Colorado Radio Collectors Antique Radio Club

The FLASH!

Colorado Radio Collectors Antique Radio Club

Volume 22, Issue 1 | The January 9th meeting is at the Bemis Library in Littleton | January/February

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

In the first part of this article ("The Flash!" Volume 21, Issue 2) we read about the events leading to the invention of the transistor by William Shockley, John Bardeen and Walter Brattain with help from their talented co-workers at Bell Labs. Now we will examine how the transistor was taken from the lab, developed into a viable product, and then utilized in military, telephone system and computer applications and in one of its very successful and early commercial products, the transistor radio.

The new invention was announced June 23rd, 1948 in secrecy to the military where the Bell staff were told that the Naval Research Lab had made similar discoveries and wanted a joint public announcement. After Shockley asked them some technical questions it was determined that they had no data which showed power gain and probably wouldn't get any. The military was given a few days to determine if they wanted the invention kept secret or jointly announced, but never requested either. Bardeen and Brattain prepared papers to be published in the July 15th issue of "Physical Review". Then, on June 30th, 1948 it was publicly announced at a Bell Labs press conference. "We have called it the Transistor because it is a resistor or semiconductor device which can amplify electrical signals as they are transferred through it". They held up the cylindrical "Type A" transistor, made comparisons to vacuum tubes, and declared it could handle up to 100mW of power and operate to 10MHz. Through headphones the reporters could listen to presenter's voices and radio stations amplified and detected by only the transistor. Although the reporter's present gasped during the demonstrations, the press paid little attention to it, not knowing that the unremarkable little cylinder with flimsy wires would ultimately transform the world. The revolution it created in communications, computing and miniaturization is still underway today. A more technical presentation was held July 20th. Lee de Forest was an invitee, but he refused stating that he could not attend "the Wake of my forty-two year old infant, the Audion". Technical publications on the Transistor were very popular where it was declared to have far-reaching effects on technology. September's 1948 "Electronics" magazine's cover showed Shockley working at a laboratory workbench with Bardeen and Brattain (right) idly standing behind him watching. In fall all three hit the scientific and engineering lecture circuits across the nation. Shockley then turned his attention to classic writings on the theory of P-N junctions and on patent applications. His intellectual output was phenomenal.

The Three Inventors on the Cover of September's 1948 "Electronics"

The "Type A" transistor was not ready to hit the market in late 1948, but samples were given to military and university researchers and sent to GE, Motorola, RCA and Westinghouse under licensing agreements. No two transistors behaved the same and they were electrically noisy. Advances in pure single crystal growth, needed to produce semiconductors with easily controllable and uniform properties, were made by starting with "seed" crystals. The seed crystal growth was based on work in 1917 by Polish scientist

(Continued on page 3)

Inside this issue:

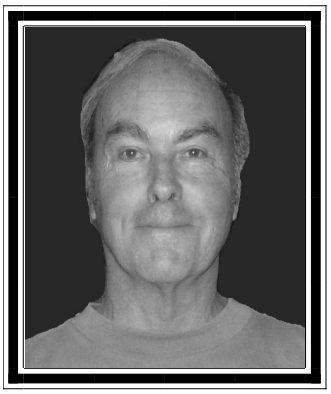
COLORADO RADIO COLLECTORS ANTIQUE RADIO CLUB

Founded October 1988

Message from the President

Presidents Message

Greetings fellow club members! I hope the holidays are going well for you. Are you finding any treasures out there? I found a Homebrew Crystal Set for $1 at a yard sale. They called it a "radio thingie". It's all there, it just needs a good cleaning and some reassembling. The cabinet is in good shape, and it is made out of red mahogany.



We need to decide on a category for our Vintage Voltage show in March, so come with some ideas.

See you at the Bemis Library in Littleton on Jan 9th.

Tom

Workbench Pictures

Sometimes I need fill material for The Flash and I put in what ever I have to fill in the blank spaces. This month I put in a picture of my workbench..

Send me a picture of yours and I will include it in a future issue, as space allows, Send your high quality image (.jpg) to: **ROKuberski@msn.com**

Dave Boyle's Tesla Coil Demonstration

By Rich Kuberski

After the last meeting, Dave invited club members to his home to view his Tesla Coil in action. About 15 of us went for the demonstration.

