Colorado Radio Collectors Antique Radio Club

The FLASH!

Colorado Radio Collectors Antique Radio Club

Volume 21, Issue 5 | The September 12th meeting is at the Bemis Library in Littleton | September/October

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

A History of the Transistor and the First Transistor Radios

By Dave Laude

For antique radio collecting, a tube radio with its glass orbs sitting in a beautifully crafted cabinet epitomizes the hobby. The warm glow of the tubes has a primeval attraction like that of a campfire. But as our collections of these beloved radios grow our space for them diminishes and we are compelled, perhaps with influence from others, to seek new collecting strategies. For small size (easier to sneak into house), low price and alternative styling reasons some of us have taken to collecting transistor radios, a few models of which are now older than 50 years! Vacuum tubes have been around for about a century and the earliest functioning transistor since late 1947. The transistor, that cold chip of crystal hiding in its sealed capsule and never seen by most humans, has lead to the information age and many other great achievements. Indeed, it has come to be so widely utilized that if every transistor were to suddenly stop working nearly every aspect of human endeavor and modern civilization would come to an abrupt and disastrous halt. Such an important invention is worthy of a look back to its preconception, birth and its early and highly successful commercial product, the transistor radio. If you have not read my previous article "A History of Early Radio's Crystal Detector" in the March-April, 2010, Volume 21, Issue 2 of the FLASH please consider doing so because this article will begin in semiconductor history where that one left off.

The transistor had three primary fathers, all of whom stood on the shoulder's of giants like Heisenberg, Einstein, Pauli, Maxwell, Faraday, Dirac, Bohr and von Neumann. They were William Shockley, John Bardeen and Walter Brattain who all worked at Bell Labs in Murray Hills, NJ. All had tinkered with crystal radios in their youth and all had Ph.D. degrees in physics. In 1932 Shockley entered MIT to seek his Ph.D. where Linus Pauling suggested that he study quantum mechanics. He began to explore how electrons pass through crystalline materials such as salt and this was the first attempt to apply quantum mechanics to a compound rather than a pure element. The soft spoken and cerebral Bardeen skipped three grades in high school and started college at age 15 where he earned two degrees in electrical engineering. Dirac's lectures on quantum mechanics led him into physics. His dissertation involved calculating the energy required to free an electron from a sodium atom. He was often lost in thought and spoke softly thus earning the nick name "Whispering John". He was considered an oracle, so when he spoke he was listened to. During the 1920s Brattain found ways to enhance electron emission efficiency in tubes using thorium or tungsten and he developed a portable crystal oscillator standard while working for the National Bureau of Standards. Intrigued by the newly invented copper-oxide rectifier, Brattain studied it in hopes of understanding how it worked. Understanding it would lead to advances, but by the 1930s there was only a rudimentary understanding. At the time physicists were beginning to recognize a new class of solid-state materials called "semiconductors" of which crystal detectors are examples. They fall between

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Inside this issue:

2010 CRC Auction and Picnic

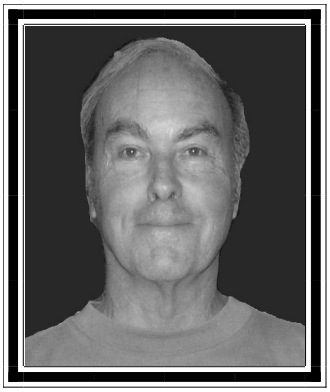
The 2010 CRC Auction/Picnic will be September 19th.
Same location as the past few years
The grounds of Tectonic Management Group in Wheat Ridge.
See pages 6 & 7 for additional information.

COLORADO RADIO COLLECTORS ANTIQUE RADIO CLUB

Founded October 1988

Message from the President

Greetings fellow club members, its that time of year again! Auction time! Time to grab out those treasures and find new homes for them.



Last year's auction was huge! Lets see what happens this year.

It's also picnic time! The club will supply hot dogs, hamburgers, and drinks. Bring a side dish to share. Should be lots of fun!

Details at the September 12th club meeting at the Bemis Library in Littleton at 1:00 PM. See you there!

