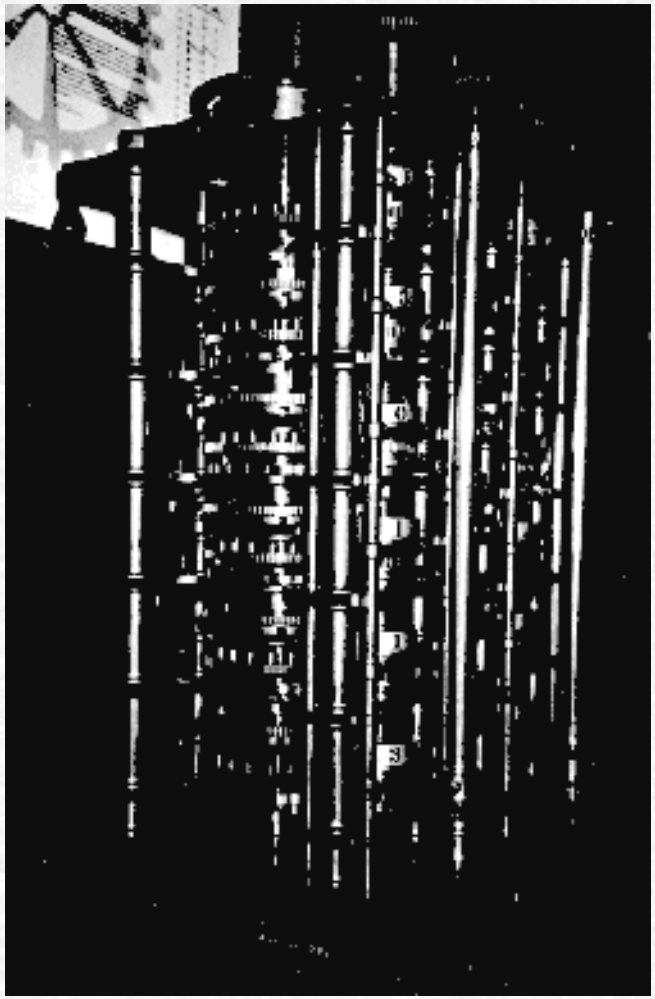
Computer History

Charles Babbage

- English inventor
- 1791-1871
- taught math at Cambridge University
- invented a viable mechanical computer equivalent to modern digital computers

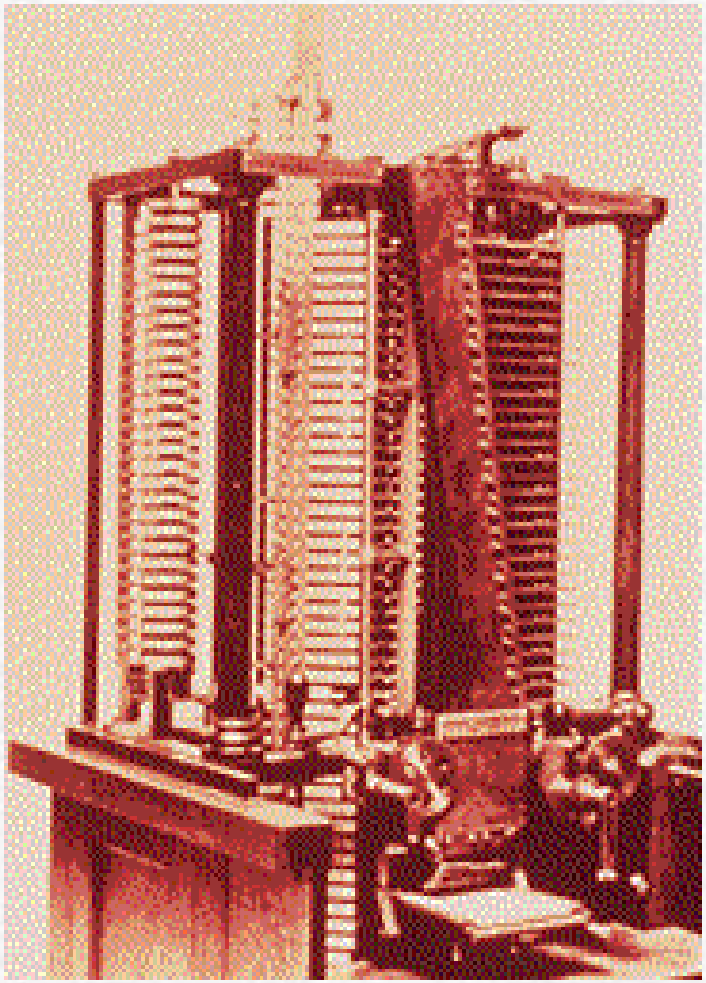
Babbage's first computer



difference engine

- built in early 1800's
  - special purpose calculator
  - naval navigation charts

