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Journal of the CALIFORNIA HISTORICAL RADIO SOCIETY

Radio Day Live 2015

Golden Gate Radio Orchestra

"War of the Worlds" Radio Play

FOR THE RESTORATION AND PRESERVATION OF EARLY RADIO

FROM THE BIRTHPLACE OF BROADCASTING

CALIFORNIA HISTORICAL RADIO SOCIETY

HOME OF THE BAY AREA RADIO MUSEUM & HALL OF FAME

The California Historical Radio Society (CHRS), is a non-profit educational corporation chartered in the State of California. CHRS was formed in 1974 to promote the restoration and preservation of early radio and broadcasting. Our goal is to enable the exchange of ideas and information on the history of radio, particularly in the West, with emphasis on collecting, preserving, and displaying early equipment, literature, and programs. Yearly membership is $30.

CHRS Museum in Alameda

CHRS has been fortunate to through the generosity of its donors to purchase a home for the CHRS museum and education center. It is located at 2152 Central Avenue. The building was built in 1900 as a telephone exchange.

CHRS volunteers are actively restoring the building to make it optimal for use. Our goal is to create an environment to share our knowledge and love of radio and enable us to create an appreciation and understanding for a new generation of antique radio collectors and historians.

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Contact us:

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Visit us at: www.CaliforniaHistoricalRadio.com

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- David Vasquez – Electrical Transcription Project
- Larry Clark – Technical Advisor & Librarian

Contents of the Journal

Front and Rear Covers: Images from Radio Day Live in July 2015

From the Editor

This issue is primarily focused on Amateur Radio topics. Once again I've had the pleasure of working with very generous and capable contributors. I want to thank Bart Lee, John Staples, Tom Bonomo, Walter Hayden, Scott Scheidt, and Steve Kushman.

It is my desire to continue to improve this journal and provide you with relevant high-quality content. To do this I need your constructive comments. I am always in need of quality content related to broadcast radio, ham radio, and television. If you have something to contribute, I urge you to let me know. I am especially interested in technical content. It can be of two types, a narrow topic in depth or a more broad topic with less depth.

Enjoy . . .

Richard Watts, jrchrs@comcast.net ◊

From The President

by Steve Kushman

Much has been going on with our favorite vintage radio organization. Here is a brief wrap up and some thoughts about CHRS.

Radio Central Progress: We continue to slowly but surely turn Radio Central into our West Coast educational and historical center devoted to radio and radio history. Every Saturday and sometimes during the week we have dedicated volunteers working hard to turn this 115 year old telephone building into our homage to radio. I can't say enough about how fortunate we are to have this core of passionate volunteers. Our thanks and admiration goes out to them. I am proud to be associated with this group who continues to produce professional results on every project. Soon after the purchase of Radio Central, Chairman Mike Adams stated that he believed we should not skimp on our projects and do them first rate. Well, Mike can be assured that this is happening with every project. Please check out Project Manager Walt Hayden's article on page 6 chronicling our progress at Radio Central.

Fund Raising: Yes, CHRS owns Radio Central free and clear but we have monthly expenses and many construction projects that require funding. Fund raising has become an integral part of CHRS and will always continue. This year has proven to be good for fundraising. Our generous supporters met the challenge and donated $32,000 for our compact mobile storage unit. Thanks to Jon Winchell, Tom Bonomo, Tom Nelson, Scott Robinson, Dave Sauer, Bart Lee & Judy Mears! Last March we held a mini Radio Day auction and clearance sale and raised $13,000. And our main annual event, Radio Day By The Bay 2015 in July netted CHRS almost $25,000. Most recently CHRS hosted a sale featuring several estates and extra CHRS gear and raised $8,200. Sales and events are one of our funding sources along with donations from Members. Thank you to Director Philip Monego for donating $5,000 toward our new Marvin windows for the Maxwell Library. Grants from other organizations are also very important. This year the Rex Foundation, the philanthropic foundation of the Grateful Dead, presented CHRS with a $5,000 grant to support our projects "KSAN Jive 95: The Movie" and the brick and mortar Bay Area Radio Hall Of Fame within Radio Central. And late last year the Yasme Foundation, the philanthropic wing of the ARRL, gave CHRS a grant of $9,500 toward the completion of the Maxwell Library and Archives. We also benefit from the sales of our KSAN Live Jive CD and from the book Gary Gielow donated to CHRS, "The Story of KPEN – A Concept in Great Radio!" Thank you Gary! And thanks to Super Volunteer Seth Arp who brings a bunch of items that our collectors do not yet collect to the monthly Alameda Point Antiques Fair. Seth brings in an average of $700 a month for CHRS. Nice work Seth! Even though CHRS has funding to address current operations and near-term projects, we must continue to depend on support and from our Members and others for the long-term existence of our favorite vintage radio society. We encourage and need your support and participation.

Events: CHRS has had another year of successful events. Our mini auction in March was a lot of fun. Radio Day By The Bay featured several improvements this year. We blocked out the day so we had two auction segments with the entertainment segment in between. This worked quite well. Our Master of Ceremonies was KCBS' Stan Bunger (BARHOF 2010) with guest auctioneers Rene Richardson of KFOG and Peter Finch (BARHOF 2014). The other big change was the formation of the CHRS Radio Dog Theater, whose premier presentation at Radio Day was H. G. Wells' "War of the Worlds" live on stage. This WOTW version was based on the play done in 1964 on KPEN by James Gabbert (BARHOF 2006) and Gary Gielow. Our production was directed by Terry McGovern (BARHOF 2008) and featured Michael Bennett, Stan Bunger, Jim Gabbert, Gary Gielow, Monterey Morrissey, Celeste Perry (BARHOF (2014), Kevin Radich, Kim Wonderley (BARHOF 2011) and yours truly. David Jackson adapted the play with sound design and playback by Bob Brown. The live mix was by Dan Healy and I was honored to produce the show and very pleased to work with this group of professionals. The auction moved along well and some items fetched high bids. Our Silent Auction was popular and profitable. The flea market was a beehive of activity and the CHRS Doggie Diner served many hungry guests who numbered close to 400. And of course, over 30 hard working volunteers made it happen. Our Halloween Sale in October was also a successful way to raise funds and get some great gear into the hands of people who appreciate it. We have also had several vintage radio swap meets at Radio Central and remember that every Saturday is an event at RC as we work hard and have a nice lunch.

Bay Area Radio Museum: Our popular BARM site has had some broken link problems. CHRS I.T. Superhero Alan Bowker has stepped up and for many weeks now has been repairing links on the site. This is tedious work and Alan has done a great job of getting our site back into good working order. Thank you Alan! Our Bay Area Radio Museum site is an important program of CHRS. For so long, CHRS was only about radios; the style, the technology, the history and the inventors. But that's only half of the radio story. What comes out of the speaker can be just as fascinating as the tubes in the cabinet. It took the radio and the programming to create the lasting impact on the development of our culture. So, check out www.bayarearadio.org/site and discover the voices, music, sounds and station histories that have made Bay Area Radio great!

Bay Area Hall of Fame: The 2015 BARHOF Class represents the best in Bay Area Radio. BARHOF was pleased to name KPEN 101.3 FM as the 2015 Legendary Station. KPEN was founded in 1957 by James Gabbert and Gary Gielow and featured many new technical and programming innovations. The other 2015 inductees include: In News – Mike Colgan (KCBS), Pioneers –

Gil Haar (KNEW) & Elma Greer (KSFO), Executive – Harvey Stone (KBLX), Specialty – Peter Scott (KSFO), Engineer & Educator – Ken Neilsen (KALW) and Program Hosts – Lissa Kreisler (KBAY) & Dusty Street (KSAN). To read more about the 2015 BARHOF Class visit our BARM site. In June CHRS celebrated KPEN as 2015 Legendary Station featuring Jim Gabbert and Gary Gielow being interviewed by Ben Fong-Torres (BARHOF 2010) at the Broadcast Legends Spring luncheon. And in September we inducted the 2015 BARHOF Class at the Legends Fall luncheon with Terry McGovern as our Master of Ceremonies.

AWA Houck Award to CHRS: CHRS was honored this year with the Antique Wireless Association's most prestigious Houck Award. The AWA annually presents the Houck Award to an individual or organization that excels in historic preservation, research and publication. Bart Lee and Mike Adams, who spoke at the annual AWA convention in New York, received the award for CHRS.

Why CHRS Works: As I write this I look back and am amazed how far CHRS has come since I joined in 1988. From meeting in parking lots to owning an historic building in Alameda is a dream come true. Many organizations of our type would love to be in our shoes. So, what makes CHRS so special? We are extremely lucky to have a passionate Membership who is supportive of our goals and ideas about radio preservation and presentation. Our volunteers and Membership tirelessly donate their time and dollars to continue the phenomenal success of our little vintage radio society. Thank you is not enough to express the way we feel about the great work being done by CHRS volunteers in pursuit of radio history preservation.

Volunteer Of The Year: Two of our tireless volunteers have exhibited extreme dedication and passion for CHRS and Radio Central. We were honored to name Kevin Payne and Cliff Farwell as the 2015 Volunteers of the Year. Kevin, a semi retired electrician, continues to upgrade our aging electrical system. And Cliff is a Jack-of-All-Trades and has worked on projects such as our new water heater, our new window installation and our wood shop construction. They both spend lots of time working at RC and we can't say enough how much we appreciate their efforts.

And Finally: CHRS is proud to present another terrific CHRS Journal. Again, Editor Richard Watts has done a wonderful job producing a Journal second to none. Our Journal really stands out and is nice perk that comes with Membership. Thank you Richard. Another job well done!

Remember that I always enjoy hearing from you. Whether it's a good comment or a complaint, please let me know. I hope you feel as proud and enjoy being a part of CHRS as much as I do.

Best Regards, **Steve**

(415) 203-2747, kushseal@flash.net ◊

CHRS Central Valley Chapter News

by Scott Scheidt, photos by Mick Daniels

Annual CVC Swap Meet: The Central Valley Chapter of CHRS held their 16th annual radio swap meet at the Stanislaus County Fairgrounds in Turlock on October 3rd, 2015. There were many vendors with lots of nice radios and parts for sale, coffee and donuts were on hand and the CVC had a nice collection of items in its raffle. Everyone had a great time. Attendance was down this year due to other radio related events occurring on the same day. The CVC, which generates much of its income from the raffle sales, is depending on attendance levels to return to normal so they may continue the tradition of holding their annual swap meets.

Classes: The weekly radio theory and radio repair class will be given 6-8pm Thursday nights by Vernon Larson at the CVC Clubhouse in Turlock. A weekly evening workshop is also scheduled enabling members to work on radios together.

For more information plus meeting times and locations, visit the CVC website at http://www.cvantiqueradio.com/ . ◊

Radio Central Renovation Update

by Walter Hayden

Original exterior front elevation of 2152 Central Ave.

Library Renovation: Walls and ceiling have been painted. Baseboard and crown molding are installed. Bookcases are installed. Ceiling mounted light fixtures are installed above aisles between bookcases. Major progress has been made populating shelves with periodicals and books from storage. The installation of new library windows will be completed in the coming months.

Electrical Upgrade: New electrical panel to provide power for rear portion of building has been installed, inspected and energized. Kevin Payne is moving electrical loads to new panel when appropriate. Conduit and cable was installed from Main Electrical Panel to Wood & Crafts Shop Electrical Panel.

Wood & Crafts Shop: Concrete pad for metal building and outside work area adjacent to sheds was poured in April. Installation of 380 square foot metal building started in May and finished in late June. During August and September the walls and ceiling were insulated and interior walls covered with plywood. Floor and walls were painted. In June an electrical permit for the metal building was issued by City of Alameda. Electrical panel, outlets, switches and light fixtures were installed by Kevin Payne.

Garden Shed: A 50 square foot shed made of wood was on the property when CHRS bought Radio Central. This small shed has been cleaned, repaired and painted. The shed is now positioned in its final location on the new concrete slab.

Mobile Storage: Installation of mobile storage system is complete including ceiling mounted light fixtures. The storage system is now in service. It contains numerous radios and other electronic items. Mobile storage system provides 180 linear feet of 24 inch deep shelving and 600 linear feet of 18 inch deep shelving.

Amateur Radio Antenna: Temporary dipole antennas for 20 and 40 meters were erected in June by Dennis Monticelli. The antennas allowed CHRS station W6CF to participate in the annual ARRL Field Day amateur radio event. These antennas will continue to be used until permanent antennas are erected.

Front Gate: Gate visible from Central Avenue on left side of Radio Central was covered with redwood planks to block view. Area behind gate is used for storage of unwanted material before it is hauled away and for display of flea market items. Blocking view of this material improves overall appearance of Radio Central and obscures an attraction that may invite theft.

Water Heater: A tankless water heater was installed outside the building on wall adjacent to kitchen. Natural gas and water lines were routed from Boiler Room where old water heater was located to location of new water heater. While piping new water heater, all water and gas lines in Boiler Room were repositioned to prepare room for conversion from Boiler Room to Vacuum Tube Storage Room.

Re-faced front gate

Newly constructed Wood and Crafts Shop.

Kevin Payne installing electrical in the wood and crafts shop.

Mobile Storage houses items for easy accessibility.

Refurbished garden shed.

Library now being filled with books.

Larry Drees and Robert Swart finish installing a new window.

Keith Scott removes and old sink.

Lunch break for the volunteers.

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California Amateur Radio Since 1903

By Bart Lee, K6VK © 2015

The California Historical Radio Society operates amateur radio station W6CF. Radio ("wireless telegraphy") was, in the beginning, an all-amateur endeavor, inasmuch as there simply were no professionals at first. Amateur radio evolved in parallel with both communications circuits and then, in the early 1920s, broadcasting. It has always been devoted to public service, and to advancing the radio art. A challenge many amateur radio operators, around the world, enjoy is contacting distant stations -- "DX." CHRS inherited the callsign, W6CF, of a master DXer, Jim Maxwell, with hundreds of countries (and entities) contacted on many bands from near Santa Cruz. Jim also served as the ARRL Pacific Division Director. Jim undertook to manage a very large library of radio related periodicals and books. CHRS also inherited his periodicals and ephemera. CHRS is pleased to manage that library, and W6CF in Jim's honor. CHRS is grateful to the Yasme Foundation for its substantial financial support for the library and W6CF, and its encouragement, especially from Pacific Director Bob Vallio, W6RGG. CHRS is also pleased to tell the following story about amateur radio's early days, particularly in California, in Jim Maxwell's honor:

California Amateur Radio, since 1903…

Here on the West Coast, in August 1899, wireless telegraphy announced of the appearance of the troopship *USS Sherman*, bringing a California regiment back from the Spanish American War. Widely publicized, the success of this first radio transmission outside of England, stimulated young men and boys to experiment with spark coils and detectors.[1] Marconi's transatlantic success in 1901 also stimulated many an experimenter.

Whenever others actually took to the air, in 1902, Francis McCarty in San Francisco experimented with voice over a spark transmission (he eventually used an arc system). In 1903, another San Francisco experimenter, Rev. Richard Bell, sent wireless messages from San Francisco to San Jose, about 60 miles.

