

The Branly Coherer

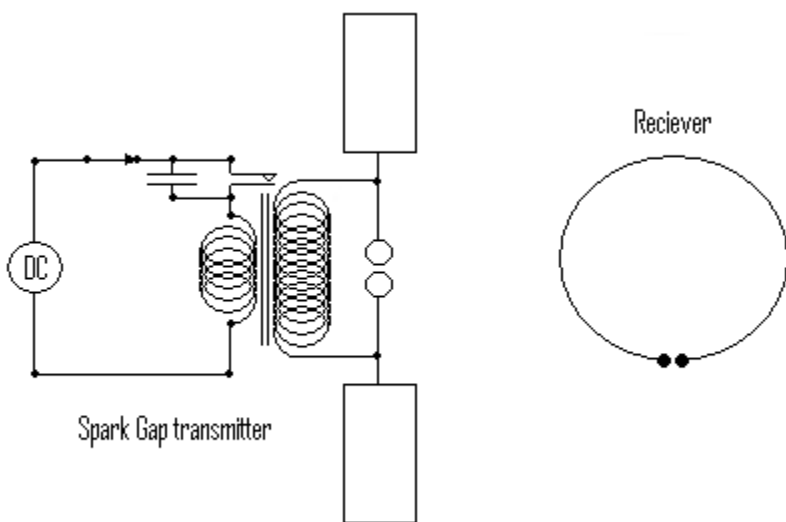
Tom Duncan, KG4CUY





Some History ^{ref. 1}

- Maxwell's Equations in 1873 explained the theoretical basis for radio transmission.
- David Edward Hughes first radio transmission in 1879 demonstrated this, but not rigorously.
- Hertz in 1886 proved Hughes had transmitted electromagnetic waves as predicted by Maxwell.

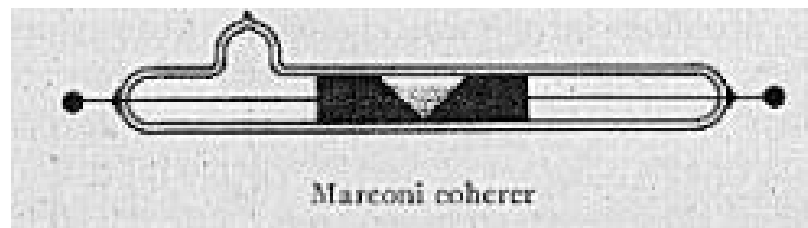


Not only his transmitter, but also Hertz's receiver was a spark gap, not capable by itself of driving a telegraph printer or sounder.



