H. C. Snyder USN

INTRODUCING THE-

ERA

1101

An *operationally proven*
high-speed, electronic,
general purpose digital computer

ENGINEERED AND MANUFACTURED BY

Engineering Research Associates, INC.

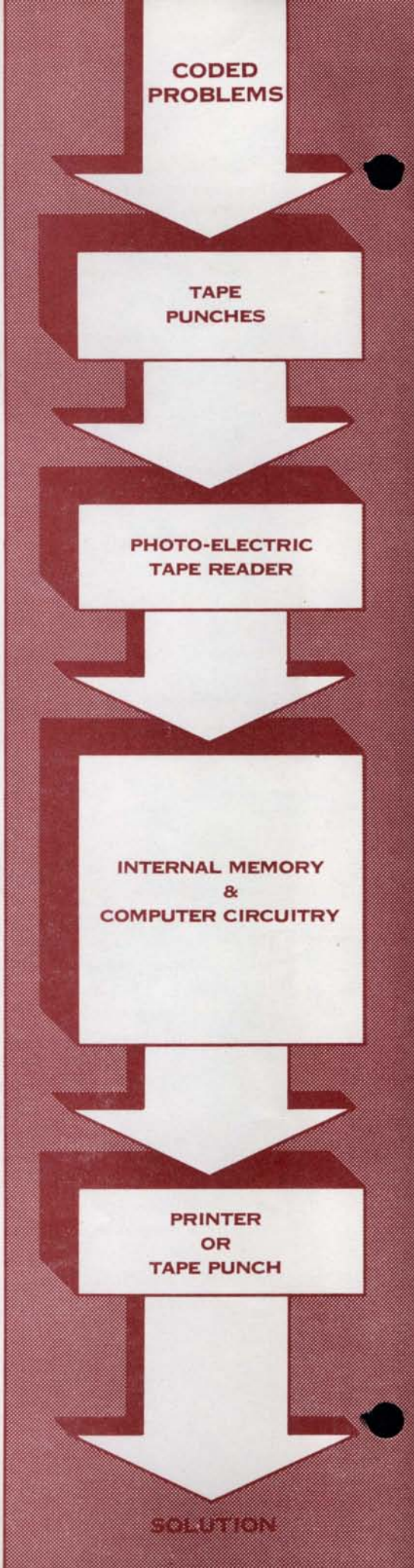
ST. PAUL, MINNESOTA ERA ARLINGTON, VIRGINIA

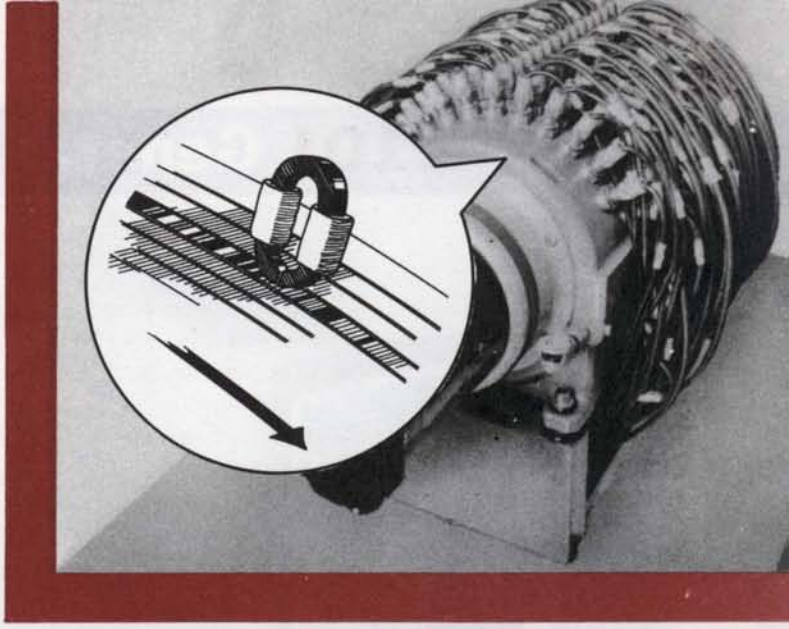
The **ERA 1101** is a new electronic 24-binary-digit computer incorporating high-speed arithmetic circuits and large internal storage capacity. It utilizes circuits and techniques resulting from more than five years of extensive **ERA** research and development, and is daily proving its worth as an invaluable mathematical aid.

