

1926 – 1928



Loewe 3NF vacuum
"integrated circuit"
1926

Heintz and Kauffman
vs. RCA
Electron tube patent
litigation – computers
c. 1926

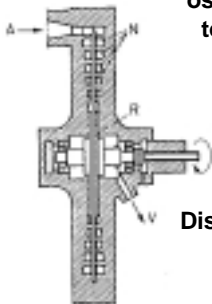


Philo T. Farnsworth
(1906-1971)
Image Dissector
1926

Farnsworth demonstrates
an all-electronic
television system
1927

Harold S. Black
Principle of
negative feedback
1927

Kenjiro Takayanagi
(1899-1990)
Demonstrates a gas focused
oscillograph cathode ray tube
to display television images
1926



Karl Manne
Siegbahn
Disk-type molecular
drag pump
1926

Landmark UX 280
rectifier introduced
(produced for
over 50 years)
May 1927



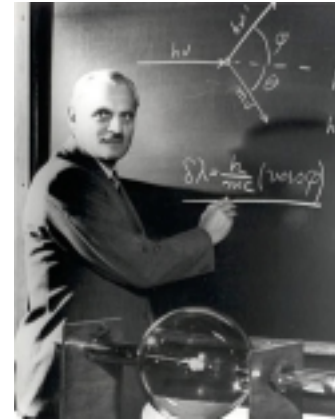
Irving Langmuir
with Hull Thyratron tube
in 1927



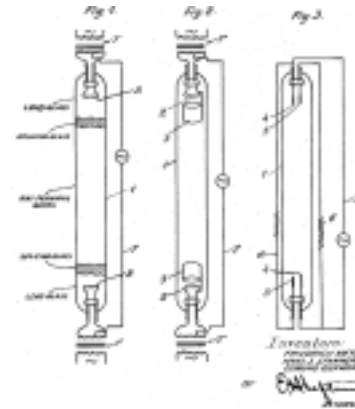
Edmund Germer

Friedrich Meyer, Hans J. Spanner and Edmund Germer,
High-pressure metal vapor ultraviolet and fluorescent lamp
U.S. Patent 2812732 (1939)
filed 1927

First RCA AC
filament tube
RCA UX-226
Sept. 1927



Arthur Holly Compton
(1892-1962)
Nobel Prize in Physics for
scattering of x rays by electrons
1927



First U.S. screen
grid tube
RCA UX-222
Oct. 1927



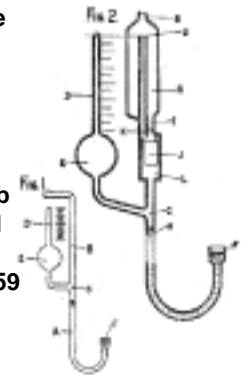
Owen W. Richardson
(1879-1959)
Nobel Prize in Physics for
thermionic phenomena,
Richardson's Law
1928

Cecil Reginald Burch
(1901-1983)
Low vapor-pressure oils
and greases for high
vacuum
(Apiezon products)
1928

Paul Kollsman
First accurate
barometric
altimeter
1928

Johannes (Hans) Wilhelm
Geiger (1882-1945) and
Erwin W. Müller
Geiger- Müller tube
radiation counter
1928

Ezechiel Weintraub
Improved McLeod
gauge
British Patent 264759
(1927)
filed 1926



1926

Vacuum Science & Technology Timeline

1928



1929 – 1931



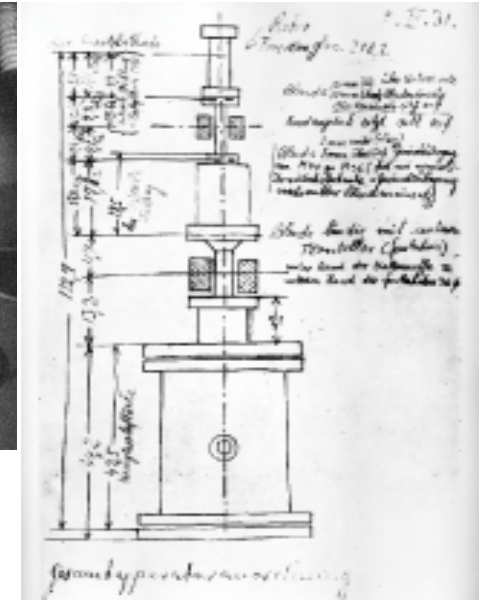
Kenneth C. D. Hickman
Synthetic low-pressure
diffusion pump fluids
1929



Vladimir Kozma Zworykin
(1889-1982)
Files patent on the
kinescope and
later develops the
iconoscope
1929



