The Signal

OFFICIAL MAGAZINE OF THE
COLLINS COLLECTORS ASSOCIATION
Q3 2018 Issue #91

The Collins Log Periodic Antennas

The Barry Goldwater Collins 237B-3 Log Periodic Antenna

$7.50 USA $8.00 Canada 700 円日本

Collins Collectors Association

From the President's Desk...

These past few months have really been special for the CCA. We had the rare opportunity to gather early last month at the Longbranch Hotel where the KWM-380 was first rolled out to the dealers in Cedar Rapids and celebrate the beginnings of this wonderful amateur radio transceiver. It was a "first" to gather the Collins engineers who designed and built the KWM-380 with the hams who own and use the KWM-380 all in the same room!

The CCA members in attendance actually got to meet the Rockwell Collins engineer who worked on the KWM-380 synthesizer (Dennis Hrncirik), so now we all know who to thank when our synthesizer unlocks and begins to beep relentlessly!

It was a treat to have Dave Berner as our speaker who conceived the Rockwell HF-80 system and was able to persuade the company to include this new amateur product at the same time. It was a huge undertaking inside a large corporation like Rockwell Collins. To me, this was a "once in a lifetime event" and I just wish all of you were able to attend! An added opportunity for me was to visit the estates of two former Rockwell Collins engineers and acquire their literature as well as some parts and other equipment! Cedar is the place to find these things!

In this issue we have a fascinating article by Loney Duncan on the early beginnings of the Pi Network transmitter circuit which Mr. Collins developed and integrated in early and later circuit designs. Be sure you note the story of Mr. Collins teaching the government inspector about his "loosely coupled" circuit when he came to inspect his station for a ham license. I mentioned how the AACLA is reproducing Mr. Collins' first Ham Shack Lab as he did so much inventing and development at a young age! By telling this story to young people we can inspire new engineers and new hams to what we love and enjoy.

This past year I have been working with Gary, our acting Signal Editor, to share with you different parts of my own Collins Collecting. In this issue it is my privilege to share with you my passion for collecting huge RLP's (rotating log periodic antennas). These antennas are fascinating and I look forward to erecting my 3-30 MHz twin tower unit in the next few years! I can help you find one if you are interested as I did for Ray Kassis (SK) and Mike Lyman.

Be sure to check out Dick Weber's extensive article on the 516F-2 that we are publishing on our website and providing a brief overview in this Signal. This integration of the Signal Magazine with our website is a great part of our future, and it gives us a chance to give Dick's Article the exposure and space it really deserves!

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You can renew your membership or join the CCA on our website using the "JOIN US" link.

From the President Continued...

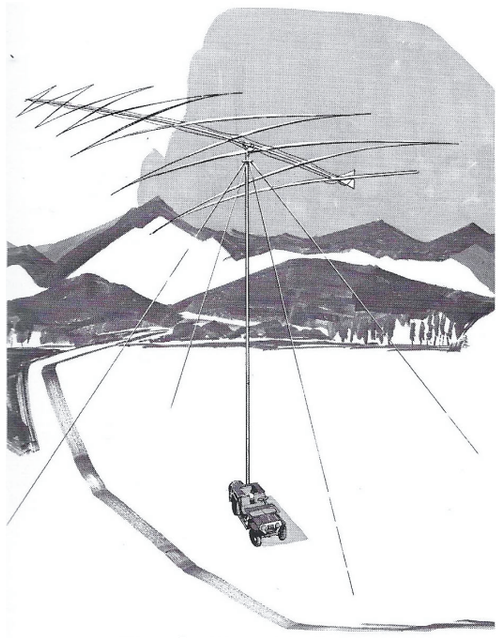
Scott Johnson presents the first of a two-part series based on the prototypes Collins produced between the Gold Dust Twins and the S-Line. This is a fascinating picture of where Collins was heading "next" as they moved toward low power (100mW) exciters that drove high power amplifiers for military and commercial applications. Scott writes in his clear and engaging style that brings us along in our understanding. A great read!

As we publish this Q3, 2018 issue of the Signal it will be the last that Gary Halverson, K6GLH, will be with us as acting editor. Gary's talents and creativity are amazing and it has been wonderful working with him and the rest of our team (Josephine Toynette, Don Jackson and Scott Kerr) in the production of five great issues of the Signal. Over the past 20 years Gary has contributed a remarkable body of writing in the Signal and Electric Radio, as well as producing videos ("The Lost Decade" on our CCA website, and the "California Hammin" series on YouTube) that document his collecting and restoration projects! He sets an example for all of us to look up to. Thank you Gary! And all the best to you as you face new challenges in the future!

Jim Stitzinger, WA3CEX
President, CCA

A Passion for RLP's

By Jim Stitzinger, WA3CEX, CCA President



The Collins 637B-1A

Early in my ham radio collecting world I became fascinated with large rotating log periodic antennas (RLP's). My first acquisition was the Collins 637B.

This is the antenna Collins developed where all the elements connected to each other at the tips in a triangular fashion. While Collins did not invent the RLP they worked carefully with an engineering department of a major Midwestern university to advance rotating log periodic technology in many directions. They developed the 237B-3 which was 6.5-40 MHz antenna as a single tower unit with the rotator at the top of the antenna. (The 237B-3 was the only Collins RLP to have a "tail fin" at the back of the antenna.) This lead to the 237B-1 dual tower version where the rotator was located at the base of dual towers and the whole array could be folded over from the top for maintenance and erection. Despite this construction feature it was always better to put these antennas up with a crane for safety and stability. Collins installed many of these units in military and government locations, and especially at FAA sites. Two of the 237B-1's were installed in the Antenna Farm in Cedar Rapids behind Building 120 as part of Com Central and were later refurbished and relocated 60 miles east of the site at the new Com Central, under the supervision of Rod Blocksome and Don Pearson of Rockwell Collins.