When we arrived, Dave showed how his coil was constructed, then, as we waited for darkness, we took a tour of his very fine radio collection. If you haven't been there, you really missed out. Dave's collection , though relegated to the basement (my wife lets me put them all over the house,) is certainly one of the finest in the club.

Once it became dark enough to see the bolts of electricity flying off of the Tesla Coil, we adjourned to the crisp cool outside. Dave cranked up the machine and provided us with a very fine display. The bolts of electrical energy flew fast and furiously, some as long as 6' out from the coil. Check out the pictures on page 8.

CRC CONTACTS

President	Tom Kelly (303)504-0550
Vice President	**Marty Phillips** 719-495-4229
Treasurer	Mike Cook (303) 471-9596 mldcook@hotmail.com 2383 Indian Paintbrush Circle Highlands Ranch, CO 80129
Archive and Books	Charles Brett (719) 495-8660 brett3729@aol.com
Egroup Manager	Mark Dittmar (303) 403-0669 mbdittmar@comcast.net
Flash! Publisher	Steve Touzalin (303) 988-5394 stevetou@comcast.net
Flash Graphic Editor	Rich Kuberski ROKuberski@msn.com
Flash! Distribution	Richard Beckman (303) 344-8565 rebdalbeck@msn.com
Webmaster	Bill Grimm
Website	www.radioace.com

Upcoming Events

1/9—CRC Meeting
2/14—Valentines Day
3/13—CRC Meeting
3/27—Vintage Voltage/CRC Show

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.

(Continued from page 1)
J. Czochralski whose technique was to place the seed in contact with a molten liquid while slowly withdrawing it as uniform layers of atoms accumulated on its lower end. Work went on at Bell by physical chemist Morgan Sparks to replace the troublesome and noisy point contacts with P-N junctions. Meanwhile, RCA and other research labs tried developing similar metallic amplifiers that did not infringe on existing patents. In 1950 Sparks fabricated a single crystal N-P-N sandwich by applying P-type "pills" of gallium (base) to N-type germanium (collector) to form a P-N junction and then an N-type pill of antimony (emitter) on top the P to form an N island inside the P. This first NPN sandwich had poor frequency response compared to point contacts because of the large 20-30 mil thickness of the P base region. This same year Bardeen's and Brattain's point-contact transistor patent was approved. By 1951 the P-layer was reduced to 1-2 mils and frequency response was improved. Soon after, pea sized junction transistors were developed that were more efficient and vastly less noisy than point-contact transistors, allowing much weaker signals to be amplified.

Germanium Junction Transistor

Shockley advised military ordinance officers on the use of the new junction transistor in weapons. Another first, Shockley devised a demonstration consisting of a wireless transmitter and microphone that he walked around with while giving presentations. In 1951 Shockley was elected a member of the prestigious National Academy of Sciences. In 1951 Bardeen subsequently left Bell Labs for a university where he could perform pure research and Brattain quietly got himself reassigned elsewhere within the Labs. Bardeen wrote to his supervisor "My difficulties stem from the invention of the transistor. Before that there was an excellent research atmosphere here". The three would meet again briefly in Stockholm to share the Nobel Prize in physics for their invention of the transistor in 1956.

On July 4th of 1951 Bell Labs held another press conference to show the junction transistor. The spidery, pea-sized device was called "a radically new type of transistor that has astonishing properties never before achieved in any amplifying device". It could operate highly efficiently consuming just 10 micro-watts of power where a vacuum tube would require 100,000 times more power and the point-contact transistor 200 times more power. Its supreme efficiency was a great advantage for the newly emerging digital computers. Also announced was that the point-contact transistor, produced at Western Electric, was ready to be put into trial use in the Bell System's switching equipment the following year. The point-contact transistor never made it big in the commercial market due to the superior junction transistor.

