AWA Newsletter

#58

October 2010

A Member of the SARL

Antique Wireless Association of Southern Africa

Inside this issue:

AWA Committee:

* President—Don ZS5DR
* Technical Advisor—Rad ZS6RAD
* Net Controller—Willem ZS6ALL
* Secretary/PRO—
  Andy ZS6ADY

Reflections:

Finally it seems as though the bands are starting to change. 40m has been really good these last few weeks and what a pleasure it is to be able to hear all and sundry that call in.

I guess there were times in the past when band conditions were similar to what we have just gone through, but were there really that many Radio Amateurs around to experience it when it happened ? I know there are reports available to verify similar conditions, but what were the actual effects they had on communications systems, if any ? I am sure the communications systems were not as sophisticated as they are today, so would the effect have been felt as much ?

I ask these questions because I am also sure, when this last happened, Amateur Radio was still using AM as a primary mode and communication would not have been as extensive as it is today.

These are all questions I have asked myself, and maybe one day when I am also retired and have nothing better to do, I will be able to sit and research some of these topics. (Not that all retirees sit around with nothing better to do, please don't get me wrong), in my case it may be a valid point.

Although, I must say, I have so much work waiting for the day I do retire, I will probably not have time to play Amateur Radio, which would be really disappointing, so before that happens, I need to start sorting out the important issues so, when I do retire, I will be able to play Amateur Radio.

Sounds to me a bit like a "Catch 22" here and I've probably talked myself in to a hole. But there again, where would we be if we could not procrastinate.

Who said it's "the thief of time". It's more than likely the grandfather of all excuses. Where would we be if we were not able to dream and say to ourselves "what if ?"or "one of these days I'm going to….."or "as soon as I have done abc, I will get to this one".

I am sure of course, there are many of you out there who do not suffer with these issues though.

Best 73

De Andy ZS6ADY

Wikipedia—The Resistor

Resistance standards

The primary standard for resistance, the "mercury ohm" was initially defined in 1884, as a column of mercury 106mm long and 1 square millimeter in cross-section, at 0 degrees Celsius. Difficulties in precisely measuring the physical constants to replicate this standard result in variations of as much as 30 ppm. From 1900 the mercury ohm was replaced with a precision machined plate of manganin. Since 1990 the international resistance standard has been based on the quantized Hall effect discovered by Klaus von Klitzing, for which he won the Nobel Prize in Physics in 1985.

Resistors of extremely high precision are manufactured for calibration and laboratory use. They may have four terminals, using one pair to carry an operating current and the other pair to measure the voltage drop; this eliminates errors caused by voltage drops across the lead resistances, because no current flows through voltage sensing leads. It is important in small value resistors (100–0.0001 Ohm) where lead resistance is significant or even comparable with respect to resistance standard value.

CW Net:

Straight keys, Paddles, bugs. Surely this is terminology only a radio Ham can really understand properly. Anyone else would be thinking about the great outdoors when you start to converse in these terms.

Sadly they are terms that are becoming less used in the Amateur Radio fraternity and one of these days even the radio Hams will think you are talking about the great outdoors when using words like this.

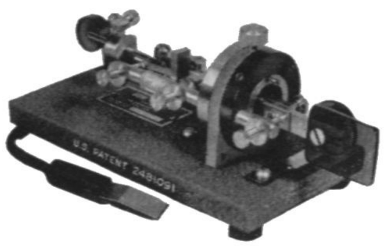
Fortunately the Antique Wireless Association is trying to prevent this from happening by running a CW net every Saturday afternoon at 14:00 on 7020.

There you will hear Barrie ZS6AJY and John ZS6JBJ, using straight keys. John ZS5JON uses a bug and Pierre ZS6BB uses a paddle as does Andy ZS6ADY.

There are many more who call in on the net using various means of communicating in CW, but each one has his own particular way of using the tool of choice and making CW what it is. A language spoken by Hams using all their skills to send messages to each other through a complex system of dots and dashes.

This is the world of amateur Radio at its best and you can easily become a part of it by just joining in.

Every Wednesday night at 19:30, on the Centurion Repeater 145.750, there are now Morse classes being given again. So if you feel the need to brush up on your CW or perhaps learn this Language, then join the guys there and see how you can open up the doors to a new world of communication.



Now I know this sounds like some kind of KFC advert, but if it gets us some more budding CW fans, I will write this every month.

Come along and join us and learn how to cope with the stress in your life.

Best 73,
De ZS0AWA … -.-

SSB activity:

Finally we are starting to see a change in band conditions and 40m is coming alive.

The past few weeks conditions have been much improved and what a pleasure it is to be able to hear Willem well enough to put out on the 80m relay.

There are still times when 80m is the frequency of choice for local stations to be heard well by the 2 control stations, but I think we may be going to see the end of that soon, as 40m starts to open earlier in the morning.

