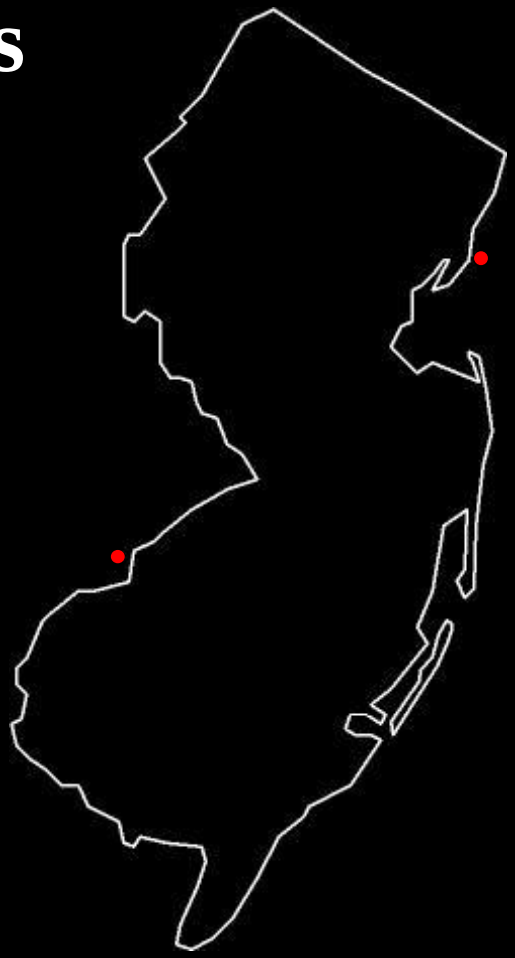
Beyond Einstein : New Jersey's* Contributions to World Science and Technology



* also New York City and Philadelphia

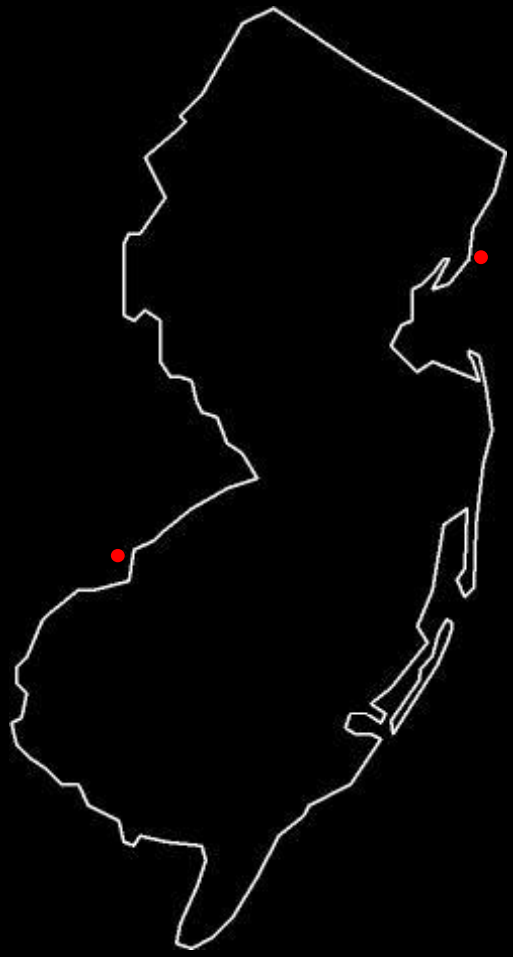
Michael G. Littman
Mechanical and Aerospace Engineering
Princeton University

Since 1664 …

• What radical innovations originate and thrive in NJ ?

• Who are the key people ?

• How has society changed ?



Since 1664 …

• What radical innovations originate and thrive in NJ ?

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For this talk …

• List NJ innovators, innovations, and organizations

• Select the most significant

• Group them

Common theme emerges – NJ contributions to origin and development of electric power and information networks is extensive

CEE 102 “Engineering in the Modern World”

DESIGN

Structures	Civil
Machines	Mechanical
Networks	Electrical
Processes	Chemical

DISCOVERY

Physics
Astronomy
Chemistry
Geology

No Life Science or Medicine

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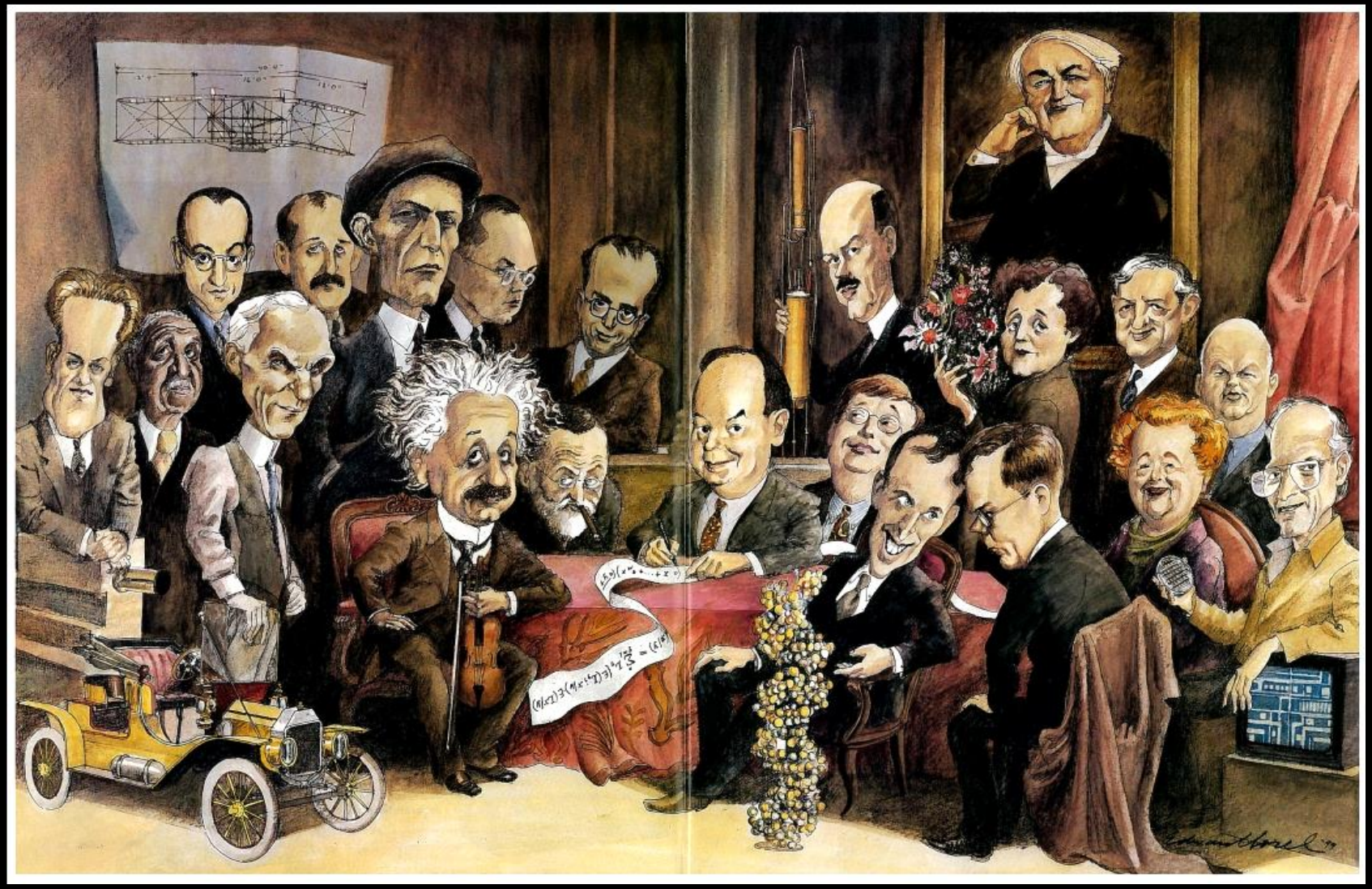
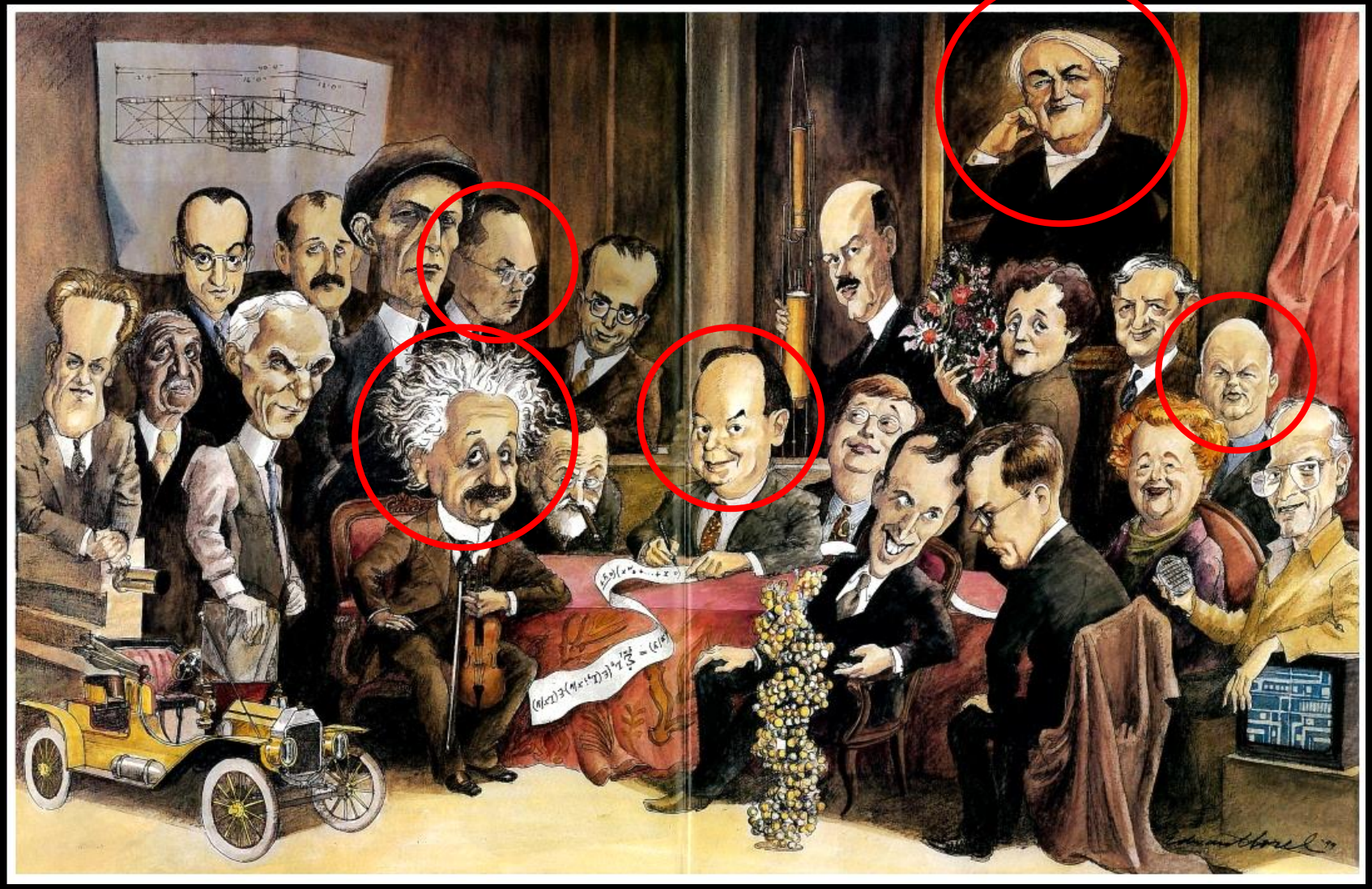


Edward Sorel – “People of Progress” – 20th Century

(left to right): Philo T. Farnsworth, George Washington Carver, Jonas Salk, Henry Ford, Orville Wright, Wilbur Wright, Albert Einstein, Charles H. Townes, Charles Steinmetz, J. C. R. Licklider, John Von Neumann, William H. Gates III, Robert Goddard, James Dewey Watson, Wallace Hume Carothers, Rachel Carson, Willis Carrier, Gertrude Elion, Edwin H. Armstrong, Robert Noyce