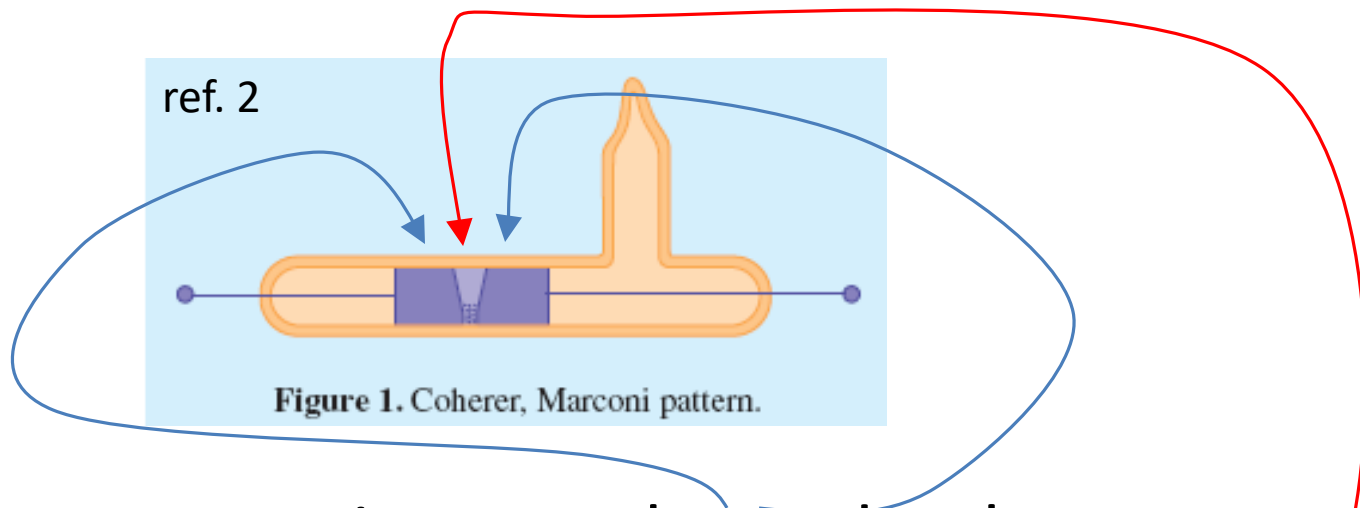
More History

- Edouard Branly in 1890 devised a tube loosely filled with metal filings which conducted “when hit by an electric charge”.
- Oliver Lodge in 1893 used this “Branly Tube” to detect Hertzian waves and dubbed it “the coherer”. This provided a useful output capable of driving a telegraph sounder.
- Marconi conducted experiments beginning in 1895 using the coherer as his original detector.





What is it?

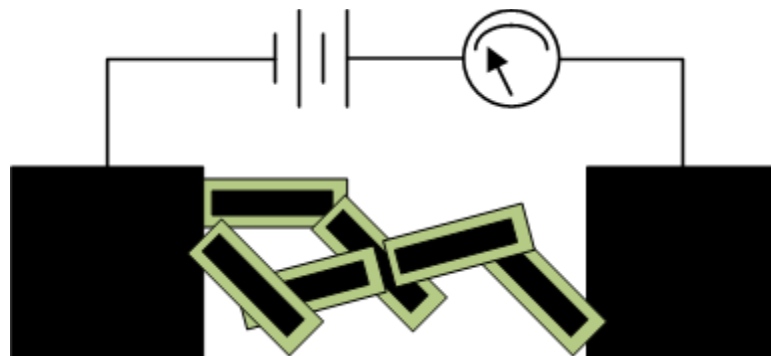


The coherer contains two electrodes, between which are loosely-packed metal filings. Two competing theories explain how the filings transition from a non-conducting to a conducting state. Once conducting, the coherer remains conducting until it is tapped slightly: this was the function of the de-coherer.

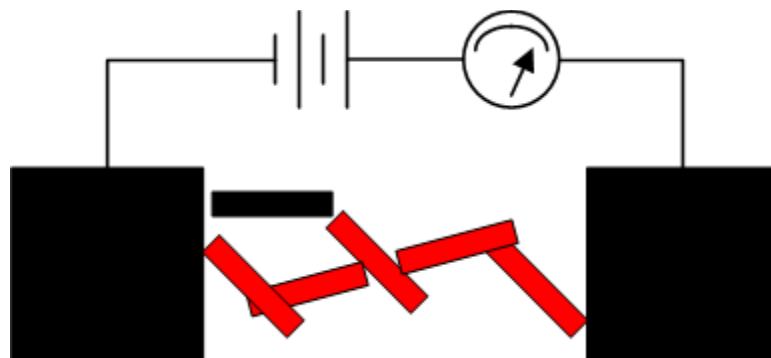


Theory 1 – Oxide Breakdown

Initially, the oxide coatings prevent conduction between adjacent filings.



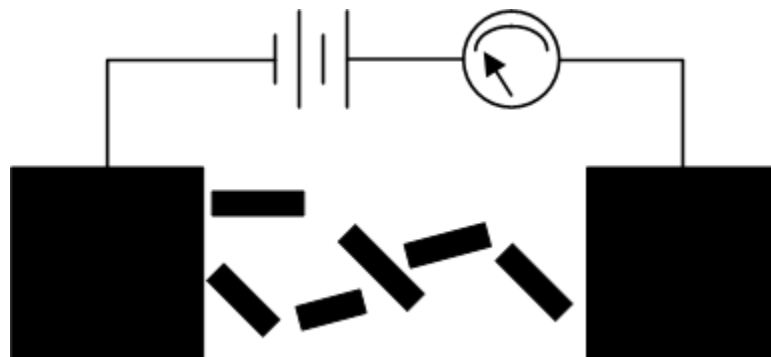
An electric field breaks down the oxide, causing conduction between filings, and ultimately between the electrodes.