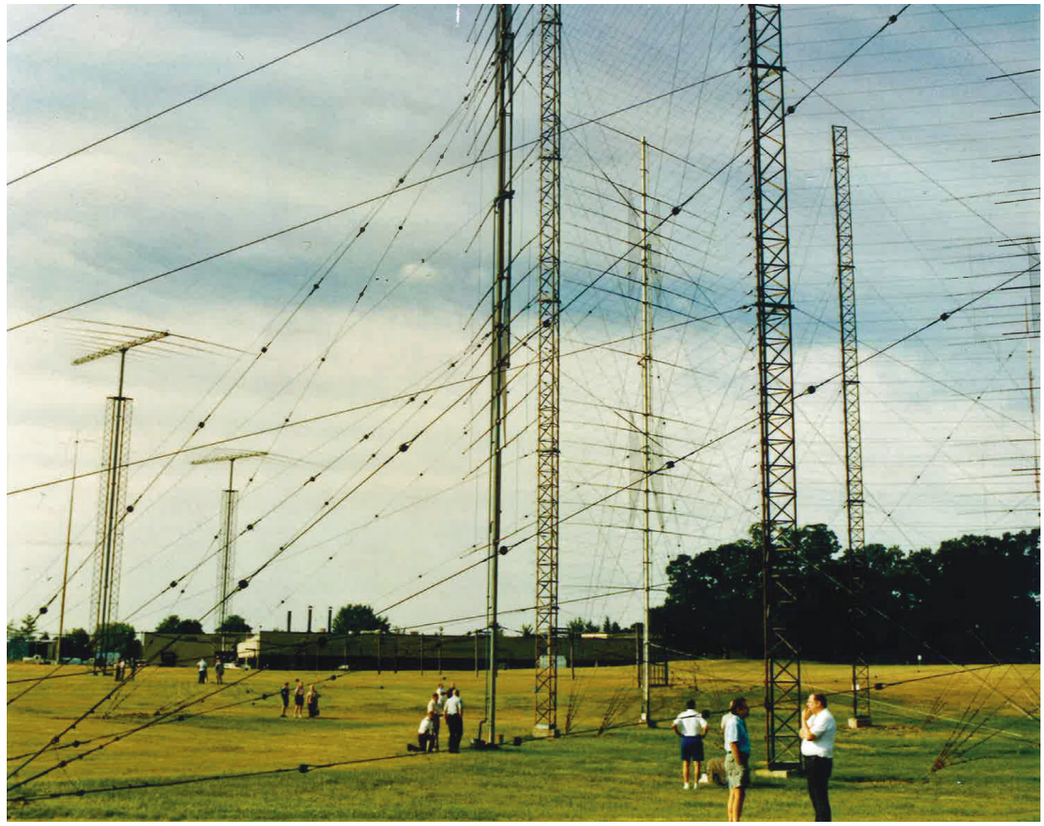


Figure 2, The Collins Com Central Antenna Farm

Figure 3, The Signature Round Emblem on the 237B-1

Figure 4, The 237B-3 RLP

The signature round emblem was part of the control conduit at the top and bottom of the antenna.

At some point Collins sold the basic antenna technology to Hygain Electronics of Lincoln, Nebraska who further distributed it as their commercial line before selling the basic antenna to US Antenna in Frederick MD (owned by Joe Burdette) who still manufactures the single and dual versions in 6.5-40 and 3-30 MHz at 45KW models which are considerably larger with more rugged elements to accommodate a substantial snow and ice load.

A group of Collins engineers split and the Antenna Division was sold from Richardson, TX to form Antenna Products Inc. in Mineral Wells, TX which went on to develop more advanced rotating logs and still exists today.

After acquiring a 237B-3 that was used at the over-the-horizon site in Lost Hills, CA, my crowning acquisition was the Rockwell Collins 237B-4 which was built for KLM Royal Dutch Airlines to track their overseas flights before the days of Satcom. I brought the entire RLP back to the states but as of now I have not been able to erect it. This RLP has dual 80' towers, 3-30 MHz coverage which also goes under the Hygain part number LP1005AA with a boom length of 72' and a longest element of 104.2' It has 19 elements, with the larger 4 elements containing coils. Power is 25 KW average and 50 KW peak. The gain is 7.5 dB with a front-to-back of 15dB.

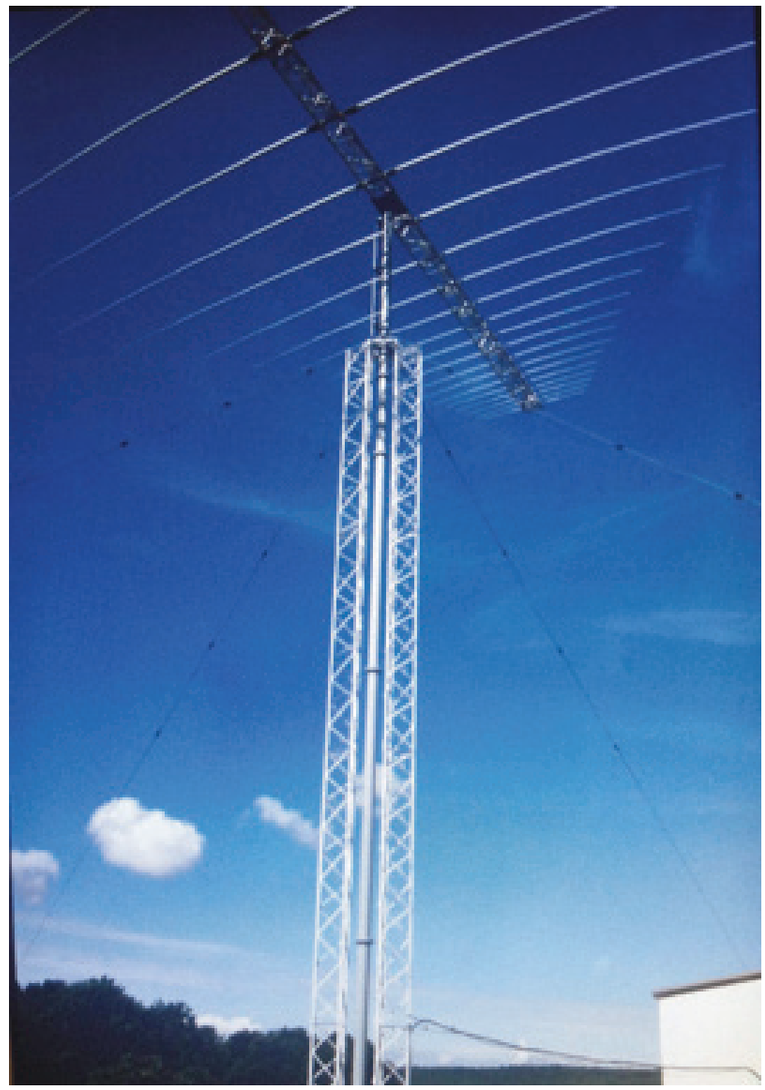


Figure 5, The 237B-4 RLP

Figure 6, Rotor base of the 237B-4

During this collecting period I began to have conversation with hams who had visited the site of Senator Barry Goldwater (K7UGA) and seen his Collins 237B-3. His log had been erected at his QTH by Air Force MARS during the Vietnam War years when Goldwater was connecting tens of thousands of soldiers back to the states through phone patches. After the war effort the RLP was decommissioned in 1982 and moved (there were various urban legends as to its new location).

After several years of searching in the Phoenix area I was randomly contacted by an Air Force MARS group who was using a Collins 237B-3 on an Army Base at Costa Masa, CA, who had been tasked with removal of the antenna as the base was slated to be sold for a shopping center. I was able to purchase the 237B-3 from the Air Force MARS program in exchange for its removal and replacement with a less imposing antenna on a smaller site, however, during this time my MARS contact became a Silent Key. During this period I was able to establish the provenance as the Goldwater log which had been moved to CA and set up on the base with corresponding dates. As it turned out the ARRL had given a tour of Goldwater's QTH and pictures were taken of an attendee standing by the base of the antenna and in Goldwater's shack.

K4LEM in Cocoa, FL provided the funds for two cranes and to allow me to gather a crew (including Wayne Spring and Gordon West from HamNation) to remove the antenna and drive it to Florida.

On the way down I stopped first at the QTH of the man who saw the antenna in the ARRL tour at Goldwater's Home and had the pictures.