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Christian Schussele – “Men of Progress” – 19th Century

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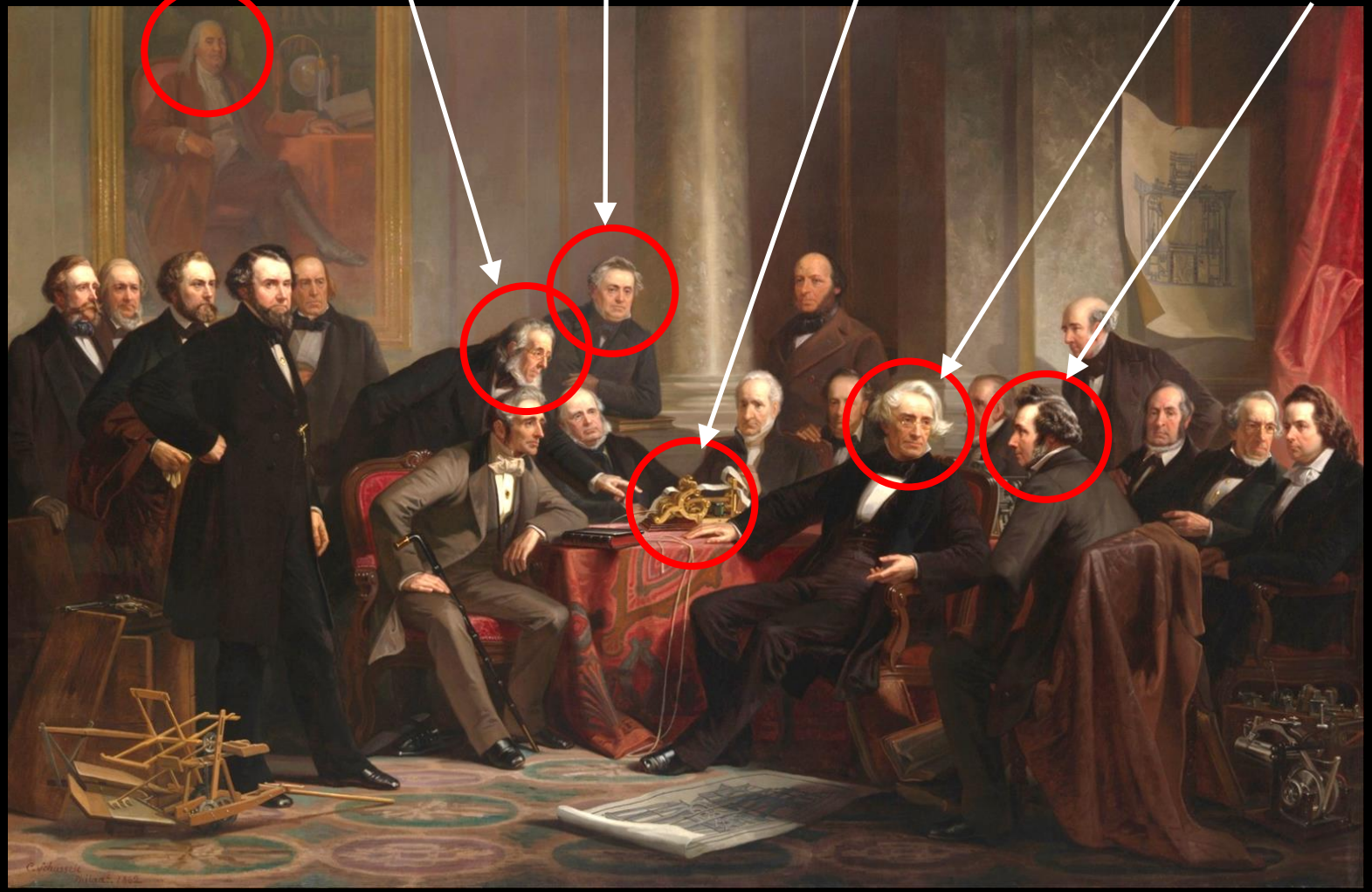

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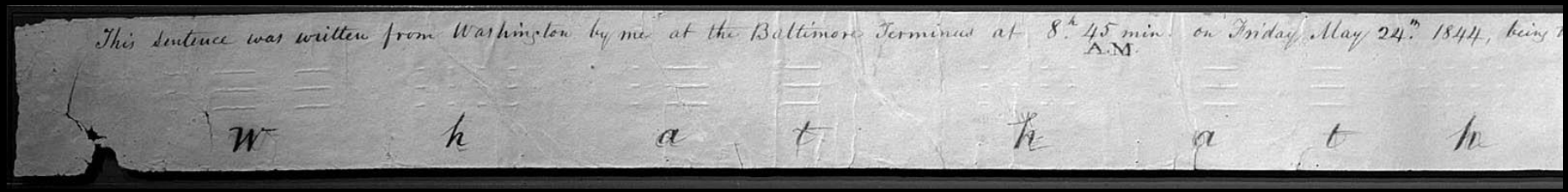
Telegraph Register (Printer) by Alfred Vail of Morristown NJ

moving tape

• — —

Morse code

Register base-plate signed by Alfred Vail in 9 places – note on bottom …."This lever and roller were invented by me in the sixth story of the New York Observer office, in 1844, before we put up the telegraph line between Washington and Baltimore... I am the sole and only inventor of this mode of telegraph embossing writing. Professor Morse gave me no clue to it... and I have not asserted publicly my right as first and sole inventor, because I wished to preserve the peaceful unity of the invention, and because I could not, according to my contract with Professor Morse, have got a patent for it. "



First Grouping

- Ideas
- Inventions
- Industries

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- Ideas
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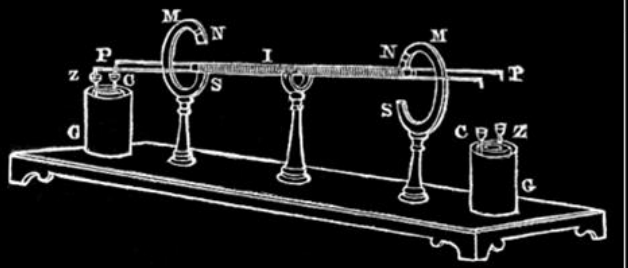
Ideas

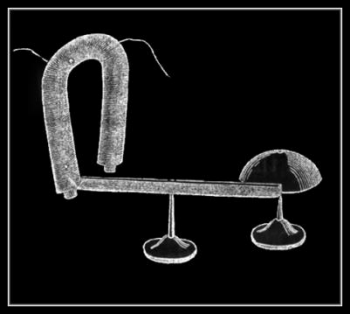
Joseph Henry
strong electromagnet

Albert Einstein
theory of relativity

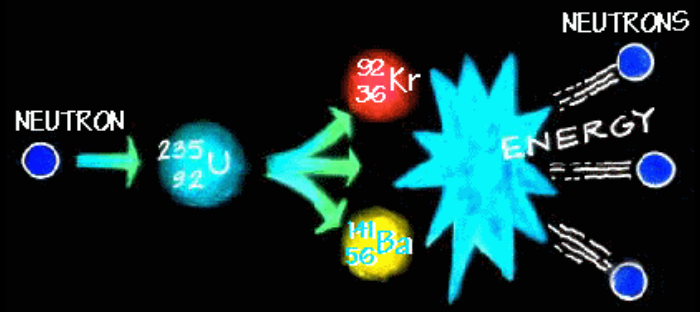
John von Neumann
stored-program
digital computer



Electric Motor
POWER

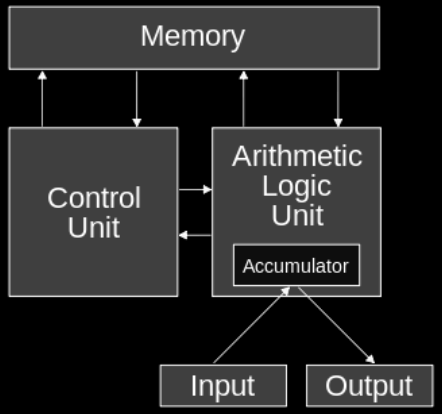


Telegraph
INFORMATION



NUCLEAR POWER NUCLEAR WEAPONS

Memory used for program and data



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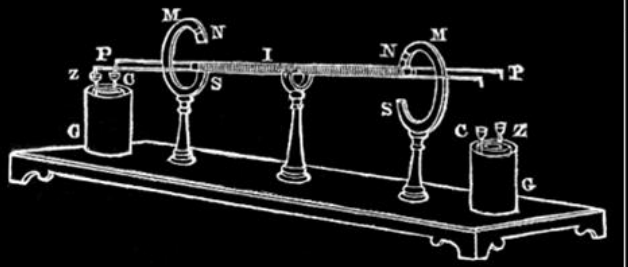
How society changed



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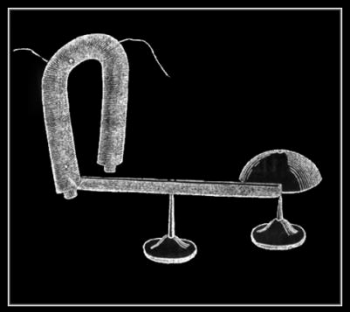

Telegraph

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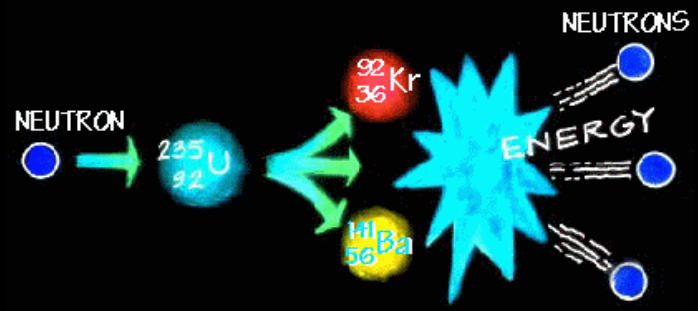
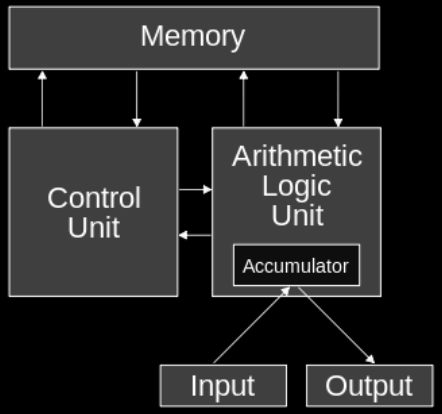


NUCLEAR POWER NUCLEAR WEAPONS

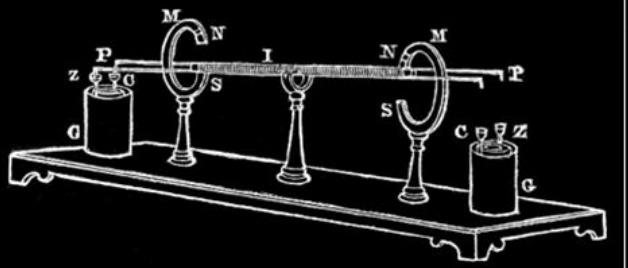
At the time of … my original experiments on electro-magnetism …, I was urged by a friend to take out a patent, both for its application to machinery and to the telegraph, but this I declined, on the ground that I did not then consider it compatible with the dignity of science … In this perhaps I was too fastidious. – J. Henry 1876

The release of atom power has changed everything except our way of thinking...the solution to this problem lies in the heart of mankind. If only I had known, I should have become a watchmaker. – A. Einstein 1945

Memory used for program and data



It would appear that we have reached the limits of what it is possible to achieve with computer technology, although one should be careful with such statements, as they tend to sound pretty silly in 5 years. – J. von Neumann 1949



