

## Lecture 23. Constant Contact: from smoke signals to Wi-Fi

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*Note: the majority of vintage magazine images used in this lecture come from <http://www.magazineart.org/main.php/v/technical>*

### Introduction

The need to stay connected is one of the defining characteristics of our civilization. Together with other desires, such as conquering the seas and skies, of capturing and storing images and sounds, with hopes of travelling large distances within and beyond our world – the need to stay connected is one of the defining characteristics of our civilization. The goal to achieve interactive and instant communication anytime and in any place has been powering our social and technological evolution.

At present, wireless information and computer technologies allow us to satisfy our communication needs by providing a variety of instant and interactive communication methods from direct phone calls and teleconferencing, to electronic mail, text, and voice over IP services, such as Skype. But as with other computer and information technologies, our present and sophisticated communication technologies have not been invented overnight. They, too, culminate a long chain of events spanning centuries. In this lecture we look at the path taken by our civilization to achieve our present day digital communication competence.

## We won!

In summer of 490 BC, on the battlefield of Marathon, outnumbered Athenians defeated Persians. According to the legend of Marathon, an Athenian soldier by the name of Pheidippides (sometimes called Erchius, Eucles, or Philippides) was sent to Athens (some 43km from Marathon) to announce victory. He ran the entire distance without resting. When he finally arrived in Athens, he shouted "we won", then collapsed and died. If there were any long distance methods for instant communication, Pheidippides would just make a call, announce victory and enjoy the rest of the day. But, of course, we would not have the legend of Marathon and there would be no Marathon runs so popular around the world.



Fig. 1.: Statue of Pheidippides along the Marathon Road. Source: Hammer of the Gods27.

Before we continue our narrative, let us list some of the most desired features of technologies that provide infrastructure for inter-personal communication. We shall use this list to evaluate the various communication methods and technologies that we have developed over several centuries.

- instant ("real-time") communication ability,
- interactivity,

- distance independent,
- personal utilization,
- security,
- affordability.

## Smoke and light

Perhaps the oldest methods for long-distance communication were those that utilized our basic senses: hearing and seeing. Sending coded information using sounds, such as those produced using drums, and visual information, such as smoke signals, flags, light flashes are very old communication techniques used by cultures all over the world.



Fig. 2. Drum corps of the 93rd NY Infantry in Bealeton, Va in August 1863. Source: Library of Congress, LC-B817- 7514.

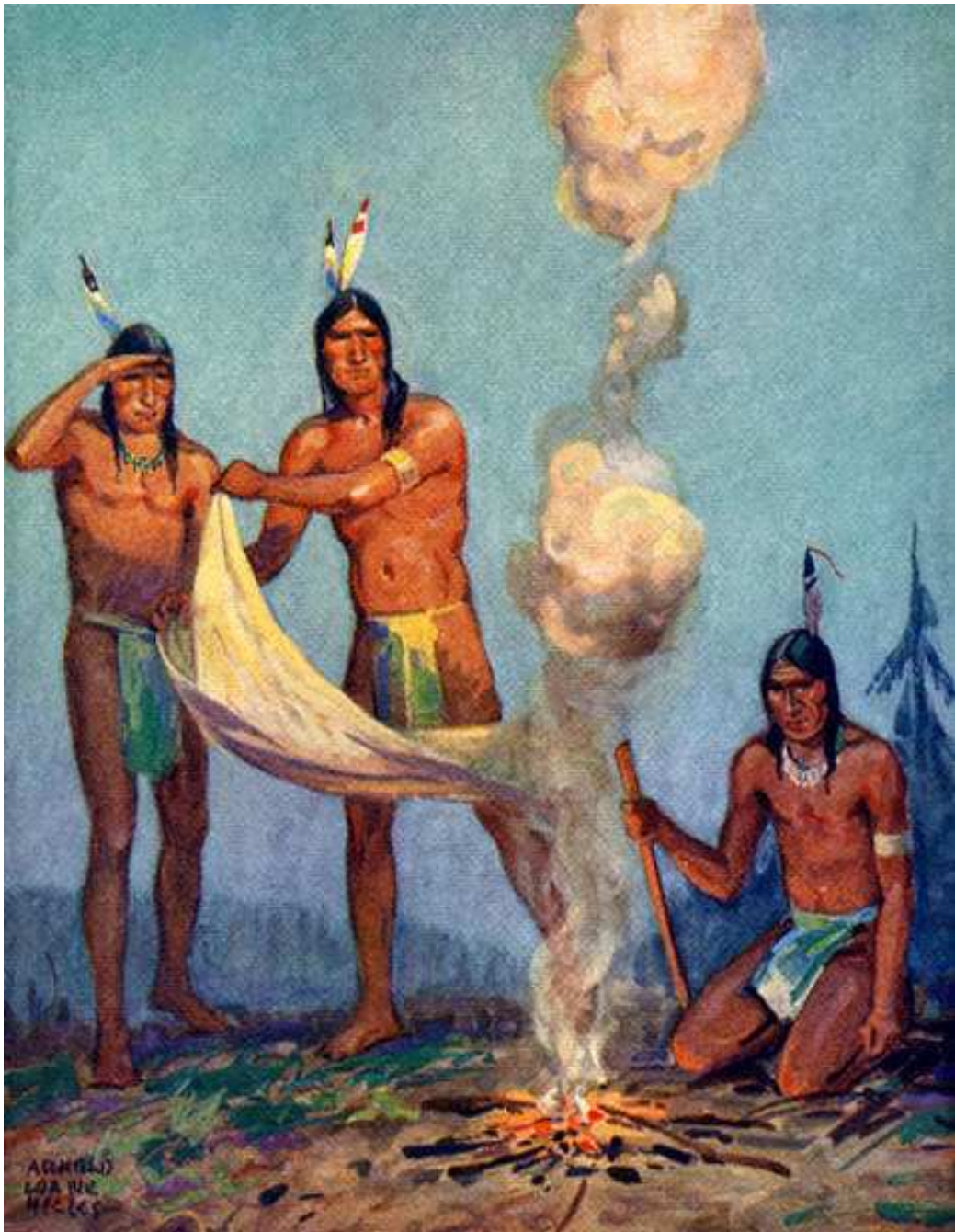


Fig. 3. Native American – smoke signals. Source: Eve Warren : A History of..., <http://e-warren1114-aho.blogspot.ca/>; author unknown.



Flag signals, i.e. coded information conveyed by displaying various flags, is one of the oldest ways employed by ships to communicate with each other at sea. This communication method is still in use.



Fig. 4.: "Signalman Second Class Shondon Martin, USN, communicates with U.S. Navy fast combat support ship USS Seattle using signal flags during an underway replenishment off the Virginia Capes." Source: Keeping USNS Patuxent Shipshape U.S. Navy's Military Sealift Command, May 2004; <http://www.msc.navy.mil/sealift/2004/May/shipshape.htm>; author and photographer unknown.

Apart from flags, light and sound signals (cannons, bells, whistles) have been in use for centuries. This small set of rules taken from the International Regulations for Preventing Collisions at Sea document (<http://cgate.co.il/eng/rules/tafrit.htm>) demonstrates the way sound signals are used today in sea navigation:

### **Sound and Light Signals Definitions Rules**

Manoeuvring and warning signals Rule 34

*When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorized or required by these Rules, shall indicate that manoeuvre by the following signals on her whistle*

- (one short blast) – I am altering my course to starboard
- (two short blasts) – I am altering my course to port
- (three short blasts) – I am operating astern propulsion

- - ○ – I intend to overtake you on your starboard side

- - ○○ – I intend to overtake you on your port side

- ○ - ○ – Agree

○○○○○ (at least five short and rapid blasts) – a vessel fails to understand the intentions or actions of the other.

Sound waves reach everybody in the neighbourhood of the source, so using sound signals is not a very secure method of communication. Furthermore, sound signals are restricted in its scope since the rapid transmission of several consecutive signals would result in a wave of noise from which no information could be derived reliably. The use of light signals proved to be a much faster and more directed method of rapid communication at sea. Since foggy weather affects visibility, both sound and light signals are still in use.