Babbage's second computer



analytical engine, 1834

- Analytical engine
  - general-purpose
  - used binary system
  - punched cards as input
  - branch on result of previous instruction
  - Ada Lovelace (first programmer)
  - machined parts not accurate enough
  - never quite completed

invention of the light bulb, 1878

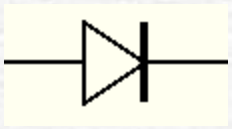
- Sir Joseph Wilson Swan
  - English physicist and electrician
  - first public exhibit of a light bulb in 1878
- Thomas Edison
  - American inventor, working independently of Swan
  - public exhibit of a light bulb in 1879
  - had a conducting filament mounted in a glass bulb from which the air was evacuated leaving a vacuum
  - passing electricity through the filament caused it to heat up, become incandescent and radiate light
  - the vacuum prevented the filament from oxidizing and burning up

Edison's legacy

- Edison continued to experiment with light bulbs
- in 1883, he detected electrons flowing through the vacuum of a light bulb
  - from the lighted filament
  - to a metal plate mounted inside the bulb
- this became known as the *Edison Effect*
- he did not develop this any further

invention of the diode (late 1800's)

- John Ambrose Fleming
  - an English physicist
  - studied Edison effect
  - to detect radio waves and to convert them to electricity
- developed a two-element vacuum tube
  - known as a *diode*
- electrons flow within the tube
  - from the negatively charged *cathode*
  - to the positively charged *anode*
- today, a *diode* is used in circuits as a *rectifier*



the switching vacuum tube, 1906

- Lee de Forest introduced a third electrode into the vacuum tube
  - American inventor
- the new vacuum tube was called a *triode*
  - new electrode was called a *grid*
- this tube could be used as both an amplifier and a switch

Lee De Forest

- many of the early radio transmitters were built by de Forest using triodes
- triodes revolutionized the field of broadcasting
- their ability to act as switches would later be important in digital computing

on/off switches in digital computers

- earliest:
  - electromechanical relays
    - solenoid with mechanical contact points
    - *physical switch* closes when electricity animates magnet
- 1940's:
  - vacuum tubes
    - no physical contacts to break or get dirty
    - became available in early 1900's
    - mainly used in radios at first

- 1950's to present
  - transistors
    - invented at Bell Labs in 1947
    - John Bardeen, Walter Brattain, and William Shockley
    - Nobel prize, 1956

