Crystal detectors and how they work

Join us in a trip down memory lane to the time when *radio* meant *crystal*

by James A. Fred

RADIO WOULD NOT BE POSSIBLE without a means of detecting the signals. Detection of a signal refers to the separation of the audible signal from the radio frequency carrier signal. Over the years since 1873, many kinds of detectors have been used. The first really sensitive and stable detector was the mineral detector of Dr. Greenleaf Whittier Pickard. Utilizing the research of Professor Braun which showed the "unilateral" conductivity of certain minerals such as Pyrite and Galena, Dr. Pickard developed the crystal detector. During the developmental process, Pickard found over 250 different minerals that would detect radio signals when used in conjunction with metal contacts. He actually tested over 31,000 combinations, finding many hundreds of useful pairings.

Early Development. The crystal detector developed by Dr. Pickard between 1902 and 1906 was the first truly sensitive and fairly stable detector. The crystal detector was more sensitive than the Fleming Valve (diode) and even the deForest Audion (triode). As testimony to that fact, many radio operators kept a crystal detector on standby for their vacuum tube receivers. The one drawback to any detector, including the crystal detector, is that they do not amplify signals, but merely detect the signals received.

Ups and Downs. This lack of amplification requires that every possible step be taken to provide the highest level of signal to the receiver. The antenna gathers in the radio signals and the higher it is and the longer it is (to a point) the stronger the signal is. Of course in this day and age there has to be a limit to the height and length of the antenna. These limits will vary with where you live and how far you are from radio stations. For use with the crystal radio we are about to describe, your antenna should be from 10 to 25-feet high, and from 50 to 100-feet long.

Lack of caution in erecting antennas has caused some fatal accidents, so we urge that you use care when making your installation. No antenna should cross, go under, or even be erected *near* power lines, or even telephone lines. Keep your antenna in the clear. Not only will this prevent an accident, but it will help avoid picking up power line noises that could drown out the radio signals.

A good ground is next in importance, since the ground completes the antenna circuit. Usually a connection to a cold water pipe is considered an acceptable ground, but today this is not always true. The pipe could have a plastic section, or could be separated from the earth by a meter or other device. A better ground can be obtained by driving a copper-plated rod at least six-feet long into moist soil. Try to avoid sandy or dry soil, as it makes a poor ground. Don't drive the rod under the eaves of the house, because the rain will not moisten the ground there. The old-time radio experimenters sprinkled a few crystals of copper sulphate around the upper section of the ground rod. The copper salts would improve the soil conditions and make a better ground. Use a good ground clamp to attach your ground lead-in or better yet solder it to the ground rod.

The Human Connection. With further respect to the fact that crystal detectors do not amplify, and that every possible way to improve the strength of the received signal must be taken advantage of, the need for a set of the most sensitive headphones available must be recognized. You cannot use crystal headphones or the low-impedance (4 to 16-ohms) dynamic phones found on today's market. Most of the mail order radio parts catalogs will list 2000-ohm headphones, which are the ones you should buy. If you can find 4000 to 8000-ohm units, you will hear an even stronger signal on your crystal radio.

While the preceeding tells us what to do to receive the best signal possible, we have not discussed the crystal detector itself. If a crystal detector is examined, it will be found to be merely a

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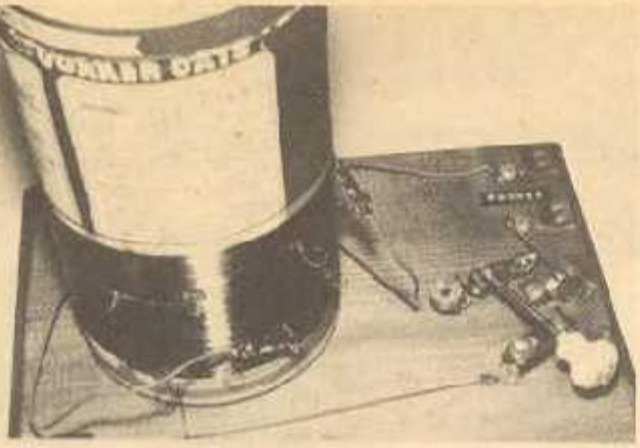
stand that holds the mineral in place with electrical contacts probing the mineral. Most minerals are mounted in a metal cup filled with a low melting-point metal, called Woods metal. The low melting-point prevents damage to the mineral crystal, which could cause it to loose its sensitivity. The adjustable electrical contact probing the mineral is called a "Cat Whisker," since it is a fine, springy wire. These two contacts to the mineral form a junction that permits electrical current to flow in one direction, or, as Pickard called it, "unilateral conductivity." This is a form of rectifier diode, and its action detects the audible signal which operates the headphones and permits us to hear the program material.

Now that we have all the necessary background for building and using crystal detectors, let's build a simple Cat Whisker crystal set which requires no parts beyond the wire and crystal, which we in jest have called the "No Parts Crystal Set."



You can't make a simpler, or less expensive BCB receiver than this one. Even the coil winding isn't terribly critical, but the value we selected gave the best result.

Construction. You can build your crystal receiver on a piece of pine board, just as the oldtimers did. If you follow our layout, you won't need any fancy hardware, and in fact, you can use the exact same materials which were used years ago to build the first sets. Don't laugh! They actually worked, as you will see.

First, mount 4 terminals. You can use Fahnestock clips, or make your own with four wood screws and washers on them. Run the antenna wire, etc. between the washers and tighten the screws. Build your crystal detector stand at the right-hand side of the board. Use the small battery clip to hold the mounted crystal, and attach this battery clip to the board with a small angle bracket. Connect this to one headphone terminal. Take a 3-inch piece of wire, strip away the insulation, and mount it about 1½-inches from the mounted crystal. Form a cat whisker with this wire so that it touches the surface of the crystal. If you want to go first-class, you can buy a complete, mounted detecter, but this is not necessary. Connect this catwhisker to the ground terminal on your board.

