

E3: THE NEXT ELECTRICITY

How Bad Science Gave Us Electricity and How a New Electricity Will Change the Future

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In memory of David Faust – electrical engineer

E1: Electricity One

Theoretical understanding of electrical effects began in the 1600s. However, it wasn't until the mid-1700s that experimenters began to invent and use devices to produce effects that had not been seen in nature - that is to create the first stage of electrical technology. A popular name to associate with this first stage is Benjamin Franklin.

In addition to his famous kite experiment that showed lightning to be electrical, he carried out lesser known but more entertaining experiments such as the “electrical kiss” when one enthusiast was in contact with an electrical device caused a spark on the lips when kissing an adventurous partner.

Franklin also wrote that after a season of experimentation the weather was turning hot “when electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure ... a turkey is to be killed for our dinner by *electrical shock*, and roasted by the *electrical jack* [spit] before a fire kindled by the *electrified bottle* [Leyden Jar].”



Electric kiss

Though Franklin was willing to kill for science the bird he preferred for the symbol of America the more important element of his party story is the killing machine, the Leyden jar. Invented in 1745 and again in 1746 the jar was a way to store electricity. How electricity got into the jar and how the jar stored it can be explained by what happens when a balloon is rubbed with wool.

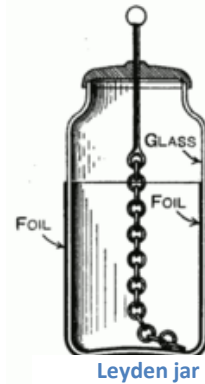
An electrical charge is built up on the balloon when it is rubbed on wool. When the charged balloon is held near a wall, the pull of the charges on the balloon causes opposite electrical charges to build up on the wall. Opposites attract and the balloon will stick to the wall.

Electrical generators in Franklin's time worked essentially on the same principle – one material rubbed against another but at higher speeds causing large, and sometimes, lethal, charges to be collected at one point and opposite charges at another point on the machine. When wires

were attached to the two points of opposite charge were brought near each other a spark would jump from one wire to another.

If the charges from the two opposite points were brought together on a turkey, the experimenters had a turkey ready for the electrical spit.

Now how to store the electricity generated by these friction machines – after a lot of trial and error, aka experimentation, it was found that if one end of the friction machine was connected to metal inside a jar and the other end was connected to metal on the outside of the jar, electricity would be stored in the bottle. When metal connected the rod inside the bottle with the outside the bottle, there would be a spark. If several bottles were connected together, there would be a bigger spark – from whence the expression “lightning in a bottle.”



When several bottles were connected together the cumulative electrical charge could be dangerous. The first human death by electrocution, that of an experimenter, was in 1783.

One hundred years after Franklin’s experiments and parties researchers found that when electricity went through a wire conductor it created a magnetic field. This fundamental discovery led to the invention of primitive electrical motors and generators. James Maxwell described the relationship between electricity and magnetism in a now famous set of equations that can be seen on sweatshirts at academic locations.

E2: Electricity Two

Stage Two of electrical technology is the one we are now in. Though a number of inventors in a number of countries made contributions to today’s technology the short version as told in the U.S. is as follows:

In 1882 Thomas Edison opened the Pearl Street Power station in New York City. The power station generated direct current and could power 5000 lights which Edison also invented. Though the DC electrical system required plants to be within a mile or so where the lights were to be lighted – which in New York City would be every few blocks – people who could afford it were in awe, fewer whales were killed to produce lamp oil and investors were eager to get a piece of the new technology.

Then there was 1884. Nikola Tesla invented an electric generator producing an alternating current that could be transmitted over long distances. By 1888 he demonstrated his full AC system including generators, transformers and motors. George Westinghouse, who patented improved air brakes for trains in 1873, bought the patents for Tesla’s alternating current electrical system.

There was a “battle of the currents” in which Edison supporters tried to show that alternating current was dangerous by electrocuting animals but the bottom line won out when it was shown that Tesla’s AC system could light more homes at a lower cost.

Investors in Edison's DC system were not happy to have direct current overtaken by alternating current. However, not all was lost for investors – Edison formed the *Edison General Electric Company* in 1892 which later became *General Electric* which now manufactures alternating current generators.