He signed the statement of provenance, I then stopped at Scott Johnson's home and had a picture taken of him standing at the front of my trailer where thousands of Vietnam Phone patches had radiated.

I then took the Log to Dallas in time to show it to the CCA gathering at HamCom. Last it went to Cocoa, FL near the Space Coast. Sadly K4LEM became a silent key before it could be set up at his broadcast center.

During that time, I had been in contact with Mike Lyman back in Phoenix who had seen the Goldwater Log at its Phoenix location.

He had long wanted to locate the antenna and so when I offered the Goldwater Log to Mike, he was thrilled to purchase it.

Figure 7, 237B-3 Just lifted off the Tower

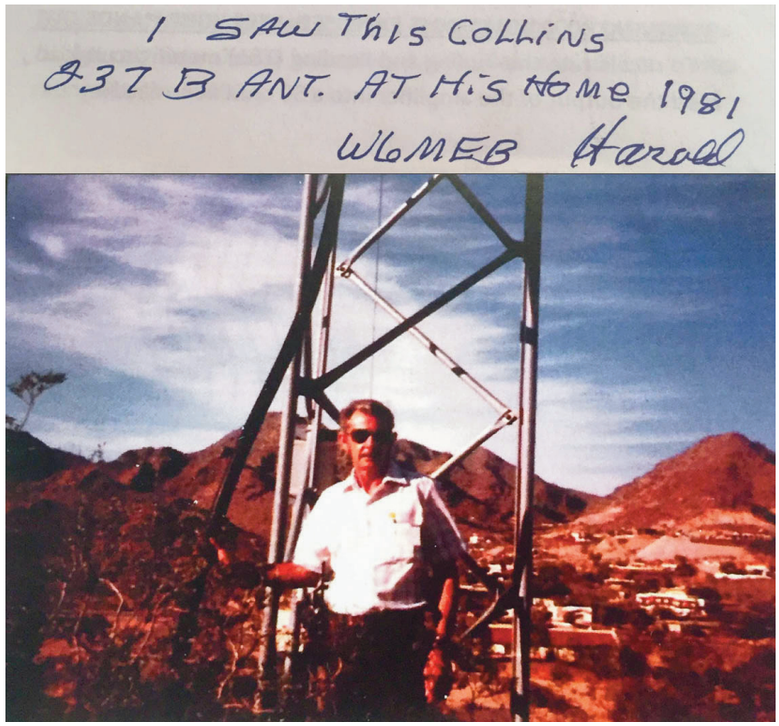


Figure 8, Harold Shotts, W6MEB,
in front of Goldwater's RLP Tower in 1981

I drove it back to Phoenix and so far he has the antenna portion of the log set up in the antenna portion of his back yard 3 feet off the ground, awaiting a new tower. He can work the world from this location and has checked into the CCA 20 Meter net!

What an amazing trip back to Phoenix! Mike says this about the experience:

I grew up about 40 miles east of Cedar Rapids (in Maquoketa Iowa) and as long as I can remember my brother Gary, K0JAM, worked for and eventually retired from Collins. I guess that makes me "growing up Collins," but that's another story. I spent a lot of time in Cedar Rapids and would often pass by the magnificent Collins antenna farm where the log periodic antenna would always catch my eye, never seriously thinking I would actually own one. Naturally when Jim contacted me about the possibility of owning Barry's Log Periodic I jumped at the chance and a short time later Jim was wheeling the antenna and tower to my residence. I had to swallow hard because the reality of its sheer size set in. I've had a wonderful time reconditioning it and now it's ready for a tower. I can't wait!

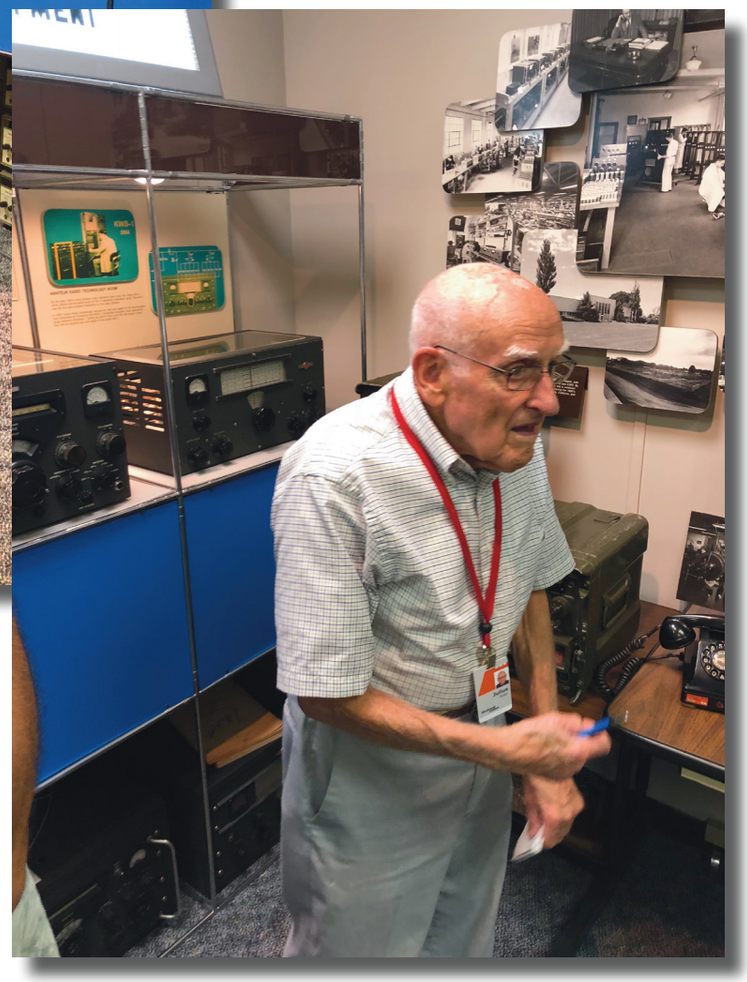
- Michael, W0JAM

Figure 9, Scott Johnson in front of the Goldwater RLP in Scottsdale AZ

Cedar Rapids Report: The KWM-380 Thirtieth Anniversary Event

By Scott Kerr, KE1RR

Collins Museum in Cedar Rapids followed by a banquet at the Longbranch Hotel. Most of us arrived on Thursday and gathered at the Longbranch Friday morning for coffee and a chance to swap stories about Collins. At about 2pm we drove over to the Collins plant and we were escorted through the Museum by the new curator, Michael Hynek. Tours were given by Michael Hynek, Terry Lamb, Rod Blocksome and Jules Yoder ("ART-13 Repair Guru").



We had time to wander through the exhibits that showed the history of the company, from the equipment of the 30's all the way through the equipment that provided the communication with the various space programs. What a treat to see the wonderful work that the AACLA has done to collect and preserve the equipment that made the Collins name famous in the communication industry.

