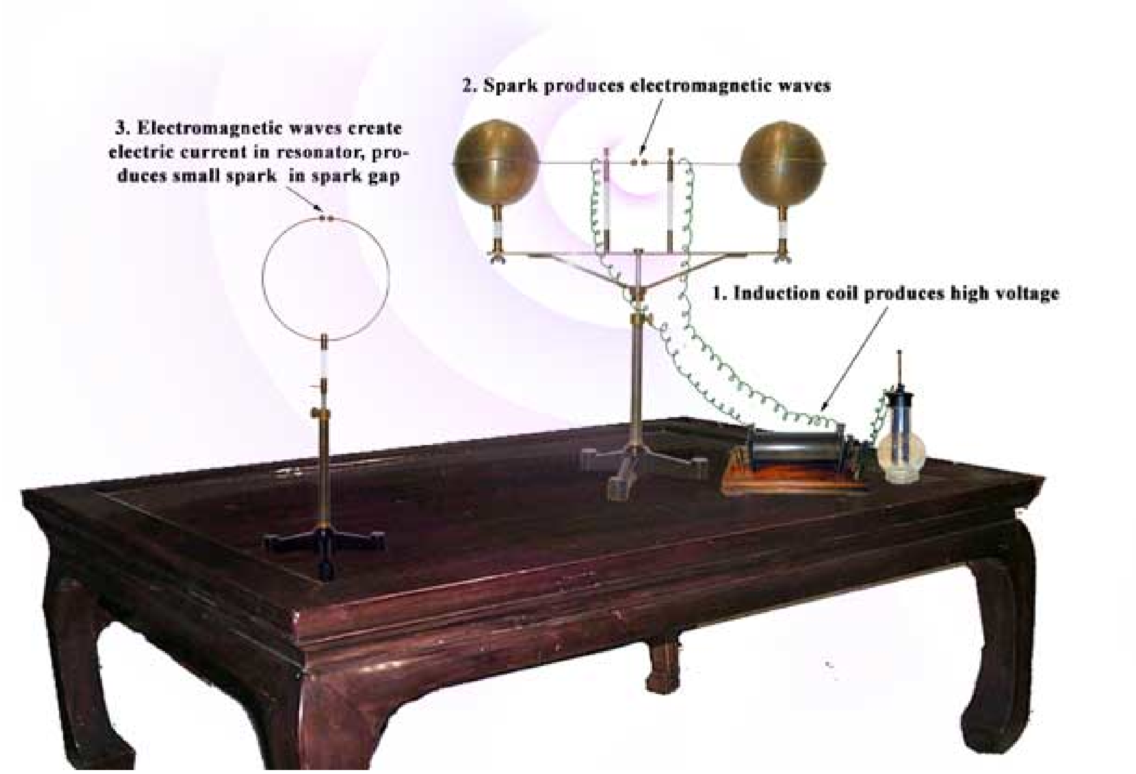
HERTZ DISCOVERS RADIO

Heinrich Rudolf Hertz was a German physicist, who first experimentally demonstrated the production and detection of electromagnetic waves. He did these experiments between 1885 and 1899, while he was professor of physics at Karlsruhe Polytechnic University.

James Clerk Maxwell had predicted the existence of electromagnetic waves in about 1864, and had calculated that their speed would be the (experimentally determined) speed of light. Hertz's experimental work demonstrated their existence, which reinforced Maxwell's conclusion that light must be electromagnetic waves. The idea could then arise that light was just a part of the "electromagnetic spectrum", which was gradually realized to encompass different kinds of (invisible) waves as well as light.

Here is a picture of Hertz's apparatus:



The ring at the left detects the waves. The ring is not completely closed: there is a small gap. The waves cause small sparks to be seen jumping the gap. If the ring is turned ninety degrees, you don't see the sparks, showing that the waves are "transverse waves", i.e., vibrate perpendicular to the direction of propagation, as Maxwell predicted. To be more precise about the apparatus: the loop, which is only 7.5 cm in diameter, is made from 1 millimeter thick brass wire; on one side of the gap is a small brass sphere, and on the other side the end of the wire has a sharp point, the position of which is controlled by a screw adjustment so the gap can be made as small as “hundredths of a millimeter.”

The sending apparatus consists of an induction coil, a capacitor, and two plates separated by a small air gap. The induction coil generates a high-voltage alternating current, which builds up in a capacitor, and when the capacitor discharges, the current charges the two plates. A high enough voltage makes a spark jump the air gap, and at the same time radio waves are generated. When the alternating current goes the other way, a spark goes the other way, and another half-wave is generated.

Hertz was not only able to detect the waves, he was able to measure their wavelength and velocity. Here is how he measured the wavelength: He was able to reflect the waves, and so create a “standing wave”, much like you could do shaking one end of a rope whose other end is attached to a wall. The “nodes” of such a standing wave are where the rope doesn’t move; the nodes of Hertz’s waves can be found because at a node, the detector does not spark. So to determine the wavelength, you find a place where the node does not spark, then move the apparatus until it sparks, and more until again it does not spark, and the distance you moved it is one wavelength. Luckily the wavelengths of his radio waves were less than the size of his laboratory; but for that to be true, Hertz must have been using what are now considered VHF (very high frequency).

The speed, frequency, and wavelength of waves are related, because the frequency is the number of waves per second, so the speed is that number of wavelengths per second. Having determined the wavelength, Hertz could determine the speed if he could determine the frequency. He was able to determine the frequency from the known laws of electricity. Then he calculated that the speed of the waves was equal to the speed of light, as Maxwell had predicted.

After Hertz’s experiments, the world paid attention: in 1895, Marconi could transmit signals a distance of 1.5 miles, and by 1897, the Marconi company was operating ship-to-shore “wireless telegraphy” in Britain. The first transatlantic voice transmission was in 1901. There was quite a battle over the patents for radio in the U. S., between Nicholas Tesla (who was first awarded two key patents for which he applied in 1897), and Marconi, who won the patents in 1904 when the Patent Office reversed its decision.

Hertz never got to see these developments, let alone file patents, because he died of blood poisoning in 1894, at the tragic age of only 36. That was just 14 years after earning his Ph. D. in Berlin, and eight years after marrying. His two young daughters were deprived of their father and the world of a great scientist.