Plextek

100 Years of Radio
Thursday 6th February 2014
Dr Colin Smithers

1914-1934: The Wireless Wave

Agenda

- Major wireless events
- 1914 as a moment in history
- Transmission types
- Spectrum and spectrum management
- Devices and technology
- International competition and IP
- EMC
- Licensing and tax
- The effect of war
- Data pricing

Major wireless events

- 1897 Wireless Telegraph and Signal company Ltd incorporate
  - November – Needles ioW – Bournemouth 14.5 miles
  - December Needles – ship – 18 miles
- 1898
  - June – 1st paid Marconigram
  - July – reports of Kingstown regatta for Dublin Daily Express
- 1900
  - April - British Patent “7777” – Tuning using Syntonisation
  - Dec - Fessenden transmits speech
- 1901
  - Fessenden engaged to develop weather station network
  - 1st signals cross the Atlantic, received by Marconi
- 1904 Fleming invents Thermionic diode

Major wireless events -cont

- 1905 Ship messages accepted at all British post offices
- 1906 – Dec – Fessenden broadcasts Handel's Largo
- Lee de Forest invents Audion – Triode – amplification
- 12th Jan 1910 Birth of Broadcasting, Lee de Forest, The Father of radio
- 1912 – April – Titanic sinks. All survivors listed in NY press
- Laws start to change in mandate ships use of radio

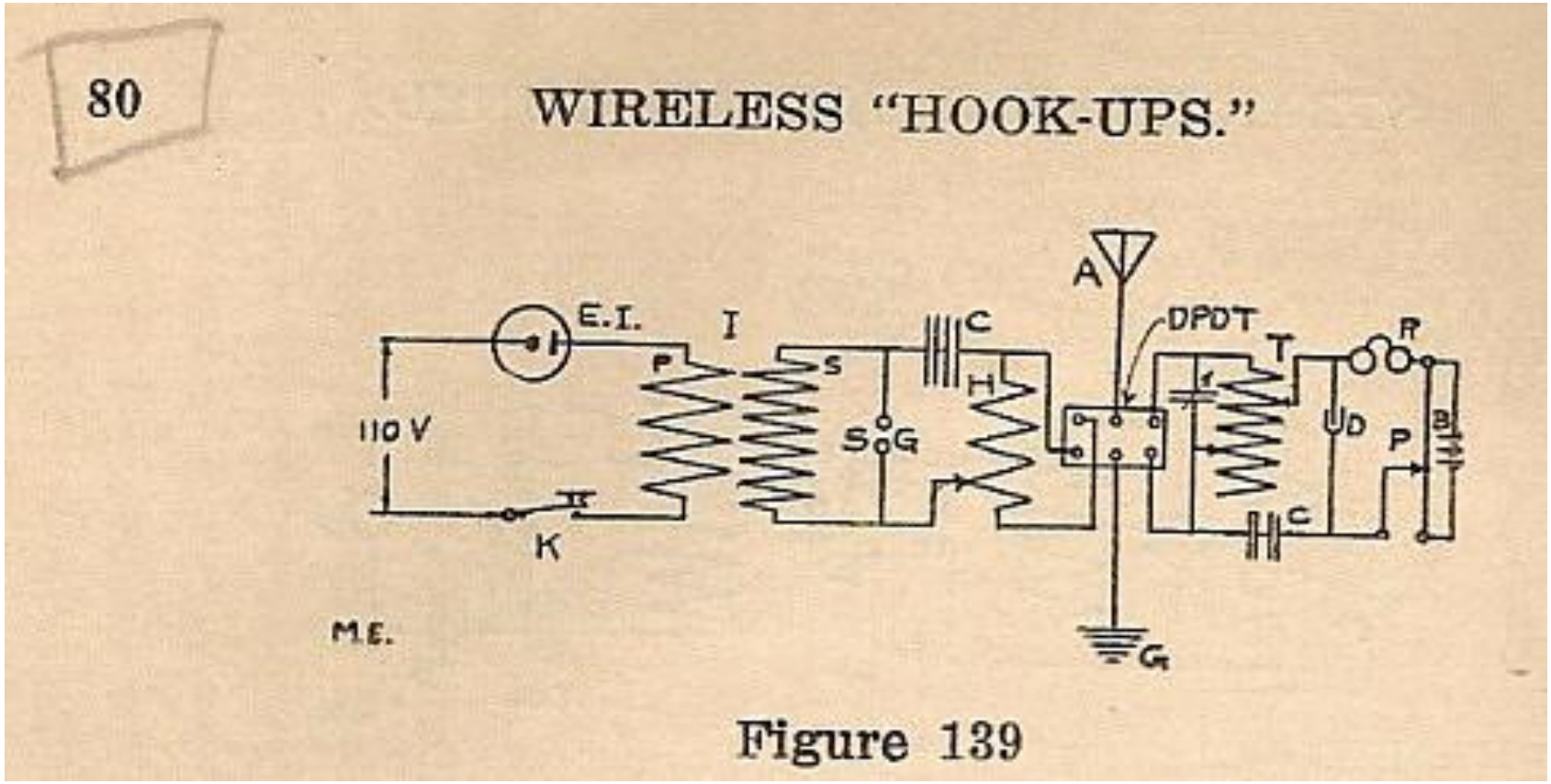
1914 – a snapshot

- 10% of all ships carry wireless – growing rapidly
- Wireless Telegraph stations covered the developed world
- Ships newspaper arrives daily by telegraph
- Transmission are “Damped sparks”
- Professional transmissions up to 200m (1.5MHz)
- Amateur transmissions above (“useless” spectrum)
- Titanic disaster allowed monopolisation by Marconi
  - Nearby ships had closed down at 11pm – missing SOS
  - Radios not universally fitted – cost, space, manpower
- Production of continuous waves subject of discussion
- “Broadcasting” sporadic
- Anuity rates at 65: Men 14%, Women 10%

