

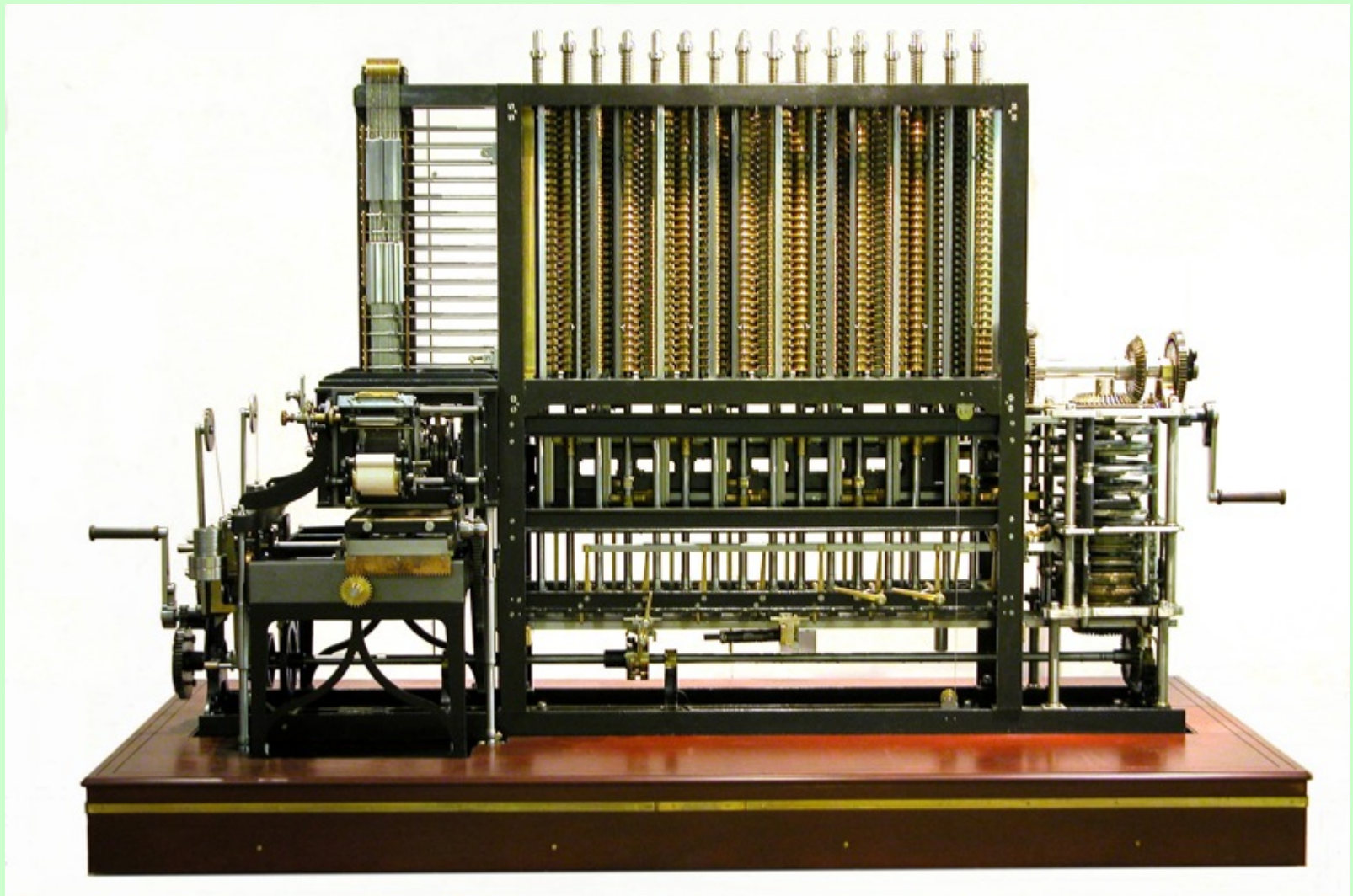
William Stallings  
Computer Organization  
and Architecture  
8<sup>th</sup> Edition

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Chapter 2  
Computer Evolution and  
Performance

# Analytical Engine

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# ENIAC - background

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- Electronic Numerical Integrator And Computer
- Eckert and Mauchly
- University of Pennsylvania
- Trajectory tables for weapons
- Started 1943
- Finished 1946
  - Too late for war effort
- Used until 1955

