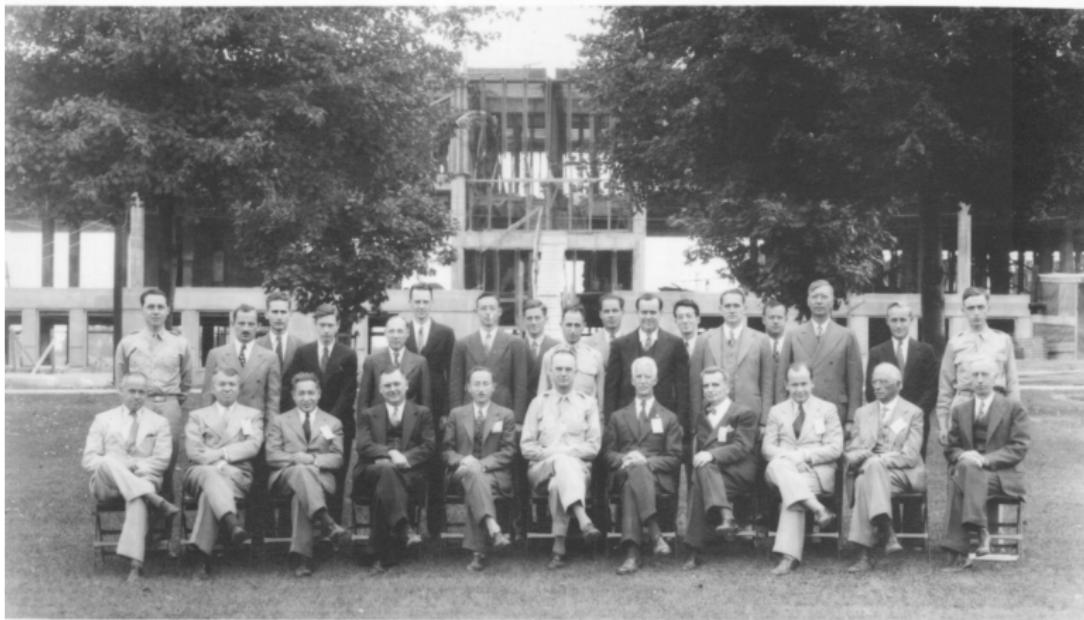


# Hidden Pioneers: Programmers of the ENIAC and the Birth of Modern Computing

Nelson Jovel • Education Commonwealth Project •  
[joveln@gmail.com](mailto:joveln@gmail.com)

FIRST MEETING OF THE SCIENTIFIC ADVISORY COMMITTEE  
BALLISTIC RESEARCH LABORATORY SEPTEMBER 1940



Lt. Gillon	Mr. Moerman	Mr. Dickinson	Mr. Carr	Mr. McNeilly	Mr. Shanks	Mr. Leeder	Lt. Steele			
Mr. Lane	Mr. Reno	Mr. Hitchcock	Dr. Charters	Capt. Simon	Dr. Hodge	Mr. Beeman	Mr. Toich	Mr. Gay		
Mr. Kent	Prof. Urey	Prof. Rabi	Dr. Dryden	Dr. Lewis	Col. Zornig	Dr. Hull	Prof. von Karman	Prof. von Neumann	Prof. Russell	Dr. Dederick

Howitzer

## Example Artillary

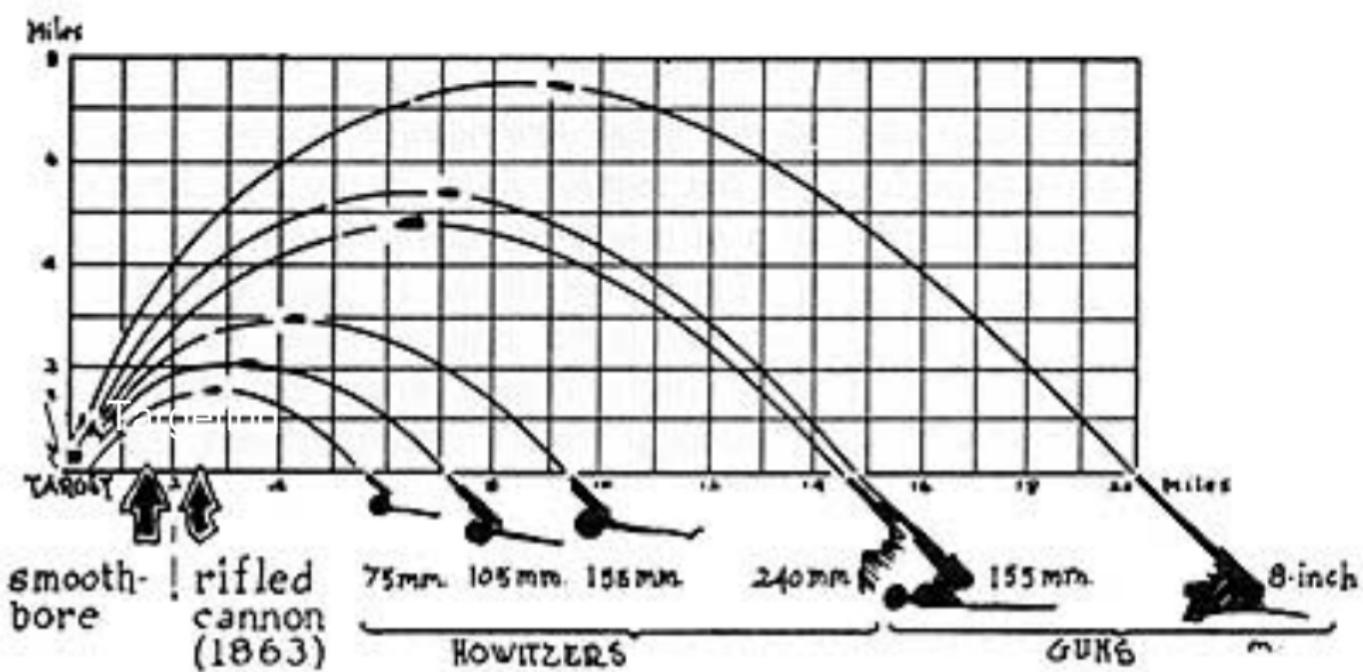


Tank



Anti-Aircraft





600	30.6	1.9	1.06	19	1	1.9	0.3	0.03
700	35.8	2.2	0.91	19	1	2.3	0.4	0.03
800	41.1	2.5	0.79	19	1	2.6	0.5	0.04
900	46.4	2.8	0.71	19	1	2.9	0.6	0.04
1000	51.7	3.2	0.63	19	1	3.2	0.7	0.04
1100	57.1	3.5	0.57	19	1	3.6	0.8	0.05
1200	62.5	3.8	0.53	18	1	3.9	0.8	0.05
1300	67.9	4.2	0.48	18	1	4.3	0.9	0.05
1400	73.4	4.5	0.45	18	1	4.6	1.0	0.06
1500	78.9	4.9	0.42	18	1	4.9	1.1	0.06
1600	84.4	5.2	0.39	18	2	5.3	1.2	0.07
1700	90.0	5.5	0.37	18	2	5.8	1.3	0.07
1800	95.6	5.9	0.35	18	2	6.0	1.4	0.07
1900	101.3	6.2	0.33	18	2	6.3	1.6	0.08
2000	107.0	6.6	0.31	17	2	6.7	1.7	0.08
2100	112.8	6.9	0.30	17	2	7.0	1.8	0.08
2200	118.5	7.3	0.28	17	2	7.4	1.9	0.09
2300	124.4	7.6	0.27	17	2	7.7	2.0	0.09
2400	130.3	8.0	0.26	17	2	8.1	2.1	0.09
2500	136.2	8.3	0.25	17	2	8.4	2.2	0.10
2600	142.2	8.7	0.24	17	2	8.8	2.3	0.10
2700	148.2	9.1	0.23	17	2	9.2	2.5	0.10
2800	154.3	9.4	0.22	16	2	9.5	2.6	0.11
2900	160.4	9.8	0.21	16	3	9.9	2.7	0.11
3000	166.6	10.2	0.20	16	3	10.3	2.9	0.12
mean	172.8	10.6	0.20	16	3	10.6	3.0	0.12

FT 155-AM-2

TABLE H

CHARGE  
4GPROJ, HE, M107  
FUZE, PD, M577

## ROTATION - RANGE

CORRECTIONS TO RANGE, IN METERS, TO COMPENSATE  
FOR THE ROTATION OF THE EARTH

RANGE METERS	AZIMUTH OF TARGET - MILS									
	0 3200	200 3000	400 2800	600 2600	800 2400	1000 2200	1200 2000	1400 1800	1600 1600	
500	0	0	-1+	-1+	-2+	-2+	-2+	-2+	-2+	
1000	0	-1+	-2+	-2+	-3+	-4+	-4+	-4+	-4+	
1500	0	-1+	-3+	-4+	-5+	-5+	-6+	-6+	-7+	
2000	0	-2+	-3+	-5+	-6+	-7+	-8+	-8+	-9+	
2500	0	-2+	-4+	-6+	-7+	-9+	-10+	-10+	-10+	
3000	0	-2+	-5+	-7+	-9+	-10+	-11+	-12+	-12+	
3500	0	-3+	-5+	-8+	-10+	-12+	-13+	-14+	-14+	
4000	0	-3+	-6+	-9+	-11+	-13+	-14+	-15+	-15+	
4500	0	-3+	-8+	-9+	-12+	-14+	-16+	-16+	-17+	
5000	0	-4+	-7+	-10+	-13+	-15+	-17+	-18+	-18+	
5500	0	-4+	-7+	-11+	-14+	-16+	-18+	-19+	-19+	
6000	0	-4+	-8+	-11+	-14+	-17+	-18+	-20+	-20+	
6500	0	-4+	-8+	-11+	-14+	-17+	-19+	-20+	-20+	
7000	0	-4+	-8+	-11+	-15+	-17+	-19+	-20+	-21+	
7500	0	-4+	-8+	-11+	-14+	-17+	-18+	-20+	-20+	
8000	0	-3+	-7+	-10+	-13+	-15+	-16+	-17+	-18+	

COMPUTING  
DIVISION  
COMPUTING  
SECTION

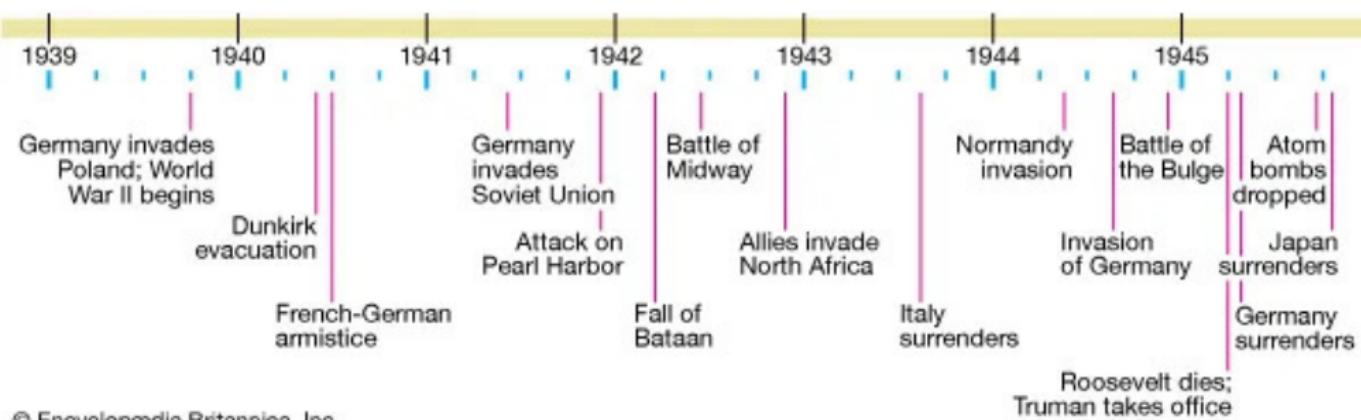




# DIFFERENTIAL ANALYZER



## Chief Events of World War II, 1939–45



© Encyclopædia Britannica, Inc.