The 1914 Transmitter

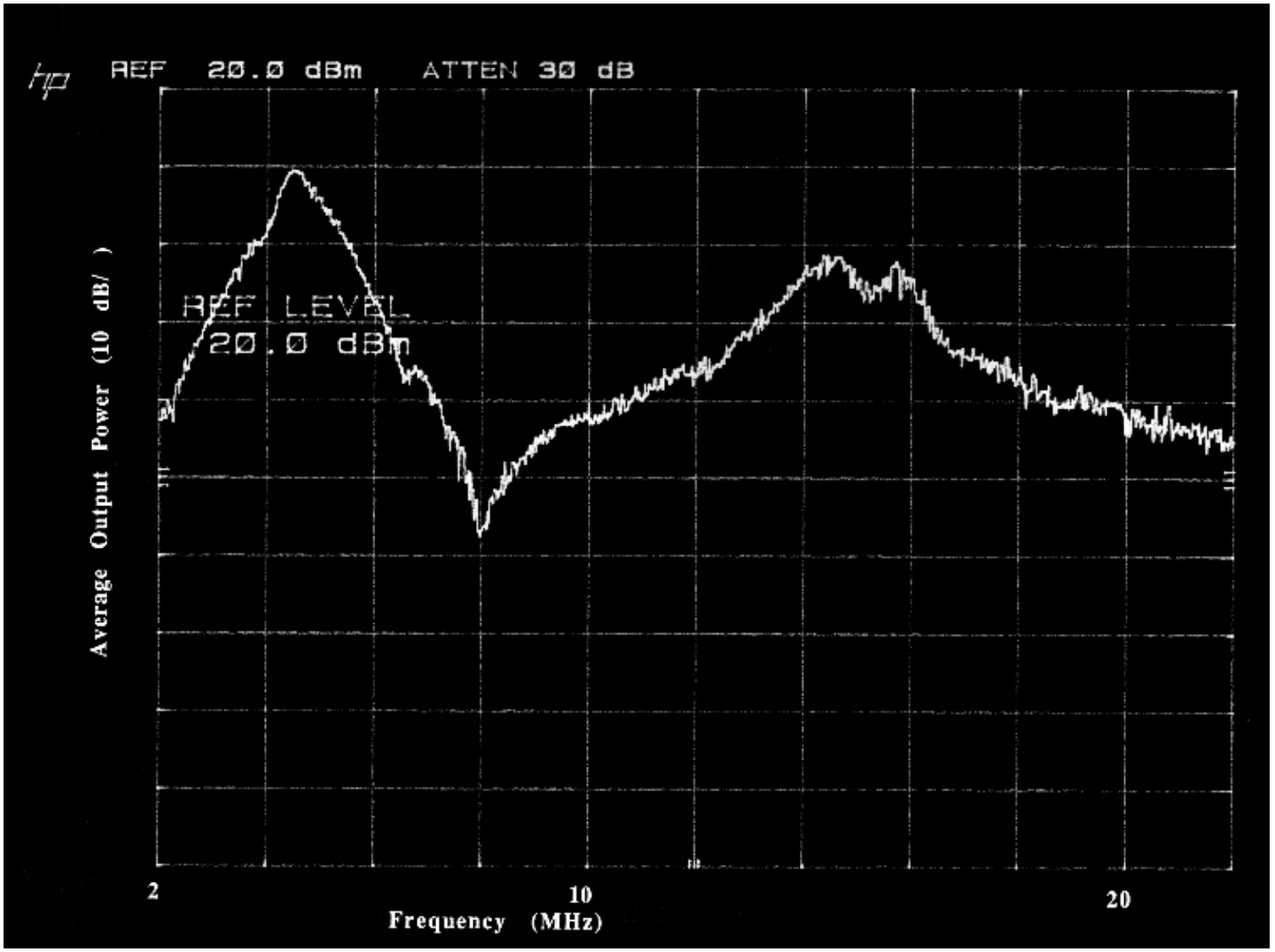
- Spark transmission the norm
  - Power 40W – 5kW
  - Efficiency low ~ 10%
  - “Damped Wave”
  - What was its spectrum?
    - Spark = broad
    - Single resonator, Q of 20
    - Antenna Q of 20
    - Spark resulted from transformed AC or DC supply
      - 25Hz – 60 Hz = 50-100Hz
      - Transformer deliberately leaky – air gap
      - Interupter disc added 3-500Hz “note”
        - » Aided detection – human ear ~10Hz detection bandwidth

1912 transceiver circuit



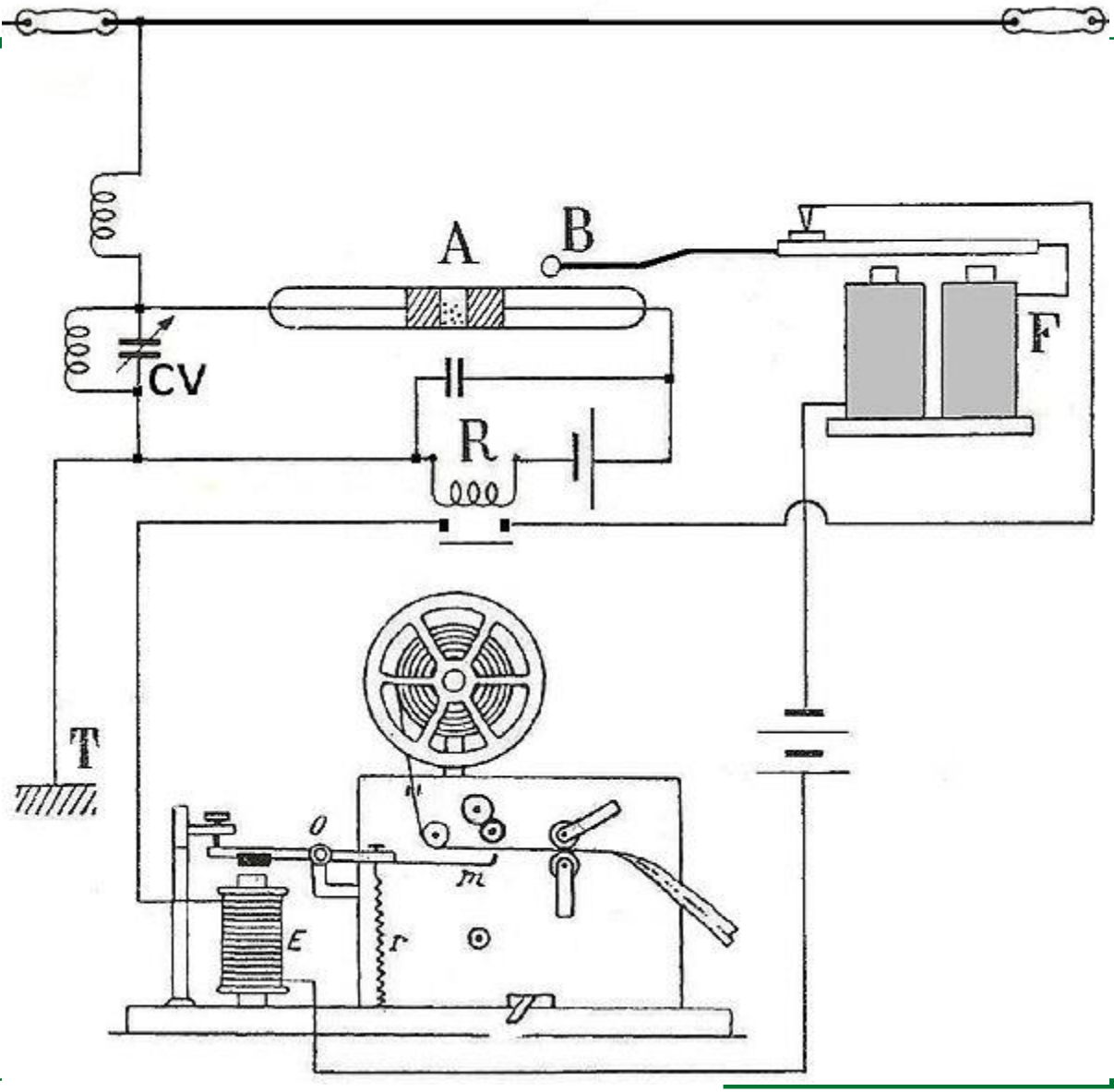
Rotary disc spark gap

Spark transmitter spectrum



The 1914 Receiver

- Use of Syntony – resonance
- Tuned antenna structure
- Main input tuned circuit
- Variable coupling to exchange senstivity and selectivity
- Detector
  - Coherer
  - Magnetic
  - Crystal – many types
  - Thermionic diode – novel


