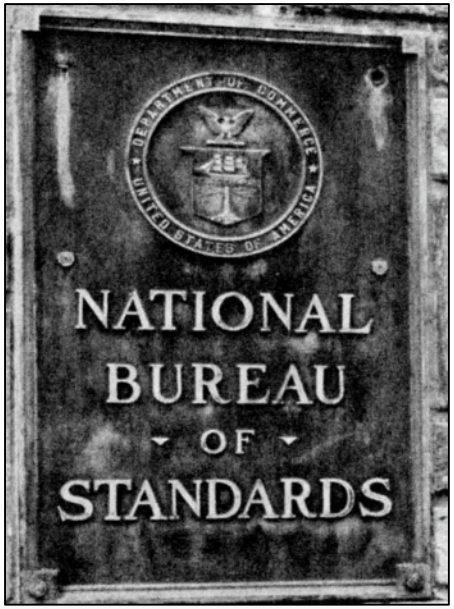
Measurements And Standards For Radio

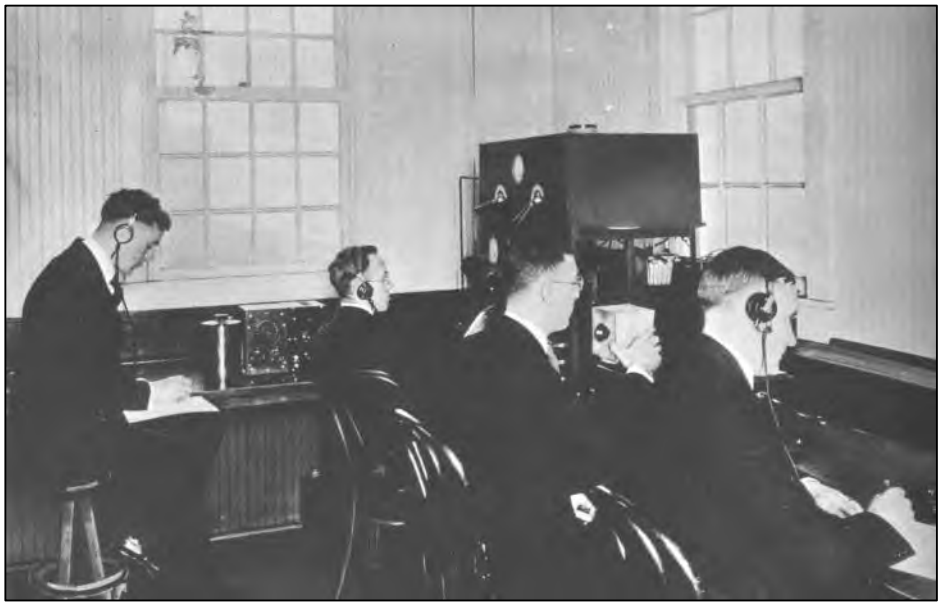


NBS Supports A New Industry

The Bottom Line First:

Radio had a huge impact
on the 20th Century,
and
NBS made
important contributions
to radio science & technology

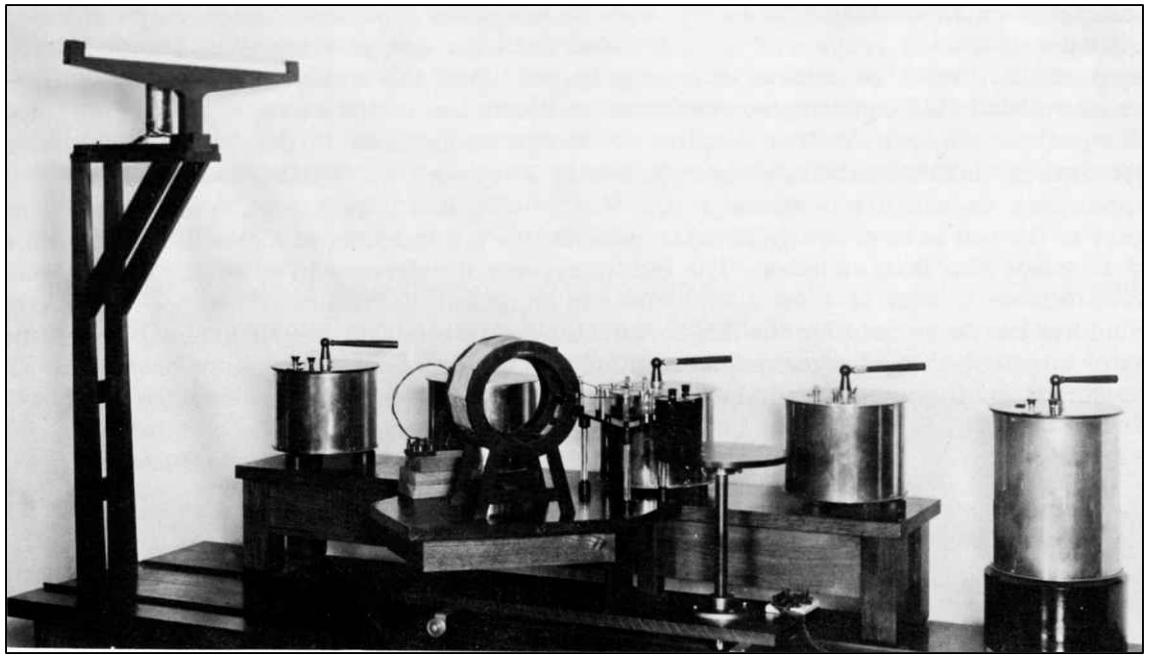
NBS began its radio research almost two decades before entertainment radio broadcasting to American homes became widespread



