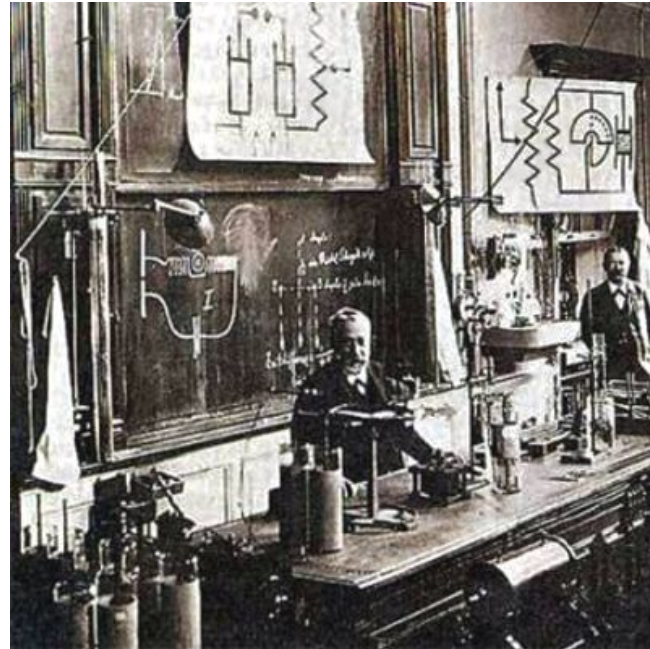


1874 - Semiconductor Point-Contact Rectifier Effect Discovered



Ferdinand Braun
Nobel Laureate in Physics in 1909

In the first written description of a semiconductor diode, he noted that current flows freely in only one direction at the contact between a metal point and a **galena crystal (lead sulfide)**. More famous for his invention of CRT.

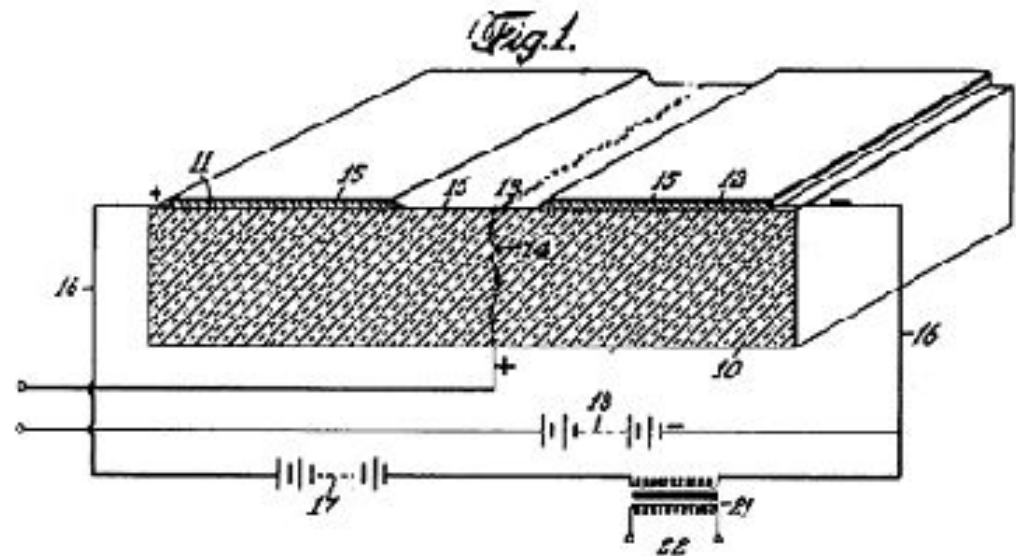
Source for this and next 8 slides: <http://www.computerhistory.org/semiconductor/timeline.html>