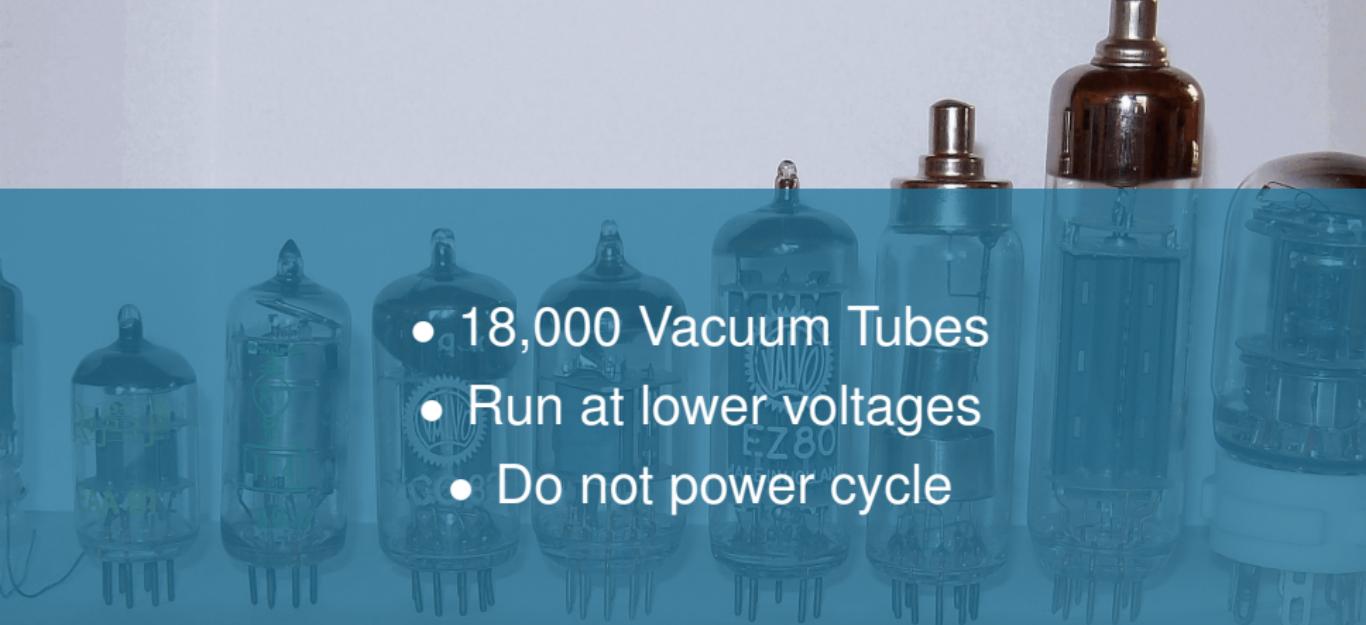
- Designers: John Mauchley and J. Presper Eckert

- The Use of High Speed Vacuum Tube Devices for Calculating
- 1000 times faster than the differential analyzer
  - General Purpose computer