The first **1101** was delivered to the United States Government in 1950—it was in operation eight days later. Operation of the computer on a nearly continuous basis since the installation date has established for the **1101** a standard of utility heretofore unknown for large scale computers.

Dependability has been designed into the **1101**. Only thoroughly tested components and systems have been incorporated. All components are operated sufficiently below their electrical and thermal ratings to assure excellent operational life. Preventive maintenance features built into the machine keep the computer operating with large margins of reliability. Electronic sections of the equipment are built up of pluggable chassis which may be readily replaced to minimize machine maintenance time.

In developing the new **ERA 1101**, Engineering Research Associates, Inc. has produced an *operationally practical* large-scale high-speed digital computer—*proven* in operation and *available* for early installation at *moderate cost.*





A maximum of 16,384 24-digit binary numbers may be stored as magnetic marks on the surface of the continuously rotating **1101** storage drum. The marks, stored at a density of 1280 per square inch, are arranged in parallel peripheral tracks, with a single magnetic head for reading and writing assigned to each track.

Description

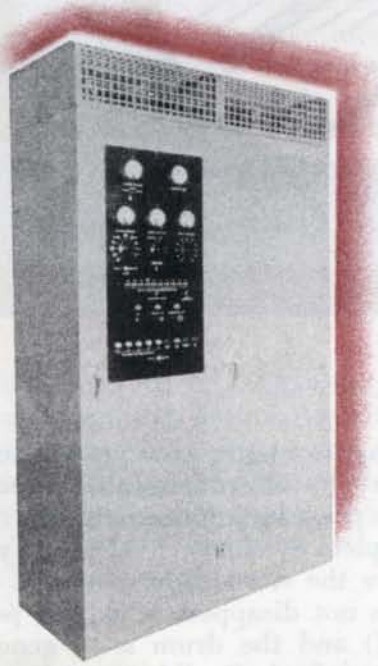
The **ERA 1101** consists of a photo-electric punched tape reader as the input, an internal memory (magnetic drum type) having a capacity of over 16,000 numbers, electronic arithmetic and control circuits, and an electric typewriter and a tape punch as output.

The photo-electric tape reader receives 7-level punched tape prepared with a simple 10-key keyboard and tape punch. The tape is read at high speed; should complete loading of the 16,384-item storage drum be necessary, it can be done in less than eight minutes. Numbers may be converted from decimal or octal to binary notation within the computer.

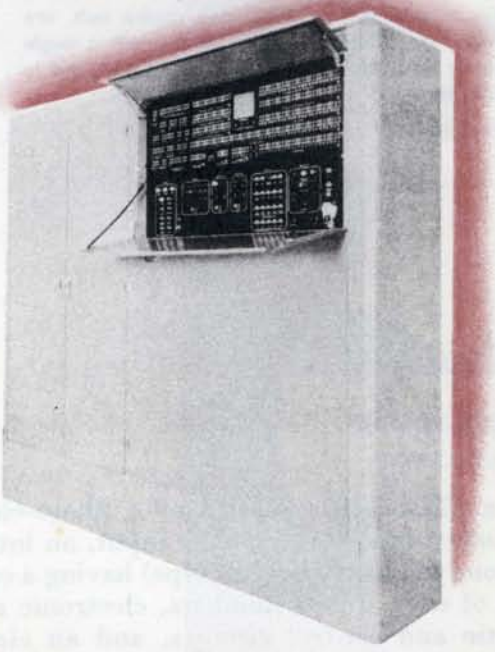
The magnetic drum storage system receives and holds the program of orders with which to solve a problem, the initial data on which operations are to be performed, and the intermediate and final results. The drum is subdivided into eight groups of 24-binary-digit numbers along its length; however all storage positions may be interchangeably used for either data or program information. The drum makes a complete revolution in about 17 milliseconds. Since the stored information is non-volatile (does not disappear when the power is turned off) and the drum is of generous capacity, it is perfectly feasible to retain whole problems and portions of problems on the surface of the drum from one day to the next. "Sub-routines" and standard test routines may be stored indefinitely if desired.

