



STRASBOURG UNIVERSITY PHYSICS INSTITUTE

The mind of a scientist

All wireless (radio, TV, cell phone, radar, etc.) is based on the transmission of electromagnetic waves first proposed by James Clark Maxwell in 1864 and demonstrated by Heinrich Hertz in 1887. Amongst others, Marconi developed a wireless transmitter and receiving apparatus that could transmit a signal for about 30 km. He could transmit no farther until he incorporated the circuits invented by Professor Karl Ferdinand Braun, a physicist, 500 km to the north in Strasbourg, Alsace, then part of Germany.

Electromagnetic waves are produced when there is a change in flow of electric current. These are transmitted at the speed of light and their wavelength is inversely proportional to frequency. Therefore, practical wireless, which requires reasonably short antennas, needs very high frequency oscillating current. In 1895-1897, Marconi used a spark circuit directly connected to his antenna to produce these currents. At high power the spark itself damped the oscillations. Braun, who had already discovered the rectifying effect of crystals (think transistors), the cathode ray tube (think TV picture tubes), powdered iron inserts in induction coils (think ferrite core computer memories), studied vibrations, first in solids and liquids, then in electric circuits. In 1898, he was successful in developing circuits that could tune these circuits and by inductive coupling, allow the antenna circuit to resonate. Marconi used this concept in 1901 to increase the power of this transmission sufficiently to cross the Atlantic from Poldhu England to Newfoundland just 14 years after the discovery of electromagnetic waves. Marconi received the Nobel Prize in 1909. At the same time Braun received the prize for his work in developing the science of wireless telegraphy.

Braun was not only a brilliant scientist but also an exemplary teacher. Early in his career he taught physics to a school of women in Alsace Lorraine. Here he is in 1905 giving a public lecture on wireless telegraphy. The Kaiser attended the lecture. In those days leaders of countries actually attended scientific lectures from time to time. Braun's 17 year old daughter transcribed his speech:

When a church bell is rung, we know the bell ringer makes it easy for himself: he draws on the pull rope, but always at the right intervals. He gives a little pull and then waits until the bell has passed through an entire oscillation; then he give another pull at the right time. All his pulls add up until the sum of the individual pulls causes large movements of the heavy bell.

Now the spark which has received the signal honor of having the whole thing named after it is a thankless customer. On occasion I have compared it to Saturn, who ate his own sons. We can't increase its strength arbitrarily. We are led then to a

simple conclusion: If we have already chosen a draft horse from the strongest existing breed, then to get more work done we shall simply have to use two horses instead of one. You don't need a professor for that sort of advice. (Laughter)

But if I am to harness two horses, I must make sure they don't pull in opposite directions, else I should be better off with one: and if I took four horses and one pulls forward, the second backward, the third to the right, and the fourth to the left, I shall have four horses to feed and still I shall be unable to budge from the spot. So the trick is to train the four horses to pull together. (The Kaiser laughs)

So the spark must be set off with a precision of one hundredth of one millionth of a second. Easy to say, but consider that one hundredth of one millionth of a second is to one second as a second is to I figured this out beforehand, else I shouldn't know it by heart (laughter) three years I tried to make sure in every way that the sparks would set in at exactly the right moment, but it could not be done; I came close to saying, I can't do anything with these sparks, they are even more stubborn than I am. (General amusement)

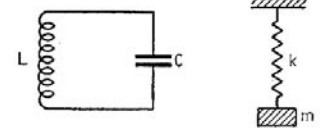
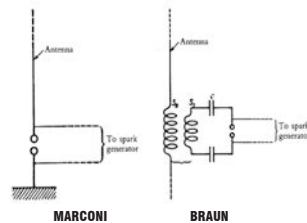
But I would not let go and went back to try just once more, and this time it worked. To begin with the circuits were so tightly coupled that when I drew energy from one circuit it was immediately replenished from the next. They acted like two ideal brothers when one runs up debts, the other pays them (His Majesty laughs and shakes his head as if to negate this)

But now the relation is transformed into that of a college student and his father. When one circuit runs up debts the other still pays them, but only after a certain phase delay. (General amusement)

At this point Braun demonstrated his energy circuit in action. The printed text states, Discharges a meter long and as thick as an arm were drawn from a coil.

The next time you visit the museum, have a look at Bob's weighted spring demonstration in the Massie building, which shows how a capacitor, represented by a spring, and a magnetic field, represented by a weight can be made to resonate with stored energy alternatively flowing from one to the other. Better yet, try this at home yourself.

Then go to the Wireless Building to review the display case showing a copy of Professor Braun's Nobel Prize and several of his personal items, complements of Ruth Braun, his daughter in law, a friend of Nancy and Bob, who lived in Kingston.



~ Fred Jaggi

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Worth Reading

During our work at the museum, we often talk about books portraying the fascinating history of science and technology. In this and future newsletters I'd like to share with you the names of some of our favorites. Ferdinand Braun A life of the Nobel Prize winner and inventor of the Cathode-Ray Oscilloscope, Kurio, translated from the German by Charles Susskind. MIT press ISBN 0-262-11077-6 (Bob and Nancy helped in the publication)
The Lunar Men by Jenny Uglow. Five men, Mathew Bolton, James Watt, Josiah Wedgwood, Darwin's grandfather Erasmus, and Joseph Priestly met monthly on a moonlit night when travel was possible. They encouraged each other in much technological advancement. ISBN 0570216102

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Bob and Nancy Merriam receive gifts and a plaque celebrating the 50th Yankee Steam-up



A 1917 Federal Truck towing a 1908 an Amoskeag Steam Powered Fire Engine at the 2014 Yankee Steam-UP