# ENIAC - details

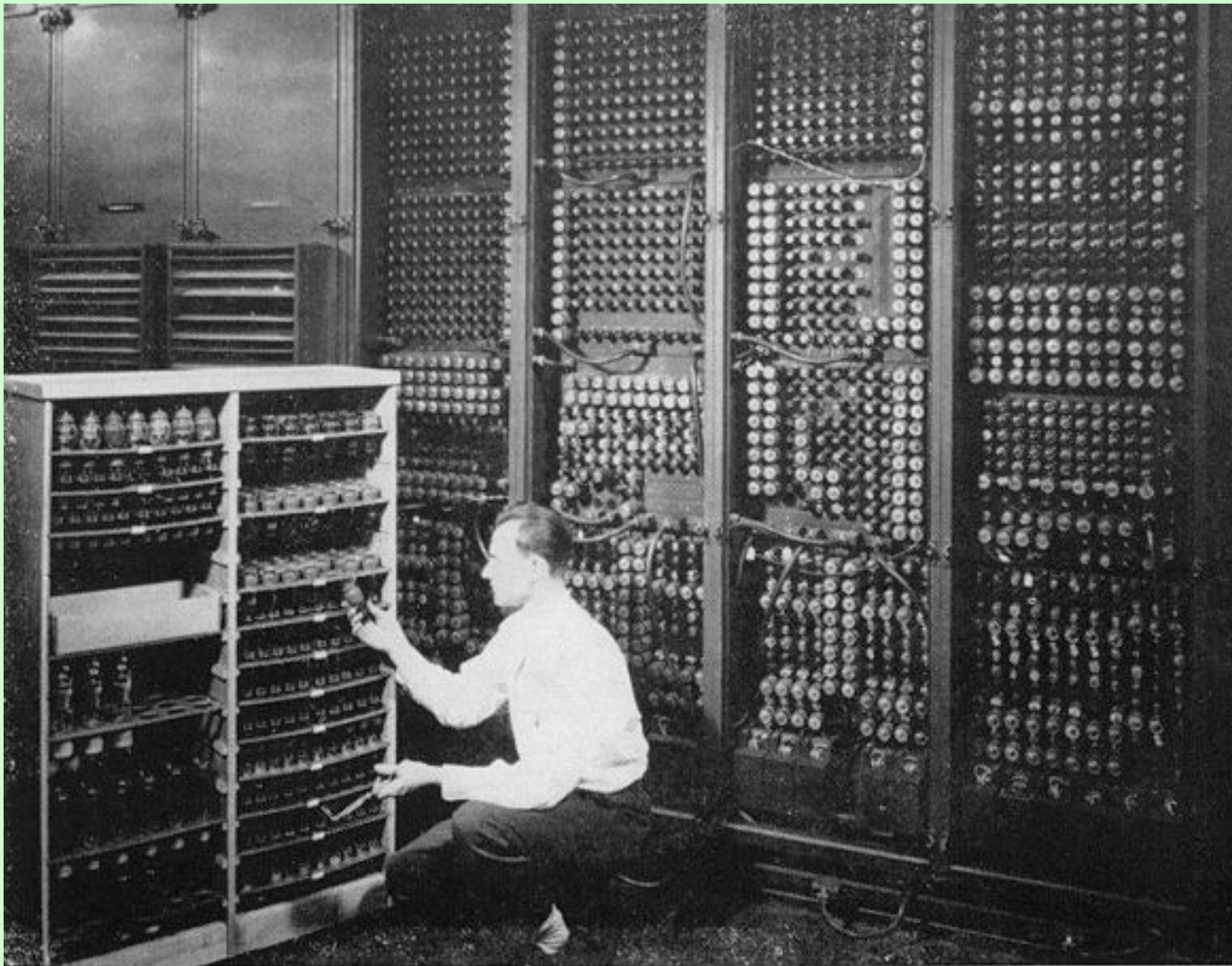
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- Triode Valve



# ENIAC - details

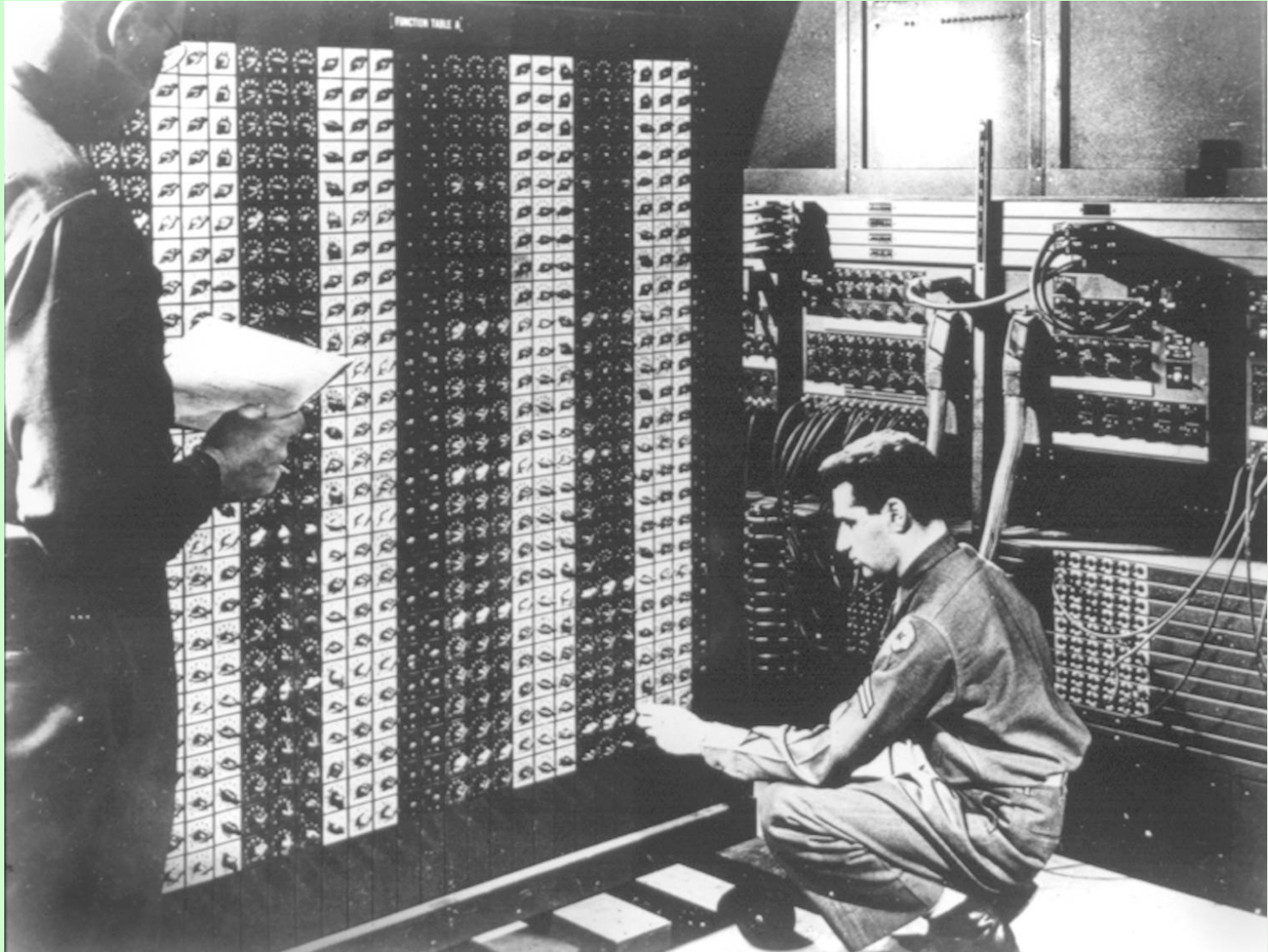
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Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.