The **1101** operates on 24-digit binary numbers, equivalent to about seven decimal digits and a sign. A large order repertoire of 38 built-in commands (including add, subtract, divide, multiply, shift, sign detection, and zero detection) permits numbers of multiple precision to be used with appropriate programming. The sign- and zero-detection commands, in combination with the **1101**'s ability to perform arithmetic operations on program material give powerful versatility. The arithmetic circuits assume the binary point fixed in the right-hand position. Control is of the single address type.

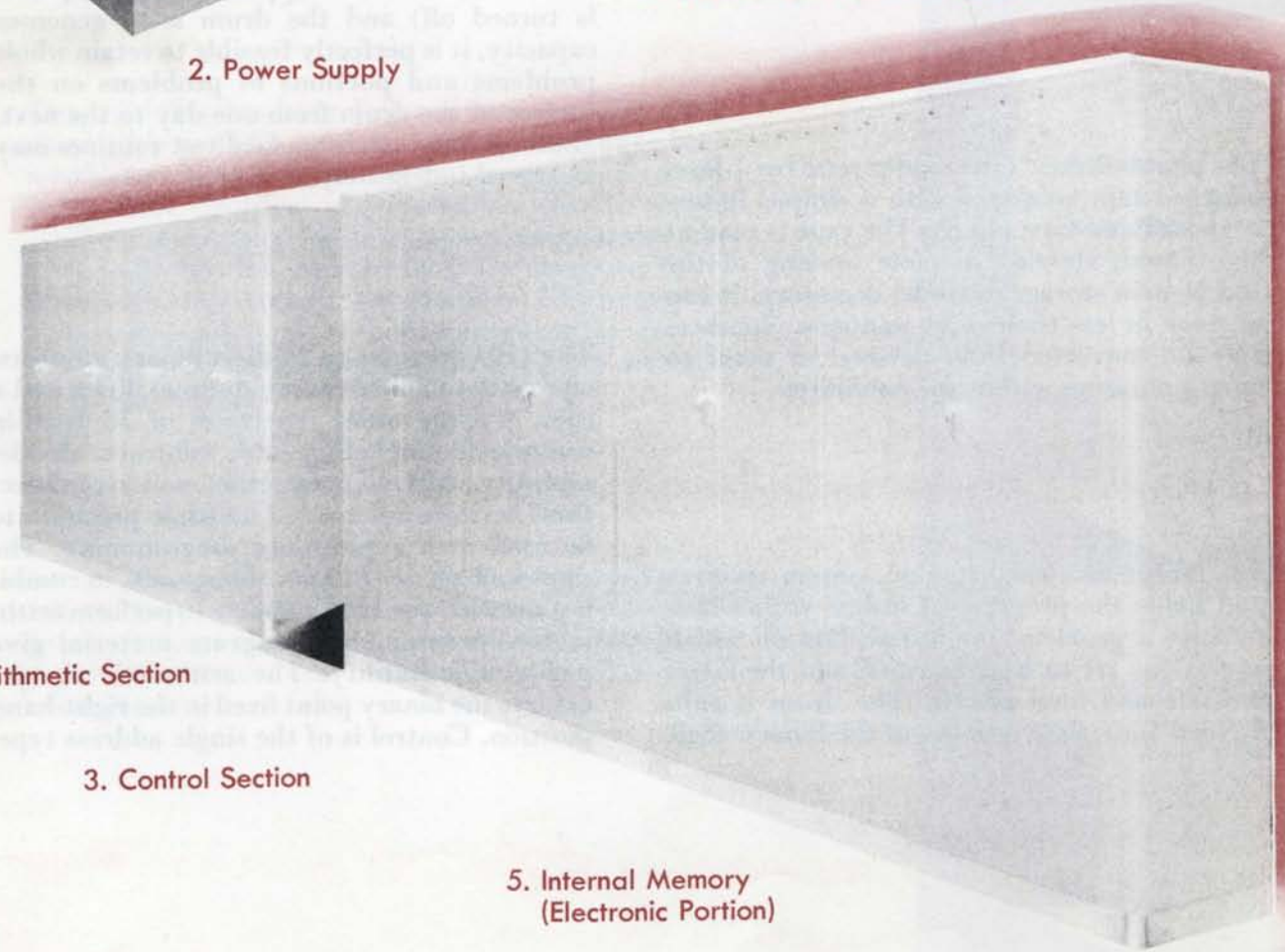
1101 General Purpose Electronic Digita



2. Power Supply



4. Maintenance Control Station

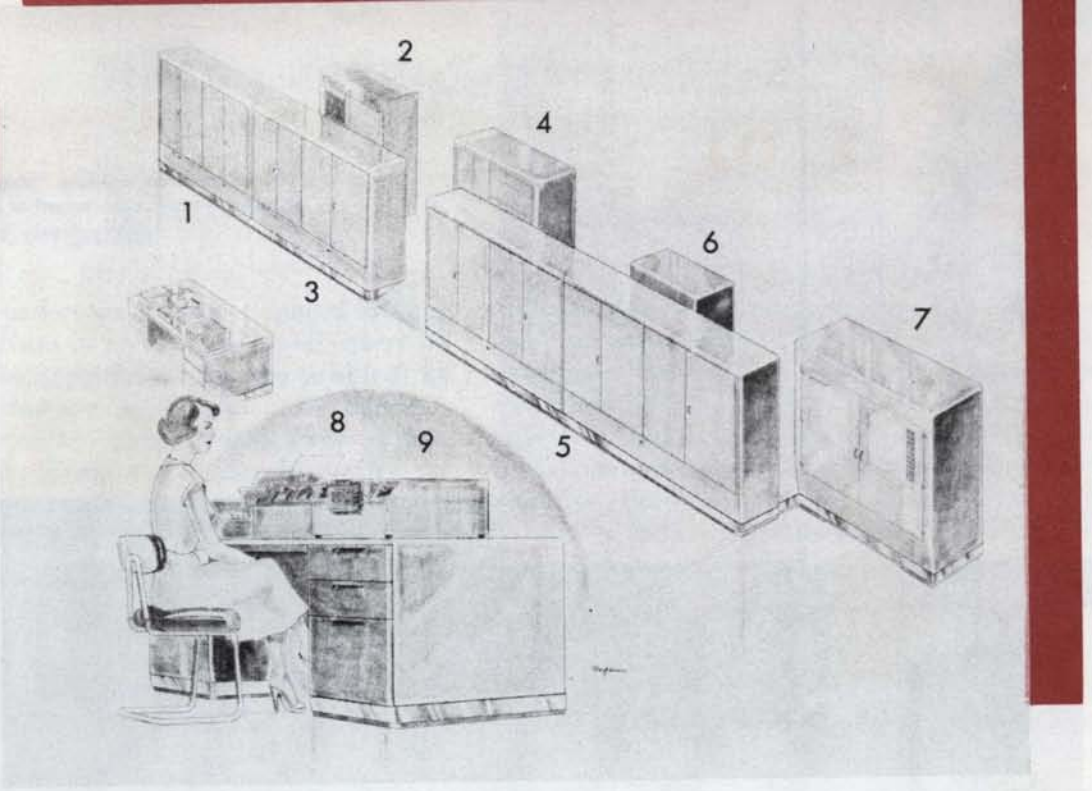


1. Arithmetic Section

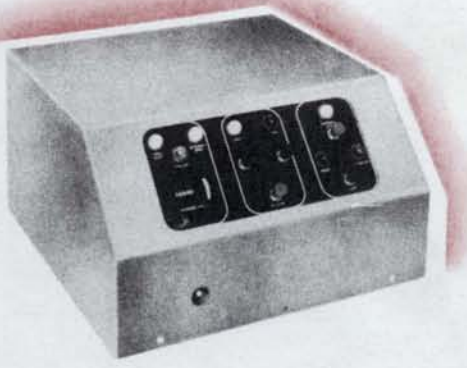
3. Control Section

5. Internal Memory
(Electronic Portion)

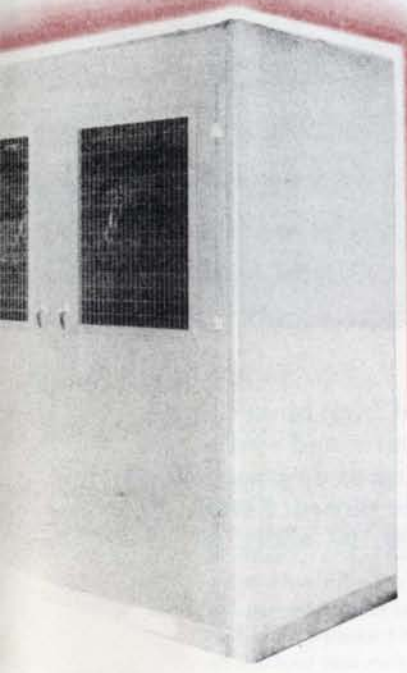
l Computer



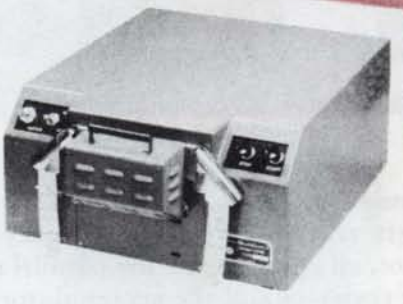
nternal Memory
Magnetic Drum)



