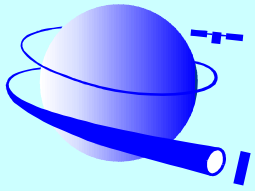


TELECOMMUNICATION
ENGINEERING

UNIVERSITY
of
TWENTE

The History of Telecommunications

Part I:

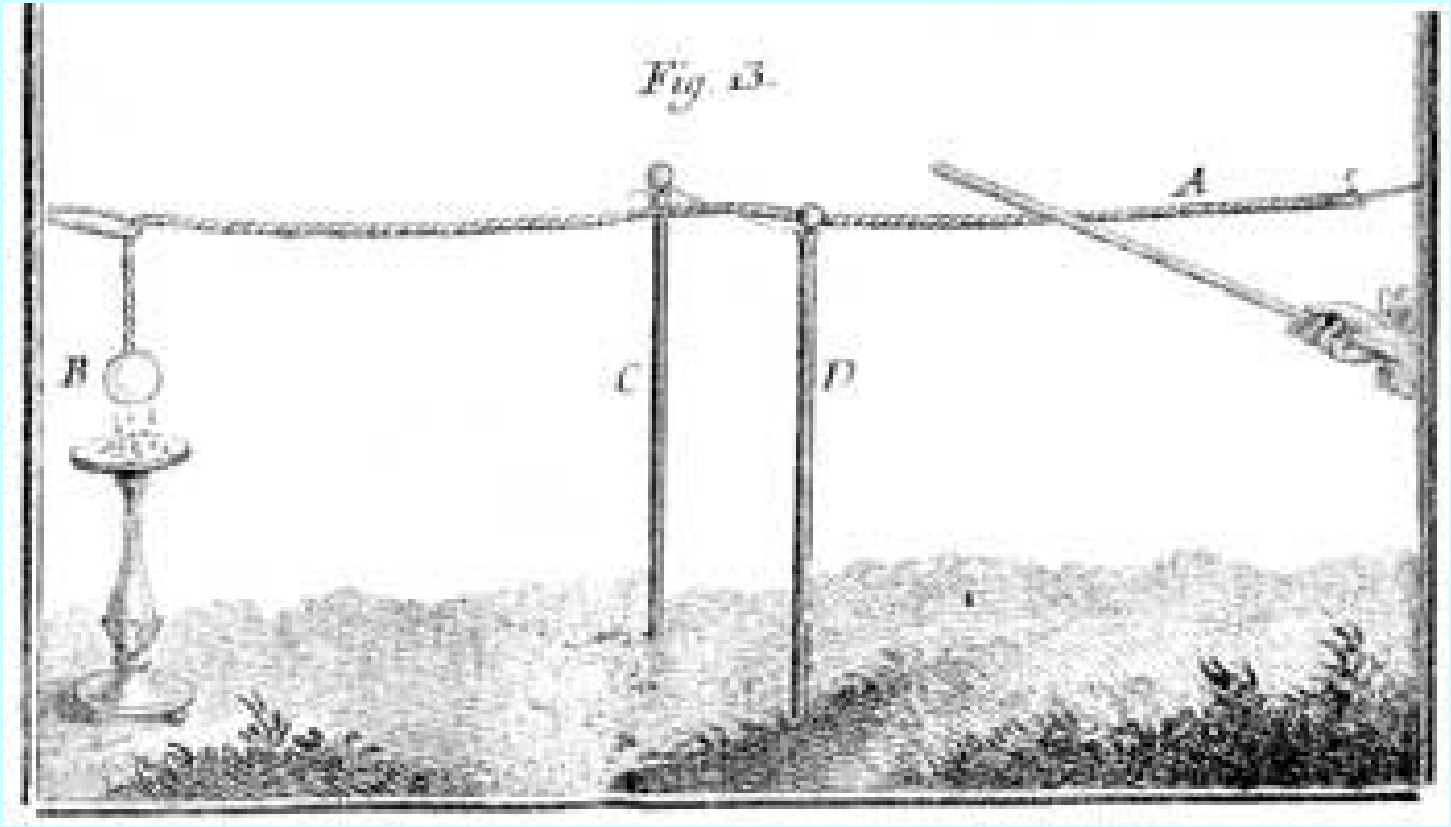
The Telegraph and its Inventors

by

Wim van Etten

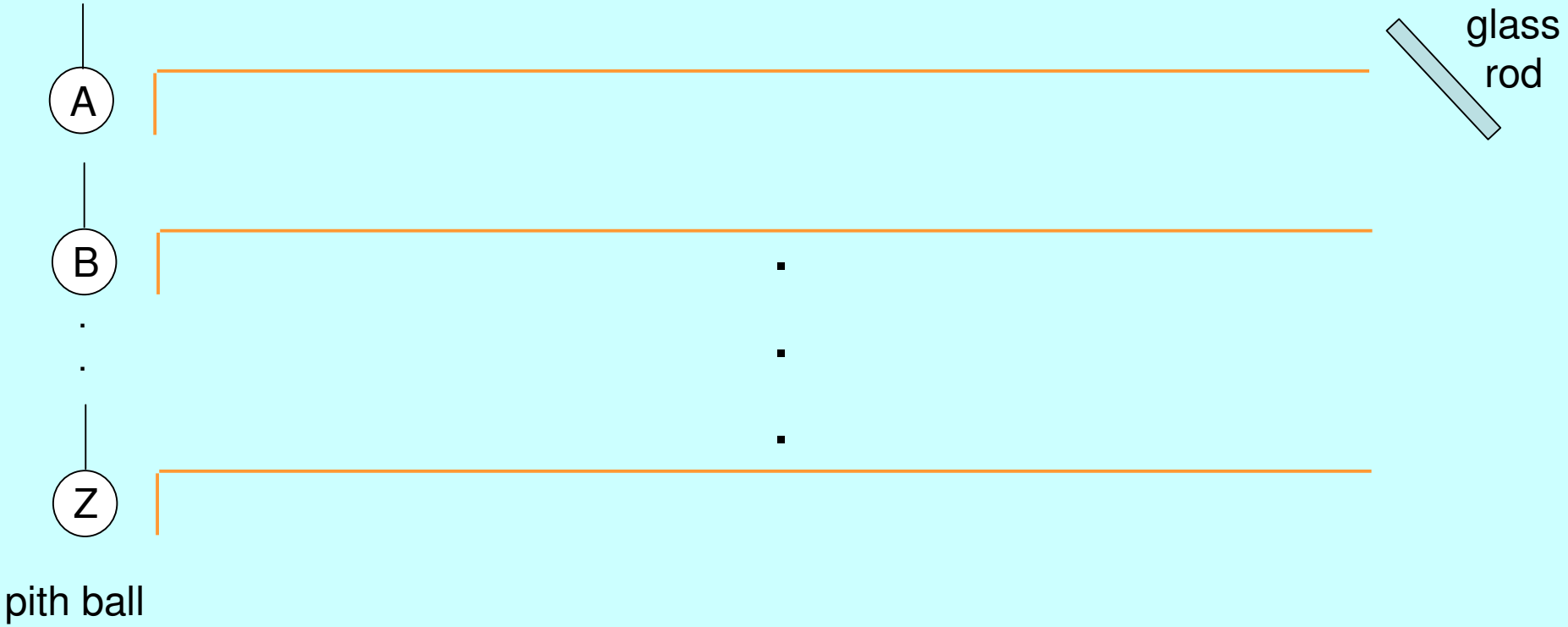
Electrostatic experiments

1729: Stephen Gray



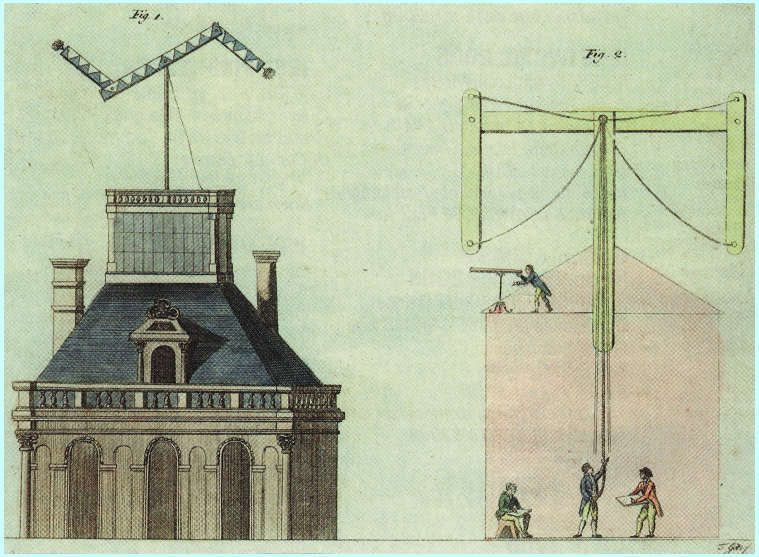
Electrostatic telegraph

17 February 1753: proposal in the “Scotch Magazine”

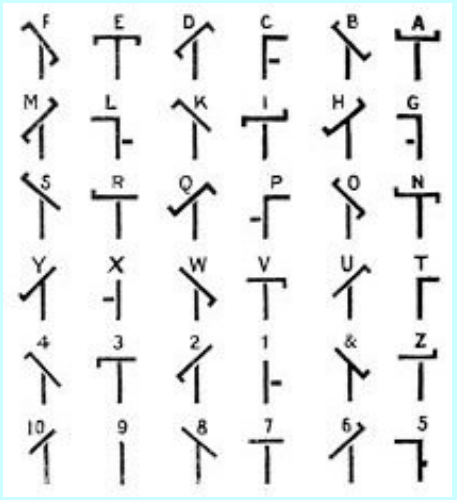


1787: Bétancourt spanned a distance of 42 km between Madrid and Aranjuez

Semaphore telegraph of Chappe (1793)



Telegraph



Chappe's alphabet

Claude Chappe
(1763-1805)

Electrochemical telegraph (1809)

1809: von Sömmering

26 parallel wires causing bubbles in a fluid

due to chemical reaction under influence

of electrical current

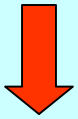
Electromagnetism

1800 Volta: chemical pile (battery)
⇒ electrical current

1820 Ørsted: electrical current ⇨ magnetism
Ampère proposes electromagnetic telegraph

1825 Sturgeon: produces an electromagnet
for the first time

1835 Henry: produces a relay for the first time



prerequisite for electromagnetic telegraph

Volta

Alessandro Volta
(1745 - 1827)

- Italian physicist know for pioneering work in electricity
- professor of physics University of Pavia
- experimented on ignition of gases by an electric spark
- developed the voltaic pile, forerunner of the battery, based on the work of Galvani;