Tom

Changes to Show Scoring & Categories.

The following recommendations were approved at the July meeting.

1. Create new MILITARY category.
2. Separate KIT and HOMEBREW into 2 categories.
3. Break ACCESSORIES into two categories; ACCESSORIES and TEST EQUIPMENT.
4. No changes to scoring.

CRC CONTACTS

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Upcoming Events

9/6—Labor Day
9/12—CRC Meeting
9/19—Annual Auction/Picnic

Meeting Locations

(Unless noted otherwise)

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

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

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.

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conductors with many free electrons and insulators with no free electrons and can generate voltage when exposed to light. Brittain said "Ah, if only one knew how to put the third electrode in the cold rectifier like a grid in a vacuum tube one could have an amplifier" He was influenced by provocative articles about the newest developments in quantum theory emerging from Europe and lectured at Bell Labs on the quantum theory of electrons in metal. European theoretical physicists of the time where intensely studying and developing quantum mechanics while the practical-minded Americans began to employ the new quantum tools to their research into atoms, molecules, metals and crystals. Brattain joined Bell Labs in 1929, Shockley in 1936, and Bardeen in 1945.

Bell's research director encouraged Shockley to seek ways to fabricate a rugged solid-state device to replace the bulky and unreliable mechanical switches and amplifiers found in phone equipment. He said that he looked forward to the time when metal contacts would be replaced by electronic devices. Shockley organized a weekly study group of scientists at work to discuss recent books on atomic physics and quantum mechanics. In 1939 Shockley's familiarity with quantum physics led him to an idea for a transistor. On the 29th of December he wrote "It has occurred to me that an amplifier using semiconductors rather than a vacuum is in principle possible". With Brattain's help his idea was fabricated, but it was a complete failure. Better insights into solid-state theory and purer semiconductor materials were needed for further progress. Just prior to WWII Ph.D. scientists fleeing Hitler and Mussolini had bolstered U.S. university physics departments, but the war effort interrupted the theoretical research into semiconductors. Shockley's, Bardeen's and Brattain's efforts were directed to war research.

After the war and upon returning to Bell Labs in 1945, Shockley began organizing Bell's solid-state research program under Mervin Kelly. There was now a new emphasis on the physics and chemistry of solids. Quantum physics research was promising new materials with new and useful properties. Kelly wanted to fashion the equivalent of the mission-oriented multidisciplinary research teams that proved so effective during the war. Shockley also headed a sub-group of Solid-state Physics. Brattain joined this team. Researcher Russell Ohl briefed Shockley about P-N junctions, the photo-voltaic effect and methods of processing silicon for detectors that he had been studying at Bell since the mid 1930s. Intrigued, Shockley said "Did you ever think that if you put a point-contact at the barrier that you could get control of the current flowing through?" Both men had ideas for controlling current through the silicon by use of very thin metal plating between the junction. Using quantum theory Shockley proposed changing the behavior of narrow P type (has electron vacancies called holes through which electrons can flow) and N type (has excess available electrons for conduction) materials with a strong electric field applied at their junction. The easily controlled fields, he thought, should cause electrons or holes to move as directed thus changing the semiconductor's conductivity. He referred to this as a "solid-state valve". Experiments with a thousand volts across a narrow gap of <1mm above the silicon resulted in no change of current flow. Calculations said a large current change should commence. He soon abandoned these particular efforts for awhile. New ideas came about after Bardeen was hired. He had come up with the key ideas, which were skillfully implemented by the genial Brattain. Shockley asked him to check his calculations concerning the "field effect" with which he had hoped to make a solid-state amplifier. He confirmed Shockley's calculations. Later Bardeen realized that the electron wave function extends slightly beyond that of the ions at the crystal's edge thus leading to excess negative charge at the surface and excess positive charge just beneath it. If electrons were trapped at the surface as "surface states" in N type silicon they would form a shield thus preventing an applied external field from having effect. In 1946 he revealed his theory at a group meeting. This double charge layer explained many phenomena that eluded other theorists including Shockley. Amplifying device

