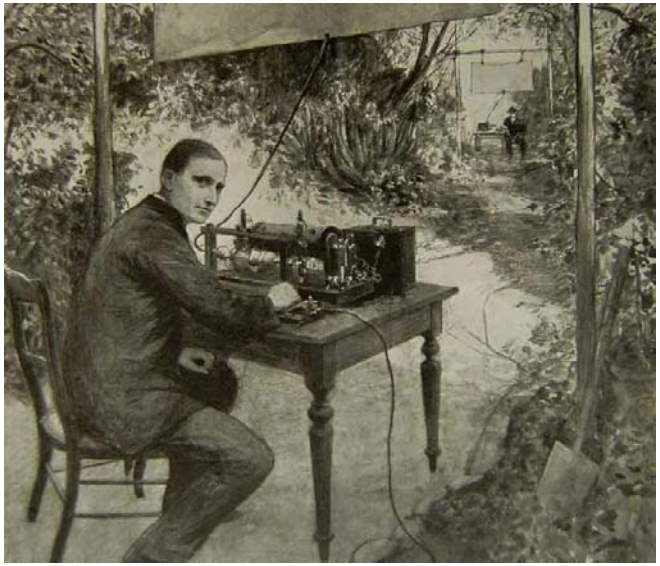
Radio in the Teens

Al Klase
NJARC
14 April 2017

Coming In

- King Spark
- CW
- Crystal Detectors
- Audion



Marconi

Library of Congress

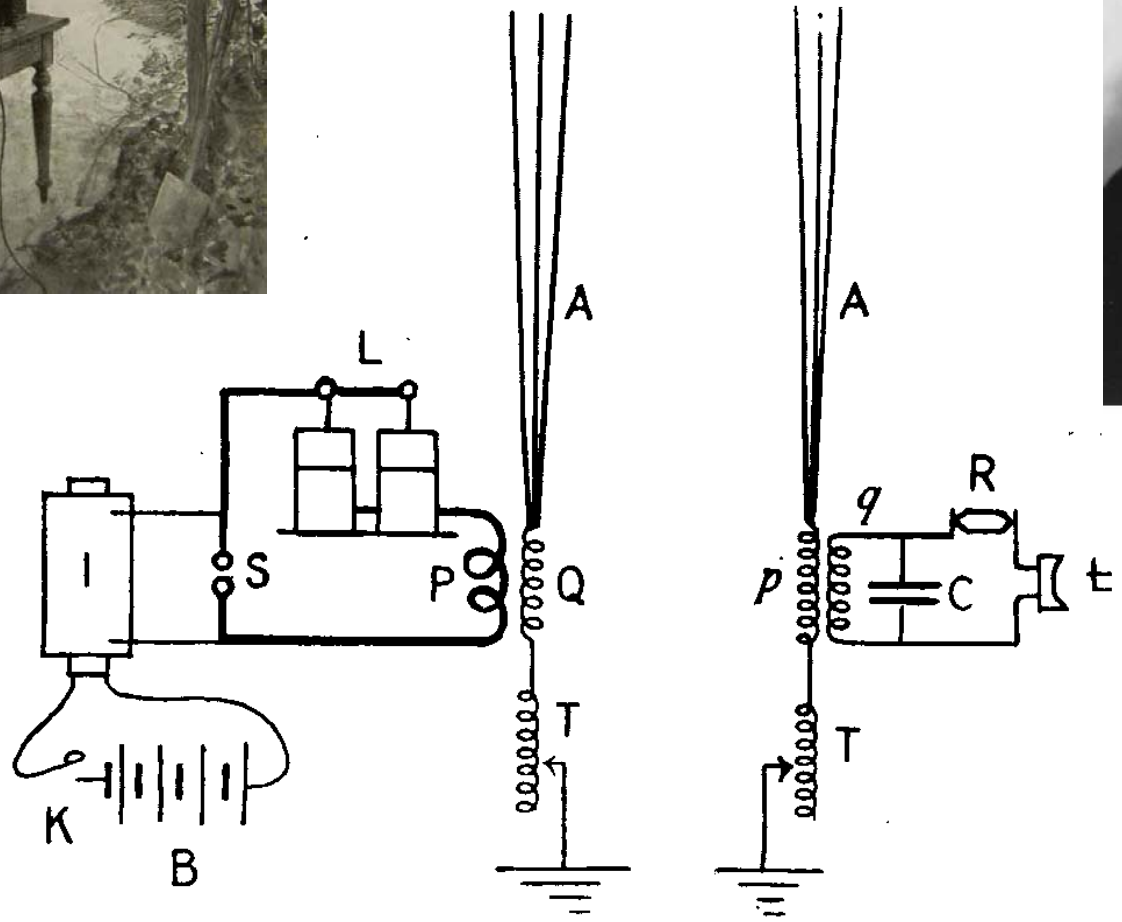


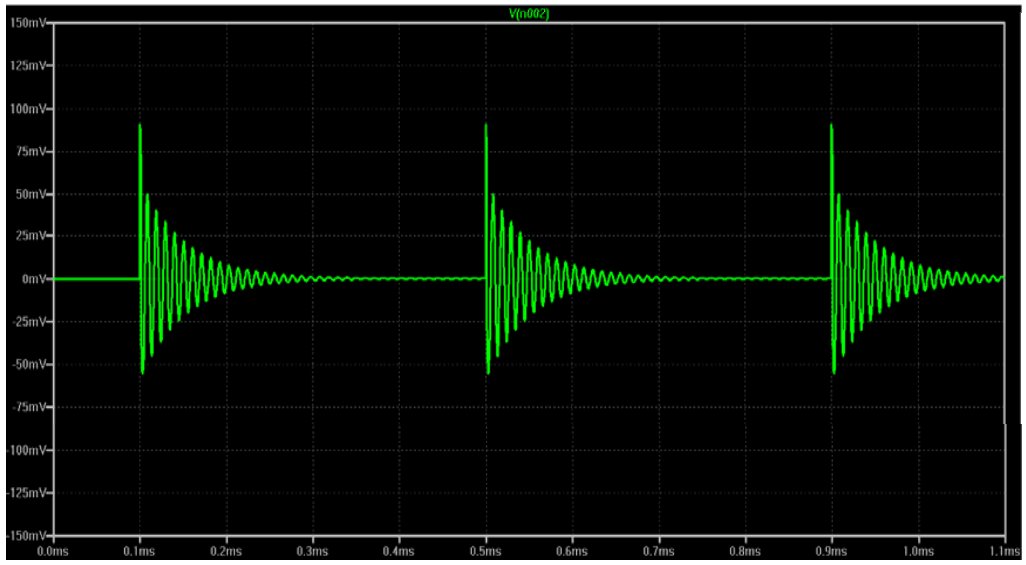
FIG. 45.—Marconi syntonic transmitter and receiver.

British Patent 7777 – 26 APRIL 1900

The Problem With Spark

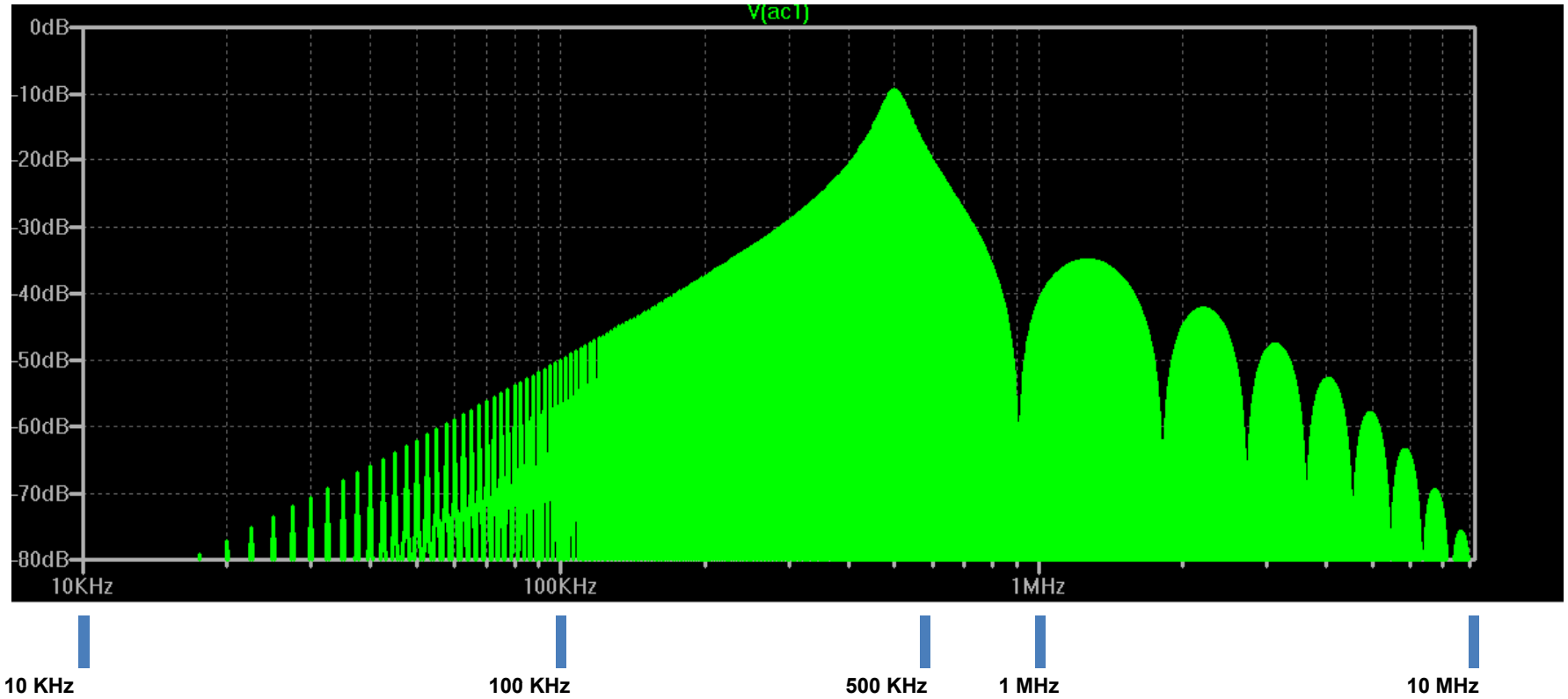
Damped Waves:

- Produced by spark-gap transmitters.
- Each spark discharge causes the RF tuned circuit to ring like a bell or plucked string.
- Each pulse dies away.
- The carrier wave is inherently amplitude-modulated at the spark frequency.
- At the receiver, detection in easily accomplished with a simple rectifier.



Time Domain ->

The Problem With Spark



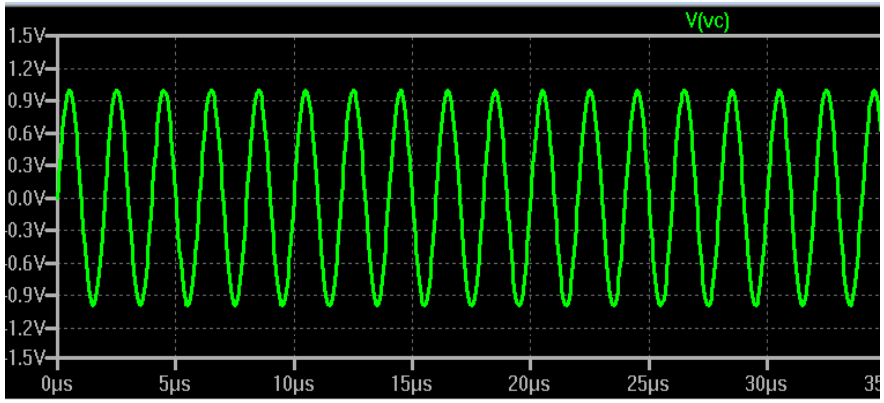
Frequency Domain ->

Very wide bandwidth

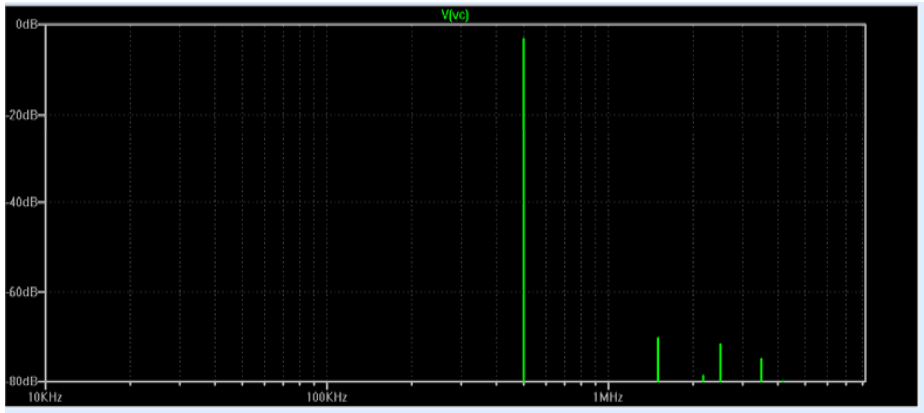
Fessenden's Fix

Continuous Waves:

- Greater efficiency due to narrow bandwidth.
- Produced by:
  - High-Frequency rotating machinery, e.g.the Alexanderson Alternator
  - Poulsen Arc Converter
  - Vacuum-Tube or Solid-State Oscillators

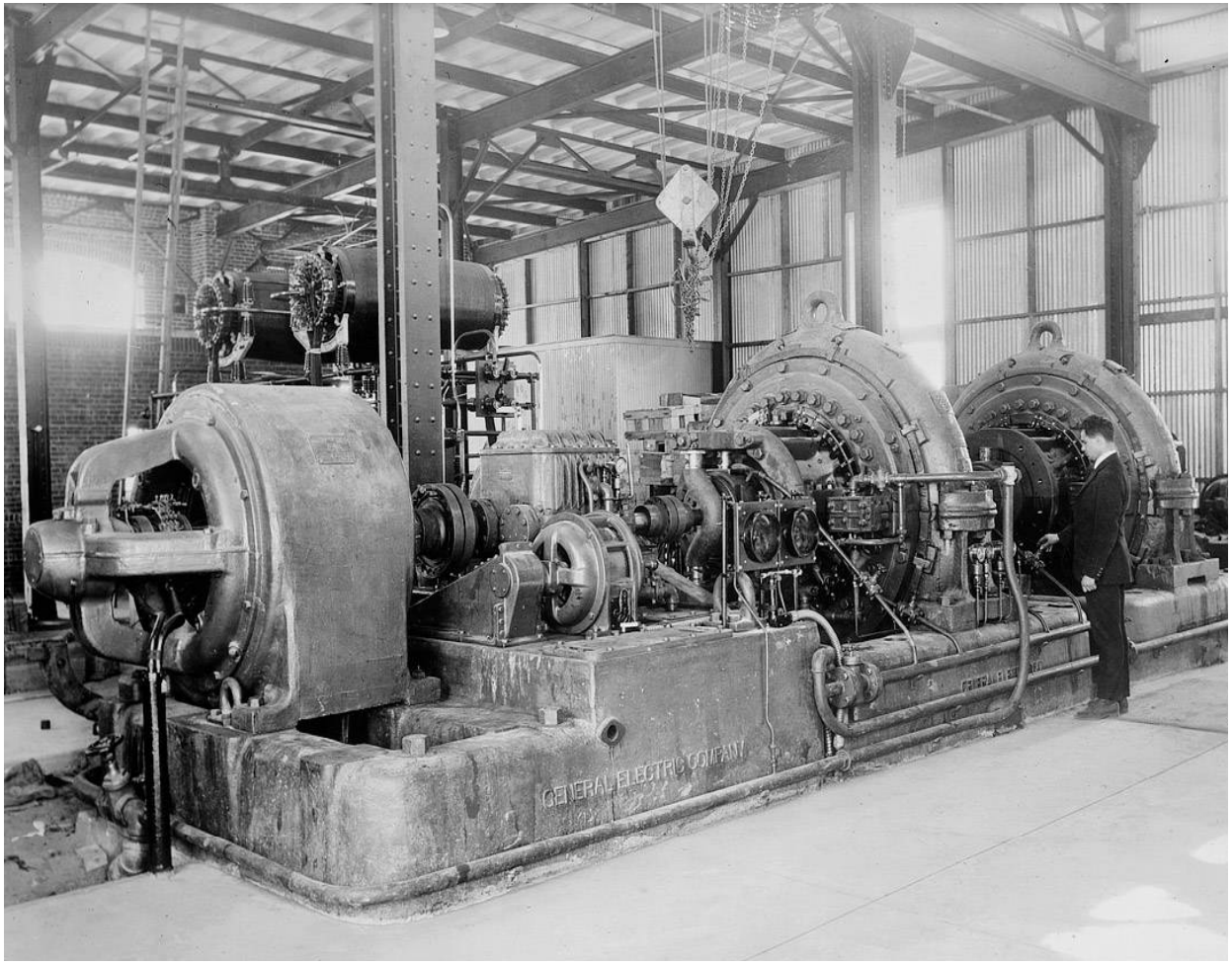


Time Domain ->



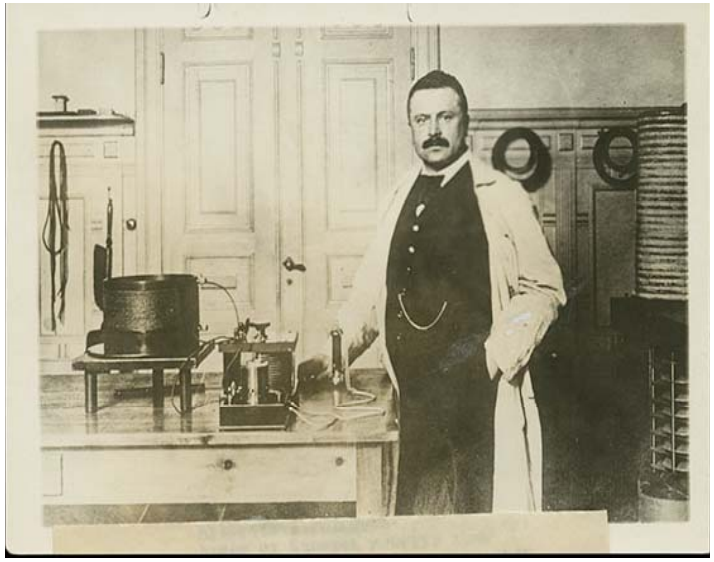
Frequency Domain ->

Alexanderson Alternator Continuous-Wave Transmitter

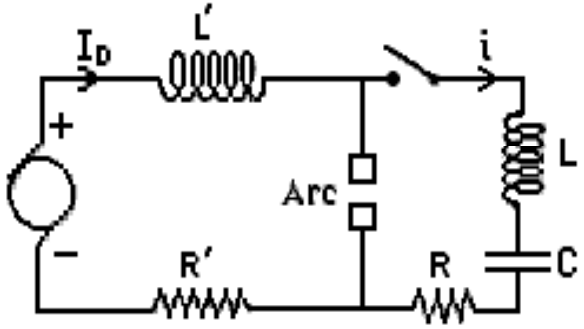


AC Motor (left) turns high-frequency alternator (center) producing 200 KW in the frequency range of 15 – 30 KHz.

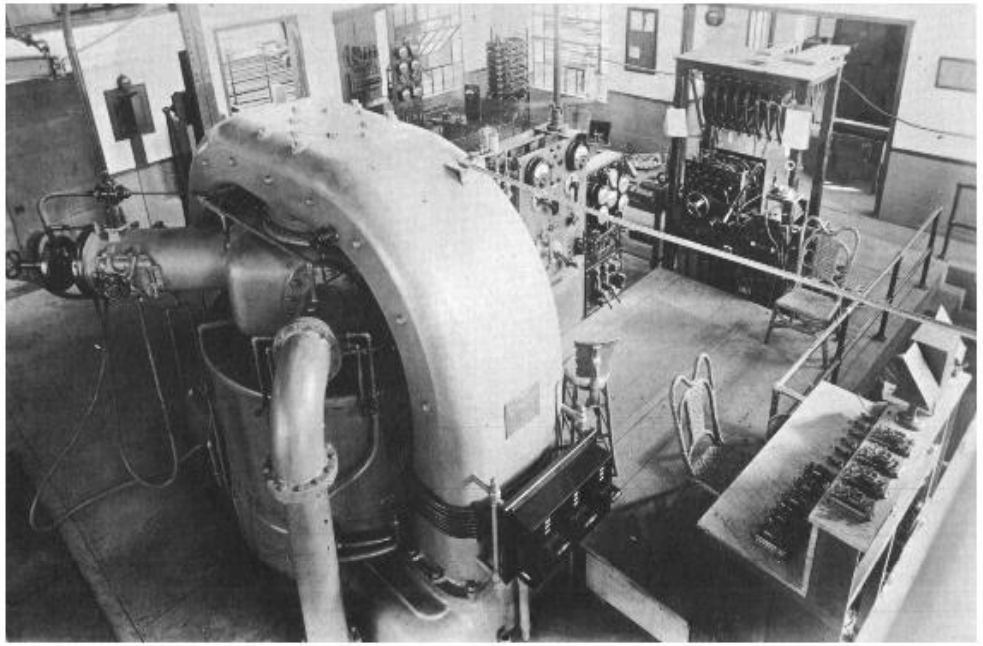
Poulsen Arc Continuous-Wave Transmitter



Vladimir Poulsen with small arc converter.

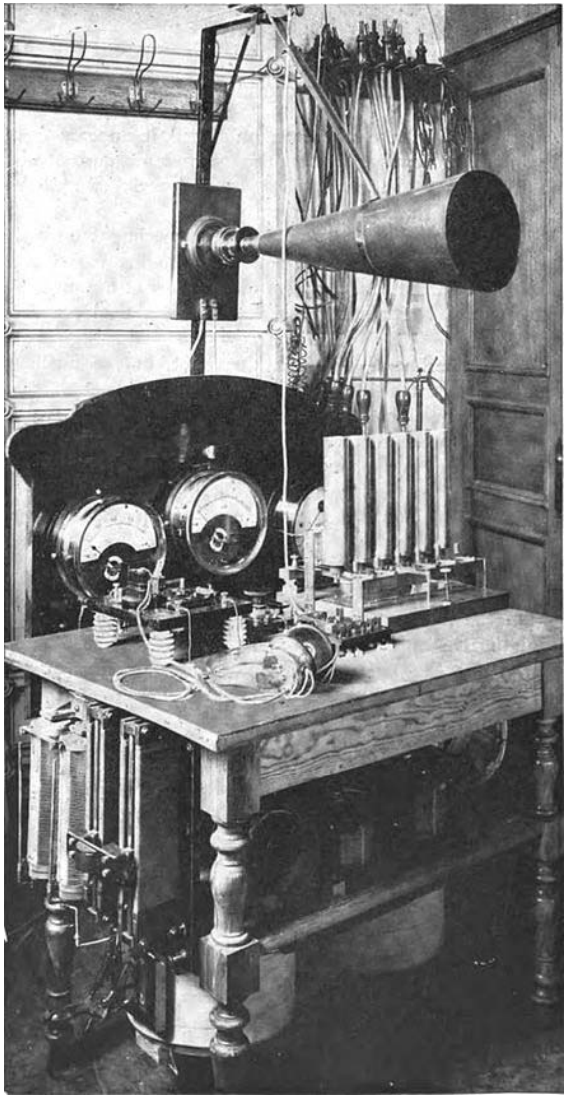


The DC arc has negative resistance causing the LC circuit to oscillate.



**350 KW Federal Telegraph Co.
Arc Transmitter - 1919**

CW Opens the Door to RT



- Telefunken arc transmitter from 1906.
- The carrier wave is generated by 6 electric arcs in the vertical tubes, connected to a tuned circuit.
- Modulation is done by the large carbon microphone *(cone shape)* in the antenna lead

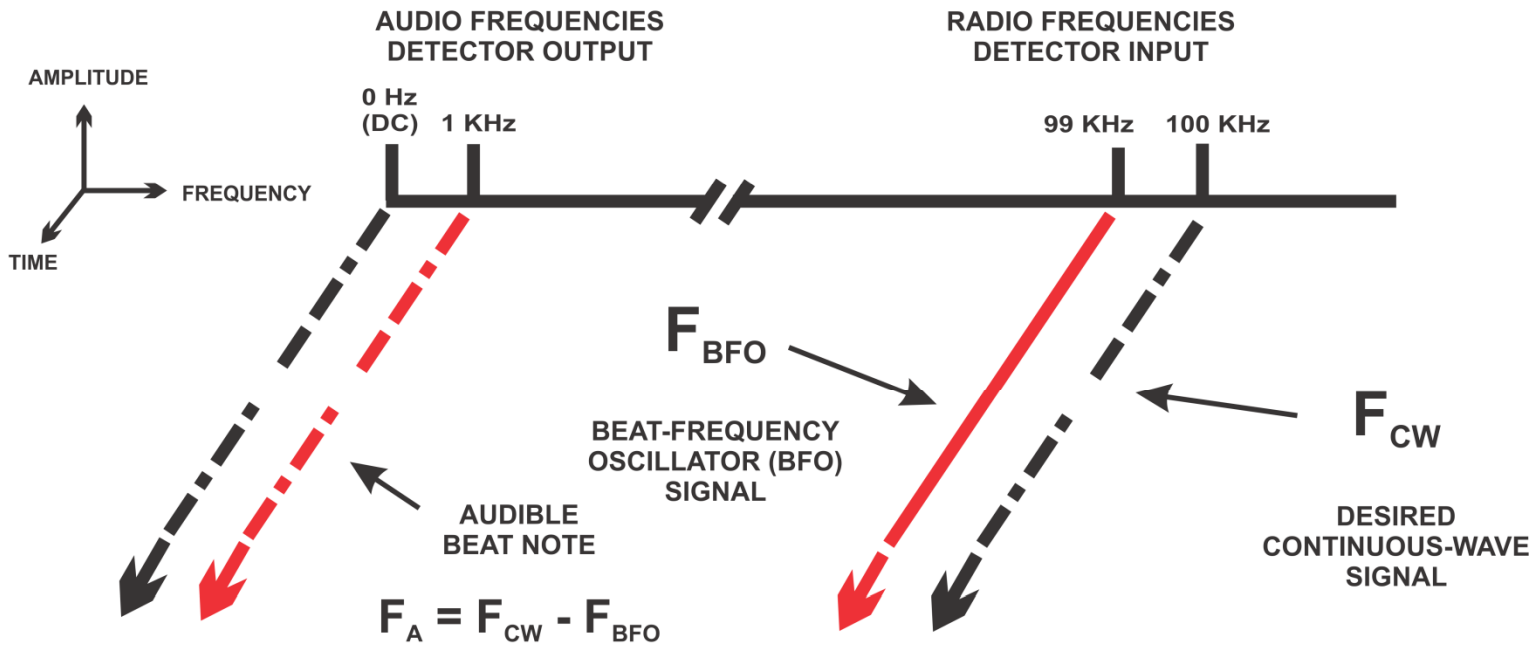
“An Act to Regulate Radio Communication”
13 AUGUST 1912

- All stations to be licensed.
- Ships to maintain 24-hour radio watch.
- 600-200 Meters (500-1500 KHz)
- Or more than 1600 Meters (Less the 187.5 KHz)
- Amateurs: “200 Meters and Down” (above 1500KHz)
- The Navy retained the prime real-estate between 600 and 1600 Meters

Receiving Continuous Waves

HETERODYNE DETECTION

The Old Frequency-Changer Trick!