A
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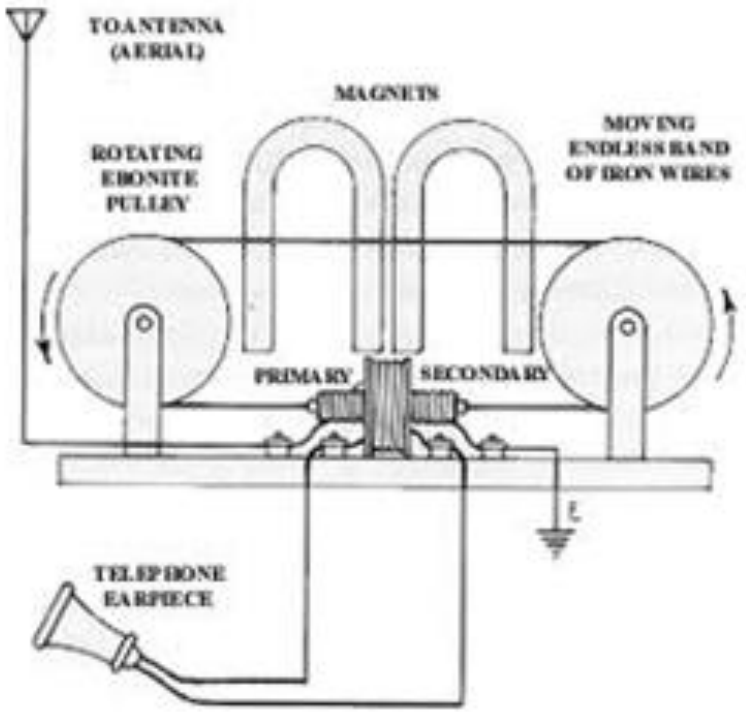

TO ANTENNA
(AERIAL)
MAGNETS
ROTATING
EBONITE
PULLEY
MOVING
ENDLESS BAND
OF IRON WIRES
PRIMARY
SECONDARY
TELEPHONE
EARPIECE

1909 receiver

1912 detector board

1912 Semiconductor technology

- Peroxide of Lead –
- Perikon - this is a detector that uses two different minerals, usually zincite and chalcopyrite, in contact with each other for detection.
- Iron Pyrite- a single mineral detector that, at the time, was thought to be easy to use and fairly sensitive.
- Carborundum

The International Convention, London, July 1910

- Article 3 – bound to exchange..reciprocally..regardless of type
- Article 4 - NO JAMMING
- Article 10 – Allowable charges:Coast, ship, land, relays
- Organisation of Stations
  - Art 1 Up to date
  - Art 2
    - 600m (normal) and 300m: general correspondence
    - 1800m for long range
    - 150m for radio location
  - Art 7
    - Minimum power necessary
    - As little damping as possible
    - NO sparks only to the aerial (except SOS)
    - 20WPM min
    - High selectiviy rx

1910 Convention - cont

- SII, Art 14
  - Ship first
  - Call only if within range
  - Listen before transmit
  - Use calling channel
  - Cease upon request by coast station
  - Formal close down
- SS II, Art 28
  - Distance, in miles
  - Position
  - Next port
  - Numer of messages
  - Queuing information

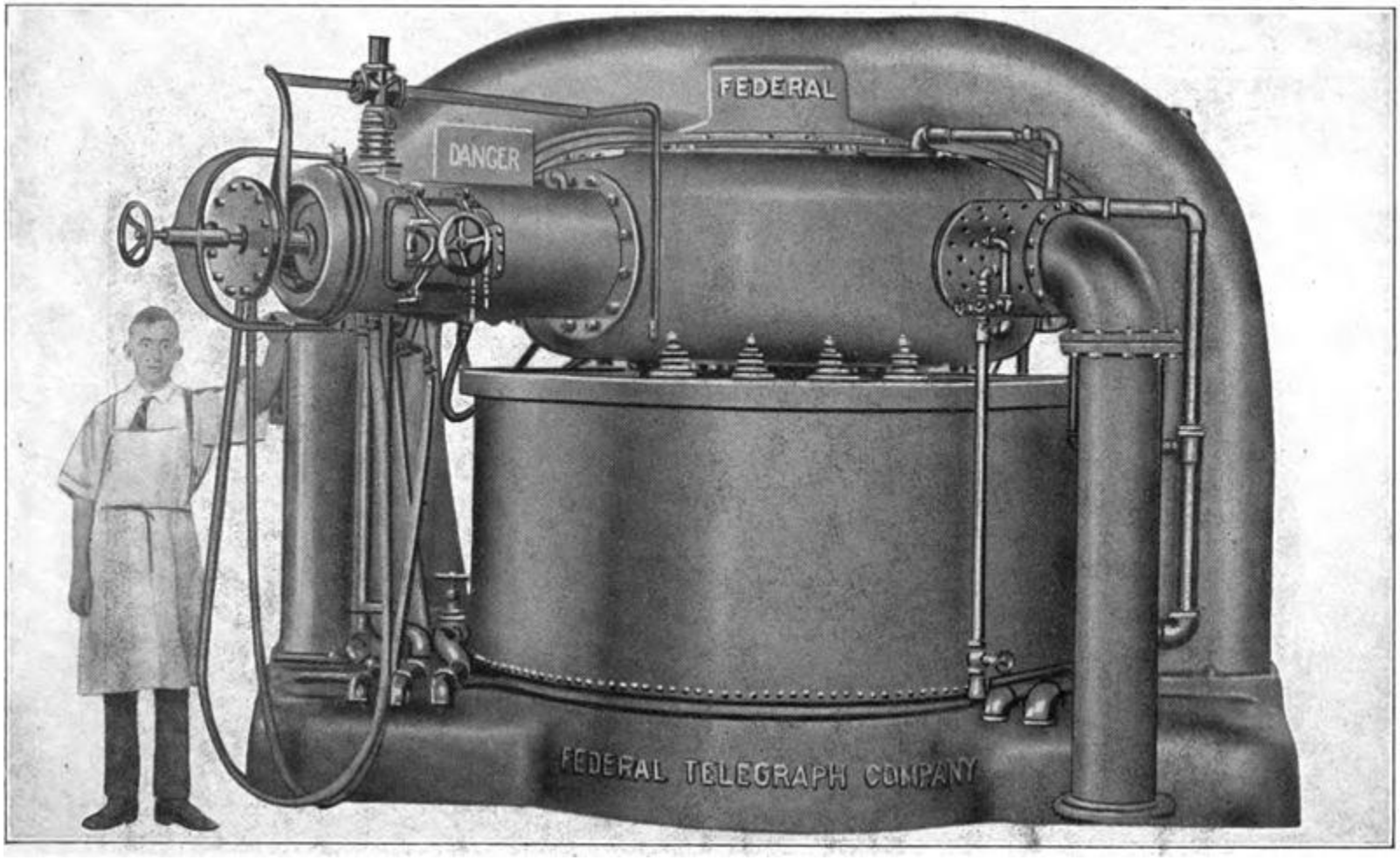
1910 Convention - cont

- Navigation act (Aus) 1912
  - All ships carrying 50 or more:
    - Must be able to transit 100miles, day and night
    - Must pass messages if asked
    - 6 hours back-up power
    - Have a sound-proof radio room
  - Penalty £1,000 (= £20,000)

Achievements by 1915

- Spark CW
- Modulated CW
- AM
  - Rotary transmitter (max 100kHz 3kW)
  - Arc
- FDM
- TDM
- SSB AM
- Duplication of letters – early teletype
- Obstacle detection for ships – radar
- Frequency Hopping – “Change Tune” (1912)
- Protocol!