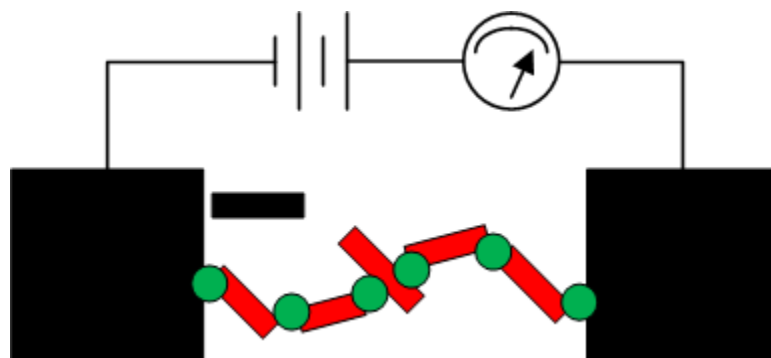
Theory 2 – Micro-Welding

A competing theory says that tiny spark gaps exist between the filings in the non-conducting state.



The electric field welds filings together, creating a conducting path.

These welds are easily broken, returning the coherer to a non-conducting state.





Wideband Receiver Using a Coherer

ref. 2

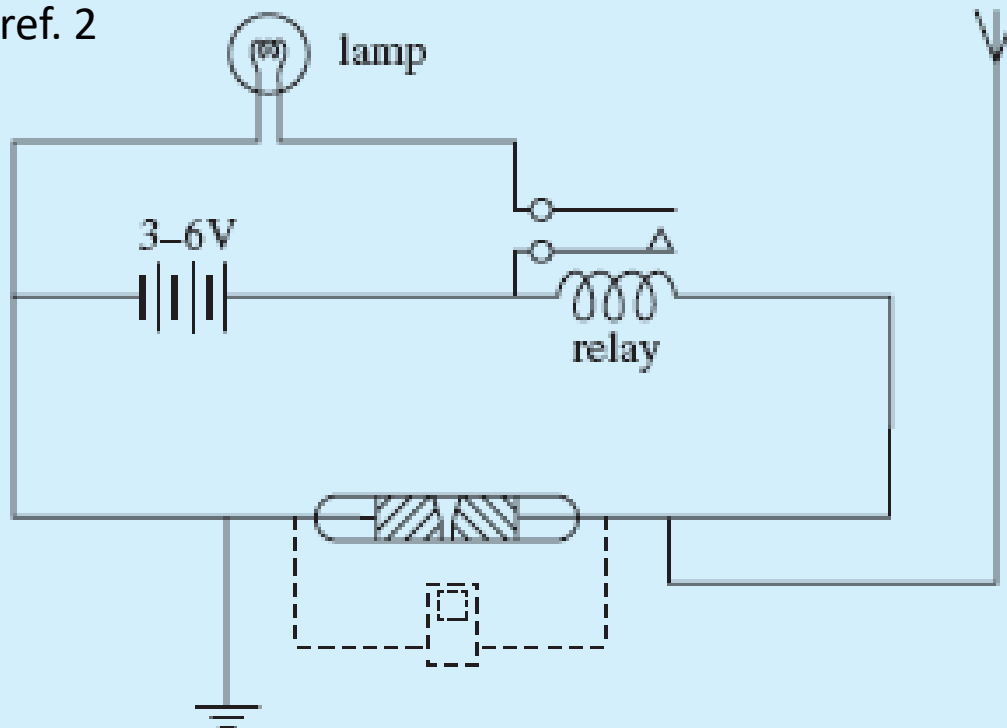


Figure 6. Circuit combining a coherer with a relay.