The SSB net is still well attended though and it is always such a pleasure to hear all the calls coming in once the net is opened by Willem on 40m. We are still fairly well represented between the divisions with calls from Div 1, 2, 5 and 6 and an average of 18-20 stations every week between the 2 bands. On the odd occasion we will hear a div 3 and whenever William is at home, a div 4.

Can't understand why div 4 is so scarce, but I suppose those guys don't have antique wireless there.

Which reminds me, don't forget the AM/SSB Valve QSO party coming up on the weekend of the 9th and 10th of October. You will find details in this newsletter, so come on guys, lets burn up the ether with some good pure RF being produced from valves and enjoy yourselves out there with these wonderful old boatanchors.

Collins 75A4 Rx with CE100es600L

AM:

Conditions on AM this past month have been really good and what a time we have had producing this wonderful old mode of communication.

Saturday morning nets have been really well attended with an average of 6 –7 stations calling in every Saturday, with good 5/9 plus conditions and no QRN.

Even the Wednesday evening nets have been really good. Not such a great turnout, but conditions also 5/9 plus with no QRN.

Some pointers again, if you are going to call in on the AM net:

1. Wait for a break in transmission between 2 stations before calling. We always leave a long enough gap for people to change relays or antenna and for any breakers to call in. Unlike SSB, you can't call in while someone is Tx, all you do is put a carrier over their signal and we can't hear either of you.

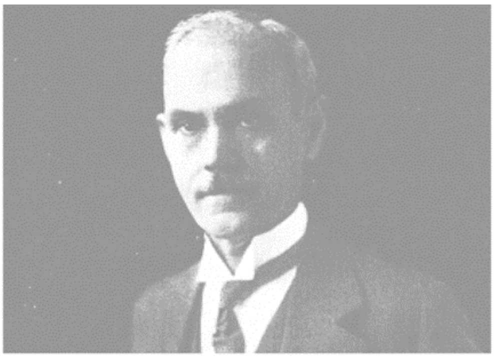
2. Remember, to set your rig on AM before transmitting. Unlike SSB, where you may hear an AM station perfectly clear after nulling out the carrier, we will not be able to understand when you call on SSB, you're only transmitting half a waveform.

3. Turn your mic gain up a bit more than on SSB so as to be heard by the other stations. If you are overmodulating, someone will definitely tell you.

And that's how simple it is. Come and join us on the AM net and stand a chance to win this lovely FR50B receiver pictured below at the end of the year. By calling in or sending us a report, you will automatically be placed on the list.

Yaesu FR50B Rx

HAMMARLUND COMPANY HISTORY



OSCAR HAMMARLUND
FOUNDER AND PRESIDENT
THE HAMMARLUND MANUFACTURING CO., INC.

The founder of the Hammarlund Manufacturing Co., Oscar Hammarlund was born in 1861 in Stockholm, Sweden. As a student he won the admiration of his classmates as well as high honors for his engineering ability. After completing technical college he went to work as a special tool designer and inspector of electrical instruments for the L.M. Ericsson Co. of Stockholm, a leading manufacturer and the originator of the French-type telephone. Shortly after taking this job, he received an offer for a similar position with the Elgin Watch Co. in the United States, and accepted the opportunity to come to this country. He arrived in 1882.

His outstanding engineering achievements at Elgin attracted the attention of Western Electric Co. officials, and in 1886 he joined Western Electric as superintendent of their Chicago plant. Six years later he left Western Electric to go with the Gray National Teleautograph Co., which was then engaged in the development of the Teleautograph. As the design engineer and plant superintendent, he spent many years with Elisha Gray, the co-inventor of the telephone, and was able to follow the early history of wireless development.

The Teleautograph was a device designed to electrically transmit writing by varying a dc current over a wire. However, many problems were encountered by Gray in the designing and building of this unique instrument. After working out most of the details, he found that the frequent failures and dulling of the stylus or pencil at the remote end seriously handicapped the entire system.

Oscar Hammarlund received the assignment to design a means of overcoming the handicap of the troublesome stylus. He solved the problem by developing a propelling pencil, and inadvertently invented the present-day automatic advancing lead pencil. At the time he didn't realize the ultimate possibilities of his invention. It was the first of many important items that he eventually was to create and see become highly successful products.

Oscar Hammarlund's interest in the advance of wireless communications was keen enough that in 1910 he decided to organize a company for the purpose of developing his own ideas. The initial success of the Hammarlund Manufacturing Co., was due solely to his painstaking research and struggle during the early days, but was not until 1919 when radio broadcasting was about to become a reality, that Oscar Hammarlund had the opportunity to put the results of his early experiments to practical use.

From that point forward, the Hammarlund Manufacturing Co. had a sensational series of "firsts". Included among these was the first mid-line tuning capacitors, standard in receivers for many years; the first MC and APC types variable capacitors, built originally for a small group of radio experimenters of the 1920's; the first commercially-produced superheterodyne short-wave receiver; the first band-spread dial with amateur band calibrations; the first beat-frequency oscillator with a front panel adjustment calibrated in kc. Literally dozens of innovations and advances were incorporated in the company's communications receivers, ranging from the early models to the famous SP-600 which was designed to be the finest receiver of it's type available.