Poulsen 1MW Arc transmitter 1920



Military

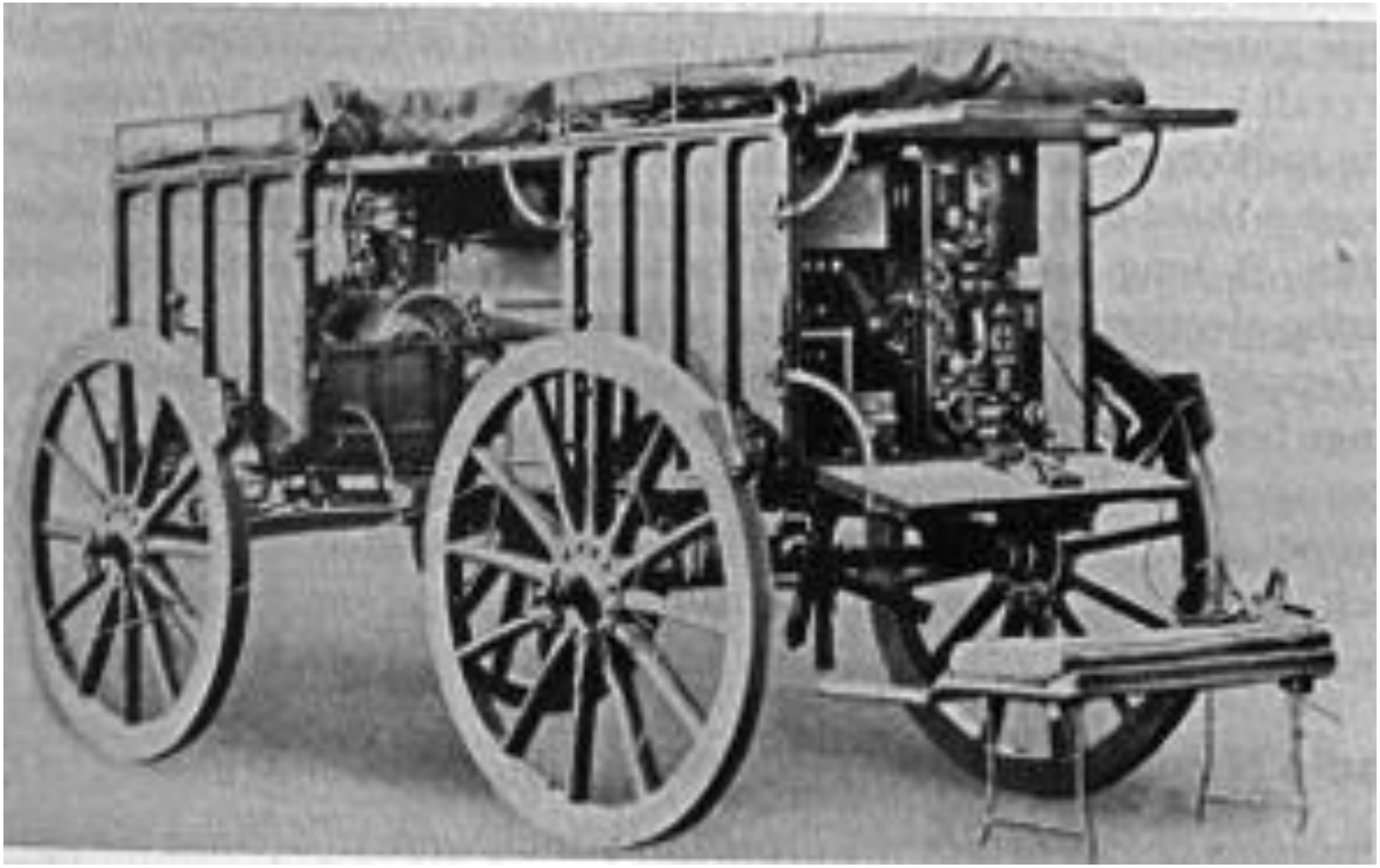
- 1914 UK cut German lines of communications
- Germans cut British lines to colonies through Turkey
- Marconi building furiously to re-connect Empire
- 1916 Levy – supersonic modulation of carrier - secrecy
- Frequency hopping “Change Tune”
- Tx ban 1917 – 1919
- Admiralty Room 40 – decryption
  - German inducement to Mexico
  - Promised Texas, new Mexico and Arizona
  - Brought US into WW1

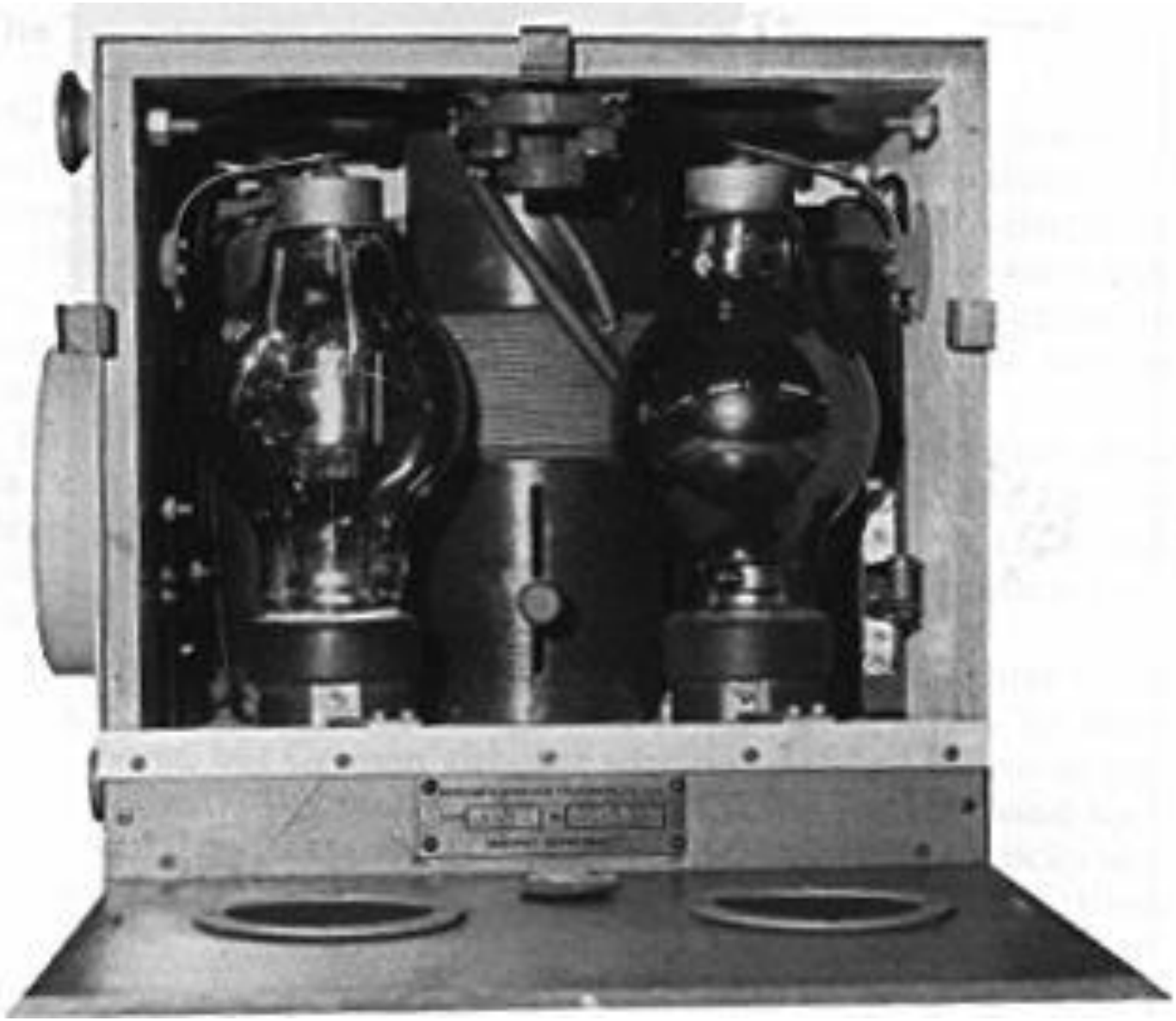
PORTABLE MILITARY STATIONS

(*See* pp. 378–385).