- the battery of Volta used copper and zinc as electrodes with sulphuric acid as electrolyte
- discovered Volta's law: $Q = CV$
- the SI unit of electrical potential difference, volt (V), is named after him

Ørsted

Hans Christian Ørsted
(1777 – 1851)

- Danish physicist and chemist
- professor at the University of Copenhagen
- discovered relationship between electricity and magnetism
- produced aluminum for the first time
- in the CGS system the unit of magnetic induction, oersted, is named after him

Ampère

André-Marie Ampère
(1775 – 1836)

- French physicist
- professor of physics and chemistry University of Bourg
- professor of mathematics polytechnic Paris
- explained the discovery of Ørsted
- SI unit of electrical current, ampère, is named after him

Sturgeon

William Sturgeon
(1783 - 1850)

- English physicist and inventor
- made the first electromagnets
- invented the first practical DC electric motor incorporating a commutator
- invented a galvanometer

Henry

Joseph Henry
(1797 – 1878)

- American scientist
- professor of mathematics and natural philosophy
- discovered the phenomenon of self-inductance
- discovered the mutual inductance, though Faraday was the first to publish this result
- improved the magnets developed by Surgeon to make them much more powerful
- worked also in the fields of astronomy and acoustics
- the SI unit of inductance, henry, is named after him