Fig. 5. "Quartermaster 2nd Class Tony Evans of Houston, Texas, sends Morse code signals from the bridge wing aboard the command ship USS Blue Ridge (LCC 19) to the Military Sealift Command (MSC) combat stores ship USNS Concord (T-AFS 5), during a replenishment at sea." (2005) Navy photo by Photographer's Mate 3rd Class Tucker M. Yates. [http://www.navy.mil/view\\_single.asp?id=22943](http://www.navy.mil/view_single.asp?id=22943)

## Communication powered by electricity

The relationship between humans and electricity has always been a mixture of caution, fear, mystery, and fascination. Early humans feared lightning (some of us do as well) as this form of atmospheric disturbances is capable of burning forests and instant killing. They were fascinated by the properties of amber which, when sufficiently rubbed against cloth, could produce tiny electric sparks, tiny lightnings.

Although the first scientific investigations into electricity and magnetism go back to the early 17th century (English physician William Gilbert started it all) it would take more than two centuries to understand these phenomena better and to apply them practically. By the mid 19th century we already knew how to generate, transmit, and store electricity. We started to understand the relationship between electricity and magnetism: a magnet moved inside a coil of wire would induce electricity in the wire; the same piece of wire coiled around a piece of metal turns into a magnet when the wire is carrying electrical current.

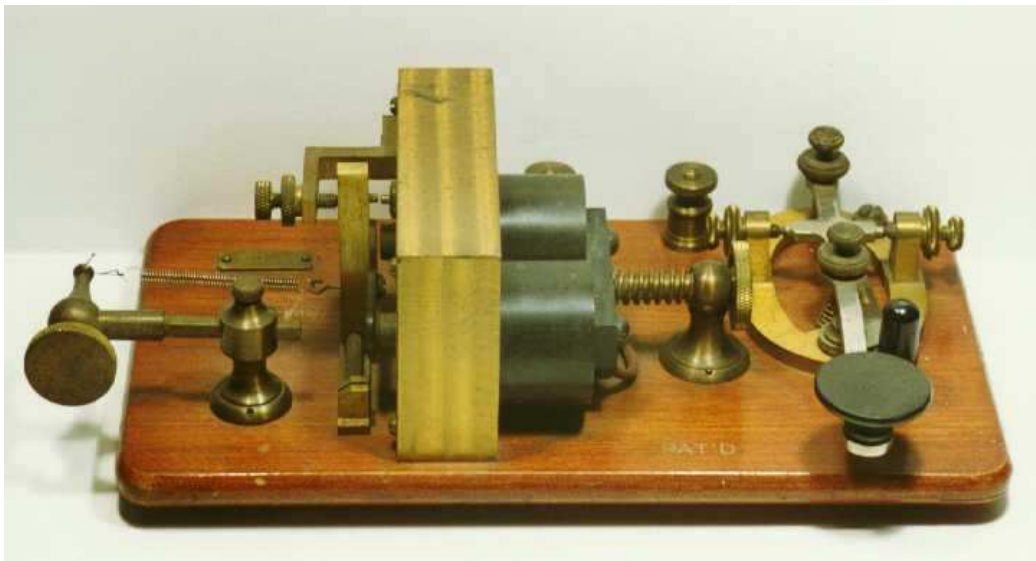


Fig. 6. Telegraph set with the key (right) and sounder (left) Source: <http://www.telegraphlore.com>.

Some of the first practical and most successful uses of electricity was in devices designed to send and receive information. The *telegraph* was designed



to transmit (send and receive) information over wires. These electrical signals represented encoded characters of a text and even images.

In the 1830s and 40s, a number of individuals developed and patented telegraphs in Europe and North America, including an American Samuel Morse whose inventions helped to wire the world for the telegraph communication.



Fig. 7. Samuel Morse demonstrates its telegraph. Source: unknown.

The success of the telegraph was achieved not so much by capturing the public's attention and in firing the public's interest in electricity but by proving its unrivalled usefulness in a time of peace and war.

During the American Civil War of 1861-1865, the president Abraham Lincoln was extensively using telegraph communication through the War Department Telegraph Office which he visited daily.  
(cf. <http://www.alincolnlearning.us/Civilwartelegraphing.html>)

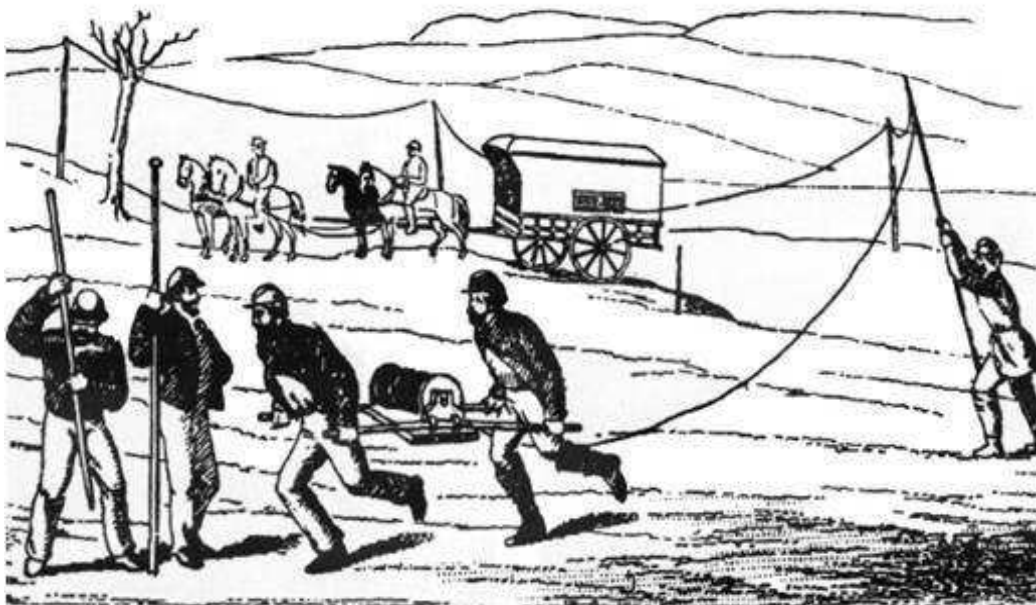


Fig. 8. Soldiers stringing temporary field lines-called "flying telegraph lines" during the Civil War Source: <http://signal.army.mil/history/history-telegraph.html>

During the war, Signal Corps of the Union Army established the US Military Telegraph which, in turn organized the "Telegraphic or Signal Train to accompany the Army on the march. The train would carry all the equipment needed for both aerial and electric signals and would include among its personnel "selected electric telegraphists.""  
(quote from <http://signal.army.mil/history/history-telegraph.html>)

By the early 20th century, the telegraph wires formed the first world wide communication web.



Fig. 9. According to Melanie Modlin, this photograph depicts telegraph wires of New York City, 1880s. (Photo: Brown Brothers.); cf.

[http://nihrecord.od.nih.gov/newsletters/09\\_18\\_2001/story03.htm](http://nihrecord.od.nih.gov/newsletters/09_18_2001/story03.htm)

In the 1930s and 40s, the telegraph was still a convenient and "quiet" way of transmitting information.



Fig. 10. "Telegraphers sending press back to their home newspapers at speech by President Roosevelt in October 1936." Source: <http://www.telegraphlore.com>.

## The telephone



Fig. 11. *L'indovino* by Pietro Longhi (1701-1785). Photograph by Z. Stachniak.

Almost as soon as the first telegraph poles were erected some inventors started to openly speculate about the possibility of transmitting not just textual information over the telegraph wires but also acoustic signals such as human voice. The terms "speaking telegraph", "sound telegraph", and "acoustic telegraph" were used and experimentation soon followed. Between 1850s and 1870s, several individuals contributed significantly to what we now call the telephone communication. There is a lot of controversy regarding the assignment of pioneering roles to these individuals and in resolving possible influences. In the end, the person who is most frequently mentioned in the context of the pioneering work on the telephone is Alexander Graham Bell who was awarded the US patent for the invention of the telephone in 1876. On August 10th, 1876 Bell received the world's first successful "long distance" phone call using a 13 km long cable between Bell's residence in Brantford, Ontario, and Robert White's Boot & Shoe Store and Telegraph Office in Paris, Ontario.