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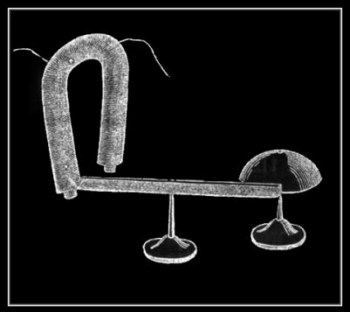
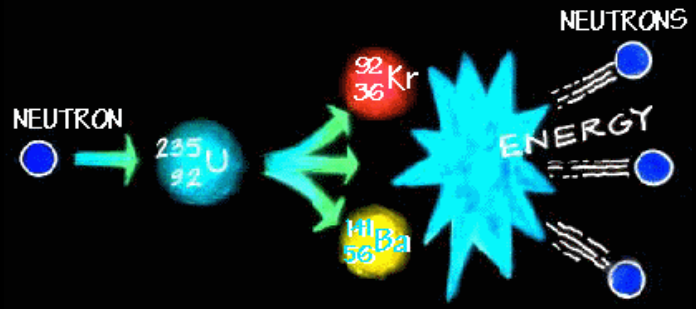


Telegraph
INFORMATION

All residents of Princeton NJ

Daniel Chester French
Statue of Joseph Henry
at Princeton University

Horse-shoe
Electromagnet



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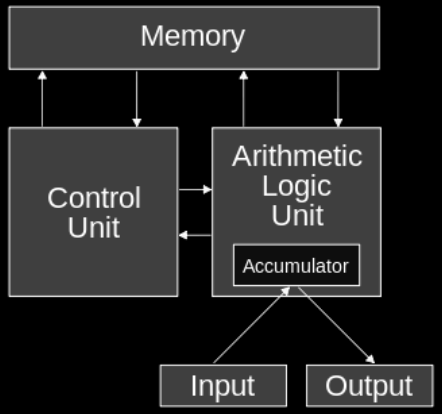

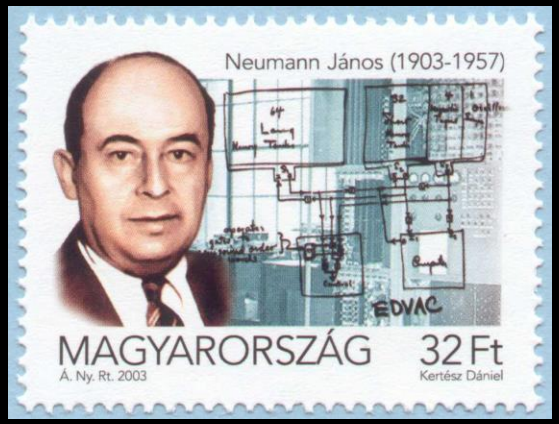

Inventions

Edison
Phonograph

Bardeen, Brattain, Shockley
Transistor

Townes, Schawlow
Laser

All residents of Princeton NJ

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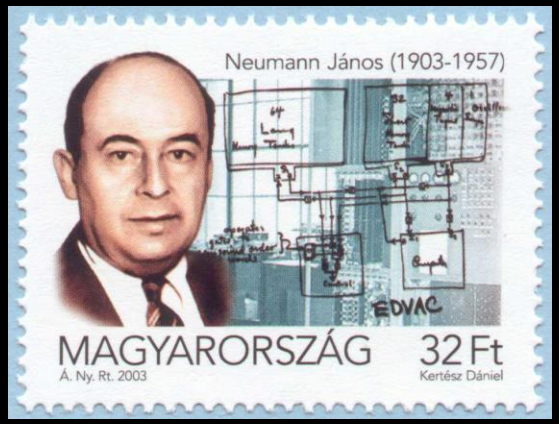

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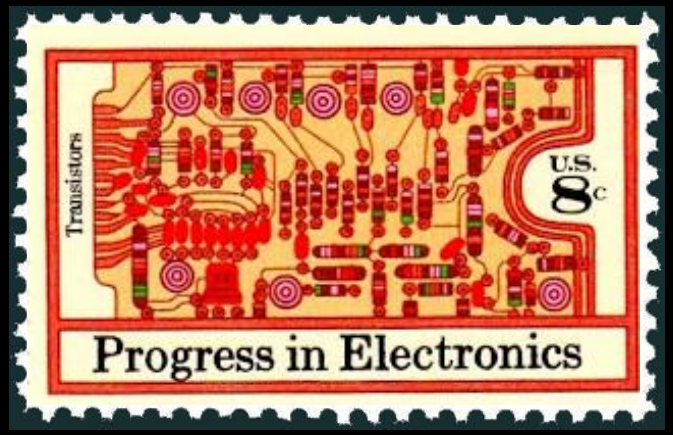
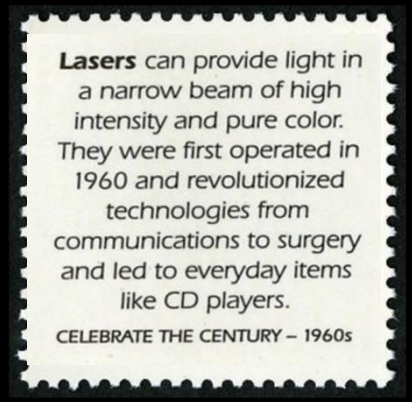
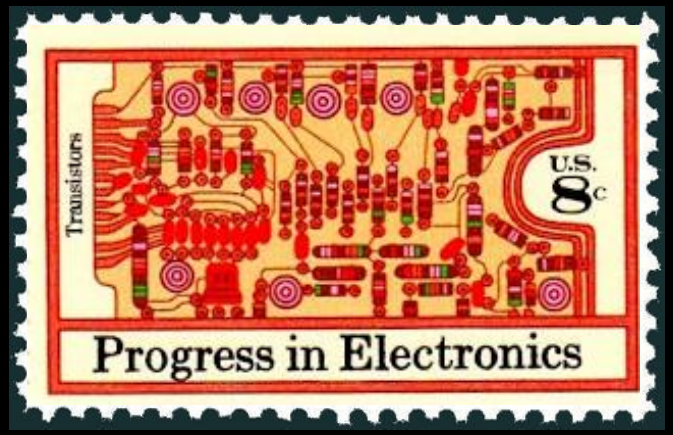




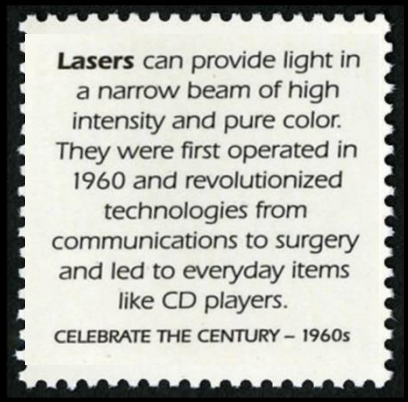
How society changed

Archival recordings of voice and music - as significant as photography

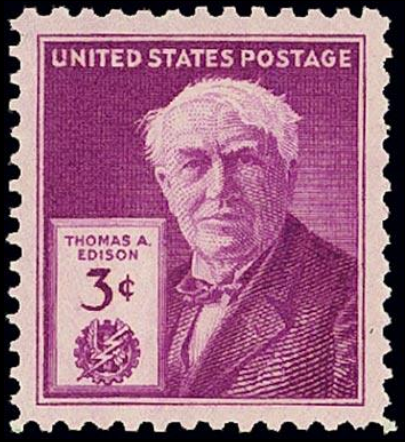
Miniature electronic devices; portable, rugged, fast, instant on



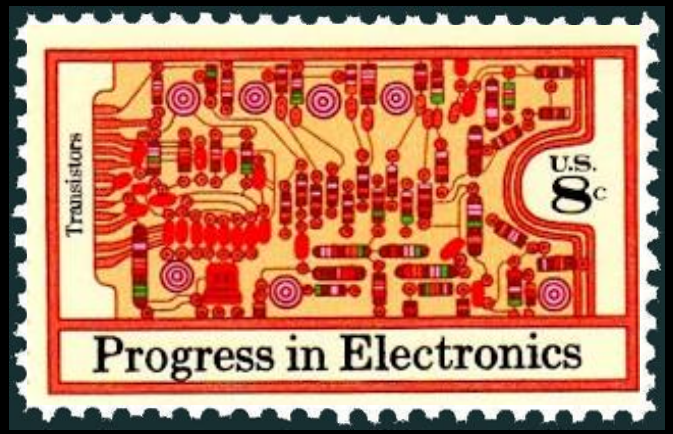
Optical storage of digital data; Optical transmission of data



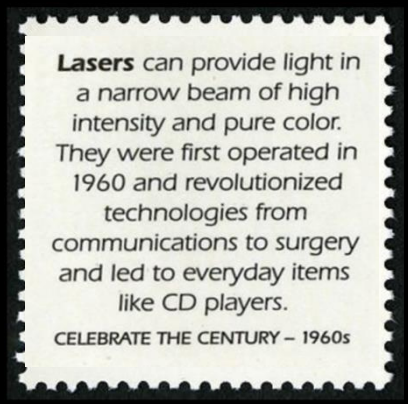
Menlo Park, NJ
West Orange, NJ



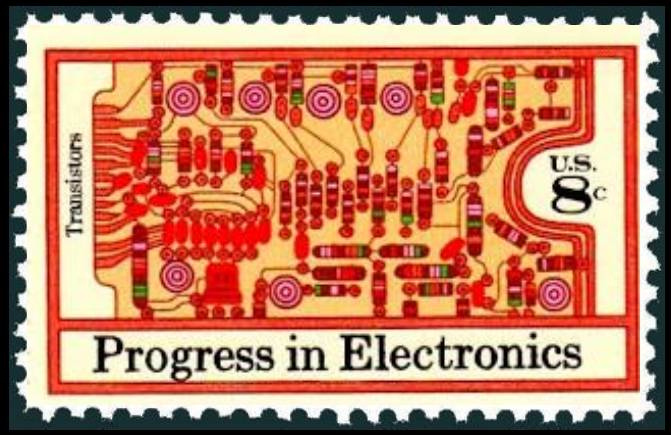
Murray Hill, NJ



New York, NY
Murray Hill, NJ



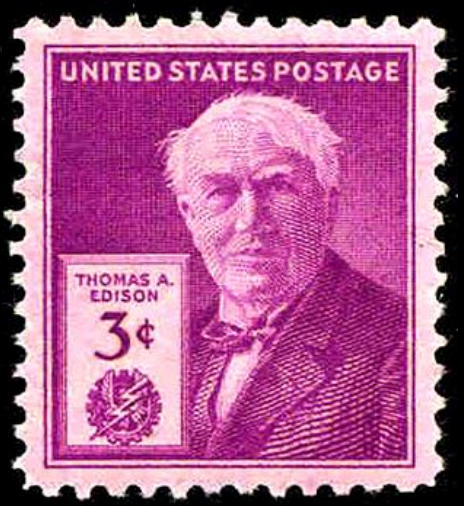
One invention leads to another – carbon button microphone leads to the phonograph

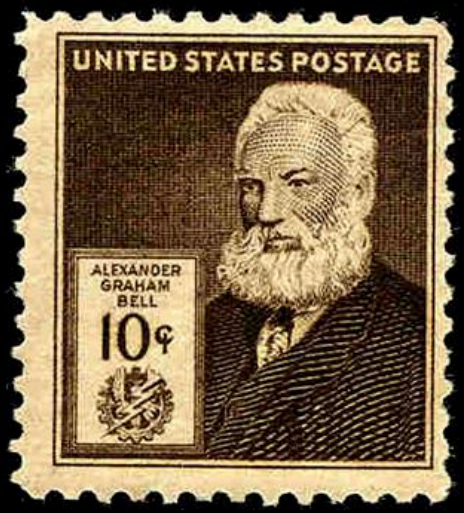


Lasers can provide light in a narrow beam of high intensity and pure color. They were first operated in 1960 and revolutionized technologies from communications to surgery and led to everyday items like CD players.

