

Vacuum Time Line, 1500–1799

Time Line Color Code Key

- Related scientific developments
- Cathode Ray Tube
- Radio & electronics
- Historical events
- Vacuum gauges
- Vacuum pumps
- Captions
- Vacuum tube development
- Vacuum tube manufacturing

Hero of Alexandria writes *Pneumatics* summarizing what is then known about syphons, pumps, etc. ~150 B.C.E.

Johannes van Helmont defines "gas" (Flemish = chaos) to mean an air-like substance 1620

Ferdinand II, Grand Duke of Tuscany, invents liquid-in-glass thermometer 1641



Evangelista Torricelli mercury barometer 1643



Rene Descartes (1596-1650) in his *Principa Philosophiae* suggests that a vacuum cannot exist 1644

Evangelista Torricelli (1608-1647) Substitutes mercury for water in overhead pump 1644



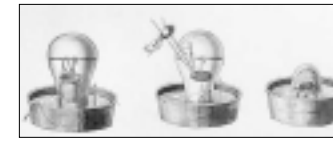
Otto von Guericke Magdeberg hemisphere demonstration 1654



Otto von Guericke (1602-1686) Water barometer 1654

Experiments by Richard Townley (1628-1707) and Henry Power (1623-1668) establish PV law for expansion (later called Boyle's Law or Marriotte's Law) 1660

In response to Boyle's ideas, Franciscu Linus (1595-1675) suggest the properties of a vacuum is due to invisible thread-like "funiculus" that strive to hold nearby objects together 1660



Mayow Apparatus ca. 1669 John Mayow (1641-1679) suggests that air may be made up of two different gases 1674



Otto von Guericke's air pump 1672

George Ernts Stahl introduces idea of phlogiston as the agent of burning and rusting 1697

Jakob Hermann (1678-1733) postulates that pressure is proportional to density and to the square of the average velocity of the particles in motion 1716



Jean Antoine Nollet Falling bodies in a vacuum experiment 1743

Phlogiston theory abandoned 1791



1500 1600

1650

1700

1725 1750 1775 1799

Santorre Santorro (1561-1636) and Galileo independently invent thermoscope for measuring temperature ~1612



Galileo Galilei (1564-1642) measures limit of overhead water pump 1638

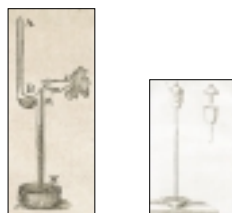


Galileo Galilei's Syphon Experiment 1638

Gasparo Bertl first vacuum produced (in water barometer) ~1640



Puy de Dôme Experiment—Florin Perrier showed that the height of the column in mercury barometer decreased with altitude, confirming a prediction of his brother-in-law, Blaise Pascal (1623-1662) 1648



Gilles Personne de Roberval (1602-1675) Void within a void experiment Expanding bladder experiment 1648



Robert Boyle (1627-1691) Vacuum, mercury barometer ~1660



Boyle's bell in a vacuum 1660



Robert Boyle publishes *New Experiments Physio-Mechanical, touching the Spring of Air, and its Effects* 1660

Robert Boyle states Boyle's Law for compression of gases 1661

Jean Picard observes "barometric light," a glow discharge induced by static electricity when a mercury barometer is shaken 1675

