T H E   B I N A C

A product of the Eckert-Mauchly Computer Corp.

BINAC STATISTICS

Repetition Rate

4,000,000 pulses per second.

Memory

Mercury Delay Line
512 "word" capacity
(15,360 binary digits)

Operational Rates

Addition	*3500 per second*
Subtraction	*3500 per second*
Multiplication	*1000 per second*
Division	*1000 per second*

Input to Computer

From keyboard or magnetic tape.

Output from Computer

To typewriter or magnetic tape.

Digital System

Octal input and output; binary computation.

Checking System

Synchronized duplicate arithmetic, control and memory organs check every operation.

The BINAC - General Characteristics

The BINAC has been designed and constructed by the Eckert-Mauchly Computer Corp. for the rapid solution of complex mathematical problems confronting the Research Staff of the Northrop Aircraft Company. That its completion is a new landmark in the history of computing instruments becomes apparent upon consideration of its salient characteristics:

1. The BINAC is an all-electronic device.

2. Owing to newly developed techniques, and despite its remarkable performance, the BINAC employs but a fraction of electronic equipment hitherto considered necessary. Less than 700 miniature tubes are contained in one computer and its associated memory.

3. The BINAC'S internal processing operations are prescribed by means of digitally coded instructions rather than manual "set-up" switches or plugboards.

4. At least 16 different types of instructions are at the disposal of the problem planner thus providing a high degree of flexibility in "programming".

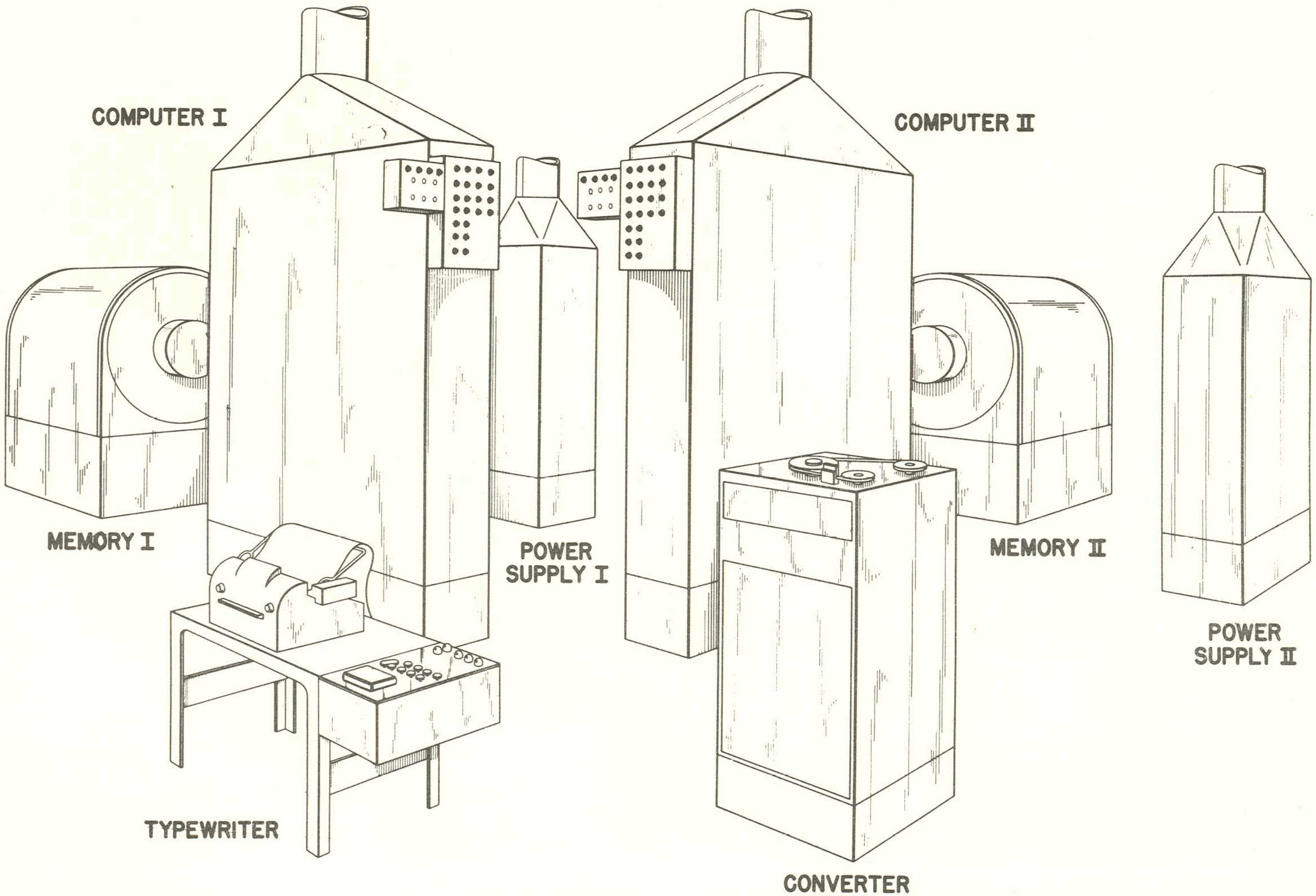
5. Operational speeds are measured in millionths of a second.

