training tool and as a prototype for computer study in courses of the UCLA curriculum. Its increased use as a data translator is contemplated if the University acquires another high-speed computer. Some data conversion is now done on SWAC in connection with problems to be solved on the WDPC 709 computer, operated on campus under the direction of the Department of Business Administration.

The SWAC was moved during the period from September 1959 to June 1960, from quarters in a temporary building to a permanent site in one of the Engineering buildings on campus. While the move was underway modernization of the power equipment was undertaken, primarily to replace obsolescent equipment with new. The console was modernized with the addition of a portable keyboard permitting remote operation of the computer for instructional purposes. The drum, which had been in operation since January 1956, was rebuilt with new bearings, and the surface turned down. A new air conditioning plant was installed. The computer was debugged by September 1, 1960, and has been operating regularly since that date. Its reliability is better than before the move, but by how much will have to be determined by the performance records for the next few months.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	64	5.3
Multiply:	368	296
Divide:	Not a logical operation	

Construction: Nine tubes per register.
Rapid access word registers: Three.
Basic pulse repetition rate: 125 kilocycles per second.
Arithmetic mode: Parallel.
Timing: Synchronous.
Operation: Sequential.

Auxiliary equipment asynchronous, computer halts and waits for signal. The storage access time includes the fourth address reference. There are 37 parallel registers in the arithmetic unit (three input adders). System uses simultaneous carry and static storage of the addend and the augend. Germanium diodes (semi-conductors) for logical "and" and "or" circuitry.

STORAGE

Electrostatic (CRT)

Number of words: 256.
Number of digits: 9,984.
Access: 8 microseconds.

Magnetic drum

Number of words: 8,192.
Number of digits: 311,296.
Access: 17,000 microseconds.

The regeneration time on the electrostatic storage unit is eight microseconds. The drum access time is given for a 64-word block transfer. The drum transfers in blocks of 64, 32, 16 or eight words. Average time of transfer for less than a 64-word block is 13,000 microseconds. A magnetic core memory of 512 words has been built to replace the present 256-word electrostatic store, and it is currently planned to attach two magnetic tape units of 150 inch per second read-record speed.

Checking features:

Fixed: No interlocks or transfer checks are used.

Optional: Parity check on drum transfers is controlled by a toggle switch. Breakpoints may be stored on non-commands to halt machine when loss of control occurs.

INPUT MEDIA

Punched cards (IBM)

240 cards per minute.

Keyboard

Manual speed.

Eleven words may be punched on each card. The keyboard is adapted for code checking. Peripheral equipment includes IBM punched card reader, card punch, and EAM printer, for on-line use, and a typewriter. The usual card preparation equipment forms part of the installation.

OUTPUT MEDIA

Punched cards

100 cards per minute.

Tabulator (IBM 402)

80 lines per minute.

Typewriter

30 words per minute.

Twenty-four words per card may be punched on output. The tabulator is a decimal output device, printing 72 characters per line.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 37 including sign.
Binary digits per instruction: 36.
Instructions per word: 1.
Instructions decoded: 13.
Instructions used: 13.
Arithmetic system: Fixed point.
Instruction type: Four-address.

Binary point lies between sign and most significant digit. Arithmetic is done with absolute value and sign. The fourth address controls an optional jump and selects the auxiliary devices.

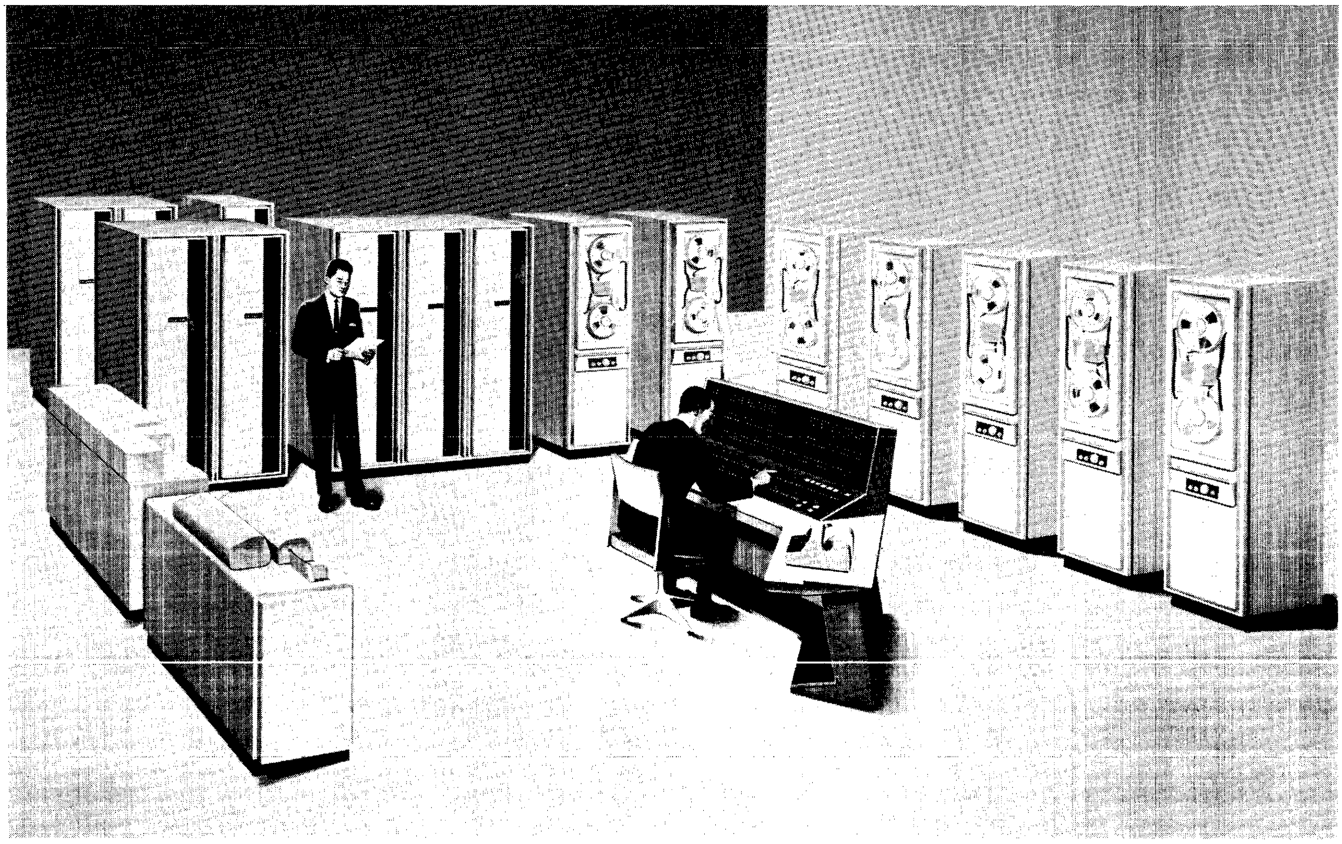
Cost, price and rental rates

Approximate cost of basic system: $400,000.

Rental rates for additional equipment: IBM equipment, $750 per month.

The rental charge for use of the computer and auxiliary equipment is $40 per hour. The rental rate does not apply to use of peripheral equipment when not connected to the computer. Such additional use is free.

SYLVANIA 9400 SYLVANIA ELECTRIC PRODUCTS, INCORPORATED



THE SYLVANIA 9400 Data Processing System has been designed as a general purpose computing system with built-in real time applications ability. The computer is capable of handling commercial data processing and scientific problems.

The manufacturer advises that these systems are presently built for their own use.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	8	4
Multiply:	43	39
Divide:	44	40

Construction (Arithmetic unit only):

Vacuum tubes: None.

Transistors: 13,507.

Condenser-diodes: 5,565.

Checking features: Internal parity, marginal checking capabilities.

STORAGE

Magnetic cores

Number of words: 32,768.
Number of binary digits: 38.
Access: 4 microseconds.

Random access disc

Number of words: 6,000,000.
Access: 200,000 microseconds.

Magnetic tape

Number of units that can be connected: 64.
Number of characters per linear inch of tape: 600 A/N.
Channels or tracks on the tape: 16.
Blank tape separating each record: 1 inch.
Tape speed: 150 inches per second.
Transfer rate: 90kc A/N characters per second.
Start time: 3 milliseconds.
Stop time: 1.5 milliseconds.
Average time for experienced operator to change reel

of tape: 45 seconds.
Physical properties of tape:
Width: 1 inch.
Length of reel: 3,600 feet.
Composition: Mylar.

INPUT MEDIA

Magnetic tape

90,000 characters per second.

Card reader

2,000 characters per minute.

Paper tape

270 characters per second.

Real time

120,000 characters per second.

OUTPUT MEDIA

Typewriter

10 characters per second.

Magnetic tape

90,000 characters per second.

Paper tape punch

100 characters per second.

Card punch

250 characters per minute.

Printer

900 lines per minute, 120 characters per line, 64 printing charatters.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 37.
Binary digits per instruction: 37.
Instructions per word: 1.
Instructions decoded: 64.
Arithmetic system: Fixed and floating point.
Instruction type: Modified single-address.
Number range: $-2^{242}+2^{255}$
-1×2^{-256}
$+1\times 2^{-256}$
$+(2^{242}-2^{255})$

Instruction word format

OP	1	M	A
1 — 6	7 — 9	10 — 21	22 — 36

Automatic built-in subroutines include clear memory.
Automatic coding includes COBOL, ALGOL, 94AP.
Registers and B-boxes:
Arithmetic Registers
Accumulator
B Auxiliary Register of the Arithmetic Unit
Q Used during multiplication and division
P/C Program Counter to count steps of program
P/C facilities return from subroutines
Index Registers
Instruction Register
Address Register
X Register
G Register
Error Alarm Register
Real Time In
Real Time Out
Control Register
Decoder Register

Power, space, weight, and site preparation

Power, computer: 20 KVA, 0.9 pf.
Area, computer: 360 sq. ft.
Room size, computer, 1,200 sq. ft.
Weight, computer: 21,825 lbs.

Cost, price and rental rates

Description	Model No.	Monthly Rental	Purchase Price	Monthly Maintenance
On-Line System Units:				
Central Processor	9401	$16,500	$825,000	$1,110
Includes:				
Arithmetic and Control Unit				
Console and Output Typewriter				
Floating Point				
Power Supply				
32,768 Word Memory	9432	12,500	625,000	633
16,384 Word Memory	9416	9,400	470,000	475
Input-Output Processor	9410	2,750	137,500	140
Magnetic Tape Unit	9490	950	47,500	185
High-Speed On-Line Printer and Buffer	9440	3,200	160,000	610
Disc Storage Unit and Control Buffer:				
20 Million Char. 1 Address Register	9452	5,640	282,000	1,340
80 Million Char. 1 Address Register	9453	6,800	340,000	1,750
20 Million Char. 3 Address Registers	9450	6,720	336,000	1,340
80 Million Char. 3 Address Registers	9451	8,840	442,000	1,750
Card Reader Punch				

and Buffer 100 cpm	9481	850	42,500	90
Card Reader Punch and Buffer 800-250 cpm	9482	2,250	112,500	380
High-Speed Card Reader and Buffer 2,000 cpm	9486	2,400	120,000	550
Paper Tape Reader and Punch System	9460	1,200	60,000	276
Real Time System	9415	760	38,000	50
Off-Line Systems:				
High-Speed Paper Tape to Magnetic Tape System	9465	4,140	207,000	925
Includes: Magnetic Tape Unit, Buffer and Control Unit, 2 Paper Tape Readers (1,000 cps)				
High-Speed Off-Line Printer System	9445	5,750	287,500	1,195
Includes: Magnetic Tape Unit, Buffer and Control Unit, High-Speed Printer				
High-Speed Card to Magnetic Tape System	9485	5,200	260,000	1,135
Includes: High-Speed Card Reader (2,000 cpm), Buffer and Control Unit, Magnetic Tape Unit				

TELEREGISTER MAGNETRONIC BID ASKED TELEREGISTER CORPORATION

DATA PROCESSING associated with stock exchange bid-asked price quotations.

Special purpose system.

System is operated "on line" with current updating features.

Status reporting feature included.

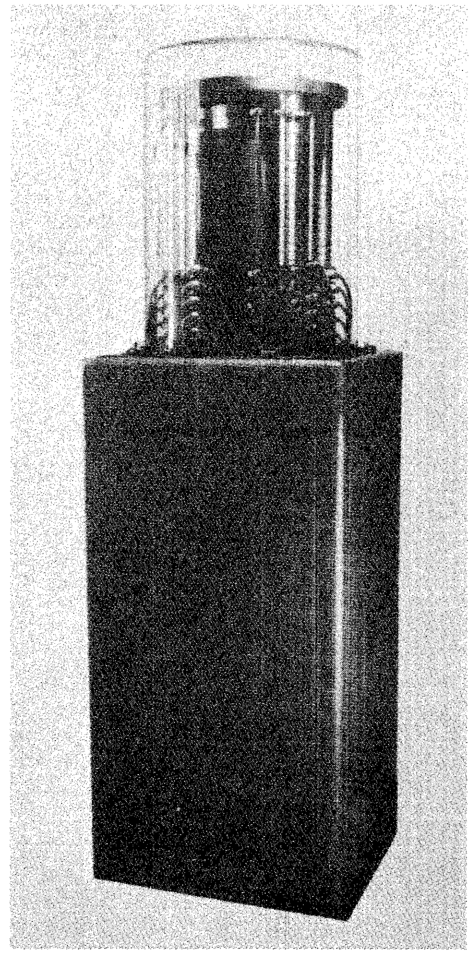
Control is possible from all input transactions recording locations.

System incorporates remote control of the data processor from input-output stations.

The following is a technical, operational and historical description of the system:

In 1937 The Teleregister Corporation installed for the Toronto Exchange an automatic, electro-mechanical system for displaying, storing and disseminating bid-asked prices on the more actively traded stocks. Bid-asked prices, generating at the trading posts on the floor of the Exchange from orders placed on the outside, were transmitted by reporters over an interphone system to keyset operators in the basement of the Exchange building. These keyset operators entered the bid-asked prices into the automatic system. The prices were displayed on electro-mechanical indicator units located at the posts on the floor for the information of the traders at that location. Simultaneously, the same prices were posted on indicators in a "check-board" located in front of the keyset operators.

The system also included a Canadian National Telegraphs network from the common equipment at the Exchange to brokers' offices in the Toronto area, who were provided with dial-ticker units.



A broker desiring the current bid-asked prices for a particular stock, looked up the three-digit code number for the stock in a code-assignment register. When he was ready to dial, he pressed a request button on his dial set. The operation of this button connected his dialing circuit and ticker line, through the line connecting equipment, to one of 24 transmitters which may be idle at the time. When the connection to the transmitter was completed, a ready lamp lighted on the broker's dial set, telling him that the equipment was ready to receive his dialing. The operation thus far is similar to that of a telephone exchange when the subscriber picks up the hand set and receives a dial tone. The dialed code numbers were stored in the transmitter, which was conditioned to extract the requested bid-asked price from the system's memory.

Up until several years ago the display indicators in the check board served a dual purpose in that they were also used as storage devices or memory units. These indicators were pulse actuated mechanisms which display the digits 1 through 0 and blank, on an 11-position rotatable drum. An indicator was set to display the desired digit by transmitting counted pulses to its winding after it has first been pulsed to its blank display position. In order to respond to a broker's dialed request, the indicators displaying the selected stock prices were actuated by exactly 11 pulses. This would leave the indicators in the same display position as before, but since it was possible to determine the number of pulses required to move each unit from its display position to its blank position, a coded read-out of the stored prices was accomplished. These prices were then automatically sent by one of the 24 transmitters to a ticker at the calling broker's office.

The magnetic drum storage equipment is time shared between the 24 transmitters and the six operators' positions by the seeker equipment. The purpose of the operators' positions is to keep the prices displayed at the Exchange and stored on the magnetic drum up to date with the trading. The seeker is a relay switching device which connects the next transmitter or operator's position awaiting access to the drum storage, which is time-shared to all positions. When a transmitter gets access to the storage, the three-digit code number, dialed by a subscriber and stored in the transmitter, is translated by the selector into the energization of one of 600 single-wire selection leads which were previously used to connect the transmitters to a specific section of the check-board display when that unit was used as the system's memory. In the new system these 600 leads are coded by use of a diode matrix with the position code of the same information on the magnetic drum storage. The output of the diode matrix is connected through drum selection coding relays to the drum connecting relays which, in turn, select one of 40 channels on the drum. If one of the six operators' positions has been given access to the storage drum, the electronic equipment is used to write the new price information stored on the operators' keyset in the section of the drum selected by one of 100 keys on the operators' keyset.

The magnetic storage unit consists of a solid aluminum billet, eight inches in diameter and 15 inches high, coated with an iron oxide film about 0.003 inches thick. The drum has capacity for storing approximately 2000 sets of prices, 600 being the initial usage. Prices are stored in permutation code on the drum coating as positively or negatively magnetized spots, the coding being changed as the prices alter. The drum is divided into circumferential tracks, or channels, each channel providing price storage for 25 stocks. The packing factor for this application is approximately 40 bits (or code elements) per inch along the track. A read-record head is mounted over each channel with a clearance of .001 inch from the drum surface. In recording, these heads polarize the magnetic coating as the drum rotates at a speed of 1450 rpm. beneath them, under control of electronic writing and gating circuits which are triggered off as the operators send in new prices. In a reading operation resulting from a broker's dialed request, the selected magnetized spots passing under the read-record head induce positive and negative pulses which are amplified and shaped into usable dynamic pulses.

The electronic equipment is under control of a program unit which is basically divided into seven circuits; starting, function determination, counting, one of 25 stock selection, one of six stock digit selection, read gating and write gating. Counting is in binary code and under control of three permanently magnetized tracks on the drum which are called synchronizing or "clock" tracks. These tracks deliver 1256 and 600 pulses, respectively, for each revolution of the drum. The clock pulses to the electronic counters of the program unit open electronic gates at the precise instant that the desired storage area on the drum is passing beneath the selected read-record head. There is a reference pulse from the drum which assures that the electronic counting will always start in synchronism with the drum rotation. There are pulses which are used to select one or a combination of the six digits representing a bid-asked price. Since each price digit has a four-element permutation code, there are $25 \times 6 \times 4$, or a total of 600 storage bits in use on each drum track. The function of the shift registers is to read the amplified serial bid-asked price pulses from the drum and send the price in parallel to the transmitters, 24 elements at a time. In the case of a write operation, the shift registers control serial writing into the drum from parallel price code inputs from the operators' keysets.

ARITHMETIC UNIT

Timing: Synchronous.

Operation: Sequential.

Five seconds of additional time are required for a transaction when input-output data are transmitted over teletype lines.

STORAGE

A single magnetic drum storage unit is utilized.

The drum capacity is 100,000 binary digits.

The system is designed to handle a maximum of eight million average transactions per hour.

Relays are used for temporary storage of information.

INPUT MEDIA

There may be 200 special input-output devices located near the printing mechanisms.

For remote locations, special transceivers are utilized to serialize and check data.

OUTPUT MEDIA

Visual verification of input-output data (response) is possible at the originating input point.

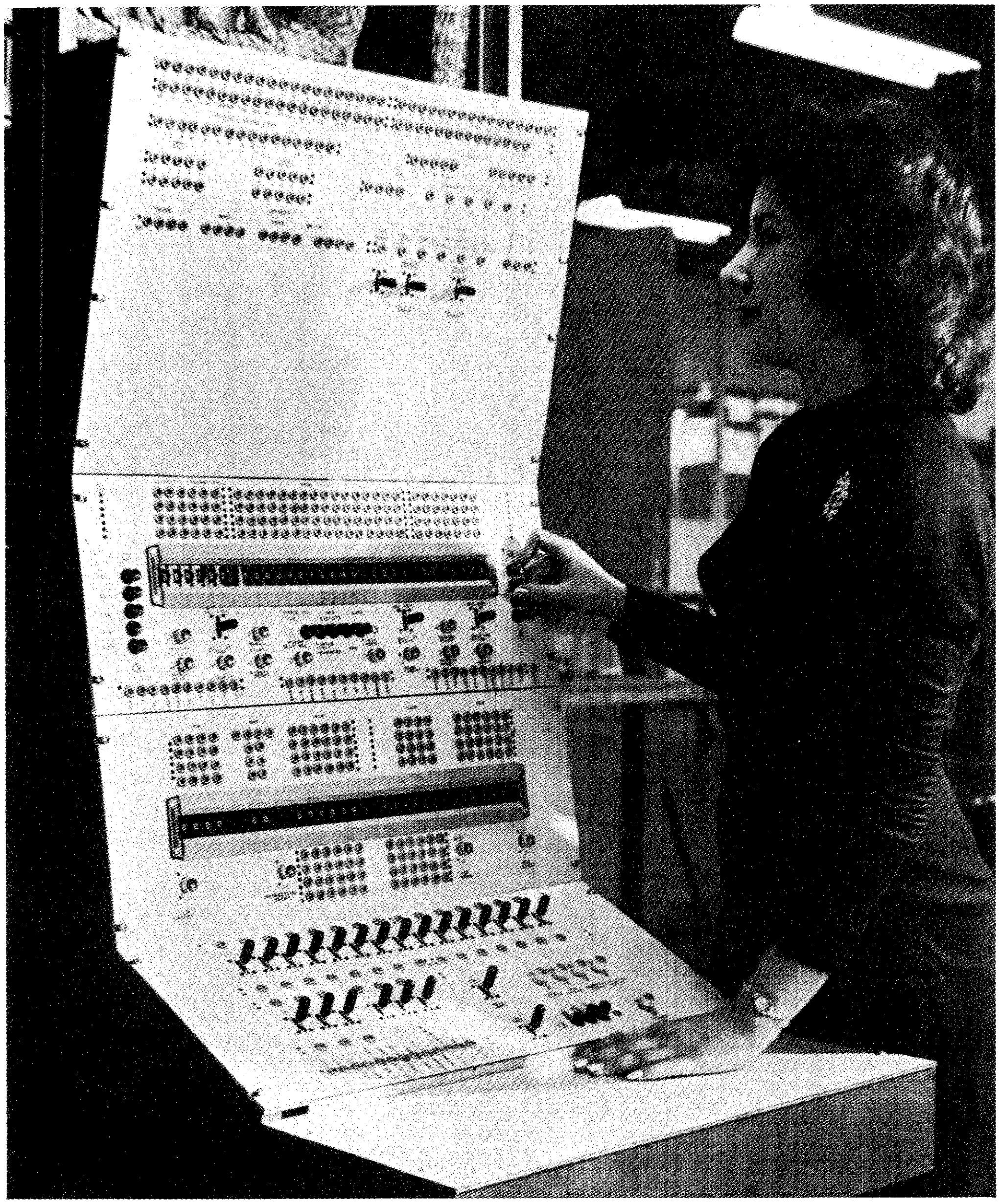
Input error or data rejection is immediately signalled to the originating input device.

Automatic checking and data verification controls are built into the system.

Cost, price and rental rates

Cost is dependent upon customer requirements.

TELEREGISTER TELEFILE TELEREGISTER CORPORATION



THIS SYSTEM is performing the following applications:

Banking Systems — On-line, real-time.
Airlines Reservations — On-line, real-time.
Communications Switching — On-line, real-time.
General Purpose Data Processing — Off-line.
Passenger Record Retrieval — Real-time.

These systems are constructed to operate on-line with nation-wide data communications networks consisting of high-speed (1,000 bits per second) and low-speed (75 bits per second) facilities. The switching, terminating and transceiver apparatus to equip these networks are provided by the manufacturer.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	160 + 16	80 + 16
(No. of augend + addend digits)		
Multiply:	80 + 16	
(Sum of product digits)		
(3 × No. of Multiplier + Multiplicand digits)		
Divide:	80 + 16	
(Sum of quotient digits) (No. of digits in dividend)		

Construction (Arithmetic unit only): Unit consists of transistors, diodes and modular packages.

Arithmetic mode: Serial by digit, parallel by bit.

Timing: Synchronous.

Operation: Sequential.

Checking features: System has parity checking in and out of any subsystem. Duality cross checks are available between processors and/or drums. Checks may also be programmed.

STORAGE

Magnetic cores

Decimal digits: 15,000.
Access: 16 microseconds.

Magnetic drums

Decimal digits: 1,050,000 per drum.
Access: 17,000 microseconds.

Discs

Decimal digits: 15,000,000 per assembly.
Access: 100,000 microseconds.

Magnetic tape

Number of units that can be connected: 54.
Physical properties of tape:
  Width: ½ inch.
  Length of reel: 2,400 feet.
  Composition: Mylar sandwich.

INPUT-OUTPUT MEDIA

Teleregister systems are primarily on-line rapid access business computing systems. Up to 29 subsystems can be connected to any single main frame.

The system can consist of any number of processors each acting independently or with any two processors cross checking each other. The systems have been designed to accommodate any conventional input-output media.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Decimal digits per word: 1.
Decimal digits per instruction: 8.
Instructions per word: Digit. Addressable.
Instructions decoded: Over 200, depending on system.
Arithmetic system: Fixed point.
  Variable length fields up to 100 digits.
Instruction type: One-address.
  Sequential; first four digits can be considered an instruction.

Instruction word format

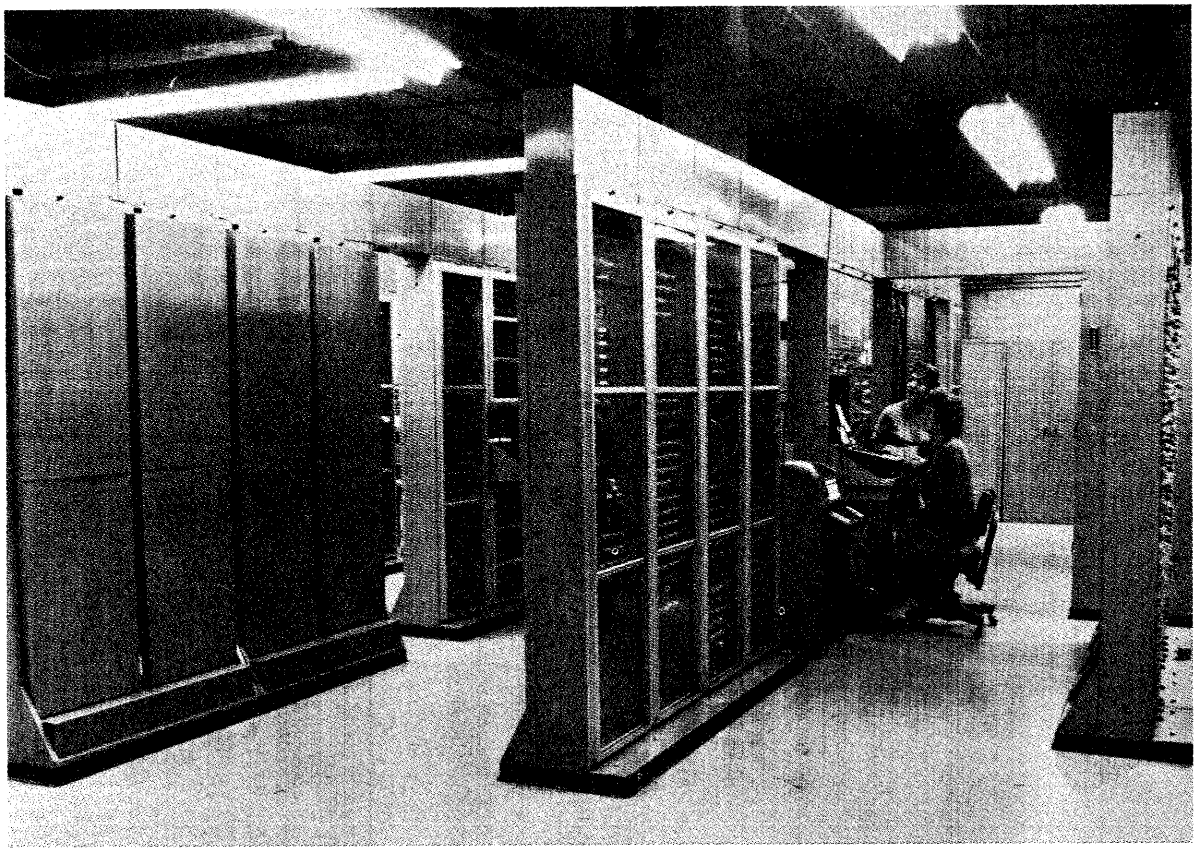
Order	Length of Field	Memory Address
1 — 2	3 — 4	5 ——— 8

Automatic built-in subroutines include Automatic Rerun in the event of certain failures and programmable separation of dual system.

Registers include the Accumulator Control (ACR), Memory Control (MCR), Instruction Control (ICR) and Quotient Control (QCR) registers.

All orders are performed by defining field lengths in the core memory. The addressable classification is digits. Instructions can be performed on from one to a hundred digits per operand.

TELEREGISTER UNIFIED AIRLINE TELEREGISTER CORPORATION



SPECIAL PURPOSE, on-line, real-time wired program data processor, designed for inventory applications with a high volume of random, undisciplined on-demand inquiries and transactions. Approximately 12,000 such transactions can be processed in one hour.

The term "Unified" stems from the unification of design requirements which enabled Teleregister to provide similar systems to several airlines. These systems permit the airlines to process requests for reservations very quickly, and have measurably improved load factors and customer relations. A Unified system also handles hotel reservations.

Forerunners of the Unified Systems were Teleregister's Magnetronic Reservisors.

The outstanding feature of the Unified Airline Processor is its ability to handle inputs from several hundred remote devices on a random demand basis. Since it is a real-time system, it makes accessible to hundreds of agents current information on seats available, returning cancelled space to inventory immediately.

Reports on inventory, seats sold, status of flights, etc. can be printed out.

A Unified Airline Data Processing System almost always includes communications equipment so that input-output sets may be located at any distance from the central equipment.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	17,010	10

Construction (Arithmetic unit only): Vacuum tubes and relays.

Arithmetic mode: Parallel.

Timing: Synchronous.

Operation: Sequential.

Checking features: Checking features include checks on magnetic drum recording and checks input data codes. Read back check on translation is optional. Also two processors are supplied with each system. They operate in "dual" mode, meaning that they operate simultaneously on the same problem, and cross check each other.

STORAGE

Magnetic drums

Number of binary digits per drum: 1,300,000.
Access: 17,000 microseconds.

INPUT MEDIA

Keysets

Parallel input.

Punched tape

200 words per minute.

Teletype

200 words per minute.

OUTPUT MEDIA

Keysets

Parallel output.

Punched tape

200 words per minute.

Teletype

200 words per minute.

Printer

100 words per minute.

The principal input-output device used with the Teleregister Unified Airline Processor is the special purpose agent's keyset. To make an inquiry or initiate an inventory transaction, the agent selects and inserts a patented code plate in a slot in the agent set. The plate lists a total of 64 flights or segments thereof, but only a single row listing eight flights is visible at the time. On an availability inquiry the processor reply causes a display on the agent set by eight lamps associated with the eight flights listed on the code plate. Four conditions can be shown for each flight, such as lamp on — "open for sale," lamp out — "flight closed," fast flash — "wait list open," and slow flash — "special, check further." Keys on the agent set are used to designate month, date, and number of persons in the party, and one of ten command keys is used to initiate the call. Besides availability inquiries and sell and cancel transactions, the command keys include requests for departing and arriving flight information and the print out at the processor location of wait list requests.

There are approximately 800 keysets of the unified type in use. They are compatible with the 600 keysets of the earlier "Reservisor" type.

The code plate eliminates the keying in of flight numbers and gives a positive reference for all replies. The set is rugged and compact.

The processors include a teletype message editor, which scans incoming messages for data on seats sold or canceled. When the editor finds a transaction affecting inventory, it bids for the processor and passes on the data so that inventory is updated.

Similarly, when variable inventory control levels are reached, teletype status messages are automatically generated and transmitted to the interested stations.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.

All logic and programs are wired into the processors by Teleregister. Additional programs and changes in logic are made by the manufacturer on a charge basis at the customer's request.

Cost, price and rental rates

Price varies with the number of modules required by the application.

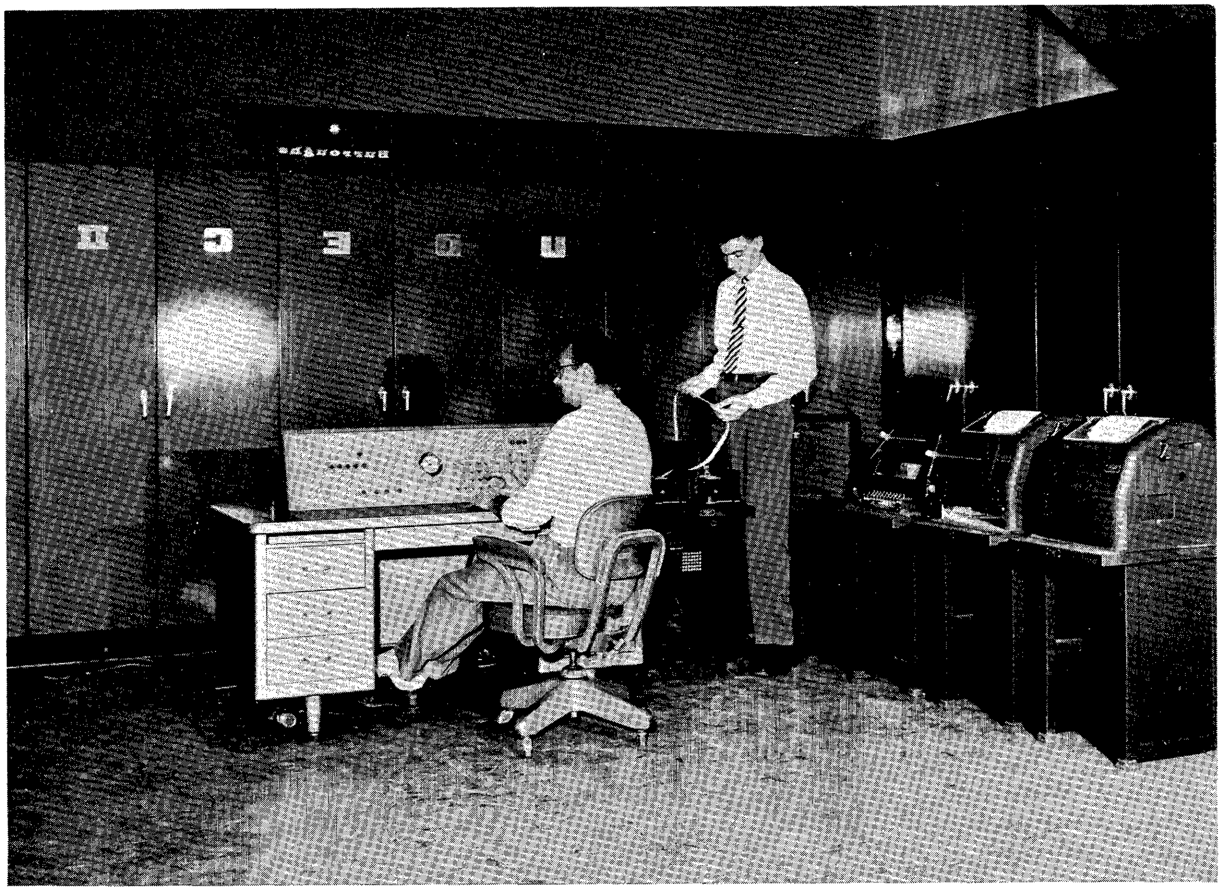
Power, space, weight, and site preparation

Room size: 1,000 square feet including benches and cabinets.

Figures are for central equipment, including two processors and typical communications equipment.

All interconnections between processor units are made through overhead ducts.

UDEC I, II & III BURROUGHS CORPORATION



BURROUGHS UDEC III is a general modification of UDEC II. UDEC III consists of Burroughs pulse control equipment which was used in UDEC II. The basic flexibility of this equipment provides for a maximum of modification with respect to special instructions and special input-output equipment added as required for scientific computing and commercial data processing.

ARITHMETIC UNIT

UDEC I:

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	176-264	88-176
Multiply:	4,000	3,912 (avg.)
Divide:	6,000	5,912 (avg.)

Construction: 3,000 vacuum tubes; 320 magnetic cores.

Rapid access word registers: 2.

Basic pulse repetition rate: 125 Kc. per second.

Arithmetic mode: Serial-parallel.

Timing: Synchronous.

UDEC II, III:

	Excluding Storage access (microseconds)
Add:	680
Multiply:	30,000
Divide:	30,000

Construction: Vacuum tubes.

Basic pulse repetition rate: 125 Kc. per second.

Arithmetic mode: Serial-parallel.

Timing: Synchronous.

Operation: Sequential.

Checking features: (UDEC I)

Modulo three arithmetic check.

Modulo three check on each word transferred to and from storage.

Forbidden combination multiply and divide check.

STORAGE

UDEC I:

Magnetic drum

Number of words: 5 300.
Number of digits: 53,000.
Access: 8,000 microseconds (average).

Magnetic cores

Number of words: 100.
Number of digits: 1,000.
Access: 88 microseconds.

UDEC II, III:

Magnetic core

Number of words: 1,000.
Access: 20 microseconds per five digits.

Magnetic drum

Number of words: 10,000.
Access: 8,500 microseconds (average).

53,000 decimal digits total drum storage. Drum information contained in blocks of 200 words for transfer to and from core storage.

INPUT MEDIA

UDEC I:

Paper tape (Ferranti photoelectric)

400 characters per second.

Keyboard

Manual speed.

UDEC II, III:

Paper tape (Ferranti photoelectric)

120 characters per second.

Paper tape (Potter magnetic tape handler modified for photoelectric input)

Magnetic tape (Potter)

OUTPUT MEDIA

UDEC I:

Printer

Six characters per second.

Paper tape

60 characters per second.

UDEC II, III:

Paper tape (Teletype) (2)

60 characters per second (five-level).

Paper tape (Teletype)

60 characters per second (seven-level).

Magnetic tape (Potter)

PROGRAMMING AND NUMERICAL SYSTEM

UDEC I:
Internal number system: Binary coded decimal.
Decimal digits per word: 10
Decimal digits per instruction: 5.
Instructions per word: 2.
Instructions decoded: 34.
Instructions used: 34.
Arithmetic system: Fixed point.
Instruction type: One- or two-address.

Program selection permits one- or two-address modes of operation. The decimal point may be manually set at any desired location. Two-address operation is optional for optimum programming.

UDEC II, III:
Internal number system: Excess-three binary coded decimal.
Decimal digits per word: 9 plus sign digit.
Decimal digits per instruction: 5.
Instructions per word: 2.
Instructions decoded: 40.
Instructions used: 32.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: Movable decimal point.

Two-address word possible if second instruction in each word is unconditional transfer. Each instruction is one-half word, i.e. five digits. Of these, three digits specify address and two digits the command.

Cost, price and rental rates

UDEC I:
Approximate cost of basic system: $500,000.
Approximate cost of modifications and additions: $200,000.

UDEC II, III:
Approximate cost of basic system: $200,000.
Additional equipment: $100,000.

Power, space, weight, and site preparation

UDEC I:
Power, computer: 32 KVA.
System arranged in form of an almost closed rectangle.

UDEC II, III:
Power, computer: 33 Kw.

UNIVAC FILE 0 UNIVAC DIVISION, SPERRY RAND CORPORATION

THE UNIVAC FILE-COMPUTER SYSTEM is an electronic computer system which provides for magnetic filing combined with electronic computing for random access processing of unsorted data. It has common language versatility and many types of input-output may be used simultaneously. Input-output units, and storage units, can be put together as building-block units to produce a system satisfying individual requirements. Such a system is expandable at any time.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	8,610	1,200
Multiply:	23,800	16,300
Multiplier = 55555.		
Divide:	27,500	approx. 20,000
Six-digit dividend and six-digit divisor.		

The storage access for add, multiply and divide operations includes accessing of the two operands and the result.

Arithmetic mode: Serial.

Timing: Synchronous.

Operation (System): Concurrent.

Checking features: Checking features include odd parity, execution of arithmetic and some transfer instruction with built-in checks, complete tape read checks, and logical checks.

Registers

Register A: Receives first operand.

Register B: Receives second operand.

Register C: Accumulates the result in add and subtract operation, in division it receives the remainder, in multiplication it receives most significant product digits.

Register D: Accumulates the result in add and subtract operations, in division it stores the quotient, in multiplication it stores the least significant product digits.

STORAGE

Drum (high-speed)

Number of words: 1,070.
Number of alphanumeric characters: 12,840.
Access: 2,500 microseconds average.

Drum (mass memory) (optional)

Number of words: 15,000 per unit.
Number of alphanumeric characters: 180,000 per unit.
Access: 17,000 microseconds.
Maximum eight units.

Magnetic tape

Number of units that can be connected: 10.
Number of characters per linear inch of tape: 139.
Channels or tracks on the tape: 7.
Blank tape separating each record: 0.5 inch.
Tape speed: 75 inches per second.
Transfer rate: 10,425 characters per second.
Start time: 7 milliseconds.
Stop time: 10 milliseconds.
Average time for experienced operator to change reel of tape: 30 seconds.
Physical properties of tape:
Width: 0.5 inch.
Length of reel: 2,400 feet.
Composition: Mylar or metal.
900 microseconds, above, includes time to transfer one word to an arithmetic register.

INPUT MEDIA

Magnetic tape

10,425 characters per second.

Paper tape

200 characters per second.

Card read-punch unit

150 cards per second.

All input devices are on-line. 80- or 90-column cards may be used.

OUTPUT MEDIA

Magnetic tape

10,425 characters per second.

Paper tape

60 characters per second.

Card punch 80 or 90

150 cards per minute.

High-speed printer

600 lines per minute.

Inquiry typewriter

10 characters per second.

Compatibility of tapes is possible with other UNIVAC tape systems. Printer may be operated on- or off-line.

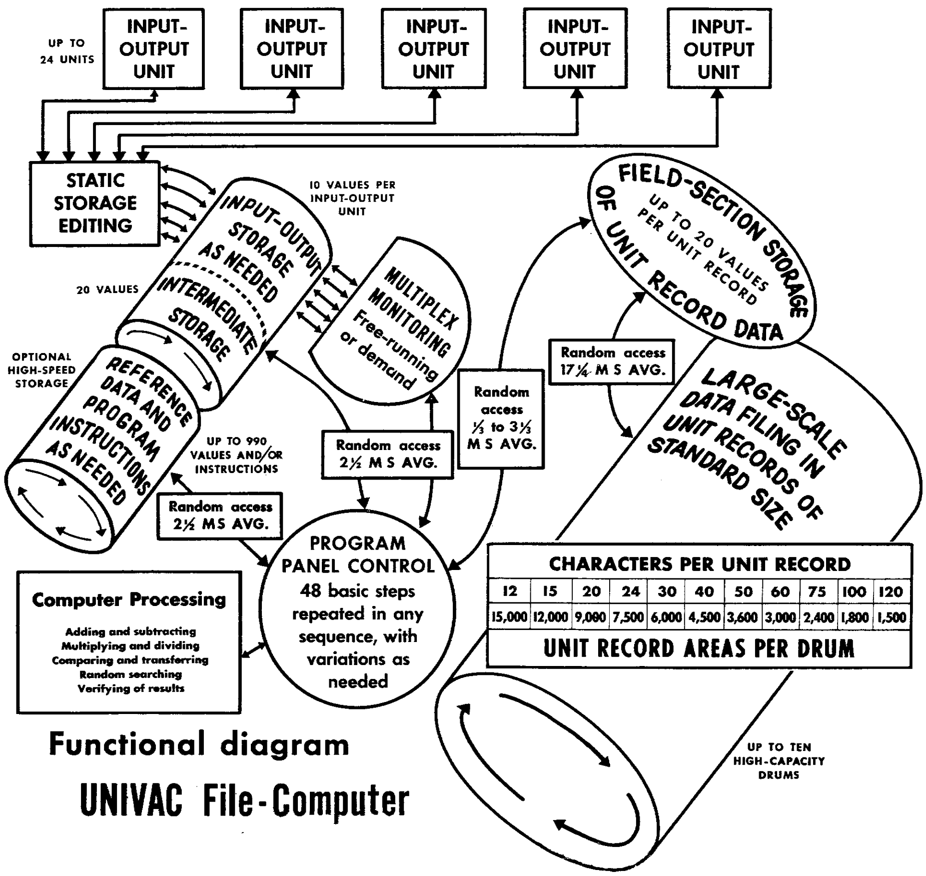
PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal (excess three).
Digits per word: 12 digits including sign.
Digits per instruction: 12 characters per instruction.
Instructions per word: One plus sub command.
All instructions are programmed by external plugboard.
Arithmetic system: Fixed point.
Instruction type: Three-address.

Instruction word format

V_1 Address of first operand	V_2 Address of 2nd operand	R Address for Result Storage	Process	Special Char. Sub-Command
3 digits	3 digits	3 digits	2 digits	

Automatic built-in subroutines include tape search.



CHARACTERS PER UNIT RECORD										
12	15	20	24	30	40	50	60	75	100	120
15,000	12,000	9,000	7,500	6,000	4,500	3,600	3,000	2,400	1,800	1,500
UNIT RECORD AREAS PER DRUM										

Functional diagram

UNIVAC File-Computer

UNIVAC File Computer (UFC-1) UNIVAC DIVISION, SPERRY RAND CORPORATION

THE BASIC UFC-1 SYSTEM consists of the central processor comprising a program control unit, a program control storage unit, and an arithmetic unit; a control console; and an input-output system consisting of any combination of input-output units up to a maximum of ten units. The input-output system may consist of magnetic tape units, inquiry typewriters, 80- or 90-column punched card systems, punched paper tape systems, and line printers. The basic system may be expanded by the addition of a general storage system comprising a general storage control unit and up to ten magnetic drum storage units; and a sort-collate system comprising a sort-collate control unit and four magnetic tape units. Vacuum tubes are the principal electronic components of the central processor, while most of the input-output units are transistorized.

SYSTEM COMPONENTS

General

Word Length: Fixed, 12 characters.
Numeric Characters Per Word: 11 plus sign.
Alphabetic Characters Per Word: 12.
Character Code: 6-bit binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 168 kilocycles.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	11
Multiply: 555555 by 5555	45
Divide: 3086108025 by 5555	60

Average access time:
High speed drum: 2.5 milliseconds.
Magnetic core buffers: 0.9 milliseconds.
General storage drum: 17.0 milliseconds.

Checking features:

Automatic checking of all arithmetic processes, if desired, by means of zero balancing.

Automatic checking of all transfers of data within the central processor by means of parity check.

Automatic checking of all transfers of data into and out of the central processor by means of parity check.

Registers

Arithmetic registers: Registers A, B, C, and D. 12 character magnetic core registers storing operands and results of arithmetic computations.

General storage address register: A 7-digit register that holds a general storage drum address.

Program address counter: A 3-character shift register used to sequence internally stored programs.

Storage address register: A 3-character register which holds a program control storage address while the location that address specifies is being found and the storage reference completed.

Code distributor register: A 1-character register used to store any one of a group of 40 permissible characters for routing pluses or "dc enables" on the program control plugboard.

Processor register: A 2-character register that contains the operation code of the process being performed during the execution of the current instruction word, or the number of the plugboard step currently being executed.

Special character register: A 1-character register that contains the special character code designating any subcommands to be performed.

Instruction revolver: Actually two 12-character registers; one to hold the current instruction word; the other to hold the next instruction word.

Shift revolver: A 12-character register to hold shift words used to control shifting operations.

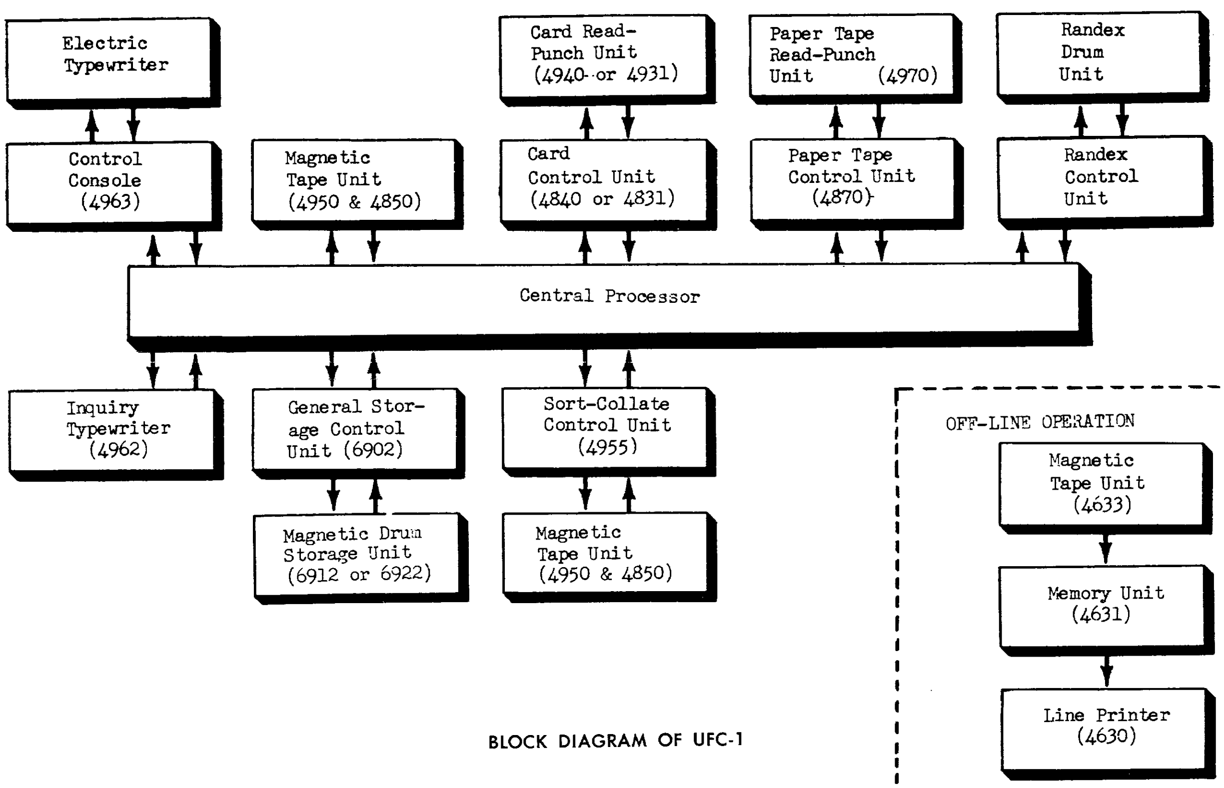
Memory

High speed magnetic drum: This unit is the internal storage medium of the system. It is physically located in the program control storage unit of the central processor. The drum rotates at a speed of 12,000 revolutions per minute and is divided into 111 tracks, each having a capacity of 120 characters. The tracks are assigned as follows:

20—input-output.
85—intermediate storage.
2—factor storage.
1—field selector pattern.
2—instruction revolvers.
1—shift revolver.

Magnetic core buffers: In addition to the high speed magnetic drum, two 120-character magnetic core buffers are provided. These buffers may be used as rapid access locations for the temporary storage of data.

General storage magnetic drums: Up to ten general storage drums may be used with the system to increase memory capacity by 180,000 characters per drum.



BLOCK DIAGRAM OF UFC-1

Control panel (4963)

This unit is a part of the control console and contains switches and indicators to monitor and alter program conditions.

INPUT MEDIA

Magnetic tape unit (4950) and associated control unit (4850)

Maximum number per system: Any combination of input-output units (magnetic tape units, punched card units, line printers, etc.) may be used up to a maximum of nine units.
Packing density: 130 characters per inch.
Number of channels: 8.
Record length: Fixed, 120 characters.
Record gap: 0.5 inch or 1 inch.
Tape speed: 75 inches per second/10,425 characters per second.
Rewind time: 6 to 6.6 minutes.
Start-stop time: 7 to 10 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
 Composition: Mylar base.
 Length: 2,400 feet.
 Width: ½ inch.
Error detection: Parity check, on each character. Count check on each record. Check for bad spots on tape.

Punched card system, 80-column

This system consists of a card control unit (4840) and a card read-punch unit (4940). The card read-punch unit has two channels, a read channel and a punch channel. It can operate simultaneously on two stacks of cards, reading input data from either or both stacks and punching output data into one stack. The card control unit is under command of the central processor and passes data from the central processor to the read-punch unit or from the read-punch unit to the central processor. The read-punch unit punches 80-column cards at a rate of 150 cards per minute, and reads cards at a rate of 300 cards per minute, and also has the ability to check reading and punching. It has the ability to read data into the central processor while simultaneously punching output data from the central processor.

Punched card system, 90-column

This system consists of a card control unit (4831) and a card read-punch unit (4931). The operation of this system resembles the 80-column card system in that it provides the ability to punch in the same card from which it reads. The read-punch unit has one channel. Its read and punch speed is 150 cards per minute.

Electric typewriter

This unit is mounted on the control console and is used for the manual input of data to the central processor or to print out data from the central processor.

Punched paper tape system

This system consists of a paper tape read-punch unit (4970) and associated control unit (4870). The system will read information from and punch information into paper tape in 5-, 6-, 7-, or 8-channel code. It reads at the rate of 200 characters per second and punches at the rate of 60 characters per second.

OUTPUT MEDIA

Magnetic tape, punched card, and punched paper tape system

As previously described.

AUXILIARY COMPONENTS

Magnetic drum storage units (6912 or 6922)

These units are used with the general storage control unit (6902). They are available in two models, one drum per unit and two drums per unit. A maximum of ten drums may be used wtih the system. Each drum is divided into 300 tracks, 600 characters per track; a capacity of 180,000 characters per drum.

Sort-collate system

This system consists of a sort-collate control unit (4955) and four magnetic tape units. It is a special purpose on-off-line magnetic tape file processing system, which performs a wide variety of soring, collating, merging, and extracting operations of data from magnetic tape.

Off-line speed printers (4630, 4631, 4632, and 4633)

These units operate completely off-line (with magnetic tape) at a rate of 600 lines per minute. There are 130 positions per line with a choice of 51 characters per position.

Inquiry typewriter (4962)

This unit is a modified electric typewriter. It is used for manual input to the central processor or to print out data from the central processor.

Randex system

This system consists of a Randex control unit and from one to ten Randex drum units connected to a demand station. Each drum unit has a capacity of 6 million 7-bit alphanumeric characters, providing a total capacity of 60 million characters.

PROGRAMMING

General: The UFC-1 uses a three address type of instruction. The operation of the system can be controlled by a stored program, a plugboard program, or by a combination plugboard/stored program.

Instructions:

Number of instructions per word: 1.

Number of digits per instruction: 12.

Total number of operation codes: 27 instructions; 33 subcommands which modify the instructions.

Instruction word format

U	V	W	PR	Sign
XXX	XXX	XXX	XX	X

U, V, and W are storage addresses.

PR—two characters specify the operation process.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Central Processor, including	$4,190	$176,000					
6901 Arithmetic Unit				80x30x71	1,420	4.50	22,000
6900 Program Control Unit #1				80x30x71	2,200	5.50	23,000
6903 Program Control Unit #2				80x30x71	2,200	17.00	25,000
6902 Storage Unit (General)	1,400	59,000		61x30x71	1,240	3.00	20,000
6912 Extension Cabinet, 1 Drum	500	21,000		46x30x71	1,480	1.50	1,700
6922 Extension Cabinet, 2 Drums	900	38,000		46x30x71	1,480	1.50	1,700
4963 Console Control Panel	150	6,300		36x78x53	600	0.25	3,400
4931 90-Col. Card Read-Punch Unit	1,300	55,000		30x41x65	1,200	2.00	6,000
4940 80-Col. Card Read-Punch Unit	1,300	55,000		34x34x49	1,000	(3)	(3)
4831 80-Col. Card Control Unit	(2)	(2)		60x30x71	1,560	(2)	(2)
4840 80-Col. Card Control Unit	(4)	(4)		81x30x71	1,840	2.00	6,000
4950 Magnetic Tape Unit	750	34,000		50x31x56	1,200	4.80	16,200
4630 Off-Line Printer System	3,300	185,000		48x32x48	800	9.00	4,800
4962 Inquiry Typewriter	350	15,000		36x78x30	500	0.25	3,400
4970 Punched Paper Tape System	1,450	61,000		81x27x60	1,800	1.50	5,100
4834 Multiple Adapter Power Supply Unit(5)	140	6,000		36x29x31	500	4.00	1,000
4955 Sort-Collate Control Unit	750	34,000		50x31x66	1,200	4.00	13,400
Randex Control Unit	1,750	73,500		30x80x71	2,000	6.6	18,800
Randex Drum Unit	1,050	44,100		34x77x69	2,000	3.9	9,200

[1] Maintenance included in rental price. Separate maintenance contract provided for purchased equipment.

[2] Included in 4931.

[3] Included in 4840.

[4] Included in 4940.

[5] For use when more than two (2) light peripheral units (typewriters, etc.) are used.

THE UNIVAC LARC

UNIVAC DIVISION, SPERRY RAND CORPORATION

THE UNIVAC LARC is a general-purpose computing system designed to solve a wide variety of problems that are beyond the range of current large-scale systems. It is both a business and scientific data-processing system.

The UNIVAC LARC incorporates many modern electronic data-processing advances including modular construction, large data storage, versatile input-output, solid-state circuitry, "time-shared" operation, and extremely fast computation.

The wide range between the basic and expanded UNIVAC LARC Systems allows the user to select a system to meet immediate needs while allowing for expansion in the future. A basic UNIVAC LARC, for example, includes a Computer, for high-speed arithmetic and logical computations, and a Processor for handling input-output and "secondary" computing operations. In an expanded system, two Computers may be included for greatly increased computing capacity.

Supporting the computing units of the UNIVAC LARC is an extensive high-speed data storage system, comprised of magnetic ferrite-core and magnetic drum storage units. The UNIVAC LARC storage is expandable to a capacity of over 73 million decimal digits of information.

The input-output units of the UNIVAC LARC System offer magnetic tape input-output, high-speed punched-card input, output printers which produce printed lines at a rate of 600 per minute, and page recorders which record an entire page at a speed of 10,000 lines per minute. The magnetic tape used with the UNIVAC LARC is compatible with tapes used by UNIVAC I and II Systems and the broad complement of UNIVAC data-conversion devices.

Solid-state circuitry and parallel input, processing, and output operations are combined in the UNIVAC LARC System.

COMPUTER AND PROCESSOR

A basic UNIVAC LARC System contains a Computer and a Processor. Both have most of the attributes of a general-purpose computer but each performs specialized functions in the system. The primary function of the Processor is the control of all input-output operations and data transfers between the auxiliary storage and the main storage of the system. The Computer is designed to perform arithmetic computation.

If increased computing capacity is required, the basic system may be expanded to include a second Computer. The Computers and the Processor, controlled by separate programs, operate either cooperatively or independently by communicating through the common core storage.

The two Computers in an expanded system can be programmed to solve a single problem jointly or each Computer can solve independently one or more separate problems. The Processor is designed to accommodate the input, output, and auxiliary storage needs of both Computers. It can also perform any necessary editing of output data. If input-output demands are not excessive, the Processor can also perform sorting, merging and other operations simultaneously with the Computer programs.

STORAGE

A magnetic ferrite-core storage with a capacity of up to 97,500 12 decimal-digit words is accessible to both the Computer and Processor. With a word access time of four microseconds this storage serves as the main storage of the system and as a common communications link between the Computers, the Processor, the auxiliary magnetic drum storage and the input-output units.

The core storage is divided into independently operating modules. Instructions and operands are sent to and received from core storage at maximum speed and without interference. Any part of core storage not being used by the Computers can be used as an input-output buffer without slowing input-output data transfers for the Computers.

Since the Computers and the Processor have access to the same storage, they can alert one another to the presence of information in a particular part of storage. This permits an almost limitless degree of cooperation to be achieved between the Computers and the Processor.

The Computer can cause the Processor to transfer data between the main storage and a drum storage which has the capacity, speed, and reliability to keep abreast of the unusually high computing rates of the system.

INPUT AND OUTPUT

A full complement of both on-line and off-line input-output equipment can be provided with the system. The on-line equipment consists of:

1. *Magnetic Tape Read-Write Units* for introduction of data into the system and recording of output for subsequent conversion on an auxiliary device or for long-term storage.
2. *Electronic Page Recorders* for direct, fast recording of output data in either tabular or graphical form. The Page Recorder can represent output data as numeric or alpha-numeric characters in an edited or unedited format. It can also represent data in the form of plotted curves complete with call-outs, titles, scales, and grid patterns.
3. *On-Line High-Speed Printers* for multiple-copy printing of numeric or alpha-numeric data in an edited or unedited format.
4. *A High-Speed Card Reader* for introducing data into the system directly from 80-column punched cards at a speed of up to 450 cards per minute.
5. *Console Typewriter-Printers,* with an attached paper tape reader and punch, for communication between the Computer or Processor and the operator.

UNIVAC LARC off-line auxiliary equipment includes:

1. *The UNIVAC High-Speed Printer* for printing in an edited format or plotting data recorded on magnetic tape.
2. *The Unityper II* for direct keyboard-recording of data on magnetic tape.
3. *The Tape Verifier* for direct keyboard-recording of data on magnetic tape or verification and correction of data already recorded on magnetic tape.
4. *The Punched Card-to-Magnetic Tape Converter.*
5. *The Magnetic Tape-to-Punched Card Converter.*
6. *The Paper Tape-to-Magnetic Tape Converter.*
7. *The Magnetic Tape-to-Paper Tape Converter.*
8. *The Bi-Directional Paper-to-Magnetic Tape Converter.*

MODULAR CONSTRUCTION

The UNIVAC LARC System consists of modular units. These units can be joined together in various numbers and combinations to form a system balanced for a wide range of problems. The modular units of equipment that can be included in a UNIVAC LARC System are listed in table below.

Each cabinet within the system is self-contained and has its own power supplies, clock pulse generators, and heat exchangers. The Synchronizers are modular units of control represented by solid-state component packages contained within the Processor cabinet. The cabinet may contain all of the Synchronizers in the expanded system. Each of the storage and input-output units of the system is designed for off-line maintenance while the remainder of the system is operating. The tape, drum and core storage units are connected into the system by means of plugboards which make it possible to quickly substitute one unit for another of the same type.

Modular Units of a Typical and Completely Expanded UNIVAC LARC System

Equipment Name	Typical	Expanded
Magnetic Core Storage Units (2,500 words each)	8	39
Computers	1	2
Multipurpose Fast Registers (per Computer)	26	99
Processor	1	1
Drum-Read Synchronizers	2	3
Drum-Write Synchronizers	1	2
Tape Read-Write Synchronizers	2	4
Electronic Page Recorder Synchronizer	0	1
High-Speed Printer Synchronizer	1	2
Card Reader Synchronizer	0	1
Console Printer Synchronizer	1	1
Tape Positioning Checker	1	1
Magnetic Drum Storage Units (250,000 words each)	6	24
Uniservo II Magnetic Tape Units	12	40
Electronic Page Recorders	0	2
High-Speed Printers	1	2
High-Speed Card Readers	0	1
Control Consoles	1	2
Numeric Keyboards (one per Console)	1	2
Alpha-Numeric Console Printers (one per Console)	1	2

CHARACTER CODES

The basic internal code of the UNIVAC LARC is a modified five-bit biquinary code. Alphabetic information is represented in the UNIVAC LARC in *pairs* of numeric characters represented in the basic code. Thus, a word (12 digits) of alpha-numeric information actually consists of only six characters.

On UNIVAC Magnetic Tape, alpha-numeric characters are represented in the standard UNIVAC seven-bit excess-three code.

The alpha-numeric characters, when read into the LARC as alpha-numeric information, are expanded to digit pairs. The decimal digits are distinguishable in this mode because the most significant digit of the pair is always a 2.

UNIVAC code

LARC input data is represented on magnetic tape in the UNIVAC seven-bit excess-three code. Input information from the tapes is automatically translated to LARC internal code and output information that is to be recorded on tapes is automatically translated back to the standard UNIVAC code.

The Tape Read-Write Synchronizers in the Processor can be instructed to translate a block of numeric input data into the LARC one-digit numeric code, or translate a block of alpha-numeric data into the LARC two-digit alpha-numeric code. Similarly, output can be translated from either the LARC one-digit numeric code or two-digit alpha-numeric code.

LARC one-digit numeric code

In the basic five-bit biquinary code of the UNIVAC LARC, 15 digit combinations are allowed, any one of which may be stored in any digit position in storage.

The 15 combinations and the characters they normally represent are shown on the following page. The fifth bit of the code is a parity check bit. Only combinations containing an odd number of binary "ones" are allowed. The code combination 001101, although it contains an odd number of "ones," is not allowed.

In the Computer, all 15 digit combinations can be shifted, extracted or transferred. Except for a minus or period digit in the sign position, only the numerics 0 through 9 are allowed in the adder-comparator of the Computer. In the Processor adder-comparator, however, the non-numeric digits (plus, minus, space, period, and ignore) are allowed in any digit position of a word. When non-numerics are added, they appear in the result in accordance with a predetermined order of precedence. (Word formats for both the Computer and the Processor are explained later.)

LARC two-digit alpha-numeric code

An alpha-numeric character is represented in LARC by two adjacent numeric digits that are handled as a pair. An equivalent alpha-numeric character is represented on magnetic tape by a single 7-bit digit in UNIVAC magnetic tape code.

Console-printer code

Because the Console Printer is a relatively slow device, its Synchronizer is designed to operate only in the alpha-numeric mode. The form a print-out takes is determined by the Processor program. If numeric data is printed, it is first translated by the Processor program to the two-digit alpha-numeric code. The Printer Synchronizer decodes a LARC two-digit alpha-numeric combination to perform a function or print a character. Many of the two-digit combinations can print either of two characters depending upon whether the type basket of the printer is in the upper or lower case. The type basket is shifted to the upper case position by the two-digit combination 10 and is shifted to the lower case position by the combination 11.