In 1903, few could afford coherers even if a source could be found. So amateur experimenters made detectors from carbon rods on steel edges. (In 1905, the Mt Tamalpais wireless station proposed to use a steel needle on a graphite disk to detect signals from Hawaii. This technique reappeared in World War Two as the Foxhole Radio using a steel razor blade and a graphite pencil lead as a detector). The first amateur wireless man in the San Francisco area was Bill Larzelere, later a member of the Bay Counties Wireless Club *circa* 1907.

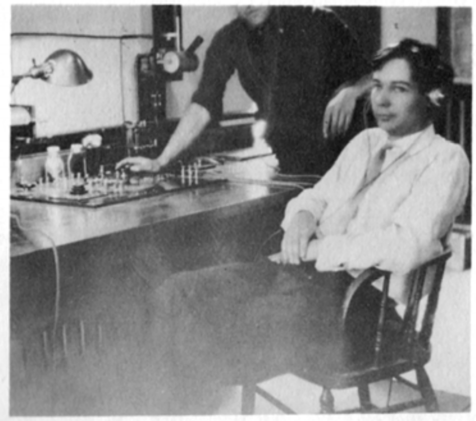
Irving Vermilya of the Boston area is sometimes said to have been America's first amateur radio operator. On a visit as a boy to Canada in 1901, he listened to a talk by Marconi. From an older companion, he got a piece of Marconi gear, probably a coherer. He built a receiver; then a spark transmitter. He identified on the air as VN. When he found out that the government would require licenses in 1912, he stood first in line for the test in Brooklyn. The Department of Commerce awarded him certificate number one. His claim to be the first licensed amateur radio operator in America is widely credited. He operated as 1HAA and then W1ZE. Initially as 1ZE, Vermilya began to entertain neighbors as well as to promote amateur radio, about 1921. He worked for decades in the broadcast industry, operated in the ham bands enthusiastically, wrote for the ARRL magazine *QST*, and eventually founded the Old Old Timers Club. [2]

But in California, by 1906 many boys had taken to the air. The young radio amateurs often caused consternation. The 1906 log of San Francisco station PH also noted amateur operators on the weekend:

"8:30 a.m. The combined forces of 3,000 ham factories are bursting forth with their weird codes upon the quietude of this lovely rainy morning."

The term "ham" for amateur operators probably derives, at least in part, from the old landline telegraphers' description of badly sent traffic as "ham." Hence the description in the PH log of amateur stations a "ham factories." One of Doc Herrold's associates, many years later, closed a letter to Herrold along the lines of "one of your old ham factories."

By 1907, the word about "crystal detectors" (*e.g.* galena) was out — this banished the coherer (and graphite) to history. 1907 amateur wireless operators formed the Bay Counties Wireless Telegraph Association. Haraden Pratt of San Francisco was an active member. He was later telecommunications advisor to Presidents Truman and Eisenhower. Another active member was Ellery W. Stone of Oakland, later Radio Inspector, naval officer, and a distinguished technical author. The club issued licenses to operate as club members, along with club callsigns. They were three letter calls starting with "S" (perhaps in honor of Marconi). A member had to copy 20 words per minute in Morse code and pass a technical test in order to qualify. By 1912 some 50 operators held "S" calls licensed by the club. Haraden Pratt, President of the club, held SKH. Ray Newby, who also worked with Doc Herrold, held SEW.



Haraden Pratt and the University of California's first radio station, which he built in 1914. With de Forest audions and a crystal detector, he got Washington, Yap, Siberia.

Source: Jane Morgan, Wireless in the West (1967) .

The later careers of the members of this club show how important engagement by amateurs with the evolving technology was for commercial success. At each meeting of the Bay Counties club, the President assigned one or more topics for scientific investigation and discussion. Bill Larzelere's call was SWL; circa 1908, he ran five kilowatts at 720 meters. His station operated from the second floor of a barn at his home in San Francisco. Many of the amateurs went to sea as wireless operators as soon as they could get a license. In 1908 the Bay Counties Wireless Association pioneered sports radio. It reported by wireless on the "Big Game," to Palo Alto and Alameda from Berkeley. This was (and is) the annual clash of the football teams of Stanford University and the University of California at Berkeley.

In this period, commercial and naval wireless flourished in California as in the rest of the country and world. Boys with skills sharpened in amateur radio could move on to professional engagements. In 1908, Dick Johnstone, as a very new amateur, heard nearby McCarty experimenters sending out voice and recorded music: " – a real first in wireless transmission." The great White Fleet on its San Francisco visit also broadcast music. The ether was getting more interesting.

The Key Year of 1909, and Thereafter …

In 1909 young amateur wireless operators at the initiative of then 12 year-old Henry Dickow formed the San Francisco Radio Club. Several others clubs also met regularly. A San Francisco newspaper ran a full-page story on the young wireless operators of San Francisco associated with Lowell High School, on December 26, 1909:

"This is amateur morning in the wireless world. San Francisco and adjoining suburbs alone have between 200 and 300 young wireless operators; amateurs who rank as such principally in name, who are everywhere dotted about the city and country for a stretch of miles that extends way beyond the city and county boundaries. The handiwork of the young wireless expert is seen all about on house-top and barntop in the form of a pole a few feet long projecting above the gables, with a few wires running to it top window. Such signs denote the residence of a lad who may some day, somewhere, if not in San Francisco, assist materially in perfecting the system of wireless telegraphy that, while considered by electrical wizards to be still in an embryo condition, is one of the greatest achievements of modern times."

The 1909 *Modern Electrics* callbook, the *Wireless Blue Book* of the Wireless Association of America, lists only ten of the many amateur operators in California. It includes Ray Newby, as EZM. It also lists the Ozone Wireless Company of San Francisco, as callsign MJ, perhaps its principal's initials.

In 1909 for young wireless amateurs in San Francisco, their hopes to qualify for maritime radio work provided a reason to form the San Francisco Radio Club. In 1916, San Francisco Radio Club formally revived after its founding in 1909 was followed in 1912 by the challenges of the new law requiring amateurs to operate only in the wasteland under 200 meters in wavelength (just at the top of today's broadcast band in frequency). In 1919, anticipating the revival of amateur radio after World War One, the San Francisco Radio Club incorporated. It has met continuously since then (but for wartime interruptions) and uses the callsign of an early (1930s) member, W6PW, for its club station and repeater. The San Francisco Radio Club, born in 1909, looks to be the oldest continuously operating amateur radio club in the world.

A man's "wireless house" is his castle! In 1915, Charles V. Litton, 11, was proud owner of his own radio "shack."

Source: Jane Morgan, Wireless in the West (1967) .

In Los Angeles in 1910 Howard Seefred as a teenage amateur operator monitored stations each a thousand miles North: Friday Harbor, Washington, callsign PD, and Seattle callsign PA. Later as W6EA, he ran the American Radio Relay League (ARRL) Pacific Division. The League, formed in 1914, fostered cooperation among amateurs and created a traffic handling relay network for nationwide distribution of personal and emergency messages. California and the West took considerable benefit from this public service.

In 1911 federal regulation had come to wireless. The Ship Act of 1911 required licenses of maritime wireless operators. In a typical success story, Sydney Fass was active in the San Francisco Radio Club as a young man, then at 16 years old in 1911, obtained his marine wireless telegrapher's license. He then went to sea on schooners, crude oil tankers and liners. He also operated for United Wireless at station PM at Eureka, California. Fass was a friend of Haraden Pratt and Dick Johnstone. Fass was later to serve in the Navy in both wars. He retired as a Commander after 33 years in the Naval Reserve. Fass owned and operated one of San Francisco's largest Radio and TV stores in the fifties.

In July of 1911 a new kind of scandal came to wireless. In Los Angeles, teenaged wireless amateur operators, trained at Los Angeles Polytechnic High School, intercepted and disclosed collusion over the Catalina Island wireless telegraph circuit. This involved the Hearst newspapers, with much attendant publicity from the rival press. The Hearst interests instituted a criminal prosecution but it was later dismissed. The affair garnered a great deal of publicity, and Hugo Gernsback's *Modern Electrics* reported nationally on the prosecution and its dismissal. The Wireless Association of Southern California, over 200 young Los Angeles amateurs, formed as a result of the incident. It operated a two kilowatt spark transmitter using the callsign ALA.

By 1915, amateur radio continued to call out to the young and technically adept. In 1915 Charles V. Litton, then 11 years old and the later founder of Litton Industries, operated his own amateur radio station in Redwood City. The official callbook of 1913 listed just over 300 amateur operators in the Sixth District (California, Nevada, Utah, Arizona and Hawaii) perhaps 10% fewer than the Second District (southern and central New York and northern New Jersey); Seattle's Seventh District had about 75 licensees for Washington, Oregon, Alaska, Idaho, Montana and Wyoming. In 1914 an amateur radio station at the University of California at Berkeley began to operate, with Haraden Pratt as the principal.

Three of the Bay Area "hams" who became nationally known in electronics. Above, Frederick E. Terman in 1917 with spark gap transmitter, crystal detector, one-tube amplifier. He listened to voice from Herrold's San Jose station and to code from others as far away as Fred Roebuck in Phoenix, Arizona, before Fred moved to California.

Source: Jane Morgan, Wireless in the West (1967).

Somewhat later, in 1917 Frederick E. Terman, later the Vice President of Stanford University and the father of electronics development in what became Silicon Valley, as a teenager operated an amateur radio station callsign 6AE in Palo Alto. Hewlett-Packard in the 1930s would not have flourished without his support, and intervention, in their favor, in a patent dispute. Dave Packard's callsign was 9DRV (Colorado).

Amateurs quickly heard the virtues of Lee de Forest's audions. He wrote: "By 1915, the cult of radio "hams" was growing rapidly…" making demands on de Forest's first manufacturer, McCandless. Westinghouse put McCandless out of the vacuum tube business. As a result, wrote de Forest: "several bootleggers sprang up over the country, chief and most mischievous of whom was Moorehead of San Francisco." He referred to O.B. (Otis) Moorehead, manufacturer of the "audiotron" triode.

In October 1916, *Electrical Experimenter* magazine featured a young woman wireless operator on its cover in full color. The magazine declared Miss Kathleen Parkin of San Rafael, California to be an "Expert Radio Operator at Fifteen Years of Age." She held the amateur callsign 6SO and a First Grade Commercial license. She made all of her own instruments including her 250 watt spark transmitter. She and her brother formed Parkin Manufacturing in San Rafael and made radios and parts for many years.

Ms. Kathleen Parker, San Rafael.
From: Electrical Experimenter, Oct. 1916.

In late 1916 Henry Dickow founded the magazine *Pacific Radio News* in San Francisco, the first issue of which was published in January 1917. He started as an amateur in 1907 and initiated the San Francisco Radio Club in 1909. Dickow went to sea as a newly licensed teenager in 1914, after Larry Malarin (the famous "LM") of United Wireless then Marconi, told him to wear long pants. Dickow, after helping in 1909 to found the San Francisco Radio Club, also served as an officer in 1921.[3] *Pacific Radio News* evolved into the monthly *Radio.* The ARRL's *QST* magazine from 1915, Gernsback's publications, and Dickow's publications, and many others, all popularized radio developments and enthused thousands of young men (and a few women) about the new art both before and after World War One.

Organized amateur radio set itself the task of relaying messages ("traffic"). By 1916, ARRL members set out to get messages across the country and back. In those days, mail was slow, telegraph expensive and telephones rare. In Los Angeles, the Seefred brothers (Howard and Lyndon) operated station 6EA. This station received the first transcontinental message on February 5, 1917.[4] The Seefred brothers started out in Fremont in the Bay Area.

World War One Silences Amateur Radio, But it Comes Back even Stronger

America's entry into the Great War shut down all radio stations after April 1917, especially amateur stations. There was great and justified fear of German espionage and sabotage at the time. The war shut down even commercial radio in the United States. Only the armed forces or stations operated by them could take to the air. Even receivers were prohibited and antennas were search for and removed. Widespread wireless and radio experimentation stopped dead. Clarence Tuska, a founder of ARRL in 1914 as a very young man, served in the Army Air Service, and wrote:

"The amateurs have come across in the case of the Army. ... I have turned out a whole lot of operators for the Air Service and have become pretty well acquainted with the type of human it takes to make a first-class radio operator… The very first sort of student we looked for is an ex-Amateur. He seems to have had all the experience and all we have to do is acquaint him with a few special facts and he is ready for his Army job. They've surely done their bit and I am mighty proud I was one."

No. 100

THE AMERICAN RADIO RELAY LEAGUE, Inc.

STATION APPOINTMENT

This Certifies that Radio Station located at 343 South Fremont Avenue, Los Angeles, Cal. and under the control of Seefred Brothers who holds United States Radio License No. for First Amateur Grade operator, is until further notice and subject to the rules and regulations of the American Radio Relay League, hereby appointed AN OFFICIAL RELAY STATION. This appointment expires December 31, 1917, unless officially cancelled.

THE AMERICAN RADIO RELAY LEAGUE, Inc.

Secretary President

1917 Howard Seefred 6EA in Los Angeles.

Several thousand amateur radio operators served in the Army and Navy in World War One. [5]

After World War One's prohibitions, in September of 1919 amateur radio operators could once again listen and in early 1920 came back on the air. The San Francisco Radio Club was incorporated in May 1919, in anticipation of the lifting of the wartime ban. It had been active well before World War One as well but went dormant in 1917 along with all other radio amateur enterprise. The club operates today as it has continuously for over one hundred years since 1909; it remains known as the San Francisco Amateur Radio Club.

1920 Certificate of Membership. Clarence Schomaker became Treasurer in 1921-'22. Bart Lee collection.

In the twenty years after the 1899 message "Sherman in sight," wireless on the West Coast had evolved into major international communications circuits, reliable ship to shore messaging, and the beginnings of broadcasting. Almost everyone involved had enjoyed amateur radio operation as his introduction to the art. At the November 1920, Pacific Coast Radio Convention, a hundred or more men sat for a group portrait. Several clubs help up placards including: "SF Radio Club," the "Bay Counties Radio Club" and the "Polytechnic Radio Club S.F." (Dick Johnstone had attended Polytechnic High School).

Bart Molinari, 1924 Hoover Cup winner, Best Amateur Station in US — 6AWT. From K8CX gallery, Tom Roscoe.

After World War One, vacuum tubes became widely available. CW Morse code replaced spark Morse code. Publications made amateur radio a national and international hobby. Receiving circuits evolved quickly from Major Armstrong's regenerative radio of 1913. The rich could afford the new receivers and transmitters of the new manufacturers such as Hammerlund, Hallicrafters and National. (To be fair these companies tried also to produce affordable radios). "Homebrew" challenged and rewarded young men with a technical bent, but these companies created the classic ham radios of the 1930s. The bands grew to include 20 meters and then ten meters. Clubs expanded. DX ensued (long distance contacts). "Phone" (voice) rather than Morse code became a frequent ambition. VHF (five meters) for short range work came on the scene. This 21 years' long Golden Age ended in flames on December 7, 1941.