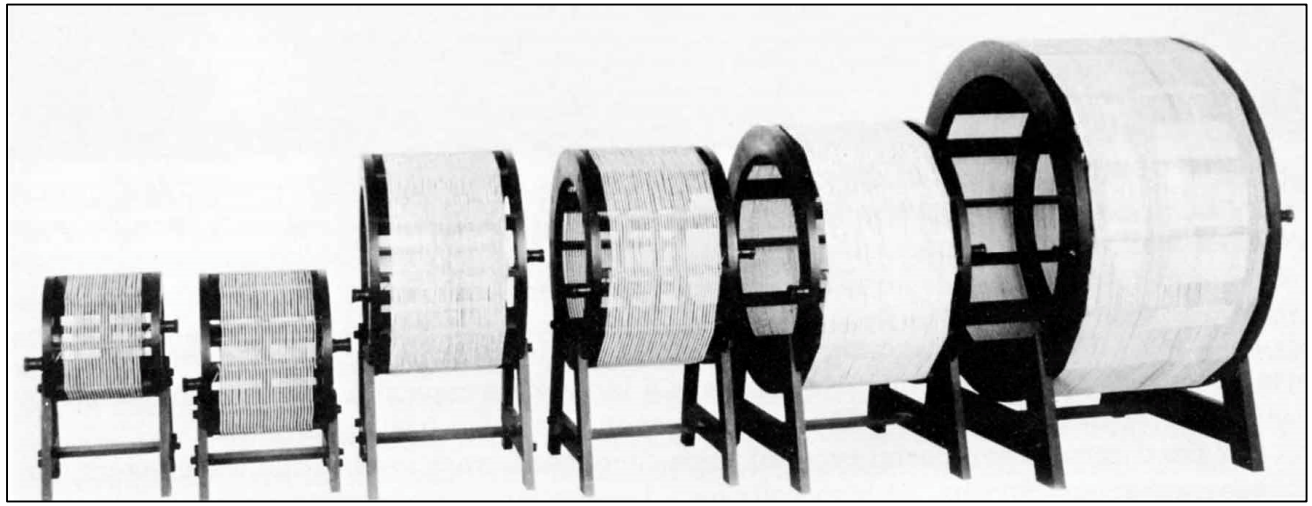
How Did NBS Get Started in Radio?

Essential Electrical Measurements:

- Voltage (AC and DC)
- Current (AC and DC)
- Capacitance
- Resistance
- Inductance
- Wavelength/Frequency
- Properties of conductors and insulators