1930: Field Effect Semiconductor Device Concepts Patented



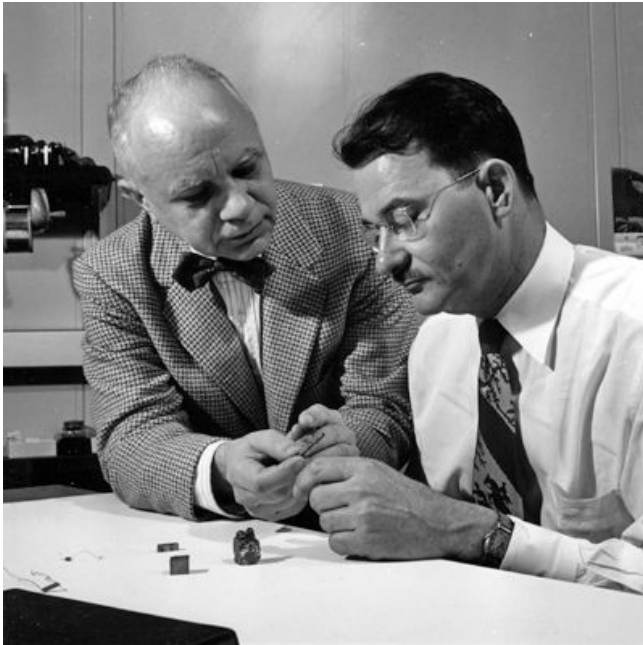
Julius Lilienfeld

Jan. 28, 1930. J. E. LILIENFELD 1,745,175
METHOD AND APPARATUS FOR CONTROLLING ELECTRIC CURRENTS
Filed Oct. 8, 1926

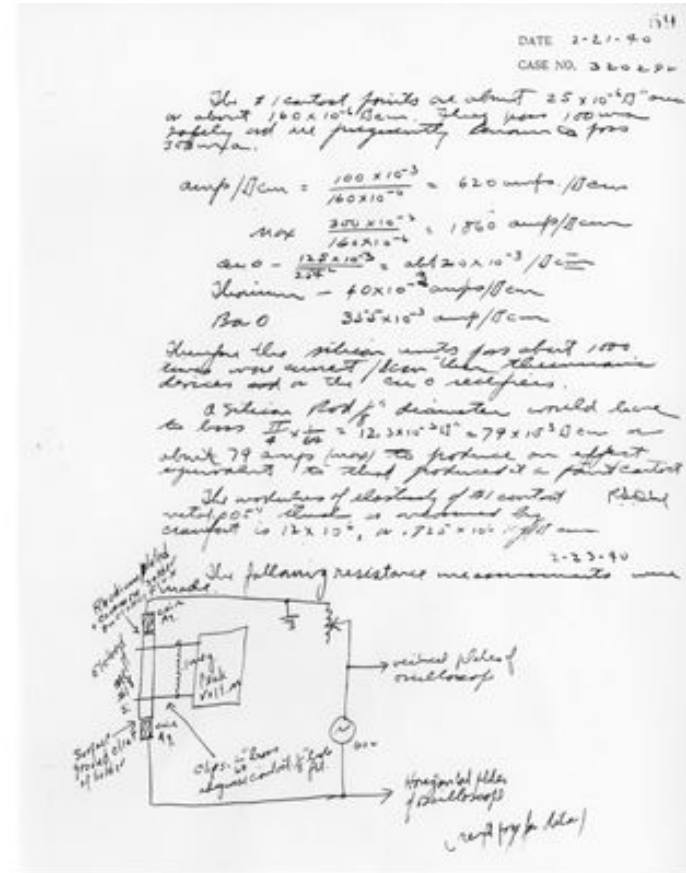


Julius Lilienfeld filed a patent describing a three-electrode amplifying device based on the semiconducting properties of **copper sulfide**. He did not demonstrate the device experimentally.

1940 - Discovery of the p-n Junction



Russell Ohl and Jack Scaff

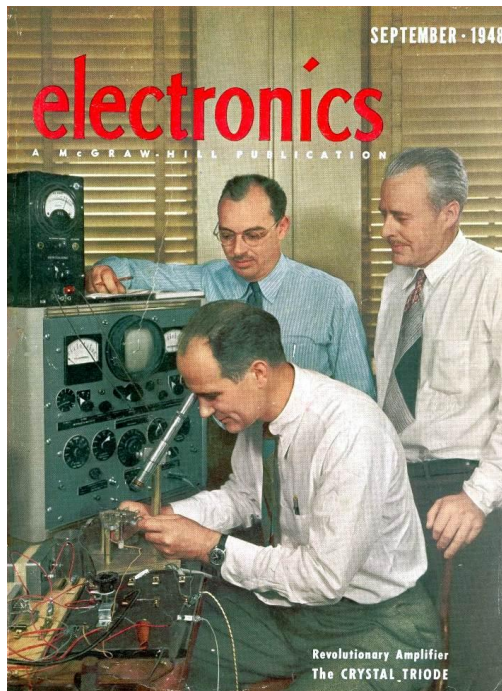


Russell Ohl and Jack Scaff at Bell Telephone Labs discovered the p-n junction and photovoltaic effects in **silicon** that lead to the development of junction transistors and solar cells.