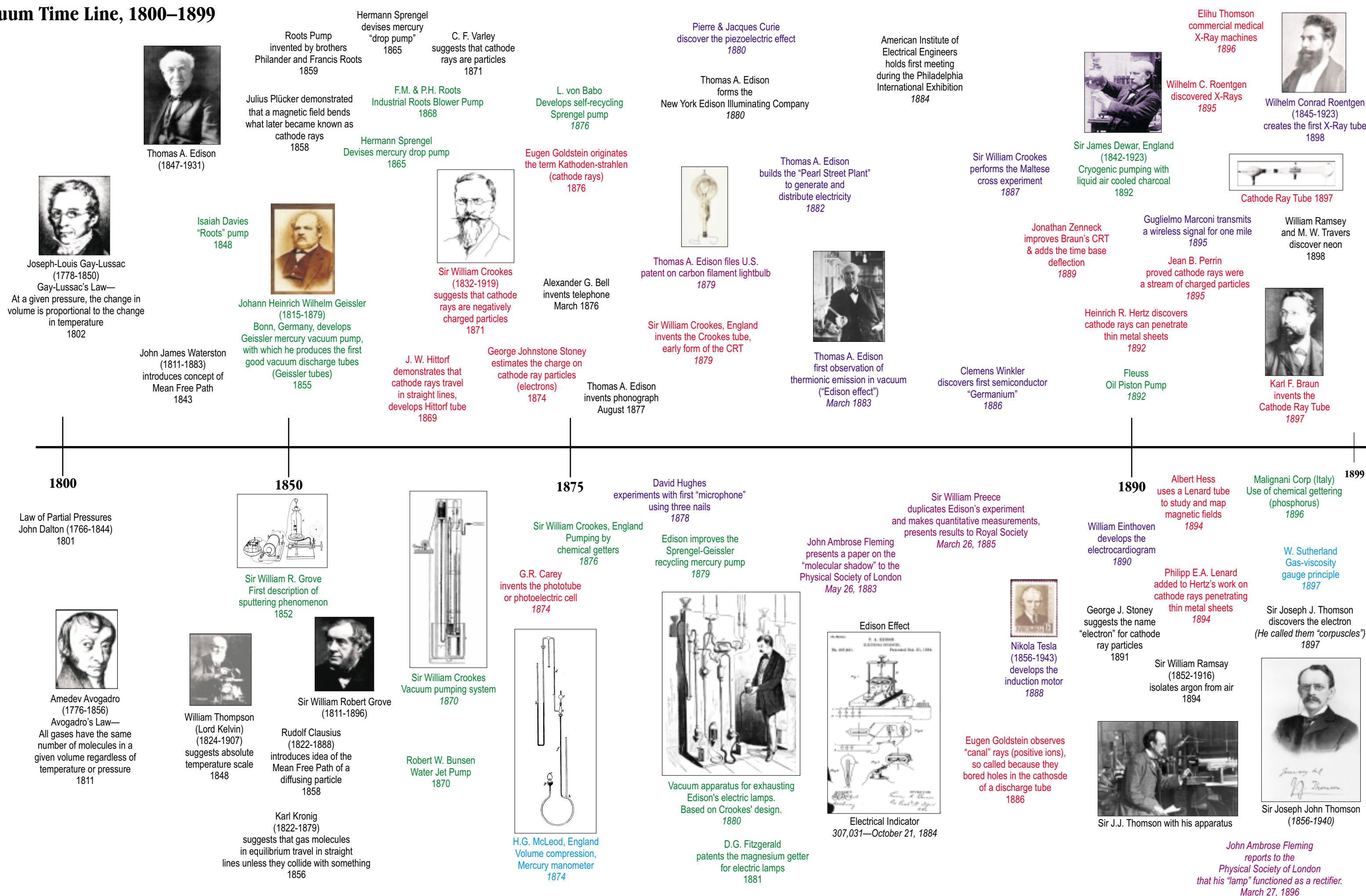
Edmé Mariotte in France (~1620-1684) independently publishes relation between pressure and volume in *On the Nature of Air* 1676

Francis Hauskbee shows that sound is not transmitted in a vacuum 1705

Daniel Bernoulli (1700-1782) First truly statistical treatment of kinetic theory of gasses 1728-1733

Charles Law— Jacques-Alexandre Charles establishes that for a given temperature change, different gases expand the same amount 1787

Vacuum Time Line, 1800–1899



Vacuum Time Line, 1900–1924

1900 Seismograph

1901 Guglielmo Marconi transmits a wireless signal from England to North America 1901

1902 W.C. Roentgen Nobel Prize in Physics for discovery of x-rays. 1901

1903 P. Cooper-Hewitt Fluorescent lamp 1901

1904 G. Marconi Vacuum coherer (used as a detector) 1898–1905

1905 Lee deForest Diode introduced

1906 Navy Receiver using Lee deForest diodes (Audion) 1906

1907 Philipp Eduard Anton von Lenard Nobel Prize in Physics for cathode rays. 1905

1908 Lee deForest's Space Telegraph 879,532—February 18, 1908

1909 Guglielmo Marconi & Carl F. Braun Nobel Prize in Physics for wireless telegraphy. 1909

1910 Robert A. Millikan Measures charge on the electron (oil drop experiment) 1909-1912

1911 H.M. Fessenden Hetrodyne receiver 1912

1912 S. Dushman 40 KV vacuum rectifier 1913

1913 W.D. Coolidge High-voltage x-ray tube 1913

1914 Irving Langmuir formulates essential elements of gas/surface interactions, structural dependence, etc. that we now know as "Surface Science" 1910-1920

