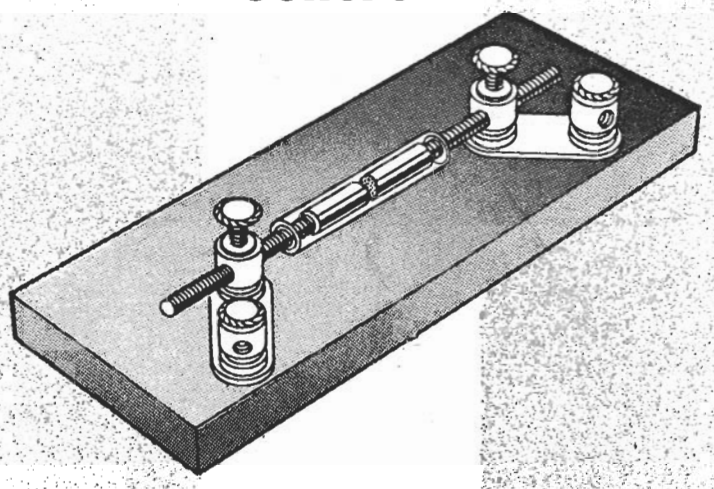
The "Coherer"



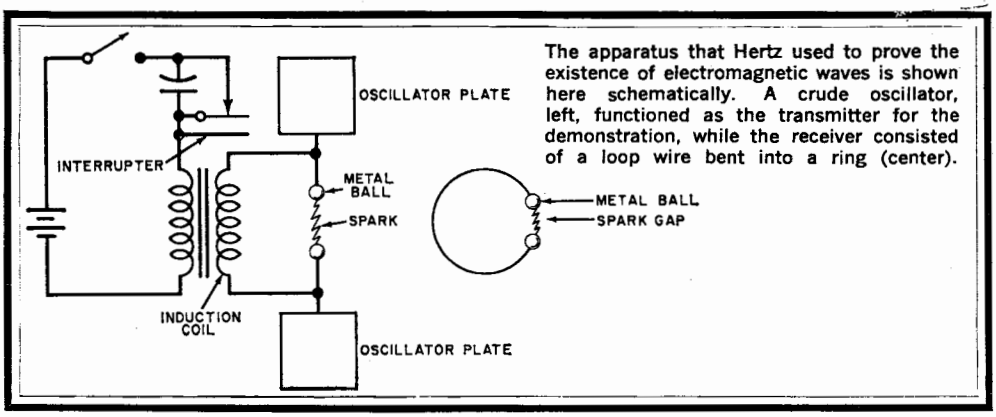
THE EARLY HISTORY OF RADIO COMMUNICATIONS AND THE MEN AND DEVICES THAT MADE IT POSSIBLE

By HENRY B. DAVIS

WHILE MOST HISTORY BOOKS date the birth of radio from Marconi's invention of wireless, this is only a half-truth. Like many scientific discoveries, the radio phenomenon was known as a "paper theory" many years before its actual existence was proven.

As early as 1845, Michael Faraday observed that the characteristics of light and electricity were basically similar. It was this observation that spurred James Clerk Maxwell, a brilliant British physicist, to dig deeper into the phenomenon.

In his paper "On A Dynamical Theory Of The Electromagnetic Field," written in 1864, Maxwell noted that a change in a magnetic field could bring about a change in an electrical field, and vice versa. This led to his conclusion that electromagnetic energy could be propa-



The apparatus that Hertz used to prove the existence of electromagnetic waves is shown here schematically. A crude oscillator, left, functioned as the transmitter for the demonstration, while the receiver consisted of a loop wire bent into a ring (center).

gated into space from a wire conductor, and that the energy traveled at the speed of light. He failed, however, to present physical proof of his theory.

In the years that followed, a great deal of scientific thought was given to Maxwell's theory. But it was 1887 before Heinrich Hertz, a German physicist, demonstrated a device which proved that the Maxwell theory was correct.

To generate electromagnetic energy (really radio waves), Hertz used a spark transmitter, operating around 4 meters (75 MHz). His "receiver" consisted of a length of wire with a small metal ball at each end; the wire was bent to form a ring with a small air gap between the metal balls. When the transmitter switch was thrown, the spark generated electromagnetic energy and this energy was induced into the wire "receiver," causing a spark to jump the gap between the receiver's metal balls. Thus, a spark produced by the transmitter induced a spark in the "receiver." No physical contact between the transmitter and the "receiver" existed.