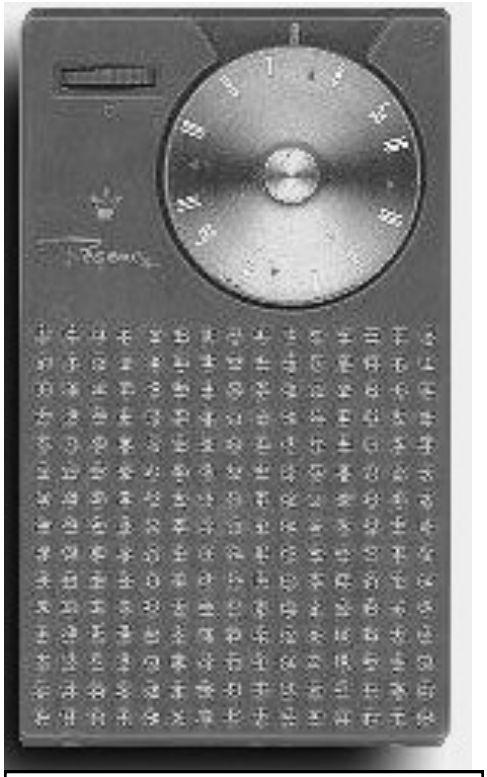
After Shockley's junction transistor patent was issued in late 1951, Western Electric began licensing the rights to manufacturing it for a $25K fee. The art of fabrication was not a secret much longer. In early 1952 licensed companies sent representatives from 26 US and 14 foreign companies (all NATO) to attend the Transistor Technology Symposium. Everything known about the point-contact and junction transistors was revealed including a new method of obtaining 99.99999999 % pure germanium by a process called zone refining. Texas Instruments was reluctantly licensed after convincing Western Electric lawyers that it could develop competence to compete in the field. Nascent Sony, named Tokyo Telecommunications at the time, was barely able to spend the $25K that represented 10% of its worth. Hitachi, Mitsubishi and Toshiba had signed up as well.

In 1951 GE fabricated a PNP transistor using alloy-junction techniques where two small pellets of indium are placed on opposite sides of a thin slice of N-type germanium and heated to 840F, until just short of dissolving all the way through, leaving a narrow base. Although cruder than junction types their low resistance was superior for switching applications in digital computers. In 1946 engineers at the University of Pennsylvania had built the first large digital computer dubbed **ENIAC** (**E**lectronic **N**umerical **I**ntegrator and **C**omputer). Weighing in at 30 tons with 18,000 vacuum tubes consuming 150 kW in a 30' x 50' room, it performed calculations for ballistic tables. Bushel baskets of spare tubes were always on hand. In 1949, on GE's radio program Science Forum, Shockley had prophesized the use of transistors for electronic brains. An early military application for transistors was in data transmitters that took target coordinates from radar and converted the data to binary form for transmission over phone lines to a control center for display on a CRT video display. In 1954 a fully transistorized computer for the Air Force called **TRADIC** (**TRA**nsistorized **DI**gital **C**omputer) using 700 point-contact transistors at $20 apiece and 10,000 germanium diodes was built. From 1953 to 1955 almost half the funding for transistor development came from the military. In 1953 the Signal Corps underwrote construction costs of a Western Electric plant and spent millions on production lines at GE, RCA, Raytheon and Sylvania. A new industry was born. Transistors were an important component to AT&T's direct dialing system and repeater circuits for rural areas and the hearing impaired which could derive their operating power over the telephone lines. In 1952 Sonotone began replacing the three vacuum tubes in their hearing aids with one junction transistor. Bardeen's wife used one of the first transistorized hearing aids. A 1953 Fortune Magazine article titled "The Year of the Transistor" proclaimed "In the transistor and the new solid-state electronics, man may hope to find a brain to match atomic energy's muscle".