1	2	3	4	5	6	7	8	9
Type.	Description of Station.	Output of Generator in Kilowatts.	Guaranteed Range over flat Country.	Approx. maximum Range.	Normal time of erection in minutes.	Number of Horses or Mules required for transport.	Total Gross Weight of complete Station.	Height of Masts.
K	Knapsack	·04	6 miles 10 kms.	12 miles 20 kms.	6	By Hand	86 lbs. 39 kgs.	30 ft.† 9 m.
A	Pack	·5	30 miles 50 kms.	50 miles 80 kms.	10	4	804 lbs. 365 kgs.	30 ft. 9 m.
A1	Pack (Special)	·5	50 miles 85 kms.	80 miles 130 kms.	20	5	969 lbs. 431 kgs.	54 ft. 17 m.
C	Handcart	·5	30 miles 50 kms.	50 miles 80 kms.	10	1	1,157 lbs. 526 kgs.	30 ft. 9 m.
F	Cart	1·5	150 miles 250 kms.	250 miles 410 kms.	20	4 or 8	5,024 lbs. 2,284 kgs.	70 ft. 21 m.
H	Motor-Car	1·5	150 miles 250 kms.	250 miles 410 kms.	20	15-20 h.p. Motor	7,600 lbs.* 3,455 kgs.	70 ft. 21 m.
G	Semi-Portable	1·5‡	150 miles 250 kms.	250 miles 410 kms.	360	—	1,400 lbs. 600 kgs.	—§
L	Aeroplane	·04	6 miles 10 kms.	12 miles 20 kms.	—	—	50 lbs. 25 kgs.	—
L1	Aeroplane	·5	50 miles 85 kms.	80 miles 130 kms.	—	—	200 lbs. 90 kgs.	—
M	Dirigible	1·5	200 miles 335 kms.	300 miles 495 kms.	—	—	500 lbs. 225 kgs.	—
B	Cabinet	·5‖	75 miles 125 kms.	150 miles 250 kms.	—	—	350 lbs. 160 kgs.	—§
H1	Motor-Car	·5	85 miles 140 kms.	150 miles 250 kms.	20	20–25 h.p. Motor-Car	4,430 lbs. 2,013 kgs.	70 ft.
H2	Motor-Car	3	200 miles 335 kms.	300 miles 495 kms.	20	20–25 h.p. Motor-Car	7,800 lbs. 3,545 kgs.	70 ft.

* Including personnel. † One mast. ‡ If 70-ft. masts are used. ‖ If 50-ft. masts are used.
None supplied unless called for.





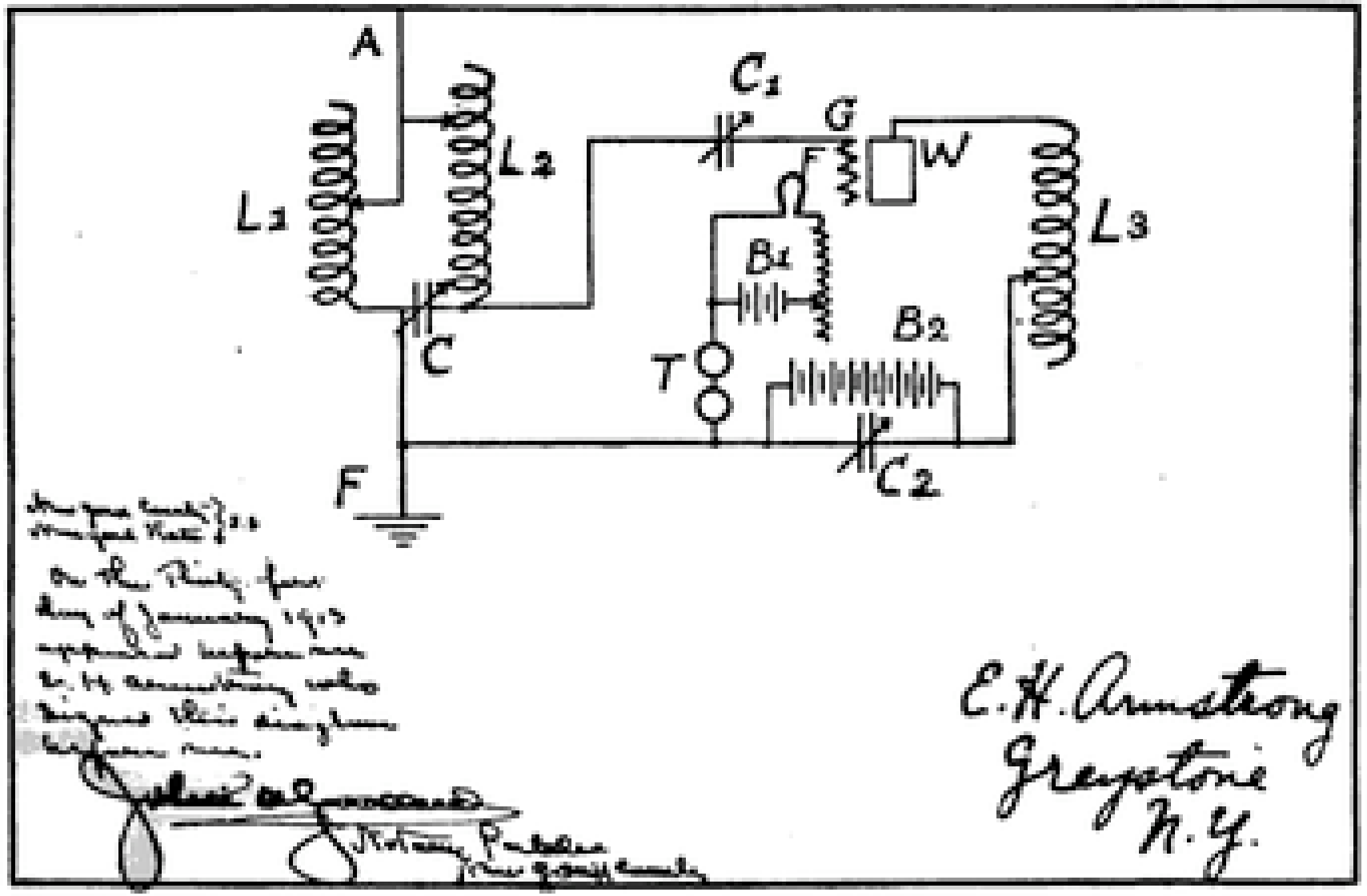
Knowledge of propagation

- Inverse square law of radiation 1604
- Applied to wireless
  - Diffraction does not explain
- 1902 iononsphere - Heaviside layer
- 1910 Skywaves
- Ionisation by sun-rays
  - Day - night differences
- Knowledge of SW propagation starts 1923