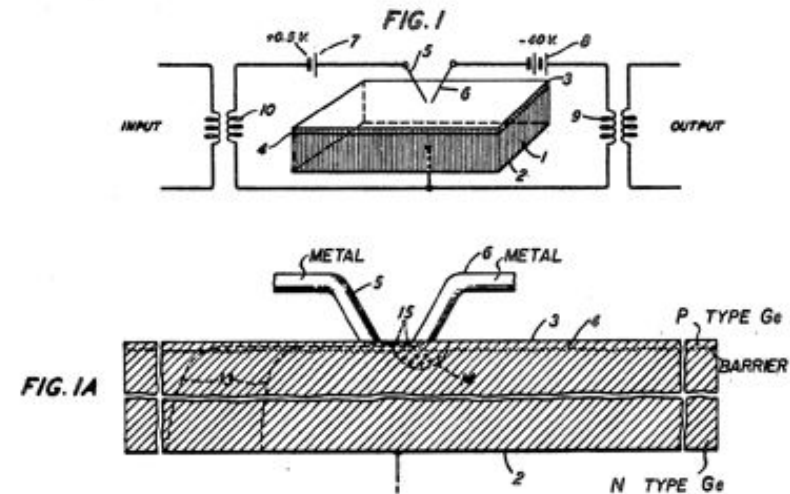


1947 - Invention of the Point-Contact Transistor in Germanium

By Bardeen, Brattain, and Shockley,
Nobel Laureates in Physics 1956

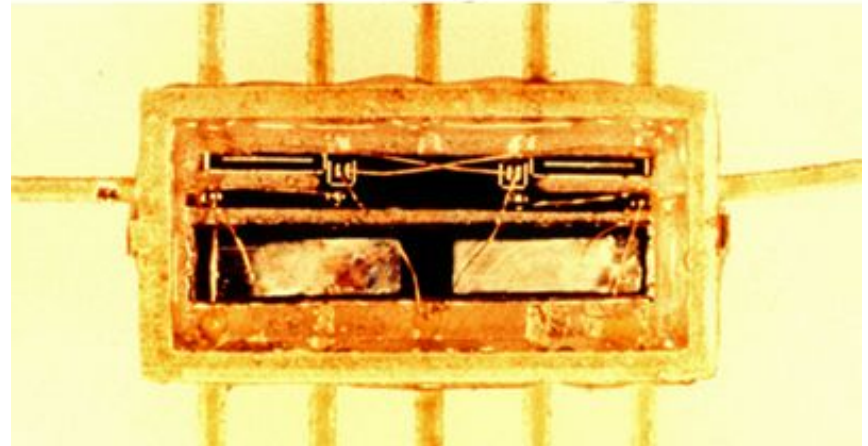
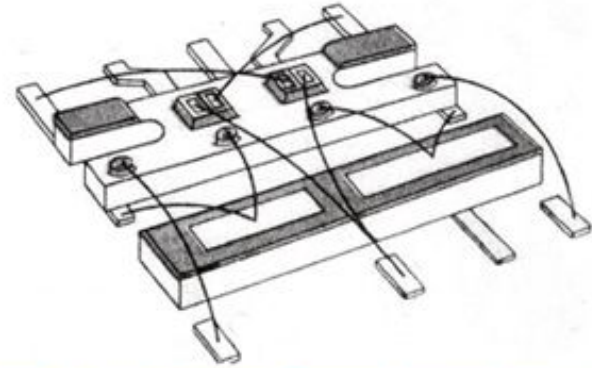
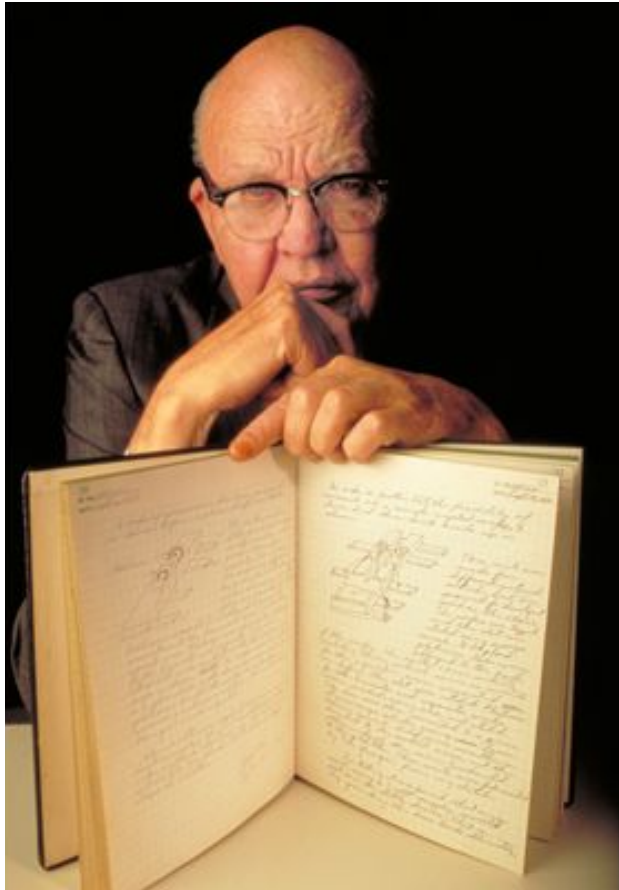