8. Operator's Control Station



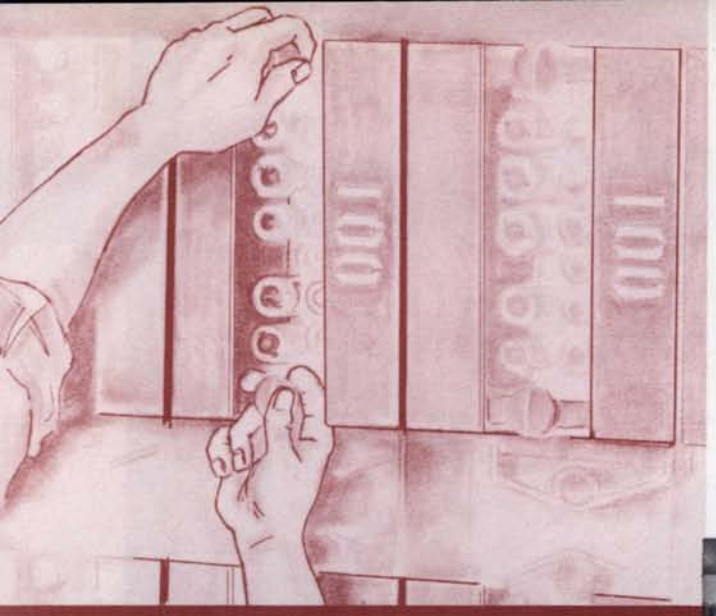
eat nsfer Unit



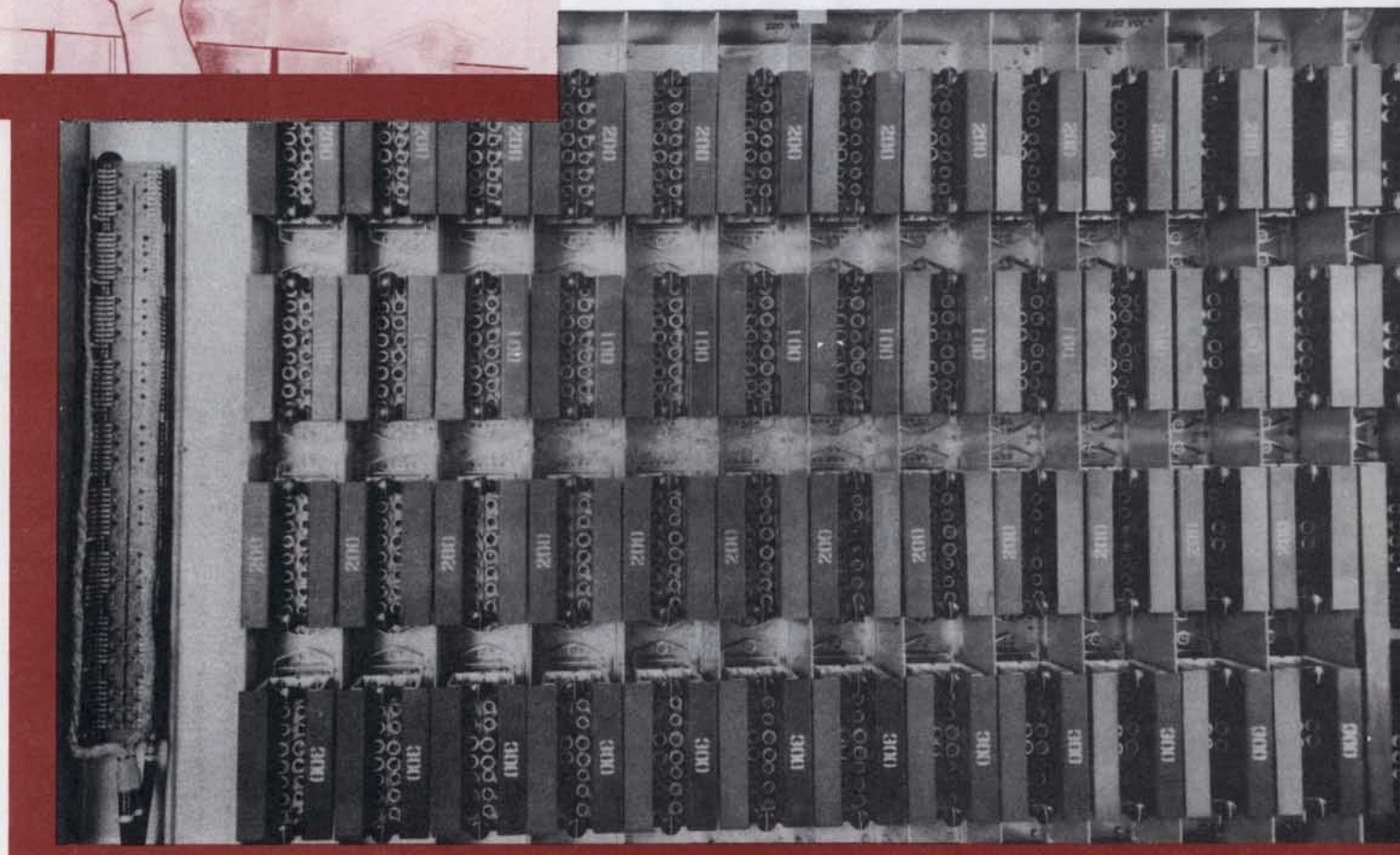
9. Photo-electric Tape Reader

Engineering Research Associates, INC.

PIONEERS IN THE DEVELOPMENT OF DIGITAL COMPUTER TECHNIQUES



1101 construction, utilizing "pluggable packages" of 16 tubes, makes replacement of units a simple matter.



The arithmetic system consists of two 24-binary-digit registers and a 48-binary-digit accumulator, all operating in the parallel mode. One of the registers and the accumulator have the ability to shift numbers to the left with end-around carry.

Output data may be converted from binary to decimal form within the computer and sent to an electric typewriter for typing or to a paper tape punch if the data are to be reused. Faster output devices may, of course, be added as they become available.