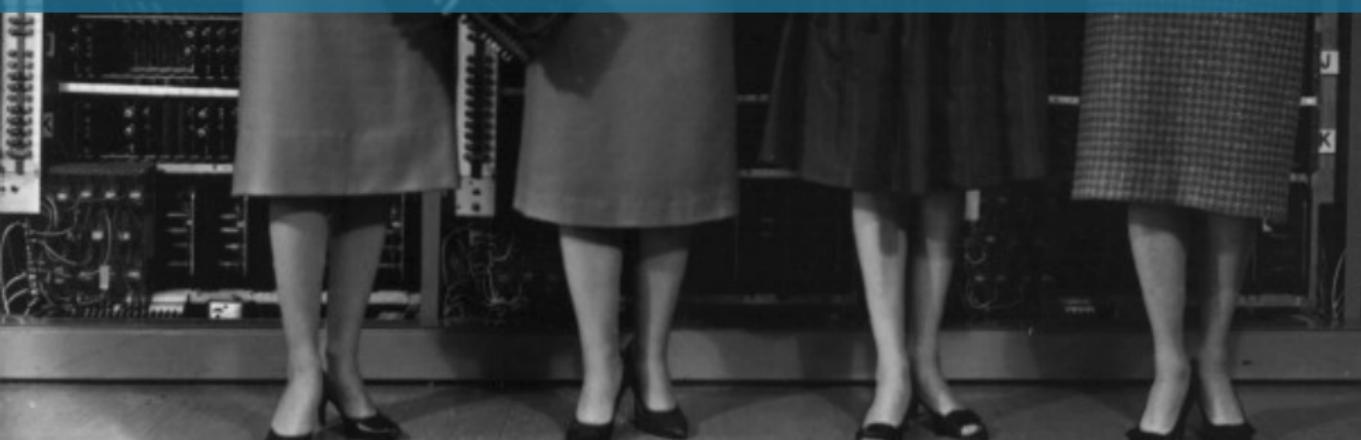


- Projected Cost: 61,000
- Actual Cost: 500,000
- Today: 7,000,000+



- 
- 18,000 Vacuum Tubes
  - Run at lower voltages
    - Do not power cycle







# • ENIAC



• ENIAC  
• BINAC

- 
- ENIAC
  - BINAC
  - EDVAC

- 
- ENIAC
  - BINAC
  - EDVAC
  - UNIVAC



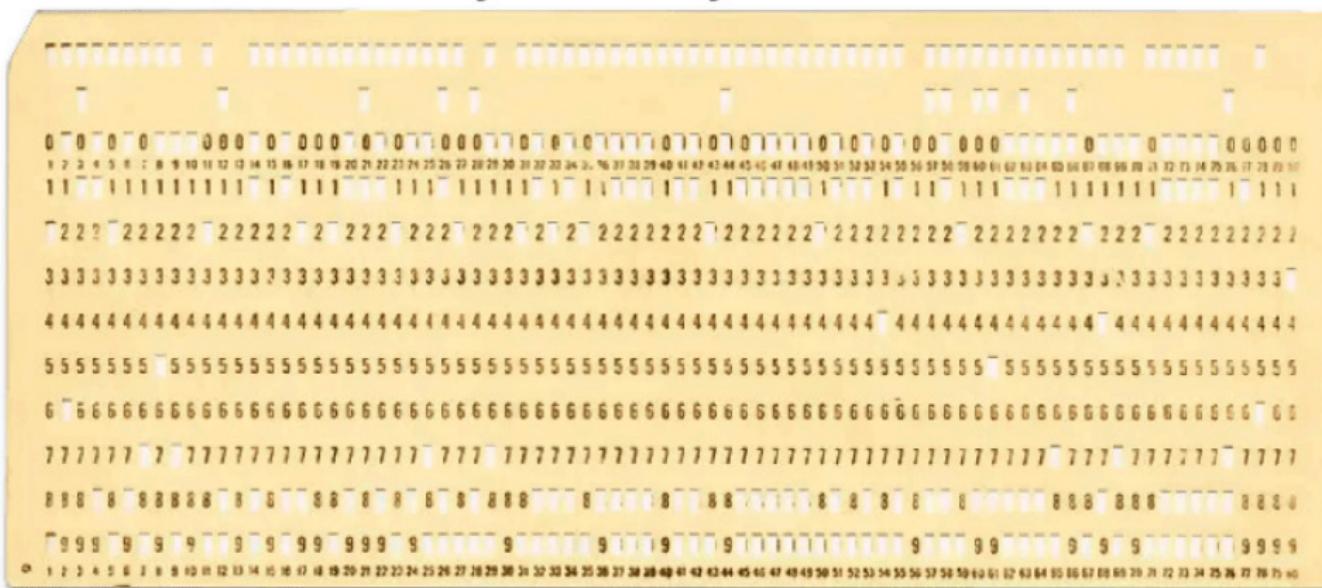
D  
DATA  
ENCL  
1  
1  
1

W  
K

# IBM CARD PUNCH



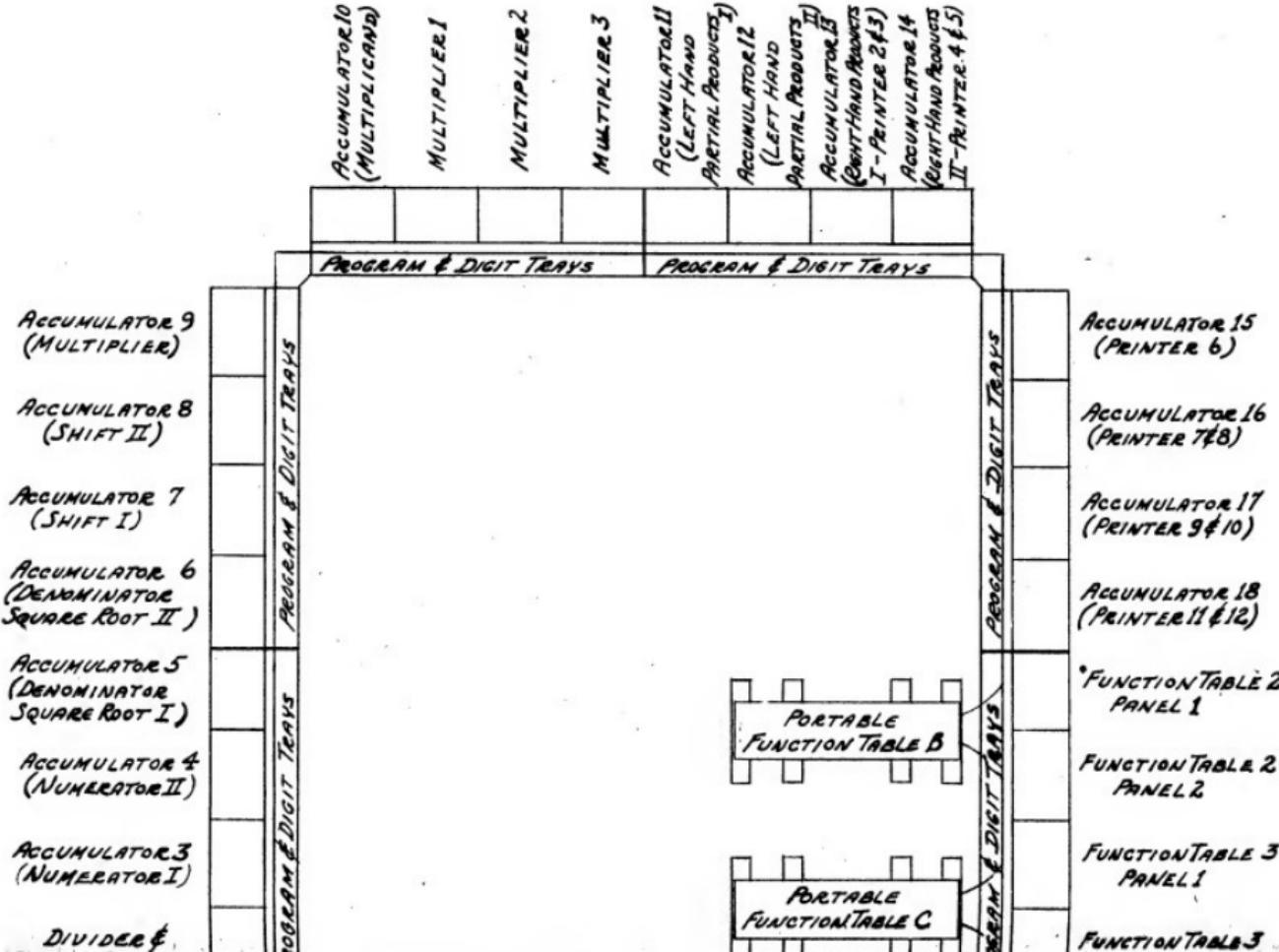
## Example of a punch card



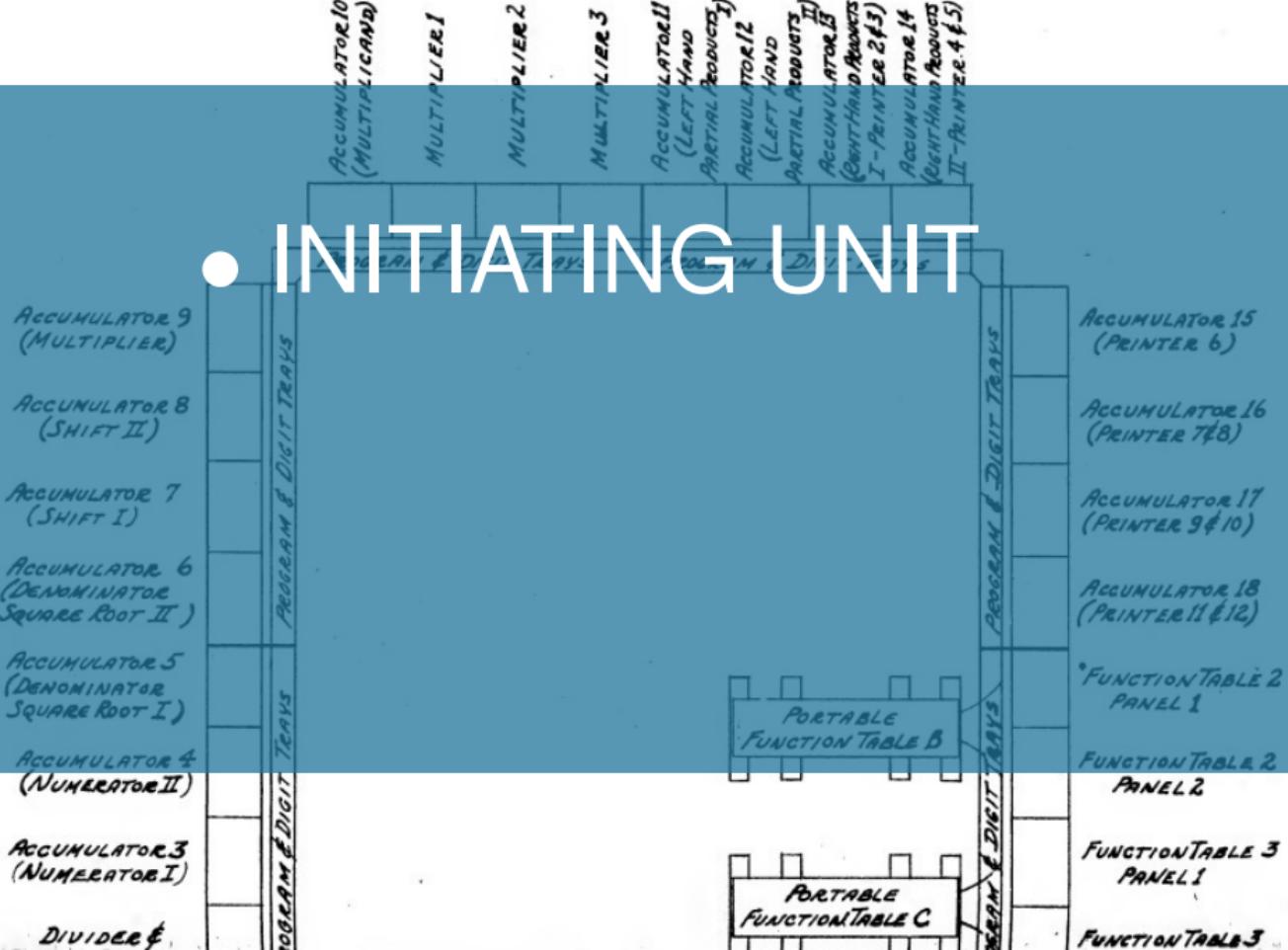


A black and white photograph of a woman from the mid-20th century. She has dark, curly hair and is wearing a dark, long-sleeved dress with a row of buttons down the front. A pearl necklace is visible around her neck. She is standing behind a massive, sprawling stack of paper, which appears to be several thousand pages thick. In the background, there's a filing cabinet and some office equipment. The entire scene is overlaid with a solid blue rectangular shape.

5MB OF DATA



# • INITIATING UNIT



# • INITIATING UNIT • CYCLING UNIT

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER 4

ACCUMULATOR 10  
(MULTICANDIDATE)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
PARTIAL PRODUCTS)

ACCUMULATOR 12  
(LEFT HAND  
PARTIAL PRODUCTS)

ACCUMULATOR 13  
(LEFT HAND  
PARTIAL PRODUCTS)

ACCUMULATOR 14  
(LEFT-HAND PRODUCTS  
I - PENTER 2 & 3)

ACCUMULATOR 15  
(LEFT-HAND PRODUCTS  
II - PENTER 4 & 5)

ACCUMULATOR 15  
(PENTER 6)

ACCUMULATOR 16  
(PENTER 7 & 8)

ACCUMULATOR 17  
(PENTER 9 & 10)

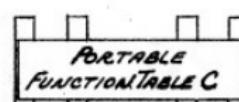
ACCUMULATOR 18  
(PENTER 11 & 12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



# • INITIATING UNIT • CYCLING UNIT • MASTER PROGRAMMER

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER 4



ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

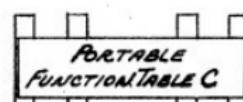
ACCUMULATOR 18  
(PRINTER 11&12)

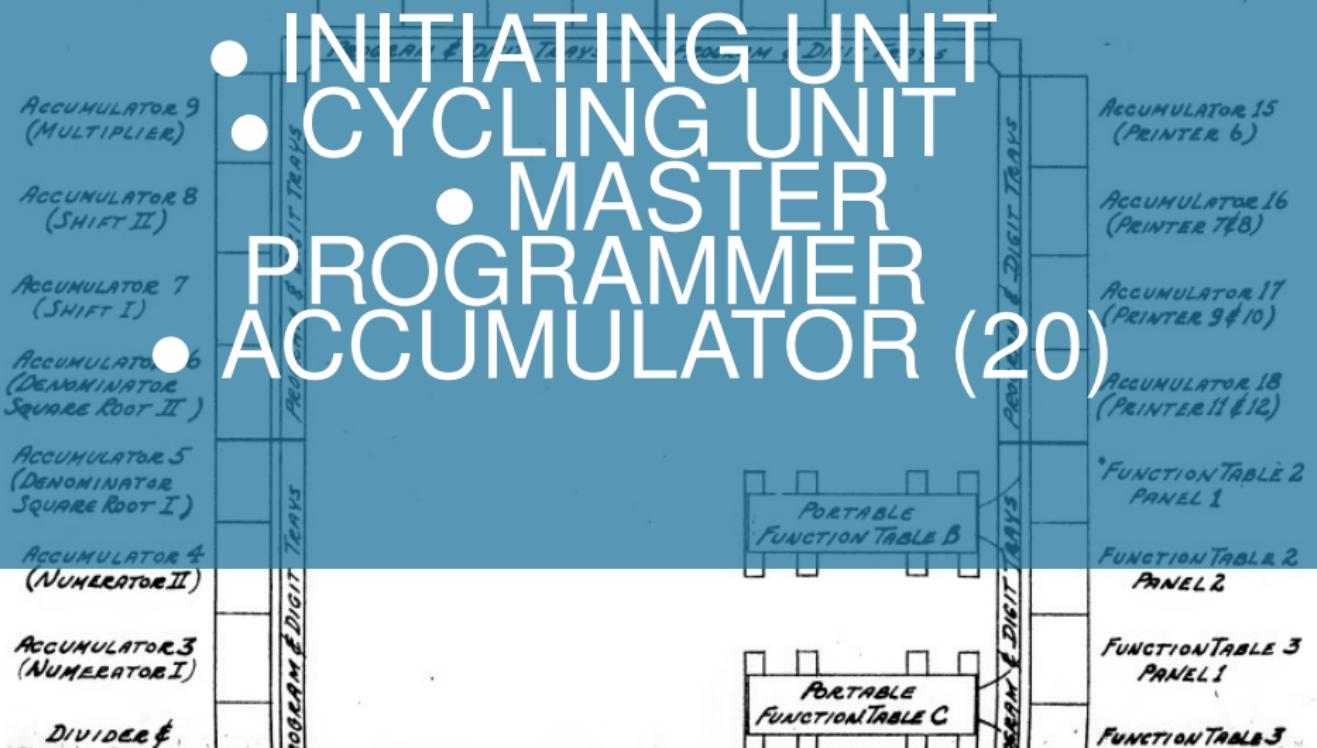
\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2





# • DIVIDER/SQUARE ROOTER - 35 PER SECOND

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER

PROGRAM 5-DIGIT TRAYS

ACCUMULATOR 10  
(MULTIPLICAND)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
MULTIPLYING PRODUCTS)

ACCUMULATOR 12  
(RIGHT HAND  
MULTIPLYING PRODUCTS)

ACCUMULATOR 13  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 14  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 15  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

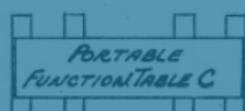
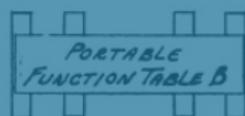
ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