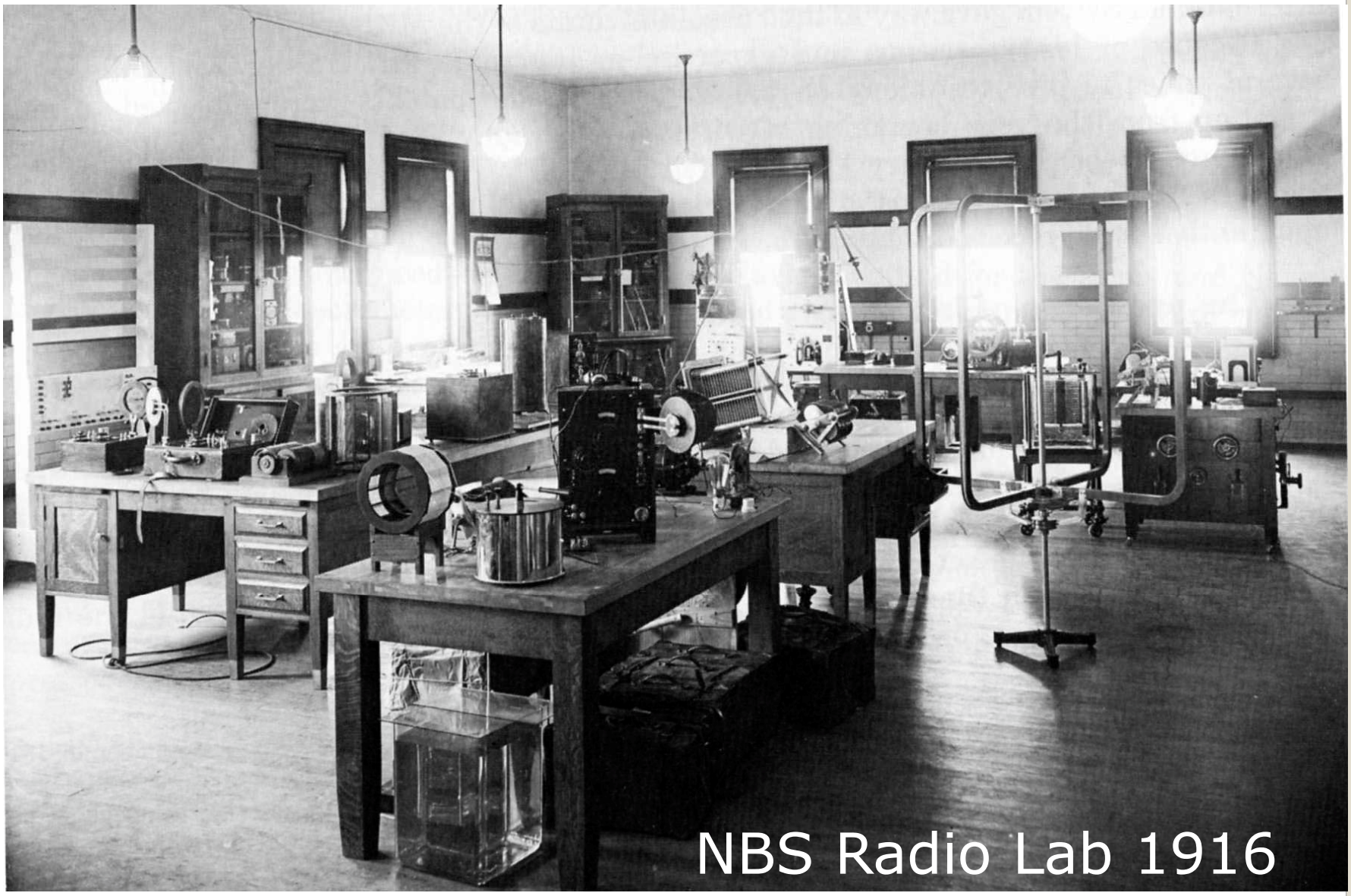
Standard capacitors



Standard inductors

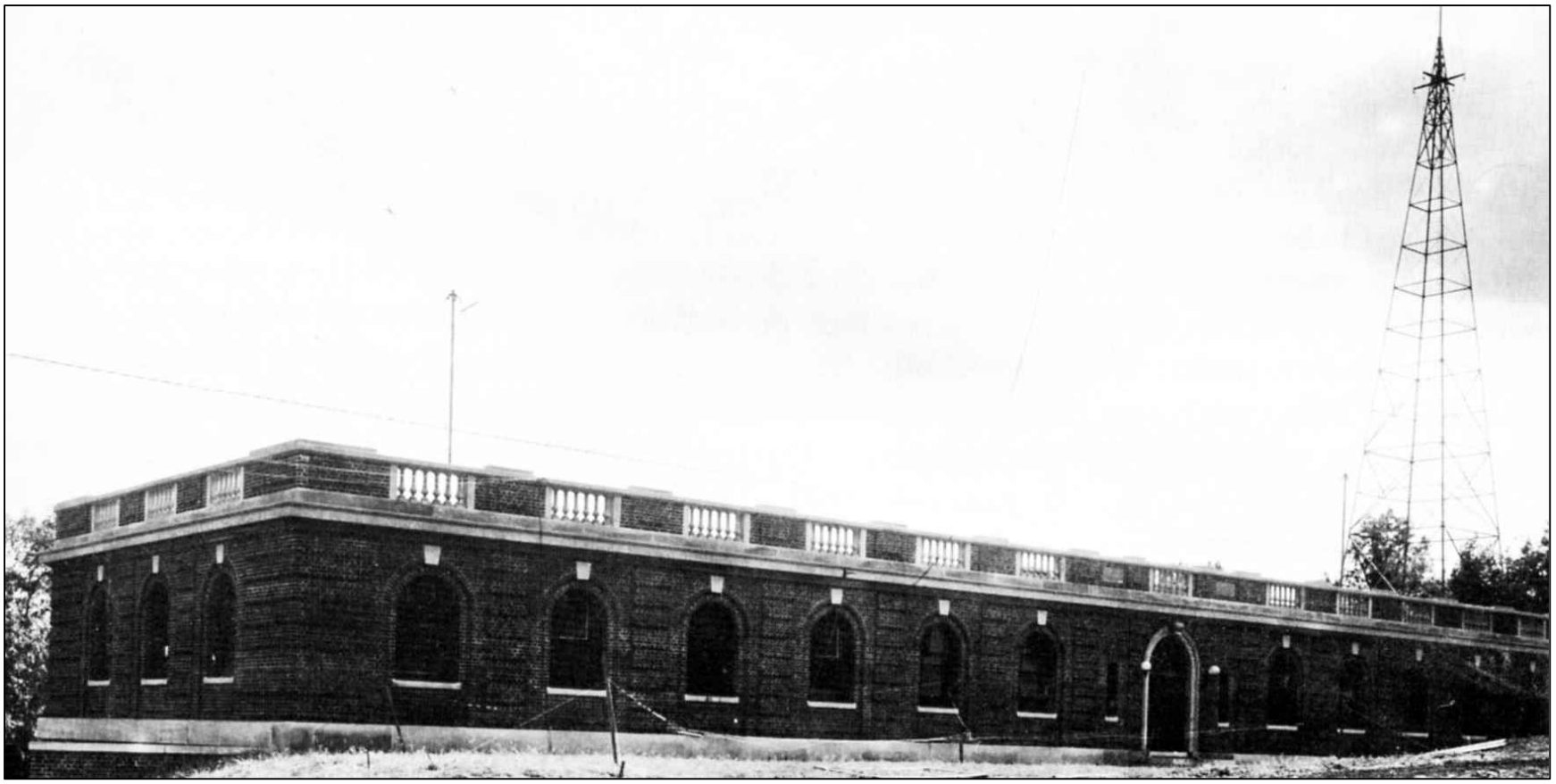
NBS Gears Up To Support The Radio Industry