# ENIAC - details



# ENIAC - details

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- Decimal (not binary)
- 20 accumulators of 10 digits
- Programmed manually by switches
- 18,000 vacuum tubes
- 30 tons
- 15,000 square feet
- 140 kW power consumption
- 5,000 additions per second

# ENIAC - details





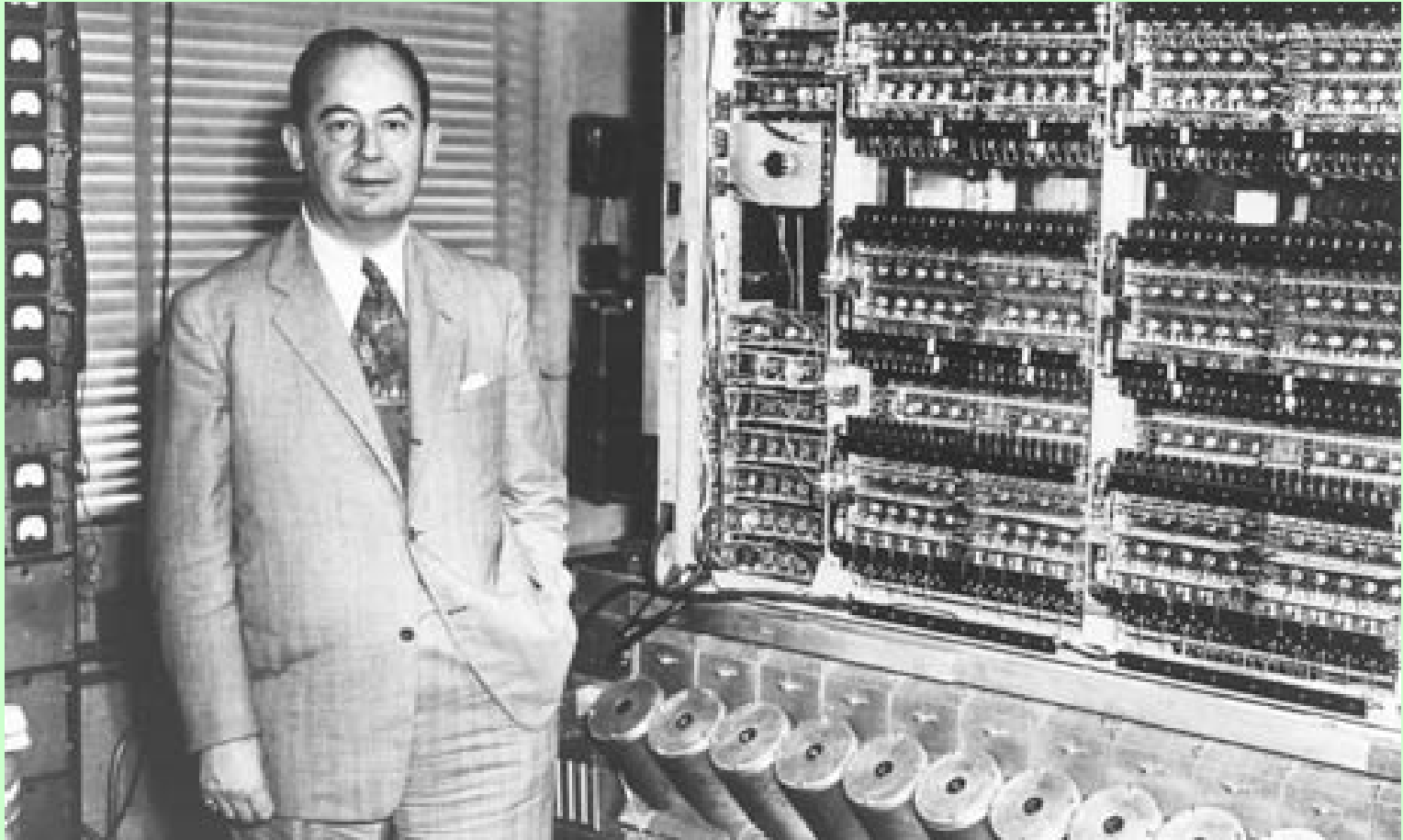
# von Neumann/Turing

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- Stored Program concept
- Main memory storing programs and data
- ALU operating on binary data
- Control unit interpreting instructions from memory and executing
- Input and output equipment operated by control unit
- Princeton Institute for Advanced Studies
  - IAS
- Completed 1952