Pioneers of the telegraph

1833 Gauss & Weber: mirror galvanometer telegraph

1835 Steinheil: 2-needle telegraph

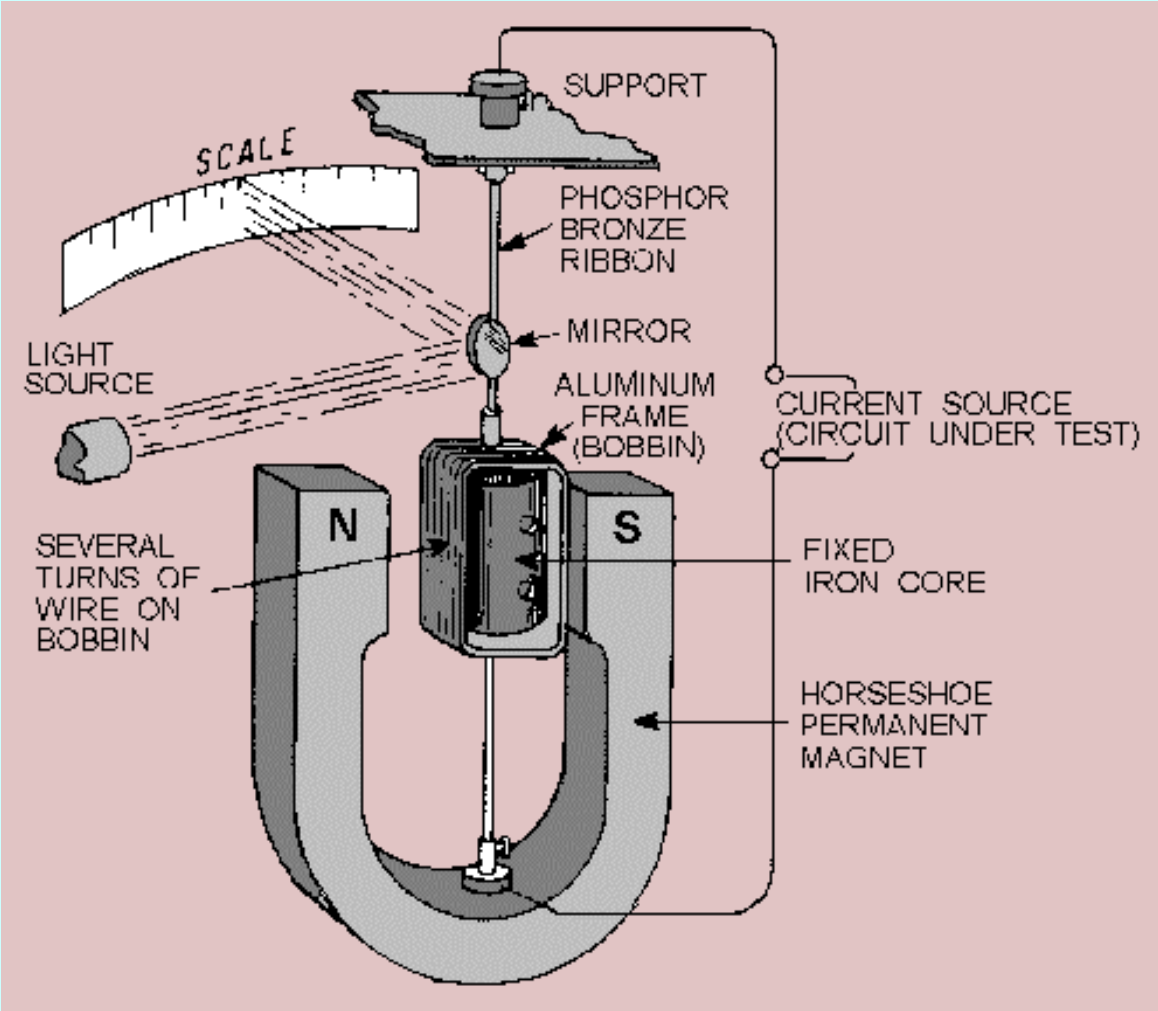
} Germany

1837 Wheatstone & Cooke: improved needle telegraph (1-needle and 5-needle versions) — Great Britain

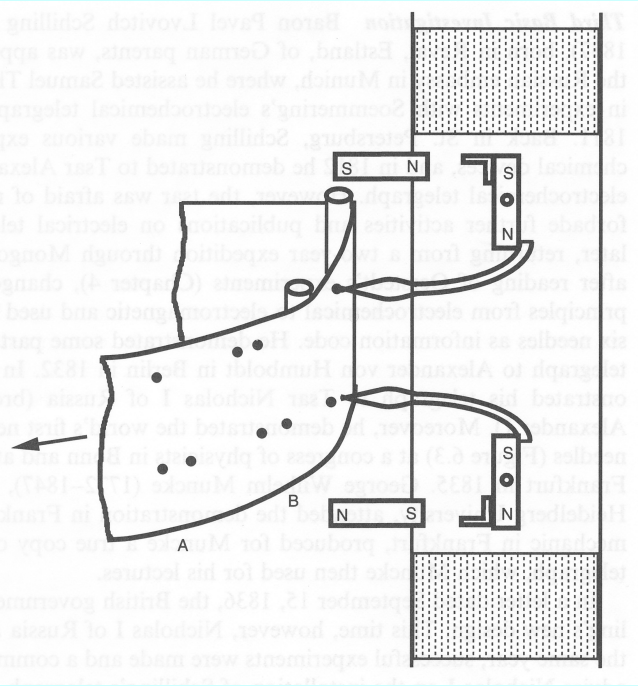
1838 Morse & Vail: inking paper tape telegraph (and Morse code) — U.S.

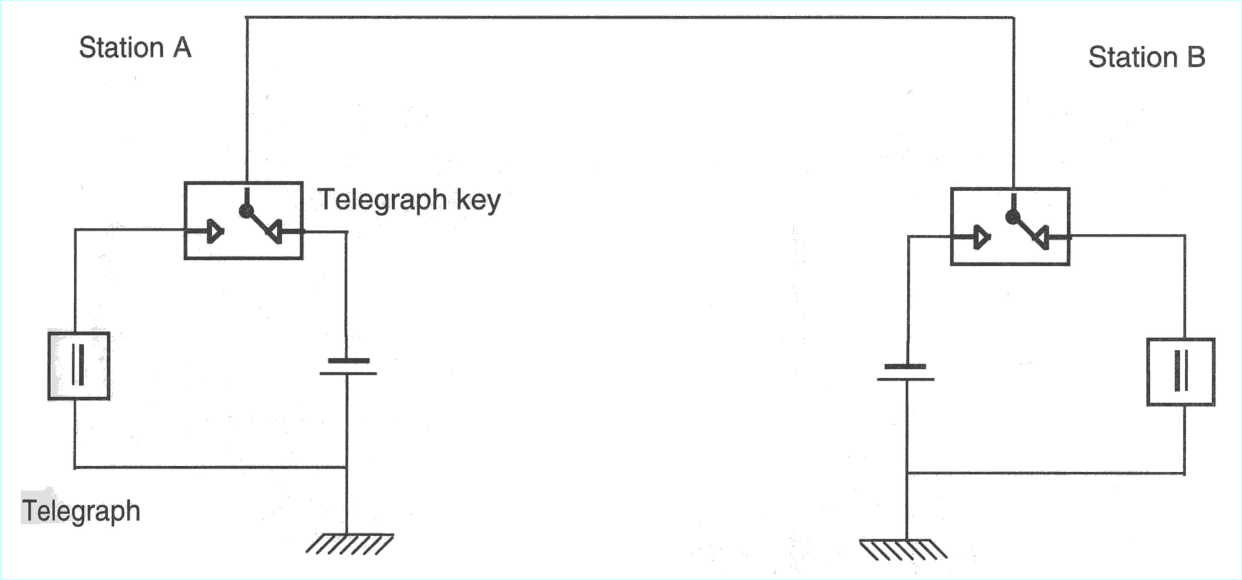
1865 Foundation of the ITU (International Telegraph Union), later on renamed as International Telecommunication Union

Mirror galvanometer



2-needle telegraph (Steinheil)





1-needle telegraph (Wheatstone & Cooke)

5-needle telegraph (Wheatstone & Cooke)