- 1904 - First radio researcher – Louis Austin – arrives at NBS
- 1905 - NBS' first publication on wireless
- 1911 - First regular radio-related calibration service (wavemeters)
- 1913 – Radio Section formed


NBS Radio Lab 1916

NBS' Radio Work in WW I

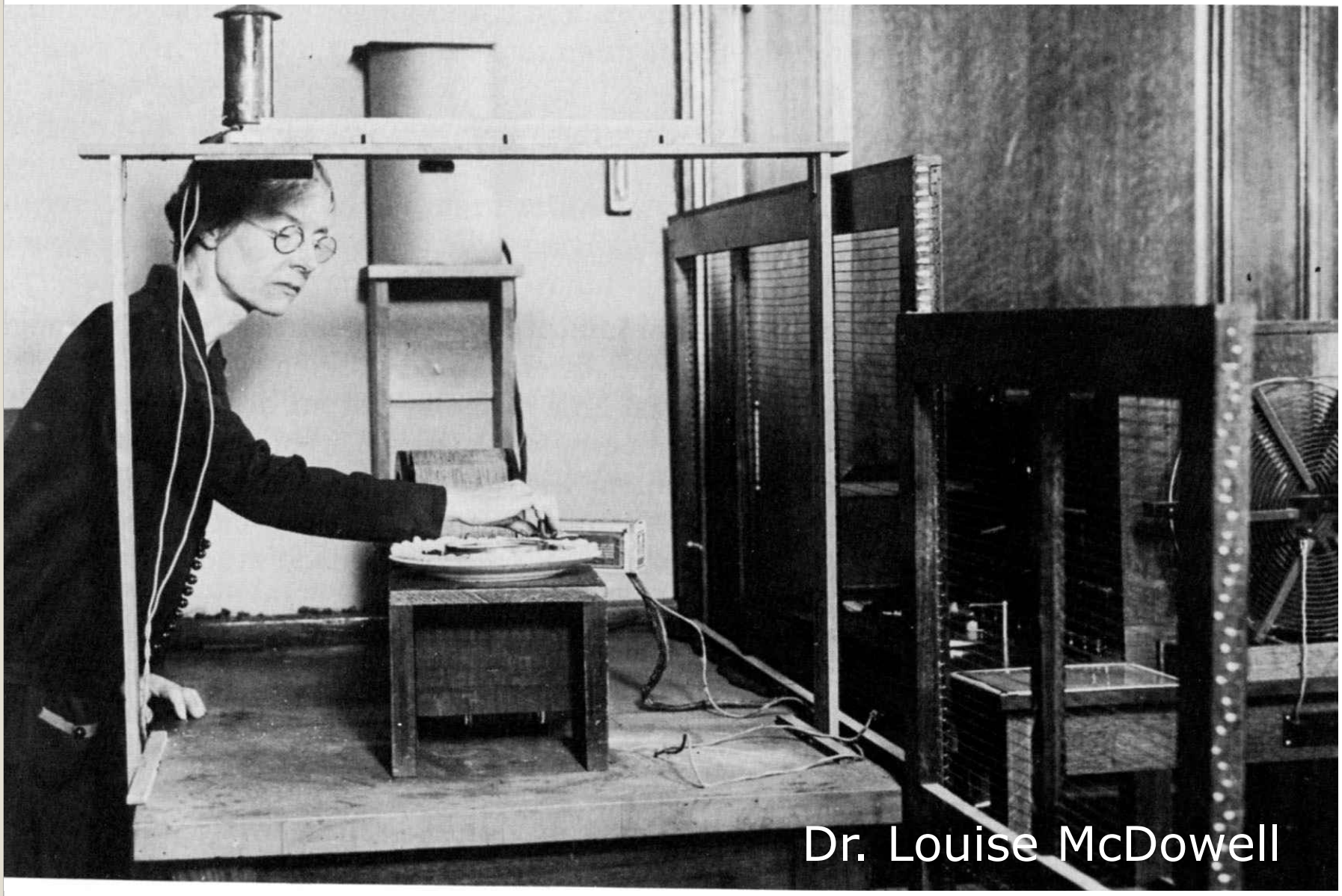
- NBS' Radio Section was dedicated to the War effort
- 7 employees at the beginning of the war, 40 by the end)
- Radio was sufficiently important that it got its own separate building in 1918