The following two-digit combinations are decoded by the Synchronizer to perform specific functions. In each case the same function is performed regardless of whether the type basket is in the upper or lower case.

15 Neither prints a character nor leaves a space, but is ignored.

16 Leaves a space.

35 Returns the carriage to the left margin.

55 Advances the carriage to the next present tab stop.

The Console Printer may also be used to prepare punched paper tapes. With the type basket in the upper case position, all 15 LARC code combinations and several special code combinations may be punched on the paper tape.

Console keyboard code

The keyboard on the Operator Control Console is used to manually enter data into either the five-digit or 12-digit display register. It consists of 18 keys. Fifteen keys are used to enter the 15 LARC code combinations into either display register; two keys are used to connect the keyboard to the proper display register, and one key is used to disconnect the keyboard from the display registers.

Console decimal displays

The decimal displays on the Operator Control Console display in decimal form the contents of the five-digit display register, the 12-digit display register, and a Computer control counter register. Characters representing all of the 15 LARC code combinations may be displayed. Since the number of single characters that can be displayed is limited to 12, the ignore, space, and period are represented by superimposing one character upon another. The ignore is represented by a 1 and 8 superimposed, the space by a 0 and — superimposed, and the period by a 1 and 0 superimposed.

THE COMPUTER of the UNIVAC LARC System is specifically designed to perform fixed or floating point arithmetic operations in single or double-precision. To accomplish this, many operations are performed in parallel including the transfer and processing of bits and digits of a Computer word. Secondary operations such as input, output, storage transfer, address modification, floating point, and error checking operations, which otherwise slow arithmetic and logical operations, are also performed in parallel with these operations.

COMPUTER WORD FORMAT

A Computer word usually consists of 11 decimal digits and an algebraic sign. Two Computer words may be combined for double-precision operation.

INSTRUCTIONS

The repertoire of the Computer includes 75 instructions. They increase the speed of computation by enabling operations to be performed with fewer instructions than would otherwise be required.

Many Computer instructions are, in effect, built-in subroutines. By designing into the instructions operations which formerly had to be programmed, more of the Computer program and the efforts of the programmer can be devoted to furthering the computations at hand rather than to organizing the computations or the program itself.

The table below contains performance times, expressed in microseconds, for representative Computer arithmetic instructions.

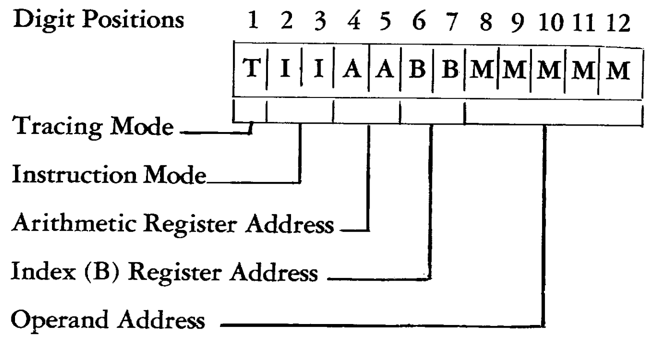
Arithmetic instruction execution times

	Single-Precision		Double-Precision	
	Fixed point	Floating point	Fixed point	Floating point
Add or Subtract	4	4	12	16
Multiply	8	8	36	36
Divide	32	28	184	168

The instruction times listed include the time required for storage access, address modification, error checking, etc. All input, output, and auxiliary storage operations may be assumed to be performed in parallel with the instructions.

Instruction word format

A UNIVAC LARC Computer instruction word is composed of 12 decimal digits. The format on an instruction word is illustrated in the table below.



Tracing mode

Any Computer instruction may be tagged with any one of nine tracing mode digits (1-9). Just before an instruction is executed, the tracing mode digit is detected and, if the Computer is operating in the designated tracing mode, an automatic transfer of control will be effected to a routine associated with the tracing mode digit. At the completion of the routine, control is transferred back to the main program. Instructions are available which direct the Computer to enter or leave any one of the nine tracing modes.

An "enter tracing mode seven" instruction, for example, will cause all succeeding instructions that are tagged with a tracing mode seven digit to cause a transfer of control to an associated routine. Either the program directly or the operator indirectly, by a manual intervention routine, may instruct the Computer to enter or leave any one of the nine tracing modes. The tracaing mode routines can be constructed to perform any number of functions. Usually these functions are related to debugging or monitoring a program.

Instruction code

Digit positions two and three of a Computer instruction word contain the instruction code for the operations to be executed by the Computer. An instruction code not in the Computer repertoire of instructions will cause a transfer of control to an error routine.

Arithmetic register address

The address of one of the multipurpose fast registers is normally contained in digit positions four and five of a Computer instruction word when the register is to be used as an arithmetic register for storing operands and processing results.

Index register address

Instruction word digit positions six and seven normally specify the address of one of the multipurpose fast registers that is to be used as an index (B) register for storing an address modifier. The storage address (m) portion of an instruction is automatically modified by a modifier in the specified index register after the instruction is read from storage, but before the instruction is executed.

If the index register specified is 00, the m address is not modified. All normal Computer instructions containing an operand address may refer to an index register for modification of the address.

Storage address

The storage address portion of the instruction, digit positions 8 through 12, usually specifies the address of an operand. It may contain a main storage address or the address of a multipurpose fast register.

Instruction overlapping

The Computer is designed to process several instructions simultaneously and perform different steps of the several instructions in parallel. While one instruction is actually being executed, the operand of the second instruction is being transferred to or from storage, the operand address of a third instruction is being modified, and a fourth instruction is being obtained from storage.

Although an add instruction actually takes more than four microseconds to perform, a series of these instructions are executed at the rate of one every four microseconds. For all practical purposes the total instruction time is four microseconds.

If control is transferred to a new sequence of instructions, the first instruction of the new sequence would require time to propagate through the several steps before it is executed. Therefore, whenever a transfer of control takes place, eight microseconds are added to the execution time of the instruction that caused the transfer.

Sense flip-flops

The Computer instruction code contains instructions for setting or resetting any one of ten sense flip-flops together with transfer of control instructions that are conditional on the state of the sense flip-flops. The sense flip-flops have no predetermined function. Essentially, they are general purpose single-bit storage units that may be used by the programmer in numerous ways. The sense flip-flops may be set directly by the program or indirectly through manual intervention by the operator.

Address modification

Any Computer instruction that contains an operand address may be tagged with the address of any index register. Before such an instruction is executed, its operand address will be modified automatically by the addition of a constant contained within the specified index register. Arithmetic instructions also contain the address of an "accumulator" register which is used to store an operand involved in an instruction or the result of an instruction.

The fast registers in the UNIVAC LARC Computer not only enable the address modification operations to be completely overlapped with the execution time of the instruction, but they also enable extremely flexible control to be exercised over the iterative processes.

An instruction may be tagged to refer to any one of the fast registers for address modification. Since a fast register that is used as an index register may also be used in the role of an accumulator register, its contents are subject to all of the arithmetic, test, and other instructions in the computer repertoire. Special index instructions are also provided which are, in effect, small subroutines for controlling the entry, re-entry, and exit from the program loop using control information stored within the index register.

The UNIVAC LARC Computer is a single address computer, since each instruction contains only one main storage address. However, any one (or two) of a number of fast registers may be addressed and used by an instruction either as an accumulator register or in the same way as a standard storage location. Arithmetic instructions are also available which take one operand from one fast register, a second operand from main storage, and place the result in an adjacent fast register. In practical use these features enable the Computer to be used as a three-address computer. Quantities can be accumulated in several fast registers and combined without recourse to separate instructions for returning intermediate partial results to the main storage.

MULTIPURPOSE FAST REGISTERS

The index and accumulator registers are multipurpose fast registers that are logically interposed between the main core storage and the arithmetic system of the Computer. They may be addressed and used interchangeably as index registers, as accumulator registers or as a standard core storage location.

The registers are composed of fast-switching tape-wound cores having a read-regenerate or clear-write cycle of one microsecond. By functioning as fast-access storage for operands and results in either arithmetic operations or address indexing operations, they decrease the number of references to the slower main core storage and improve control of the arithmetic processes.

As many as 99 multipurpose registers may be included in the Computer. These are in addition to the various control and arithmetic registers that are used during the actual execution of an arithmetic instruction.

ERROR CHECKING

To prevent the loss of valuable computer time, an error occurring in the UNIVAC LARC System is detected automatically and, whenever possible, corrected without human intervention. When manual intervention is necessary, the general source of the error is detected and isolated from the system. The error is pinpointed and corrected "off-line," thereby releasing the system for further computation.

Built-in checking circuitry

The Computer contains built-in checking circuits designed to detect all single-bit errors. The checking circuits are designed to detect an error and indicate the specific area of the Computer in which the error occurred. Twenty percent of the total circuitry in the UNIVAC LARC System is devoted to duplicate circuits and associated checking circuits. These circuits double the utility of the system by locating faults and by eliminating the need for programmed checks.

Error procedures

When an error is detected, control is transferred to an instruction in a specific storage location which is the beginning of an error routine. The routine determines the type of error committed and then initiates a print-out which assists the maintenance engineer or programmer in analyzing and correcting the error. The print-out might contain the following information:

1. The type of error (adder, index register, etc.);
2. The digit position at which the error occurred;
3. The time at which the error occurred;
4. The instruction that caused the error;
5. The storage address of the instruction that caused the error;
6. The contents of the accumulator register or registers involved, if any;
7. The contents of the index (B) register involved, if any; and
8. The operand involved.

More elaborate error routines can be designed which will isolate the error source still further and print out the designations of the specific printed circuit packages that are to be replaced. However, such routines might not be justified by the frequency of occurrence of the errors.

Contingency checking

The Computer contains checking circuits for detecting overflow conditions within the arithmetic system and certain conditions reflecting mistakes in programming. If one of these conditions arises, it is handled in much the same way as a machine error in that the Computer automatically transfers control to an error routine. These built-in circuits continuously and automatically check for the following conditions:

1. *Floating Zero Result:* Occurs on floating point add and subtract instructions when an arithmetic subtraction of two numbers with equal exponents produces a zero answer.
2. *Non-normalized Divisor:* Occurs on floating point division instructions when the divisor has a zero in the most significant digit position (the digit position adjacent to the exponent).
3. *Exponent Overflow:* Occurs on floating point add, subtract, multiply, and divide instructions when the addition, subtraction, multiplication, or division of two floating point numbers results in an exponent greater than 99.
4. *Exponent Underflow:* Occurs on floating point add, subtract, multiply, and divide instructions when the addition, subtraction, multiplication, or division of two floating point numbers results in an exponent less than 00; or on fixed-to-floating point or floating-to-fixed point conversion instructions which would cause a loss of significant digits.
5. *Fixed Decimal Overflow:* Occurs on single and double left shift instructions when at least one non-zero digit is shifted out of the register causing a loss of significant digits; or on fixed point add, subtract, multiply, and divide instructions when the result is greater than or equal to one in absolute value.

THE PROCESSOR is a stored-program two-address computer with many general-purpose characteristics. Its primary role in the UNIVAC LARC System is to coordinate and control concurrent input, output and auxiliary drum storage operations under summary command of the Computer program.

FUNCTIONAL DESCRIPTION

The Processor picks up summary orders issued by the Computer, acknowledges their receipt, interprets them, supervises their execution, and informs the Computer of their completion. All these functions are accomplished under control of a fluid loop program which need not change for every program run on the Computer. A flexible Processor program for controlling input, output, and auxiliary storage was developed along with the UNIVAC LARC System as the equipment was developed and tested. In fact, the program, in conjunction with the general-purpose computing abilities of the Processor, is an alternative to using a multitude of costly and inflexible built-in control equipment to perform a similar function.

An important advantage of the programmed-control approach is that the programmer is given the ability to modify the input, output and auxiliary storage control. As a programmer gains experience with the system, he may take advantage of advanced programming techniques to devise control programs for the Processor which will greatly improve and even change the performance characteristics of the Processor.

The Processor has speed and flexibility to handle the complete complement of input, output, and auxiliary storage devices in parallel, and to service both Computers in the expanded system. Its general-purpose characteristics enable the system to be expanded with ease.

When the Processor is not being used to the limit of its ability in controlling input, output, and auxiliary storage, it can relieve the Computer of various tasks, or it can perform sorting, merging, compiling, or other "side" routines concurently with and entirely unrelated to a program being run on the Computer.

Logically, the Processor separates into three major sections which represent different levels of control. The three major sections are:

1. The Central Processor.
2. The Synchronizers.
3. The Dispatcher.

CENTRAL PROCESSOR

The Central Processor is the general-purpose computing section of the Processor. Compared to the Computer, it has less elaborate facilities for performing arithmetic operations. The arithmetic system of the Central Processor consists of a serial adder-comparator and two connecting 12-digit shift registers that are used for the temporary storage of operands. When an add instruction is executed, operands are shifted from the two registers into and through the adder a digit at a time. The result is shifted back into one of the registers, which also serves as an accumulator register. The bits and digits of a word are transferred between the registers and the main core storage completely in parallel.

Instructions

The Central Processor has an instruction code that is separate and distinct from that of the Computer. It contains a complement of general-purpose instructions, such as add, subtract, shift, and transfer, that are used in carrying out its primary editing, interpreting and supervisory functions, but which may also be used in executing a side program. The Central Processor does not, however, have instructions for multiplying and dividing since these instructions are not required in the editing and control routines which carry out its primary functions.

The Central Processor has the ability to set an "intervention" flip-flop in either Computer which will force the Computer to transfer control to a routine associated with the flip-flop. Normally, the transfer is programmed so that the Computer will automatically return after completing the routine to the point in its own program at which it was interrupted.

The Central Processor, although slower than the UNIVAC LARC Computer, can perform in 16 microseconds an addition instruction which takes an operand from the storage, adds it to an operand in the accumulator register and returns the result to storage.

Basic instruction types

The majority of the Central Processor instructions are specialized instructions that are used to communicate with or control the error circuits, the input-output devices, the drums, the Synchronizers, and the Dispatcher. Most of these instructions are one of the three types listed below. Many can be addressed to any of several Synchronizers or other devices.

1. *Set Flip-Flop Instructions:* Alert a Synchronizer or other device to perform a specific function such as connect or read 100 words.

2. *Transfer Instructions:* Transfer control information between the Central Processor accumulator register and the Dispatcher or a Synchronizer. The control information might specify the mode in which a Synchronizer should operate or the first address of a storage area to which the Dispatcher should transfer data for a Synchronizer.

3. *Test Flip-Flop Instructions:* Are actually conditional transfer instructions dependent on the state of the flip-flop tested. These instructions are used by the Central Processor to monitor and test the availability of a Synchronizer or to test if a Synchronizer or other device has completed a previously ordered operation.

Time reference

The UNIVAC LARC System is designed to change over to a new program without interruption. As computations are being performed on one problem, the next problem may be in the process of being loaded into the storage, while results from a previous problem are being printed. All of the above are made possible by the parallel operation of the various units of the system.

To aid in a changeover, a real-time reference is provided in the Central Processor. The timing reference may be used, for example, to determine when the time allotted for one program on the Computer is exhausted so that an automatic changeover may be made (without human intervention) to a new program. The timing source is a clock which continually alerts the Processor program to keep a running count of time. The Computer can order the Processor program to keep a check on the running time of a program and, after a specified period of time has passed, direct the Computer to a routine for effecting a changeover.

The Processor program may use the clock to time certain extra long logical operations, such as tape reversal operations on a tape unit or information displays on the operator console, thereby eliminating the need for costly fixed delay elements. Such a timing reference may be used for any number of other purposes; for example, to record the time at which errors or other events occur during the course of running programs. It is particularly useful in scheduling problems on the system and in solving problems in real time.

SYNCHRONIZERS

The Central Processor does not have time to control every step of the several input, output and drum operations being performed in parallel. Consequently, much of the detailed and specialized work of controlling these operations is performed by the Synchronizers.

A Synchronizer represents a modular grouping of logical circuits for controlling a particular reading or recording process. Its logical form is dependent to a great extent on the characteristics of the reading or recording device with which it is associated. Physically the Synchronizers are contained within the Processor cabinet. All of the Synchronizers of the expanded UNIVAC LARC System may be housed within the cabinet.

Functional description

The Synchronizers control the actual reading or recording process and the transition and the serial flow of information, digit by digit, between a buffer register and an input-output device or storage drum. In the process of transferring information, a Synchronizer may perform functions such as synchronizing input information with the internal timing of the system, checking and counting the information for errors, or translating the information in one way or another.

Whereas a single summary order from the Computer might call for the transfer of a block of several hundred or even thousands of words, a single instruction by the Central Processor alerts the Synchronizer to process a smaller block of words which is some increment of the block specified by the summary order. The Synchronizer is designed to process the smaller block automatically without direct intervention by the Central Processor. While one block of information is being processed, the Central Processor program may alert the Synchronizer to process the next block of information. The actual instruction that alerts the Synchronizer is executed by the Central Processor in four microseconds, whereas the operation initiated in the Synchronizer or other device by the instruction may take several milliseconds. In the meantime, the Central Processor is free to continue processing other summary orders.

Communication with the central processor

Whenever a Synchronizer, input-output device, or drum is ready to accept further instructions from the Central Processor program, it records this fact by setting a flip-flop. The Central Processor program determines whether or not a Synchronizer or other device requires attention by testing the flip-flop with a conditional transfer instruction. If it is set when tested, control is transferred to a routine which determines the action to take and instructs the device accordingly.

Rather than waste time testing each and every flip-flop to arrive at the specific flip-flop which is set, the Central Processor first performs a master test on all of the flip-flops and then a series of group tests. The testing is performed in an order of priority so that the flip-flops of the Synchronizers that require the most frequent attention are tested first. In general, the frequency at which a Synchronizer requires attention is a function of its data transfer rate. Consequently, the Drum Synchronizers which operate at the highest rate are tested first, then the Tape Synchronizers, and so on.

DISPATCHER

The Dispatcher is a central exchange which controls the transfer of data between the buffer registers of the Synchronizers and the main core storage. There are one to four one-word buffer registers for each Synchronizer. They are used to perform the serial-parallel conversions and to store data preparatory to transferring it to the main storage or to a drum or input-output device. Transfers between the buffer registers and the drums or input-output devices are controlled by the Synchronizers. The rate and order of flow is governed primarily by the characteristics of the particular device concerned.

Whenever a Synchronizer completes the processing and transfer of a word to or from a buffer register, it signals the Dispatcher to transfer the word to the main storage (if it is an input synchronizer) or to obtain a new word from storage (if it is an output synchronizer).

ERROR CHECKING

The Processor, like the Computer, contains checking circuits designed to detect all single bit errors. An error in the Central Processor section of the Processor causes transfer of control to an error routine. The Central Processor has error test instructions which may be used in the error routine to determine the type and location of the failure.

Checking circuits in the Synchronizer section of the Processor indicate the type of error detected and the particular Synchronizer in which the error occurred.

The checking circuits within the Processor are also designed to indicate whether an error originated within its own logical circuits or within the circuits of a storage or input-output unit.

Often, because of the use of solid-state circuitry, it is possible to exchange a faulty circuit with a reliable one with a minimum of time loss. The tape units, magnetic storage drums, and core storage units are all connected to the system through plugboards which simplify the substitution of one identical unit for another. These external devices are provided with test controls and other provisions for "off-line" testing which does not interrupt computing and processing.

The UNIVAC LARC System is equipped with both magnetic ferrite-core and magnetic drum storage systems, each of modular construction. In a completely expanded UNIVAC LARC System, these data storage systems offer a combined data storage capacity of over 73 million decimal digits of information.

The magnetic ferrite-core storage of the UNIVAC LARC is the main storage for both Computers, in an expanded system, and the Processor. It is the common link for Computer-Processor and Computer-Computer information exchange. The core storage system is also used as a flexible buffer storage for transferring data between the auxiliary storage (magnetic drum) and the input-output units.

The magnetic drum storage system serves as an auxiliary to the main core storage system. The drums are a repository for all data including input, intermediate processing results, output, and service routines.

MAGNETIC CORE STORAGE

The core storage is divided into modular units each of which has a capacity of 2,500 words of 12 decimal digits. Four storage units are contained in a cabinet. The storage units may be added to a system in units of four up to a maximum of 39 units (10 cabinets); the equivalent of 97,500 words. Each cabinet has its own power supply, clock-pulse generator, and heat exchangers. Because of a logical limitation on the number of storage addresses available for assignment, one cabinet in a completely expanded storage system of ten cabinets would contain only three 2,500-word units.

Each storage unit contains the switching, timing, and amplifying circuits that are required for independent operation. The division of the storage into independent units permits simultaneous reference to storage: by the Computer, for obtaining instructions and for transferring operands; and by the Processor, for transfers involved in carrying out its program and for transfering data to or from the auxiliary storage or input-output. It also permits off-line maintenance to be performed on a single unit while the others are operating.

Timing

A complete clear-write or read-generate cycle of the core storage actually takes approximately eight microseconds to complete. However, reading or clearing data from the cores may be overlapped and performed in parallel with the operations of selecting the cores and writing or regenerating the data. As a result, the storage cycle is, for all practical purposes, four microseconds. The allowable transfer rate to or from the storage is further increased by the fact that the storage units can operate independently and in parallel.

Core storage units are connected to the Computers and the Processor by a transfer bus which is time shared to serve as the data transfer path to and from the storage for both the Computers and the Processor. The bus is time shared on the basis of a repetitive 4-microsecond time cycle which is broken down into eight ½-microsecond time intervals (time slots). During any time slot one word of data can be transmitted to the storage in parallel. The time slots are apportioned to the various connecting areas of the Computers and the Processor in the following order:

← 4 Microseconds →

P CP	CI I	C2 O	P D	Not Used	C2 1	C1 O	P D

Legend:

- P Processor time slot.
- CP Central Processor; indicates the time slot on which the Central Processor section of the Processor transfers operands on instructions that are used in its program.
- D Dispatcher; indicates the time slots on which the Synchronizer Dispatcher section of the Processor transfers input-output or drum data for a Synchronizer.
- C1 Computer number 1.
- C2 Computer number 2.
- I Instruction; indicates the time slot on which a Computer obtains an instruction.
- O Operand; indicates the time slot on which a Computer transfers operands.

Interlocks

The UNIVAC LARC System is normally programmed to avoid simultaneous reference to the same storage unit by two or more sections of the system (the Computers, the Central Processor, or the Dispatcher). However, each storage unit is provided with interlocks to prevent conflicts and establish priorities. A storage unit is unavailable for four microseconds from the time it is addressed by a calling unit. During this time any other calling unit is prevented from gaining access to that storage unit.

Continual reference (once every four microseconds) to a storage unit by a Computer or the Central Processor could, if a system of priorities did not exist, lock out the Dispatcher indefinitely from access to the same storage unit. Because the Dispatcher must transfer data for the Synchronizers within a definite period of time in order to maintain a continual flow of input-output data, each storage unit is provided with a priority interlock which ensures access by the Dispatcher within four microseconds after it addresses the storage unit. Should the Dispatcher address a storage unit that is busy, the interlock prevents the Computers or the Central Processor from gaining access to that unit again until the Dispatcher has successfully completed its storage reference. Because the Central Processor must monitor within a definite period of time the real-time operations of the Synchronizers, it has the same type of storage priority over the Computers.

The Processor instruction repertoire contains write-interlock instructions to prevent either Computer from writing data into any designated storage unit. It also contains an instruction for removing the write interlock from any designated storage unit. These instructions are provided to prevent the accidental destruction by the Computer of data in the storage.

Up to 24 magnetic drums may be included in a UNIVAC LARC System. Each drum is capable of storing 250,000 words of 12 decimal digits. Up to three Read Synchronizer and two Write Synchronizer units can be added to the Processor for simultaneous control of as many as three reading and two writing operations on the drums concurrently with input-output operations. The Processor program can connect any drum to any Synchronizer. Two drums, operating alternately with a single Synchronizer, can transfer data at a continuous rate of 330,000 decimal digits per second.

The drum units are self-contained modules with individual test controls for off-line maintenance. They may be functionally interchanged by means of a plugboard.

A complete 250,000-word drum is serviced by a single six-channel read-write head assembly which is held in a gimbal mounting and is floated on a thin film of air. The "floating" head assembly enables the heads to record and read at a high density of 450 pulses per inch.

For protection against the effects of dirt and moisture, the drum, the head assembly, and the mechanism that positions the head assembly, are housed in an airtight, dust-free enclosure. Largely due to the inherent simplicity of the floating head assembly, the drum storage is extremely reliable.

Organization of data

Each drum has 100 circumferential information bands. Each band is capable of storing 2,500 computer words of 12 decimal digits; a capacity equal to that of one core storage unit. The bands are divided into 25 sectors of 100 words each, making it possible to begin reading or recording at any one of 25 access points around a band. One sector (100 words) is the smallest unit that can be read or recorded during any one reference to the drum.

A band consists of six tracks. The four information bits and parity check bit of a decimal digit are recorded in parallel on five of the tracks. Words and digits of a word are stored serially. The sixth track of a band is used to store serially a band number and an address for each sector.

Access to a particular band is gained by moving the single six-channel head assembly back or forth along the length of the drum. The six individual read-write heads are spaced in the head assembly at twice the track spacing on the drum. The six tracks of one band are always interspaced with the tracks of another. Two bands are interlaced by recording one band of an interlaced pair with the head assembly in one position and recording the other band of the pair with the head assembly shifted a distance equal to the track spacing. Interlacing the bands enables a high track density of 30 tracks to the inch to be achieved without the difficulties attendant in designing a head assembly with extremely close spacing between the individual heads.

The 100 bands of a drum are numbered in the following order:

00,99 01,98 02,96 . . . . . . 47,52 48,51 49,50.

Where 00 and 99 are the numbers of the first pair of interlaced bands, 01 and 98 are the numbers of the next, and so on. To achieve minimum latency, data is normally organized in a systematic manner so that the processing of data begins at band 00 and proceeds through bands 01, 02, 03, and so on. During each read or write operation, a complete band of data is processed after which the head assembly is stepped, in sequence, to the next band. After the data on band 49 is processed, the head assembly is shifted to band 50, the stepping mechanism is reversed, and the head assembly is stepped in the opposite direction through bands 51, 52, 53, etc. After a complete pass through the drum the head assembly is back to the starting point, thereby eliminating the equivalent of rewind time. Data can be organized on the drum in a less systematic manner and less than a full band can be read during each reference, although by so doing latency time would ordinarily be increased. The Computer can order the Processor to position the head assembly over any band and process any number of sectors from 1 to 25.

Access time

Stepping the head assembly from one band of an interlaced pair to the equivalent band of the next pair requires 70 milliseconds. When the head assembly is continuously stepped without reading or writing, only 50 milliseconds are required for each step after the first. To reverse the direction of stepping requires 10 milliseconds. Shifting the head assembly from one band to the band with which it is interlaced requires 50 milliseconds. However, the shifting operation can be performed in parallel with a reversal.

Positioning of the head assembly is controlled by the Processor program which keeps a running account of the current position of the head assembly of each of the drums and moves the head assembly to any position ordered. The circuits in the Processor that control the head positioning are independent of the Drum Synchronizers. The head assembly on a drum can be positioned in parallel with a read or write operation being performed on any other drum.

A single summary order from the Computer can specify the transfer to or from sequential main storage locations of from one to 25 sectors of data on a band. If a complete band of 2,500 words is to be transferred, reading or writing can begin as soon as one complete sector has been traversed with the drum connected to the Synchronizer. Therefore, from one to two sector intervals (from 2.7 to 5.4 milliseconds) may be required before access is obtained to a complete band. If a specific sector on a band is desired, up to a full drum revolution of latency time (68 milliseconds) may be required to gain access to it. However, any number of sectors on a band can be read or written during the time required for one drum revolution and one to two sector traversals.

The head assembly on any drum can be moved to the next band in sequence during the time required to read or write a band of data. By organizing the data in such a way that the reading and writing of bands alternate between two drums, the head movements can be executed in parallel with the reading and writing (while a band of data is being processed on one drum the head assembly on the other drum can be moved to the next band in the sequence). Using this technique, data can be transferred continuously at a rate of 2,500 words every 83 milliseconds; the equivalent of 370,000 decimal digits per second. The 83 milliseconds required to transfer 2,500 words includes:

1. The time required to pick up and interpret the summary order from the Computer.
2. The time required to connect the drum to the Synchronizer (assuming that the required drum and Synchronizer are available).
3. The time required to gain access to the first sector.
4. The time required to transfer the complete band of data to the main storage and notify the Computer of the completion of the transfer.

The modular input-output units of the system include UNIVAC Uniservo II Magnetic Tape Units, UNIVAC High-Speed Printers, Punched-Card Readers, and Electronic Page Recorders.

MAGNETIC TAPE UNITS

Input and output is provided in the UNIVAC LARC System by Uniservo II Magnetic Tape Units. The tape units are used to introduce data into the system and to record output, either for long-term storage or for off-line conversion on an auxiliary device such as a High-Speed Printer.

Control

The UNIVAC LARC System can accommodate up to 40 Uniservo II Tape Units. As many as four modular tape control units (Synchronizers) can be included in the Processor, each of which can control a reading or recording operation on any one of 10 tape units that can be connected to the Processor. Plugboards are provided which make it possible to substitute any tape unit for any other controlled by the same Synchronizer. The four Tape-Read-Write Synchronizers can perform in parallel with one another and in parallel with the Drum Synchronizers or other input-output Synchronizers in the system. While a reading or recording operation is being performed on one tape unit, the tapes on any one or all of the others can be rewinding.

Read-write specifications

The tape units read or record on either plastic or metal tapes at a tape speed of 100 inches per second. Data is recorded at a density of 250 numeric or alphanumeric characters to the inch for use on the UNIVAC LARC or UNIVAC II Systems or at a lesser density for use on the UNIVAC I System or UNIVAC off-line auxiliary devices. Tapes having a wider range of pulse densities can be read, including tapes recorded by the Unityper I, at 20 pulses per inch. The length of a block of data on the tapes can be any multiple of ten 12-digit words. The Tape Synchronizers perform a parity check and count of the characters that are read or recorded in a 10-word block. The Processor program checks the number of 10-word blocks that are read or recorded. The tapes can be recorded in a forward direction or read in either a forward or backward direction. The data read from the tapes can be transferred to the main core storage or merely checked by the Processor program to locate a particular block of data or to ensure that the recorded data is reliable.

Tape code translation

Data recorded on tapes is in UNIVAC excess-three 7-bit code. Input and output data is translated by built-in translators. The Processor program can instruct the Tape Synchronizer to translate the UNIVAC 7-bit code that is read from the tape into either a 1-digit numeric or 2-digit alpha-numeric code that is used within the UNIVAC LARC System. When output is being recorded on tape, the Synchronizer can be instructed to translate from either the 1-digit numeric or 2-digit alpha-numeric code to the UNIVAC 7-bit code.

Read-write interlocks

A mechanical interlock is provided on each tape unit to prevent writing on a designated reel of tape. A rewind interlock is also provided on each tape unit which can be set at the discretion of the Processor program to prevent reading or writing on a rewound tape until the operator releases the tape unit from the interlocks.

A photoelectric cell on each tape unit detects unusable sections of tape indicated by holes punched through the center of the tape at intervals throughout the section. When an unusable section is detected, the reading or writing process is interrupted until the unusable section has passed the read-write heads. The tapes may be easily spliced and the spliced joint invalidated for reading or recording by punching spaced holes in the tape.

Access time

Access time to the nearest block of data on the tape is 15 milliseconds. This includes the time required to connect the read-write heads and accelerate the tape. An additional 0.6 seconds is required if the tape direction is reversed. When a tape is in a rewound state 1.2 seconds is required to reach the first block of data on the tape.

ELECTRONIC PAGE RECORDER

For direct large-volume output of data in tabular or graphical form, an Electronic Page Recorder can be provided with the UNIVAC LARC System. Output data may be represented by the Page Recorder in the form of a curve plot, a grid pattern, alpha-numeric characters, or a combination of all three, (a plotted curve with call-outs, titles, scales, grid patterns, etc.). The output is displayed on the face of a cathode ray tube and is recorded by means of a high-speed 35mm. camera controlled by the Processor program. For occasional monitoring of the output, a self-developing camera is provided.

Operating speeds

The Page Recorder operates at an average character rate per film frame of approximately 15,000 characters per second. When used for graphing, it operates at average rates per frame of approximately 2,000 points per second or 1,000 grid lines per second. These output rates match internal Computer speeds and make it possible to produce a sufficient volume of timely and easily interpreted output data for efficient program debugging, program monitoring, or engineering and mathematical analysis.

Control

Two identical, fast-interchange Page Recorders may be provided with the System. Each has a 35mm. and a self-developing camera. Both Recorders are controlled from a single Synchronizer in the Processor. Each is provided with an internal test program generator which may be used to simulate Processor instruction for purposes of off-line maintenance and adjustment. To achieve continuous output while the 35mm. camera film is advanced, data can be recorded alternately on the two printers. Should one Page Recorder become inoperative or exhaust its film supply, all of the output can be recorded on the other.

The shutter for the self-developing camera is controlled by the Processor program. The camera can produce either standard paper prints or positive transparencies that are suitable for projection and for easy overlay comparison of graphs. The operator can advance the film and develop a paper print in approximately one minute. A transparency may be developed in approximately two minutes.

Modes of operation

The format for recording numeric or alpha-numeric characters contains a maximum of 65 lines of 130 character positions each. Any one of 64 characters or symbols can be recorded. The Recorder Synchronizer can operate in either a numeric or alpha-numeric mode. In the numeric mode, a single digit in UNIVAC LARC code is used to select a numeric character or one of five special symbols. In the alpha-numeric mode, two digits in UNIVAC LARC code are used to select any one of 64 alpha-numeric characters or symbols. The Page Recorder Synchronizer can operate in an unedited mode, in which case all of the characters are recorded in a standard format, or in an edited mode, in which case the format is determined by digits within the output data itself.

Any one of the 64 characters or symbols can be selected by the Processor program for use in plotting a curve. The center of the plotting symbol can be directed to any position in a 1,000 x 1,000 mesh of discrete locations. The Recorder Synchronizer can operate in either of two plotting modes. In one mode, two sets of X and Y coordinates (2 points) are specified in a single word of output data. In the other plotting mode, X and Y coordinates are specified in two consecutive words of output data. The output data can be edited by a special routine in the Processor or Computer program. The Synchronizer can operate in two additional modes; one for plotting horizontal grid lines and the other for plotting vertical grid lines. In these two modes, a pair of abscissas or ordinates are specified in each output word for plotting respectively a vertical or horizontal grid line.

UNIVAC HIGH-SPEED PRINTER

Either one or two electro-mechanical Printers and Printer Synchronizers can be connected into the System to produce multiple-copy records or results. The Printer can record either numeric or alpha-numeric data in a standard or a completely edited format. The paper can be fed in steps for single-line spacing or fast-fed for multiple-line spacing. The paper feed accepts paper from 4½ to 21 inches in width. The Printer has the following characteristics:

Printable characters: 51.
Lines per minute: 600.
Characters per line: 120.

Character positions per line: 130.
Characters per minute (maximum): 72,000.
Characters per inch: 10.
Lines per inch: 6.

HIGH-SPEED CARD READER

An on-line, High-Speed Card Reader and a Card Reader Synchronizer can be provided as part of the UNIVAC LARC System. Readers are available for processing 80-column punched cards at speeds of up to 450 cards per minute.

TWO TYPES of control consoles are provided with the UNIVAC LARC System. One is the Operator Control Console; the other is the Engineer Control Console.

OPERATOR CONTROL CONSOLE

In a UNIVAC LARC System containing one Computer, a single Operator Console is used to exercise complete operational control over both the Computer and the Processor. In a UNIVAC LARC System containing two Computers, two identical Operator Consoles are used, one for each Computer. When separate problems are being run on the two Computers, the operators at both Consoles can communicate with and exercise control over the Processor without in any way interfering with one another.

Keyboard and display registers

A numeric keyboard is provided on each Operator Control Console. The keyboard is used to enter data into either a five digit or 12-digit general-purpose display register in the Computer. The contents of both registers are displayed in decimal form on the Operator Control Console Panel. Both the Computer and Processor have access to the display registers by way of their accumulator registers and may be instructed to display data in the registers or pick up data entered into the registers from the keyboard. To prevent conflicts between the Computer and Processor in the use of the display registers, all displays are normally handled by the Processor program which times the duration of the display using the real time reference.

Control panel

Operator direction of the Computer and Processor is exercised chiefly by means of manual intervention buttons provided on the control panel. There are five such buttons on each panel for the Computer and five for the Processor. Pressing a Computer manual intervention button causes the Computer to transfer control to a routine associated with the button. If necessary, provisions are made in the routine for re-entry into the main program when the routine is completed.

Although only five manual intervention buttons are provided for the Computer, the number of routines to which the operator may direct the Computer is not necessarily limited to five. For example, the data picked up from a display register may be interpreted by a manual intervention routine in such a way as to direct the Computer to any number of subroutines.

Pressing a Processor manual intervention button causes a transfer of control in the Processor to a routine associated with the button. Instead of forcing an immediate transfer, however, the button alerts the Processor to transfer control at the discretion of its program. The actual transfer may not be made immediately but may be delayed until the Processor has reached a point in its program at which it may enter the routine without interfering with other concurrent operations.

Typewriter-printer

An alpha-numeric Typewriter-Printer is provided on each Operator Control Console. The Printer is controlled through a Synchronizer in the Processor. It is used by the Processor program, or by the Computer program indirectly by way of summary order to the Processor program, to communicate with the operator. A print-out might consist of data relative to errors or contingencies that occur in a program or instructions to the operator, such as instructions for mounting tapes for a forthcoming program.

Paper tape reader

A Paper Tape Reader is provided with the Printer on each Operator Control Console. It is used primarily during a start-up procedure as a fast means of initially loading the first part of the Processor program into main storage. When used for this purpose, data is read from the tape for transmittal to the main storage via the display registers. After sufficient data has been transferred into storage from the paper tape, the Processor program completes the loading from magnetic tape. The Paper Tape Reader may also be used to relieve the operator from typing data into the display registers from the keyboard while a problem is being run or as an optional method of loading data into the storage for the Computer. The Printer is also provided with a paper tape punch which may be used by the operator or the program to prepare punched paper tapes for the Reader.

ENGINEER CONTROL CONSOLE

The Engineer Control Console is physically separate from the Operator Control Console or Consoles. It contains an engineer control panel for the Processor and a separate panel for each Computer in the system. All of the controls and indicators on the Operator Control Console, including an operator control panel, a numeric keyboard, and an alpha-numeric printer with an associated paper tape punch and reader, are duplicated on the Engineer Control Console.

In a system containing two Computers, either one or two sets of operator controls and indicators can be provided. Should one set be provided, it can be manually connected to either Computer. A single Console Printer Synchronizer is provided in the Processor which can be connected by the Processor program to any of the four console printers in an expanded system. Naturally, error analysis information and the like is routed to a printer at the Engineer Control Console and data on contingencies, instructions to the operator, and so forth are routed to the printer at the Operator Control Console.

Computer control panel

The Computer Control Panel on the Engineer Control Console contains 60 neon lights which display *in binary form* the contents of the Computer 12-digit display register. Switches are provided on the engineer panel to operate the display register in either of three following modes:

Manual Display Mode: In the manual display mode, the engineer can set controls to select and sample data at various points within the Computer and transfer the data to the 12-digit display register where it can be observed in binary form on the panel. Data can be sampled at a specific pulse time and step of an instruction that is being executed. It may be obtained for display from the various registers within the arithmetic and control sections of the Computer, from the various data transfer paths including the main storage bus, and from various combinations of flip-flops.

Program Display Mode: In the program display mode, the engineer can select data for sampling at specific times and from specific points as in the manual display mode. However, the display will only be effected for instructions that are tagged with a "one" digit in the most significant digit position of the instruction word.

Fast Register Display Mode: In the fast register display mode, the engineer can select for display the contents of any of the fast registers within the Computer.

The display registers may also be used by the engineer, in conjunction with a type-in from the keyboard, to enter data into the main instruction register of the Computer, enter data into any main storage location, or display data from any storage location.

In addition to those associated with the display registers, the following controls and indicators are included on the Computer Control Panel:

1. Error and contingency indicator lights that indicate any error or contingency condition detected by the checking circuits of the Computer. The error indicator lights indicate the type of error detected and, for certain types of errors, the digit position at which the error occurred. An error option switch is provided on the panel. The switch has three positions labeled STOP, NORMAL, and IGNORE. When the switch is in the STOP position, the Computer stops if an error is detected. When the switch is in the NORMAL position, the Computer enters an error routine if an error is detected. When the switch is in the IGNORE position, the Computer ignores any error detected. A reset button is also provided with which the engineer may reset the error flip-flops. A similar contingency option switch and a reset button are provided on the panel for controlling contingency conditions.
2. Two neon pushbuttons are provided on the panel to control the gating-in of various control signals that the engineer can manually introduce into the Computer for trouble shooting purposes by connecting signal input lines to terminals in the circuits.
3. A switch abnormal light which is lit if any switch on the Computer Control Panel is set in a position to interfere with the running of a normal program or to allow errors to go undetected.
4. A transfer switch which the engineer may use to force the Computer to either transfer control or not transfer control on conditional transfer of control instructions.
5. Buttons for clearing the Computer as a whole or selected parts of the Computer.
6. Retain buttons which can be used to retain the contents of the main instruction register, the control counter, or a fast register.

Processor control panel

The controls and indicators on the Processor Control Panel on the Engineer Control Console include:

1. Illuminated master power control buttons for applying power to the various units of the system. A set of 24 pushbuttons is provided to select the drums that are to be turned on. When the master drum-power control button is pressed, the selected drums are turned on in sequence.
2. Air-flow, power failure, and temperature indicators for the Processor, the Computers, each type of input-output device, and each main storage cabinet.
3. Start and stop pushbuttons.
4. Illuminated pushbuttons to control the mode in which the Processor operates. The Processor can operate in a continuous, one instruction, one step, arithmetic test stop, or input-output test stop mode or any of five breakpoint stop modes. With the test stop pushbuttons, the Processor can be made to stop on conditional transfer of control instruction (arithmetic tests, input-output tests, or breakpoint tests) and indicate whether a transfer of control is imminent. When the Processor stops, the engineer has the option of forcing the Processor to transfer control or forcing it to continue on the same sequence of instructions.
5. Clear buttons for clearing the Processor as a whole or selected parts of the Processor.

6. Retain buttons to prevent changing the contents of certain registers within the Processor.

7. Error indicators to display errors detected within the Central Processor, Dispatcher, and each of the Synchronizers. Separate error option switches are provided for the Central Processor and each of the Synchronizers.

8. A switch abnormal light which is lit if any switch on the Processor panel is set in a position to interfere with the running of a normal program or to allow errors to go undetected.

9. A master error-set pushbutton to set all of the Processor error flip-flops for the purpose of testing the error flip-flops and the indicators on the panel.

10. A gain control switch for each Tape Synchronizer enables the engineer to manually set the tape amplifier gain control of a Tape Synchronizer to high or low gain, or have the gain setting determined by the Processor program.

11. A sector-address write switch used in conjunction with a special Processor program to lay out the data bands on the magnetic drums when the drums are first installed into the system. If a bad spot (unusable recording area) should develop on a drum after it is installed, one or more bands can be repositioned so that the bad spot will lie in an area that is not used for recording.

12. A memory simulator consisting of a set of 60 switches used to manually insert a word of data into the Processor. A word set up on the switches can be directed to the main instruction register, the arithmetic registers and to the Synchronizer buffer registers.

13. Switches to run each of the Synchronizers.

14. A binary display of the main instruction register and various other registers, counters, and control flip-flops in the Processor.

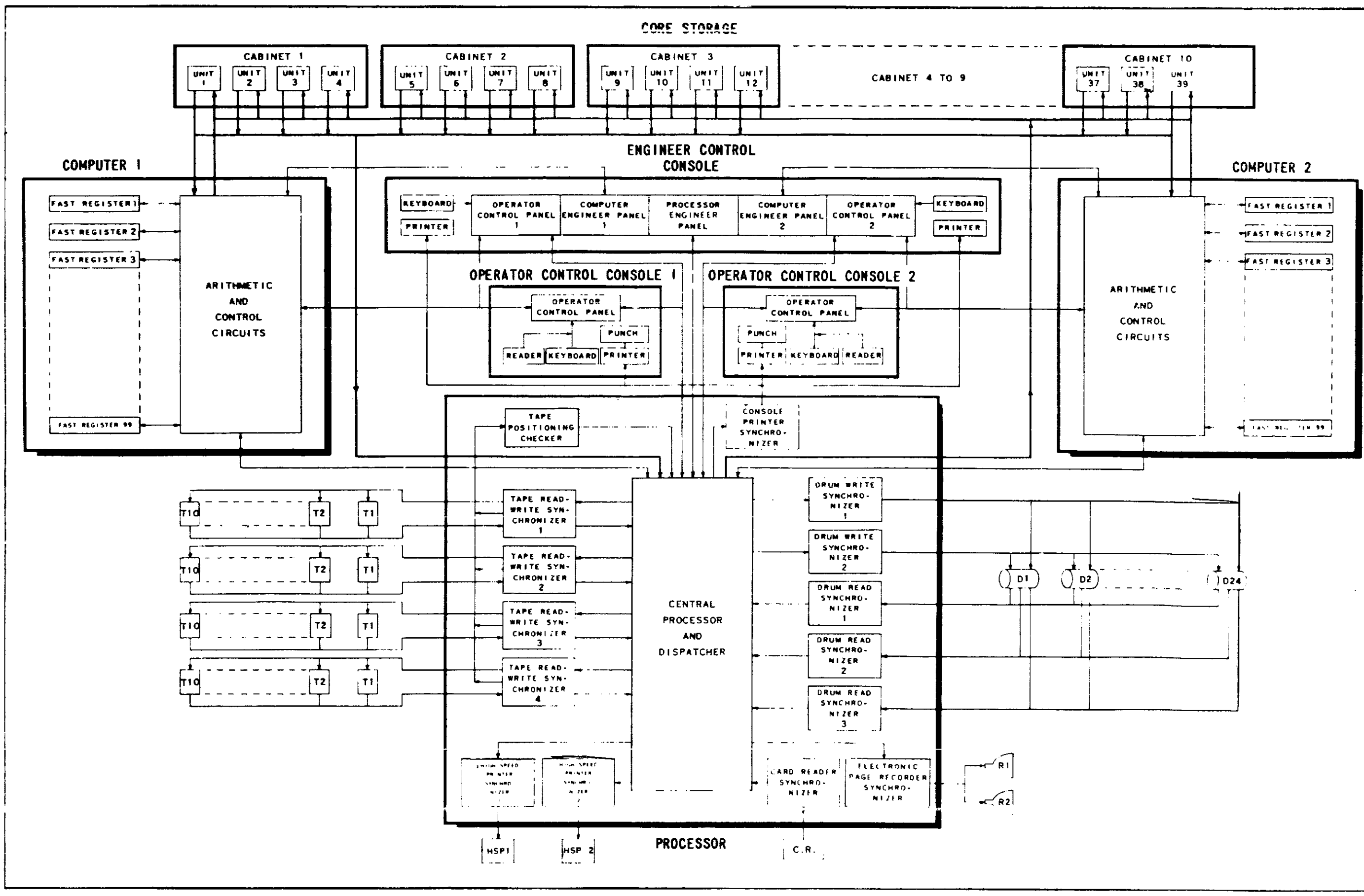
15. Display register controls which can be used to transfer the contents of the main Processor instruction register or either arithmetic register to a Computer display register for visual inspection, or to transfer the contents of a display register to the instruction and arithmetic registers. Data can be manually entered into the display register from the keyboard.

16. A type-out button which causes a type-out on a selected console printer of the contents of the Processor arithmetic registers.

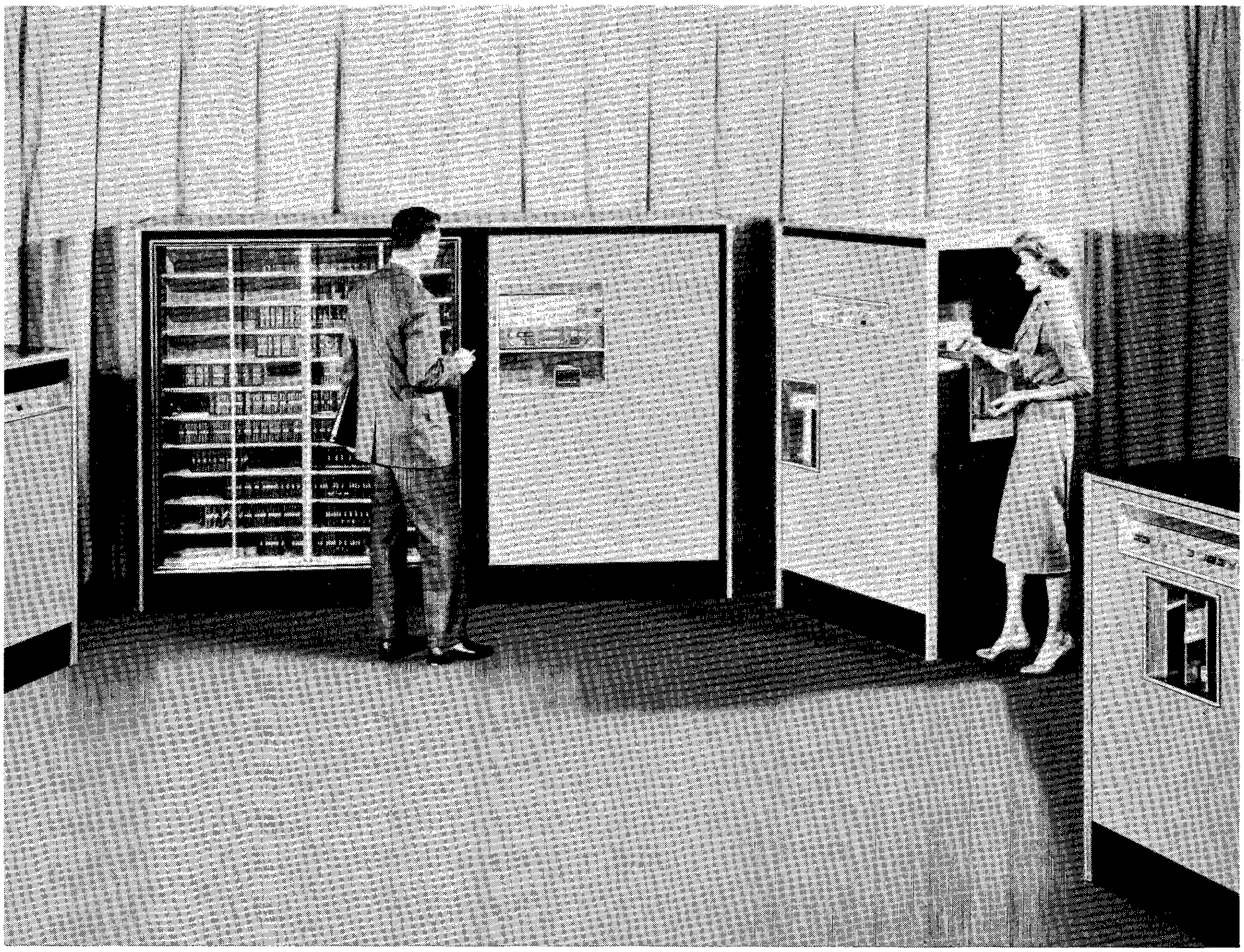
17. A jam-signal button which is used to control the gating-in of various control signals that may be manually introduced into the Processor logical circuits for trouble shooting purposes.

18. An audio monitor than can be connected to either Computer or to the Processor. By changing pitch the audio signal gives an indication of the frequency of instruction execution.

19. A film monitor to indicate the status of the film in the 35mm. and self-developing cameras of the Electronic Page Recorder.



UNIVAC Solid State Computer UNIVAC DIVISION, SPERRY RAND CORPORATION



THE BASIC UNIVAC SOLID STATE COMPUTER SYSTEM consists of the central processor with an associated control panel, an 80- or 90-column card reader, an 80- or 90-column card read-punch unit, and a line printer. The basic system may be expanded by the addition of a tape synchronizer unit and up to 10 magnetic tape units. Transistors and ferrite cores (magnetic amplifiers) are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 10 decimal digits plus sign.
Numeric Characters Per Word: 10 plus sign.
Alphabetic Characters Per Word: 5 (two numerics for one alphabetic).
Character Code: Biquinary, 4 bits plus parity bit.
Timing: Synchronous.
Pulse Repetition Rate: 707 kilocycles.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.153
Multiply: 555555 by 5555	0.561
Divide: 3086108025 by 5555	0.867

Average access time: 0.425 milliseconds, fast access storage; 1.7 milliseconds, general storage.

Checking features: Parity check on all data transfers within the central processor, automatic timing check of drum synchronization.

Registers

Four 1-word registers.

A register: Accumulator. Holds the results of addition and subtraction operations, and the most-significant digits of a product or quotient.

L register: Used to hold one of the operands in a multiplication or division operation.

X register: Used to hold the ten least-significant digits of a product or quotient.

C register: Used to hold the complete instruction while it is being executed.

Memory

The internal storage media of the system is a magnetic drum. The drum is divided into two sections; a general storage section with a capacity of 4,000 words, and a fast access storage section with a capacity of 1,000 words. The drum also contains 800 words of input-output buffering and the timing bands.

Control panel

This unit is an integral part of the central processor main frame. It contains a decimal keyboard for manual input to the system, and indicators for display of the contents of memory locations or registers.

INPUT MEDIA

Magnetic tape synchronizer

This unit directs the exchange of information between the central processor and the magnetic tape units. It serves as a control and buffer for up to ten magnetic tape units.

Magnetic tape unit

Maximum number per system: 10.
Packing density: 125 or 250 characters per inch.
Number of channels: 8.
Record length: Fixed, 720 characters or 1,000 characters.
Record gap: 1 inch or 2.4 inches.
Tape speed: 100 inches per second/25,000 characters per second maximum.
Rewind time: 3.04 minutes for 1,500 feet, 4.79 minutes for 2,400 feet.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
Composition: Mylar or metal.
Lengths: 2,400 feet, mylar; 1,500 feet, metal.
Width: ½ inch.
Error detection: A sprocket bit and a parity bit are recorded with each character for checking purposes.

Punch card reader

This unit mechanically reads 80- or 90-column punched cards at a rate of 450 cards per minute. The unit consists of two reading stations and three output stackers. Each card is read twice and the results of the two readings compared in the central processor. The three output stackers provide the capability of combining reading and sorting operations.

Card read-punch unit

This unit mechanically reads and/or punches 80- or 90-column cards at a rate of 150 cards per minute. Punching may take place in blank cards and in original data cards. Each card is read both before and after punching and the results of the two readings compared in the central processor. Two output stackers are provided so that the read-punch operation can be combined with a sorting operation.

Keyboard

This unit is a part of the control panel located on the central processor main frame. It provides the capability of manually inserting numeric data into the system.

OUTPUT MEDIA

Magnetic tape

As previously described.

Card read-punch unit

As previously described.

Line printer

This unit prints out information from the central processor at a rate of 600 lines per minute, 130 characters per line. There are 51 characters in each print position available for printing. Format is controlled by the program.

PROGRAMMING

General: The UNIVAC Solid State Computer uses a one plus one type of instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 10.
Total number of operation codes: 36.

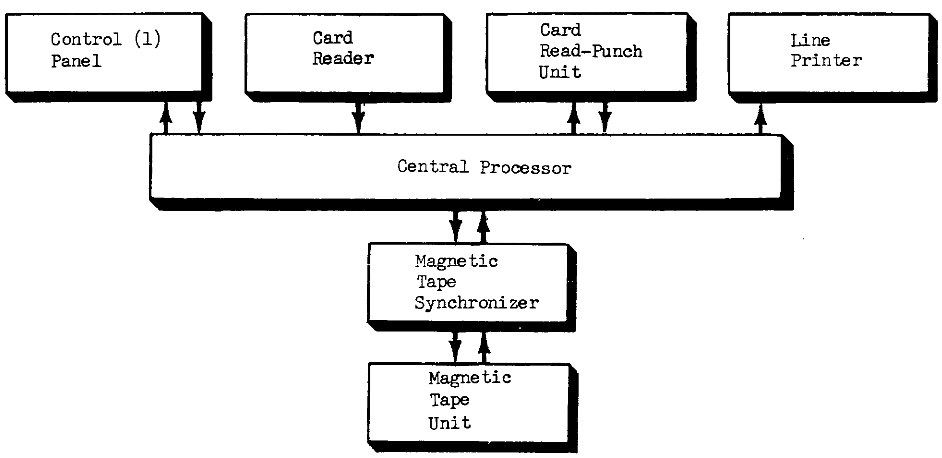
Instruction word format

Op. code	Operand address	Next instruction address
XX	XXXX	XXXX

Cost, Power Requirements, and Physical Characteristics

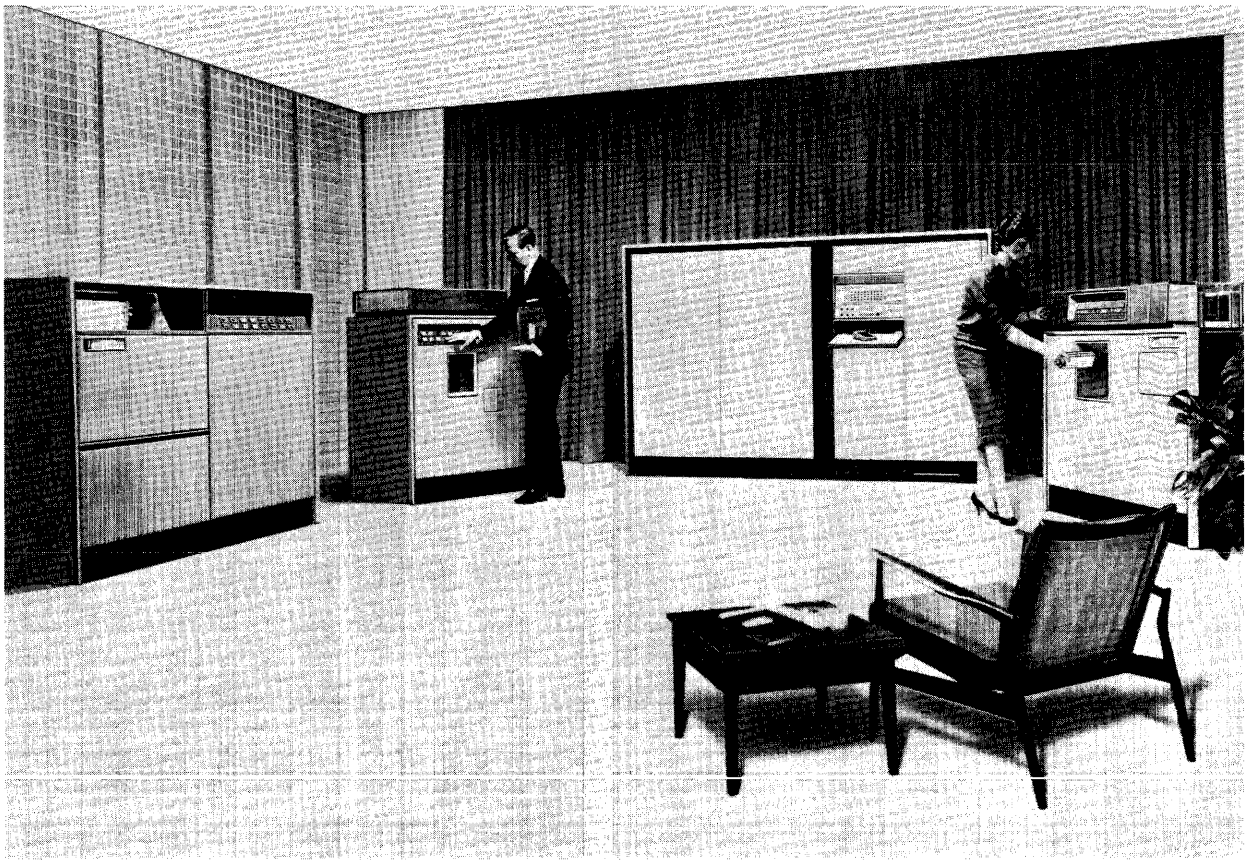
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Central Processor, including	$6,645	$332,210		108x32x69	3,500	9.800	22,847
Magnetic Drum Memory							
Console							
10 Key Inquiry Unit							
Card Reader 80- or 90-Column Cards	(2)	(2)		51x27x49	625	(2)	(2)
Card Read-Punch Unit 80- or 90-Column Cards	(2)	(2)		49x32x69	700	(2)	(2)
High Speed Printer	985	49,345		72x32x51	1,600	4.700	10,957
Magnetic Tape Unit	450	20,000		31x32x69	650	2.600	6,780
Tape Synchronizer	1,000	50,000		108x32x69	3,500	6.000	13,560
Index Registers (3 Registers of 4 Digits each) as an optional feature	150	7,500		(2)	(2)	(2)	(2)

[1] Included in rental price. Separate maintenance contract available for purchased equipment.
[2] Included in Central Processor.



BLOCK DIAGRAM OF UNIVAC SOLID STATE COMPUTER

UNIVAC STEP UNIVAC DIVISION, SPERRY RAND CORPORATION



GENERAL PURPOSE data processing system designed for general accounting, inventory, billing, budget control, sales anlysis, and statistics, as well as scientific applications.

The UNIVAC Solid State STEP System (Simple Transition Electronic Processing) is a modular version of the Solid State 80 and 90 System. STEP offers speed, accuracy, and economy of the UNIVAC Solid State Computer to the user not requiring the full capabilities of the larger system. STEP is available to either the 80- or 90-column card user. Magnetic tapes, Randex Drum Unit and card punching printer are also available.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	1,360	85
Multiply:	1,275 plus	

Average access time was used, also assumed operands and results were stored in high-speed access portion of drum.

Divide:	1,275 plus	

Access time includes accessing two operands and result address.

Calculation of multiply time in word times is the sum of three factors. Five word times, plus the number of multiplier digits, plus the sum of the multiplier digits. Minimum time 119 microseconds. Maximum time 1,785 microseconds.

Divide time expressed in word times is calculated as follows: Five word time, plus twice the number of digits in the quotient, plus the sum of the odd digit positions in the quotient, plus the sum of the tens complement of the even digit — positions in the quotient. Minimum time 425 microseconds. Maximum time 1,955 microseconds.

Arithmetic mode: Serial by digit, parallel by bit. Word time is 17 microseconds.

Timing: Synchronous.

Operation: Concurrent.

Checking features: Odd parity, arithmetic overflow, complete magnetic tape. Checks — card equipment has two read stations; punch unit has a post read station for checking card punching. Central processor and printer design include logical checks.

STORAGE

Drum (fast memory)

Number of words: 2,400 basic.
Number of digits: 24,000.
Access: 1,700 microseconds.

Additional fast memory can be specified in increments of 4,000 digits up to a maximum of 16,000 digits. Maximum fast memory available on one processor is 40,000 digits.

Drum (high-speed memory)

Access: 425 microseconds.

First 2,000 digits (200 words) of high-speed memory is a prerequisite to additional high-speed memory and /or additional fast memory. Additional high-speed memory can be specified in increments of 2,000 digits up to a maximum of 8,000 digits. Maximum high-speed memory of any one processor is 10,000 digits.

Drum (mass memory)

Number of words: 2,304,000 (minimum).
Number of digits: 24,000,000 including signs.
Access: 385,000 microseconds (average).

(Randex drum) optional

Number of words: 23,040,000 (maximum).
Number of digits: 240,000,000 including signs.

Magnetic tape

Number of units that can be connected: 10.

INPUT MEDIA

High-speed card reader

450 cards per minute.

Read-punch card unit

150 cards per minute.

Magnetic tape

100 inches per second; 25,000 pulses per second.

Tape densities and formats are compatible with other UNIVAC tape systems. 80- or 90-column cards may be used (no plug-boards).

OUTPUT MEDIA

Read-punch card unit

150 cards per minute.

Magnetic tape

100 inches per second; 25,000 pulses per second.

High-speed printer

600 lines per minute; 130 characters per line possible.

Card punching printer

150 cards per minute.

Card Punching Printer prints on both sides of tab card. A maximum of 13 lines on a side. Instantaneous printing rate is 400 lines per minute. (Optionally available on either the 80-column card or 80-column tape systems. Not available on 90-column systems.)

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary coded decimal.
Decimal digits per word: 10 plus sign.
Decimal digits per instruction: 10 (sign pos. not used).
Instructions per word: 1.
Instructions decoded: 53.
Arithmetic system: Fixed point.

Add, subtract, multiply, and divide.

Instruction type: One and one-half address.

One address refers to the operand or (m) portion of the instruction word. The half address refers to the address of the next instruction to be executed. Next instruction address is given in the (c) portion of the instruction word.

Number range: − 9999999999 to + 9999999999.

Instruction word format

X	X	X	X	X	X	X	X	X	X
Instruction Code		m				c			

(m) address is address of operand.

(c) address is address of the next instruction to be executed.

A basic package of input-output and test routines are supplied to all STEP users. None are built in. Automatic coding.

All input-output units are buffered, including Randex availability of card punching printer.

Instruction list and programming aids:

Instruction format: The UNIVAC Solid State Computer employs a one and one-half address instruction code system, with one instruction per processor word. Each instruction word is written in 10 decimal digits and consists of an operation code, the address of the operand, and the address of the next instruction. The left-most digit position is considered the most significant digit (MSD) and the right-most digit position is considered the least significant digit (LSD).