1915 W. D. Coolidge X-Ray tube manufacturer 1915

1916 F. Lowenstein Negative Bias Patent 1,231,764—July 3, 1917

1917 Marconi IP501 1 Tube detector 1919

1918 KDKA transmits first licensed broadcast almost a decade after "Doc" Herrold in San Jose, CA 1920

1919 Irving Langmuir Thoriated tungsten filaments 1920

1920 Edwin Howard Armstrong (1890–1954) Invents Superheterodyne receiver 1920

1921 Albert Einstein (1879-1955) Nobel Prize in Physics for photoelectric effect 1921

1922 Robert A. Millikan (1868-1955) Awarded Nobel Prize in physics for measuring charge on electron 1923

1923 L.T. Jones/H. G. Tasker demonstrates electrostatic focusing in a magnetically deflected CRT 1924

1924 K.M.G. Siegbahn Nobel Prize in Physics for x-ray spectroscopy 1924

1921 Albert W. Hull Magnetron tube 1921

1919 Radio Corporation of America founded 1919

1918 Armstrong invents super-regenerative circuit 1918

1915 M. von Laue Nobel Prize in Physics for x-ray diffraction from crystals 1914

1914 W.H. Bragg & W.L. Bragg Nobel Prize in Physics for crystal structure derived from x-ray diffraction 1915

1913 A. Dufour develops a high-voltage continuously pumped CRT and records directly on photographic plates 1913

1913 John B. Johnson/H. J. Van der Bijl develops the first commercial CRT (Western Electric 224-A) 1913

1911 "Doc" Herrold begins first radio broadcast service in San Jose, CA 1911

1911 Edwin H. Armstrong invents the regenerative circuit 1911

1910 Lee deForest Audion detector 1910

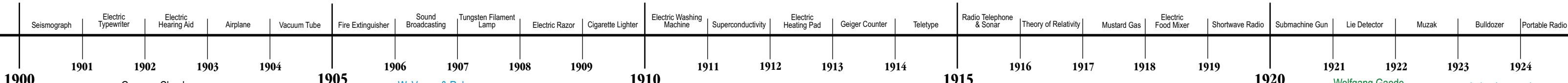
1910 Georges Claude demonstrates neon lamp in public 1910

1907–1908 Navy use of Triode

1906 Lee deForest (1873–1961) invents the Triode (Audion) November 1906

1906 Sir John Ambrose Fleming devises the first practical electron tube; the Fleming Valve (diode) c 1906

1902 E. Weintraub Mercury arc lamp and rectifier 1902



1900 Cryosorption Pump James Dewar using activated charcoal and liquid air ~1900

1901 Harris J. Ryan developed magnetic deflection CRT's 1903

1902 Georges Claude (1870–1960) builds first neon lamp ~1902

1903 Edison's National Phonograph company uses sputter coating to produce phonograph cylinder masters 1903

1904 Wolfgang Gaede Rotary mercury-sealed mechanical vacuum pump 1905

1905 Wolfgang Gaede Oil-sealed Vane mechanical vacuum pump 1905

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1910 M. Knudsen Radiometer effect vacuum gauge 1910

1910 Pfeiffer Co. Rotary oil-sealed mechanical vacuum pump 1910

1910 Wolfgang Gaede First theory and experiment on molecular-drag pumping 1912

1910 Lee deForest enables the vacuum tube to function as an amplifier 1912

1911 AEG-Telefunken develops standardized tubes for radio reception (EVN94, EVN129) in Germany 1914

1911 Wolfgang Gaede Diffusion pump concept using Mercury 1913

1912 ATT purchases license from deForest August 1914

1912 Marconi files suit against Lee deForest re: triode 1914

1912 GE develops Tungar rectifier December 1915

1912 Edison & Swan Co. Produces round valves and Fleming valves for Marconi Co. in Great Britain 1915

1912 GE begins production of Plotrons (triode) 1915

1912 Western Electric begins production of biased tubes for AT&T (Type M/101A first) 1915

1913 Irving Langmuir gas filled incandescent lamp 1915

1913 Western Electric patents indirectly heated cathode 1915

1913 GE develops VT-1 & VT-2 for Signal Corps Goes into high production 1917

1913 Siemens & Halske develop Type "A" vacuum tube—about 50,000 produced in Germany 1916

1913 British Thomson Houston begins production of triodes including "R" valve for military Marconi Co. in Great Britain 1916