Fig. 12. Painting of Alexander Graham Bell Receiving First Long-Distance Telephone Call in Paris, Ontario, 1876, D.A. Smith Photograph Collection, 1999.9191.13, Paris Museum and Historical Society. Source: Paris Museum and Historical Society, Paris, Ontario, Canada.

In comparison with the telegraph, the telephone became more "personal". General public could access telegraphs at post offices, railway stations, telegraph centers. On the other hand, telephones, initially installed in the above mentioned institutions as well as in governmental centers, large corporations, and in residencies of wealthy and technology-savvy individuals, gradually became accessible to a large number of individuals thanks to the invention of the telephone exchange switchboard which allowed to interconnect all the telephone users locally and long-distance.



Fig. 13. "Bell sits at the New York end of the first long-distance line to Chicago and inaugurates real long-distance telephone service in 1892." Source: Reproduction Number LC-G9-Z2-28, 608-B Gilbert H. Grosvenor Collection, Prints and Photographs Division, Library of Congress." <http://memory.loc.gov/ammem/bellhtml/004046.html>

By the early 20th century, the typewriter, telegraph, telephone, telegraph, and the mechanical calculator were the essential tools for composing, processing, and transmitting information. The telephone had started to redefine social foundations of our culture.



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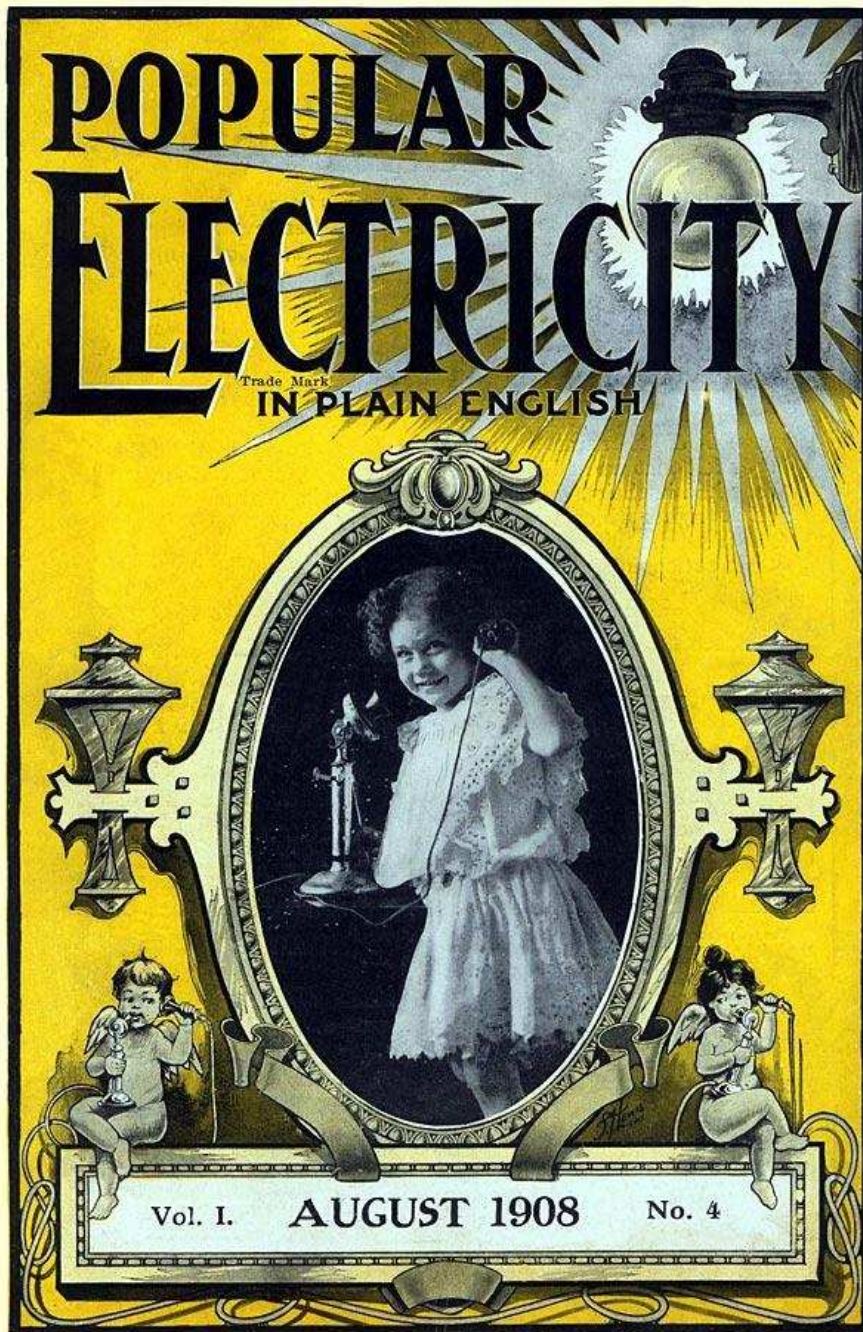


Fig. 14. The use of images of children in computer advertising followed similar marketing ideas developed in the early days of the telephone. August 1908 cover of the *Popular Electricity Magazine*.



JUNE

15 CENTS

# Popular Electricity Magazine



Fig. 15. Candle stick telephones were popular and elegant. June 1913 cover of the *Popular Electricity Magazine*.



## Information goes wireless

It was James Clerk Maxwell, a renowned Scottish physicist, who in the early 1800s theoretically explained the concept of electric and magnetic fields and how they propagate through space as combined electromagnetic waves. It would take almost a century to apply Maxwell's findings to wireless communication.

There are other wave-like phenomena well known to us such as vibrations of water caused by a leaf gently touching the surface of a quiet lake. The wave-like disturbance of water surface is moving outward from the place where the leaf made a contact with the surface.

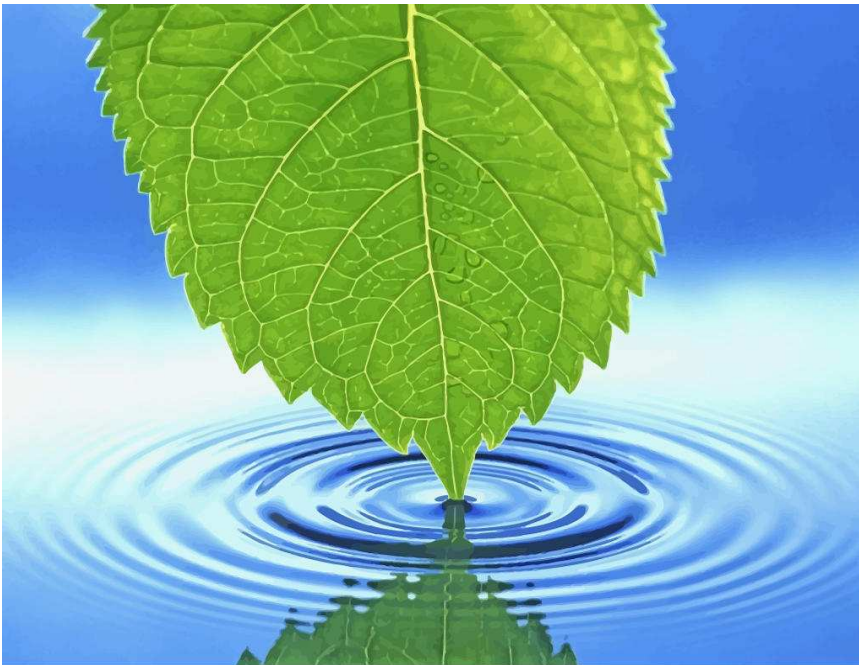


Fig. 16. Green Leaf Water Ripple. Source: Your Vectors, Free Vector Graphics, <http://www.yourvectors.com/realistic-water-ripples-vector>

Like water waves, electromagnetic waves move outward from its source (electrical current) by generating alternating perpendicular magnetic and electrical fields: electrical field induces a magnetic field which induces an electrical field which, in turn, induces a magnetic field, and so on, all of that with the constant speed of light.