CELEBRATE THE CENTURY – 1960s

One invention leads to another – carbon button microphone leads to the phonograph





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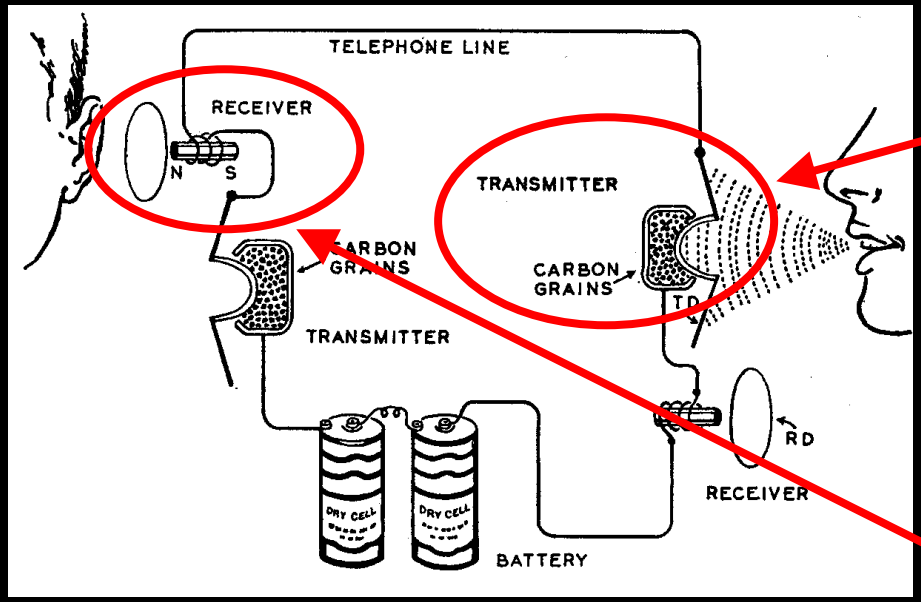

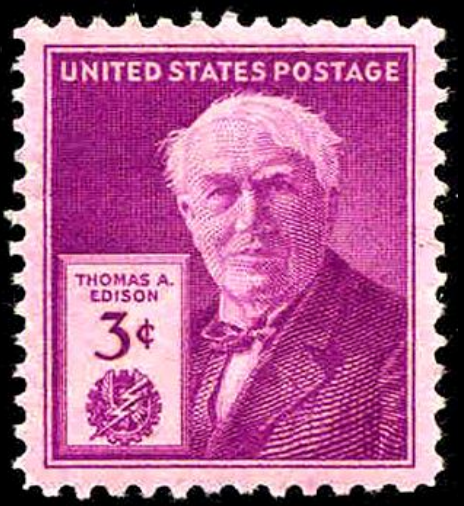

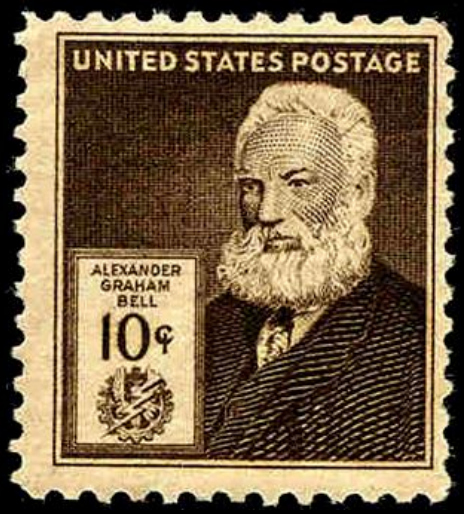

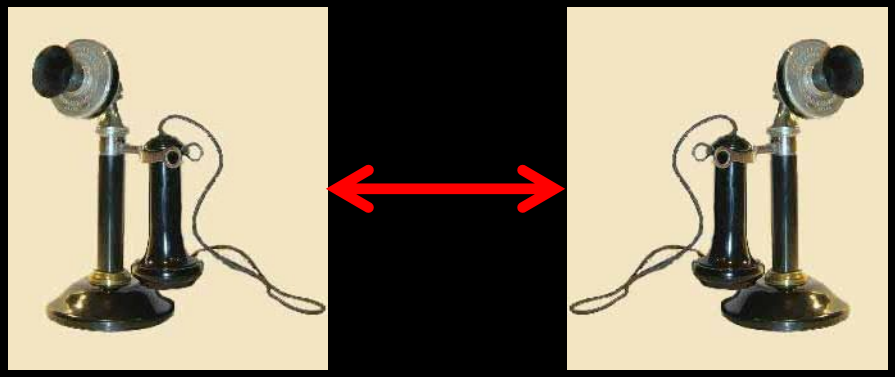

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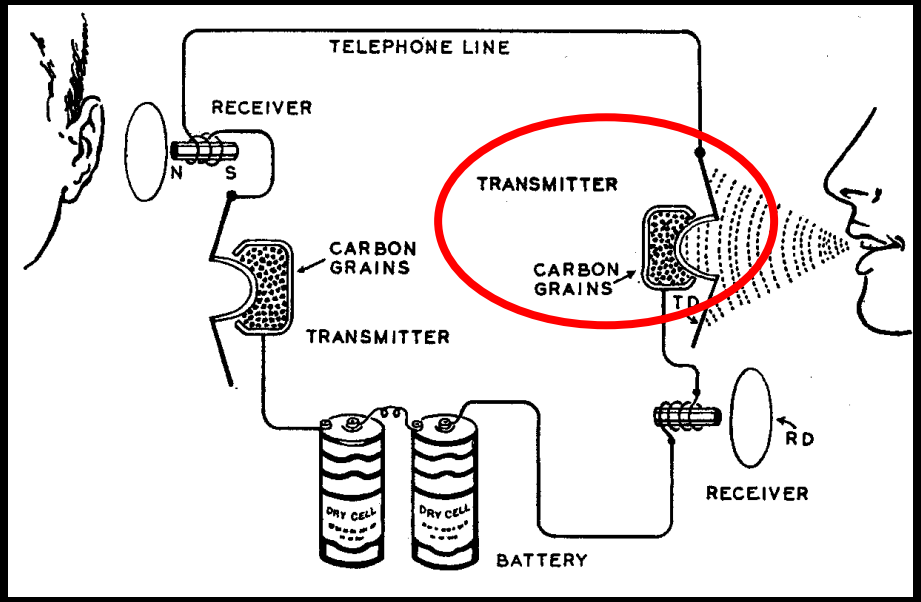
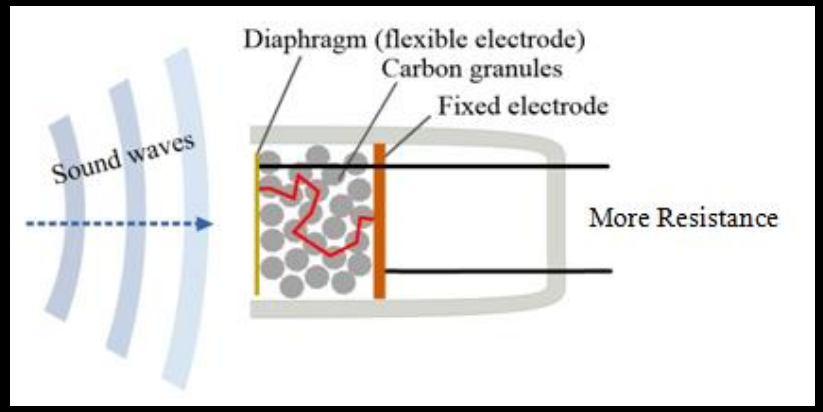
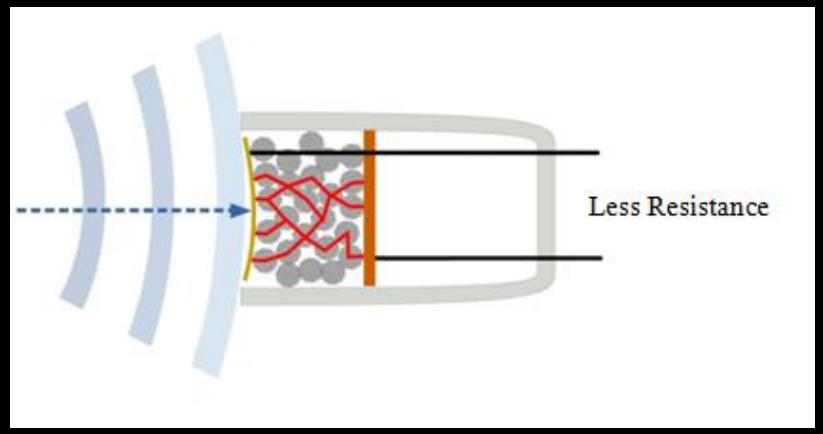




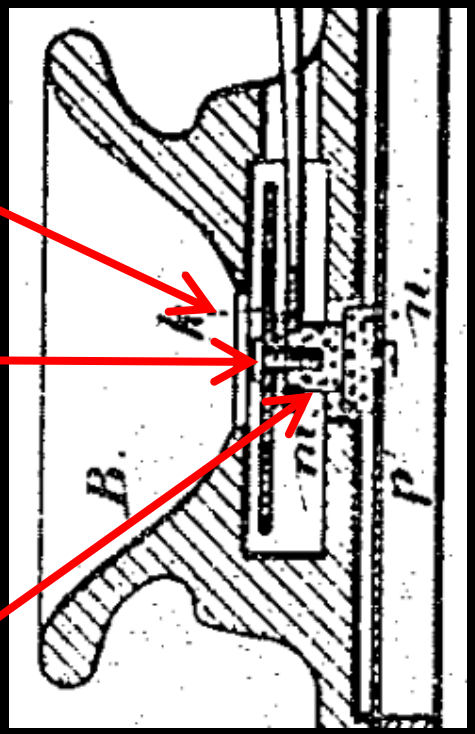


Edison Transmitter – Compressing carbon grains reduces resistance which increase current – transforms sound undulations into current undulations.