Oct. 3, 1950
J. BARDEEN ET AL
THREE-ELECTRODE CIRCUIT ELEMENT UTILIZING
SEMICONDUCTIVE MATERIALS
2,524,035
Filed June 17, 1948
3 Sheets-Sheet 1



1958 - All semiconductor "Hybris Integrated Circuit" is demonstrated in Germanium

By Jack Kilby (TI),
Nobel Laureates in Physics 2000



1959 - Practical Monolithic Integrated Circuit Concept Patented



Robert Noyce

April 25, 1961 R. N. NOYCE 2,981,877
SEMICONDUCTOR DEVICE-AND-LEAD STRUCTURE
Filed July 30, 1959 3 Sheets-Sheet 2

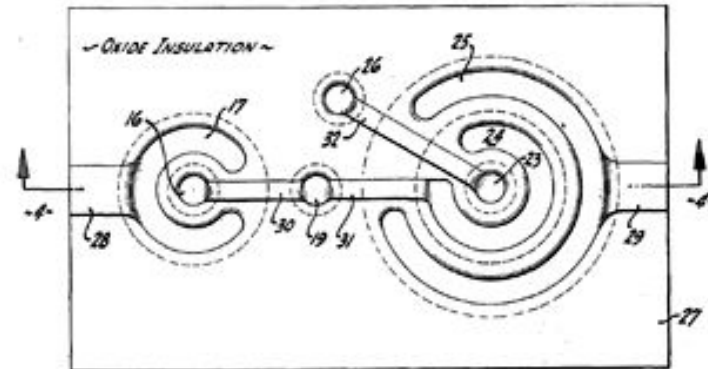


FIG-3

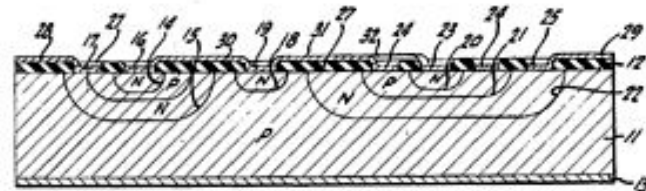


FIG-4

Challenged by patent attorney to identify other uses for Hoerni's planar process, Fairchild co-founder Robert Noyce conceived the idea for a monolithic integrated circuit (IC) in **silicon**.