# • DIVIDER/SQUARE ROOTER - 35 PER SECOND • MULTIPLIER - 357 MULTIPLICATIONS PER SECOND

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER

ACCUMULATOR 10  
(MULTIPLICAND)  
MULTIPLIER 1  
MULTIPLIER 2  
MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
MULTIPLYER PRODUCTS)  
MULTIPLIER 12  
(RIGHT HAND  
MULTIPLYER PRODUCTS)  
ACCUMULATOR 13  
(RIGHT HAND  
PRODUCTS)  
ACCUMULATOR 14  
(RIGHT HAND  
PRODUCTS)  
ACCUMULATOR 15  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



• DIVIDER/SQUARE ROOTER - 35 PER SECOND

• MULTIPLIER - 357 MULTIPLICATIONS PER SECOND

• 3 MOVEABLE FUNCTION TABLES

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER

ACCUMULATOR 10  
(MULTIPLIER)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
MULTIPLYER PRODUCTS)

ACCUMULATOR 12  
(RIGHT HAND  
MULTIPLYER PRODUCTS)

ACCUMULATOR 13  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 14  
(LEFT HAND  
PRODUCTS)

ACCUMULATOR 15  
(RIGHT HAND  
PRODUCTS)

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

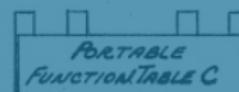
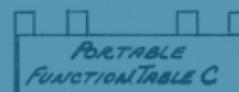
ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



• DIVIDER/SQUARE ROOTER - 35 PER SECOND

• MULTIPLIER - 357 MULTIPLICATIONS PER SECOND

• 3 MOVEABLE FUNCTION TABLES

• CARD READER

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER &

ACCUMULATOR 10  
(MULTIPLIER)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 12  
(RIGHT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 13  
(LEFT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 14  
(RIGHT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 15  
(RIGHT HAND  
MULTIPLYER PRODUCTS III)

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2

PORTABLE  
FUNCTION TABLE C

- DIVIDER/SQUARE ROOTER - 35 PER SECOND
- MULTIPLIER - 357 MULTIPLICATIONS PER SECOND
- 3 MOVEABLE FUNCTION TABLES
- CARD READER
- CARD PUNCH

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER &

ACCUMULATOR 10  
(MULTIPLIER)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
(LEFT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 12  
(RIGHT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 13  
(LEFT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 14  
(RIGHT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 15  
(RIGHT HAND  
MULTIPLYER PRODUCTS III)

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

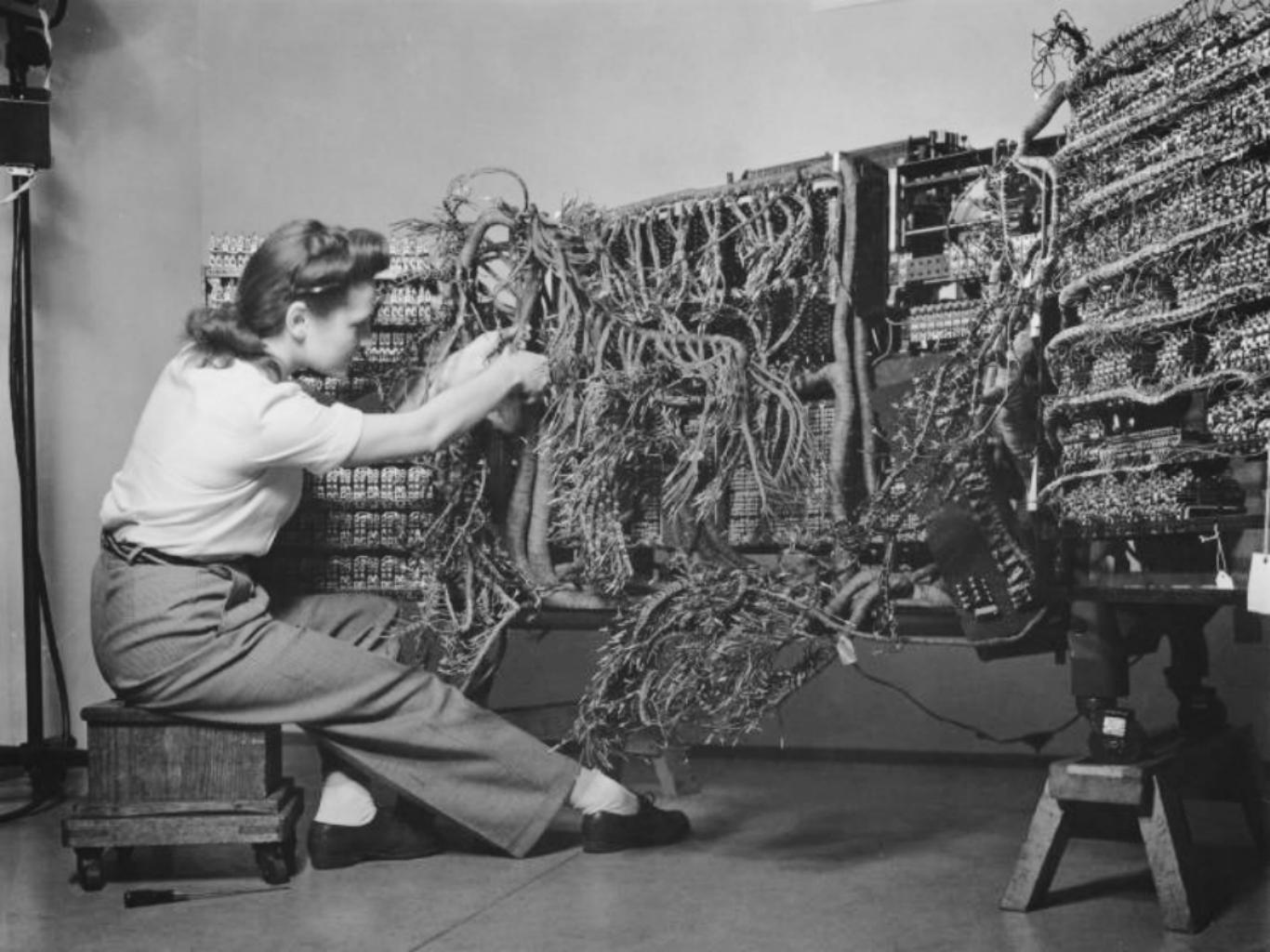
FUNCTION TABLE 2  
PANEL 2

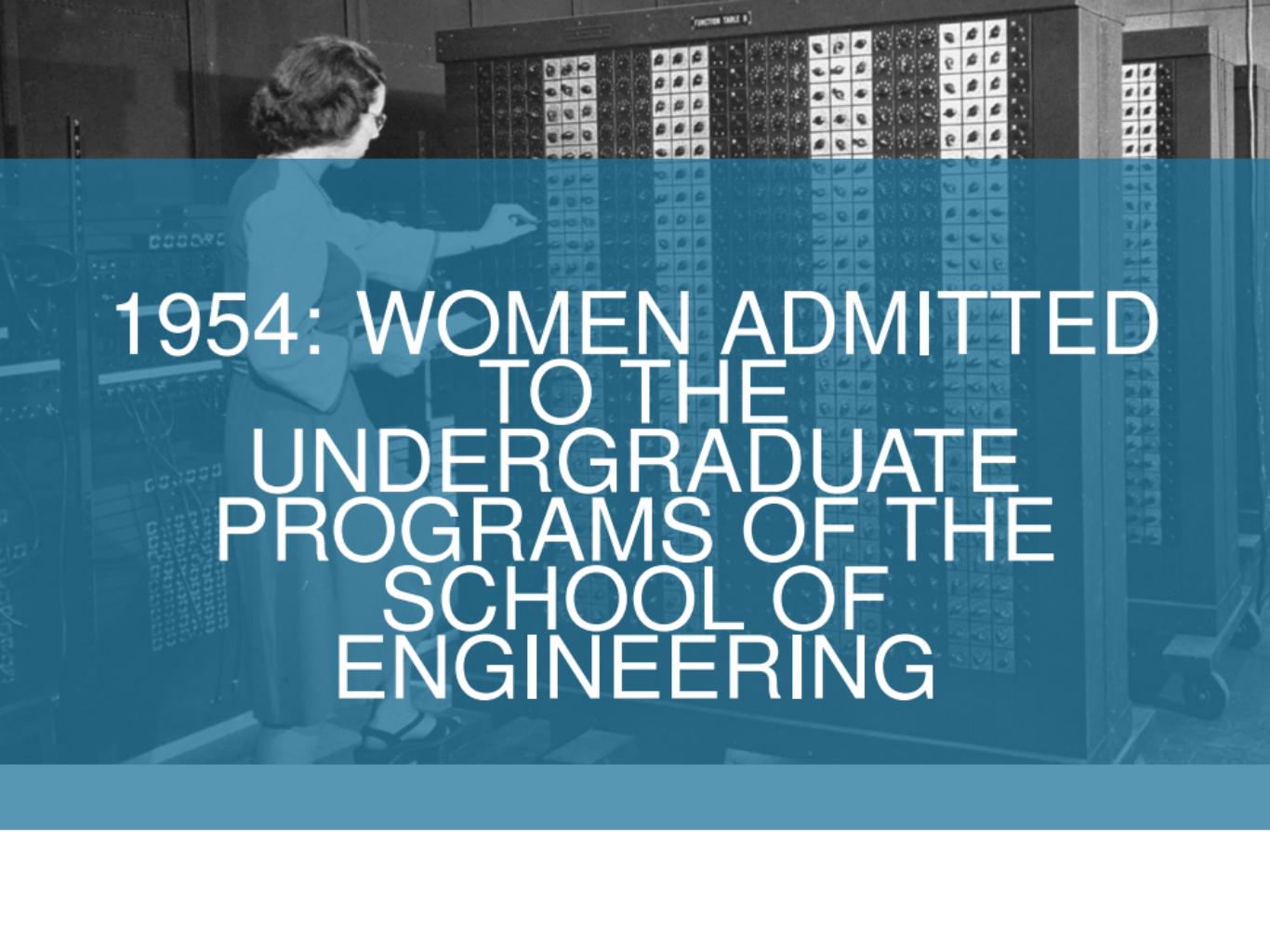
FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2

PORTABLE  
FUNCTION TABLE C

- 
- Robert F. Shaw (function tables)
  - Jeffrey Chuan Chu (divider/square-rooter)
    - Thomas Kite Sharpless (master programmer)
  - Frank Mural (master programmer)
    - Arthur Burks (multiplier)
    - Harry Huskey (reader/printer)
    - Jack Davis (accumulators)



A black and white photograph showing a woman from the side, wearing a light-colored dress, operating a large-scale control panel. The panel is filled with a grid of numerous knobs and switches. The words "FUNCTION TABLE" are visible at the top of the panel. The background shows more of the complex machinery of the computer.