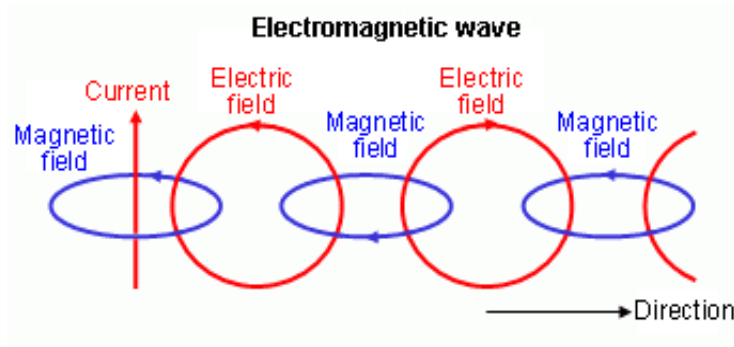


Fig. 17. Propagation of electromagnetic field. Source: <http://am.renesas.com>

Since some parameters of an electromagnetic field can be controlled, e.g. the length between two peaks of the wave (or wavelength), such fields could be used to carry information. It is therefore not a surprise that both the success and the drawbacks of the telegraph resulted in the frenzy of activities aimed at the harnessing the power of electromagnetic fields for the purpose of wireless transmission of information. If successful, such transmissions would eliminate costly and delicate cable infrastructure necessary for telegraph transmissions. There would be no need for erecting poles and no need for telegraph trains. During emergencies at sea, the ineffective sound and light signalling would be replaced by a more reliable method of long-distance communication.

Several people contributed to the successful experiments and, then commercialization of what would be called "wireless telegraph". Among them, an inventor, engineer, and scientist Nikola Tesla (best known for the invention and introduction of alternating current technology) demonstrated in the early 1890s that such wireless transmissions were possible. In 1898, in an indoor pool at the Electrical Exhibition at Madison Square Garden, Tesla demonstrated a radio-controlled boat (cf. [1,2])! The demonstration was met with signs of disbelief and dismay by the public: "The craft alarmed those in the crowd who saw it and who claimed it to be everything from magic and telepathy to being piloted by a trained monkey hidden inside." [2]

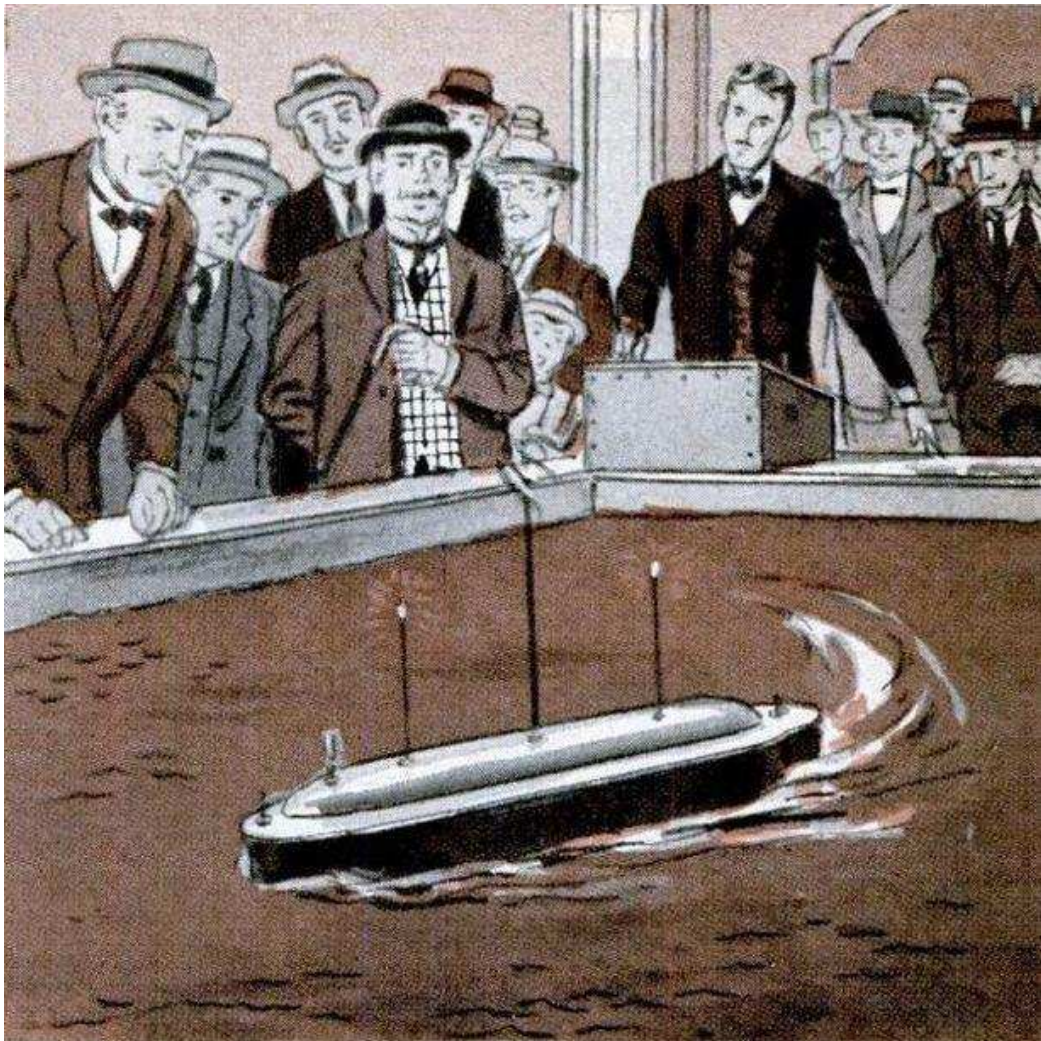


Fig. 18. "Tesla as he demonstrated a radio-controlled boat to the public during an electrical exhibition at Madison Square Garden on 1898." 1900. Source: *Popular Science*, July 1956. See also <http://cyberneticzoo.com/precyber/1898-telautomaton-nikola-tesla-serbianamerican/>

Tesla also patented the equipment for transmitting and receiving of wireless communication.



Another inventor, Guglielmo Marconi, started his experiments with wireless telegraph in the early 1880s. Step by step, he managed to send wireless Morse code transmissions at a longer and longer distances. Eventually, he succeeded in receiving a message at Signal Hill, St. John's, Newfoundland, send from England. "On the 12 December Marconi pressed his ear to the telephone headset of his rudimentary receiver and successfully heard "pip, pip, pip" - 1700 miles from the transmitter." ([3])

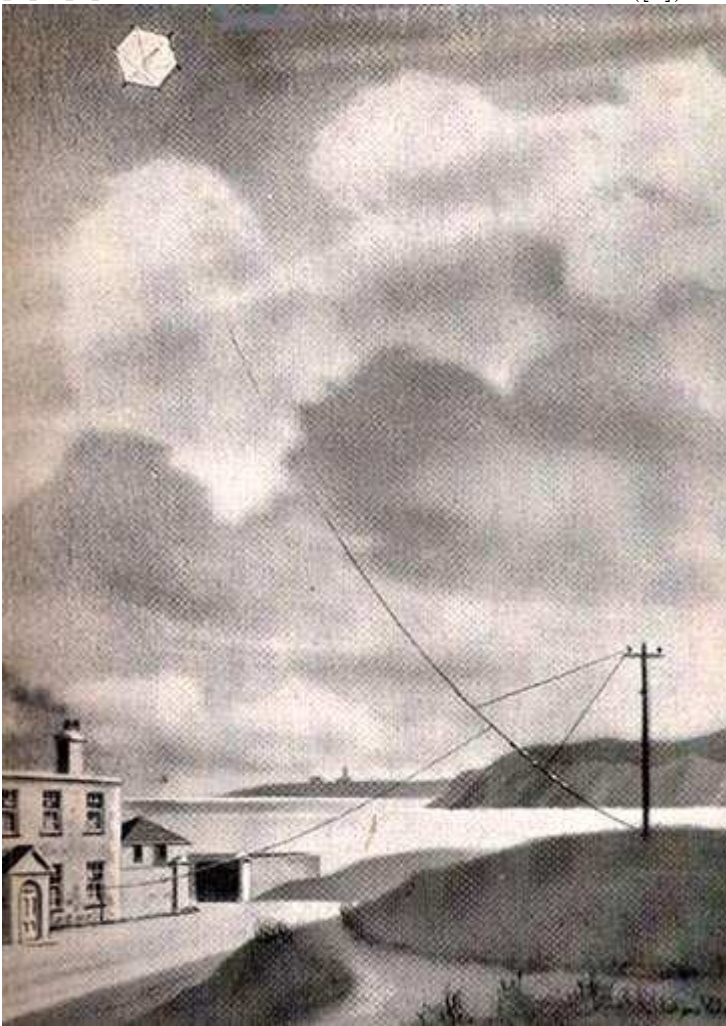


Fig. 19. "Kite Aerial, Signal Hill. A drawing of the kite aerial used at Signal Hill for reception of the first Transatlantic wireless signal, 12th December 1901." [3]. Source: Marconi Jubilee 1897-1947 (Chelmsford, England: Marconi's Wireless Telegraph Company Limited, 1947); artist unknown.

