Alternating Currents and Ether

Two Paradigms of Radio Development
U.S. vs. Europe

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Wolfgang Hagen

It is a strange circumstance that a symposium on 100 years of radio in 2007 in Vienna causes us to remember a long-past and distant event in American history. Ultimately, we will have to clarify what this event has to do with the history of European radio.[1]

1

Our starting point: two broadcasts, if they actually existed and if the term «broadcast» makes sense at all in this context—if, then, on Christmas Eve and New Year's Eve of 1906 in Brant Rock. From the east coast of Massachusetts, 150 miles south of Boston, Reginald A. Fessenden, the lone engineer, eccentric, outstanding theorist, and equally ingenious experimenter, transmitted peaceful violin music and recorded singing to a few ships at sea. He had pre-announced the transmission by telegraph. This he told us himself a few decades later. A few earwitness reports, arising after another few decades, would nail the forgotten event down more firmly.

What did Fessenden do? He transmitted clearly audible modulation with the aid of an alternating current transmitter with amplitude modulation. It probably

sounded like a better telephone line. Today, we would say: Fessenden used the first longwave transmitter to transmit speech and sound on a frequency of about one hundred kilohertz. Because it was a special transmitter that he was working with, we also know: if anyone could do it, then only Fessenden.

His longwave transmitter, then, was simply a steam-driven machine generating alternating current—a current generator. The frequency of its alternating current was very high, that is, the machine rotated very quickly and was, at the same time, extremely stable in terms of torque. The microphone that Fessenden used modulated the strength and voltage of this alternating current. If Fessenden's lips had touched this device, he would have been dead on the spot. Fessenden used an electromagnetic sine wave modulated by speech and sound. He knew what he was doing. Epistemologically, he was pursuing a radio mechanism based fundamentally on the wave paradigm.

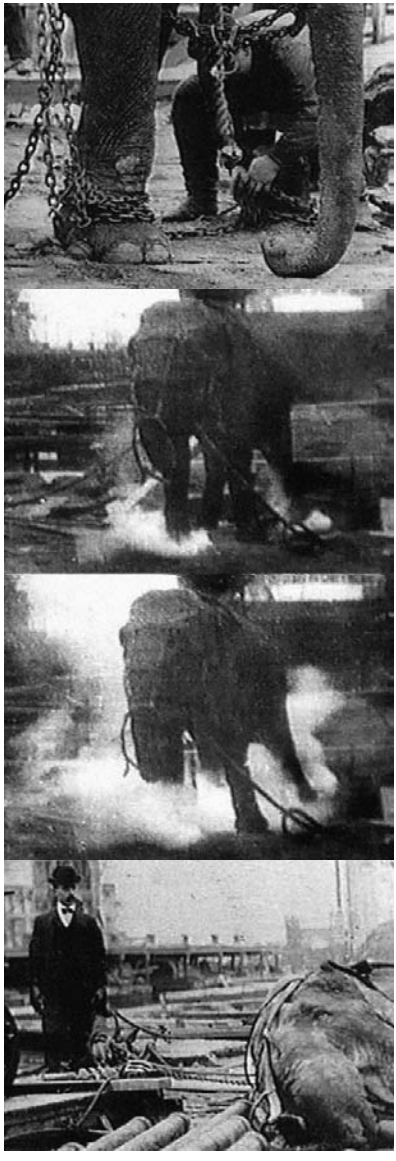
Here we must clearly distinguish the technological from the epistemological aspect. Fessenden's current generator, built by Ernst Alexanderson, a pupil of Charles Steinmetz, was mechanically still extremely unstable. It could not take more than a few hours of running at one hundred thousand rotations per minute. And its power was weak. Broadcasting power? Maybe twenty-five watts or a few more.

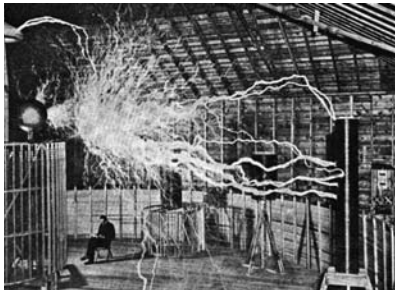
So if it was the beginning, at Brant Rock in 1906, then technologically it was a very precarious one. Altogether it was a very civilian, partly amateurish, thoroughly experimental event with a low range. The first test run of a little local radio, as it were.

The very non-amateurish epistemology behind this experimentation was alternating current. Fessenden knew precisely what he was doing, even if his means were humble. Epistemology means «knowledge of knowledge.» The chain of knowledge that knows something about the knowledge of alternating current goes back seamlessly from Fessenden to Alexanderson, who built the machine for him, to Charles Steinmetz, who supplied the theory and the necessary characteristics of the machine, to Nikola Tesla, the great propagandist and spiritualist of alternating current in the U.S. of the eighteen-eighties and nineties. «In almost every step of progress in electrical engineering, as well as radio, we can trace the spark of thought back to Nikola Tesla,»[2] Alexanderson later said, thus clearly defining the context of Fessenden's experiment.