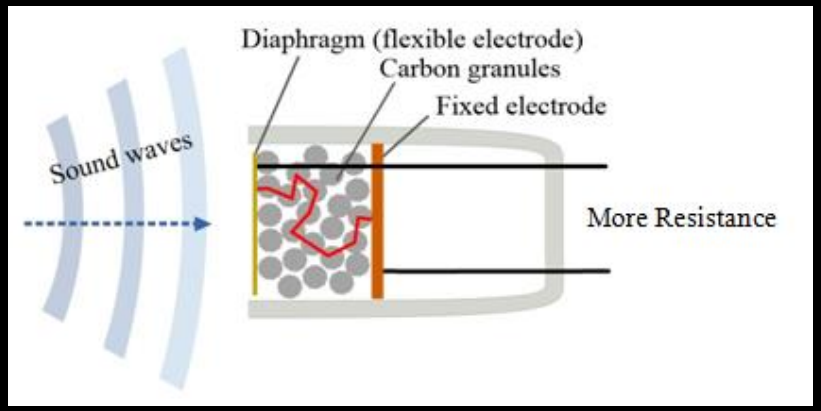
Diaphragm

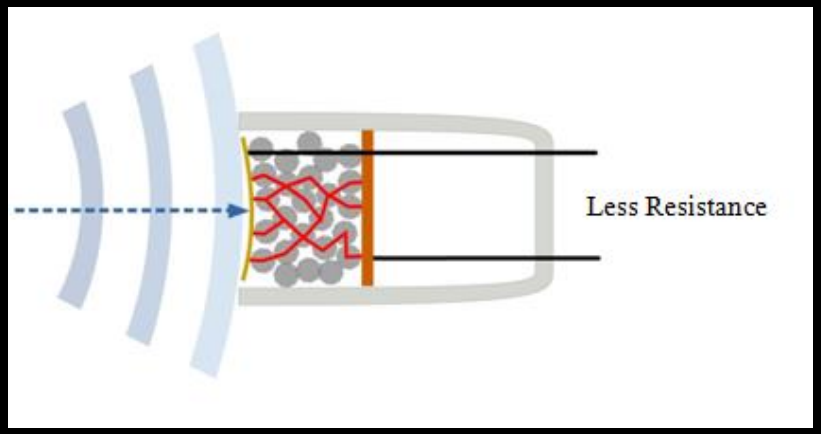
Pin to compress granules

Carbon granules



Edison's Patent Drawing of Carbon Microphone





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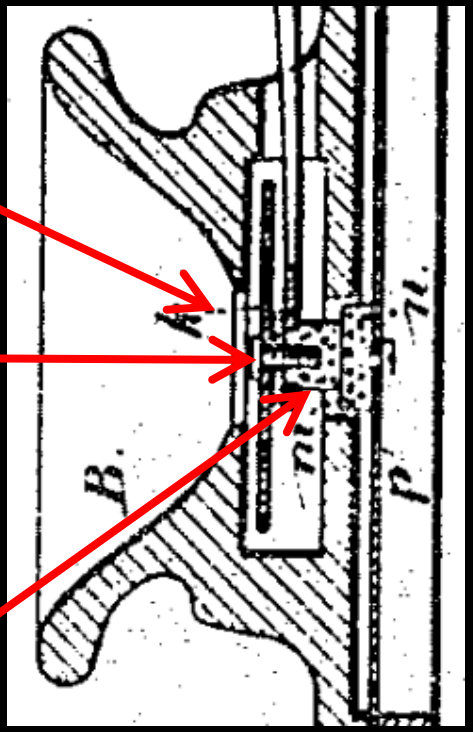
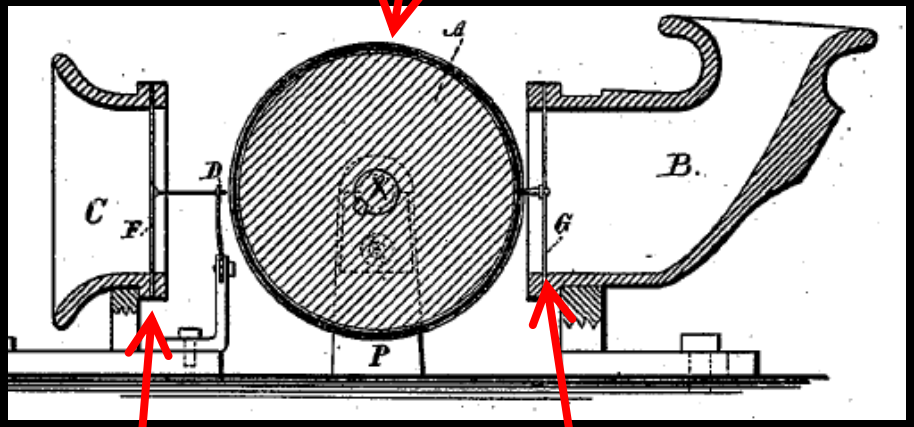


Edison's Patent Drawing of Carbon Microphone

Rotating Tin Foil Cylinder



Recorder

Sharp pin deforms the foil

Reproducer

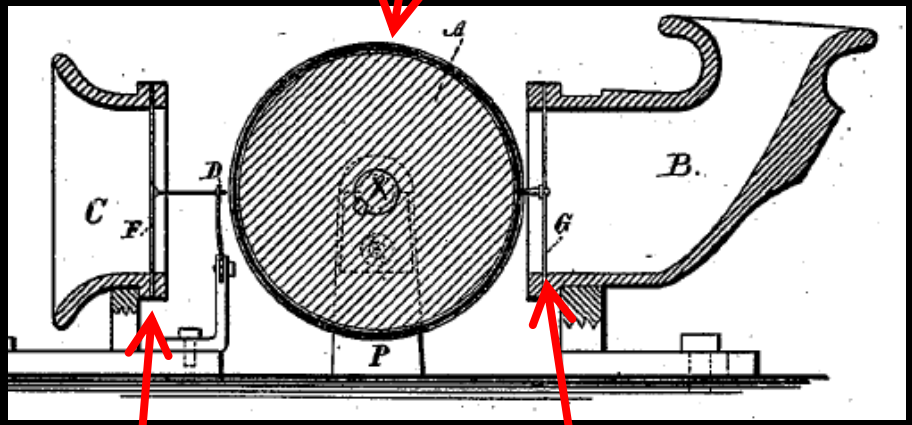
Blunt pin follows deformations

Edison's Patent Drawing of Phonograph

"Nipper" with Victor Phonograph

"Nipper" with Edison Phonograph

Rotating Tin Foil Cylinder



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Edison's Patent
Drawing of Phonograph

"Nipper" with Victor Phonograph

"Nipper" with Edison Phonograph

Industries

Edison
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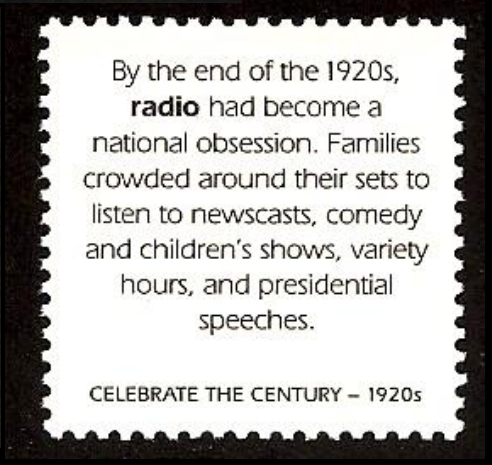
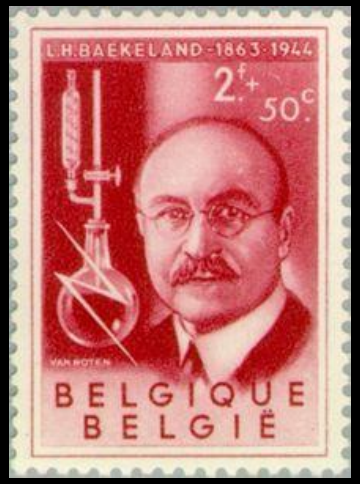
Radio & TV

J. P. Morgan and T. N. Vail
Telegraph & Telephone

L. H. Baekeland
Bakelite – first plastics





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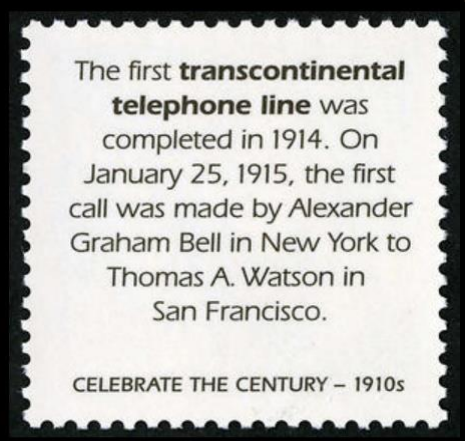

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L. H. Baekeland
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RCA Victor
Radio and Phonograph

RCA
Color Television

Alpine NJ – First FM Radio Tower

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Electric Power

Sarnoff and Armstrong
Radio & TV

J. P. Morgan and T. N. Vail
Telegraph & Telephone

L. H. Baekeland
Bakelite – first plastics

R & D Laboratories

Edison Laboratories
Menlo Park, NJ

RCA Laboratories
NYC; West Windsor, NJ

Bell Laboratories
NYC; Murray Hill, NJ

Industries

Edison
Electric Power

Sarnoff and Armstrong
Radio & TV

J. P. Morgan and T. N. Vail
Telegraph & Telephone

L. H. Baekeland
Bakelite – first plastics

R & D Laboratories

Edison Laboratories
Menlo Park, NJ

RCA Laboratories
NYC; West Windsor, NJ

Bell Laboratories
NYC; Murray Hill, NJ

Manufacturing

Edison Lamp Works
Harrison, NJ

RCA Vacuum Tubes
Harrison, NJ

Western Electric Company
Kearny, NJ

General Bakelite Company
Perth Amboy, NJ

Manufacturing

Second Grouping

- Capturing
- Communicating
- Computing

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Second Grouping

- Capturing
- Communicating
- Computing

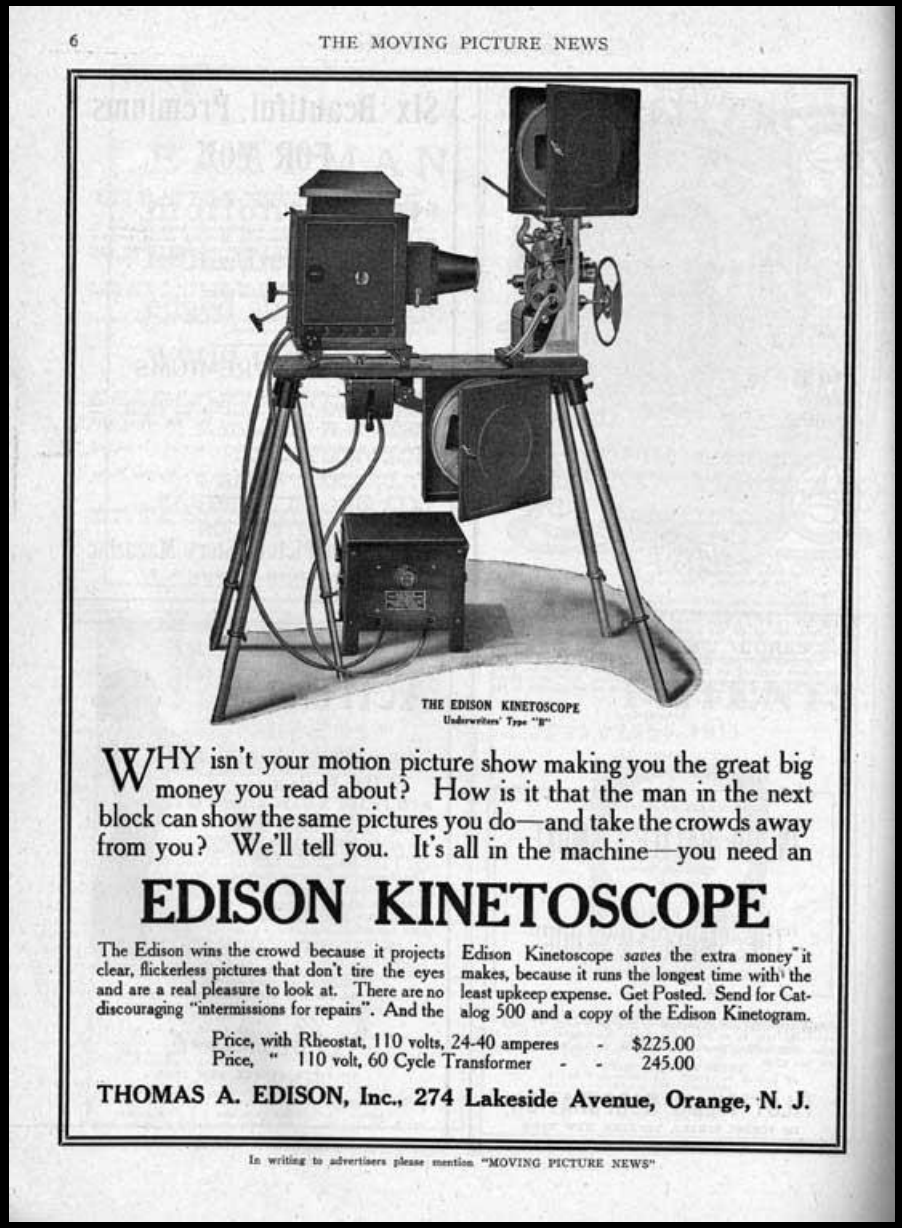
Capturing

Edison – Phonograph - Sound
Kinetoscope - Movies

Jansky – Radio Astronomy
Penzias & Wilson – Big Bang

Boyle & Smith – CCD
Digital Photography

Heilmeier – LCD



6 THE MOVING PICTURE NEWS

THE EDISON KINETOSCOPE
Underwriters' Type "B"

WHY isn't your motion picture show making you the great big money you read about? How is it that the man in the next block can show the same pictures you do—and take the crowds away from you? We'll tell you. It's all in the machine—you need an

EDISON KINETOSCOPE

The Edison wins the crowd because it projects clear, flickerless pictures that don't tire the eyes and are a real pleasure to look at. There are no discouraging "intermissions for repairs". And the Edison Kinetoscope *saves* the extra money it makes, because it runs the longest time with the least upkeep expense. Get Posted. Send for Catalog 500 and a copy of the Edison Kinetogram.

Price, with Rheostat, 110 volts, 24-40 amperes - $225.00
Price, " 110 volt, 60 Cycle Transformer - - 245.00

THOMAS A. EDISON, Inc., 274 Lakeside Avenue, Orange, N. J.