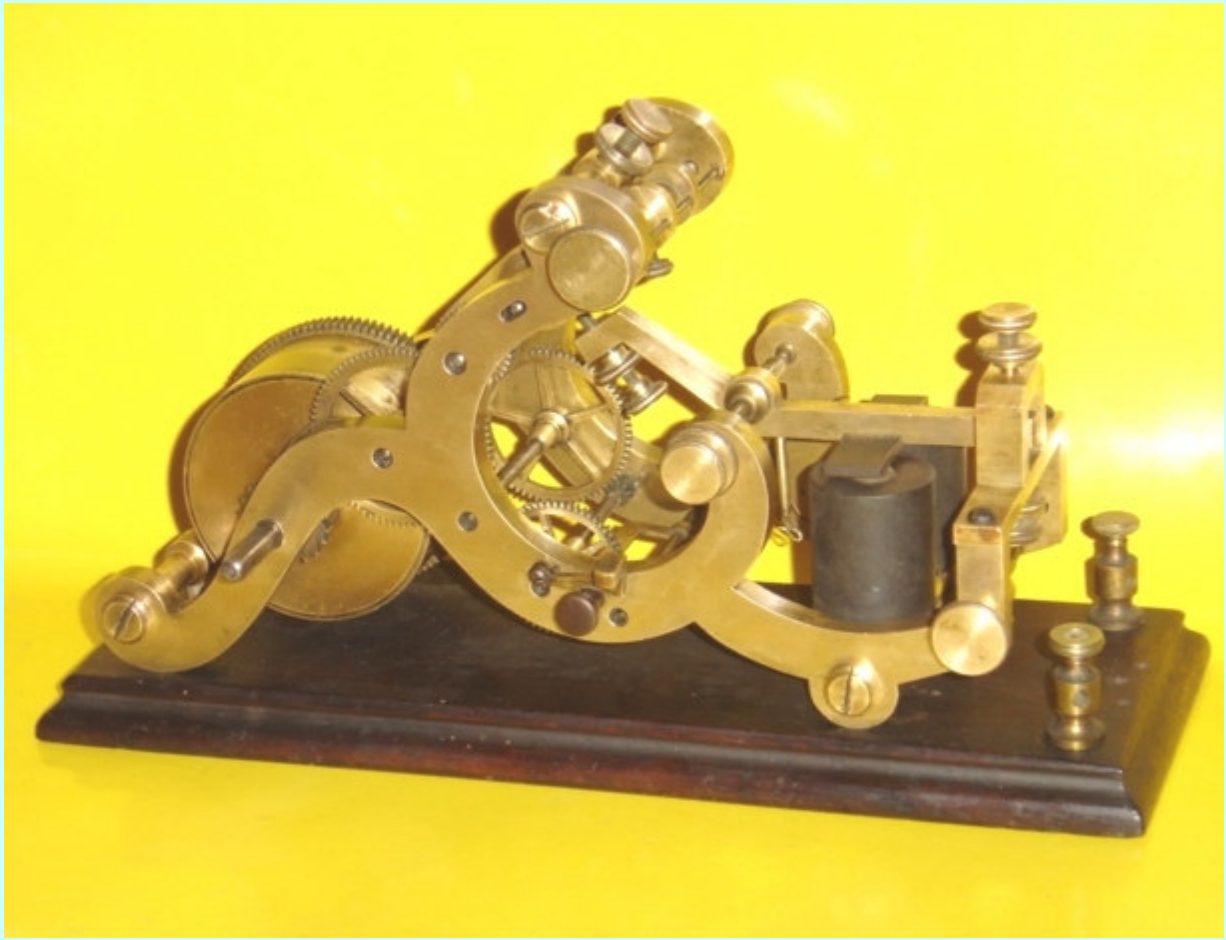
Dial telegraph (Breguet)

Transmitter

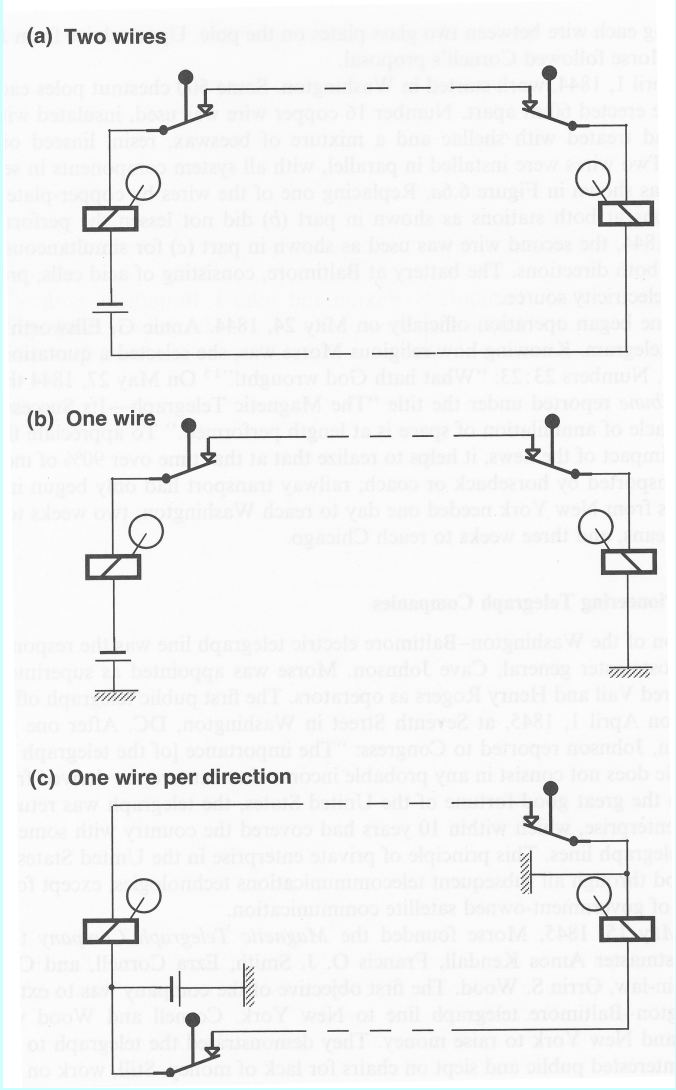
Receiver

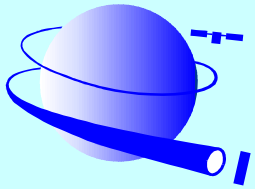
Dial telegraphs

Early Morse telegraph



Morse schemes





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Morse alphabet

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Character	Morse	Character	Morse	Number	Morse	Punctuation		Morse
A	·—	N	—·	0	—————	.	period	·–·—·—
B	–···	O	———	1	·————	,	comma	——··——
C	—·—·	P	·——·	2	··———	?	question mark	··——··
D	—··	Q	——·—	3	···——	-	dash	—····—
E	·	R	·—·	4	····—	/	slash	—··—·
F	··—·	S	···	5	·····	:	colon	———···
G	——·	T	—	6	—····	'	apostrophe	·————·
H	····	U	··—	7	——···	)	right parenthesis	—·——·—
I	··	V	···—	8	———··	;	semicolon	—·—·—
J	·———	W	·——	9	————·	(	left parenthesis	—·——·
K	—·—	X	—··—			=	sign of equality	—···—
L	·—··	Y	—·——					
M	——	Z	——··					

Compare to Huffman code

Hughes telegraph (1858)

