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The Wireless Specialty Apparatus Silicon Detector

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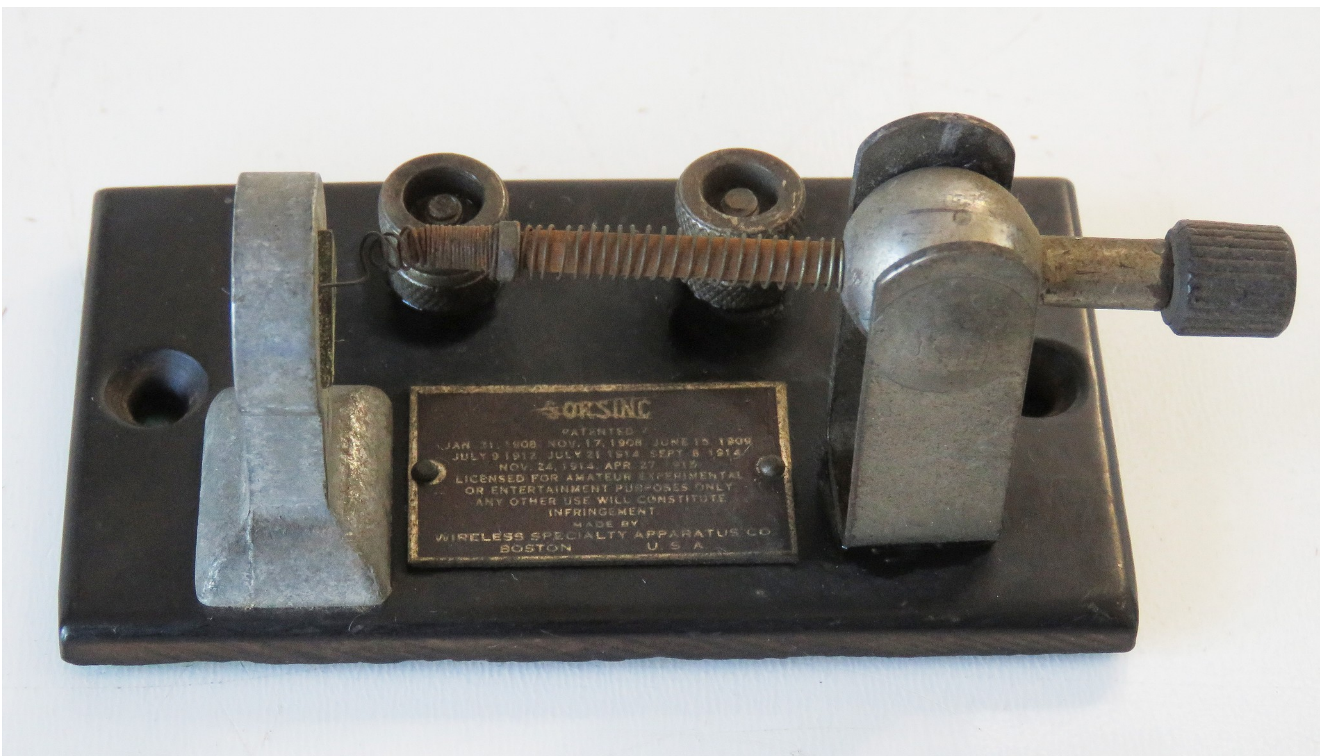
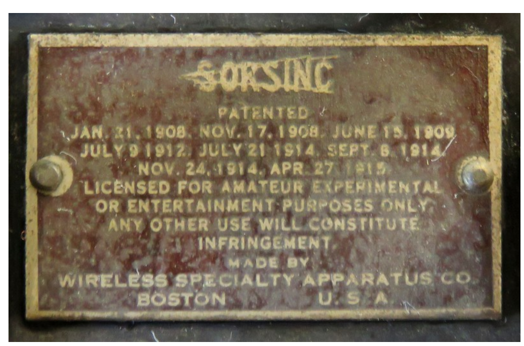
Early crystal detectors used a variety of materials under the cats-whisker to produce a non-linear circuit that would detect (demodulate) an RF signal.

The Wireless Specialty Apparatus (WSA) company, founded in Boston in 1907 was later acquired by RCA in 1920’s. Their catalog listed a wide variety of receivers, leyden jar condensors and various radio-related equipment including crystal detectors.