electromechanical relay

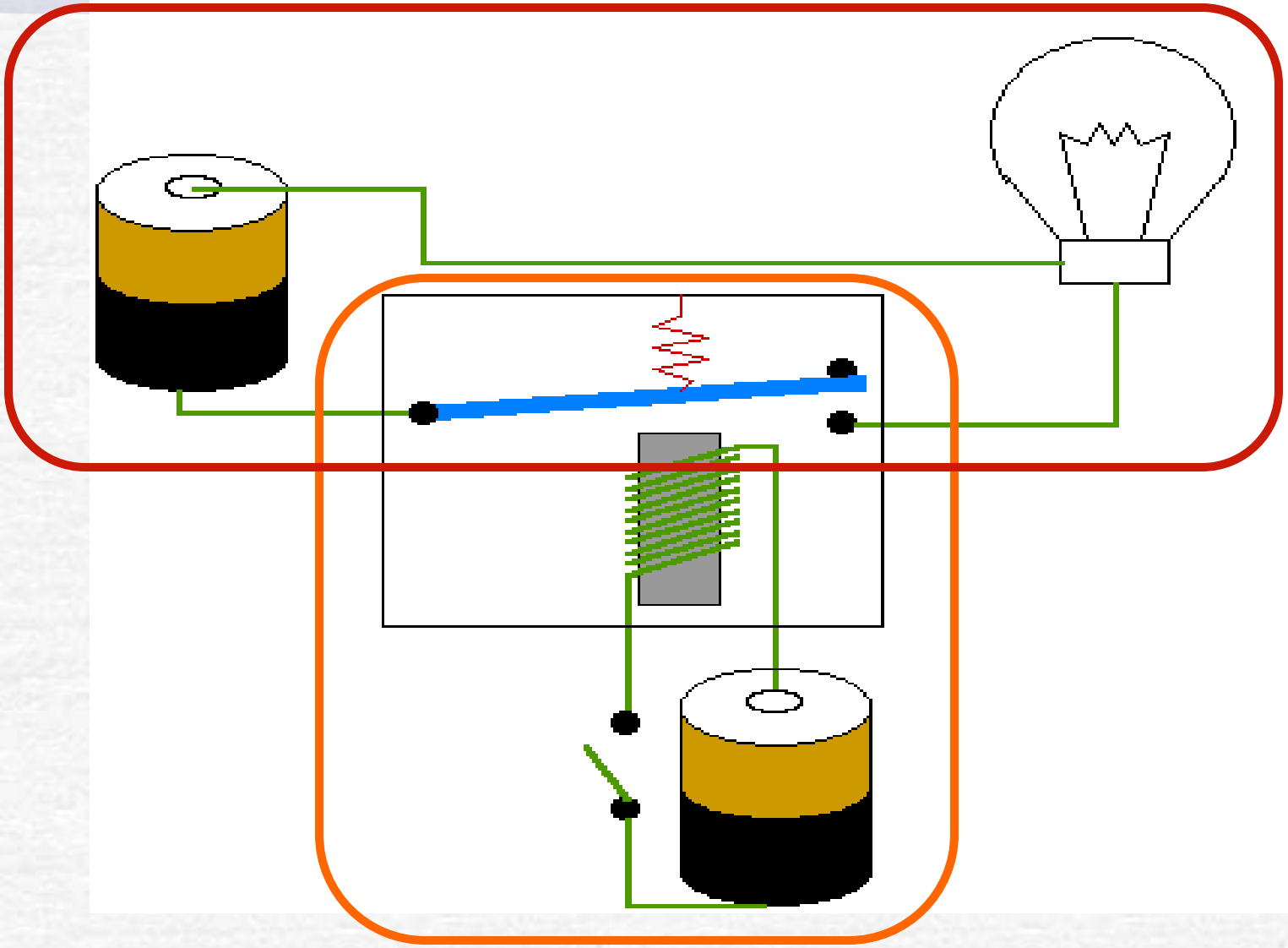