Tesla died in 1943 in a modest hotel room. Public spokespeople for GE now present the company's history as having been founded by Edison – which in a business sense it was but it was not founded on Edison's abandoned DC electrical system.

The twentieth century saw electrical technology go into high gear – experimenters who were making bigger and bigger sparks found that messages could be transmitted that way and wireless telegraphy came into being which led to voices and music by wireless, then radio, television and eventually to our electrical nirvana in which the developed world can share everything all the time with everyone. It's hard to imagine what more can be expected from electricity.

E3: Electricity Three

The third epoch of electrical technology will materialize from ideas developed in the early 1900s. Why this technology has been delayed has a lot to do with the changes in physics that took place at the end of the 19th century and the beginning of the 20th century.

The New Generator

In 1902 Nikola Tesla [wrote](#) his friend Robert U. Johnson that he had worked on a new type of generator ... using the energy of the surrounding medium to generate electricity. This new type of generator would not "consume fuel." He had written an overview of how this new generator would work in a 1900 article *The Problem of Increasing Human Energy - Through the Use of the Sun's Energy*.

What could be greater than having electricity generated without the use of polluting fuels and operated at no cost "though the use of the sun's energy?" The only costs would be the initial investment in generators – electrical energy would be virtually free.

But this generator has not happened for a number of reasons. First, there appeared unsigned articles from scientists who declared such a generator "impossible." Either the writers did not understand the physics of the new Tesla design or, perhaps, they did understand how the new device worked but were sponsored by the people who lost money on direct current technology and didn't want to lose again on yet another technological advancement.

In Tesla's time (he died in 1943) there is no documentation that further development work was done on this new type of generator. After the 1976 discovery of his letter to Johnson a number of amateurs attempted to replicate the generator based what they understood to be the science involved.

This is where the change in physics that took place at the start of the last century undermined their efforts. When Tesla wrote that the energy for the new generator came from the "ambient

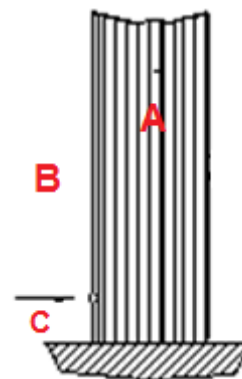
medium” some experimenters assumed that the energy came from the air. Though there is a difference in potential energy between the earth and any point above the earth, there is not enough energy to run anything but the smallest devices.

When Tesla wrote about the “ambient medium” he meant the primary energy in nature as understood by scientists, including his teachers, for hundreds of years. Up to about the year 1900 scientists believed that a pre-material aether filled the universe and that matter and energy were created from this aether. In Franklin’s time it was thought that electric fluid could be condensed from the aether and captured in bottles. In some of his 1900 experiments Tesla used energy stored in champagne bottles as a power source.

Even though science was changing, the bottles that stored electrical fluid and their solid material successors continued to be called “condensers” up to the 1950s* which by then few knew what was being condensed and referred to them by their physical properties of how much charge could be stored per volt, that is, their Capacitance, $C = q/V$, capacitance = charge in coulombs/voltage.

When the current new age experimenters based their understanding that electrical energy was extracted from the air by the new generator they were not successful at recreating the energy extracting generator. Neither were the experimenters who had their own less historically informed understanding of Tesla’s “ambient medium.”

Tesla does provide an analog example of how his generator would work and provided a drawing. **A** is a closed cylinder with little energy inside; **B** is the ambient medium with high energy; **C** is an opening where energy can be transferred from the high energy medium into the low energy enclosed cylinder.



Tesla continues with the analog – when energy flows through the opening at **C** “and might be then converted on its passage into some other form of energy.” With the conversion to another form of energy an artificial sink “for the energy to flow in [and]... be enabled to get at any point of the globe a continuous supply of energy, day and night.” With the conversion into some other form of energy the cylinder remains empty and the ambient energy continues to flow into the cylinder.

So this is pretty straight forward – we would only need to know is how to convert the high energy of the medium to some other form of energy and what that other that other form of energy is. And this is where it gets complicated.

The first complication is that the science used to create the electrical technology we continue to use today was based on what is now considered bad science.