1 Wolfgang Hagen, lecture, ORF Broadcasting House, Vienna, January 19, 2007; see his essay in this volume.

2 Quoted in Margaret Cheney and Robert Uth, *Tesla: Master of Lightning* (New York: Barnes & Noble, 1999), p. 157.





Thomas Edison,
Electrocuting an Elephant,
film, 1903.

Participant sitting in
Nikola Tesla's laboratory,
publicity photograph,
Colorado Springs, CO, U.S.,
circa 1900.

Nikola Tesla invented the induction motor and the induction generator. He built the first practicable alternating current transformers. His patents, marketed by Westinghouse, allowed the electrification of the U.S. by safely transporting electricity over distances of hundreds and thousands of kilometers. For instance from the Niagara Falls to New York. Tesla was the winner of the «Battle of Currents» in the U.S. in the eighteen-eighties and nineties, beating Thomas Alva Edison, who strictly refused any dealings with alternating current, operating with his direct current generators only in wealthy districts, as direct current can only be transported without loss for a few hundred meters.

And indeed, a fierce social dispute concerning access to electricity took place in the U.S.—and notably not in Europe—shortly before the 1900 turn of the century, a dispute fought with images conveying the essence of electricity that are nothing short of supernatural. Tesla put on a real show, launching loud bangs and eerie sparks into the universe, while Edison demonized alternating current as a deadly evil, electrocuting an elephant in public on an alternating current platform. For only his direct current devices, only direct current was «good» electricity. The battle for electrification was inflated with illusory images—and with deceptive arguments and notions. For concepts such as essence, substance, and form, that may have held good for the mechanical world of the Modern Age, cannot be applied to electricity.

His whole life long, Tesla hence believed in telepathic phenomena—and not only upon the death of his mother. He made all of his inventions by means of imaginary inspirations.

> On one occasion, ever present in my recollection, we were enjoying ourselves in the City Park, I was reciting poetry, of which I was passionately fond … «*Sie rückt und weicht, der Tag ist überlebt, Da eilt sie hin und fordert neues Leben, Oh, dass kein Flügel mich vom Boden hebt Ihr nach und immer nach zu streben! Ach, zu des Geistes Flügeln wird so leicht kein körperlicher Flügel sich gesellen!*»[3] As I spoke the last words, plunged

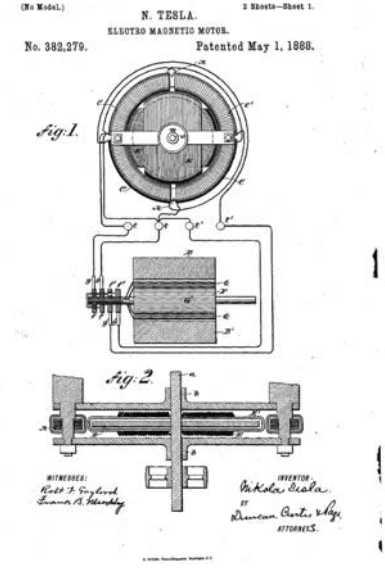
3 The sun retreats—the day, outlived, is o'er
It hastens hence and lo! a new world is alive!
Oh, that from earth no wing can lift me up to soar And after, ever after it to strive!
. . . . . .
Alas! To wings that lift the spirit light
No earthly wing will ever be a fellow.
(Goethe, *Faust I*, Faust monologue «Outside the gate of the town»)

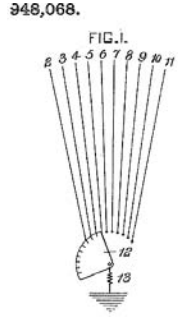
4 Nikola Tesla, *Lectures, Patents, Articles*, sine loco, sine anno, p. 198.

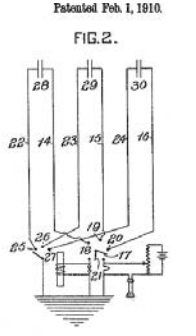
in thought and marveling at the power of the poet, the idea came like a lightning flash. In an instant I saw it all, and I drew with a stick on the sand the diagrams which were illustrated in my fundamental patents of May, 1888.[4]

The outcome (supposedly): the most important of the numerous induction motor patents held by Tesla, with which he secured his lifelong wealth, sporting new suits, spats, and shoes everyday and enjoying lifelong residence in the best hotels. The history of radio in the U.S. is epistemologically founded upon the alternating current wave from the context of Nikola Tesla. It is multiply overloaded with the specter and madness of a psychotic inventor, who delivered largely practicable, detailed blueprints for his dynamos, circuits, and motors, the origins of which, however, are shrouded in the dark mystery of visions, delusions, and telepathic phenomena. What Tesla describes in these crazed visions is the un-place of electricity. It simply cannot be described with the means of modern science.