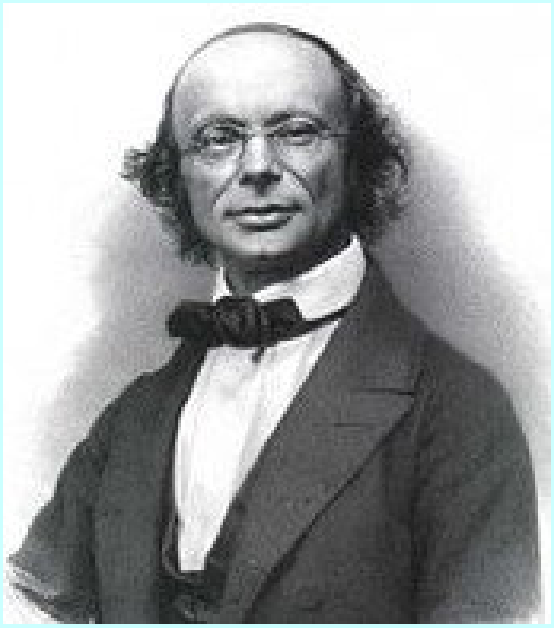
- provides direct printing of alphabetic characters
- characters are produced by alphabetic keyboard

Gauss

Carl Friedrich Gauss
(1777-1855)

- German scientist: professor at the University of Göttingen
- probably the greatest mathematician ever
- contributed to: number theory, statistics, analysis, differential and integration calculus, geometry, electrostatics, geodesy, astronomy and optics
- cooperated with Wilhelm Weber on magnetism
- the two constructed the first telegraph in 1833
- the CGS unit of magnetic induction was named gauss in his honour

Weber



Wilhelm Eduard Weber
(1804-1891)

- German physicist
- professor at the University of Göttingen
- studied magnetism with Gauss
- cooperated with Gauss to develop the first telegraph
- SI unit of magnetic flux, the weber, is named after him

Steinheil

Carl August von Steinheil
(1801-1870)

- professor of physics and mathematics
  University of Munich
- used silver chloride to make pictures in negative
- designed 2 needle telegraph
- designed telegraph network for Austria and Switzerland
- founded optical-astronomical company: telescopes, spectroscopes, photometers (which he invented), refractors and reflectors

Wheatstone

Charles Wheatstone
(1802-1875)

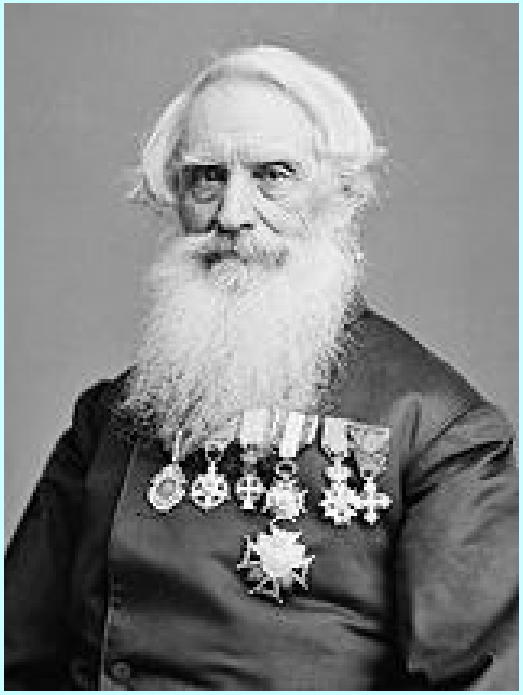
- British scientist and inventor
- invented a.o. stereoscope, Playfair cipher technique, Wheatstone bridge
- major contribution to telegraphy together with Cooke
- patented the dial telegraph

Cooke

William Cooke
(1806-1879)

- initially in the army
- while traveling in Germany saw telegraph
- made own design of telegraph
- lacked theoretical knowledge
- cooperated with the scientist Wheatstone
- later on the two got a difference about who mainly contributed

Morse



Samual Morse
(1791-1872)

- originally an American painter of portraits
- co-inventor, with Alfred Vail, of the Morse code
- developed the concept of single wire telegraph
- Morse telegraph was officially adopted as standard for European telegraphy in 1851
- did not get full credits for his inventions in US
- gave large sums to charity

Vail

Alfred Vail
(1807-1859)

- American technician and inventor
- with Morse he was the central person in developing and commercializing the telegraph
- responsible for several innovations of Morse's system
- there has been a controversy who invented Morse's code, Vail or Morse
- left the telegraph industry in 1848, due to lack of credits for his contributions

Hughes

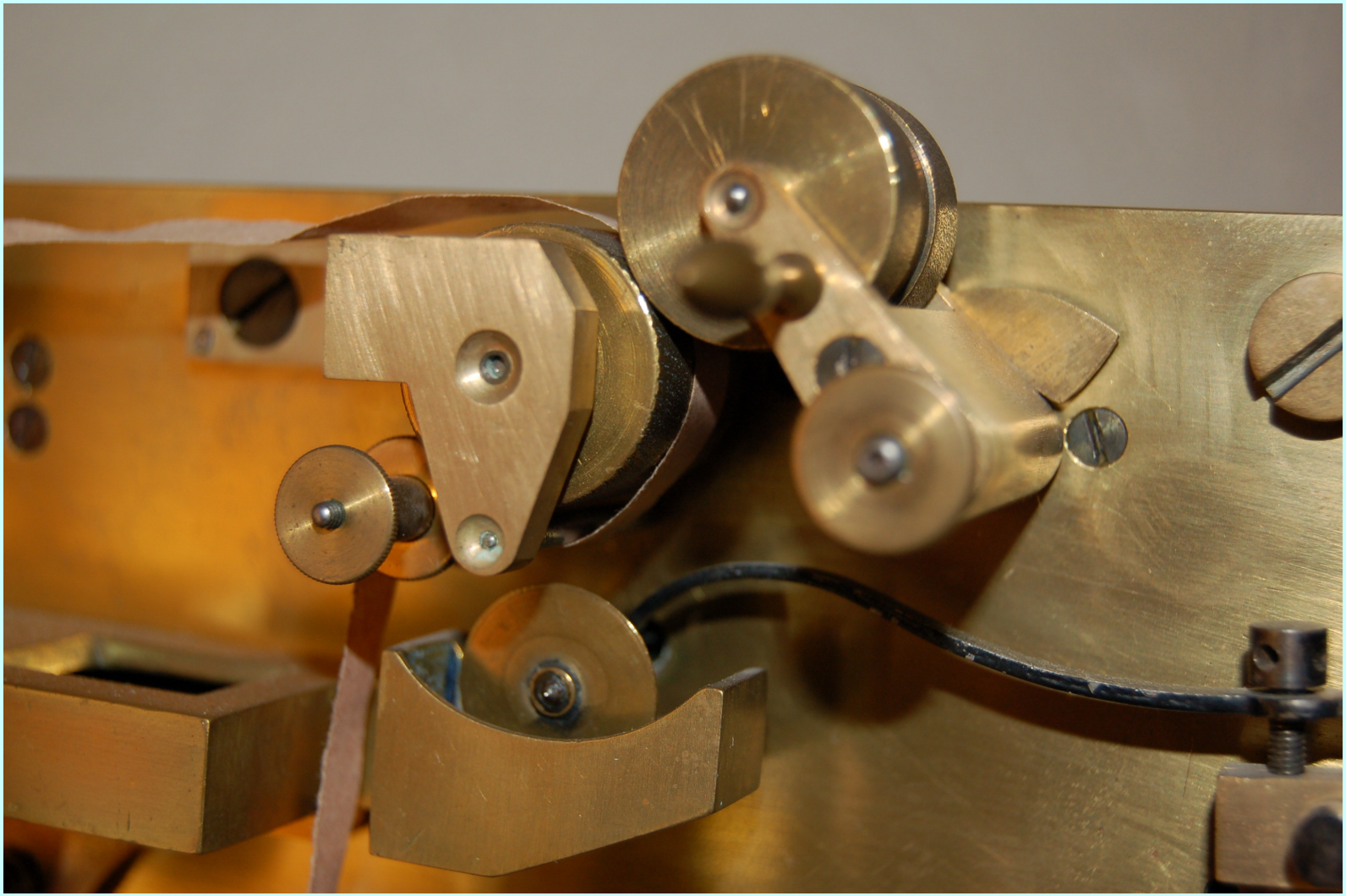
David Hughes
(1831-1900)