1960 - MOS Transistor Demonstrated



Dawon Kahng



John Atalla

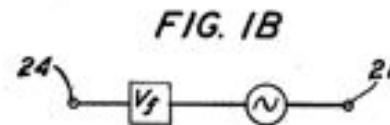
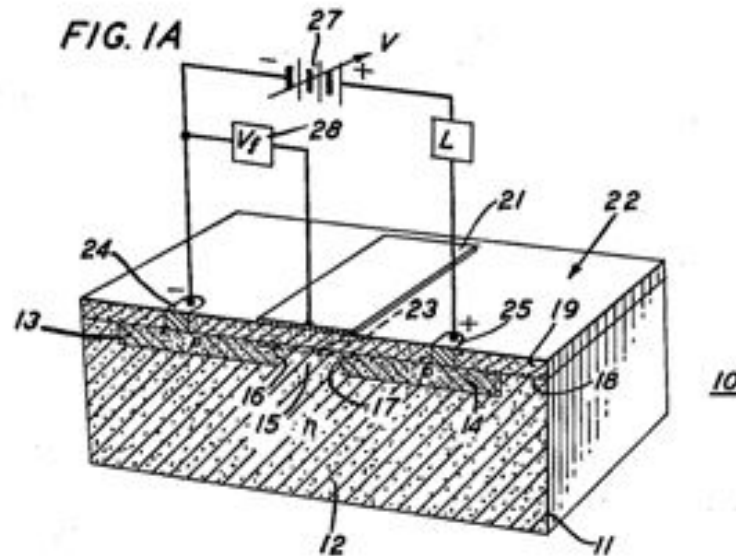
Aug. 27, 1963

DAWON KAHNG

3,102,230

ELECTRIC FIELD CONTROLLED SEMICONDUCTOR DEVICE

Filed May 31, 1960



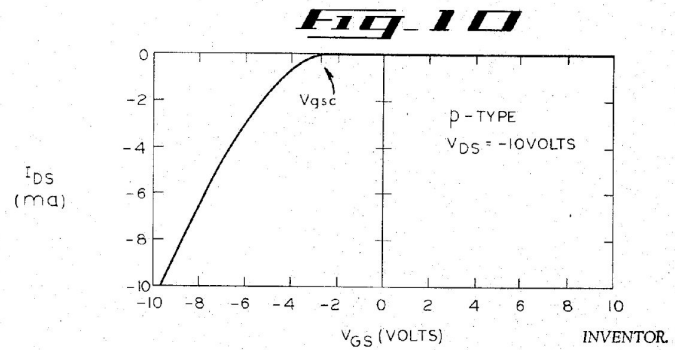
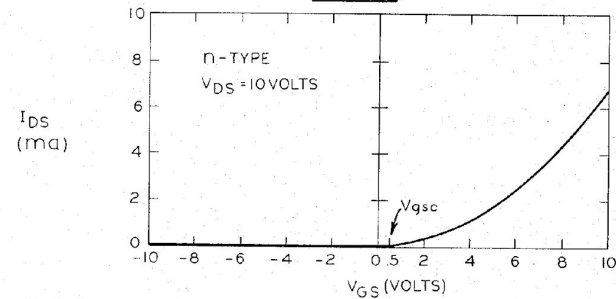
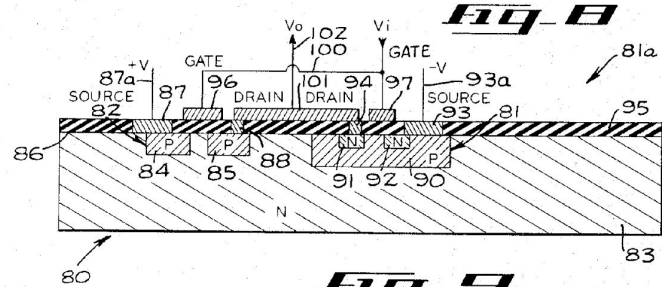
John Atalla and Dawon Kahng at Bell demonstrate the first successful **silicon** PMOS field-effect amplifier.

1963 - Complementary MOS Circuit Invented



Frank Wanlass and C. T. Sah at Fairchild R & D Labs report the lowest power logic configuration .