We were then led over to the main plant to spend some time in the Collins Club station. Outside was a Collins 7MHz-30MHz Log standing atop a 60 foot tower. Inside were a few rigs that could be directed to various antenna's via a custom built switching unit. Of particular interest to me was one of the few 1KW PA units built for the KWM-380 coupled to the Autotune Antenna Coupler that matched it. I think there were only a few prototypes built and only two are known to have survived. What a shame that this was never put into production.

Then it was back to the Longbranch for some time to rest before the banquet. Happy Hour and fellowship started at 6pm followed by a great dinner and then our speaker, Dave Berner was introduced by Dennis Day. Dave Berner took us through the history of the company leading up to the acquisition of the company by Rockwall and then the challenges faced in getting the next generation of Collins products out the door, including the one of most interest to the hams in the group, the KWM-380.

The banquet was actually held in the very room where the KWM-380 was introduced to the public! In attendance were some of the engineers that had worked on the KWM-380 and were instrumental for its development. We took some time to have everyone in attendance (over 50) introduce themselves and we found the mixture was about half being Hams and the other half were ex-Collins guys.

The engineers involved in the development of the KWM-380 from left to right are: Rod Blocksome, John Koskela, Dean Barnum, Dennis Hrncirik, Dave Berner, Dennis Day, and Jim Maccani. The radios from left to right: HF-380A, HF-380 Prototype, SC-381 Prototype, KWM-380 originally presented to Barry Goldwater at the 1979 Midwest ARRL Convention in Cedar Rapids, IA, 451S-1 Receiver - one of only ten produced, KWM-380.

Saturday was the Cedar Rapids Hamfest. I attended the talk that Rod Blocksome gave that covered his work in the search for Amelia Earhart and then listened to Francesco Leddas' talk on the 718U, followed by a really long drive back to Dallas!

Thanks for all the hard work by our President, Jim Stitzinger and Jim Jones from Cedar Rapids. The two of them did an excellent job of pulling all of this together and making for a memorable weekend.

- Scott KE1RR

A Look at the Low Voltage Section of the 516F-2 Power Supply and Related Issues

By Dick Weber, K5IU

Editor's Comments:
Dick recently submitted an article for The Signal covering the extensive testing he did comparing ten 516F-2 power supply configurations when used with a 323S-3 and KWM-2. These configurations address issues caused by increased AC line voltage, installation of solid state rectifiers, and excess heat.

Due to the extent of testing and topics discussed in Dick's article, it is too large for us to publish in the The Signal. As a result, you can find the article on our CCA website: http://www.collinsradio.org/516f2.

Using the information in Dick's article, you will be able to select a 516F-2 configuration based on measured data and a companion assessment to enhance the reliability of the power supply and the reliability and operation of both a 32S-3 and KWM-2.

Here is a list of some of the topics covered in his article:

- Definition of the ten power supply configurations used for testing – rationale and history.
- Test results for each of the ten configurations when used with a 32S-3 and KWM-2. This includes tables listing all voltages from the 516F-2 when each rig was in its Receive, PTT Activated, and Key Down states. In addition, the 6.3 VAC filament voltages seen by a 32S-3 were recorded.
- Testing to see whether the bias voltage adjustment range for each power supply configuration was sufficient to allow the plate idling current to be set to either 40 or 50 mA. It was found not all configurations allowed setting of the idling current to the correct levels.
- The operation of the 0A2 voltage regulator that supplies regulated B+ to the PTO in a 32S-3 is assessed based on measured cathode currents and the specification sheet for the 0A2. To allow the 0A2 to be within spec, the value of R17 has to be changed. This change will provide well regulated B+ using any of the ten 516F-2 configurations and reduce the heat within a 32S-3.
- There is an extensive assessment of several Zener diode voltage regulators used to provide regulated B+ to the PTO in a KWM-2. This includes the Vietnam Mod and factory versions. As a result, two designs are suggested, which are variants of the Vietnam Mod and factory versions.
- Throughout the article, there is an emphasis on reducing the heat produced with the goal of improving the reliability of a 516F-2, 32S-3, and a KWM-2.
- Lastly, there are summaries of all the testing. There is also a systematic explanation of the merits of suggested changes to a 516F-2 and for the minor changes suggested for a 32S-3 and KWM-2.

Dick was first licensed in 1960 becoming an Extra class in 1974. He works CW only using his S-Lines and is a member of CWOPS. At one time, he was a die-hard CW DX contester including holding a world title for five years. He is now a casual DXer and spends many enjoyable hours working on his S-Lines. He has published numerous articles in ham radio magazines and has made presentations at Dayton, HamCom, and ham radio clubs in the Dallas area. In addition, he has had ten articles published in The Signal.

Dick is retired from Raytheon where he held the title Principal Engineering Fellow. He is a mechanical engineer holding BSME and MSME degrees specializing in servo hydraulics and two-phase thermal management systems. He has 34 US patents and has published articles in the professional literature. He is also a registered Professional Engineer.

Arthur Collins and the Pi-Network

By Loney Duncan, W0GZV

It was around 1968, and the engineering division I headed was completing the development of the 2nd generation 250-kW shortwave broadcast transmitter, 821-A2. Arthur Collins was totally immersed in the C-System development, but occasionally would stop by the Richardson, Texas 412 transmitter lab to check on the A2. This was a time of intense computer control and monitoring in all new radios at Collins. AAC not only was Arthurs initials, but stood for Assume A Computer, and the 821A-2 was no exception.

On one of these visits, Arthur asked us if we had time for a story. We assured the President that we certainly did!

Arthur said that when he was in the Cedar Rapids, Iowa high school, he persuaded his father to purchase an expensive vacuum tube for a ham transmitter he was building to communicate with his friend John. This John would be the radio operator on an imminent Greenland polar expedition.

Further, Arthur stated that the completed transmitter would have to be approved by the Department of Commerce inspectors, who not only issued ham operating licenses, but required station licenses as well. This was years before the formation of the FCC.

Arthur wrote to the inspector at Omaha, and asked him to stop by when he came through Cedar Rapids, and in due course the inspector came. After examining the new transmitter, the inspector stated that it did not have a loosely coupled circuit to the antenna, a new requirement for all self-excited power oscillators, to minimize frequency shift with wind movement of the antenna. Of course, he was looking for an adjustable link coupled to the plate coil. Arthur insisted that his circuit was loosely coupled. The inspector disagreed.

Finally, Arthur fired up the transmitter, and with a lead pencil drew big RF arc off of the tube plate cap. Then he drew an arc from the antenna terminals feeding a non-resonate antenna with 600-ohm line. Carefully touching the inductor of the pi-network he was using to impedance match the antenna, at the point he knew was at low impedance, there was no arc.

"See," said Arthur, "loosely coupled." The bewildered inspector, never having seen a pi-network before, scratched his head and said, "Yeah, I think I see what you mean," and proceeded to write out a station license.

As for the low impedance point, Arthur recognized the low pass pi-network as two low pass L-networks back to back, forming the series inductor. By experimentation, he knew where the low impedance point would be on the inductor.

Arthur told us that his friend John certainly didn't have a loosely coupled circuit, and that he would copy John's CW signal with his right hand, while sweeping his regenerative receiver back and forth with his left hand as each roll of the ship, Bowdoin, would detune the transmitter by several kHz.