1913 Osram/G.E. Begins production of "R" valves in Great Britain 1916

1914 O.E. Buckley Hot cathode ionization gauge development 1916

1914 Irving Langmuir High-speed diffusion pump and all-metal condensation pump 1916

1914 Tubular Audion developed by Cunningham October 1915 Lee deForest follows April 1916

1914 Lee deForest Radio Telephone & Telegraph company makes VT-21 and CF-185 tubes for the U.S. Government 1917

1914 AEG-produces 250 RE11's per day for war effort in Germany 1918

1914 GE produces YB-1 1918

1914 Moorhead Laboratories, San Francisco begins production of SE-1444 for U.S. Navy Rate of 50,000 per month claimed 1918

1915 Irving Langmuir formulates essential elements of gas/surface interactions, structural dependence, etc. that we now know as "Surface Science" 1910-1920

1915 A.J. Dempster Magnetic sector mass spectrometer 1918

1915 ATT purchases patent rights for triode from deForest March 1917 Lee deForest kept rights for amateur and experimental use

1915 Marconi/deForest/Moorhead reach agreement on patents 1919

1915 F. Holweck Spiral drum-type, molecular drag pump 1922

1915 First Fleming patent expired Nov 1922

1915 First Lee deForest patent expired Jan. 1924

1916 Wolfgang Gaede Box Pump Early 1920s

1916 Irving Langmuir Vibrating reed (viscosity) gauge 1923

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Vacuum Time Line, 1925–1950

Scientific Foundation of Vacuum Techniques
published by Saul Dushman
1949

1925 Heintz & Kauffman vs. RCA tube patent litigation

1926 Loewe 3NF vacuum "integrated circuit" 1926
Philo T. Farnsworth demonstrates an all-electronic television system in San Francisco 1927

1927 A.H. Compton Nobel Prize in Physics for scattering of x-rays by electrons. 1927
James Franck and Gustav Hertz— Nobel Prize in Physics— Laws governing collision between electron and atom 1925
Kenjiro Takayanagi demonstrates a gas focused oscillograph CRT to display television images 1927

1928 Complete amateur (ham) radio station—1 tube receiver & 1 tube transmitter 1929
Manfred von Ardenne demonstrates an all electronic television in Berlin 1929

1929 Harold S. Black discovers negative feedback 1927
Vladimir K. Zworykin files a patent on the kinescope. He later developed the iconoscope. 1929

1930 Atwater Kent 3 tube receiver 1930
Late night DX with a 1 tube receiver 1930
Irving Langmuir— Nobel Prize in Chemistry— Surface Chemistry 1932

1931 Brigadier General David Sarnoff (1881-1971)
Harold Urey— Nobel Prize in Chemistry— Discovery of deuterium 1934

1932 John L. Baird demonstrates a 700 line high resolution television 1935
Alan B. Du Mont begins applying CRT's to television 1932

1933 Alan B. Du Mont founds the Du Mont Laboratories 1931
E. H. Armstrong announces frequency modulation 1933

1934 Peter Debye Nobel Prize in Chemistry for diffraction of x-rays and electrons in gases. 1936
Oskar Heil patents the field effect transistor (but did not work) 1935

1935 James Chadwick Nobel Prize in Physics for the neutron. 1935
McMurdo Silver 15 tube console receiver 1937
RCA & Du Mont demonstrates television at the NY World's Fair 1939

1936 Sir Henry Tizard brings cavity magnetron to U.S. Sept. 6, 1940

1937 Model B Klystron Varian brothers first working klystron Stanford University 1937
John Randall and Harry Boot develop the magnetron at Birmingham University Feb. 21, 1940

1938 Hewlett-Packard partnership begins on \$538. 1938
Rudi Kompfner first traveling wave tube Oxford University 1942

1939 Ernest O. Lawrence Nobel Prize in Physics for invention of Cyclotron. 1939
525-line NTSC system approved by FCC for commercial B & W TV 1941
ENIAC computer developed at Univ. of Penn. It used 18,000 vacuum tubes. 1943
Percy Spencer of Raytheon Co. designed the laminated anode magnetron which increased production