The left-most two digits are the operation code (OC), which tells the processor the arithmetic or logical operation to execute. The next four digits, the m portion, supply the address of the operand, which is usually the address of a word in storage. The remaining four digits, termed the c address, are the location of the next instruction. The m and c addresses may have different significance for some special instructions, as noted in the instruction definitions.

Instruction cycle: The instruction cycle — the steps the processor takes in executing a command — usually occurs in four phases. (In a few instructions, there is no search for the operand.) The duration of a phase is measured in units called word times. A word time is that interval in which the drum revolves one word under the read-write heads — in the UNIVAC Solid State Computer, 0.017 milliseconds. The four phases are:

1. Staticize the Instruction: The instruction located by the previous search (4) is transferred from the drum location to the static register (operation code only) and register C (the entire word). This step requires one word time.

2. Search for the Operand: If the m address part of the instruction does not refer to a drum storage location or a register, this step is ignored and no time is required. If it does refer to a drum location, the address of the next available storage location on the drum is compared with the first address part of the contents of register C every word time until a match is obtained. Register C contains the entire instruction. This step requires a minimum of one word time and a maximum of 200 word times.

3. Execute the Instruction: The operation indicated in the instruction is performed. The time required for this phase depends upon the type of operation to be performed.

4. Search for the Next Instruction: The address of the next available storage location on the drum is compared with the second address part of the contents of Register C until a match is obtained. This step requires a minimum of one word time and a possible maximum of 200 word times.

Cost, price and rental rates

	Cost	Monthly Rental
Sale Price of Basic STEP Card System (80- or 90-column)	$175,000	$3,500
Price includes:		
Central Processor (24,000 digits of fast memory)		
High-Speed Card Reader 450 cards per minute		
Read-Punch Unit 150 cards per minute		
High-Speed Printer 600 lines per minute w/a 100 printing positions		
Registers A, X.L.		
Sale Price of Basic STEP Tape System (80- or 90-column)	175,000	3,500
Basic units listed above plus the following:		
Tape Synchronizer 8	50,000	1,000
Uniservo II Tape Units (maximum 10)	ea. 20,000	450
Index Registers (3)	7,500	150
Sale Price of Additional Equipment:		
Multiply and Divide Feature	20,000	400
Pre and Post Reading Station on Punch Unit and Stacker Select on Card Reader and Punch	15,000	300
Additional Print Positions for High-Speed Printer:		
30 Additional Print Positions	2,500	50
Available in increments of 20 positions	1,500	30
Available in increments of 10 positions	1,000	20
600 Cards per minute speed for Card Reader	10,000	200
Index Registers (3) Card System option	7,500	150
Additional Memory:		
First 2,000 digits of High-Speed Memory	22,500	450
Each additional increment of High-Speed Memory (2,000 digits) (maximum 10,000 digits per system)	15,625	312.50
Each additional increment of Fast Memory (4,000 digits) (maximum 40,000 digits per system)	12,000	250
First 2,000 digits of High-Speed Memory is a prerequisite to additional High-Speed Memory and/or additional Fast Memory.		
Randex. Includes Randex Drum Unit (24 million digits), Power Control Unit	166,850	3,550
Additional Randex Drum Units (24 million digits)	ea. 89,300	1,900
This price is for each additional drum unit up to a total of four (96 million digits). Prices on units in excess of four up to a total of nine will be quoted on request.		
Synchronizer	50,000	1,000
Randex requires a synchronizer. When specified with a tape system, Randex will be under the control of the tape synchronizer. No additional synchronizer is required.		

	Cost	Monthly Rental
When Randex is specified for use with a card system, a synchronizer must be included.		
Card-Punching Printer	125,000	2,700
An on-line card punching printer is available for 80-systems.		

Maintenance included in rental contract. Service contract available to STEP System purchasers.

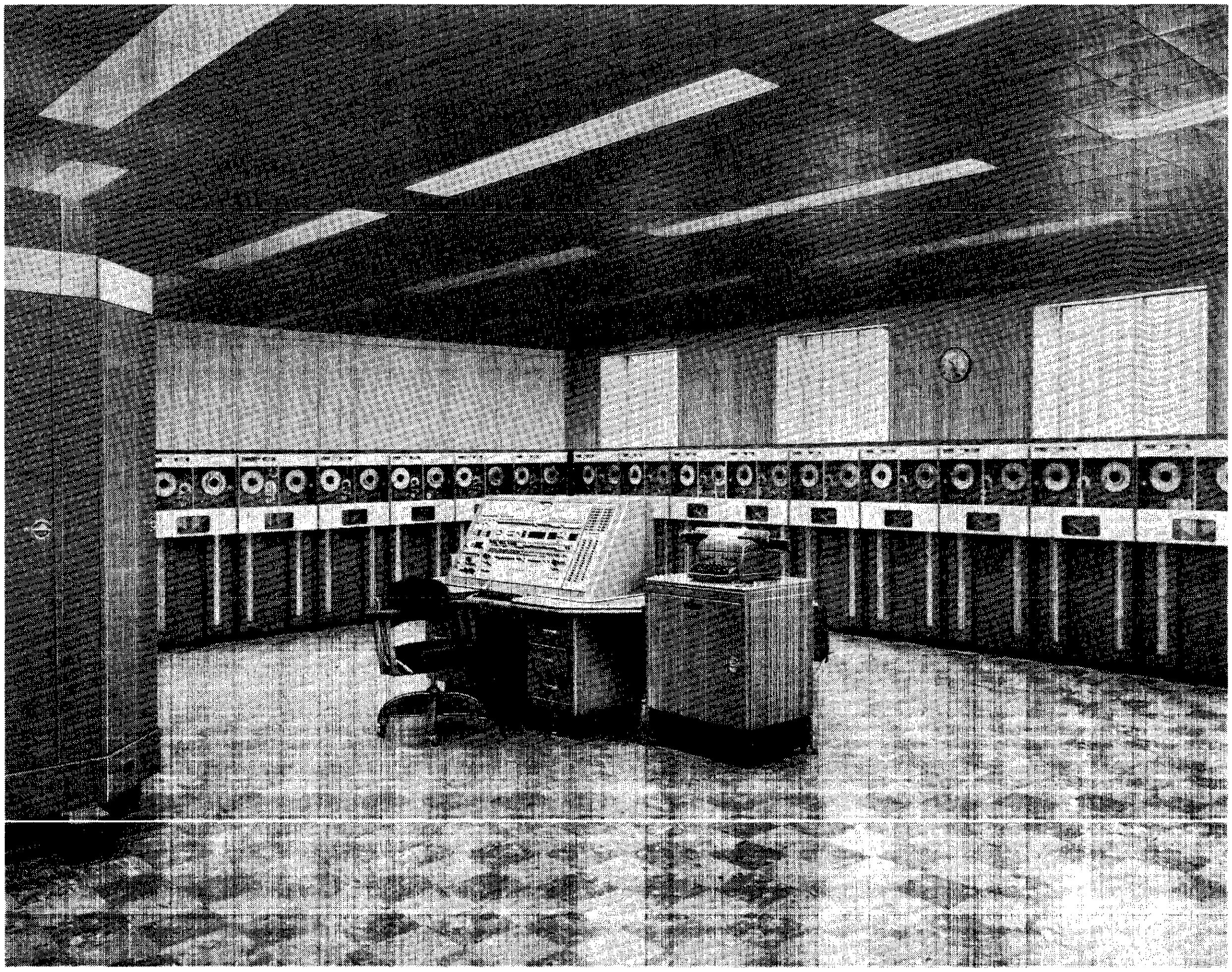
Power, space, weight, and site preparation

Power, computer (card system) (Reader, punch, printer and processor): 16.9 KVA, 0.8 pf.

Power, computer (tape system):
Add 7.0 KVA for synchronizer and first tape unit.
Add 2.5 KVA for each additional tape unit.
Volume, processor: 144 cu. ft.
Volume, reader: 24 cu. ft.
Volume, punch: 36 cu. ft.
Volume, printer: 64 cu. ft.
Area, processor; 24 sq. ft.
Area, reader; 6 sq. ft.
Area, punch: 6 sq. ft.
Area, printer; 16 sq. ft.
Weight, computer: 7,162 lbs.

Cable duct work is supplied with computer, if desired. No special flooring required.

UNIVAC II UNIVAC DIVISION, SPERRY RAND CORPORATION



THE UNIVAC II SYSTEM consists of the central processor, a supervisory control console, a supervisory control printer, up to 16 magnetic tape units, and various off-line input-output devices and auxiliary equipment. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 12 characters.
Numeric Characters Per Word: 12.
Alphabetic Characters Per Word: 12.
Character Code: 6-bit binary coded decimal.
Timing: Synchronous.
Pulse Repetition Rate: 2.25 megacycles.

Central processor

Operation: Serial, fixed point.

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.44
Multiply: 555555 by 5555	1.52
Divide: 3086108025 by 5555	3.68

Access time: 0.04 milliseconds.

Checking features:

Automatic checking of all arithmetic processes by means of parallel circuitry.

Automatic checking of transfers of data within the central processor, character by character, by means of parity check and parallel circuitry.

Registers

Control counter register: One word, holds the location from which the next instruction word is to be taken.

Control register: One word, holds the current instruction word while its two instructions are being executed.

Static register: Half-word, holds the current instruction.

W register: Nine words. Instructions affecting register W can cause from one to nine words to be stored in or read from this register.

Z register: Sixty words. The instructions affecting register Z can cause from 10 to 60 words, always in multiples of ten, to be stored in or read from this register.

A register: One word. Receives the results of all arithmetic operations, provides the augend to an addition operation, the minuend to a subtraction operation, the dividend to a division operation, one of the two quantities entering into a comparison.

L register: One word. Provides the multiplicand to a multiplication operation, the divisor to a division operation, and one of the two quantities entering into a comparison.

X register: One word. Provides the addend to an addition operation, the subtrahend to a subtraction operation, the multiplier to a multiplication operation.

F register: One word. Provides an "extractor pattern" to indicate which characters of another UNIVAC word are to be operated upon.

Memory

The internal memory of the system is a magnetic core storage unit with a capacity of 2,000 words, 24,000 characters.

Control panel

This unit is a part of the supervisory control console, and contains a keyboard and all the necessary controls and indicators for operating the system.

INPUT MEDIA

Note. Direct input-output to and from the central processor is obtained only through the use of magnetic tape, control input keyboard and control output printer. Conversions to and from punched cards, punched paper tape, etc. must be accomplished off-line.

Magnetic tape unit (Uniservo II)

Maximum number per system: 16.
Packing density: Variable—50, 125, or 250 characters per inch.
Number of channels: 8.
Record length: Fixed, 60 words (720 characters); may be subdivided into 6 groups of 10 words (120 characters) each if required.
Record gap: 1 inch or 2.4 inches between each 720 characters (one tenth inch or one inch between each 120 character group).
Tape speed: 100 inches per second/25,000 characters per second maximum.
Rewind time: 3.04 minutes for 1,500 feet; 4.79 minutes for 2,400 feet.
Start-stop time: 5 milliseconds.
Change tape time: 1 minute (approx.).
Physical characteristics of tape:
Composition: Mylar or metal.
Length: 2,400 feet, mylar; 1,500 feet, metal.
Width: ½ inch.
Error detection: A "sprocket bit" and a parity bit are recorded with each character for checking purposes.

Keyboard

This unit is a part of the supervisory control console. It provides a means for entering information directly into the central processor.

Punched card to magnetic tape converter

This unit consists of a card reading unit, a control unit, and a magnetic tape unit. The converter is available in two models for the conversion of both 90-column and 80-column cards. These units operate at a maximum rate of 240 cards per minute and record information on magnetic tape at a density of 125 characters per inch with a 1.0 inch space between each 120 characters and a 2.4 inch space between each 720 characters. The rearrangement of information during the conversion process is controlled by a plugboard. The conversion is completely automatic and is self-checking for accuracy.

OUTPUT MEDIA

Magnetic tape unit (Uniservo II)

As previously described.

Supervisory control printer

This unit is a modified electric typewriter used for printing out information from the central processor.

Magnetic tape to punch card converter

This unit consists of a card punch unit, a control unit, and a magnetic tape unit. Information is read from magnetic tape and punched into 80-column or 90-column cards at the rate of 120 cards per minute. A plugboard permits the selection and rearrangement of information during the conversion process. The converter accepts information recorded on magnetic tape at a density of 125 characters per inch with a one tenth inch space between each 120 characters and a 2.4 inch space between each 720 characters.

High speed line printer system

This system consists of a line printer, a control unit, a storage unit, and a magnetic tape unit. The printer operates at a maximum rate of 600 lines per minute, 130 positions per line. Format is controlled by a plugboard in the control unit. It accepts information recorded on magnetic tape at a density of 50 or 125 characters per inch with a one inch space between each 120 characters, and a 2.4 inch space between each 720 characters.

AUXILIARY COMPONENTS

Unityper II

This unit is a keyboard operated device which records each key stroke on magnetic tape while also producing a printed copy. Information is recorded on magnetic tape at a density of 50 characters per inch with a 2.4 inch space between each 120 characters.

Verifier

This unit records information on magnetic tape at a density of 50 characters per inch with a 2.4 inch space between each 120 characters. It is capable of operating in either of two modes:

1. As a keyboard operated device which records information on magnetic tape in a manner similar to the Unityper II.
2. As a proof reading device which corroborates information recorded on tape and permits the correction of detected errors.

PROGRAMMING

General: The UNIVAC II uses a single address type of instruction.

Instructions:

Number of instructions per word: 2.
Number of digits per instruction: 6.
Total number of operation codes: 52.

Instruction word format

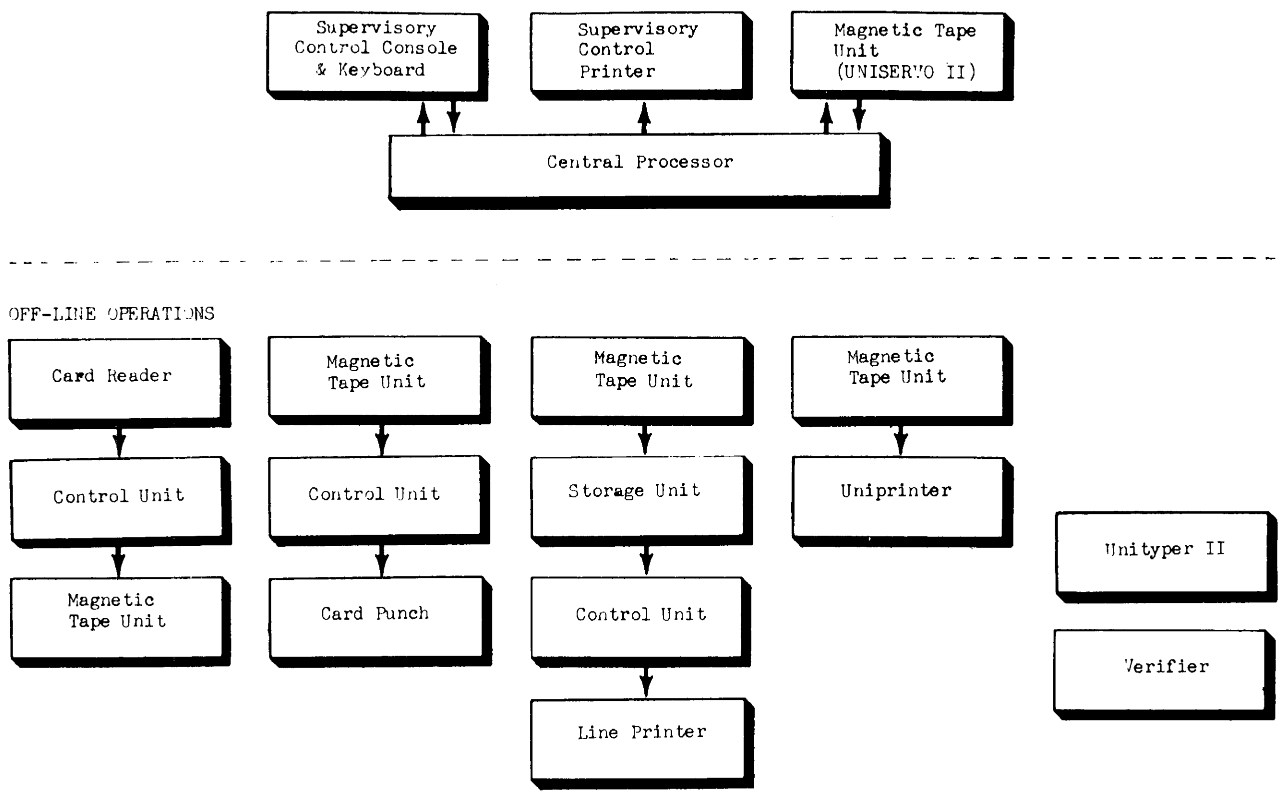
A	A	B	B	B	B	A	A	B	B	B	B
Left hand instruction						Right hand instruction					

A—Operation to be performed.
B—Address of word on which operation is to be performed.

Cost, Power Requirements, and Physical Characteristics

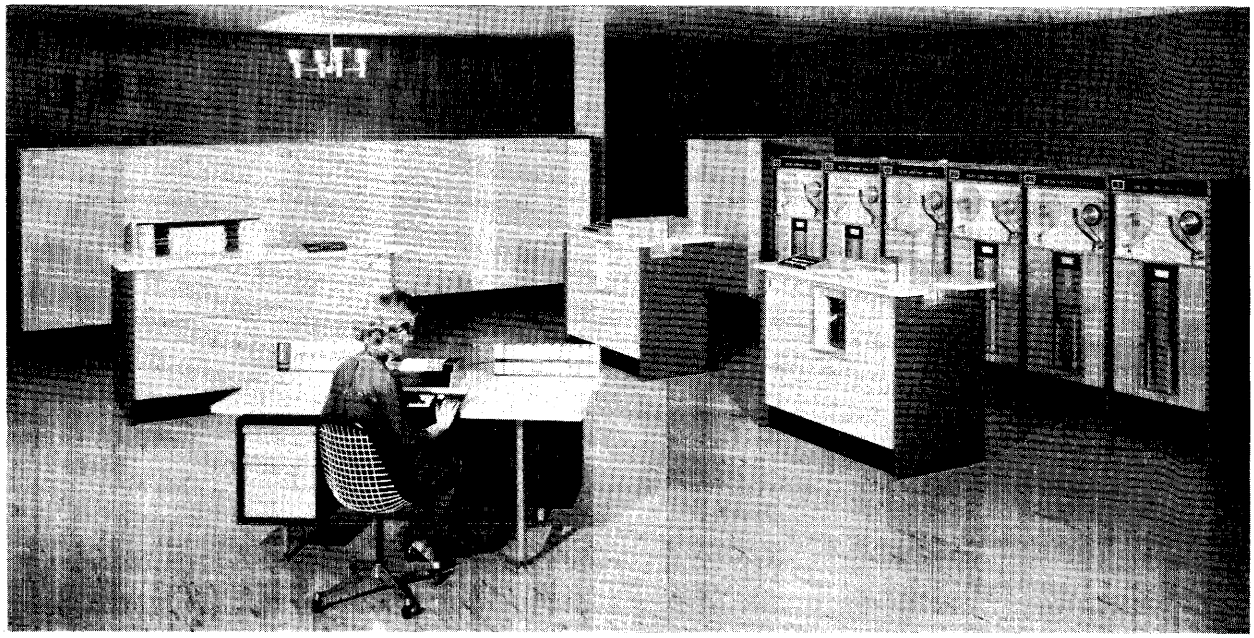
Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
Central Processor, including	$18,540	$970,000		94x172x103	15,000	85.00	289,000
Supervisory Control Desk				33x29x63	725	(2)	5,100
Power Supply				30x74x71	3,700	5.70	19,380
Uniservo II	450	20,000		24x36x48	468	0.75	2,550
Unityper II	90	4,500		25x18x14	100	0.75	255
High Speed Printer System	3,300	185,000				18.00	61,200
Printer Unit				32x47x48	800		
Power Supply				51x33x68	2,000		
Memory Unit				51x33x68	1,200		
Tape Unit				22x29x60	650		
Card to Magnetic Tape Converter	2,520	142,100				10.00	37,400
Card Read Unit				32x24x36	320		
Tape Unit				22x29x60	450		
Electronic Unit				33x51x77	2,265		
Magnetic Tape to Card Converter	2,300	130,000				10.00	27,200
Card Punch Unit				36x36x49			
Tape Unit				23x29x47			
Electronic Unit				30x178x84			
Verifier	250	15,000		24x24x12	150	0.05	171

[1] Maintenance included in rental price. Separate maintenance contract provided for purchased equipment.
[2] Included in central processor.



BLOCK DIAGRAM OF UNIVAC II

UNIVAC III UNIVAC DIVISION, SPERRY RAND CORPORATION



THIS SYSTEM is designed for commercial data processing as well as scientific applications. The UNIVAC III is a medium-cost electronic data processing system designed to meet the needs of business and science. The magnetic core memory holds from 8,192 to 32,768 words in increments of 8,192 words each with a cycle time of 4.5 microseconds. Words can be pure binary, binary coded decimal, UNIVAC Xs-3, or any other form. UNISERVO III tape units allow reading, writing, and computing simultaneously. The read-write rate is 200,000 digits per second.

Up to 32 Uniservo III tape units and six Uniservo II tape units are possible. Auxiliary on-line units may include card-readers which operate at a rate of 700 cards per minute, high-speed printers at 700 lines per minute, card punch units at 300 cards per minute, mass storage and other devices. The UNIVAC III is compatible with other UNIVAC tape units or with those of other manufacturers.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*	
Add:	8	8	6+6 Digits
Multiply:	48-124	48-124	6×6 Digits
Divide:	68-144	68-144	6÷6 Digits

Arithmetic mode: Serial by digit; parallel by bit.

Timing (Computer): Synchronous.

Operation (System): Concurrent.

The computer instruction execution cycle is such that the effective access time is zero.

Checking features: Modulus three word parity checking, arithmetic, transfer and comparison operations, and logical checks.

STORAGE

Core

Number of words: 32,768.
Decimal digits: 196,608.
Access: 1.07 microseconds.

Drum (mass memory)

Number of words: 4,000,000 per drum.
Decimal digits: 24,000,000.
Access: 385 microseconds.

Magnetic tape

Number of units that can be connected: 32.

In addition to the units described above, a maximum of six Uniservo II may be included in the system. Check during writing on Uniservo III. Digital representation (four bits) 200,000 pulses per second transfer rate,2,000 digits per inch.

INPUT MEDIA

Cards

700 cards per minute. 80- or 90-column. No plugboard.

Uniservo III

200 pulses per second (digital). Up to 32 in system. 133.3 (alphanumeric).

Uniservo II

25 pulses per second (alphanumeric). For compatibility with other UNIVAC Tape Systems.

Paper tape

OUTPUT MEDIA

Cards

300 cards per minute. 80- or 90-column. No plugboard.

Card printing punch

Prints 900 lines per minute; punches 150 cards per minute. Punches and prints same card in one pass.

High-speed printer

700 lines per minute. Editing program controlled.

Paper punch

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary or binary coded decimal.
Binary digits per word: 24.
Decimal digits per word: 6.
Alphanumeric characters per word: 4.
Instructions per word: 1.
Instructions decoded: 75 (approximately).
Arithmetic system: Fixed point.
Instruction type: One-plus-one.

Instruction word format

Parity	Indirect Address or Field Select Opt	IR	Oper. Code	AR/IR'	m Address
27–26	25	24–21	20–15	14–11	10–1

Automatic built-in subroutines include automatic interrupt.

Automatic coding includes COBOL and assembly system.

Cost, price and rental rates

	Price	Monthly Rental
Basic System Units:		
Computer — 8 K Memory	$390,000	$8,000
High-Speed Reader	35,000	750
Punch Unit	40,000	850
High-Speed Printer	79,000	1,650
Uniservo III Synchronizer (maximum 16 Uniservos)	145,000	2,900
Uniservo III Power Supply	17,500	350
Uniservo III	24,000 ea.	500 ea.
Additional Equipment Units:		
Card Punching Printer	197,500	4,300
Uniservo II	20,000	450
Uniservo II Synchronizer	92,500	1,925
Uniservo II Power Supply	17,500	350
Memory — Add 8 K	67,500	1,400
Add. 24 K	193,500	4,030
Second Uniservo III Synchronizer or Mass Memory Device	145,000	2,900

Maintenance and service contracting is included in rental price.

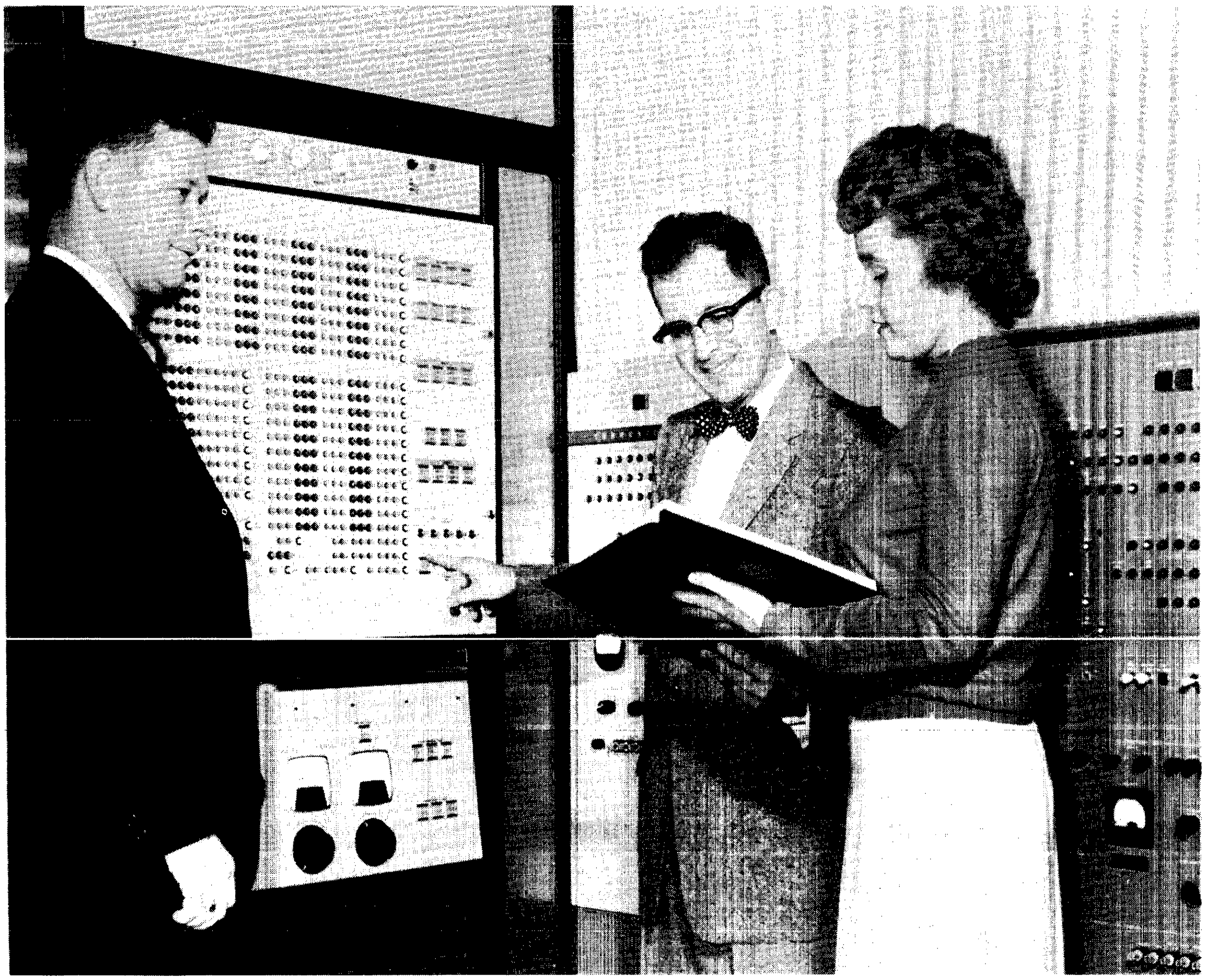
Power, space, weight, and site preparation

Power, computer: 75.2 Kw, 94 KVA, 0.80 pf.
Room size: 43 ft. x 43 ft. x 12 ft.
Weight, computer: 27,225 lbs.

Heat exhaust vents should be located at roof of each unit. Air conditioning output ducts should be near unit inlet vents.

These figures include the UNIVAC III large system w/16 tape.

UNIVAC 490 UNIVAC DIVISION, SPERRY RAND CORPORATION



UNIVAC 490 SYSTEM is a communications-computer network which provides instantaneous inventory and production control data to companies and government agencies having widely scattered offices, plants and warehouses. Transmitting and receiving devices strategically located throughout the country can communicate directly with the central processor. As a result, the computer can receive real-time data from a transaction source, process the raw data and deliver the necessary answers in ample time to complete the original transaction. A wide variety of input and output devices are available to meet specialized requirements.

Arithmetic registers

Seven B-registers (Address modifying registers, 15 bits each).
One A-register or accumulator, 30 bits.
One Q-register and auxiliary arithmetic register, 30 bits.
One P-register program address counter, 15 bits.

Transient registers

One X-register, 30 bits.
One K-register, 6 bits.
One S-register, 15 bits.
One Z-register, 30 bits.
One U-register, 30 bits.
One R-register, 15 bits.
One R′-register, 15 bits.
One D-register, 30 bits.

One C^0-register (Communication Buffer Register).
One C'-register (Communication Buffer Register).

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	7.2-12	4.8-12
Multiply:	19.2-84	7.2-72
Divide:	84	72

Arithmetic mode: Parallel.
Parallel one's complement binary notation.
Timing: Synchronous.
Operation: Concurrent.

STORAGE

Magnetic core

Number of words: 16,384-32,768.
Number of decimal digits: 491,520-983,040.
Access: 1.9 microseconds.
Magnetic core cycle time: 6 microseconds

Magnetic drum type FH 500

Number of words: 327,680.
Number of decimal digits: 9,830,400.
Access: 8,500 microseconds average.

Magnetic drum type FH 880

Number of words: 786,432.
Number of decimal digits: 23,592,960.
Access: 17,000 microseconds average.

Magnetic tape UNIVAC Uniservo IIA

Number of units that can be connected: As many as 12 Uniservo Model IIA Tape Units may operate through a tape control unit and a channel synchronizer connected to a single input-output channel. The 490 System provides 12 input-output channels. Uniservo Model III may also be used with 490 System.
Number of characters per linear inch of tape: 125 or 250.
Channels or tracks on the tape: 8.
Tape speed: 100 inches per second.
Transfer rate: 25,000 characters per second.
Start time: 12 milliseconds.
Stop time: 9 milliseconds.
Average time for experienced operator to change reel of tape: 30 seconds.
Physical properties of tape:
Width: 0.500 inch.
Length of reel: 2,500 feet.
Composition: Metallic or Mylar.

INPUT MEDIA

Magnetic tape

125,000 kilocycle/second, Model III.

Card reader

600 80-column cards per minute.

Read-punch unit

150 80-column cards per minute.

Keyboard and printer

Printed-page output is 60, 75 or 100 words per minute depending on telegraphic service.

Twelve Model IIA Units can be connected to one input-output channel. Can be operated by remote control.

OUTPUT MEDIA

Magnetic tape

125,000 Kilocycle/second.

High-speed printer

600 lines per minute, on-line

Read-punch unit

150 cards per minute.

Keyboard and printer

Because the central site equipment can communicate directly with nearly any type of external digital equipment, remote inquiry answering devices of many different designs can be a part of a 490 System. Usually remote inquiry answering units are especially designed to meet the requirements of a real-time application.

PROGRAMMING AND NUMERICAL SYSTEM

Internal number system: Binary.
Binary digits per word: 30.
Binary digits per instruction: 30.
Instructions per word: 1.
Instructions decoded: 62 function code designators.
Arithmetic system: Fixed point.
Instruction type: One-address.
Number range: − 536,870,911 to + 536,870,911 decimal.

Instruction word format

6	3	3	3	15
f	j	k	b	y

f—Function code designator
j—Branch condition designator
k—Operand-interpretation designator
b—Operand address modification designator
y—Operand designator

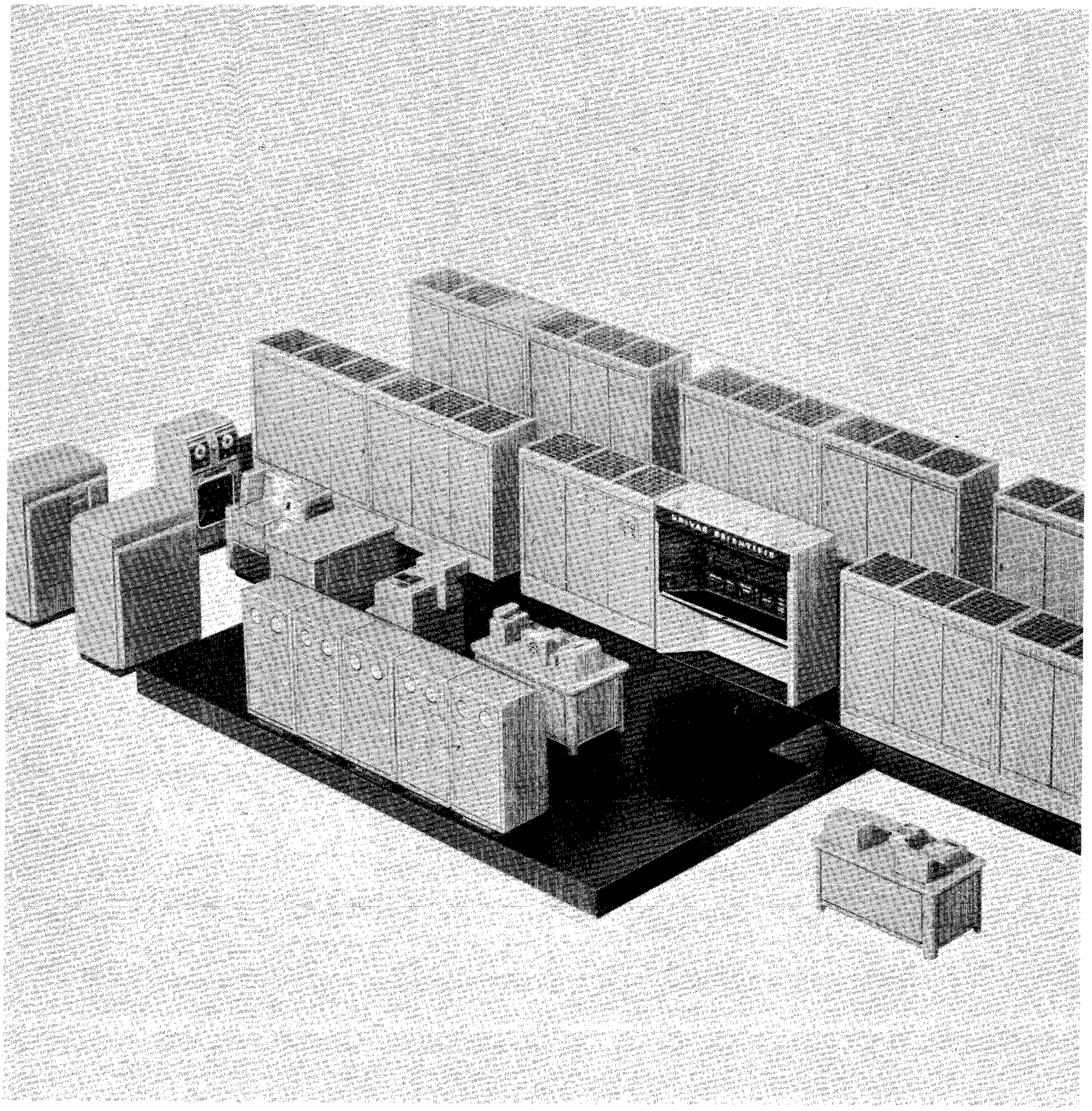
Automatic coding: Compiler and assembly routines will be supplied to all 490 users.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Comments	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
M 490 Compute w/Memory	$10,000		16,384 word	120x36x96		4.0	20,000
M 490 Compute w/Memory	14,000		32,768 word	120x36x96		4.0	20,000
Flying Head Drum Control	1,340			24x30x21	180	0.25	1,000
Flying Head Drum Syn.				24x30x14	120	0.10	400
Flying Head Drum	2,000			36x30x40	400	1.3	
High-Speed C. and Syn.	1,450						
High-Speed Printer	500		600 cpm				
Tape Synchronizer	1,450		Servo II A	24x30x14	120	0.10	400
Tape Synchronizer	4,800		Servo III	24x30x14	120	0.10	400
Uniservo Control	550			12x30x28	240	0.20	750
Uniservo Power				12x30x28	240	0.20	750
Uniservo II A	450			30x33x66	750	2.0	6,500
Uniservo III	750			30x33x66	750	2.0	6,500
Card Reader	350		450-650 cpm				
Console (Double)				42x18x60	300		1,100
CR Synchronizer	1,600						
CR Punch	500		150 cpm				

490 System rental $25,000 to $35,000 per month.

UNIVAC 1103A UNIVAC DIVISION, SPERRY RAND CORPORATION



THE BASIC UNIVAC 1103A SYSTEM consists of the central processor, a control console, a punched card input-output system, a paper tape reader, a paper tape punch, a monitoring electric typewriter and up to ten magnetic tape units. The basic system may be expanded by the addition of magnetic core storage units, a magnetic drum storage unit, a high speed printer, floating point arithmetic, and various off-line input-output devices and auxiliary equipment. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 36 bits.

Numeric Characters Per Word: 35 bits plus sign (10 digits maximum).

Alphabetic Characters Per Word: Depends on code used.

Character Code: Binary, numerics; optional, alphabetics.

Timing: Synchronous, internal; asynchronous, input-output.

Pulse Repetition Rate: 500 kilocycles.

Central processor

Operation: Parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.028
Multiply: 555555 by 5555	0.176
Divide: 3086108025 by 5555	0.482

Magnetic core access time: 0.008 milliseconds.

Magnetic drum access time: 0.017 milliseconds (average).

Checking features: Parity.

Registers

X register: 36 bits. As an "exchange register" exchanges words between various sections of the processor. As an "arithmetic register" holds one operand.

Q register: 36 bits. As a "storage register" holds one word. As an "arithmetic register" holds one operand. Contains shifting properties. It is directly addressable.

A register: Accumulator, 72 bits. As a "storage register" holds the single-extension (36 bits) or the double-extension (72 bits) of the single computer word. As an "arithmetic register" holds the result of an arithmetic operation. Contains shifting properties. It is directly addressable.

Program control register: 36 bits. This register holds the instruction that is currently being executed. This register is made up of the main control register, the U-address register and the V-address register.

Program address counter: 15 bits. This register is used as an additive and subtractive counter to generate successive addresses for obtaining program instructions; also serves as a counter during repeat operations.

Storage address register: 15 bits. This register stores the address of the command being executed by the computer. The seven lower bits are used as a shift counter during the shifting of registers A or Q.

Input-output register "A" (IOA): 8 bits. Temporarily stores data between the computer and paper tape reader, and the punched card input-output unit.

Input-output register "B" (IOB): 36 bits. Temporarily stores data between the computer and magnetic tapes, and the punched card input-output unit.

Tape register: 36 bits. Used to assemble and transfer information between the magnetic tapes and IOB. This register functions in conjunction with the tape buffer registers.

Memory

The main internal storage media is a magnetic core matrix with a capacity of 4,096 words and a magnetic drum with a capacity of 16,384 words. Optional core storage units are available to increase core storage capacity to 12,288 words. An additional magnetic drum unit is also available to increase drum storage capacity to 32,768 words.

Control panel

This unit is a part of the control console and contains all the necessary controls and indicators for operating and checking the system. Switches on the panel provide a means for entering data into the system.

INPUT MEDIA

Magnetic tape unit (Uniservo II)

Maximum number per system: 12.

Packing density: 128 or 250 characters per inch.

Number of channels: 8.

Record length: Fixed, 720 characters; variable, limited by memory size only; continuous, limited by length of tape.

Record gap: 1.2 inches and 2.4 inches.

Tape speeds: 100 inches per second/25,000 characters per second maximum.

Rewind time: 3.04 minutes for 1,500 feet, 4.79 minutes for 2,400 feet.

Start-stop time: 5 milliseconds.

Change tape time: 1 minute (approx.).

Physical characteristics of tape:

- Composition: Metal or mylar.
- Length: 1,500 feet, metal; 2,400 feet, mylar.
- Width: ½ inch.

Error detection: Parity, sprocket or timing and bad areas.

Paper tape reader

This unit is a photoelectric unit which reads 7-level punched paper tape at a rate of 200 characters per second.

Punched card input-output system

This system consists of a card read-punch unit and a control unit. The card read-punch unit reads and/or punches 80-column cards at the rate of 120 cards per minute. Simultaneous reading and punching of cards can be achieved.

OUTPUT MEDIA

Magnetic tape unit (Uniservo)

As previously described.

Monitoring typewriter

This unit punches data from the central processor into paper tape at a rate of ten characters per second, while simultaneously producing a typewritten copy of the data. The keyboard and paper tape punch may be used off-line for the preparation of punched paper tape.

Paper tape punch

This unit punches 7-level paper tape at a rate of 60 characters per second.

AUXILIARY COMPONENTS

High speed printer

This unit is generally operated off-line; however, it can be modified for on-line use, and is used for large volume printing. The printer system consists of a storage unit, a control unit, a line printer, and a magnetic tape unit. Information is read from magnetic tape and converted to hard copy at a rate of 600 lines per minute, 130 character positions per line. Format is controlled by a plugboard in the control unit. This unit can be modified to permit using it as a plotting device for preparing charts or graphs. The entire operation is self-checking.

Punched card to magnetic tape converter

This system consists of a card reader, a control unit, and a magnetic tape unit. Information is read from punched cards and converted to magnetic tape at a rate of 240 cards per minute. Two models are available for the conversion of both 80-column and 90-column cards. The entire operation is self-checking.

Magnetic tape to punched card converter

This system consists of a card punch, a control unit, and a magnetic tape unit. Information is read from magnetic tape and converted to 80-column or 90-column cards at a rate of 120 cards per minute. The entire operation is self-checking.

Punched paper tape to magnetic tape converter

This system consists of a paper tape reader, a control unit, and a magnetic tape unit. Information is read from paper tape and converted to magnetic tape at a rate of 200 characters per second. The entire operation is self-checking.

Magnetic tape to punched paper tape converter

This system consists of a paper tape punch, a translator unit, a control unit, and a magnetic tape unit. Information is read from magnetic tape and converted to punched paper tape, teletypewriter code, at a rate of 60 characters per second. The entire operation is self-checking.

Unityper II

This unit is a keyboard operated device which records each key stroke on a magnetic tape while also producing a printed copy. Information is recorded on tape at a density of 50 characters per inch, with a 2.4 inch spacing between groups of 120 characters.

Verifier

This unit records information on magnetic tape at a density of 50 characters per inch with a 2.4 inch spacing between groups of 120 characters. It is capable of operating in either of two modes:

1. As a keyboard operated device which records information on magnetic tape in a manner similar to the Unityper II.
2. As a proof reading device which corroborates information recorded on tape and permits the correction of detected errors.

Visual display unit

Output from the UNIVAC 1103A system, including numbers, letters, and dots for analog printing may be visually displayed on the screen of a 19-inch cathode-ray tube. The display may be permanently recorded on 35-millimeter film at the rate of one frame every two seconds. The operation of this unit is governed by program instructions. The various modes of operation include printing of one character upon each individual command or a series of characters from a single command.

Paper tape preparation unit, Model II

This unit produces and verifies seven-level punched paper tape at a rate of 10 characters per second.

PROGRAMMING

General: The UNIVAC 1103A uses a two address type of instruction.

Instructions:

Number of instructions per word: 1.
Number of digits per instruction: 36 bits.
Total number of operation codes: 41 plus 9 floating point.

Instruction word format

Op. code	U address	V address
6 bits	15 bits	15 bits

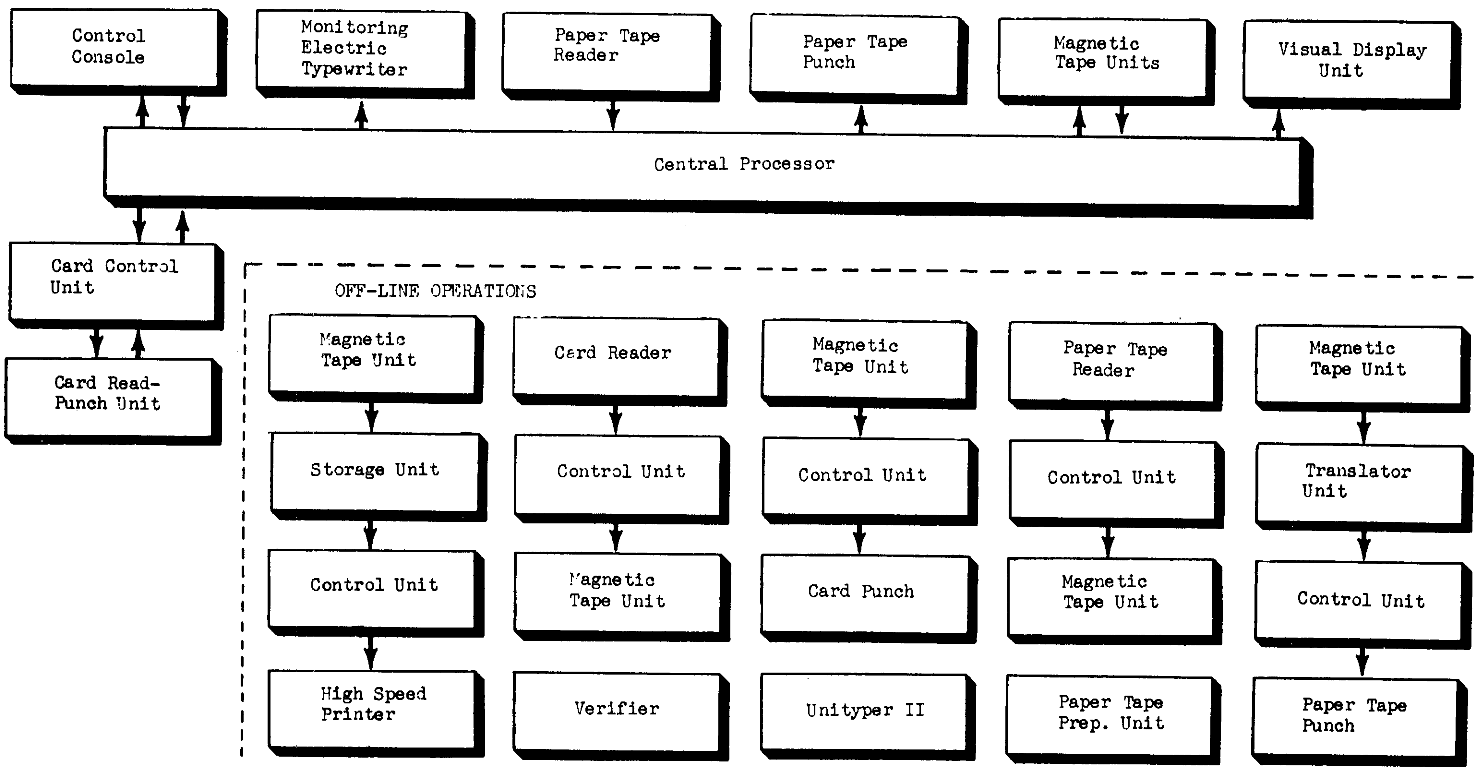
Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1103A Central Processor	$21,560	$922,000		680x39x87	29,000	51.000	154,000
a. Magnetic Core Storage (4,096 words)							
b. Magnetic Drum Storage (16,384 words)							
c. Variable Block Length Feature							
d. Magnetic Tape Control							
e. Power Supply							
f. Control Console							
g. Arithmetic Section							
h. Main Control Section							
i. Air Conditioning Section							
j. High Speed Paper Tape Reader							
k. High Speed Paper Tape Punch							
l. Monitoring Electric Typewriter							
Additional Core Storage (4,096 words)	4,500	195,000		81x30x75	1,300	5.000	17,065
Additional Drum Storage (16,384 words)	1,500	60,000		(2)	(2)	(2)	(2)
Floating Point Unit	1,545	65,000		(2)	(2)	(2)	(2)
Uniservo II (Magnetic Tape Unit)	450	20,000		30x33x63	725	2.800	9,550
Punched Card Input/Output Unit	1,310	55,000		72x30x57	1,072	2.500	8,500
Punched Paper Tape Preparation Unit Model II	225	8,045		12x24x12	20	0.075	256
Verifier	250	15,000		24x24x12	35	0.050	171
Unityper II	90	4,500		30x24x12	30	0.078	266
High Speed Printer	3,300	185,000		150x144x66	4,650	18.000	60,350
Card to Magnetic Tape Converter (47 character code)	2,520	142,100		110x32x78	3,235	10.000	34,130
Magnetic Tape to Card Converter (47 character code)	2,355	(3)		204x72x78	4,225	11.300	38,450
Monitoring Electric Typewriter	110	3,365		21x18x12	20	0.070	221
High Speed Paper Tape Reader	90	2,715		12x9x9	5	0.006	19
High Speed Paper Tape Punch	70	1,600		9x9x10	7	0.020	68

[1] Maintenance included in rental price. Separate maintenance contract available for purchased equipment.

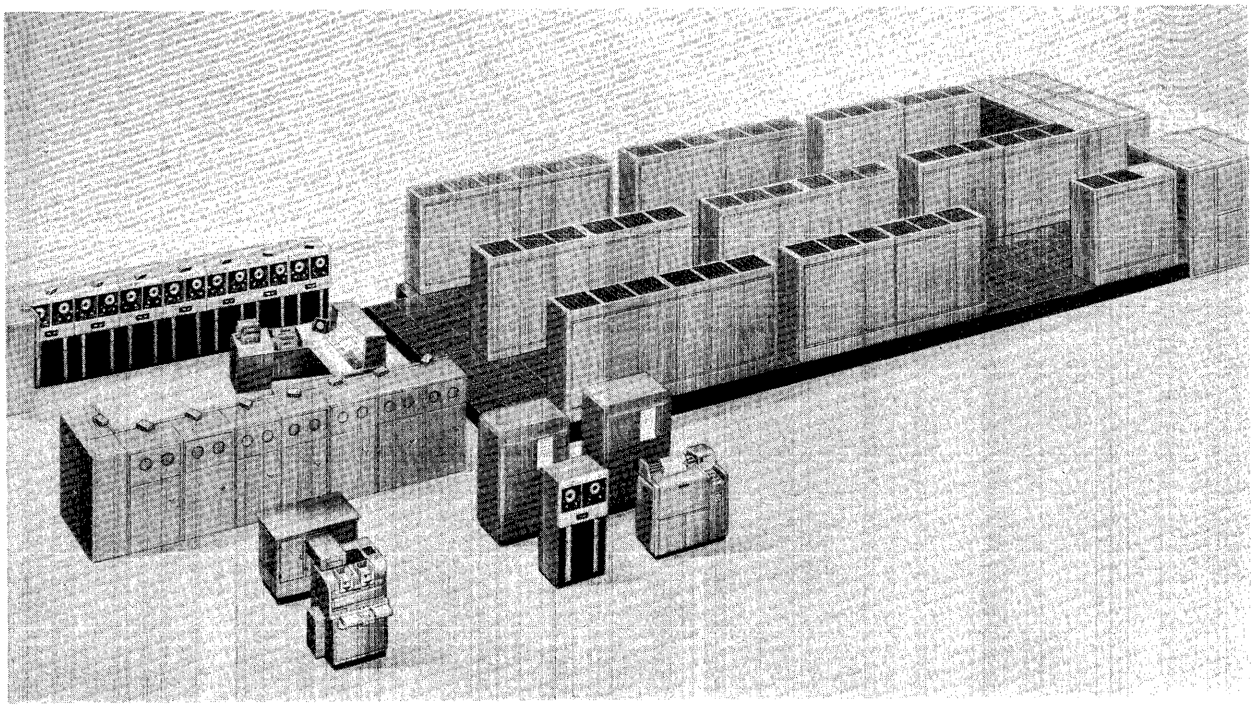
[2] Included in basic unit.

[3] Price will be quoted on request.



BLOCK DIAGRAM OF UNIVAC 1103-A

UNIVAC 1105 UNIVAC DIVISION, SPERRY RAND CORPORATION

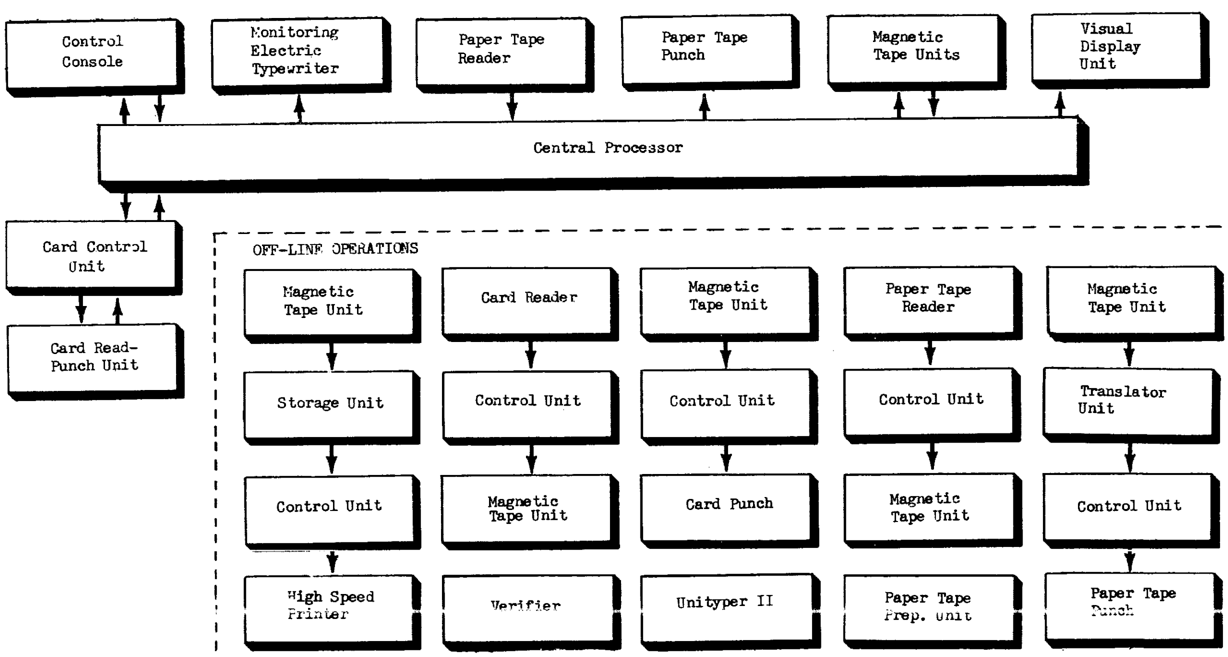


THE BASIC UNIVAC 1105 SYSTEM consists of the central processor, a control console, a monitoring typewriter, a photoelectric paper tape reader, a paper tape punch, a punched card input-output system, and up to 24 magnetic tape units. The basic system may be expanded by the addition of a magnetic core storage unit, a magnetic drum unit, and various off-line input-output devices and auxiliary equipment. Vacuum tubes are the principal electronic components of the system.

SYSTEM COMPONENTS

General

Word Length: Fixed, 36 bits.
Numeric Characters Per Word: 35 bits plus sign (10 digits maximum).
Alphabetic Characters Per Word: Depends on code



BLOCK DIAGRAM OF UNIVAC 1105

used.

Character Code: Binary, numerics; optional, alphabetics.

Timing: Synchronous, internal; asynchronous, input-output.

Pulse Repetition Rate: 500 kilocycles.

Central processor

Operation: Parallel, fixed point (floating point optional).

Computation speed: (program and operands are in memory).

	Time (milliseconds) Fixed point
Add: 555555 to 555555	0.028
Multiply: 555555 by 5555	0.176
Divide: 3086108025 by 5555	0.482

Magnetic core access time: 0.008 milliseconds.

Magnetic drum access time: 0.017 milliseconds (average).

Checking features: Parity.

Registers

X register: 36 bits. As an "exchange register" exchanges words between various sections of the processor. As an "arithmetic register" holds one operand.

Q register: 36 bits. As a "storage register" holds one word. As an "arithmetic register" holds one operand. Contains shifting properties. It is directly addressable.

A register: Accumulator, 72 bits. As a "storage register" holds the single-extension (36 bits) or the double-extension (72 bits) of the single computer word. As an "arithmetic register" holds the result of an arithmetic operation. Contains shifting properties. It is directly addressable.

Program control register: 36 bits. This register holds the instruction that is currently being executed. This register is made up of the Main Control Register, the U-address register, and the V-address register.

Program address counter: 15 bits. This register is used as an additive and subtractive counter to generate successive addresses for obtaining program instructions; also serves as a counter during repeat operations.

Storage address register: 15 bits. This register stores the address of the command being executed by the computer. The seven lower bits are used as a shift counter during the shifting of registers A or Q.

Input-output register "A" (IOA): 8 bits. Temporarily stores data between the computer and paper tape reader, or the punched card input/output unit.

Input-output register "B" (IOB): 36 bits. Temporarily stores data between the computer and magnetic tapes, or the punched card input/output unit.

Tape register: 36 bits. Used to assemble and transfer information between the magnetic tapes and IOB. This register functions in conjunction with the tape buffer registers.

Memory

The main internal storage media is a magnetic core matrix with a capacity of 8,192 words and a magnetic drum with a capacity of 16,384 words. Optional core storage units are available to increase the core storage capacity to 12,288 words. An additional magnetic drum unit is also available to increase drum storage capacity to 32,768 words.

Control panel

This unit is a part of the control console and contains all the necessary controls and indicators for operating the system. Switches on the panel provide a means for entering data into the system.

INPUT MEDIA

Magnetic tape unit (Uniservo II)

Maximum number per system: 24.

Packing density: Variable—128 or 250 characters per inch.

Number of channels: 8.

Record length:

Fixed: 120 words (720 characters), subdivided into 6 groups of 20 words (120 characters) each.

Variable: Limited by memory size only.

Continuous: Limited by length of tape.

Record gap: 1.2 inches or 2.4 inches between each 720 characters (0.0, 0.1, or 1.0 inch between each 120 character group).

Tape speed: 100 inches per second/25,000 characters per second maximum.

Rewind time: 3.04 minutes for 1,500 feet; 4.79 minutes for 2,400 feet.

Start-stop time: 5 milliseconds.

Change tape time: 1 minute (approx.).

Physical characteristics of tape:

Composition: Mylar or metal.

Length 2,400 feet, mylar; 1,500 feet, metal.

Width: ½ inch.

Error detection: A "sprocket bit" and a parity bit are recorded with each character for checking purposes. Bad areas of tape are also detected and passed over, automatically.

Paper tape reader

This is a photoelectric unit which reads 7-level punched paper tape at a rate of 200 characters per second.

Punched card input-output system

This system consists of a card read-punch unit and a control unit. The card read-punch unit reads and/or punches 80-column cards at the rate of 120 cards per minute. Simultaneous reading and punching of cards at a rate of 240 cards per minute can be achieved.

OUTPUT MEDIA

Magnetic tape unit (Uniservo II)

As previously described.

Monitoring typewriter

This unit punches data from the central processor into paper tape at a rate of ten characters per second, while simultaneously producing a typewritten copy of the data. The keyboard and paper tape punch may be used off-line for the preparation of punched paper tape.

Paper tape punch

This unit punches 7-level paper tape at a rate of 60 characters per second.

Punched card input-output system

As previously described.

AUXILIARY COMPONENTS

High speed printer

This unit is generally operated off-line; however, it can be modified for on-line use and is used for large volume printing. The printer system consists of a storage unit, a control unit, a line printer, and a magnetic tape unit. Information is read from magnetic tape and converted to hard copy at a rate of 600 lines per minute, 130 character positions per line. Format is controlled by a plugboard in the control unit. This unit can be modified to permit using it as a plotting device for preparing charts or graphs. The entire operation is self-checking.

Punched card to magnetic tape converter

This system consists of a card reader, a control unit, and a magnetic tape unit. Information is read from punched cards and converted to magnetic tape at a rate of 240 cards per minute. Two models are available for the conversion of both 80-column and 90-column cards. The entire operation is self-checking.

Magnetic tape to punched card converter

This system consists of a card punch, a control unit, and a magnetic tape unit. Information is read from magnetic tape and converted to 80-column or 90-column cards at a rate of 120 cards per minute. The entire operation is self-checking.

Punched paper tape to magnetic tape converter

This system consists of a paper tape reader, a control unit, and a magnetic tape unit. Information is read from paper tape and converted to magnetic tape at a rate of 200 characters per second. The entire operation is self-checking.

Magnetic tape to punched paper tape converter

This system consists of a paper tape punch, a translator unit, a control unit, and a magnetic tape unit. Information is read from magnetic tape and converted to punched paper tape, teletypewriter code, at a rate of 60 characters per second. The entire operation is self-checking.

Unityper II

This unit is a keyboard operated device which records each key stroke on a magnetic tape while also producing a printed copy. Information is recorded on tape at a density of 50 characters per inch, with a 2.4 inch spacing between groups of 120 characters.

Verifier

This unit records information on magnetic tape at a density of 50 characters per inch with a 2.4 inch spacing between groups of 120 characters. It is capable of operating in either of two modes:

1. As a keyboard operated device which records information on magnetic tape in a manner similar to the Unityper II.
2. As a proof reading device which corroborates information recorded on tape and permits the correction of detected errors.

Visual display unit

Output from the UNIVAC 1105 system, including numbers, letters, and dots for analog printing, may be visually displayed on the screen of a 19-inch cathode-ray tube. The display may be permanently recorded on 35-millimeter film at the rate of one frame every two seconds. The operation of this unit is governed by program instructions. The various modes of operation include printing of one character upon each individual command or a series of characters for a single command.

Paper tape preparation unit, Model II

This unit produces and verifies seven-level punched paper tape at a rate of 10 characters per second.

PROGRAMMING

General: The UNIVAC 1105 uses a two address type of instruction.

Instructions:

Number of instructions per word: 1.

Number of digits per instruction: 36 bits.

Total number of operation codes: 41 plus 9 floating point.

Instruction word format

Op. code	U address	V address
6 bits	15 bits	15 bits

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance (1)	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1105 Central Processor, including	$33,060	$1,612,000		1080x256x87 or 648x432x87	49,000	85.000	290,100
a. Magnetic Core Storage (8,192 words)							
b. Magnetic Drum Storage (16,384 words)							
c. Two-Section Tape Input-Output Buffer; 120 words/section.							
d. Variable Block Length Feature							
e. Magnetic Tape Control (2)							
f. Power Supply							
g. Control Console							
h. Arithmetic Section							
i. Main Control Section							
j. Air Conditioning Section							
k. High Speed Paper Tape Reader							
l. High Speed Paper Tape Punch							
m. Monitoring Electric Typewriter							
Additional Core Storage (4,096 words)	4,500	195,000		81x30x74	1,300	5.000	17,065
Additional Drum Storage (16,384 words)	1,500	60,000		(4)	(4)	(4)	(4)
Floating Point Unit	1,545	65,000		(4)	(4)	(4)	(4)
Uniservo II (Magnetic Tape Unit) (2)	450	20,000		30x33x63	725	2.800	9,550
Punched Card Input-Output Unit	1,310	55,000		72x30x57	1,072	2.500	8,500
Punched Paper Tape Preparation Unit Model II	225	8,045		12x24x12	20	.075	256
Unityper	90	4,500		30x24x12	30	.078	266
Verifier	250	15,000		24x24x12	35	.050	171
High Speed Printer	3,300	185,000		150x144x66	4,650	18.000	60,350
Plotting Feature	590	35,400					
Card to Magnetic Tape Converter (47 character code)	2,520	142,100		110x32x78	3,235	10.000	34,130
Magnetic Tape to Card Converter (47 character code)	2,355	(3)		204x72x78	4,225	11.300	38,450
Monitoring Electric Typewriter	110	3,365		21x18x12	20	.070	221
High Speed Paper Tape Reader	90	2,715		12x9x9	5	.006	19
High Speed Paper Tape Punch	70	1,600		9x9x10	7	.020	68

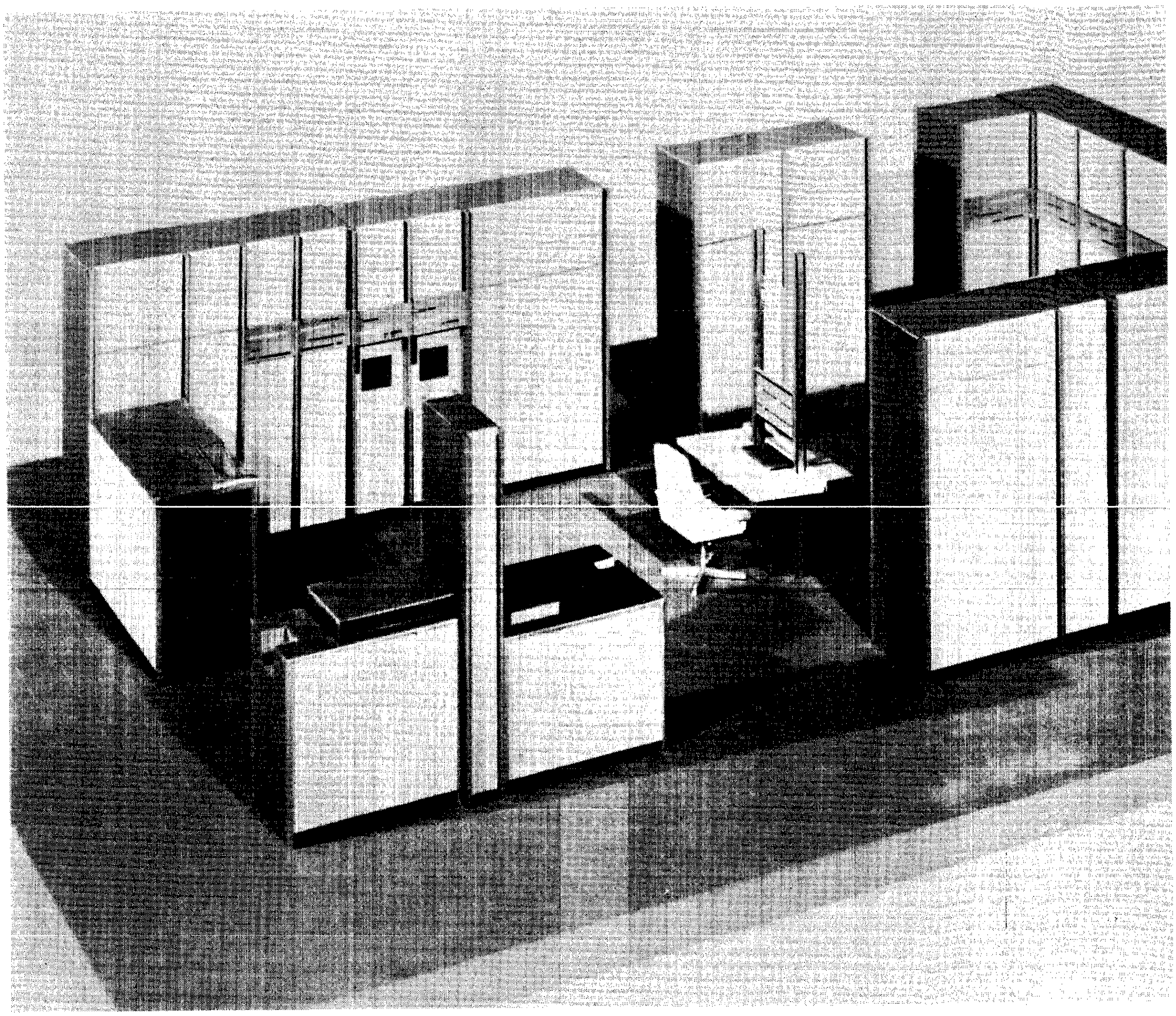
[1] Maintenance included in rental price. Separate maintenance contract available for purchased equipment.