In the early 1950s Lyda Teal at Bell Labs was concentrating on the nearly insurmountable task of growing and doping large silicon crystals. The melting point of silicon is 1410C instead of the 937C of germanium and is more reactive with almost any crucible. Even the best quartz containers slowly dissolve in the melt. But it is abundant and has preferable electrical properties. Germanium's main limitation is that performance degrades greatly with increasing temperature because its electrons can too easily break free for conduction with thermal energy. Teal left Bell for TI where he continued work on silicon. Finally in 1954, using $500 per pound silicon from du Pont he grew a working NPN junction device. This was a defining moment for TI and it raced to set up production before other companies had a similar breakthrough. The device was publicly

(Continued from page 3)
announced at a conference where one after another presenter remarked how hopeless it was to expect development of a silicon transistor. By the time Teal began the audience was drowsy and many began to nod off as he droned on monotonously. Finally he proclaimed "Contrary to what my colleagues have told you about the bleak prospects for silicon transistors, I happen to have a few of them in my pocket". The audience suddenly woke up and was further told that TI had three types in production. Teal then demonstrated a phonograph amplifier with germanium transistors dunked into a hot beaker of oil until it failed to operate. When a silicon-based amplifier was substituted the audio continued without interruption. They initially sold for hundreds of dollars apiece, mostly to the military.

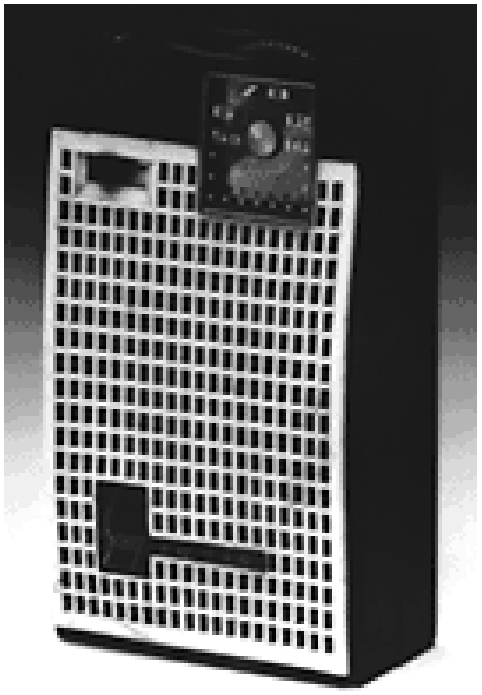
With the end of the Korean War TI's military business was faltering and a boost in income was needed from the commercial arena. TI was convinced that an all transistor pocket radio was feasible, but RCA and others preferred to stick with vacuum tubes and had a wait and see attitude towards the transistor. Amateurs used transistors to design experimental radio circuits as early as 1950 and Western Electric engineers made a wrist radio in 1952 with 4 transistors as a gift for Dick Tracy creator Chester Gould. In June 1954 TI finally reached agreement with a small Indianapolis company named Regency to design and manufacture the first commercial transistor radio for the Christmas market. To keep cost down in was designed to use four junction germanium transistors which had to come in at $2.50 apiece with the remaining parts at $18 for a profitable sales price of $50. Normally the transistors were $16 apiece, but expected high production and increasing yields from 10% would drop the price. Workers grew doped germanium crystals sawed into tiny bars. Each bar was etched and polished then three wires attached. After testing and rejecting most of every lot they affixed capacitors to those that passed to compensate for variability and then encapsulated them. TI also designed and built the compact circuitry. They found companies that supplied the tiny speakers, coils and other components on short notice. Regency's master engineer, Dick Koch, designed a feedback circuit that accommodated the tolerance of components and let them be soldered directly into the boards without manual selection. The TR-1 utilized a 22.5V battery that ran for over 20 hours and was 3"x5"x1.25" in size. Fortunately everything came together and



Regency TR-1

Regency's TR-1 pocket radio began production on schedule in October. Despite a major promotional campaign Regency only shipped 1500 radios by the end of 1954, but surged to 100K by late 1955. It sold out quickly, but at $50 the radio was under priced for demand and was not profitable because the transistor price goal wasn't met. TI became the principal transistor supplier to Admiral, Motorola, RCA and Zenith after it had shown them the way. Mention the word "transistor" to owners of these early radios and images of them instantly come to mind. The transistor radio finally brought the publics attention to the tiny and esoteric transistor. In 1955 IBM bought over a hundred TR-1s to give to its top executives telling them "If that little outfit down in Texas can make these radios work for that kind of money, they can make transistors that will make our computers work too." Two years later TI agreed to provide transistors for IBM's first fully transistorized computer.