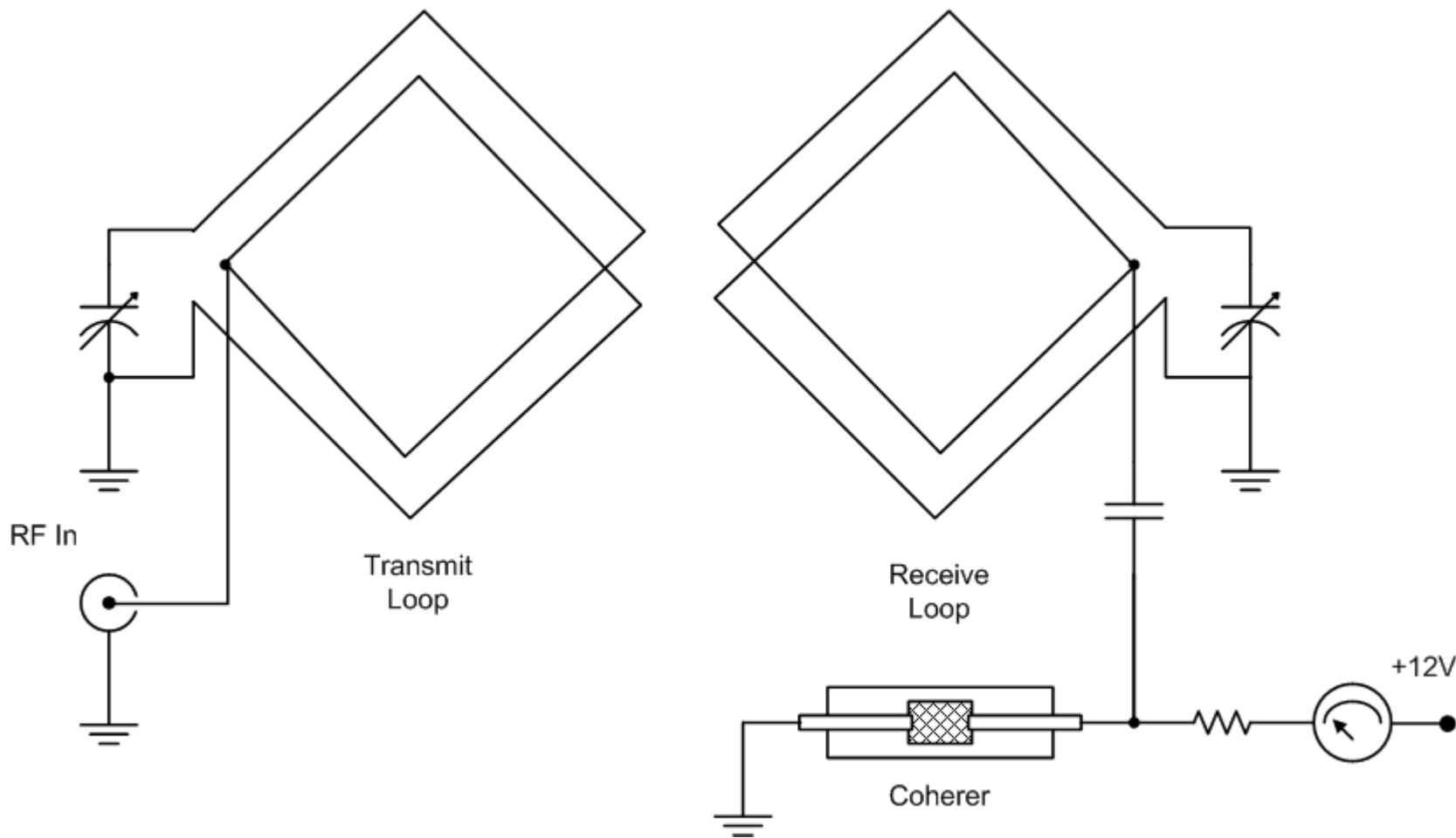


Demonstration Set-up

- In the days of spark, tremendous power (often tens of kW) was delivered to the antenna, and the signal occupied huge bandwidth. Such transmitters are no longer legal.
- Not having a spark-gap transmitter and wishing to operate legally, the demonstration uses a narrow-band continuous wave signal at low power (~ 40 mW) in the AM broadcast band. The receiver is also narrow-band: a high-Q loop antenna.