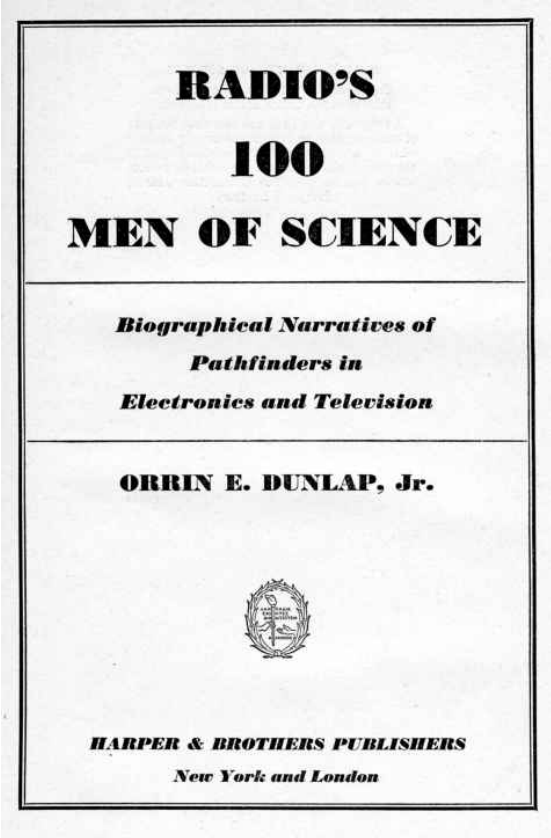
NBS Radio Building - 1918

NBS' Radio Section in WW I

- The Army Signal Corps and the Navy both maintained radio laboratories at NBS
- 40 Classified papers, 7 open publication papers
- Research emphasis included:
  - Vacuum tube theory and characterization
  - Submarine antennas
  - Direction finding
  - Dielectric and other materials


Dr. Louise McDowell

Recognition for NBS Radio Scientists and Engineers


RADIO'S
100
MEN OF SCIENCE

Biographical Narratives of Pathfinders in Electronics and Television

ORRIN E. DUNLAP, Jr.

HARPER & BROTHERS PUBLISHERS
New York and London

<u>This 1944 book honors four NBS people:</u>

- Louis Austin
- John Dellinger
- Frederick Kolster
- George Southworth

Louis Austin

- Came to NBS in 1904 as a guest worker
- Worked on early detectors
- 1908-1923 Headed US Naval Wireless Telegraphic Lab at NBS
- 1923: Lab for Special Radio Transmission Research
- IRE President and Medal of Honor winner
- Developed Austin-Cohen equation

$$\epsilon = 377\frac{hI}{\lambda d}\sqrt{\frac{\theta}{\sin\theta}}e^{\frac{-0.0014d}{\lambda^{0.6}}} \times 10^3$$

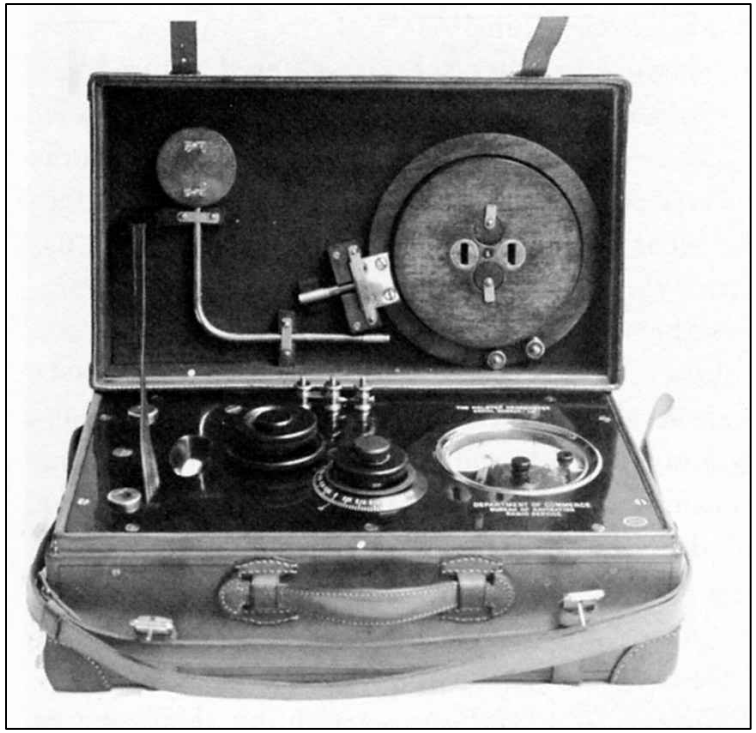
John Dellinger

- Came to NBS in 1907
- 1919 Chief of Radio Section
- Worked on instruments, ionospheric propagation (Dellinger Effect), radio beacons, aircraft landing systems
- IRE President and Medal of Honor
- Officer of International Scientific Radio Union
- Write numerous papers and books, e.g., *Circular 60: Electrical Units and Standards* (1920)
- Retired in 1948, CRPL Chief

Frederic Kolster

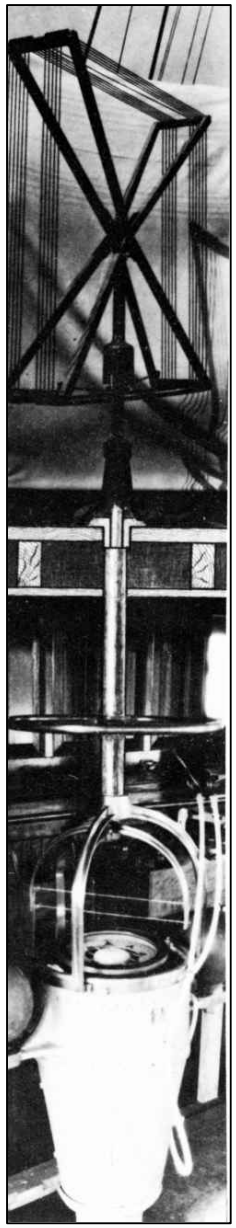
- 1913-1921 Chief of Radio Section
- Invented the Kolster decremeter
- Developed the Kolster radio compass and radio beacons for navigation
- Consultant to US Navy on direction finding technology

