

The Thing, also known as the Great Seal bug, was one of the first covert listening devices (or "bugs") to use passive techniques to transmit an audio signal. Because it was passive, being energized and activated by electromagnetic energy from an outside source, it is considered a predecessor of RFID technology.

Operating principles

The Thing was designed by éon Theremin, who also made the eponymous theremin. It consisted of a tiny capacitive membrane connected to a small quarter-wavelength antenna; it had no power supply or active electronic components. The device, a passive cavity resonator, became active only when a radio signal of the correct frequency was sent to the device from an external transmitter. Sound waves caused the membrane to vibrate, which varied the capacitance "seen" by the antenna, which in turn modulated the radio waves that struck and were re-transmitted by the Thing. A receiver demodulated the signal so that sound picked up by the microphone could be heard, just as an ordinary radio receiver demodulates radio signals and outputs sound.

Theremin's design made the listening device very difficult to detect, because it was very small, had no power supply or active electronic components, and did not radiate any signal unless it was actively being irradiated remotely. These same design features, along with the overall simplicity of the device, made it very reliable and gave it a potentially unlimited operational life.

The principle of a resonant cavity microphone was patented by Winfield R. Koch of the Radio Corporation of America (RCA) in 191. In US patent 2,238,117 he describes the principle of a sound-modulated resonant cavity. High-frequency energy is inductively coupled to the cavity. The resonant frequency is varied by the change in capacitance resulting from the displacement of the acoustic diaphragm.

Technical details

The device consisted of a 9 inch (22.86 cm) long monopole antenna (quarter-wave for 330 Megahertz (MHz) frequency, but able to also act as half-wave or full-wave, the accounts differ) - a straight rod, led through an insulating bushing into a cavity, where it was terminated with a round disc that formed one plate of a capacitor. The cavity was a high-Q round silver-plated copper "can", with the internal diameter of 0.775 in (19.7 mm) and about 11/16 in (17.5 mm) long, with inductance of about 10 nanohenry. Its front side was closed with a very thin (3 mil, or 75 micrometers) and fragile conductive membrane. In the middle of the cavity was a mushroom-shaped flat-faced tuning post, with its top adjustable to make it possible to set the membrane-post distance; the membrane and the post formed a variable capacitor acting as a condenser microphone and providing amplitude modulation (AM), with parasitic frequency modulation (FM) for the re-radiated signal. The post had machined grooves and radial lines into its face, probably to provide channels for air flow to reduce pneumatic damping of the membrane. The antenna was capacitively coupled to the post via its disc-shaped end. The total weight of the unit, including the antenna, was 1.1 ounce (1 grams).

The length of the antenna and the dimensions of the cavity were engineered in order to make the re-broadcast signal a higher harmonic of the illuminating frequency. (Note that the transmitting frequency is higher than the illuminating one.)

The original device was located with the can under the beak of the eagle on the Great Seal presented to W. Averell Harriman (see below); accounts differ on whether holes were drilled into the beak to allow sound waves to reach the membrane. Other sources say the wood behind the beak was undrilled but thin enough to pass the sound, or that the hollowed space acted like a soundboard to concentrate the sound from the room onto the microphone.

The illuminating frequency used by the Soviets is said to be 330 MHz.

The Thing was discovered in a stroke of luck by a technician with an untuned video receiver – a wideband receiver with a simple diode detector/demodulator, similar to some field strength meters. It was then located during a technical surveillance counter-measures "sweep" of the Ambassador's office, using a signal generator and a receiver in a setup that generates audio feedback ("howl") if the sound from the room is transmitted on a given frequency; the generator was tuned to 1800 MHz. The device was first assumed to operate on this frequency, but tests showed it was unstable and insensitive. Peter Wright, a British scientist, then got the Thing operating reliably at 800 MHz.

The membrane of the Thing was extremely thin, and was damaged during handling by the Americans; Wright had to replace it. Wright's examination led to development of a similar British system codenamed SATYR, used throughout the 1950s by the British, Americans, Canadians and Australians.

The simplicity of the device caused some initial confusion during its analysis; the antenna and resonator had several resonant frequencies in addition to its main one, and the modulation was partially both amplitude modulated and frequency modulated. The team also lost some time on an assumption that the distance between the membrane and the tuning post needed to be increased to increase resonance.

There were later models of the device, some with more complex internal structure (the center post under the membrane attached to a helix, probably to increase Q), and some American models with dipole antennas. Maximizing the Q-factor was one of the engineering priorities, as this allowed higher selectivity to the illuminating signal frequency, and therefore higher operating distance and also higher acoustic sensitivity.

Use in espionage

Theremin's device was used by the Soviet Union to spy on the United States. The device was embedded in a carved wooden plaque of the Great Seal of the United States. On August 4, 1945, a delegation from the Young Pioneer organization of the Soviet Union presented the bugged carving to U.S. Ambassador W. Averell Harriman, as a "gesture of friendship" to the USSR's World War II ally. It hung in the ambassador's Moscow residential study until it was exposed in 1952 during the tenure of Ambassador George F. Kennan. The existence of the bug was accidentally discovered by a British radio operator who overheard American conversations on an open radio channel as the Russians were beaming radio waves at the ambassador's office. The Department of State found the device in the Great Seal carving after an exhaustive search of the American Embassy, and Peter Wright, a British scientist and former MI5 counterintelligence officer, eventually discovered how it worked.

United Nations

On the fourth day of meetings in the United Nations Security Council, convened by the Soviet Union over the 1960 U-2 incident where a U.S. spy plane had entered their territory and been shot down, the U.S. ambassador showed off the bugging device in the Great Seal to illustrate that spying incidents between the two nations were mutual and to allege that Nikita Khrushche had magnified this particular incident under discussion out of all proportion as a pretext to abort the 1960 Paris Summit.