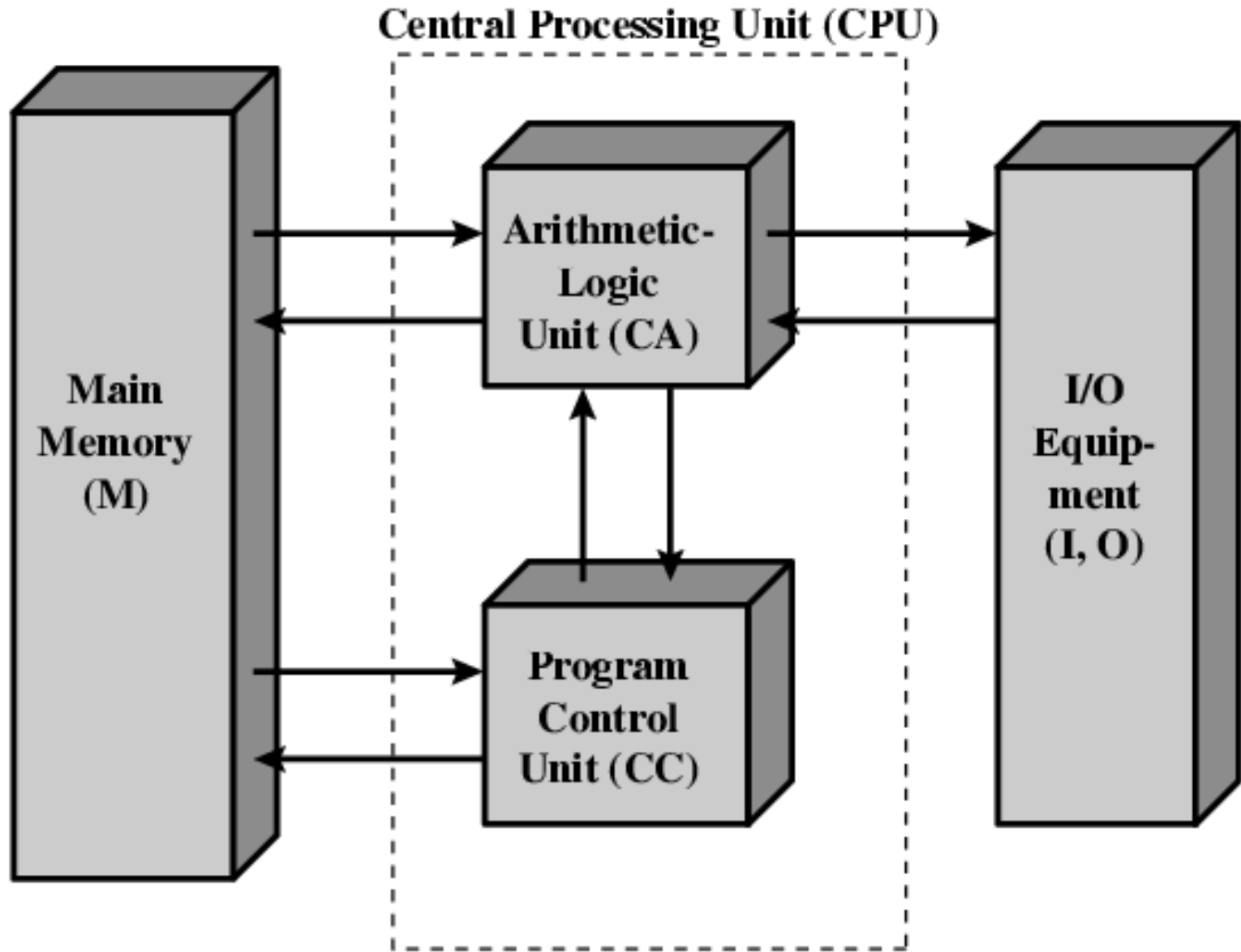
# von Neumann/Turing

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John von Neumann with the stored-program computer at the Institute for Advanced Study, Princeton, New Jersey, in 1945. Photograph: Getty