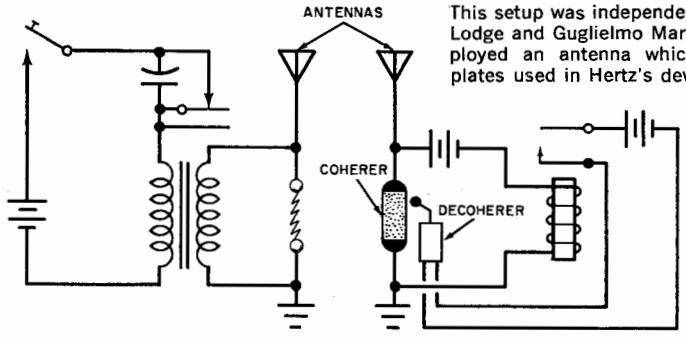
Although the distance between the two units was limited to a few feet, it was soon learned that this range could be increased to about 50 feet simply by limiting the size of the "receiver" wire to the wavelength of the oscillator's frequency and carefully adjusting the gap between the metal balls at the wire's ends.

Hertz's demonstration encouraged new interest in electrical waves—which came to be called "Hertzian" waves. Attempts to conduct radio waves through earth and water were carried out. Then experiments were made with large coils of wire to try and find a method of transmitting and receiving electromagnetic radiation by induction alone. But it was the introduction of the first sensitive radio wave detector—the "Coherer"—that made it possible to use radio waves as a means of demonstrating intelligent communications.

Back in 1850 the French scientist, Pierre Guitard, had discovered that dust particles in the air *cohered,* or collected together, when electrified. Later, in 1879, David E. Hughes, an American electrician and the inventor of the carbon microphone, while investigating the resistance properties of loose carbon granules, discovered that the granules *cohered,* going from a high-resistance to a low-resistance state, when a current was passed through them.

Dr. Edouard Branley, another French physicist, perhaps borrowing from Hughes' elementary discovery, built the first "Coherer." His Coherer consisted of a glass tube partially filled with iron filings and plugged with corks through which wire electrodes had been forced. In operation, the iron filings *cohered* when a strong radio signal was impressed across the electrodes. Branley did not use his instrument for the reception of radio waves, but he did find that the Coherer had to be tapped manually to *decohere* the filings in order to return the unit to a high-resistance condition.

A British physicist, Sir Oliver Lodge, was the first to use the Coherer in place of Hertz's wire loop, for the detection and pen recording of Morse code signals.



This setup was independently designed by Sir Oliver Lodge and Guglielmo Marconi. The transmitter employed an antenna which replaced the oscillator plates used in Hertz's device. The receiver consisted of Branley's Coherer, a Popov decohering device, and a receiving antenna. Operation was essentially the same as in Hertz's setup, but there was an enormous increase in sensitivity.

Because the Coherer had to be *decohered* after detecting each pulse of electromagnetic energy, it was suitable only for a Morse code type of communications setup. Sir Oliver, understanding this to be the case, used a "trembler" to *decohere* the iron filings.

In 1895, when the Russian physicist, Aleksandr Stepanovitch Popov, employed the armature of an electric bell to *decohere* the particles, practical transmissions of pulses at a reasonable rate of speed became possible. The bell did away with the need for necessarily slow manual *decohering*. But an even more significant achievement attributed to Popov is the fact that he was the first person to consider using an antenna with the Coherer circuit. The addition of the receiving antenna increased the radio range to more than 900 feet.

At this point, Marconi enters the picture. Sir William Crookes, in the British publication *Fortnightly Review,* predicted in 1892 that wireless [radio] telegraphy would replace all other means of rapid communications. It is likely that this prediction inspired Guglielmo Marconi, the Italian inventor, to make the dream come true.

Marconi took the crude Coherer Branley had designed and made improvements on it. He replaced the corks with silver plugs. And by using a mixture of silver and nickel filings in place of iron filings and evacuating the air from the tube, Marconi succeeded in producing a device many times more sensitive than the original Coherer.

With his own improved version of the Coherer, the Popov method of *decohering,* and a receiving antenna, Marconi attained results that can be described as only slightly less than spectacular. Signals of from 2 to 9 miles were observed almost immediately, and by early 1901 the figure had increased to 200 miles. About the same time, at the suggestion of Sir Oliver Lodge, Marconi incorporated an "oscillation transformer" in his radio system which permitted the system to be tuned to a given resonant frequency.