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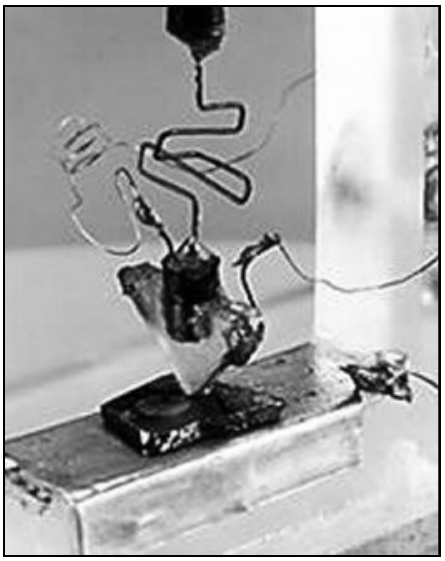
attempts were abandoned in favor of experiments with surface states led by Brattain. Attempts were made to search for a field-effect in a thin germanium film vapor deposited on ceramic. This time they saw the field-effect Shockley had expected with a mystifying 0.1% change in conductivity. Two factors for poor performance were surface states and low electron mobility. Shockley's other interest in surface states was clinging precariously to the stone walls at Bell Labs during lunch break!

By 1947 Brattain's experiments of light effects with an electrode on cooled silicon in a thermos produced enhanced photo effects. To keep condensation away he had filled the thermos with alcohol. He and chemist Robert Gibney discovered a positive voltage increased the photo effect, while a negative could eliminate it. With this accidental discovery Brattain realized he could effectively control the charge on the silicon surface. This apparatus was very similar to earlier experiments to search for the field-effect except that it had a liquid between the plate and semiconductor. Liquid electrolytes that contain positive and negative ions worked best. Under the influence of an electric field these mobile ions migrated to the silicon surface where they enhanced or reduced the charge density there. This "electrifying" breakthrough in field-effects, which would allow a semiconductor amplifier to work, swept through the semiconductor group (most modern microchips are almost exclusively made up of field-effect transistors). A few days later Bardeen suggested to Brattain a new way to make an amplifier by jabbing a sharp metal point onto a piece of silicon surrounded by an electrolyte. They used a slab of silicon and coated the tip of a sharp tungsten wire with liquid wax to insulate it from a drop of distilled water on the silicon. With the tip on the silicon and the water contacted with an electrode they were able to alter the current through the silicon 10% by varying the water voltage. Because the input control current was smaller than the output current the device was amplifying current and power! Brattain told others "I'd taken part in the most important experiment that I'd ever do in my life". He realized they had stumbled onto something big because they demonstrated that it is possible to effectively control and amplify current in a semiconductor. Shockley became excited by the developments and suggested a few ideas of his own. One was to apply an electrolyte that they extracted from electrolytic capacitors (glycol borate) directly across a P-N junction and use it to control the current. This succeeded and further hastened the feverish pace of discoveries and breakthroughs that elevated power gains. A problem of poor frequency response was linked to the liquid electrolytes. When glycol borate was used on germanium a thin green film was forming. Recognizing this as germanium dioxide, an insulator, they figured they could put an electrode on the film to control the current. Gibney prepared a new slab of germanium with a shimmering green oxide layer on one surface and several small spots of gold on the oxide. The water soluble film was accidentally washed away before the gold dots were placed and the experiment didn't work as expected since the dots were not insulated from the germanium, but they serendipitously discovered a new phenomenon instead. Brattain chanced to apply a positive voltage to a gold spot and a negative voltage to a point-contact placed at its edge. He got some modulation with no power gain, but a doubling of voltage gain independent of frequency to 10kHz. This led them to theororise that putting two closely spaced point-contacts on germanium would yield good results. Brattain figured out how to space two contacts 2 mils apart and on December 16th, 1947 they were ready to test it. The results were marvelous with high power gains and no frequency degradation. The solid-state amplifier, using the primitive point-contact form of a bipolar transistor, was finally born!