6. Every step of each operation may be checked by an independent computer and memory system; disagreement of results at any point will instantly halt all further processing.

7. If, however, the computations to be executed are self-checking by nature, the twin computing and memory components may be used individually on two distinct problems.

8. With a minimum of equipment, the new mercury memory system provides storage for a large amount of data, any desired portion of which is readily available during computation.

THE BINAC



COMPUTER I
COMPUTER II
MEMORY I
POWER SUPPLY I
MEMORY II
POWER SUPPLY II
TYPEWRITER
CONVERTER

ELEMENTS OF THE BINAC SYSTEM

Please refer to the sketch of the complete BINAC system on the opposite page to identify the following components.

NOTE: *All units, with the exception of the input-output devices, are in duplicate to provide complete checking of computations.*

Typewriter-Keyboard Unit

A. KEYBOARD: A device for translating manual key strokes into "computer language". There are eight keys, representing the octal numbers zero thru seven, each of which when depressed, produces a unique set of binary pulse codes (3 pulse combination). Keyboard is used to introduce either the "program" or quantitative data into the computer and memory.

B. TYPEWRITER: Printing unit only; contains type bars for numerals 0 through 7 only. This device is used to produce printed copy of:

1. All input information typed by means of the adjacent keyboard. This printing operation is simultaneous with the operation of the keys.

2. Information contained in designated portions of the memory which is to be read out; such information may be computed results, input data which is to be verified, intermediate results, etc.

The Converter

A. TAPE READ-WRITE MECHANISM ON TOP OF STRUCTURE.

1. This is used to read intelligence into the computer from a previously prepared magnetic tape; such data will usually represent instructions to the computer for a given problem but may also, on occasion, include input data and constant values.

2. This same device is used to record the contents of specified memory locations. Thus a new problem may be arranged for repetitive use by first inserting all necessary instructions into the memory through use of the keyboard, and then reading these same instructions from memory to tape for permanent preservation.

B. CONVERTER PROPER.

This is a device which acts as an intermediary and synchronizer between the relatively slow operational rates of the manual keyboard, the typewriter printer, or the tape read-write mechanism and the high speed computer which is operating at a basic repetition rate of 4,000,000 pulses per second.

Main Computing Instrument

This component not only performs the necessary labor required to execute the prescribed instructions but also acts as coordinator of the system. All arithmetic and control operations are carried out by this unit. Normally, it follows the operations called for by the "program" (instructions) but may also be operated manually by means of the control panel.

Mercury Memory

The memory is of the acoustic delay line type and contains 18 channels within a tube of mercury. Sixteen of these are used for the storage of data, each having a capacity of 320 octal digits. Thus one complete memory is capable of holding 5,120 octal digits. The 17th channel maintains exact constant temperature throughout the mercury tank; the 18th is a spare.

BINAC INSTRUCTIONS

A = ACCUMULATOR

L = L REGISTER--HOLDS MULTIPLICAND AND DIVISOR

( ) = "CONTENTS OF". THUS (A) DESIGNATES CONTENTS OF ACCUMULATOR.