World War Two again Silences Amateur Radio, but Post War Ham radio, with War Surplus Gear, again Flourishes

Once again, amateur radio operators served in the armed forces by the thousands, as once again, all amateur operation was prohibited. But it's an ill wind that blows no one good: after the war, an avalanche of military surplus radios fell into every city in America (*e.g.*, Zack's Electronics in San Francisco). Amazing radios such as the BC-348 aircraft liaison receiver cost but a few dollars. The ARC-5 command sets (receivers and transmitters) cost even less. Many a ham lit up

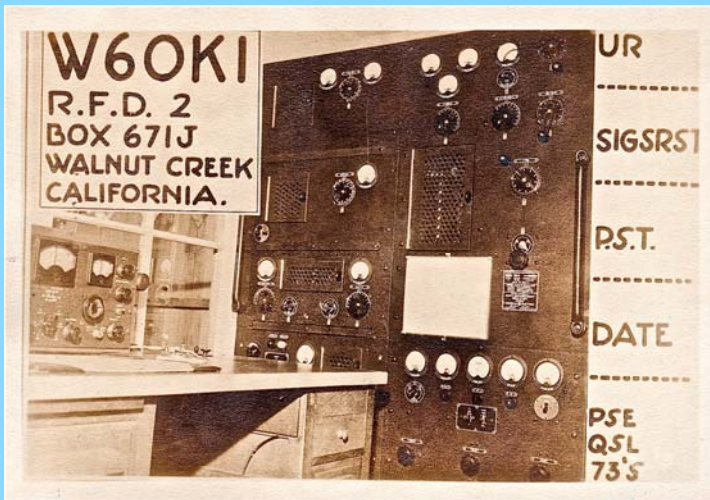
Surplus Military and Commercial Receivers

Pre-WWII 1930's Collins 10B Exciter. CHRS Collection — Bart Lee donation.

1950's BC-348 aircraft receiver. CHRS Collection.

1950's AR-5/R-27 receiver post war ham conversion. Bart Lee collection.

Vintage Bay Area "Big Iron" Stations



QST from late 1940's station with Navy transmitter of W6OKI.
From the Bart Lee collection.

QST from a 1935 Walnut Creek station of W6GHD.
From the Bart Lee Collection.

the post war ether with a converted (or original) surplus radio, well into the great sunspot cycle 19 of 1958 -- 62. To this day these radios have their devotees.

Top of the line commercial gear still attracted those who could afford it. The coming of single sideband operation demanded it. Big Iron occupied the desks and consoles of hams around the world. But then, some smaller but fully functional radios appeared such as the Drake line. Big lost favor. Less is more… And then much less in size with the coming of transistorized gear. The Japanese invaded: Trio / Kenwood, Icom, Yaesu. Everything in one small appliance.

The "top band," 160 meters, had provided the gathering places for local operation. But soon VHF at two meters replaced it with the coming of repeaters. A small "handy-talkie" (HT) five watt radio could hit a nearby repeater and talk around the county or farther. FCC licensing stopped requiring Morse Code proficiency, first for VHF, then for all operation. Old Timers looked down on the no-code appliance operators, but they didn't care: they enjoyed their hobby just as much.

Amateur radio in California, and everywhere, turned hobby fun into emergency preparedness. From its earliest days, ham radio served its communities in disasters and emergencies. Sometimes no other communication could be had for days or longer. The work of W6AM, Don Wallace, in the 1933 Long Beach, California earthquake and recovery became a national model for such responses. Even though his house was destroyed in by the earthquake, he set up a field station and was able to to provide a critical communications link while his family set up a camp with a tent.


This Certifies that____________________

is a member of the

AMERICAN RADIO RELAY LEAGUE
EMERGENCY CORPS
FOR PUBLIC SERVICE

QRR

This operator is prepared to furnish communication to his community in the event of failure of regular communication facilities due to storms, floods and similar disasters.

____________________Comms. Mgr. A.R.R.L.

1930's ARRL Emergency Corps.
From Gil McElroy, VE3PKD "QRR: The Beginnings of Amateur Radio Emergency Communications," QST, Sep. 2007, P. 48

Don's portable transmitter set up in the field after the 1933 earthquake. Don's family stayed in the tent in the background.

Don Wallace W6AM provides a main link in the 1933 Long Beach earthquake.
From Jan David Perkins, Don Wallace, W6AM, Amateur Radio's Pioneer, Vestal, 1991.

1989 Loma Prieta earthquake — David Otey, WB6NER, at a Kaiser Facility.

1940 Field Day — San Francisco.

In 1933 the ARRL sponsored the first "Field Day" emergency exercises and soon put together the Amateur radio Emergency Corps, now ARES (and RACES). The privilege of a federal radio license always came with responsibilities. Hams served in the 1989 Loma Prieta earthquake, the 1992 Oakland Fire, and nationally in New York on 9/11 and during Hurricane Katrina and its flooding. David Otey pioneered the Use of Amateur Radio in Aid of Disaster Recovery for Hospitals and Public and Private Institutions, now part of FCC Regulations, in the spirit of "QRR." As the ARRL says: When All Else Fails. And of course there is always time for DX'ing, contesting, and enjoyable contacts between disasters.

73 de Bart Lee, K6VK © 2015.

2013 QSL GW9T Wales UK, K6VK. For a contact made during contesting.

Notes:

1. This note's information about early California amateur radio comes from Lee, Wireless comes of Age on the West Coast (AWA review, available on the CHRS website).
2. Donna Halper, "Irving Vermilya—America's #1 Amateur" at www.bostonradio.org/ essays/vermilya.html.
3. *Radio and Television News* in the 1950s ran a series honoring early wireless operators such as Dickow.
4. Willis P. Corwin (9 ABD), "This Trans-Continental Relay a Record Breaker" Wireless Age, June 1917, at p. 670.
5. See Lee, Clarence D, Tuska, (AWA review, available on the CHRS website.

About the Author

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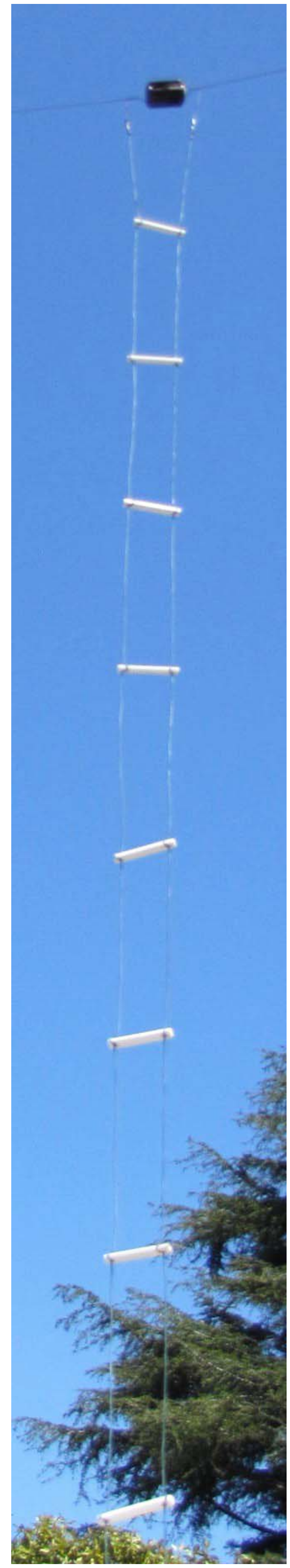
Open-Wire Feedlines and Their Tuners

By John Staples, W6BM



Most ham radio operators feed their antennas with coaxial cable, but unless a balun is installed at the antenna feedpoint or ferrite beads are strung along the coax, RF current may travel back down the outer conductor of the coax back to the transmitter. This can result in RF in the shack or strange radiation patterns. One alternative is to use an open-wire balanced feedline to the mid-point of a dipole antenna. A balanced feedline will not radiate, good RF grounding of the transmitter is not required, and feedline losses will be reduced.

A half-wave dipole exhibits an impedance at the feed point somewhere around 40-80 ohms, with an additional reactive component, either capacitive or inductance, depending on the transmitting frequency. When a standing-wave-ratio (SWR) bridge indicates an SWR greater than one, some power is reflected from the antenna back to the transmitter. Older tube-type transmitters can cope with a fairly large SWR, but the modern solid-state rigs (and a few special tube rigs such as the Central Electronics 200V and 600L) require an SWR of less than 2:1. Antenna tuners allow the SWR seen by the transmitter to be reduced to 1:1, with the high SWR region remaining in the transmission line between the tuner and the antenna.

A high SWR in itself doesn't necessarily increase transmission line loss, but it results in high voltage regions along the line which can lead to dielectric breakdown. The power radiated from the antenna may be reduced, however, due to the return power absorbed in the transmitter itself, or the transmitter folding back its output power to protect its output circuitry.

Open-wire transmission lines from a balanced-output tuner to the center of the dipole antenna offer a way to avoid radiation from the transmission line, RF in the shack and power loss in the transmission line. We have a selection of antenna tuners and tuner components in our collection at the W6CF shack at CHRS Radio Central in Alameda that will drive open-wire transmission lines. I will analyze some of the tuners we have or that we can construct.

The **Johnson Viking Kilowatt Matchbox** is the king of tuners: produced for the Johnson kilowatt AM transmitters, it uses edge-wound coils and large-spaced capacitors. Some versions include an SWR bridge (ours does not). The input is link-coupled to the secondary, which includes a ganged variable capacitor to tune the reactive part of the load, and a ganged differential capacitor to match the resistive part of the load. The secondary coil has taps to select the operating band. This tuner has good harmonic suppression. One deficiency is that there is no DC path to ground from the output terminals that bleeds to ground static voltage that may build up on the antenna.

The **MFJ-986** tuner is quite a different beast. It includes a roller coil and a differential capacitor, along with an SWR bridge. There is no bandswitch, as all bands are covered by the large inductance range of the roller coil. This tuner has no harmonic rejection, as it is a high-pass filter. The ability to drive an open-wire feedline looks like an afterthought: a toroid transformer provides an out-of-phase drive for a balanced wire line. One side of the line has a DC path to ground, the other does not. This type of circuit can tune over a wide range of antenna impedance and operating frequencies, which is probably the reason that MFG selected this particular circuit.

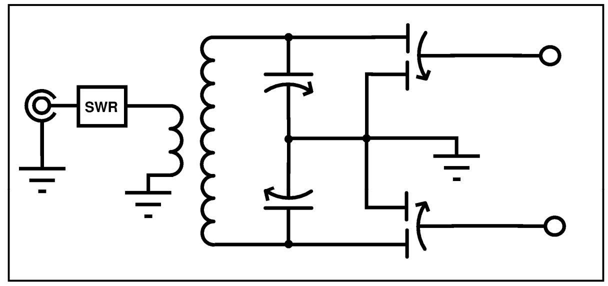
The **Ten-Tec 4229** tuner uses an L-network, which is configurable to either a forward or a backwards arrangement (lo-Z or hi-Z) of the series roller coil and a wide-spaced capacitor to ground. An SWR bridge is included, and no bandswitch is required. The L-network works over a somewhat limited range of SWR, and the forward or reverse sequence of the roller coil and variable capacitor is reversable to drive load of lower or higher than 50 ohms. This circuit has good harmonic rejection. As with the MFJ tuner, a wide-band toroid transformer is included to provide a balanced output for open-wire lines. In this case, both sides of the open wire are have a DC ground return.

The **Drake MN2700** includes an SWR meter, and an optional (and expensive if purchased separately) toroid transformer to drive an open-wire line. The capacitors and inductor taps are selected by a bandswitch, which limits the range of SWR that can be accommodated over the wide-band tuners that use roller inductors and variable vacuum capacitors.

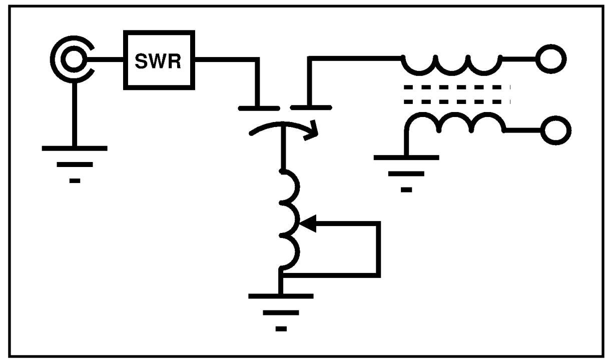
At W6BM, separate open-wire antennas and tuners are used for 160 and 75 meter AM phone. The tuners are models of simplicity, compromising a center-tapped roller coil and a variable vacuum capacitor. In the 75 meter unit, the antenna is placed directly across the ends of the coil, and in the 160 meter unit, the antenna is tapped a few turns in from the ends of the coil.

The two tuning controls of the W6BM tuners are orthogonal: the resistive and reactive compensation of the antenna impedance do not interact with each other, allowing fast tuning for contest operation, for example.

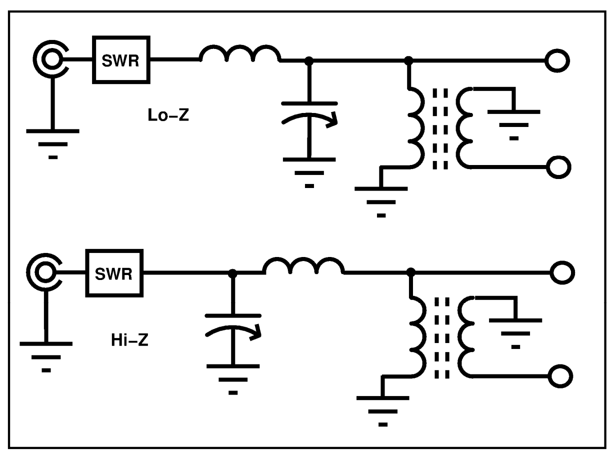
An important design aspect is the unloaded and loaded "Q" of the tuner. The tuner contains a resonant circuit. A high unloaded "Q" keeps the losses in the tuner low, so the quality of the components and the wiring between them should have a low resistance. The unloaded "Q" of a tuner with quality components can easily be above 100. But when the antenna and transmitter are connected to the tuner, the circulating currents and peak voltage in the components of the tuner, as well as the bandwidth, are proportional to the loaded "Q" of the circuit, which will generally be much lower than the unloaded "Q" of the tuner itself. When the reactive impedance of the tuner components are similar to the resistance of the antenna connected to it, the loaded "Q" will be around unity. Loaded "Qs" that are below 2-



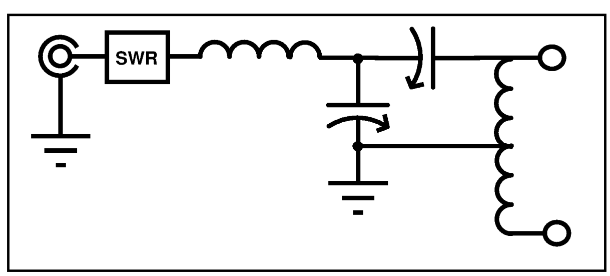
Johnson KW Matchbox diagram.



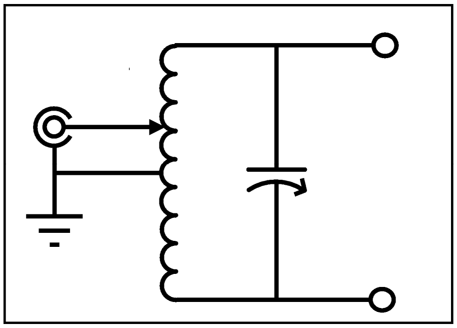
MFJ-986 diagram.