While TI and Regency were designing their TR-1, Sony was developing its TR-52 junction transistor radio. It was nicknamed the "UN Building" by its engineers because the black plastic case with a white plastic grid on the front tapered slightly at the top. It was meant to be the first transistor radio on the market, but was beat to the finish by the TR-1. In early 1955 watch maker Bulova wanted to order 100K units of the TR-52, but the catch was that they would sell them under their name because at the time nobody had heard of the "Sony" name. Sony refused the order. Soon disaster struck. As summer temperatures climbed, the front lattice section gradually peeled away from the black cabinet on all of the 100 sets manufactured so far. The radios were unsaleable**.** In August that year the remodeled 5 transistor model TR-55 went on sale. During construction transistors which were slow to operate would be paired with coils which hastened the effect. It had the honor of being Japan's first transistor radio. It was followed the same year by the 6 transistor TR-72, with a push-pull amplifier for improved sound, which continued to be a popular radio into the 1960s. Transistor radios became a status symbol for teenagers who owned one. Other U.S. companies introduced dozens of transistor radio models and by 1959 almost half of the 10 million radios made and sold in the U.S. were the portable transistor type.



Sony TR-52

Philco introduced the first transistor TV in 1959, but after Sony began manufacturing transistor TV sets in the 1960s U.S. leader-

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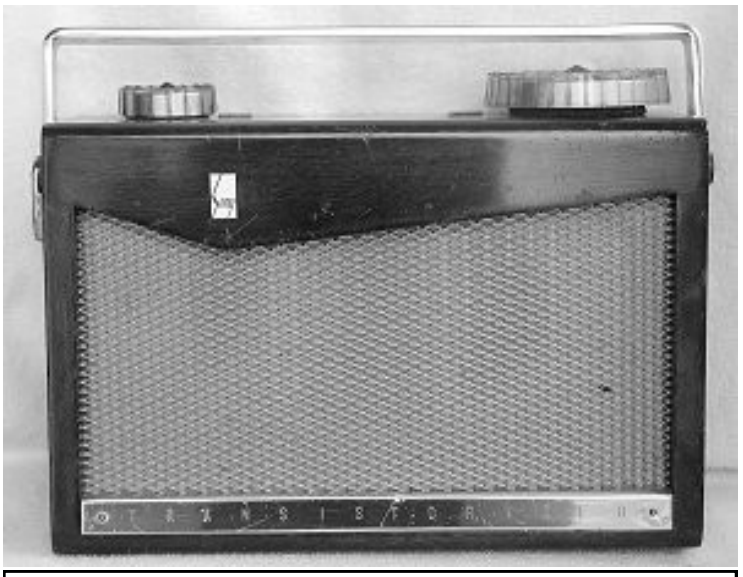
Sony TR-55



Sony TR-72

ship in consumer electronics began to wane. By 1961 transistors were the foundation of a fast growing, billion dollar, industry. In 1963 a transistor cost US $10. That transistor corresponded to half a storage bit and cost as much as an automobile tire at the time. Today (2010), flash memory costs $25 for 8 gigabytes (64 billion bits!), enough storage to encode the text of all the books in a small town library. And it will be cheaper by the time you read this article. Consider that the transistors in state-of-the-art chips are so small that 4 million of them will fit into the period at the end of this sentence. The invention of the transistor, a few years before my birth, allowed sufficient time for progression to the integrated circuit chip and for me to make a career of its circuit design starting in 1977. Even while knowing how these chips are fabricated and function, I am in awe over what man has accomplished with them. The staggering amount of transistors on chips, produced in billion dollar factories, which the average consumer product utilizes and sells for the cost of a tire, amazes me! The industry is currently a $255.6 billion-a-year juggernaut. The long lived revolution created by the three fathers continues today with no end in sight.

Resources

Riordan, Michael. "Crystal Fire" W.W. Norton & Company, Inc. 1997

http://transistorhistory.50webs.com/xstr.html

2011 CRC Annual Show

Holy Smokes! It's January and there are only two months left until the Annual CRC Show. At the November meeting there was a brief discussion of what the Special Category would be. In the table below, you can see what has been done in the past and what the current judging categories are. At the January meeting we must decide on the Special Category.