1940 World's first regular TV broadcasting by BBC in England electronic system by EMI 1936
John Randall and Harry Boot develop the magnetron at Birmingham University Feb. 21, 1940

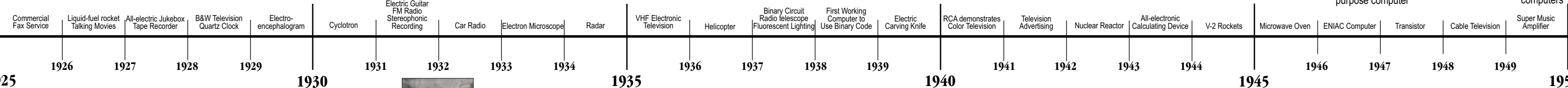
1941 Sir Charles Oatley (1904-1996) Co-developer of scanning electron microscope 1948
Bardeen, Brattain, and Shockley demonstrate the first semiconductor amplifier (transistor) 1947
Patent 2,535,035 — October 3, 1950

1942 Paul Eisler perfects the printed circuit board 1942

1943 ENIAC computer developed at Univ. of Penn. It used 18,000 vacuum tubes. 1943

1944 First general purpose computer

1945 Vacuum tube memory for computers



1925 M. Siegbahn Disk-type, molecular drag pump 1926
Farnsworth Image Dissector 1926
Irving Langmuir (1881-1957) Holding Thyatron Tube invented by Albert W. Hull 1927

1926 Cecil R. Burch Gas diffusion pump using low-vapor pressure oils 1928
First RCA AC filament tube RCA UX-226 Sept. 1927
First US screen grid tube RCA UX-222 Oct. 1927
Landmark UX 280 rectifier introduced (produced for over 50 years) May. 1927
Arcturus founded 1927

1927 Owen W. Richardson (1879-1959) Nobel Prize in Physics for Thermionic phenomena, Richardson's Law 1928
Farnsworth Electron Multiplier 1929
National Union and Champion Tube Manufacturers founded 1930
Perryman Tube Manufacturer founded 1929

1928 Cecil R. Burch & Bancroft Oil diffusion pump 1930
Kenneth C.D. Hickman Low-pressure synthetic oils 1929
National Union produced first tubes for car radios 1931
Mercury vapor rectifier 82, 83 1932
Westinghouse announced Mercury-arc rectifier (Ignitron) 1933

1929 Kenneth C.D. Hickman Fractionating oil diffusion pump and fluids 1935
G.E. 6E5 "Magic Eye" tube 1934
RCA 9 original tubes in metal family 1935
Metal tube introduced by RCA— 6L7 1935
First electron ray (magic eye) tube introduced by RCA— 6E5 1935
GE starts to manufacture receiving tubes after 5½ year absence 1935

1930 A.R. Olsen & L.L. Hirst Capacitance manometer 1929
First Transmission Electron Microscope— Ernst Ruska 1931
Wolfgang Gaede Gas Ballast Pump 1935
Mahn & Mecalf Paper on Velocity Modulated Electron Tubes 1936
C.M. Van Atta Diffusion pump speed >100 liter/sec. 1937
Ernest O. Lawrence Nobel Prize in Physics— The Cyclotron 1939
Radar set using magnetron built by British September 1940
First button base 1.4 V miniature tube 1R5 1940

1931 F.M. Penning Cold-cathode, ionization gauge 1937
Ernest O. Lawrence Nobel Prize in Physics— The Cyclotron 1939
RCA demonstrates Color Television 1941
Television Advertising 1941
Nuclear Reactor 1942
All-electronic Calculating Device 1943
V-2 Rockets 1944
Microwave Oven 1945
ENIAC Computer 1946
Transistor 1947
Cable Television 1948
Super Music Amplifier 1949

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RCA 9 original tubes in metal family 1935
Metal tube introduced by RCA— 6L7 1935
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G.E. 6E5 "Magic Eye" tube 1934
RCA 9 original tubes in metal family 1935
Metal tube introduced by RCA— 6L7 1935
First electron ray (magic eye) tube introduced by RCA— 6E5 1935
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RCA 9 original tubes in metal family 1935
Metal tube introduced by RCA— 6L7 1935
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Vacuum Time Line, 1951–1975