Demonstration Set-up



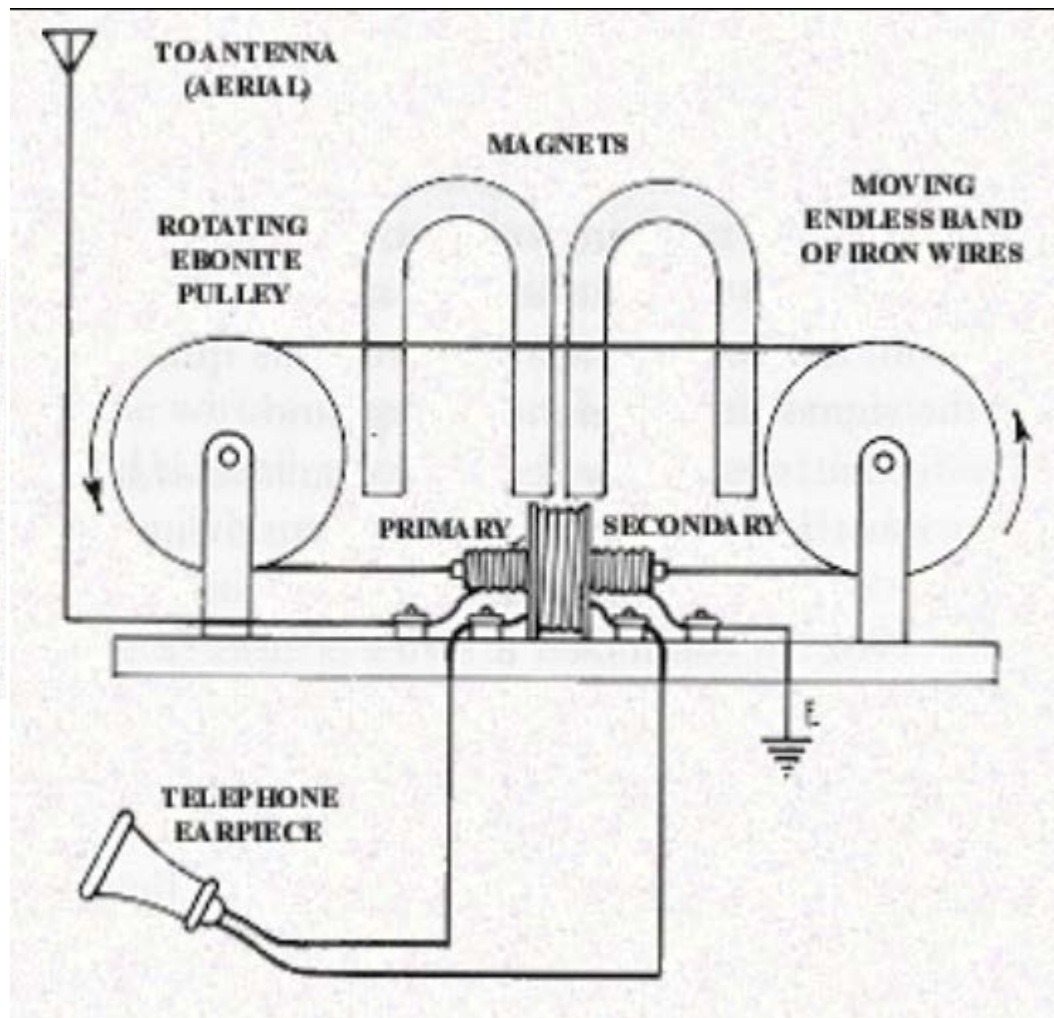


ref. 3

Competition – Marconi “Maggie”



Marconi Magnetic Detector





Competition – Ball Detector

Theory is similar to Branly Coherer, but instead of iron filings, a stack of balls is used. Both the oxide and microweld theories of operation are applicable here as well. The stack conducts poorly until a signal is received. Like Branly, requires a de-coherer.



Epochet Ball Coherer
4th qtr 19th century
(German)



Einstein Sums it Up

The wireless telegraph is not difficult to understand.

The ordinary telegraph is like a very long cat.

You pull the tail in New York, and it meows in Los Angeles.

The wireless is the same, only without the cat.

Bibliography:

- 1) *Signor Marconi's Magic Box*, Gavin Weightman, 2003, Da Capo Press.
- 2) *The Coherer, with Simple Demonstrations of the Generation and Detection of Radio Waves*, Alan Mills, 2010 "Physics Education", IOP Publications.
- 3) *Spark Museum*, www.sparkmuseum.com