Once again, we need a Show Coordinator. Tain't a hard job, after all, Robert Baumann did it last year. But, the fact remains that someone has to do it. See the box on the next page describing the duties. It seems that the same guys are volunteering most of the time, how about some new blood pitching in this year? Yes, **YOU can DO IT!**

CRC Annual Show

CRC Show Specialty Categories Used In Past Shows

1991	Either '91 or '92 was Crosley	2001	Art Deco
1992	Either '91 or '92 was Crosley	2002	Portable Tube Radios
1993	RCA	2003	Emerson
1994	Philco	2004	Silvertone
1995	Atwater Kent	2005	Zenith
1996	Zenith	2006	Philco
1997	GE	2007	Golden Age of Radios
1998	Motorola	2008	Obscure Brands
1999	Wards/Airline	2009	Homebrew/Kits
2000	Radio Time Line "A Century of Radio"	2010	Plastic Radios

Possible Specialty Categories For Future Shows

Admiral	Fada	Truetone
Arvin	Stewart Warner	Westinghouse
Carlson	Stromberg	Radio Types, i.e. technology, style, power

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

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 "go-to" guy

Photos from November 14th Meeting at the Philip Miller Library in Castle Rock

Marty Philips shows different types of cabinets used on radios

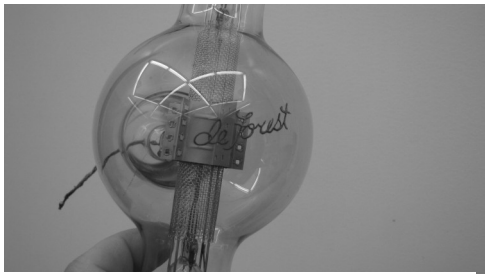
A good turnout for the meeting.

Dennis Lawrence shows off his very fine FREE radio

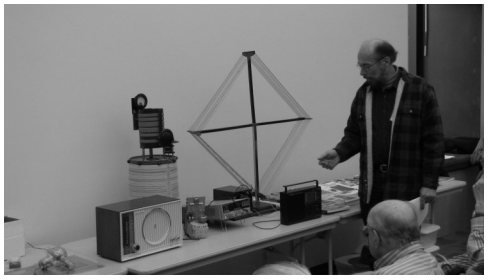
Barney Wooters shows copies of the first RCA catalogs 1920/1921

Dave Boyle gives "chalk talk" on how his Tesla coil works

Bill Harris with his General Radio Broadcast Frequency Checker



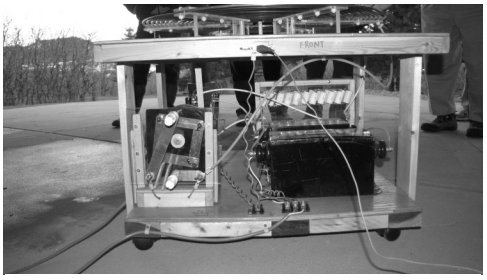
Barney Wooters also showed a De Forest transmitting tube



Tom Pouliot discusses 1500 meter (160-190khz) 1 watt communications

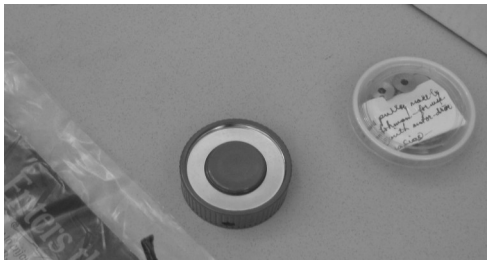
Close up of General Radio Broadcast Frequency Checker

Dave Boyle demonstrating how his Tesla coil works



The electronics package of the Tesla Coil

Tesla coil in action.



Barney Wooters is looking for a knob for a NC type 193

The control Panel for the Tesla Coil

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

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

FOR SALE: New construction—120 volt power supply with variac. Includes volt meter, amp meter and integral fuse to protect the connected load.

Give me a call and I will bring it to the next club meeting.