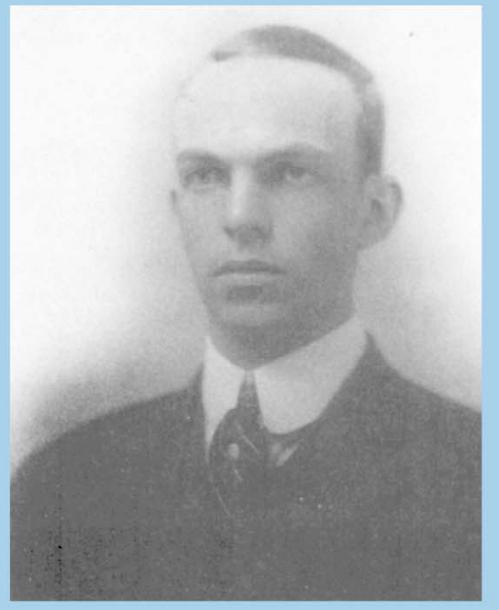
This is easy with an Armstrong regenerative detector in the "autodyne" (oscillating) mode.

REGENERATION

Edwin H. Armstrong - 22 September 1912

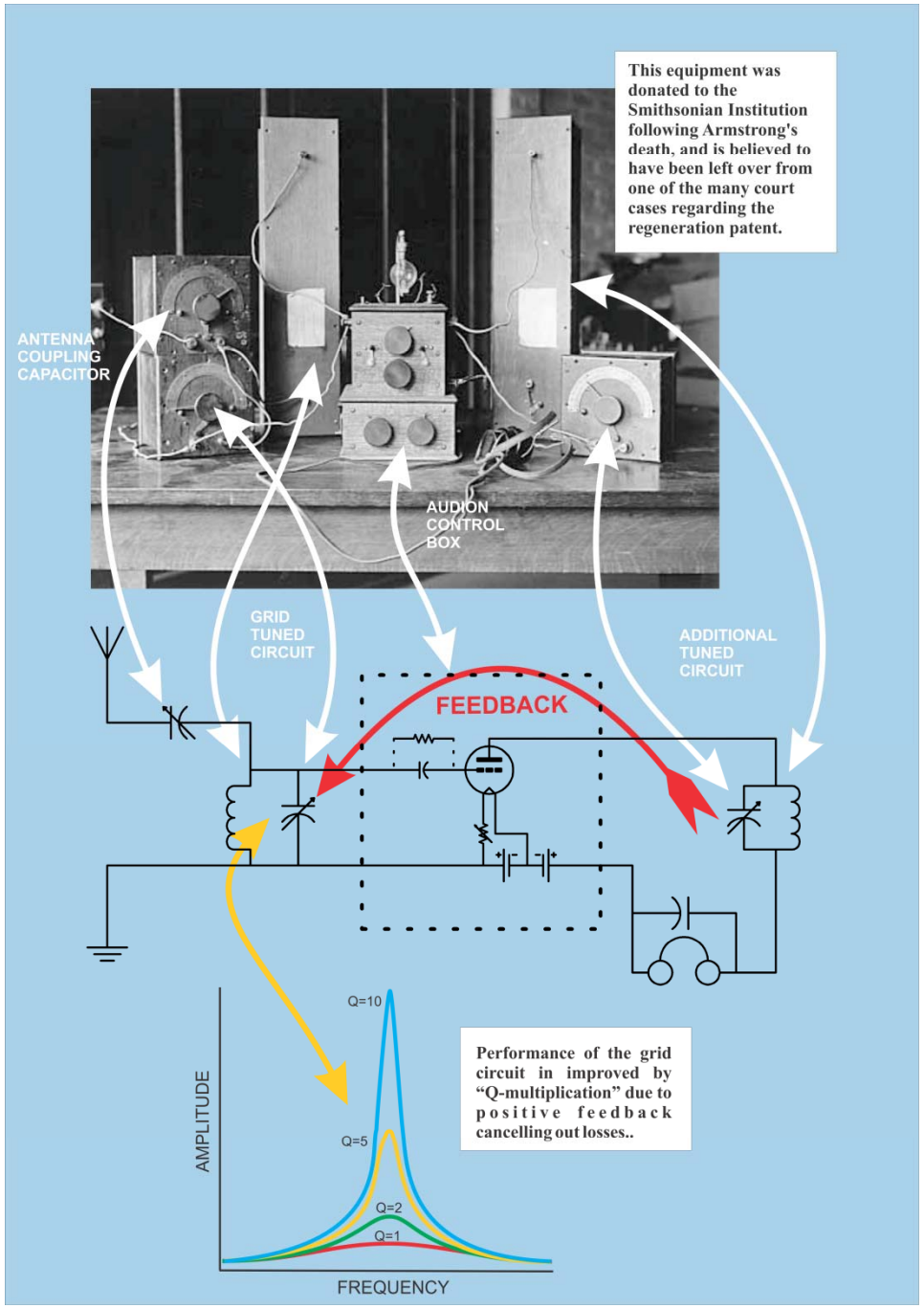
"Great amplification obtained at once!"

- **Sensitivity increased 100-fold.**
- **Improved selectivity**
- **Receive continuous-wave signals**
  CW more efficient than spark
- **First vacuum-tube RF oscillator**
  The enabling technology for both CW radio-telegraphy and radio-telephony.



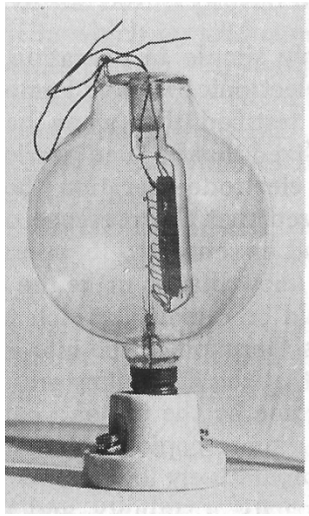
Armstrong while at Columbia

Armstrong Family Archive

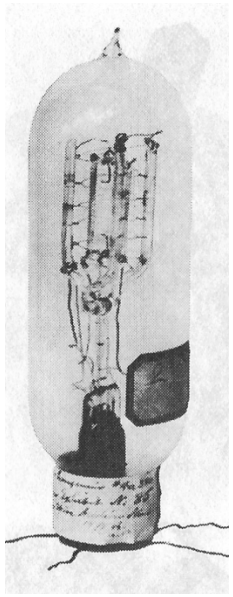

This equipment was donated to the Smithsonian Institution following Armstrong's death, and is believed to have been left over from one of the many court cases regarding the regeneration patent.
ANTENNA COUPLING CAPACITOR
AUDION CONTROL BOX
GRID TUNED CIRCUIT
ADDITIONAL TUNED CIRCUIT
FEEDBACK
Q=10
Q=5
Q=2
Q=1
AMPLITUDE
FREQUENCY
Performance of the grid circuit in improved by "Q-multiplication" due to positive feedback cancelling out losses..

Vacuum-Tube Development

- AT&T Long-Distance – Harold Arnold
  - 20 Oct 1912: de Forest demo to AT&T
  - Late 1912: start work on high vacuum
  - 1913 oxide-coated filament
  - 18 Oct 1913 - New York to Washington
  - 15 Jan 1915 – NY to San Francisco
- General Electric – Irving Langmuir
  - AM Modulation of Alexanderson Alternator
  - 1913 - high-vacuum “Audion”

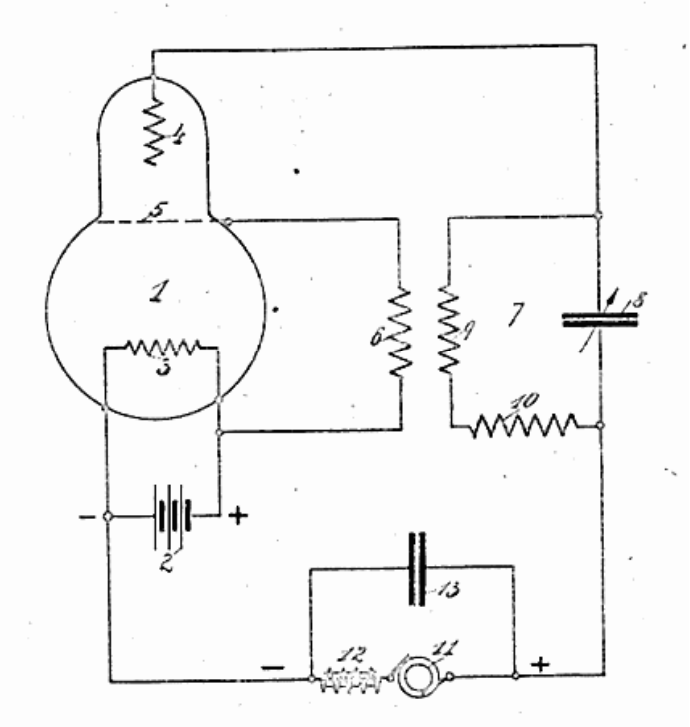


- High-Vacuum Technology
- Greater Reliability
- Improved Manufacturing Techniques

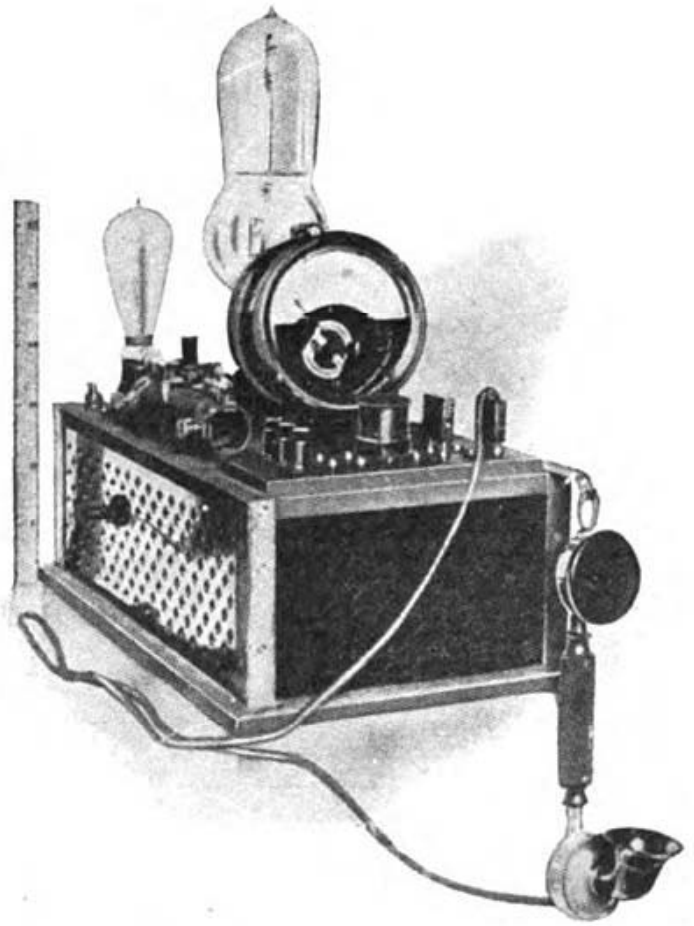


Alexander Meissner

Description **Deutsch:** Meissner Oszillator Patentschrift
Date 10 April 1913 Source Deutsches Patent 291604 vom 10.Apr.1913 Author Telefunken, Alexander Meissner Remarks **Deutsch:** Abgelaufene Patentschrift



Meissner - 1913



One of the first vacuum tube AM radio transmitters, built by Meissner in 1913 with an early triode tube by Robert von Lieben. He used it in a historic 36 km (24 mi) voice transmission from Berlin to Nauen, Germany.