On December 23, 1947 with just a tiny slab of germanium, a thin plastic wedge for a mount and a couple strips of gold foil, they amplified an electrical signal almost a hundredfold. Besides the three fathers, two executives were present for the demonstration. Without tubes, Brattain's voice spoken into a microphone was amplified loudly in a headphone. Both executives shook their heads in wonder, but the apparatus had a long way to go in reliability and reproducibility before it could replace vacuum tubes. Immediately the invention went into secrecy.



It was well known that Purdue University was also working on semiconductors, but their research was open to the public. Shortly after the demonstration Shockley found that Bardeen and Brattain were consulting with patent attorney Harry Hart. As group leader, Shockley wanted to write a patent starting with the field-effect and then the rest. Unfortunately prior art was discovered on a patent issued to a German physicist named Julius Lilienfeld in 1930 for a field-effect device. It was evident that Shockley's field-effect idea was not original and so the patent had to be based on Bardeen and Brattain's work which was clearly original. Having not been one of the inventors, Shockley was chagrined to have no direct role in this crucial breakthrough even though his efforts began eight years before. Not only had his field-effect idea been anticipated two decades earlier, but also the patent attorneys refused to include his name on the patents for the solid-state amplifier. With this, a wedge was driven into the semiconductor group. Now nearly every moment he spent trying to design a better solid-state amplifier that could be manufactured and used more easily. In

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1948 he had solutions. His idea was use nothing but a strip of semiconductor material, either silicon or germanium, with wires attached at "junctions" at the ends and middle rather than the delicate and unpredictable "point-contacts" made by Bardeen's and Brattain's device and used in early crystal radio detectors. The semiconductor material would form a compact and reliable layered P-N-P device. Later he realized that an N-P-N layered device, produced by evaporation and with a directly contacted thin base, would be even more efficient. Shockley was secretive about this idea. The modern NPN bipolar junction transistor (BJT), a type commonly used in transistor radios, was thus conceived!

Physicist John Shrive began work on a bipolar transistor configuration suitable for encapsulating into a rugged and compact cartridge with leads. He ground down a sliver of N-type germanium to a thin taper and on both sides of the 2 mil thick end point contacts were placed. The fact that it worked was puzzling to him because in the past they had used thin surface layers of opposite type over the semiconductor, but not here. Shockley was startled when Shrive presented his findings at a meeting. It showed that his secretly held layered idea would work. Shockley knew that Bardeen would immediately reach the same conclusion, possibly in the next few minutes, so he jumped up and presented his ideas to interpret the findings that holes could diffuse through bulk germanium in the presence of a much larger population of electrons or vice versa. This surprise revelation encouraged patents to be filed quickly. On February 26, 1948 three patents for Bardeen and Brattain's use of electrolytes and point-contact devices were filed. A rift had widened between Bardeen and Brattain with their working point-contact amplifier and Shockley with his layered approach still in development. Shockley had strong convictions that his layered junction idea would win out and he reminded his subordinates, Bardeen and Brattain, so. Shockley felt he could devise all theoretical ideas himself and the Bell Labs brass was placing its bets on him. The free sharing of ideas with no concern over patents was gone. Bardeen developed equations relating currents and voltages from which gains in performance were made in the point-contact device. Shockley had obtained similar conclusions, but by using more complex differential equations.

Meanwhile Bill Pfann developed a cartridge device that enclosed the point-contact amplifier. It was a 0.75" long by 0.25" metal cylinder that had two fine wires pressed onto an internally mounted slender chip of germanium that made connections to the emitter and collector. The base was connected to the cylinder. Although noisy, the power gain was good and their electrical characteristics were stable and reliable enough to be designed into new products. Bell scientists perfected techniques to grow usable germanium crystals for mass production and by June Bell engineers designed the point-contact transistor into new telephone equipment such as repeaters and a radio receiver. Scientific papers were being prepared for the nearing public announcement. Now a proper and enduring name for the device was needed. Names such as "semiconductor triode", "surface states amplifier", "crystal triode" and "iotatron" were considered by a committee. Finally, based on its perceived operation of trans-resistance, the name "transistor" was overwhelmingly approved.