[2] A minimum of 16 magnetic tape units are required for each system.

[3] Price will be quoted on request.

[4] Included in basic unit.

UNIVAC 1107 UNIVAC DIVISION, SPERRY-RAND CORPORATION



THE 1107 is an advanced solid-state data processing system designed and developed to provide solutions to complex problems. This computer system is well suited to off-line, on-line, and real-time problems in commercial, scientific and military applications.

The 1107 can handle a wide range of applications.

General characteristics

Average monthly rental: $40,000-$60,000.
Solid state: Yes.
Storage capacity, main memory: Magnetic core, 65,536 words; thin film, 128 words.
Storage type: Thin film and core.
Word size: 36 bits.
Instruction addresses: One (modified single-address).

Special features

Index Registers
Indirect Addressing
Floating Point Arithmetic
Console Typewriter
Random Access File
Random Inquiry

Features

A thin film control memory is used for arithmetic and index register, for input-output access control and for special controls and for auxiliary storage.

The thin film storage has a 300 nanoseconds access time with a complete cycle time of 600 nanoseconds.

A ferrite core memory for instructions and operands, available in capacities of 16,384 words in one bank; or of 16,384, 32,768, 49,152 or 65,536 words in two separately accessed banks.

Two microsecond effective cycle time for core storage (overlapping of two banks).

There are 36 bit words in both the magnetic film and core memories.

Computer system has an extremely powerful instruction repertoire, including fixed and floating point integer and fractional arithmetic.

Design includes 16 bi-directional channels, capable of concurrent input-output transmissions up to 250,000 words per second, without direct supervision of the main program.

ALGOL and COBOL compiling programs and a FORTRAN translating program will be provided. (The 1107 will accommodate all routines previously coded in FORTRAN).

Also provided is an Executive Routine capable of integrating routines of multiple programs.

The 1107 instruction word format provides for indexing, automatic index-register incrementation, partial word transfer, and indirect addressing along with a current operand reference and specification of an arithmetic register.

ARITHMETIC UNIT

	Including Storage access (microseconds)	*Excluding Storage access (microseconds)*
Add:	4.0	0.8
Multiply:	12.7	7.4
Divide:	31	24

Arithmetic mode: Parallel.

Timing: Synchronous.

Operation: Concurrent.

Checking features: Logical checks include parity bits checking on magnetic tape. Transfer checks are made on all other peripheral devices. Special instructions facilitate program parity checks.

STORAGE

Magnetic core

Number of words: 65,356 maximum.
Total number of binary coded decimal digits: 589,824.
Access: 1.8 microseconds.

Thin film

Number of words: 128.
Total number of binary coded decimal digits: 1,152.
Access: 0.3 microsecond.

Drum, FH 500

Number of words: 262,144 each.
Total number of binary coded decimal digits: 2,359,296.
Access: 8,500 microseconds average.

Drum, FH 800

Number of words: 786,432.
Total number of binary coded decimal digits: 7,077,888.
Access: 17,000 microseconds average.
Number of units that can be connected: Up to 12 tape units may be connected to one channel. One magnetic tape control unit required per channel.

INPUT-OUTPUT MEDIA

Magnetic tape (Model IIA)

25,000 kilocycles per second.

Magnetic tape (Model III)

120,000 kilocycles per second.

Paper tape reader

400 frames per second.

Card reader

600 or 700 cards per minute.

Paper tape punch

110 frames per second.

Card punch

150 or 300 cards per minute.

Printer

600 or 700 lines per minute.

The complete line of UNIVAC peripheral devices as well as specialized devices may be used if so desired. The input-output section of the computer has been designed to be adaptable to future peripheral equipments.

Sixteen bi-directional channels are provided.

Up to 12 tape units may be connected to one channel.

One magnetic tape control unit is required per channel.

PROGRAMMING

Internal number system: Binary.
Binary digits per word: 36.
Binary digits per instruction: 36.
Instructions per word: 1.
Instructions decoded: 114.
Arithmetic system: Fixed and floating point.

Partial and multiple arithmetic may be performed. In partial arithmetic any 1/2, 1/3, or 1/6 of a word may be added in an entire (A) Register, giving one sum. Fields or Partial Words may be used in all the arithmetic operations. In multiple arithmetic, the two halves or three thirds of a word may be added in an (A) Register, giving two or three sums respectively. Subtraction may also be performed in a similar manner.
Instruction type: One-address (modified).

Instruction word format

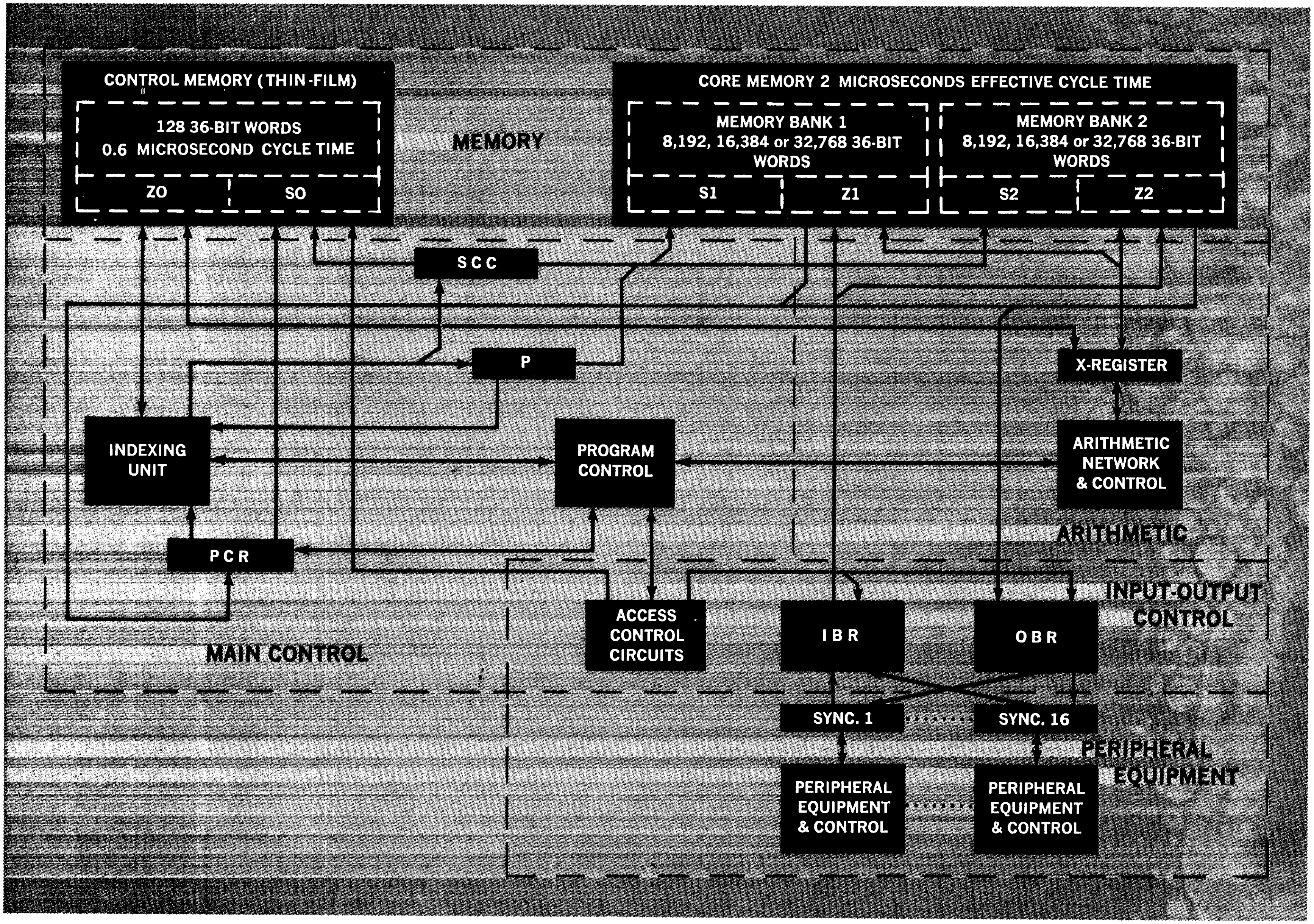
36–31	30–27	26–23	22–19	18	17	16–1
f	j	a	b	h	i	u

Legend:
- u—Base Operand Address Designator (16 Bits)
- i—Indirect Address Designator (One Bit)
- h—Increment Designator (One Bit)
- b—(B) Register Designator (Four Bits)
- a—(A) Register Designator (Four Bits)
- j—Partial Word or Minor Function Code (Four Bits)
- f—Function Code (Six Bits)

Automatic coding includes ALGOL, with Fortran Translator and COBOL. Basic Utility Library includes an executive routine and an Advanced Computer-Oriented Mnemonic Code Assembly System; also sort-merge and debugging programs.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Comments	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr. (M)
Central Processor	($19,750	($888,750		74x35x82	1,850	7.5	19.9
Power Control Center				48x35x35	800		
Operator Console	)	)		54x35x50	550		
Core Memory (65,536) W	17,750	798,750	2 Banks	36x35x82	2,000	5.0	14.
Mag. Tape Control	1,550	69,750		20x35x82	125	1.9	5.1
Uniservo II A Power S.	550	24,750	12 Units Max.	57x33x82	3,000	40.6	10.0
Uniservo II A	450	20,000		31x34x82	800	3.1	8.5
Mag. Drum Control FH 880	1,440	64,800		20x35x82	125	1.5	4.1
FH 880 Drum 4,718,592c 786,432w	2,000	90,000		50x33x50	800	1.9	5.1
Line Printer Control	2,050	92,250		20x35x82	125	1.5	4.1
46 Line Printer 600 min.				72x32x53	1,613	4.4	12.0
AB Card Control — Uniservo II A			A comb. B comb.	20x35x82	125	1.5	4.1
A Card Punch	2,700	121,500	150 cpm	27x49x55	1,100	1.5	4.1
B Card Punch			300 cpm	27x49x55	1,100	1.5	4.1
A Card Reader			600 cpm	27x51x50	400	1.3	3.5
B Card Reader	3,500	157,500	700 cpm	27x51x50	400	1.3	3.5
Paper Tape Control	700	31,500	Tape (incl. reader punch)	24x35x82	800	1.2	2.6
Uniservo III A	750	33,750	Density 1000 per min.				
Memory 16384 W	4,750	213,750	1 Bank				
Memory 16384 W	7,000	315,000	2 Bank				
Memory 32768 W	9,000	405,000	2 Bank				
Memory 49152 W	13,500	607,500	2 Bank				
Tape Control — Uniservo III A	5,000	225,000	16 Units				
Paper Tape Synchronous	540	24,300					
Tape Power Supply	550	24,750					



CONTROL MEMORY (THIN-FILM)
128 36-BIT WORDS
0.6 MICROSECOND CYCLE TIME
ZO
SO
MEMORY
CORE MEMORY 2 MICROSECONDS EFFECTIVE CYCLE TIME
MEMORY BANK 1
8,192, 16,384 or 32,768 36-BIT WORDS
S1
Z1
MEMORY BANK 2
8,192, 16,384 or 32,768 36-BIT WORDS
S2
Z2
SCC
P
X-REGISTER
INDEXING UNIT
PROGRAM CONTROL
ARITHMETIC NETWORK & CONTROL
ARITHMETIC
PCR
INPUT-OUTPUT CONTROL
ACCESS CONTROL CIRCUITS
IBR
OBR
MAIN CONTROL
SYNC. 1
SYNC. 16
PERIPHERAL EQUIPMENT
PERIPHERAL EQUIPMENT & CONTROL
PERIPHERAL EQUIPMENT & CONTROL

NOTES

MICR Equipment

NOTES

INTRODUCTION TO MICR EQUIPMENT

JUST TWO YEARS ago, in April, 1959, the American Bankers Association (A.B.A.) published the specifications for a machine language to be used in banking. This long-awaited release unlocked the door to the automation of the largest non-government paper handling application in the world — checks. Since then, banks throughout the country have been applying themselves to the task of opening that door and a few of them, at least, have a foot in the door.

The language is known in general as MICR, for magnetic ink character recognition. The ink is not really magnetic; it contains iron oxide particles which are magnetized by machines handling the documents, and the magnetized fields are detected by magnetic reading heads. The A.B.A.'s choice of this kind of reading, rather than optical scanning, was due to the handling and over-stamping that checks normally receive; where optical reading is impossible, magnetic reading can still be accomplished so long as the over-stamping contains no magnetic material.

There are fourteen characters in the type font — digits 0 through 9 and four control symbols. The characters resemble the digits they represent. The stylized numerals are necessary to create waveforms of a distinctive shape, both to allow recognition and to prevent incorrect identification. After the characters have been magnetized by passing them beneath a strong electromagnet, they are moved at a constant speed under a magnetic reading head. The waveforms thus created are tested to find which characters were read.

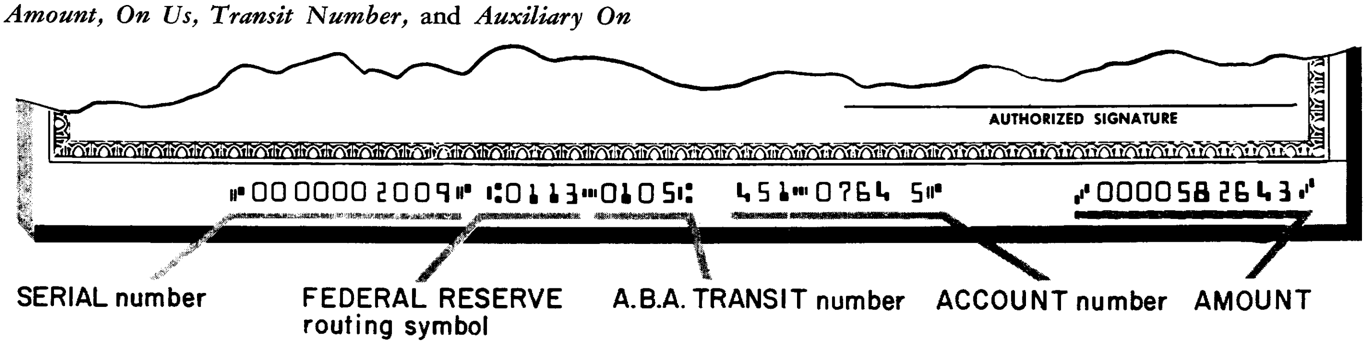
To make these E-13B characters usable as a *common language* for bankers, the A.B.A. fully defined what magnetic ink printing was to appear on the checks, and in which places on the checks. A minimum of six inches was placed on check lengths, and the bottom ⅝ inch was reserved for MICR encoding; regular ink can appear in this ⅝ band, but magnetic ink in this area must be limited to the prescribed characters. Magnetic ink is permissible on any other part of the check. The E-13B characters are printed in a single line across the bottom of the check, ¼ inch above the lower edge.

This line of printing is divided into four fields: *Amount, On Us, Transit Number,* and *Auxiliary On Us.* The *Amount* field consists of 10 digits bracketed by amount symbols; the field boundaries are ¼ inch and 1⅞ inches from the right edge of the check. The *On Us* field, used for account number and transaction codes, has 19 spaces which may be used or left blank; its boundaries are 1⅞ inches and 4¼ inches from the right edge. The *Transit Number* field consists of two four-digit numbers separated by a dash with a transit number symbol at each end. Note the similarity between the transit number and the routing symbol in the upper right corner of the check; boundaries for the transit number field are 4¼ inches and 5¾ inches from the right edge. The remainder of the printing line on the check is the *Auxiliary On Us* field, that is, everything but the right hand 5¾ inches. In checks of sufficient length this field can be used by the issuing bank for check numbering or whatever else it desires.

The coding of all but the amount field is normally done before the checks are issued. The amount is encoded by the first bank receiving the check for collection (that is, it will be so encoded when every bank begins to use the common language system). Every bank, regardless of its size, has been urged by the A.B.A. to begin printing its transit number on all checks. The Federal Reserve System will be able to effect great savings in clerical time because of this; to hasten the encoding, the Fed has been looking for ways to penalize non-conforming banks or to reward banks which have begun MICR encoding of transit number.

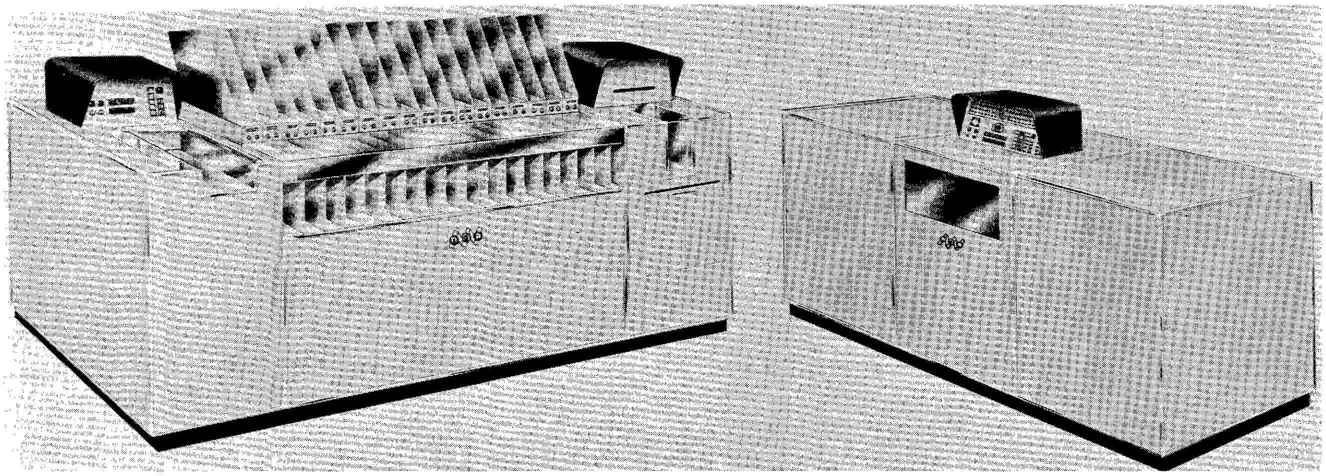
For a number of months, it looked as if the tight printing tolerances might prevent the success of the whole common language program. Commercial check printing companies were having batch after batch of test runs rejected and improvement was hard to see. Banks pioneering in the field found that they could expect failures in *every* batch of data.

But improvement did come, slowly but surely, until today it is practicable that banks do their *own* preprinting of checks, a concept which was out of the question just a year ago. One can be quite certain that his documents will be readable if he exercises care in their preparation.



NOTES

BANK DOCUMENT PROCESSOR NATIONAL DATA PROCESSING CORPORATION



THE BANK DOCUMENT PROCESSOR is available in three different models. The basic sorter, Model 201, has 18 pockets of which 16 receive sorted documents and two receive rejects. The sorting speed of this machine is 1,200 items per minute and at this same rate the sorter has the capability of automatically endorsing documents handled. Self checking features, such as "on-us" bank number verification and customer account number check digit computation are included to insure the accuracy required.

The Model 201 Processor provides two operating modes. Mode A is a conventional digital sort to the first 10 pockets of the machine, with outsorting of high activity items to the remaining six pockets. Mode B sorts selected high activity items to all 16 sort pockets and delivers remaining items to one of the reject pockets. This multiple pocket outsorting is accomplished through the use of a memory device which stores the high activity numbers, along with their pocket destinations for comparison to the whole numbers read from the documents. Information encoded on checks passing through the sorter is placed in temporary storage within the sorter and is thereby available for readout to peripheral equipment as well as for sorting operations.

Document Processor, Model 202, includes all features of the Model 201 and in addition provides a 24-column lister with capacity for accumulating three totals. The lister prints at 1,200 lines per minute and provides item listings of all documents passed through the processor, and upon command of control documents, lists accumulated totals. Typical totals may be: batch total, cash letter total, and master total. Model 203 is the same as Model 202 but contains sixteen additional accumulators providing totals for each of the sixteen sorting pockets.

Dictionary look-up

The NDP Dictionary Look-Up control units may be used with any of the three document processor models. Dictionary look-up provides economy in the sorting of large volumes of documents. Sorting to 4,960 end points, for instance, can be accomplished in a maximum of three sorting passes; or 65,536 end points in a maximum of four sorting passes with another model. The Dictionary look-up control will direct the operation of up to three document processors simultaneously and provides two separate sort programs either of which may be used for any one of the connected processors. The entire program can be changed in less than seven minutes.

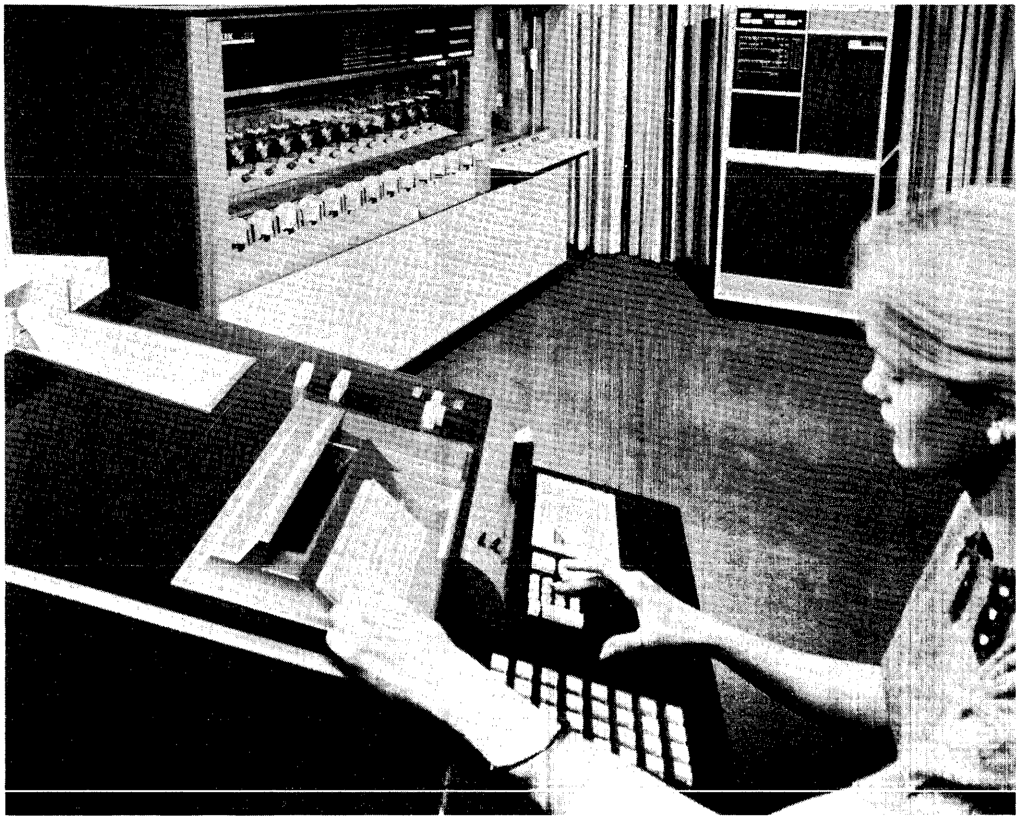
Equipment is also provided for the conversion of data read from the documents passing through the sorter. Data conversion units are available to intercouple the document processor to most banking machines or to provide off-line, computer compatible magnetic tapes.

Encoders

Five models of encoding machines are available to enter E-13 B magnetic characters on documents. The Proof Machine Encoder attaches to a standard IBM 802 or 803 Proof Machine and provides the amount encoding of documents as an automatic by-product of the normal proofing operation. The Adding Amount Encoder enters amount and control data information on documents, accumulates two proof totals and prints a proof list on adding machine tape. The Account Number Encoder and the Bank Number Encoder provide for the encoding of the remaining check fields as recommended by the American Bankers Association.

CHARACTER SENSING EQUIPMENT – SERIES 1200

INTERNATIONAL BUSINESS MACHINES CORPORATION



THIS EQUIPMENT is designed for the recording technique known as Magnetic Ink Character Recognition (MICR). Information is inscribed or printed on paper and card documents of varying size and thickness in MICR common language.

Series 1200 machines read the inscribed data directly from documents and transmit it to standard data processing machines or systems. Several inscribers augment the readers. The IBM 1412, used for direct input to 1401 and 1410 processors, is associated with the 1200 series.

EQUIPMENT

Machine	Model	Description
1201	1	Proof Inscriber—Endorsing, 32 pockets
1201	2	Proof Inscriber—No Endorsing, 32 pockets
1201	3	Proof Inscriber—Endorsing, 24 pockets
1201	4	Proof Inscriber—No Endorsing, 24 pockets
1202	1	Utility Inscriber
1203	1	Unit Inscriber
1210	1	Reader-Sorter
1412	1	Reader-Sorter

RECORDING TECHNIQUE

The equipment is designed to meet the needs of the banking industry and incorporates the recommendations of the American Bankers Association for automatic check handling. From the initial handling, the IBM system can prove and sort, post accounts, calculate service charges, write customer statements, analyze account profitability and provide management reports. Beyond automatic demand deposit accounting the Series 1200 offers new applications in other fields.

The recommendations of the ABA are used: location of the printing line is on the face of documents in a ¼″ band, parallel to and 3/16″ up from the bottom edge; spacing is eight characters per inch, starting approximately 5/16″ from the right edge; and the type font is E-13B. Prequalify fields at the left are usually preprinted; post-qualify data are located on the right side.

MACHINE FUNCTIONS

The 1201 Proof Inscriber is used to list, distribute, inscribe, prove and endorse checks, deposit slips, batch control slips and similar bank documents. These operations are performed simultaneously.

Intermixed paper and card documents may be processed within the following specifications:

Dimension	Minimum	Maximum
Length	6″	8¾″
Width	2¾″	3⅔″
Thickness	.003″	.007″

Speed of the 1201 Proof Inscriber is dependent on the operator. Continuous high-speed operation is made possible through fast-cycle speed, an electric adding machine keyboard, and a repeat key.

Documents are fed face forward, inscribing edge toward the entry chute. All are directed by key depression to any one of 24 or 32 pockets, depending on the model used. This is the familiar proof-sort phase of operation. All amounts to be accumulated and/or inscribed are set up by using the 10-key keyboard. Amounts are listed on two tapes: a control tape and an individual distribution pocket tape. The control tape serves as a record of every transaction processed through the machine, while each distribution tape contains a listing and total of the amounts of that distribution.

The 1201 will inscribe two fields in magnetic ink on the bottom line of documents. The amount is inscribed as 10 digits bracketed by the amount symbol. Process control is inscribed on each document adjacent to the amount. The digits to be printed are manually established by setting levers. Process control is used to identify types of transactions or batches of work.

The 1202 Utility Inscriber is a modified IBM electric typewriter for printing numerals and four special characters on documents in magnetic ink. Intermixed documents within the specifications may be processed. It is also possible to use continuous forms with this unit. Speed is dependent on the operator.

The 1203 Unit Inscriber prints, in magnetic ink, information required for machine-handling of checks and deposit slips as they are first received. Banks are able to use the 1203 unit inscribers or 1201 proof inscribers, or combinations of both. The 1203 combines listing, proving, endorsing and inscribing functions into one operation. Entries are listed on an adding machine tape with progressive sub-totals for proving to control or batch lists. The 1203 magnetically inscribes the 10-digit amount field, bracketed by ABA symbols, and a process control field of four digits. During the proving and inscribing operations, partial or full endorsements can be printed on the checks.

Optional features of the 1203 are:

Warning light and key lock, to indicate an out-of-balance condition,

Document counting,

Inscribing of transit numbers and symbols,

Inscribing in a second pass account number and on-us symbols,

Repetitive printing of a specific or credit digit.

The 1210 Reader-Sorter reads and sorts documents of intermixed sizes and thickness. Sorting speed ranges up to 950 documents per minute. Each magnetic character in each field may be processed and may be verified each time a document is read and/or sorted. Documents not satisfying the check conditions are rejected. Model 1 is an independent unit; Model 4 has been changed to the Model 1412 for input to either a 1401 or 1410 system.

Pockets — 13 (left to right: reject, 9 through 0, and two for selection).

Hopper Capacity — 13″ with continuous feeding.

Operator Panel — Consists of a series of keys for control of all functional patterns.

Special Devices — Also available are several features:

Electronic accumulator and sequence checking

Document counter

Multiple column select sort suppress

Process control - additional

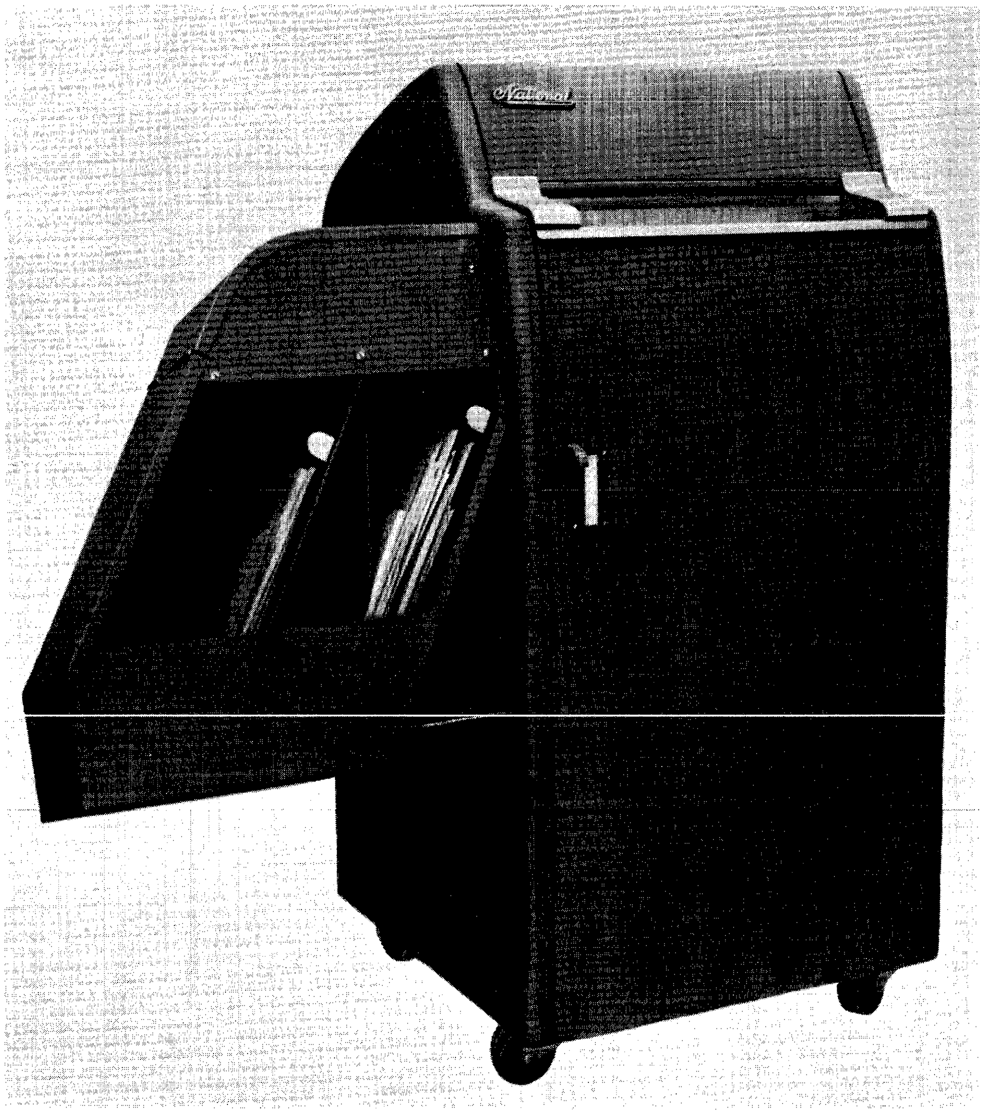
Self-checking numbers.

The 1412 Magnetic Character Reader is similar to the 1210 Model 1 described above, but reads directly into the 1401 or 1410 systems.

Cost, Power Requirements, and Physical Characteristics

Item	Rent/mo.	Purchase	Maintenance	Dimensions inches l x w x h	Weight lbs.	Power kva	Heat dissipation B.t.u./hr.
1201-1 Proof Inscriber	$ 285	$16,400		43½x49½x46	1,160	.92	1,400
1201-2 Proof Inscriber	277	15,800		43½x49½x46	1,160	.92	1,400
1201-3 Proof Inscriber	260	14,550		43½x49½x46	1,107	.92	1,400
1201-4 Proof Inscriber	252	13,950		43½x49½x46	1,107	.92	1,400
1202-1 Utility Inscriber	75	1,850		16½x17x11¾	52	.20	480
1203-1 Unit Inscriber	145	5,900		52x26x29	200	.20	700
1210-1 Reader-Sorter	1,750	71,800		112x32x60½	2,500	2.30	6,000
1412 Reader-Sorter	2,000	83,100		112x41¼x61	2,400	2.7	6,300

MAGNETIC AMOUNT PRINTER THE NATIONAL CASH REGISTER COMPANY

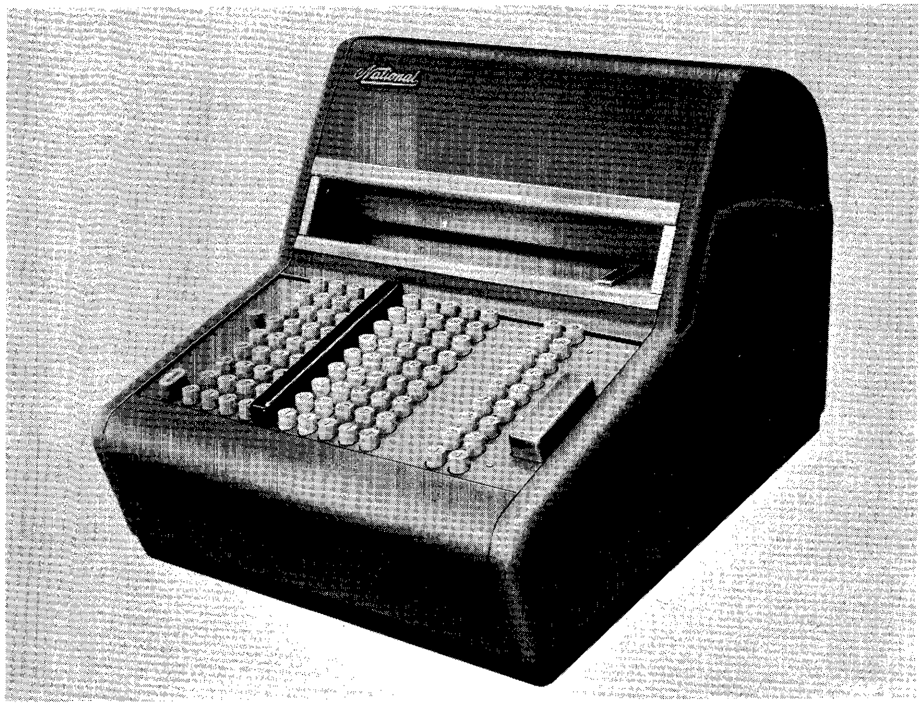


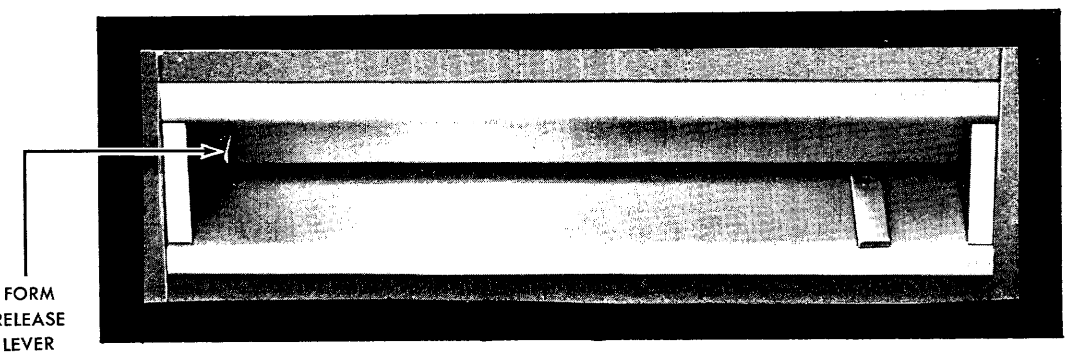
THE MAGNETIC AMOUNT PRINTER is specifically designed for imprinting amounts on checks, deposits and other media in the ABA-approved "E-13 B" character shape as the items are being proved. Imprinting amounts on media as a by-product of the proof procedure eliminates the need for rehandling the items to obtain magnetic impressions. It does not cause delay or interference with the normal proof operation. Imprinting as part of the proof procedure provides legible, proved figures for automatic processing.

OPERATING FEATURES

The printer can be located conveniently for the operator at the proof machine. Documents to be imprinted are placed directly into the throat of the printer. Alignment of the item for printing in the area specified by the ABA is automatic. The Magnetic Printer can print ten digits of amounts, beginning and ending symbols, and an automatic numeric or transaction code to the left of the amount. Interlocks between the proof machine and the printer provide positive control over the printing. Improper alignment of an item in the printer prevents operation of the proof machine. The Magnetic Amount Printer can be used with any National Class 2000 Proof Machine in use today, with slight modification of the proof machine.

MAGNETIC QUALIFICATION PRINTER NATIONAL CASH REGISTER COMPANY





PRINTING TABLE

THE MAGNETIC QUALIFICATION PRINTER is designed to print the account number or the transaction number, or both, in the ABA-approved Arabic font on checks and deposits in the New Account Department at the time the account is opened. The Qualification Printer can also be used in other locations throughout a bank.

OPERATING FEATURES

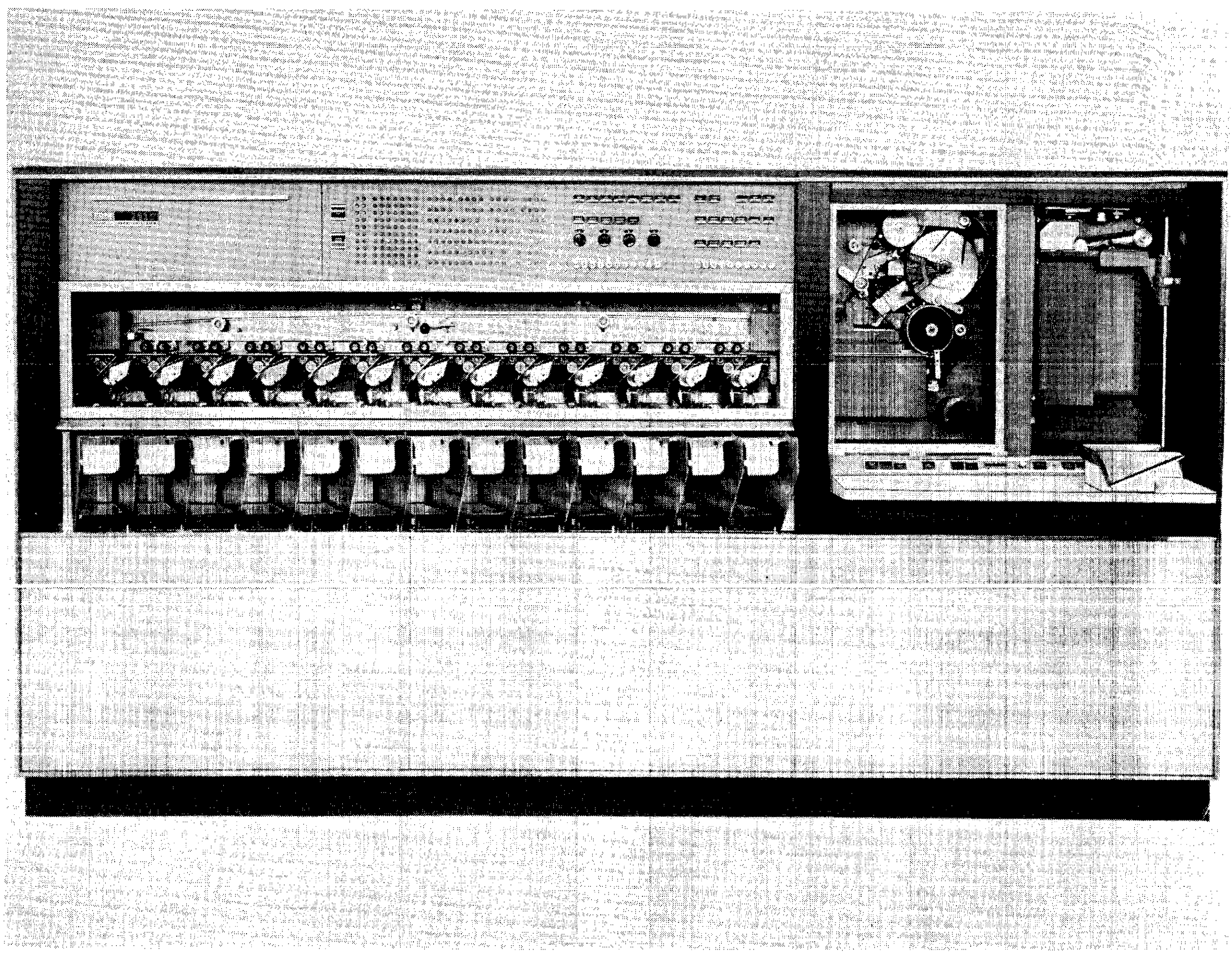
The printer keyboard consists of twelve rows of keys, a repeat key, release key and motor bar. Ten rows of keys are usable for the account number, and two are for transaction number recording. Zero printing is automatic. Hyphen printing and printing of the account number symbol are also automatic; position of the hyphen can be readily changed.

The printing table is designed for fast insertion of media. Printing on the form is controlled by the automatic tripping of the printer as the form is inserted, and by a touch of the motor bar. Exact form alignment is assured by a protective mechanism which disables the operation of the machine in the event the printer is tripped by a form improperly aligned. The repeat key permits any desired number of items to be similarly imprinted merely by inserting them into the printing table.

SPECIFICATIONS

Height	1 ft. 2½ in.
Desk Space	1 ft. 9 in. x 1 ft. 3 in.
Net Weight	35 lbs.

SORTER READER
INTERNATIONAL BUSINESS MACHINES CORPORATION



THE SORTER-READER reads and sorts magnetic ink coded documents at speeds up to 1,650 per minute. Documents may be intermixed, of varying sizes and thicknesses. They may be fed into and removed from the sorter-reader while sorting continues.

OPERATING FEATURES

The operator can work efficiently within an operating distance of only nine feet. The 13-pocket sorting area is comprised of ten digital sort pockets, two special item pockets and a reject pocket. Pushbutton controls and communication lights provide systematic control. A mobile carrier guides a detachable item tray forward and backward along the entire length of the sorting area. The document transport system is enclosed to provide safety. Sorted items may be placed in the temporary storage area above the sorter pockets.

SPECIFICATIONS

Height	4 ft. 10 in.
Floor Space	12 ft. x 2 ft. 11½ in.
Current	214-254 Volts, 60 Cycle, Alternating
Speed	Max. 1,560 items per min.
	Each Item Reading — 32 microseconds
Document Feed Capacity	3,000 Items
Sort Pocket Capacity (thirteen)	800 Items each
Net Weight	3,982 lbs.

SORTER READER B101 BURROUGHS CORPORATION

THE SORTER-READER reads and sorts magnetic ink coded documents at speeds up to 1,650 per minute. Documents may be intermixed, of varying sizes and thicknesses. They may be fed into and removed from the sorter-reader while sorting continues.

OPERATING FEATURES

Th operator can work efficiently within an operating distance of only nine feet. The 13 pocket sorting area is comprised of ten digital sort pockets, two special item pockets and a reject pocket. Pushbutton controls and communication lights provide systematic control. A mobile carrier guides a detachable item tray forward and backward along the entire length of the sorting area. The document transport system is enclosed to provide safety. Sorted items may be placed in the temporary storage area above the sorter pockets.

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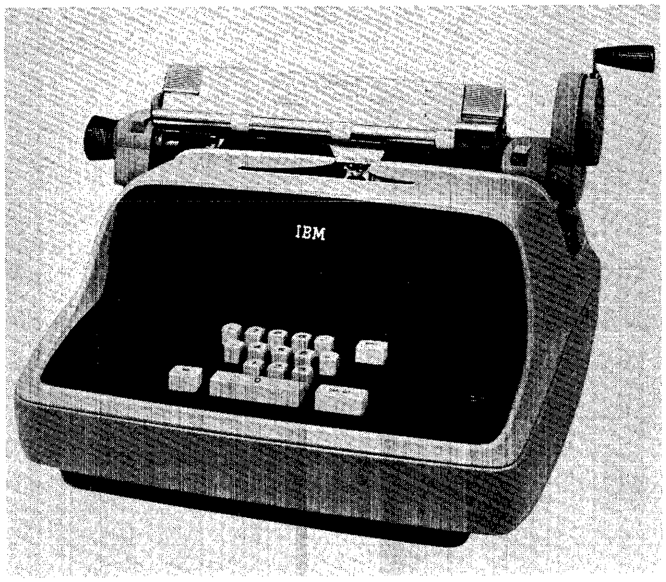
Current	214-254 Volts, 60 Cycle, Alternating
Speed	Max. 1,560 Items per min.
Each Item Reading	32 microseconds
Document Feed Capacity	3,000 Items
Sort Pocket Capacity	(Thirteen) 800 Items each
Net Weight	3,982 lbs.



THE 1202 is a modified IBM electric typewriter used for printing numerals and four special characters on paper documents in magnetic ink.

The type font (E13B), spacing of characters, and magnetic ink printing conform to the recommendations established by the American Bankers Association for the mechanization of check handling. The machine can be used by any industry where printing requirements conform to the ABA specifications.

OPERATING FEATURES

Intermixed paper documents, within the following specifications, may be processed: length — minimum 6″, maximum 8¾″; width — minimum 2¾″, maximum 3⅔″; thickness — minimum .003″, maximum .007″.

Speed is dependent upon the operator. Generally the quantity of typing is less than one full line per document. If continuous form documents are used, they are advanced by a smooth manual action. If precut forms are used, each is individually inserted and removed. Therefore, maximum speed can be attained only by maintaining uniform typing rhythm plus a uniform document change procedure.

Magnetic Transfer Ribbon. Magnetic transfer ribbons are available from the Supplies Division (Part #365980). The ribbon is 900 feet long and prints 6 digits per inch.

Standard features

Individual Form Feature. This feature permits insertion of individual documents between the pressure rolls and the platen. A base assures proper vertical positioning. The operator must provide horizontal positioning of the document against the right frame. The pressure rolls are released by depressing either the upper left or upper right release lever.

Continuous Form Feature. The 1202 is equipped with the IBM Electric Typewriter Continuous Form feature. Maximum form-to-form length is 7⅓″. The feature can be adjusted for shorter lengths.

Magnetic Transfer Ribbon Feed. The machine has the IBM Electric Typewriter Carbon Ribbon Feed feature, which advances the ribbon to provide fresh ribbon for each typebar impression.

Keyboard. The keyboard has 14 keys. 10 numerical keys are arranged in the same relative sequence as on the 1201 Proof Inscriber. There are four special character keys, one for each of the four ABA symbols. There are also three operational keys: tabulate, carriage return, and space.

Margin Stops. The 1202 has preset margin and tab stops, so that all printing is within ABA specifications. Additional tabular stops may be set by the Customer Engineer as required for the particular operation.

Carriage. The carriage is equipped with a pin feed platen (9⅜″ pin-to-pin). The hard platen is manufactured to close tolerances for high quality inscribing.

SPECIFICATIONS

Height	11¾ in.
Desk Space	1 ft. 5 in. x 1 ft. 9¼ in.
Motor Size	1/40 H.P.
Current	115 Volts, 60 Cycle, Alternating
Net Weight	52 lbs.

Optical Scanning Devices

NOTES

INTRODUCTION TO OPTICAL SCANNING DEVICES

THE INVENTION of the optical scanner is credited to David H. Shepard of Arlington, Virginia. In 1950 he and a friend, Harvey Cook, Jr., started working on a machine that would recognize printed figures. By 1952, they had developed a machine capable of identifying the complete alphabet as produced by a standard typewriter. Mr. Shepard patented the machine and formed a company to handle the manufacturing, the Intelligent Machines Research Corporation. The first I.M.R. machine was sold in 1954 to the Farrington Manufacturing Company, a Massachusetts firm which owns the Charga-Plate service and a pioneer in the credit identification field. Farrington purchased almost all of I.M.R.'s optical scanners for lease to its customers, and in 1959, bought out the entire I.M.R. and made Mr. Shepard the Farrington vice president.

Farrington has had the field almost entirely to itself until now, but a number of companies have indicated that there will be plenty of competition in the near future. RCA, IBM, National Cash Register Co., Addressograph-Multigraph, and National Data Processing of Dallas have all started making scanning equipment.

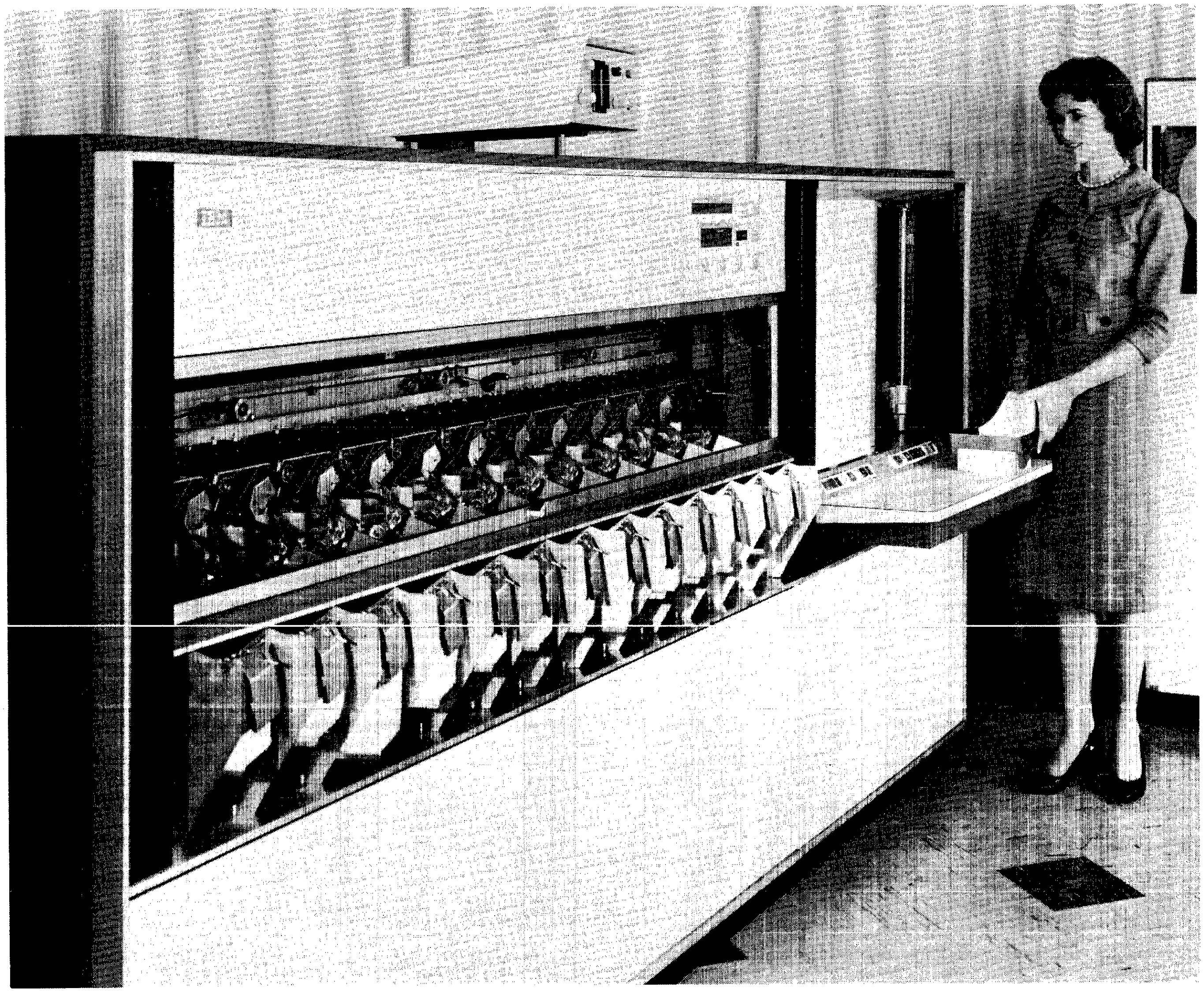
The scanners available today have many limitations. Some create punched cards, some punched tape, and others go directly into computers. Every one has severe restrictions on what can be read; each scanner has one or possibly two type fonts which are acceptable, and few machines have any provision for reading alphabetic information. Some can read only one or two lines from a document in a single pass. The formats which can be handled are often very closely defined. The chances are slim that any company could use an optical scanner on its own documents without at least a new design of forms; in each of the current applications, the work has been tailored to fit the scanner.

One of the most versatile scanners on today's market is the Farrington 10DP2. It can read both upper and lower case letters in a particular type font, common punctuation marks, and Selfchek* numerals, the stylized numbers found on many oil company credit cards. The EYE, as Farrington calls it, can read an entire page, or can be programmed to take only part of the page. Output is a paper tape, punched in either five-level or six-level code. Other Farrington scanners read only Selfchek* numbers and punch them in cards or paper tape.

IBM has announced the 1418 optical character reader which accepts two kinds of numeric type fonts as input, the conventional 407 font and an elongated type which can be put on the 407. Information can be read from at most two lines, and each field read must be identified by field marks. Optional equipment on the 1418 allows mark-reading, similar to mark-sensing but not requiring conductive marks. The information read by the 1418 is available as direct input to the IBM 1401 data processing system.

National Cash Register has designed a relatively small processing system which optically scans cash register tapes and summarizes what it reads. The National idea is a sound one, for the processing of punched paper tapes attached to registers has been costly and not too neat; in addition, the summarization which the scanning unit performs may significantly reduce the cost of data processing in retail stores. The cash register print wheels must be changed to conform with the self-checking style used by National, but this relatively small change is all that is needed to make the input acceptable.

OPTICAL CHARACTER READER INTERNATIONAL BUSINESS MACHINES CORPORATION

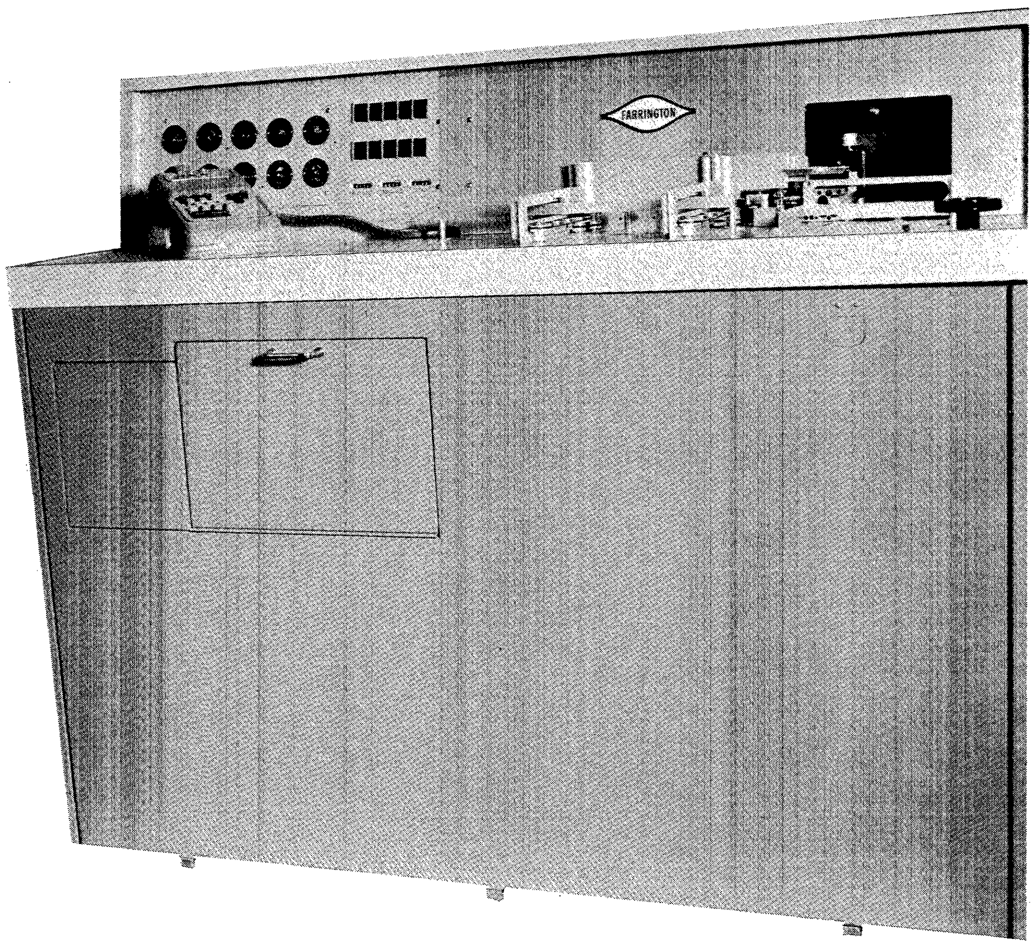


THE OPTICAL CHARACTER READER TYPE 1418 provides direct input from a conventionally printed paper document to a computer. It can be used with any Model C, D, E, or F1401 magnetic tape data processing system. It reads typed, printed or imprinted numerical data from paper or card documents of varying sizes and thicknesses, automatically translates the printed data into machine language and feeds this directly into the magnetic core storage of the 1401 Computer. It reads at rates up to 480 characters per second from a maximum of 400 documents per minute. It is designed to read numbers and three special characters printed in standard IBM type style, or in elongated IBM 407 type style commonly used by credit card imprinters. It can be equipped to mark-read vertical marks made by ordinary pencil or dark ink.

SPECIFICATIONS

Height	5 ft. 8 in.
Floor Space	9 ft. 4 in. x 2 ft. 6 in.
Current	208 or 230 Volts, 60 Cycle, Alternating
Speed	Max. 480 Characters per sec.
Net Weight	
Model 1	1,950 lbs.
Model 2	2,300 lbs.

OPTICAL SCANNER-1D SERIES FARRINGTON ELECTRONICS INCORPORATED



THE MODELS in this series have the ability to read up to two lines of information from small to medium size documents and translate it into a media compatible with the customer's accounting systems. The information read may be upper and lower case alphabetic characters, numeric characters, and special symbols. These scanners are used for cash accounting where the customer account number, the amount billed, and other pertinent collection data, printed on bill stubs, premium notices or other cash receipt tickets, are scanned, verified, and translated to the output media.

OPERATING FEATURES

Document Size: The height ranges from 2½ inches to 6 inches; the width from 2⅝ inches to 8½ inches. The thickness ranges from 0.0035 inch to 0.0100 inch.

Feed Mechanism: An automatic feed system is employed, and approximately 600 documents can be stacked in the feed hopper at one time. A simple adjustment in the feed mechanism is required to handle document batches of different dimensions.

Type Style: Font — Farrington Specification #12H1, although alphabetic typefonts, capitals only, presently used on business machines, may be acceptable.

Pitch — 10 per inch.

Height — Approximately 0.100 inch.

Impressions: The impressions from most business machines and high-speed printers are acceptable; however, impression to be read should be consistently free of background interference.

Reading Field Location: The information to be read may be located anywhere in a reading area bounded by a ¼ inch border on the sides and top (or bottom) of the document; and, above 2-3/16 inches from the bottom edge of the document (or below 2-3/16 inches from the top of the document). The reading area is 0.311 inch x 3.9 inches x 6 inches maximum.

Buffer: Magnetic drum. Additional control information can be stored and emitted into each record by means of set switches.

Output: The choice of output is based upon the accounting system of the user. Output devices include:

1. Summary punch to produce tabulating cards.
2. Paper tape perforator to produce perforated tape in customer desired coding.
3. Tape drive system to produce magnetic tape compatible to user's computer.

Optional Features:

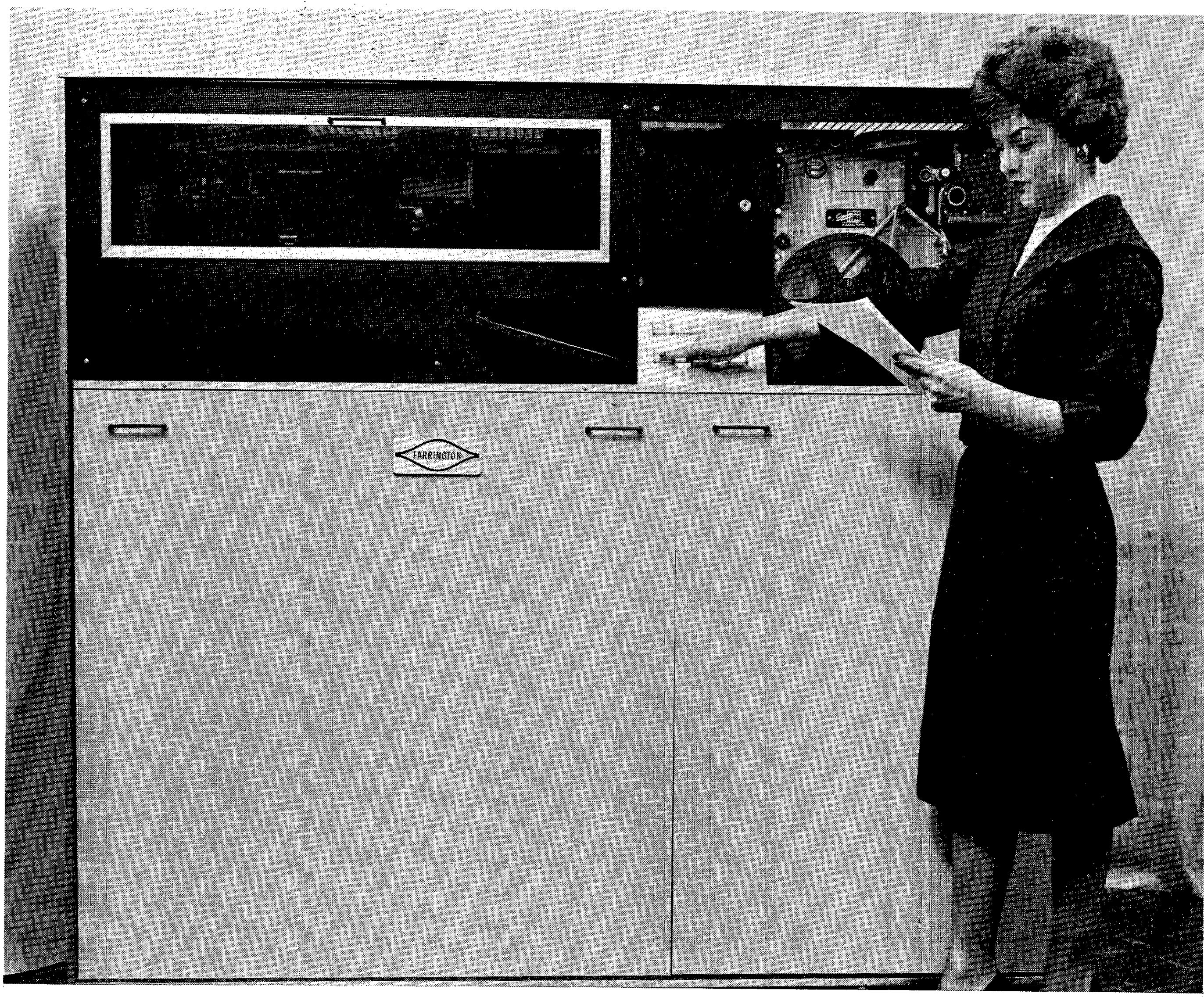
1. Accumulator — To accumulate a selected field of numeric characters.
2. Line Printer — To print the selected field of numeric characters or their totals.
3. Two-Line Read — To simultaneously read two horizontally adjacent lines.
4. Mark Reading — To read significant marks, made by common pencils, which represent numeric characters or other special codings.