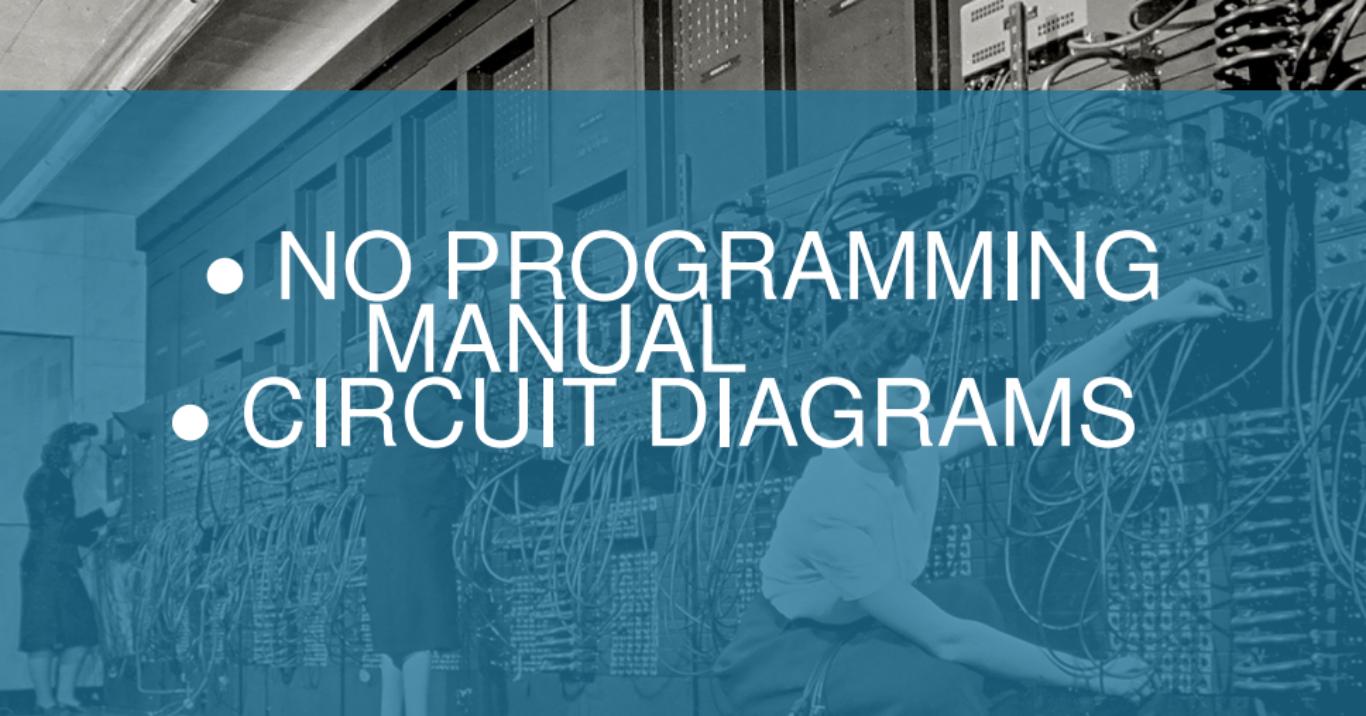
1954: WOMEN ADMITTED  
TO THE  
UNDERGRADUATE  
PROGRAMS OF THE  
SCHOOL OF  
ENGINEERING



# COMPUTERS



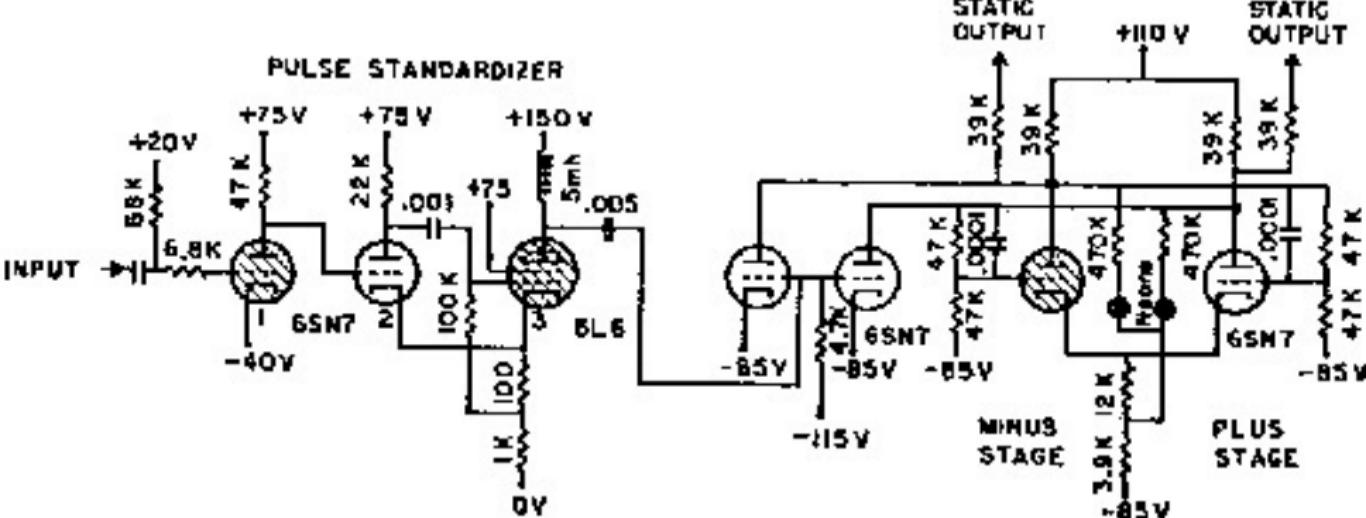
• NO PROGRAMMING  
MANUAL

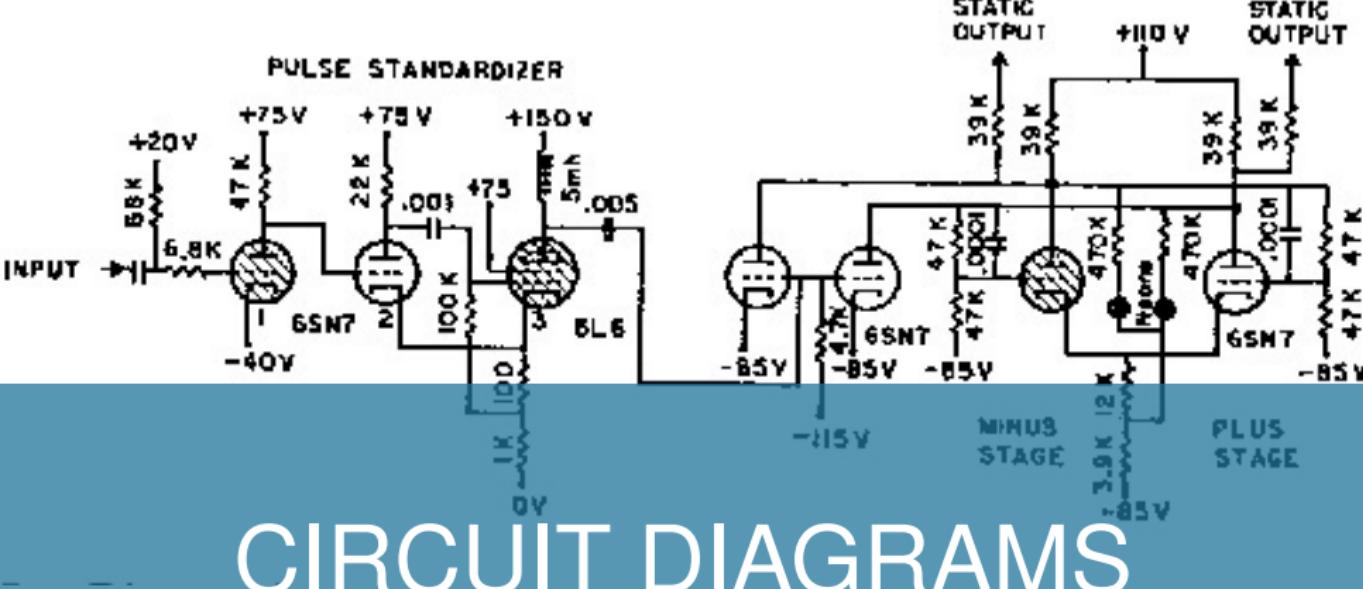
- 
- NO PROGRAMMING
  - MANUAL
  - CIRCUIT DIAGRAMS

- 
- NO PROGRAMMING  
MANUAL
  - CIRCUIT DIAGRAMS
  - LOGIC DIAGRAMS

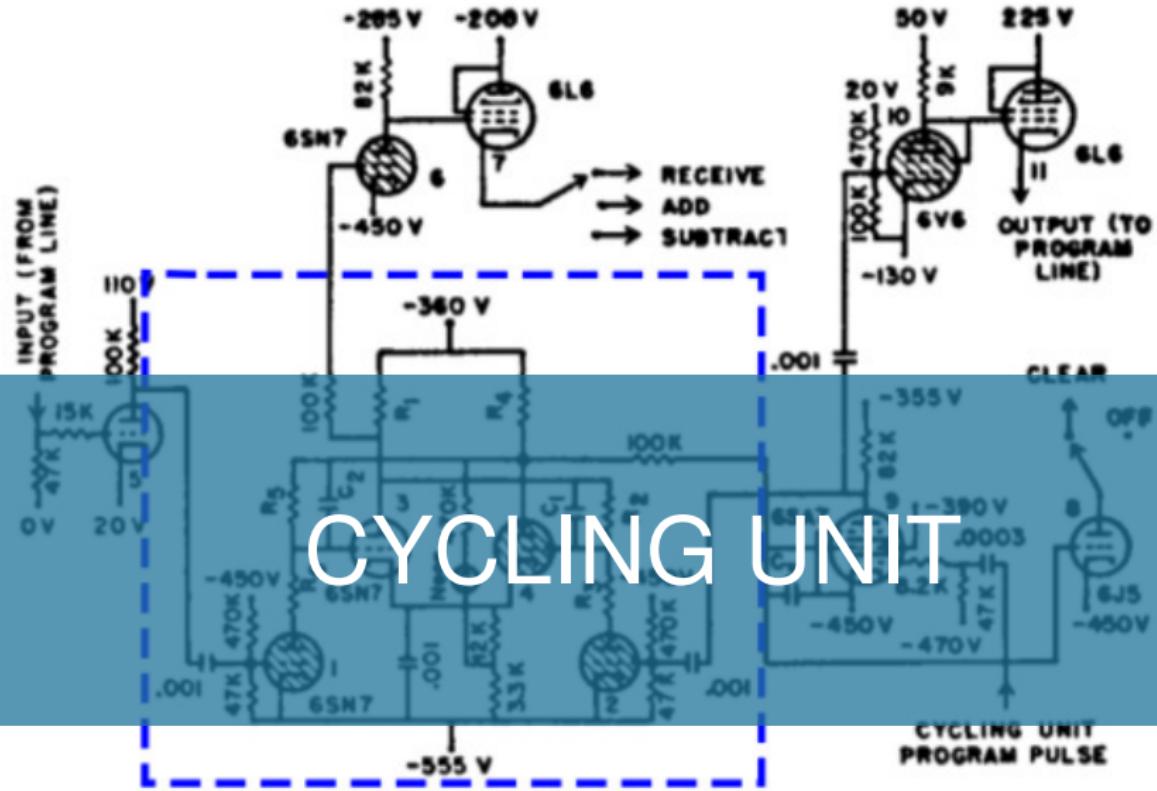
- NO PROGRAMMING  
MANUAL
- CIRCUIT DIAGRAMS
- LOGIC DIAGRAMS
- FRONT PANEL  
DIAGRAMS