Max Knoll (1897-1969)
and **Ernst A. F. Ruska (1906-1988)**
First Transmission Electron Microscope
1931

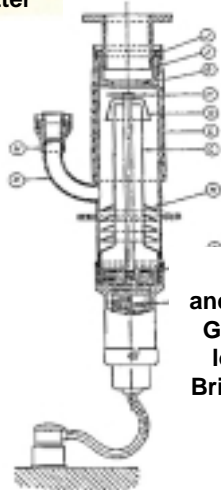


Complete amateur radio station
1-tube receiver and 1-tube transmitter
1929



Manfred von Ardenne
(1907-1997)
Demonstrates an all-electronic
television in Berlin
1929

A. R. Olsen and L. L. Hirst
Capacitance manometer
1929



Cecil Reginald Burch
and **Frank Edmund Bancroft**
Gas diffusion pump using
low-vapor pressure oils
British Patent 346293 (1931)
filed 1930

Farnsworth
Electron Multiplier
1929

Allen Balcom DuMont
(1901-1965)
Electron-Ray Tube
(Tuning Eye)
1930

Karl Guthe Jansky
(1905-1950)
Detects cosmic
radio waves
1931



Atwater Kent
3-tube receiver
1930



Pieter Clausing
(1898-1994?)
Equations for molecular flow
1929-1932

First automobile radio
vacuum tubes
National Union Company
1931

Du Mont Laboratories
founded
1931

1929

Vacuum Science & Technology Timeline

1931



1932 – 1936

Mercury vapor
rectifier 82, 83
1932

Alan B. Du Mont
Television cathode
ray tubes
1932

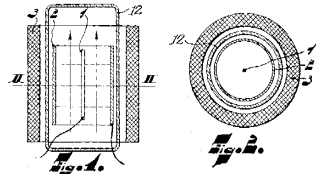
John Donovan Strong
Reports telescope mirror
coating by evaporation of
aluminum
1933

Westinghouse Ignitron
mercury-arc rectifier
1933

E. H. Armstrong
Frequency modulation (FM)
1933

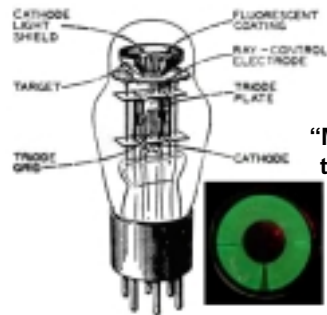
Kinetic Theory of Gases text
published by Martin Knudsen
1934

Irving Langmuir
Nobel Prize in Chemistry
Surface Chemistry
1932



Frans Michel Penning
(Netherlands)
Coating by Cathode
Disintegration (sputtering)
U.S. Patent 2146025 (1939)
filed in Germany 1935

Observation of sputtering and thin
film formation in radio-frequency
glow discharges
J. K. Robertson and C. W. Clapp
D. Banerji and R. Ganguli
1933



RCA 6E5
"Magic Eye"
tuning eye
tube
1935

6.3 V set as standard
for AC and DC filaments
1934

Harold Clayton Urey
(1893-1981)
Nobel Prize in Chemistry
Discovery of deuterium
1934

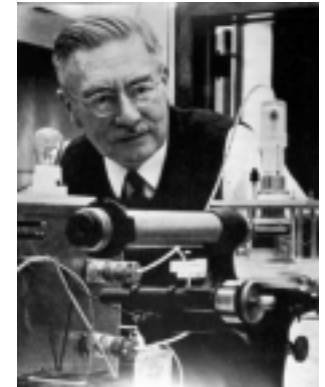


Wolfgang Gaede
Gas Ballast Pump
1935

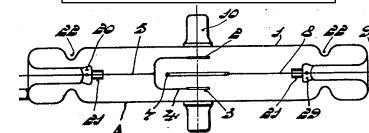
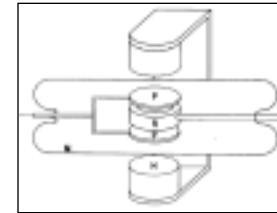
Kenneth C. D. Hickman
Fractionating oil diffusion
pump and fluids
1935

Oskar Heil (1908-1994)
Patents the principle of
the field-effect transistor
1935

James Chadwick
(1891-1974)
Nobel Prize in Physics
Discovery of the neutron
1935



Peter Joseph William Debye
(1884-1966)
Nobel Prize in Chemistry
for diffraction of x rays
and electrons in gases
1936



Frans M. Penning
Cold-cathode ionization vacuum
gauge – "Philips Gauge"
U.S. Patent 2197079 (1940)
filed 1936