SPECIFICATIONS

Height	4 ft.
Desk or Floor Space	4 ft. x 2 ft. 6 in.
Current	115 Volts, 60 Cycle, Alternating
Speed	Maximum 350 Characters per sec. (Document speed is related to size of document, number of characters to be read, and speed of output device.)
Net Weight	Approx. 2,600 lbs.

OPTICAL SCANNER-1P SERIES

FARRINGTON ELECTRONICS INCORPORATED



THE MODELS in this series have the ability either to read full pages of typewritten information, single or double-spaced, or to scan entire pages in search of particular information, further translating it into a punched paper tape code. Using either five-level or six-level code, the page reader scans and punches 240 characters per second, automatically feeding from page to page. These scanners are used in communications transmission, typesetting, data reduction, scientific literature abstraction, catalog-indexing and language translation.

SPECIFICATIONS FOR ALL MODELS

Height . . . . 5 ft. 2 in.
Floor Space . . . . 5 ft. 8 in. x 2 ft. 6 in.
Current . . . . Three 115 ± 10 Volt Lines, 60 Cycle, Alternating

Speed
Models 1P3C, 1P4C and 1P5C
133 Characters per sec.
Models 1P3M, 1P4M and 1P5M
350 Characters per sec.
Models 1P3P, 1P4P and 1P5P
240 Characters per sec.
Net Weight . . . . 1,200 lbs.

SPECIFICATIONS FOR EACH INDIVIDUAL MODEL

Model 1P3C
Numeric Page to Punched Card

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

100 cards per minute maximum (8,000 characters).

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

Farrington Selfchek — numeric only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each card punched.

Output

IBM Type 523 summary punch.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

Model 1P4C
Alphanumeric Page to Punched Card

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

100 cards per minute maximum (8,000 characters).

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck — numeric.
2. Farrington Alphabetic #12H1 — capitals only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each card punched.

Output

IBM Type 523 summary punch.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

Model 1P5C
Full Alphanumeric Page to Punched Card

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

100 cards per minute maximum (8000 characters).

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck #12H1 — numeric.
2. Farrington Alphabetic #12H1 — lower case and capitals.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each card punched.

Output

IBM Type 523 summary punch.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P3M
Numeric Page to Magnetic Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

350 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

Farrington Selfchek® — numeric only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each record by set switches.

Output

IBM tape computer system — magnetic tape compatible with IBM 727, 729 tape units in the low density mode. For other computer systems scanner output will control compatible tape units, i.e., Uniservo I, II; RCA 581, Datamatic 804, etc.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P4M
Alphanumeric Page to Magnetic Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

350 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck® — numeric.
2. Farrington Alphabetic #12H1 — capitals only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each record by set switches.

Output

IBM tape computer system — magnetic tape compatible with IBM 727, 729 tape units in the low density mode. For other computer systems scanner output will control compatible tape units, i.e., Uniservo I, II; RCA 581, Datamatic 804, etc.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P5M
Full Alphanumeric Page to Magnetic Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

350 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck® #12H1 — numeric.
2. Farrington Alphabetic #12H1 — lower case and capitals.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Magnetic Drum — additional control information can be stored and emitted into each record by set switches.

Output

IBM tape computer system — magnetic tape compatible with IBM 727, 729 tape units in the low density mode. For other computer systems scanner output will control compatible tape units, i.e., Uniservo I, II; RCA 581, Datamatic 804, etc.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P3P
Numeric Page to Punched Paper Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

240 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

Farrington Selfchek® #12H1 — numeric only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Depending upon application, buffer will be magnetic drum, shift register, or some other kind of electronic storage. Additional control information can be stored and emitted into each record by set switches.

Output

Soroban GP-2 Paper Tape Perforator.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P4P
Alphanumeric Page to Punched Paper Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

240 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck® — numeric.
2. Farrington Alphabetic #12H1 — capitals only.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Depending upon application, buffer will be magnetic drum, shift register, or some other kind of electronic storage. Additional control information can be stored and emitted into each record by set switches.

Output

Soroban GP-2 Paper Tape Perforator.

Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

Model 1P5P
Full Alphanumeric Page to Punched Paper Tape

Feed

An automatic feed system is employed, which, upon completion of reading a page, inserts the next page into the scanner. A three-inch stack of pages can be stacked in the feed tray. Each stack must contain documents of the same size and reading format. The feed is changed for another document size by operator adjustment.

Document

		Height	Width
Pages	Min.	8½ in.	4½ in.
	Max.	13½ in.	8½ in.

Weight: Ordinary typing bond paper in the area of 20-lb. stock.

Height: The dimension which is perpendicular to the lines of printing. Width is the dimension which is parallel to the lines of printing.

Translation rate

240 characters per second.

Reading field

The information to be read must fall within a margin 0.750 in. from any edge of the page.

Typeface

1. Farrington Selfcheck® #12H1 — numeric.
2. Farrington Alphabetic #12H1 — lower case and capitals.

Format

Double or single-spaced lines. Selected line scan or full-page scan.

Buffer

Depending upon application, buffer will be magnetic drum, shift register, or some other kind of electronic storage. Additional control information can be stored and emitted into each record by set switches.

Output

Soroban GP-2 Paper Tape Perforator.

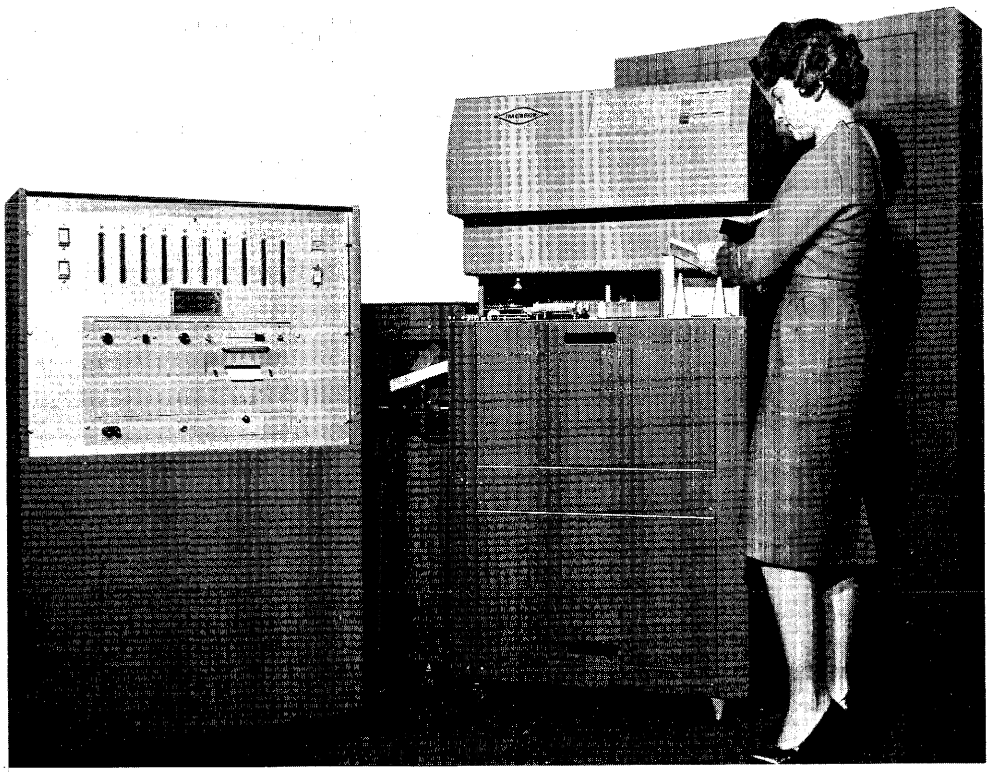
Optional

Accumulator — to accumulate a selected column of numeric characters.

Line Printer — to print the selected column of numeric characters being accumulated.

® *Trademark of Farrington Electronics Inc.*

OPTICAL SCANNER–MODEL 9SP4 FARRINGTON ELECTRONICS INCORPORATED



THIS UNIT of electronic equipment provides automatic punching of tabulating cards used in many modern applications, eliminating manual punching of the data imprinted on these tabulating cards. Model 9SP4 is a character-sensing punch which reads numbers imprinted on an 80-column tabulating card and punches this information back into the card. Cards punched by this model can be processed on 80-column IBM electric accounting machines.

Numeric punching only can be read, but various typefaces can be accommodated. The impression to be read must be of consistent quality and relatively free of background interference. The field must be a maximum of .311 inches high, consisting of a single line which may be positioned vertically anywhere on the card, except for a border ⅛ of an inch from all edges.

Checking features

Model 9SP4 contains two checks: a reading check and a punching check. Each completely read field is tested by automatic circuits to insure that the number satisfies a "Luhn" or "Casting Out 9's" checking scheme. Non-checking causes the card to fall into the reject pocket unpunched. If one or more digits cannot be read, the card will fall into the reject pocket unpunched. After punching, a post-punch sensing station reads the punched holes and verifies that the punching satisfies a formula based on the character-sensed information. Non-checking causes the incorrectly punched card to fall into the accept pocket, the next card to fall into the reject pocket unpunched and an equipment failure stop.

The accumulator

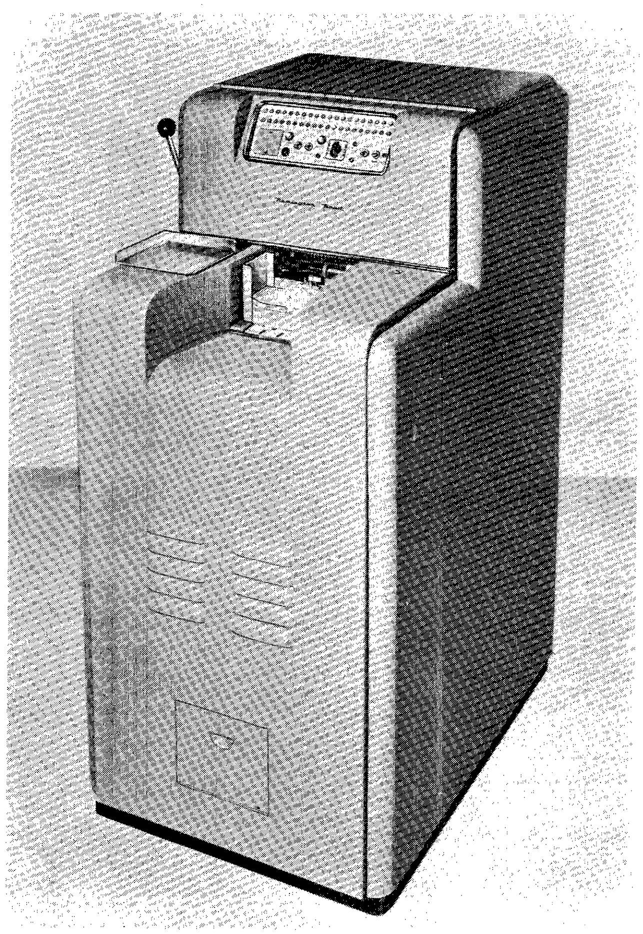
The accumulator, with a manual reset, registers the total of a selected field for each card punched. A total is punched into a blank card by depressing a button on the control panel. A punched total automatically resets the accumulator. A sub-total may be obtained by the same procedure and by depressing the Reset-Suppress Switch when the total button is depressed. When the switch is in a depressed position, the accumulator is not reset.

SPECIFICATIONS

Height	
Punch Unit	5 ft.
Accumulator	3 ft. 11¼ in.
Interpreter	4 ft. 8 in.
Floor Space	
Punch Unit	2 ft. 7 in. x 1 ft. 9 in.
Accumulator	1 ft. 11½ in. x 1 ft. 10 in.
Interpreter	4 ft. 5 in. x 2 ft. 6 in.
Current	117 Volts, 60 Cycle, Alternating
Speed	180 Cards per min.
Net Weight	2,360 lbs.

OPTICAL SCANNING PUNCH 5340

UNIVAC DIVISION, SPERRY RAND CORPORATION



THE OPTICAL SCANNING PUNCH is available in three capacities, providing up to 40 columns of marking on one side of a card. The sensed numbers or symbols are translated and may be punched into as many as 40 preselected columns on a 90-column card. The sensed data is punched in Remington Rand 90-column code. The punching format can be changed through wiring a plugboard, located on the upper left side of the machine.

The input magazine has a capacity of 650 cards. From the magazine, a card passes to the sensing unit where it is optically scanned by photocells while in motion. Each photocell is designed to be insensitive to red-orange color. The card then moves to the punching station where it is stopped and block punched with translated data held in storage from the sensing. When the punching is completed, the card is sent to one of two receiving magazines, that is, a normal card receiver holding 400 cards, or an error card receiver with a capacity of 15 cards.

OPERATING FEATURES

The connections between the sensing unit and the individual punching columns are made on a removable plugboard. The connecting of individual columns into groups for the signaling of errors, such as missing or double marks, is also performed on the plugboard. Sensing and punching column hubs provide for each position of the 90-column code.

The control system automatically checks each card to ensure that only one data mark exists in any column. Double marking or missing marks are indicated by control panel lights: a red light for double marks, and a green light for missing marks. A light is provided on the panel for each mark column. Multiple marks may be made in a column. In this case, the double-mark check is not used. Each mark is read and punched in its own right. If 1 and 2 marks are made in a column, the final output is a 1 and 9 punch combination.

The Optical Scanning Punch can be programmed to deal with error cards in either of two ways: first, stop and indicate the column and type of error on the control panel. The card can be removed and the machine can be restarted, and second, deposit the error card in the selected receiving magazine.

In both instances, the error card can be left unpunched or, it can be punched. If punching is allowed, the entire marking data will be punched, including erroneous double-mark columns.

Two alternate switches built into the control panel govern the 6-pole alternate selectors on the plugboard. These switches enable the user to select the desired one of two or three variations to the basic program merely by using the switch instead of rewiring the panel. Card controlled selectors are also provided to allow identification of different card types according to control marks and to alter punching, or to select various functions. Among the functions are the emission of constants for punching; selecting a card for segregation, with or without marking errors; and repeat punching data from a lead card. It is not possible to sense prepunched holes for any purpose.

SPECIFICATIONS

Height	4 ft. 9 in.
Floor Space	2 ft. 11 in. x 2 ft. 1 in.
Current	110-220 Volts, 50-60 Cycle, Alternating
Speed	150 Cards per min.
Card Feeding Magazine Capacity	650 Cards
Card Receiving Magazine Capacity	400 Cards
Net Weight	552 lbs.

LIST OF DATA PROCESSING ABBREVIATIONS

ABBREVIATIONS, or acronyms, are numerous in the field of data processing. In recent years with the advent of stored programs and the problem of man-to-machine language, even more acronyms have appeared in data processing. COBOL, for example, is the acronym for *C*ommon *B*usiness *O*riented *L*anguage.

This list of data processing acronyms may be a helpful guide. It is not complete but represents a start toward a dictionary. Here we show the acronym, its meaning, who developed it and its computer use where applicable. Some abbreviations or acronyms are further explained in the glossary of terms.

A0, A1, A2
Automatic Coding Systems
Sperry Rand Corp., UNIVAC I

ABA
American Banking Association

ABC
The ABC Automatic Coding System
Atomic Weapons Research Est., Berkshire, England, IBM 704

ACM
Association for Computing Machinery

ACM-GAMM
Association for Computing Machinery - German Association for Applied Mathematics and Mechanics
ALGOL Effort

ACOM
Automatic Coding System
General Motors Corp., IBM 701, 705

ACRE
Automatic Checkout and Readiness Equipment
Lockheed Missiles and Space Division

ACT
Automatic Code Translation
Sperry Rand Corp., UNIVAC

ACT I
Algebraic Compiler and Translator
Royal McBee Corp., LGP-30

ACT III
Extension of ACT I
National Carbon, LGP-30

ADES
Automatic Digital Encoding System
U. S. Naval Ordnance Lab., IBM 704

ADES II
Automatic Digital Encoding System
U. S. Naval Ordnance Lab., IBM 650

ADI
American Documentation Institute

ADPS
Automatic Data Processing Systems

AFAC
Automatic Coding System
Allison G. M., IBM 704

AFCAL
Association Francaise de Calcul

AFIPS
American Federation of Information Processing Societies

AFOSR
Air Force Office of Scientific Research

AICHE
American Institute of Chemical Engineers

AIEE
American Institute of Electrical Engineers

AIMACO
The AIMACO Compiling System
Air Materiel Command, UNIVAC 1105

AIP
American Institute of Physics

ALGO
Algebraic Compiler Based on International ALGOL
Bendix, G-15

ALGOL
Algorithmic Language
ACM-GAMM Committee

ALGOL 60
1960 Version of Algorithmic Language
ACM-GAMM Committee

ALTAC
The Transac Algebraic Translator
Philco Corp., Philco 2000

ALU
Arithmetic and Logical Unit

ALWAC USERS
ALWAC Users Organization

ANCP
Automatic Coding System
Burroughs Corp., Datatron 201, 204, 205

AP2
Rice Institute Computer Version of ALGOL
Rice Institute, Rice Institute Computer

APAR
Automatic Programming and Recording
Sandia Corp.

APT
Automatic Programming Tool
Aero-Space Industries of America, UNIVAC 1103, 1103-A, IBM 650

APX III
Automatic Programming System Extended
Burroughs Corp., Datatron 201, 204, 205

ARGUS
Automatic Routine Generating and Updating System
Minneapolis-Honeywell Regulator Co., Honeywell-800

ARITH-MATIC (A-3)
Automatic Coding System
Sperry-Rand Corp., UNIVAC II

ARTOC
Army Tactical Operations Center

ASA
American Standards Association

ASLIB
Association of Special Libraries and Information Bureau

ATA
Air Transport Association

AUTOCODE
A Scheme to Simplify the Programming of Mathematical and Scientific Problems
Elliott Brothers, London, National-Elliott 802

AUTOCODE
An Autocoding Scheme for the Ferranti Mercury Computer
Univ. of Manchester, England, Ferranti Mercury

AUTOCODE
The Pegasus Autocode
Ferranti Ltd., Ferranti Pegasus Computer

AUTOCODER
The IBM Autocoder System
IBM Corp., IBM 702, 705, 7070

B15
Automatic Coding System
Texas Instruments, Inc., IBM 650

BACAIC
The Boeing Airplane Company Algebraic Interpretive Computing System
Boeing Airplane Co., IBM 701, 650

BALITAC
Automatic Coding System
M.I.T., IBM 650

BASIC
Battle Area Surveillance and Integrated Communications

BASIC AUTOCODER
The 7070 Basic Autocoder
IBM Corp., IBM 7070

BCD
Binary Coded Decimal

BCS
British Computer Society

BELL
A Complete Floating-Decimal Interpretive System
Bell Telephone Lab. Inc., IBM 650
Shell Oil Co., Datatron 205
Burroughs Corp., Datatron 220
IBM Corp., IBM 704

BELL L2, L3
The General Purpose System for the 650
Bell Telepone Lab., IBM 650

BIOR
Business Input-Output Rerun Compiling System
Sperry Rand Corp., UNIVAC I, II

BIZMAC
Business Machine Computer
Radio Corp. of America

BLESSED
Bell Little Electrodata Symbolic System for the Electrodata
Michigan Bell Telephone, Arthur D. Little, Inc., Burroughs Electrodata, Datatron 220

BLIS
Bell Labs Interpretive System

BOEING COMPILER
The Boeing Programming System for the UNIVAC Scientific 1103-A
Boeing Airplane Co., UNIVAC 1103-A

BSI
British Standards Institution

CAGE
Compiler and Assembler by General Electric
General Electric Co., IBM 704

CAMP
Computer Applications of Military Problems Users Group

CAOS
Completely Automatic Operational System
Lockheed Aircraft Corp., UNIVAC 1103-A

CAP
Card Assembly Program
Wright Air Dev. Center, UNIVAC 1103-A

CASE SOAP III
Modified Version of SOAP II
Case Institute of Tech., IBM 650

CCITT
Comite Consulatif Internationale Pour Telegraphie et Telephonie

CHIP
An Interpretive Subroutine for Packed Floating Point Operands
Wright Air Dev. Center, UNIVAC 1103

CL-1
CL-1 Programming System
Technical Operations, Inc., IBM 704, 709

CLIP
Compiler Language for Information Processing
System Development Corp.

COBOL
Common Business Oriented Language

CODASYL
Conference on Data Systems Languages

CODEL
The CODEL Automatic Coding System
Computer Developments Limited, and International Computers and Tabulotors Ltd., I.C.T. 1400

COL
Computer Oriented Language

COMIT
Computing System
Mass. Inst. of Tech., IBM 704

COMMERCIAL TRANSLATOR
An Automatic Coding System
IBM Corp., IBM 705 III, 709, 7070, 7080, 7090

COMPLEAT
The Compleat Programmer
Burroughs Corp., Datatron 205, 220, E101

COMPREHENSIVE
A System of Automatic Coding
Mass. Institute of Tech., Whirlwind 1

COOP
Automatic Coding System
Computer Development Corp., 1604

CORBIE
CORBIE System for the 704
National Bureau of Standards, IBM 704

CORDIC
Coordinate Rotation Digital Computer
Convair

CORREGATE
Correctable Gate
Carnegie Institute of Tech., IBM 650

CPC
Card Programmed Calculator
IBM Corp.

CPU
Central Processing Unit

CRT
Cathode Ray Tube

CSL
Computer Sensitive Language

CUE
Cooperating Users Exchange
Datatron 220

DACOM
Datascope Computer Output Microfilmer
Eastman Kodak Co.

DAFT
Digital/Analog Function Table
Packard-Bell Computer Corp.

DAISY 201
Double Precision Automatic Interpretive System
Bendix Aviation Corp., Bendix G-15

DARA
Deutsche Arbeitgemeinschaft Fur Rechen-Anlagen

DAS
The Datatron Assembly System
Westinghouse Electric Co., Datatron 204

DATACODE I
Automatic Coding System
Datatron 201, 204, 205

DCA
Digital Computers Association

DICTATOR
Automatic Coding System
D.O.D. Company, LGP-30

DOD
Department of Defense

DOW COMPILER
Automatic Coding System
Dow Chemical Co., Datatron 201, 204, 205

DRUCO I
An Interpretative Floating Decimal System
IBM Corp., IBM 650

DUAL
Fixed Decimal and Floating Decimal Computing System
AEC Los Alamos, IBM 701

DUMBO
An Automatic Programming System for the Datatron 205
The Babcock and Wilcox Co., Datatron 205

DUO
Datatron Users Organization
Datatron 201, 204, 205

DYANA
Dynamics Analyzer-Programmer
General Motors Corp., IBM 704

DYSTAC
Dynamic Storage Analog Computer
Computer Systems, Inc.

E-364
A Program for Translation of Mathematical Equations for Whirlwind 1
Mass. Institute of Tech., Whirlwind 1

EAI
Electronics Associates, Inc.

EAM
Electric Accounting Machines

EASE II
Engineering Automatic System for Solving Equations
General Motors Corp., IBM 650

EASIAC
EASIAC, a Pseudo Computer
Univ. of Michigan, MIDAC

EASY FOX
A 701 Coding System
The Rand Corp., Johnniac

ECMA
European Computer Manufacturers Assoc.

EDP
Electronic Data Processing

EDPM
Electronic Data Processing Machines

EIA
Electronic Industries Association

EJCC
Eastern Joint Computer Conference

ELI
The Equitable Life Interpreter
Equitable Life Assurance Society, IBM 650, 705

ENIAC
Electronic Numerical Integrator and Calculator

ERFPI
The Extended Range Floating Point Interpretive System
Royal McBee, LGP-30

ERMA
Electronic Recording Machine Accounting
General Electric Co.

ESCAPE
Expansion Symbolic Compiling Assembly Program for Engineering
Curtiss-Wright Corp., IBM 650

EXCHANGE
G-15 Users Exchange Organization
Bendix G-15

FACS
Floating Decimal Abstract Coding System
Lockheed Aircraft Corp., IBM 650

FACT
Factual Compiler
Ramo-Wooldridge Corp.

FACT
Fully Automatic Compiling Technique
Minneapolis-Honeywell Regulator Co., Honeywell-800

FAIR
Automatic Coding System
Eastman Kodak Co., IBM 705

FAP
Floating Point Arithmetic Package
Lockheed MSD, UNIVAC 1103-A

FAP
Fortran Assembly Program
IBM Corp., IBM 704, 709

FAST
Fieldata Applications, Systems and Techniques
Fieldata Users Group, Mobidic, Basicpac, Compac, Impac

FAST
Four Address to Soap Translator
Texas A and M College, IBM 650

FLAC
Florida Automatic Computer
Patrick Air Force Base

FLAIR
Automatic Programming System
Lockheed MSD, IBM 650
Convair, IBM 704

FLINT
Floating Interpretive Language
Princeton Univ., IAS

FLIP
A Floating Point Subroutine System
Consolidated Vultee, UNIVAC 1103, 1103-A

FLIP
Film Library Instantaneous Presentation
Benson-Lehner Corp.

FLIP
Floating Indexed Point Arithmetic
Argonne National Lab.

FLIP
Floating Point Interpretive Program
Humble Oil and Refining Co., Bendix G-15

FLOP
Floating Octal Point
Lockheed Aircraft, IBM 701

FLOW-MATIC (B-0)
Automatic Programming System
Sperry Rand Corp., UNIVAC I, II

FORC 2
Formula Coder, and Automatic Coding System
General Electric Co., IBM 704

FORTRAN
Formula Translating System
IBM Corp., IBM 704, 705, 709, 7070, 7090, 7080, 1620, 650
NOL Corona, Datatron 205
Burroughs 220

FORTRANSIT
Fortran and IT System
IBM Corp., IBM 650

FORTRUNCIBLE
Fortran Style Runcible
Case Institute of Tech., IBM 650

FOSDIC
Film Optical Sensing Device for Input to Computers
National Bureau of Standards

GAMM
German Association főr Applied Mathematics and Mechanics
Gesellschaft fur Angewante Mathematik und Mechanik

GAT
Generalized Algebraic Translator
University of Michigan, IBM 650

GAT-2
Generalized Algebraic Translator, 2nd Version
University of Michigan, IBM 650 RAMAC

GATE
GAT Extended
Carnegie Institute of Tech., IBM 650

GEPURS
General Electric General Purpose
General Electric Co., IBM 701

GIF
Gulf IT to Fortran Translator
Gulf Oil Corp., IBM 650

G-O
Modification of UNIVAC I Flowmatic
Sperry Rand Corp., UNIVAC I

GP
Generalized Programming
Sperry Rand Corp., UNIVAC I, II

GPX
Generalized Programming Extended
Sperry Rand Corp., UNIVAC II

GUIDE
Computer Users Group
IBM 702, 705, 7070, 7080

HAYSTAQ
A Joint Effort of U. S. Patent Office and NBS

HEEP
Highway Engineering Exchange Program for IBM Civil Engineering Programs

ICIP
International Conference on Information Processing
Paris, 1959

IDABEE
Institute of Defense Analysis Compiler
Institute of Defense Analysis, LGP-30

IDP
Integrated Data Processing

IEC
International Electrotechnical Commission

IFCS
International Federation of Computer Sciences

IFIPS
International Federation of Information Processing Societies

ILLIAC
ILLIAC Programming
University of Illinois, ILLIAC

INTERCARD
Interpreter-Compiler
North American Aviation, Bendix G-15

INTERCOM 101, 1000
Automatic Coding System
Bendix Aviation Corp., Bendix G-15

INTRAN
Input Translator
SOS System, IBM 709, 7090

I/O
Input-Output

IOCS
Input-Output Control System
IBM Corp., IBM 7070, 7080

IOPKG
The Input/Output Package
IBM Corp., IBM 705 III

IPC
Industrial Process Control

IPL
Information Processing Language
Newell, Shaw and Simon

IRE
Institute of Radio Engineers

IRL
Information Retrieval Language

ISO
International Organization for Standardization

IT
Internal Translator
Carnegie Institute of Tech., IBM 650

JAZ
The JAZ Interpretive Routine
Philco Western Dev. Lab., LGP-30

JCS-13
A 701 Assembly Routine
The Rand Corp., IBM 701

JOVIAL
Jules Own Version of IAL
System Development Corp.

K5
Automatic Coding System
Sperry Rand Corp., LARC

KISS
Automatic Coding System
Computer Usage, IBM 704
Chrysler, IBM 650

KOMPILER 2
An Algebraic Compiler
Livermore AEC, IBM 701

KOMPILER 3
Kompiler 3 of Livermore AEC
Livermore AEC, IBM 704

KWIC
Keyword in Context
IBM Corp.

L1
Automatic Coding System
Technical Operations, Inc., IBM 704

L2
Automatic Coding System
Technical Operations, Inc., IBM 7090

LARC
Livermore Automatic Research Computer
Sperry Rand Corp.

LINC
LARC Users Group
UNIVAC LARC

LISP
List Processor
Mass. Institute of Tech., IBM 704

LT
Language Translation

LT
Logic Theory

LT-2
Automatic Coding System
IBM 701

MAC
Autocoding for the Ferranti Mercury Computer
Norwegian Defense Research Est., Ferranti Mercury

MAD
Michigan Algorithmic Decoder
University of Michigan, IBM 704

MAGIC
MIDAC Automatic General Integrated Computation
University of Michigan, MIDAC

MAGNET
Shell Oil Co., IBM 709, 7090

MAID
Monrobot Automatic Internal Diagnosis
Monroe Calculating Machine Co.

MANIAC
Mechanical and Numerical Integrator and Computer
Los Alamos

MATH-MATIC (AT-3)
UNIVAC Math-Matic Programming System
Sperry Rand Corp., UNIVAC I, II

MCUG
Military Computers Users Group

MICR
Magnetic Ink Character Recognition

MIDAC
Michigan Digital Automatic Computer
University of Michigan

MIMAC
The Rand Corp., IBM 704

MISHAP
Automatic Coding System
Lockheed, MSD, UNVAC 1103, 1103-A

MITILAC
Automatic Coding System
Mass. Institute of Tech., IBM 650

MJS
Automatic Coding System
UCRL Livermore, UNIVAC I, II

ML
Machine Language

MOBIDIC
Mobidic Computer
Sylvania Electric Products

MOL
Machine Oriented Language

MORTRAN
The Rand Corp., Johnniac

MOS
Management Operating System
IBM Corp.

MT
Machine Translation

MT
Mechanical Translation

MTAC
Mathematical Tables and Other Aids to Computation

MYSTIC
Air Force Missile Test Center Automatic Coder
Patrick Air Force Base, UNIVAC 1103, 1103-A, IBM 650, 704

NASA
National Aeronautics and Space Administration

NBS
National Bureau of Standards

NEAT
National Cash Register Electronic Autocoding Technique
National Cash Register Co., NCR 304

NELIAC
Naval Electronics Lab International Algebraic Compiler
Navy Electronics Lab., M-460

NJCC
National Joint Computer Committee
ACM, AIEE, IRE

NMAA
National Machine Accountants Association

NOL
Naval Ordnance Laboratory

NOMA
National Office Management Association

NORC
Naval Ordnance Research Computer
U. S. Naval Ordnance Proving Grounds

NSF
National Science Foundation

NYAP
New York Assembly Program
The Service Bureau Corp., IBM 704

OEMI
Office Equipment Manufacturers Institute

OMNICODE
Automatic Coding System
General Electric Co., IBM 702

OMNIFAX
Automatic Coding System
New York University, UNIVAC I, II

OMNIFLEX
Integrated Service Routine
Sperry Rand Corp., UNIVAC II

OOL
Operator Oriented Language

OR
Operations Research

ORBIT
Oracle Binary Internal Translator, Algebraic Programming System
Union Carbide Corp., Oak Ridge National Lab., Oracle

ORSA
Operations Research Society of America

OTRAC
Oscillogram Trace Reader
Non-Linear System Inc.

OUTRAN
Output Translator
SOS System, IBM 709, 7090

PACT I
Project for the Advancement of Coding Techniques
Douglas Aircraft, Lockheed Aircraft,
Naval Ordnance Test Station, North American Aviation,
Rand Corp., IBM 701

PACT IA
Project for the Advancement of Coding Techniques
PACT for IBM 704

PAL
Programmed Application Library
IBM Corp.

PB-250
Packard-Bell 250 Users Group
Packard-Bell 250

PENNCODE
A Floating Point Interpretive Routine
Penn. State Univ., Pennstac

PERT
Program Evaluation and Review Technique
Naval Ordnance Proving Grounds

PGEC
Professional Group on Electronic Computers
IRE

PKMAD
Monitored Automatic Debugging System
IBM Corp., IBM 704

POGO
Program Optimizer for the Bendix G-15
Bendix Aviation Corp., Bendix G-15

POL
Problem Oriented Language

POOL
LGP-30 Users Group Organization
Royal McBee, LGP-30

POUCHE
Program Distribution Service of the AICHE

PRINT
Pre-Edited Interpretive System
IBM Corp., IBM 705

PRINT 08
A. O. Smith Executive Routine for Print
A. O. Smith Corp., IBM 705

PROXY
Datatron 205 Simulator
Shell Oil Co., IBM 650

Q-0
The Q-Zero Compiler
Sperry Rand Corp., UNIVAC I, II

QUEASY
Automatic Coding System
Nots Inyokern. IBM 701

QUICK
Automatic Coding System
Douglas Aircraft Co., IBM 701

RAFT
Recomp Algebraic Formula Translator
North American Aviation, Autonetics Div., Recomp

RAMAC
Random Access Method of Accounting and Control
IBM Corp.

RAWOOP-SNAP
Ramo-Wooldridge One-Pass Assembly Program
Ramo-Wooldridge Corp., UNIVAC 1103, 1103-A

RELCODE
Relative Coding
Sperry Rand Corp., UNIVAC I, II

ROAR
Royal Optimizing Assembly Routine
Royal McBee, RPC-4000

RPQ
Request for Price Quotation

RUG
Recomp Users Group
Recomp II

RUNCIBLE
Revised Unified New Compiler with IT Basic Language Extended
Case Institute of Tech., IBM 650

SAC
The SAC Assembly Routine
Burroughs Corp., Datatron 201, 205

SACCS
Strategic Air Command Control System

SAGE
Semi-Automatic Ground Environment Computer
IBM Corp.

SAIL
Automatic Coding System
Sperry Rand Corp., LARC

SALE
A Simple Algebraic Language for Engineers
A. O. Smith Corp., IBM 705

SALT
U. S. Army Signal Eng. Agency, Recomp

SAM
Selective Auto Monitoring Tracing Routine
Chance Vought Aircraft Inc., IBM 650

SAM
Society for Advancement of Management

SAP
Share Assembly Program
Share Users Group, IBM 704

SCAT
Share Compiler Assember and Translator
IBM Corp., IBM 709

SNACS
Share News on Automatic Coding Systems

SOAP I, II
Symbolic Optimum Assembly Programming
IBM Corp., IBM 650

SOHIO
Sohio 705 Floating Point System
Standard Oil of Ohio, IBM 705

SOS
Share Operating System
Users Group, IBM 709, 7090

SO2
Automatic Coding System
IBM Corp., IBM 701

SPACE
Symbolic Programming Anyone Can Enjoy
IBM Corp., IBM 650

SPAR
Automatic Coding System
Burroughs Corp. Datatron 205

SPEED
Self Programmed Electronic Equation Delineator
Royal McBee, LGP-30

SPEEDCO
Automatic Coding System
IBM Corp., IBM 701

SPEEDCODE
Automatic Programming System
Redstone Arsenal, IBM 650
Convair, IBM 704

SPEEDEX
Fixed Point Symbolic Long Hand Coding System
North American Aviation Co., IBM 701

SPOOK
Supervisor Program Over Other Kinds

SPOOL
IBM 7070 Spool System
IBM Corp., IBM 7070

SPS
Symbolic Programming System
IBM Corp., IBM 1401, 1620

SPUR
Automatic Coding System
Boeing Airplane Co., Wichita, IBM 650

SPUR
Single Precision Unpacked Rounded Floating Point Package
Consolidated Vultee, UNIVAC 1103

SSEC
Selective Sequence Electronic Calculator
IBM Corp.

STAR
Automatic Coding System
Burroughs Corp., Datatron 205, 220

STC
Standard Transmission Code

STEP
Supervisory Tape Executive Program
National Cash Register Co., NCR 304

STRETCH
Computer for Los Alamos
IBM Corp.

SURGE
Sorting, Updating, Report Generating, Etc.
A Data Processing Compiler
Aerojet General, C.E.I.R., Douglas Aircraft, Glenn L. Martin Co.
IBM Corp., North American Aviation, Inc., IBM 704

SWAC
National Bureau of Standards Western Automatic Computer
NBS

SWAP
Automatic Coding System
Stone and Webster Engineering Corp., IBM 650

TAC
Transac Assembler Compiler
Philco Corp., Philco 2000

TASS
Tech Assembly System
Carnegie Institute of Tech., IBM 650

TELE-PROCESSING
Data Communication Systems
IBM Corp.

TIMS
The Institute of Management Sciences

TRANSAC
Transistorized Automatic Computer
Philco Corp.

TRANSCODE
A System of Automatic Coding for Ferut
University of Toronto, Ferut

TRAWL
Tape Read and Write Library
Sperry Rand Corp., UNIVAC II

TRICE
A Transistorized Realtime Incremental Computer
Packard-Bell Computer Corp.

TUG
Transac Users Group
Philco Corp., Philco 2000

TYDAC
A Typical Digital Automatic Computer
D. D. McCracken

UGLIAC
United Gas Laboratory Internally-Programmed Automatic Computer
United Gas Corp., Datatron

UNCOL
Universal Computer Oriented Language

UNICODE
Automatic Coding System
Sperry Rand Corp., UNIVAC 1103-A

UNISAP
SAP Assembly System
Case Institute, UNIVAC I, II

UNIVAC
Universal Automatic Computer
Sperry Rand Corp.

UNIVAC USERS
UNIVAC Users Organization
UNIVAC I, II

USE
UNIVAC Scientific Exchange
UNIVAC 1103, 1103-A Users Group

WESCON
Western Electronic Show and Convention

WJCC
Western Joint Computer Conference

X-1
The X-1 Assembly System
Sperry Rand Corp., UNIVAC I

X-2
The X-2 Assembly System
Sperry Rand Corp., UNIVAC UCT

X-6
The X-6 Assembly System
Sperry Rand Corp., UNIVAC SS 90, SS 80

ZMMD
Zurich, Mainz, Munich, Darmstadt
A Joint University Effort on ALGOL Processors

9 PAC
The 9 PAC System
Share Users Group, IBM 709

GLOSSARY OF COMPUTING TERMS

Abacus — A device for performing calculations by sliding beads or counters along rods.

Abstract — (N) A short form or summary of a document. (V) To shorten or summarize a document.

AC — A suffix meaning "automatic computer" as in ORDVAC, EDVAC, ENIAC, etc.

Acceleration Time — The elapsed time between the interpretation of tape read or write instructions and the availability of the information for transfer to or from tape and internal storage.

Access Arm — Mobile arm carrying read-write heads to locations on magnetic disks used in magnetic disk storage. See Disk Storage.

Access, Random — Access to storage under conditions in which the next position from which information is to be obtained is in no way dependent on the previous one.

Access Time — (1) The time interval between the instant at which information is: (a) called for from storage and the instant at which delivery is completed, i.e., the read time; or (b) ready for storage and the instant at which storage is completed, i.e., the write time. (2) The latency plus the word-time.

Accumulator — The zero-access register (and associated equipment) in the arithmetic unit in which are formed sums and other arithmetical and logical results; a unit in a digital computer where numbers are totaled, i.e., accumulated. Often the accumulator stores one quantity and upon receipt of any second quantity, it forms and stores the sum of the first and second quantities.

Accuracy — Freedom from error. Accuracy contrasts with precision; e.g., a four-place table, correctly computed, is accurate; a six-place table containing an error is more precise, but not accurate.

Activity — A term to indicate that a record in a master file is used, altered or referred to.

Activity Ratio — When a file is processed, the ratio of — the number of records in a file which have activity — to — the total number of records in that file.

Adder — A device capable of forming the sum of two or more quantities.

Address — A label such as an integer or other set of characters which identifies a register, location, or device in which information is stored.

Address, Absolute — The label(s) assigned by the machine designer to a particular storage location; specific address.

Address Modification — The process of changing the address part of a machine instruction by means of coded instructions.

Address, Relative — A label used to identify a word in a routine or subroutine with respect to its position in that routine or subroutine. Relative addresses are translated into absolute addresses by the addition of some specific "reference" address, usually that at which the first word of the routine is stored, e.g., if a relative address instruction specifies an address n and the address of the first word of the routine is k, then the absolute address is n + k.

Address, Symbolic — A label chosen to identify a particular word, function or other information in a routine, independent of the location of the information within the routine; floating address.

ALGOL — (for ALGOrithmic Language) an international problem language designed for the concise, efficient expression of arithmetic and logical processes, and the control (iterative, etc.) of these processes.

Algorithm — A fixed step-by-step procedure for accomplishing results, usually a simplified procedure for accomplishing a complex result.

Allocate — To assign storage locations to the main routines and subroutines, thereby fixing the absolute values of any symbolic addresses. In some cases allocation may require segmentation.

Allocate Storage — To assign storage locations or areas of storage for specific routines, portions of routines, constants, working storage, data, etc.

Alphameric — A generic term for alphabetic letters, numerical digits, and some special characters.

Alphanumeric — See Alphameric.

Alteration Switch — A manual switch on the computer console or a program simulated switch which can be set on or off to control coded machine instructions.

Amplifier, Buffer — An amplifier used to isolate the output of any device, e.g., oscillator, from the effects produced by changes in voltage or loading in subsequent circuits.

Amplifier, Torque — A device which produces an output turning moment in proportion to the input moment, wherein the output moment and associated power is supplied by the device, and the device requires an input moment and power smaller than the output moment and power.

Analog — The representation of numerical quantities by means of physical variables, e.g., translation, rotation, voltage, resistance; contrasted with "digital."

Analyzer, Differential — An analog computer designed and used primarily for solving many types of differential equations.

And — A logical operator which has the property such that if P and Q are two statements, then the statement "P and Q" is true or false precisely according to the following table of possible combinations:

P	Q	P and Q
false	false	false
false	true	false
true	false	false
true	true	true

The "and" operator is often represented by a centered dot (.), or by no sign as in P, Q or PQ.

And-Gate — A signal circuit with two or more input wires which has the property that the output wire gives a signal only if all input wires receive co-incident signals.

Aquadag — A graphite coating on the inside of certain cathode ray tubes for collecting secondary electrons emitted by the screen.

Argument — The independent value or independent variable of a function.

Arithmetic Operation — Any of the fundamental operations of arithmetic, e.g., the binary operations of addition, subtraction, multiplication and division, and the unary operations of negation and absolute value.

Arithmetic Shift — A shift of digits to the left or right within a fixed framework in order to multiply or divide by a power of the given number base equivalent to the number of positions shifted.

Arithmetic Unit — That portion of the hardware of an automatic computer in which arithmetical and logical operations are performed.

Array — Planes of magnetic core storage aligned to represent alphabetic and numeric data in binary configuration. See magnetic core, core storage.

Artificial Intelligence — Research and study in methods for the development of a machine which can improve its own operations.

Assemble — To integrate subroutines (supplied, selected, or generated) into the main routine, by adapting, or specializing to the task at hand by means of preset parameters, by adapting, or changing relative and symbolic addresses to absolute form, or incorporating, or placing in storage.

Assembler — A computer routine which assembles other routines.

Asynchronous — A term applied to a computer in which the execution of one operation is dependent on a signal that the previous operation is completed, rather than on a fixed time cycle.

Attenuate — To obtain a fractional part or reduce in amplitude an action or signal. Measurement may be made as percentage, per unit, or in decibels, which is 10 times log $_{10}$ of power ratio; contrasted with amplify.

Augmented Operation Code — An operation code which is further defined by information from another portion of an instruction.

Auto-Abstract — A document abstracted by machine methods.

Auto-Index — To prepare an index by a machine method.

Automatic Coding — A technique by which a machine translates a routine written in a synthetic language into coded machine instructions, e.g., assembling is automatic coding.

Automatic Programming — Technique which employs the computer itself to translate computer instructions from a form that is easy for a human being to produce and understand into a form suitable for use by a computer.

Automation — The entire field of investigation, design, development, application and methods of rendering or making processes or machines self-acting or self-moving; rendering automatic; theory, art or technique of making a device, machine, process or procedure more fully automatic; the implementation of a self-acting or self-moving, hence, automatic process or machine.

Auxiliary Storage — Storage which supplements the primary storage.

Available-Time, Machine — Time during which a computer has the power turned on, is not under maintenance, and is known or believed to be operating correctly.

Azimuth — The angular measurement in a horizontal plane and in a clockwise direction from a specific reference direction, usually a form of North, i.e., true azimuth is measured from true north, magnetic azimuth from magnetic north, grid-azimuth from grid north or thrust or base line.

Backspace — To move one unit in the reverse or backward direction as opposed to moving one unit in the forward direction, e.g., to move back one record or file on an I/O device.

Band — A group of recording tracks on a magnetic drum.

Base — A number base; a quantity used implicitly to define some system of representing numbers by positional notation; radix.

Basic Linkage — A linkage which is used repeatedly in one routine, program or system and which follows the same set of rules each time. See Linkage.

Batch Processing — A systems approach to processing where a number of similar input items can be grouped for processing during the same machine run.

Beam, Holding — A diffused beam of electrons used for regenerating the charges stored on the screen of a cathode ray storage tube.

Bias — The average D.C. voltage maintained between the cathode and control grid of a vacuum tube.

Binary — A characteristic or property involving a selection, choice or condition in which there are but two possible alternatives.

Binary Coded Character — One element of a notation system for representing alphameric characters such as decimal digits, alphabetic letters, punctuation marks, etc., by a fixed number of consecutive binary digits.

Binary Coded Digit — One element of a notation system for representing a decimal digit by a fixed number of binary positions.

Binary Digit — A digit, or mark in the binary number system, i.e., either zero or one.

Binary, Number — A single digit or group of characters or symbols representing the total, aggregate or amount of units utilizing the base two; usually using only "0" and "1" digits to express quantity.

Binary Point — That point in a binary number which separates the integral from the fractional part. It is analogous to the decimal point for a decimal number.

Binary to Decimal Conversion — Conversion of a binary number to the equivalent decimal number, i.e., a base two number to a base ten number.

Biquinary — A form of notation utilizing a mixed base; see Notation, Biquinary.

Bit — See Digit, Binary, a contraction of binary digit.

Block — A group of words considered or transported as a unit; an item; a message; in flow charts, an assembly of boxes, each box representing a logical unit of programming, usually requiring transfer to and from the high speed storage; in circuitry, a group of electrical circuits performing a specific function, as in a "block" diagram, in which unit, e.g., oscillator, is represented as a block (symbol).

Block Diagram — A graphic representation of the logical sequence of procedural steps for processing data.

Blocking — Combining two or more records into one block.

Block, Input — A section of internal storage of a computer reserved for the receiving and processing of input information.

Block Length — The total number of records, words, or characters contained in one block.

Boolean Algebra — An algebra named for George Boole. This algebra is similar in form to ordinary algebra but with classes, propositions, on-off circuit elements, etc., for variables rather than data values. It includes the operators and, or, not, except, if, then.

Bootstrap — The special coded instructions at the beginning of an input tape, together with one or two instructions inserted by switches or buttons into the computer; in circuitry, a positive feedback or regenerative circuit.

Borrow — A negative form of carry; see Carry; normally arising in direct subtraction by raising a lower order (less significant digit) and compensating by lowering a higher order digit, e.g., when subtracting 67 from 92, a tens digit is "borrowed" from the 9, thus the 7 of 67 is subtracted from 12, yielding 5 as the units digit of the difference and then 6 is subtracted from 8 (or 9-1) yielding 2 as the tens digit. Thus, 25 is the difference.

Branch — A conditional jump.

Breakpoint — A point in a routine at which the computer may, under the control of a manually-set switch, be stopped for a visual check of progress.

Buffer — An isolating circuit used to avoid any reaction of a driven circuit upon the corresponding driving circuit, e.g., a circuit having an output and a multiplicity of inputs so designed that the output is energized whenever one or more inputs are energized. Thus, a buffer performs the circuit function which is equivalent to the logical "OR."

Bus — A path over which information is transferred; a trunk; an electrical conductor, channel or line; a heavy wire or heavy lead.

Byte — A generic term to indicate an easily manipulated portion of consecutive binary digits, e.g., an 8-bit or 6-bit byte.

Cable — An electrical conductor designed to provide common electric potential between two or more points.

Cable, Coaxial — A transmission line consisting of two conductors concentric with and insulated from each other.

Calling Sequence — The instructions used for linking a closed routine with a main routine, i.e., basic linkage and a list of the parameters.

Call-Number — A set of characters identifying a subroutine and containing information concerning parameters to be inserted in the subroutine, information to be used in generating the subroutine, or information related to the operands; a call-word when exactly one word is filled.

Capacitance — The property of two or more bodies which enables them to store electrical energy in an electrostatic field between the bodies.

Capacity — The upper and lower limits of the numbers which may be processed in a computer register, e.g., in the accumulator, e.g., the capacity of a computer may be ten decimal digits or the capacity of a computer may be +.00000 00001 to +.99999 99999. Quantities which exceed the capacity usually interrupt the operation of the computer in some fashion; the quantity of information which may be stored in a storage unit.

Capacity, Storage — Maximum number of words or characters which a device is capable of storing; a measure of the ability of a device to store information for future reference.

Card — Heavy, stiff paper of uniform size and shape, adapted for being punched in an intelligent array of holes. The punched holes are sensed electrically by wire brushes or mechanically by metal feelers. One standard card is 7⅜ inches long by 3¼ inches wide and contains 80 columns in each of which any one of 12 positions may be punched.

Card Code — The combinations of punched holes which represent characters (letters, digits, etc.) on a punched card.

Card Field — A fixed number of consecutive card columns assigned to a unit of information, e.g., card columns 15-20 can be assigned to identification.

Card Image — A representation in storage of a punched card, e.g., a copy of the original card matrix where one represents a punch and zero represents a no-punch.

Card Punch — A device to record information in cards by punching holes in the cards to represent letters, digits, and special characters.

Card Reader — A device which senses and translates into internal form the holes in punched cards as the cards pass through the machine.

Card to Tape — Pertaining to equipment which transfers information directly from punched cards to punched or magnetic tape.

Caret — A symbol (an inverted v) used to indicate the location of an insertion.

Carriage, Automatic — A typewriting paper guiding or holding device which is automatically controlled by information and program so as to feed forms or continuous paper to a set of impression keys and to provide the necessary space, skip, eject, tabulate, or performing operations.

Carrier Wave — The basic frequency or pulse repetition rate of a signal, bearing no intrinsic intelligence until it is modulated by another signal which does bear intelligence. A carrier may be amplitude, phase, or frequency modulated. For example, in a typical mercury delay line memory of a digital computer, the 8 megacycle/second sound wave carrier is amplitude (pulse) modulated by a 1 megacycle/second pulse code signal, the presence or absence of a pulse determining whether or not a one or a zero is present in the binary number being represented.

Carry — (1) A signal, or expression, produced as a result of an arithmetic operation on one digit place of two or more numbers expressed in Positional Notation and transferred to the next higher place for processing there. (2) Usually a signal or expression as defined in (1) above which arises in adding, when the sum of two digits in the same digit place equals or exceeds the base of the number system in use. If a carry into a digit place will result in a carry out of the same digit place, and if the normal adding circuit is bypassed when generating this new carry, it is called a High-Speed Carry, or Standing-on-Nines Carry. If the normal adding circuit is used in such a case, the carry is called a Cascaded Carry. If a carry resulting from the addition of carries is not allowed to propagate (e.g., when forming the partial product in one step of a multiplication process), the process is called a Partial Carry. If it is allowed to propagate, the process is called a Complete Carry. If a carry generated in the most significant digit place is sent directly to the least significant place (e.g., when adding two negative numbers using nine complements) that carry is called an End-Around Carry. (3) In direct subtraction, a signal or expression as defined in (1) above which arises when the difference between the digits is less than zero. Such a carry is frequently called a Borrow. (4) The action of forwarding a carry. (5) The command directing a carry to be forwarded.

Catalog — To assign a representative label for a document according to a definite set of rules.

Catena — A chain, a series, especially a connected series.

Catenate — See Concatenate.

Catenation — See Concatenation.

Cathode-Follower — A vacuum-tube circuit in which the input signal is applied to the control grid and the output is taken from the cathode, possessing high input impedance and low output impedance characteristics.

Cathode Ray Tube — A vacuum tube used as a storage or a visual display device.

Cell — Storage for one unit of information, usually one character or one word; usually a location specified by whole or part of the address and possessed of the faculty of store; specific terms as column, field, location and block are preferable when appropriate.

Cell, Binary — An element that can have one or the other of two stable states or conditions and thus can store a unit of information.

Central Processing Unit — That component of a computing system which contains the arithmetic, logical and control circuits of the basic system.

Chain or Chaining — (1) A series of items linked together. (2) A system of storing records in which each record belongs to a chain or group of records and has a linking field for tracing the chain.

Chain Printer — A recently developed machine technique where the printing is accomplished by type assembled on a chain. The chain travels in a horizontal plane, and each character is printed as it is positioned opposite a magnet-driven hammer that presses the form against the chain.

Channel — A path along which information, particularly a series of digits or characters, may flow. In storage which is serial by character and parallel by bit (e.g., a magnetic tape or drum in some coded-decimal computers), a channel comprises several parallel tracks. In a circulating storage a channel is one recirculating path containing a fixed number of words stored serially by word.

Character — One of a set of elementary symbols such as those corresponding to the keys on a typewriter. The symbols may include the decimal digits 0 through 9, the letters A through Z, punctuation marks, operation symbols, and any other single symbols which a computer may read, store, or write; a pulse code representation of such a symbol.

Character Density — A measure of the number of characters recorded per unit of length or area.

Character Reader — An input device which reads printed characters directly from a document.

Character Set — A list of characters acceptable for coding to a specific computer or input-output device.

Characteristic — (1) The integral part of a common logarithm, e.g., in the logarithm 2.5, 2 is the characteristic and 5 is the mantissa. (2) Sometimes that portion of a floating point number indicating the exponent.

Check — A means of verification of information during or after an operation.

Check Bit — Used on tape and internally in computer systems to maintain an odd or even 1 bit pattern. Check bits for an even number of 1 bits have even parity. Codes using an odd number of 1 bits have odd parity. The check bit determines the accuracy of a character representation in binary code.

Check, Built-In or Automatic — Any provision constructed in hardware for verifying the accuracy of information transmitted, manipulated, or stored by any unit or device in a computer. Extent of automatic checking is the relative proportion of machine processes which are checked or the relative proportion of machine hardware devoted to checking.

Check, Duplication — A check which requires that the results of two independent performances (either concurrently on duplicate equipment or at a later time on the same equipment) of the same operation be identical.

Check, Forbidden-Combination — A Check (usually an Automatic Check) which tests for the occurrence of a nonpermissible code expression. A self-checking code (or error-detecting code) uses code expressions such that one (or more) error(s) in a code expression produces a forbidden combination. A parity check makes use of a self-checking code employing binary digits in which the total number of 1's (or 0's) in each permissible code expression is always even or always odd. A check may be made for either even parity or odd parity. A redundancy check employs a self-checking code which makes use of redundant digits called check digits.

Check, Mathematical or Arithmetical — A check making use of mathematical identities or other properties, frequently with some degree of discrepancy being acceptable; e.g., checking multiplication by verifying that A·B = B·A, checking a tabulated function by differencing, etc.

Check, Modulo N — A form of check digits, such that the number of ones in each number A operated upon is compared with a check number B, carried along with A and equal to the remainder of A when divided by N, e.g., in a "modulo 4 check," the check number will be 0, 1, 2, or 3 and the remainder of A when divided by 4 must equal the reported check number B, or else an error or malfunction has occurred; a method of verification by congruences, e.g., casting out nines.

Check, Odd-Even — A check system in which a one or zero is carried along in a word depending on whether the total number of ones (or zeros) in a word is odd or even.

Check, Parity — A summation check in which the binary digits, in a character or word, are added (modulo 2) and the sum checked against a single, previously computed parity digit; i.e., a check which tests whether the number of ones is odd or even.

Check, Programmed — A system of determining the correct program and machine functioning either by running a sample problem with similar programming and known answer, including mathematical or logical checks such as comparing A times B with B times A and usually where reliance is placed on a high probability of correctness rather than built-in error-detection circuits or by building a checking system into the actual program being run and utilized for checking during the actual running of the problem.

Check, Redundant — A check which uses extra digits, short of complete duplication, to help detect malfunctions and mistakes.

Check, Summation — A redundant check in which groups of digits are summed, usually without regard for overflow, and that sum checked against a previously computed sum to verify accuracy.

Check, Transfer — Verification of transmitted information by temporary storing, re-transmitting and comparing.

Check, Twin — A continuous duplication check achieved by duplication of hardware and automatic comparison.

Checking, Marginal — Á system or method of determining computer circuit weaknesses and incipient malfunctions by varying the power applied to various circuits, usually by a lowering of the D.C. supply or filament voltages.

Checkout — The application of diagnostic or testing procedures to a routine or to equipment.

Checksum — A summation of digits or bits used primarily for checking purposes and summed according to an arbitrary set of rules.

Clamping-Circuit — A circuit which maintains either amplitude extreme of a waveform at a given voltage level, or potential.

Clear — To replace all information in a storage device by ones or zeros as expressed in the number system employed.

Clock, Master — The source of standard signals required for sequencing computer operation, usually consisting of a timing pulse generator, a cycling unit and sets of special pulses that occur at given intervals of time. Usually in synchronous machines the basic frequency utilized is the clocking pulse.

Closed Routine — A routine which is not inserted as a block of instructions within a main routine but is entered by basic linkage from the main routine.

Closed-Shop — This is intended to mean that mode of computing machine support wherein the applied programs and utility routines are written by members of a specialized group whose only professional concern is the use of computers.

COBOL — A COmmon Business Oriented Language designed for expressing problems of data manipulation and processing in English narrative form.

Code — A system of symbols and their use in representing rules for handling the flow or processing of information; to actually prepare problems for solution on a specific computer.

Code, Computer — The code representing the operations built into the hardware of the computer.

Code, Excess-Three — A coded decimal notation for decimal digits which represents each decimal digit as the corresponding binary number plus three, e.g., the decimal digits 0, 1, 7, 9 are represented as 0011, 0100, 1010, 1100, respectively. In this notation, the nines complement of the decimal digit is equal to the ones complement of the corresponding four binary digits.

Code, Instruction — An artificial language for describing or expressing the instructions which can be carried out by a digital computer. In automatically sequenced computers, the instruction code is used when describing or expressing sequences of instructions, and each instruction word usually contains a part specifying the operation to be performed and one or more addresses which identify a particular location in storage. Sometimes an address part of an instruction is not intended to specify a location in storage but is used for some other purpose.

If more than one address is used, the code is called a multiple-address code.

Code, Interpreter — A code which is acceptable to an interpretive routine.

Code, Multiple-Address — An instruction or code in which more than one address or storage location is utilized. In a typical instruction of a Four-Address Code the addresses specify the location of two operands, the destination of the result, and the location of the next instruction in the sequence. In a typical Three-Address Code, the fourth address specifying the location of the next instruction is dispensed with, the instructions are taken from storage in a preassigned order. In a typical Two-Address Code, the addresses may specify the locations of the operands. The results may be placed at one of the addresses or the destination of the results may be specified by another instruction.

Code, Operational — That part of an instruction which designates the operation to be performed.

Coding — The list, in computer code or in pseudo-code, of the successive computer operations required to solve a given problem.

Coding, Absolute, Relative or Symbolic — Coding in which one uses absolute, relative, or symbolic addresses, respectively; coding in which all addresses refer to an arbitrarily selected position, or in which all addresses are represented symbolically.

Coding, Alphabetic — A system of abbreviation used in preparing information for input into a computer such that information is reported in the form of letters, e.g., New York as NY, carriage return as CN, etc.

Coding, Automatic — Any technique in which a computer is used to help bridge the gap between some "easiest" form, intellectually and manually, of describing the steps to be followed in solving a given problem and some "most efficient" final coding of the same problem for a given computer; two basic forms are Routine, compilation and Routine, interpretation.

Coding, Numeric — A system of abbreviation used in the preparation of information for machine acceptance by reducing all information to numerical quantities; in contrast to alphabetic coding.

Collate — To combine two or more similarly ordered sets of items to produce another ordered set composed of information from the original sets. Both the number of items and the size of the individual items in the resulting set may differ from those of either of the original sets and of their sums, sequence 23, 24, 48 may be collated into 12, 23, 24, 29, 42, 48; to combine two or more sequences of items according to a prescribed rule such that all items appear in the final sequence.

Column — One of the character or digit positions in a positional notation representation of a unit of information, columns are usually numbered from right to left column, zero being the right-most column if there is no point, or the column immediately to the left of the point if there is one; a position or place in a number in which the position designates the power of the base and the digit is the coefficient, e.g., in 3876, the 8 is the coefficient of 10^2, the position of the 8 designating the 2.

Column Binary Card — 80 column card with binary information recorded in columnar fashion. Binary data is arranged in parallel with each column containing 12 information bits. Thus, one 36 bit word requires three columns. Entire card could contain twenty-six 36 bit words. See also Row Binary Card.

Command — A pulse, signal, or set of signals initiating one step in the performance of a computer operation. See Instruction and Order.

Common Language — A language in machine sensible form which is common to a group of computers and associated equipment.

Comparator — A device for comparing two different transcriptions of the same information to verify the accuracy of transcription, storage, arithmetic operation or other process, in which a signal is given dependent upon the relative state of two items, i.e., larger, smaller, equal, difference, etc. A device for making a comparison.

Compare — To examine the representation of a quantity for the purpose of discovering its relationship to zero, or of two quantities fcr the purpose of discovering identity or relative magnitude.

Comparison — Determining the identity, relative magnitude and relative sign of two quantities and thereby initiating an action. The examination of the relation between two groups of characters.

Comparison, Logical — The operation concerned with the determination of similarity or dissimilarity of two items, e.g., if A and B are alike, the result shall be "1" or yes; if A and B are not alike or equal, the result shall be "0" or no, signifying "not alike."

Compiler — A program making routine, which produces a specific program for a particular problem by determining the intended meaning of an element of information expressed in pseudo-code, selecting or generating the required subroutine, transforming the subroutine into specific coding for the specific problem, assigning specific storage registers, etc., and entering it as an element of the problem program, maintaining a record of the subroutines used and their position in the problem program and continuing to the next element of information in pseudo-code.

Complement — A quantity which is derived from a given quantity expressed to the base n, by one of the following rules and which is frequently used to represent the negative of the given quantity. (a) *Complement on n:* subtract each digit of the given quantity from *n-1*, add unity to the least significant digit, and perform all resultant carrys. For example, the *twos complement* of binary 11010 is 00110; the *tens complement* of decimal 456 is 544. (b) *Complement on n-1:* subtract each digit of the given quantity from n-1. For example, the *ones complement* of binary 11010 is 00101; the *nines complement* of decimal 456 is 543.

Component — A basic part. An element.

Computer — Any device capable of accepting information, applying prescribed processes to the information, and supplying the results of these processes; sometimes, more specifically, a device for performing sequences of arithmetic and logical operations; sometimes, still more specifically, a stored-program digital computer capable of performing sequences of internally-stored instructions, as opposed to *calculators* on which the sequence is impressed manually (desk calculator) or from tape or cards (card programmed calculator).

Computer, Analog — A calculating machine which solves problems by translating physical conditions like flow, temperature or pressure into electrical quantities and using electrical equivalent circuits for the physical phenomenon.

Computer, Asynchronous — A calculating device in which the performance of any operation starts as a result of a signal that the previous operation has been completed; contrasted with synchronous computer.

Computer, Automatic — A calculating device which handles long sequences of operations without human intervention.

Computer, Digital — A calculating device utilizing numbers to express all the variables and quantities of a problem. The numbers are usually expressed as a space-time distribution of punched holes, electrical pulses, sonic pulses, etc.

Computer, Synchronous — A calculating device in which the performance of all operations is controlled with equally spaced signals from a master clock.

Concatenate — To unite in a series; to link together; to chain.

Concatenation — The process of linking or joining sets or series. Chaining.

Conditional — Subject to the result of a comparison made during computation; subject to human intervention.

Connector — A symbol used on a flowchart or block diagram to indicate the interconnection of two points.

Console — External, central control unit for a computer system. Data may be entered here, by depressing keys; data and data flow may be checked, and a typewriter attached provides output from the computer. A monitor and supervising point for a computer system.

Constant — A fixed or invariable value or data item.

Contents — The information stored in any storage medium. Quite prevalently, the symbol ( ) is used to indicate "the contents of"; e.g., (m) indicates the contents of the storage location whose address is m; (A) indicates the contents of register A; (T_2) may indicate the contents of the tape on input-output unit two, etc.

Contents Of — A phrase frequently represented by parentheses enclosing an address and used to denote the contents of the corresponding storage location, e.g., the contents of storage location M— is written (M).

Context — The overall meaning. The meaning of a work or term as it is related to the surrounding words or terms.