From Wikipedia AM

Military Electronics 1914

Spark transmitters and crystal sets

Gustave-Auguste Ferrié

- French radio pioneer
- Ferrié headed the French Radiotelegraphie Militaire (Signal Corps)

Quand la tour Eiffel sert de support publicitaire !

Paul Pichon
(A Spy Story)

Mata-Hari

- Year Book of the Institute of Radio Engineers – 1914
- **Pichon, Paul**, Patent Expert and Oberingenieur, Telefunken Co., Berlin, Germany
- Held a German patent for a crystal detector

Paul Pichon

- Pichon was a Frenchman, but he had deserted from the French Army in 1900 and, emigrating to Germany, he earned his living teaching French.
- Among his pupils were the children of Count von Arco, one of the founders of the Telefunken Company, by whom he was subsequently recruited as a technical representative.
- During the summer of 1914, he was touring the USA on an assignment from the Telefunken Company of Germany, to gather samples of all the latest wireless equipment he could find and to return to Germany with his samples for assessment.
- In the course of his tour he visited the Western Electric Company, and was given samples of the latest high-vacuum Audions together with full information on their use.
- Also visited General Electric, and received Pliotron samples

Paul Pichon

- On his way back to Germany at the end of his American tour he travelled by Atlantic liner to Southampton and he found himself in London on 3 August 1914, the very day upon which Germany declared war on France.
- The poor chap was in a fix, a French deserter yet an alien in Germany; what was he to do?
- In his hesitation, he called on Godfrey Isaacs, the managing director of Marconi's, to seek his advice.
- He explained that he was still a French subject, but that he would face immediate arrest if he returned to France. Whether or not Isaacs regarded him as a 'hot potato' is not clear; what is certain is that Isaacs failed to appreciate the importance of the samples Pichon carried in his baggage, and which thus lay virtually within his grasp.
- He advised Pichon to return to France, and offer his services to the French authorities.

Paul Pichon

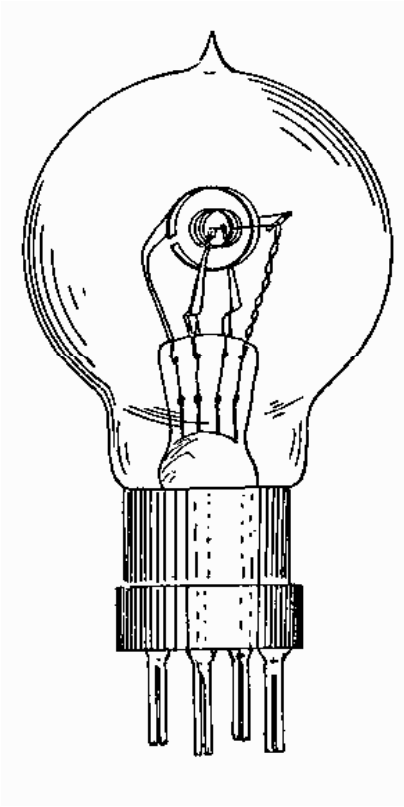
- Pichon crossed to Calais where he was promptly arrested.
- Protesting that he had brought back vital samples and information from America, he persuaded the authorities to communicate with the commandant of the French Military Telegraphic Service, Colonel Gustav Ferrié.
- Ferrié ordered that Pichon be immediately brought before him with all his baggage and papers.

Paul Pichon

- Convinced of the reliability of Pichon's information, Colonel Ferrié immediately submitted the samples to a panel of eminent physicists for further assessment.
- Simultaneously, he ordered arrangements to be put in hand for manufacture at the works of Messrs E. C. & A. Grammont at Lyons.
- The design was substantially modified by French engineers, Michel Peri and Jacques Biguet, but within 12 months valve production was in full swing at the Grammont works.
- Known as the Type TM in France, samples were sent by the French to the Admiralty in London and to the Royal Naval Signal School at Portsmouth early in 1916, and it very quickly became evident that these French valves were vastly superior in every way to the soft-vacuum Round valves and the earlier model Audions in use hitherto.

French TM Valve

"Télégraphe Militaire" - 1915



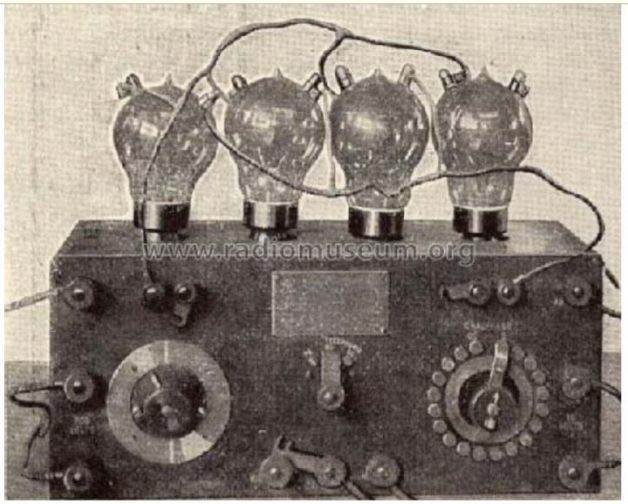
- The First Mass-Produced Vacuum Tube.
- "Hard-Vacuum" Triode Amplifier Tube
- Based on General Electric Co. (US) "Pliotron" technology
- Total WWI production more than 100,000 Units.
- 50,000 by Moorhead in California
- Many more produced by the British as the "R" Valve

- High Vacuum
- "Bright Emitter" – Straight Tungsten Filament
- Un-Gettered

Amplificateur 3TER
(Amplifier Type 3.3)

- One of the earliest applications of the TM valve, 1916.
- Used as an audio amplifier for “earth telegraphy” and as a detector and amplifier in radio receivers

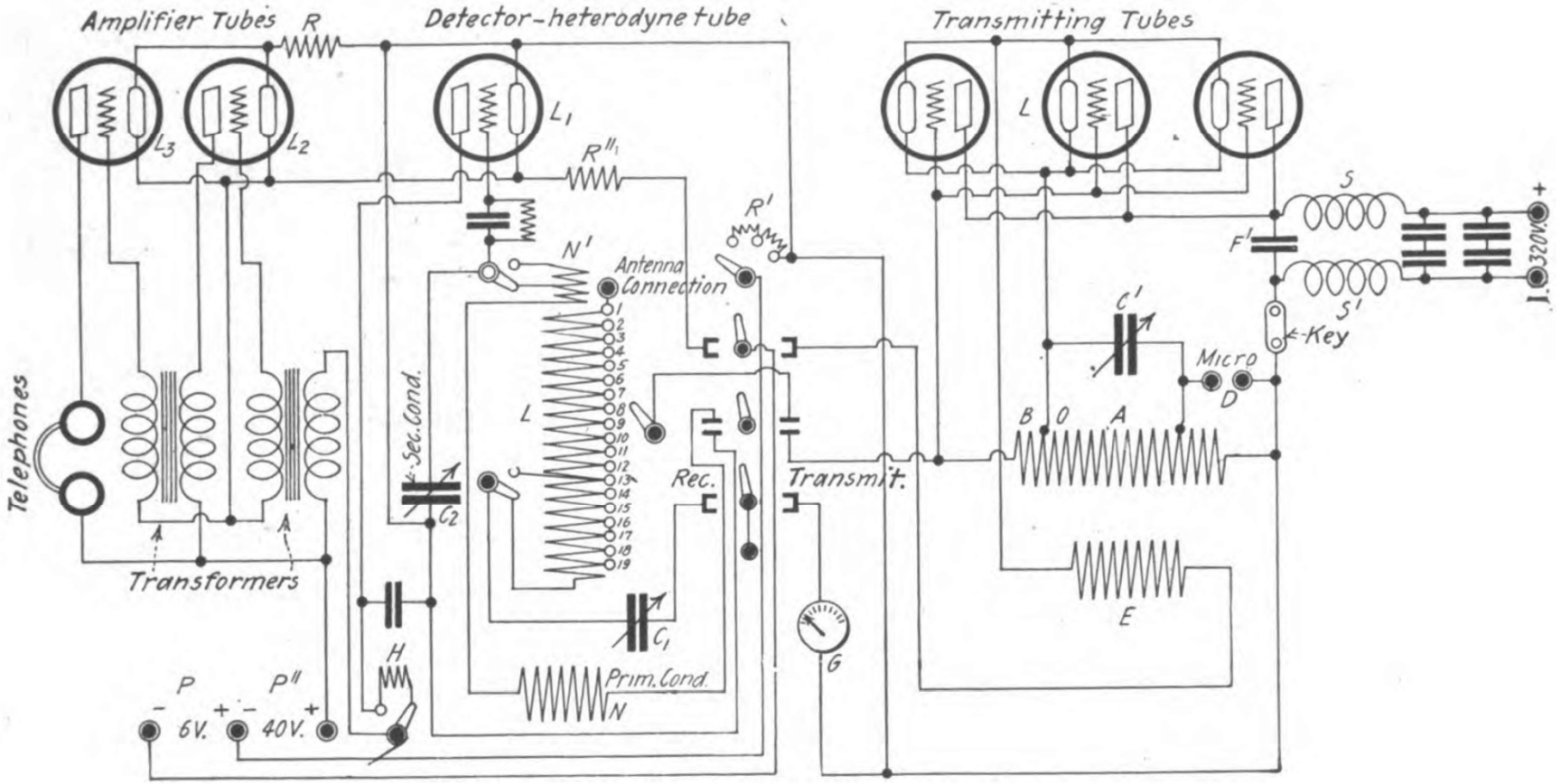
French Equipment



MILITARY France,: Récepteur à 4 lampes TMC [Radio] ID = 758339 611x491

E 10BIS - CW Transmitter Receiver

E 10BIS - CW Transmitter Receiver



Circuit diagram of Radio Set Type E-10 bis

Meanwhile, Back at the Ranch…

The Phone Company

The President's Analyst Staring James Coburn – Paramount Pictures – 1967

"The Cerebrum Communicator"

TPC

- AT&T Long-Distance
  - 20 Oct 1912: de Forest demo to AT&T
  - Late 1912: start work on high vacuum
  - 1913 oxide-coated filament
  - 18 Oct 1913 - New York to Washington
  - Early 1914 – Armstrong Demo and Disclosure
  - 15 Jan 1915 – NY to San Francisco
  - 1915 Arlington AM transmitter

TPC 2

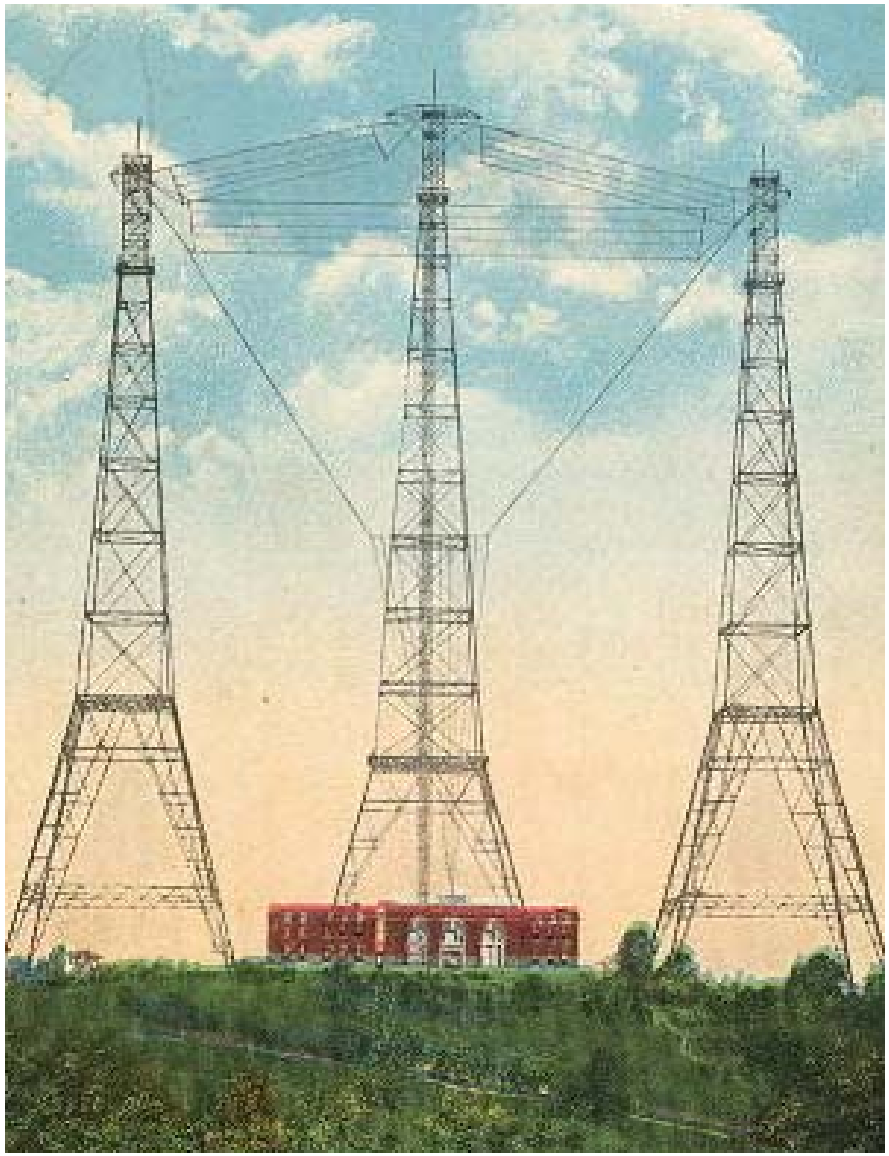
- *Dramatis Personae*
  - John J. Carty, Chief Engineer
    - Ralph Hartley
    - Edwin H. Colpitts
    - Raymond A. Heising