For many years, long before most of the present day radio and electronic manufacturers even existed, every wireless enthusiast and experimenter in electricity knew of Hammarlund, and amateur radio operators and experimenters turned to this company for many of their needs. Based on several generations of experience and know-how, the Hammarlund Manufacturing Co. reached high levels of achievement during its lifetime.

A quick look back through the years discloses a history of tremendous growth and advancement. Unfortunately, much of it was never recorded and has been lost to time.

The last manufacturing facility at Mars Hill, North Carolina with it's production line manufacturing capabilities and bright modern offices would have seemed unbelievable to Oscar Hammarlund in the early years after founding the company in 1910.

The company was originally located in a loft on Fulton St. in Manhattan. In order to provide work for his small group of skilled people, Hammarlund built a weird assortment of products, ranging from the "Anti-Window Rattler" which was merely slipped in between a window frame and the window to hold it tight after the wood had shrunk, to the "bango" a protection device inserted in windows so that if it were disturbed during the night by an intruder, a blank cartridge would be set off to awaken the household.

Other items manufactured in those days included twin liquor decanters, a finger gauge for use by jewelers, precision metal measuring rules, mechanical window displays and metal watch cases. At one time they turned out air alarms for installation in ceilings as fire protection devices. This apparatus consisted of a metal bulb in which was installed a diaphragm; when the bulb became overheated the diaphragm expanded and set off an alarm at a distant locations.

Another product from the early days of the company was the "Armagraph", this was used to train radio operators in Morse Code. It consisted of a rotating disc in which notches were cut and over which glided a platinum tip contact. As the disc rotated, the needle hit each of the holes in turn and produced the sounds of dots and dashes. During the same time period, they were also producing a centrifuge used by medical and test laboratories.

The first Hammarlund electronic-related product was the variable air capacitor developed in 1916, not as a product for a specific application but as a construction item for the experimenter who furnished the plans.

In 1920 Hammarlund moved to 18th St. in New York City; there were approximately 50 employees on the payroll. At the time he developed a new automatic machine for making spring clips to go into the tops of Christmas decorations. The clip expanded to provide a support for the decoration. As a result, this style of clip exists today to permit easier decoration of our Christmas trees.

The company became well known in the 1920's for its Western Union call boxes, which it manufactured by the hundreds of thousands. These small fixtures were a part of nearly every business office. When someone wanted to send a message, they would turn a crank on the call box, which would send a signal to the nearest Western Union office; a messenger would be sent over immediately to pick up the message. There were also double-throw knife switches as well as cordless table jacks for the telephone systems, all of which marked the beginning of the movement towards manufacturing of electrical products.

In 1925 the company moved to 424 West 33rd St. in Manhattan, where the first Hammarlund-Roberts Radio Kits were built. These kits, designed for construction and broadcast listening by experimenters incorporated capacitors, coils and other related items manufactured by Hammarlund. They were generally considered to be the finest and most successful kit-type radio receivers of all time, with the circuit technique ahead of nearly all ready-made receivers.

That same year, the famous mid-line variable condenser, designed by Oscar and his son Lloyd was developed as the most practical solution to the tuning problem at the high end of the dial. This design became standard in almost all home entertainment receivers, and remained in use until the advent of electronic tuning.

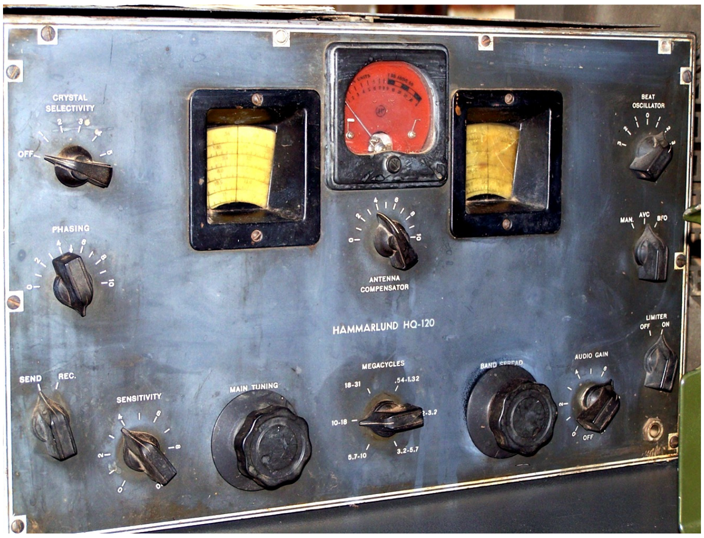
The first commercially produced short-wave superheterodyne receiver, the Comet-Pro was a Hammarlund pioneered product. It was introduced in April of 1932, and was designed as an eight-tube receiver covering the range of 14-200 meters with four sets of two coils each. By 1936, the Comet-Pro was in use all over the world by thousands of commercial operators, in broadcast stations and by many amateur radio operators. All the important expeditions included one as part of their standard equipment.