In writing to advertisers please mention "MOVING PICTURE NEWS"

Capturing

Edison – Phonograph - Sound
Kinetoscope - Movies

Jansky – Radio Astronomy
Penzias & Wilson – Big Bang

Boyle & Smith – CCD
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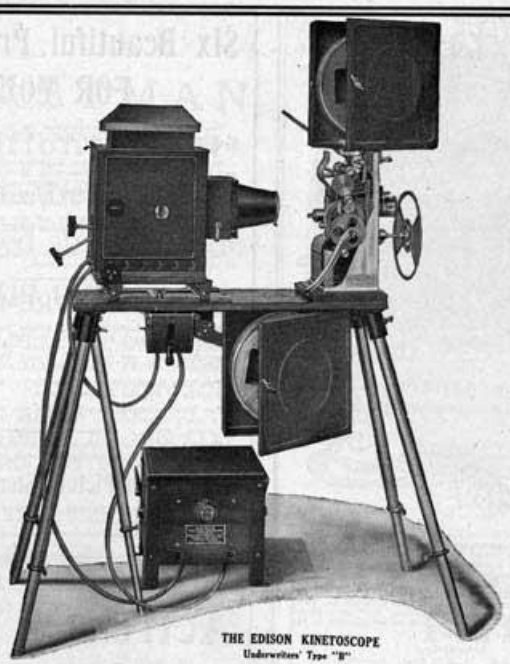
Heilmeier – LCD



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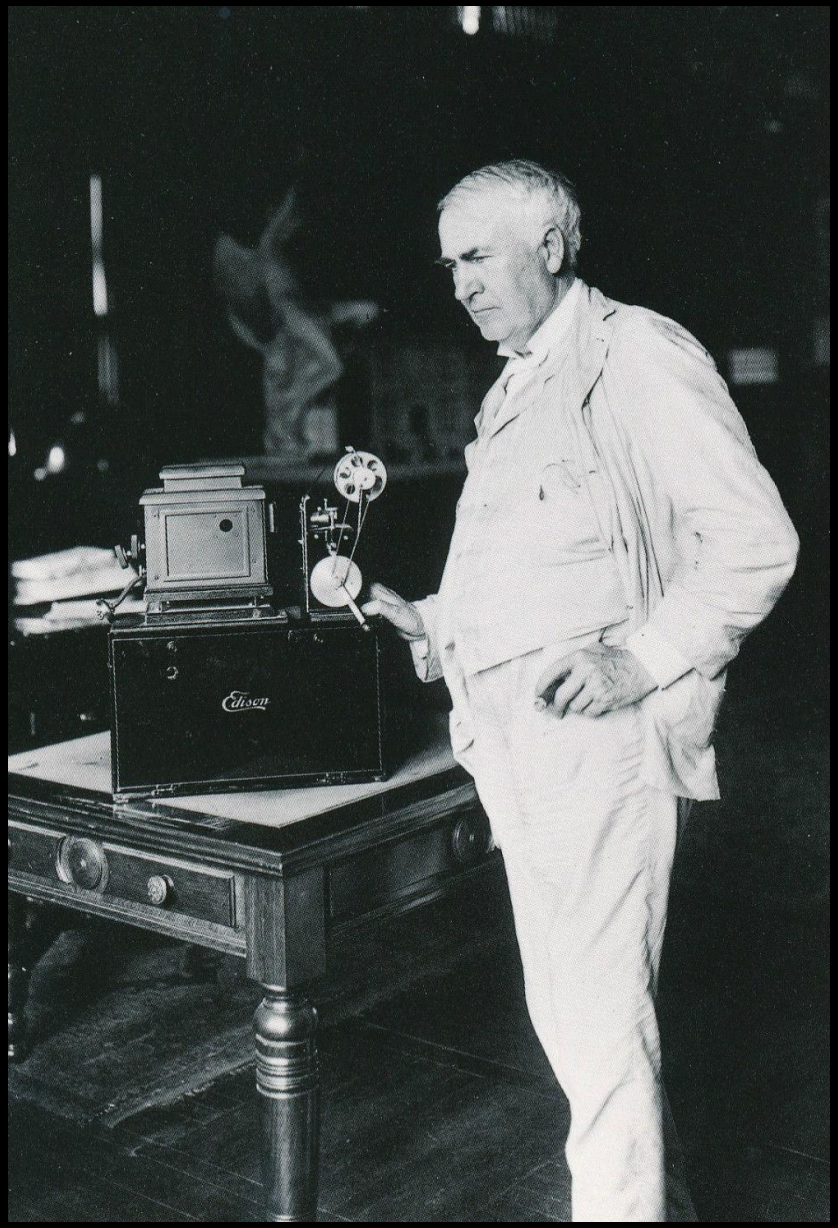


EDISON FILMS

PATENTED AND COPYRIGHTED.

Replete with Thrilling and Exciting Incidents in Fourteen Scenes,

THE GREAT TRAIN ROBBERY

Was shown to crowded houses during Xmas week in New York at the following theatres:

Hurtig & Seamon's
Circle Theatre
Proctor's 125th St.

Keith's 14th St.
Harlem Opera House
Tony Pastor's
Eden Musee
Huber's Museum
Orpheum, Brooklyn
Comedy Theatre
Orpheum Music Hall

SEND FOR FULLY ILLUSTRATED AND DESCRIPTIVE PAMPHLET.

LENGTH, 740 FEET.
PRICE, $111.
CODE WORD, VACUNABAN.

Edison Exhibition Kinetoscope, $115.00. Edison Universal Kinetoscope, $75.00.

MAIN OFFICE and FACTORY, Orange, N. J.

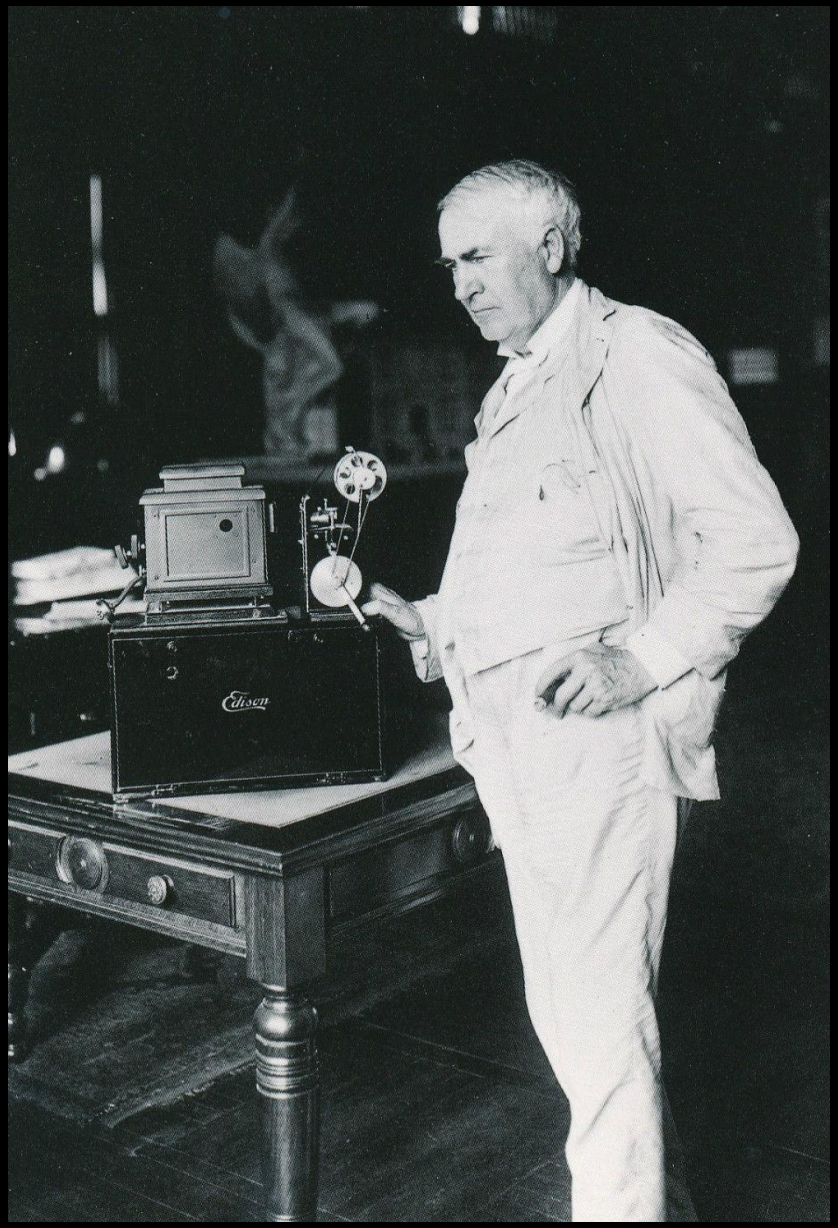
EDISON MANUFACTURING CO., NEW YORK OFFICE: 83 Chambers St.

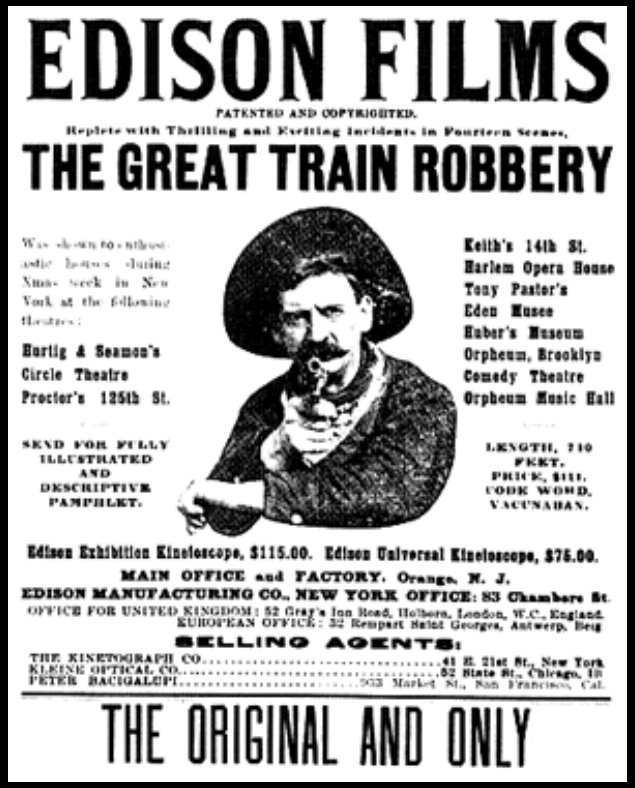
OFFICE FOR UNITED KINGDOM: 52 Gray's Inn Road, Holborn, London, W.C., England.
EUROPEAN OFFICE: 32 Rempart Saint Georges, Antwerp, Belg

SELLING AGENTS:

THE KINETOGRAPH CO. ..... 41 E. 21st St., New York
KLEINE OPTICAL CO. ..... 52 State St., Chicago, Ill.
PETER BACIGALUPI ..... 933 Market St., San Francisco, Cal.