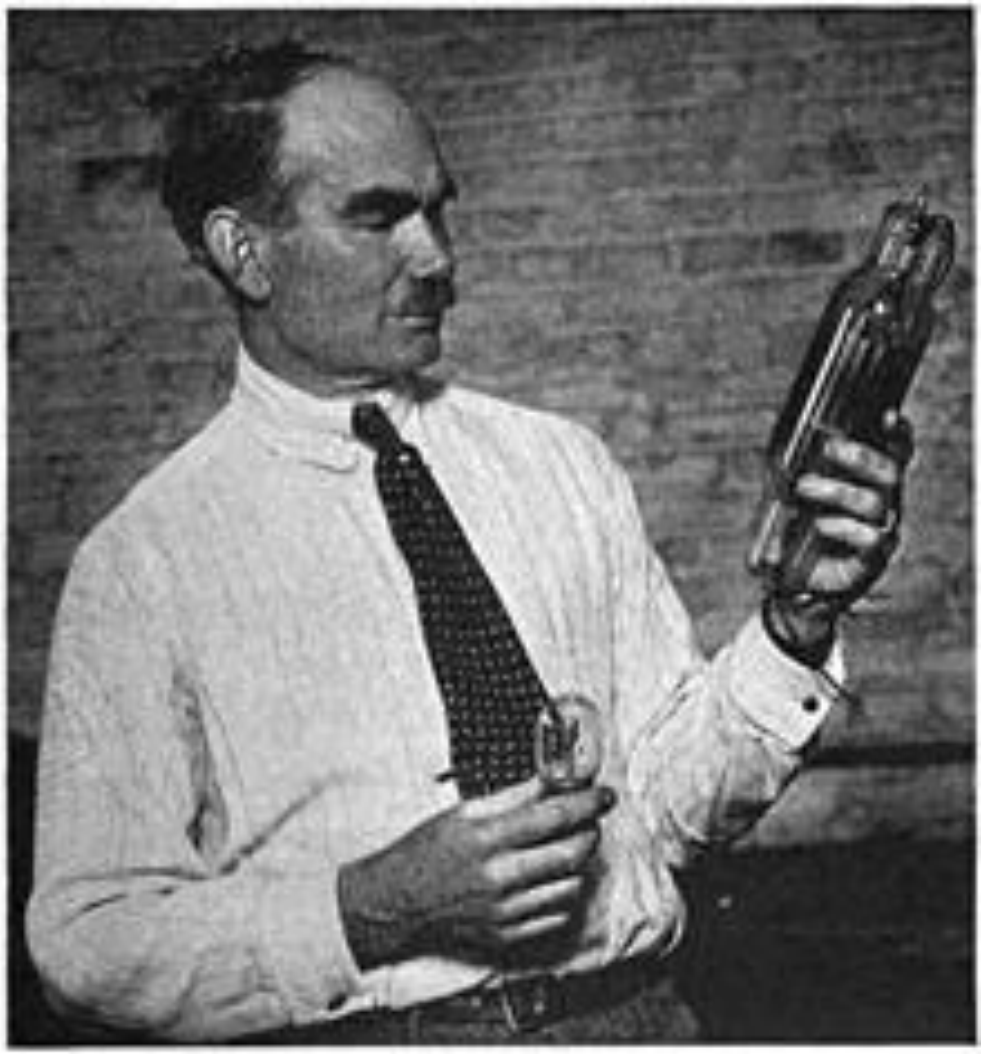
Patent wars

- Fessenden 500 patents. Fight with RCA
- US grabs all wireless patents 1917
- Gave them all to RCA 1919
- Regeneration
  - De Forest 1914
  - Armstrong 1916
  - Fight in supreme court lasted 12 years. Remains controversial
- Armstrong v RCA
  - 90% of his life spent on this!
  - Arguably caused his suicide
  - David Sarnof “I did not kill Armstrong”

THE ORIGINAL DRAWING OF THE FEED-BACK CIRCUIT WHICH LARGELY DETERMINED THE COURT IN ARMSTRONG'S FAVOR



Circa 1920 De Forrest with two valves



Wireless patents in force 1897-1912

form the [illegible] telegraphy extracted from these records.

Figure 1 shows the total number of patents accepted and

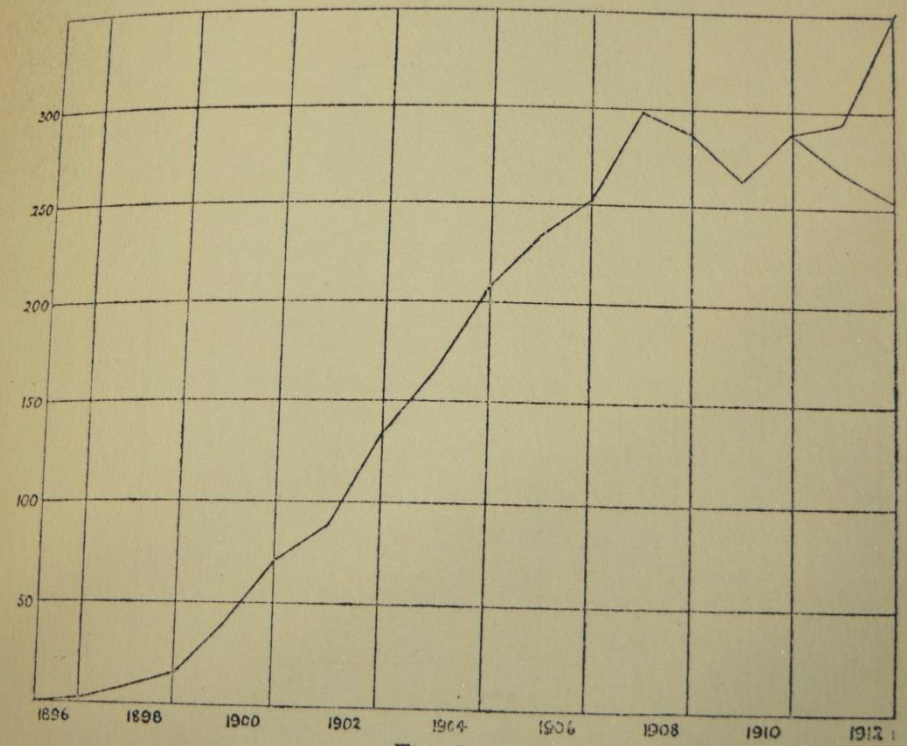


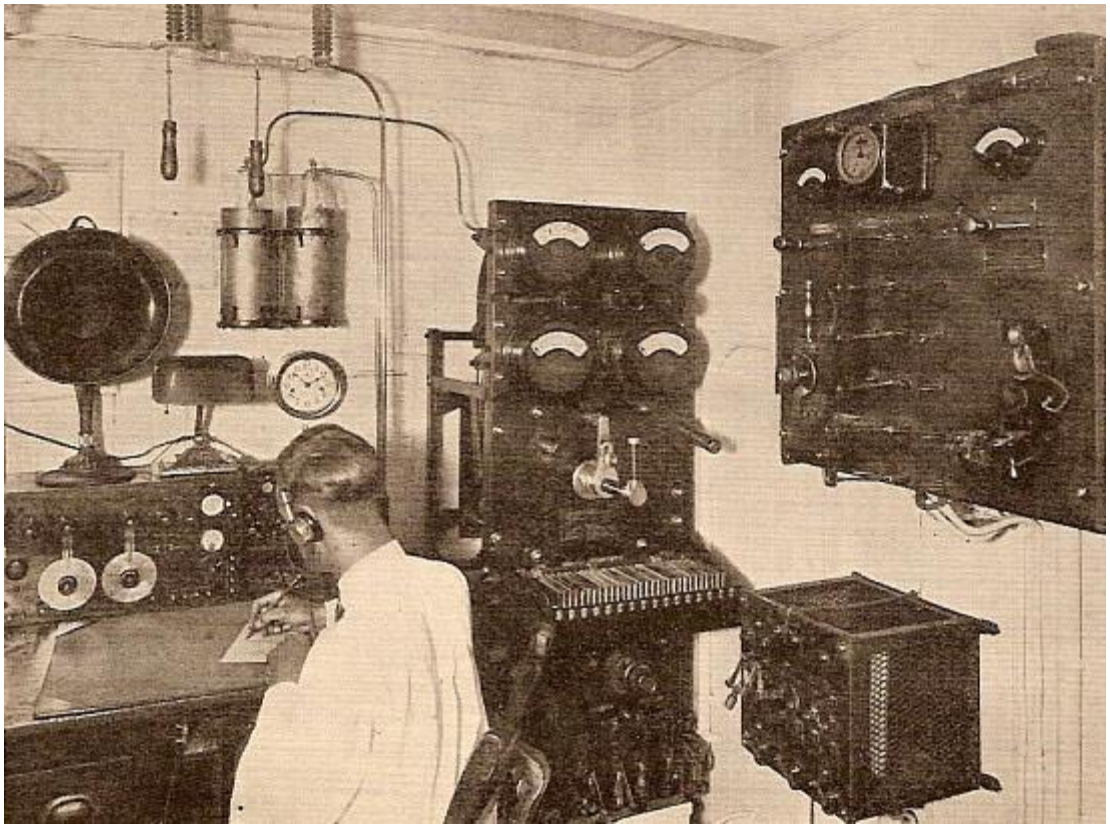
Fig. 1.