Kolster's Work



Decremeter/wavemeter

Direction Finding Antenna



Kolster Model 6D, 1926 ($85)

George C. Southworth

- 1917-18 at NBS
- Went to Bell Labs and became famous for his work on waveguide theory

Another NBSer With A Successful Career In Industry

- Asst. Chief, NBS' Radio Section, 1922 to 1930
- Chief Engineer, Federal Radio Commission 1930-35
- RCA Board of Directors, Chief Scientist and VP, until retired in 1964

Charles B. Jolliffe

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

RADIO INSTRUMENTS AND MEASUREMENTS

CIRCULAR C74

1924

The Principles Underlying Radio Communication

(SECOND EDITION)

▽

Radio Communication Pamphlet No. 40

Prepared by the Bureau of Standards

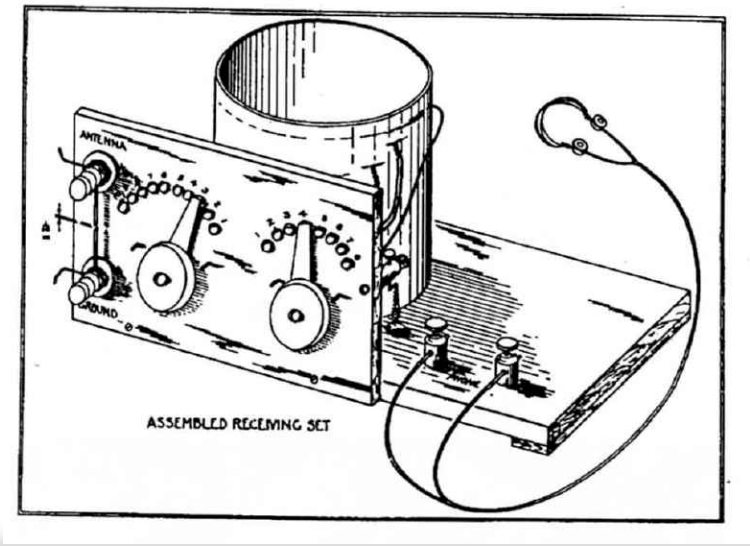
Revised to May 24, 1921

Signal Corps, U. S. Army

Washington : Government Printing Office : 1922

"Construction and Operation of a Simple Homemade Radio Receiving Outfit" (1922 Circular # 120)

- Published in response to public demand for information
- Sold for 5 cents, reprinted in newspapers and magazines
- Many other radio LCs published