- NO PROGRAMMING  
MANUAL
- CIRCUIT DIAGRAMS
- LOGIC DIAGRAMS
  - FRONT PANEL  
DIAGRAMS
- PAIRED TEACHING





# CIRCUIT DIAGRAMS



## MULTIPLICATION TABLE

MULTIPLIER  
ACCUMULATOR  
STATIC OUTPUTS:

TENS      UNITS

TENS (LEFT-HAND)

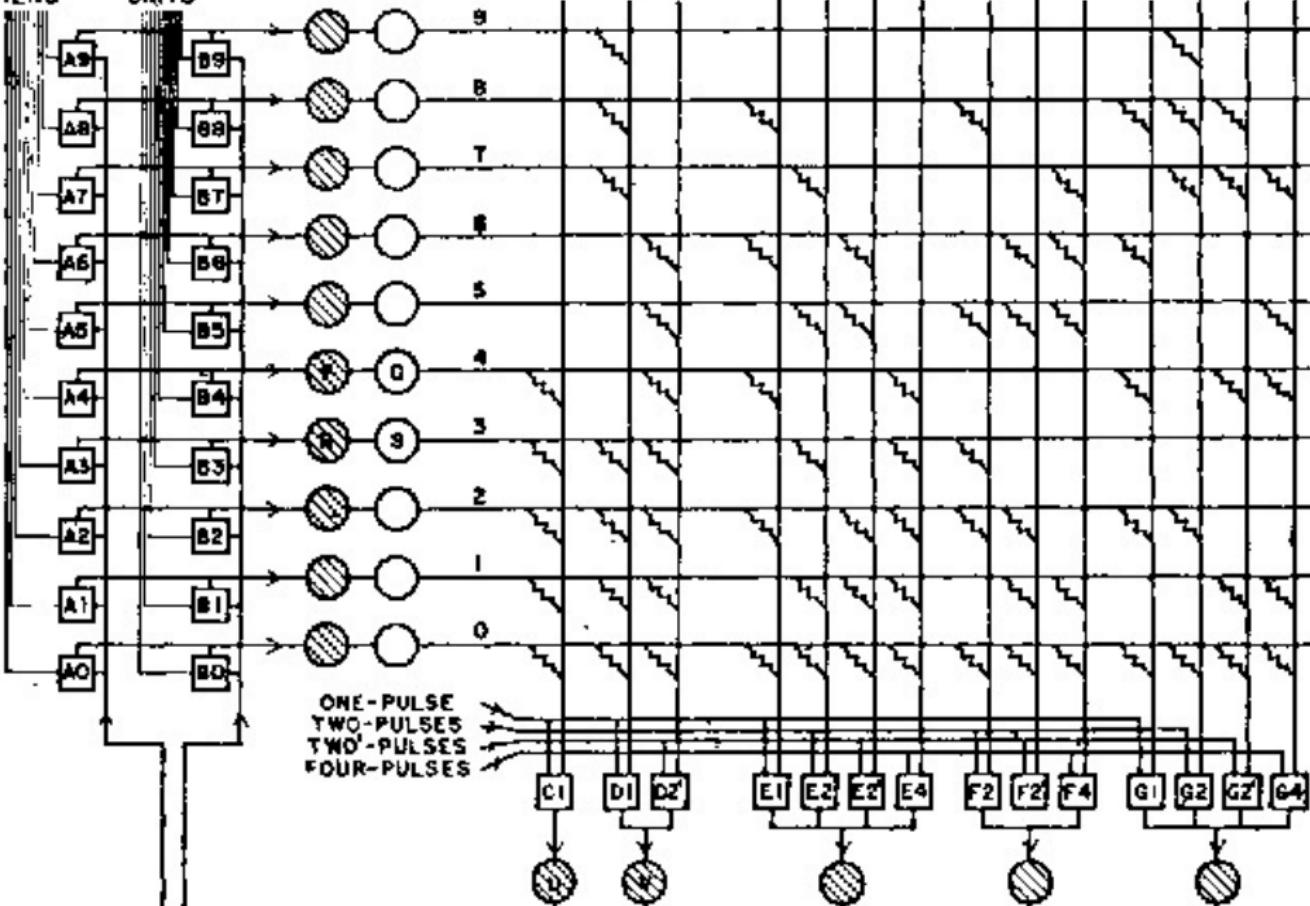
TWO    THREE

UNITS (RIGHT-HAND)

ONE

TWO

THREE



MULTIPLIER  
ACCUMULATOR  
STATIC OUTPUTS:

# MULTIPLICATION TABLE

## TENS (LEFT-HAND)

## UNITS (RIGHT-HAND)

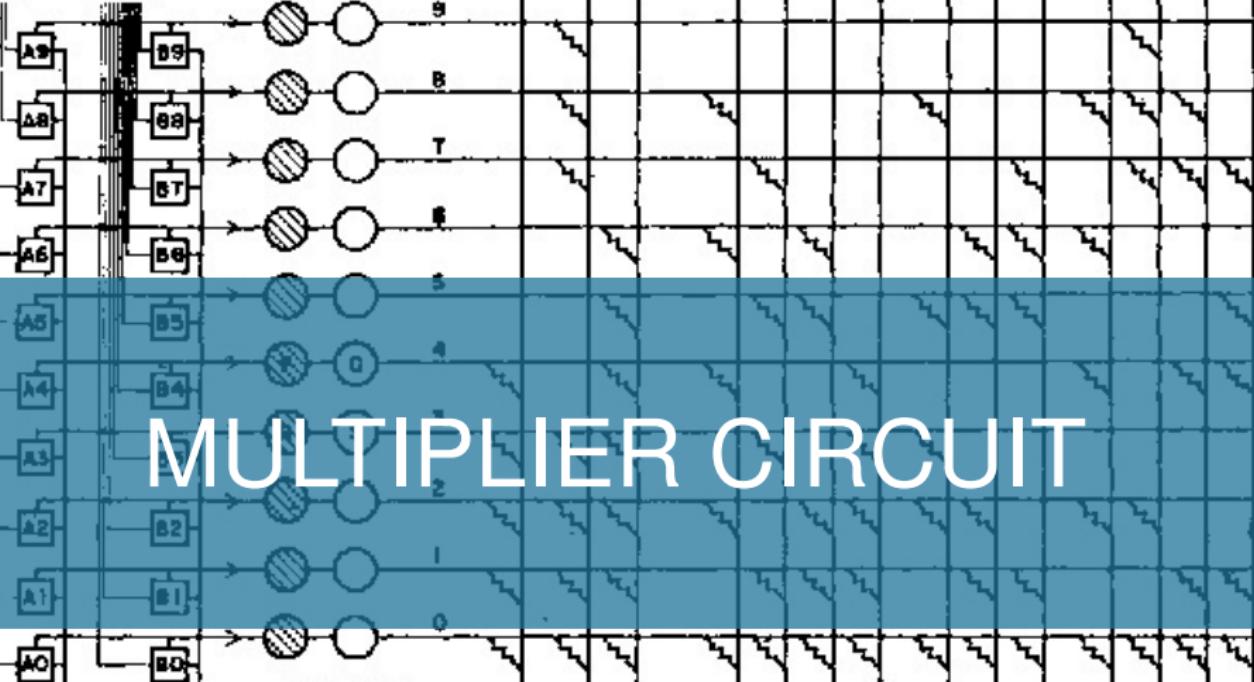
TENS      UNITS

TWO    THREE

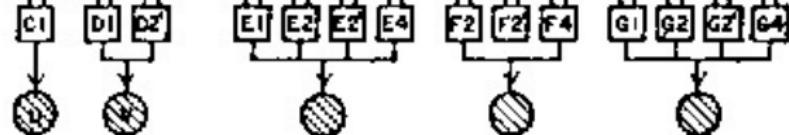
ONE

TWO

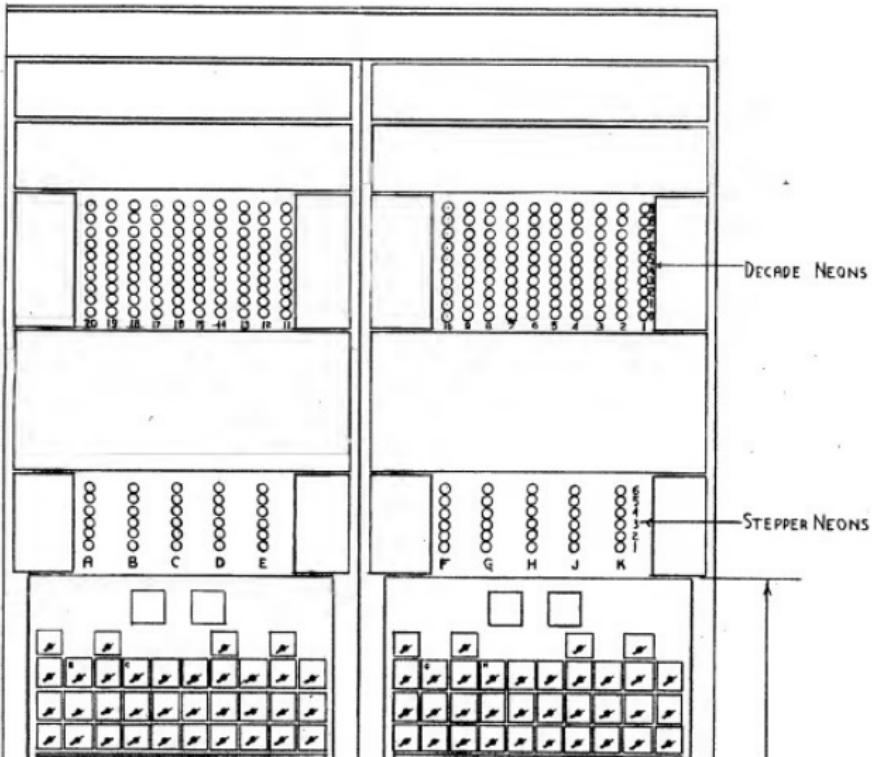
THREE



ONE-PULSE  
TWO-PULSES  
THREE-PULSES  
FOUR-PULSES

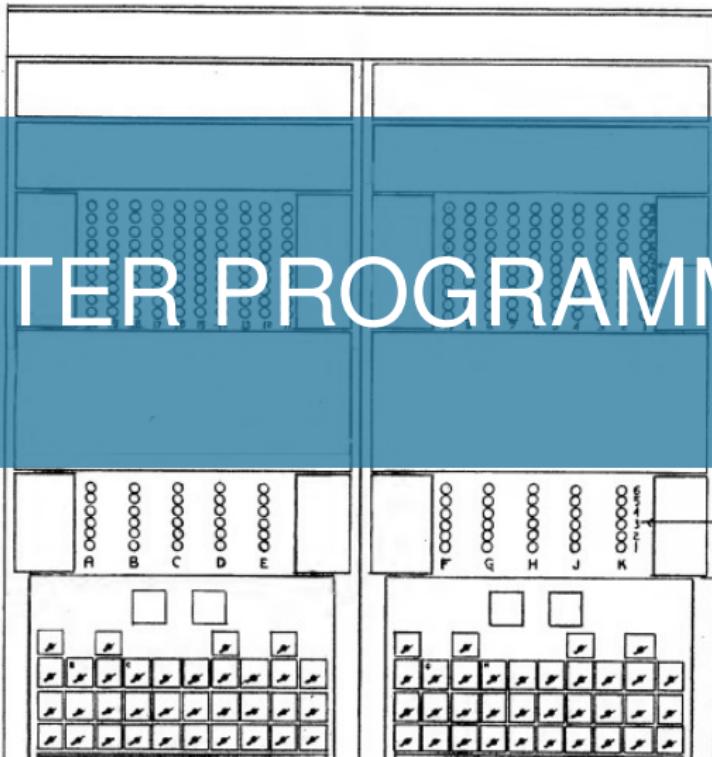


144



147

# MASTER PROGRAMMER



# ● PROGRAMMED WITH WIRES AND SWITCHES

ACCUMULATOR 9  
(MULTIPLIER)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER 4

PROGRAM 6-DIGIT TRAPS

ACCUMULATOR 10  
(MULTIPLIER AND)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
LEFT HAND  
MULTIPLY PRODUCTS

ACCUMULATOR 12  
LEFT HAND  
MULTIPLY PRODUCTS

ACCUMULATOR 13  
RIGHT HAND  
MULTIPLY PRODUCTS

ACCUMULATOR 14  
RIGHT HAND  
MULTIPLY PRODUCTS

ACCUMULATOR 15  
RIGHT HAND  
MULTIPLY PRODUCTS

ACCUMULATOR 15  
(PRINTER 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

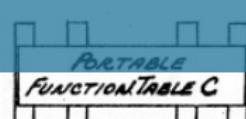
ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3



# • PROGRAMMED WITH WIRES AND SWITCHES • ACCUMULATORS ARE THE ONLY MEMORY

ACCUMULATOR 9  
(MULTIPLIER I)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER 4

ACCUMULATOR 10  
(MULTIPLIER II)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
LEFT HAND  
TOTAL PRODUCTS I

ACCUMULATOR 12  
LEFT HAND  
TOTAL PRODUCTS II

ACCUMULATOR 13  
RIGHT HAND  
TOTAL PRODUCTS III

ACCUMULATOR 14  
RIGHT HAND  
TOTAL PRODUCTS IV

ACCUMULATOR 15  
RIGHT HAND  
TOTAL PRODUCTS V

ACCUMULATOR 16  
RIGHT HAND  
TOTAL PRODUCTS VI

ACCUMULATOR 15  
(QUOTIENT 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 9&10)

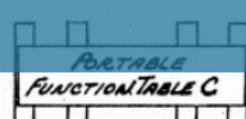
ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



● PROGRAMMED WITH WIRES AND SWITCHES  
● ACCUMULATORS ARE THE ONLY MEMORY  
● NO SEPARATION BETWEEN STORAGE AND COMPUTATION

ACCUMULATOR 9  
(MULTIPLIER I)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER €

ACCUMULATOR 10  
(MULTIPLIER II)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
LEFT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 12  
LEFT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 13  
RIGHT HAND  
MULTIPLYER PRODUCTS III)

ACCUMULATOR 14  
RIGHT HAND  
MULTIPLYER PRODUCTS IV)

ACCUMULATOR 15  
RIGHT HAND  
MULTIPLYER PRODUCTS V)

ACCUMULATOR 15  
(DENOMINATOR 6)

ACCUMULATOR 16  
(PRINTER 7&8)

ACCUMULATOR 17  
(PRINTER 2&3)

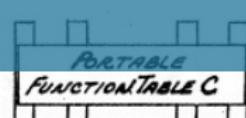
ACCUMULATOR 18  
(PRINTER 11&12)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



- PROGRAMMED WITH WIRES AND SWITCHES
- ACCUMULATORS ARE THE ONLY MEMORY
- NO SEPARATION BETWEEN STORAGE AND COMPUTATION
- PARALLEL

ACCUMULATOR 9  
(MULTIPLIER I)

ACCUMULATOR 8  
(SHIFT II)

ACCUMULATOR 7  
(SHIFT I)

ACCUMULATOR 6  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 5  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 4  
(NUMERATOR II)

ACCUMULATOR 3  
(NUMERATOR I)

DIVIDER 4

ACCUMULATOR 10  
(MULTIPLIER II)

MULTIPLIER 1

MULTIPLIER 2

MULTIPLIER 3

ACCUMULATOR 11  
LEFT HAND  
MULTIPLYER PRODUCTS I)

ACCUMULATOR 12  
LEFT HAND  
MULTIPLYER PRODUCTS II)

ACCUMULATOR 13  
RIGHT HAND  
MULTIPLYER PRODUCTS III)

ACCUMULATOR 14  
RIGHT HAND  
MULTIPLYER PRODUCTS IV)

ACCUMULATOR 15  
RIGHT HAND  
MULTIPLYER PRODUCTS V)

ACCUMULATOR 16  
RIGHT HAND  
MULTIPLYER PRODUCTS VI)

ACCUMULATOR 17  
RIGHT HAND  
MULTIPLYER PRODUCTS VII)

ACCUMULATOR 18  
RIGHT HAND  
MULTIPLYER PRODUCTS VIII)

ACCUMULATOR 19  
(DENOMINATOR  
SQUARE ROOT I)

ACCUMULATOR 20  
(DENOMINATOR  
SQUARE ROOT II)

ACCUMULATOR 21  
(DENOMINATOR  
SQUARE ROOT III)

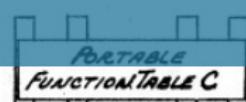
ACCUMULATOR 22  
(DENOMINATOR  
SQUARE ROOT IV)

\*FUNCTION TABLE 2  
PANEL 1

FUNCTION TABLE 2  
PANEL 2

FUNCTION TABLE 3  
PANEL 1

FUNCTION TABLE 3  
PANEL 2



## 2.2. TESTING AN ACCUMULATOR

Cards should be prepared as follows:

1. P 11111 11111

2. P 00000 00001 :

The numbers should be so placed on a card that one group in the constant transmitter, say  $A_{LR}$ , corresponds to these numbers. Next, a **master programmer** stepper should be used to transmit the first number into the accumulators which are to be tested eighteen times. At this time the accumulators should read

M 99999 99998

and all stages of each decade have been checked as well as the delayed carry-over circuits. Now the stepper (used above) should cause the reader to read the next card and the number to be transmitted to the accumulators twice. This should

## 2.2. TESTING AN ACCUMULATOR

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# MASTER PROGRAMMER

M 99999 99998

and all stages of each decade have been checked as well as the delayed carry-over circuits. Now the stepper (used above) should cause the reader to read the next card and the number to be transmitted to the accumulators twice. This should