- Working in Comparative Secrecy

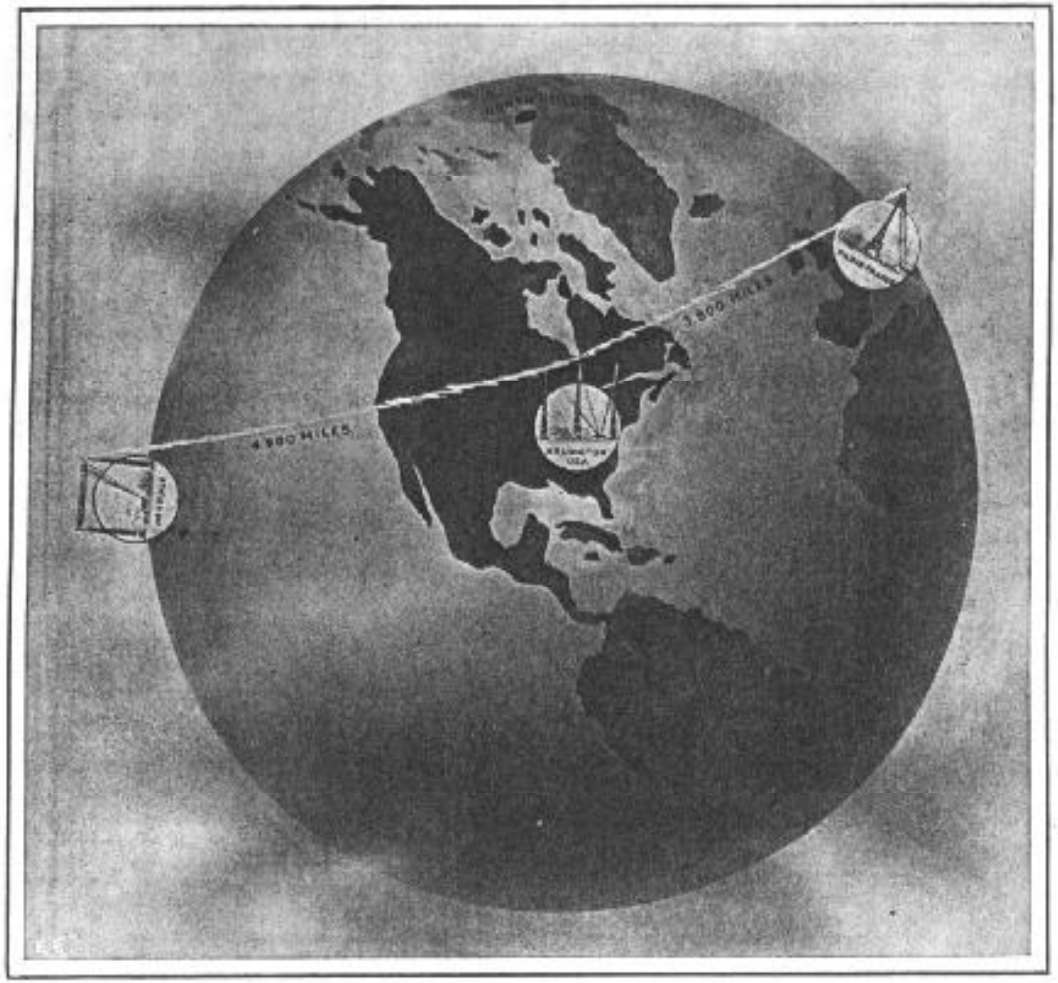
John J. Carty

- Chief Engineer, At&t (1907)
- Armstrong receiver demo (Early 1914)
- 1st Transcontinental Long-Distance (24 January 1915)
- 1st Trans-Atlantic radio telephone (1915)
- Becomes Major U.S. Army (1915). Ultimately Chief Signal Officer
- 4525 Bell System employees into the Signal Corps (1917)

Radio Station NAA - Arlington

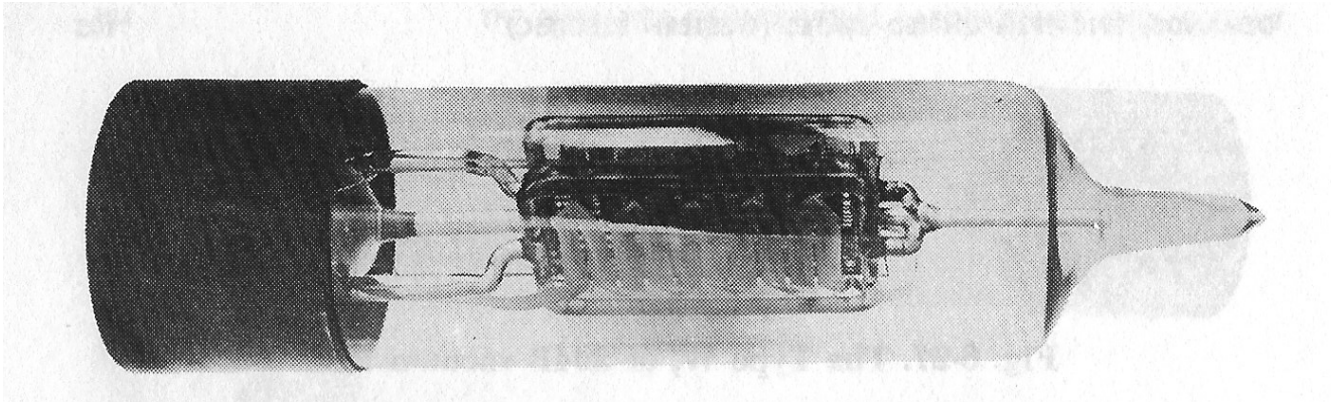


Arlington

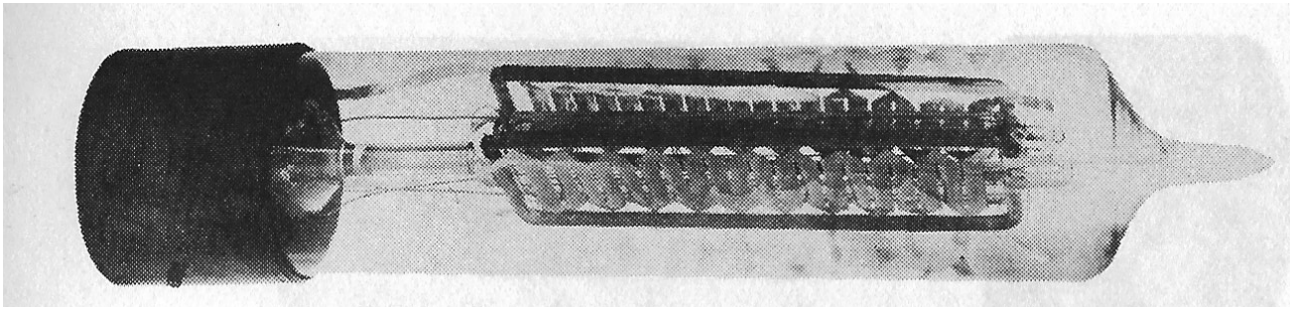


Graphic Illustration of Arlington to Honolulu and Arlington-Paris Radiophone Tests Recently Conducted; the Distances Covered Being 4,900 and 3,800 Miles Respectively.

Arlington



- Type-S, 204A used in Modulator



- Type-W, 204B used in RF power Amp

Arlington

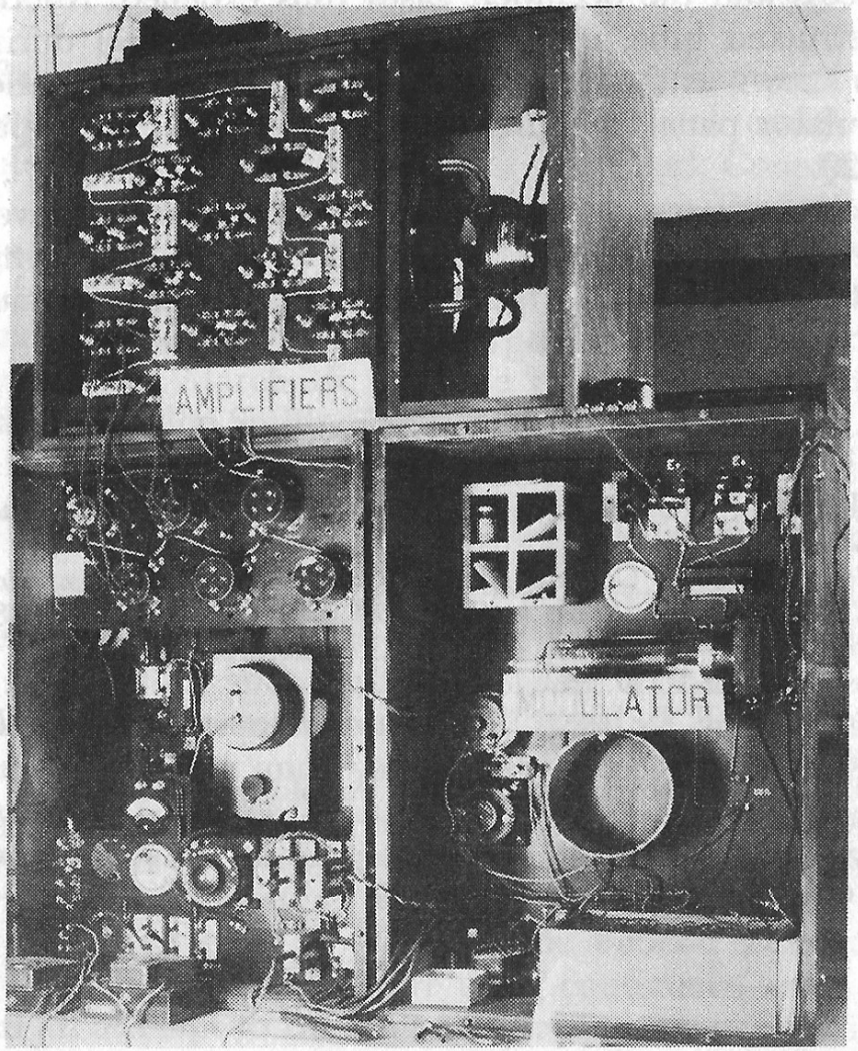


Fig. 6-28. The modulator panel at Arlington, Virginia, using a Type S or 204A vacuum tube as modulator.