Looks like I'm out of space for now. I hope you look forward to the final part of this article that will culminate with early transistor radios in a near future issue of "The FLASH".

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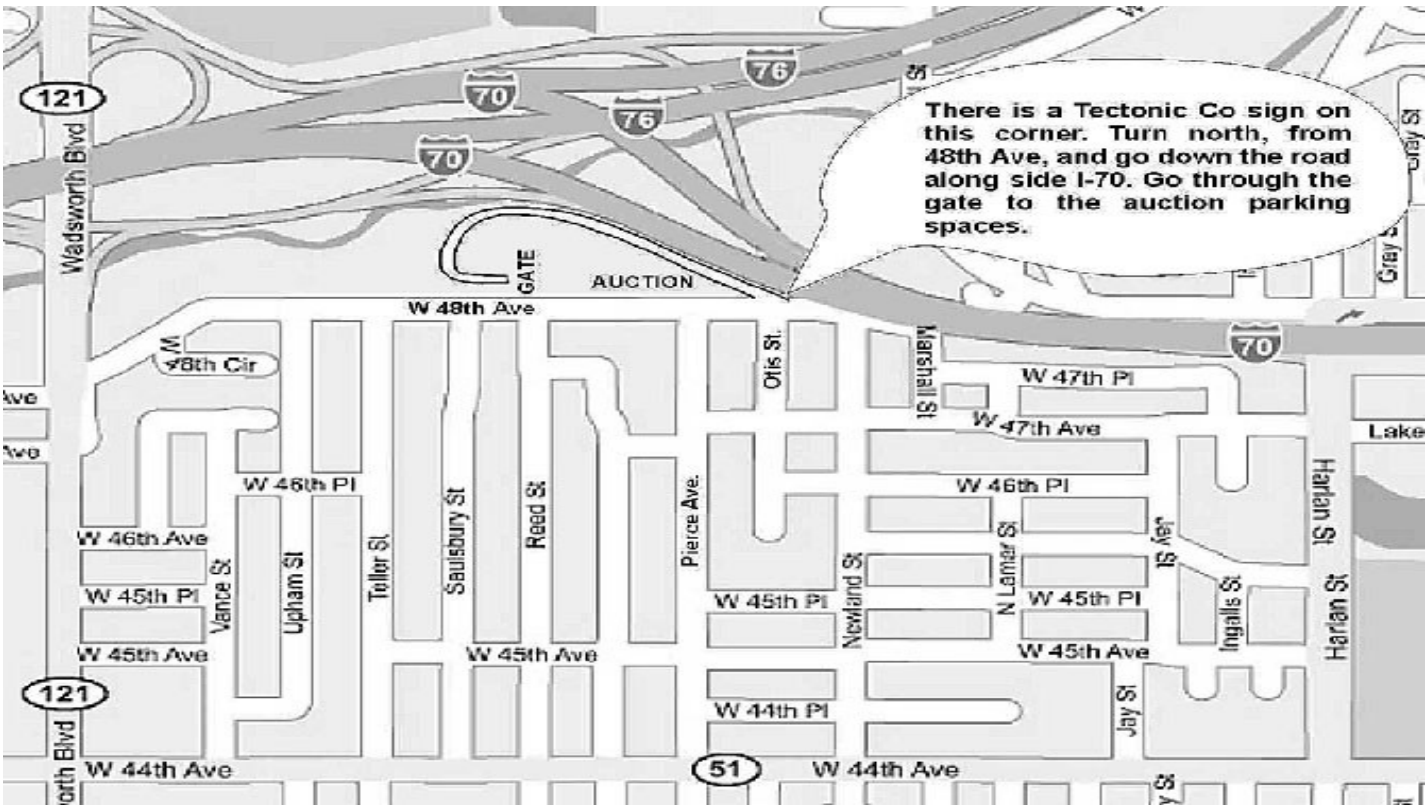
Thanks to the generous donations to the club our treasury continues to grow. At the July meeting, between the raffle tickets and donations, about $372.50 was added. Special thanks to Bill Grimm and Tom Zaczek for their contributions of equipment.