This groundbreaking Trans-Atlantic radio transmission, as well as the work of many others who concurrently developed similar technology in Europe and North America, had initiated the era of global wireless communication.

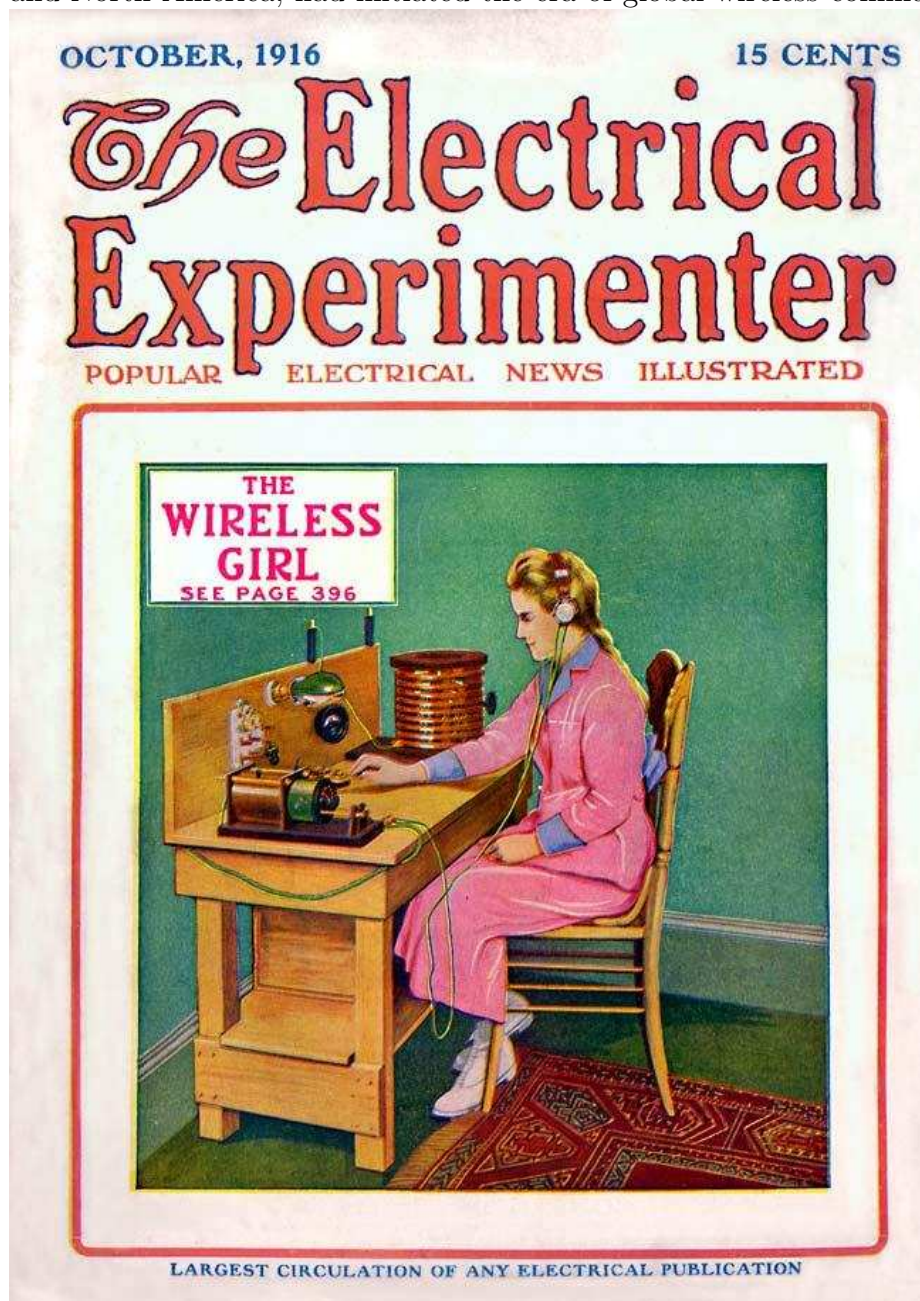


Fig. 20. "The Wireless Girl"; October 1916 issue of *The Electrical Experimenter*.



The new technology proved especially useful at sea. According to Thomas White, “By 1912, ... all the major passenger liners were equipped with radio transmitters. ... [R]adio now kept vessels on transatlantic voyages in nearly constant communication with shore stations and each other.” Furthermore, “Radio greatly reduced the terrible isolation of ships during emergencies, and was quickly responsible for saving thousands of lives.” (cf. [5]).

The sinking of *Titanic* on April 15, 1912, clearly demonstrated how essential the new wireless technology started to become. As described by White,

The *Titanic* – along with the *Carpathia*, which picked up the survivors – was staffed by Marconi Wireless operators, and Marconi shore stations along the Canadian, Newfoundland, and U.S. coasts handled most of the communication as the *Carpathia* slowly made its way to New York City. ([5])



Fig. 21. A replica of the *Titanic* radio room at the Sandford Mill Museum in Chelmsford, Essex. This scaled down version of the ship’s room, features the Marconi broadcasting equipment that would have been used on the liner. Information and photograph from <http://www.bbc.co.uk/news/uk-england-esssex-17598786>.

As a result of the Titanic disaster, in 1913 the International Convention for the Safety of Life at Sea adopted a treaty that required ship radio stations to be manned 24 hours a day. Several other important applications for business and military use of wireless telegraph communication were developed concurrently.