Control — (1) Usually, those parts of a digital computer which effect the carrying out of instructions in proper sequence, the interpretation of each instruction, and the application of the proper signals to the arithmetic unit and other parts in accordance with this interpretation. (2) Frequently, one or more of the components in any mechanism responsible for interpreting and carrying out manually-initiated directions. Sometimes called manual control. (3) In some business applications of mathematics, a mathematical check.

Control Card — A card which contains input data or parameters for a specific application of a general routine.

Control, Cascade — An automatic control system in which various control units are linked in sequence, each control unit regulating the operation of the next control unit in line.

Control Data — One or more items of data used as control to identify, select, execute or modify another routine, record, file, operation, data value, etc.

Control-Sequence — The normal order of selection of instructions for execution. In some computers, one of the addresses in each instruction specifies the control sequence. In most other computers the sequence is consecutive except where a jump occurs.

Control, Sequential — A manner of operation of a computer such that instructions are fed in a given order to the computer during the solution of a problem.

Control-Unit — That portion of the hardware of an automatic digital computer which directs the sequence of operations, interprets the coded instructions, and initiates the proper commands to the computer circuits to execute the instructions.

Convert — To change numerical information from one number base to another (e.g., decimal to binary) and/or from some form of fixed point to some form of floating-point representation, or vice versa.

Converter — A unit which changes the language of information from one form to another so as to make it available or acceptable to another machine, e.g., a unit which takes information punched on cards to information recorded on magnetic tape, possibly including editing facilities.

Coordinate Indexing — A system of indexing individual documents by descriptions of equal rank, so that a library can be searched for a combination of one or more descriptors.

Copy — To reproduce information in a new location replacing whatever was previously stored there and leaving the source of the information unchanged.

Core, Magnetic — A magnetic material capable of assuming and remaining at one of two or more conditions of magnetization, thus capable of providing storage, gating or switching functions, usually of toroidal shape and pulsed or polarized by electric currents carried on wire wound around the material.

Core Storage — Computer storage by tiny rings of ferromagnetic material a few hundredths of an inch in diameter. Compact assembly of these record data by two states of 0 and 1 based on their polarity. Stacks and arrays of cores combined and addressable make up computer cores for storage and high speed access. See Magnetic Core.

Counter — A device, register, or storage location for storing integers, permitting these integers to be increased or decreased by unity or by an arbitrary integer, and capable of being reset to zero or to an arbitrary integer.

Counter, Control — A device which records the storage location of the instruction word, which is to be operated upon following the instruction word in current use. The control counter may select storage locations in sequence, thus obtaining the next instruction word from the following storage location, unless a transfer or special instruction is encountered.

Counter, Ring — A loop of interconnected bistable elements such that one and only one is in a specified state at any given time and such that, as input signals are counted, the position of the one specified state moves in an ordered sequence around the loop.

Coupling — The means by which energy is transferred from one circuit to another; the common impedance necessary for coupling.

Coupling, Capacitive — A method of transferring energy from one circuit to another by means of a capacitor that is common to both circuits.

Coupling, Direct — A method of transferring energy from one circuit to another by means of resistors common to both circuits.

Cross Check — To check the computing by two different methods.

Crossfoot — To add several horizontal fields of information.

Crosstalk — (1) A term used to describe the reason for a false retrieval arising from a lack of keyword role indication. (2) Interference in communication caused by received waves of frequency other than that to which the receiver is tuned.

CRT — Cathode Ray Tube; a device yielding a visual plot of the variation of several parameters by means of a proportionally deflected beam of electrons.

Cybernetics — The comparative study of the control and intracommunication of information handling machines and nervous systems of animals and man in order to understand and improve communication, e.g., a study of the art of the pilot or steersman.

Cycle — A set of operations repeated as a unit; a non-arithmetic shift in which the digits dropped off at one end of a word are returned at the other end in circular fashion; cycle right and cycle left. To repeat a set of operations a prescribed number of times including, when required, supplying necessary address changes by arithmetic processes or by means of a hardware device such as a *B-box* or *cycle-counter*.

Cycle Count — To increase or decrease the cycle index by unity or by an arbitrary integer.

Cycle-Criterion — The total number of times the cycle is to be repeated; the register which stores that number.

Cycle-Index — The number of times a cycle has been executed; or the difference, or the negative of the difference, between that number and the number of repetitions desired.

Cycle, Major — The maximum access time of a recirculating serial storage element; the time for one rotation, e.g., of a magnetic drum or of pulses in an acoustic delay line; a whole number of minor cycles.

Cycle, Memory — A repeated, periodic sequence of events occurring when information is transferred to or from the storage device of a computer. Storing, sensing, and regeneration form parts of the storage sequence. Usually a "timing chart," showing pulse times on all leads to a storage cell describe such a cycle.

Cycle, Minor — The word time of a serial computer, including the spacing between words.

Cycle, Reset — To return a cycle index to its initial value.

Damping — A characteristic built into electrical circuits and mechanical systems to prevent rapid or excessive corrections which may lead to instability or oscillatory conditions, e.g., connecting a resistor on the terminals of a pulse transformer to remove natural oscillations; placing a moving element in oil or sluggish grease to prevent overshoot.

Data — A collection of facts, numbers, letters, symbols, etc., which can be processed or produced by a computer.

Data Conversion — The process of changing data from one form of representation to another.

Data Processing — A generic term to engulf all machine business applications.

Data-Reduction — The art or process of transforming masses of raw test or experimentally obtained data, usually gathered by instrumentation, into useful, ordered, or simplified intelligence.

Data-Reduction, On-Line — The processing of information as rapidly as the information is received by the computing system.

Debug — To isolate and remove all malfunctions from a computer or all mistakes from a routine.

Decade — A group or assembly of ten units, e.g., a decade counter counts to ten in one column; a decade resistor box inserts resistance quantities in multiples of powers of 10.

Decimal, Coded, Binary — Decimal notation in which the individual decimal digits are represented by some binary code, e.g., in the 8-4-2-1 coded decimal notation, the number twelve is represented as 0001 0010 for 1 and 2, respectively. Whereas in pure binary notation, it is represented as 1100. Other coded decimal notations are known as: 5-4-2-1, excess three, 2-4-2-1, etc.

Decode — To ascertain the intended meaning of the individual characters or groups of characters in the pseudo-coded program.

Decoder — A device capable of ascertaining the significance or meaning of a group of signals and initiating a computer event based thereon; matrix.

Decrement — (1) The quantity by which a variable is decreased. (2) A specific part of an instruction word in some computers.

Deflection-Sensitivity — The quotient of the displacement of the electron beam at the place of impact by the change in deflecting field. It is usually expressed in millimeters per volt applied between the deflection electrodes, or in millimeters per gauss of the deflecting magnetic field.

Delay-Line, Electric — A transmission line of lumped or distributed capacitive and inductive elements in which the velocity of propagation of electromagnetic energy is small compared with the velocity of light. Storage is accomplished by re-circulation of wave patterns containing information, usually in binary form.

Delay-Line, Magnetic — A metallic medium along which the velocity of propagation of magnetic energy is small relative to the speed of light. Storage is accomplished by recirculation of wave patterns containing information usually in binary form.

Delay-Line, Mercury or Quartz — A sonic or acoustic delay-line in which mercury or quartz is used as the medium of sound transmission. See Delay-Line, Sonic or Acoustic.

Delay-Line, Sonic or Acoustic — A device capable of transmitting retarded sound pulses, transmission being accomplished by wave patterns of elastic deformation. Storage is accomplished by re-circulation of wave patterns containing information, usually in binary form.

Delete — To remove or eliminate, e.g., to remove a record from a master file.

Delimit — To fix the limits of; to bound.

Delimiter — A character which limits a string of characters, and therefore cannot be a member of the string.

Density Packing — The number of units of useful information contained within a given linear dimension, usually expressed in units per inch, e.g., the number of binary digit magnetic pulses stored on tape or drum per linear inch on a single track by a single head.

Descriptor — A significant word which helps to classify the contents of a document.

Design, Logical — (1) The planning of a computer or data processing system prior to its detailed engineering design. (2) The synthesizing of a network of logical elements to perform a specified function. (3) The result of (1) and (2) above, frequently called the logic of the system, machine, or network.

Detail File or Record — A file or record to be processed against a master file.

Diagnosis — The process of locating and explaining detectable errors in a computer routine or hardware component.

Diagnostic Routine — Routine designed to detect and locate either a malfunction of the system or a mistake in programming.

Diagnotor — A combination diagnostic and edit routine which questions unusual situations and notes the implied results.

Diagram, Block — A schematic representation of a sequence of subroutines designed to solve a problem; a coarser and less symbolic representation than a flow chart, frequently including descriptions in English words; a schematic or logical drawing showing the electrical circuit or logical arrangements within a component.

Diagram, Logical — In logical design, a diagram representing the logical elements and their interconnections without necessarily expressing construction or engineering details.

Dictionary — A list of code names or key words used in a routine or system and an indication of their intended meaning in that routine or system.

Differential Analyzer — An analog computer designed primarily for solving certain types of differential equations.

Differentiator — A device whose output function in proportional to a derivative of its input function with respect to one or more variables.

Digit — One of the *n* symbols of integral value ranging from 0 to *n-1* inclusive in a scale of numbering of base n, e.g., one of the ten decimal digits, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

Digit, Binary — A whole number in the binary scale of notation; this digit may be only 0 (zero) or 1 (one). It may be equivalent to an "on" or "off" condition, a "yes" or a "no," etc.

Digit, Decimal, Coded — One of ten arbitrarily-selected patterns of ones and zeros used to represent the decimal digits.

Digital — The quality of utilizing numbers in a given scale of notation to represent all the quantities that occur in a problem or a calculation.

Digitize — To render an analog measurement of a physical variable into a numerical value, expressing the quantity in digital form.

Digits, Check — One or more redundant digits in a character or word, which depend upon the remaining digits in such a fashion that if a digit changes, the malfunction can be detected, e.g., a given digit may be zero if the sum of other digits in the word is odd, and this (check) digit may be one if the sum of other digits in the word is even.

Digits, Equivalent Binary — The number of binary digits required to express a number in another base with the same precision, e.g., approximately 3-1/3 times the number of decimal digits is required to express a decimal number in binary form. For the case of coded decimal notation, the number of binary digits required is 4 times the number of decimal digits.

Diode — An electronic device used to permit current flow in one direction and to inhibit current flow in the other.

Disk Storage — One type of storage used in computers. 50 disks of metal about two feet in diameter coated on both sides with ferrous oxide material on a vertical shaft spinning at 1200 rpm used for random access to concentric, addressable tracks by moving access read-write arms. See Access Arm, Magnetic Disk.

Document — Any representation of stored information.

Double Precision — Pertaining to a quantity having twice as many digits as are normally carried, e.g., a double precision number requires two machine words in a fixed word machine.

Down-Time — The period during which a computer is malfunctioning or not operating correctly due to machine failures; contrasted with available time, idle time or standby time.

Drum, Magnetic — A rotating cylinder on whose magnetic-material coating information is stored in the form of magnetized dipoles, the orientation or polarity of which is used to store binary information.

Drum Storage — One of several types of storage in computers. Steel cylinder enclosed in copper sleeve which is plated with cobalt and nickel alloy that is the actual storage medium. Drums rotate at high speed and information is written by magnetizing cells as the surface passes read-write heads. Drum storage is permanent. Each drum has storage locations which are addressable. See Magnetic Drum.

Dummy — An artificial address, instruction, or other unit of information inserted solely to fulfill prescribed conditions (such as word-length or block-length) without affecting operations.

Dump, A.C. — The removal of all A.C. power, intentionally, accidentally or conditionally from a system or component. An A.C. dump usually results in the removal of all power.

Dump, D.C. — The removal of all D.C. power, intentionally, accidentally, or conditionally, from a system or component.

Dump, Power — The removal of all power accidentally or intentionally.

Dynamic Printout — A printout of data which occurs during the machine run as one of the sequential operations, as contrasted to a static printout.

Eccles-Jordan (Trigger) — A direct coupled multivibrator circuit possessing two conditions of stable equilibrium. Also known as a flip-flop circuit or "toggle."

Echo Checking — A system of assuring accuracy by reflecting the transmitted information back to the transmitter and comparing the reflected information with that which was transmitted.

Edit — To rearrange information. Editing may involve the deletion of unwanted data, the selection of pertinent data, the insertion of invariant symbols such as page numbers and typewriter characters, and the application of standard processes such as zero-suppression.

Electronic — Pertaining to the application of that branch of science which deals with the motion, emission and behavior of currents of free electrons, especially in vacuum, gas or phototubes and special conductors or semi-conductors. Contrasted with electric which pertains to the flow of large currents in wires only.

Electrostatic Storage — A storage device which uses electric charges to represent data.

Element, Logical — In a computer or data processing system, the smallest building blocks which can be represented by operators in an appropriate system of symbolic logic. Typical logical elements are the and-gate and the flip-flop, which can be represented as operators in a suitable symbolic logic.

Elevation — The angular measurement in a vertical plane from a specific reference, usually the horizontal plane.

Empirical — Pertaining to a statement or formula based on experience or experimental evidence rather than on mathematical conclusions.

Encoder — A network or system in which only one input is excited at a time and each input produces a combination of outputs. Sometimes called a matrix.

End Around Carry — (N) The bit carried over from the high order to the low order position. (V) To carry over from the high order to the low order position.

End-Mark or End-of-File Mark — Any indicator to signal the end of a word or other unit of data.

Erase — To replace all the binary digits in a storage device by binary zeros. In a binary computer, *erasing* is equivalent to clearing, while in a coded decimal computer where the pulse code for decimal zero may contain binary ones, *clearing* leaves decimal zero while *erasing* leaves all-zero pulse codes.

Error — The amount of loss of precision in a quantity; the difference between an accurate quantity and its calculated approximation; *errors* occur in numerical methods; *mistakes* occur in programming, coding, data transcription, and operating; *malfunctions* occur in computers and are due to physical limitations on the properties of materials; the differential margin by which a controlled unit deviates from its target value.

Error, Inherited — The error in the initial values; especially the error inherited from the previous steps in the step-by-step integration.

Error, Rounding — The error resulting from deleting the less significant digits of a quantity and applying some rule of correction to the part retained. A common round-off rule is to take the quantity to the nearest digit. Thus, pi, 3.14159265 . . . , rounded to four decimals is 3.1416. Note: Alston S. Householder suggests the following terms: "initial errors," "generated errors," "propagated errors" and "residual errors." If x is the true value of the argument, and x^* the quantity used in computation, then, assuming one wishes f(x), $x-x^*$ is the initial error; $f(x) — f(x^*)$ is the propagated error. If f_a is the Taylor, or other, approximation utilized, then $f(x^*) — f_a(x^*)$ is the residual error. If f^* is the actual result then $f_a — f^*$ is the generated error, and this is what builds up as a result of rounding.

Error, Truncation — The error resulting from the use of only a finite number of terms of an infinite series, or from the approximation of operations in the infinitesimal calculus by operations in the calculus of finite differences.

Excess-Fifty — A representation in which the number —N— is denoted by the equivalent of (N + 50).

Exchange — To interchange the contents of two storage devices or locations.

Executive Routine — That portion of a program which controls the execution of other routines.

Exclusive Or — The Boolean operator which gives a truth table value of true if only one of the two variables it connects is true. If both variables it connects are true, the value is false.

Exclusive-Or-Operator — A logical operator which has the property that if P and Q are two statements, then the statement P + Q (i.e., + is Exclusive-Or-Operator) is true or false depending whether the variables are odd or even, e.g.,

P	Q	P + Q	
0	1	1	(odd)
1	0	1	(odd)
1	0	1	(even)
0	0	0	(even)

Note that the Exclusive-Or is the same as the Inclusive-Or, except that the case for both inputs present yields no output. See Inclusive-Or; $P \ddagger Q$ is True if P or Q is true, but not both. Primarily used in comparator circuits.

Exponent — A number placed at the right and above a symbol in typography to indicate the number of times that symbol is a factor, e.g., 10 to the 4 = 10 x 10 x 10 x 10 = 10,000.

Expression — A source language combination of one or more operations.

External Storage — A storage device outside the computer which can store information in a form acceptable to the computer, e.g., cards, tapes.

Extract — To remove from a set of items of information all those items that meet some arbitrary criterion; to replace the contents of specific parts of a quantity (as indicated by some other quantity called an extractor) by the contents of specific parts of a third quantity, e.g., if the number 01101 is stored, the machine can remove and act upon or according to the third digit, in this case a 1.

Factor, Scale — One or more coefficients used to multiply or divide quantities in a problem in order to convert them so as to have them lie in a given range of magnitude, e.g., plus one to minus one.

False Retrievals — Library references which are not pertinent to but are vaguely related to the subject of the library search, and are sometimes obtained by automatic search methods.

Feed, Card — A mechanism which moves cards serially into a machine.

Feedback — The feeding back of part of the output of a machine, process or system to the computer as input for another phase, especially for self-correcting or control purposes.

Ferroelectric — A phenomenon exhibited by materials within which permanent electric dipoles exist and a residual displacement in the D-E plane occurs.

Ferromagnetics — In computer technology, the science that deals with the storage of information and the logical control of pulse sequences through the utilization of the magnetic polarization properties of materials to store binary information.

Field — A set of one or more characters (not necessarily all lying on the same word) which is treated as a whole; a set of one or more columns on a punched card consistently used to record similar information.

Field, Card — A set of card columns fixed as to number and position into which the same unit of information is regularly entered.

Field-Decrement — A portion of an instructor word set aside specifically for modifying the contents of a register or memory location specified by the tag digits of the same instructor word.

File — A sequential set of items.

File Maintenance — The processing of a file to effect changes in the file, e.g., updating a master file.

Fixed-Point — A notation or system of arithmetic in which all numerical quantities are expressed by a pre-determined number of digits with the point implicitly located at some pre-determined position; contrasted with floating-point.

Fixed Word Length — A term which refers to computers in which data is treated in units of a fixed number of characters or bits (as contrasted to variable word length).

Flag Bit — In a six bit numeric code the flag bit (F) represents the sign (+ or —) of a numeric field.

Flip-Flop — A bi-stable device; a device capable of assuming two stable states; a bi-stable device which may assume a given stable state depending upon the pulse history of one or more input points and having one or more output points. The device is capable of storing a bit of information; controlling gates, etc.; a toggle. See Eccles-Jordan.

Floating-Point — A notation in which a number x is represented by a pair of numbers y and z (and two integers n and m which are understood parameters in any given representation) with y and z chosen so that $x = y \cdot n^z$ where z is an integer, ordinarily either $m > [y] \geqslant m/n$, or $y = 0$ (where n is usually 2 or 10 and m is usually 1). The quantity y is called the *fraction* or *mantissa*; the integer z is called the exponent or characteristic, e.g., a decimal number 241,000,000 might be shown as 2.41, 8, since it is equal to 2.41×10^8.

Flow-Chart — A graphical representation of a sequence of operations, using symbols to represent the operations such as compute, substitute, compare, jump, copy, read, write, etc. A *flow chart* is a more detailed representation than a *diagram*.

Force — To intervene manually in a routine and cause the computer to execute a jump instruction.

Format — A predetermined arrangement of characters, fields, lines, punctuation, page numbers, etc.

Four-Address — See Code, Multiple-Address.

Fragmenting — The breaking down of a document into a series of terms or descriptions.

Function — An association of a certain object from one set with each object from another set.

Function-Table — Two or more sets of information so arranged that an entry in one set selects one or more entries in the remaining sets; a dictionary; a device constructed of hardware, or a subroutine, which can either (a) decode multiple inputs into a single output or (b) encode a single input into multiple outputs; a tabulation of the values of a function for a set of values of the variable.

Functor — A logical element which performs a specific function or provides a linkage between variables.

Gang-Punch — To punch all or part of the information from one punched card onto succeeding cards.

Gap — Refers to magnetic tape. Record gap separates groups of data and is about ¾ inch long. Inter-record gap is this space before and after each record or group of data. End-of-file gap in some tape systems recognizes the last record of a file and is about 3¾ inches long.

Gate — A circuit which has the ability to produce an output which is dependent upon a specified type or the co-incidence nature of the input, e.g., an "and" gate has an output pulse when there is time coincidence at all inputs; an "or" gate has an output when any one or any combination of input pulses occur in time coincidence; any gate may contain a number of "inhibits," in which there is no output under any condition of input if there is time coincidence of an inhibit or except signal.

Generalized Routine — A routine designed to process a large range of specific jobs within a given type of application.

Generate — To produce a needed subroutine from parameters and skeletal coding.

Generator — A program for a computer which generates the coding of a problem; a mechanical device which produces an electrical output.

Grid, Control — The electrode of a vacuum tube other than a diode upon which a signal voltage is impressed in order to control the plate current.

Gulp — A small group of bytes, similar to a word or instruction

Half-Adder — A circuit having two output points, S and C, and two input points, A and B, such that the output is related to the input according to the following table:

INPUT		OUTPUT	
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

If A and B are arbitrary input pulses, and S and C are "sum without carry" and carry, respectively, it may be seen that two half-adders, properly connected, may be used for performing binary addition.

Half Adjust — To round by one half of the maximum value of the number base of the counter.

Hard Copy — A printed copy of machine output in a readable form for human beings, e.g., printed reports, listings, documents, summaries, etc.

Hardware — The mechanical, magnetic, electronic and electrical devices from which a computer is fabricated; the assembly of material forming a computer.

Hash Total — A summation for checking purposes of one field or of a combination of fields which are not normally related.

Head — A device which reads, records or erases information in a storage medium, usually a small electromagnet used to read, write or erase information on a magnetic drum or tape or the set of perforating or reading fingers and block assembly for punching or reading holes in paper tape.

Header Record or Header Table — A record containing common, constant or identifying information for a group of records which follow.

Heuristic — An approach which encourages further experimentation and investigation. An intuitive trial-and-error method of attacking a problem (as opposed to the algorithmic method).

Hierarchy — A specified rank or order of items. A series of items classified by rank or order.

Hold — The function of retaining information in one storage device after transferring it to another device; in contrast to clear.

Home Record — The first record in a chain of records used with the chaining method of file organization.

Housekeeping — Operations in a routine which do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

Hunting — A continuous attempt on the part of an automatically controlled system to seek a desired equilibrium condition. The system usually contains a standard, a method of determining deviation from standard and a method of influencing the system such that the difference between the standard and the state of the system is brought to zero. See Servomechanism.

Identification — A code number or code name which uniquely identifies a record, block, file or other unit of information.

Ignore — A typewriter character indicating that no action whatsoever be taken. (In Teletype or Flexowriter code, all holes punched is an ignore); an instruction requiring non-performance of what normally might be executed; not to be executed.

Illegal Character — A character or combination of bits which is not accepted as a valid representation by the machine or by a specific routine.

Image — An exact logical duplicate stored in a different medium.

Impedance, Characteristic — The ratio of voltage to current at every point along a transmission line on which there are no standing waves; the square root of the product of the open and short circuit impedance of the line.

Inclusive Or — The Boolean operator which gives a truth table value of true if either or both of the two variables it connects is true. If neither is true, the value is false.

Inclusive-Or-Operator — See Or-Operator. P or Q is True if P or Q or both are True; when the term OR is used alone, as in OR-gate, the Inclusive-OR is usually implied; buffer.

Index Register — A register which contains a quantity to be used under direction of the control section of the computer hardware, e.g., for address modification and counting.

Indexing — A technique of address modification often implemented by means of index registers.

Indirect Addressing — Any level of addressing other than the first — level of direct addressing.

Information — An aggregation of data.

Initialize — To set certain counters, switches and addresses at specified times in a computer routine.

Input — The information which is transferred from external storage into the internal storage; a modifier designating the device performing this function.

Input/Output Channel — A device which allows independent, simultaneous communication between any Memory Module and any of the several input-output units. It controls any peripheral device and performs all validity checking on information transfers.

Inquiry — A request for information from storage, e.g., a request for the number of available airline seats or a machine statement to initiate a search of library documents.

Inquiry Station — The device from which any inquiry is made.

Instruction — A set of characters which defines an operation together with one or more addresses (or no address) and which, as a unit, causes the computer to operate accordingly on the indicated quantities. The term "instruction" is preferable to the terms "command" and "order"; command is reserved for electronic signals; order is reserved for "the order of the characters" (implying sequence) or "the order of the interpolation," etc.

Instruction, Breakpoint — An instruction which, if some specified switch is set, will cause the computer to stop.

Instruction, Breakpoint, Conditional — A conditional jump instruction which, if some specified switch is set, will cause the computer to stop, after which either the routine may be continued as coded or a jump may be forced.

Instruction Code — The assigned list of symbols for instructions for a given computer or computing system.

Instruction Counter — A counter which contains the address of the current machine instruction or the next machine instruction.

Instruction, Multiple-Address — See Code, Multiple-Address.

Instruction, One-Address — An instruction consisting of an operation and exactly one address. The instruction code of a single-address computer may include both zero- and multi-address instructions as special cases.

Instruction, One-Plus-One or Three-Plus-One Address — A two- or four-address instruction, respectively, in which one of the addresses always specifies the location of the next instruction to be performed.

Instruction Register — A storage device which contains the instruction being executed.

Instruction, Transfer — A computer operational step in which a signal or set of signals specifies the location of the next operation to be performed and directs the computer to that operation (or instruction).

Instruction, Two, Three or Four Address — An instruction consisting of an operation and 2, 3, or 4 addresses, respectively.

Instruction, Zero-Address — An instruction specifying an operation in which the locations of the operands are defined by the computer code, so that no address need be given explicitly.

Instructional Constant — A constant written in the form of an instruction but not intended to be executed as an instruction. One form of dummy instruction.

Integrated Data Processing — (1) Information processing which is organized, directed and carried out according to a systems approach. (2) Complete machine control of a sphere of interest.

Integrator — A device whose output is proportional to the integral with respect to the input variable.

Interface — A common boundary, e.g., the boundary between two systems or two devices.

Interfix — A technique which allows the relationships of keywords in an item or document to be described so that very specific inquiries can be answered without false retrievals due to crosstalk.

Interlace — To assign successive storage locations to physically separated storage positions, e.g., on a magnetic drum or tape, usually for the express purpose of reducing access time.

Interleave — To insert segments of one program into another program such that the two programs can be in essence executed simultaneously, e.g., a technique used in multiprogramming.

Interlock — To prevent a machine or device from initiating further operations until the operation in process is completed.

Internal Storage — Storage within the computer from which instructions can be executed directly.

Interpreter — An interpretive routine.

Interpretive Routine — A routine which decodes instructions written as pseudo-codes and immediately executes those instructions as contrasted with a compiler which decodes the pseudo-codes and produces a machine language routine to be executed at a later time.

Interrupt — A signal generated by an input-output device, by an operational error, or by a request by the Processor for more data or program segments. Provides the Master Control Program with the facility to maintain control of all system functions.

Inverted File — A method of file organization in which a keyword identifies a record, and all item numbers or documents described by that keyword are indicated.

Item — A set of one or more fields containing related information; a unit of correlated information relating to a single person or object; the contents of a single message.

Iterate — To repeatedly execute a loop or series of steps, e.g., a loop in a routine.

Jargon — The technical vocabulary of a special trade group or scientific group.

Jump — An instruction or signal which, conditionally or unconditionally, specifies the location of the next instruction and directs the computer to that instruction. A jump is used to alter the normal sequence control of the computer. Under certain special conditions, a jump may be forced by manual intervention, in other words a transfer of control is made to a specified instruction.

Jump, Conditional — An instruction which will cause the proper one of two (or more) addresses to be used in obtaining the next instruction, depending upon some property of one or more numerical expressions or other conditions.

Key — A group of characters usually forming a field, utilized in the identification or location of an item; a marked lever manually operated for copying a character, e.g., typewriter, paper tape perforator, card punch manual keyboard, digitizer or manual word generator.

Keywords — The most informative words in a title or document which describe the content of that document; the significant words.

Label — A code name which classifies or identifies a name, term, phrase or document.

Lag — A relative measure of the time delay between two events, states, or mechanisms.

Language — (1) A defined set of characters which are used to form symbols, words, etc., and the rules for combining these symbols, words, etc., for meaningful communication, e.g., English, French, Algol, Fortran, COBOL, etc. (2) A combination of a vocabulary and rules of syntax.

Language, Machine — Information recorded in a form which may be made available to a computer, e.g., punched paper tape may contain information available to a machine, whereas the same information in the form of printed characters on a page is not available to a machine; information which can be sensed by a machine.

Language Translation — The translation of information from one language to another.

Latency — In a serial storage system, the access time less the word time, e.g., the time spent waiting for the desired location to appear under the drum heads or at the end of an acoustic tank.

Library, Routine — An ordered set or collection of standard and proven routines and subroutines by which problems and parts of problems may be solved, usually stored in relative or symbolic coding. (A library may be subdivided into various *volumes*, such as floating decimal, double-precision, or complex, according to the type of arithmetic employed by the subroutines.)

Limited — A word often attached to another word or term to indicate the particular machine activity which needs the most time, e.g., tape-limited, input-limited, compute-limited, etc.

Line, Delay — A device capable of causing an energy impulse to be retarded in time from point to point, thus providing a means of storage by circulating intelligence bearing-pulse configurations and patterns. Examples of delay lines are material media such as mercury, in which sonic patterns may be propagated in time; lumped constant electrical lines; co-axial cables, transmission lines and recirculating magnetic drum loops.

Line-Printing — Printing an entire line of characters across a page as the paper feeds in one direction past a type bar or cylinder bearing all characters on a single element.

Line Transmission — Any conductor or systems of conductors used to carry electrical energy from its source to a load.

Linkage — A technique for providing interconnections between a main routine and a closed routine, i.e., entry and exit for a closed routine from the main routine.

List — A series of items which may be referred to as one item.

Literal — A symbol which names itself and not the name of something else.

Load — To fill internal storage of a computer with information from auxiliary or external storage.

Location — A unit storage position in the main internal storage, storing one computer word; a storage register.

Location, Storage — A storage position holding one computer word, usually designated by a specific address or a specific register.

Logarithm — The logarithm of a number is the exponent indicating the power to which it is necessary to raise the given number, called the base, to produce the original number.

Logger — A device which automatically records physical processes and events, usually with respect to time.

Logic — The science that deals with the canons and criteria of validity in thought and demonstration; the science of the formal principles of reasoning; the basic principles and applications of truth tables, gating, interconnection, etc., required for arithmetical computation in a computer.

Logic, Symbolic — Exact reasoning about relations using symbols that are efficient in calculation. A branch of this subject known as Boolean algebra has been of considerable assistance in the logical design of computing circuits.

Logical — See Operation, Logical.

Loop — The repetition of a group of instructions in a routine.

Loop, Closed — Repetition of a group of instructions indefinitely.

Loop Storage — Several computer systems use open loops of magnetic tape with read-write heads as basis of additional storage. The tape loops are read forward and backward.

Machine Code — The absolute numbers, names, or symbols assigned by the machine designer to any part of the machine.

Machine Language — The coded operations that control information and addresses employed within the Processor to express a program. See Problem Language.

Machine Operator — The person who manually controls a machine.

Macro Instruction — A machine-like source language statement which can produce a variable number of machine instructions.

Macroprogramming — The process of writing machine procedure statements in terms of macro instructions.

Magnetic Core — See Core Storage. Tiny rings of ferromagnetic material which can be energized, polarity changed, to give the on-off or 0-1 patterns of storage in present day computers. Joined in planes stacked in array to make compact storage.

Magnetic Disk — Thin metal disks about 2 feet in diameter used to store data. Coated on both sides with a ferrous oxide recording material. See Access, Random Access, Disk Storage.

Magnetic Drum — See Drum, Magnetic.

Main Frame — The main part of the computer, i.e., the arithmetic or logic unit; the central processing unit.

Malfunction — A failure in the operation of the hardware of a computer.

Mantissa — The fractional part of a logarithm, e.g., in the logarithm 2.5, 2 is the characteristic and 5 is the mantissa.

Mapping — (1) A transformation from one set to another set. (2) A correspondence.

Mask — (N) A fixed word pattern of bits or characters used for the purpose of selecting or eliminating parts of other words. (V) To extract a selected group of characters from a string of characters.

Master Control Program — A computer program to control the operation of the system. It is designed to reduce the amount of intervention required of the human operator. The Master Control Program performs the following functions: schedules programs to be processed; initiates segments of programs; controls all input-output operations to insure efficient utilization of each system component; allocates memory dynamically; issues instructions to the human operator and verifies that his actions were correct; performs corrective action on errors in a program or system malfunction.

Master File — A main reference file of information.

Matrix — In mathematics, an array of quantities in a prescribed form, usually capable of being subject to a mathematical operation by means of an operator or another matrix according to prescribed rules; an array of circuit elements, e.g., diodes, wires, magnetic cores, relays, etc., which are capable of performing a specific function, e.g., conversion from one numerical system to another.

Mechanical Translation — A generic term for language translation by computers or similar equipment.

Memory — The term "storage" is preferred.

Merge — To produce a single sequence of items, ordered according to some rule (i.e., arranged in some orderly sequence), from two or more sequences previously ordered according to the same rule, without changing the items in size, structure, or total number. Merging is a special case of collation.

Message — A group of words, variable in length, transported as a unit; a transported item of information.

MICR — For Magnetic Ink Character Recognition. A standardized procedure base developed by the American Banking Association and various manufacturers to expedite bank document processing. Magnetic ink characters are encoded on checks in advance for prequalifying information. Also, after the check is written, magnetic characters are encoded with control and amount. Recognition is by special scanners which read across the magnetic, or ferrite sensitive numbers.

Microprogramming — Machine language coding in which the coder builds his own machine instructions from the primitive basic instructions built into the hardware.

Microsecond — A millionth part of a second.

Millisecond — A thousandth part of a second.

Mistake — A human blunder which results in an incorrect instruction in a program or in coding, an incorrect element of information, or an incorrect manual operation.

Mnemonic — Assisting, or intended to assist, memory; of or pertaining to memory; mnemonics is the art of improving the efficiency of the memory (in computers, storage).

Mode — (1) A method of operation, e.g., the binary mode, interpretive mode. (2) The most frequent value in the statistical sense.

Modifier — A quantity used to alter the address of an operand, e.g., the cycle index.

Modify — To alter in an instruction the address of the operand; to alter a subroutine according to a defined parameter.

Modularity — The property of a system resulting from the construction or assembly of the system from logical sub-units (modules).

Module — A logical sub-unit that may be easily detached from, or included with, the whole system.

Monitor — To control the operation of several unrelated routines and machine runs so that the computer and computer time are used advantageously.

Multi-Processing — Processing several programs or program segments concurrently on a "time-share" basis. See also, Parallel Operation.

Multivibrator — A type of relaxation oscillator used for the generation of non-sinusoidal waves in which the output of each of its two tubes is coupled to the input of the other to sustain oscillations.

Multivibrator, Astable — A free running type of relaxation oscillator used for the generation of non-sinusoidal waves.

Multivibrator, Monostable — A type of relaxation oscillator used to sustain a trigger pulse for a specified time, since the device assumes another state for a specified length of time at the end of which it returns to its original state, after being pulsed or forced into another state.

Nanosecond — One-billionth of a second.

Nesting — Including a routine or block of data within a larger routine or block of data.

Noise — Meaningless extra bits or words which must be ignored or removed from the data at the time the data is used.

Noisy Mode — A floating point arithmetic procedure associated with normalization in which digits other than zero are introduced in the low order positions during the left shift.

Normalize — To adjust the exponent and mantissa of a floating-point result so that the mantissa lies in the prescribed standard (normal) range; standardize.

Notation — See Number-System.

Notation, Biquinary — A two-part representation of a decimal digit consisting of a binary portion with values of 0 or 5 and a quinary portion with values 0 to 4, e.g., the number 7 is coded as 12 which implies 5 + 2.

Notation, Coded-Decimal — Decimal notation in which the individual decimal digits are represented by some code.

Notation, Mathematical — General definition of several compilers developed to simplify computer instruction.

Notation, Polish — A method of writing logical and arithmetic expressions without the need for parentheses, originated by the Polish logician, J. Lukasiewicz. For example: Normal algebraic notation (X + Y) x (A — B), in Polish Notation: XY+AB—x.

Null — A lack of information (as contrasted with zero or blank for the presence of no information).

Number, Binary — A numerical value written in the base-two system of notation.

Number, Operation — A number indicating the position of an operation or its equivalent subroutine in the sequence forming a problem routine. When a problem is stated in pseudo-code each step is sometimes assigned an operation number.

Number, Random — A set of digits constructed of such a sequence that each successive digit is equally likely to be any of n digits to the base n of the number.

Number-System — Numerical notation; positional notation; a systematic method for representing numerical quantities in which any quantity is represented approximately by the factors needed to equate it to a sum of multiples of powers of some chosen base.
Other notations of number systems are: decimal, binary, ternary, quotenary, quimary, octal or octonary, duodecimal, sexodecimal or hexadecimal, duotricenary, etc.

Number Systems — The representation of a quantity by a positional value to a given number base, e.g., binary system for base 2, octal system for base 8, decimal for base 10, hexadecimal for base 16, etc.

Numerical Control — That field of computer activity which centers around the direction of mechanical devices, e.g., a computer can control certain assembly line tools for machining.

Object Program — A set of machine-language instructions for the solution of a specified problem, obtained as the end result of the compilation process.

Octal — Pertaining to the number base of eight, e.g., in octal notation, octal 214 is 2 times 64 plus 1 times 8 plus 4 times 1 equals decimal 140; octal 214 is binary 010, 001, 100.

Off-Line — Refers to operations of input and output handled aside from the main computer. Examples of off-line operations: card to magnetic tape; magnetic tape to card; magnetic tape to printer, etc. Off-line operations are performed to realize better production or balance in the computer system. See On-Line Operation.

One-Address — Single address; a system of machine instruction such that each complete instruction explicitly describes one operation and one storage location.

On-Line Operation — A type of system application in which the input data to the system is fed directly from the measuring devices and the computer results obtained during the progress of the event, e.g., a computer receives data from wind tunnel measurements during a run, and the computations of dependent variables are performed during the run enabling a change in the conditions so as to produce particularly desirable results.

Open Shop — A computing installation at which computer programming, coding and operating can be performed by any qualified company employee.

Operand — Any one of the quantities entering or arising in an operation. An operand may be an argument, a result, a parameter, or an indication of the location of the next instruction. An operand is typically a number for arithmetic operations. For comparison operations, an operand may be an alphanumeric field. Also, part of a computer instruction that designates the address (location) or device involved in the instruction.

Operation — A defined action; the action specified by a single computer instruction or pseudo-instruction; an arithmetical, logical, or transferal unit of a problem, usually executed under the direction of a subroutine.

Operation, Arithmetical — An operation in which numerical quantities form the elements of the calculation (e.g., addition, subtraction, multiplication, division).

Operation, Average-Calculating — A common or typical calculating operation longer than an addition and shorter than a multiplication; often taken as the mean of nine addition and one multiplication time.

Operation Code — A combination of bits specifying an absolute machine language operator.

Operation, Complete — An operation which includes (a) obtaining all operands from storage, (b) performing the operation (c) returning resulting operands to storage, and (d) obtaining the next instruction.

Operation, Computer — The electronic action of hardware resulting from an instruction; in general, computer manipulation required to secure computed results.

Operation, Fixed-Cycle — A type of computer performance whereby a fixed amount of time is allocated to an operation; synchronous or clocked type arrangement within a computer in which events occur as a function of measured time.

Operation, Logical — An operation in which logical (yes-or-no) quantities form the elements being operated on (e.g., comparison, extraction). A usual requirement is that the value appearing in a given column of the result shall not depend on the values appearing in more than one given column of each of the arguments.

Operation, Real-Time, On-Line, Simulated — The processing of data in synchronism with a physical process in such a fashion that the results of the data processing are useful to the physical operation.

Operation, Red-Tape — An operation which does not directly contribute to the result; i.e., arithmetical, logical, and transfer operations used in modifying the address section of other instructions in counting cycles, in rearranging data, etc.

Operation, Serial — The flow of information through a computer in time sequence, using only one digit, word, line or channel at a time. Contrasted with parallel operation.

Operation, Transfer — An operation which moves information from one storage location or one storage medium to another (e.g., read, record, copy, transmit, exchange). *Transfer* is sometimes taken to refer specifically to movement between different media; *storage* to movement within the same medium.

Operation, Variable Cycle — Computer action in which any cycle of action or operation may be of different lengths. This kind of action takes place in an asychronous computer.

Operator — The person who actually manipulates the computer controls, places information media into the input devices, removes the output, presses the start button, etc.; a mathematical symbol which represents a mathematical process to be performed on an associated function.

Optimize — To arrange the instructions or data in storage so that a minimum amount of machine time is spent for access when an instruction or data is called out.

Or-Circuit — An electrical or mechanical device which will yield an output signal whenever there are one or more inputs on a multichannel input, e.g., an OR gate is one in which a pulse output occurs whenever one or more inputs are pulsed; forward merging of pulses simultaneously providing reverse isolation.

Order — A defined successive arrangement of elements or events. The word order is losing favor as a synonym for instruction, command or operation part due to ambiguity.

Origin — (1) The absolute storage address of the beginning of a program or block. (2) In relative coding, the absolute storage address to which addresses in a region are referenced.

Or-Operator — A logical operator which has the property such that if P or Q are two statements, then the statement "P or Q" is true or false precisely according to the following table of possible combinations:

P	Q	P or Q
False	True	True
True	False	True
True	True	True
False	False	False

Oscillations, Free — Oscillating currents which continue to flow in a tuned circuit after the impressed voltage has been removed. Their frequency is the resonant frequency of the circuit.

Output — Information transferred from the internal storage of a computer to secondary or external storage; information transferred to any device exterior to the computer.

Output-Block — A portion of the internal storage reserved primarily for receiving, processing and transmitting data which is to be transferred out.

Overflow — In an arithmetic operation, the generation of a quantity beyond the capacity of the register or location which is to receive the result; over capacity; the information contained in an item of information which is in excess of a given amount.

Overlay — The technique of repeatedly using the same blocks of internal storage during different stages of a problem, e.g., when one routine is no longer needed in internal storage, another routine can replace all or part of that storage.

Pack — To include several brief or minor items of information into one machine item or word by utilizing different sets of digits for the specification of each brief or minor item.

Padding — A technique used to fill out a block of information with dummy records, words or characters.

Parallel — Handled simultaneously in separate facilities; operating on two or more parts of a word or item simultaneously; contrasted with serial.

Parallel Operation — Flow of data through the system or any part of it, using two or more communication lines or channels simultaneously.

Parameter — In a subroutine, a quantity which may be given different values when the subroutine is used in different main routines or in different parts of one main routine, but which usually remains unchanged throughout any one such use; in a generator, a quantity used to specify input-output devices, to designate subroutines to be included, or otherwise to describe the desired routine to be generated. A quantity to which arbitrary values may be assigned.

Parameter, Preset — A parameter incorporated into a subroutine during input.

Parameter, Program — A parameter incorporated into a subroutine during computation. A program parameter frequently comprises a word stored relative to either the subroutine or the entry point and dealt with by the subroutine during each reference. It may be altered by the routine and/or may vary from one point of entry to another.

Parity or Parity Check — A check within the computer system of accuracy of each character. Also applied to magnetic tape. Can be either even 1 bit check or odd 1 bit check codes. See Check Bit.

Partitioning — Subdividing one large block into smaller subunits which can be handled more conveniently, e.g., partitioning a matrix.

Patch — Section of coding inserted into a routine to correct a mistake or alter the routine; explicitly transferring control from a routine to a section of coding and back again.

Pentode — A five-electrode vacuum tube containing a cathode, control grid, suppressor grid, screen grid, and plate.

Perforation, Rate of — Number of characters, rows or words punched in a paper tape by a device per unit of time.

Peripheral Equipment — Any of the several devices, primarily used to communicate with a system, not considered a part of the main processing and control system, e.g., the peripheral equipment includes Magnetic Tape Units, Line Printers, Card Readers, Card Punches, Keyboard, Message Printer, and Plotter.

Permutation — Any of the total number of changes in position or form that are possible in a group.

Phosphorescence — The property of emitting light for some time after excitation.

Piezoelectric — The effect of producing a voltage by placing a stress, either by compression, by expansion, or by twisting, on a crystal; and, conversely, the effect of producing a stress in a crystal by applying a voltage to it.

Plotting-Board — A unit capable of graphically presenting information, usually as curves of one or more variables; analogue curve or point tracer.

Plug-Board — A removable panel containing an ordered array of terminals which may be interconnected by short electrical leads according to a prescribed pattern and hence designating a specific program. The entire panel, pre-wired, may be inserted for different programs.

Point — The dot that marks the separation between the integral and fractional parts of a quantity; i.e., between the coefficients of the zero and the minus one powers of the number base. It is usually called, for a number system using base two, a *binary point;* for base ten, a *decimal point,* etc.; base point; radix.

Post Edit — To edit the results of a previous computation.

Post Mortem — A routine which, either automatically or on demand, prints information concerning the contents of the registers and storage locations at the time the routine stopped, in order to assist in the location of a mistake in coding.

Potentiometer — A variable voltage divider, a resistor which has a variable contact arm so that any portion of the potential applied between its ends may be selected.

Precision — The degree of exactness with which a quantity is stated; a relative term often based on the number of significant digits in a measurement. See also Accuracy.

Precision, Double — Retention of twice as many digits of a quantity as the computer normally handles, e.g., a computer whose basic word consists of 10 decimal digits is called upon to handle 20 decimal digit quantities by keeping track of the 10-place fragments.

Preselection — A programming technique in buffered computers in which a block of information is read into the input buffer register from the next input tape to be called upon.

Pre-Store — To set an initial value for the address of an operand or a cycle index; to restore; to store a quantity in an available or convenient location before it is required in a routine.

Primitive — A basic or fundamental unit, often referring to the lowest level of a machine instruction or lowest unit of language translation.

Priority — A value assigned to a program or program segment to specify the relative processing sequence. The Priorities of all programs to be run are taken into consideration by the Master Control Program in arriving at a schedule.

Problem Language — The language used by the programmer to state the definition of a problem. ALGOL and COBOL are examples of problem languages. Problem languages are closely related to the type of problem being stated, i.e., algebraic statements for mathematical problems (ALGOL) and narrative English statements for commercial problems (COBOL). Problem language should not be confused with machine language. A program is written in problem language by the programmer. This source program is then translated to the object program (in machine language) by a compiler program. (See Object Program, Compiler.)

Procedure — A precise step-by-step method for effecting a solution to a problem.

Procedure-Oriented Language — A source language oriented to the description of procedural steps in machine computing.

Process — A generic term which may include compute, assemble, compile, interpret, generate, etc.

Process Control — Pertaining to systems whose purpose is to provide automation of continuous operations. This is contrasted with numerical control which provides automation of discrete operations.

Processor — The program or equipment to process, e.g., a compiler, translator, generator, etc.

Program — A plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer and plans for the absorption of the results into the system. The list of coded instructions is called a *routine;* to plan a computation or process from the asking of a question to the delivery of the results, including the integration of the operation into an existing system. Thus programming consists of planning and coding, including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

Program Sensitive Malfunction — A malfunction which occurs only when some unusual combination of program steps occurs.

Programmer — A person who prepares instruction sequences without necessarily converting them into the detailed codes.

Programming, Automatic — Any technique in which the computer is used to help plan as well as to help code a problem; e.g., compiling routines, interpretive routines.

Programming, Optimum — Improper terminology for minimal latency coding, i.e., for producing a minimal latency routine.

Programming, Random Access — Programming without regard for the time required for access to the storage positions called for in the program; contrast with minimum access programming.

Property Sort — A technique for selecting records from a file which satisfy a certain criterion.

Pseudo-Code — An arbitrary code, independent of the hardware of a computer, which must be translated into computer code.

Pseudo-Random — Having the property of satisfying one or more of the standard criteria for statistical randomness but being produced by a definite calculation process.

Pulse — A change in the intensity or level of some medium usually over a relatively short period of time, e.g., a shift in electric potential of a point for a short period of time compared to the time period, i.e., if the voltage level of a point shifts from -10 to $+20$ volts with respect to ground for a period of 2 microseconds, one says that the point received a 30 volt 2 microsecond pulse.

Pulse-Code — Sets of pulses to which particular meanings have been assigned; the binary representations of characters.

Punch, Calculating, Electronic — A card handling machine which reads a punched card, performs a number of sequential operations and punches the result on a card.

Punch, Card — A device which perforates or places holes in cards in specific locations designated by a program.

Punch, Summary — A card handling machine which may be electrically connected to another machine, e.g., tabulator, and which will punch out on a card the information produced, calculated or summarized by the other machine.

Punch-Position — The location of the row in a columniated card, e.g., in an 80-column card the rows or "punch position" may be 0 to 9 or "X" and "Y" corresponding to position 11 and 12.

Punching, Rate of — Number of cards, characters, blocks, fields or words of information placed in the form of holes distribution on cards, or tape per unit of time.

Pushdown List — A list of items where the last item entered is the first item of the list, and the relative position of the other items is pushed back one.

Pushup List — A list of items where each item is entered at the end of the list, and the other items maintain their same relative position in the list.

Quantity — A positive or negative real number in the mathematical sense. The term quantity is preferred to the term number in referring to numerical data; the term number is used in the sense of natural number and reserved for "the number of digits," the "number of operations," etc.

Quantity, Double-Precision — A quantity having twice as many digits as are normally carried in a specific computer.

Radix — A number which is made the fundamental number or base of any system of numbers.

Random Access — Access to storage under conditions in which the next position from which information is to be obtained is in no way dependent on the previous one.

Random Access Storage — (1) A storage in which the time required to obtain information is independent of the location of the information most recently obtained. (2) A type of storage in which access can be made directly to any storage location regardless of its absolute location, or its location relative to the previously referenced information.

Random Number Generator — A special machine routine or hardware designed to produce a random number or series of random numbers according to specified limitations.

Range — All the values which a function may have.

Rank — To arrange in an ascending or descending series according to importance.

Ratio, Operating — The ratio obtained by dividing the number of hours of correct machine operation by the total hours of scheduled operation, e.g., on a 168 hour week scheduled operation, if 12 hours of preventive maintenance are required and 4.8 hours of unscheduled down time occur, then the operating ratio is $(168 - 16.8)/168$, which is equivalent to a 90% operating ratio.

Raw Data — Data which has not been processed or reduced.

Read — To copy, usually from one form of storage to another, particularly from external or secondary storage to internal storage; to sense the meaning of arrangements of hardware; to sense the presence of information on a recording medium.

Read-Around-Ratio — In electrostatic storage tubes, the number of times a specific spot (digit or location) may be consulted before "spill over" will cause a loss of information stored in surrounding spots, immediately prior to which the surrounding information must be restored; read-around number.

Reader, Card — A mechanism that permits the sensing of information punched on cards by means of wire brushes or metal feelers.

Reader, Tape, Magnetic — A device capable of restoring to a train or sequence of electrical pulses, information recorded on a magnetic tape in the form of a series of magnetized spots, usually for the purpose of transferring the information to some other storage medium.

Reader, Tape, Paper — A device capable of restoring to a train or sequence of electrical pulses, information punched on a paper tape in the form of a series of holes, usually for the purpose of transferring the information to some other storage medium.

Reading, Rate of — Number of characters, words, fields, blocks or cards sensed by an input sensing device per unit of time.

Real Time — Describes computer operation that is simultaneous with an event, such as controlling and altering the trajectory of a missile in flight. The central computer immediately solves problems given it from widely scattered locations and delivers answers fast enough to control the operations containing the problems.

Record — A listing of information, usually in printed or printable form; one output of a compiler consisting of a list of the operations and their positions in the final specific routine and containing information describing the segmentation and storage allocation of the routine; to copy or set down information in reusable form for future reference to make a transcription of data by a systematic alteration of the condition, property or configuration of a physical medium, e.g., placing information on magnetic tape or a drum by means of magnetized spots.

Record Gap — A space between records on a tape, usually produced by tape acceleration or deceleration during the write status.

Recursion — The continued repetition of the same operation or group of operations.

Recursive — Having the ability to be repeated.

Redundancy Check — A check which uses extra bits.

Redundant — More than necessary; more than sufficient; excessive.

Regeneration — The process of returning a part of the output signal of an amplifier to its input circuit in such a manner that it reinforces the grid excitation and thereby increases the total amplification; periodic restoration of stored information.

Region — A group of machine addresses which refer to a base address.

Regional Address — An address of a machine instruction within a series of consecutive addresses, e.g., R18 and R19 are specific addresses in an —R— region of —N— consecutive addresses, where all addresses must be named.

Register — The hardware for storing one or more computer words. Registers are usually zero-access storage devices.

Register, Circulating or Memory — A register (or memory) consisting of a means for delaying information and a means for regenerating and reinserting the information into the delaying means.

Register, Control — The accumulator, register or storage unit which stores the current instruction governing a computer operation; an instruction register.

Register, Program — A register in the control unit which stores the current instruction of the program and controls computer operation during the execution of the instruction; control register; program counter.

Regulation, Voltage — A measure of the degree to which power source maintains its output-voltage stability under varying load conditions.

Relative Address — An address of a machine instruction which is referenced to an origin, e.g., R + 15 is a specific address relative to —R— where —R— is the origin, the other R + machine addresses do not need to be named.

Relative Coding — Coding using relative addresses.

Relocate — To modify the instructions of a routine in such a way that the routine can be moved to another location and then executed at that location, to modify the addresses relative to a fixed point or origin.

Repetition, Rate of Pulse — The number of electric pulses per unit of time experienced by a point in a computer, usually the maximum. normal, or standard rate of pulses.

Report Generation — A technique for producing complete machine reports from information which describes the input file and the format and content of the output report.

Report Generator — A special machine routine designed to prepare an object routine that, when later run on a computer, will produce the desired report.

Representative-Calculating-Time — A method of evaluating the speed performance of a computer. One method is to use one-tenth of the time required to perform nine complete additions and one complete multiplication. A complete addition or a complete multiplication time includes the time required to procure two operands from high speed storage, perform the operation, and store the result and the time required to select and execute the required number of instructions to do this.

Reproduce — To prepare a duplicate of stored information, especially for punched cards, punched paper tape or magnetic tape.

Rerun — To repeat all or part of a program on a computer.

Rerun-Point — That stage of a computer run at which all information pertinent to the running of the routine is available either to the routine itself or to a rerun routine in order that a run may be reconstituted.

Reset — To return a device to zero or to an initial or arbitrarily selected condition.

Resolver — A device which separates or breaks up a quantity, particularly a vector, into constituent parts or elements, e.g., to form the three mutually perpendicular components of a space vector.

Response, Frequency — A measure of the ability of a device to take into account, follow or act upon a rapidly varying condition, e.g., as applied to amplifiers, the frequency at which the gain has fallen to the one-half power point or to 0.707 of the voltage gain factor; as applied to a mechanical controller, the maximum rate at which changes in condition can be followed and acted upon.

Restart — To return to a previous point in a program and resume operation from that point.

Restore — To return a cycle index, a variable address, or other computer word to its initial or preselected value; periodic regeneration of charge, especially in volatile, condenser-action storage systems.

Retrieve — To find and select specific information.

Return — To go back to a specific, planned point in a program, usually when an error is detected, for the purpose of rerunning the program. Rerun points are usually three to five minutes apart to avoid long periods of lost computer time. Information pertinent to a rerun is available in standby registers from point to point.

Rewind — To return a film or magnetic tape to its beginning.

Rollback — Equivalent to rerun when referring to tape-sequenced computers; to recapture tape-inscribed data.

Role Indicator — A code assigned to a keyword to indicate the role of that keyword, e.g., a keyword is coded as a noun, verb, adjective, etc.

Roll-out — To read a register or counter by adding ones to the respective digits simultaneously obtaining a signal as each column returns to zero, until all columns have returned to zero, usually requiring n additions, where n is the number base.

Round — To adjust the least significant digits retained in truncation to partially reflect the dropped portion, e.g., when rounded to three digits, the decimal number 2.7561 becomes 2.76.

Round-Off — To change a more precise quantity to a less precise one, according to some rule.

Rounding Error — The error resulting from dropping the less significant digits of a number, and adjusting the most significant digits.

Routine — A set of coded instructions arranged in proper sequence to direct the computer to perform a desired operation or series of operations.

Routine, Compiling — An executive routine which, *before* the desired computation is started, translates a program expressed in pseudo-code into machine code (or into another pseudo-code for further translation by an interpreter). In accomplishing the translation, the compiler is required to decode, convert, select, generate, allocate, adapt, orient, incorporate, or record.

Routine, Diagnostic — A specific routine designed to locate either a malfunction in the computer or a mistake in coding.

Routine, Executive — A set of coded instructions designed to process and control other sets of coded instructions; a set of coded instructions used in realizing "automatic coding"; a master set of coded instructions.

Routine, Floating-Point — A set of coded instructions arranged in proper sequence to direct the computer to perform a specific set of operations which will permit floating-point operation, e.g., enable the use of a fixed-point machine to handle information on a floating-point basis from an external point of view. Floating-point routines are usually used in computers which do not have built-in floating-point circuitry, in which case floating-point operation must be programmed.

Routine, General — A routine expressed in computer coding designed to solve a class of problems, specializing to a specific problem when appropriate parametric values are supplied.

Routine, Interpretive — An executive routine which, as the computation progresses, translates a stored program expressed in some machine-like pseudo-code into machine code and performs the indicated operations, by means of subroutines as they are translated. An interpretive routine is essentially a closed subroutine which operates successively on an indefinitely-long sequence of program parameters (the pseudo-instructions and operands). It may usually be entered as a closed subroutine and exited by a pseudo-code exit instruction.

Routine, Minimal Latency — Especially in reference to serial storage systems, a routine so coded, by judicious arrangement of data and instructions in storage, that the actual latency is appreciably less than the expected random-access latency.

Routine, Rerun — A routine designed to be used in the wake of a computer malfunction or a coding or operating mistake to reconstitute a routine from the last previous rerun point; roll back routine.

Routine, Sequence Checking — A routine which checks every instruction executed, printing certain data, e.g., to print out the coded instruction with addresses, and the contents of each of several registers, or it may be designed to print out only selected data, such as transfer instructions and the quantity actually transferred.

Routine, Service — A routine designed to assist in the actual operation of the computer. Tape comparison, block location, certain post mortems, and correction routines fall in this class.

Routine, Specific — A routine expressed in computer coding designed to solve a particular mathematical, logical, or data-handling problem in which each address refers to explicitly stated registers and locations.

Routine, Test — A routine designed to show whether a computer is functioning properly or not.

Row Binary Card — A method of representing binary information of an 80-column card, arranging in serial across each row of card — left to right. Each punched hole represents a binary 1, and no punch represents a binary 0. 72 columns are used only, and twenty-four 36 bit words may be contained on a card. See Column Binary Card.

Run — One performance of a program on a computer; performance of one routine, or several routines automatically linked so that they form an operating unit, during which manual manipulations are not required of the computer operator.

Scale — To alter the units in which all variables are expressed so as to bring all magnitudes within the capacity of the computer or routine at hand.

Scale Factor — A value used to change a quantity from one notation to another.

Scaling — The process of changing a quantity from one notation to another.

Scan — To examine stored information for a specific purpose, i.e., for content, arrangement, etc.

Scanner — An instrument which automatically samples or interrogates the state of various processes, conditions, or physical states and initiates action in accordance with the information obtained.

Scanning, Mark — Scanning of a card or form for a specific mark in a specific location. Mark can be with any pen or pencil. Mark sensing relies on special pencil marks in fixed locations, but is somewhat similar.

Scanning, MICR — Reading by machines of magnetic ink characters developed by American Bankers Association for uniformity. Several scanning means exist.

Scanning, Optical — Machine reading and pick up of figures on cards or paper documents; requires fixed locations and fixed type size.

Search — To scan all available stored information.

Seek — Specifically applied to obtaining records in a random access file.

Segment — To divide a routine in parts each consisting of an integral number of subroutines, each part capable of being completely stored in the internal storage and containing the necessary instructions to jump to other segments; in a routine too long to fit into internal storage, a part short enough to be stored entirely in the internal storage and containing the coding necessary to call in and jump automatically to other segments. Routines which exceed internal storage capacity may be automatically divided into segments by a compiler.

Select — To take the alternative A if the report on a condition is of one state, and alternative B if the report on the condition is of another state; to choose a needed subroutine from a file of subroutines.

Selector — A device which interrogates a condition and initiates a particular operation according to the interrogation report.

Sense — To examine, particularly relative to a criterion; to determine the present arrangement of some element of hardware, especially a manually-set switch; to read holes punched in paper.

Sentinel — A symbol marking the beginning or the end of some element of information such as a field, item, block, tape, etc.; a tag.

Sequence, Pseudo-Random — An order of numbers produced by a definite recursive rule but satisfying one or more of the standard tests for randomness.

Sequencer — A machine which puts items of information into a particular order, e.g., it will determine whether A is greater than, equal to, or less than B, and sort or order accordingly.

Sequencing — Ordering in a series or according to rank or time.

Serial — Handle one after the other in a single facility, such as transfer or store in a digit by digit time sequence.

Serial Transfer — A transfer of data in which elements are transferred in succession over a single line.

Servomechanism — A closed loop system in which the error or deviation from a desired or pre-set norm is reduced to zero, and one in which mechanical position is usually the controlled variable, e.g., a synchronized drum storage system requires a servomechanism to insure synchronism between a crystal controlled electronic oscillator and a rotating cylinder; an AA fire control gun-positioning system requires a servo to insure that deviations are corrected.

Set — A group, a number of particular things, a collection of elements.

Set Name — An identifier.

Set Theory — The study of the use and application of groups or sets.

Shift — To move the characters of a unit of information columnwise right or left. For a number, this is equivalent to multiplying or dividing by a power of the base of notation.

Shift, Arithmetic — To multiply or divide a quantity by a power of the number base, e.g., binary 1011 represents decimal 11, therefore two arithmetic shifts to the left is binary 101100, which represents decimal 44.

Shift, Cyclic — A shift in which the digits dropped off at one end of a word are returned at the other in a circular fashion; logical, non-arithmetical or circular shift.

Significance — The arbitrary rank, priority, or order of relative magnitude assigned to a given position or column in a number; the significant digits of a number are a set of digits, usually from consecutive columns beginning with the most significant digit different from zero and ending with the least significant digit whose value is known or assumed relevant, e.g., 2300.0 has five significant digits, whereas 2300 probably has two significant digits.

Simulation — The representation of physical systems and phenomena by computers, models or other equipment.

Simulator — (1) A program or routine corresponding to a mathematical model or representing a physical model. (2) A routine which runs on one computer and imitates the operations of another.

Simultaneity — Concurrent communication between various units of a system at the same instant.

Skeletal Coding — The framework of a routine which is completed by a generalized routine using input parameters.

Skip — An instruction to proceed to the next instruction; a "blank" instruction.

Snap, Snapshot — Dynamic printouts during computing (at breakpoints and checkpoints) of selected items in storage (as contrasted with one static printout for a dump).

Solid State, Components — Transistors and semi-conductor diodes which replaced vacuum tubes in switching functions of computers; results are smaller units and more reliability. Magnetic core storage also is part of the solid state componentry.

Solid-State Computer — A computer using semiconductor devices.

Solver, Equation — A calculating device, usually analog, which arrives at the solution to systems of linear simultaneous non-differential equations or determines the roots of polynomials or both.

Sort — To arrange items of information according to rules dependent upon a key or field contained in the items.

Source Language — The language used to prepare a problem as input for computer operations.

Special Character — A character other than a digit or letter, e.g., * + — $ =, etc.

Spool — (1) The mounting for a magnetic, paper, or plastic tape. (2) A tape reel.

Stacker, Card — A mechanism that accumulates cards in a bin after they have passed through a machine operation; a hopper.

Standard — (1) An accepted criterion or an established measure for performance, practice, design, terminology, size, etc. (2) A rule or test by which something is judged.

Standardize — To adjust the exponent and mantissa of a floating-point result so that the mantissa lies in the prescribed normal range; normalize. See Floating-Point.

Static Printout — A printout of data which is not part of the sequential operations and occurs after the machine run, as contrasted to a dynamic printout.

Stochastic — A term which refers to trial and error procedures as contrasted with the fixed step-by-step procedures of algorithms.

Storage — Preferred to memory, any device into which units of information can be copied, which will hold this information, and from which the information can be obtained at a later time; devices, such as plugboards, which hold information in the form of arrangements of physical elements, hardware, or equipment; the erasable storage in any given computer.

Storage Allocation — The process of assigning blocks of storage to specified units or blocks of information.

Storage, Buffer — A synchronizing element between two different forms of storage, usually between internal and external; an input device in which information is assembled from external or secondary storage and stored ready for transfer to internal storage; an output device into which information is copied from internal storage and held for transfer to secondary or external storage. Computation continues while transfers between buffer storage and secondary or internal storage or vice versa take place.

Storage, Circulating — A device using a delay line, or unit which stores information in a train or pattern of pulses, where the pattern of pulses issuing at the final end are sensed, amplified, reshaped and re-inserted in the delay line at the beginning end.

Storage Dump — A printout of the contents of all or part of a particular storage device.

Storage, Dynamic — Storage such that information at a certain position is moving in time and so is not always available instantly, e.g., acoustic delay line, magnetic drum; circulating or re-circulating of information in a medium.

Storage, Electrostatic — A device possessing the capability of storing changeable information in the form of charged or uncharged areas on the screen of a cathode ray tube.

Storage, Erasable — Media which may hold information that can be changed; i.e., the media can be re-used; e.g., magnetic tape, drum, or core.

Storage, External — Storage facilities divorced from the computer itself but holding information in the form prescribed for the computer; e.g., magnetic tapes, magnetic wire, punched cards, etc.

Storage, Internal — Storage facilities forming an integral physical part of the computer and directly controlled by the computer; the total storage automatically accessible to the computer.

Storage, Non-Erasable — Media used for containing information which cannot be erased and reused, such as punched paper tapes, and punched cards.