(m) = CONTENTS OF MEMORY LOCATION m (000_777)

Symbol	Numeric Equivalent	Arithmetic	Microseconds* per Operation
A(m)	05(m)	ADD (m) TO (A), SUM IN A; $\lvert (A)+(m) \rvert < 1$.	285
S(m)	15(m)	SUBTRACT (m) FROM (A), DIFFERENCE IN A; $\lvert (A)-(m) \rvert < 1$.	285
M(m)	10(m)	MULTIPLY (L) BY (m), PRODUCT IN A, ROUNDED TO 30 BINARY DIGITS.	654
D(m)	03(m)	DIVIDE (A) BY (m), QUOTIENT IN A, ROUNDED TO 30 BINARY DIGITS; $\lvert (m) \rvert > \lvert (A) \rvert$, CONTENTS OF L ARE LOST.	633
F(m)	02(m)	ADD (L) TO (A), SUM IN A.	123

Data Handling

C(m)	04(m)	TRANSFER (A) TO m, CLEAR A.	285
H(m)	13(m)	TRANSFER (A) TO m, DO NOT CLEAR A.	285
L(m)	12(m)	CLEAR L, TRANSFER (m) TO L.	285
K(m)	11(m)	CLEAR L, TRANSFER (A) TO L, CLEAR A.	123
+(m)	22(m)	SHIFT ALL DIGITS OF (A) INCLUDING SIGN DIGIT ONE POSITION LEFT, INVOLVES LOSS OF SIGN DIGIT; EQUIVALENT TO 2(A).	123
—(m)	23(m)	SHIFT ALL DIGITS OF (A) INCLUDING SIGN DIGIT ONE POSITION RIGHT, DUPLICATE SIGN DIGIT IN SIGN POSITION; EQUIVALENT TO $(A) \div 2$.	123

Control

SKIP	25(m)	CONTINUE TO NEXT INSTRUCTION.	123
U(m)	20(m)	OBTAIN NEXT PAIR OF INSTRUCTIONS FROM m, AND CONTINUE FROM THAT POINT.	123
T(m)	14(m)	IF $(A) < 0$, OBTAIN NEXT PAIR OF INSTRUCTIONS FROM m, AND CONTINUE FROM THAT POINT; CLEAR A. IF $(A) \geq 0$, CONTINUE WITHOUT TRANSFER OF CONTROL; CLEAR A.	123

BINAC Instructions (Cont'd)

Symbol	Numeric Equivalent	Control	Microseconds* per Operation
BP	24(m)	IF BREAK-POINT SWITCH IS SET, STOP. IF BREAK-POINT SWITCH IS NOT SET, CONTINUE TO NEXT INSTRUCTION AS UNDER SKIP INSTRUCTION.	123
STOP	01(m)	STOP	---

*1 Microsecond = $\frac{1}{1,000,000}$ second.

The times shown are <u>*average*</u> *times; individual operations may require more or* <u>*less*</u> *time depending on the actual digit values in multiplication and division, and depending on where a number is stored in the memory at the time it is to be used.*

CONVERSION TABLE

0-50

DECIMAL	CODED - DECIMAL	BINARY	OCTAL
0	00	000	0
1	01	001	1
2	02	010	2
3	03	011	3
4	04	100	4
5	05	101	5
6	06	110	6
7	07	111	7
8	10	001 000	10
9	11	001 001	11
10	01 00	001 010	12
11	01 01	001 011	13
12	01 02	001 100	14
13	01 03	001 101	15
14	01 04	001 110	16
15	01 05	001 111	17
16	01 06	010 000	20
17	01 07	010 001	21
18	01 10	010 010	22
19	01 11	010 011	23
20	02 00	010 100	24
21	02 01	010 101	25
22	02 02	010 110	26
23	02 03	010 111	27
24	02 04	011 000	30
25	02 05	011 001	31
26	02 06	011 010	32
27	02 07	011 011	33
28	02 10	011 100	34
29	02 11	011 101	35
30	03 00	011 110	36
31	03 01	011 111	37
32	03 02	100 000	40
33	03 03	100 001	41
34	03 04	100 010	42
35	03 05	100 011	43
36	03 06	100 100	44
37	03 07	100 101	45
38	03 10	100 110	46
39	03 11	100 111	47
40	04 00	101 000	50
41	04 01	101 001	51
42	04 02	101 010	52
43	04 03	101 011	53
44	04 04	101 100	54
45	04 05	101 101	55
46	04 06	101 110	56
47	04 07	101 111	57
48	04 10	110 000	60
49	04 11	110 001	61
50	05 00	110 010	62
511	05 01 01	111 111 111	777

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