When Nikola Tesla invented the electrical generators and motors we use today there was no such thing as an electron. Tesla patented his alternating current system in 1891. It wasn’t until 1897 that J.J. Thomson discovered the electron which then was understood to be an aether

* An exception is the automobile industry which commonly refers to these components as “condensers.”

whirlpool condensed into matter. However, by 1905 the aether theory of matter was abandoned by main line physicists in favor of the atomic theory of matter. One of the curiosities of science which deals, it claims, with universal, eternal, truths is how is it that we can use an electrical technology based on what is now considered bad science.

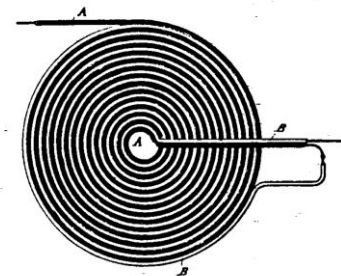
The second complication is how to model the Tesla energy “sink” in terms of current science. Here is a possible explanation:

The high energy outside the cylinder is the aether or primary energy. When it enters the cylinder that primary energy is condensed, as Franklin would have understood it, into electrical fluid, that is, into electricity. The next question is how would this process continue without the cylinder filling up with electrical fluid?

Let's change the mental picture of the cylinder to a coil of wire. In a coil of wire electricity would come in through the first turn, go into the second turn and so on until it reached the end of the wire where it could be used to make heat or to operate a motor.

However, if the coil was constructed in such a way that the energy in the first turn of the coil was positive and the energy in the second turn was negative the energy coming into the coil would be changed from flowing, kinetic, energy into static or potential energy. Electrical energy in the first turn of the coil would set up an electrical field between it and the second turn of the coil and so on through the length of the coil. The whole coil would have changed the incoming energy of the ambient medium into a different form of energy – potential energy.

Tesla patented such a coil as a *Coil for Electro-Magnets* in 1893. In this coil there are two windings of wire. The end of the first winding is connected to the beginning of the second winding. When a correct frequency is injected to the coil the adjacent windings have opposite polarity.



Because potential energy is generally considered as something that is sitting around waiting to be used – like a rock at the top of a hill waiting to be turned into moving or kinetic energy by rolling the rock down the hill – potential energy doesn't sound all that useful if it is waiting around for something to happen. This is where the notion of two types of electricity comes in.

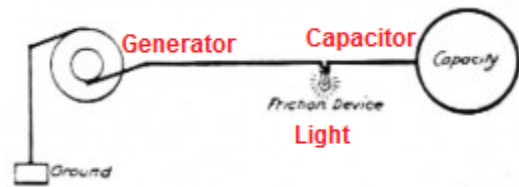
When electricity moves from where it is generated to where it is used it moves as a current. The electricity used in most devices is known as a conduction current – it moves from one place to another place where it is used, say, to light a light bulb. In between the generator and the light bulb there is a meter that keeps track of how much of this conduction current is used over time so the company owning the generator can charge the light bulb owner.

The other kind of electricity is a displacement current. With a displacement current electricity doesn't move from one place to another but stays in one place. Instead of the electricity moving through a wire the first charge carrier presses against the next electrical carrier which presses against the following electrical carrier and so on until that pressure started at the generator reaches the device to be operated. Instead of a current of flowing electrical carriers in a

conduction current the displacement current is a current of pressure in which the charge moves from carrier to carrier.

There is not enough original documentation to know if the Coil for Electro-Magnets was the basis for the Tesla generator that would not consume fuel or whether there was another device that operated in the similar way to convert the energy of the ambient medium into another form of energy that could be collected anywhere on earth, night or day.

In order to make use of a displacement current instead of a conduction current to operate a device the receiving device would have to be modified. Tesla gives a hint of how this may have been done with his experiments with one wire power transmission (his drawing shows ground, generator, friction device and capacity).



In the one wire setup instead of having a second wire return path Tesla makes use of a capacitor attached to the device being powered. The charge in the capacitor increases or decreases in response to the action of the generator. The one wire experiment was carried out with a conduction current circuit in mind, but the addition of a capacitance could be applied to a displacement current circuit.