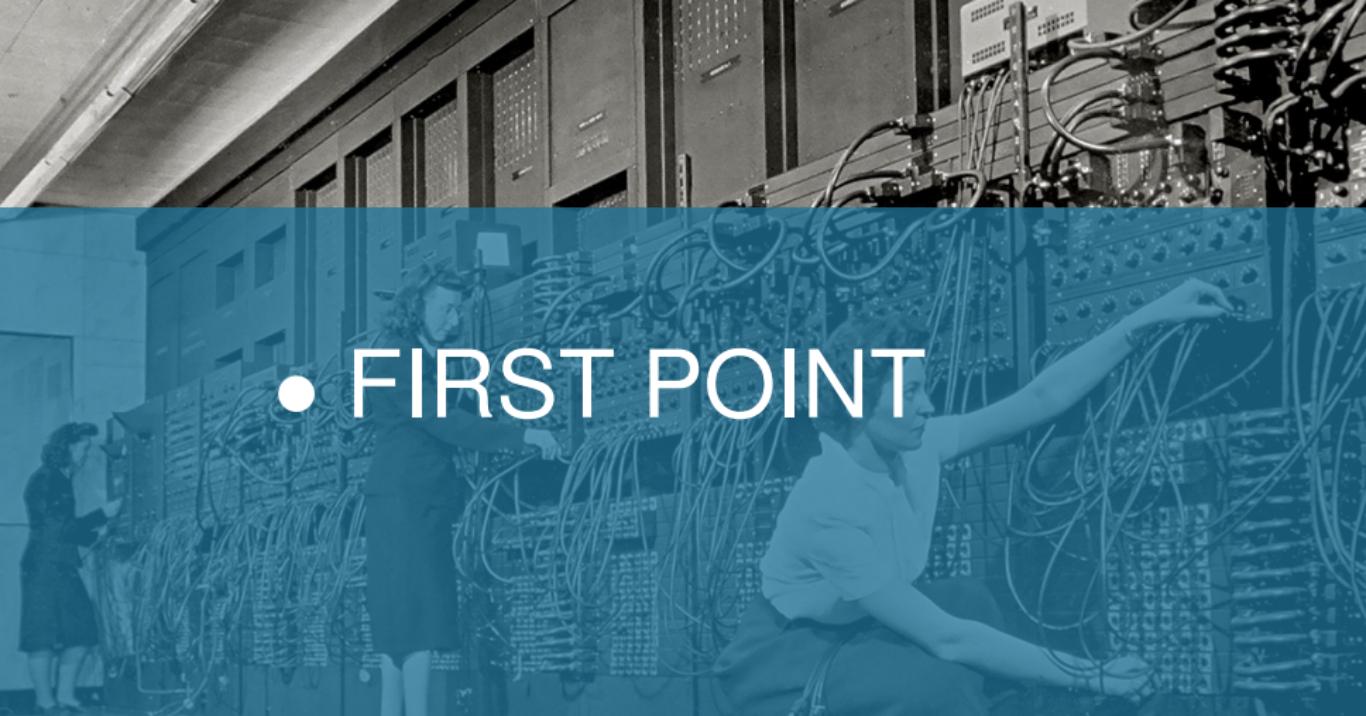


MAIN POINT

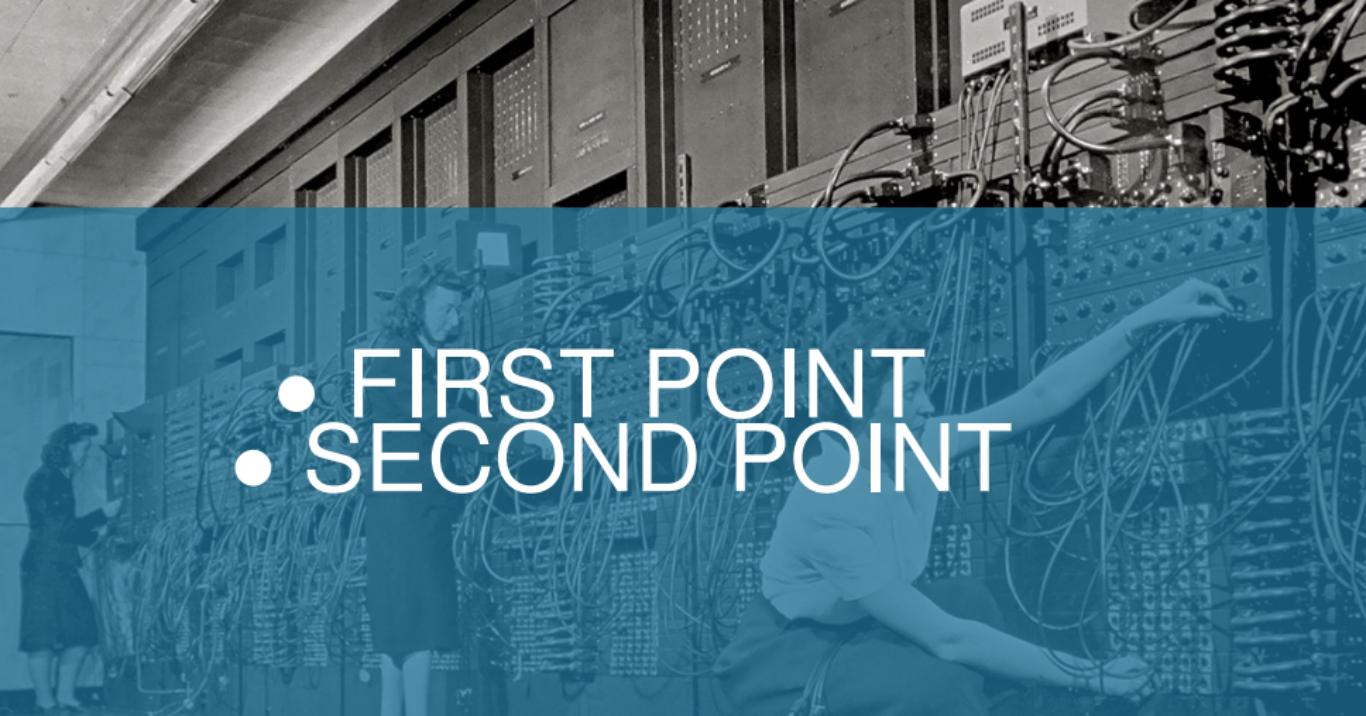


EXPLAINED CLEARLY  
WITH MORE TEXT

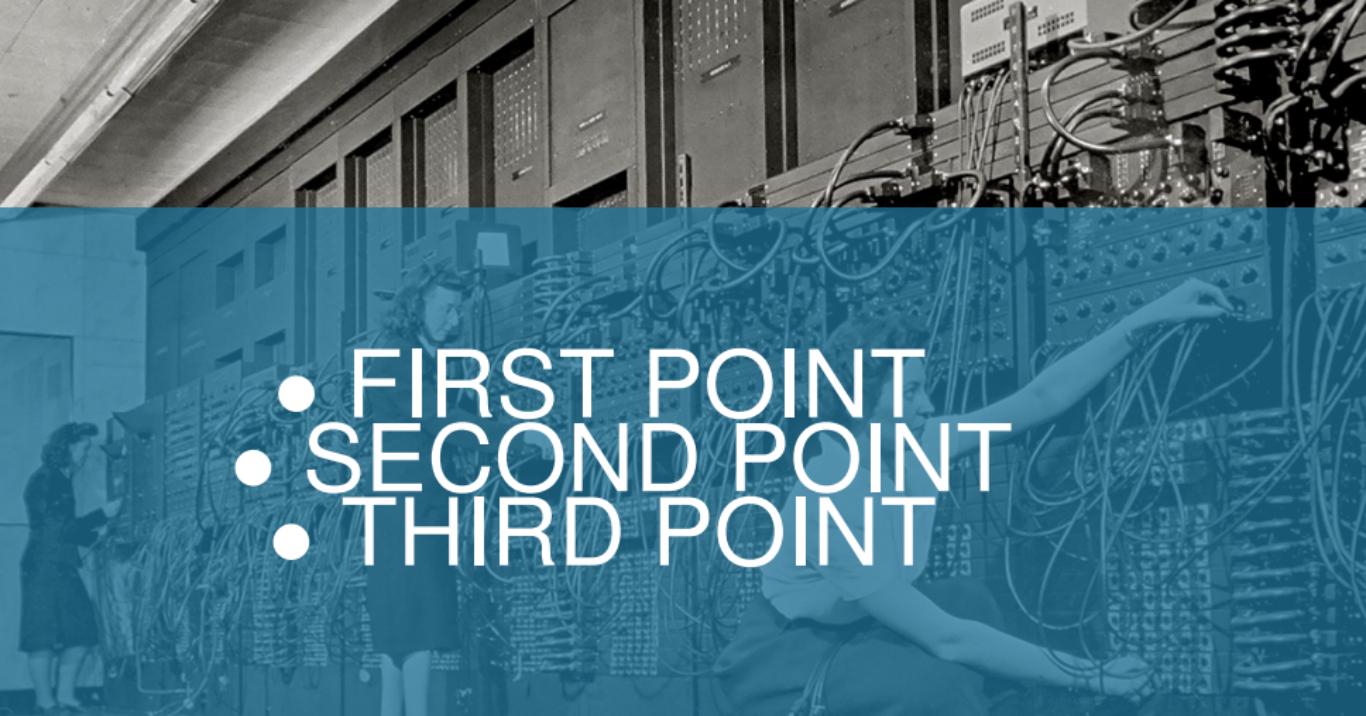
- or as a list containing multiple points
- alternatively, you may want a few main points appearing one by one...



• FIRST POINT



• FIRST POINT  
• SECOND POINT

- 
- FIRST POINT
  - SECOND POINT
  - THIRD POINT

A black and white photograph showing two women in a technical or industrial setting. They are standing in front of large, complex control panels with numerous knobs, switches, and indicator lights. The woman on the right is reaching up towards the top of one of the panels, while the woman on the left stands beside her, looking at a clipboard or a small device. The room is filled with the intricate web of wires and cables that connect these panels.

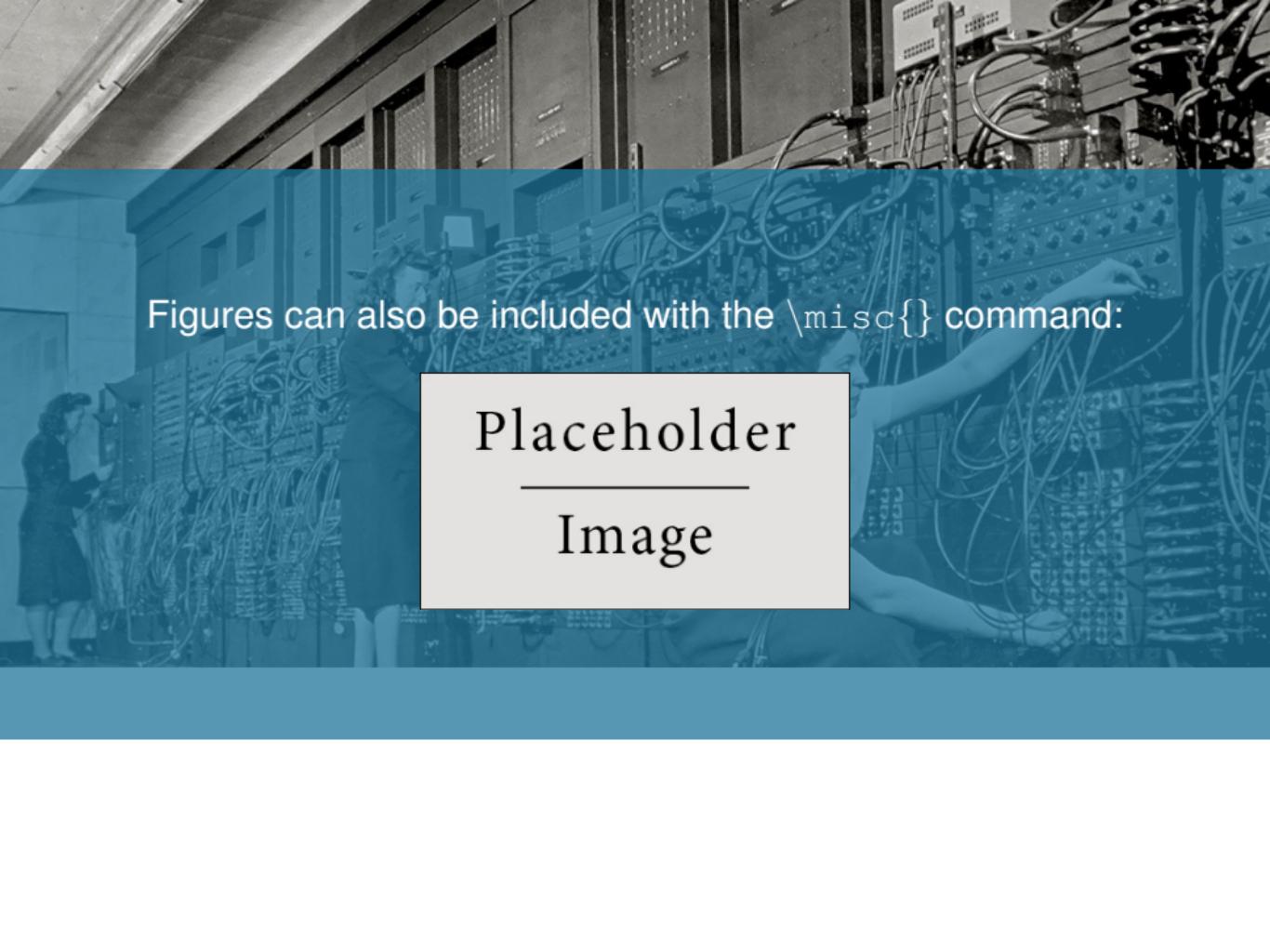
Numbered list:

1. First item
2. Second item
3. Third item



Tables can be included with the `\misc{}` command:

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

A black and white photograph of a server room or control room. The foreground is dominated by a large rack of server hardware with many cables. In the background, several people are visible, some standing and looking at monitors, others working at desks. The room is filled with rows of equipment and complex wiring.

Figures can also be included with the \misc{} command:

Placeholder  
—  
Image

A historical black and white photograph showing two women in a technical environment. One woman is seated at a console with numerous knobs and switches, while another stands beside her, also interacting with the equipment. The room is filled with complex electrical wiring and large metal racks, characteristic of mid-20th-century computing facilities.

THANK YOU

# SOURCES



flickr/lovelornpoets



flickr/apsmuseum