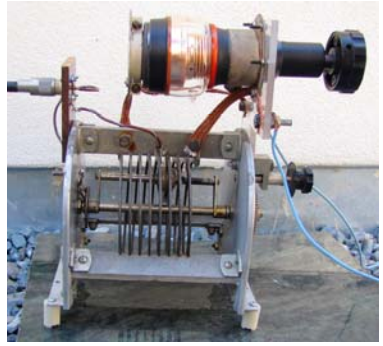
Ten-tec 4229 Lo-Z and Hi-Z diagrams.



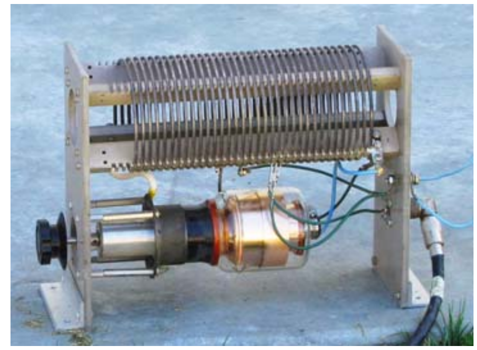
Drake MN2700 diagram.



W6BM 75 meter antenna tuner schematic.



W6BM 75 meter antenna tuner.



W6BM 160 meter antenna tuner.

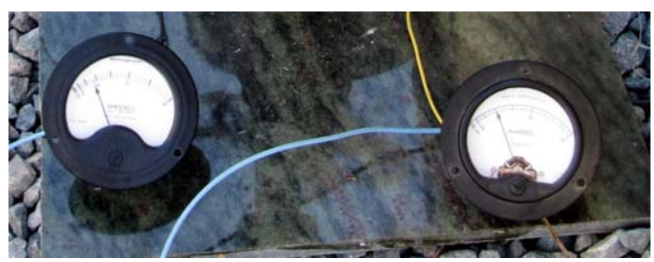
3 insure that the voltage across the capacitor will not be significantly higher than the voltage on the coaxial line feeding the tuner and the tuner will have a reasonably wide bandwidth for small changes in transmitter frequency.

The open-wire feed has a fairly high characteristic impedance. At W6BM, the wire spacing is 3.6 inches, and the diameter of each wire is 0.064 inch (#14 copper wire), for a feedline impedance of 567 ohms. The wires are held apart by ceramic spacers every 18 inches.

But 567 ohms is very large compared to the antenna driving impedance. Wouldn't this result in a large SWR as the open -wire line impedance is very large compared to the antenna impedance? Yes, but it does not matter. The open-wire feed itself can handle very large power, as the wide spacing can handle high peak voltage, and the open construction cools well. The loss in the open-wire line is small, so almost all power coming from the tuner is delivered to the antenna.

The impedance transformation along a transmission line depends on how long the transmission line is compared to the wavelength of the transmitted signal. At the low bands (160 and 75 meters) the feedline at W6BM is less than one-tenth of a wavelength long, so the impedance looking into the feedline at the tuner end is similar to the impedance of the antenna itself. If the feedline is a multiple of a half-wave the impedance at the tuner equals the impedance at the antenna. If the feedline is an odd multiple of a quarter-wavelength, the impedance at the tuner may be very high and difficult to tune with any tuner. So some thought must be paid to the actual feedline length.

So, how well does it work? At W6BM, RF ammeters were place in each leg and showed a very good balance, 4 amps in each leg. (During development, one leg showed zero current, which was traced to a bad connection right at the antenna center insulator of one of the legs, a good diagnostic.) Tuning for 1:1 SWR is straightforward.



Meters show the that each leg in in balance.

How good was each antenna for receiving on other bands? Due to the low-Q circuit of the tuner, the antennas worked well for receiving on all the HF bands. This was a bit of a surprise, so other receiving antennas were not needed just to listen to the other bands.

John Staples, W6BM, has a Ph.D. in nuclear physics and has been building particle accelerators for almost 50 years, most of them at the Lawrence Berkeley Lab. He was first licensed in 1956. ◊

Vintage TV Demo

Photos by Richard Watts

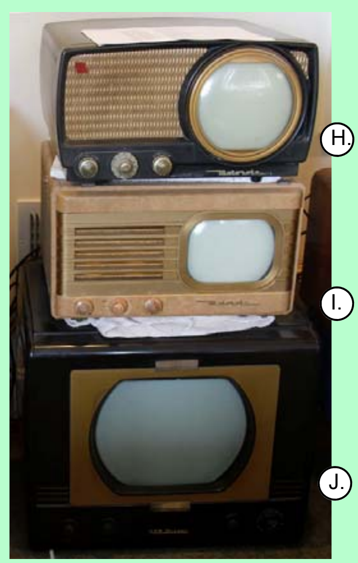
John Staples hosted this year's vintage TV demo at his home. It was well attended by dedicated TV collectors and experimenters. John organized a most informative and engaging day of presentations and demonstrations. Topics included:

- Compare Early RCA TV Circuits – John Staples
- Ceramic Capacitors in HV Circuits – Tom Albrecht
- High Quality NTSC Modulator – Gilles Vrignaud
- B&K Flying Spot Scanners – John Staples
- 2003 ETF Video of RCA RR-359 – Nat Pendleton
- Dumont Royal Sovereign Restoration – John Staples
- Sutro Tower and KRON Facility – John Staples
- Triniscope and Mechanical Color – Richard Diehl

There were many interesting and impressive vintage TVs on display including those in John's collection plus others brought by attendees, most in working order. Richard Diehl demonstrated two experimental televisions that he constructed, a Triniscope and a Sequential Field device.

Gilles Vrignaud discusses NTSC Modulators.

Tom Albrecht discusses HV ceramic capacitor behavior.



A. GE 800 B/W 10"
B. Raytheon 7DX22-P B/W 7"
C. Teletone TV-220 B/W 7"
D. Pilot TV-37 B/W 3"
E. Motorola 9VT1A BW 8"
F. Crosley Portavision 9-425 B/W 7"
G. Hallicrafters TV-54 B/W 7"
H. Motorola VT-2 B/W 7"
I. Motorola VT-73 B/W 7"
J. RCA Victor T-120 B/W 12"

John Staples discusses flying spot scanner.

RCA CT-100, an early color TV.

RCA 9PC41 projection TV.

John Staples discussing early RCA TV circuits.

2.

3.

4.

5.

1.

1. Major B/W ~9”
2. RCA 621TS B/W 7”
3. 1938 (pre-WWII) RCA TT-5 & radio for audio.
4. RCA 630TS B/W 7”
5. Automatic TV707 B/W 7”
6. Andrea B/W 10”

6.

◊

Making a Heathkit Mohawk RX-1 Useable

By Thomas Bonomo, K6AD

The first ham radio station I saw as a kid was the Heathkit Mohawk RX-1 receiver with the matching Apache transmitter. Those big green high-tech boxes sure made an impression! So, when I spotted a good cosmetic-condition Mohawk to complement my Marauder transmitter, I jumped at the opportunity.

The Mohawk, which was introduced as a kit in 1958, was Heath's first ham band-only receiver, and was the first Heathkit to sport the now-famous "Heathkit green" colors. This receiver offers a number of interesting features. Heath separated the usual single knob RF gain control found on most receivers into two controls, an RF Gain and an IF Gain control. The ability to control the gain of the front-end stage separately makes it possible to reduce cross modulation from extremely strong signals, while maintaining good receiver sensitivity. The Mohawk also had a selectivity switch control allowing bandwidths of 5, 3, 2, 1 and .5 KHz.

I devoted many days to the restoration of my Mohawk. The results, however, disappointed me, so I took to the forums. The views of other owners ran along these lines: "What a junky receiver . . . .." "Terrible AGC . . ." "Worst audio of any receiver I own." "Product detector really distorts." "Drifts too much to keep up with."

The crummy performance of this receiver is probably the reason so few of these receivers have survived despite the great number sold. But with a few "reversible" modifications, it has the potential to be a wonderful receiver. The purpose of this article is to outline those modifications necessary to correct the most glaring deficiencies.

Even if you don't own a Mohawk, the theory presented in this article can be applied to other vintage receivers. The modifications are compartmentalized, so you can evaluate the results as you proceed. Threshold Automatic Volume Control (AVC) is addressed at the end of this article (rather than being grouped with the other AVC modifications), simply due to the larger nature of the topic. Just a note regarding the terms Automatic Gain Control (AGC) and Automatic Volume Control (AVC). The AVC circuitry in the Mohawk is intended to operate as AGC typically does. Since the Heathkit literature uses the term AVC, AVC will be used in this article in lieu of AGC.

Modifications philosophy

Everyone has their own philosophy when it comes to vintage radio modifications. With classic gear, I prefer to keep the original design as intact as possible by implementing only easily reversible "no holes" modifications. This means restricting mods to engineering "refinements" rather than wholesale change: no tube lineup changes, no additional tubes requiring chassis punching, no IF strip chips from National Semiconductor, no mechanical filters from Collins, etc.

I do, however, believe in using a handful of solid state components, when necessary, on the bottom side of the chassis, where they can be hidden from view. Adding some solid state circuitry was unavoidable to achieve the "high priority" performance and usability enhancements I desired, but my goal was to end up with an improved Mohawk, not a Collins 75A-4 inside a Heathkit case.

Design problems

These were the performance issues that annoyed me the most about the Mohawk:

* *Lousy AGC system*. It was too easy to get blasted listening to this receiver.
* *IF GAIN control lacks the benefits of a threshold-type system*. The IF GAIN control cannot be used to effectively reduce background noise and static crashes without also reducing the audio level of desired signals.
* *Severe SSB distortion*. SSB signals were almost always severely distorted unless the IF and RF gain controls were turned way down. Even then, intermodulation distortion was irritating.
* *Severe AM distortion*. Strong AM signals were distorted, which became worse when the ANL was turned on.
* *Useless ANL*. Excessive audio distortion rendered the ANL unusable.
* *Inaccurate S meter*. SSB signal readings were totally inaccurate when compared to a calibrated CW signal.
* *Poor audio fidelity*. The audio had too much bass and sounded muffled. Summertime static crashes on 75 meters sounded more like a train rumbling through my shack than atmospheric noise.
* *Horrendous VFO drift*. On 75 m this radio would drift nearly 3.5 KHz in the first hour in the cabinet (2 KHz when open on the bench)! The drift was much worse on the higher bands.

AVC system problems

The Mohawk's AVC and audio distortion problems are interrelated, and both stem from the fact that the receiver's high gain is not properly controlled by the AVC system. The distortion forces you to turn down the front panel's IF and RF gain controls to clean up the audio. While this helps, it renders an already weak AVC system useless. As you tune across the band or listen to nets you'll frequently get blasted by strong signals. So the Mohawk, as designed, offers you clean audio with no AVC, or lots of distortion with very weak AVC. Turning the AVC switch on and off demonstrates how weak the AVC system is — only very strong signals show any AVC reduction.

If you examine the Mohawk's AVC circuit in Figure 1, you'll notice a number of design problems:

1. Heath used "delayed" AVC, wherein the incoming signal must reach a predetermined level before the AVC detector tube produces AVC output. The purpose of delayed AVC is to allow for a better signal to noise ratio by permitting maximum gain on weak signals. Heathkit set the AVC signal threshold very high (look at the +10 V bias on the cathode), so only very strong signals generate AVC control voltage.
2. Heath only applies AVC to the front-end RF section and the first IF amplifier. There is no AVC applied to either of the second conversion stages (50 KHz IF amplifiers).
3. The Mohawk's AVC time constant is very fast — 10 ms — with no difference between rise and fall times (i.e. no fast attack, slow decay characteristic). The short time constant allows background noise crashes to pop up in between words and syllables.

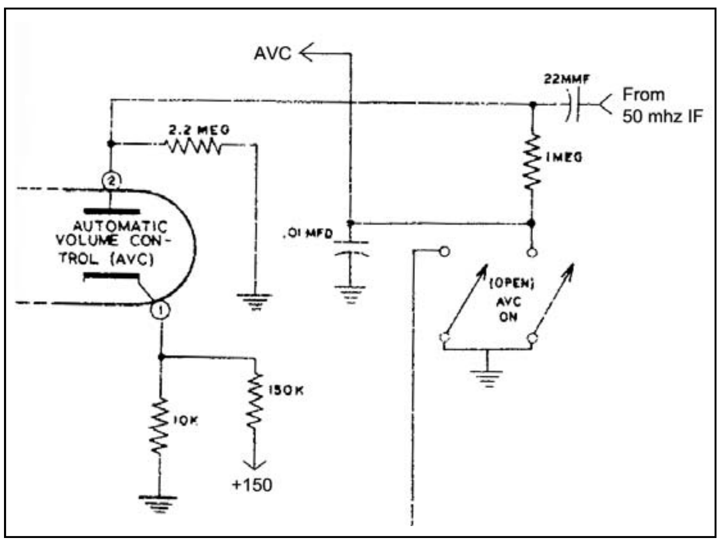


Fig.1. Mohawk AVC detector.

One wonders why Heath designed the AVC system this way. I could find no good receiver of similar vintage in which the AVC system was designed in this manner. What *were* they thinking? However you look at it, the Mohawk's AVC system is just a bizarre piece of engineering.

Fast attack, slow decay circuit modification

The modifications shown in Figure 2 provide a fast attack, slow decay AVC characteristic and increase the time constant from 10 ms to about 3 seconds. D1 rapidly charges C2 to produce a fast attack, while the decay time is controlled by the time constant produced by C2 and R1+R2+R3. The time constant resistors serve double duty as a voltage divider for the S meter amp (discussed later in this article). Changing the value of the charging capacitor C1 from 22pf to 100pf reduces its reactive impedance from 140K ohms down to about 32K ohms (using the formula for capacitive reactance: $X_C=1/2\pi fC$ @ f=50KHz), thereby reducing the time necessary to charge C2.

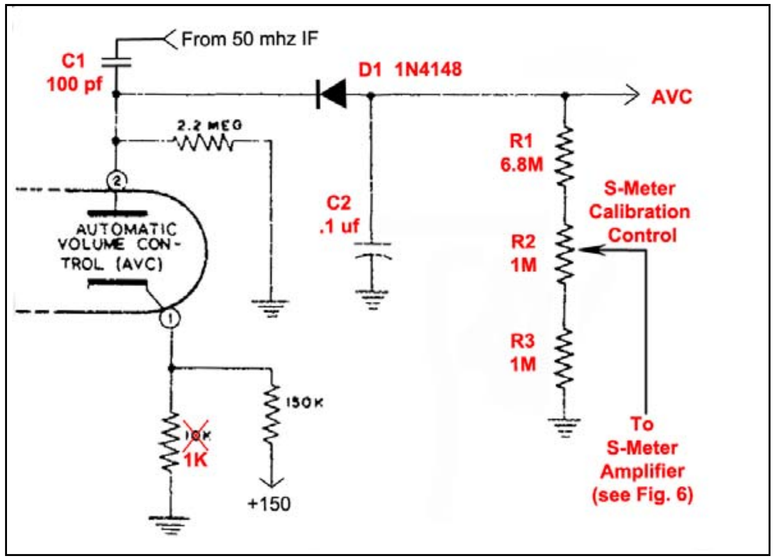


Fig. 2. Simple fast attack AVC circuit. Note added or changed components are labeled in red.