The type of electrical system that “would not consume fuel” and would require a change in the receiving device brings up an important consideration – it would be very different from his alternating current system that is in use around the world. When Tesla was discussing his new generator design with a former assistant who was then a professor at Yale he said “My turbine will scrap all the heat engines in the world.” The professor replied “That will make quite a pile of scrap.”

The professor’s remark was, of course, that of a conservative scientist defending the intellectual status quo and protecting the profits of companies like General Electric. But it raises an interesting consideration – could we abandon our present electrical technology if a new one was developed. It is not likely that would happen.

What might happen is the fuelless generator will be forgotten and re-discovered in 200-300 years from now when there may be something better and the Tesla invention will be a historical curiosity like Di Vinci’s helicopter. Or maybe some bright engineer in Korea, or Russia or Latvia will figure out how reproduce the fuelless system and it is adopted to benefit energy-poor regions in the world then is gradually adopted worldwide.

The Tesla Death Ray

“The potential of new technologies to change things for the better is invariably overstated, while the ways in which they will make things worse are usually unforeseen.” Tom Standage, The Victorian Internet

Tesla said he developed a way of sending power without wires. His system was to use his generators to charge the whole globe to a high static potential and that individual receivers could make use of the energy anywhere on the planet. His idea was to replace the capacitor in the one wire system with the earth functioning as the capacitor. He also noted that the electrical waves transmitted through the earth would travel at "471,200 kilometers per second--fifty-seven per cent. greater than that of the so-called Hertz [radio] waves," a claim that was accepted in US Patent 717,482. The speed of light is usually given as 300,000 k/s so $\frac{471,200}{300,000} = 1.57$ times the speed of light.

He also saw that his wireless power transmission system "will be undoubtedly [used] for the propulsion of flying machines to which power can be readily supplied without ground connection" and that "no fuel of any kind will be required as the propulsion will be accomplished by light electric motors operated at great speed... I am developing a novel type of flying machine which seems to be well suited for meeting the present necessity of a safe, small and compact "aerial fliver" capable of rising and descending vertically." He also saw that his wireless power transmission system could be used to broadcast what we know as radio and television.



Tesla transmitter

Of course these ideas were beyond what other researchers and, more importantly, investors who could not absorb Tesla's vision at the beginning of the last century. Also, he had competition from Marconi.

In 1900 he received \$150,000 (about \$4 million in 2015 dollars) from J.P. Morgan to build a transmitter to signal Europe. On December 12th, 1901 Marconi claimed to have sent the first transatlantic signal, the letter "S," from Cornwall, England to Newfoundland, Canada. He did this with, as the financiers noted, equipment much less costly than the large plant being built by Tesla.

To encourage a larger investment in the face of Marconi's success, Tesla revealed to Morgan in 1903 his real purpose was not to just send radio signals but the wireless transmission of power to any point on the planet. Morgan was uninterested and declined to provide further funding. There also a financial panic that fall put an end to Tesla's hopes for financing by Morgan or other wealthy industrialists. Even George Westinghouse, who bought Tesla's patents for alternating current motors and generators in the 1880's, turns down the inventor's power transmission business proposal.

By 1907 a new topic enters his writings and interviews. Tesla is quoted that electrical waves could be sent to any part of the world to be used in future warfare. He wrote, "When I spoke of future warfare I meant that it should be conducted by direct application of electrical waves without the use of aerial engines or other implements of destruction."

In the period from 1900 to 1910 Tesla's creative thrust was to establish his plan for wireless transmission of energy. Undercut by Marconi's accomplishments (for which Marconi shared the Nobel Prize in 1909), beset by financial problems, and spurned by the scientific establishment, Tesla was in a desperate situation by late-decade. In order to make a final effort to have his grand scheme recognized, he may have tried one high power test of his transmitter to show off its destructive potential. This would have been in 1908.

The Tunguska event took place on the morning of June 30th, 1908. An explosion estimated to be equivalent to 10-15 megatons of TNT flattened 500,000 acres of pine forest near the Stony Tunguska River in central Siberia. Whole herds of reindeer were destroyed. Several nomadic villages were reported to have vanished. The explosion was heard over a radius of 620 miles.