THE ORIGINAL AND ONLY





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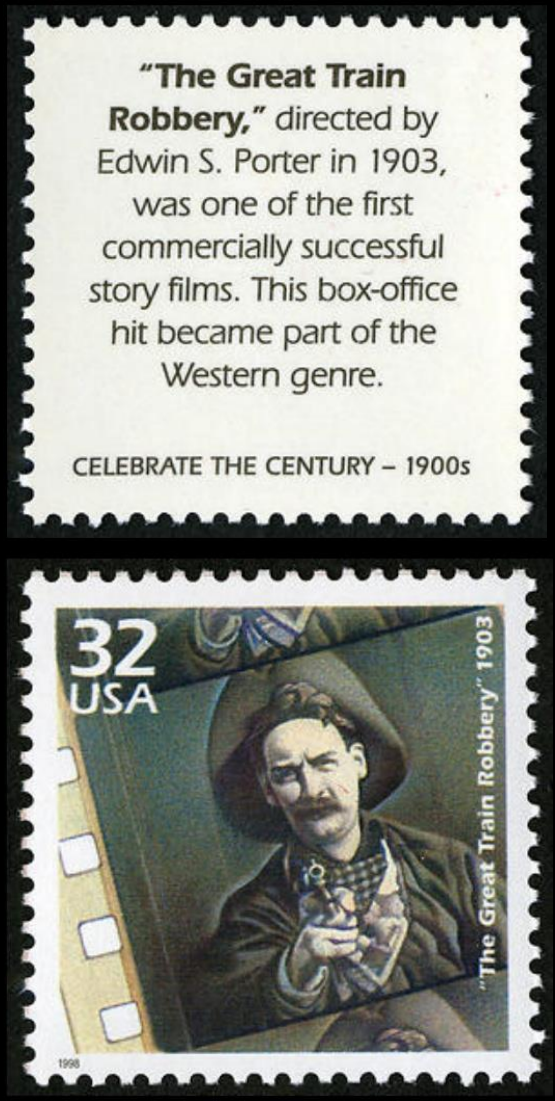

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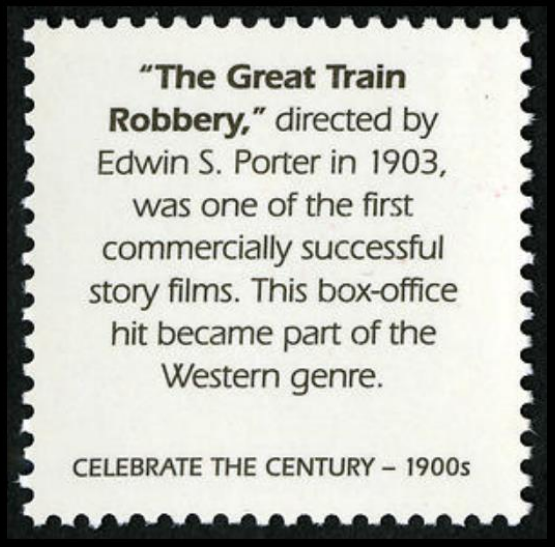

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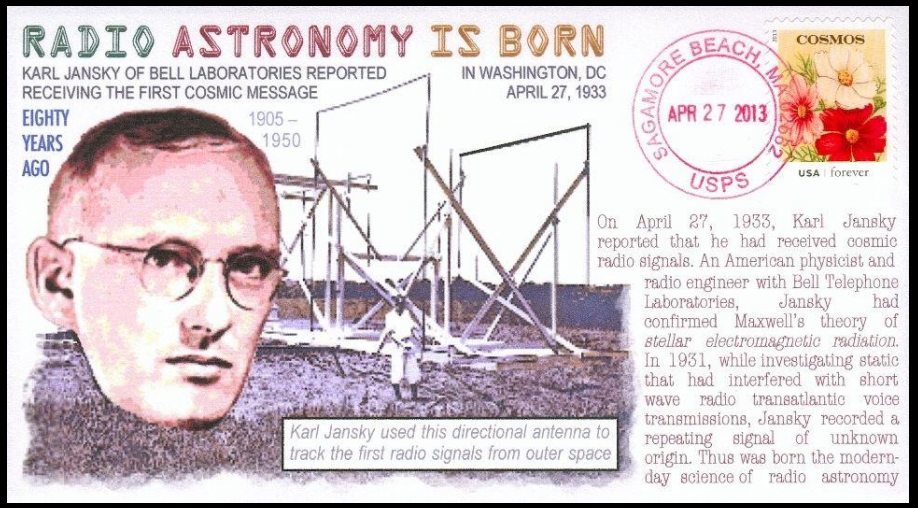
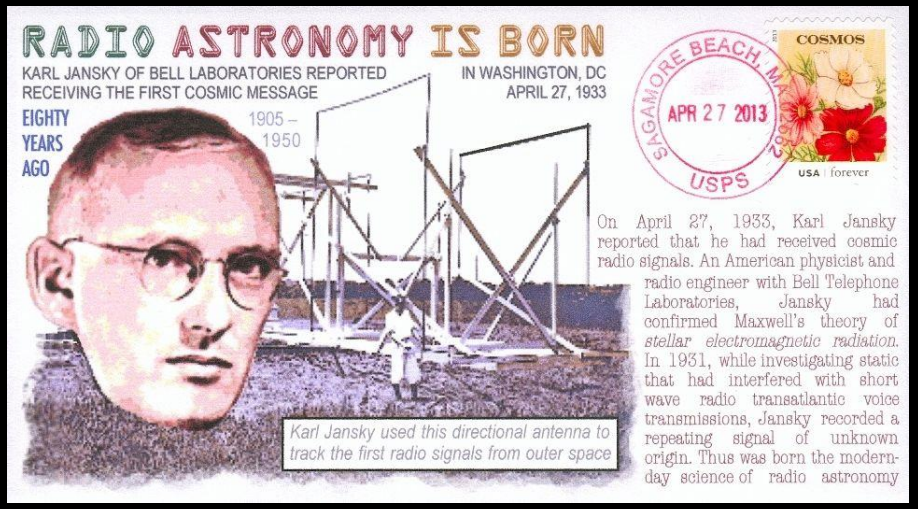
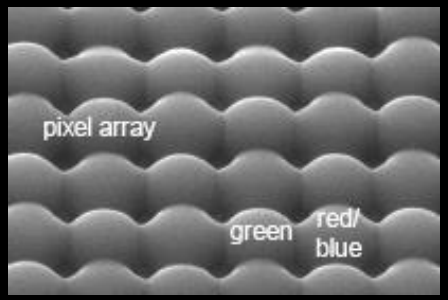


Penzias and Wilson – Big Bang



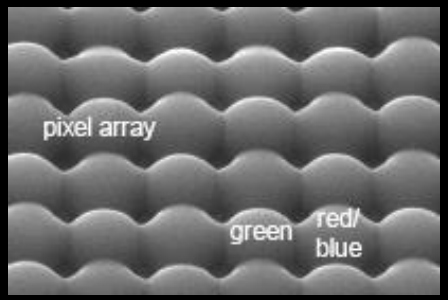


SEM image of iPhone 4 CCD

CCD invented at Bell Labs (Murray Hill NJ) by Willard Boyle and George Smith

Penzias and Wilson – Big Bang

LCD invented at RCA Labs (Princeton NJ)
by George Heilmeier



SEM image of
iPhone 4 CCD

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Communicating

Telegraph & Telephone
- Bell

Radio & TV
- RCA

Satellites
- Bell and RCA
- J. R. Pierce

LCD invented at RCA Labs (Princeton NJ)
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Radio & TV
- RCA

Satellites
- Bell and RCA
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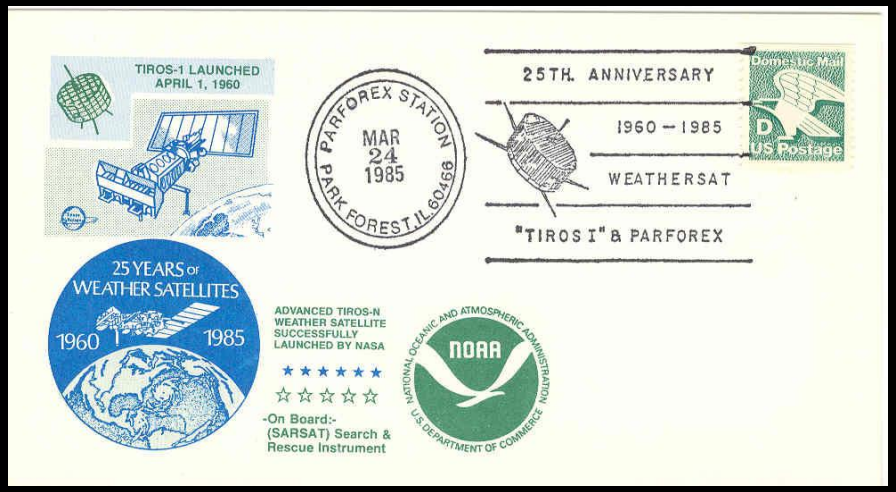
From left, RCA Project Director Edward Herold, RCA Labs Director Elmer Engstrom, shadow-mask inventor Harold Law, and electronic television pioneer Vladimir Zworykin show off color television tube options during an internal competition in 1950; Engstrom is pointing at the winner



TIROS 1 – first weather satellite
RCA Astro Labs in East Windsor, NJ

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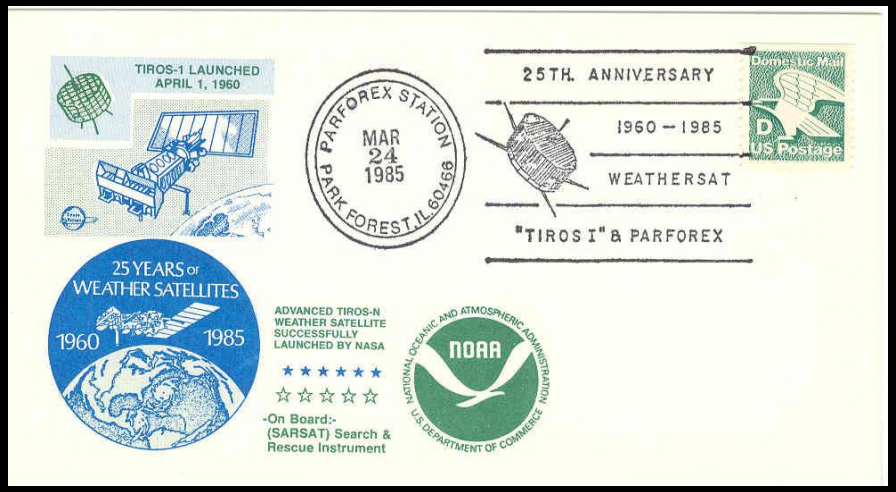

TIROS 1 – first weather satellite
RCA Astro Labs in East Windsor, NJ

ECHO 1 – first communications relay
Bell Labs – Holmdel, NJ

TELSTAR – first television pictures
and telephone calls
Bell Labs – Murray Hill, NJ