We all laughed and thoroughly enjoyed the story. I never forgot it. But it would be decades before I would discover "the rest of the story", especially about the pi-network, and John.

In the past two years, Rod Blocksome, Collins retiree in Cedar Rapids, and I have researched magazines and Collins documents stored at the University of Iowa to get a better understanding of those AAC teenage years of about 1923 to 1926.

Friend John

Arthur became a licensed ham at age 13 in 1923 as 9CXX. It is remarkable that a year later he would become a friend of the most prominent ham operator on the planet, John Reinartz, the John of the story, almost 16 years his senior. Reinartz became famous for establishing the theory and use of HF short waves below 200 meters, contrary to established theory.

On January 22, 1925, John Reinartz, 1AXM/1QP, in Massachusetts, and Ed Willis, 6TS in Los Angeles, successfully communicated on 20 meters midday, an absolute first, establishing practical daylight long distance communication by shortwaves. Young Arthur had been notified of this schedule by an 80-meter contact with John, and listened to the 25 minute QSO when it happened. This contact was a two ionospheric hop with the ground reflection midpoint close to Cedar Rapids. Arthur modified his transmitter overnight to 20 meters and was able to join John and Ed for a 3-way QSO the next day. This was a most remarkable encounter.[1]

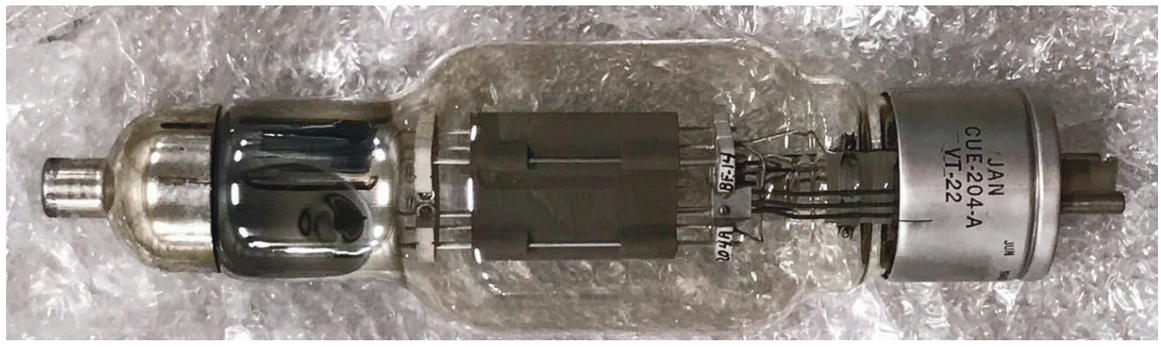


Figure 1, The 204A Power Triode

Reinartz had analyzed several thousand ham short wave contacts during 1924, and published a landmark article in the April 1925 QST, The Reflection of Short Waves. He would become famous for his unique understanding of short wave propagation, recognized by both the newly formed Naval Research Lab, and the MacMillan Greenland expedition.

He would be the chief radio operator on that expedition, and by prearrangement would involve his young friend, Arthur Collins in Cedar Rapids, Iowa. The stunning ham communications between the two for several weeks during the summer of 1925, relaying vital messages to the USN and the National Geographic, is well known history.

Reinartz more than any single individual caused the ham community to get away from 200 meters, the "useless band" Commerce had forced them to use, and embrace the shorter wavelengths such as 80, 40, and 20 meters. And Arthur Collins was fortunate to have been influenced by friend John.

Thirty-five years later at a February 1, 1960 testimonial retirement dinner for Reinartz, Arthur Collins would tell the large audience that he had always given John credit for discovering the world-wide communication capability of HF. He further stated that an analysis of those 1925 Greenland contacts served as a model for SAC's HF communication system, "which now provides vital contact with SAC aircraft across polar areas." That hand-written talk is worth reading, and I've placed it on the CCA website, collinsradio.org/JR.

The encounter with the Department of Commerce inspector probably happened shortly after the coast-to-coast 20-meter day light experiment. We know for certain that the expensive tube was a 204A power triode, Figure 1. John was using this tube in the "Reinartz self-excited kilowatt", Figure 2, and Arthur, no doubt, got the idea from him. A photo of Arthur's breadboard power oscillator transmitter is shown in Figure 3.

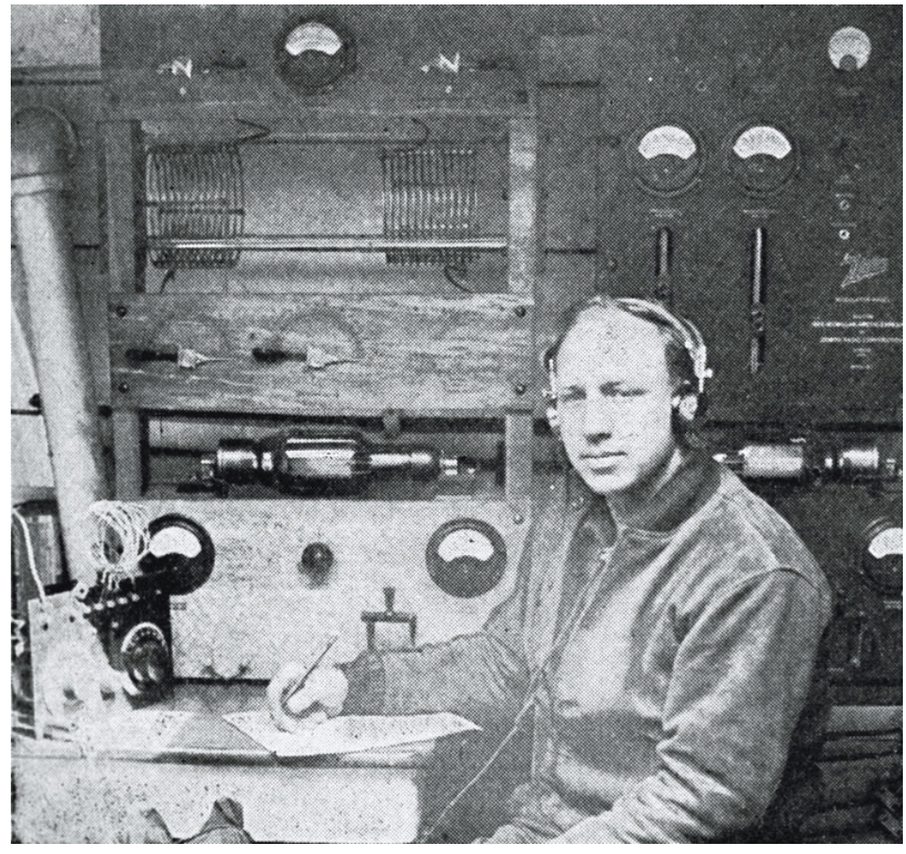


Figure 2, John Reinartz on the Bowdoin

The Pi-Network

At this point there is a mystery. The left power oscillator of Figure 3 with the new tube shows no pi-network that Arthur told of in the story. Nor do published schematics by him in QST and other radio magazines during 1925-26. These all show conventional link coupling to the antenna. We know that he did a lot of experimentation and encouraged this in his articles. Maybe he felt that the matching network he understood was beyond his readers at that time.