Dec. 5, 1967 F. M. WANLASS 3,356,858
 LOW STAND-BY POWER COMPLEMENTARY FIELD EFFECT CIRCUITRY
 Filed June 18, 1963 5 Sheets-Sheet 5

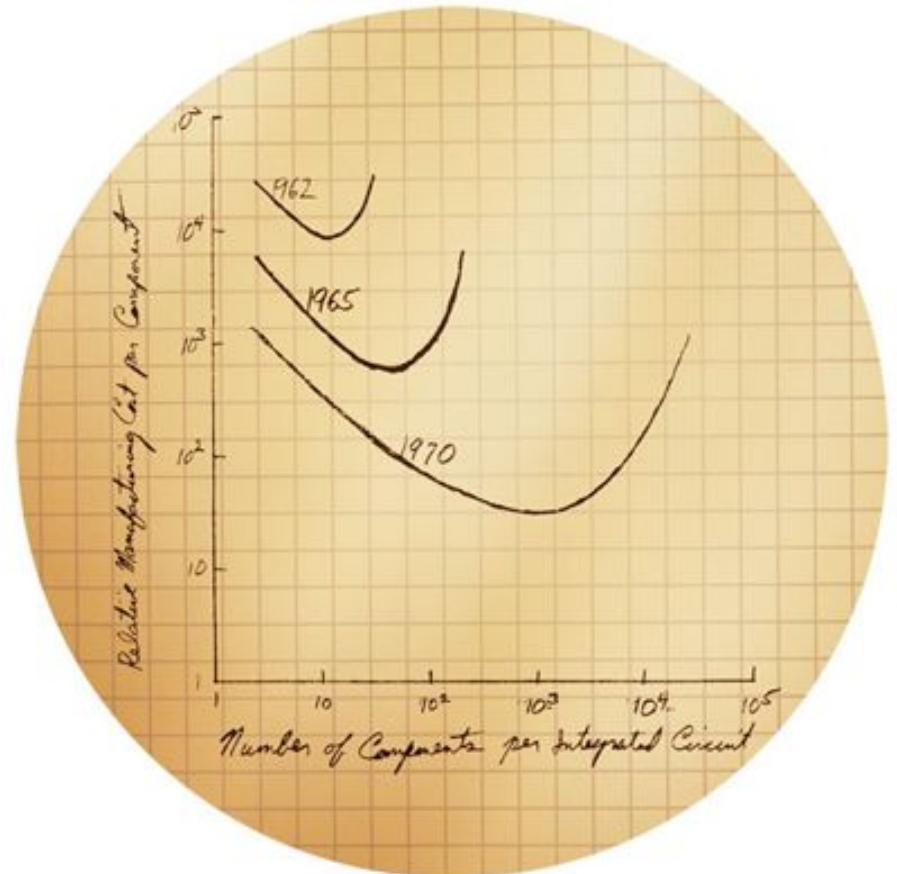


INVENTOR.
 FRANK M. WANLASS
 BY
Suppincott, Falke & Henderson
 ATTORNEYS

1965 - "Moore's Law" Predicts the Future of Integrated Circuits



Gordon Moore

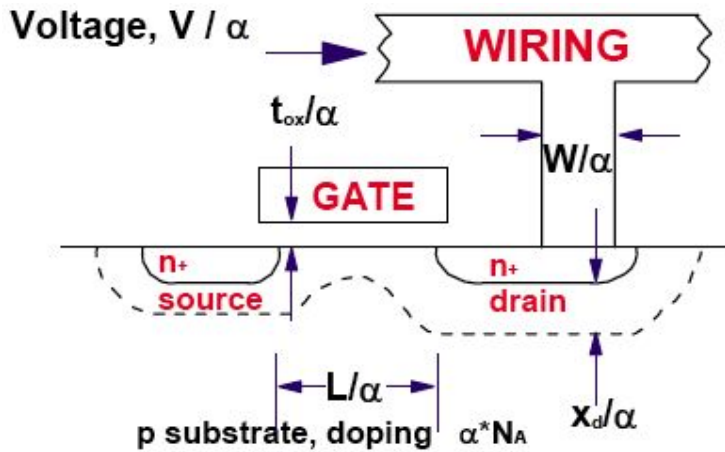


Cost vs. time sketch from Moore's 1964 notebook

1974 - Scaling of IC Process Design Rules Quantified



Robert Dennard, et al.,
IEEE J. Solid State
Circuits, Oct. 1974.



Constant E Field Scaling

All device parameters are scaled by the same factor α .

- Channel length $L \downarrow$
- Gate oxide thickness $t_{ox} \downarrow$
- Supply voltage $V_D \downarrow$
- Source/drain junction depth $X_j \downarrow$
- Channel doping \uparrow

Thank you