Arlington

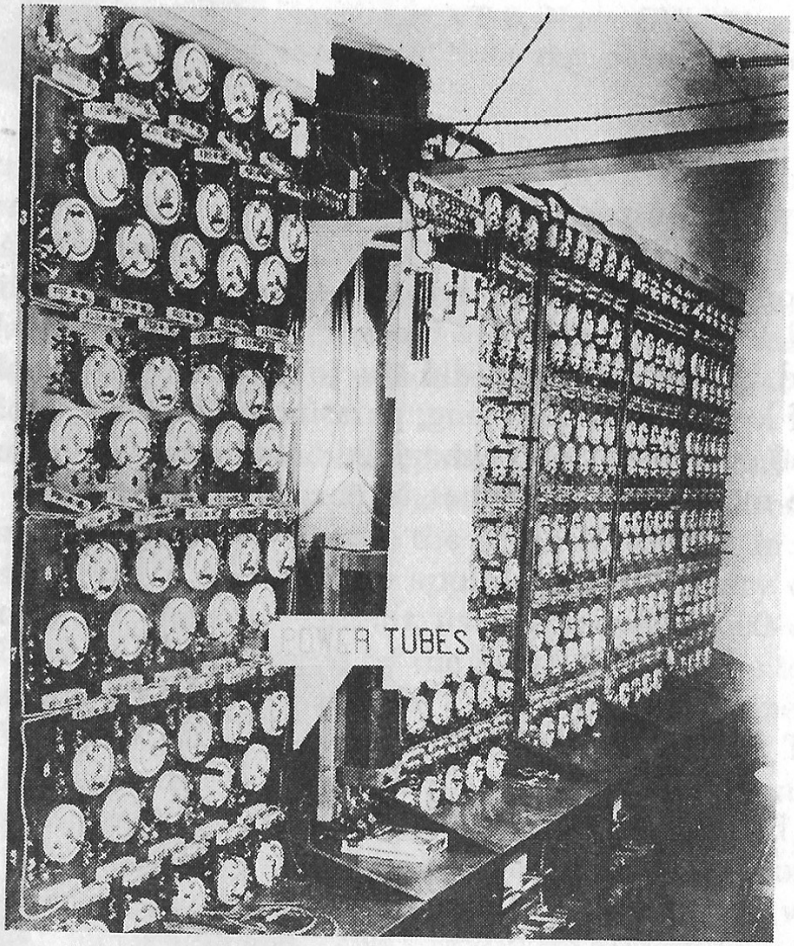
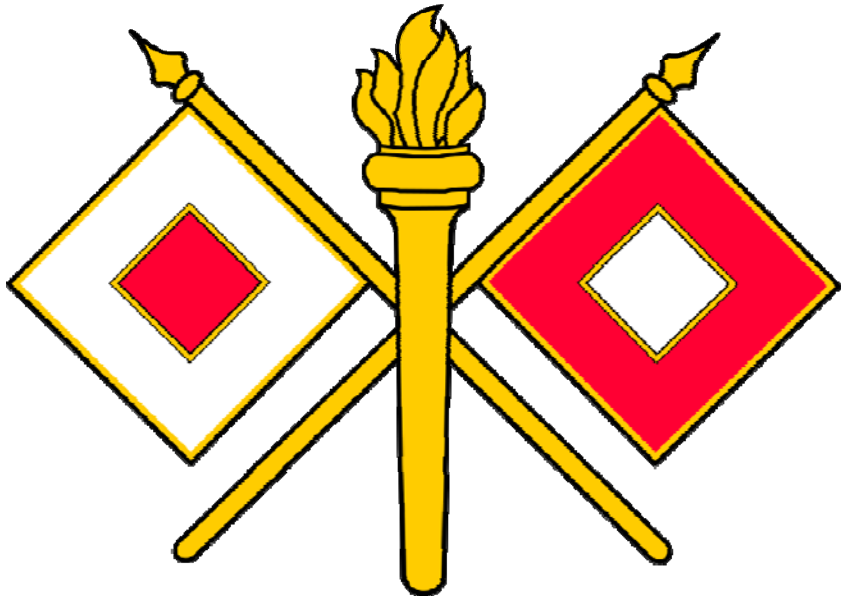
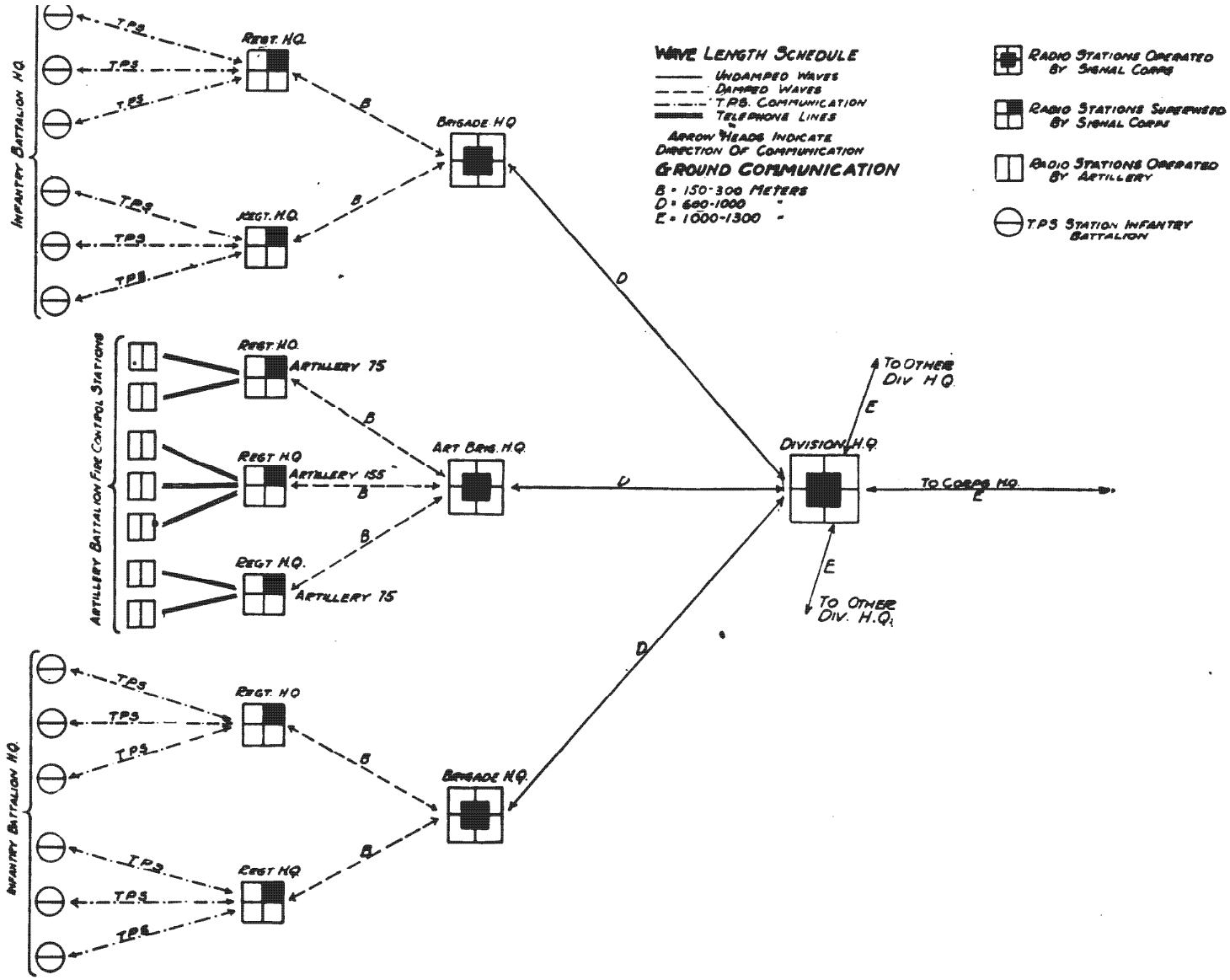


Fig. 6-26. One of the banks of power tubes comprising the final amplifier at Arlington, Virginia, during the Arlington-Paris radiotelephone tests conducted in 1915.

U.S. Army Signal Corps



Division Radio Network



BATTALION REGIMENT BRIGADE DIVISION

U. S. Army – 1917-1918

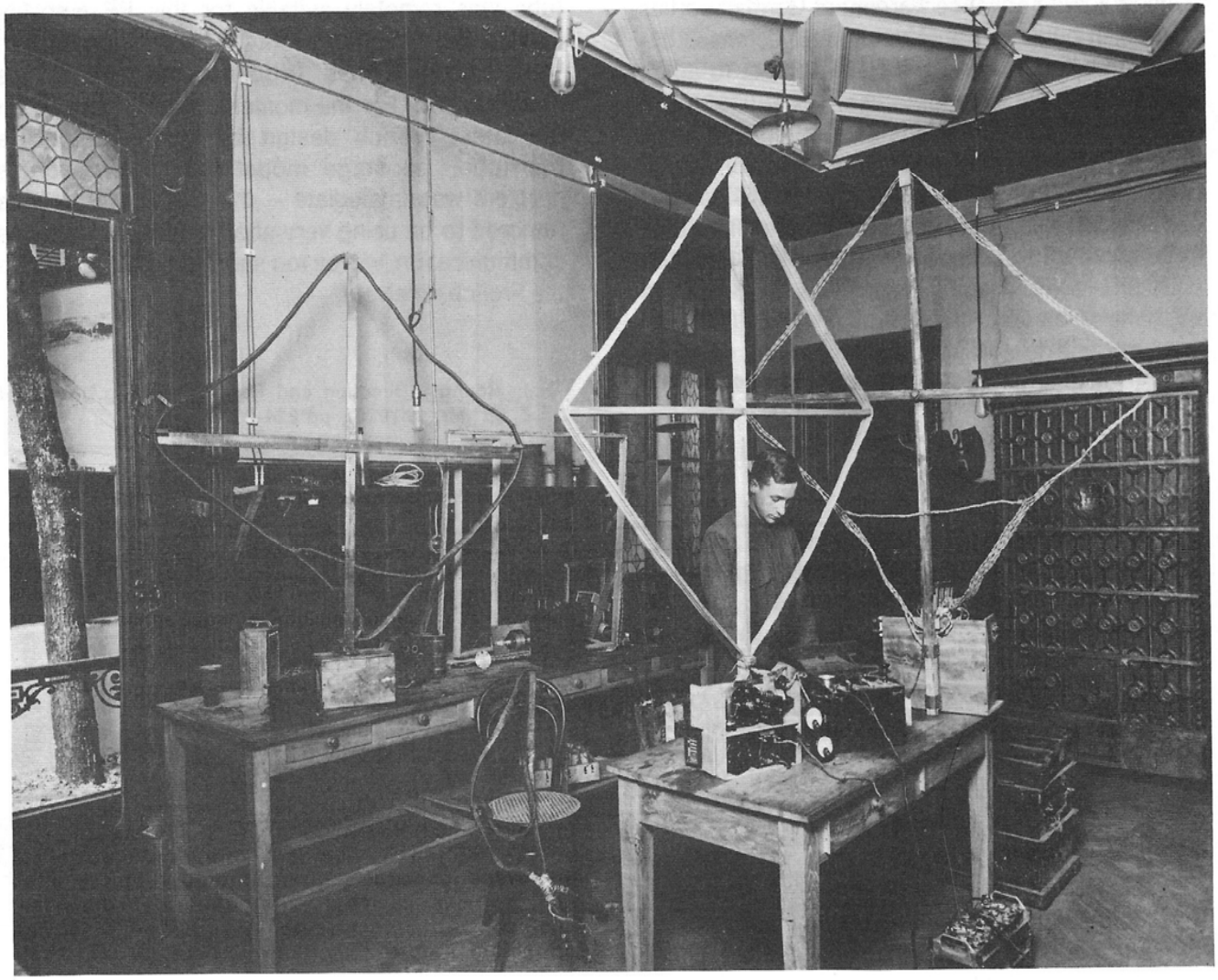
Division of Research and Inspection

The Signal Corps "Dream Team" in Paris France

EXTERIOR OF THE RESEARCH AND INSPECTION BUREAU, SIGNAL CORPS, PARIS, FRANCE.

REAR VIEW OF RESEARCH AND INSPECTION LABORATORY. PARIS, FRANCE.

- Organized by Colonel J. J. Carty – Recruited personnel from industry and the academic community.
- Officer in Charge Major E. H. Shreeve - Executive Officer, Research Department, Western Electric
- Research Section - Major O. E. Buckley - Physicist from Cornell University
  - Researcher at AT&T – Developed the Arlington Radio-Telephone Transmitter - 1915
- Inspection Section - Major Maurice K. McGrath – AT&T



Armstrong's Paris Laboratory (U.S. Army Signal Corps photo)

$100,000 in laboratory equipment as shipped to Paris in crates designed to be made into work benches.

Division of Research and Inspection

The Functions of the Division

(a) The gathering of information on all signaling apparatus, allied as well as enemy.

(b) The dissemination of this information through channels among the Signal Corps units.

(c) The application to existing and proposed Signal Corps practice of devices which had already been tested out by the various armies and found satisfactory.

(d) Research along original lines and development of new apparatus.

(e) The inspection of all Signal Corps apparatus arriving from the United States or purchased. in Europe to insure its reaching the combatant troops in serviceable condition.

(f) Constructive criticism of all apparatus used by the Signal Corps.