By his own admission, Arthur stated that during high school study hall, he would cut and go to the Cedar Rapids library where there were volumes of the IRE Proceedings.[1] Probably this is where he got the idea of network matching to the antenna. No doubt he was having difficulty loading his transmitter on his wire antenna for more than one of the shortwave bands with the conventional link coupling. It's remarkable that he knew enough to turn to the pi-circuit.

Incidentally, the term, "pi"-circuit, results from the connection of two shunt capacitors on each side of a series inductor, a low-pass filter, roughly forming the Greek letter pi used in mathematics. If the capacitors and the inductor are variable, the result is a flexible impedance matching circuit.

My first notice of the pi-network being associated with Collins Radio was from a 1938, 4th edition, Radio Handbook, published by the magazine Radio, and Frank C Jones. In it was an article about the Collins "pi" coupler. I searched for other articles that might show Collins usage of the network in its early years.

This search led to the classic February 1934 QST article by Arthur Collins (after Collins Radio was formed) titled: A Universal Antenna Coupling System for Modern Transmitters.

This article persuasively stated the need for an efficient method of impedance matching a multi-band, complex impedance antenna to a transmitter, while at the same time reducing RF harmonic radiation.

It became so influential in the ham community that the pi-network was called "The Collins Pi" throughout the 1930s. As were the cases many times, Collins didn't invent it, but Collins used it before most others did.

Notice the word "Coupler" in the title. Others spoke of these matching circuits as antenna tuners. At Collins we always referred to them as couplers, and it started with Arthur. I've had ham contacts say that I must be from Collins when I would mention an antenna coupler. The antenna isn't tuned by these networks. It is matched, or coupled to the transmitter.

In the article Arthur spoke of the "exasperation" of hams who could tune up the plate tank, but could not adequately couple power to the antenna with the conventional tank coupling circuit. And this was exacerbated when a single wire antenna was used for several ham bands. You can just imagine that he had encountered this as a teenager in 1925 trying to load his wire antenna to both 80 and 20 meters, concluded that a specific match had to be effected at each frequency, and used the pi-circuit.

In the article he described it in considerable, practical details for several types of transmitter output circuits. It should be noted that Arthur connected the pi-circuit to the existing plate tank circuit instead of connecting it directly to the plate as we do today. This made it easier for hams to adapt their transmitters to the pi-circuit. He made a considerable argument for this approach, but later changed his view. Collins transmitters such as the 32G and the 30J had the pi-circuit connected directly to the plate without the parallel tank circuit.

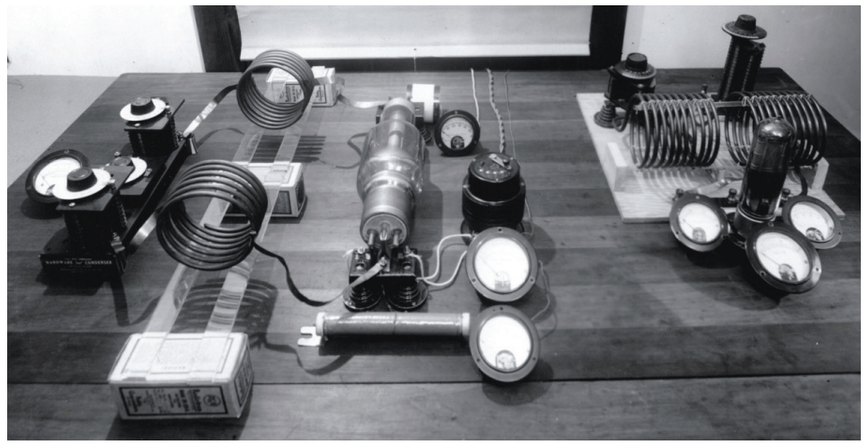


Figure 3, AAC 1925 Transmitter

Additionally, Arthur pointed out that the ham bands are not completely harmonically positioned, and that transmitter harmonics could fall outside the ham bands. He urged the use of the lowpass pi-network as an effective means to suppress these harmonics.

It's obvious that Arthur had been influenced by a May 1931 IRE article by Everitt of Ohio State University[2]. Some of the math at the end of the article comes from that paper. Arthur stated that he had no particular novelty with the pi-circuit, and that it had been used for years in network impedance matching.

Evidentially there was a heavy response to this article, and a lot of questions came to Arthur Collins. He responded by a short article in the March 1934 Radio magazine. This is shown in Figure 4. Here you can see the various transmitter output circuits that he addressed. It's evident that his QST article had been very influential. Some of these circuits were shown in the 1938 Radio Handbook and described as the Collins Pi. The 1947 eleventh edition of that Handbook referred to the Collins coupler.

Collins Timing

It is fascinating to observe the uncanny, successful timing of Arthur Collins in using existing technology over the years. The pi-circuit was one, but there were many others.

One that comes to mind is high level Class B plate modulation of transmitters. One day as I was observing the modulation transformer and reactor of the 821A-2 shortwave transmitter, as large as power substation transformers, I asked Arthur if he had invented high level plate modulation. He replied that he had not, but that Loy Barton of the University of Arkansas had in about 1930. Arthur incorporated this superior technique in the 150B transmitter in 1932, and the 20B transmitter in 1933, earlier than many other companies did in their transmitters.

Collins didn't invent the mechanical filter, but it improved and mass produced it at the right time better than anyone else.

Collins certainly didn't invent single sideband, but it caused a revolution by producing mobile SSB equipment at the right time with the right technology. There are many more examples.

Parker Heinemann skillfully summed this up in his excellent article on Collins[3] "This young genius would set the pace for solutions to some of the most vexing problems which plagued shortwave transmitter design at the time, including: control of parasitic oscillations, control of frequency instability, neutralization of RF amplifiers, efficient coupling of antenna to transmitter, single antennas for multifrequency use, and efficiency and quality of class B modulators." I couldn't agree more. But many of these were examples of existing technology, improved and applied at the right time by Arthur Collins.

Automatic Antenna Coupling

As the years passed, Collins showed more skill in matching transmitters to antennas than any other company. This was especially the case with aircraft transmitters. The late 1930s ART-13 had exceptional capability to match various WW2 aircraft wire antennas, using selectable L and pi-circuits with its mechanical memory autotune.

When post war, closed loop servo systems became available, Collins incorporated them into automatic antenna matching circuits in the 180L and 180R aircraft antenna couplers of the 1950s, and the specialized antenna couplers for supersonic aircraft of the 1960s.

Additionally, its fixed station transmitters had servo-controlled impedance matching circuits, both for SSB linear PAs and high-power Class-C shortwave broadcast transmitters. Even the 200-kW airborne VLF 17-30 kHZ TACAMO transmitter could automatically match its 5-mile trailing wire antenna, with a frequency change, in 30 seconds.

A key factor in the impedance matching of these antennas was the tremendous percentage bandwidth of the 2-30 MHZ HF band. It is four octaves wide, the greatest in the used radio spectrum. Those aircraft antennas, whether wires, tail caps, tail probes, and tail shunts, had enormous impedance changes over that frequency range. This required innovative matching networks in the Collins couplers. They were the best in the industry.