Mahn and Mecalf
Velocity modulated
electron tube
1936

First beam power
tetrode – 6L6
1936

John L. Baird
demonstrates a 700-line
high resolution television
1935



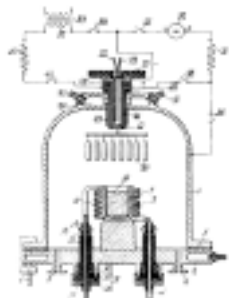
First nine RCA metal radio tubes
1935

First regular television
broadcasting by BBC in England
using EMI electronic system
1936

1932

1937 – 1940

Erwin Müller (Germany)
Field Emission
Microscope
1935-1937



Plasma-enhanced evaporation deposition – non-dc substrate biasing
Bernhard Berghaus
German Pat. 668639
UK Pat. 510993
1938



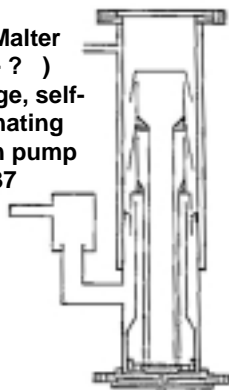
Siemens Transmission Electron Microscope
Max Knoll and Ernst Ruska
1938



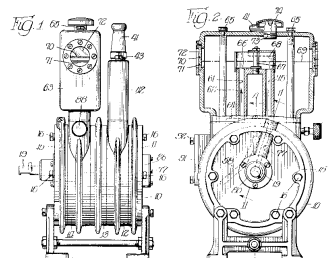
Ernest O. Lawrence (1901-1958)
Nobel Prize in Physics
The Cyclotron
1939

C. M. Van Atta
Diffusion pump speed
over 100 liter/ second
1937

Louis Malter (1907- ?)
Multi-stage, self-fractionating
diffusion pump
1937



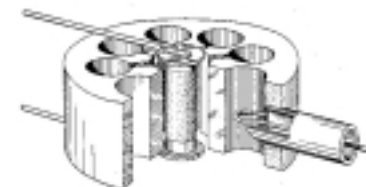
Grote Reber (1911-2002)
First radio telescope
1937



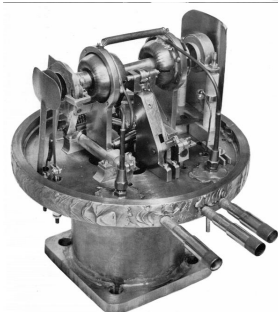
Welch Duo-Seal Mechanical Pump
John Dubrovin
U.S. Patent 2337849 (1943)
filed 1939



John Randall and Harry Boot
develop the cavity magnetron
at Birmingham University
Feb. 21, 1940



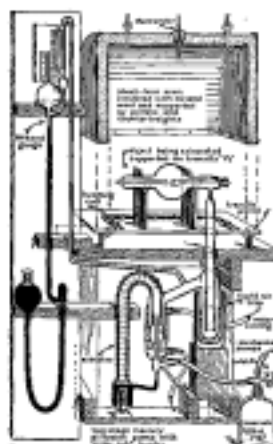
Sir Henry Tizard (1885-1959)
Brings cavity magnetron to U. S.
September 6, 1940



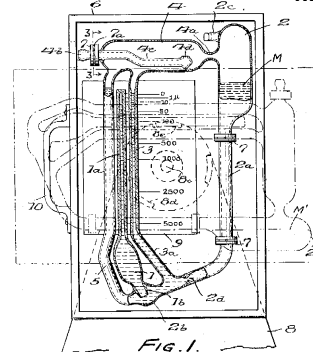
Model B Klystron
First working klystron
Russell Varian (1899-1959)
and **Sigurd Varian (1901-1961)**
1937



McMurdo Silver
15-tube console receiver
1937



Procedures in Experimental Physics
John D. Strong, et al.
Prentice-Hall, 1938



Earl W. Flordorf and John C. Coleman
Improved tilting McLeod
vacuum gauge
U.S. Patent 2278195 (1942)
filed 1939

RCA and DuMont
demonstrate television
at the New York
World's Fair
1939

Radar set using magnetron
built by British
September 1940

First button base 1.4 V
miniature tube 1R5
1940

Varian brothers join Sperry Corp.
in Long Island, N.Y.
1940

Science Museum, London

1937

Vacuum Science & Technology Timeline

1940



1941 – 1947

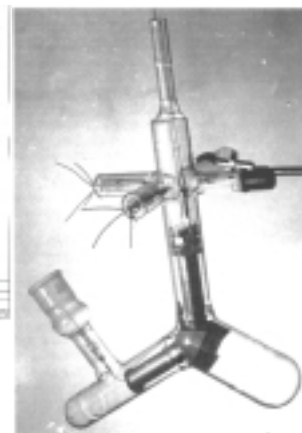
20-MeV Bevatron accelerator
G.E. – University of Illinois
1941