- English citizen, who emigrated to US as a young man,
- professor of music and natural philosophy
- besides experimental physicist in electricity and signals
- improved Edison's carbon microphone
- transmitted Morse code using radio waves via induction
- patented his telegraph system in the US in 1858

Telegraph with top reel (1900)

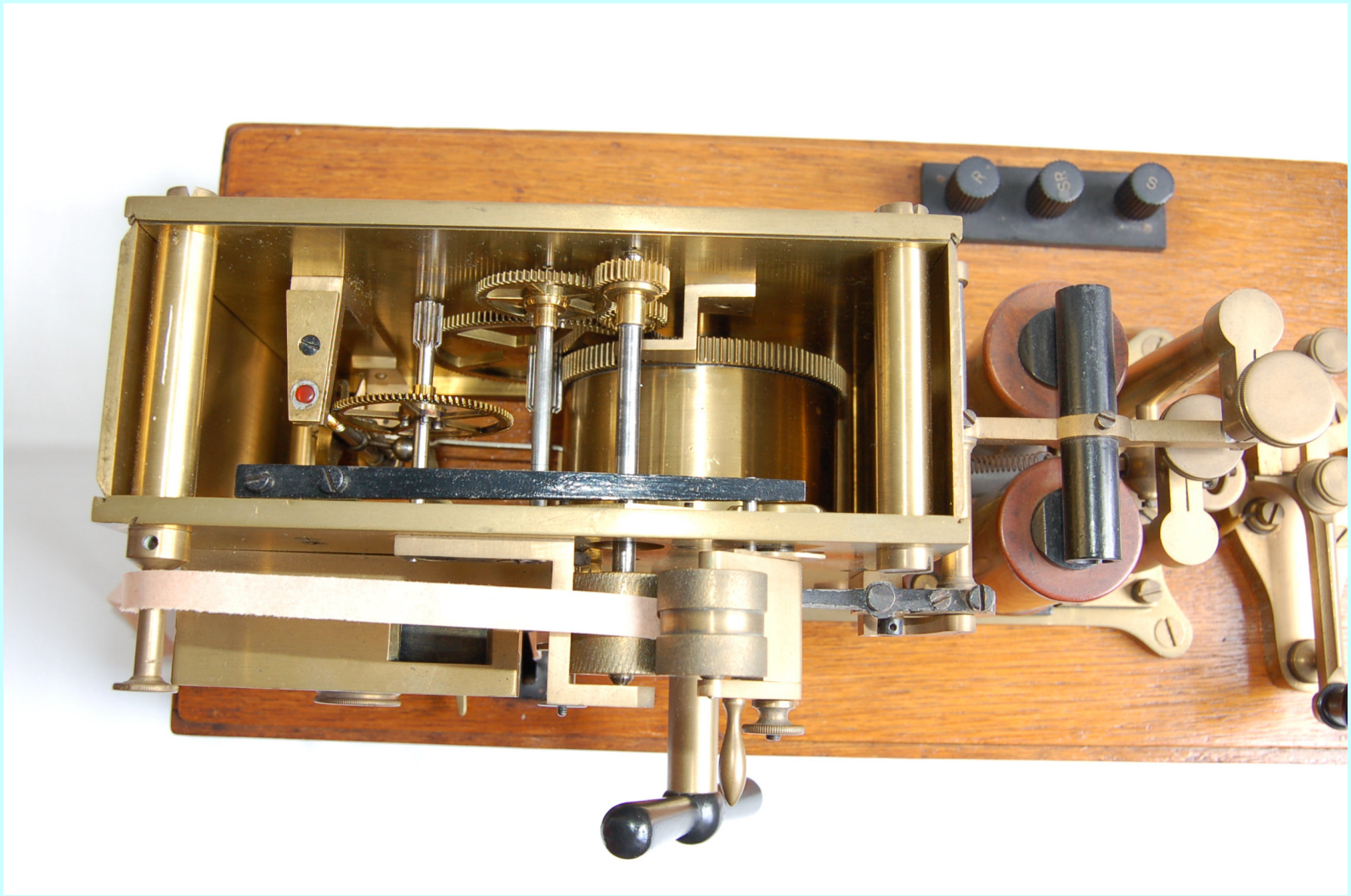
Siemens & Halske telegraph 1880 (overall view)

Siemens & Halske telegraph (tape transport)