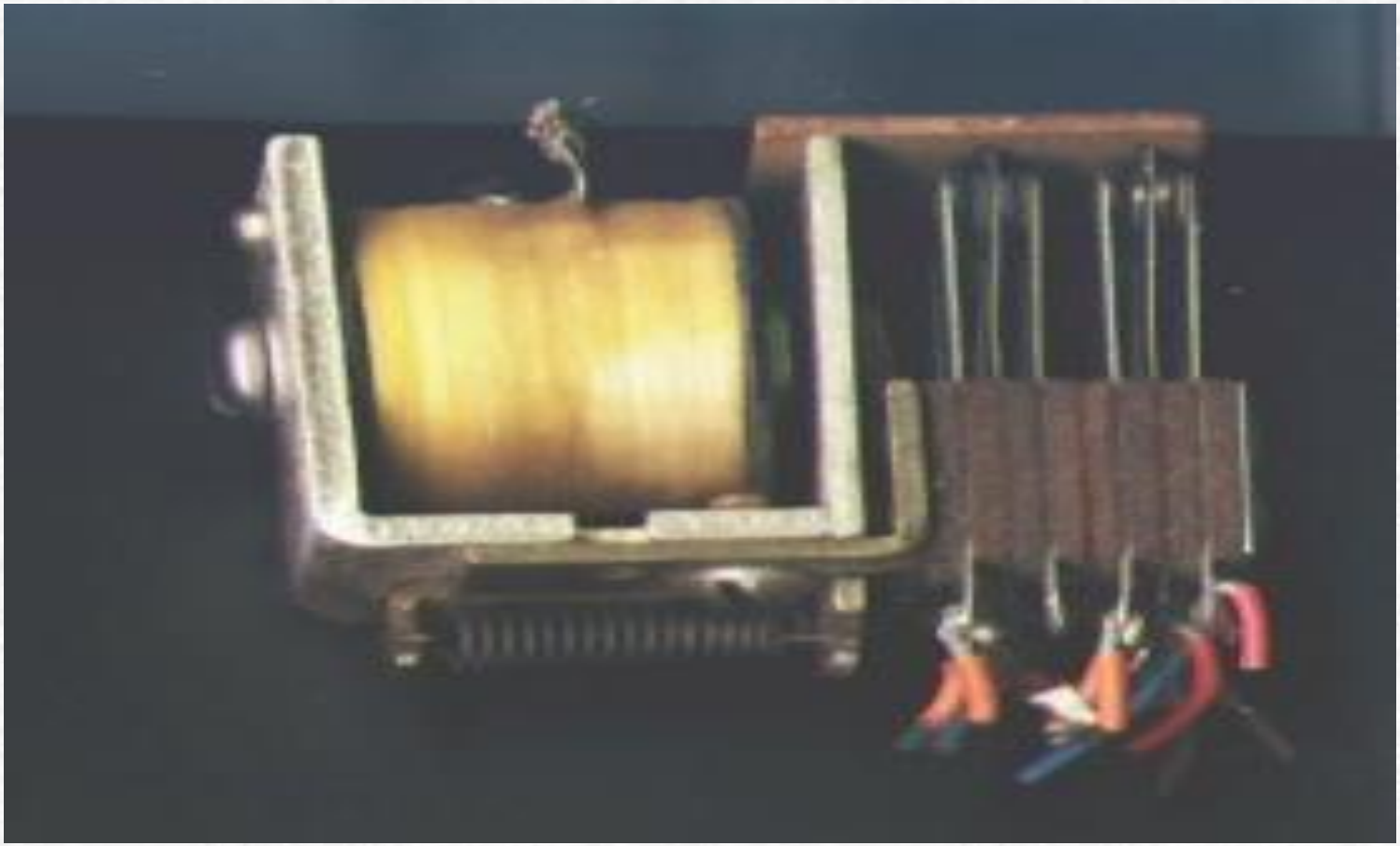
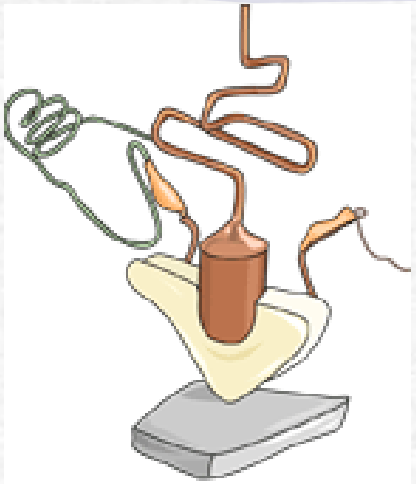


