Colorado Radio Collectors Antique Radio Club

The FLASH!

Colorado Radio Collectors Antique Radio Club

Volume 21, Issue 2 | **The January 10th meeting is at the Air & Space Museum** | March/April

Dedicated to the Preservation and Education of Wireless, Radio, Television and Associated Equipment

A History of Early Radio's "Crystal Detector"

By Dave Laude, CRC Member

I have recently been through an alignment of events that has led me to enthusiastically write this article. Books several friends have recently loaned me with "Crystal" in their titles appeared to me spontaneously. These have revived one of my earliest memories which is of a crystal radio that I recently identified as a Remco brand from the 1950s. My career as an analog microelectronics design engineer has ended and I'm at an age where history is far more appealing to me than it was in high school. And now it fascinates me as to how crystal detectors could be envisioned and invented at a time so near Hertz's demonstration of the existence of electromagnetic waves in 1888. I can see an inductor conceived from the discovery of magnetic fields when current passes through a wire or capacitance from the storage of charge in a Leyden jar, but a detector? I just had to know and now so can you.

A detector is extremely important in amplitude modulated (AM) radio receivers to rectify or convert higher frequency radio carrier waves, with a lower frequency audio signal riding them, to a varying signal representing only the audio. The higher frequency radio carrier waves are necessary to allow efficient transmission and reception with reasonable length wire antennas that must be a significant portion of a wavelength long. The audio range electrical wavelengths are 20km-6000km (12-3700 miles!), but the AM broadcast band radio carrier range is only 180m-550m. The AM radio signal consists of the carrier's higher frequency with an undulating (modulated) envelope (amplitude) that symmetrically follows, in both its positive and negative excursions, the amplitude contour of the audio waveform. Rectification with a detector allows only the upper positive or lower negative half voltages of the AM radio signal to pass, depending on the rectifier's connection. In other terms, the alternating current signal is converted into a pulsating direct current. With this half wave it is a simple matter to extract the envelope. A capacitor shunting the half wave signal will eliminate the carrier wave while leaving the envelope, but this may not be necessary as headphones can't respond to the carrier's higher frequency anyway. Without rectification the envelope containing the desired audio can't so easily be extracted because of the carrier's symmetry. If both sides of the wave were used, they would cancel each other out as they are opposite each other. For an explanation of detection with graphs please see the "What is this thing we call a radio?" article in The FLASH, Volume 20, Issue 6 from Nov/Dec 2009. Now that you might appreciate the detector's importance to AM radio function, let's look at its history.

The first discovery directly related to the detector occurred in 1874 by German physicist Ferdinand Braun. His interest in the electrical conductivity of metal salts in solution (electrolytes) ultimately led to his study of crystals. He was studying the passage of currents through a crystal of galena (lead sulfide) when

(Continued on page 3)

Inside this issue:

NOTICE

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Hey, it's only 2 weeks until the next CRC Show/ Vintage Voltage.

Mark your calendar: 3/28

This is one of the premier events of the club.

Don't miss it.

And, do participate.

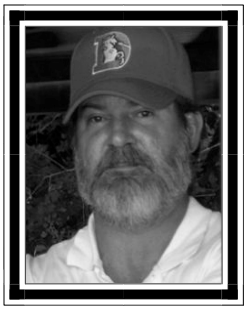
See you there

COLORADO RADIO COLLECTORS ANTIQUE RADIO CLUB

Founded October 1988

Message from the President

OK Folks It's Show Time!



It's that time of year again when we share our passion and hobby with family, friends, and total strangers. We've got the same wonderful venue as in past years as well as the partnership with the Vintage Voltage Expo.

This is one of the premier events for the CRC and one of our best recruiting opportunities for new members.

Please look over the judging categories and try to bring a specimen in 3 or 4 different categories. This will make for a wide diversity of "Jewels" to share with everyone.

Final details will be discussed at our March 14th meeting in Castle Rock.

See you there!

Brian

HELP!

Your *Colorado Radio Collectors* Club needs your

HELP!