CHRS has come into possession of a crystal detector from WSA. They listed two types of crystal detectors in their catalog, a silicon and a Pericon variety, and the one in our possession uses a silicon crystal in a matrix contacting a cats-whisker.





The name plaque lists patents up through April 1915, which places its manufacture after that.

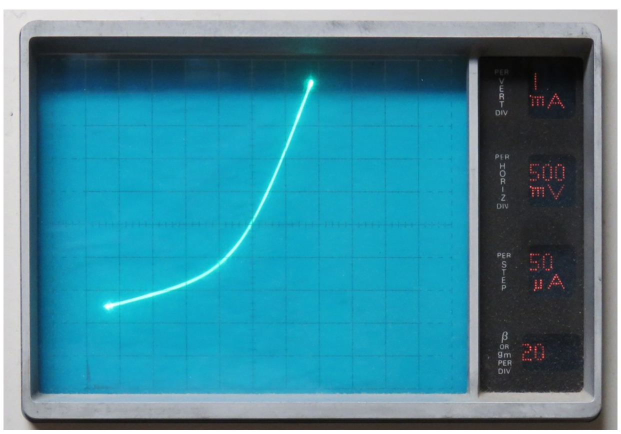
The detector is mounted on an insulating base, with the silicon crystal embedded in a carrier material such as lead, which is then mounted on a vertical header. The cat’s-whisker mounts on a ball joint and is spring loaded to present a force to the crystal.

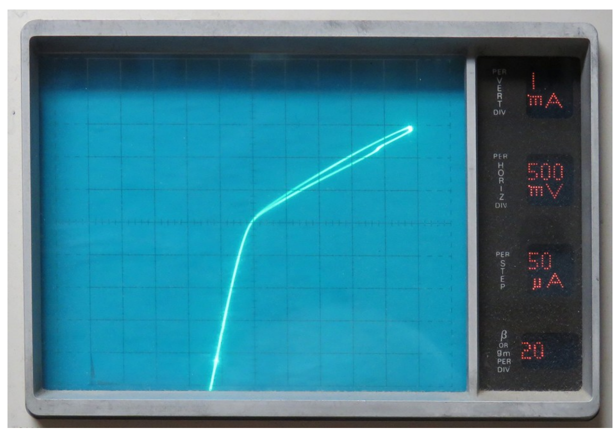
The detector operates by presenting a non-linear conduction curve to the RF impressed across it. The non-linearity translates variations in the amplitude of the RF wave to a signal that is presented to headphones connected to the detector.

The higher the non-linearity, the more sensitive the detector is.

The detector uses a cat's-whisker that contacts the surface of the silicon crystal. Some areas of the crystal exhibit this non-linear voltage-current profile, and are sought out by placing the cat's-whisker at various positions on the silicon crystal until a signal is detected. Often, there is a "buzzer" in the receiver that simulates an RF signal, which assists in finding a good spot on the silicon crystal to generate the loudest signal.

A Tektronix 576 curve tracer displayed the detector characteristic for various positions of the cat's-whisker. A few "special" places on the face of the crystal gave various non-linear responses. The curves below show the current (vertical axis) through the detector as a function of the voltage across (horizontal axis) the detector. A "kink" or curvature of the curve indicates the non-linearity we are looking for. The applied voltage is alternating current, and passes through zero in the center of the screen. The scale factor is 0.5 volts per horizontal major division, and 1 mA major vertical division.