photo of an electromechanical relay



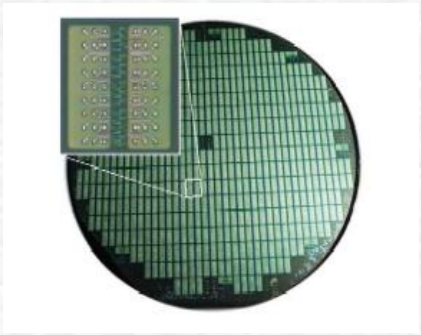
transistor evolution

- first transistor made from materials including a paper clip and a razor blade



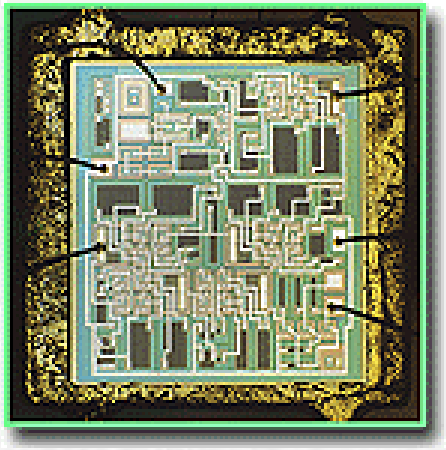
- later packaged in small IC's

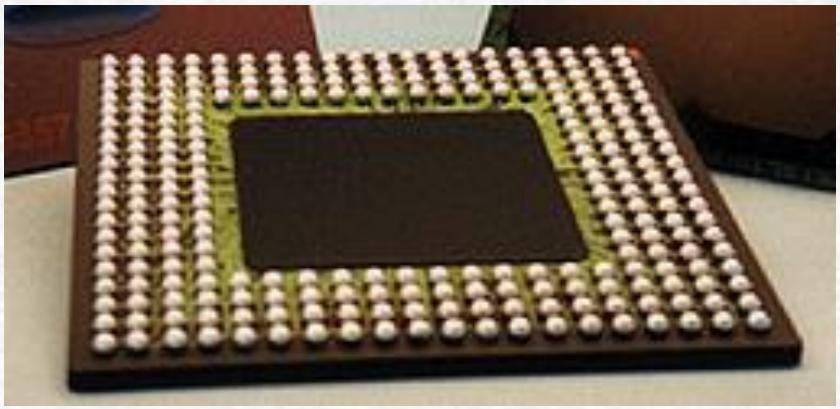
- eventually came VLSI
  - Very Large Scale Integration
  - millions of transistors per chip