That's right bubbie, it is **YOU** that we need. At the last meeting, our president, **Tom Kelly** asked for volunteers to step forward to assume the position of **Vice-President** for 2010. The silence was deafening.

There is a very small group of people that continue to volunteer for **ALL** of the jobs in the club. It is certainly time that **YOU** consider what **YOU** can do for **YOUR CLUB.**

Don't let the same small group do all of the work. Pitch in, it really is not all that hard, besides, you may even enjoy it.

In addition to a VP, we need a show coordinator (see page 6.) This is another great opportunity to contribute.

Put your hat in the ring at the next meeting.

Thanks for your support.

CRC CONTACTS

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Upcoming Events

3/14—CRC meeting in Castle Rock
3/28 — CRC Show/Vintage Voltage

CRC MEMBERSHIP

Annual membership in the CRC runs from July to June. Dues entitle members to attend meetings, "The Flash!" our newsletter, discount book prices, participation in our spring show and Fall auction. Current annual dues are $12. New memberships will be prorated to the following June.

CRC MEETINGS

Meetings are held on the 2nd Sunday of every other month starting in January (except 3rd Sunday of May) at 1:00 pm. The meetings consist of business, "show & tell", raffles, auctions, swap meets, technical discussions and other subjects of interest

Meeting Locations
(Unless noted otherwise)

Littleton	**Castle Rock**
January	March
May	July
September	November

(Continued from page 1)
he discovered that they flowed only in one direction (rectification) if one of the two metal contacts was pointed. He found more than 250 minerals that were capable of rectification when used in conjunction with a metal contact or with another mineral (called "Perikon"). Some of the more successful minerals include galena, pyrites, bornite, zincite, and silicon. In 1897 he built the first cathode ray tube and cathode ray tube oscilloscope. In 1899 Braun found that the crystal detector provided no improvement over the coherer when the wireless telegraphy messages were automatically recorded on a moving strip of paper, as was the normal practice at the time. By 1901 the advantages of having a human telegraph operator decipher by ear and manually record the messages were recognized. Now Braun's crystal detector was found to be superior to the coherer. When transmitters that produced continuous oscillations became available, neither the coherer nor Braun's crystal detector could produce an audible response. However, his crystal detector was "rediscovered" and improved by others for use as an inexpensive and reasonably reliable detector for radio-telephony. India born Sir Jagadish Bose filed the first patent for a galena detector in 1901 that was issued in 1904. General Dunwoody of the U. S. Army is also considered among the first to put the crystal detector to practical use with his patented carborundum (silicon carbide) detector. Braun went on to develop a new type of transmitter not requiring a spark-gap. His 1904 patent on the resonant circuit allows tuning to the frequency of interest. In early wireless transmission, the antenna was directly in the power circuit and broadcasting was limited to a range of about 15 kilometers. Braun greatly increased the range by producing a sparkless antenna circuit that linked transmitter power to the antenna circuit inductively. Marconi would later admit to Braun himself that he had "*borrowed*" portions of Braun's work. In 1909 Braun shared the Nobel Prize with Marconi for their contribution to wireless telegraphy.

The crystal rectifier was far superior in detecting radio signals than were the poor sensitivity "coherers" and was useful for both code and audio broadcast reception. The crystal detector was the first sensitive and stable detector. Coherers consisted of glass filled tubes with metal filings in the space between two electrodes. In operation the metal filings are attracted under the influence of a sufficiently high electric field from a radio transmitter. Once attracted, a strong electrical conduction path is established to operate a relay or buzzer through which Morse code could be heard. Coherers are totally unsuitable for detecting the complex waveforms of audio. Primitive electrolytic detectors came about around 1900 and were used only briefly. They used a liquid electrolyte (a weak acid and provider of ions) over the mineral and probably had poor sensitivity and frequency response. A wire made contact with the electrolyte and the electrolyte to the mineral. Some were open in a cup while others were sealed in a glass bulb.