The following words stem from Heinrich Hertz himself: «We form for ourselves images or symbols of external objects; and the form which we give them is such that the necessary consequents of the images in thought are always the


(No Model.) 2 Sheets—Sheet 1.
N. TESLA.
ELECTRO MAGNETIC MOTOR.
No. 382,279. Patented May 1, 1888.
Fig. 1.
Fig. 2.
WITNESSES:
INVENTOR
ATTORNEYS.


348,068.
FIG. 1.
2 3 4 5 6 7 8 9 10 11
12
13


Patented Feb. 1, 1910.
FIG. 2.
28 29 30
22 14 23 15 24 16
19 20
25 26 27 18 17 21

Nikola Tesla, *Patent for Electro Magnetic Motor*, 1888.

Reginald Aubrey Fessenden, *Patent for Wireless Telegraphy*, 1906.

images of the necessary consequents in nature of the things pictured. In order that this requirement may be satisfied, there must be a certain conformity between nature and our thought.»[5] Electricity can only be «represented» in the four Maxwellian equations. They describe with mathematical precision the interrelationship between electric and magnetic vectors in four-dimensional space.

In all other respects, electricity eludes any ontological definition. At best, we can find correspondences between images and follow-up images of images. The fact that classical metaphysics is overtaxed in terms of model theory when facing the problem of electricity is what resounds in Tesla's delusions but also paves the way for building innovative electricity machines.

2

The fact that radio history is not just radio history—and American radio history is certainly not European—is illustrated by the example of Hans Bredow. Not that he failed to notice Fessenden. All of these very young radio pioneers around the globe were watching each other very closely. In his memoirs *Im Banne der Ätherwellen* from the nineteen-fifties, Bredow could not help but declare Fessenden as the first person to make radio with high-frequency generators because he was able to modulate undamped vibrations. The go-getting young gentlemen from Telefunken were only too familiar with Fessenden's American patents. Bredow hastens to add that a certain Professor Goldschmidt in 1911 and Count Arco from Telefunken in 1912 had done it better and more effectively. The old father of German radio from 1923, slave-driven and deprived of power by the Nazis, but as loyal to the Emperor as ever, wrote this as late as 1954. Right down to his choice of words, he repeats in detail what he had already written as editor in his Telefunken newspaper back in 1910.[6]

The young Telefunken boss Bredow, the later-to-be radio founder of the Weimar Republic, was forced to deal with Fessenden for the simple reason that his was an inexpensive and simple system, weak in range but of high electroacoustic quality. Telefunken was forced to copy Fessenden's patents because the company

5 Heinrich Hertz, *Die Prinzipien der Mechanik in neuem Zusammenhange dargestellt: Drei Beiträge* (1894; repr., Thun et al.: Deutsch, 1996), p. 67.

6 Hans Bredow, *Im Banne der Ätherwellen*, vol. 1, *Daseinskampf des Deutschen Funks* (Stuttgart: Mundus Verlag, 1954), pp. 267–68.

7 *Telefunken-Zeitung* 1, no. 6 (1911), p. 81.

8 Bredow 1954 (see note 6), p. 200.

had been wanting to get in on the exploding colonial world markets of electric wireless telegraphy since the first decade of the twentieth century. Fessenden, the technologically so dangerous rival, had to remain a footnote. As of 1911, every two months the *Telefunken-Zeitung*, with director Bredow as editor in chief, would above all praise the company's own sales in Asia, Africa, Latin America, China, and the South Pacific.

German colonialism was, even then, for Bredow simply a question of dominating the ether. At the last international radio conference before World War I, in London in June 1913, Telefunken handed out a paper in which it read: «Of the approximately 3000 radio stations in operation [around the world], some 45 % use the German system, while all the other systems, Marconi, de Forest, Fessenden, … Rochefort, Poulsen, etc. divide up into the remaining 55 %.»[7] And he adds in his memoirs of 1954: «One could thus have claimed, without any arrogance, that German radio had taken the lead before World War I and won an international standing.»[8]

As early as 1906, radio had become a colonial instrument of power both in Imperial Germany and Victorian England. If the discourse of «postcolonial studies» were more conclusive in terms of media analysis, we could leave it at this

Telefunken Wireless Transmission Station, 1906.

diagnosis. The European dispositives of early radio development were aggressively militaristic and colonialistic, while the American ones proved amateurish and overloaded with the paradigm of alternating current as energy and salvation for humankind/civilization/nation. Bredow, Marconi, Telefunken, and all the other European «electricians» were not concerned with transmitting music and speech but rather with imperialist control of the command codes of power, military logistics, and trade information, that is, technologically speaking: with telegraphy. When, likewise in 1906, one somewhat eccentric but ingenious engineer at Telefunken by the name of Wilhelm Max Schloehmilch began to experiment with and talk about wireless telephony—even demonstrating transmission of Caruso records to the Emperor—he was sharply reprimanded by Telefunken boss Arco to refrain from this fooling around. His equipment ended up in a museum just three years later, where it can still be viewed today.