1951 Credit Card, Power Steering, Magnetically focused electron beam gun—Leslie Holland 1951, RCA demonstrated the shadow mask color TV tube 1950

1952 Telephone-answering Machine, Beck & Brisbane Inverted, cold-cathode magnetron gauge 1952, Ring Getter with U-shaped cross section (used in vacuum tubes) 1952, M-type Carcinotrons (voltage tuned microwave oscillators) developed 1952, British & Japanese begin using Traveling Wave Tubes for radio relay systems 1951

1953 AVS became incorporated October 19, 1953, DNA Radial Tire, R. G. Herb Evapor-Ion pump with titanium sublimation and ionization 1950, Committee on Vacuum Techniques (later the AVS) holds its first symposium 1953

1954 First silicon transistor Texas Instruments 1954, A.M. Gurewitsch & W. F. Westendorf Single cell sputter ion pump 1954, R.G. Herb Getter-Ion pump 1953

1955 William Shockley celebrates Nobel Prize 1956, William Shockley, John Bardeen, and Walter H. Brattain Nobel Prize in Physics for discovery of transistor effect 1956, Erwin W. Müller invents Field Ion Microscope images individual atoms 1956, Leybold Company Roots vacuum pump mfg. 1955, Compactron developed (multipurpose tubes for TV) 1955

1956 Vacuum Deposition of Thin Films by Leslie Holland published 1956, Field Ion Microscope Optic Fiber Synthetic Diamond, W. Becker Multi-stage turbine (turbo-molecular) pump concept 1955

1957 Computer Hard Disk, Fortran ICBM, Willi Becker Turbomolecular Pump 1958

1958 External Pacemaker Integrated Circuit Modem, J.P. Hobson & Paul A. Redhead UHV Inverted magnetron, cold-cathode gauge 1958, First of a series of amateur oriented vacuum articles in Scientific American 1958, Mars Hablanian Axial flow, automotive (thin-bladed) supercharger at high vacuum Showed air compressors make good vacuum pumps, confounding existing theory 1957, Introduction of 'modern' Vacsorb cryosorption pump Varian 1958, Nixie Indicator Tubes 1957

1959 IBM 7090 computer first transistor computer, 1959, Ampex video tape recorder 1958, IBM 709 computer last major vacuum tube computer, used magnetic core memory 1958, Lewis D. Hall, R.L. Jepsen & J.C. Helmer Vacion (sputter-ion) pump based on Penning discharge—all electronic pump made surface science possible 1957

1960 Integrated circuit patent Robert Noyce 2,981,877 April 25, 1961, Integrated circuit Fairchild Semiconductor 1962, Varian Assoc. Inc. 1000 liter/sec VacIon Pump 1960, L.L. Levenson, Norman Milleron and D.H. Davis compute vacuum conductances using Monte Carlo simulations 1960, Gas laser invented 1960, First use of quadrupole mass spectrometer as residual gas analyzer 1960, Nuvistor developed 1960

1961 Fiber Tip Pen Halogen Lamp, J.W. Beams Spinning-rotor gauge (viscosity) 1960, 2000 ft³ space chamber U.S. Air Force 1960, E-13 torr, XHV vacuum chamber (2 ft. diameter) using cryogenic helium-cooled traps and baffles National Research Corp. 1960, J.M. Lafferty Hot-cathode magnetron, ionization gage 1961, C.H. Kruger & A.H. Shapiro Statistical theory of turbo-molecular pumping 1961, William R. Wheeler UHV (CF) metal-gasket captured step-seal 1961

1962 Low energy electron diffraction (LEED) image from nickel Varian 1962, Varian VA-126 High-power traveling wave tube 1962, Radio-frequency sputter deposition—G.S. Anderson et al. 1962, Ross Aiken CRT for aircraft and 14" Thin CRT tube 1960, Varian Clinac x-ray machine for cancer radiation therapy 1963

1963 Audio Cassette, Instant Color Film Navigation Satellite Videodisc, Touch Tone Phone, First practical capacitance manometer MKS Instruments, Inc. 1961

1964 Integrated circuit patent Jack S. Kilby 3,138,744 June 23, 1964, Integrated circuit patent Robert Noyce 2,981,877 April 25, 1961, SLAC Linear Accelerator invented by William Hansen, developed by Edward Ginzton (pictured), and completed under the direction of Dr. Wolfgang Panofsky 1966, First JVST, Vol. 1, No.1, Sept./Oct. 1964