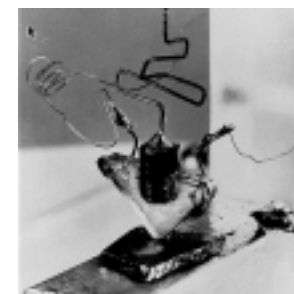
William W. Hansen
(1909-1949)
Inventor of the
microwave cavity



Alfred Otto Carl Nier, et al.
Mass spectrometer
helium leak detector
1943



Metal version of Nier's glass leak detector
manufactured by General Electric
1944-45



John Bardeen,
Walter H. Brattain, and
William B. Shockley
Demonstrate first
semiconductor amplifier
(transistor)
1947
U.S. Patent 253503
(1950)



UHF oscillator using
acorn tube
1941

Rudi Kompfner
Traveling wave tube
Oxford University
1942

Percy LeBaron Spencer
Laminated anode
magnetron tube
c. 1942

525-line NTSC system
approved by U.S. FCC
for commercial
monochrome television
1941

Percy LeBaron Spencer
Microwave oven using
magnetron vacuum tube
U.S. Patent 2495429 (1950)
filed 1945



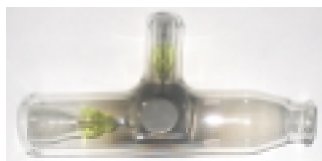
ENIAC computer
John William Mauchly (1907-1980)
and John Presper Eckert (1919-1995)
University of Pennsylvania
requires 18,000 vacuum tubes
1943

Thermistor vacuum gauge
Joseph A. Becker,
Charles B. Green,
and Gerald L. Pearson
1947

Wayne B. Nottingham
(1899-c.1966)
Proposes that soft x rays limited
the low- pressure range of a
conventional triode
ionization gauge
1947



200-inch Mt. Palomar
telescope mirror coated by
aluminum evaporation
from 350 tungsten filaments
(mirror cleaning c. 1997)
John D. Strong
1947



Penning ionization gauge
Distillation Products, Inc.
c. 1940s

Twin triodes
6SN7, 7F8
1945

William Stevens
Time-of-flight
mass spectrometer
1946

A "High Vacuum Symposium" held
in Cambridge, Massachusetts,
sponsored by the Division of
Industrial and Engineering
Chemistry of the American
Chemical Society
October 1947

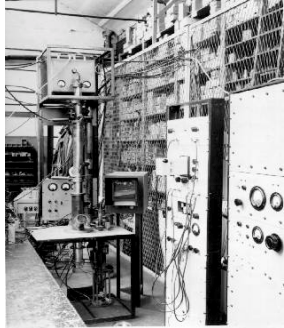
1941

Vacuum Science & Technology Timeline

1947



1948 – 1951



Scanning Electron Microscope prototype:
SEM1
Dennis McMullan
1948



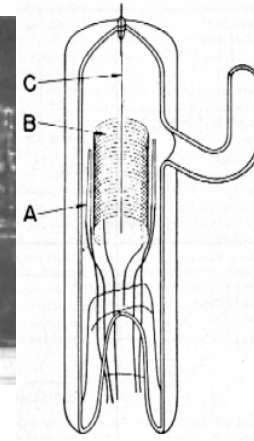
Charles Oatley (1904-1996)
Co-developer of scanning electron microscope
1948



Saul Dushman (1883-1954)
Pioneer vacuum scientist, and author of *Scientific Foundation of Vacuum Techniques*
1949



Daniel Alpert



Robert T. Bayard and Daniel Alpert
Bayard-Alpert triode ionization gauge with fine-wire collector
1950



Erwin W. Müller (1911-1977)
Field-Ion Microscope images individual atoms
1951-1955

Flash filament technique for estimating pressure below 10^{-8} torr
LeRoy Apker
1948

John A. Hipple, H. Sommer and H. A. Thomas
Radio-frequency ion cyclotron resonance mass spectrometer (Omeatron)
1949

Synchrotron Accelerator operational at Berkeley, California
Invented by Edwin Mattison, constructed at the General Electric Research Laboratory by Herbert C. Pollock and Willem F. Westendorp.
1949

British and Japanese begin using traveling wave tubes for radio relay systems
1951



Leslie Arthur Holland
Magnetically focused electron beam gun
British Patent 754102 filed 1951