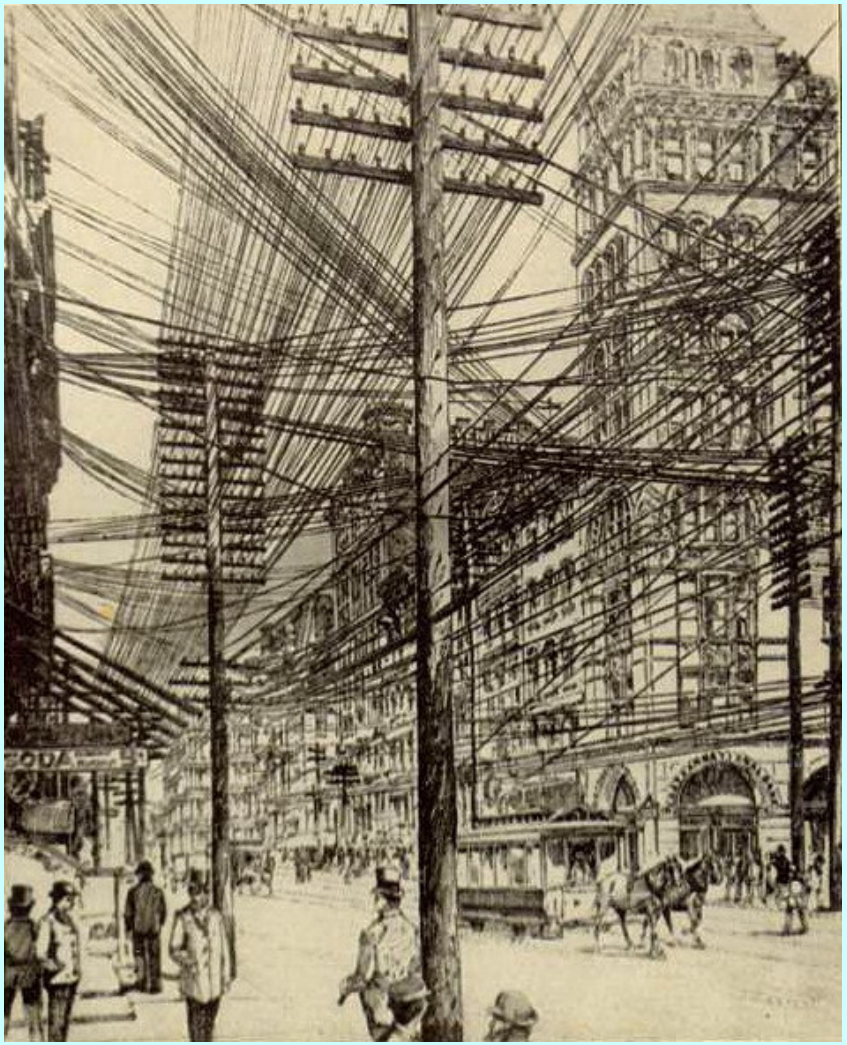
Siemens & Halske telegraph (coils and repeater)

Siemens & Halske telegraph (clockwork)



Telegraph cables I

- Initially isolated iron wires
- Later on copper wires as overhead lines on poles

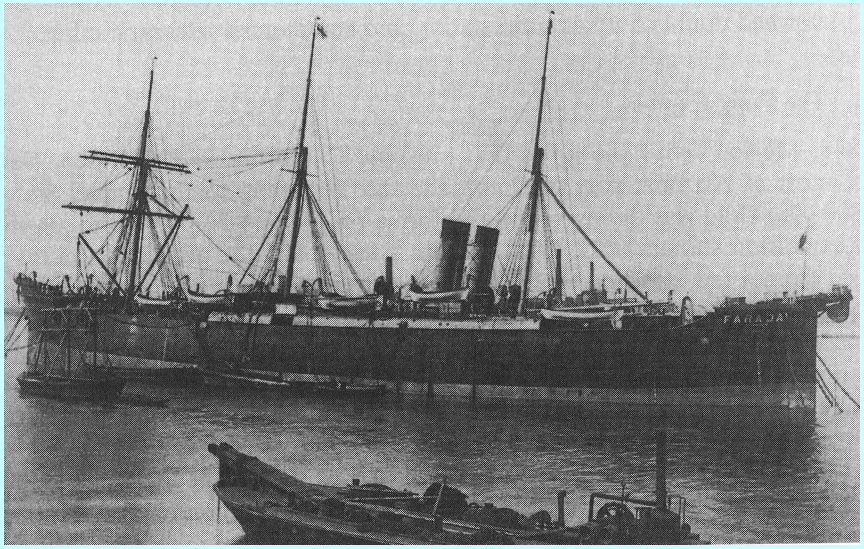


Broadway, New York, 1890

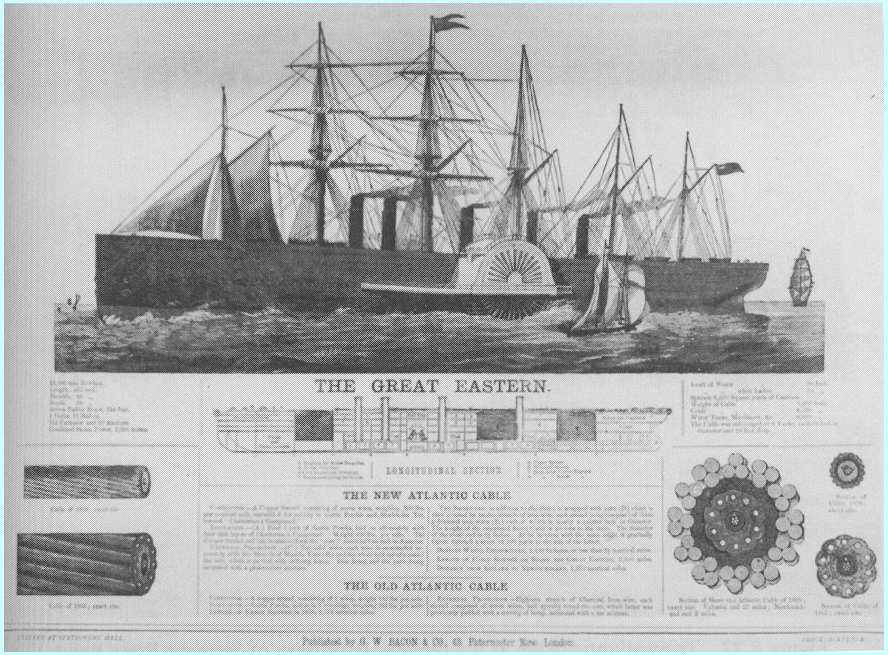
Telegraph cables II

1850/51: first cable across the Channel (Europe/Great Britain)

1858/66: first transatlantic cable (Europe/U.S.)

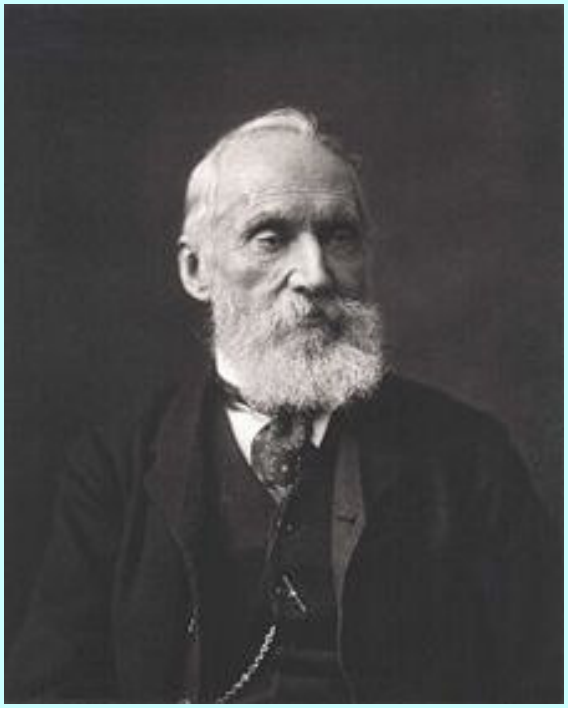


Faraday:
first ship designed for cable laying



Great Eastern:
laid the first trans Atlantic cable

Thomson



William Thomson (1824-1907)
later: Lord Kelvin

- Irish mathematical physicist and engineer
- professor at Glasgow University
- did important work in: mathematical analysis, electricity and thermodynamics