1965 "Moore's Law" appears in Electronics Magazine April 1965, "The amount of information storable on a given amount of silicon has roughly doubled every year since the technology was invented.", Moore's Law

1966 P.A. Redhead Extractor gauge 1966, Charles W. Hanks—270° bent-beam electron-beam gun evaporation source 1968, A.Y. Cho, et al.—Molecular-beam epitaxy 1968, The Physical Basis of Ultra-high Vacuum by Paul A. Redhead, J.P. Hobson and E.V. Kornelson published 1968, W.M. Brubaker, P. Michael Utte, & Robert Finnigan First commercial quadrupole mass spectrometer residual gas analyzer EAI 1964, J.C. Helmer & W.H. Hayward Bent-beam (Helmer) gauge 1966

1967 Fuel Injection for Automobiles, Coronary Bypass Handheld Calculator, Computer Mouse Arpnet (proto internet) Bar-code Scanner Unix, Daisy-wheel Printer Floppy Disk, Peter Clarke—Cylindrical and conical magnetron sputter deposition sources 1971, Allied Radio sold to Tandy became part of Radio Shack 1970

1968 Robert Noyce & Gordon Moore founded Intel July 1968, Computer With Integrated Circuits, Computer Mouse Arpnet (proto internet) Bar-code Scanner Unix, A.Y. Cho, et al.—Molecular-beam epitaxy 1968, The Physical Basis of Ultra-high Vacuum by Paul A. Redhead, J.P. Hobson and E.V. Kornelson published 1968, W.M. Brubaker, P. Michael Utte, & Robert Finnigan First commercial quadrupole mass spectrometer residual gas analyzer EAI 1964, J.C. Helmer & W.H. Hayward Bent-beam (Helmer) gauge 1966

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1970 Intel 4004 Microprocessor Die, Intel introduces 1103, the first DRAM October, 1970, Commercial scanning electron microscope—Cambridge Instruments, U. K. 1970, K.H. Mirgel Vertical uni-directional turbomolecular pump 1969, Sylvania buys Philco Taiwan TV plant 1975

1971 Dot Matrix Printer Liq. Crystal Display Space Station, Gene Splicing, Post-it Note, Zenith shuts down Lansdale, PA unit 1975

1972 8008, the first 8-bit microprocessor August, 1972, John Chapin—Planar Magnetron sputter deposition source 1974, NASA Cryo-pumps for Space Simulation and semiconductor fabrication 1975

1973 Compact Disk Landsat Word Processor, Gene Splicing, Post-it Note, Zenith shuts down Lansdale, PA unit 1975

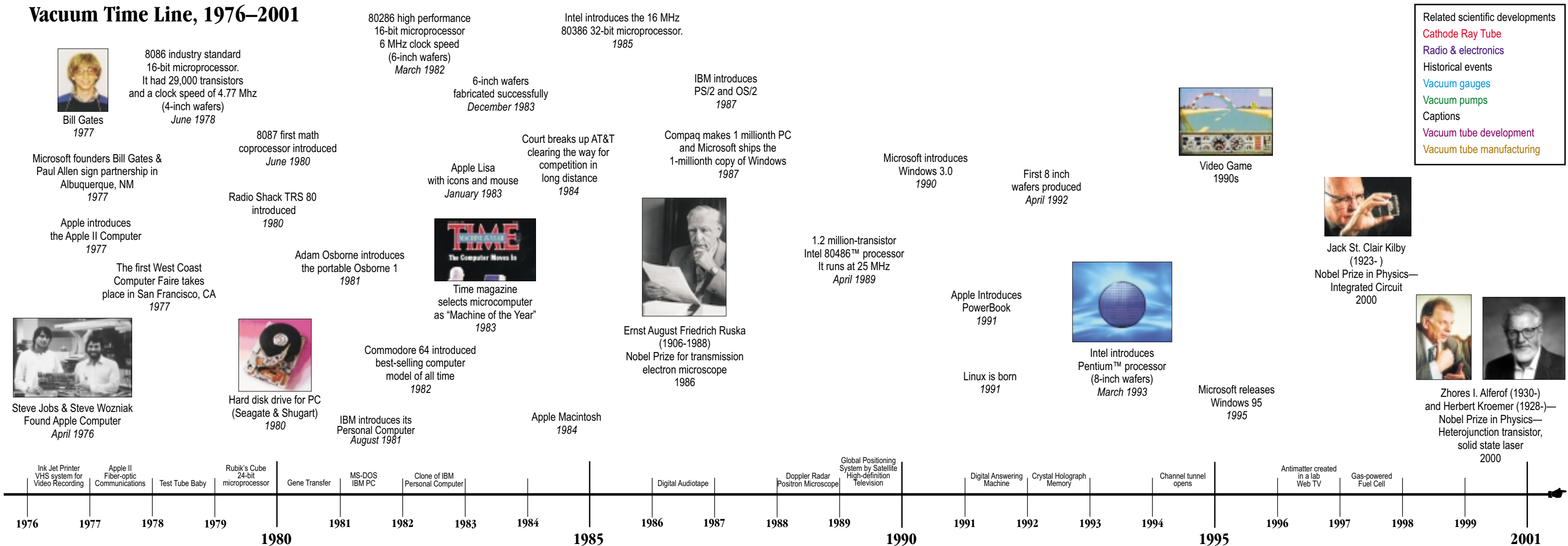
1974 John Chapin—Planar Magnetron sputter deposition source 1974, NASA Cryo-pumps for Space Simulation and semiconductor fabrication 1975