# Structure of von Neumann machine



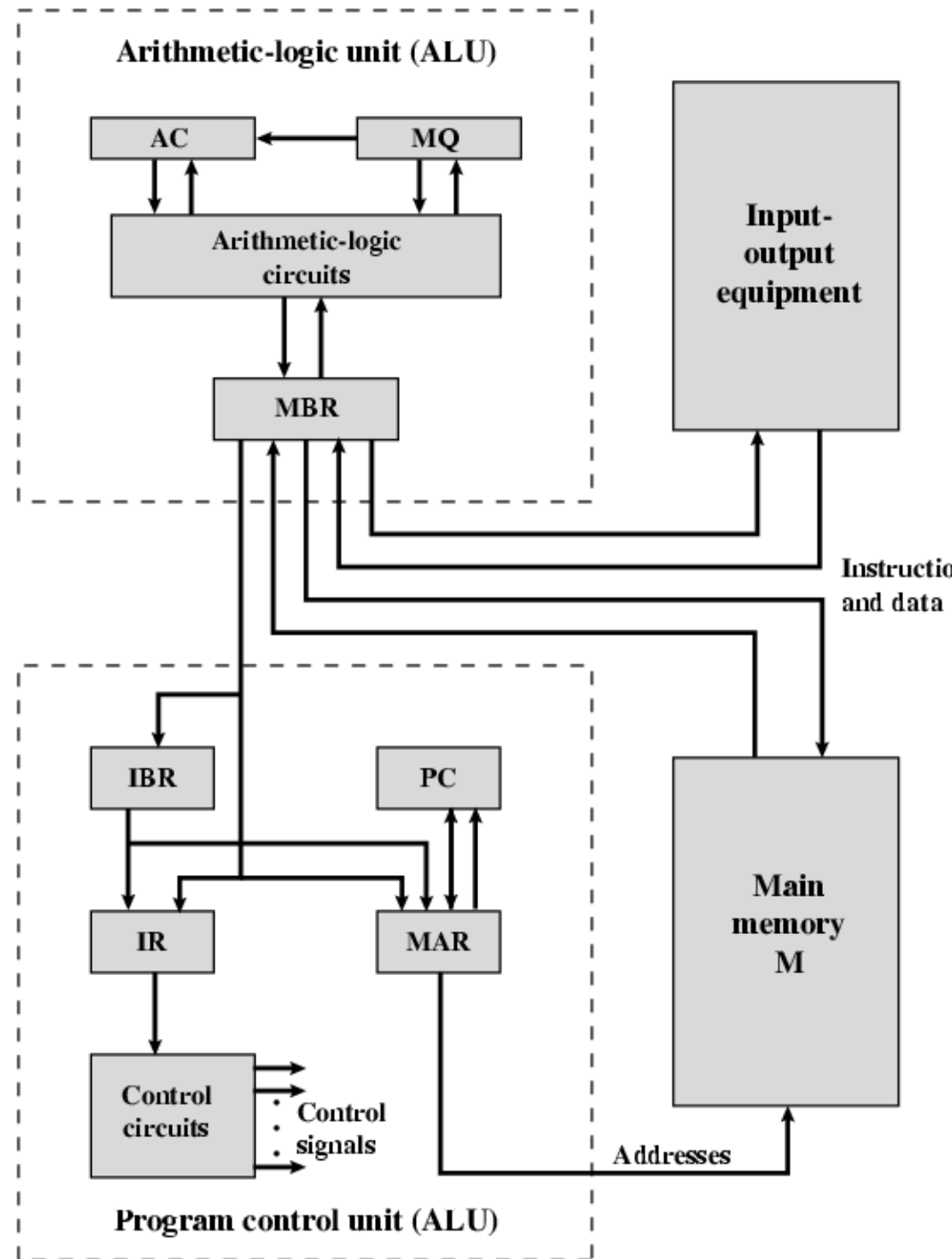
# IAS - details

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- 1000 x 40 bit words
  - Binary number
  - 2 x 20 bit instructions
- Set of registers (storage in CPU)
  - Memory Buffer Register
  - Memory Address Register
  - Instruction Register
  - Instruction Buffer Register
  - Program Counter
  - Accumulator
  - Multiplier Quotient



# Structure of IAS – detail



# Commercial Computers

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- 1947 - Eckert-Mauchly Computer Corporation
- UNIVAC I (Universal Automatic Computer)
- US Bureau of Census 1950 calculations
- Became part of Sperry-Rand Corporation
- Late 1950s - UNIVAC II
  - Faster
  - More memory

# IBM

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- Punched-card processing equipment
- 1953 - the 701
  - IBM's first stored program computer
  - Scientific calculations
- 1955 - the 702
  - Business applications
- Lead to 700/7000 series

# IBM

- IBM 7000 Series





# Transistors

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- Replaced vacuum tubes
- Smaller
- Cheaper
- Less heat dissipation
- Solid State device
- Made from Silicon (Sand)
- Invented 1947 at Bell Labs
- William Shockley et al.

# Transistor Based Computers

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- Second generation machines
- NCR & RCA produced small transistor machines
- IBM 7000
- DEC - 1957
  - Produced PDP-1



# Microelectronics

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- Literally - “small electronics”
- A computer is made up of gates, memory cells and interconnections
- These can be manufactured on a semiconductor
- e.g. silicon wafer