<u>Enabled transatlantic telegraphy by:</u>

- improving cable design
- modeling the cable laying process
- modeling transmission quality (data rate)
- designing more sensitive receivers (siphon receiver)

Cable resume

- The Morse telegraph remained the most widely used
- The telegraph was used until the fifties of last century
- In 1956 the first transatlantic telephone cable was laid;

  until then telegraphy was the only fixed line

  transatlantic telecommunication service

Radio telegraphy

1873 James Clerk Maxwell: EM theory

1887 Heinrich Hertz: experimental proof of EM theory

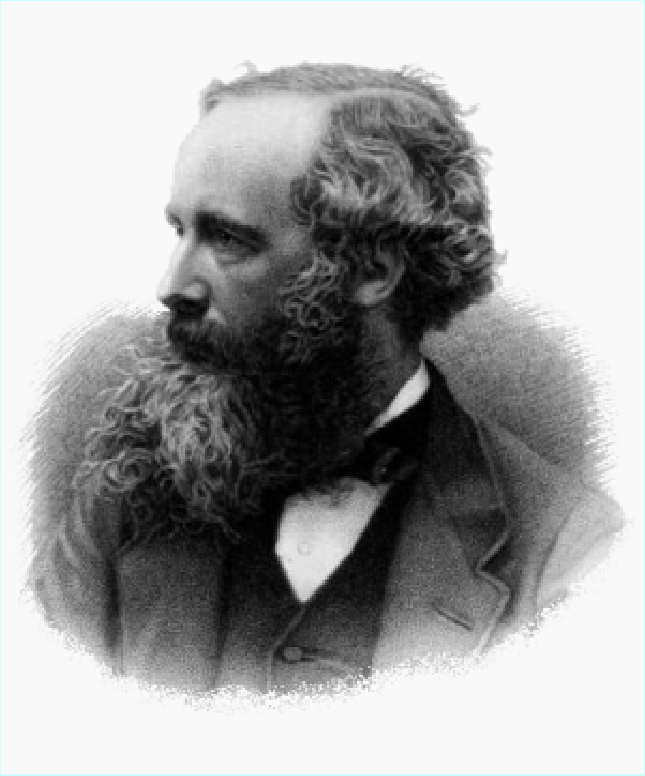
1896 Guglielmo Marconi: first patent on radio telegraphy

1899 English Channel crossed by radio signal

1900 First radio telegraphy service in Europe (mainly maritime)

1902 First transatlantic radio telegraphy message (3500 km)

Maxwell



James Clerk Maxwell
(1831-1879)

- Scottish mathematician and theoretical physicist
- professor at University of Aberdeen, King's College London and University of Cambridge (erected Cavendish Laboratory)
- famous for developing electromagnetic theory (Maxwell's equations) in 1873
- proposed that light is an em wave
- developed kinetic gas theory (Maxwell distribution)
- created the first colour photograph (1861)
- concluded that Saturn's rings comprise numerous small particles; this was confirmed by Voyager flyby (1980)
- CGS unit of magnetic flux, the maxwell (Mw), was named after him

Hertz

Heinrich Hertz
(1857-1894)

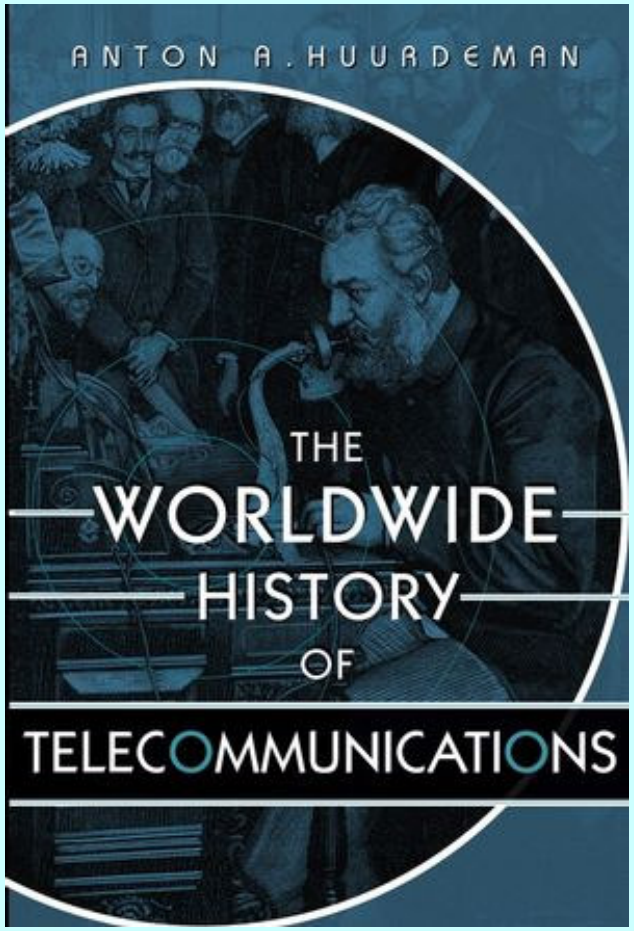
- German physicist
- professor at the University of Karlsruhe
- demonstrated that Maxwell's theory was right
- showed that em waves travel
- observed photoelectric effect
- produced and received em waves
  for the first time (1887) by a spark gap
- developed the dipole antenna
- demonstrated that velocity of light equals em waves
- his experiments explain: reflection, refraction,
  polarization, interference and velocity of em waves
- not aware of practical importance of his work
- the SI unit for frequency, Hertz (Hz), was established
  in his honour

Marconi

Guglielmo Marconi
(1874-1937)

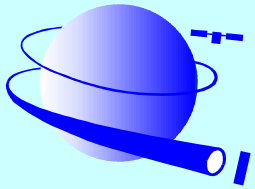
- Italian inventor
- Nobel Prize (1909) with Karl Ferdinand Braun
- developed radio telegraphy
- did not discover any new principle, but used, improved and combined results of others
- founded “Wireless Telegraph and Signal Company”, later named “Marconi Wireless Telegraph Company” (1900)
- commercialized radio
- several lawsuits against him on patent infringements (a.o. Lodge, Dolbear, Popov, Tesla, Lee de Forest)
- joined the Italian Fascist Party in 1923

References



Wiley: 2003

- Wikipedia
- “The Worldwide History of Telecommunications” by Anton Huurdeman
- “The Electromagnetic Telegraph” by J.B. Calvert
- “Guglielmo Marconi 1874-1937” Science Museum, London
- Pictures S&H telegraph: Kitty van Etten



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