The American Greenleaf Pickard improved upon crystal rectification by making it more practical and utilizing it as a detector for radio-telegraphy. He was granted patent No. 836531 in 1906 for an improved silicon crystal detector. It was revolutionary in that he found that a finely pointed wire known as a "cat's whisker", in delicate contact with a mineral, produced the best detector effect. His claim stated "As an element of a means for receiving intelligence communicated by electric waves, the substance silicon, substantially as and for the purpose described". His patent's illustration clearly depicts a "spring which presses the sleeve-contact" metal point against silicon to produce a radio detector. The principle of detection was incorrectly stated in the patent as "generation of heat into electrical energy at a thermo-junction and of the generation of electrical energy by the heat energy at a thermo-junction". Pickard was eventually granted many patents relating to radio. His silicon crystal detector was first produced and marketed in 1906 with the first patent granted in 1908. He also produced carborundum detectors in 1906. A partnership between Pickard and Philip Farnsworth in 1906 produced the Wireless Specialty Apparatus Company (WSA) that began selling detectors in 1907. When the Canadian inventor and pioneer of radio Reginald Fessenden sent the first voice radio-telephony transmission from near Boston in late 1906 the crystal rectifier was already well established for detection. At the time few, including Edison, believed that the transmission of voice was possible. Fessenden lost control of many of his patents and the royalties from his radio-telephony made others rich. He went on to invent the radio compass and even to demonstrate a crude television system in 1919.

The most common early crystal detector consisted of the crystal, a crystal holder and a mounted yet adjustable metal probe for contacting the crystal's surface. The probe was usually a spring loaded "cat whisker" made of springy phosphor bronze wire. Probe pressures varied from light to moderate. The heavy contact required by high temperature manufactured carborundum makes it less sensitive to static that can destroy a galena crystal. Galena, a more sensitive mineral, could not handle high temperatures and was usually mounted with a low temperature alloy such as Wood's metal or with thumbscrews. Experimentation with position and pressure was required to obtain good performance that could be easily upset with an unintended vibration. Fixed sealed detectors that were less sensitive to vibration came about in the mid-1920s. These were often in cartridge form. Some adjustable units could hold up to six different types of detector materials that the user could select as needed. Other detectors were enclosed in a glass cylinder capped on the ends with various materials to keep out dust and dirt. These were adjustable by use of a movable rod with cat whisker that poked through a port in one end. Some adjustable units had several controls for adjustment. Even some fixed detectors were actually semi-fixed and could be tweaked. Adjustability was a key requirement to keep the detectors operat-

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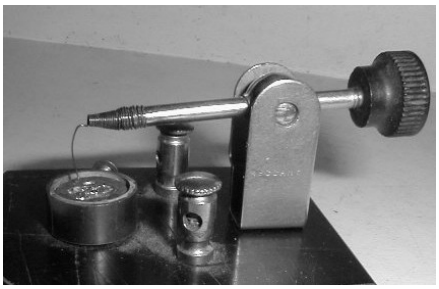
ing on an efficient hot spot. It took some poking around to locate a hot spot where the performance was adequate. Detector performance often depended on the particular mine from which the mineral came. At this time how crystal detectors worked was a mystery, but you can learn how by reading the "How Crystal Rectification Works" section of this article.

Until 1919 crystals were usually sold unmounted and in bulk for use in a detector that often had a holder available for the unmounted crystal. Distributors put little effort into packaging these. By 1920 individual crystals were usually mounted with Wood's metal or thumbscrews inside of a cup style metal holder and were displayed in attractive colorful boxes. The boxes were usually made of tin, wood or cardboard and were in rectangular or round pillbox form. A few were offered in a plush jewel type hinged case.