In principle, this was no different than with young Arthur in 1925, when he had to match his wire antenna on 80 meters, and then again two octaves lower on 20 meters. It required a specific match for each of the two bands with the large antenna impedance excursion over that range. He used the pi.

The Story

What Arthur Collins told us in the story about his use of the pi-circuit seemed a remarkable technical insight for a teenager at that time in radio history. Yet it's not surprising that nine years later and after starting Collins Radio, he had an even greater understanding of this critical transmitter/antenna matching requirement, and was an early promoter of the technology. Some of us were privileged, decades later, to work at Collins Radio developing superior radio equipment with these impedance matching technologies. In a way, it all started with this very innovative teenager. Those of us who heard the story never forgot it.

References:

1 - AAC Letter to Eric Roling, Oct 3, 1983
2 - Everitt, "Output Networks for Power Amplifiers", Proc. IRE, May 1931
3 - Parker Heinemann, "The Collins Radio Company Ingredients of Success"

The Answers to the Flood of Inquiries Regarding The Collins Antenna System

By ARTHUR A. COLLINS

THE recently published data on the use of a pi network to couple a transmitter to an antenna has brought a flood of inquiries to my office from amateurs who are interested in applying this system to their own transmitters. Because the thing is somewhat new to them, each has some particular question or point on which he desires more information. A study of this correspondence makes it possible to discuss the various questions which are raised and to present a brief resume of the important points.

Fist of all is the construction of the coupling system itself. It seems desirable to give some concrete values from which to work rather than to discuss the circuit in a general way. Referring first to figure 1: The inductance L 1 can be constructed using 30 turns of No. 12 enameled magnet wire, wound on a bakelite tube 2½ inches in diameter and spacing the turns so that the toal length of the winding is about 5 inches. Taps can be soldered on the winding about every four or five turns. A convenient method of connecting these taps is to bend a piece of No. 12 tinned buswire into a small "L," scrape off ½ inch of the enamel on the turn and solder the bus bar "L" onto the coil so that the bus bar extends radially about ½ inch. The wire to be connected to this tap can be terminated with a standard phone-tip jack, which will just slip over the No. 12 bus bar used for the tap. If desired, a piece of bakelite tubing can be fitted under the phone-tip jack to provide a convenient handle. For transmiters using 46's, 210's, 830's or tubes of similar power, the variable condensers C1 and C2 can be Cardwell 407B's with a maximum capacity of 360 mmfds. For a higher-powered transmitter a condenser of about the same maximum capacity with a wider spacing will be needed. This is the proper set-up for a single-ended transmitter going into an antenna which has only one feeder wire.

Now referring to Figure 2: L1 and L2 can be exactly the same as described for Figure 1, although about one half as many turns will be used in actual operation since the two inductances are effectively in series. Condensers C1 and C2 can be the same as described for Figure 1, but C2 may be a split stator condenser if one with a sufficient amount of capacity is available.

When series plate feed is used in the final amplifier, a blocking condenser should be inserted in series with "A" in Figures 1 and 2. This can be a fixed mica condenser with a voltage rating equal to approximately twice the plate voltage of the transmitter and a capacity of .002 mfds. or larger.

So much for the constructional details. One point that has come up is how this system can be applied to single-ended transmitters using a split stator condenser in the final tank circuit. The correct connection is shown in Fig. 3a. The input terminal of the network must be connected directly on the plate end of the tank circuit. If this connection is used, the neutralization of the circuit will not be upset and very excellent efficiency will be obtained. It should be noted that with this system the filter is adjusted to give input impedances of two or three thousand ohms, which will be the proper load for the class C tube.

Figure 3b shows how a two-wire system is coupled to the same type of an amplifier. The two taps on the plate coil should be placed symmetrically about the center. Their exact position is not critical, although it is sometimes convenient to make the number of turns between the taps equal to the number of turns between each tap and the end of the coil. With this two-wire antenna system the amplifier will remain at exact neutralization when the antenna is connected.

Another point is how a two-wire antenna can be connected to a single-ended amplifier of the ordinary type. Figure 3c shows how this is done. This is the circuit used when a "Zepp." or any of the other common types of antennas using two feeders is connected to the ordinary single-ended amplifier. Here the two taps are connected equal distances from the neutral point on the coil, that is, the filament or ground tap. The exact distance between the two output taps is not critical. One or two people have raised the question as to whether it is permissible to draw power off the bottom or neutralizing end of the coil. The fact to point out is that as long as the network is properly tuned it presents a pure resistance to the tank circuit and acts, as far as the tube and neutralizing is concerned, as if a noninductive resistor were connected across part of the tank coil. This does not in any way disturb the capacity balance required for exact neutralization.

All of the circuits shown in Figure 3 are drawn with series plate feed to the amplifier, since this is a common system in high frequency practice. Shunt feed, of course, can be used as well.

Fig. 3 "D" shows the correct connection for using the matching network with a push-pull transmitter. It is usually desirable to use a 2-wire antenna system with a push-pull transmitter. This is the arrangement shown. It is also possible to connect a push-pull transmitter to a single-wire antenna using a coupling network, but this involves some special considerations, which I will not attempt to cover at the present time.

Another small point that caused some uncertainty is why the unused portion of the inductance should be short-circuited as shown in the various drawings. If only five or six turns are not used, it is desirable not to short circuit them, but if, as is usually the case, only a small part of the coil is used, it is very much better to short out the unused portion. Careful measurements of the coil resistance have shown that when the unused part is shorted the resistance is not appreciably higher than if the unused turns were taken off the coil entirely.

A few remarks regarding the adjustment of this system might not be amiss. First of all, it is important to neutralize the final amplifier and tune its tank circuit to exact resonance with the antenna network disconnected. **The neutralization and tuning of the final amplifier should not be touched again after this is done.** In starting to adjust the network it is well to start out with about thirty turns of inductance for 160 meter operation, fifteen turns for 80, eight turns for 40 and five turns for 20. In the circuits using an inductance on each side of the line, about one half this number of turns should be used in each coil.

The next step is to set C2 at mid-scale, connect the network to the transmitter, apply the power to the final amplifier and rotate C1 until a resonance dip is obtained in the plate current to the final amplifier. It will be noticed that C1 apparently tunes the tank circuit much as the tank condenser does. After the first adjustment of C1 to restore the circuit to resonance it probably will be found that the minimum plate current to the final amplifier is either too high or too low for normal operation. C2 should then be reset and C1 again adjusted for resonance. A differential setting of the two condensers will be found where the transmitter works into exactly the correct load. It is important that the condensers always be readjusted for exact resonance as indicated by minimum plate current. It may be found that it is impossible to load the final amplifier heavily enough in some instances. If this condition exists, the load can be brought up to normal by decreasing the value of inductance in the circuit and increasing the capacity of the condensers by a corresponding amount to restore resonance.