Storage, Magnetic — Any storage system which utilizes the magnetic properties of materials to store information.

Storage, Mercury — Columns of a liquid mercury medium used as a storage element by the delaying action or time of travel of sonic pulses which are circulated by having electrical amplifier, shaper, and timer circuits complete the loop.

Storage, Non-Volatile — Storage media which retain information in the absence of power and which may be made available upon restoration of power; e.g., magnetic tapes, drums, or cores.

Storage, Parallel — Storage in which all bits, or characters, or (especially) words are essentially equally available in space, without time being one of the coordinates. Parallel storage contrasts with serial storage. When words are in parallel, the storage is said to be *parallel by words;* when characters within words (or binary digits within words or characters) are dealt with simultaneously, not one after the other, the storage is *parallel by characters* (or *parallel by bit* respectively).

Storage, Secondary — Storage facilities not an integral part of the computer but directly connected to and controlled by the computer; e.g., magnetic drum, magnetic tapes, etc.

Storage, Serial — Storage in which time is one of the coordinates used to locate any given bit, character, or (especially) word. Storage in which words, within given groups of several words, appear one after the other in time sequence, and in which access time therefore includes a variable latency or waiting time of zero to many word-times, is said to be *serial by word.* Storage in which the individual bits comprising a word appear in time sequence is *serial by bit.* Storage for coded-decimal or other non-binary numbers in which the characters appear in time sequence is *serial by character;* e.g., magnetic drums are usually serial by word but may be serial by bit, or parallel by bit, or serial by character and parallel by bit, etc.

Storage, Static — Storage such that information is fixed in space and available at any time; e.g., flip-flop, electrostatic, or coincident-current magnetic-core storage.

Storage, Temporary — Internal storage locations reserved for intermediate and partial results.

Storage, Volatile — Storage media such that if the applied power is cut off, the stored information is lost; e.g., acoustic delay lines, electrostatic tubes.

Storage, Working — A portion of the internal storage reserved for the data upon which operations are being performed.

Storage, Zero-Access — Storage for which the latency (waiting time) is negligible at all times.

Store — (V) To transfer an element of information to a device from which the unaltered information can be obtained at a later time. (N) The British term for storage.

Subroutine — The set of instructions necessary to direct the computer to carry out a well defined mathematical or logical operation; a subunit of a routine. A subroutine is often written in relative or symbolic coding even when the routine to which it belongs is not.

Subroutine, Closed — A subroutine not stored in its proper place in the linear operational sequence, but stored away from the routine which refers to it. Such a subroutine is entered by a jump, and provision is made to return, i.e., to jump back to the proper point in the main routine at the end of the subroutine.

Subroutine, Dynamic — A subroutine which involves parameters, such as decimal point position or item size, from which a relatively coded subroutine is derived. The computer itself is expected to adjust or generate the subroutine according to the parameter values chosen.

Subroutine, Open — A subroutine inserted directly into the linear operational sequence, not entered by a jump. Such a subroutine must be recopied at each point that it is needed in a routine.

Subroutine, Static — A subroutine which involves no parameters other than the addresses of the operands.

Subscript — (1) A letter or symbol in typography written below a set-name to identify a particular element or elements of that set. (2) An indexing notation.

Subset — (1) A set contained within a set. (2) In communications, a subscriber set.

Substitute — To replace an element of information by some other element of information.

Superscript — A letter or symbol in typography written above a set-name to denote a power or a derivative, or to identify a particular element of that set.

Supervisor — An executive, e.g., a supervisor routine is an executive routine.

Switch, Electronic — A circuit which causes a start-and-stop action or a switching action by electronic means.

Switch, Function — A circuit having a fixed number of inputs and outputs designed such that the output information is a function of the input information, each expressed in a certain code or signal configuration or pattern.

Symbol, Logical — A symbol used to represent a logical element graphically.

Symbolic Coding — Coding in which the instructions are written in non-machine language, i.e., coding using symbolic notation for operators and operands.

Syntax — The orderly arrangement usually associated with sentence structure.

Synthesis — The combination of parts to form a whole.

Synthetic Language — A pseudo-code or symbolic language; a fabricated language.

System — An assembly of components united by some form of regulated interaction; an organized whole.

Systems Analysis — The analysis of a business activity to determine precisely what must be accomplished and how to accomplish it.

Table Lookup — The process of using a known value (the argument) to locate the unknown value (the function) in a list or table.

Tabulator — A machine which reads information from one medium, e.g., cards, paper tape, magnetic tape, etc., and produces lists, tables, and totals on separate forms or continuous paper.

Tag — A unit of information, whose composition differs from that of other members of the set so that it can be used as a marker or label; a sentinel.

Tank — A unit of acoustic delay line storage, containing a set of channels each forming a separate recirculation path; a circuit consisting of inductance and capacitance used for the purpose of sustaining electrical oscillations.

Tape, Magnetic — A tape or ribbon of any material impregnated or coated with magnetic material on which information may be placed in the form of magnetically polarized spots.

Tape, Program — A tape which contains the sequence of instructions required for solving a problem and which may be read by the computer.

Tape to Card — Pertaining to equipment or methods which transfer information directly from tape to cards, usually off line.

Ternary — Pertaining to the system of notation utilizing the base of 3, employing the characters 0, 1, and 2.

Test, Crippled-Leapfrog — A variation of the leapfrog test, modified so that it repeats its tests from a single set of storage locations rather than a changing set of locations.

Test, Leapfrog — A program designed to discover computer malfunction, characterized by the property that it performs a series of arithmetical or logical operations on one group of storage locations, transfers itself to another group of storage locations, checks the correctness of the transfer, then begins the series of operations over again. Eventually, all storage positions will have been occupied and the test will be repeated.

Tetrad — A group of four, usually four pulses; in particular, a group of four pulses used to express a decimal digit, or a sexadecimal digit by means of four (binary) pulses.

Tetrode — A four-electrode vacuum tube containing a cathode, control grid, screen grid, and plate.

Thermistor — The thermistor is a solid state, semiconducting device made by sintering mixtures of the oxide powders of various metals. It is made in many shapes, such as beads, disks, flakes, washers, and rods, to which contact wires are attached. As its temperature is changed, the electrical resistance of the thermistor varies. The associated temperature coefficient of resistance is extremely high, nonlinear, and negative.

Thermocouple — A device made up of two bi-metal joints (usually wires forming a closed loop) having the property that if the two junctions are maintained at different temperatures, a difference of potential is brought into existence equally distributed between the two junctions.

Thin Film — A ferro-magnetic film (a few millionths of an inch thick) made by depositing vapors of iron, nickel, cobalt, or other ferro-magnetic metals or their alloys, on a sub-strate such as thin glass plate. The film has very unusual properties when deposition is made under controlled conditions. If a magnetic field is applied parallel to the surface of the sub-strate during deposition, the thin film then becomes easier to magnetize in the direction of the field in which it was applied than it is at right angles to that direction.

Three-Address — See Code, Multiple-Address.

Through-Put — The total productive work of a system. Taken into account in determining Through-Put are compilation, debugging, and production times on the system and the system time required by the operators in starting and stopping the jobs. In a broader sense, Through-Put applies to the productive work accomplished by the combination of programmers, system operators, and the system.

Thyratron — A hot-cathode, gas-discharge tube in which one or more electrodes are used to control electrostatically the starting of an unidirectional flow of current.

Time, Code Checking — All time spent checking out a problem on the machine making sure that the problem is set up correctly, and that the code is correct.

Time, Engineering or Servicing — All machine down time necessary for routine testing (good or bad), for machine servicing due to breakdowns, or for preventive servicing measures, e.g., block tube changes. Includes all test time (good or bad) following breakdown and subsequent repair or preventive servicing.

Time, Idle — Time in which machine is believed to be in good operating condition and attended by service engineers but not in use on problems. To verify that the machine is in good operating condition, machine tests of the leapfrog variety may be run.

Time, No Charge Machine-Fault — Unproductive time due to a computer fault such as the following: (1) non-duplication, (2) transcribing error, (3) input-output malfunction, (4) machine malfunction resulting in an incomplete run.

Time, No Charge Non-Machine-Fault — Unproductive time due to no fault of the computer such as the following: (1) good duplication, (2) error in preparation of input data, (3) error in arranging the program deck, (4) error in operating instructions or misinterpretation of instructions, (5) unscheduled good testing time, run during normal production period when machine malfunction is suspected but is demonstrated not to exist.

Time, Production — Good computing time, including occasional duplication of one case for a check or rerunning of the test run. Also, duplication requested by the sponsor; any reruns caused by misinformation or bad data supplied by sponsor. Error studies using different intervals, convergence criteria, etc.

Time, Standby Unattended — Time in which the machine is in an unknown condition and not in use on problems. Includes time in which machine is known to be defective and work is not being done to restore it to operating condition. Includes breakdowns which render it unavailable due to outside conditions (power outages, etc.).

Time, System, Improvement — All machine down time needed for the installation and testing of new components, large or small, and machine down time necessary for modification of existing components. Includes all programmed tests following the above actions to prove machine is operating properly.

Tracing — An interpretive diagnostic technique to record on an output device during execution each executed instruction and its results.

Tracing Routine — A routine which supplies automatic tracing.

Track — In a serial magnetic storage element, a single path containing a set of pulses.

Trailer Record — A record which follows one or more records and contains pertinent data related to those records.

Transcribe — To copy, with or without translating, from one external storage medium to another.

Transducer — A device which converts energy from one form to another, e.g., a quartz crystal imbedded in mercury can change electrical energy to sound energy as is done in sonic delay lines in computer storage systems.

Transfer — To copy, exchange, read, record, store, transmit, transport, or write data; to change control; to jump to another location.

Transfer, Conditionally — To copy, exchange, read, record, store, transmit, or write data or to change control or jump to another location according to a certain specified rule or in accordance with a certain criterion.

Transfer, Parallel — A system of data transfer in which the characters of an element of information are transferred simultaneously over a set of paths.

Transfer, Serial — A system of data transfer in which the characters of an element of information are transferred in sequence over a single path in consecutive time positions.

Transfer, Unconditional — An instruction which causes the subsequent instruction to be taken from an address which is not the next one in the sequence in a digital computer which ordinarily obtains its instructions serially from an ordered sequence at all other times.

Transform — To change information in structure or composition without altering the meaning or value; to normalize, edit, or substitute.

Transient — A phenomenon experiencing a change as a function of time; something which is temporary; a build-up or breakdown in the intensity of a phenomenon until a steady state condition is reached; an aperiodic phenomenon; the time rate of change of energy is finite and some form of energy storage is usually involved.

Transistor — An electronic device utilizing semi-conductor properties to control the flow of currents from one source in one circuit by currents from another circuit, e.g., a triod transistor permits the control of current in one circuit by the use of a smaller current in another circuit, with the transistor common to both circuits.

Translate — To change information (e.g., problem statements in pseudo-code, data, or coding) from one language to another without significantly affecting the meaning.

Translator — A routine for changing information from one representation or language to another.

Transliterate — To represent the characters or words of one language by corresponding characters or words of another language.

Transmit — To reproduce information in a new location replacing whatever was previously stored and clearing or erasing the source of the information.

Transport — To convey as a whole from one storage device to another.

Trouble-Shoot — To search for a coding mistake or the cause of a computer malfunction in order to remove same.

Truncate — To drop digits of a number of terms of a series thus lessening precision, e.g., the number 3.14159265 is truncated to five figures in 3.1415, whereas one may round off to 3.1416.

Trunk — A path over which information is transferred; a bus.

Tube, Acorn — A small vacuum tube designed for ultra-high-frequency circuits. The tube has short electron transit time and low interelectrode capacity.

Tube, Cathode-Ray — An electronic vacuum tube containing a screen on which information may be stored by means of a multigrid modulated beam of electrons from the thermionic emitter, storage effected by means of charged or uncharged spots; a storage tube; a Williams tube; an oscilloscope tube; a picture tube; CRT.

Tube, Williams — A cathode ray tube used as an electrostatic storage device of the type designed by F. C. Williams, University of Manchester, England.

Two-Address — See Code, Multiple-Address.

Typewriter, Electric — A hand operated electric powered individual character printing device having the property that almost every operation of the machine after the keys are touched by human fingers is performed by electric power instead of manual power; a typewriter powered by electricity, in all other respects the same as a manually powered typewriter.

Ultrasonics — The field of science devoted to frequencies of sound above the human audio range, i.e., above 20 kilocycles per second.

Unconditional — Not subject to conditions external to the specific instruction.

Underflow — The generation of a quantity smaller than the accepted minimum, e.g., floating point underflow.

Unpack — To decompose packed information into a sequence of separate words or elements.

Unwind — To code explicitly, at length and in full all the operations of a cycle thus eliminating all red-tape operations in the final problem coding. Unwinding may be performed automatically by the computer during assembly, generation, or compilation.

Update — To modify a master file with current information according to a specified procedure.

Utility Routine — A standard routine used to assist in the operation of the computer, e.g., a conversion routine, a printout routine, a tracing routine, etc.

Validity — Correctness; especially the degree of the closeness by which iterated results approach the correct result.

Variable — A quantity that may assume a succession of values.

Variable Connector — A connector to indicate a branchpoint or an interconnection of more than two points on a flowchart.

Variable Word Length — A phrase referring to a computer in which the number of characters addressed is not a fixed number but is varied by the data or instruction.

Varistor — A passive resistor-like circuit element whose resistance is a function of the current through it or voltage across its terminals, i.e., the current through it is a non-linear function of the voltage across its terminals, hence the linear form of Ohm's Law is not obeyed; a self-varying resistance.

Vector — A line denoting magnitude and direction as contrasted with a scalar denoting magnitude only.

Verifier — A device on which a manual transcription can be verified by comparing a retranscription with it character-by-character as it is being retranscribed.

Verify — To check a data transfer or transcription, especially those involving manual processes.

Wire, Magnetic — Wire made of a magnetic material along small incremental lengths of which magnetic dipoles are placed in accordance with binary information.

Word — A set of characters which occupies one storage location and is treated by the computer circuits as a unit and transported as such. Ordinarily a word is treated by the control unit as an instruction, and by the arithmetic unit as a quantity. Word lengths are fixed or variable depending on the particular computer.

Word, Information — An ordered set of characters bearing at least one meaning and handled by a computer as a unit, including separating spacing, which may be contrasted with instruction words.

Word-Time — Especially in reference to words stored serially, the time required to transport one word from one storage device to another. See also Access Time.

Write — To transfer information to an output medium to copy, usually from internal storage to external storage; to record information in a register, location, or other storage device or medium.

Zero — Nothing; positive binary zero is usually indicated by the absence of digits or pulses in a word; negative binary zero in a computer operating on one's complements by a pulse in every pulse position in a word; in a coded decimal machine, decimal zero and binary zero may not have the same representation. In most computers, there exist distinct and valid representation both for plus and for minus zero.

Zero-Suppression — The editing or elimination of non-significant zeros to the left of the integral part of a quantity before printing operations are initiated; a part of editing.

Zone — A portion of internal storage allocated for a particular function or purpose; any of the three top positions of 12, 11 and 0 on a punched card. In these zone positions, a second punch can be inserted so that with punches in the remaining positions 1 to 9, alphabetic characters may be represented.

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Waltham 54, Massachusetts

Univac Division, Sperry-Rand Corporation
315 Park Avenue
New York 10, New York

Royal Precision Corporation
Data Processing Division
Westchester Avenue
Port Chester, New York

Sylvania Electric Products, Incorporated
100 First Avenue
Waltham, Massachusetts

Teleregister Corporation
445 Fairfield Avenue
Stamford, Connecticut

Thompson Ramo Wooldridge, Incorporated
23555 Euclid Avenue
Cleveland 17, Ohio

Underwood Corporation
1 Park Avenue
New York 16, New York

University of California
Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico

University of Illinois
Digital Computer Laboratory
Urbana, Illinois

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

COMPUTER SYSTEMS

THE HISTORY OF CURRENT COMPUTERS dates from 1937, when Howard H. Aiken conceived the Automatic Sequence Controlled Calculator capable of following a sequence of steps punched into a tape. Electromechanical in operation, with speeds of three-tenths of a second for addition or subtraction, this machine stores numbers consisting of 23 decimal digits. The ENIAC, built between 1942 and 1946 at the University of Pennsylvania, was the first computer to use electronic or vacuum tubes for calculations.

Computer number systems

Many types of number systems have been used in the logical design of computers. Among these number systems are the straight binary, octal, binary coded decimal, straight decimal, sexadecimal, biquinary, binary coded alphanumeric, and excess three-binary coded decimal. A majority of the computer systems utilize a straight binary system internally.

In nearly every computer system, information is ultimately handled in binary form. The primary method of storage exploits the properties of material such as semiconductors, ferroelectric and ferromagnetics. The state of conduction or polarization in these materials determines the information stored or being processed. Decimal digits are handled as groups of four bits, or tetrads. Alphanumeric data usually require the use of six bits.

Some computer systems use seven bits for expressing a single character, or may use a single bit as an "odd-even" check bit.

Programmers and coders preparing problems for solution on these systems may work with decimal or alphanumeric notation and need not be concerned with the internal number system.

Word length

The selection of word length for computing systems is based on many considerations. For information words, the precision required may be the major consideration, since word space must be allocated to the command, the address or addresses of the data, and spares, tags, or check requirements. The variation of word lengths among existing systems is wide. The average or nominal word length for fixed word length machines is approximately forty (40) binary or twelve (12) decimal digits. A few computer systems compact several words to accomplish increased input speed.

In many systems, the machine word structure permits several instructions to be expressed by a single word. However, the majority of computer systems operate on a one instruction per word basis.

Arithmetic system

Early computer systems operated on a fixed point arithmetic basis, in which the decimal point was arbitrarily fixed at either the right or left end of the number.

For some systems a centered decimal point permitted the direct expression of whole and fractional parts of numbers. Scaling is required when a decimal point is located at the left end of a number, in which case all quantities must be scaled between the values of minus one and plus one.

Most of the present computer systems are manufactured with built-in automatic floating point in the arithmetic unit, permitting numbers to be expressed as fractional parts and exponent parts. The exponent usually is a power of two or ten. There are, in lesser number, many other instruction-address combinations.

Most systems require adherence to a specific format or set of formats for preparing coded instructions in machine language. The instruction word format thus outlines the form in which the instruction is prepared. An accounting must be made of each digit or character in the instruction word.

Arithmetic units

The primary function of an arithmetic unit of any computer system is to perform repetitive arithmetic. The time required to execute an add instruction or a given sequence of arithmetic or logical instructions must be considered with caution. In most computers these operations are so fast that no input or output device can recover the solutions at equal speed. This is often referred to in a computer as "input-output device limitations."

Also, the operation time of arithmetic units is expressed in two main categories: including access time and exclusive of access time. Other considerations make computer speed comparisons difficult.

Computer systems utilize tubes or transistors as the basic element of the arithmetic unit. Several systems have magnetic cores in the arithmetic units. Gating for arithmetic and logical units is mostly performed by diodes, transistors, or vacuum tubes.

Storage

An extremely diverse and dynamic field of interest in the study of computer systems is the subject of storage devices. Many ingenious devices to store or record data have been devised. Early forms of storage involved mechanical deformation of material media. These are exemplified by cams, springs, gears, music box cylinders, perforated player piano rolls, code wheels and perforated paper tape. All of these storage devices required the movement of mechanical parts and consequently long access time was inherent and mechanical failures were possible.

During World War II, the search for more rapid access storage devices led to the use of the vacuum tube. The two states, that of conduction and that of cut-off, permit information storage on a binary basis.

This system, as was used on the ENIAC, proved effective from an access time consideration; however, the system was extremely bulky and required thousands of electronic vacuum tubes for a storage unit consisting of only 20 words of 10 decimal digits each.

Chronologically, the next development was the use of acoustic delay lines of mercury and quartz. A transducer at each end of a length of these materials permits energy conversions and allows the storage of information in the form of high frequency (e.g. 8 megacycles per second) pulse packets. The information is continuously recirculated. Information is inserted or read out through the use of standard gating techniques. Among the computers utilizing acoustic mercury delay lines are the DYSEAC, EDVAC, ELECOM 125, SEAC and UNIVAC I. Quartz acoustic delay lines were also used. Other types of delay lines used for storage of information are the magnetostrictive and the electromagnetic or distributed L-C network. See Tables VI, VII and VIII, in Appendix E, which list the computing systems utilizing delay line storage units. Although in operating principle there is no difference, it is necessary to make a distinction between a delay line used in a storage loop in which information is continuously circulated, and a delay line used only for purposes of timing the arrival of information at selected points for performing various logical operations. In the latter, the function is delay, or temporary storage, rather than permanent storage. Since delay lines store information serially as a train of electrical or sonic pulses, average random access time is limited to half of the time length of the delay line plus the time quivalent to one word length.

Because of the serial nature of the system, delay line storage units are limited in speed. Notice how the delay line types of systems lie near the bottom of the Access Time of High Speed Storage, Table VI.

The search for shorter access time brought about the development of the electrostatic storage unit, also called the cathode ray tube storage device. The material medium in motion was now limited to electrons, i.e., in beams and on charged areas on the screen of a cathode ray tube. These charged areas behaved somewhat like an array of charged capacitors. Selection of storage locations and the transfer of information was efficiently performed by an easily deflected pencil or beam of electrons which was used for both writing and interrogation. Parallel transfer, in which all digits of a given word are transferred simultaneously, became possible with this type of storage system.

The electrostatic storage system, with the inherent problems associated with high accelerating voltages, screen imperfections and other tube failures, has all but yielded to the utilization of magnetic cores for the storage of information. A 32 x 32 array of ferrite cores, which might constitute a typical storage plane, may measure only a few inches on each side. The cores are placed at the intersection of the wires of a mesh, and a third winding may be threaded through all the cores for sensing stored data.

The storage takes place in the form of magnetically oriented molecular or atomic dipoles which retain their orientation upon removal of the magnetizing force. Many manufacturers intend to provide computing systems with large capacity core storage units. Advances have been made in the use of perforated ferrite plates and magnetic films deposited on glass as a magnetic storage unit.

The UNIVAC 1107 utilizes thin films. The storage principle is the same as the magnetic cores. Table VI shows the access time of high speed storage units in their approximate relative order of magnitude for the storage units used in various computing systems. It must be emphasized that the question of precisely what constitutes access time cannot easily be resolved unless a common understanding as to the definition is reached. In the usual sense, one may consider access time as the elapsed time between the initiation of a command to transfer an item of information, usually one word, from one address in the storage to another designated register, and the complete arrival of the item at the designated location.

In many systems, particularly serial storage units, access time depends upon the time location of the word in the serially circulating group of words at the instant the transfer command is initiated. For this and other reasons, much misunderstanding can arise in the consideration of access time. The data presented in Table VI should therefore be considered to be approximate and should be used with caution.

The capacity of high speed storage units has risen during the past few years as rapidly as access time has diminished. Table VII shows the capacity of high speed storage units in terms of numbers of words and word lengths, arranged in relative order of magnitude of equivalent binary capacity.

Rapid access storage of limited capacity is usually supported by a larger capacity storage unit for a well balanced storage system. This permits the transfer of large blocks of information from the rapid access storage unit to the large capacity storage unit for use at another location or time in the computation process.

The most prevalent devices for auxiliary storage of this type are the magnetic drum or the magnetic disk. The access time for large blocks of information is of the order of tens of milliseconds for most magnetic drum or disk units. Many computing systems utilize magnetic drums or disks as the primary storage unit. Several systems utilize large capacity drum or disk units particularly for commercial type applications, such as payroll, stock inventory, and personnel records where access times of the order of microseconds are not required. Table IX shows the capacity of various drum or disk storage systems currently in use. It should be remembered, when glancing at Table IX, that although an attempt was made to show maximum capability, additional drum or disk units can be attached to some systems.

Many systems employ magnetic tape as a medium of storage. Although access time is relatively long because of its inherently serial nature, a large volume of data can be stored on tape with a high packing density in terms of data units per unit volume.

The characteristics of a storage device, namely, capacity and access time are two aspects of a storage system which come under consideration when designing or using a machine. The user or manufacturer of a system, at times, can trade capacity for access in the sense that under certain conditions he can accomplish an equivalent amount of computation with a large capacity, somewhat longer access time system as with a small capacity, short access time system. This is the old problem of trading time for space or vice versa. There are limits to this, however. For example, when access time approaches the order of milliseconds, computation is seriously slowed down. Since large capacity and short access time are features to be desired, let us examine a quantity determined by the expression:

$$\log_{10} (\text{Capacity in Equivalent Binary Digits}/\text{Access Time in Seconds})$$

In early storage devices, such as music boxes and signal coding equipment, this number is of the order of two to three. Relay storage units have a number of the order of four or five. Tube registers of the ENIAC vacuum tube accumulator storage type, enabled this figure to be as high as 6.3. Magnetic drum storage units are in the region of 6 to 7. Acoustic delay line storage systems show that this figure is in the range 8.6 to 9.6. The cathode ray tube storage (electrostatic) raised the figure as high as 10.79. The magnetic core storage unit permitted an increase of this figure to over 12. Thin films have now arrived on the scene as a practical storage medium. The following table shows the growth, or increase of this number, as development of computing system components progressed:

Storage Device	*Approx. Median $\log_{10}$ Capacity/Access*	*Approximate Year of Development*
Early Mechanical	2 - 3	Prior to 1930
Electromechanical	4 - 5	1935
Vacuum Tube	5 - 6	1940
Magnetic Drum	6 - 7	1945
Electrostatic (CRT)	9 - 10	1950
Static Magnetic (Mag. Core)	9 - 12	1955
Thin Film	10 - ?	1960

Table VII is a tabulation of the $\log_{10}$ Capacity/Access figures for the high speed storage units of various computing systems in approximate relative order of magnitude.

Input-output

The above discussions on arithmetic units and storage devices have shown the great strides that have been made in these fields during the past several years. Arithmetic operation and storage access times have decreased and storage capacity increased. Yet, the communication link between the person and the machine still presents a major problem. Paper tape and cards, inherently bulky, are prevalent and relatively slow, particularly for scientific applications. The main convenience afforded by cards, particularly in commercial systems, is their capability of storing a complete item of information on one card which may be handled separately or as part of a group, such as data on an insurance policy, a payroll line, a stock item, a set of corresponding test data, etc. There is no doubt that punching cards is a slow process. Paper tape perforators are also relatively slow in the sense that the data to be punched is usually available at a rate faster than paper may be mechanically perforated, although high speed perforators are being developed and are finding application. Keyboard input systems are useful primarily for the manual insertion of words for test or other special purposes.

In addition to paper tape and card readers and punches, many systems utilize high speed printers and magnetic tape units as a medium of input and output. Magnetic tape output still requires a conversion from magnetic tape to cards or printed page in order that the information be available to operating personnel.

However, since human intervention is gradually being reduced, the use of magnetic tape for input, output and storage is increasing rapidly.

One method for decreasing machine time spent waiting for reading and writing instructions to be carried out is to provide for concurrent operation. The later machines have built-in circuitry for permitting reading and writing to take place during computations. Apparently the only stipulation is that a given storage location does not become involved in reading, writing and computing at the same time. Many machines, for example, compute while punching and reading cards or while "looking-up" information on tape. Others fetch the next instructions out of storage while performing an operation.

Magnetic tape-to-card converters and inverters are becoming available as well as magnetic tape-to-printed-page converters. Paper tape and cards may sometimes be considered as forms of storage, since information recorded on these media may be returned to the machine. Considerable progress is being made in the field of printed page readers. See, for example, the IBM 1401 System.

It is often necessary to have computing systems capable of communicating with one another directly. For this reason, input-output media conversion is becoming quite prevalent and large conversion equipment is rapidly becoming available. Input-output schemes are so many and varied, that a complete treatment of this subject is not undertaken.

Circuit elements of the entire system

There are many impressions which come to mind when one examines such things as transistor, tube and crystal diode counts in a large scale computing system. There is a tendency to visualize a large, sprawling system when the tube count is high. There may be large tube-changing programs based on experience in effect on these large systems. Failure rates, preventive maintenance techniques, tube life problems, design limitations and tube specifications must all be considered on a systematic basis when the tube count is high. Tube count and a knowledge of tube operating characteristics may yield an approximate estimation of some of the problems that may be encountered in the operation of the system. Table X shows the approximate number of tubes utilized in some of the computing systems.

Maintenance of transistorized systems has become somewhat simpler than maintenance of vacuum tube systems. Power and space requirements for transistorized systems are considerably reduced.

The servicing of a large electronic computing system can be materially simplified by reducing the number of tube types in the system. Standards for tube testing need apply to fewer tube types and tube checking can be further systematized due to a reduced number of test variations. Of course, a test specification or test criterion must be established for the most severe application for which the particular tube type will be applied. A severe or special circuit requirement may be better served through the use of another tube type.

This, then, increases the number of tube types. Normally, it is possible to select a type of tube for a group of duties. In a given system, for example, a certain type is selected for driving, for voltage amplification, for flip-flop circuits, normally "on" or "off" conditions, etc. This establishes a number of tube types for a given system and any modification of the system usually should include this tube type complement.

The questions of crystal diode reliability, diode testing techniques, and diode logical network design, such as individual clamps versus wired plug-in units, become subjects of interest when diodes are utilized. The quantity of diodes in a given computing system may be indicative of the nature of the servicing problem, but only when the failure rates, life and circuit demands placed upon the diode are known. To some extent, malfunctions due to diodes can be aggravated by elevated temperatures. The printed circuit logical package, containing a specific array of "And" and "Or" gates have become the most prevalent means of fabrication. The extent of crystal diode use is shown in Table XI

Many recently developed systems utilize transistors for driving, switching (gating) and other logical functions. Reduced power and reduced space requirements are advantages of these systems. The question of reliability is rapidly being resolved, as printed circuits and packaging techniques continue to be improved. Table XII shows the quantity of transistors utilized in the various computing systems.

Checking features

The question of what type of checking features should be incorporated into a given general purpose computing system is still being tossed about by various manufacturers. The type of built-in check varies from manufacturer to manufacturer and from system to system.

It is usually possible to check all machine calculations by programming techniques.* A well designed system can proceed for many hours without a malfunction. If this is the case, it is entirely possible that the installation of a checking system can do more harm than good since the checking features can malfunction and cause an alarm or stoppage when a machine malfunction has not occurred.

For example, the second unit of twin arithmetic units can malfunction, the comparer of a redundancy checker can malfunction, or a forbidden pulse combination decoder can malfunction, all yielding false indications of a machine malfunction. For those systems which do not have built-in checking circuits, the operator or programmer must program a check or the output may be reviewed.

About 87% of computing systems utilize some form of automatic built-in check. A redundancy or duplication check is used in about 8% of the systems. Some type of overflow or exceed capacity is used on about

23% of the systems and an odd-even parity check in one form or another is used on 50% of the systems. Interesting to note here is that in 1957 only 20% of the systems had a form of parity check. Various kinds of transfer checks are used on 19% of the systems. Approximately 28% of computer systems established a checking system by detecting pulse combinations which are not supposed to occur anywhere in the system. Forbidden pulse combinations checking stations are scattered around the system, e.g. in memory transfer points, recording stations, reading stations, etc. The various names that have been applied to this type of check are forbidden pulse combination, unused order (instruction), unallowable order digit, improper operation code, improper command, false code, forbidden digit, non-existent code, and unused code.

There is a distinction to be made between the terms order, instruction, and command. The preferred definitions are given in the glossary.

TABLES

The tables in Appendix E are reprinted with permission from Ballistic Research Laboratories report number 1115, *A Third Survey of Domestic Electronic Digital Computing Systems,* by Martin H. Weik, 1961.

I.
MANUFACTURERS OF COMPUTING SYSTEMS

MANUFACTURER	SYSTEM
Airborne Instruments Laboratory	MODAC 404, MODAC 410, MODAC 414, MODAC 5014
Alwac Computer Division El-Tronics, Incorporated	ALWAC II, ALWAC III E
Argonne National Laboratory	GEORGE
Automation Management, Inc.	PERK I II
Autonetics Division North American Aviation Corp.	AN/MJQ 1 REDSTONE, FADAC, JUKEBOX, RECOMP I CP 266, RECOMP II, REPAC, VERDAN
Bell Telephone Laboratories, Inc.	LEPRECHAUN
Bendix Computer Division Bendix Corporation	BENDIX CUBIC TRACKER, BENDIX D 12, BENDIX G 15, BENDIX G 20
Brookhaven National Laboratories	MERLIN
Burroughs Corporation	BURROUGHS 204, BURROUGHS 205, BURROUGHS 220, BURROUGHS D 103, BURROUGHS D 104, BUROUGHS D 105, BURROUGHS D 107, BURROUGHS D 201, BURROUGHS D 202, BURROUGHS D 203, BURROUGHS D 204, BURROUGHS D 208, BURROUGHS D 209, BURROUGHS E 101, BURROUGHS E 102, BURROUGHS E 103, UDEC I II III
Computer Control Company	CCC REAL TIME, SPEC
Concord Control Incorporated	NUMERICORD
Control Data Corporation	CDC 160, CDC 1604
Cubic Corporation	CUBIC AIR TRAFFIC, CUBIC TRACKER
Digital Equipment Corporation	PROGRAMMED DATA PROCESSOR
Digitronics Corporation	DIGITAL CONVERTER
Electronics Corp. of America	MAGNEFILE B, MAGNEFILE D
General Electric Company	GENERAL ELECTRIC 100 ERMA, GENERAL ELECTRIC 210, GENERAL ELECTRIC 225, GENERAL ELECTRIC 250, GENERAL ELECTRIC 312, OARAC
General Mills	GENERAL MILLS AD/ECS, GENERAL MILLS APSAC
Geotechnical Corporation	GEOTECH AUTOMATIC
Hampshire Engineering Company	CCC 500, HAMPSHIRE TRTDS 932
Hogan Laboratories, Inc.	CIRCLE
HRB Singer, Incorporated	HRB SINGER
Hughes Aircraft Company	HUGHES ADV AIRBORNE III, HUGHES BM GUIDANCE, HUGHES D PAT, HUGHES DIGITAIR, HUGHES LRI X, HUGHES M 252

MANUFACTURER	SYSTEM
International Business Machines Corp.	AN/ASQ 28(v) EDC, AN/ASQ 28(v) MDC, AN/FSQ 7 AN/FSQ 8 (SAGE), AN/FSQ 31(v), AN/FSQ 31, AN/TYK 7v INFORMER, ASC 15, IBM 305 RAMAC, IBM 604, IBM 607, IBM 608, IBM 609, IBM 610, IBM 632, IBM 650 RAMAC, IBM 701, IBM 702, IBM 704, IBM 705 I II, IBM 705 III, IBM 709, IBM 1401, IBM 1410, IBM 1620, IBM 7070, IBM 7074, IBM 7080, IBM 7090, IBM CPC, IBM STRETCH, NORC, STORED PROGRAM DDA
Intelex Systems Incorporated	INTELEX AIRLINE RESERVATION
Iowa State University	CYCLONE
ITT Laboratories	ITT BANK LN PROC, ITT SPES 025
J. B. Rea Company, Inc.	READIX
Laboratory for Electronics	DE 60, DIANA, RASTAC, RASTAD
Leeds and Northrup Company	LEEDS NORTHRUP 3000
Librascope Division General Precision Incorporated	LGP 30, LIBRASCOPE 407, LIBRASCOPE AIR TRAFFIC LIBRASCOPE ASN 24, LIBRASCOPE CP 209, LIBRASCOPE MK 38, LIBRASCOPE MK 130, LIBRATROL 500, LIBRATROL 1000
Lincoln Laboratory Mass. Institute of Technology	LINCOLN CG 24, LINCOLN TX 0, LINCOLN TX 2
Litton Industries	LITTON C 7000, LITTON DATA ASSESSOR
Marchant Calculators, Inc.	MINIAC II
Mass. Institute of Technology Digital Computer Laboratory	WHIRLWIND II
Michigan State University	MISTIC
Minneapolis Honeywell Regulator Company	DATAMATIC 1000, HONEYWELL 290, HONEYWELL 800
Monroe Calculating Machine Co.	DISTRIBUTAPE, MONROBOT III, MONROBOT V, MONROBOT VI, MONROBOT IX, MONROBOT XI, MONROBOT MU
National Cash Register Co.	NATIONAL 102 A, NATIONAL 102 D, NATIONAL 107, NATIONAL 304, NATIONAL 315, NATIONAL 390
United Aircraft Corporation	NORDEN VOTE TALLY, SCRIBE
Oak Ridge National Laboratory and Argonne National Laboratory	ORACLE
Oklahoma University	OKLAHOMA UNIV
Packard Bell Computer Corp.	PACKARD BELL 250, TRICE
Pennsylvania State University	PENNSTAC

MANUFACTURER	SYSTEM
Philco Corporation	AN/TYK 6v BASICPAC, AN/TYK 4v COMPAC, PHILCO 1000, PHILCO 2000, PHILCO 3000, PHILCO CXPQ
Radio Corporation of America	BIZMAC I, BIZMAC II, RCA 110, RCA 200, RCA 300, RCA 301, RCA 501, RCA 601
Thompson Ramo Wooldridge, Inc.	RW 300, RW 400
The Rand Corporation	JOHNNIAC
Remington Rand Univac Division Sperry Rand Corporation	AF/CRC, AN/USQ 20, ATHENA, BOGART, LOGISTICS, TARGET INTERCEPT, UNIVAC 60, UNIVAC 120, UNIVAC 490, UNIVAC 1101, UNIVAC 1102, UNIVAC 1103 1103A, UNIVAC 1105, UNIVAC 1107, UNIVAC FILE 0, UNIVAC FILE 1, UNIVAC LARC, UNIVAC SOLID STATE 80/90, UNIVAC STEP, UNIVAC I, UNIVAC II, UNIVAC III
Rice University	RICE UNIVERSITY
Royal McBee Corporation	RPC 4000, RPC 9000
Sylvania Electric Products, Inc.	MOBIDIC A, MOBIDIC B, MOBIDIC C D AND 7A, SYLVANIA S 9400, SYLVANIA UDOFTT
The Teleregister Corporation	TELEREGISTER MAGNET BID ASKED, TELEREGISTER MAGNET INVENT CONT, TELEREGISTER TELEFILE, TELEREGISTER UNIFIED AIRLINE
Underwood Corporation	ELECOM 50, ELECOM 100, ELECOM 120, ELECOM 125 125 FP
University of California Los Alamos Scientific Laboratory	MANIAC I, MANIAC II,
University of Chicago Institute for Computer Research	MANIAC III
University of Illinois Digital Computer Laboratory	ILLIAC, ORDVAC
University of Pennsylvania Moore School of Electrical Eng.	EDVAC
University of Wisconsin	WISC
U. S. Army Ordnance Corps Ballistic Research Laboratories	BRLESC
U. S. Navy Naval Research Laboratory	NAREC, UNIVERSAL DATA TRANS
U. S. Department of Commerce National Bureau of Standards	AMOS IV, DYSEAC, SEAC, SWAC
Western Reserve University Center for Documentation and Communications Research	WRU SEARCHING SELECTOR
Westinghouse Electric Corp.	WESTINGHOUSE AIRBORNE

II.

QUANTITY OF COMPUTING SYSTEMS MANUFACTURED TO DATE

QUANTITY	SYSTEM
Over 2,993	IBM 604
(Est. All Models) 1,500	IBM 650
693	IBM CPC
462	LGP 30
Over 400	LIBRATROL 500
Over 300	BENDIX G 15
Over 267	IBM 607
(Incl. E 101) 210	BURROUGHS E 103
200	UNIVAC STEP
180	VERDAN
(Incl. Mod. 1) 164	UNIVAC FILE 0
164	UNIVAC FILE 1
127	BURROUGHS E 101
(Incl. 204) 112	BURROUGHS 205
11	UNIVAC SOLID STATE 80/90
100	BURROUGHS D 104
Over 90	IBM 1401
(Est.) 70	IBM 704
70	MONROBOT IX
50	AN/FSQ 7 AN/FSQ 8 (SAGE)
48	LIBRASCOPE CP 209
45	UNIVAC 1105
42	BURROUGHS 220
Over 30	IBM 709
25	UNIVAC III
24	RCA 501
Over 18	IBM 701
18	GE 100 ERMA
18	RW 300
16	NATIONAL 102 A
14	LIBRASCOPE MK 38
Over 13	IBM 702
Over 13	IBM 705 III
Over 13	UNIVAC 1103 1103A
Over 12	BURROUGHS 204
12	TELEREGISTER UNIFIED AIRLINE
10	CDC 1604
10	JUKEBOX
10	RPC 4000
10	RPC 9000
9	DE 60
Over 8	IBM 7090
Over 8	RECOMP II
8	GENERAL ELECTRIC 210
8	NUMERICORD
Over 7	UNIVAC II
7	AN/TYK 6v BASICPAC
7	CDC 160
7	CUBIC TRACKER
7	MONROBOT XI
Over 6	PHILCO 2000
6	ELECOM 125 125FP
6	NATIONAL 304
6	NATIONAL 390
6	READIX
Over 5	BURROUGHS E 102
Over 5	DATAMATIC 1000
5	BURROUGHS D 204
5	ELECOM 120
5	FOSDIC
5	TRICE
Over 4	NATIONAL 102 D
Over 4	UNIVAC 120
4	GENERAL ELECTRIC 312
4	ILLIAC
4	LIBRASCOPE ASN 24
4	RW 400
3	ALWAC III E
(Incl. All Models) 3	BIZMAC I
(Incl. All Models) 3	BIZMAC II
3	DIGITRONIC CONVERTER
3	DISTRIBUTAPE
3	ELECOM 50
3	ELECOM 100
3	HRB SINGER
3	PACKARD BELL 250

QUANTITY	SYSTEM
3	UNIVAC 1102
2	ALWAC II
2	CIRCLE
2	GENERAL MILLS AD/ECS
2	IBM STRETCH
2	LIBRASCOPE AIR TRAFFIC
2	PHILCO 3000
2	UDEC I II III
2	WESTINGHOUSE AIRBORNE
1	AF/CRC
1	AMOS IV
1	AN/USQ 20
1	BOGART
1	BRLESC
1	BURROUGHS D 201
1	BURROUGHS D 202
1	CCC REAL TIME
1	COMPAC
1	CUBIC AIR TRAFFIC
1	CYCLONE
1	DIANA
1	DYSEAC
1	EDVAC
1	GENERAL MILLS APSAC
1	GEORGE
1	GEOTECH AUTOMATIC
1	HAMPSHIRE CCC 500
1	HAMPSHIRE TRTDS 932
1	INTELEX AIRLINE RESERVATION
1	ITT BANK LN PROC
1	ITT SPES 025
1	JOHNNIAC
1	LEPRECHAUN
1	LIBRASCOPE MK 130
1	LINCOLN CG 24
1	LINCOLN TX 0
1	LINCOLN TX 2
1	LOGISTICS
1	MAGNEFILE B
1	MAGNEFILE D
1	MANIAC I
1	MANIAC II
1	MANIAC III
1	MERLIN
1	MINIAC II
1	MISTIC
1	MOBIDIC A
1	MOBIDIC B
1	MOBIDIC C D & 7A
1	MODAC 404
1	MODAC 410
1	MODAC 414
1	MODAC 5014
1	MONROBOT III
1	MONROBOT V
1	NAREC
1	NATIONAL 107
1	NATIONAL 315
1	NORC
1	NORDEN VOTE TALLY
1	OARAC
1	OKLAHOMA UNIVERSITY
1	ORACLE
1	ORDVAC
1	PENNSTAC
1	PERK I II
1	PHILCO 1000
1	PHILCO CXPQ
1	PROGRAMMED DATA PROCESSOR
1	RASTAD
1	RCA 200
1	RCA 300
1	RCA 301
1	RCA 601
1	RECOMP I CP 266
1	REPAC

QUANTITY	SYSTEM
1	RICE UNIVERSITY
1	SEAC
1	SPEC
1	STORED PROGRAM DDA
1	SWAC
1	SYLVANIA S 9400
1	SYLVANIA UDOFTT
1	TARGET INTERCEPT
1	TELEREGISTER MAGNET BID ASKED
1	TELEREGISTER MAGNET INVENT CONT
1	UNIVAC 490
1	UNIVAC 1101
1	UNIVAC LARC
1	UNIVERSAL DATA TRANS
1	WHIRLWIND II
1	WISC
1	WRU SEARCHING SELECTOR

III.
WORD LENGTH OF COMPUTING SYSTEMS

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
Variable	Fixed	3	—	BIZMAC I
Variable	Fixed	3	—	BIZMAC II
Variable	Fixed	1	2	DIANA
Variable	—	—	—	FOSDIC
Variable	Fixed	—	2	IBM 305 RAMAC
Variable	Fixed	—	1	IBM 702
Variable	Fixed	—	1	IBM 705 I II
Variable	Fixed	—	1	IBM 705 III
Variable	Fixed	—	1 or 2	IBM 1401
Variable	—	—	—	IBM 1410
Variable	Fixed	—	2	IBM 1620
Variable	Fixed	—	1	IBM 7080
Variable	—	Variable	1	RASTAC
Variable	—	2	—	RASTAD
Variable	Fixed	Variable	2	RCA 301
Variable	Fixed	Variable	2	RCA 501
Variable	Fixed and Floating	1 or 2	1, 2 or 3	RCA 601
Variable	—	1 to 3	1	SCRIBE
Variable	Fixed	—	1	TELEREGISTER TELEFILE
Variable	Fixed	—	3	UNIVAC 60
Variable	Fixed	—	3	UNIVAC 120
3 Dec	—	0.5	1	AMOS IV
3 Dec	Fixed	2 or 4	1 or 2	NATIONAL 315
12 Bin	Fixed	1	1	CDC 160
13 Bin	Fixed	1	1	RCA 300
13 Bin	Fixed	1	1	SPEC
14 Bin	Fixed	1, 2 or 3	—	LIBRASCOPE CP 209
3 Dec + 5 Bin	Fixed	—	—	NORDEN VOTE TALLY
16 Bin	Fixed	0.5	—	BURROUGHS D 209
16 Bin	—	—	—	HRB SINGER
16 Bin	Fixed	1	1	WHIRLWIND II
17 Bin	Fixed	1	3 Mod	HUGHES DIGITAIR
17 Bin	Fixed	1	2	HUGHES ADV AIRBORNE III
3 or 5 Dec	Fixed	—	1 or 2	IBM 604
3 or 5 Dec	Fixed	—	1 or 2	IBM 607
3 or 5 Dec	Fixed	—	1 or 2	IBM CPC
17 Bin	Fixed	1	1	LEPRECHAUN
18 Bin	Fixed and Floating	1	1	HONEYWELL 290
18 Bin	Fixed	1	1, 2 or 4	LIBRASCOPE MK 38
18 Bin	—	1	1	LINCOLN TX 0
18 Bin	Fixed	1	1	PROGRAMMED DATA PROCESSOR
18 Bin	Fixed	0.5	1 + 1	RW 300
19 Bin	Fixed	1	3	HUGHES D PAT
19 Bin	Fixed	1	3	HUGHES LRI X
19 Bin	Fixed	1	1	LIBRASCOPE MK 130
20 Bin	Floating	1	1	BURROUGHS D 103
20 Bin	Fixed	—	—	CUBIC AIR TRAFFIC
20 Bin	Fixed and Floating	1	1	GENERAL ELECTRIC 225
20 Bin	Fixed	1 + 1	1	GENERAL ELECTRIC 312
20 Bin	Fixed	—	—	HAMPSHIRE CCC 500
20 Bin	Fixed	2	1	HUGHES M 252
20 Bin	—	0.5	1	MODAC 5014
20 Bin	—	—	1	RCA 200
6 Dec	Fixed	1	1	GENERAL ELECTRIC 210
6 Dec	Fixed	—	1	MODAC 404
6 Dec	Fixed	—	1	MODAC 414
21 Bin	Fixed	1	1	BURROUGHS D 201
21 Bin	Fixed	—	—	CUBIC TRACKER
21 Bin	Fixed	1 or 0.5	1 or 1 + 1	LEEDS NORTHROP 3000
21 Bin	Fixed	1	1	LITTON C 7000
21 Bin	Fixed	1	1	SYLVANIA UDOFTT
22 Bin	Fixed	1	1	BURROUGHS D 202
22 Bin	Fixed	—	—	HAMPSHIRE TRTDS 932
22 Bin	Fixed	1	4	LIBRASCOPE 407
22 Bin	Fixed	1	1	PACKARD BELL 250
22 Bin	Fixed	1	1 or 1 + 1	PHILCO 3000
22 Bin	Fixed	5	—	STORED PROGRAM DDA
23 Bin	Fixed	1	1	AN/ASQ 28 (v) MDC
7 Dec	—	—	—	GE 100 ERMA
24 Bin	Fixed	1	1	ATHENA
24 Bin	Fixed	1	1 + 1	BURROUGHS D 203
24 Bin	Fixed	1	1	BURROUGHS D 208
24 Bin	—	—	—	TELEREGISTER MAGNET BID ASKED
24 Bin	Fixed	—	1	RCA 110
24 Bin	Fixed	1	1	TARGET INTERCEPT
24 Bin	Fixed	1	1	UNIVAC 1101
24 Bin	—	1	1	UNIVAC 1102
24 Bin	Fixed	1	1 + 1	UNIVAC III
24 Bin	Fixed	1	1.5	VERDAN
24 Bin	Fixed	1	1	WESTINGHOUSE AIRBORNE
25 Bin	Fixed	1	1 + 1	CCC REAL TIME
25 Bin	Fixed	1	1 + 1	LIBRASCOPE ASN 24
25 Bin	Fixed	1	1	LINCOLN CG 24
26 Bin	Fixed	1	1 + 1	AN/ASQ 28 (v) EDC
26 Bin	Fixed	1	2	RW 400
27 Bin	Fixed	3	2	ASC 15
27 Bin	Fixed	—	—	TRICE
8 Dec	Fixed	—	—	BENDIX D 12
8 Dec	Fixed and Floating	1	3	ELECOM 120
8 Dec	Fixed	1	1	LIBRASCOPE AIR TRAFFIC
8 Dec	Fixed	—	1	MAGNEFILE B
29 Bin	Fixed	—	—	BENDIX CUBIC TRACKER
29 Bin	Fixed	1	2	BENDIX G 15
30 Bin	Fixed	1	1	AN/USQ 20
30 Bin	Fixed	1	3	ELECOM 100
30 Bin	Fixed	—	1	UNIVAC 490
9 Dec	Fixed	—	1 or 2	IBM 608
31 Bin	Fixed	—	1	BURROUGHS D 204
31 Bin	Fixed	1	1	LIBRATROL 500
32 Bin	Fixed	1	1	AN/FSQ 7 AN/FSQ 8 (SAGE)
32 Bin	Fixed	1	1	LIBRATROL 1000
32 Bin	Fixed	1	1	LITTON DATA ASSESSOR

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
32 Bin	Fixed	1	1	LGP 30
32 Bin	Fixed	2	1	MONROBOT XI
32 Bin	Fixed	1	1 over 1	RPC 4000
33 Bin	Fixed	0, 1, 2, 3, 4	1	ALWAC II
33 Bin	Fixed	2, 3, 4	1	ALWAC III E
33 Bin	1	1	1	BENDIX G 20
33 Bin	Fixed	1	1	ITT SPES 025
34 Bin	Fixed	1	1	BURROUGHS D 107
10 Dec	Fixed	—	—	AF/CRC
10 Dec	Fixed and Floating	1	1	BURROUGHS 204
10 Dec	Fixed and Floating	1	1	BURROUGHS 205
10 Dec	Fixed and Floating	1	1	BURROUGHS 220
10 Dec	Fixed	—	—	ELECOM 50
10 Dec	Fixed and Floating	1	2	ELECOM 125 125FP
10 Dec	Fixed and Floating	1	1	IBM 650 RAMAC TAPES
10 Dec	Fixed and Floating	1	1	IBM 7070
10 Dec	Fixed and Floating	1	1	IBM 7074
10 Dec	Fixed	1	1	INTELEX AIRLINE RESERVATION
10 Dec	Fixed	1	1	MINIAC II
10 Dec	Fixed	—	1	MODAC 410
10 Dec	Fixed	1	2	OARAC
10 Dec	Fixed and Floating	—	1	READIX
10 Dec	Fixed	2	1 or 2	UDEC I II III
10 Dec	Fixed	1	1.5	UNIVAC SOLID STATE 80/90
10 Dec	Fixed	1	1.5	UNIVAC STEP
35 Bin	Fixed	1	1 + 1	FADAC
36 Bin	Fixed	2	1	GENERAL MILLS APSAC
36 Bin	Fixed	2	1	IBM 701
36 Bin	Fixed and Floating	1	1	IBM 704
36 Bin	Fixed and Floating	1	1	IBM 709
36 Bin	Fixed and Floating	1	1	IBM 7090
36 Bin	—	1	2	PHILCO 1000
36 Bin	Fixed and Floating	1	2	UNIVAC 1103 1103A
36 Bin	Fixed and Floating	1	2	UNIVAC 1105
36 Bin	Fixed and Floating	—	1	UNIVAC 1107
36 Bin	—	—	—	UNIVERSAL DATA TRANS
9 Dec + 6 Bin	Fixed	1	3	NATIONAL 102 D
37 Bin	Fixed	1	1	AN/TYK 6v BASICPAC
37 Bin	Fixed	2	1	GENERAL MILLS AD/ECS
37 Bin	Fixed	1	4	SWAC
37 Bin	Fixed and Floating	1	1	SYLVANIA S 9400
37 Bin	—	—	—	TELEREGISTER MAGNET INVENT CONT
11 Dec	Fixed	1	3	NATIONAL 107
11 Dec	Fixed	1	1 + 1	PENNSTAC
38 Bin	Fixed	1	1	AN/TYK 7v INFORMER
38 Bin	Fixed	1	1	COMPAC
38 Bin	Fixed	1	1	LINCOLN TX 2
38 Bin	Fixed	1	1 or 2	MOBIDIC A
38 Bin	Fixed	1	1 or 2	MOBIDIC B
38 Bin	Fixed	1	1 or 2	MOBIDIC C D & 7A
40 Bin	Fixed	2	1	CYCLONE
40 Bin	Fixed and Floating	Variable	2	GEORGE
40 Bin	Fixed	2	1	ILLIAC
40 Bin	Fixed	2	1	JOHNNIAC
40 Bin	Fixed	2	2	JUKEBOX
40 Bin	Fixed	2	1	MANIAC I
40 Bin	Fixed	2	1	MISTIC
40 Bin	Fixed	2	1	ORACLE
40 Bin	Fixed	2	1	ORDVAC
40 Bin	Fixed	2	1	RECOMP I CP 266
40 Bin	Fixed and Floating	2	1	RECOMP II
40 Bin	Fixed and Floating	2	1	REPAC
12 Dec	Fixed	1	1	BURROUGHS E 101
12 Dec	Fixed	1	1	BURROUGHS E 102
12 Dec	Fixed	—	1	BURROUGHS E 103
12 Dec	Fixed	1	3	DATAMATIC 1000
12 Dec	—	—	2	IBM 609
12 Dec	Fixed	—	1	IBM 632
12 Dec	Fixed	1	1	ITT BANK LN PROC
12 Dec	Fixed	—	3	LOGISTICS
12 Dec	Fixed	1	4	NATIONAL 390
12 Dec	Fixed	6	1	RPC 9000
12 Dec	Fixed	2	1	UNIVAC I
12 Dec	Fixed	2	1	UNIVAC II
12 Dec	Fixed and Floating	1	1	UNIVAC LARC
42 Bin	Fixed	1	3	NATIONAL 102 A
44 Bin	Fixed	2	1	CIRCLE
44 Bin	Fixed and Floating	1	4	EDVAC
45 Bin	Fixed	1	3	DYSEAC
45 Bin	Fixed	1	3 or 4	SEAC
48 Bin	Fixed and Floating	2	1	CDC 1604
48 Bin	Fixed and Floating	1	3	HONEYWELL 800
48 Bin	Fixed and Floating	2	1	MANIAC II
48 Bin	Floating	1	2	MANIAC III
48 Bin	Fixed and Floating	1	1 or 2	MERLIN
48 Bin	Fixed	2	1	NAREC
48 Bin	Fixed and Floating	2	1	PHILCO 2000
48 Bin	Fixed	2	1	PHILCO CXPQ
50 Bin	Fixed and Floating	1	1	AN/FSQ 31 (v)
50 Bin	Fixed and Floating	1	1	AN/FSQ 32
50 Bin	Fixed and Floating	1	3	WISC
15 Dec	Fixed and Floating	—	1	IBM 610
52 Bin	—	—	—	BURROUGHS D 104
54 Bin	Floating	1	1 or 3	OKLAHOMA UNIVERSITY
54 Bin	Fixed and Floating	1	1	RICE UNIVERSITY
16 Dec	Fixed and Floating	1	3	NORC
10 Alphanum	Fixed and Floating	0.5 to 6	1 or 3	NATIONAL 304
62 Bin	Fixed	—	1	MONROBOT IX
18 Dec	Fixed	—	up to 5	DE 60
64 Bin	Fixed and Floating	1 or 2	1 or 2	IBM STRETCH
68 Bin	Fixed and Floating	3	1	BRLESC
20 Dec	Fixed	1	4	MONROBOT III
20 Dec	Fixed	—	4	MONROBOT V
20 Dec	Fixed	2	4	MONROBOT VI
12 Alphanum	Fixed	1	3	UNIVAC FILE 0
12 Alphanum	Fixed	13	3	UNIVAC FILE 1
96 Bin	Fixed	2	3	MONROBOT MU
42 Dec	Fixed	—	1	MAGNEFILE D
Variable	Fixed	3	—	BIZMAC I
Variable	Fixed	3	—	BIZMAC II

WORD LENGTH DIGITS	ARITHMETIC POINT	INSTRUCTIONS PER WORD	ADDRESSES PER WORD	SYSTEM
Variable	Fixed	1	2	DIANA
Variable	—	—	—	FOSDIC
Variable	Fixed	—	2	IBM 305 RAMAC
Variable	Fixed	—	1	IBM 702
Variable	Fixed	—	1	IBM 705 I II
Variable	Fixed	—	1	IBM 705 III
Variable	Fixed	—	1 or 2	IBM 1401
Variable	—	—	—	IBM 1410
Variable	Fixed	—	2	IBM 1620
Variable	Fixed	—	1	IBM 7080
Variable	—	Variable	1	RASTAC
Variable	—	2	—	RASTAD
Variable	Fixed	Variable	2	RCA 301
Variable	Fixed	Variable	2	RCA 501
Variable	Fixed and Floating	1 or 2	1, 2 or 3	RCA 601
Variable	—	1 to 3	1	SCRIBE
Variable	Fixed	—	1	TELEREGISTER TELEFILE
Variable	Fixed	—	3	UNIVAC 60
Variable	Fixed	—	3	UNIVAC 120

Systems indicated as "floating-point" systems have built-in automatic "floating-point" circuitry.

"Fixed-point" systems may be programmed for "floating-point" operation through the use of subroutines.