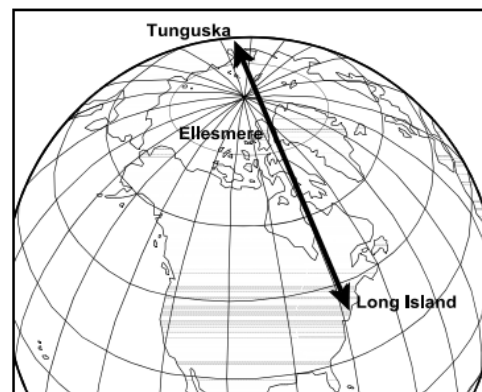
The accepted explanation of the Tunguska destruction is that a meteorite exploded over the area creating a fireball and shock wave but no crater. However, several expeditions to the blast area never found traces of meteorite material such as nickel, iron or stone.

Then, in 1915, Tesla stated bluntly:

“It is perfectly practical to transmit electrical energy without wires and produce destructive effects at a distance. I have already constructed a wireless transmitter which makes this possible. ... But when unavoidable [it] may be used to destroy property and life. The art is already so far developed that the great destructive effects can be produced at any point on the globe, defined beforehand with great accuracy.”

Why would Tesla want to cause such destruction even in a remote area? At the end of 1908, the whole world was following the daring attempt of Peary to reach the North Pole which he claimed in the spring of 1909. If Tesla wanted the attention of the international press, few things would have been more dramatic than the Peary expedition sending out word of a cataclysmic explosion on the ice near or at the North Pole. Tesla, then, if he could not be hailed as the master creator that he was, would be seen as the master of a mysterious new force of destruction.

The test was not a complete success. It must have been difficult controlling the vast amount of power in transmitter to the exact spot Tesla intended. The North Pole lies close to a great circle line connecting his transmitter site on Long Island and the Tunguska region. That path passes close by Ellesmere Island where Peary spent the winter. The uninhabited region between Ellesmere and the North Pole might have been the intended target for a test firing of the wireless power transmission system. However, "the accepted terrestrial measurements" of that day were not precise enough for the task. The destructive electrical wave overshot its target exploding instead in Tunguska.



Magnifying Transmitter's Test Path

The evidence linking Tesla and the Tunguska explosion is only circumstantial. Outside of Tesla's several statements to the press about the destructive potential of his wireless system there is no documentation that has been found where the inventor, or anyone associated with him, makes a claim about the multi-megaton explosion.

Suspending judgment for the time being assume that Tesla technology was the cause of the Tunguska explosion.[†] The country or company that controlled the technology would be able to dominate the world with the threat of wirelessly sending atomic magnitude explosions to any point on earth. However, building and especially testing such a system would not be easy to hide. A powerful transmitter like that would cause many secondary effects such as a large charge build up at the site of the transmitter and changes in the ionosphere that would be quickly detected with today's sensor technologies. Such efforts would invite preemptive air strikes on the transmitter site – unless the country operating the transmitter was a major military power and could defeat an air strike. In such a scenario a dominant country would be able to instantly destroy any location on the globe.

Claiming that electrical waves could be used to destroy a city or military site on the other side of the world does sound like one of the many YouTube prophecies predicting the end of the world at various dates. However, there already have been significant attempts at electrically modifying the global environment for military purposes. One was funded by the United States – that was the much mythologized HAARP program.

HAARP is the High Frequency Active Auroral Research Program, an ionospheric research program jointly funded by the U.S. Air Force, the U.S. Navy, the University of Alaska, and the Defense Advanced Research Projects Agency located on an Air Force–owned site in Alaska. Work on the facility started in 1993 with the purpose of “analyz[ing] the ionosphere and investigate the potential for developing ionospheric enhancement technology for radio communications and surveillance.” The transmitters in Alaska would aim radio waves at the electrically charged shell surrounding the earth, the ionosphere, in order to find out how it works and to see if changing the ionosphere could be used for long distance communication, surveillance, submarine communication and underground research.

HAARP was the object of many conspiracy theories claiming weather modification, mind control, earthquakes and diseases. In May 2014 it was announced that the facility would be closed down at the end of the year.