Between the mid 1910s and mid 1920s an ever growing number of companies produced unmounted crystals and crystal detector units that included a crystal mounted in holder on a base, cat whisker with adjuster and terminals. These came in a great many usually attractive forms although some were very basic. Bases made of Bakelite, hard rubber and wood were common, but elegant marble was available as well. In their trade names or mottoes companies made various claims regarding volume (T.N.T. High Power), clarity (Krytal-Kleer), tone (Clara Bell) and sensitivity (Hot Spot) to differentiate between products. Ad claims such as these were common: "Clearer tone, greater volume, longer life than other detectors.", "Absolutely the best crystals that can be purchased at any price.", "Radio engineers pronounce it the only electrically and scientifically perfect crystal detector.", "it will increase your range wonderfully" and "… sensitive piece of wireless mechanism that cannot be duplicated.". A few manufacturers offered stabilized detectors with rheostat and a one or two cell battery for biasing the crystal. The biasing would lower the impedance resulting in higher volume and sensitivity. Others claimed that various gases could be fed into their sealed detectors through a port to enhance performance.



Crystal detectors first found widespread use in ship to shore and military communications. By 1919 WSA had entered agreements for crystal detector manufacturing with other companies such as GE, RCA, AT&T and Westinghouse. Other familiar manufacturers with their earliest manufacturing dates include Allied Radio (1933), Atwater Kent (1923), Briggs & Stratton (1922), DeForest (1919), Dixie Distant Crystal (1926), Grebe (1914) and Lego (1924). Philmore Mfg. (1921) produced crystal set items for 60 years and Western Manufacturing (1932) for 30 years. Products from these companies carried a wide variety of trade names and were marketed by many distributors. Crystal detector prices in past dollars typically ranged from $1.00 to $ 6.00. Even after thermionic vacuum tube detectors came about crystal detectors were marketed as plug in replacements that claimed reduced battery consumption and improved tone quality. Some were Bakelite and tube shaped with the top part of the dome separated into an adjustment knob.

Since the detector needed other components to function as a radio receiver, companies were quick to develop these as well. Crystal receiving sets were offered by WSA starting in 1907 with its basic IP-76 model. Sets were comprised of a case or a simple base, crystal detector unit, inductor and or capacitor tuning circuits to which antenna (often called "aerial" then), ground and headphones could be attached. Antennas were usually 50'-150' of strung wire. They frequently had a broad tuning range of 200 (1.5MHz) to 3500 (86Khz) meters that covered the 2500 meter time signals sent by the Navy from Arlington, Va. starting in 1913. The time signals were often used as a test signal or by jewelers to set timepieces. By 1914 some sets were complex instruments with many controls, connectors and meters on their panels. Cases or bases were usually made of metal, Bakelite, leatherette or wood such as walnut, oak or mahogany. A buzzer accessory was sometimes used to create a signal for calibrating the cat whisker.

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Around 1912 orders from the United Fruit Company to equip its ships operating in the West Indies and the Americas with radios greatly expanded the WSA company. WSA became the major supplier of other commercial ships and shore installations, and during WWI supplied the U.S. Navy. With the development of the Audion some early crystal sets utilized these triode tubes for amplification. After RCA was chartered in 1919 it acquired cross-licensing agreements and had exclusive selling rights for all public receiving sets manufactured by GE, Westinghouse, AT&T, Western Electric, United Fruit Co. and WSA. Each company owned important radio patents useful to RCA. Products from these companies carried a wide variety of trade names and were marketed by many distributors.

Some crystal set manufacturers and their earliest manufacturing dates include Aetna (1929), DeForest (1918), Lafayette Radio (1939), Philmore Mfg. (1925), Quaker Oats (1921), Radio Apparatus (1922), Westinghouse (1921) and RCA (1920). Crystal set prices in past dollars typically ranged from $2.50 to $ 25.00, but could go much, much higher. Kits and novelty sets such as coin banks, ash trays and candle stick phones came about as more companies competed for buyers.

The two-book set "Crystal Clear" (see Resources) contains a thorough list of manufacturers along with hundreds of pictures of crystals, crystal detectors and crystal sets. It lists 180 companies and 229 trade names for crystals, 267 companies and 415 trade names for crystal detectors, and 379 companies and 750 trade names that produced crystal sets originating from 24 states! The "Resources" listed can give you many pictures to view and sources of more information and hardware as well. If you enjoyed this article then look for a continuation of the crystal's history that leads to the transistor in a future FLASH.