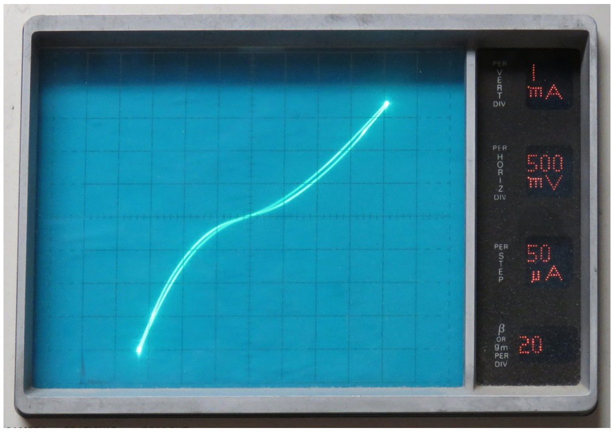


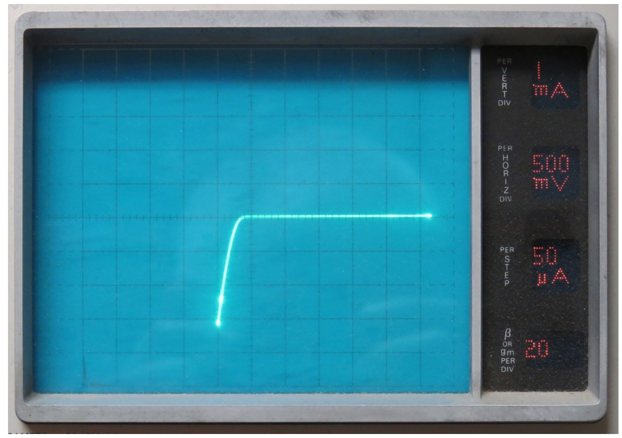


The first plot shows a gentle non-linearity with maximum curvature at a voltage of about -0.5 volts across the detector. At more negative voltage across the detector, the current decreases, and with positive potential, the current continues to rise. Thus, the resistance varies with the voltage across the detector. The detector in this mode would work best with a bias of 0.5 volts across it.

The second plot shows the response at a different spot on the silicon crystal, where the non-linearity occurs right at the zero-voltage cross-over point with a substantial non-linearity. This would be the most sensitive spot. The plot also shows a "loop", showing that the non-linearity is time-dependent.

Other characteristic curves showed up. The first one below shows an almost symmetric pattern around zero voltage, but would not be a sensitive demodulation point.





As a comparison, the last plot shows the response of a 1N56 germanium detector, at least 60 years old. Here, the conduction starts abruptly at about 0.25 volt. The 1N56 is a high-conductivity version of the venerable 1N34 germanium diode.

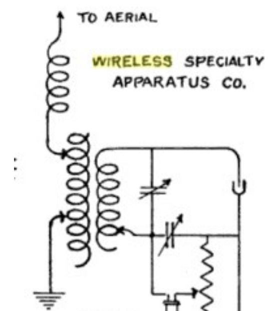
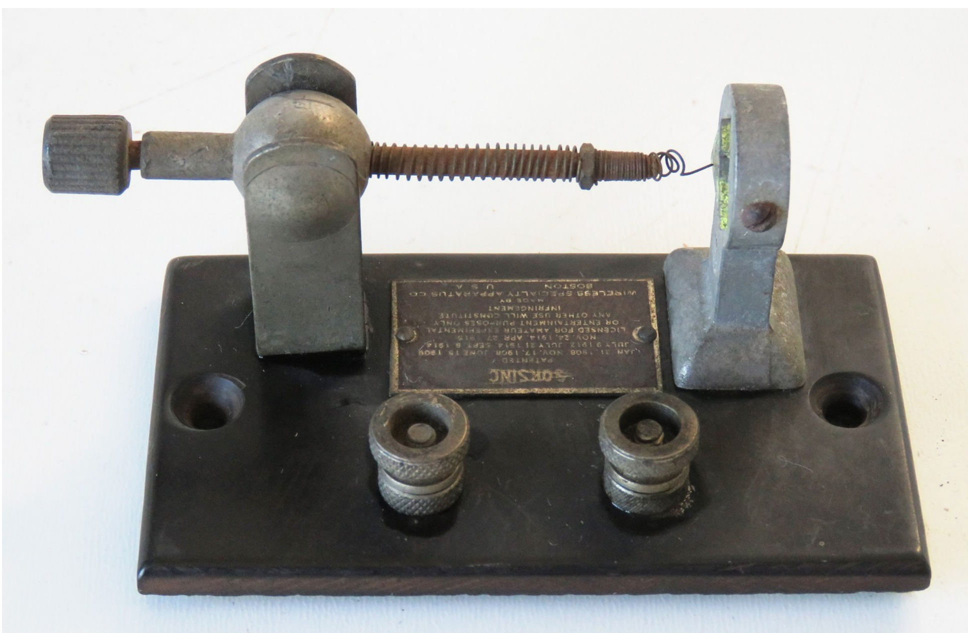


FIG 86

As the maximum kink in the characteristic curve may not occur at the zero crossing, as in the first plot above, the receivers often included a bias circuit that moved the operating point of the detector.



Acknowledgment: Bart Lee, who suggested I write this up, and for providing the schematic above.