More significant in terms of money spent, size of structure and public impact was the Soviet Union's over-the-horizon radar project known in the press as the Russian Woodpecker that operated from 1976 to 1987. The main component was a huge antenna complex almost 50 stories high and over 1600 feet long weighing 14,000 tons located near Chernobyl. The cost has been estimated in billions of dollars - more than twice the cost of the nearby nuclear power plant.

[†] Since the 1990 publication of the Tesla/Tunguska connection, there have been a large number of imaginative stories and videos on the internet claiming many mysterious properties for the “Tesla Death Ray” including the destruction of the Twin Towers in New York.

The antenna complex could send extremely powerful radio waves that would bounce off the electrically charged ionosphere and the return pulse would send back information from over the curve of the earth of a possible missile launch before it could be detected by standard line of sight radar. The drawback of the Soviet system and how it got the Woodpecker name

was because it transmitted radio pulses sounding like the [repeated tapping](#) of its namesake bird. These signals were sent out on frequencies used by radio amateurs, commercial aviation and utility transmissions which caused international complaints. They also made the transmitter easy to locate.



Soviet OTH radar antenna near Chernobyl

Of course, conspiracy theories labeled it as a mind or weather control attempt. Operations at the facility were ended after the reactor meltdown at the Chernobyl nuclear plant in 1987 making the surrounding area dangerously radioactive. The purpose of the Woodpecker complex was made public after the fall of the Soviet Union in 1991.

The Future

Tesla explored a new region of nature and discovered what can be called a “new electricity.” This discovery could be used to provide non-polluting, inexpensive electrical power to everyone on earth. He also discovered a method of sending electrical power wirelessly from transmitting centers which could provide low cost power to consumers.

However, both of these technologies have a cost. The new generator would replace the current electrical infrastructure which would be economically very disruptive. The wireless power transmission system could, and likely, would, be developed into a long range, instant annihilation weapon. As an engineer has said the only difference between electrical communication, electrical power transmission and electrical weapons is the amount of power used.

Predictions about the future from historical data are reliable as predictions in financial markets. One good financial day does not mean that the next one or the next six months will follow the same upward track. Historical predictions are even more tenuous. However, at the fringes of history there was a notable exception to this rule.

Isaac Newton, perhaps the greatest scientific intellect in western history, predicted that the world will end in 2060. He based his prediction on biblical studies which were more extensive than his celebrated scientific work. Like the failed prediction of the end of the world in 2012 based on the Mayan calendar it is not likely that the world will end but it is likely will be changed in ways that Newton could not have foreseen.

There are examples in history when a change in technology caused major, long term changes in world history. One of these historical pivot points was the rise of the British Empire that

stretched from the colonies in America to Australia, Egypt, Rhodesia and India. And this empire had its beginning in gaining access to foreign technology.

When Queen Elizabeth I came to the throne, 1558, she recognized that Britain had not kept up with the rest of Europe of technical advances brought about by the Renaissance especially in mining technology. Her advisor Sir William Cecil decided to import expertise from Germany which had centuries of experience with silver and salt mines. Sir Cecil soon found that the Germans were not going to easily part with their knowledge and hardware. One of the early contracts with a German mining expert stated that all mining equipment brought to England had to be returned to Germany when their business venture ended. This technical information was essential to the production of weaponry.

In time, and with what today might be called “social engineering,” the English got the technology they needed to successfully mine copper and zinc to make brass which, in turn, made canon for the navy. With new weapons Britain was able to hold off its maritime enemies and with them out of the way Britain was able to colonize many of the less developed areas around the world allowing British merchants’ access to the natural resources of their new territories which resulted in banks and merchants becoming extraordinarily wealthy. The British Empire dominated the world for 200 – 300 years.

A similar shift in world power around the year 2060 could happen with the development of a new electrical technology, E3. At present governments have taken the first steps at the electrical modification of the earth’s environment, international war with ancient roots have renewed their bloody battles, old belief systems are in conflict with modern science, economic theories that reward the few and leave the many in poverty are being challenged and frustration can be communicated almost instantly around the globe. All of these conflicts point to a near-future time of major historical change. If the change is positive, the result could be a rare global golden age. If the change is disruptive, the golden age may come after people have agreed on new ideals.