How Crystal Rectification Works

A crystal rectifier with a cat whisker has a rectifying junction called a Schottky barrier junction that is formed between the mineral (semiconductor) and the metal. It is like the P-N (mineral to mineral) junction found in modern diodes and transistors. Today's Schottky rectifiers are known for their very high speed of operation, low forward voltage and are frequently used in switching voltage regulators to achieve the highest efficiency. Rectifying junctions have a built in potential (electrostatic) barrier that blocks electrons of insufficient energy from crossing the barrier. When an external voltage is applied across the junction the barrier either raises and further blocks electrons or lowers with opposite polarity voltage and allows electron flow (current is directly proportional to electron flow). This is rectification, the basis for the radio detector.

For a basic understanding of how the barrier functions we need to examine some semiconductor physics. Semiconductors come in two basic flavors as determined by specific impurities. N-type semiconductors have an excess of electrons free to migrate and P-type have vacancies (called "holes") to which electrons are attracted and can readily flow though. The impurities must be of a certain type that when combined with the specific host mineral creates either an excess of electrons or holes. For modern semiconductors these impurities are precisely controlled. For early crystal detectors the impurities were naturally occurring and thus the amount and type were haphazardly distributed throughout the mineral. Crystalline minerals provide a periodic structure for which impurities can orderly reside and electrons can efficiently flow. When metal is brought in contact with one type of semiconducting crystal, electrons will diffuse one way across the junction from N-type to metal or from metal to P-type. Think of electron diffusion like the smoke particles from the fallen burning cookie in my oven making its way throughout my home as I write this. Electrons migrate from the higher electron concentration side until the resulting electrostatic field produced by this relocation of charged particles sets up a potential barrier that opposes further diffusion and equilibrium is reached. With an electric field provided from an applied voltage the barrier is either lowered or heightened depending on the voltage polarity. Such barrier movement is called the Schottky effect.

Resources

Sievers, Maurice. "Crystal Clear" Volumes 1 and 2, 3rd Edition. Sonoran Publishing LLC, 2008
Riordan, Michael. "Crystal Fire" W.W. Norton & Company, Inc. 1997

Crystal Radio Museum Pictures: http://www.crystalradio.net/museum/radios/index.shtml
Crystal Radio General: http://www.crystalradio.net/
Excellent kits: http://www.arcsandsparks.com/radiokitpage.html
Source of parts, kits and NOS crystal radio sets: http://xtalman.com/detectors.html

CRC Meeting at the
Wings Over the Rockies Air & Space Museum

Once again, our esteemed member, Bart Whitehouse made arrangements for the club to use the museum for one of its bimonthly meetings. At Brian Hagrman's suggestion, the club provided lunch for everyone and their spouses.

So, Brian had 36' of gourmet sandwiches made up especially for us.

We had an excellent turnout and every-

one enjoyed the food and conversation.

The museum has an excellent collection of aircraft of all types. If you have any interest at all in this type of equipment this is the place to be. They also have a lot of history of the Lowry AFB and information on some of the people that have been stationed here.

Many of the wives came (as did mine)

Step Right UP

We need a
SHOW COORDINATOR
for the annual CRC Show.

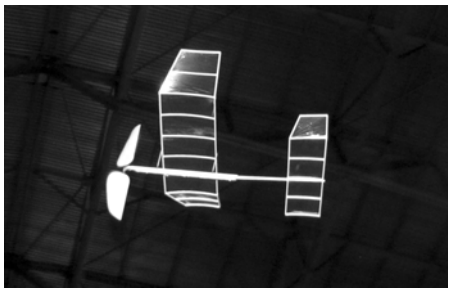
Duties of the show manager:
* Be at the hotel as soon as show participants and get in
* Coordinate with the Vintage Voltage Expo operator; tables/chairs, costs, power
* Check that the show tables are laid out in an appropriate style
* Coordinate getting show items for the various categories displayed together
* Check that category signs are displayed
* Check that the show ribbons are available
* Coordinate info and last minute decisions

Be the **"<u>go-to</u>"** guy

this time just to see what we do and to make sure that we aren't goofing off too much or having too much fun.