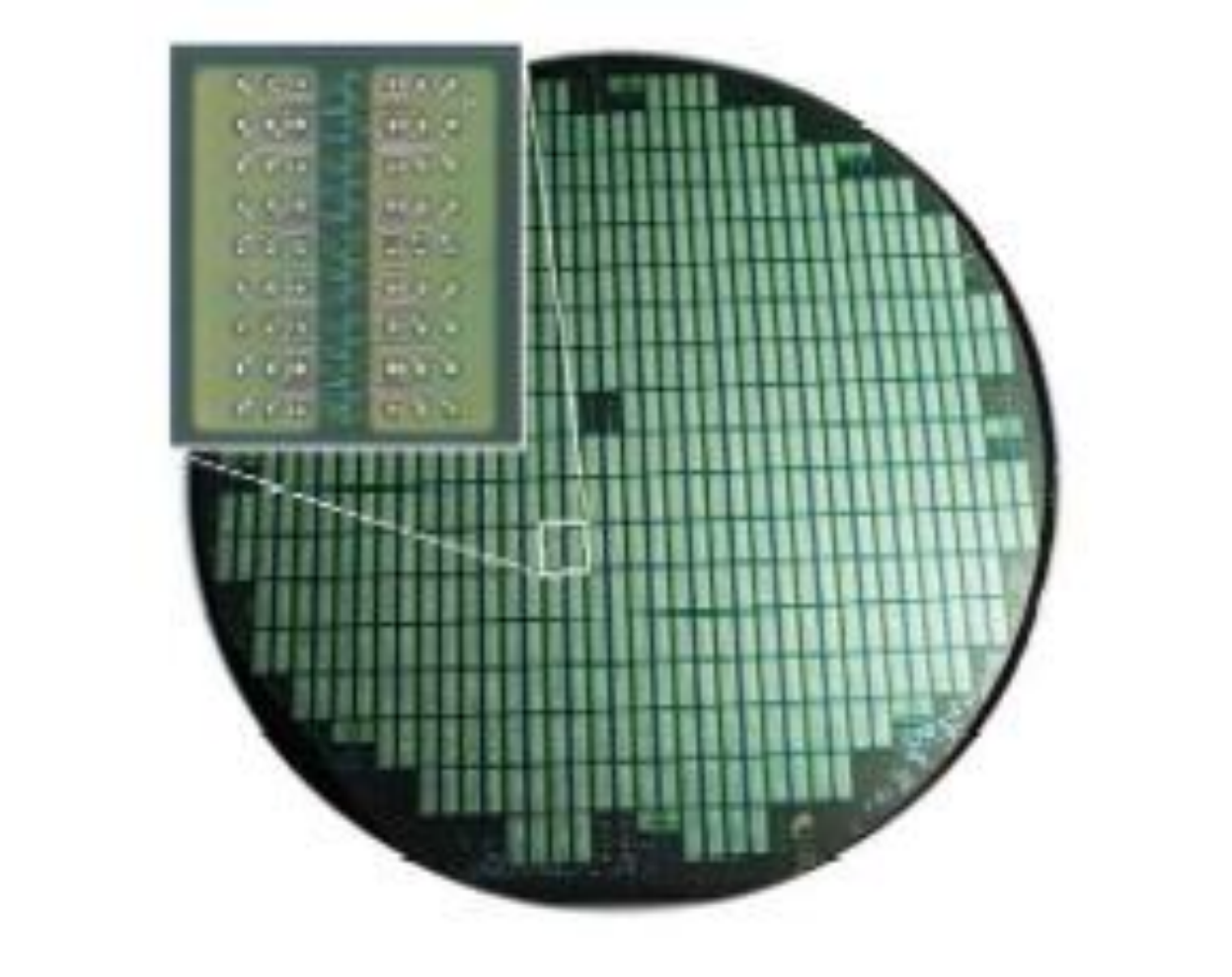
the integrated circuit (IC)

- invented separately by 2 people ~1958
  - Jack Kilby at Texas Instruments
  - Robert Noyce at Fairchild Semiconductor (1958-59)
- 1974
  - Intel introduces the 8080 processor
  - one of the first “single-chip” microprocessors