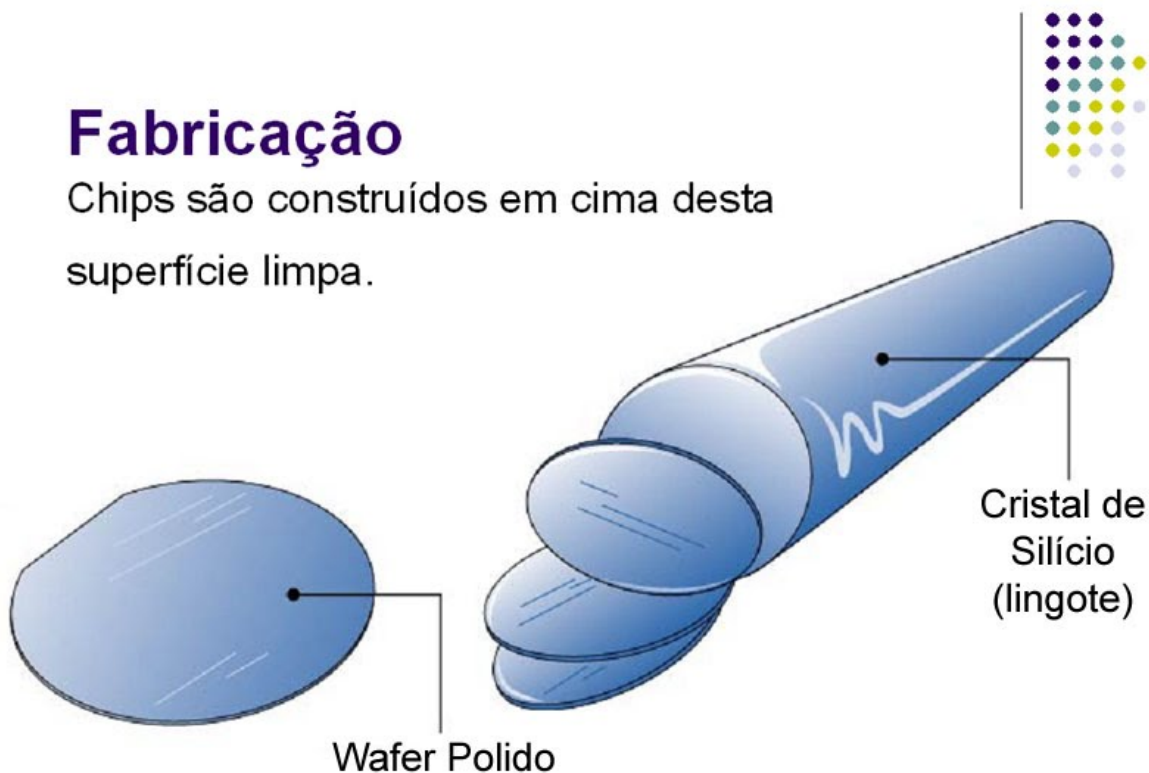
# Microelectronics



O silício metalúrgico, a lâmina (centro) e as células solares (à dir.)

## Fabricação

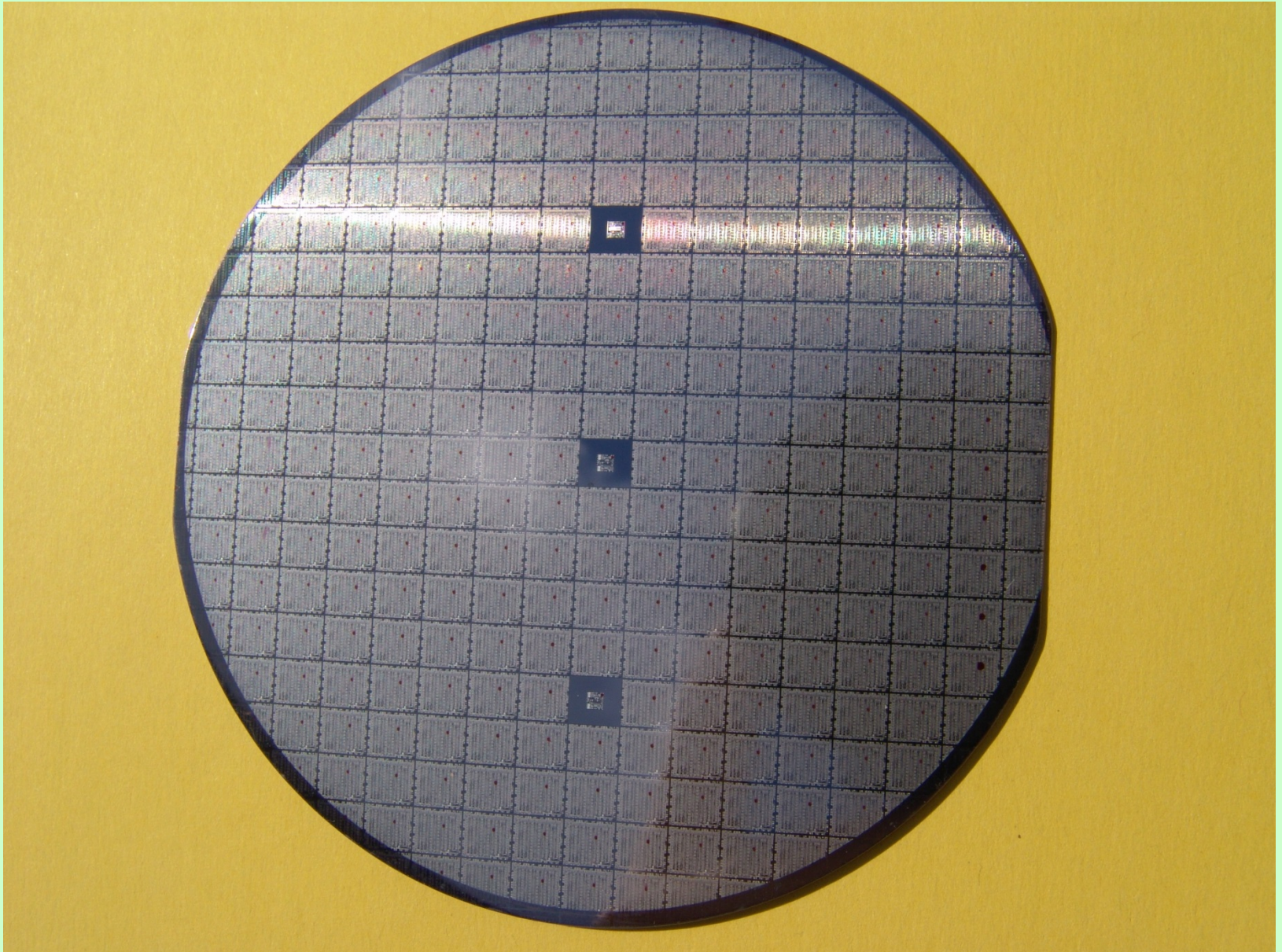
Chips são construídos em cima desta superfície limpa.