THE CRC 2010 ANNUAL AUCTION



Once again, through the efforts of club member Rich Kuberski, we are privileged to hold our annual action in a park-like setting. In addition, we will also be continuing our tradition of combining the auction with a pot luck barbecue.

That is, the club will provide the burgers, hot dogs, condiments, chips and soft drinks while the members bring side dishes to share with all.

So plan on not only on being part of the auction, by both buying and selling radio treasures, but also by bringing your family where they can enjoy the picnic and the surrounding park facilities.

WHAT:

An auction of radios, television, documentation, parts, test equipment and associated items. The public is encouraged to participate in ***both*** buying and selling.

WHEN:

Sunday, September 19th at 1:00pm

Seller's Registration 10:00a - 12:45p
Buyer's Registration 10:00a until end
Viewing As items are delivered
Auction Starts at 1:00p *SHARP*
Barbecue Lunch Served 10:30a-11:30a

Bring a side dish to share with everyone;
Slaw, Potato Salad, Fruit Salad, Desserts, Chips, Beans, Your favorite recipe, etc.

WHERE:

Tectonic Management Group Inc.
Office grounds and picnic facilities (see map.)

AUCTION RULES

There is no cost to register as a buyer or seller.

There is a seller's commission that will be equal to $1 or 10% (which ever is greater) of the "hammer" price on each lot sold to any buyer - including the sellers who may elect to "buy back" their lots.

Sellers may optionally, **at registration time only**, set a secret minimum bid (reserve) on any lot.

No commission will be incurred on any lot that is not sold.

All seller commissions will be deducted from and before the payment to the seller, and these commissions will become the property of the Colorado Radio Collector's treasury.

Buyers can not take possession of any lot(s) until the total cost for all purchases are paid. Collection of buyers fees will commence at the conclusion of the sale of the last lot entered into the auction. A buyer's receipt is required for pickup of purchased lots from the lot/item display area.

Buyer fees will be collected before sellers are paid. Identification may be requested from those paying for their purchases by personal check.

* Sellers will be paid only by C.R.C. check and may, for a $1.00 surcharge, elect to be paid by mail.

* This auction is limited to radio and electronics related items as described above. The CRC reserves the right to reject items deemed inappropriate.

* Any item registered for sale by auction may not be sold outside of the auctioneer's control, and can not be removed from the sale once the auction commences.

SELLERS

Be Prepared for the 2010 CRC Auction

Fill out this form and bring it along when you register!!!

	Brand	Model	Year	Reserve
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

2010 CRC Show Video

Don't miss out, copies of the video of the CRC Show are still available.
See interviews with each of the major award winners
Every entry is featured in this video.
They can be mailed to you for $7.00 - Send a check payable to:

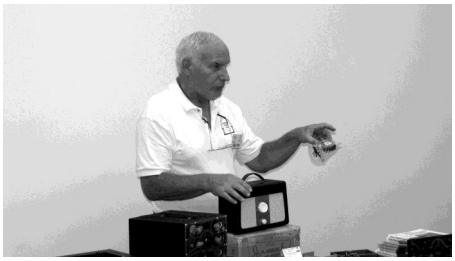
Larry Weide at 5270 Nassau, Englewood, Co. 80113