still in force from 1896, when wireless telegraphy was born

Advances during the 1920's

- 1924 - Data bandwidth
- Boradcasting
- Licencing of key patents
  - Regeneration
  - Superheterodyne
- Hiding by immersion in wax
- Tax
  - Receiver licence
  - Rated by number of valves
  - Leads to combined valves

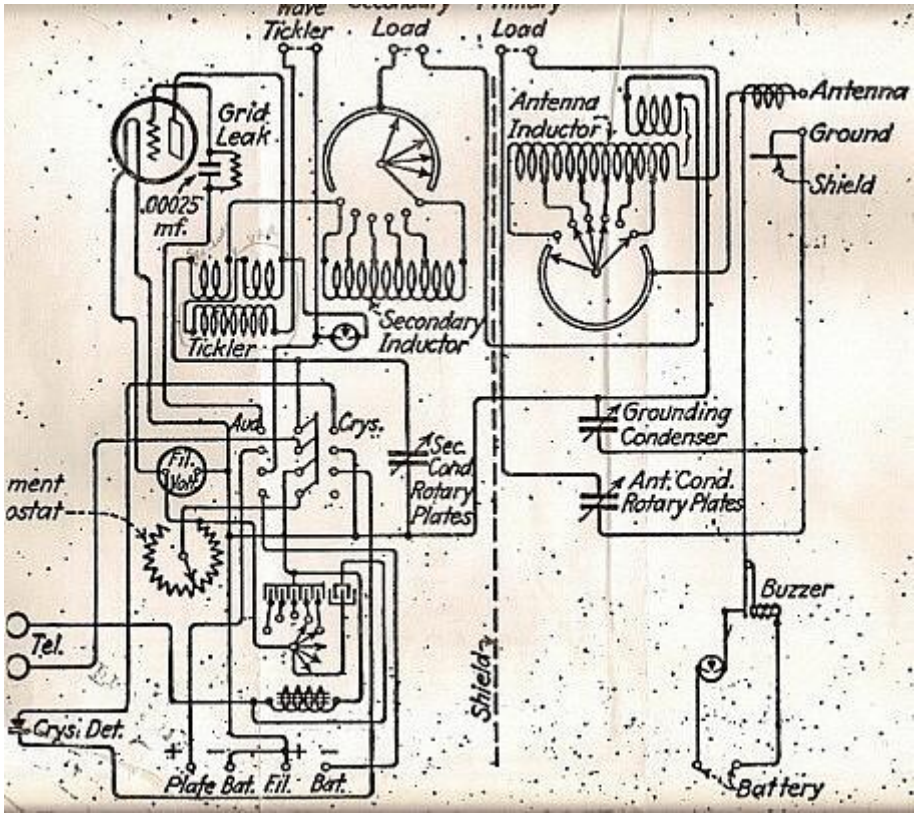
Shipboard radio room

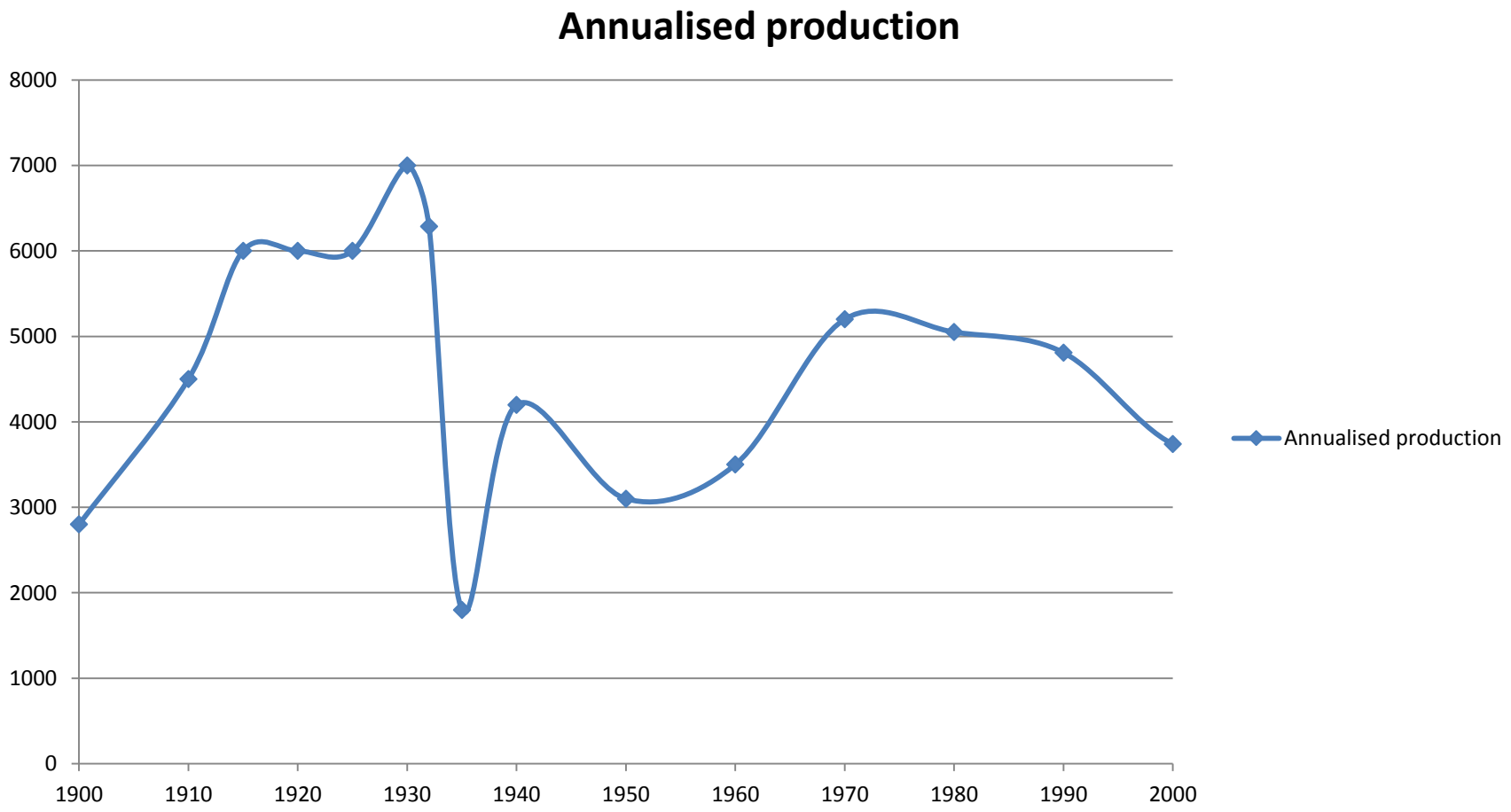


1920 shipboard receiver

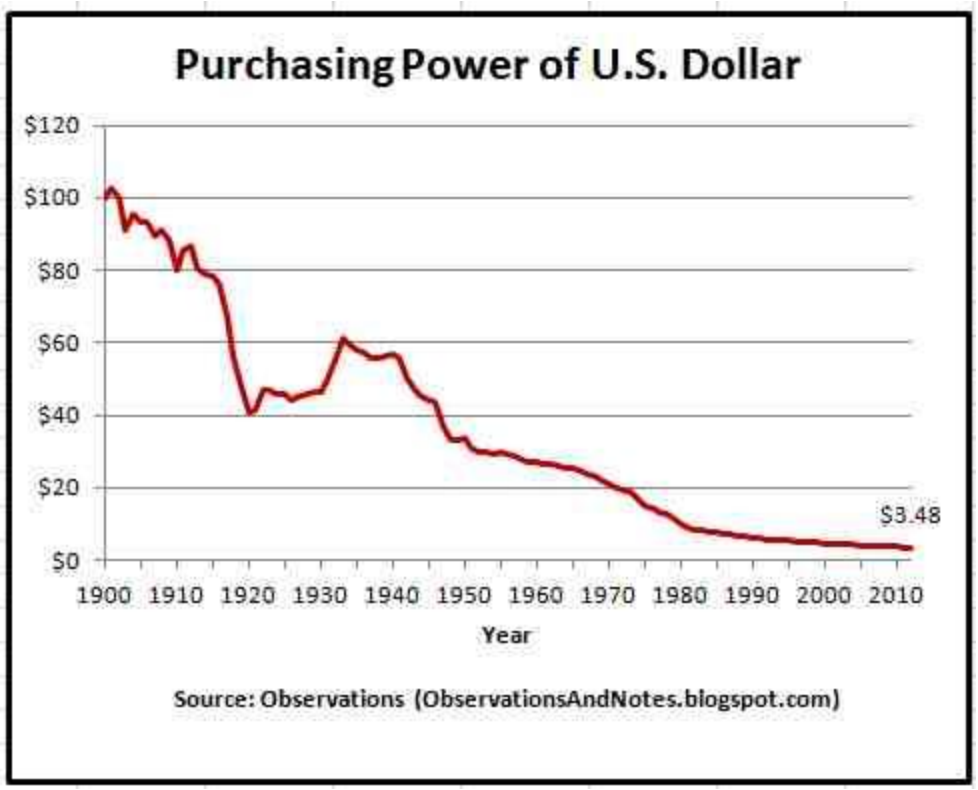
1920 army receiver

1920 receiver circuit




Annualised production
8000
7000
6000
5000
4000
3000
2000
1000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Annualised production