In 1936 the first of the famous "Super-Pro" line was introduced after more than four years of planning and engineering. It featured two stages of tuned RF amplification, electrostatically shielded antenna coils, and improved "Lamb" type crystal filter useable on both phone and cw, and a front-panel calibrated beat-frequency oscillator pitch control. Amplified automatic gain control of the IF amplifier and RF stages provided an exceptionally flat audio output over a wide range of input signal levels. Initially, two versions were manufactured. One tuned from the low end of the broadcast band to 20 MC, and the other started at 1250 KC and went up to 40 MC. Each band position had a frequency tuning range of 2:1.

The variable bandwidth IF amplifier, another Hammarlund "first", and the high-quality audio amplifier provided exceptional performance for the music lover. The separate power supply, as many a ham and former military radio operator can testify, was a challenge to the strength of the user.

Because the company had specialized in high-frequency capacitors for use in commercial and military equipment, nearly 90 percent of all American electronic military gear produced during the early part of World War II incorporated Hammarlund variable capacitors, until the other manufacturers could be taught the Hammarlund techniques and began making them. At the peak of wartime production the famous Hammarlund "APC" variable capacitor was produced at the rate of one million a month by ten different manufacturers.

During the early post World War II years, Hammarlund developed a product line designated "Centralized Operation Control", or "COC". This was a basic system designed to control various devices from remote locations. The widest application was in wire line, microwave and land-mobile radio. This product enjoyed considerable popularity until the early 1960's, when it was overtaken by the more advanced digital systems.



Hammarlund was most famous for it's amateur/short-wave receiver line. The HQ-120/129 series. The HQ-120 was truly ahead of its time when first introduced in December, 1938. It featured coverage from 540 KC to 30 MC with calibrated amateur band spread. This feature of calibrated band spread, including a 300-degree readout scale, was an industry first. Other innovations pioneered by Hammarlund included a front-panel adjustable antenna trimmer, calibrated front-panel BFO, and the famous multi-bandwidth crystal filter. The noise limiter was particularly useful on the higher frequencies. A special version of the receiver, designated the RBG, was built for the U. S. Navy.

After the war, the HQ-120 was reintroduced as the HQ-129 and sold for $129.00, but the company lost money on the product and it did not stay at this bargain price for long. The receiver was basically the HQ-120 with a modest styling change and greatly improved series-gate noise limiter. Both versions of the receiver were truly innovative at that time and many remain in use today.

The legendary SP-600 introduced in 1952 after many,

many years of development was an enhanced Super-Pro covering the frequency range of 540 KC to 54 MC with a 0-100 calibrated mechanical band spread. The receiver had provisions for optional crystal control of six selected frequencies. Several variants were produced including a VLF version, which tuned from 10 KC to 540 KC, others had various tuning ranges which eliminated the broadcast band and the top end of the range was 29.7 MC. The SP-600 series were widely used through out the world for military, laboratory and commercial applications.

About 1950, the basic cabinet styling of the Hammarlund receivers aimed at the amateur and short-wave listener market was changed by using an extruded rib around the outside of the front panel. Electrically, the single-conversion concept of the HQ-120/129 series continued in production through about 1960, with a series of receivers designated the HQ-140, and the HQ-150. These used the basic tuning assembly which provided the fully calibrated band spread of the 10-through-80 meter amateur bands. The HQ-160 was dual conversion. Above 10 MHz the first IF was 3035 KHz converted down to 455 KHz which was the IF below 10 MHz. It also uses a separate CW/SSB product detector. The use of the 3035 KHz IF significantly improved the receiver's image performance compared to many other receivers of its time. The HQ-150 and HQ-160, in addition employed a “Q” multiplier sub-assembly with front-panel adjustments appearing above the tuning dials. In 1956 the company introduced a lower cost general coverage receiver, the HQ-100 with calibrated amateur band spread. This was supplemented with the HQ-110, basically the same receiver, except that it covered only the amateur bands from 160 through 6 meters.

Another receiver, the HQ-145 was intended to be an updated replacement of the models HQ-120, 129, 140 and 150 series. These were all single-conversion designs and suffered from image responses on the higher frequencies. To counter this problem, the HQ-145 used single conversion up to 7 MHZ and double conversion above that. It retained the five bandwidth crystal filter along with a series-gate noise limiter, calibrated amateur band spread and the front panel antenna trimmer, all of which did much to make its predecessors so popular. This receiver had modest success in the market place, but never captured the hearts of amateurs and SWL’s as did the HQ-120 and 129.

The first Hammarlund product to use printed-circuit board construction was the PRO-310, introduced in 1955. It covered from 550 KHZ to 35.5 MHZ and featured double-conversion and a constant-calibration band spread. Unfortunately, the life of the PRO-310 was short with only one production run of 1,000 units, and was last advertised in July, 1956.