Photos from July 11th Meeting at the Phillip Miller Library in Castle Rock

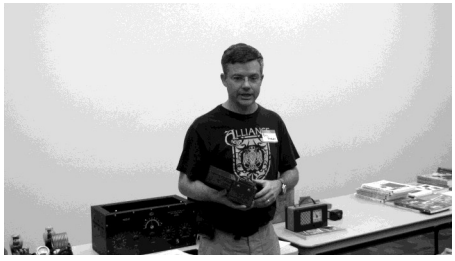
New Member
William Crebbs

Marty Phillips shows how to
repair plastic radios

Dennis Laurence shows
restoration of Delco R1145

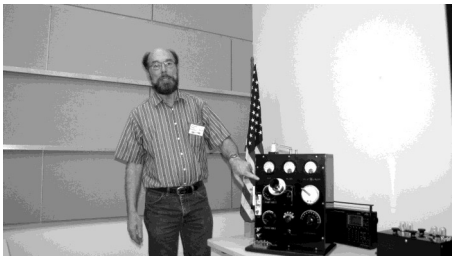


Dave Boyle shows
Pocket radio

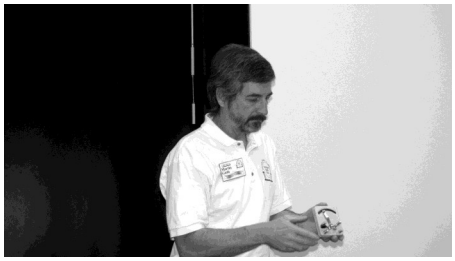


Bill Hinkely with medical equipment

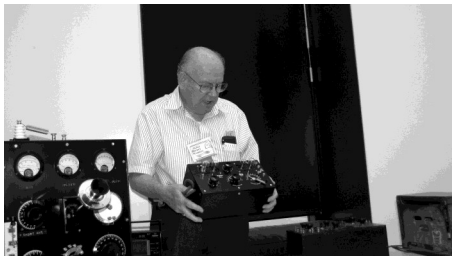
Mark McKeown shows homebrew
transmitter circa 1930



Tom Pouliot shows homebrew
cw/voice transmitter circa 1920



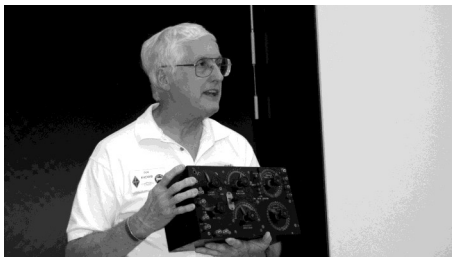
Martin Guth shows crystal detector



Barney Wooters shows
RCA 3A

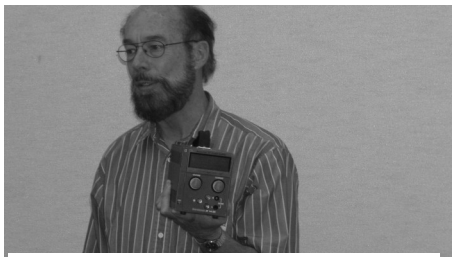
Rich Kuberski shows restored
Meissner Analyst Model 10-1154

Mark Ditmar shows Amateur Band
Deluxe Receiver circa 1929



Don Andrus shows submarine receiver
NESCO circa 1919

Part of the items for the raffle



Tom auctions items donated to club

"The Meeting"

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 but "classic" radio and TV repair instruments have been expertly refurbished, repaired, and calibrated as appropriate.

All Instruments come with test leads, as required and most have manuals. Prices might be negotiable.

1) Heathkit TV Alignment Generator; IG-52. $65.00
2) Heathkit's best "Laboratory" Signal Generator, IG-42 (I use one myself). $105.00
3) Heathkit Capacitor Tester, C-3. Also checks leakage, power factor, and resistance. $65.00
4) Heathkit Tube Tester, IT-21. Tests older types too! $50.00
5) Eico Model 324 Signal Generator. $60.00
6) Precision Apparatus Company (PACO) Model E-400 Sweep Signal Generator. $55.00
Call
David Boyle, 303-681-3258 3/10

WANTED: Shirt pocket transistor radios, working or not.