Some of the items in the collection have had a hard life such as this veteran of the Galactic Wars.

However, most of the collection is more Earth based equipment.

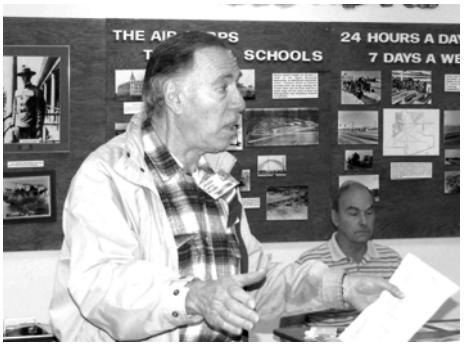


There was a group of people flying very light gliders and powered airplanes inside of the hangar. I hope you had a chance to see and talk to these people. We saw a radio controlled powered airplane that weighed only 3 grams. That included the airframe, motor, controls, radio and battery. Absolutely amazing.
If you missed this event, you can always visit the museum on your own, but it is always more fun with a group of your friends.

Photos from January 10th Meeting at the Air & Space Museum in Denver

Marty & Dave swap lies, Barney, wisely, does not believe a word they say.

Tom Kelly opens the meeting.



Larry talks about the CRC Show

Bart tells about Learadio's.

Tom with his Harnkess radio.

Peter talks about Vintage Voltage

Bart's Learadio's

Tom's Harnkess Counterflex 3

Dave's Variable Voltage unit.

Tom pleads for a bid

Charlie says "Here, it's only money."

Merrill checks out Bart's display

2010 Colorado Radio Collectors Annual Show and Competition

WHAT? It's that time again?

Yes friends and neighbors, it IS that time again. The **2010 CRC Annual Show** in conjunction with **Vintage Voltage** is upon us. By the time you receive this issue you will only have two weeks to complete the work on your entries.

This year, the Special Category is **Plastic Radios**. All years, any style and made of any of the following materials; Catalin, Bakelite, Plaskon, Beetle, Tenite and Styrene.

I believe this is the 4th year that we will be joining with the Vintage Voltage Show at the Ramada Plaza Inn at I-25 and 120th Avenue in Northglenn. Last year the turnout was tremendous with perhaps as many as 2,000 people going through the facility.

This is your chance to strut your stuff. Bring your cherished radios to show everyone and see what others have brought. Although the featured item is Plastic Radios, don't forget that all of the standard categories will still be available . We have yet to run out of space for the display of radios, so dig deep and bring it along.

These are the judging categories:

Accessories
Bakelite
Battery - 1926-1929
Catalin
Cathedral
Classic Audio
Communication Gear
Console - Full Length
Console - High/Low Boy
Crystal Set
Homebrew, Kit
Metal Box - 1920's
Metal Case
Novelty - Transistor
Novelty - Tube
Plastic - Tube
Portable - Pre 1939
Portable - Post 1938
Pre 1926
Speakers
Specialty
Television
Tombstone
Transistor
Tube/Parts Display
Wooden - Line Powered
No Judging - Display Only
Best of Show
Best Restoration
Peoples Choice

2010 Colorado Radio Collectors Annual Show and Competition

March 28, 2010 Ramada Plaza Convention Center I-25 at 120th Avenue in Northglenn.

The Special Category this year is: Plastic Radios

(Catalin / Bakelite / Plaskon / Beetle / Tenite / Styrene)

Record the information about your show entries on this form and give it to Larry when you register. *Registration deadline 9:30.*

Name _____ Phone # _____

	Brand	Model	Year	Category **(listed above)**
1				
2				
3				
4				
5				
6				
7				
8				

The Open Trunk

Member submitted advertisements

WANTED: Buy/Sell/Trade: "Heavy Metal" communications gear, telegraph related items, vintage calculators & microphones.
Robert Baumann, (303) 988-2089 HQ180A@aol.com. (07/09)

REPAIR SERVICE:
Radio repairs for club members. Reasonable rates. Good references.
Call David Boyle
303-681-3258 11/09

For Sale: by Dave Boyle
All of the following Older "Classic" radio and TV repair instruments have been thoroughly refurbished, repaired as needed, and most calibrated as appropriate. Please Note: Don't be shy about negotiating on the prices, offers welcome!