Using the Computer

Consecutive orders are normally spaced around the storage drum in an array of equal intervals which is most appropriate for the problem at hand. Once this spacing has been determined, it can be caused to occur automatically within the machine. Thus the coder has only to arrange operands at the proper place between orders to allow the machine to operate most efficiently. Exceptions to this predetermined spacing may be taken by use of the Jump Commands.

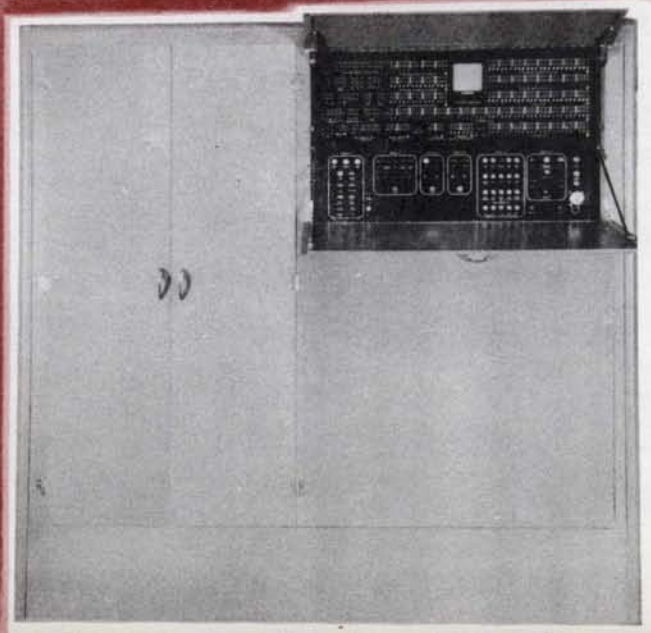
The time required for the addition of two numbers is about 96 microseconds and the time required for multiplication is about 352 microseconds. These figures include the procurement of both operands and the next command and establish the minimum operation times which can be achieved by an ingenious coder.