In the 1960’s, Hammarlund produced the basic FAA airport control tower VHF AM receiver, designed for the 108-132 CmýSportion of the spectrum.

The HQ-170 and 180 receivers were introduced in 1959. These were considerably more sophisticated than prior models and incorporated a product detector and multi-bandwidth upper and lower sideband selection with selectivity settings of 0.5, 1.2, 2.0 and 3.0 KHZ bandwidths. The 180 model was a general coverage receiver while the 170 was a band spread only unit covering the 160-through-6 meter amateur bands. With the advent of the multi-bandwidth IF filter system, the company departed from its use of the multi-band crystal filter with the sole exception of the HQ-145 series.

In 1964 the HQ-110 and HQ-170 receivers were equipped with a built-in two-meter and six-meter nuvistor preamplifier. The band spread dial was changed to include the calibration for the two-meter band.

The Hammarlund receiver line of the HQ-100, 110, 145, 170 and 180 had provisions for the installation of an optional clock to turn on and preheat the receiver. This was popular in the days before the general trend to crystal controlled first oscillator receivers, and helped considerably to reduce warm-up drift. Another step in this direction was used in the “A” versions of the HQ-170 and 180 receivers, which incorporated a stand-by filament transformer to keep the oscillator and first mixer tubes on continuously. The “A” models, in addition to having a 110-120 volt power transformers as standard equipment and dual audio outputs (3.2 and 500 ohms), also had a system socket so that a harness cable could coordinate them with the HX-150 single-sideband transmitter.

Several years after the introduction of the HQ-170 and 180 receivers, the company produced a single-sideband adapter for use with earlier receivers of almost any manufacture, as long as the if was between 450 and 500 KHZ. This consisted of the sideband-selectable multi-bandwidth IF circuitry of the 170/180, together with a variable threshold limiter and an audio amplifier and built-in power supply. Two versions were offered; a compact desk-top unit for the amateur and SWL market, the HC-10, and, a rack-mounted version for use with the SP-600, the SPC-10, which purchased in modest quantities by the FAA.

Following through on improvements to the HQ-170/180 receiver line, in 1960 Hammarlund introduced a “Lamb” type noise blanker. This device worked on Jim Lamb’s original principle of “punching a hole” in the signal to virtually eliminate the effect of ignition-noise interference. A special version of this noise silencer, which was marketed as a “noise immunizer”, was developed for the Coast Guard for use with their numerous National HRO type receivers in the vicinity of Loran stations. The device was extremely effective in reducing Loran pulse interference in the 160-meter band.

Some miscellaneous products manufactured during the 1960’s included a direction finder, the RDF-10, aimed at the small pleasure boat market, and an electronic keyer designated the HK1B. This solid-state unit offered straight keying, a “bug” mode of operation, and fully automatic dots and dashes.

The HQ-215, the first and only solid-state receiver produced by Hammarlund, was designed in the mid-1960’s by Lester Earnshaw, but did not go into production until 1967. This amateur-band receiver was compatible with the Collins “S” line units which employed the same frequency generating scheme, thus making it capable of functioning in the transceive mode with the Collins transmitter. This receiver was produced in limited quantities.

A number of transmitters were produced. These saw only limited use until Hammarlund entered the market with single-sideband equipment. In 1960 the HX-500 was introduced; this was a table-top, 100 watt output, single-sideband transmitter which also had FM and FSK transmission capability. This unit was probably too sophisticated and too expensive for the market at the time, and the HX-50 was introduced in 1962. It featured band pass coupling of the driver stages, simplifying the tuning and band changing. The HX-50 had provisions for accepting the 160-meter kit, which also could be ordered installed at the factory. This modestly priced unit used a crystal filter to eliminate the unwanted sideband.

In 1964 the company produced a table-top linear amplifier, the HXL-1, a 1500 watt unit with a built-in power supply for the 10-80 meter amateur bands. It basically matched the HX-50 in appearance and size, and its control circuitry was compatible with most of the exciters and transceivers then on the market.

Hammarlund entered the land-mobile two-way radio market in 1960, producing many units under the name “Outercom”. The first model to go into production was the FM-50, a 35 watt unit covering the 150-170 MHZ band. This was followed by the FM-60 with a frequency range of 25-54 MHZ and a rated power output of 50 watts. The company also produced a high-band (150-174MHZ) 100 watt desk-top amplifier designed to increase the power output of the FM-50.

The “Outercom” land-mobile units featured a cascode receiver front end with high-frequency crystal lattice filtering. They had unusually high sensitivity coupled with improved adjacent-channel signal rejection, and were relatively immune to desensitization. The receiver section of the Outercom was also used as a high performance monitor receiver with crystal-controlled channel selection for the Public Safety, Industrial and Land Transportation Radio Services in both the 25-50 MHZ and 150-174 MHZ bands.

The FM-50 was built for the Coast Guard in a special version, designated the AN/URC-45, with six channels and with a second receiver for continuous monitoring of the marine VHF emergency channel.