Steinway village


Purchasing Power of U.S. Dollar
$120
$100
$80
$60
$40
$20
$0
$3.48
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
Year
Source: Observations (ObservationsAndNotes.blogspot.com)

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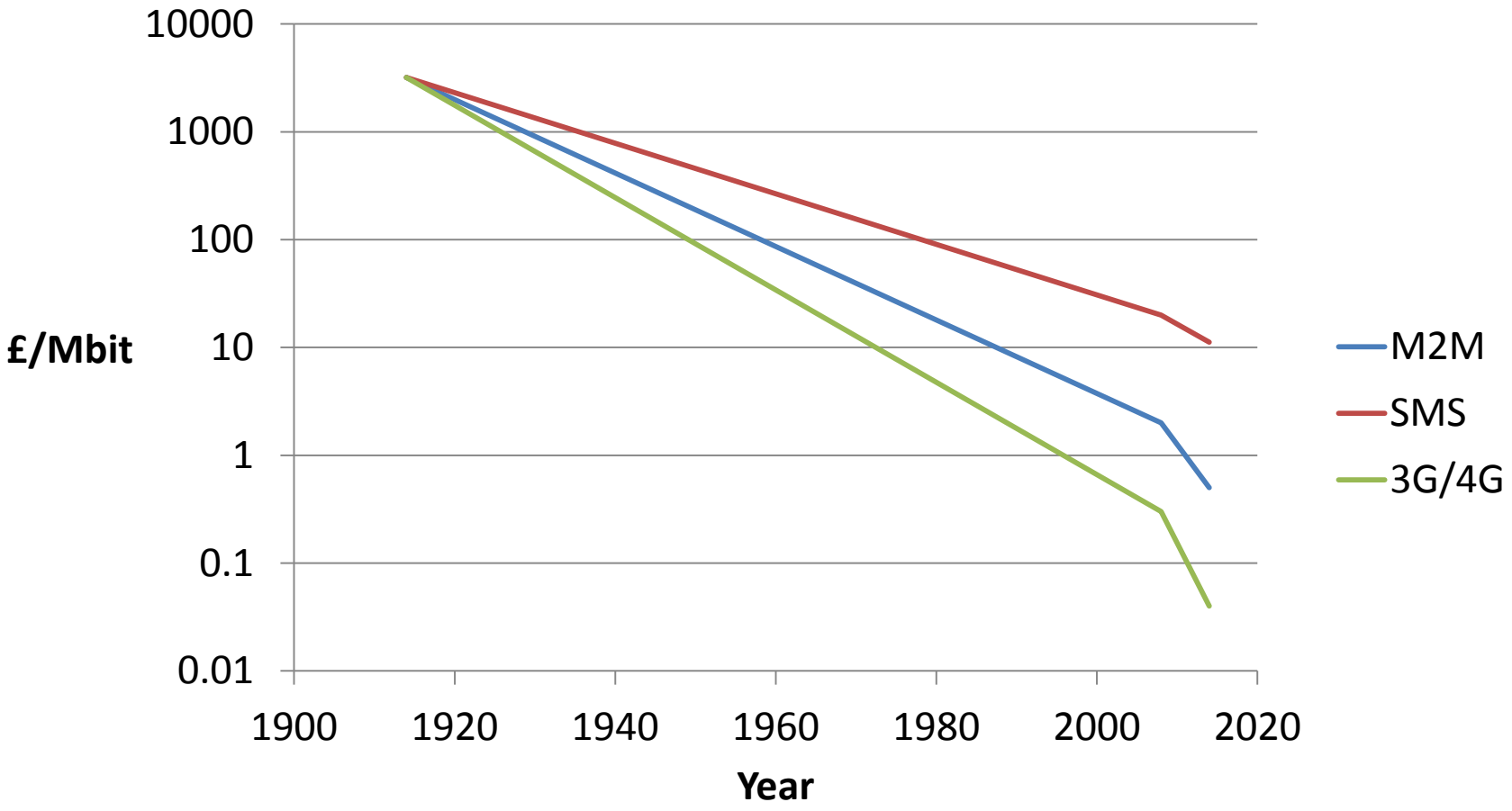
Wireless data: 1914-2014



Transmission mode lifetimes

AM	1920	2014	94
SSB	1930	2014	84
Analogue TV	1936	2010	74
CW	1920	1990	70
FM broadcast	1955	2014	59
TELEX	1933	1990	57
OFDM	1957	2014	57
2G	1990	2014	24
AMPS	1978	2000	22
Spark	1900	1920	20
PHS	1995	2011	16
TACS	1985	2000	15
CT2	1986	1996	10

End