To produce a 3 second AVC decay, I chose R1 = 6.8M, R3 = 1M, and R2 = 1M (R2 is the S-meter sensitivity pot discussed later in this article). If you desire a different response time, change the value of R1 and R3 rather than changing C2 (higher values of C2 increase the width of AVC delay spikes by increasing the time needed to charge C2; lower values lead to AVC overshoot problems, caused when the spikes themselves overcharge C2).

Other AVC rise time improvements

If you test different values of capacitance for C2, it will became clear that AVC voltage rise time is critical. Slow rise times will increase the audible "pop" heard on the leading edge of a strong signal, which is particularly irritating on SSB. To digress for a moment, the effect is similar to transient intermodulation distortion created in an audio amplifier which uses large amounts of negative feedback. As a signal passes through the amplifier, the internal stages of the amplifier operate at full gain until the signal reaches the output where it can then be fed back to reduce the input signal. Until the feedback takes effect, internal stages can reach saturation. When the feedback finally takes effect, the output is reduced. The short interval where no feedback is present produces output "spikes" (which is one reason why audiophiles don't like solid state amplifiers which use lots of negative feedback). The time needed for a signal to reach a specified output level is known as the amplifier's "slew rate" and is usually measured in micro seconds. Low slew rates produce wider output spikes when lots of negative feedback is used.

AVC circuits exhibit a similar effect because receiver stages operate at full gain until the AVC voltage (negative feedback) cuts back the gain. The effect of AVC "kick-in delay" is audible pops heard on SSB signals. The longer the duration of AVC kick-in delay, the worse the pop. At the extreme, the pop becomes a "thump" lasting a verbal syllable or more in duration.

To break down the problem even further, there are two components which contribute to the delay in generating AVC control voltage. The first component is the time delay from the input of the receiver to the AVC pickoff point. The second is the AVC rise time component: how fast the AVC circuit can generate AVC control voltage from the time it first appears at the pickoff point. Ideally, we'd like a receiver with both a minimum delay and an AVC circuit with a very fast rise time. In a good SSB receiver, spikes caused by delayed AVC action are short enough in duration that they are not noticeable (ideally less than 0.2 ms).

The first component of AVC delay in the Mohawk — from the antenna input to the AVC pickoff point at the output of the 50KHz IF transformer — was measured at 0.7 ms. This is more than most receivers, probably because Heath used LC circuits rather than crystal or mechanical filters for bandpass selectivity. There is nothing that can reasonably be done about this component of the AVC delay.

The second component of the problem in the Mohawk — AVC rise time delay — was greatly aggravated when Heath designed the AVC circuit with a super slow rise time (1M X .01µf = 10 ms) and by RC decoupling the AVC voltage to the grids of the RF amp and first IF amp with time constants that are way too large (100K X .01µf = 1 ms). The fast attack circuit configuration addresses most of this problem, but additional improvement can be realized by reducing the decoupling time constant on the grid of the first IF amp, C3, from .01 to .001, and on the RF amp by removing C4 (see Figure 3). C4 is located inside the front-end section on the top side of the chassis. It isn't easy to get to, but the easiest way is to remove the small side panel and clip the lead of C4 which goes to ground on the RF amp (the other end of C4 is very hard to get to without tearing everything apart). If you feel ambitious, remove the RF front-end section from the chassis and replace C4 with a .001 instead of just removing it. I decided it wasn't worth the extra work and instead found an easily accessible place to add C5 inside the RF front-end section. C5 ensures that any RF noise picked up by the long AVC line is not coupled into the RF amplifier. Measurements and listening tests confirmed no difference with C4 removed, but adding C5 is cheap insurance.

As with most AVC systems that utilize high impedances, you'll want to make sure the RF amp and IF tubes don't have any grid emission (easily checked on most good tube testers), because this will shift the AVC line positive and ruin an otherwise good AVC response.

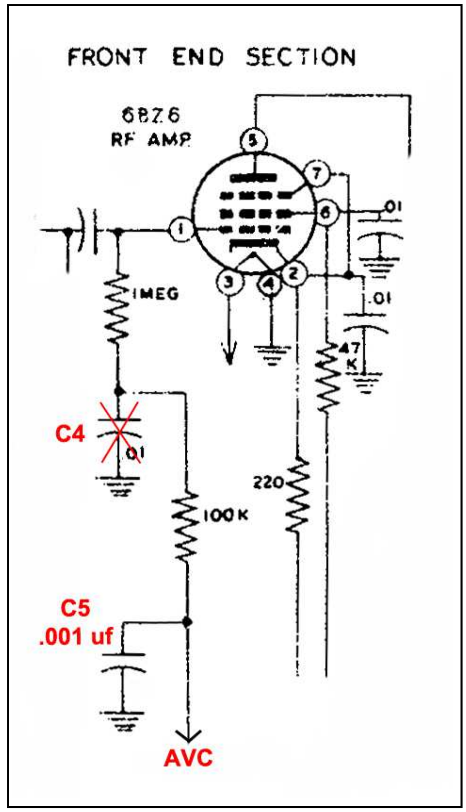


Fig. 3. RF front end

Adding AVC to both 50KHz IF amps

Heath omitted adding AVC control to both of the 50KHz IF amplifiers.
Extending the AVC line to the 50 KHz IF amplifier grids dramatically improves AVC action. A small terminal strip can be added near each IF tube using the screw which mounts the IF tube socket to the chassis. On each IF amp, remove the 1M grid resistor from ground and connect it to the AVC line.

The addition of AVC control voltage to all IF amplifiers in the Mohawk appears to be in conformance with accepted design practice at the time. It is hard to understand why Heath omitted AVC from these stages. Certainly the number of additional parts required is minimal, and the improvement in performance is dramatic. Maybe they never listened to many *real* SSB signals on this receiver when it was designed back in 1958.

Adding an AVC clipper and amplifier

There is a tradeoff between obtaining minimum AVC delay (which minimizes the audio spikes caused by delayed AVC action) and clean, undistorted audio. The problem is that you want to use a high value of C1 in order to charge C2 rapidly and therefore minimize width of the audio spikes, but higher values of C2 load the IF transformer while the AVC diode is conducting, which adds distortion that is particularly noticeable on AM. The suggested value of 100pf represents a compromise that produces AVC delay-induced audio spike widths of about 3 ms with reasonable audio. 51pf produces spikes widths of about 5 ms with better audio, while 270pf produces spike widths of 2ms but the audio is much more distorted (especially noticeable on AM). Fortunately, there is a solution to this dilemma.

Adding an AVC amp between the last IF transformer and the AVC circuit will reward you with minimum achievable AVC delay-induced audio spikes and excellent audio. The problem is that the output impedance of the IF transformer is not sufficiently low to drive the AVC circuit, which by its nature needs a low impedance to charge C2 quickly. The amplifier isolates the last IF transformer so that it is not loaded down by the AVC detector while it is charging C2. You could do the same thing using a tube, but it is much easier to implement a reversible mod using an FET, where it can be easily hidden underneath the chassis.

An alternative approach, would be to buffer the output of the AVC diode with a source follower to charge C2. However, the Mohawk lacks a negative supply and rectifying the filament voltage, even with a doubler, does not supply enough

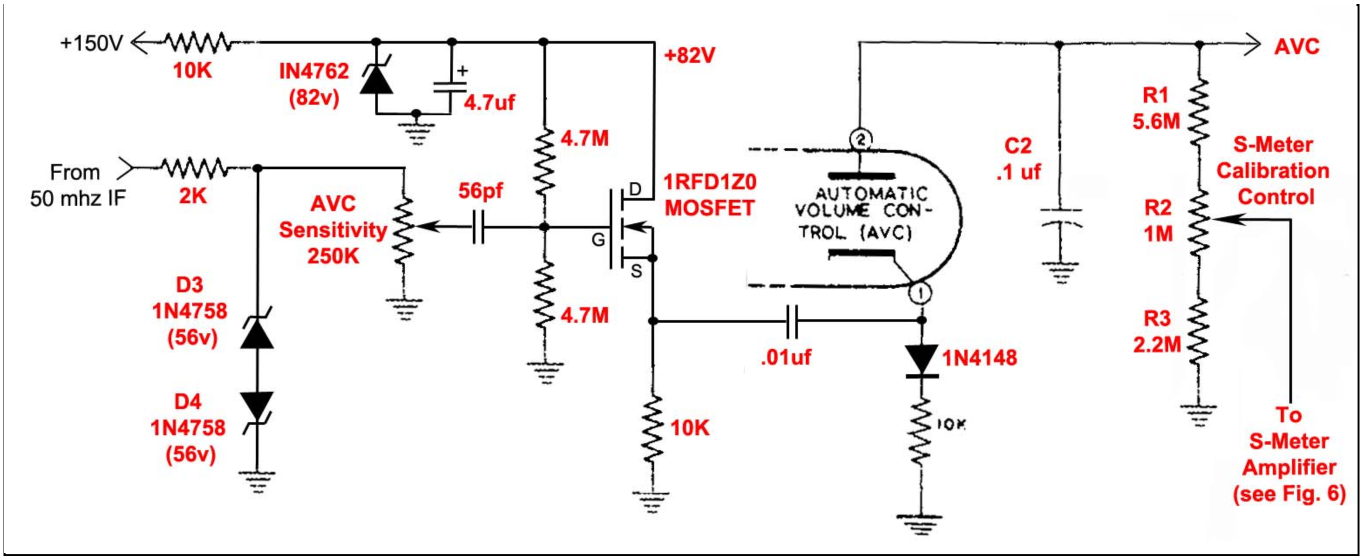


Fig. 4. Fast attack AVC circuit with limiter and amplifier.

voltage to do the job since strong signals generate an AVC voltage of over -28 volts. With circuit drops and headroom, you'd need at least a -35 VDC supply.

Figure 4 shows the new AVC amplifier. It is designed as a common drain, source follower and has a very high input impedance and a low output impedance — perfect for driving the AVC diode. This circuit configuration is largely independent of device parameters so you can use nearly any N channel JFET or any N-channel MOSFET (depletion or enhancement mode) that you have on hand, provided it has a minimum breakdown voltage (BV_{DSS}) of at least 100V. I used an International Rectifier IRFD1Z0 N-channel MOSFET simply because it was the only one I had on hand that met the required breakdown voltage requirement.

D3 and D4 limit the large AVC voltage spikes (which can exceed ± 150 volts!) at the input to the FET amplifier to ± 56 volts, preventing its destruction. The placement of the limiting diodes also limit the spike voltages seen by the AM and product detectors, further reducing AVC-induced audio pops by nearly 60%. As before, if you want to change the AVC time constant, change R1 and R3 rather than C2.

The AVC Sensitivity potentiometer should be adjusted so that strong signals do not reach the limiting point created by D3 and D4. This can be done by listening to a very strong signal (+40 db/S9) on 75 meters (with the IF and RF gain controls fully on) and adjusting the sensitivity just to the point that no audio distortion is apparent. Better yet, if you have the test equipment, inject a very strong signal at the antenna (-27 dBm) and look at the output of the 50KHz IF amplifier transformer. The limiting action at ± 56 volts is easy to see with an oscilloscope. My Mohawk produced an AVC voltage of -26 volts at this calibration point. When you are operating, you will need to back off the RF gain control to avoid distortion for signals stronger than the calibration point you choose. By calibrating the AVC system in this manner, AVC spikes will also be limited to the amplitude of the calibrating signal.

We've attacked the AVC-induced audio spike problem on two fronts: we've made the widths as narrow as possible, and we've limited their amplitude. With the MOSFET amplifier in place, the spikes caused by AVC delay are reduced to about 1 ms duration without any loading of the IF transformer, so the audio will be much improved. This isn't too bad considering that receiver delay alone contributes 0.7 ms of the spike width. Some pops are audible on strong VOX signals, but the overall improvement of the Mohawk's AVC system is dramatic.

S-meter improvements

If you calibrate the S-meter to a CW or AM signal, the readings on SSB will be quite stingy. The problem is that the S-meter is configured to measure the output of the diode detector, and the meter movement is not able to keep up with the momentum of the SSB voice peaks. Since the modified Mohawk (with an AVC amp) already has everything needed to meter AVC voltage directly, you avoid the need to build a peak-hold amp. Instead of feeding the S-meter amp with the output of the diode detector, it is fed from the voltage divider formed by the time constant resistors used in the AVC circuit in Figure 2 or 4. Now SSB voice peaks and a CW calibration signal give the same meter readings.

When calibrating the meter, it makes a difference which band you select for calibration, because the Mohawk has much more gain on the lower bands. I chose to calibrate mine on 20 meters, which means that the meter will be stingy on the higher bands, while the RF/IF gain controls needs to be backed off on 40, 80, and 160 meters for the same reading. Unfortunately, the meter doesn't respond as calibrated on its face, regardless of the circuit used. An S unit on this meter is roughly 4 dB, and depends on signal strength, front panel settings and the band selected. Because the meter is "backward" reading (off=full scale) I failed to come up with a *simple* way to make it more logarithmic. Using S7 (-79 dBm at the antenna input) as the calibration point on 20 meters produced the most satisfactory result on my unit. But give signal reports with a grain of salt.

Product detector improvement

Heathkit's product detector was another poor piece of work — equally useful as a distortion generator as much as a product detector. Distortion was improved by changes to the AVC system, but it was still unacceptably high. With an antenna input signal of -65dbm and the IF and RF gain controls fully on, the output of the product detector was clearly being driven into non-linearity as can be seen in the oscilloscope waveforms in Figure 5. The input signal to the product detector can be reduced by changing the grid resistor on pin 7 of the 6CS6 product detector from 470K to 22K (see Figure 6). Just this one simple change resulted in much cleaner SSB audio, but to my ears it still had high amounts of intermodulation distortion.

Heath tried to do everything in one tube which acts as both BFO oscillator and product detector. There are two problems with this design, both contributing to lousy audio. First, oscillator "pulling" in the tube results in very distorted low frequencies, giving it a rough sound. If you examine the output of the product detector on an oscilloscope, you will see that as the audio goes down in frequency, it changes from a sine wave to a series of spikes. The oscillator is literally trying to "sync up" to the frequency of the incoming IF signal, which begins to distort the waveform at about 600Hz. Second, the BFO waveform at the output of the product detector was a sawtooth rather than a sine wave, which resulted in tons of intermodulation distortion. This gets on your nerves quickly —it sounds like a bad speaker or something resonating and buzzing in the audio.

After much experimentation, I can say I'm not a fan of self-excited product detectors that operate at low IF frequencies like the Mohawk's 50KHz second IF. The best the existing design could deliver was a triangular waveform, which was an improvement over the sawtooth wave, but it still led to the generation of distortion products, so I redesigned the thing.