Computing

Computer

John von Neumann

UNIX

Dennis Ritchie

Ken Thompson

C Programming Language

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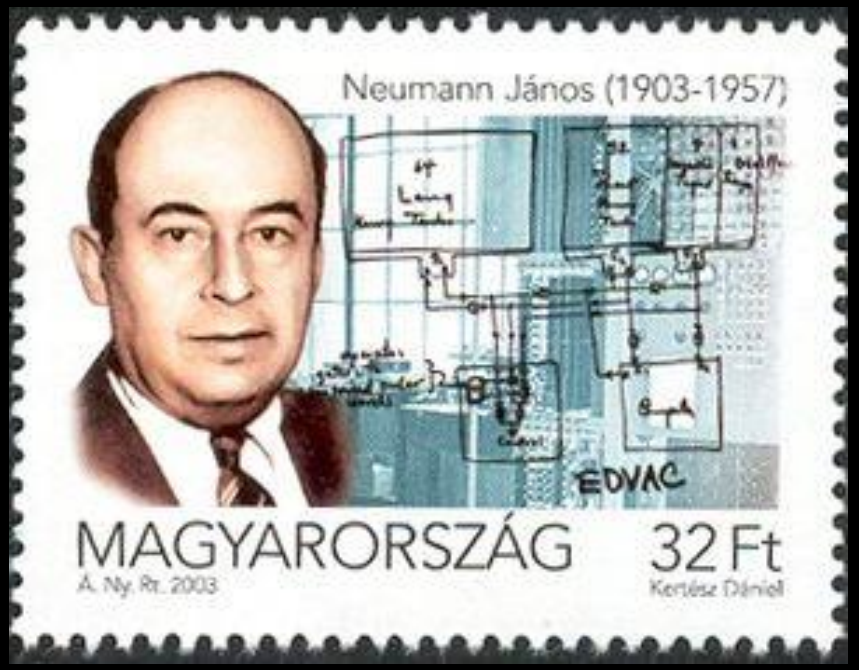
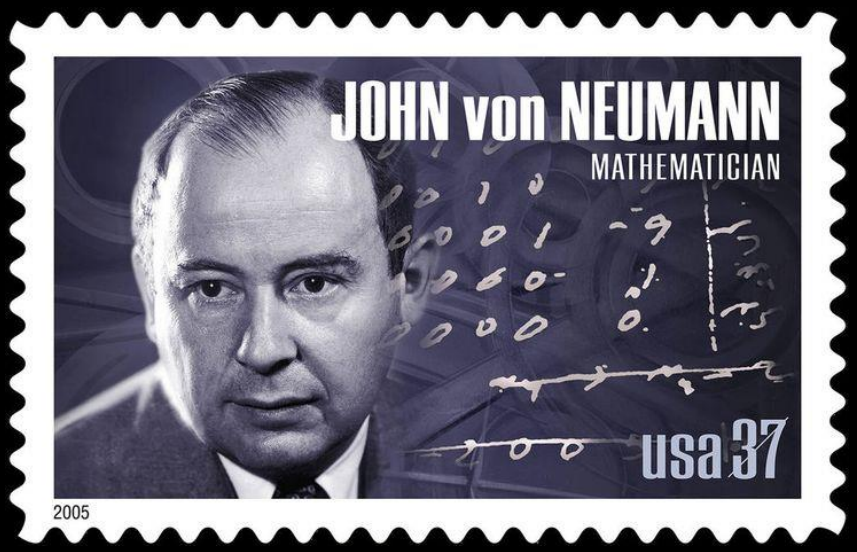
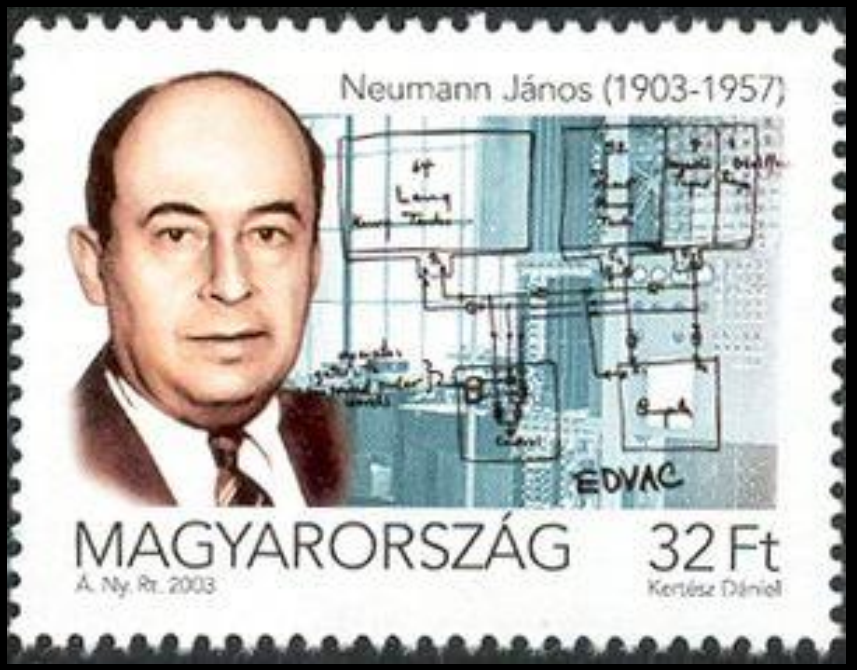
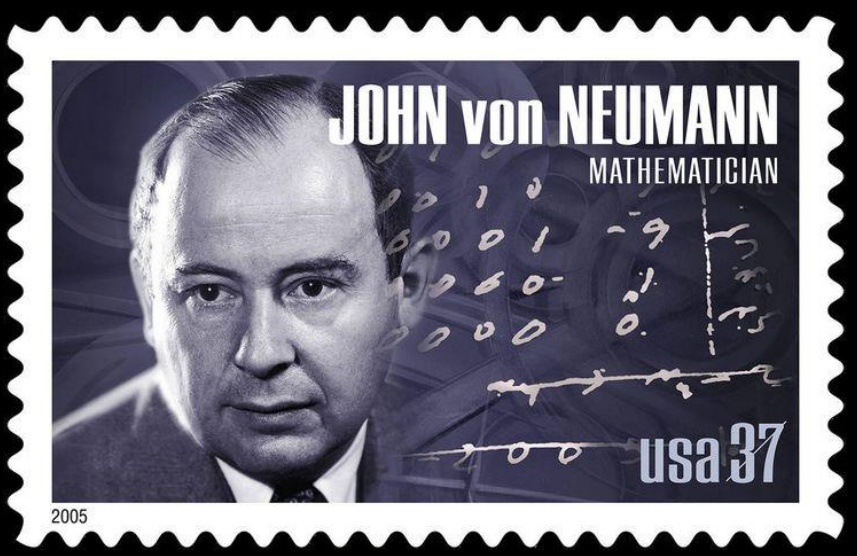




Stamp issued in 1996
50th anniversary of ENIAC





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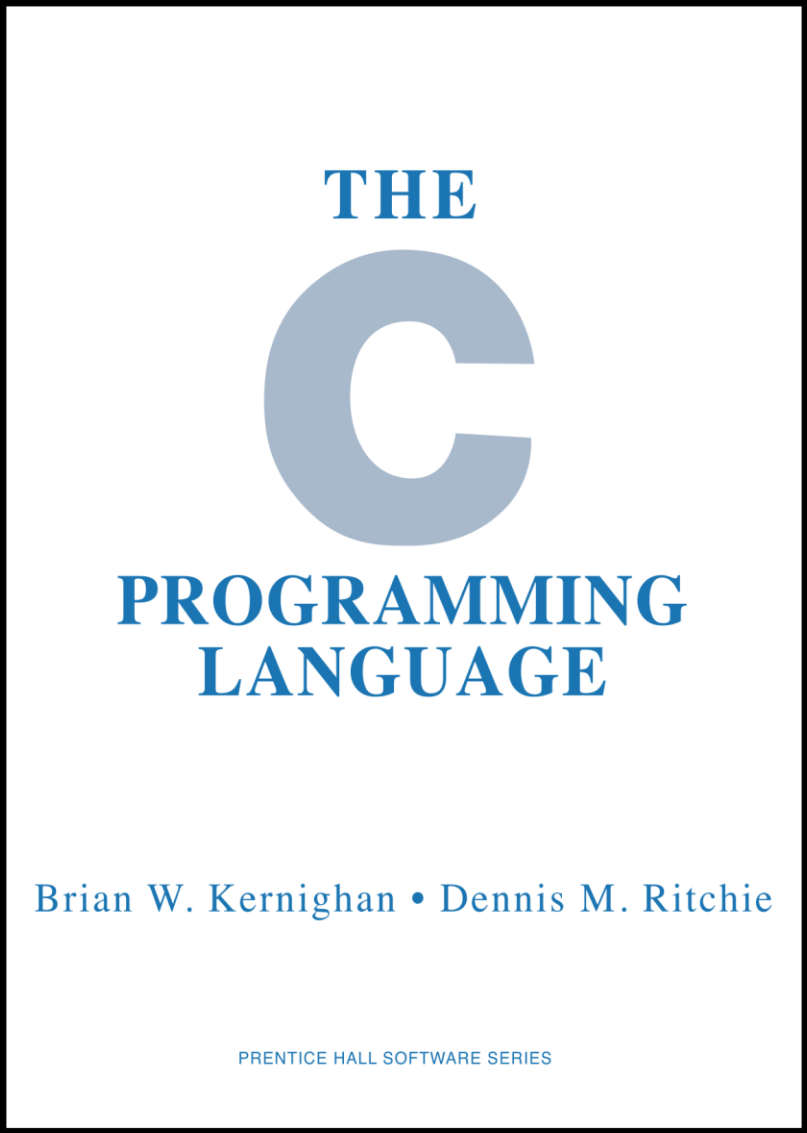
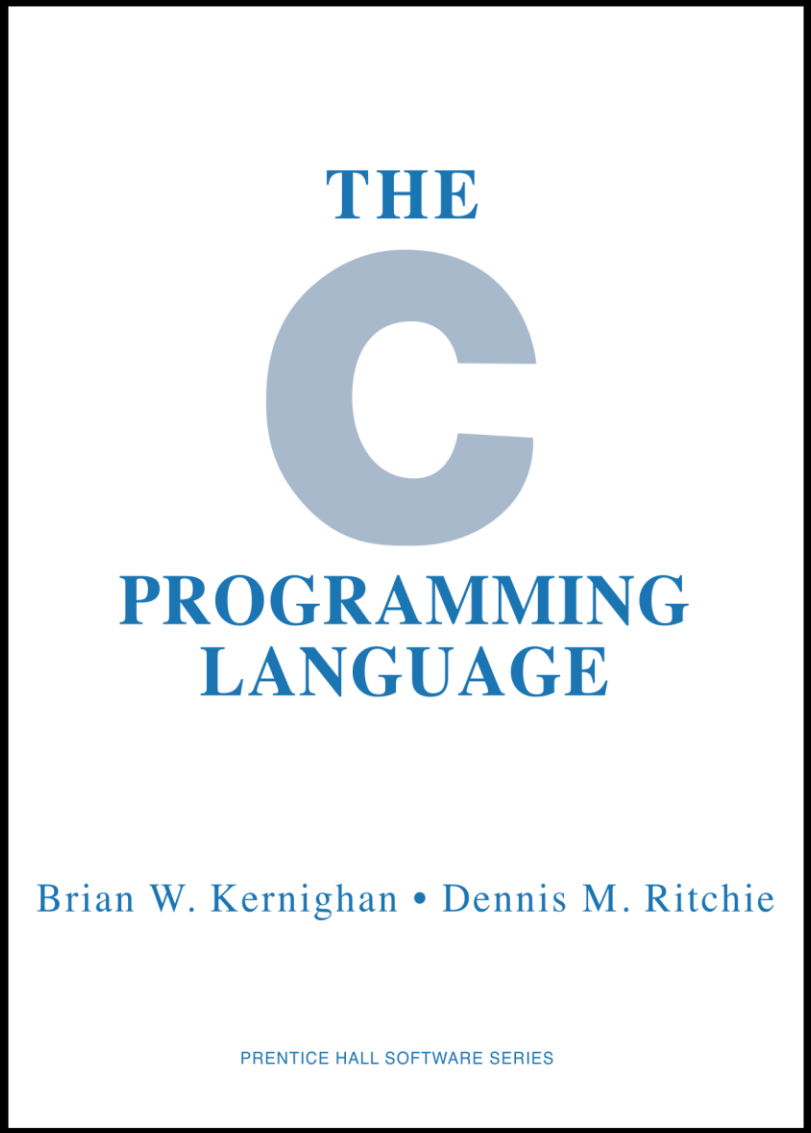


Universities

Computer
Princeton and Penn

Telegraph
NYU

Radio & Laser
Columbia



Universities

Computer

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Telegraph

NYU

Radio & Laser

Columbia

iPhone – How many components and networks relate to NJ ?

Transistor, Computer, Radio, TV, GPS, Telephone, CCD camera, LCD display, & programmed in C using UNIX OS

“Conceived in NJ but Made in China”

PEOPLE		Nobel Prizes
Electromagnet	Henry	
Relativity	Einstein	1921
Computer	Von Neumann	
Laser	Townes, Schawlow	1964, 1981
Electric Lamp	Edison	
Phonograph	Edison, Johnson	
Transistor	Bardeen, Brattain, Shockley	1956
Satellite	Pierce	
CCD	Boyle, Smith	2009
LCD	Heilmeier	
UNIX & C	Ritchie, Thompson	
Radio & TV	Sarnoff, Armstrong, Zworykin	
Electric Power	Edison	
Motion Picture	Edison	
Bakelite	Baekeland	

PLACES

Menlo Park	First Phonograph, First Electric Light
West Orange	Motion Pictures, Edison Phonograph
Princeton	Von Neumann Computer, IAS Computer
Harrison	Lamps, Vacuum Tubes
Kearny	Western Electric (Bell) manufacturing
Camden	Victor Phonograph, RCA B&W TV
West Windsor	Color TV, LCD
East Windsor	Satellite design and construction
Trenton	Wire Rope for Brooklyn and GW Bridges
Murray Hill	Transistor, Laser, CCD, UNIX
Holmdel	Satellite, Radio Astronomy
Morristown	Telegraph demonstration
NYC	Telegraph, Central Station Electricity
Philadelphia	ENIAC Computer
Perth Amboy	Bakelite

A few final observations and two questions ….

NJ technologies have been transformational. They changed the way we live our lives.

NJ (and NYC and Philadelphia) has birthed many radical innovations (Radio, TV, Telephone, Central Electric Power, Transistor, Computer, Laser, Plastics). These engineering works are the core of our modern **INFORMATION AND POWER NETWORKS.**

It's an amazing history of early stage radical innovation

Two Questions – "Why NJ?" and "Why not NJ?"