IV.
ARITHMETIC OPERATION TIME (EXCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
0.75	300	600	PROGRAMMED DATA PROCESSOR
0.8	7.4	24	UNIVAC 1107
1	1,000	1,000	LINCOLN TX 0
1 - 3.0	20	60	BRLESC
1.38 - 1.50	2.48 - 2.70	9.00 - 9.90	IBM STRETCH
1.4	5 to 17 (9 × 36 Bits)	17.2 to 75 (9/36)	LINCOLN TX 2
1.4	20	40	WESTINGHOUSE AIRBORNE
1.7	40.3	43	PHILCO 2000
2	25 - 100	100	BURROUGHS D 204
2	22	42	LITTON C 7000
2.5 - 27.5	14 - 61.5	5 - 63.5	AN/FSQ 31 (v)
2.5 - 27.5	14 - 61.5	56.5 - 70	AN/FSQ 32
3	56	68	BURROUGHS D 201
3	34	73	BURROUGHS D 202
3	—	—	ITT SPES 025
3 - 4	100	100	OKLAHOMA UNIVERSITY
3 - 7	26 - 485	27 - 595	GEORGE
3.5	130	320	MERLIN
4	39	40	SYLVANIA S 9400
4	8	28	UNIVAC LARC
4.8 - 12	7.2 - 72	72	UNIVAC 490
5	20	40	TARGET INTERCEPT
5	260	324	UNIVAC 1101
5.3	296	—	SWAC
5.5	130	200	PHILCO 1000
6.0	10.5	45.0	AN/FSQ 7 AN/FSQ 8 (SAGE)
6	48 - 90	48 - 90	LITTON DATA ASSESSOR
6	450	650	NAREC
6	10	25	RCA 601
6.4	1,000	1,800	CDC 160
6.6	—	—	NORDEN VOTE TALLY
7.8	—	—	FADAC
8	78	88	MOBIDIC A
8	78	80	MOBIDIC C D & 7A
8	—	—	ORACLE
9	76.5 - 185.5	76.5 - 312.5	UNIVAC III
9.6	35.2 - 112	112	AN/USQ 20
10	—	—	CUBIC TRACKER
10	385	385	JOHNNIAC
10	—	—	TELEREGISTER UNIFIED AIRLINE
12	240	240	COMPAC
12	74	74	LINCOLN CG 24
12	276	252	PACKARD BELL 250
12	86	156	RCA 300
12.7	376	400	AN/TYK 7v INFORMER
13	56	98	BENDIX G 20
13	—	—	SPEC
14	700	700	ORDVAC
15	31	227	NORC
16	16 to 400	16 to 436	LIBRASCOPE MK 130
17	264	340	UNIVAC 1102

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
18 + n/2	65	75	MANIAC III
20	230	480	GENERAL ELECTRIC 225
21.5	430,000	—	IBM 632
22	356	370	LIBRASCOPE AIR TRAFFIC
23/Dig	—	—	IBM 702
24	264	288	AN/ASQ 28 (v) MDC
24 or 48	444	444	IBM 701
25	50	—	CCC REAL TIME
26	700	750	BURROUGHS D 208
28	223	470	UNIVAC 1103 1103 A
32	518	1,168	GENERAL ELECTRIC 210
34	80	—	MOBIDIC B
36	—	—	NATIONAL 315
36	110	472	UNIVAC 1105
40	520	1,000	ATHENA
40	620 - 820	900	ILLIAC
40	75	75	RICE UNIVERSITY
40 to 130	—	—	INTELEX AIRLINE RESERVATION
43	—	—	BENDIX D 12
48	2,112	2,112	DYSEAC
48	2,112	2,112	SEAC
58	835	2,131	DATAMATIC 1000
59	59	177	LIBRASCOPE CP 209
60	800	920	GENERAL MILLS AD/ECS
60	1,260	3,420	NATIONAL 304
70	960	1,170	CYCLONE
80	1,000	1,000	MANIAC I
80	980	1,080	MISTIC
80	2,000	2,000	VERDAN
84	84/Bit	84/Bit	HUGHES D PAT
84	84/Bit	84/Bit	HUGHES LRI X
85	—	—	UNIVAC SOLID STATE 80/90
85	—	—	UNIVAC STEP
86	3,000	3,000	BURROUGHS D 203
88	968	1,936	HUGHES M 252
88 - 176	3,912	5,912	UDEC I II III
91	800	1,200	OARAC
94	2,985	5,076	PENNSTAC
96	1,920	2,496	GENERAL ELECTRIC 312
100	760	1,320	HONEYWELL 290
100	2,000	4,000	LIBRASCOPE 407
105	105 + 105/Bit	105/Bit	HUGHES DIGITAIR
80 + 16 (Aug + Add)	—	—	TELEREGISTER TELEFILE
120	1,500	—	GENERAL MILLS APSAC
120	1,680	2,990	UNIVAC II
130	2,730	2,730	LEEDS NORTHROP 3000
132	2,772	2,772	PHILCO 3000
156	3,276	3,276	AN/ASQ 28 (v) EDC
156	1,872	—	ASC 15
156	3,907	4,063	LIBRASCOPE ASN 24
120 + 40C	160 + 288N + 145MN	Prog	BIZMAC I
120 + 40C	—	—	BIZMAC II
170	680 - 10,710	—	ITT BANK LN PROC
185	2,055	3,970	BURROUGHS 220
186	2,577	4,270	DIANA
200	1,700	1,700	HUGHES ADV AIRBORNE III
220	1,760	5,300	HAMPSHIRE TRTDS 932
220	11,000	13,420	IBM 608
230	1,980	3,520	RPC 9000
240	—	—	MODAC 404
240 - 420	1,900 - 9,600	1,300 - 2,400	RCA 501
250	250	—	CUBIC AIR TRAFFIC
250	17,000	17,000	LGP 30
250	15,000	15,000	LIBRATROL 500
250	16,250	16,250	LIBRATROL 1000
250	17,000	17,000	RPC 4000
270	—	—	BENDIX G 15
282.6	1,907.6	3,707.6	UNIVAC I
288	8,000	8,000	MODAC 414
330	18,300	18,700	ELECOM 120
330	18,300	18,700	ELECOM 125 125FP
428	8,500	8,000	HAMPSHIRE CCC 500
440	16,000	24,000	READIX
450	13,600	14,800	MINIAC II
500	20,000	20,000	CIRCLE
500	14,000	17,000	IBM 604
520	12,940	15,700	IBM 607
540	10,800	11,340	JUKEBOX

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
540	10,800	10,800	REPAC
600	7,000	7,000	MODAC 410
650	39,000	—	ELECOM 50
672 - 768	2,210 - 19,600	6,000 - 23,400	IBM 650 RAMAC TAPES
760	13,180	15,480	IBM-CPC
780	2,990	3,120	RW 300
1,000	32,000	32,000	ALWAC II
1,000	17,000	17,000	ALWAC III E
1,000	20,000	20,500	RECOMP I CP 266
1,200	16,300	20,000	UNIVAC FILE 0
1,200	16,300	20,000	UNIVAC FILE 1
1,350	12,400	12,700	RECOMP II
3,000	140,000	140,000	DE 60
3,000	—	—	MONROBOT IX
3,000	28,000	500,000	MONROBOT XI
4,000	15,000	15,500	NATIONAL 102 D
7,400	25,000	25,800	NATIONAL 102 A
42,500	241,500	291,500	BURROUGHS E 103
100,000	—	—	MAGNEFILE D
150,000	—	—	MAGNEFILE B
280,000	1,155,000	1,155,000	IBM 610

V.
ARITHMETIC OPERATION TIME (INCLUDING ACCESS) OF COMPUTING SYSTEMS

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
2.5 - 27.5	14 - 61.5	5 - 63.5	AN/FSQ 31 (v)
2.5 - 27.5	14 - 61.5	56.5 - 70	AN/FSQ 32
3	20	40	WESTINGHOUSE AIRBORNE
3.7 - 11.7	42.3 - 50.3	45 - 53.0	PHILCO 2000
4	26	46	LITTON C 7000
4	12.7	31	UNIVAC 1107
4	8	28	UNIVAC LARC
4.36 - 32.70	4.36 - 30.52	6.54 - 32.70	IBM 7090
4.8	9.6 to 19.2	19.6 to 80.0	LINCOLN TX 2
4.8 - 9.6	25.2 to 0.8N	63.6 - 66.4	CDC 1604
5	65	80	BURROUGHS D 103
5	300	600	PROGRAMMED DATA PROCESSOR
5	10	105	SYLVANIA UDOFTT
5 - 6	25	65	BRLESC
6	1,000	1,000	LINCOLN TX 0
6.4 - 19.2	—	—	CDC 160
7 - 16	108	108	OKLAHOMA UNIVERSITY
7.2 - 12	19.2 - 84	84	UNIVAC 490
8	140	330	MERLIN
8	43	44	SYLVANIA S 9400
9	76.5 - 184.5	76.5 - 312.5	UNIVAC III
9.75	13.75	28.75	RCA 601
10	40	80	BURROUGHS D 202
10	56	70	IBM 7074
10	25	45	TARGET INTERCEPT
10	—	—	TRICE
10.2 - 12.6	30 - 108	108	BURROUGHS D 204
12.0	16.5	51.0	AN/FSQ 7 AN/FSQ 8 (SAGE)
12	60 - 102	60 - 102	LITTON DATA ASSESSOR
13.08 (6 + 6)	140 (6 × 6)	210 (10/6)	IBM 7080
16	35.2 - 112	112	AN/USQ 20
16	—	—	ITT SPES 025
16	86	88	MOBIDIC A
16	86	88	MOBIDIC C D & 7A
17/Digit	—	—	IBM 705 I II
20	—	—	CUBIC TRACKER
20.7	392	425	AN/TYK 7v INFORMER
22	300 - 600	575 - 725	NAREC
22	—	—	STORED PROGRAM DDA
22	34 - 41	71	WHIRLWIND II
22 - 26	238 - 242	238 - 242	AN/TYK 6v BASICPAC
24	264	288	AN/ASQ 28 (v) MDC
24	252	252	COMPAC
24	162	450	HONEYWELL 800
24	84	84	LINCOLN CG 24
24	96	168	RCA 300
24 + n/2	71	81	MANIAC III
24 - 84	24 - 240	36 - 240	IBM 704
24 - 84	24 - 240	36 - 240	IBM 709

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
25	75	75	BURROUGHS D 201
25	75	—	CCC REAL TIME
25	400	400	JOHNNIAC
26	700	750	BURROUGHS D 208
27	70	112	BENDIX G 20
32	—	—	BURROUGHS D 209
32	366	380	LIBRASCOPE AIR TRAFFIC
32	—	—	MODAC 5014
33	—	—	NORDEN VOTE TALLY
36	80	128	RW 400
36 or 60	456	456	IBM 701
40	230	426	BURROUGHS D 107
40	250	500	GENERAL ELECTRIC 225
40	375	520	LEPRECHAUN
40	40 to 424	40 to 460	LIBRASCOPE MK 130
42	88	—	MOBIDIC B
42	294	1,044	NATIONAL 315
44	239	486	UNIVAC 1103 1103 A
45	—	—	PHILCO CXPQ
50	85	85	RICE UNIVERSITY
50 to 140	—	—	INTELEX AIRLINE RESERVATION
56	728	868	RCA 110
59	59	177	LIBRASCOPE CP 209
60	116	508	UNIVAC 1105
64	550	1,200	GENERAL ELECTRIC 210
64	368	—	SWAC
70	370 - 590	590	ORACLE
72 (10 + 10)	672 to 1,488 (10 × 10)	792 to 984	IBM 7070
80	840	940	GENERAL MILLS AD/ECS
84	84 + 84/Bit	84 + 84/Bit	HUGHES LRI X
86	3,000	3,000	BURROUGHS D 203
90	300 - 1,700	—	AF/CRC
93	665 - 865	950	ILLJAC
95.8	770.8	3,159.2	IBM 705 III
100	990	1,200	CYCLONE
100	1,000	1,100	MISTIC
108	372	348	PACKARD BELL 250
120	1,520	16,200	GENERAL MILLS APSAC
120	540	540	MONROBOT V
120	1,320	3,480	NATIONAL 304
160	1,720	3.030	UNIVAC II
160	—	—	VERDAN
170	680 - 10,710	—	ITT BANK LN PROC
176 - 264	4,000	6,000	UDEC I II III
192	2,016	2,592	GENERAL ELECTRIC 312
160 + 16 (Aug + Add)	80 + 16	80 + 16	TELEREGISTER TELEFILE
192 - 1,536	2,208 - 3,552	2,256 - 3,600	EDVAC
192 - 1,536	2,304 - 3,648	2,304 - 3,648	DYSEAC
192 - 1,540	2,300 - 3,650	2,300 - 3,650	SEAC
200	2,070	3,985	BURROUGHS 220
200	860	1,420	HONEYWELL 290
210	105 + 105/Bit	105/Bit	HUGHES DIGITAIR
210	7,800	—	RCA 301
220	1,760	5,300	HAMPSHIRE TRTDS 932
221	—	—	SPEC
224	13,860 (6 × 6)	17,640 (6/6)	IBM 609
230.4	1,008	2,304	DATAMATIC 1000
250	250	—	CUBIC AIR TRAFFIC
264	1,144	2,112	HUGHES M 252
300	1,960	2,170	IBM 1401
312	2,028	—	ASC 15
400 - 17,000	10,000 - 26,000	10,000 - 26,000	OARAC
428	8,500	8,000	HAMPSHIRE CCC 500
440	25,000	40,000	READIX
500	500 - 1,000	—	LOGISTICS
500	17,000	17,000	RPC 4000
525	2,150	3,950	UNIVAC I
540	2,430 - 16,700	2,430 - 16,700	BENDIX G 15
540	10,800	11,300	RECOMP II
560	3,137	4,830	DIANA
624	3,744	3,744	AN/ASQ 28 (v) EDC
625	4,219	4,375	LIBRASCOPE ASN 24
780	2,990	3,120	RW 300
910	3,600	3,600	LEEDS NORTHROP 3000
924	4,224	4,224	PHILCO 3000
960 (10 Dig)	17,700 (10 Dig)	16.8	IBM 1620
1,000	17,000	17,000	ALWAC III E
1,000	17,000	17,000	LIBRATROL 1000
1,019 - 1,188	9,300	12,680	BURROUGHS 204
1,019 - 1,188	9,300	12,680	BURROUGHS 205

ADD TIME MICROSECONDS	MULTIPLY TIME MICROSECONDS	DIVIDE TIME MICROSECONDS	SYSTEM
1,110	2,860	3,520	RPC 9000
1,360	1,275	1,275	UNIVAC SOLID STATE 80/90
1,360	1,275 +	1,275 +	UNIVAC STEP
1,980	22,240	22,740	REPAC
2,000	21,000	21,500	RECOMP I CP 266
3,445	5,335	7,426	PENNSTAC
3,500	22,000	22,000	ELECOM 125 125FP
7,750	23,000	23,000	LIBRATROL 500
7,800	21,000 to 49,100	21,000 to 53,200	NATIONAL 102 D
8,000	17,000	17,000	LGP 30
8,000	8,000	8,000	MODAC 414
8,000	68,000	77,000	MONROBOT MU
8,700	23,800	27,500	UNIVAC FILE 0
8,700	23,800	27,500	UNIVAC FILE 1
9,000	34,000	500,000	MONROBOT XI
9,590	19,850	20,390	JUKEBOX
11,000	250,000	400,000	NATIONAL 390
11,200	24,300	25,600	MINIAC II
12,000	13,500	54,000	MONROBOT IX
15,000	40,000	40,000	NATIONAL 107
16,700	16,700	16,700	WISC
17,010	—	—	TELEREGISTER UNIFIED AIRLINES
19,900	37,500	38,500	NATIONAL 102 A
20,000	—	—	ELECOM 100
25,000	—	—	MODAC 404
30,000	60,000 - 190,000	100,000 - 370,000	IBM 305 RAMAC
50,000	250,000	250,000	BURROUGHS E 101
50,000	250,000	250,000	BURROUGHS E 102
51,000	250,000	300,000	BURROUGHS E 103
60,000	220,000	200,000	DE 60
110,000	2,500,000	—	IBM 632
120,000	540,000	540,000	MONROBOT III
135,000	600,000	600,000	MONROBOT VI

VI.
ACCESS TIME OF HIGH-SPEED STORAGE UNITS

ACCESS TIME MICROSECONDS	STORAGE MEDIUM	SYSTEM
0.2 - 0.8	MC	WESTINGHOUSE AIRBORNE
0.3 and 1.8	MC and TF	UNIVAC 1107
0.5 - 2.18	MC	IBM STRETCH
0.88	DL	RPC 9000
0.9 - 1.5	MC	RCA 601
1.0	—	MANIAC III
1.07	MC	UNIVAC III
1.9	MC	UNIVAC 490
2	MC	BRLESC
2	MC	BURROUGHS D 202
2	MC	BURROUGHS D 208
2 or 10	MC	PHILCO 2000
2.1	MC	HONEYWELL 800
2.2 and 3.4	MC	LINCOLN TX 2
2.4 and 15	MC and CRT	MANIAC II
2.5	MC	AN/FSQ 31 (v)
2.5	MC	AN/FSQ 32
2.5	MC	BURROUGHS D 201
2.8	—	TARGET INTERCEPT
2.18	MC	IBM 7080
2.18	MC	IBM 7090
3	MC	LINCOLN TX 0
3	MC	NAREC
3	MC	RCA 300
3 - 4	MC	NORDEN VOTE TALLY
4	MC	IBM 7074
4	MC	LITTON C 7000
4	MC	SYLVANIA S 9400
4	MC	UNIVAC LARC
4.5/Alphanum	MC	IBM 1410
4.8	MC	CDC 1604
5	MC	BURROUGHS D 103
5	MC	PROGRAMMED DATA PROCESSOR
5	MC	SYLVANIA UDOFTT
6	MC	AN/FSQ 7 AN/FSQ 8 (SAGE)
6	MC	IBM 7070
6	MC	ITT BANK LN PROC
6	MC	LITTON DATA ASSESSOR
6	CRT	MERLIN
6/Alphanum	MC	NATIONAL 304
6	MC	NATIONAL 315
6.4	MC	CDC 160
7	MC	RCA 301
7	MC	WHIRLWIND II
7.5	MC	GEORGE
8	MC	AN/TYK 7v INFORMER
8	MC	AN/USQ 20
8	MC	GENERAL MILLS AD/ECS
8	MC	ITT SPES 025
8	MC	LEPRECHAUN
8	MC	MOBIDIC A
8	MC	MOBIDIC B
8	MC	MOBIDIC C D & 7A
8	CRT	NORC
8	CRT	OKLAHOMA UNIVERSITY
8	CRT	SWAC
8	MC	UNIVAC 1103 1103 A
8	MC	UNIVAC 1105
8 to 16	CRT	MANIAC I
8.4	MC	BENDIX G 20
9.3	MC	IBM 705 III
10	MC	GENERAL MILLS APSAC
10	MC	INTELEX AIRLINE RESERVATION
10	MC	LIBRASCOPE AIR TRAFFIC
10	MC	NUMERICORD
10	CRT	RICE UNIVERSITY
10	MC	RW 400
10	DL	TRICE
10	MC	UNIVAC 1101
10	MC	UNIVERSAL DATA TRANS
10/Bit	—	CUBIC TRACKER
11.5	MC	IBM 1401
12	MC	AN/TYK 6v BASICPAC
12	MC	COMPAC
12	MC	DATAMATIC 1000
12	MC	IBM 701
12	MC	IBM 704
12	MC	IBM 709

ACCESS TIME MICROSECONDS	STORAGE MEDIUM	SYSTEM
12	MC	LINCOLN CG 24
12	MC	PHILCO 1000
12	MC	PHILCO CXPQ
12 and 216	CRT and DL	SEAC
14	MC	SCRIBE
15	MC	BURROUGHS 220
15	MC	JOHNNIAC
15	MC	ORDVAC
15	MC	RCA 501
16	MC	TELEREGISTER TELEFILE
17	MC	IBM 702
17	MC	IBM 705 I II
18	CRT	ORACLE
18 - 36	CRT	ILLIAC
20	MC	BIZMAC I
20	MC	BIZMAC II
20	MC	DIGITRONIC CONVERTER
20	MC	GENERAL ELECTRIC 225
20	MC	HONEYWELL 290
20	MC	IBM 1620
20	MC	LIBRASCOPE MK 130
20 and 20	CRT and MC	MISTIC
21.5	MC	IBM 632
22	DL	STORED PROGRAM DDA
22/Bit	MC	NATIONAL 390
24	MC	AN/ASQ 28 (v) MDC
30	CRT	CYCLONE
32	MC	GE 100 ERMA
32	MC	GENERAL ELECTRIC 210
34	MC	DIANA
40	MC	ATHENA
40	MC	UNIVAC II
40.4 to 404	DL	UNIVAC I
48 - 384	DL	DYSEAC
48 - 384	DL	EDVAC
84	MC	HUGHES D PAT
88	MC	UDEC I II III
96 - 129	VT	LOGISTICS
208	DL	SPEC
220	MC	IBM 608
250 - 500	DL	CCC REAL TIME
288	MC	MODAC 414
500	MC	ALWAC III E
500	VT	IBM 604
520	VT	IBM 607
625	MC	HUGHES BM GUIDANCE
760	VT	IBM CPC
900	MC	UNIVAC FILE 1
3,000	MC	BURROUGHS D 104

KEY TO SYMBOLS

CRT	Cathode Ray Tube (Electrostatic)
MC	Magnetic Core (Static Magnetic)
DL	Delay Line (Sonic, Electric, Magnetostrictive)
VT	Vacuum Tube
TF	Thin Magnetic Film

VII.
CAPACITY OF HIGH-SPEED STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
16,384 to 262,144 - 64 Bin	MC	IBM STRETCH
81,920 to 163,840 - 50 Bin	MC	AN/FSQ 32
65,536 to 131,072 - 50 Bin	MC	AN/FSQ 31 (v)
97,500 - 12 Dec	MC	UNIVAC LARC
69,632 - 38 Bin	MC	LINCOLN TX 2
65,536 and 128 - 36 Bin	MC and TF	UNIVAC 1107
69,632 - 32 Bin	MC	AN/FSQ 7 AN/FSQ (SAGE)
up to 262,144 Alphanumeric Char	MC	RCA 501
4,096 to 32,768 - 48 Bin	MC	PHILCO 2000
32,768 - 48 Bin	MC	CDC 1604
262,144 - 6 Bin (Var)	MC	RCA 601
up to 32,000 - 12 Dec	MC	HONEYWELL 800
32,768 - 38 Bin	MC	SYLVANIA S 9400
32,768 - 36 Bin	MC	IBM 7090
up to 32,768 - 36 Bin	MC	IBM 704
4,096 to 32,768 - 36 Bin	MC	IBM 709
65,536 - 18 Bin	MC	LINCOLN TX 0
20,000 - 16 Dec	CRT	NORC
4,096 to 32,768 - 33 Bin	MC	BENDIX G 20
32,768 - 30 Bin	MC	AN/USQ 20
16,384 to 32,768 - 30 Bin	MC	UNIVAC 490
40,000 to 160,000 Alphanumeric Char	MC	IBM 7080
16,384 - 49 Bin	MC and CRT	MANIAC II
16,384 - 48 Bin	MC	NAREC
32,768 - 24 Bin	MC	UNIVAC III
1,024 and 16,384 - 40 Bin	CRT and MC	MISTIC
16,384 - 34 Bin	MC	BURROUGHS D 107
16,384 - 33 Bin	MC	ITT SPES 025
8,192 - 63 Bin	CRT	OKLAHOMA UNIVERSITY
40,000 or 80,000 Alphanumeric Char	MC	IBM 705 III
8,192 - 54 Bin	CRT	RICE UNIVERSITY
12,288 - 36 Bin	MC	UNIVAC 1103 1103 A
4,096 to 12,288 - 36 Bin	MC	UNIVAC 1105
2,000 to 40,000 - 3 Dec	MC	NATIONAL 315
8,192 - 49 Bin	CRT	MERLIN
8,192 - 48 Bin	—	MANIAC III
to 16,384 - 22 Bin	MC	PACKARD BELL 250
10,000 - 10 Dec	MC	BURROUGHS 220
2,000 to 10,000 - 10 Dec	MC	INTELEX AIRLINE RESERVATION
5,000 or 9,990 - 10 Dec	MC	IBM 7070
5,000 or 9,990 - 10 Dec	MC	IBM 7074
2,048 to 16,384 - 20 Bin	MC	GENERAL ELECTRIC 225
8,192 - 40 Bin	MC	MOBIDIC A
8,192 - 40 Bin	MC	MOBIDIC B
8,192 - 40 Bin	MC	MOBIDIC C D & 7A
12,236 and 15 - 25 and 14 Bin	—	TARGET INTERCEPT
4,096 - 72 Bin	MC	BRLESC
2,400 to 4,800 - 10 Alphanum	MC	NATIONAL 304
40,000 Alphanumeric Char	MC	IBM 705 I II
40,000 Alphanumeric Char	MC	IBM 1410
8,192 - 27 Bin	MC	LINCOLN CG 24
4,096 - 52 Bin	MC	CDC 160
20,000 to 60,000 Decimal Digits	MC	IBM 1620
4,096 - 48 Bin	MC	PHILCO CXPQ
8,189 - 22 Bin	MC	SYLVANIA UDOFTT
4,096 - 42 Bin	MC	GEORGE
4,096 - 40 Bin	MC	JOHNNIAC
4,096 - 40 Bin	MC	ORDVAC
4,000 or 8,000 - 6 Dec	MC	GENERAL ELECTRIC 210
4,096 - 38 Bin	MC	AN/TYK 6v BASICPAC
4,096 - 38 Bin	MC	AN/TYK 7v INFORMER
4,096 - 38 Bin	MC	COMPAC
4,096 - 37 Bin	MC	GENERAL MILLS AD/ECS
4,096 - 18 or 36 Bin	MC	IBM 701
4,096 - 36 Bin	MC	PHILCO 1000
20,000 Alphanumeric Char	MC	RCA 301
4,096 and 1,024 - 21 and 24 Bin	MC	WESTINGHOUSE AIRBORNE
4,000 - 8 Dec	MC	LIBRASCOPE AIR TRAFFIC
8,192 - 13 Bin	MC	RCA 300
256 to 4,096 - 24 Bin	MC	RCA 110
4,096 - 24 Bin	MC	UNIVAC 1101
6,144 - 16 Bin	MC	WHIRLWIND II
1,400 to 16,000 Alphanumeric Char	MC	IBM 1401
4,000 - 7 Dec	MC	GE 100 ERMA
2,048 - 45 Bin	CRT and DL	SEAC

CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM	CAPACITY WORDS - DIGITS/WORD	STORAGE MEDIUM	SYSTEM
2,048 - 40 Bin	CRT	ORACLE	200 - 12 Dec	MC	NATIONAL 390
2,000 - 12 Dec	MC	DATAMATIC 1000	320 - 25 Bin	DL	CCC REAL TIME
2,000 - 12 Dec	MC	UNIVAC II	256 - 24 Bin	MC	ATHENA
4,096 - 19 Bin	MC	LIBRASCOPE MK 130	1,024 - 6 Bin	MC	DIGITRONIC CONVERTER
1,024 to 4,096 - 18 Bin	MC	HONEYWELL 290	100 - 12 Dec	MC	ITT BANK LN PROC
1,024 to 4,096 - 18 Bin	MC	PROGRAMMED DATA PROCESSOR	100 - 10 Dec	MC	UDEC I II III
			219 - 15 Bin	DL	STORED PROGRAM DDA
2,048 - 36 Bin	MC	UNIVERSAL DATA TRANS	77 - 12 Dec	DL	RPC 9000
10,000 Alphanumeric Char	MC	IBM 702	128 - 21 Bin	MC	BURROUGHS D 201
15,000 Decimal Digits	MC	TELEREGISTER TELEFILE	128 and 20 - 13 and 21 Bin	DL	SPEC
8,192 Alphanumeric Char	MC	BIZMAC II	20 - 12 Alphanum	MC	UNIVAC FILE 1
256 and 1,536 - 29 and 27 Bin	MC	BURROUGHS D 204	32 - 12 Dec	MC	IBM 609
1,024 - 44 Bin	DL	EDVAC	81 - 16 Bin	MC	BURROUGHS D 209
1,024 - 40 Bin	CRT	CYCLONE	64 - 8 to 20 Bin	—	CUBIC TRACKER
1,024 - 40 Bin	CRT	ILLIAC	40 - 9 Dec	MC	IBM 608
1,024 - 40 Bin	CRT	MANIAC I	334 Decimal Digits	MC	NUMERICORD
1,000 - 12 Dec	DL	UNIVAC I	32 - 33 Bin	MC	ALWAC III E
200 to 10,000 Decimal Digits	MC	DIANA	15 - 12 Dec	VT	LOGISTICS
1,024 - 32 Bin	MC	LITTON DATA ASSESSOR	12 - 10 Dec	VT	UNIVAC 120
1,280 - 22 Bin	MC	LITTON C 7000	20 - 20 Bin	MC	BURROUGHS D 103
4,096 Alphanumeric Char	MC	BIZMAC I	15 - 22 Bin	MC	HAMPSHIRE TRTDS 932
512 - 46 Bin	DL	DYSEAC	8 - 12 Dec	MC	IBM 632
1,024 - 23 Bin	MC	AN/ASQ 28 (v) MDC	16 - 20 Bin	MC	RCA 200
512 - 36 Bin	MC	GENERAL MILLS APSAC	9 - 22 Bin	MC	HAMPSHIRE CCC 500
1,024 - 18 Bin	MC	LEPRECHAUN	9 - 3 or 5 Dec	VT	IBM 604
512 - 32 Bin	MC	BURROUGHS D 104	9 - 3 or 5 Dec	VT	IBM CPC
256 and 512 - 24 and 16 Bin	MC	BURROUGHS D 208	37 Decimal Digits	VT	IBM 607
512 - 22 Bin	MC	BURROUGHS D 202	3 - 19 Bin	MC	HUGHES D PAT
600 - 17 Bin	MC	NORDEN VOTE TALLY	2 - 6 Dec	MC	MODAC 414
600 - 17 Bin	MC	SCRIBE	1 - 27 Bin/Module	DL	TRICE
256 - 39 Bin	CRT	SWAC	Var - 7 Dec	MC	RW 400

KEY TO SYMBOLS

CRT	Cathode Ray Tube (Electrostatic)
MC	Magnetic Core (Static Magnetic)
DL	Delay Line (Sonic, Electric, Magnetostrictive)
VT	Vacuum Tube
TF	Thin Film

VIII.
LOG_{10} CAPACITY/ACCESS TIME OF HIGH-SPEED STORAGE UNITS

LOG_{10} CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM	LOG_{10} CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM
13.527	MC	IBM STRETCH	10.766	MC	IBM 7070
12.515	MC	AN/FSQ 32	10.742	MC	UNIVAC 1103 1103 A
12.418	MC	AN/FSQ 31 (v)	10.742	MC	UNIVAC 1105
12.242	MC	RCA 601	10.727	MC	IBM 1410
12.134	CRT	NORC	10.713	MC	IBM 705 III
12.118	MC	UNIVAC 1107	10.681	MC	NATIONAL 304
12.054	MC	LINCOLN TX 2	10.646	CRT	RICE UNIVERSITY
11.997	MC	UNIVAC LARC	10.614	MC	BURROUGHS D 107
11.896	MC	PHILCO 2000	10.611	MC	MOBIDIC A
11.867	MC	UNIVAC III	10.611	MC	MOBIDIC B
11.794	MC	HONEYWELL 800	10.611	MC	MOBIDIC C D & 7A
11.733	MC	IBM 7090	10.556	MC	SYLVANIA UDOFTT
11.713	MC	UNIVAC 490	10.550	MC	RCA 300
11.644	MC	IBM 7080	10.542	CRT and MC	MISTIC
11.633	MC	WESTINGHOUSE AIRBORNE	10.532	MC	INTELEX AIRLINE RESERVATION
11.594	MC	LINCOLN TX 0	10.521	MC	CDC 160
11.594	—	MANIAC III	10.516	MC	CDC 1604
11.569	MC	AN/FSQ 7 AN/FSQ 8 (SAGE)	10.493	MC	SYLVANIA S 9400
11.418	MC	NAREC	10.474	MC	GE 100 ERMA
11.168	MC	BRLESC	10.360	MC	GEORGE
11.109	MC	BENDIX G 20	10.356	MC	BURROUGHS 220
11.090	MC	AN/USQ 20	10.289	MC	AN/TYK 7v INFORMER
11.040	—	TARGET INTERCEPT	10.278	MC	GENERAL MILLS AD/ECS
11.021	MC	RCA 501	10.266	MC	LINCOLN CG 24
10.992	MC	IBM 709	10.234	MC	RCA 301
10.983	MC	IBM 704	10.215	MC	GENERAL ELECTRIC 225
10.922	MC	MANIAC II	10.214	MC	PHILCO CXPQ
10.875	MC	IBM 7074	10.168	MC	PROGRAMMED DATA PROCESSOR
10.833	MC	NATIONAL 315	10.150	MC	IBM 705 I II
10.830	MC	ITT SPES 025	10.146	MC	WHIRLWIND II
10.824	CRT	MERLIN	10.122	MC	AN/TYK 6v BASICPAC
10.809	CRT	OKLAHOMA UNIVERSITY	10.113	MC	COMPAC

LOG$_{10}$ CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM	LOG$_{10}$ CAPACITY/ACCESS	STORAGE MEDIUM	SYSTEM
10.090	MC	PHILCO 1000	9.090	MC	BIZMAC I
10.088	MC	IBM 701	9.032	MC	BURROUGHS D 201
10.038	MC	JOHNNIAC	9.004	DL	UNIVAC I
10.038	MC	ORDVAC	9.000	MC	DIANA
10.037	MC	LIBRASCOPE AIR TRAFFIC	8.992	MC	AN/ASQ 28 (v) MDC
10.008	MC	IBM 1620	8.973	DL	EDVAC
9.992	MC	UNIVAC 1101	8.844	MC	ITT BANK LN PROC
9.922	MC	IBM 1401	8.728	MC	SCRIBE
9.868	MC	UNIVERSAL DATA TRANS	8.709	DL	DYSEAC
9.855	MC	BURROUGHS D 208	8.570	MC	NATIONAL 390
9.846	MC	LITTON C 7000	8.487	MC	DIGITRONIC CONVERTER
9.832	MC	DATAMATIC 1000	8.186	MC	ATHENA
9.750	MC	BURROUGHS D 202	8.184	DL	STORED PROGRAM DDA
9.736	MC	LITTON DATA ASSESSOR	8.056	MC	NUMERICORD
9.710	CRT	MANIAC I	7.904	MC	BURROUGHS D 103
9.708	MC	GENERAL ELECTRIC 210	7.587	MC	UDEC I II III
9.658	CRT	ORACLE	7.204	DL	CCC REAL TIME
9.590	MC	LIBRASCOPE MK 130	7.183	MC	IBM 632
9.584	CRT	SEAC	7.000	DL	SPEC
9.566	MC	HONEYWELL 290	6.806	—	CUBIC TRACKER
9.553	DL	RPC 9000	6.805	VT	LOGISTICS
9.548	MC	IBM 702	6.746	MC	IBM 608
9.531	MC	NORDEN VOTE TALLY	6.738	MC	BURROUGHS D 104
9.504	MC	TELEREGISTER TELEFILE	6.431/Module	DL	TRICE
9.390	MC	BIZMAC II	6.324	MC	ALWAC III E
9.364	MC	LEPRECHAUN	6.284	VT	IBM 607
9.356	CRT	ILLIAC	6.204	MC	UNIVAC FILE 1
9.310	MC	UNIVAC II	5.832	MC	HUGHES D PAT
9.265	MC	GENERAL MILLS APSAC	5.401	VT	IBM 604
9.135	CRT	CYCLONE	5.218	VT	IBM CPC
9.097	CRT	SWAC	5.154	MC	MODAC 414

KEY TO SYMBOLS

CRT Cathode Ray Tube (Electrostatic)
MC Magnetic Core (Static Magnetic)
DL Delay Line (Sonic, Electric, Magnetostrictive)
VT Vacuum Tube

IX. CAPACITY OF MAGNETIC DRUM OR DISK STORAGE UNITS

CAPACITY WORDS - DIGITS/WORD	SYSTEM	CAPACITY WORDS - DIGITS/WORD	SYSTEM
2, 097,152 to 67,108,864 - 64 Bin	IBM STRETCH	4,096 to 51,200 - 24 Bin	RCA 110
652,000,000 Alphanum Char	DIANA	8,500 - 42 Dec	MAGNEFILE D
72,000,000 - 12 Dec	UNIVAC LARC	16,384 to 32,768 - 36 Bin	UNIVAC 1105
24,050,000 - 10 Dec	UNIVAC SOLID STATE 80/90	2,048 to 50,000 - 20 Bin	GENERAL ELECTRIC 312
23,040,000 - 10 Dec	UNIVAC STEP	16,384 - 48 Bin	PHILCO CXPQ
6,500,000 - 36 Bin	UNIVAC 1107	40,728 - 19 Bin	HUGHES D PAT
6,000,000 - 38 Bin	SYLVANIA S 9400	8,192 or 16,384 - 18 or 36 Bin	IBM 701
62,000,000 Decimal Digits	RASTAC	16,384 - 36 Bin	IBM 704
62,000,000 Decimal Digits	RASTAD	8,192 or 16,384 - 36 Bin	IBM 709
600,000 to 4,800,000 - 10 Dec	IBM 7070	16,384 - 36 Bin	UNIVAC 1103 1103 A
600,000 to 4,800,000 - 10 Dec	IBM 7074	36,864 - 16 Bin	WHIRLWIND II
3,750,000 - 38 Bin	AN/TYK 7v INFORMER	26,624 and 6,656 - 16 and 24 Bin	AN/ASQ 28 (v) MDC
20,000,000 Alphanum Char	IBM 305 RAMAC	4,096 to 32,000 - 18 Bin	HONEYWELL 290
20,000,000 Alphanum Char	IBM 1401	12,800 - 40 Bin	ILLIAC
10,000,000 to 20,000,000 Alphanum Char	IBM 1410	12,288 - 40 Bin	JOHNNIAC
24,000,000 Decimal Digits	UNIVAC III	12,800 - 10 Dec	INTELEX AIRLINE RESERVATION
32,768 to 1,048,576 - 48 Bin	PHILCO 2000	11,000 - 11 Dec	NATIONAL 107
6,250,000 - 8 Bin	MOBIDIC B	10,000 - 12 Dec	ITT BANK LN PROC
6,000,000 Alphanum Char	IBM 705 III	20,000 - 6 Dec	MODAC 404
1,114,112 - 30 Bin	UNIVAC 490	10,032 - 40 Bin	ORDVAC
139,264 to 557,056 - 50 Bin	AN/FSQ 31 (v)	10,000 - 40 Bin	MANIAC I
139,264 to 557,056 - 50 Bin	AN/FSQ 32	8,192 - 48 Bin	NAREC
21,000 to 117,000 - 4 to 60 Dec	LOGISTICS	16,384 - 24 Bin	UNIVAC 1101
600,000 - 10 Dec/Unit	IBM 650 RAMAC TAPES	10,000 - 11 Dec	OARAC
1,070 to 151,070 - 12 Alphanum Char	UNIVAC FILE 0	10,000 - 37 Bin	GENERAL MILLS AD/ECS
1,070 to 151,070 - 12 Alphanum Char	UNIVAC FILE 1	3,770 - 96 Bin	BURROUGHS D 103
256,000 - 8 Dec	LIBRASCOPE AIR TRAFFIC	60,000 Alphanum Char	IBM 702
135,168 - 32 Bin	AN/FSQ 7 AN/FSQ 8 (SAGE)	60,000 Alphanum Char	IBM 705 I II
65,536 - 33 Bin	ITT SPES 025	16,260 - 22 Bin	LEEDS NORTHROP 3000
20,010 - 96 Bin	MONROBOT MU	8,064 to 16,256 - 22 Bin	PHILCO 3000
24,576 - 72 Bin	BRLESC	4,000 to 10,000 - 10 Dec	ELECOM 125 125FP
1,500,000 Binary Digits	TELEREGISTER MAGNETRONIC INVENTORY CONTROL	8,192 or 16,384 - 20 Bin	GENERAL ELECTRIC 225
		8,192 - 38 Bin	SWAC
1,300,000 Binary Digits	TELEREGISTER UNIFIED AIRLINE	12,800 - 22 Bin	LITTON C 7000

CAPACITY WORDS - DIGITS/WORD	SYSTEM
7,936 or 15,520 - 18 Bin	RW 300
8,320 - 33 Bin	ALWAC III E
1,000 to 10,000 - 8 Dec	ELECOM 120
12,256 - 22 Bin	BURROUGHS D 202
8,064 - 32 Bin	LIBRATROL 1000
8,008 - 32 Bin	RPC 4000
4,608 - 44 Bin	EDVAC
10,000 - 20 Bin	MODAC 5014
8,192 - 24 Bin	UNIVAC 1102
32,736 Alphanum Char	BIZMAC II
4,096 - 46 Bin	CIRCLE
5,300 - 10 Dec	UDEC I II III
5,000 - 10 Dec	MODAC 410
4,096 - 41 Bin	AN/MJQ 1 REDSTONE
4,096 - 41 Bin	JUKEBOX
4,096 - 12 Dec	REPAC
4,096 - 40 Bin	RECOMP II
5,014 - 32 Bin	BURROUGHS D 203
4,128 - 35 Bin	FADAC
4,160 - 10 Dec	READIX
4,096 - 10 Dec	MINIAC II
8,192 - 17 Bin	ATHENA
4,080 - 10 Dec	BURROUGHS 204
4,080 - 10 Dec	BURROUGHS 205
4,096 - 32 Bin	LGP 30
4,160 - 31 Bin	LIBRATROL 500
6,004 - 6 Dec	MODAC 414
6,784 - 18 Bin	LIBRASCOPE MK 38
4,040 - 8 Dec	MAGNEFILE B
5,225 - 21 Bin	BURROUGHS D 201
18,000 Alphanum Char	BIZMAC I
10,000 - 3 Dec	AMOS IV
100,000 Binary Digits	TELEREGISTER MAGNETRONIC BID ASKED
3,840 - 26 Bin	AN/ASQ 28 (v) EDC
99,584 Binary Digits	ASC 15
2,048 - 48 Bin	BURROUGHS D 104
2,500 - 11 Dec	PENNSTAC
2,064 - 40 Bin	RECOMP I CP 266
2,560 - 32 Bin	LITTON DATA ASSESSOR
22,000 Decimal Digits	AF/CRC
2,112 - 33 Bin	ALWAC II
3,000 - 22 Bin	LIBRASCOPE 407
2,560 - 25 Bin	LIBRASCOPE ASN 24
2,176 - 29 Bin	BENDIX G 15
1,031 - 50 Bin	WISC
1,024 - 42 Bin	NATIONAL 102 A
1,664 - 24 Bin	VERDAN
1,024 - 9 Dec + 6 Bin	NATIONAL 102 D
1,992 - 17 Bin	HUGHES ADV AIRBORNE III
1,024 - 32 Bin	MONROBOT XI
784 - 40 Bin	SCRIBE
1,025 - 20 Bin	CUBIC AIR TRAFFIC
300 - 20 Dec	MONROBOT V
650 - 8 Dec	BENDIX D 12
1,024 - 16 Bin	HRB SINGER
512 - 30 Bin	ELECOM 100
200 - 20 Dec	MONROBOT III
200 - 20 Dec	MONROBOT VI
32 to 160 - 18 Dec	DE 60
220 - 12 Dec	BURROUGHS E 101
220 - 12 Dec	BURROUGHS E 102
220 - 12 Dec	BURROUGHS E 103
84 - 31 Dec	IBM 610
100 - 10 Dec	ELECOM 50
114 - 29 Bin	BENDIX CUBIC TRACKER
15 - 18 Dec	MONROBOT IX
Variable	RW 400
Variable	TELEREGISTER TELEFILE

X.
TUBE QUANTITY IN COMPUTING SYSTEMS

TUBE QUANTITY	SYSTEM
5	PERK I II
6	BURROUGHS D 201
10 to 30	MONROBOT XI
13	RW 300
14	DE 60
15	AF/CRC
22	NORDEN VOTE TALLY
28	LINCOLN CG 24
48	PHILCO CXPQ
65	HAMPSHIRE TRTDS 932
74	MONROBOT IX
113	LGP 30
130	MAGNEFILE B
140	MAGNEFILE D
150	DISTRIBUTAPE
150	IBM 632
150	RASTAC
150	RASTAD
160	BURROUGHS E 101
160	BURROUGHS E 102
160	ELECOM 50
164	HAMPSHIRE CCC 500
175	LIBRATROL 500
215	UNIVAC SOLID STATE AD/90
215	UNIVAC STEP
230	ELECOM 100
240	BENDIX G 20
250	ALWAC II
250	BURROUGHS E 103
263	READIX
302	LIBRASCOPE CP 209
400	ELECOM 120
400	NATIONAL 102 A
409	HUGHES DIGITAIR
425	NATIONAL 102 D
440	LINCOLN TX 0
450	ELECOM 125 125 FP
450	PHILCO 2000
481	HUGHES ADV AIRBORNE III
535	MODAC 5014
600	MODAC 410
600	NUMERICORD
700	BENDIX D 12
765	LINCOLN TX 2
780	ALWAC III E
800	MONROBOT III
800	MONROBOT V
800	NATIONAL 107
800-1,000	CIRCLE
835	BENDIX G 15
850	MINIAC II
900	DYSEAC
1,000	MODAC 404
1,200	FOSDIC
1,200	OARAC
1,202	BURROUGHS 204
1,202	BURROUGHS 205
1,250	IBM 604
1,300	DIANA
1,300	NAREC
1,342	PENNSTAC
1,376-5,467	IBM 650 RAMAC TAPES
1,500	IBM CPC
1,800	BURROUGHS 220
1,800	SYLVANIA UDOFTT
1,800	WISC
2,000	MODAC 414
2,000	OKLAHOMA UNIV
2,044	IBM 305 RAMAC
2,148	UNIVAC 60

TUBE QUANTITY	SYSTEM
2,200	BURROUGHS D 103
2,281	SEAC
2,396	CYCLONE
2,400	MANIAC I
2,500	SWAC
2,584	IBM 607
2,610	MISTIC
2,695	UNIVAC 1101
2,700	UNIVAC 1102
2,942	MERLIN
3,000	UDEC I II III
3,430	ORDVAC
3,500	GEORGE
3,556	RICE UNIVERSITY
3,600	DATAMATIC 1000
3,907	UNIVAC 1103 1103 A
4,000	IBM 701
4,427	ILLIAC
4,500	LOGISTICS
4,500	TELEREGISTER UNIFIED AIRLINE
5,000	BIZMAC II
5,000	IBM 704
5,000	JOHNNIAC
5,000	ORACLE
5,190	MANIAC II
5,200	UNIVAC I
5,200	UNIVAC II
5,937	EDVAC
6,120	BRLESC
7,000	BURROUGHS D 104
8,293	UNIVAC 1105
9,800	NORC
10,000	IBM 702
14,500	WHIRLWIND II
30,000	BIZMAC I

XI.
CRYSTAL DIODE QUANTITY IN COMPUTING SYSTEMS

CRYSTAL DIODE QUANTITY	SYSTEM
1	MONROBOT V
40	MAGNEFILE B
100	MONROBOT III
115	PHILCO CXPQ
150	MODAC 5014
154	IBM 164
200	ORACLE
240	MAGNEFILE D
300	LEPRECHAUN
300	RCA 200
350	WISC
350	LINCOLN TX 0
406	IBM 305 RAMAC
500	JOHNNIAC
500	MANIAC I
886	STORED PROGRAM DDA
915	ORDVAC
950	AN/TYK 6v BASICPAC
1,000	HAMPSHIRE CCC 500
1,000	MONROBOT IX
1,113	IBM 1620
1,200	PHILCO 2000
1,250	CUBIC TRACKER
1,344	TARGET INTERCEPT
1,450	LIBRATROL 500
1,500	LGP 30
1,500	LIBRASCOPE AIR TRAFFIC
1,617	SPEC
1,626	BURROUGHS D 209
1,800	BURROUGHS E 101
1,800	BURROUGHS E 102
1,964	DISTRIBUTAPE
2,000	BURROUGHS E 103
2,000	CUBIC AIR TRAFFIC
2,000	DE 60
2,000	ELECOM 50
2,000	FOSDIC
2,000	MINIAC II
2,000	MODAC 404
2,000	SYLVANIA S 9400
2,200	BENDIX D 12
2,200	ELECOM 100
2,265	GENERAL ELECTRIC 312
2,292	RCA 300
2,300	MONROBOT XI
2,400	LIBRATROL 1000
2,500	ELECOM 125 125 FP
2,500	NATIONAL 107
2,385	UNIVAC 1101
3,000	HAMPSHIRE TRTDS 932
3,000	LEEDS NORTHROP 3000
3,000	MODAC 410
3,000	MODAC 414
3,000	PROGRAMMED DATA PROCESSOR
3,000	TELEREGISTER UNIFIED AIRLINE
3,000	UNIVAC 1102
3,050	MANIAC II
3,364	HUGHES ADV AIRBORNE III
3,500	ALWAC II
3,500	COMPAC
3,553	LIBRASCOPE ASN 24
3,800	BURROUGHS 204
3,800	BURROUGHS 205
3,943-11,428	IBM 650 RAMAC TAPES
4,000	HUGHES M 252
4,000	NATIONAL 390
4,000	RW 300
4,000	SWAC
4,075	READIX
4,200	PHILCO 3000
4,289	HUGHES DIGITAIR
4,395	AN/ASQ 28 (v) EDC
4,400	BENDIX G 15
4,500	ELECOM 120
Over 4,500	LIBRASCOPE CP 209
4,700	NORDEN VOTE TALLY
5,000	LOGISTICS
5,000	NUMERICORD
5,000	SCRIBE
5,194	IBM 609
5,200	BURROUGHS D 201
5,224	LINCOLN TX 2
5,316	JUKEBOX
5,400	HUGHES D PAT
5,768	PENNSTAC
6,000	GEORGE
6,000	MOBIDIC A
6,000	MOBIDIC B
6,000	MOBIDIC C D 7A
6,000	UDEC I II III
6,213-14,171	IBM 1401
6,314	AN/TYK 7v INFORMER
6,900	BURROUGHS D 203
7,000	BURROUGHS D 208
7,000	CDC 160
7,000	OARAC
7,000	RECOMP I CP 266
8,000	NATIONAL 102 A

CRYSTAL DIODE QUANTITY	SYSTEM
8,000	NATIONAL 304
8,000	RASTAC
8,000	RASTAD
8,500	NATIONAL 102 D
8,956	UNIVAC 1103 1103 A
9,000	HONEYWELL 290
10,000	IBM 704
10,000	RECOMP II
10,000	VERDAN
11,090	BURROUGHS D 204
12,000	BURROUGHS D 202
12,000	EDVAC
12,000	REPAC
12,800	IBM 701
13,000	RICE UNIVERSITY
13,076	AN/ASQ 28 (v) MDC
13,160	BURROUGHS D 107
13,500	ALWAC III E
14,000	BURROUGHS D 103
14,000	WHIRLWIND II
14,500	BIZMAC II
14,515	LIBRASCOPE MK 130
15,000	GENERAL MILLS AD/ECS
15,500	TELEREGISTER TELEFILE
15,651	LIBRASCOPE MK 38
15,985	WESTINGHOUSE AIRBORNE
16,000	OKLAHOMA UNIV
16,415	UNIVAC 1105
16,540	MERLIN
17,000	IBM 702
18,000	UNIVAC I
18,000	UNIVAC II
20,000	GENERAL MILLS APSAC
20,000	MANIAC III
20,000	SYLVANIA UDOFTT
22,000	CCC REAL TIME
23,000	LITTON DATA ASSESSOR
24,000	SEAC
24,500	DYSEAC
25,000	BURROUGHS D 104
30,000	HONEYWELL 800
30,000	ITT BANK LN PROC
30,000	NAREC
30,000	NORC
33,000	ATHENA
33,200	LINCOLN CG 24
33,787	AN/USQ 20
36,505	UNIVAC SOLID STATE 80/90
36,505	UNIVAC STEP
38,000	BENDIX G 20
50,000	ITT SPES 025
60,000	DATAMATIC 1000
62,000	DIANA
70,000	BIZMAC I
90,417	UNIVAC 1107
100,000	CDC 1604
126,300	BRLESC
170,000	AN/FSQ 7 AN/FSQ 8 (SAGE)
229,000	AN/FSQ 31 (v)
305,000	AN/FSQ 32

XII. TRANSISTOR QUANTITY IN COMPUTING SYSTEMS

TRANSISTOR QUANTITY	SYSTEM
0-211	IBM 650 RAMAC TAPES
6	PENNSTAC
16	BENDIX G 15
64	DISTRIBUTAPE
75	ALWAC III E
100	ORACLE
100	RASTAC
100	RASTAD
Over 100	LIBRASCOPE CP 209
200	BIZMAC I
200	DE 60
279	SPEC
300	NUMERICORD
309	STORED PROGRAM DDA
328	EDVAC
382	LIBRASCOPE ASN 24
383	MONROBOT XI
400	PACKARD BELL 250
500	DATAMATIC 1000
500	SYLVANIA UDOFTT
580	RW 300
592	AN/ASQ 28 (v) EDC
650	LIBRATROL 1000
700	BURROUGHS D 209
703	AN/FSQ 7
820	MERLIN
885	JUKEBOX
900	HAMPSHIRE TRTDS 932
919	UNIVAC SOLID STATE 80/90
919	UNIVAC STEP
1,100	HUGHES M 252
1,148	UNIVAC 1105
1,150	NATIONAL 390
1,160	MANIAC II
1,200	UNIVAC II
1,300	LEEDS NORTHROP 3000
1,400	CDC 160
1,500	GENERAL MILLS AD/ECS
1,500	GENERAL MILLS APSAC
1,500	HONEYWELL 290
1,500	PHILCO 3000
1,500	RCA 200
1,500	REPAC
1,500	VERDAN
1,600	CUBIC TRACKER
1,600	RECOMP I CP 266
1,683	HUGHES LRIX
1,697	AN/ASQ 28 (v) MDC
1,800	HUGHES D PAT
1,820	BURROUGHS D 208
1,887	IBM 609
1,900	RICE UNIVERSITY
2,000	RECOMP II
2,000-3,000	OKLAHOMA UNIV
2,091	ORDVAC
2,563	LIBRASCOPE MK 38
2,572	GENERAL ELECTRIC 312
2,600	CUBIC AIR TRAFFIC
2,700	CCC REAL TIME
2,700	PROGRAMMED DATA PROCESSOR
3,000	FOSDIC
3,088	IBM 1620
3,100	LITTON DATA ASSESSOR
3,470	BURROUGHS D 107
3,500	LINCOLN TX 0
3,500	SCRIBE
3,500	TELEREGISTER TELEFILE
3,900	NORDEN VOTE TALLY
4,000	NATIONAL 304
4,200	BURROUGHS D 104
4,315-9,805	IBM 1401
4,800	NAREC
5,000	BURROUGHS D 202
5,000	LEPRECHAUN
5,400	RCA 300
5,550	PHILCO CXPQ

TRANSISTOR QUANTITY	SYSTEM
6,000	HONEYWELL 800
6,500	BURROUGHS D 203
6,600	BURROUGHS D 201
7,015	LIBRASCOPE MK 130
7,500	ATHENA
7,597	WESTINGHOUSE AIRBORNE
8,500	BURROUGHS D 204
8,740	BRLESC
8,900	BENDIX G 20
10,000	COMPAC
10,000	ITT BANK LN PROC
10,000	LOGISTICS
10,265	AN/USQ 20
10,789	AN/TYK 7v INFORMER
12,000	MANIAC III
14,188	AN/TYK 6v BASICPAC
18.930	LINCOLN CG 24

TRANSISTOR QUANTITY	SYSTEM
20,000	GEORGE
20,000	TARGET INTERCEPT
23,000	LIBRASCOPE AIR TRAFFIC
25,000	CDC 1604
25,522	UNIVAC 1107
30,000	MOBIDIC B
30,000	MOBIDIC C D 7A
32,000	MOBIDIC A
36,000	SYLVANIA S 9400
Over 36,000	IBM 7080
51,000	ITT SPES 025
56,000	PHILCO 2000
61,533	LINCOLN TX 2
138,000	AN/FSQ 31 (v)
200,000	IBM STRETCH
201,000	AN/FSQ 32

XIII.
APPROXIMATE POWER REQUIREMENT OF COMPUTING SYSTEMS

POWER KILOWATTS	SYSTEM
0.010	HRB SINGER
0.020	RCA 20
0.029	STORED PROGRAM DDA
0.030	HUGHES BM GUIDANCE
0.060	SPEC
0.10	PACKARD BELL 250
0.13	LIBRASCOPE ASN 24
0.13	RCA 300
0.15	ASC 15
0.15	DE 60
0.16	LEPRECHAUN
0.20	RPC 9000
0.22	BURROUGHS D 208
0.25	AN/ASQ 28 (v) EDC
0.25	LIBRASCOPE 407
0.30	HUGHES D PAT
0.30	RECOMP I CP 266
0.31	AN/TYK 7v INFORMER
0.32	VERDAN
0.37	HUGHES M 252
0.40	CCC REAL TIME
0.50	JUKEBOX
0.50	RECOMP II
0.50	RW 300
0.60	LEEDS NORTHROP 3000
0.60	MAGNEFILE B
0.60	REPAC
0.67	MONROBOT IX
0.70	CDC 160
0.70	FADAC
0.70	PHILCO 3000
0.73	RPC 4000
0.75	IBM 632
0.80	AN/ASQ 28 (v) MDC
0.80	PROGRAMMED DATA PROCESSOR
0.85	HUGHES LRIX
0.85	MONROBOT XI
0.86	BURROUGHS D 203
0.86	GENERAL MILLS APSAC
0.90	BURROUGHS D 201
0.90	TRICE
0.95	LITTON C 7000
1.0	AN/MJQ 1 REDSTONE
1.0	BURROUGHS D 107
1.0	CUBIC TRACKER
1.0	GENERAL MILLS AD/ECS
1.0	GEOTECH AUTOMATIC
1.0	HAMPSHIRE CCC 500
1.0	IBM 609
1.0	MAGNEFILE D
1.1	LGP 30
1.2	PHILCO 1000

POWER KILOWATTS	SYSTEM
1.4	HONEYWELL 290
1.5	HAMPSHIRE TRTDS 932
1.5	HUGHES ADV AIRBORNE III
1.5	IBM 610
1.5	LITTON DATA ASSESSOR
1.8	BURROUGHS D 202
1.8	BURROUGHS E 103
1.8	LIBRASCOPE CP 209
1.8	WESTINGHOUSE AIRBORNE
1.8	BURROUGHS D 204
2.0	DISTRIBUTAPE
2.0	ELECOM 50
2.0	IBM 1620
2.0	LIBRATROL 1000
2.0	MANIAC III
2.1	IBM 608
2.5	AN/USQ 20
2.5	LIBRATROL 500
2.5	MONROBOT III
2.5	TARGET INTERCEPT
2.7	SCRIBE
2.9-12	IBM 1401
3.0	BURROUGHS E 101
3.0	BURROUGHS E 102
3.0	CIRCLE
3.0	LIBRASCOPE AIR TRAFFIC
3.0	MODAC 404
3.1	BENDIX G 20
3.5	BENDIX G 15
3.5	ELECOM 100
3.6	COMPAC
4.0	ALWAC II
4.0	GENERAL ELECTRIC 312
4.0	MODAC 410
4.3	BENDIX CUBIC TRACKER
4.3	NATIONAL 390
4.5	LIBRASCOPE MK 38
4.5	NORDEN VOTE TALLY
4.5	RCA 110
4.6	LINCOLN CG 24
5.0	ALWAC III E
5.0	ELECOM 120
5.0	ELECOM 125 125 FP
5.0	FOSDIC
5.0	LIBRASCOPE MK 130
5.0	MINIAC II
5.0	MODAC 414
5.0	MONROBOT V
5.0	UNIVERSAL DATA TRANS
5.5	ATHENA
5.6	RCA 501
5.8	IBM 7090

POWER KILOWATTS	SYSTEM
6.0	ITT BANK LN PROC
6.0	NUMERICORD
6.8	IBM 604
7.2	PENNSTAC
7.5	BENDIX D 12
7.5	CDC 1604
7.7	NATIONAL 102 A
7.7	NATIONAL 102 D
8.0	READIX
8.0	UNIVAC 120
8.5	IBM CPC
9.0	GENERAL ELECTRIC 210
9.0	PHILCO CXPQ
10	LINCOLN TX 0
10	RW 400
10	WISC
11	IBM 305 RAMAC
12	DYSEAC
12	IBM 607
12	OKLAHOMA UNIV
13	AF/CRC
13	GENERAL ELECTRIC 225
13	RASTAC
13	RASTAD
13	UNIVAC STEP
14	BURROUGHS 204
14	BURROUGHS 205
14	IBM 7080
15	UNIVAC 1101
16	IBM 650 RAMAC TAPES
17	IBM 7070
17	LOGISTICS
18	MISTIC
18	SYLVANIA S 9400
19	CYCLONE
20	AN/TYK 6v BASICPAC
20	LINCOLN TX 2
20	RICE UNIVERSITY
21	OARAC
22	SEAC
22	UNIVAC 1102
24	SYLVANIA UDOFTT
25	NAREC
26	IBM 7074
26	RCA 301
27	ILLIAC
29	BURROUGHS D 103
30	BURROUGHS 220

POWER KILOWATTS	SYSTEM
30	ITT SPES 025
30	MOBIDIC A
30	SWAC
30	UDEC I II III
30	UNIVAC 1107
31	UNIVAC 490
32	HONEYWELL 800
33	MANIAC II
34	MOBIDIC B
35	BRLESC
35	MANIAC I
37	BIZMAC II
38	NATIONAL 304
39	UNIVAC SOLID STATE 80/90
40	MERLIN
40	ORDVAC
45	MOBIDIC C D & 7A
45	PHILCO 2000
45	RCA 601
50	GEORGE
52	EDVAC
55	JOHNNIAC
60	BURROUGHS D 104
69	IBM 705 I II
71	UNIVAC FILE 0
71	UNIVAC FILE 1
74	UNIVAC 1103 1103 A
75	IBM 702
75	ORACLE
75	UNIVAC III
76	IBM 701
76	IBM 704
81	UNIVAC I
90	DIANA
95	DATAMATIC 1000
100	IBM STRETCH
107	AN/FSQ 32
109	AN/FSQ 31 (v)
113	IBM 709
124	UNIVAC II
131	IBM 705 III
150	GE 100 ERMA
160	UNIVAC 1105
167	UNIVAC LARC
168	NORC
180	WHIRLWIND II
246	BIZMAC I
750	AN/FSQ 7 AN/FSQ 8 (SAGE)

XIV.
APPROXIMATE COST OF COMPUTING SYSTEMS

COST	SYSTEM
$ 1,000	PERK I II
6,000	IBM 632
9,650	MONROBOT IX
15,000	HRB SINGER
17,000 to 20,000	ITT BANK LN PROC
18,000	DE 60
19,195	SPEC
20,000	GEOTECH AUTOMATIC
20,000	MAGNEFILE B
22,500	ELECOM 50
24,500	MONROBOT XI
29,750	BURROUGHS E 101
29,750	BURROUGHS E 102
29,750	BURROUGHS E 103
36,000	IBM 609
40,500	PACKARD BELL 250
45,000	DISTRIBUTAPE
49,500	BENDIX G 15
49,500	LGP 30
50,000	ALWAC II
50,000	HAMPSHIRE CCC 500
50,000	MAGNEFILE D
50,000	TRICE
50,000 to 100,000	HAMPSHIRE TRTDS 932
55,000	BENDIX D 12
55,000	IBM 610
56,300	NATIONAL 390
60,000	CDC 160
60,000	ELECOM 100
64,000	IBM 1620
65,000	NATIONAL 102 D
70,000	NATIONAL 102 A
70,000	READIX
75,000	IBM CPC
75,000	UNIVAC 60
76,950	ALWAC III E
80,000	AN/MJQ 1 REDSTONE
80,000	CIRCLE
82,500	NATIONAL 315
84,500	LIBRATROL 500
85,000	MINIAC II
85,000	MODAC 5014
85,200	GENERAL ELECTRIC 312
86,074	MONROBOT V
87,500	RPC 4000
95,000	RECOMP II
97,000	ELECOM 120
97,500	UNIVAC 120
98,000	RW 300
100,000	MODAC 404
100,000	PENNSTAC
110,000	PROGRAMMED DATA PROCESSOR
120,000	MODAC 410
120,000	RPC 9000
125,600	IBM 1401
127,000	FOSDIC
141,980	GENERAL MILLS AD/ECS
150,000	MODAC 414
155,000	ELECOM 125 125FP
160,000	BURROUGHS D 204
167,850	IBM 305 RAMAC
170,000	HONEYWELL 290
175,000	UNIVAC STEP
182,000	IBM 650 RAMAC TAPES

COST	SYSTEM
$ 185,000	OARAC
196,000	RCA 301
200,000	BURROUGHS 204
200,000	BURROUGHS 205
200,000	GENERAL ELECTRIC 225
200,000	RASTAC
200,000	RASTAD
225,000	GENERAL ELECTRIC 210
225,000	NUMERICORD
230,000	IBM 701
250,000	MANIAC I
257,000	RCA 501
300,000	ILLIAC
300,000	TELEREGISTER MAGNET INVENT CONT
300,000	UNIVAC FILE 1
300,000	UNIVAC FILE 0
320,000	BURROUGHS 220
347,500	UNIVAC SOLID STATE 80/90
350,000	MANIAC II
350,000	UNIVERSAL DATA TRANS
354,000	LOGISTICS
358,000	IBM 702
366,600	NATIONAL 304
400,000	RICE UNIVERSITY
400,000	SWAC
467,000	EDVAC
478,000	BENDIX G 20
500,000	AN/TYK 6v BASICPAC
500,000	GEORGE
500,000	UDEC I II III
500,000 (Donated)	UNIVAC 1101
600,000	MERLIN
600,000	NORDEN VOTE TALLY
600,000	ORDVAC
700,000	UNIVAC III
750,000	CDC 1604
750,000	UNIVAC I
800,000	AF/CRC
813,250	IBM 7070
839,700	RCA 601
895,000	UNIVAC 1103 1103A
970,000	UNIVAC II
975,000	HONEYWELL 800
1,000,000	ITT SPES 025
1,000,000	LINCOLN CG 24
1,000,000	NATIONAL 107
1,284,350	IBM 7074
1,400,000	UNIVAC 1102
1,500,000	NAREC
1,500,000	UNIVAC 490
1,600,000	PHILCO CXPQ
1,640,000	IBM 705 I II
1,800,000 to 2,700,000	UNIVAC 1107
1,932,000	UNIVAC 1105
1,994,000 (Excluding Discount)	IBM 704
2,000,000	BRLESC
2,179,100	DATAMATIC 1000
2,200,000	IBM 7080
2,500,000	NORC
2,630,000	IBM 709
2,898,000	IBM 7090
4,500,000	BIZMAC I
6,000,000	UNIVAC LARC

CHRONOLOGICAL ORDER OF INITIAL OPERATION OF COMPUTING SYSTEMS

INITIAL DATE OF OPERATION	SYSTEM
May 1950	SEAC
1950	WHIRLWIND II
March 1951	SWAC
March 1951	UNIVAC I
1951	EDVAC
March 1952	MANIAC I
March 1952	ORDVAC
September 1952	ILLIAC
1952	ELECOM 100
March 1953	LOGISTICS
April 1953	OARAC
May 1953	IBM 701
August 1953	MAGNEFILE D
August 1953	UNIVAC 1103 1103 A
December 1953	UDEC I II III
1953	IBM 604
1953	NATIONAL 102 A
February 1954	MAGNEFILE B
March 1954	JOHNNIAC
April 1954	DYSEAC
June 1954	ALWAC II
June 1954	CIRCLE
July 1954	MODAC 5014
September 1954	MODAC 404
1954	BENDIX D 12
1954	BURROUGHS 204
1954	BURROUGHS 205
1954	IBM 650 RAMAC TAPES
1954	LGP 30
1954	WISC
February 1955	IBM 702
February 1955	MONROBOT III
February 1955	NORC
March 1955	MINIAC II
March 1955	MONROBOT V
August 1955	UNIVAC 1101
November 1955	BIZMAC I
1955	ALWAC III E
1955	BURROUGHS E 101
1955	IBM 705 I II
1955	MODAC 410
1955	PENNSTAC
1955	UNIVAC 60
1955	UNIVAC 120
1955	UNIVAC 1102
February 1956	READIX
April 1956	AF/CRC
April 1956	IBM 704
October 1956	MODAC 414
1956	BENDIX G 15
1956	BIZMAC II
1956	ELECOM 50
1956	ELECOM 120
1956	ELECOM 125 125FP
1956	IBM 608
1956	LEPRECHAUN
1956	MONROBOT MU
1956	NAREC
1956	PHILCO 1000
1956	RECOMP I CP 266
1956	TELEREGISTER MAGNET INVENT CONT
September 1957	GEORGE
September 1957	UNIVAC FILE 0
November 1957	AN/FSQ 7 AN/FSQ 8 (SAGE)
1957	IBM 709
1957	LINCOLN TX 0
1957	MANIAC II
1957	PHILCO 2000
May 1958	UNIVAC II
September 1958	AN/MJQ 1 REDSTONE
1958	IBM 610
1958	LINCOLN TX 2
1958	WRU SEARCHING SELECTOR
January 1959	RCA 501
February 1959	BURROUGHS 220
February 1959	UNIVAC 1105
July 1959	GE 100 ERMA
September 1959	FOSDIC
November 1959	NATIONAL 304
1959	AN/TYK 6v BASICPAC
1959	GENERAL ELECTRIC 210
1959	LIBRASCOPE AIR TRAFFIC
1959	LIBRASCOPE ASN 24
1959	RASTAD
1959	RPC 9000
1959	RW 300
1959	TRICE
1959	UNIVAC SOLID STATE 80/90
January 1960	CDC 1604
January 1960	HUGHES BM GUIDANCE
January 1960	UNIVERSAL DATA TRANS
April 1960	SYLVANIA UDOFTT
April 1960	UNIVAC LARC
August 1960	BENDIX CUBIC TRACKER
October 1960	BURROUGHS D 209
1960	AMOS IV
1960	AN/USQ 20
1960	CUBIC AIR TRAFFIC
1960	CUBIC TRACKER
1960	DIANA
1960	FADAC
1960	GENERAL ELECTRIC 225
1960	GENERAL MILLS APSAC
1960	GENERAL MILLS AD/ECS
1960	GENERAL ELECTRIC 312
1960	HAMPSHIRE TRTDS 932
1960	HRB SINGER
1960	HONEYWELL 800
1960	HUGHES DIGITAIR
1960	INTELEX AIRLINE RESERVATION
1960	IBM 1401
1960	IBM 1410
1960	IBM 7070
1960	IBM 7080
1960	IBM 7090
1960	IBM STRETCH
1960	LEEDS NORTHROP 3000
1960	LIBRASCOPE MK 130
1960	LIBRASCOPE 407
1960	LIBRATROL 1000
1960	LITTON DATA ASSESSOR
1960	MANIAC III
1960	MERLIN
1960	MOBIDIC A
1960	MOBIDIC B
1960	MOBIDIC C D & 7A
1960	NATIONAL 315
1960	NATIONAL 390
1960	NORDEN VOTE TALLY
1960	ORACLE
1960	PACKARD BELL 250
1960	PERK I II
1960	PHILCO 3000
1960	PROGRAMMED DATA PROCESSOR
1960	RCA 200
1960	RCA 300
1960	RPC 4000
1960	RASTAC
1960	RW 400
1960	REPAC
1960	SCRIBE
1960	SPEC
1960	STORED PROGRAM DDA
1960	SYLVANIA S 9400
1960	TARGET INTERCEPT
1960	UNIVAC III
1960	UNIVAC STEP
1960	WESTINGHOUSE AIRBORNE
April 1961	BRLESC
July 1961	RCA 601
November 1961	UNIVAC 490
1961	AN/TYK 7v INFORMER
1961	IBM 7074
1961	ITT BANK LN PROC
1961	ITT SPES 025
1961	OKLAHOMA UNIV
1961	RCA 110
1961	RICE UNIVERSITY
1962	UNIVAC 1107

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