Tom Keeton **303-797-8073**
9/10

WANTED: An AK 82, 90 or 92 chassis / speaker for an empty cabinet I have. **Contact Mike Cook.**
mldcook@hotmail.com
01/10

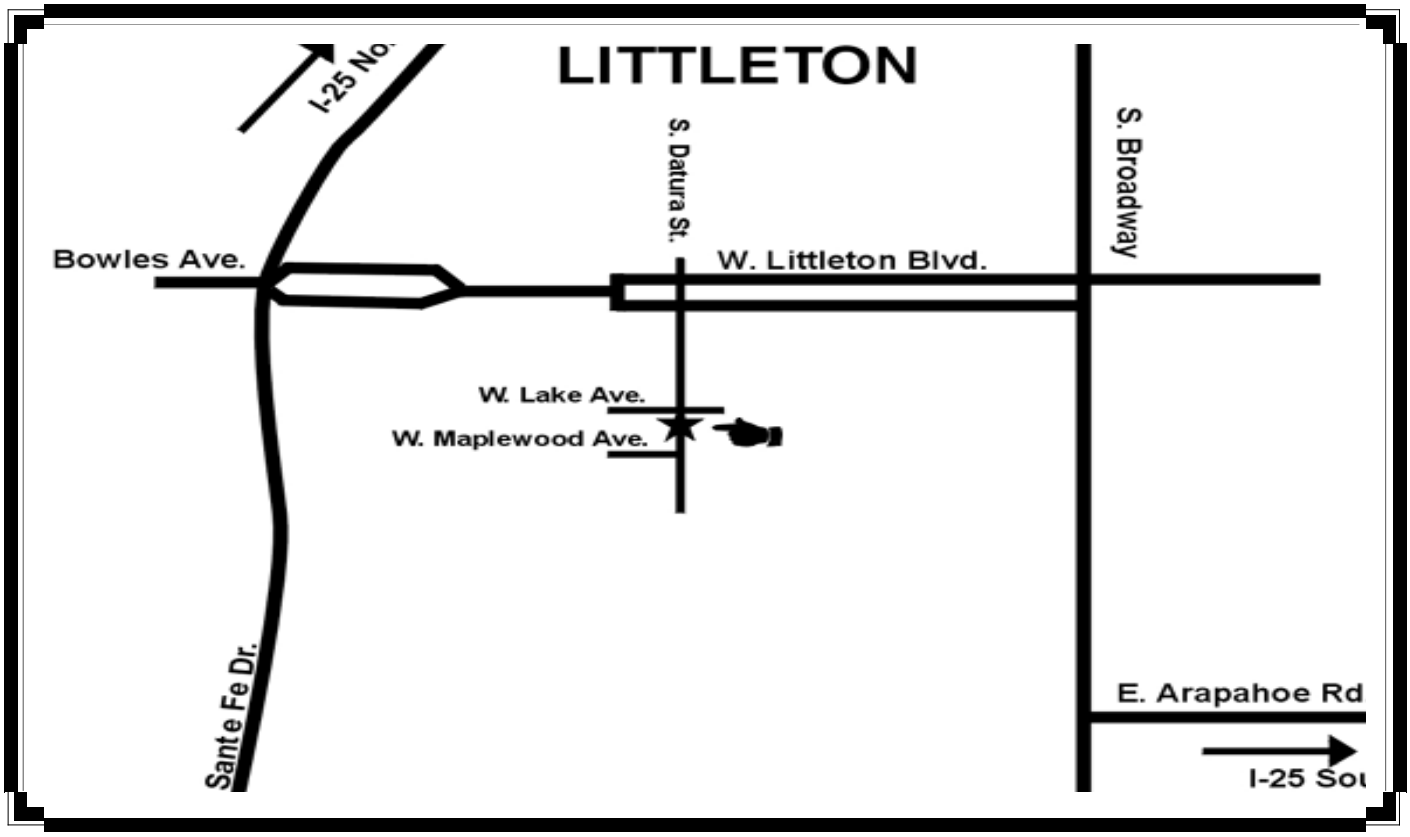
FOR SALE: Tube tester, Hickok model 533A w/supplements for European types
Electrical condition - very good, the unit is fully functional
Cosmetic condition - fair, some of the fabric covering is torn
I'll deliver the unit to Castle Rock.
Price is $125. Pete Rawson
719 687 7144 **5/10**

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 September 12th, 1:00 pm meeting will be at the Bemis Public Library in Littleton



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

FIRST CLASS MAIL