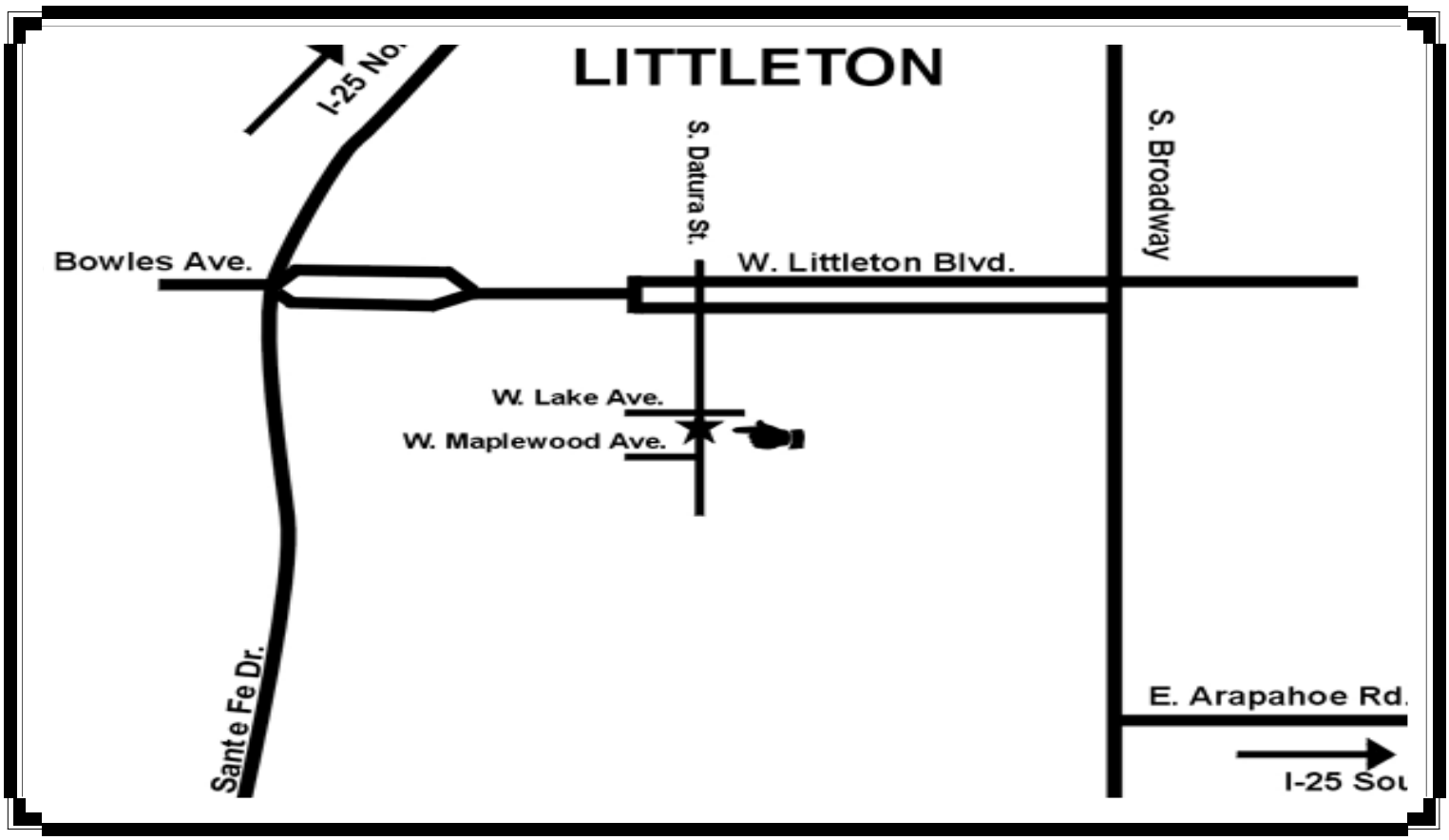
Price is $75. Rich Kuberski
303-422-9510 11/14

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 isn't 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 January 9th, 1:00 pm meeting will be at the Bemis Library in Littleton



Colorado Radio Collectors
Antique Radio Club
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Lakewood CO 80226

FIRST CLASS MAIL