Marconi's crowning achievement, however, came about when, on December 12, 1901, he succeeded in proving that radio waves could be intercepted around the curvature of the earth. On that day, he received a signal transmitted from England—some 2000 miles from where he waited on the coast of Newfoundland, Canada.

It is not really clear when radio was actually born. But it certainly was not in existence before Hertz demonstrated his apparatus, and just as certainly it came about not later than Sir Oliver Lodge's demonstration. Both of these events took place prior to Marconi's historic adventure into the new technology.

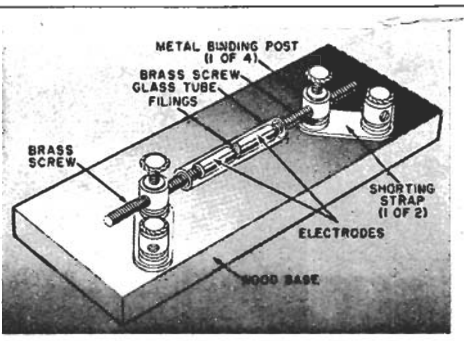
The achievements of these early pioneers were monumental considering the fact that most of the work was accomplished before the advent of the electronic amplifier. Just how incredible these achievements were can be fully realized only by building and using a Coherer yourself. The diagrams and text on the following page provide all the necessary details. -30-

MAKE YOUR OWN COHERER

THE DRAWING at right is more or less self-explanatory. Most of the dimensions will depend on the materials you use, but keep the inner diameter of the glass tube down to about 3/16" and the lengths of the electrodes to about 1/2". Also, file the ends of the electrodes opposite the screws at a slight angle to facilitate tuning.

Rub both electrodes in mercury until they take on a bright metallic coating, then attach the screws as shown. If you run into any problem trying to mate the electrodes to the glass tube, file or sand the electrodes down to fit before rubbing them in mercury.

Use a medium file to prepare a mixture of 5% silver and 95% nickel. Sift the filings through fine cheesecloth to remove all unwanted metal dust that might gum up the works.



Parts must be solidly mounted on the wood base. Screw-type metal binding posts will facilitate easy mounting of the electrode assembly and will also provide convenient circuit connections.

Slide one of the electrodes into the glass tube. Pour just enough of the filings into the tube to fill the space about halfway when the electrodes are spaced 1/16" apart. Then assemble the unit. -30-

TUNING AND USING YOUR COHERER

AFTER ASSEMBLING the Coherer, connect it up as shown below (left). Use a relay that will pull in below 60 milliamps to prevent burning the filings or electrodes.

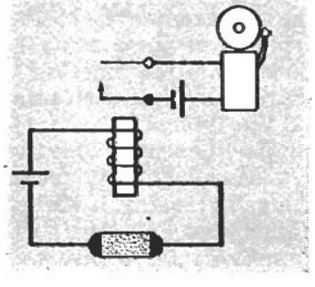
Decrease the spacing between electrodes until the relay pulls in, then slowly increase the distance between electrodes until the relay de-energizes. Do this several times until you have the Coherer set at the point just before the relay pulls in.

When properly adjusted, the Coherer should close the relay when a 1" spark coil is energized at a distance of 25 or more feet. For this test, no antenna should be connected to the Coherer. Between tests, tap the Coherer to get ready for the next pulse from the spark coil.

When you're satisfied that the Coherer is properly adjusted, tighten the screws on the binding posts connected directly to the electrode screws. Then connect your Coherer up to a circuit like that shown below (right), and it's ready for use.

A spark coil can be used for your experiments, but if you're planning any prolonged experiments, it is suggested that you use a high-voltage capacitor instead. The rapid discharge of the capacitor will have almost the same effect as that of the spark coil, and will not cause any interference on your neighbors TV's and radios.

You might want to experiment with the Popov method of decohering. If so, refer to the circuit on page 49. -30-



The tuning circuit for the Coherer is shown at left. A relay that will draw no more than 60 milliamperes is needed to prevent damaging the filings.

After tuning the Coherer, connect it up to a circuit like that shown at right, below. The circuit can be provided with a degree of selectivity if you tap the choke in several places. A decoherer can also be added.