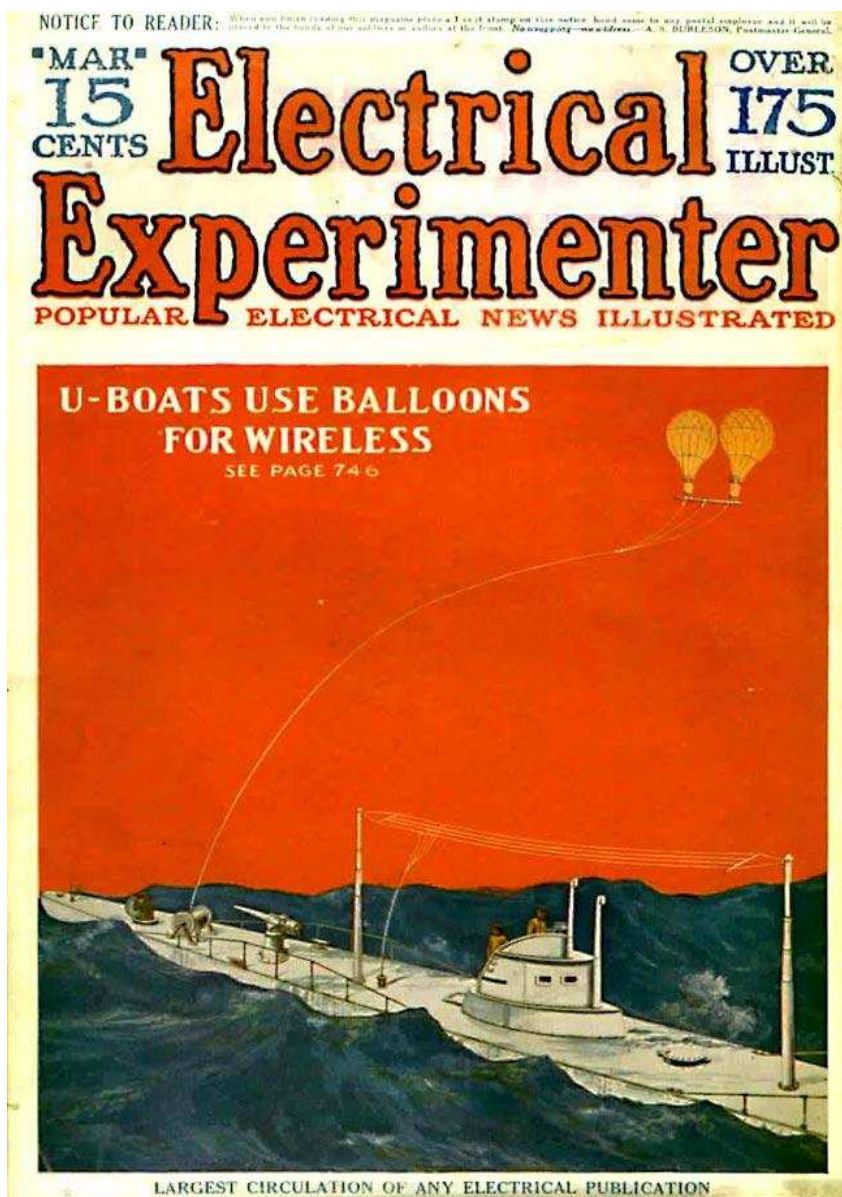


Fig. 22. Wireless U-boat. March 1918 cover of the Electrical Experimenter magazine.

## One step further: voice over radio

The next step in the development of wireless communication was an obvious one. As it had already been done with the modification of the telegraph to allow the transmission of audio signals via wires, the wireless transmission of human voice was inevitable. Indeed, the first such transmission was achieved (most likely) by a Canadian inventor Reginald Fessenden. He was born in Quebec in 1866, studied science and, in 1886 became an assistant to Edison. Some years later (in 1890), using inventions of his own and others, he managed to modify radio waves with sound waves (music) and transmit such a "mix" to radio receivers.



Fig. 23. Fessenden's commemorative stamp issued by Canada Post in 1987



By 1920s, voice over radio was widely used for military as well as civilian applications. There was also radio industry developing at a fast pace introducing a new gadget into homes – the radio set.



Courtesy of the Westinghouse Electric & Mfg. Co.  
A FAMOUS OPERA STAR AT A RADIO BROADCASTING STATION SINGING TO AN INVISIBLE AUDIENCE

Fig. 24. From the image caption: “A famous opera star at a Radio Broadcasting Station singing to an invisible audience”. Source: this image appeared in H.Ch. Hill, *The Wonder Book of Knowledge*, John C. Winston Co., 1923.



Fig. 24B. And another "The Wireless Girl" listening to a crystal radio. Photographer unknown.



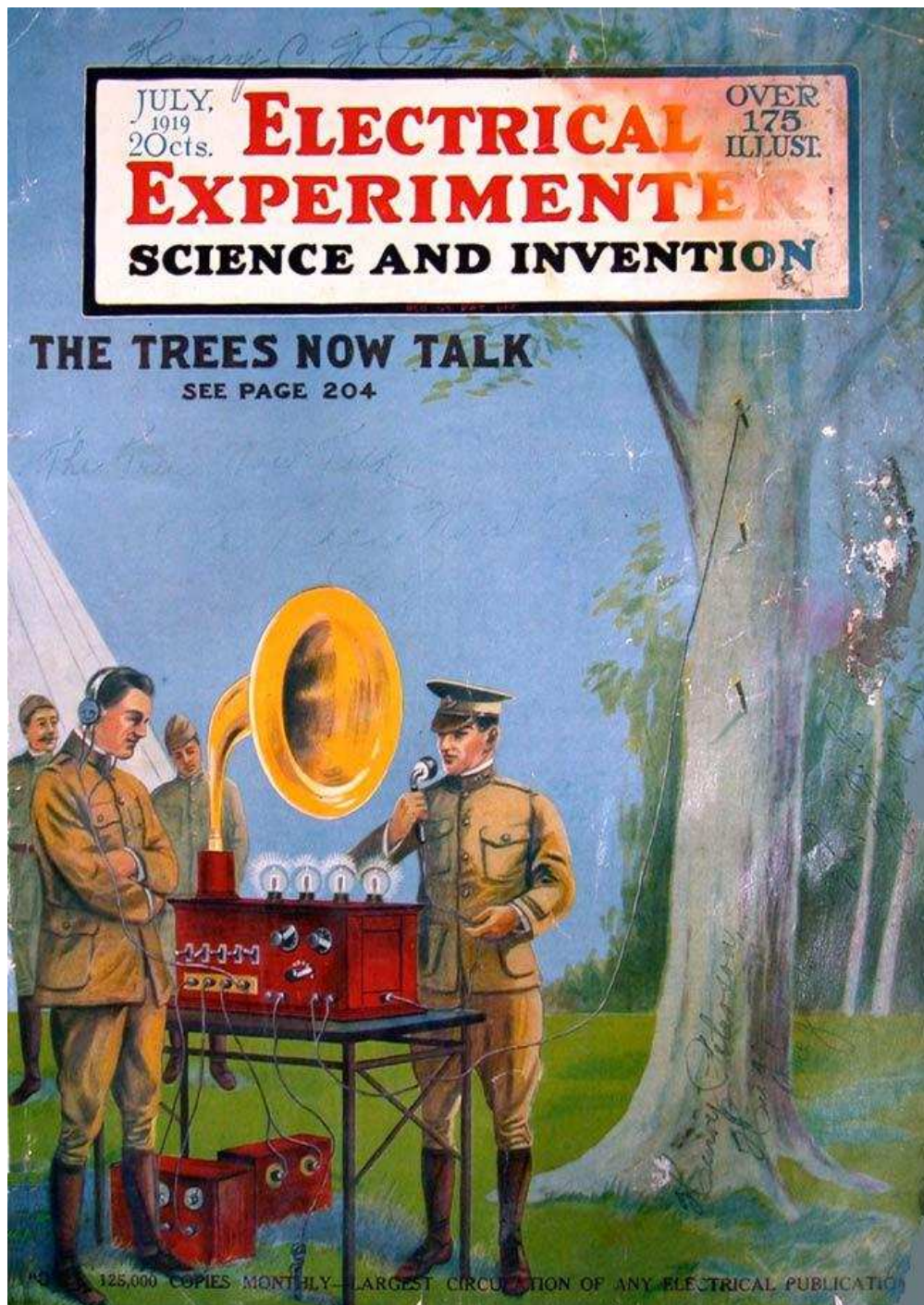


Fig. 25. Wireless and military. July 1919 cover of the *Electrical Experimenter* magazine.

In the early days of radio, the owners of such sets could listen to music and other programming using a rather rudimentary equipment called *crystal radios*. By 1920s, radio broadcasting went commercial.



Fig. 26. An example of an early crystal radio, c. 1920s. Source: unknown.



Fig. 27. The crystal radio era: a family enjoying radio broadcast in the 1920s. Source: <http://www.visionaustralia.org/living-with-low-vision/library/about-our-library/library-blog/blog/hear-this!/2013/01/31/the-first-australian-radio-broadcast>

The early 20th century also marks the beginning of the North American radio and electric hobbyism backed by a large variety of hobby magazines such as *Modern Electrics* (renamed *Electrical Experimenter*) and *Popular Electricity in Plain English* both launched in 1908 (cf. [6]) and even governmental organizations. In 1922, the U.S. Bureau of Standards printed the *Construction and Operation of a Simple Homemade Radio Receiving Outfit* booklet describing the design of a simple radio receiver (cf. [4]). The booklet begins with

Frequent inquiries are received at the Bureau of Standards for information regarding the construction of a simple receiving set which any person can construct in the home from materials which can be easily secured. This publication has been prepared to meet these inquiries. ([4])

The illustration on the next page depicts a young boy experimenting with radio (from September 1909 cover of *The Popular Electricity*).