# Microelectronics

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# Generations of Computer

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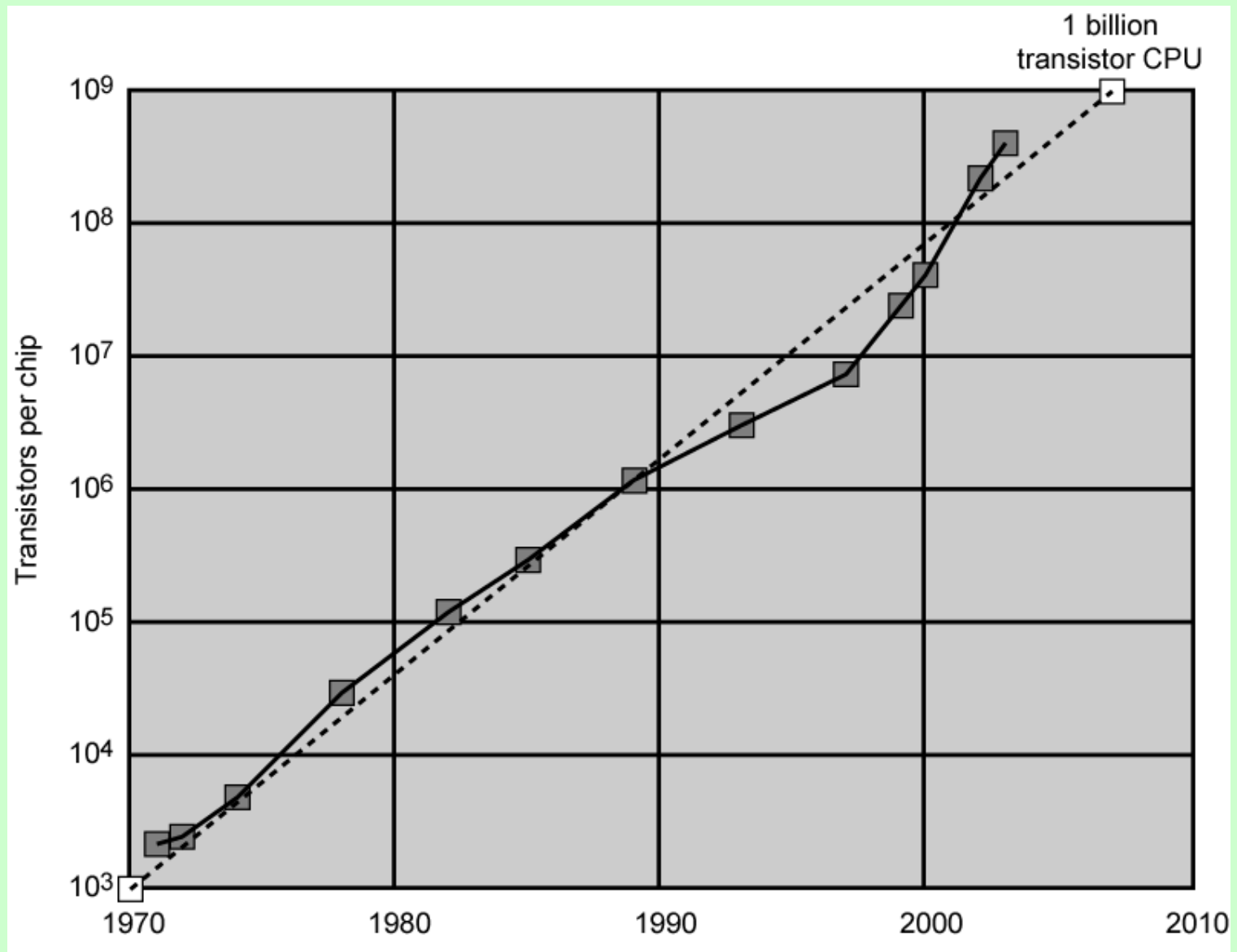
- Vacuum tube - 1946-1957
- Transistor - 1958-1964
- Small scale integration - 1965 on
  - Up to 100 devices on a chip
- Medium scale integration - to 1971
  - 100-3,000 devices on a chip
- Large scale integration - 1971-1977
  - 3,000 - 100,000 devices on a chip
- Very large scale integration - 1978 -1991
  - 100,000 - 100,000,000 devices on a chip
- Ultra large scale integration – 1991 -
  - Over 100,000,000 devices on a chip

# Moore's Law

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- Increased density of components on chip
- Gordon Moore – co-founder of Intel
- Number of transistors on a chip will double every year
- Since 1970's development has slowed a little
  - Number of transistors doubles every 18 months
- Cost of a chip has remained almost unchanged
- Higher packing density means shorter electrical paths, giving higher performance
- Smaller size gives increased flexibility
- Reduced power and cooling requirements
- Fewer interconnections increases reliability