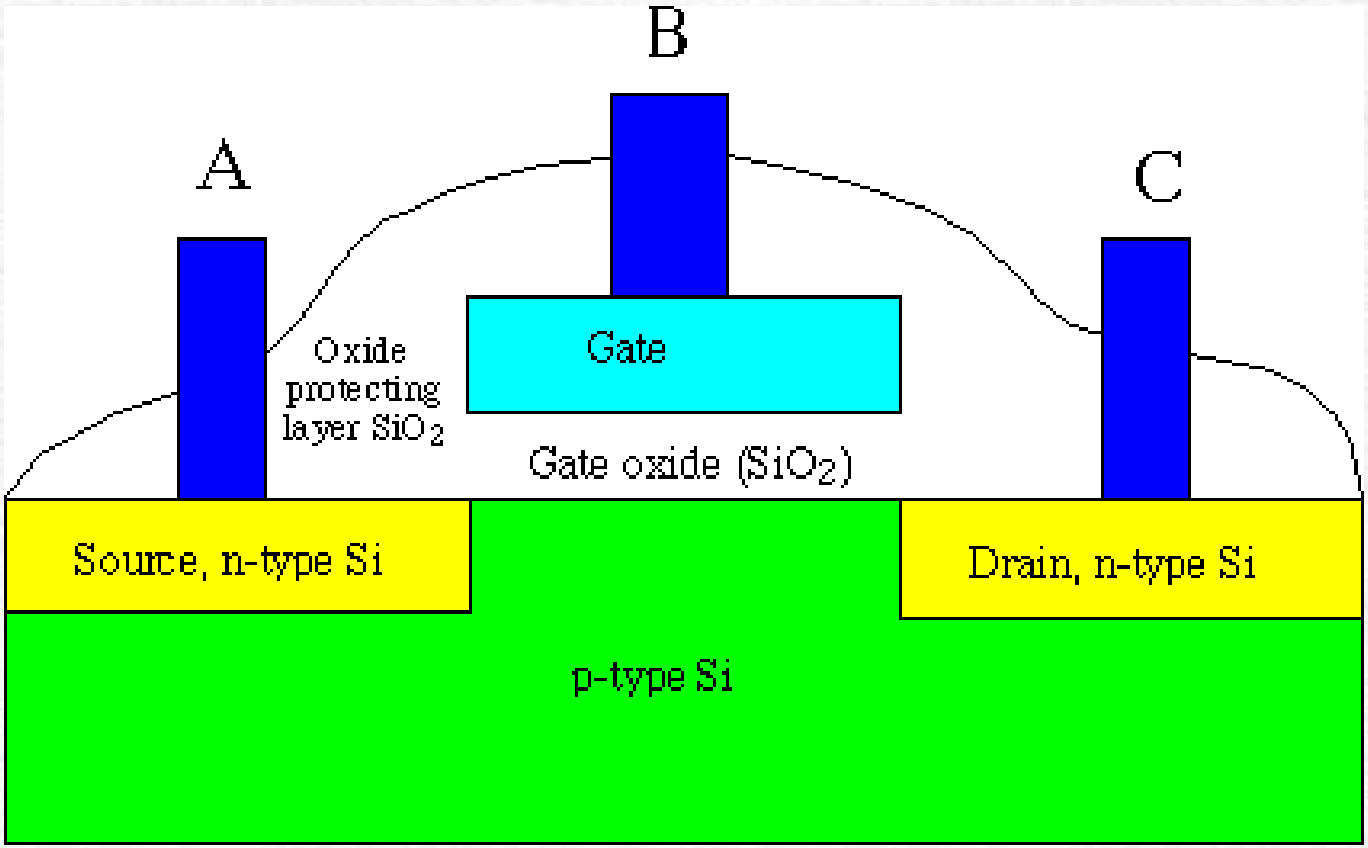




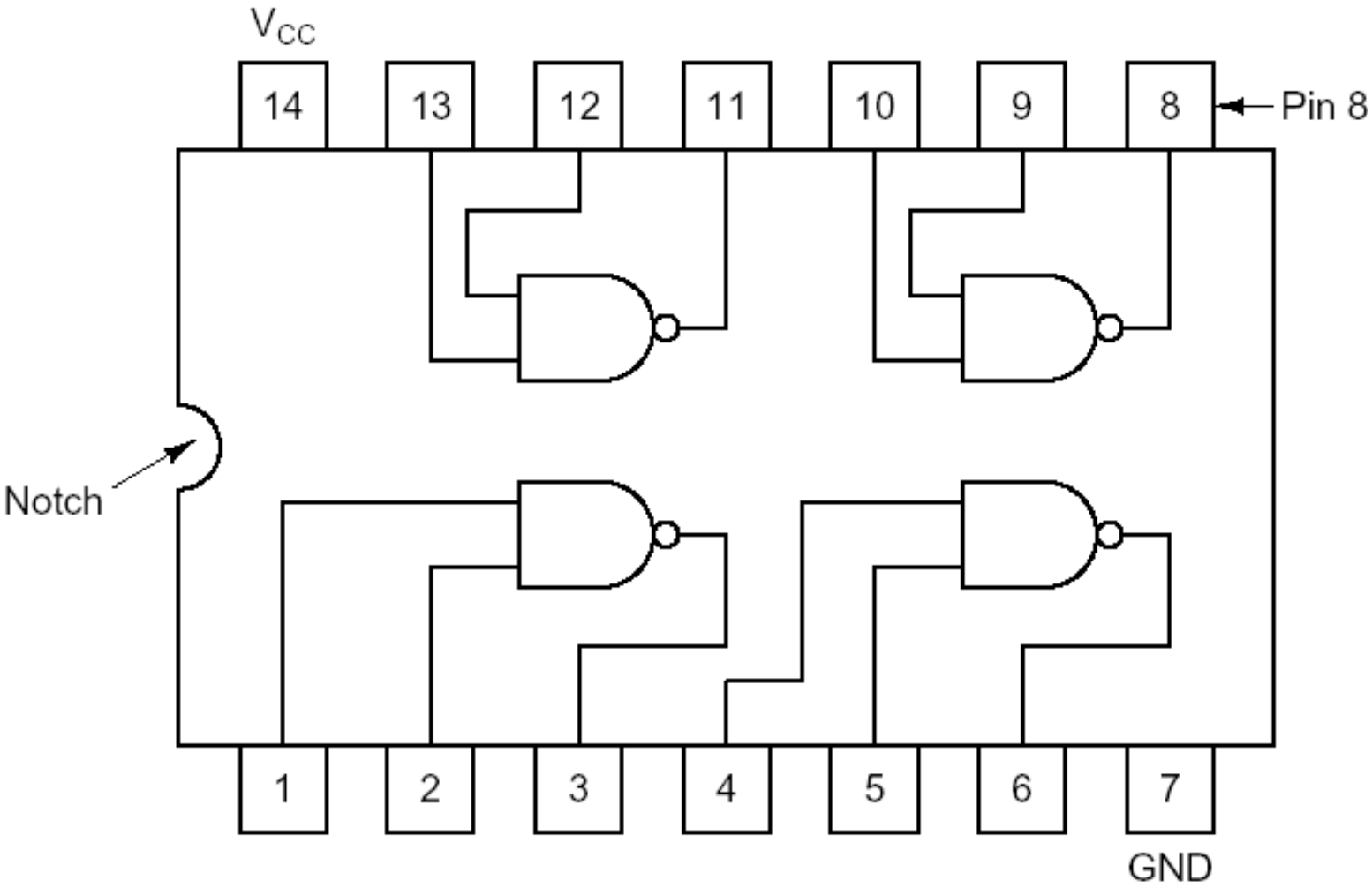
IC’s are fabricated many at a time



functional view of transistor contents



a TTL chip



An SSI chip containing four gates.