Hammarlund built a substantial quantity of the VHF FM “Village Radios” for the U. S. Agency for International Development (AID) for use in Vietnam. Several versions of these radios were produced under contract and were later made available as land-mobile units for the commercial domestic market. The SP-600 variant the R-1511/GR was also produced during the Vietnam era and used to detect signals in the HF Spectrum. These “hybrid” receivers had eight printed circuit boards and only 9 tubes. They had a 200 KHZ bandpass filter front end and were mounted in banks of five giving them 1 MHZ of audio coverage. This was recorded on video tape and the tapes were sent to the NSA at Fort Meade, Maryland for interpretation.

The Citizens Band radio market was entered into in the early 1960’s, and Hammarlund was one of the first companies to offer a synthesized 23-channel transceiver, also produced under private label for Lafayette, Allied Radio and Radio Shack. In addition, the HQ-100 general coverage receiver was redesigned to include a one-tube transmitter modulated by the receiver audio section. This unit, designated the HQ-105TR, was intended for single-channel transceiving in the 10 and 11 meter bands. A six-channel crystal-controlled unit was also produced for Business Radio and Industrial Radio use in the CB band.

For forty years all of Hammarlund’s activities were centered in New York City, but in the early 1950’s a phased move to western North Carolina was begun. The first manufacturing at the new Mars Hill, North Carolina plant built in 1951 involved the variable air capacitor line. With additional space provided by an expansion in 1959, the manufacture of receivers and other accessories was transferred, leaving engineering, accounting and general management in New York until 1965 when the remaining company functions were moved south.

This major addition to the Hammarlund Manufacturing facility brought the production space up to approximately 100,000 square feet. The plant was fairly self-sufficient, producing a number of screw machine parts and mechanical components. A complete plating facility, paint shop and a silk-screen capability for panels minimized the dependency on outside vendors.

Oscar Hammarlund’s management style was “family-like”; he frequently visited the productions lines and knew every person who worked for him by name. He passed away in 1945. The company, however, continued to flourish under the direction of Lloyd Hammarlund, his son.

In the late 1950’s, Hammarlund was sold to Telechrome, which several years later sold out to Giannini Scientific. In the late 60’s the company was once again sold to the Electronic Assistance Corporation (EAC). But, this sale was final. The product line was sold off in parts or phased out. The Cardwell Capacitor Corporation purchased all remaining stocks, including a few SP-600 VLF units. Sometime in 1972 or 1973, the Hammarlund factory closed. One of the most respected names in the history of radio manufacturing had come to an end.

This information was compiled with help from Stuart Meyer W2GHK (now a silent key) who was employed by Hammarlund from 1960 until 1966. He started out as Chief Engineer and rose through the ranks to President of the company. Stuart was gracious with time spent on the telephone and in correspondence from approximately 1987 until 1993.

While at Hammarlund, Stuart was primarily responsible for expanding the product line to include land-mobile two-way radio and high frequency equipment..

Stuart passed away on May 21, 1994 at the age of 76.

Les Locklear
November 4, 2002

(*This article reproduced from the Hammurland Historian website :http://www.hammarlund.info/home.html*)

The Dangers of Cathode Keying

Keying an older transmitter? Be careful!

Mention cathode keying to older hams and you will probably hear a chuckle as they remember how surprised they were to get shocked the first time they touched the hot side of a key. But the problem is much too serious to laugh off as nothing more than a simple rite of passage-cathode keying combines dangerously high voltages with substantial currents.

Touching voltages as seemingly benign as 40 V dc or 32 V ac can be potentially (so to speak) fatal, and many solid-state circuits in television sets, computer monitors and power supplies operate above these voltages. Because most other solid-state circuitry uses lower voltages, we have been lulled into a false sense of security working with electronic circuitry. Many younger hams have grown up with transistor circuits, which they mistakenly assume are always safe, and far too many experienced hams have become complacent working on solid-state equipment.

Cathode Keying Explained

Most transmitters built before the 1960s were cathode keyed. The external key was placed in series with the cathode and its ground return in one or more key control lines (Figure I). Cathode keying is simple and effective, but it has one very serious drawback: Because the plate voltage of the keyed stage appears on the key of a cathode keyed transmitter, anyone who happens to touch the hot side of that key and ground places himself in series with the keying circuit and the keyed stage.

Many hams learned to avoid these dangers by trial and error and most survived serious injury. A narrow escape from electrocution, however, should not be part of a learning experience. These dangers have existed since the early days of radio and they have not gone away, even with the transition to solid-state equipment in the 1970s. Dangerous voltages appear in both modern linear amplifiers and most tube equipment. Although we expect dangerously high voltages within the interior of tube-type equipment, it is also possible to get badly shocked by touching the external key line of many of these transmitters. Vintage novice rigs, including transmitters such as the popular Heathkit DX-40, commonly used cathode keying. The dangers continue to surface as older transmitters and classic boat-anchor rigs are rediscovered and restored by newer hams.

Potentially Fatal-How Many Volts?