F. C. Williams describes use of cathode ray tube as a digital memory storage device
1948

Twin triodes and miniature glass tubes including 12AU7, 12AX7, 12AT7
1948



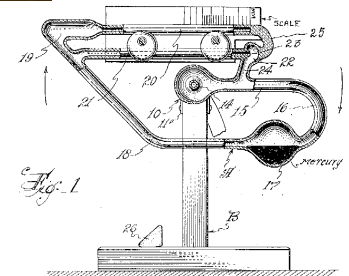
Earl W. Flosdorf
Flosdorf-McLeod vacuum gauge
U.S. Patent 2542076 (1951) filed 1949



Triode ionization vacuum gauge – Eimac 35T
Eitel-McCullough Co.
early 1950s

Vacuum tubes used in IBM computers
1951

Thermopile vacuum gauge
1951



Samuel B. Lippincott
Lippincott-McLeod vacuum gauge
U.S. Patent 2608096 (1952) filed 1951

VACUUM Journal
Vol. 1 No. 1
January 1951

John Frank Allan
Circular cross-section O-ring vacuum seal
1948

A "High Vacuum Convention" held in Gleneagles, Scotland
October 1948.

1952 – 1954

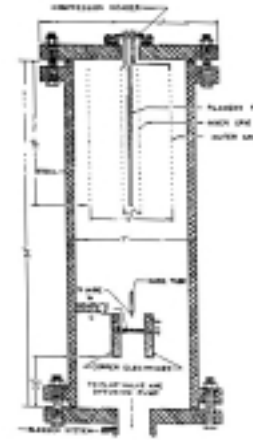
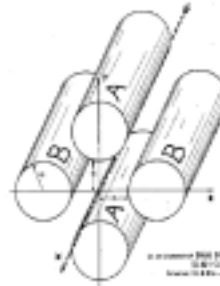


Paolo della Porta
Non-evaporable getter
c. 1950s



Wolfgang Paul
(1913-1993)

Wolfgang Paul
and **Helmut Steinwedel** German
U.S. Patent 944900 (1956)
filed 1953
described independently by
R. F. Post
Quadrupole Radio Frequency
Mass Spectrometer
1953



**Evapor-Ion ionization/
sublimation vacuum pump**
Raymond G. Herb
1953

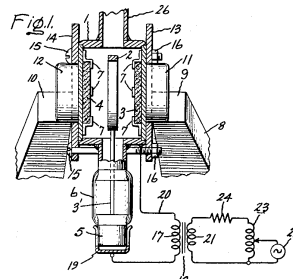


Gottfried K. Wehner
Describes the
sputtering mechanism as
momentum transfer
between atoms
1954

**First use of ion
implantation (He⁺) in
semiconductor device**
R. S. Ohl
1952

**Ring Getter with
U-shaped cross section
for electron tubes**
1952

**M-type Carcinotrons
(voltage tuned microwave
oscillators) developed**
1952

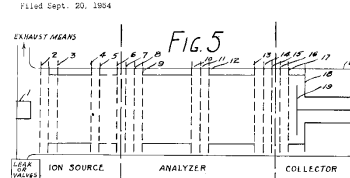


Anatole M. Gurewitsch (1911-)
and **Willem F. Westendorp**
Single cell ionic pump
U.S. Patent 2755014 (1956)
filed in 1953

**L. V. Radushkevich and
V. M. Lukyanovich (Russia)**
publish images of 50-nm
carbon nanotubes
1952

**The Committee on
Vacuum Techniques
(now the AVS)
Incorporated in
Massachusetts
19 October 1953**

Oct. 18, 1955 W. H. BENNETT 2,721,271
LINEAR RADIO-FREQUENCY MASS SPECTROMETER



**Linear radio-frequency mass
spectrometer**
U.S. Patent 2721271 (1955)
filed 1954

Willard H. Bennett
1954
First mass spectrometer in space

**Hot-cathode magnetron
vacuum gauge**
**G. K. T. Conn and
H. N. Daglish**
1954

**Committee on
Vacuum Techniques (AVS)
First symposium, Asbury
Park, New Jersey
1954**



Willard H. Bennett
(1903-1987)



**First silicon
transistor**
**Texas
Instruments**
1954

**First commercial
microwave oven**
Raytheon
1954

**First AVS Transactions
published by
W. M. Welch Mfg. Co.**
1954



**Model 1397 mechanical
vacuum pump**
Welch Mfg. Co.
1950s

**Inverted cold-cathode
magnetron vacuum gauge**
**A. J. Beck and
A. D. Brisbane**
1952

**A Symposium on Vacuum
Engineering held by the
American Institute of
Chemical Engineers
May 1952**

1952

Vacuum Science & Technology Timeline

1954