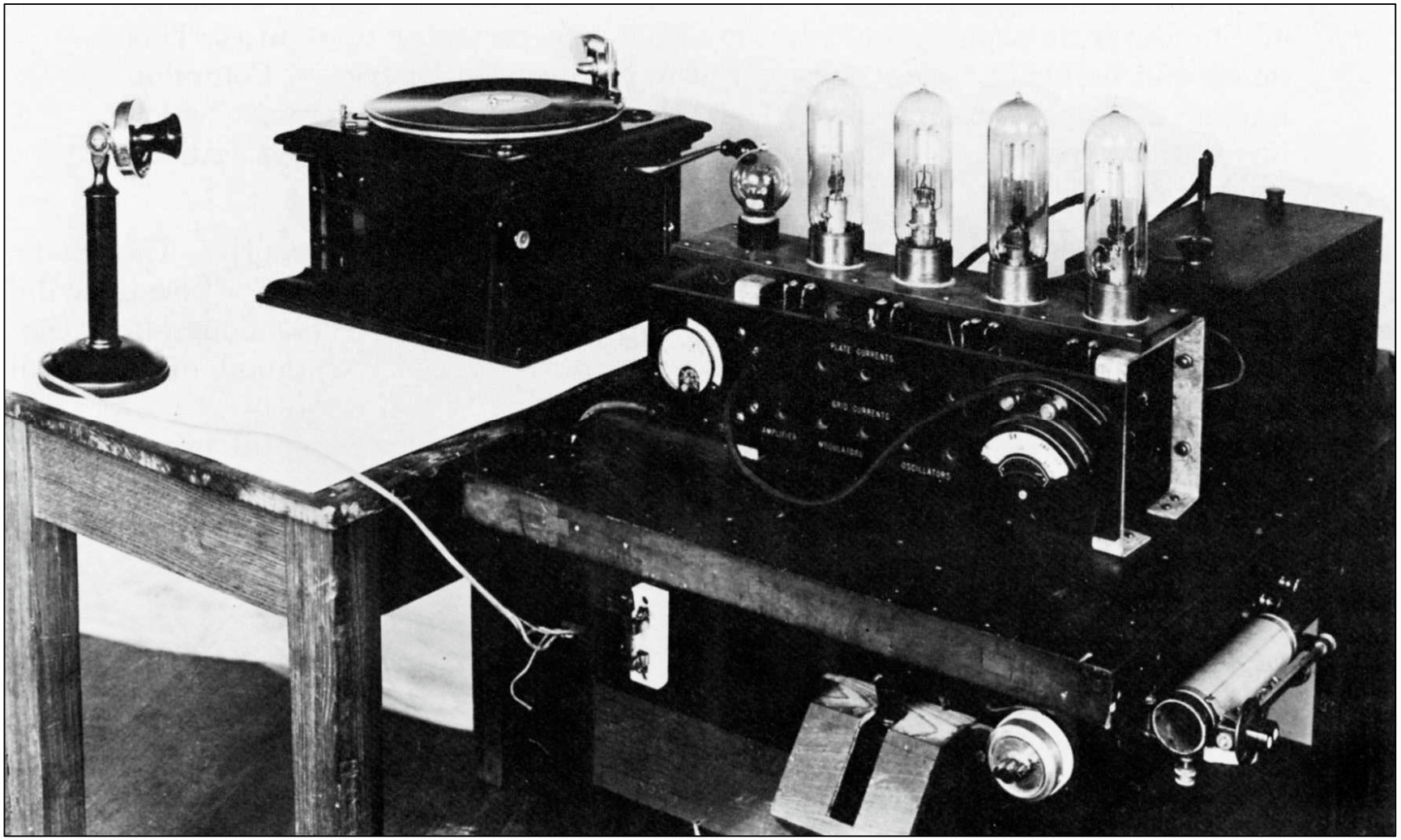


NBS' Radio Stations (WWV, WWVH, WWVL)

Check out John Lowe's colloquium:

nist.gov/news-events/video-gallery/search?combine=WWV

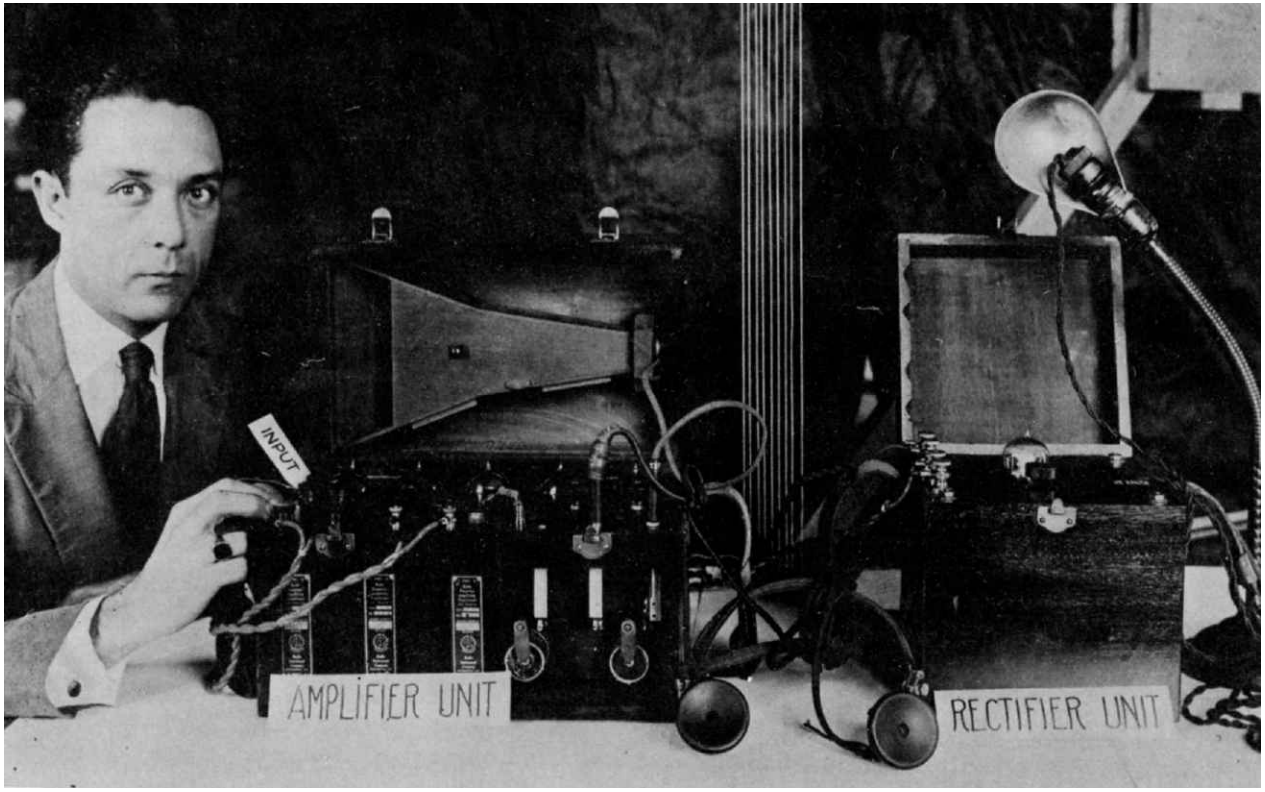
- WWV recently celebrated 100 years of service
- 1919-23: broadcasting music & market reports
- 1923 Broadcasting standard frequencies
- Expanded frequencies used as time went on



Early WWV transmitter

The First AC-Operated Radio An NBS Innovation

~1921 Percival Lowell and Francis Dunmore created the first AC-operated radio



P. D. Lowell with his AC-operated receiver

First AC Operated Radio

Exclusive rights to Lowell-Dunmore patent purchased by Dubilier Condenser and Radio Corp.