A highly skilled operator is not required. The actual operation of the **1101** is directed by information on the program tape. The program tape contains all the directions required by the computer for loading the tape, running the problem and printing out the results. The operator functions only to initiate the two basic operations of loading the tape and starting the computer. The operator's equipment group—which consists of a small control panel, photo-electric tape reader, tape punch, and electric typewriter—may be located remotely from the computer.

The **ERA 1101** has many engineering and statistical applications including: computing functions, solving simultaneous equations, matrix calculations, data reduction, numerical integration, and least squares analysis. In fact, it can carry out any computation involving a sequence of elementary arithmetical and logical steps.

Maintenance

ERA has developed routine preventive maintenance methods which assure uninterrupted periods of dependable operation. By using approximately 10 per cent of each day for these routine tests, the United States Government operated the original **1101** for its first 500 hours with only 16 hours of unscheduled maintenance. We believe this to be an unusual record for a new electronic computer.



All maintenance diagnostic work may be accomplished from observations made at this Maintenance Control Station. Better than 95 per cent of all component failures can be anticipated in about 10 per cent of machine time during scheduled preventive maintenance periods through the use of the **1101**'s built-in maintenance system.

Summary of ERA 1101 Characteristics

Number Size – 24 Binary Digits (equivalent 7 DD plus sign)

Internal Memory –

Type—Magnetic Drum
Capacity—16,384 Numbers and/or Commands
Access Time—32 microseconds (min), 17 milliseconds (max)

Operating Times –

Input—37 numbers per second from punched tape
Output—7 Decimal Digits per second to Page Printer and Tape Perforator
Addition—96 microseconds* (leaving sum in Arithmetic Register)
Multiplication—352 microseconds* (leaving 48 digit product in Arithmetic Register).

*Includes procurement of both operands and next order from optimum positions in memory.

Address System – Single Address

Commands – 38 different Arithmetic and Logical Manipulations

y is memory box at address y
( ) is interpreted as "the contents of"

X = X-Register (24 digits)
Q = Q-Register (24 digits)
A = Accumulator (48 digits)

Insert (y) in A
Insert (y) in A [multiple precision]
Insert absolute value (y) in A
Add (y) to (A)
Add (y) to (A) [multiple precision]
Add absolute value of (y) to (A)
Insert (Q) in A
Add (Q) to (A)
Insert [(y) + 1] in A

Insert complement of (y) in A
Insert complement of (y) in A [multiple precision]
Insert complement of absolute value of (y) in A
Subtract (y) from (A)
Subtract (y) from (A) [multiple precision]
Subtract absolute value of (y) from (A)
Clear right half of A
Transmit (A) to Q

Form product (Q) • (y) in A
Form logical product (Q) • (y) in A
Add product (Q) • (y) to (A)

Add logical product (Q) • (y) to (A)
Divide (A) by (y), (quotient forms in Q, non-negative remainder left in A)

Store right half of (A) at y
Store (Q) at y
Replace (y) with (A) using (Q) as operator
Replace (y) with (A) [address portion only]
Insert (y) in Q

Shift (A) left
Shift (Q) left
Take (y) as next order
Take (y) as next order if (A) is not zero
Take (y) as next order if (A) is negative
Take (y) as next order if (Q) is negative

Print right-hand 6 digits of (y)
Print and punch right-hand 6 digits of (y)

Optional Stop
Intermediate Stop
Final Stop

Engineering Research Associates, Inc.
1902 W. Minnehaha Ave.
St. Paul, Minnesota
507 18th Street South
Arlington, Virginia