1975 Atari Video game "Pong" Introduced 1972, Altair 8800 Computer introduced 1975, Sylvania buys Philco Taiwan TV plant 1975, North American Phillips acquires 85% of Magnavox Co. 1975

Vacuum Time Line, 1976–2001

Time Line Color Code Key

- Related scientific developments
- Cathode Ray Tube
- Radio & electronics
- Historical events
- Vacuum gauges
- Vacuum pumps
- Captions
- Vacuum tube development
- Vacuum tube manufacturing

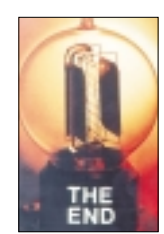


Viking I & II land on Mars 1976

Large non-evaporable getter panel 1976

RCA closes Harrison, NJ receiving tube plant Sylvania takes over Nuvistor line April 30, 1976

Daniel G. Bills and Paul C. Arnold Convection Pirani gauge 1977



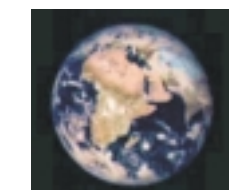
Vacuum tube production ends for all practical purposes in most Western European Countries and the US. 1977

Osaka Vacuum Ltd. Compound Molecular Pump 1980

WE 215A vacuum tube manufacture shutdown 1981 1919–1981

K.M. Siegbahn Nobel Prize in Physics for high resolution electron spectroscopy 1981

Nicolaas Bloembergen and Arthur L. Schawlow Nobel Prize in Physics for laser spectroscopy 1981



The Earth, in a vacuum, from space

Edwards introduced the dry pump for the semiconductor industry 1985

The last major vacuum tube production line was shut down (Raytheon) 1986



Gerd Binnig & Heinrich Rohrer Nobel Prize in Physics for scanning tunneling microscopy 1986

Hans Georg Dehmelt Nobel Prize in Physics for use of Penning Trap to study charged particles 1989

Wolfgang Paul Nobel Prize in Physics for Paul Trap for charged particles 1989



150 ft. diameter dish for radar and communications Stanford University

First issue of "The Bell Jar" vacuum for the amateur January 1992

CURRENT GLASS VACUUM TUBE MANUFACTURERS

- China** Shuguang Electrical Factory No. 1
- France** Amperex
- Russia** Reflector Corp, Saratov; Ryazan Plant of Electronics, Ryazan; SRPC Istok, Moscow; Svetlana Electronic Devices, St. Petersburg; Ulyanov, Ulyanovsk; Vokhod, Kaluga
- Slovakia, Czech Republics** AVVT, Prague; KR Enterprise, Prague; JJ Electronic, Prague; Teslovak, Cadca
- USA** Fritztronics, Randolph, MA; GE/Sylvania (RCA), Maryland; MU, Oceanside, CA; Richardson Electronics, LaFox, IL; Triton Services ETD, Gaithersburg, MD; Westrex Corporation, Kansas City, MO
- Yugoslavia** El Electronic Industries, Nis, Serbia

Question: What will happen next?



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