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IN THIS ISSUE { The Playgrounds of a City  
Card Indexing the Country

**POPULAR**  
**ELECTRICITY**  
Trade Mark  
**IN PLAIN ENGLISH**

Young America at the Wireless Key

Vol. II. **SEPTEMBER 1909** No. 5.

The cover features a central illustration of a young man in a suit sitting at a desk, operating a wireless telegraph. The desk is cluttered with various electrical components and a book titled 'POPULAR ELECTRICITY'. The scene is framed by ornate Art Nouveau-style columns and a decorative arch. Above the main title, a glowing light fixture is depicted with radiating lines. At the bottom, two cherubs are seated on either side of the date information.



## Wireless + Electricity = Future



Fig. 27B. 1931 National Wireless & Radio Exhibition, Olympia, London. Photographer unknown.

By the late 1930s, the wireless technologies for the telegraph, the radio, and even television were well developed. Large scale wireless exhibits organized all over the world attracted millions.

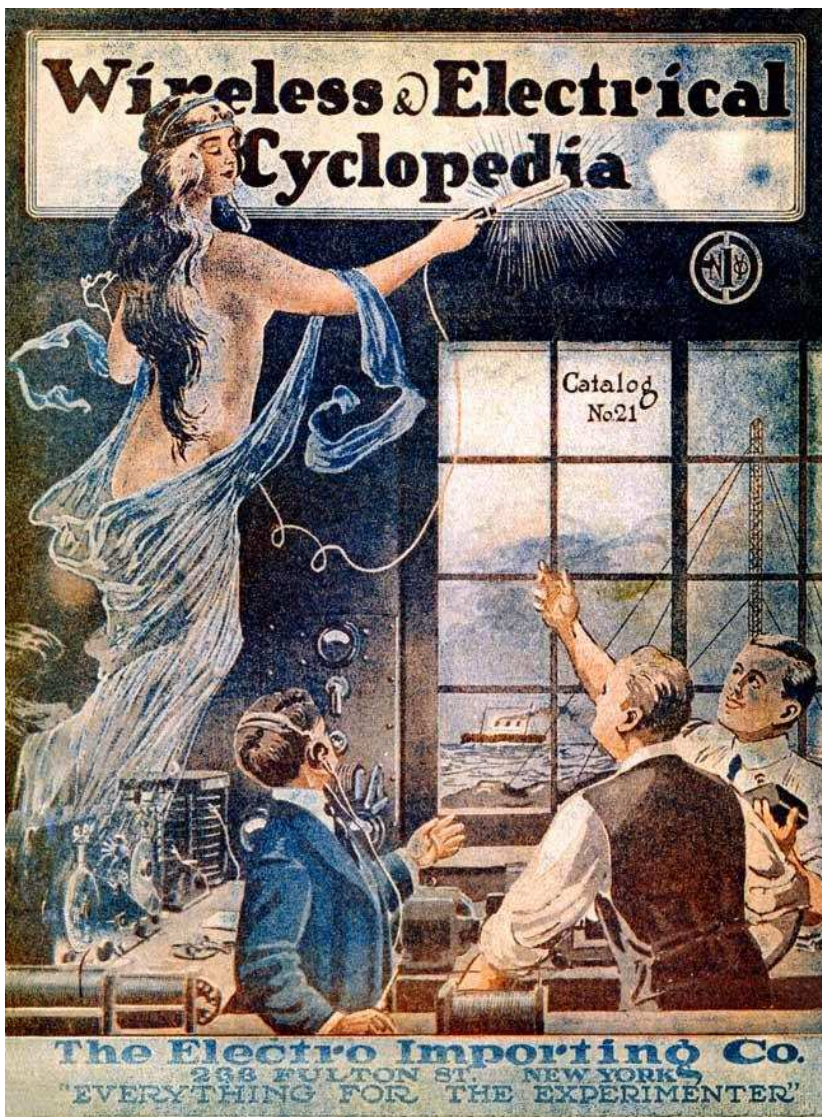


Fig. 28. The goddess of electricity. The cover of the *Electro Importing Co. Catalog*, 1919.

The great enthusiasm for electricity-based communication technologies inspired many to work on futuristic ideas some of them, as illustrated on the following pages, will be realized by the end of the 20th centuries while others remain illusive. Enjoy!



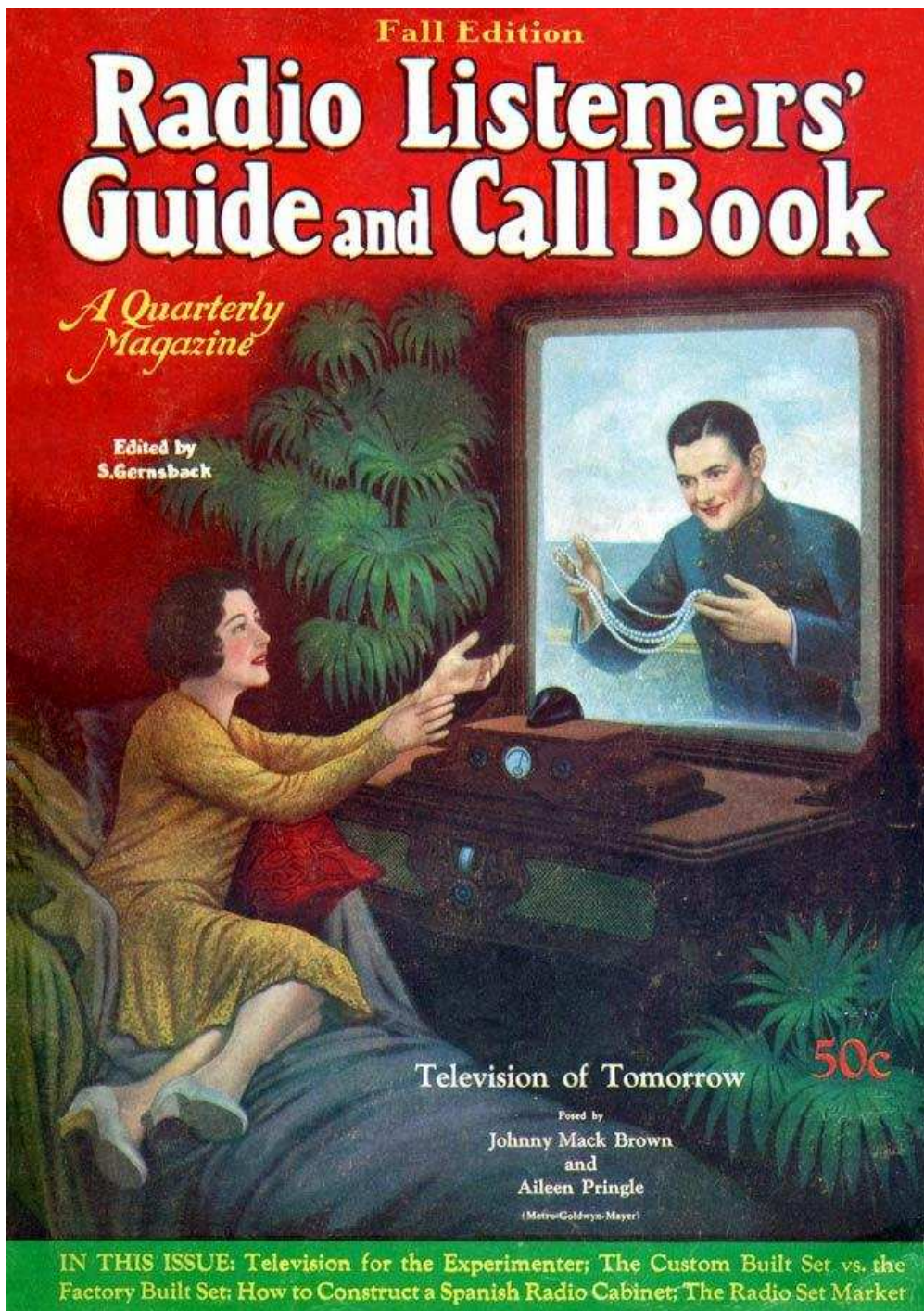
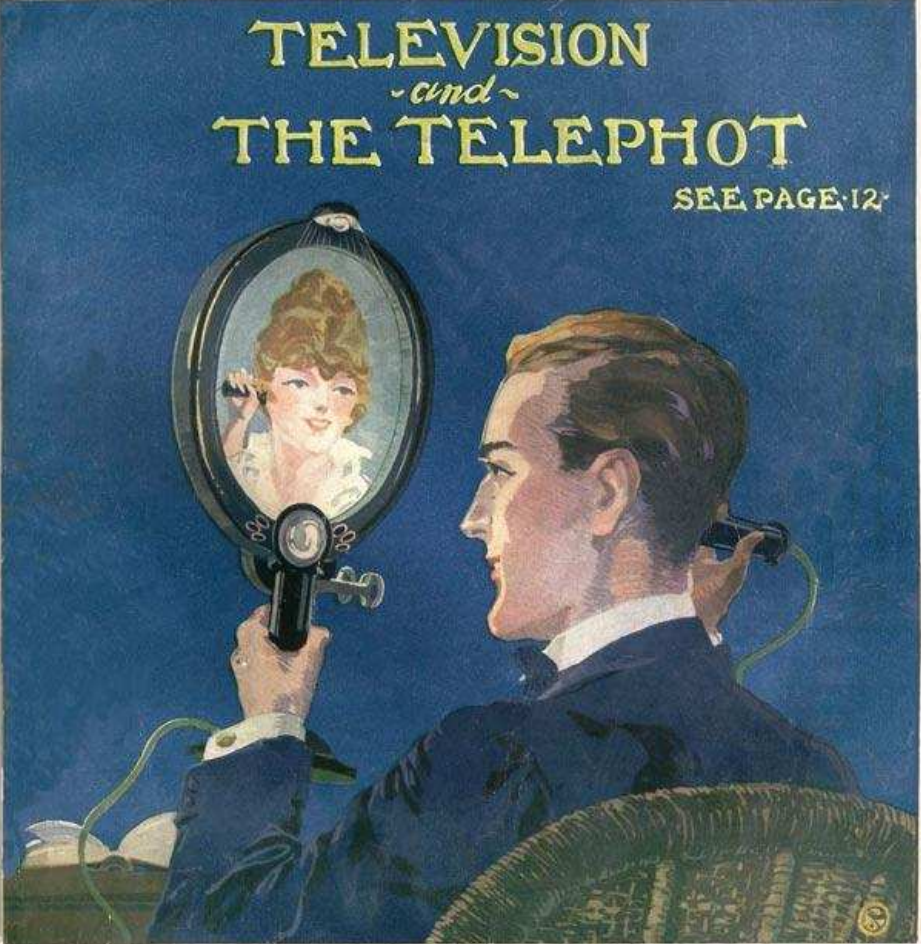