When current flows across a person's chest, which would occur between the hands or from hand to foot, a reliable medical source states that the current required to produce ventricular fibrillation is (approximately) 80 mA and that the resistance of wet skin is about 500-1000 ohm. Assuming a worst-case wet skin resistance of 500 ohm, a possibly fatal voltage, at that current level, could be E = IR = 0.08 A x 500 ohm = 40 V dc.

Calculating a potentially fatal voltage is somewhat more complicated for alternating current because ac voltages are normal1y stated in root mean square (rms) values. For example, the standard 120 V ac line voltage is an rms value, which corresponds to a peak value of 120 V rms x 1.414 = 170 V peak.

The 40 V dc value calculated in the previous example, when equated to an ac rms value, corresponds to 32 V ac rms, if the waveform is a sine wave.

The ac calculation is confusing because dc levels are usually interpreted as being the same as ac rms values. That holds true for heating and power calculations only, however. For determining electrocution potentials, the dc level and the same peak ac value are equally dangerous. This is true even though the rms value of an ac voltage is less than its peak value and it means that the 32 V ac rms potential is as dangerous as a 40 V dc potential (because they both have the same peak value of 40 V.

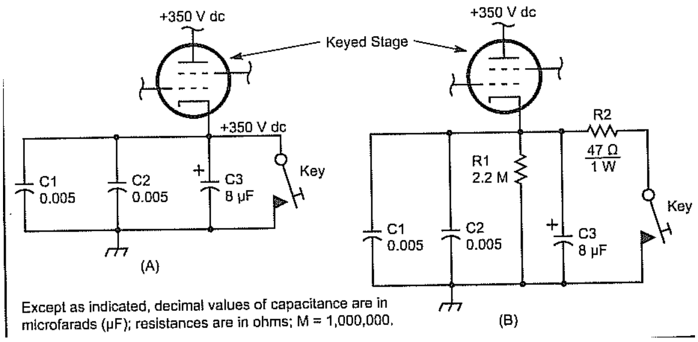


Figure 1-The keying circuit of a typical cathode keyed tube transmitter is shown in A. Note the transmit key click suppression capacitor, C3. C1 and C2 handle local keying noise caused by key sparking. In **B**, C3 and R2 furnish wave shaping of the keying pulse and suppress transmitted key clicks. Resistor R1 is added to bleed charge from C3.

Alternative to Cathode Keying

To counteract the danger of cathode keying, most ham transmitters (both pre-built and kits) began using grid-block keying in the 1960s. [Actually, grid-block or blocked-grid keying goes back to the late 1920s. Its primary purpose was to eliminate key-thump (hard clicks at turn-on) and backwave (RF output when the key is up). It also afforded an easy way to differentially key a transmitter (turn on the oscillator slightly before the amplifier... so-called timed-sequence keying). The lowered keying voltage and current were by products of this technique.-Ed.]

Grid-block keying is safer than cathode keying because grid-block keying uses much lower voltages and currents. Grid-block keying applies a negative voltage to the control grid of the keyed tube to bias it off; it is this negative voltage that the code key switches. The bias voltage is usually around-50 V dc, but it can go to-150 V dc. Although this can still produce a shock, grid-block keying is relatively safe because it uses a very low current that is well below the 80 mA danger level. Because it is more complex (since an additional power supply is required to generate the negative bias voltage), grid-block keying is rarely shown in construction articles, even those that appear in today ham magazines.

Tubes and Nostalgia

Most solid-state QRP rigs are inherently safe because of their low voltages and currents. However, those old tube-type boatanchor rigs typically use plate supplies that are ten times higher than the 40 V dc fatal value. Some hams still build tube-type rigs from scratch, similar to the one shown in an ARRL publication from the 1950s.(2) That transmitter uses cathode keying with the key connected between the tube's cathode and ground, as do most homemade transmitters of the period. It takes just the slip of a hand to come in contact with the metal part of the key that is connected to the cathode.

Although the circuit described] (whose keying circuit is shown in Figure IAJ shows no obvious connection between the cathode and plate, the tube's ungrounded cathode floats up to the same potential as its plate, which is at the B+ voltage level. At the same time, the available current is almost always far above 80 rnA. All that is required to complete the circuit is a ground. Simply touching the transmitter's case grounds the operator, with possibly dire consequences if the hot side of the key is touched at the same time.

The circuit reproduced in Figure l A shows one additional design/safety error. The 8 µF electrolytic key-click capacitor across the key is dangerous because it remains charged long after the power supply is turned off. As a result, it is possible to receive a shock from the electrolytic discharge by touching the key, even hours after everything has been turned off and disconnected. Because there already are two 0.005 µF capacitors across the key, which are sufficient for key-click suppression, that electrolytic can be removed to improve safety and eliminate arcing across the key contacts. [The twin 0.005 µF (Cl , C2) capacitors don't take care of key clicks in the transmitted signal. They mainly affect local clicks heard in the receiver due to sparking at the key contacts. The 8 µF capacitor (C3), together with a resistor (R2, 470.), effectively suppress transmitted key clicks by wave-shaping the keying pulse. For safety's sake, Rl , a 2.2 MΩ, 112 W resistor placed across the 8 µF capacitor, will take care of any lingering charge. The modified circuit is shown in Figure lB. Cathode voltage is still at the key and the operator is not protected while keying, however.-Ed.]