# Growth in CPU Transistor Count



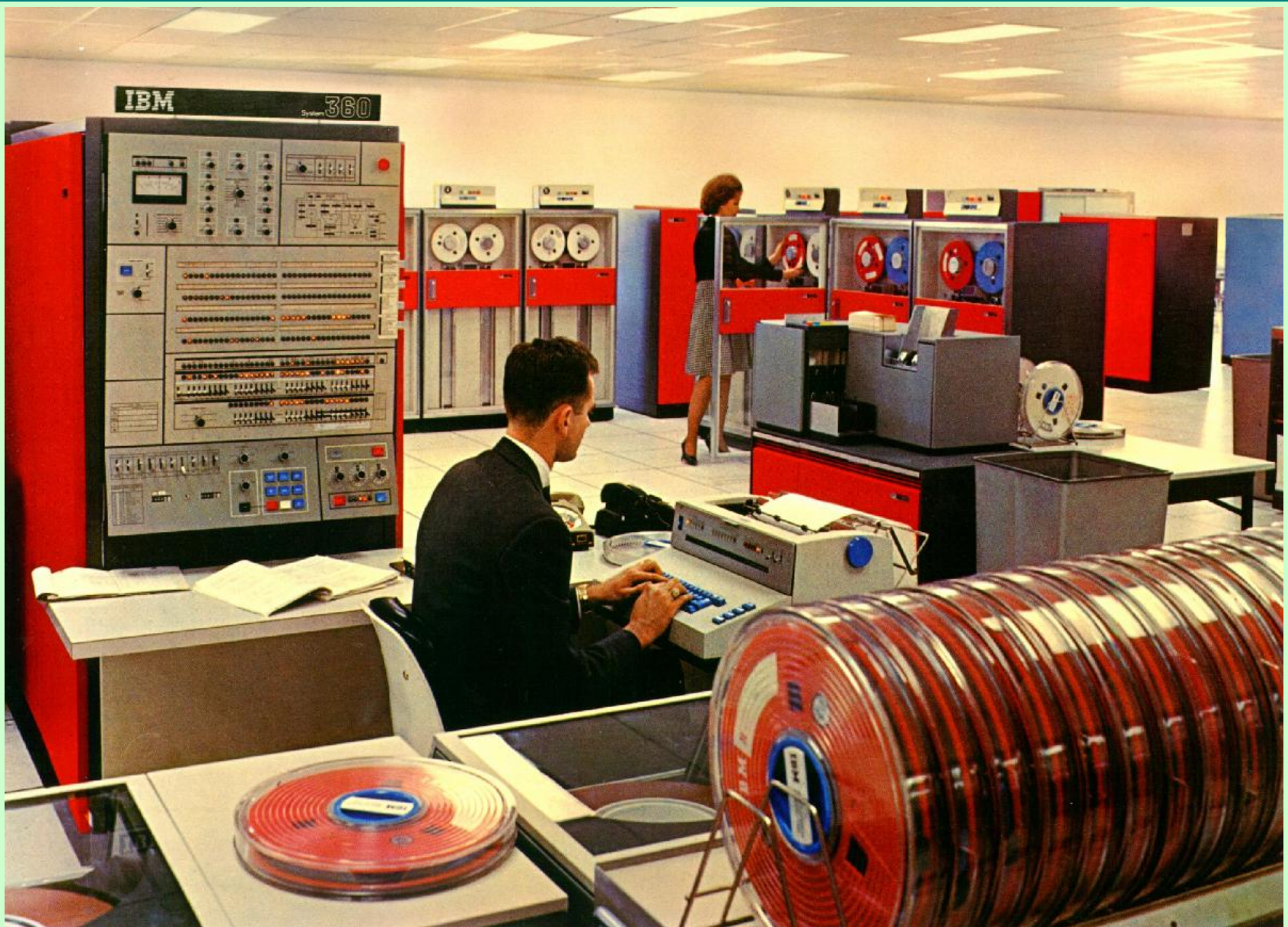


# IBM 360 series

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- 1964
- Replaced (& not compatible with) 7000 series
- First planned “family” of computers
  - Similar or identical instruction sets
  - Similar or identical O/S
  - Increasing speed
  - Increasing number of I/O ports (i.e. more terminals)
  - Increased memory size
  - Increased cost
- Multiplexed switch structure

# IBM 360 series



# DEC PDP-8

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- 1964
- First minicomputer (after miniskirt!)
- Did not need air conditioned room
- Small enough to sit on a lab bench
- \$16,000
  - \$100k+ for IBM 360
- Embedded applications & OEM
- BUS STRUCTURE

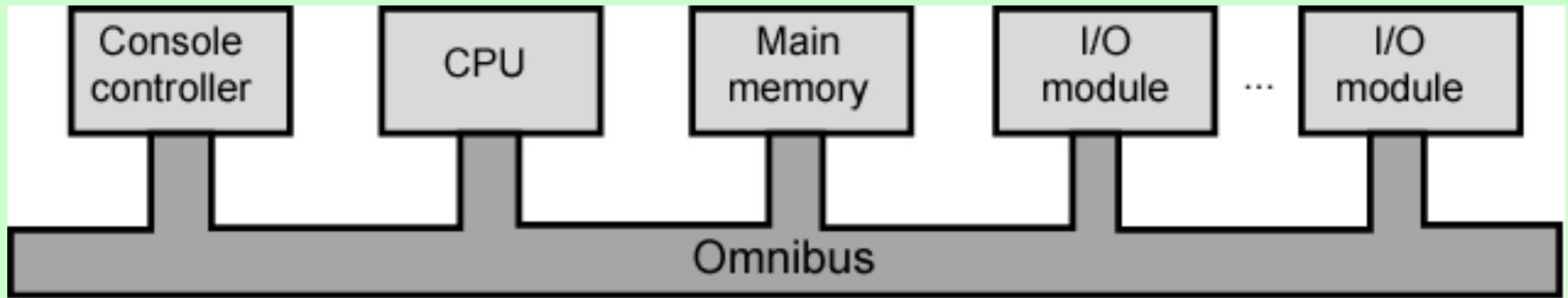


# DEC PDP-8



# DEC - PDP-8 Bus Structure

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# Semiconductor Memory

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- 1970
- Fairchild
- Size of a single core
  - i.e. 1 bit of magnetic core storage
- Holds 256 bits
- Non-destructive read
- Much faster than core
- Capacity approximately doubles each year



# Intel

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- 1971 - 4004
  - First microprocessor
  - All CPU components on a single chip
  - 4 bit
- Followed in 1972 by 8008
  - 8 bit
  - Both designed for specific applications
- 1974 - 8080
  - Intel's first general purpose microprocessor

# References

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- AMDA67 Amdahl, G. "Validity of the Single-Processor Approach to Achieving Large-Scale Computing Capability", *Proceedings of the AFIPS Conference, 1967.*