The new product detector and BFO are shown in Figure 7, which still uses the stock 6CS6. The addition of a MOSFET corrects both problems with Heath's design by separating the BFO and product detector functions. In addition to

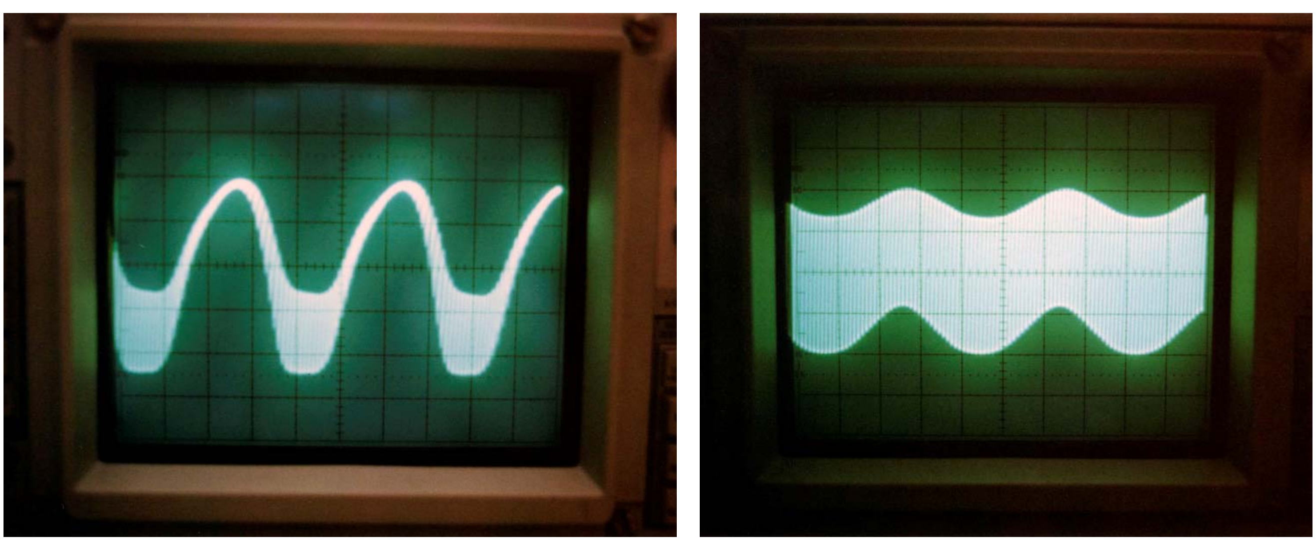


Fig. 5. Product detector output. Reduced input greatly improves linearity. Left trace shows non-linear output; right trace shows improved linearity.

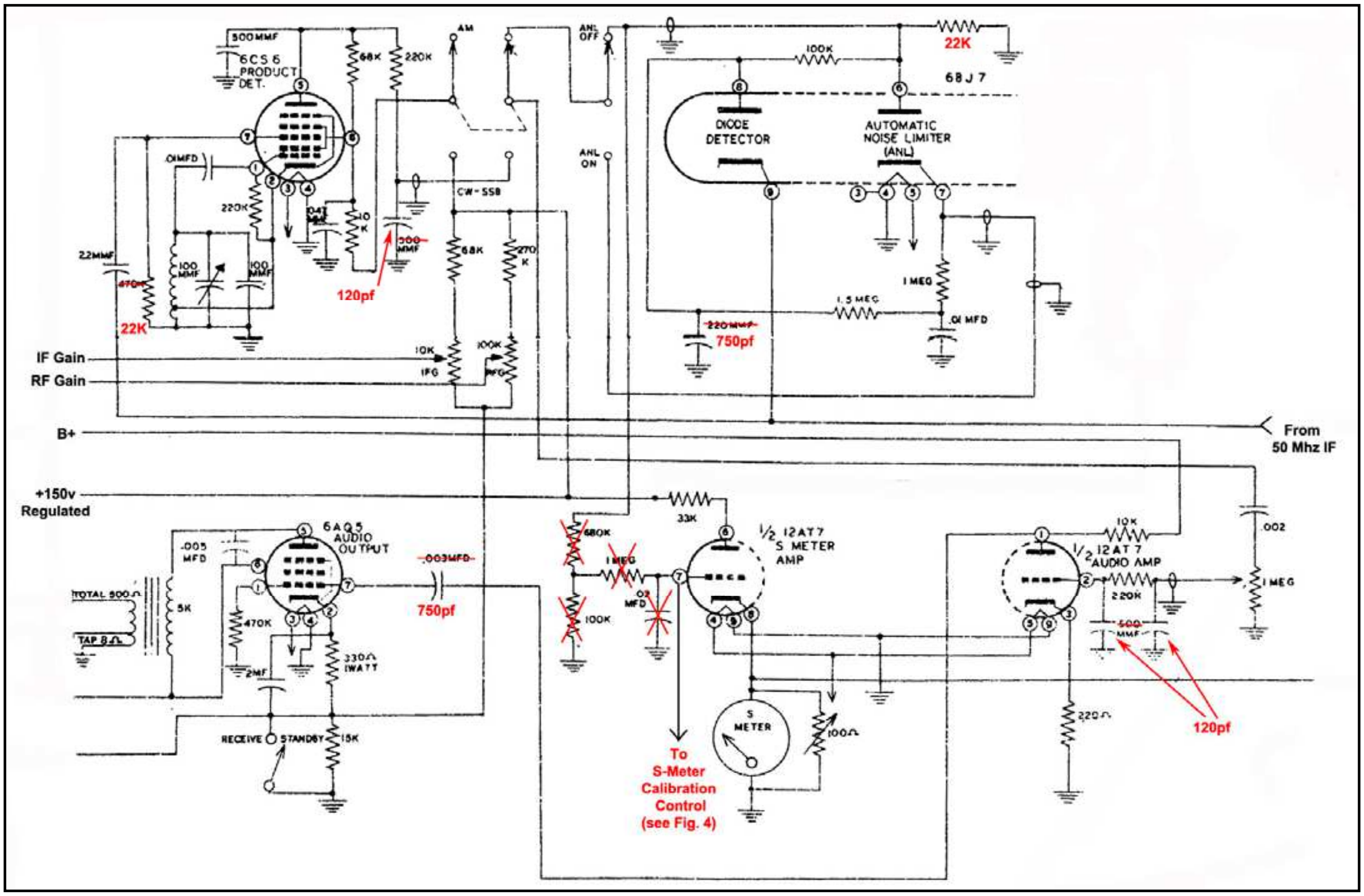


Fig. 6. Product detector, S-meter amplifier, ANL and audio amplifiers.

reducing oscillator pulling, you will notice that the 50KHz output at the plate of the product detector is a nice clean sine wave rather than a sawtooth, vastly reducing intermodulation distortion (a sawtooth wave contains the fundamental and lots of odd harmonics which each mix with the incoming IF, creating unwanted distortion products).

For convenience, I used the same MOSFET type as for the AVC amp, an International Rectifier IRFD1Z0 n-channel MOSFET. You can use nearly any N-channel type you have on hand, provided the breakdown voltage is at least 100V. The 62K biasing resistor may need to be selected depending on the particular MOSFET that you use. Values which are too high will lead to clipping of the bottom portion of the cycle (as seen at the MOSFET's source) while values which are too low will result in oscillator starting problems. I built the entire thing on one 7 lug terminal strip mounted next to the product detector on the bottom side of the chassis (there is plenty of room).

Notice that the input and BFO signal grids have been switched from Heathkit's design. These signals are injected into the product detector tube on different grids to take advantage of the tube's differing cutoff characteristics for each grid to produce a more linear output. The result is a product detector that produces *great* audio.

AM and Automatic Noise Lock problems

There is noticeable distortion of AM signals which becomes completely unacceptable when the Automatic Noise Limiter (ANL) is turned on. This circuit could never have worked as designed. Examination of the AM detector and ANL circuits in Figure 6 reveals a rather standard, but simple design which only works in the AM position (it has no effect in the SSB/CW position). Observation of various waveforms revealed that the ANL circuit was the culprit which was causing AM distortion, even when it was turned off!

Before turning to the solution, it is helpful to first understand the operation of the ANL circuit. As seen in Figure 6, the cathode of the ANL diode remains at an average voltage equal to the output of the diode detector. In order for the ANL to work properly, the peak-to-peak input signal on the anode of the ANL diode must remain less than the average

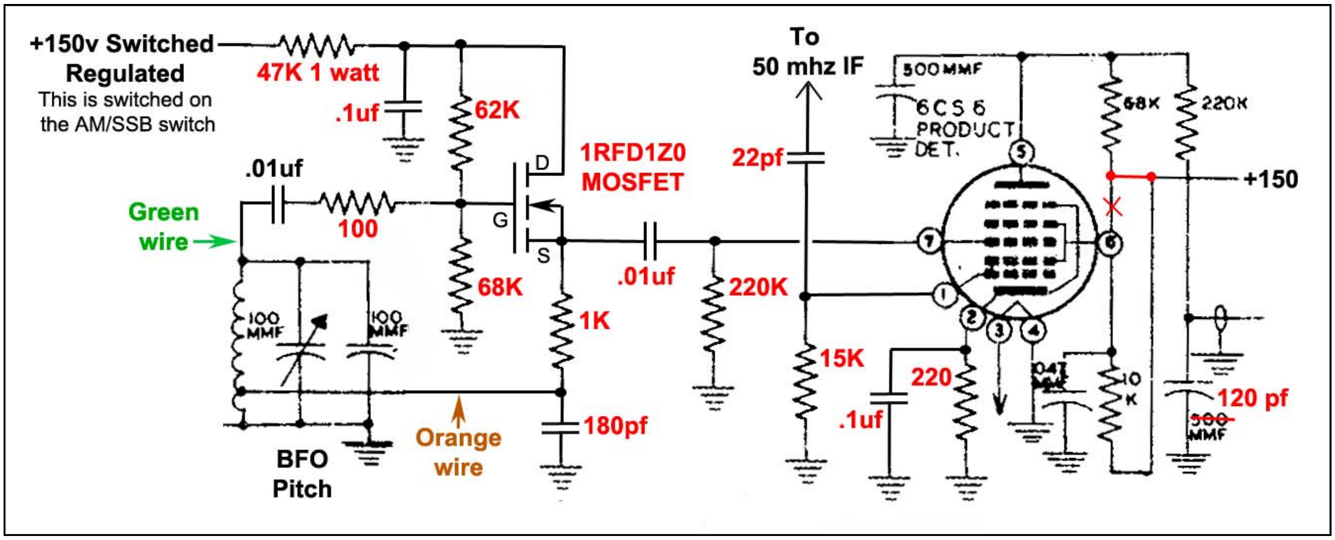


Fig. 7. Modified BFA and Product Detector.

potential seen by the cathode. The result is that the ANL diode is always on and the cathode voltage follows the anode. When properly designed, if the peak amplitude of the envelope of the received signal exceeds twice the carrier amplitude (100% modulation), as it would in the case of a noise spike, then the potential at the anode will become less than the bias on the cathode, the ANL diode will become non-conducting, and the audio frequency output will fail to reproduce the excess negative voltage.

Take a look at the input voltage divider on the plate of the 6BJ7 automatic noise limiter in Figure 6. The diode detector feeds the ANL plate through a 100K resistor which forms the top half of the voltage divider. The maximum theoretical value for the bottom half of the divider would need to be 100K in order for the plate to see a maximum signal of twice the average carrier amplitude appearing on the cathode (ignoring relatively small source impedances). Note that the bottom half of the divider is formed by the resistors feeding the S-meter amp. Since you know how the circuit is supposed to operate, you can readily see that Heath completely miscalculated the resistor divider on the ANL anode — Heath used 780K for the bottom half of this divider! As designed, the anode gets way to much signal, resulting in the diode turning off during a substantial part of each audio cycle — thus the severe distortion when the ANL is turned on.

Now if you'll remember, there was still a fair amount of AM distortion even when the ANL was turned off. As it turns out, it was the differential loading on the AM detector by the ANL diode as it turned on and off during each audio cycle (which it shouldn't have been doing) which was causing the AM distortion. Make the ANL work properly, and both forms of distortion will disappear. These are easily fixed by making these changes: remove the 680K and 100K series resistors from the plate of the ANL diode which formerly served as the voltage divider for the S-meter amp. Add a 22K from the anode of the ANL diode (pin 6) to ground (much less than the theoretically correct value of 100K due to circuit losses, source impedances, etc.). Change the 220pf on pin 8 of the diode detector to 750 pf. With these changes in place, the noise limiter works surprisingly well considering its simplicity. You'll be real happy with the AM audio too, considering that the Mohawk's configuration really only allows one sideband for AM reception.

How could Heath have miscalculated a bias point so critical to this circuit's proper operation? It is clear that it could never have worked as shown on the schematic, and it would be difficult to accept that Heath's engineers simply couldn't hear this much distortion or fail to notice that the ANL just didn't work. Perhaps the ANL anode divider resistor accidentally got changed when they decided it should also feed the S-meter divider. Or perhaps Heath knew about this mistake and released a service bulletin I've just never discovered.

Fidelity improvements

Now that your Mohawk is producing undistorted AM and SSB signals, let's address the receiver's poor audio fidelity. Take a look at the input filters on the 12AT7 audio amp and at the output of the product detector in Figure 6. Using the formula f=1/(2*m*RC) to calculate the -6db point for audio rolloff reveals that Heath began tapering the high frequency response at 677 Hz! *No wonder* it sounds so muffled. Maybe Heath thought rolling off all the highs made this receiver sound quieter (which it did, but the loss of fidelity). Changing the two filter capacitors on the input of the 12AT7 audio amp from 500 pf to 120 pf and one of the filter capacitors on the output network of the product detector from 500 pf to 120 pf (see Figure 6) produces much crisper audio with a high frequency rolloff beginning at 2.82KHz.

The audio will still have too much bass, which can be corrected by reducing the value of the coupling capacitor on pin 7 of the 6AQ5 audio output stage from .003 mfd to 750 pf, beginning a 6 dB/octave low frequency rolloff at 450 Hz. Now the fidelity is decent.

VFO Drift

The VFO drift in the Mohawk is atrocious: on 75m, nearly 3.5 KHz in the first hour in the cabinet and over 2 KHz when open on the bench! The news doesn't get better on the high bands, where drift is far worse. I'm amazed there is still chrome left on the main tuning knob, since I needed to give it a tweak every few minutes. Leave the room for an hour, and the Mohawk could drift up to a completely different QSO! Heath just didn't seem to pay to any attention to temperature compensating the VFO. Perhaps Heath's engineers only listened to AM signals where drift is not as annoying as with CW or SSB.

As shown in Figure 8, the heart of the Mohawk VFO is a 12AT7 twin triode which combines the functions of a Hartley oscillator and cathode follower. Oscillator "pulling" is eliminated by using half of the tube as a cathode follower to couple the oscillator to the mixer stage. Unlike most receivers, in which the VFO generates the same range of frequencies for each band, the Mohawk VFO generates *a completely new range of frequencies for each band*! With its 1.682 MHz 1st conversion stage, the VFO always operates 1.682 MHz above the desired frequency. This means the VFO must cover a range from 3.4 to well over 30 MHz.

This is why the drift gets worse as you go up to higher bands. If you think of the oscillator drifting a fixed percent with temperature over time, it is apparent that the number of cycles it drifts is directly proportional to the frequency generated. Since SSB reception is sensitive to drift in terms of the absolute number of cycles, not percent, the drift problem in this receiver just gets magnified as you move up to higher bands.

Another problem with Heath's design approach is that the short-term stability of the oscillator becomes worse on the higher bands. On 160 m, short-term drift is barely noticeable. But on 10 meters, within just a couple of minutes you will see short-term swings of nearly 150 Hz. (which in terms of % isn't too bad for a variable oscillator at this high frequency). This made taking measurements on the high bands a real pain.