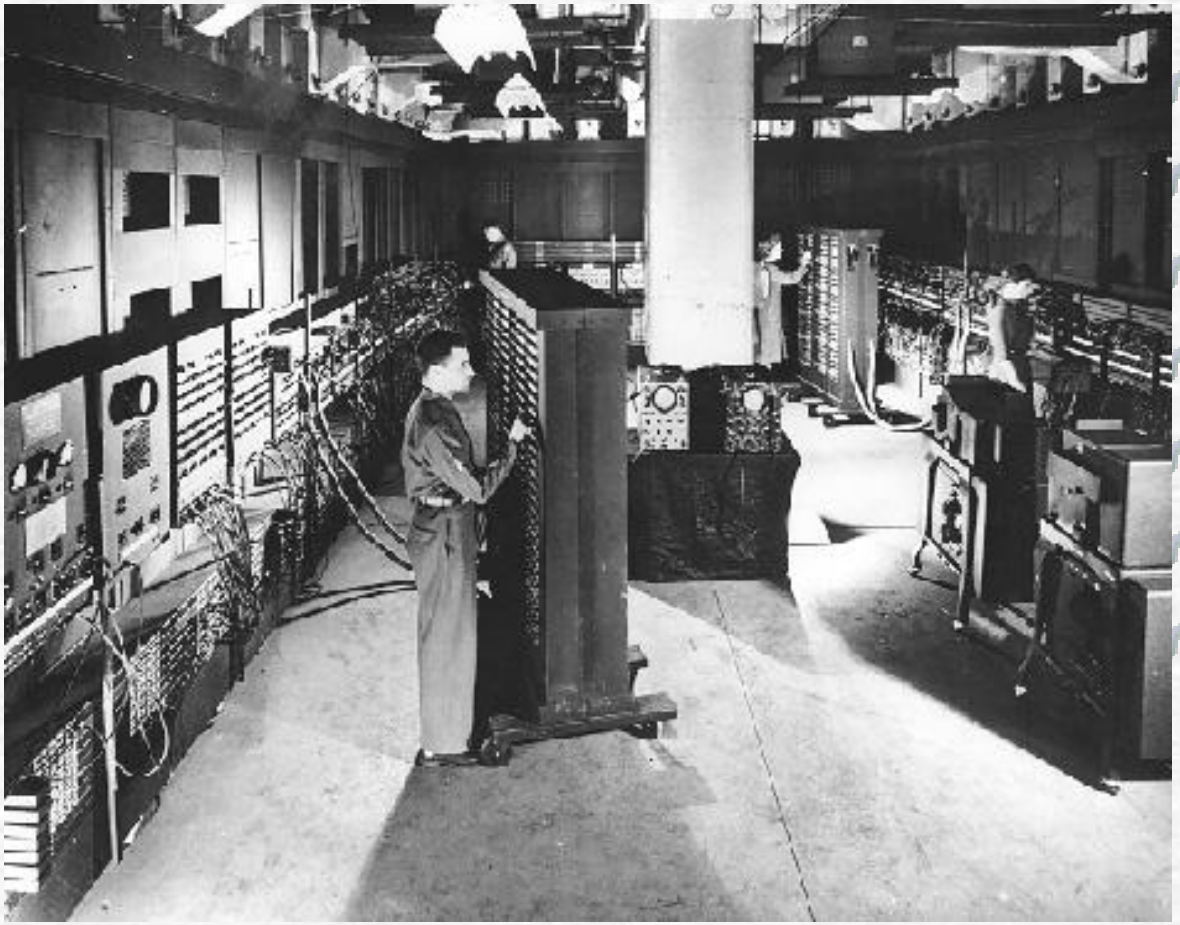
Moore's law

- deals with steady rate of miniaturizion of technology
- named for Intel co-founder Gordon Moore
- not really a *law*
  - more a "rule of thumb"
    - a practical way to think about something
- observation that chip density about doubles every 18 months
  - also, prices decline
  - first described in 1965
  - experts predict this trend might continue until ~2020
  - limited when size reaches molecular level

transistors - building blocks of computers

- microprocessors contain many transistors
  - **(ENIAC):** 19,500 vacuum tubes and relays
  - **Intel 8088 processor (1st PC):** 29,000 transistors
  - **Intel Pentium II processor:** 7 million transistors
  - **Intel Pentium III processor:** 28 million transistors
  - **Intel Pentium 4 processor:** 42 million transistors
- logically, each transistor acts as an on-off switch
- transistors combined to implement logic gates
  - AND, OR, NOT
- gates combined to build higher-level structures
  - adder, multiplexor, decoder, register, …

Electrical Numerical Integrator and Computer (ENIAC), 1940's



- an early computer
- developed at UPenn
- Size: 30' x 50' room
- 18,000 vacuum tubes
- 1500 relays
- weighed 30 tons
- designers
  - John Mauchly
  - J. Presper Eckert

Intel 8088 microprocessor (single chip)

- used in first IBM personal computer
- IBM PC released in 1981
- 4.77 MHz clock
- 16 bit integers, with an 8-bit data bus
  - transfers took two steps (a byte at a time)
  - 1 Mb of physical memory address limitation
- 8-bit device-controlling chips
- 29,000 transistors
- 3-micron technology
- speed was 0.33 MIPS
- later version had 8 MHz clock
  - speed was 0.75 MIPS.

Pentium 4 chip has 42 million transistors

electrical paths now as small as .13 micron

Moore's Law example

DEC PDP-11, mid 1970's

DEC LSI-11, Early 1980's

These 2 computers were functionally equivalent.