1) Heathkit IG-52, TV Alignment Generator, with manual and new test leads. Like new. **$85.**
2) Heathkit O-12, 5" Oscilloscope, built by seller. VG **$60.**
3) Bench variable AC power supply for powering up and for repair of old radios, as shown at the January Club meeting. With full meters and controls, newly built. **$70.00**
4) HP 3200B VHF Oscillator, 10 MHz. to 500 MHz. Laboratory grade. Solid state, Free manual on Internet. VG. **$225.**
5) HP 608E/F VHF Oscillator, Tube Type, Top of the line and sought after these days, Complete with spare new (special) tubes and manual. Comes with optional (free) 'scope cart---a perfect match. VG. **$145.**
6) Superior Tube Tester, Model TD-55, small portable in carrying case with all literature. Like New **$35**.
7) RCA Model WA-44C, Audio G, Generator, Sine and Square Wave. VG. $**38**.
8) Precision Apparatus Co (PACO) Model E-400 Sweep and AM, FM, and TV Signal Generator. Refurbished, New test leads,
With Manual **$90**

9) Power Supply; "Power One" model CP418A, 24vdc at 7amps and 5vdc at 7 amps. commercial quality, VG **$55.**
10) 2—Zenith TransOceanics # H500, Both completely refurbished inside and out. Repaired as needed and aligned. Both work great.
$95.00 OBO ea
Call
David Boyle, 303-681-3258 3/10

WANTED: Old microphones (not CB or ham), working or not.
Also, NBC chimes in good condition.
Tom Keeton 303-797-8073
11/09

FOR SALE: At a most reasonable price: Tektronix o'scope model 7704 (works) with cart, manuals, probes. Freq. resp. is 150 mhz
Call Barney Wooters
303 770-5314 11/09

WANTED: An AK 82, 90 or 92 chassis / speaker for an empty cabinet I have. **Contact Mike Cook. mldcook@hotmail.com**

01/10

FOR SALE: Heathkit Transistor Checker (in circuit/out of circuit)
$20.00

1925 Pfansteihl TRF Radio
This radio was probably built and sold in 1925, and has a rather unique distinction of having the "radio energy kept intact, exactly as received."

Even more important, this radio was refurbished by Tom Pouliot and only played by a 'little old man on Sunday evenings' since.

W/O tubes $50.00, pick up, or delivered to next meeting

Call Wayne Gilbert at
303 431 67774.
Email wagil@aol.com

01/10

SUBMISSION OF ARTICLES AND ADVERTISEMENTS

Classified Ads for The Open Trunk and articles of any radio/electronic or historical related subject to be published in the Flash are encouraged and welcomed. The article(s) should be submitted in Microsoft Word, RTF, or as text cut/paste into your email to Steve Touzalin, either by email at stevetou@comcast.net , or by postal mail to 417 So. Queen Circle, Lakewood CO 80226 .

Formatting is not necessary, but if you do, set the font to Times New Roman, size 10, left justified. If you have graphics (.jpg files) to be inserted, please name them and be specific about how you would like them placed. We will do our best based on space limitations.

The March 14th, 1:00 pm meeting will be at the Philip Miller Library in Castle Rock

Directions

From I-25: Take the Plum Creek Parkway, exit #181
Turn East onto Plum Creek Parkway.
Turn Left (North) onto S. Wilcox Street and continue north 2 tenths of a mile.
The Philip S. Miller Library is on the east side of the street at 100 S. Wilcox St.
The building is towards the back of the parking lot, past the Dairy Queen.

Colorado Radio Collectors
Antique Radio Club
417 S. Queen Cir.
Lakewood CO 80226

FIRST CLASS MAIL