Division of Research and Inspection

Just a few, of many, accomplishments:

1. **Tank radio set.**
2. **Two-watt radio loop set.**
3. **Listening-station equipment.**
4. **High-frequency amplifier. (Armstrong Superhet)**
5. **Two-way T. P. S. (Earth Telegraph) set.**
6. **Mobile telephone and telegraph offices**
7. **Telephone sets for artillery fire control.**
8. **Telephone sets for balloon service.**

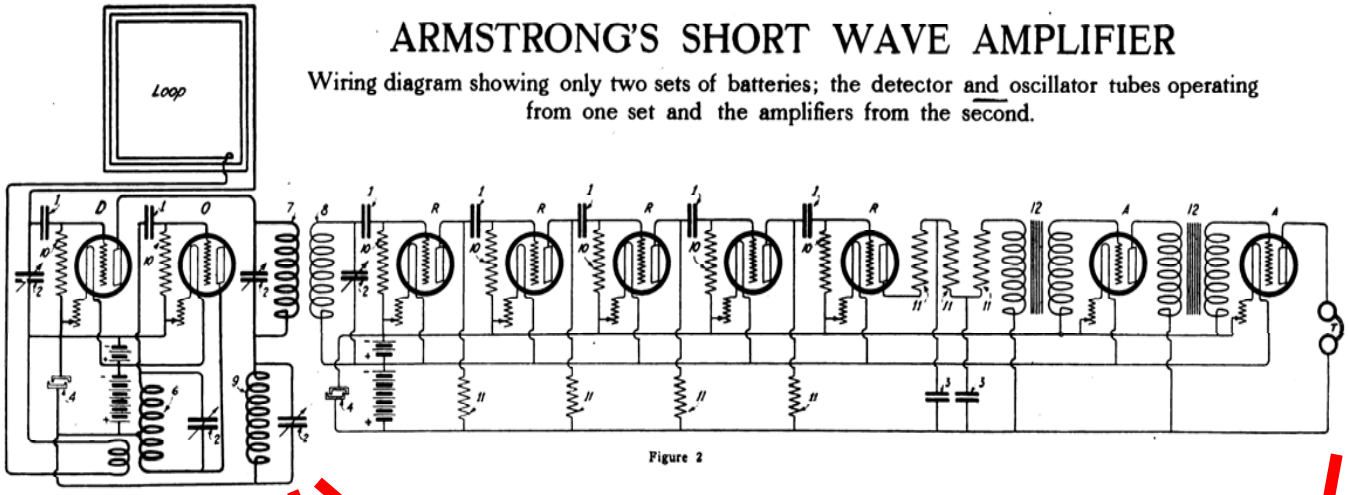
Edwin Howard Armstrong - 1918

THE SUPERSONIC-HETERODYNE RECEIVER

(Supersonic, i.e. ultrasonic)

Captain E. H. Armstrong
U.S. Army Signal Corps
1917-1918

- Improved performance at high frequencies
- Uses heterodyne frequency conversion to move the signal to another, usually lower, frequency where amplification and filtering are easier to accomplish..
- The basis for most modern radio receivers



Paul Godley's circuit 1920 for the Transatlantic test

Heterodyne Frequency Converter

- Input tuned to 1000 KHz
- Oscillator tuned to 900 KHz

Intermediate – Frequency Amplifier and Detector

- Amplifies and detects signal at 100 KHz

Early Armstrong equipment in the FT. Monmouth Museum – Note the French TM Valves in the IF.

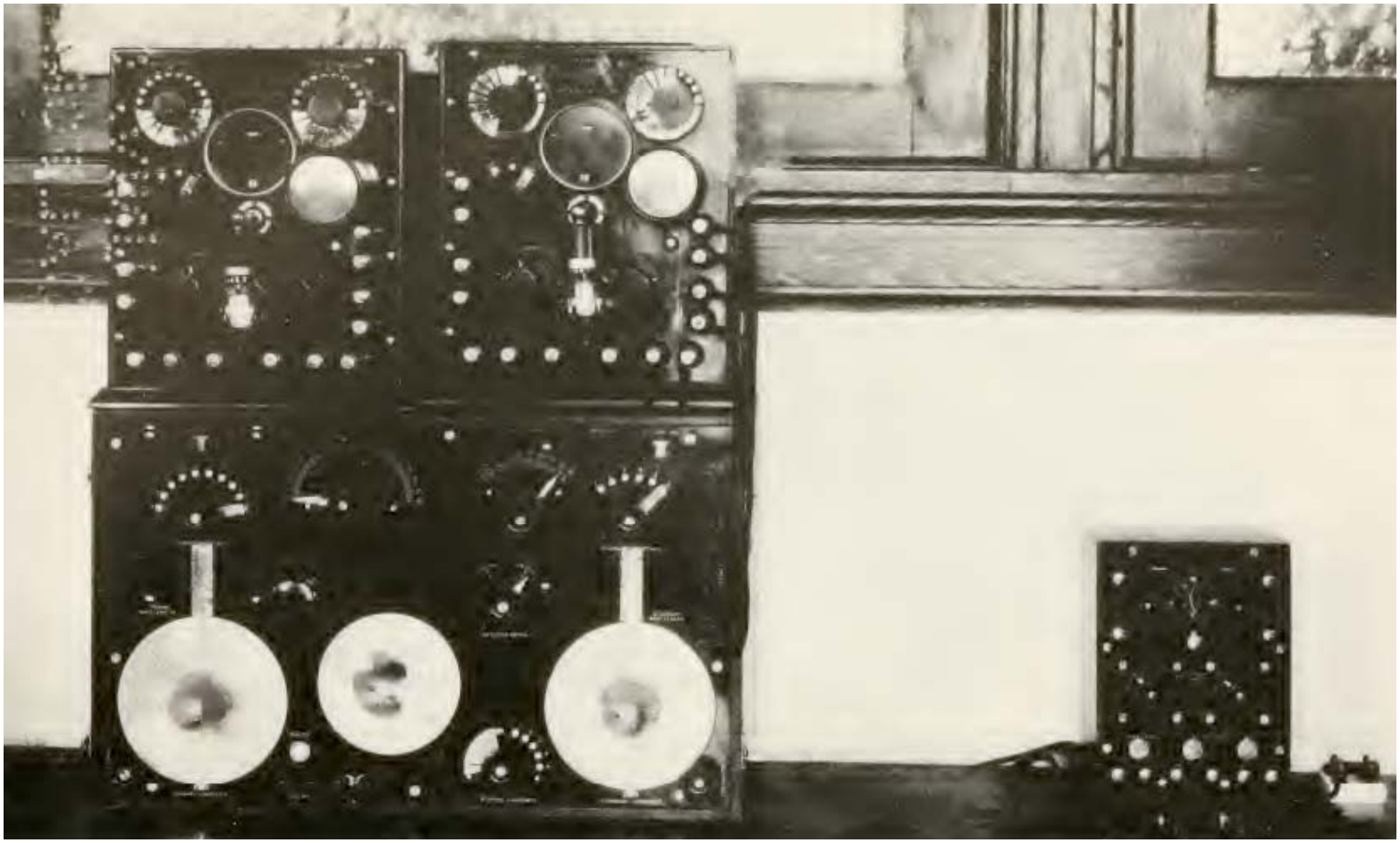
EARLY U.S. MILITARY VACUUM TUBES

VT-1
Western Electric
203A
General Purpose

VT-2
Western Electric
205B
“5-Watter”

VT-4
Western Electric 211
“50-Watter”

Navy Equipment at Belmar 1918
(Howeth)