Wind your coil on the empty oatmeal box, making a tap every 10 turns. You will need a total of 120 turns to cover the broadcast band, since this set does

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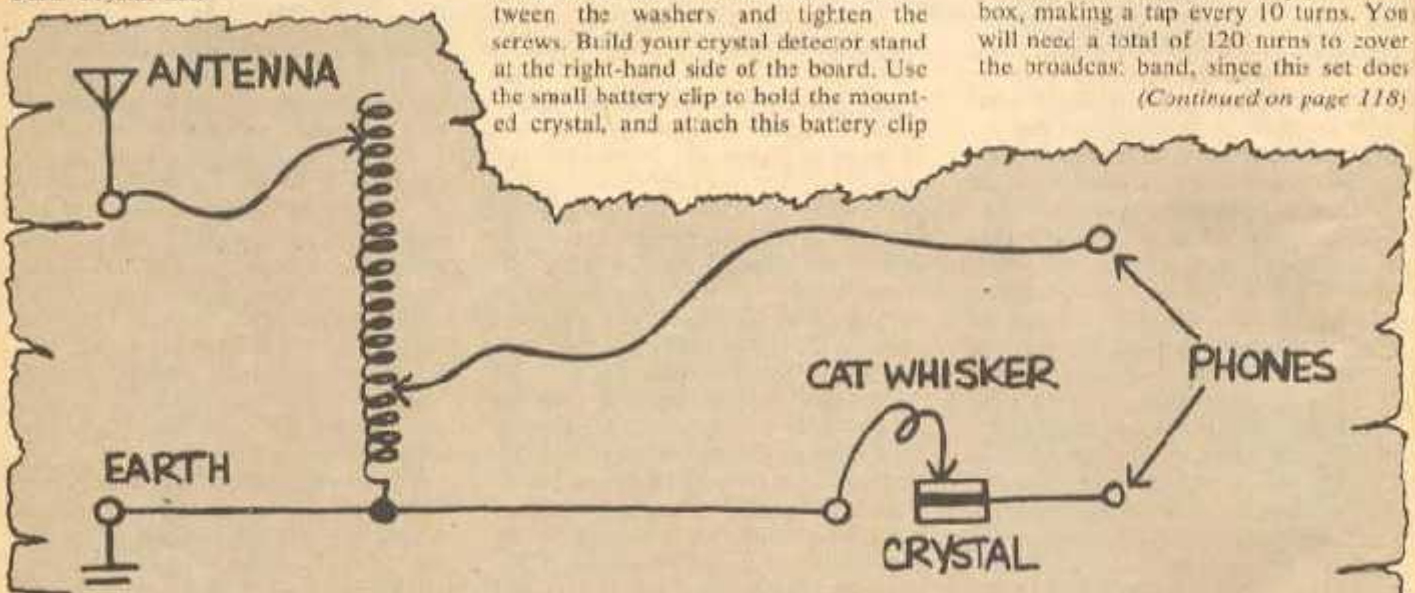

Materials

One Oatmeal Box (empty)
Four Fahnestock Clips
One Mounted Crystal
One Spring Clip (to hold crystal)
Two Small Alligator Clips
One Cat Whisker and Holder
(not from a neighbor's cat)
Hookup Wire, Solder, Wooden Base
130 feet of #22 Enameled Wire

This "authentic" schematic was found in Grandfather's trunk in the attic, wrapped around a stack of Grandmother's love letters. Gramps was never too much of a sentimentalist anyway, except when it came to radio. For good, clean fun in his day, radio couldn't be beat.

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net use a variable capacitor for tuning. You make the taps while winding the coil, by twisting the wire, at the proper turn, to form a small loop of about ¼ to ½-inch in diameter. Wind your coil so that connections can be made to the wire at each end of the coil.

Now, use a little cement on the coil around each tap to strengthen it. When the cement is dry, use fine sand paper to clean away the insulation, so a bare copper loop will be exposed. Fasten your coil form to the board with cement, or with thumb tacks thru the bottom of the box. Connect the wire at the bottom of the coil to the ground lead that runs between the cat whisker and the ground terminal on the board.

Next, prepare two short lengths of wire (about 10-inches long). Solder one end of one wire to the antenna terminal and solder a small alligator clip to the other end. Take the other piece of wire and solder it to the headphone terminal, and then solder the other alligator clip to the other end of this wire.

Operation. Now your set is finished and the fun begins. Connect an antenna and ground to the terminals, and connect your headphones to the other two terminals. You will use the two small alligator clips to tune your set. Clip the one from the headphone terminal to a tap near the upper end of the coil, and the one from the antenna terminal to a tap near the lower end of the coil. Move the end of the cat whisker over the galena crystal until you find a sensitive spot where you can hear a station. Now move the alligator clips up and down the coil to get maximum volume. You will be surprised at the clarity and tone of the signal. You see, a crystal detector doesn't amplify, so it doesn't distort the signal.

This is truly a basic crystal set. It has but one tuned circuit, therefore it is *not* selective. In fact, if you live near several strong broadcast stations, you may hear more than one signal at a time. While not intended to be the centerpiece of your home's sound system, you have learned, by building it, crystal theory and some of the history of radio development during the early part of the century.

As you listen to your crystal receiver, you will get a feeling of satisfaction akin to the thrill the experimenter of the early 1920's got when he built his first crystal set.