The hunt for drifting components

I tried heating and cooling various individual components, but everything associated with this VFO seemed to cause it to drift. Since I wasn't making good progress with the VFO mounted in the radio, I disembowel the entire oscillator section from the radio, where it would be easier to isolate and test components.

With the oscillator on the bench, I warmed it up for 2 hours. To ensure accuracy of the oscillator drift tests, the AC line voltage was regulated ± 1 volt. Heating and cooling individual components was now possible without affecting other

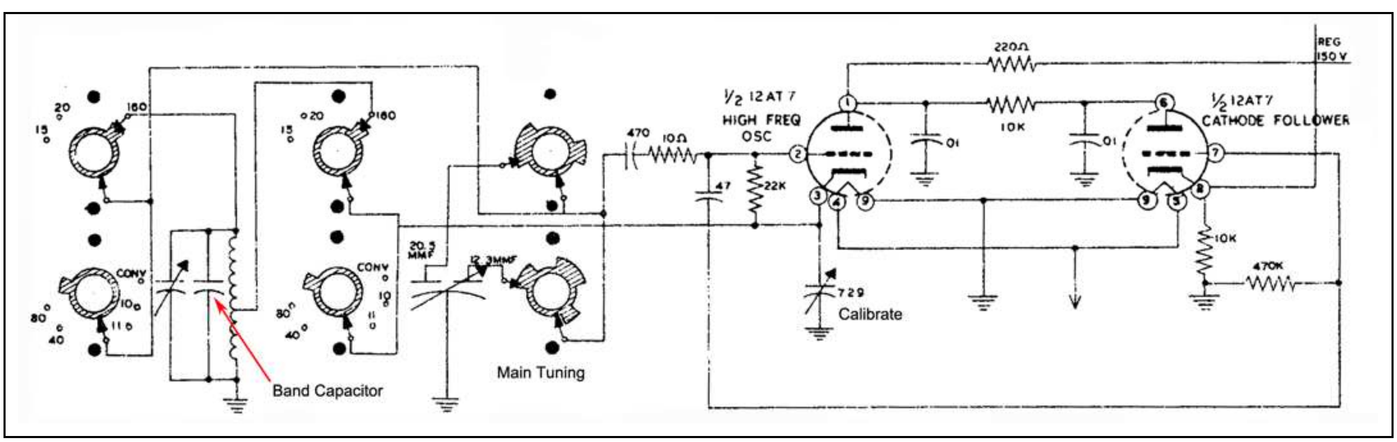


Fig. 8. HF Oscillator.

parts. The following table, derived on the 75 meter band, shows that everything is drifting in the same wrong direction.

Main Tuning Variable	-1.610 KHz	
Calibrate Variable	- .100 KHz	
12AT7 VFO Osc.	- .650 KHz	
Band coil	-1.250 KHz	
Band capacitor	-1.820 KHz	
Total Drift	-5.42 KHz	(wow!)

None of the remaining HF oscillator components are included in the list, but I went thru the gruesome task. The good news is that none of the components in the "nearly-impossible-to-get-to, fully enclosed, soldered-in-place RF front-end" cause much drift.

The VFO tube contributed much less drift than one might expect. I measured the drift contributed by various cold 12AT7 in the warmed-up steady state oscillator. Surprisingly, not all the tubes even drifted in the same direction. While most tubes made the problem worse by drifting down in frequency as they warmed up, several drifted *up* in frequency, at least partially offsetting the drift caused by other components. Out of a batch of 6 tubes, the range was from -650 Hz. to +180 Hz. For drift, GE tubes seemed to be the worst, while Sylvania gave the best results.

Finding compensating capacitors

The remaining sections of this article require temperature compensating capacitors. These days, capacitors with a negative temperature coefficient are not as easy to find as they used to be. The type of capacitor to use is a Class 1 temperature compensating disc ceramic. The temperature coefficient is measured in capacity change in parts per million and carry EIA designations like N80, N330, N470, N750, N1500, etc. These drift in a negative direction with increasing temperature. NPO capacitors are temperature stable and so have no drift.

You may find it difficult to find the exact values with the exact temperature coefficient you need, but you can combine various values. A good source of capacitors (in years past, at least) has been Johnson Shop Products in Cupertino, CA. I'd suggest ordering numerous values so you can easily combine them to get the temperature coefficient you want.

For best results, the top and bottom sides of the chassis must be compensated separately, since drifting components are located in both places and heat reaches them at different points in time. Trying to do it all in one step results in the receiver first drifting one way, and later in the opposite direction. Doing the top and bottom of the chassis separately requires more work, but the results are worth the effort.

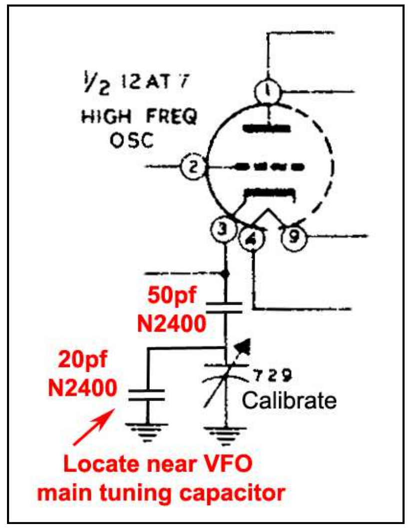


Fig. 9. VFO temperature compensation.

Chassis top side compensation

The problems created on the top side of the chassis were caused by the main tuning and calibrate air variable capacitors having a positive temperature coefficient. The circuit shown in Figure 9 adds negative compensation by adding two temperature compensating capacitors to the calibrate capacitor (at the cathode side of the oscillator). The calibrate and main tuning variables are physically close so this scheme compensates both of them in one stroke.

In addition to providing temperature compensation, this circuit also reduces the range of the calibrate capacitor, which I found excessive and hard to adjust. The original range of the trimmer was 7-29pf, while the range using the compensating circuit was reduced to 17-24pf. The reduced range makes it easier to set. This scheme isn't perfect, because Heath switches in two different sections of air variable, and they each contribute different amounts of drift. In addition, the drift will be a bit different depending on whether the air variable is fully open or fully closed, however, the bulk of the drift is still eliminated.

Experimentation revealed that the circuit of Figure 9 needed capacitors with a larger negative temperature coefficient to eliminate all the drift, but I couldn't find them. The N2400 types just don't quite do the job: the chassis top side drift component is still about -300Hz on 75m and about -1.5KC on 10m which is a big improvement.

Chassis bottom side compensation

The band coils and capacitors for each band are located on the bottom side of the chassis (only one band assembly is shown in Figure 8). Physically, the capacitor is located right on the coil for each band. Heath used precision mica capacitors for each of the bands, but with the wrong temperature coefficient. The band capacitors and coils each contribute to a drop in VFO frequency. Instead of using capacitors which offset the drift contributed by the band coils, the capacitors used by Heath had a positive temperature coefficient which contributed further to the problem. Replacing the band capacitor located on each coil assembly with one that has a small negative temperature coefficient can eliminate nearly all of the drift caused by this assembly. The values which gave the least drift in my unit are shown in the table below. Because this circuit is sensitive, your mileage will vary.

Band	C Required	Band Coil Capacitor (pf)	PPM Units (*C* X *TC*)
160	245pf	128-NPO + 110-N150 + 7-N750	21,750
80	120pf	102-NPO + 7-N750 + 11-N470	10,420
40	270pf	214-NPO + 56-N330	18,480
20	220pf	162-NPO + 47-N330 + 11-N470	20,680
15	245pf	186-NPO + 56-N330 + 3.3-N750	20,955
11	270pf	220-NPO + 47-N330 + 3.3-N750	17,985
10	165pf	80-NPO + 39-N220 + 47-N80	12,340
Conv.	75pf	36-NPO + 39-N220	8,580

On most band coils, I used a combination of three or more capacitors designed to provide the right capacitance at the right temperature coefficient. You will probably get reasonably good results using the values presented in this table, but if you find a particular band still drifts more than you want, you can have some fun fine tuning. It took about 5 hours to compensate each band through tedious trial and error (each test took about 1 hour, and there were usually 4 to 6 iterations for each band). I considered the result acceptable if the band coil assembly contributed less than -0/+300 Hz on the low bands and -0/+800 Hz on the high bands. A small positive drift is definitely better than a negative one as it helps offset the negative drift still remaining on the chassis top side.

Tips and techniques

When heating the band coil assemblies with a hair dryer or other heat source, provide only light heat and be very, very patient. Subtlety should be your guiding principle. This isn't an exercise using a heat gun and freeze spray. Take a systematic, standardized approach. Don't try providing heat by hand, because you'll get inconsistent results. I rested a hair dryer on a pile of books set to the low heat setting, 11" from the assembly. Provide low heat in this manner for at least 10 minutes. A rise of only 20° F will give you the answer you want. When you first begin heating the band coil assembly, the frequency will go up fast. Don't be alarmed — this is because the compensating capacitors heat up more quickly than the heavy ceramic band coil form.

To shorten the time required for the oscillator to re-stabilize when turning off the radio, which can take 20-30 minutes, I soldered the capacitors to the band coils "live". There aren't any high voltages in the band coil section of the radio. Just switch to a band you aren't working on when soldering the capacitor in place. Keep the temperature in the your room constant (you'd be surprised how a few degrees can throw off your measurements). Allow sufficient time for the band coil to completely cool after a heating cycle. Even using a small fan, these things take 25 minutes or more to re-stabilize (they behave as though they have memory).

During bottom side heating tests, the top side of the chassis should be continuously cooled with a fan, so heat won't reach the air variable on the chassis. There is also a 1" X 2" square hole right under air variable which you should plug to keep warm air from reaching the air variable.

It is easiest to select temperature compensating capacitors by thinking in terms of "total part per million units": PPM Units = (*temp. coefficient*) X (*capacitance*). When iterating during trial and error, it is easier to select one when thinking in terms of PPM Units. This eliminates much of the guesswork. You will find that a change of only 1,500 PPM Units will make a big difference. After selecting the compensating capacitor, use a combination of NPO values to make up the remainder of capacitance needed. It is helpful to have an LCR meter.

The acid test is trying your Mohawk in the cabinet and measuring the drift as before. You will probably find you need to make some adjustments(< 3,500 units) to get it just right (I took measurements every 5 minutes for 2 hours to be sure of the long-term trend). Remember: *drift is directly proportional to how much time and patience you have.*

The easiest way to measure the VFO frequency is to put the 12AT7 HF oscillator tube on a 9 pin extender. Hang your frequency counter on the cathode of the follower section, pin 8. The absolute frequency won't be accurate because of the extender and probe capacitances, but the drift will be readily apparent. Use a 10X scope probe to avoid killing the oscillator.

Temperature compensating results

To reduce chassis heat, I replaced the 5V4 rectifier with a 5U4 solid state replacement and added a 110 ohm 5W resistor between the rectifier and first filter cap to bring the B+ back down to +225 volts. After making the recommended changes and selecting a 12AT7 for minimum drift, my Mohawk now drifts less than -325 Hz. on 75 meters from a cold start in the first two hours. This is an incredible improvement from the 3.5 KHz on the 75m band before modification. While drift on all of the low bands is now excellent, performance 15m and up isn't as good — I measured about -1.2KC on 10m in the first two hours (but it was over 16KC before!!) Fortunately, almost all of this drift now occurs in the first 15 minutes. The short-term stability on 10 meters is still relatively poor, but design limitations prevent making reasonable improvements.

Receiver standby muting improvement

Receiver standby muting was another example of Heath not thinking this equipment through as a complete system. When the Mohawk is connected to an external transmitter like the Apache or Marauder, the receiver would come back "numb" after transmitting. If you look at the receiver muting line in the bottom corner of Figure 6 , the mute line is grounded in receive and floats to +44 volts in standby, cutting off the IF and RF tubes through the front panel gain pots. The mute relay contacts in the transmitter similarly ground this line in receive and let it float during transmit.

The problem is that Heath connected the transmitter's mute relay contacts and the standby switch on the Mohawk in parallel when they should have been connected in series. The Mohawk's standby switch grounds the line all the time in the receive position, allowing the receiver circuits to remain fully active while you are transmitting. Afterwards, the receiver will remain numb until the AVC voltage decays. The mute line from the transmitter is thus rendered useless.

You have two choices to fix this problem. The easy solution is to just leave the standby switch on the Mohawk in the "standby" position when using an external transmitter. The external relay contacts can then properly mute the receiver. The disadvantage is that the standby switch doesn't work as labeled and you have to remember to keep it in "standby" which is non-intuitive.

The second option requires rewiring the standby switch. The benefit of rewiring is that the standby switch will work like it should have to begin with. Simply remove the ground from one side of the standby switch, and reconnect the wire from pin 6 of the accessory socket to the switch terminal from which the ground was removed (the switch is now in series with the external relay contacts via pin 6). When you disconnect the transmitter from the Mohawk's accessory socket, you will need to plug in a jumper socket with pin 6 connected to pin 1 (ground). Now everything works as it should.

Threshold AVC theory and benefits

Threshold-type AVC systems can be applied to many boatanchor receivers with a noticeable improvement in performance. Manufacturers made the transition to the more modern type of AVC system at different times during the late 50s. The Collins 75A-1, and National HRO-50 and HRO-60 are examples of receivers that use the older linear-type AVC system, and they benefit greatly from the simple modifications required to convert them.

A threshold-type AVC control system is employed in every modern ham receiver and is easily recognized by the S-meter reading that increases as the RF GAIN control is reduced. If adjusting the RF GAIN control on a receiver has no effect on the S-meter's reading (other than to reduce the signal strength of incoming signals), then that receiver likely employs a linear-type AVC control system.

If, on the other hand, adjusting the RF Gain control raises the S-meter a fixed amount as the RF gain control is reduced, then the receiver employs a threshold-type control system. This simple observation works because in most receivers the S-meter measures the AVC control voltage line (or its proxy) which feeds the r.f. and i.f. stage grids. The S-meter thus gives you a visual clue as to which type of system has been implemented. But the more important benefit of a threshold-type AVC system is that the RF GAIN control can be used to reduce background noise and static crashes without decreasing the volume level of desired signals.

The RF GAIN control on a receiver with a linear system will reduce everything — both signals and noise — in a linear fashion. The effect is not much different than using the volume control, and is usually only used to reduce strong-signal overload. It isn't effective at eliminating background noise because it tends to reduce the volume level of desired signals as well.

Receivers that employ a threshold-type RF GAIN control provide a threshold, or signal floor. Signals and background noise that fall below the manually set threshold are all reduced in direct proportion to the setting of the RF GAIN control. This can be observed by noting that signals that fall below the manually set threshold do not cause any movement of the S-meter, even though you can still hear them. Signals that are strong enough to exceed the manually set threshold, however, will generate sufficient AVC voltage to further reduce the receiver's gain by an amount that exceeds the threshold. These strong signals will cause the S-meter to kick above the manually set threshold. The threshold- type system is inherently nonlinear. Below the manually set threshold, there is effectively no receiver AVC, while above it there is.

Because of the threshold effect, the RF GAIN control can be used to reduce background noise and static crashes, while allowing strong signals to come through without noticeable reduction in volume. Receivers that use a linear-type AVC system cannot offer this advantage, because there is no threshold—all signals are reduced by the same amount.