Two Audion control boxes
Receiver
2-stage audio amplifier

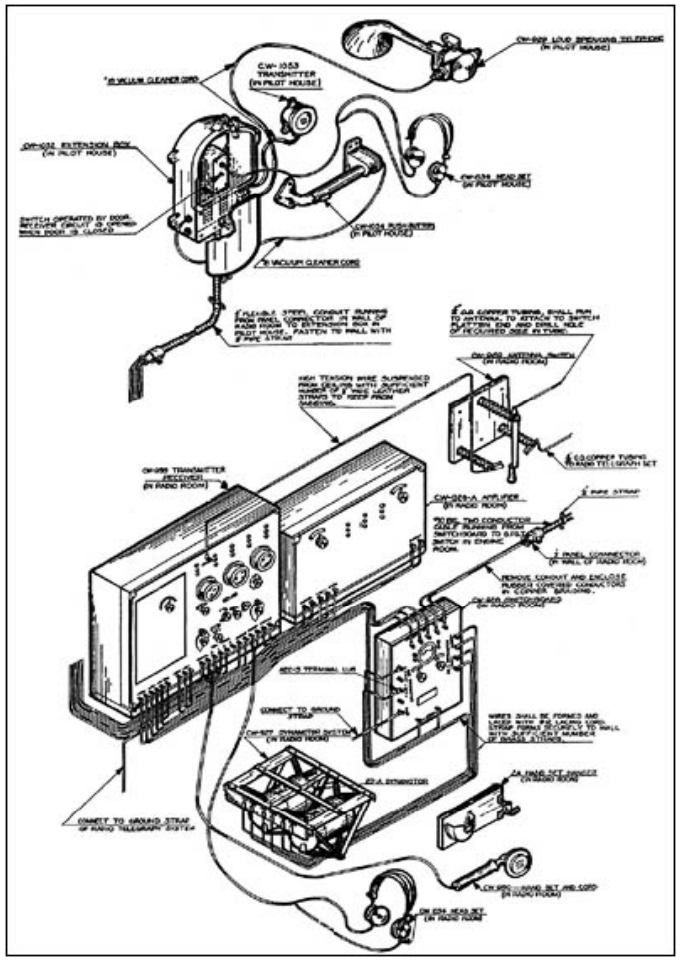
BC-32A
CW Transmitter - Receiver

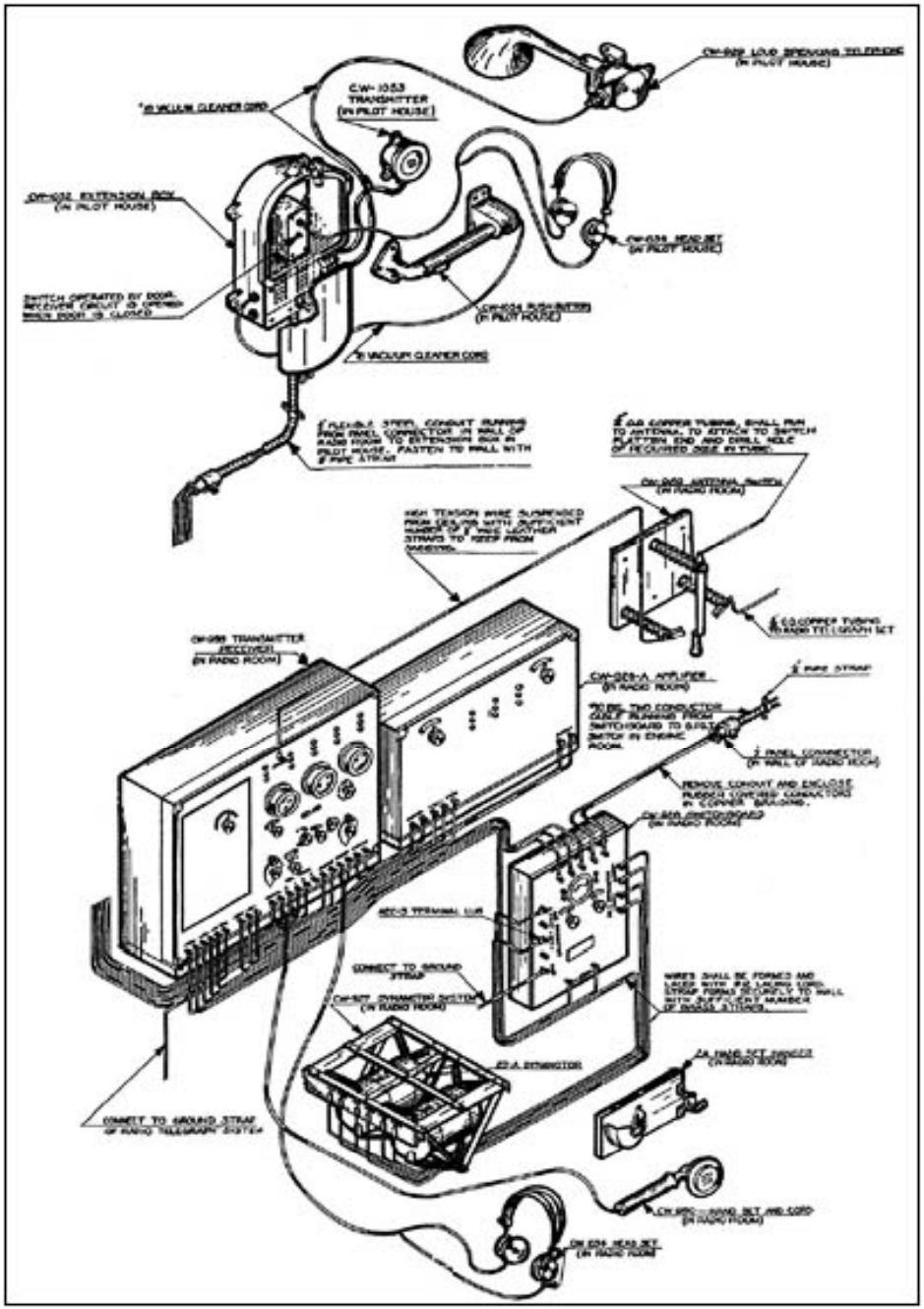
CW-936

RADIO-TELEPHONE SYSTEM

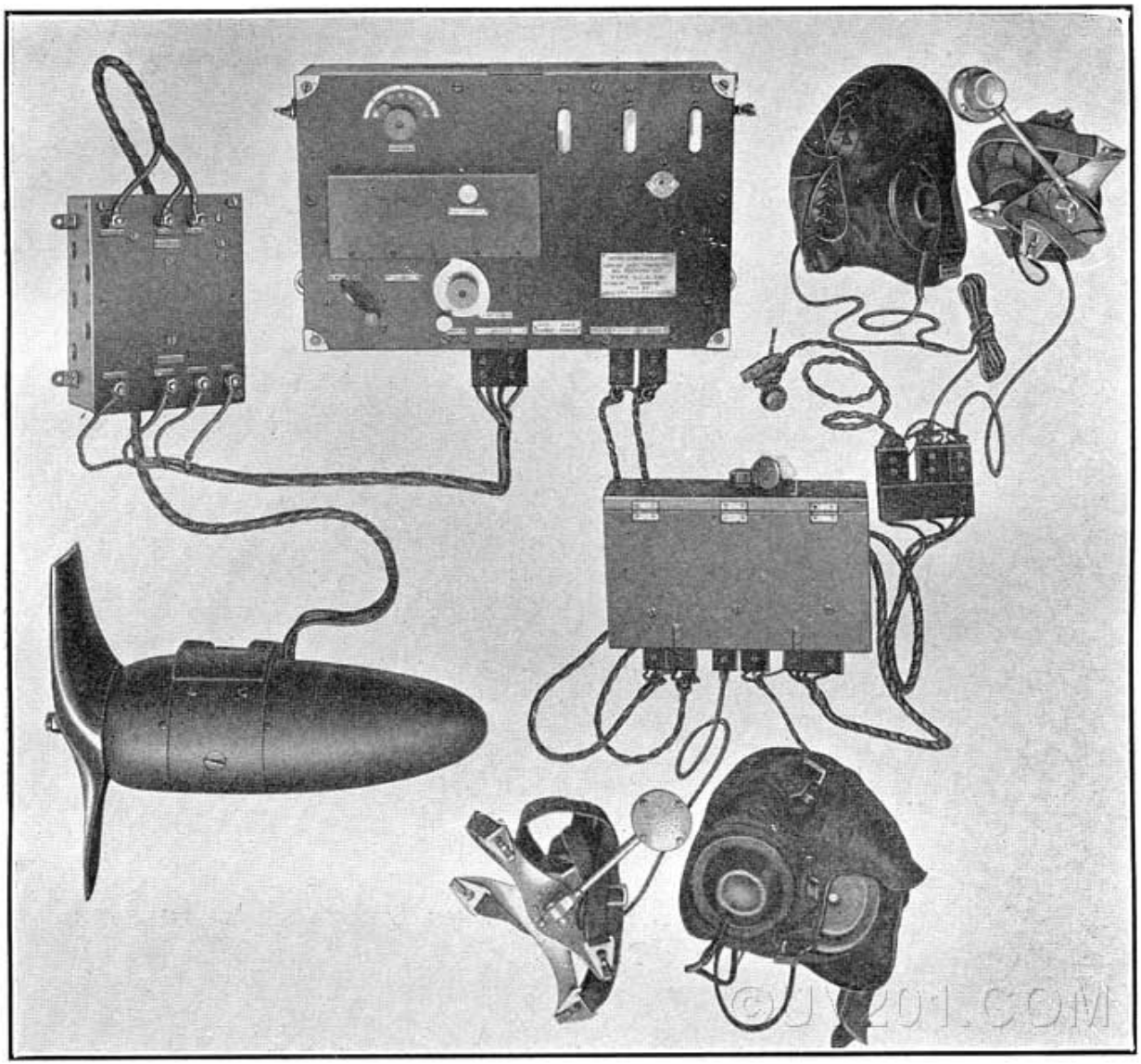
”THE SUBCHASER SET”

- Designed by Western Electric
- First commercially produced radio-telephone system
- Mic and loudspeaker on the bridge for quick communications
- 2-tube AM transmitter
- 3-tube receiver
- Five preset frequencies 870-1270 KHz
- 3-tube audio amplifier
- “Loud-speaking telephone”



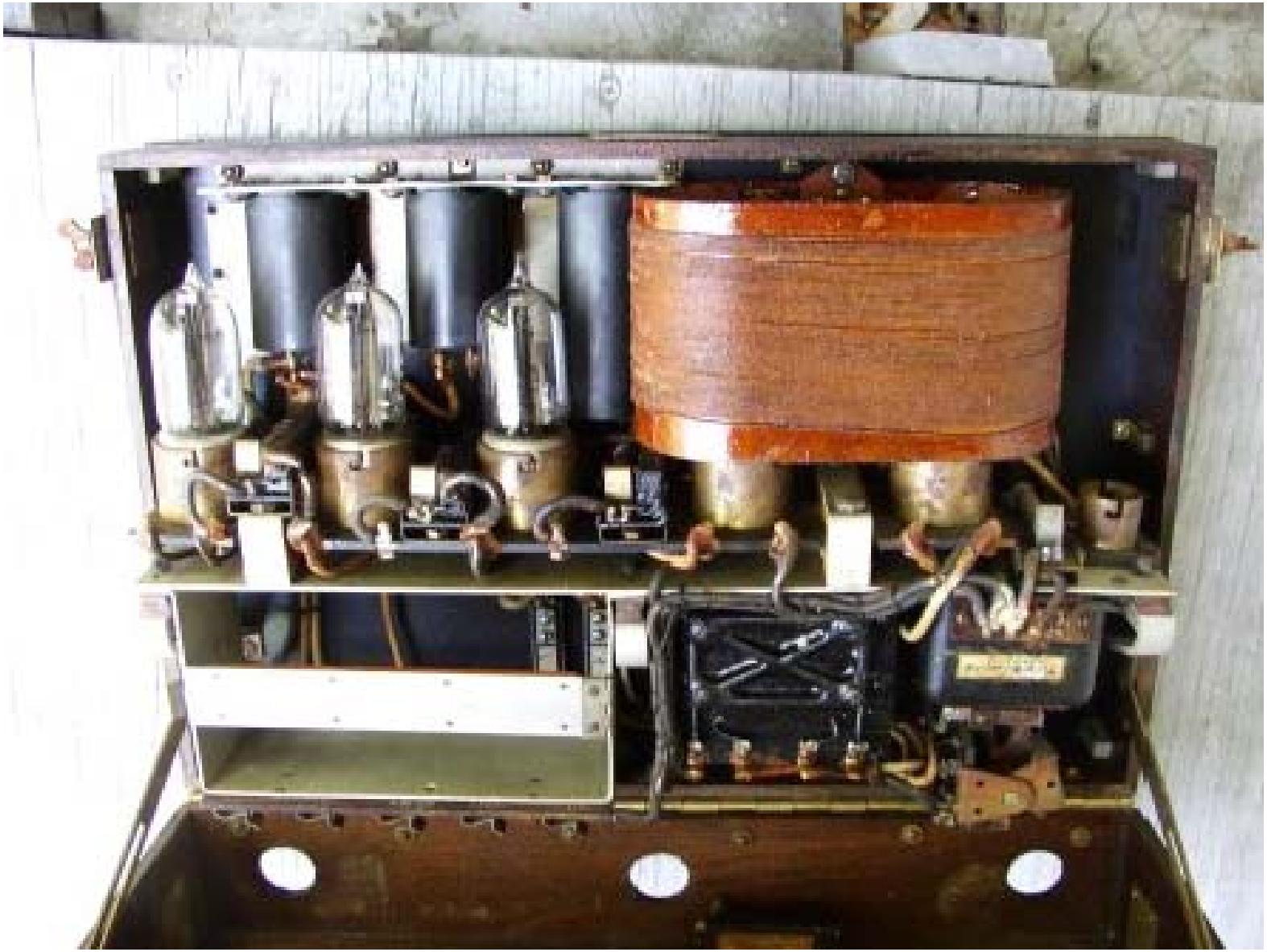

CW-1053
TRANSMITTER
(IN PILOT HOUSE)
CW-1032 EXTENSION BOX
(IN PILOT HOUSE)
CW-1034 HEAD SET
(IN PILOT HOUSE)
(IN PILOT HOUSE)
(IN VACUUM CLEANER CORD)
(IN VACUUM CLEANER CORD)
CW-1033 TRANSMITTER
(RECEIVER)
(IN RADIO ROOM)
CW-1033-A AMPLIFIER
(IN RADIO ROOM)
(IN WALL OF RADIO ROOM)
CONNECT TO GROUND
STRAP
CW-1034 HEAD SET
(IN RADIO ROOM)
CONNECT TO GROUND STRAP
OF RADIO TELEGRAPH SYSTEM

SCR-68



SCR-68

SCR-68



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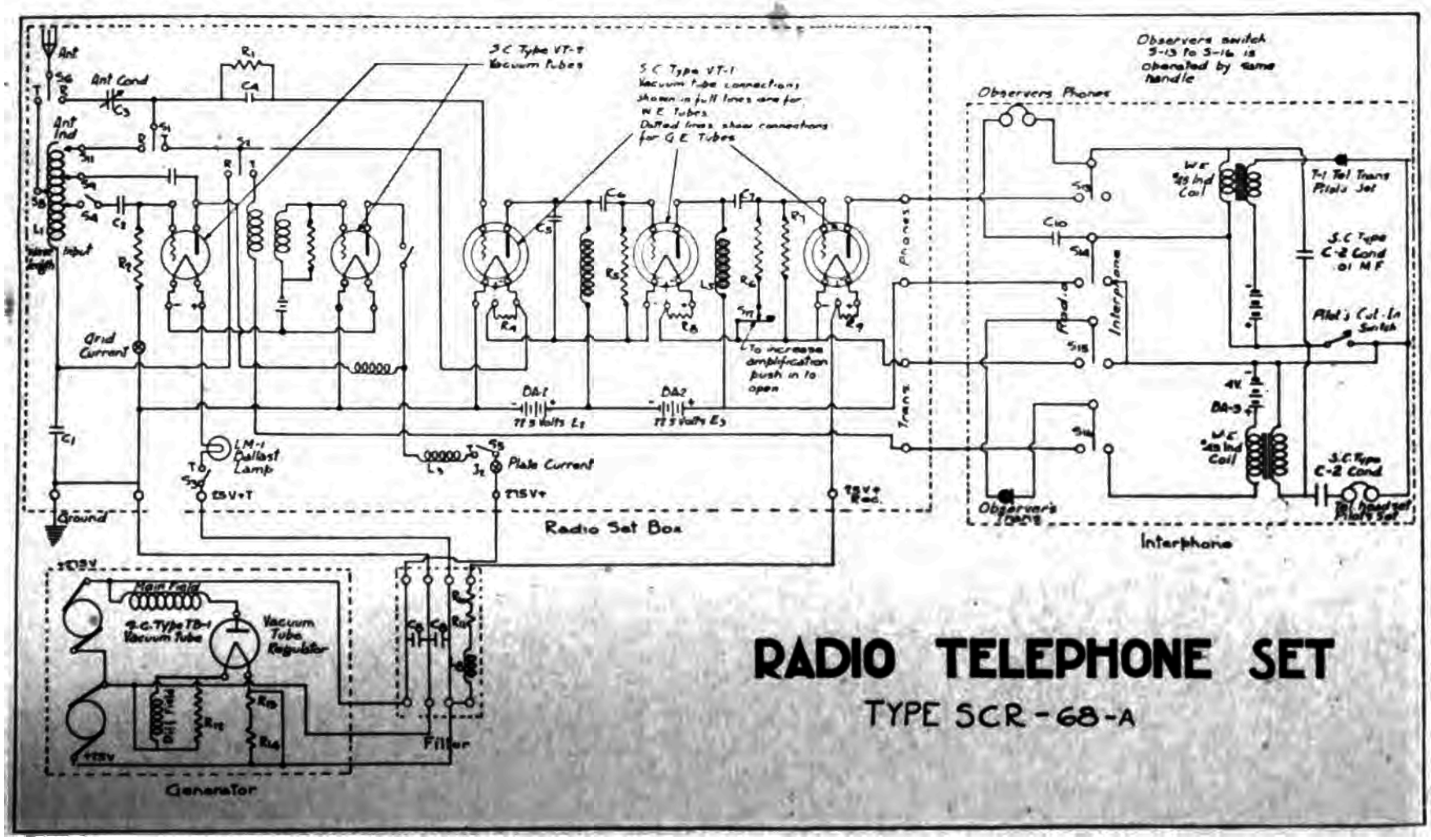
Ant
Ant Cond
Ant Ind
Input
Grid Current
Ground
3 C Type VT-1 Vacuum Tubes
3 C Type VT-1 Vacuum tube connections shown in full lines are for W E Tubes. Dotted lines show connections for G E Tubes
To increase amplification push in to open
Phones
Trans
Plate Current
LM-1 Ballast Lamp
Radio Set Box
Observers switch S-13 to S-16 is operated by same handle
Observers Phones
Interphone
Pilot's Cut-In Switch
4V
BA-3
Observer's Phones
Main Field
3 C Type TB-1 Vacuum Tube
Vacuum Tube Regulator
Filter
Generator
RADIO TELEPHONE SET
TYPE SCR-68-A

Established 17 OCT 1919

RADIO APPARATUS

for

Amateur and Experimental Use

with

Instructions for the Operation

of

CONTINUOUS WAVE APPARATUS

PRICE 25 CENTS

September 1, 1921

RADIO CORPORATION OF AMERICA

Sales Division

Woolworth Building 233 Broadway

NEW YORK CITY

Asbury Park – Summer 1920

8XK/KDKA - 2 NOV 1920

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