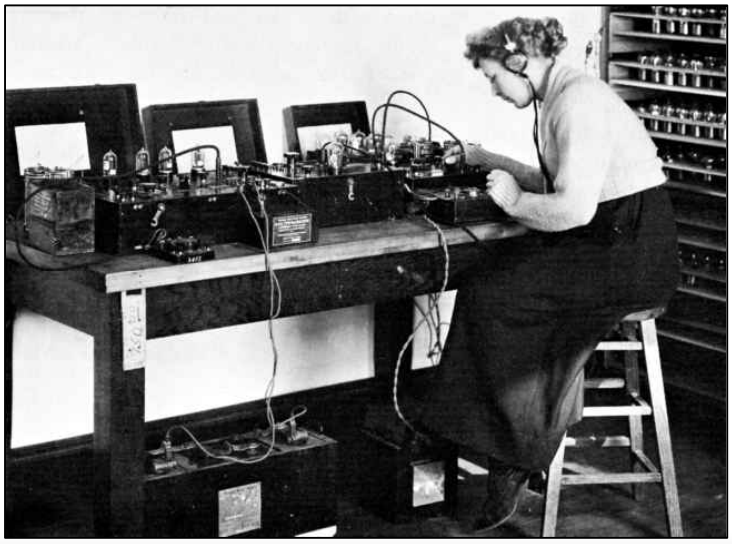
Others (RCA etc.) paid royalties to Dubilier

The Dynergy receiver (1924) - the first commercially marketed AC receiver

Vacuum Tube Research

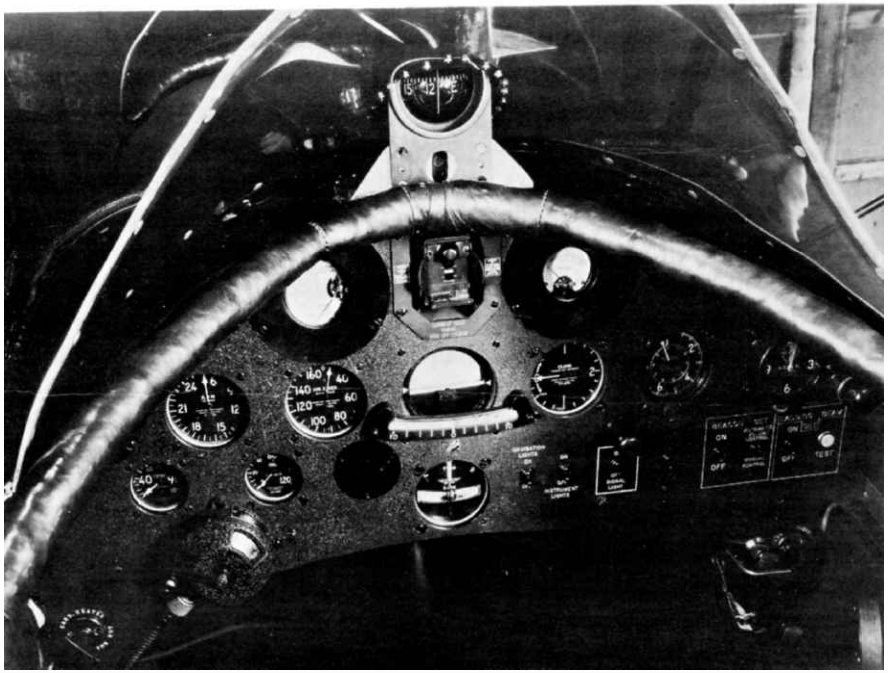
- 1919 - Dr. John Miller: "Miller Effect" explained (inter-electrode capacitance in triode vacuum tubes causes oscillation)

- Vacuum tube test methods developed for the Army and Navy



NBS built an oscilloscope in 1918

Curtiss Fledgling



First Blind Landing System

- Tests at College Park Airport
- Harry Diamond, Frances Dunmore, and John Dellinger contributed
- Adopted by the CAA in the 1930s

World War II Radio Work

- Direction finding
- Guided missiles
- Interservice Radio Propagation Laboratory (IRPL)
- Quartz crystals for frequency control
- Proximity Fuse

Harry Diamond

- 1927 Hired by NBS
- Became Chief of Electronics Section
- Worked on radio beacons & aircraft landing systems
- 1940 – Led Ordnance Development Division at NBS, proximity fuses for WW II
- 1953 transferred to Army & became Diamond Ordnance Fuse Laboratories.
- Now part of Army Research Laboratory

Take-Aways:

- Since 1904, NBS and now NIST has been recognized and respected as a center of radio science and technology excellence
- NIST's important work today supporting the communications and semiconductor industries traces back to the pioneering work described in this talk
- Today there is work on things like antenna characterization, IC measurements, standards for 5G networks, optical fiber characterization, atomic clocks for GPS, and even quantum computing