Ever since Marconi had demonstrated it to European engineers in 1897, although he himself did not understand enough of it technically, all wireless systems in Europe were geared to achieving extreme ranges. Again, postcolonial discourses would find much food for thought in the Telefunken newspaper as of 1910. Every issue outdid the previous one in the ecstatic hysteria of ranges. To transmit from Nauen to German South West Africa, that is victory. Technologically, this was only possible with gigantic spark transmitters, exploding out into East Havelland with sparks as thick as a man's arm and deafening bangs at the transmitter site. It would not have been possible to secure the majority of radio on merchant ships with high-frequency alternators à la Alexanderson or Fessenden. That would not have made the radio operators trained by Telefunken proud. And Bredow was sitting in the middle.

But in questions of media, to take a postcolonial perspective is to take the easy way out. It both overrates and underestimates colonialism prior to 1914. The European radio dispositive is the spark, but not (only) because its oscillation generates electromagnetic waves that reach as far as the South Pacific.

Rather, the radio spark is connected with a complex epistemology that, if at all, has a structural relationship to colonialism. The radio spark, you see, is based upon ether. To the extent that nothing more omnipotent than ether existed

9 Adolf Slaby, *Entdeckungsfahrten in den elektrischen Ozean: Gemeinverständliche Vorträge*, 5th ed. (Berlin: Simion, 1911), p. 118.

in pre-1900 physics that can be caused to tremble by electric sparks, we may concede that ether was congruent with colonialism.

«If we cause any kind of electric vibration, it creates a wave motion in the sea of ether surrounding us,»[9] writes Adolf Slaby in his *Voyages of Discovery into the Electric Ocean* of 1911. Ether and the spark that causes it to move is the paradigm of European radio epistemology. It is not necessary to cite Heinrich Hertz in order to illustrate the epistemological dimension of ether in modern-day physics. Hertz was certain that the sparks in his laboratory in Karlsruhe at Christmastime in 1887 caused a displacement motion in the ether. As early as the start of the nineteenth century, Fresnel and Young had indisputably demonstrated the wave structure of light, thus proving that light must swim in the ether in some way. In 1883, the «Michelson-Morley experiment» had been expected to prove ethereal drift of the earth through ether, but failed. Yet at first this «dead end» did not cause any European scientists to doubt the existence of ether. William Thomson, alias Lord Kelvin, the leading mind in Europe, had, after all, already determined the specific weight of ether, and his widely accepted atomic model consisted in eddy structures of ether as the state of matter. By means of his experiment, Hertz had thus simply confirmed this epistemic figure of ether once again, thus underscoring the irrefutability of its existence once more.

The physical properties of ether must have seemed almost crazy. It had to be a totally transparent substance, finer than any structure as yet known, all-pervading and invisible. At the same time, however, it had to transport transverse oscillations—oscillations that are transverse to the direction of their propagation. For it was shown that light is such a transverse oscillation. However, such oscillations are transported only in the very hardest of bodies, for instance in diamond or special steel alloys. Invisible and yet as hard as diamond? Reading the contemporary descriptions of ether from the nineteenth century, here again the depth of contradiction of a crazed discourse is no far stretch (from today's point of view). For the classical Newtonian mechanics of celestial bodies, this substance was obsolete. Planetary orbits need no ethereal substance to be explained. But the deeper the Modern Age penetrated electricity, leading to Hertz's proof of electromagnetic radio waves in 1887, the more this went to confirm a figure of madness that the concretion of ether was increasingly growing to be after 1890.

Electricity and the media it engendered have one thing in common: both generate illusory images that are the effect of going beyond understanding. After

all, you do not have to understand electricity to use it. Tesla may have had delusions, but in the end his motors were effective enough to allow Fessenden to transmit radio. Hertz had to consider the existence of ether proven by his experiments, but his sparking dipoles were effective enough to bring Telefunken imperial business until as late as 1914.

Media need not be understood to be used. This is both their degree of freedom and their bane. But even one hundred years after Brant Rock, nothing has changed.

Lecture presented at the conference 100 Years of Radio – The Return of Wireless Imagination, ORF Broadcasting House, Vienna, a collaboration between *Kunstradio* and the Ludwig Boltzmann Institute Media.Art.Research. The conference was part of Vienna *Art's Birthday* Celebrations, January 17–19, 2007.