A similar potential danger exists in electrolytic filter capacitors in power supplies because those electrolytics can remain charged for hours after the equipment has been turned off (if the bleeders have failed). Most power supply designs incorporate "bleeder resistors (high resistance power resistors) connected across the B+ output to discharge the filters after the power supply has been turned off. However, because they dissipate so much power, bleeder resistors sometimes fail open, leaving the electrolytics still charged. Although many magazine articles contain prominent safety warnings about the dangers of working around these high voltages," few discuss the specific dangers of a cathode keying circuit.

More Nostalgia

Unfortunately, because of the nostalgia for tubes, the danger of having high voltage across a key is not going away any time soon. In fact, this danger appears to be increasing: A recent magazine article includes plans for building a quarter-watt tube transmitter that requires a B+ supply of 150 V dc.' Instead of using cathode keying (so that only one side of the key is hot to ground), the design places the key directly in the B+ line so that both sides of the key are hot! The article states that some amateurs might be uncomfortable with 150 V dc across their

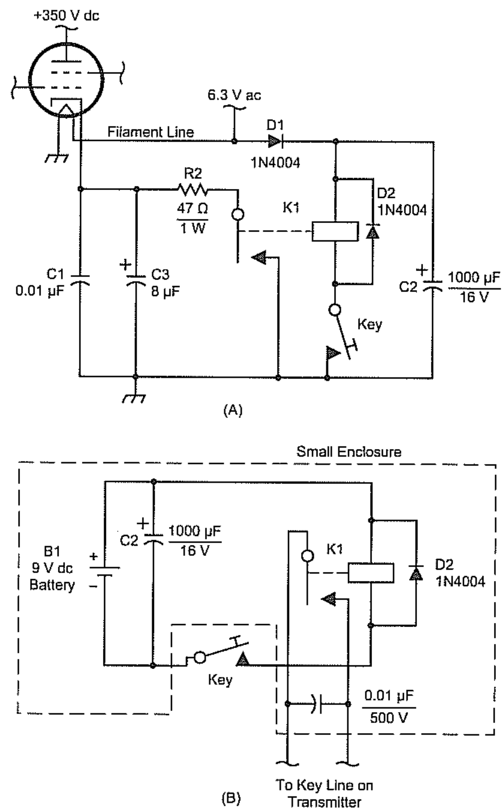


Figure 2-An inexpensive low-voltage keying relay can be used to key a cathode-keyed stage as shown in A. The dc coil voltage is obtained from a reclifierlfilter fed by the existing ac filament line. D1 and C2 provide the relay voltage and D2 suppresses the coil back voltage. The reed relay wHi follow substantial keying speeds and its contacts will handle up to 0.5 A. The key voltage is now a harmless 9 V dc; current limited by the coil resistance to about 10 rnA. Jf desired, the circuit can be built external to the transmitter, as described in the sidebar and shown in B.

key and that there are "other ways" to key this transmitter, but it leaves it up to the reader to find those other ways, any of which would be safer than having high voltage on both sides of the key.

Conclusions

That most tube circuits are dangerous because of the high voltages they require does not imply that all transistor circuits are safe, since many transistor circuits do operate above 40 V dc. Many experienced hams might consider these precautions to be just plain old common sense, until they think about how often they could have been electrocuted while learning them. It is far better to discover these dangers by reading about them, rather than by experiencing them first-hand.

As a suggestion, future articles that describe how to build tube-type transmitters should contain circuitry for the use of safe keying. At the very least, these articles should include prominent warnings about the dangers of Cathode Keying.

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Antique Wireless Association of Southern Africa

Mission Statement

Our aim is to facilitate, generate and maintain an interest in the location, acquisition, repair and use of yesterdays radio transmitters and receivers. To encourage all like minded amateurs to do the same thus ensuring the maintenance and preservation of our amateur heritage.

Membership of this group is free and by association.

Notices:

For Disposal:

I have in possession a Trio model JR60 receiver which was donated to the AWA.
It is in need of some TLC as the dial indication is completely wiped off the glass front.
Anyone wanting a good challenge of restoration can contact me and I will send photo's etc.

Andy ZS6ADY—0824484368 or email

NET TIMES AND FREQUENCIES:
The following are times and frequencies for the AWA nets:

AM Net—Wednesday evenings from around 18:30: Saturday mornings from around 06:00 or when band conditions allow. Frequency—3615.

SSB Net—Saturday mornings from 08:30. Frequencies—7070 with a relay on 3615.

CW Net—Saturday afternoon from 14:00. Frequency—7020.
(Times given are CAT or SAST)