Fig. 29. Flat screen television in the 1920s?

NOTICE TO READER: When you wish to receive this magazine please place a 1 cent stamp on this notice, hand same to any postal employee and it will be placed in the hands of the soldiers or sailors at the front. No wrapping—no address.—A. S. BURLERSON, Postmaster-General.

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*-and-*  
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SEE PAGE 12



LARGEST CIRCULATION OF ANY ELECTRICAL PUBLICATION

Fig. 30. A display phone in 1918?



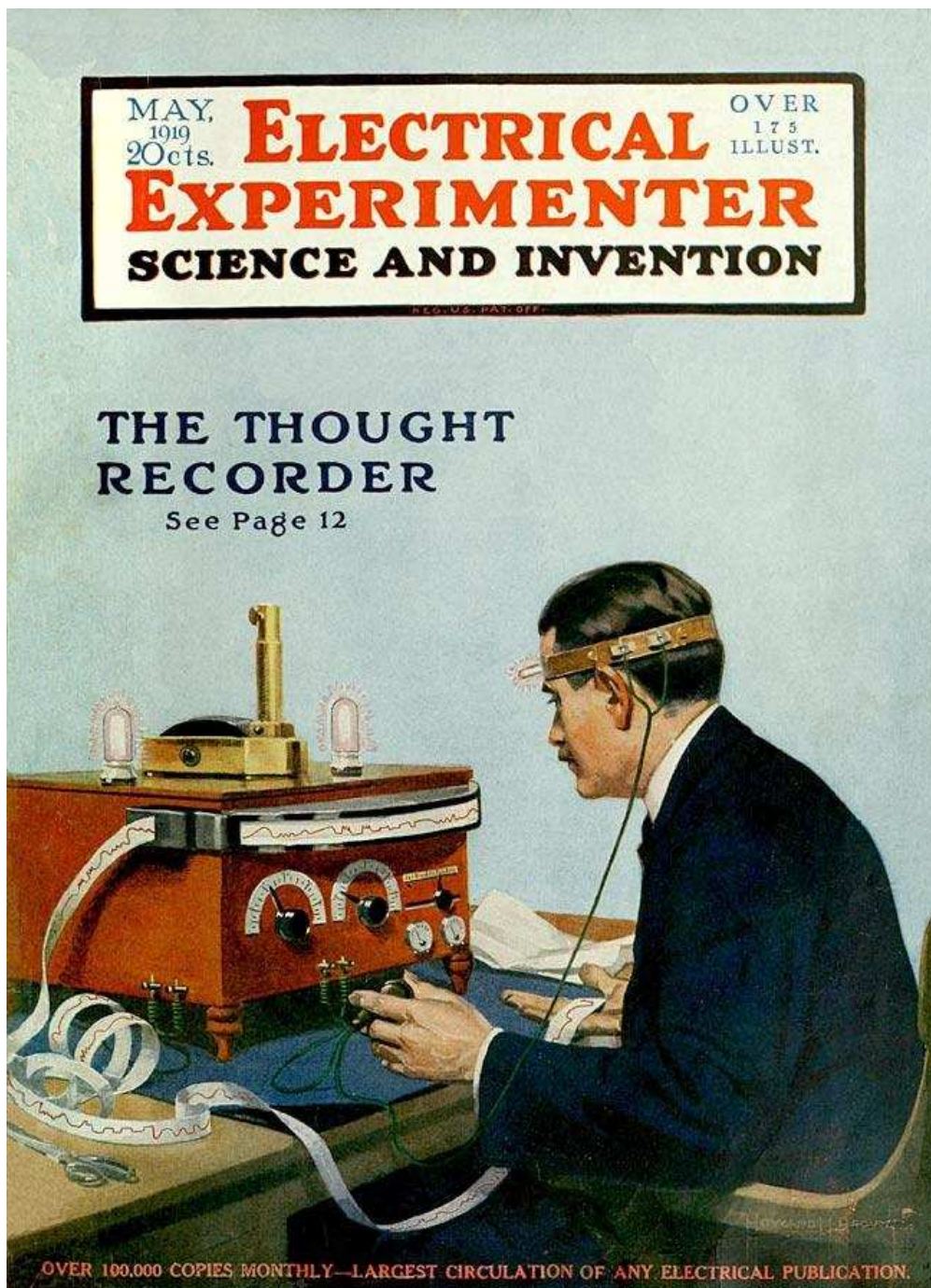


Fig. 31. Thought recorder or the precursor to MEG (MagnetoEncephaloGraphy: measures weak magnetic fields produced by currents flow in neural system (in 1919?))?

## References

- 1 Jill Jonnes, *Empires of Light: Edison, Tesla, Westinghouse, and the Race to Electrify the World*, Random House (2004).
- 2 Ch. Eger, The Robot Boat of Nikola Tesla, *101*, Apr 1, 2007, <http://suite101.com/article/the-robot-boat-of-nikola-tesla-a17758>.
- 3 J. Webb, *Marconi*, <http://www.heritage.nf.ca/society/marconi.html>.
- 4 *Construction and Operation of a Simple Homemade Radio Receiving Outfit*, Circular of the Bureau of Standards, No. 120, U.S. Government Printing Office, Washington, DC, April 24, 1922.
- 5 T.H. White, *United States Early Radio History, Radio at Sea (1891-1922)*, <http://earlyradiohistory.us/sec005.htm>.
- 6 K. Massie and S.D. Perry, “Hugi Gernsback and Radio Magazines: An Influential Intersection in Broadcast History”, *Journal of Radio Studies*, vol.9 no 2, 2002, pp. 264–281.