Common circuit implementations

There were two different approaches engineers used to implement the RF GAIN control. The primary difference lies in how the AVC control voltage and the manual control voltage are fed to the r.f. and i.f. stages. When the RF GAIN and AVC control voltages are each applied to a different tube control element, it results in a "*linear-type*" control. Accepted design practice until the mid-50s was to apply the RF GAIN control voltage to the cathodes of the gain stages, while applying the AVC voltage to the grids of those same stages. The effect of feeding the AVC and RF GAIN control voltages to different tube elements is that they combine within the tube in a linear manner with respect to the output of the stage.

The other way of implementing gain control is to mix the dc control voltage from the RF GAIN control with the AVC control voltage from the AVC detector and then apply the mixed voltage to just one tube control element in each gain stage. This produces a "*threshold-type*" system. Accepted design practice beginning sometime in the mid-50s was to apply the mixed control/AVC voltage to the grids of the gain stages (no control voltage applied to the cathodes).

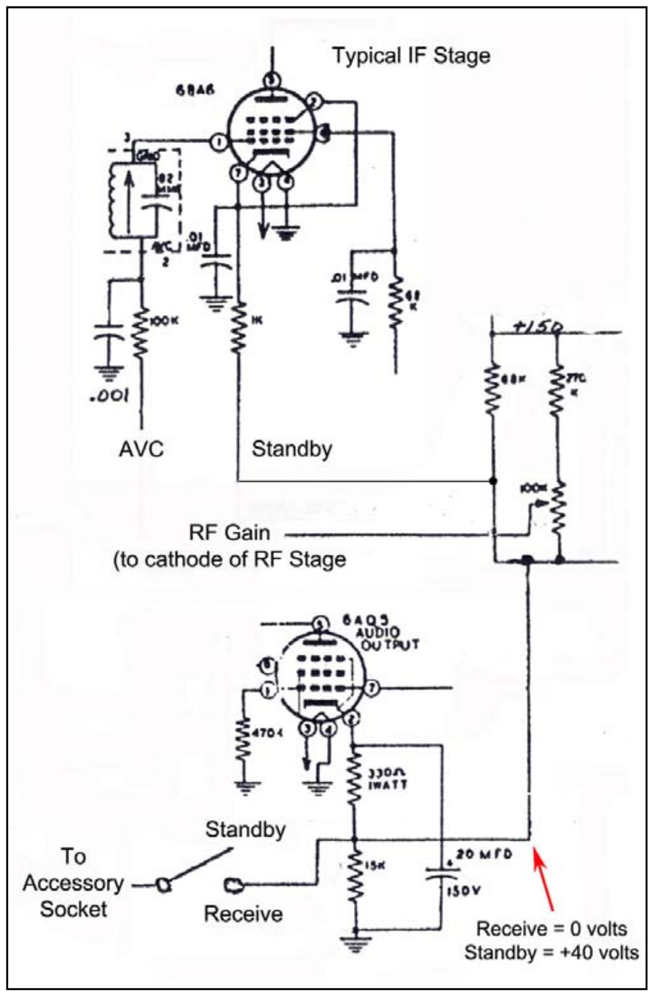


Fig. 10. Stock Mohawk uses different tube elements to control stage gain. The problem is that this results in a logical "AND" function, so there is no threshold effect.

It is useful to think about the two different systems from the perspective of analog logic to understand why the systems sound so different. First, consider the linear-type AVC system. The linear-type circuit produces a logical 'AND' within the gain control tubes. In this case, the output is directly proportional to both the AVC voltage AND the manual RF GAIN control. Unless a signal is very weak, the receiver is always under the effect of the AVC voltage being generated.

Next, consider the threshold-type system. One of the most common approaches produces a logical 'OR' circuit. In this case, the control voltage will be either the AVC voltage OR the threshold provided by the RF GAIN control, whichever is greater. The AVC-generated control voltage has no effect below the manually set threshold.

Threshold AVC for the Mohawk

It is important to distinguish between receivers that have a single RF GAIN control, and those that have separate RF and IF GAIN controls. The gain of the r.f. and i.f. stages in most receivers are controlled from a single RF GAIN control to reduce cost. Heath's dual-control implementation did not capitalize on the advantages that separate RF GAIN and IF GAIN controls can offer (both systems were linear types).

Take a look at Figure 10 and you will see that the AVC control voltage was fed to the grids while the RF GAIN and IF GAIN control voltages were fed to the cathodes of their respective stages. The optimum implementation would have been to design the IF GAIN as a threshold-type control while leaving the RF GAIN as a linear-type control.

There are advantages of using a mixed configuration of control systems. The threshold-type system will allow the IF GAIN control to offer the advantage of being able to reduce static crashes without reducing the volume of stations which exceed the threshold. Retaining a linear-type control system for the RF GAIN control is handy for cutting down on front -end overload.

Figure 10 shows the RF GAIN and IF GAIN controls prior to modification, where the control voltages each feed a separate tube elements. Figure 11 shows a threshold-type circuit, which is composed of two distinct parts: a negative bias supply and a logical OR circuit. The negative bias supply is a voltage doubler consisting of R1, C1, C2, D1 and D2. Using the filament supply of 6.3 VAC, it will provide about -14 VDC. On one half of the AC cycle, C1 charges up through D1 to about -7.7 volts. During the next half of the AC cycle, C2 charges up through D2 to about -14 volts. The negative bias supply can be built on a small terminal strip.

The voltage doubler's -14 VDC is sufficient to substantially reduce the receiver's gain, but not enough not completely cut off the r.f. and i.f. stages. It would have been nice to have more negative bias, but the -14 dc supply allows the signal sensitivity threshold to reach +30db/S9, which is sufficient for most listening situations.

The actual threshold circuit is simplicity itself. The DC output of the IF GAIN control feeds diode D3, which is attached directly to the AVC line. As shown in Figure 12, it is diode D3, in conjunction with the 6BJ7 AVC detector diode, that forms the critical logical OR function. Whichever voltage is most negative, either from the IF GAIN control or the AVC detector, will be fed to the gain stages. Because the S-meter amp is attached to the mixed AVC line feeding the control grids, it will register the manual setting of the IF GAIN control.

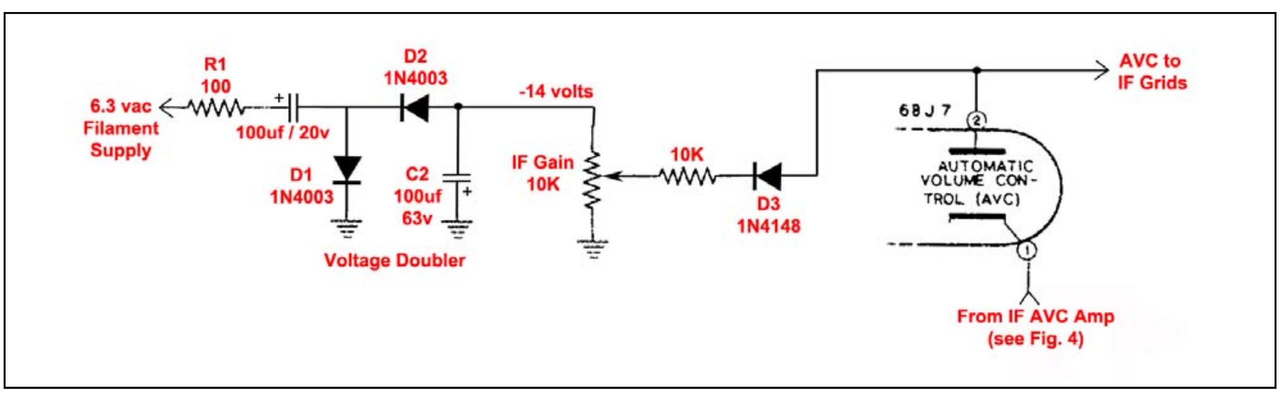


Fig. 11. Modified Mohawk combines AVC and IF Gain controls using a logical "OR" function to control only one tube element, thereby providing the desired threshold element.

The r.f. front-end stage shown in Figure 10 is a linear-type control system *only* with respect to the RF GAIN control. The other control voltage it receives is the mixed AVC/IF GAIN control voltage, rather than raw AVC, further enhancing the threshold effect.

Note that the line which fed the cathode of the 1682 KC i.f. amplifier (and a section of the selectivity switch) from the wiper of the IF GAIN control is now tied directly to the standby switch circuit. When the receiver is switched to standby, the cathodes of the 1682 KC i.f. amp and the audio output stage rise to about +40 volts, thereby cutting off these stages. Don't forget to trace the wiring from the IF GAIN control and the Standby/Receive switch to make sure they are wired correctly.

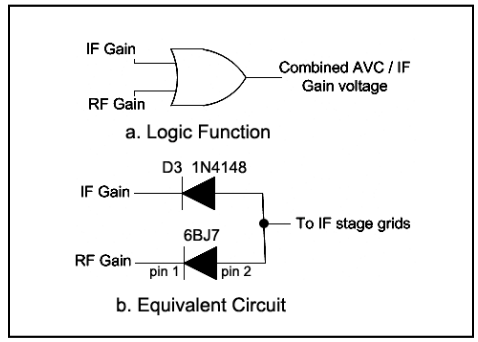


Fig. 12. "OR" implementation uses the original 6BJ7 detector diode and added solid state diode.

Schematic PDF with mods available

A modified Mohawk will offer surprising sensitivity, and the improved audio quality makes listening a joy. While it's selectivity won't match receivers with mechanical or crystal filters, the front panel's adjustable selectivity is convenient. The 5KC setting offers rich audio when band conditions permit. AM signals sound good, too, despite only one sideband being present.

I have scanned the modified Mohawk's schematic into a PDF. Email me if you'd like a copy. The schematic includes an audio feedback mod that contributes to an even smoother sounding receiver. This mod consists of a 1.5 M ohm resistor in series with a 0.47 uf capacitor from the 8 ohm tap of the audio output transformer to the grid (pin 2) of the 12AT7 audio amp. There is a modest reduction in audio gain, but there is more than enough in reserve to still blast yourself out of the shack.

Enjoy modifying your Mohawk, or applying these principles to other vintage receivers!

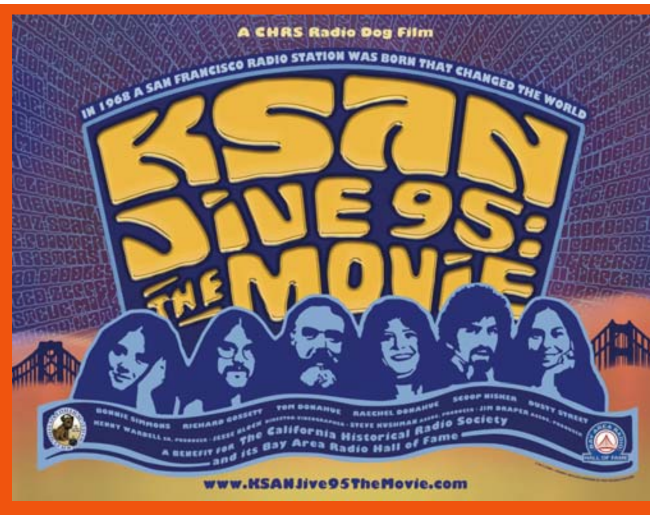
Tom is licensed as an amateur extra K6AD, earned a B.S. in electrical from the University of Colorado, and was formerly an audio and video design engineer for Ampex Corporation. If you would like a copy of the modified schematic, please contact Tom at k6adtom@hotmail.com . ◊

KSAN Jive 95: The Movie

Our CHRS Radio Dog Production, **"KSAN Jive 95: The Movie"** continues in production. But making a feature length documentary is costly. We are seeking to raise $150,000 to produce this film. The KSAN Jive 95 story is perfect for CHRS to tell and immortalize in film as it is an important part of our mission to preserve and present local radio history. KSAN, during the period 1968-1980, was pivotal in the development of our popular culture. This film will raise awareness and refresh remembrances of a time when a radio station could create change and really make a difference in so many ways.

Part of our recent grant from the Rex Foundation was earmarked toward the KSAN Movie project. We commissioned famous poster artist Wes Wilson for a movie poster. Wes and his daughter Shirryl Bayless collaborated to create this outstanding poster.

Now it's your turn to help. Please visit www.ksanjive95themovie.com and see how you can get great perks for donating to this project and help to preserve the KSAN Jive 95 legacy.

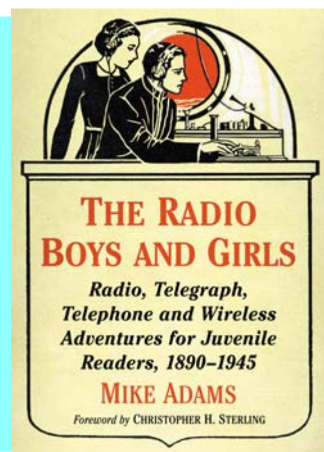


CHRS Publications

The Radio Boys And Girls—Radio, Telegraph, Telephone and Wireless Adventures for Juvenile Readers 1890-1945 is the latest book by Mike Adams, It captures the genre of series fiction about wireless and radio was a popular in young adult literature at the turn of the 20th century and a form of early social media. Before television and the Internet, books about plucky youths braving danger and adventure with the help of wireless communication brought young people together. They gathered in basements to build crystal. They built transmitters and talked to each other across neighborhoods, cities and states. By 1920, there was music on the airwaves and boys and girls tuned in on homemade radios, inspired by their favorite stories.

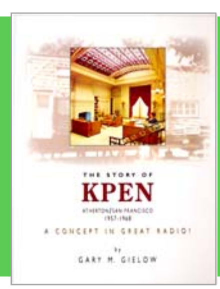
This book covers more than 50 volumes of wireless and radio themed fiction, offering a unique perspective on the world presented to young readers of the day. The values, attitudes, culture and technology of a century ago are discussed, many of them still debated today, including immigration, gun violence, race, bullying and economic inequality.

Available now at Amazon.com



The Story of KPEN: A Concept in Great Radio! CHRS member and Broadcast Legend Gary Gielow has written a new book chronicling the tales of two young men from Stanford, he and James Gabbert, who brought Stereo and new ideas to the FM radio band in the late 1950s and 1960s. This book is the definitive history of KPEN 101.3 FM, the 2015 BARHOF Legendary Station. 100% of the proceeds benefit CHRS.

Available in the Museum Store or on the website.



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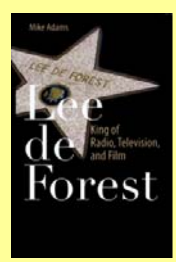
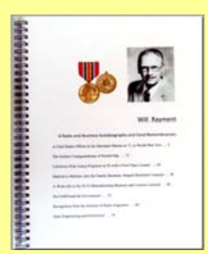


Lee de Forest

Bay Area Radio

Behind the Front Panel: The Design and Development of 1920's Radio by David Rutland has been re mastered by Richard Watts for CHRS. With emphasis on radio technology, Rutland describes the development of 1920s tubes and radio circuitry designs by De Forest, Marconi, and other inventors and manufacturers. A classic!

Buy at Amazon.com



Will Rayment

KSAN Live Jive CD

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KCBS' Stan Bunger

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Auction Gallery

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