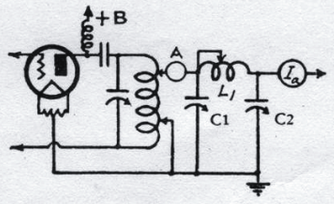


Fig. 1

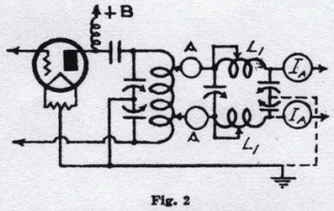


Fig. 2

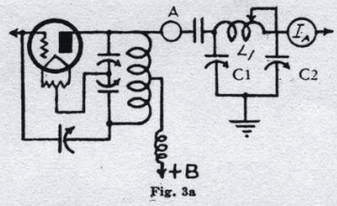


Fig. 3a

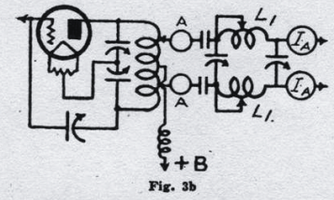


Fig. 3b

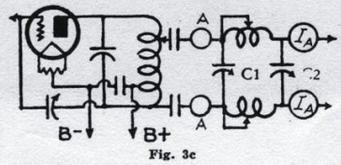


Fig. 3c

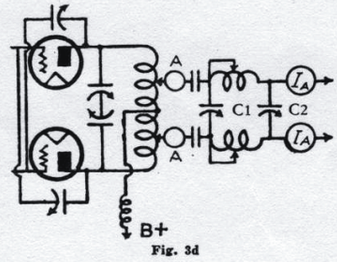


Fig. 3d

Figure 4, March 1934 Radio Magazine AA Collins Article

The 50E Receiver and 310F-1 Exciter - A Missing Link in the Collins Fossil Record? (Part 1)

By Scott Johnson, W7SVJ/AFA6SJ

When Collins introduced the KWS-1/75A-4 "Gold Dust Twins in the mid-fifties, it was inarguably the most elegant single sideband system available to the radio amateur. Behind the scenes, however, Collins was developing a sophisticated modular HF-SSB system architecture for the US military that would ultimately lead to the KWT-6/ URC-32 500W transceivers, as well as the 1 kW ARC-58/ 18Z-3/4 airborne transceivers for the USAF, and the TRC-75 I kW Mobile system for the USMC.

There would not be another amateur product introduction until that of the S-Line in 1959. But, had events occurred differently, there could well have been another, even more sophisticated amateur SSB system to follow the Gold Dust twins. Part of that system would have likely included the 310F-1 exciter, and what would have possibly been called the 50E-x receiver.

A bit of background is in order here, before much more is said about the equipment. Some 18 months ago, I was contacted by Bill Carns, N7OTQ, regarding what was believed at the time to be a KWT-6 "whatzzit" (as Bill likes to say). At the time, it was believed to be an exciter, very proto-typey, but related to the URG-0 family of equipment. Scott Kerr, KE1RR was the proud owner, he had received it from our President, Jim Stitzinger, WA3CEX, who had purchased it from a ham in California near him. There was some information as to its heritage, gleaned by the owner Larry Tinkler, K6LXT, from J.B. Jenkins, W5EU (SK), a former Collins employee. The information included a preliminary advertisement for the 310F-1 exciter, (See figure 1). This document was dated 5 November 1954, and as pictured, it resembles a KWS-1 inasmuch as the size and cabinet style are concerned. Fast forward to September 2018, and I now have possession of the unit, which upon inspection is not a 310F-1 exciter, but rather a receiver, albeit not quite complete, as I will explain. (See Figure 2).

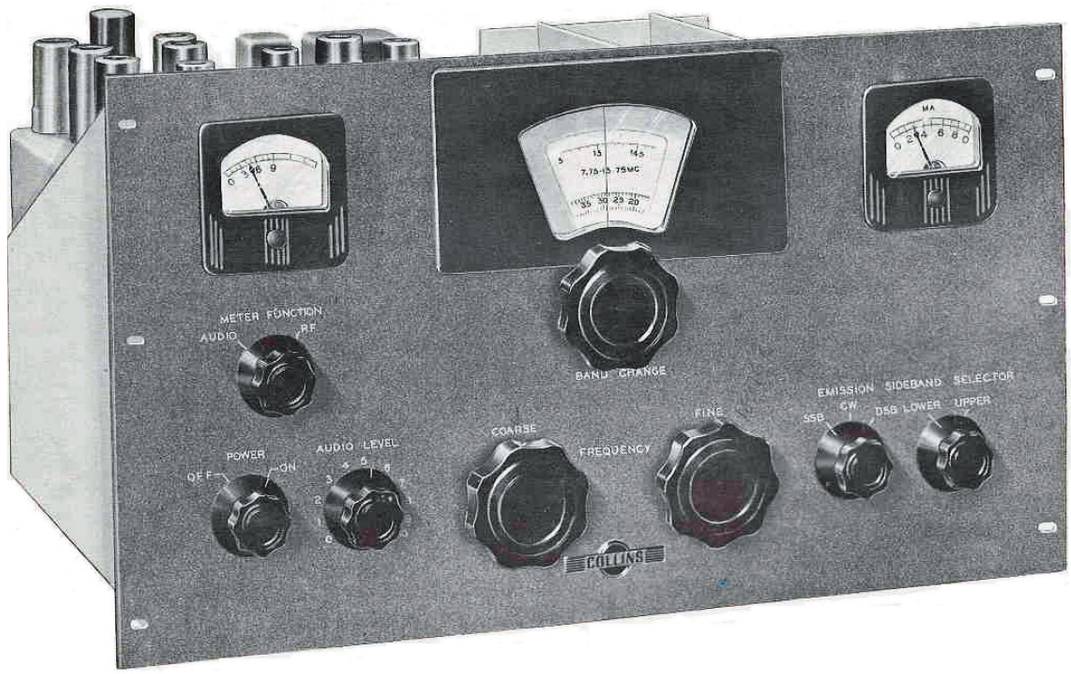


Figure 1, The 310F-1 Exciter

Figure 2, The Mystery Receiver

The receiver was briefly evaluated, and found to be a general coverage design, using the same conversion scheme as the later KWT-6 system. The 2-30 MHz range is covered in four bands, and two PTOs are used to effect coarse and fine tuning. The receiver requires 100 kHz and 1 kHz injection frequencies, presumably from the 310F-1 exciter (hence my statement about not being a complete stand-alone receiver). Essentially, the exciter and receiver would make a complete system, with the addition of a suitable power amplifier (again, with what was Arthur Collins' desire for a 50-100 mW drive requirement in HF systems). Perhaps the receiver would have been called a 75A-5, but given its general coverage, and the fact that it was eventually a 50E-6 manually tuned receiver in the URG-0 lineup, I am calling it a 50E until someone comes forward to correct me. (I hope this comes to pass).

The receiver has much to brag about -- variable and fixed passband tuning, frequency stabilization, using a component that would follow on to the URG-0, the increductor RF saturable reactor -- sort of analogous to a varactor, but with DC bias varying the inductance rather than the capacitance. The "increductor" current meter displays the bias and gives an indication of frequency stabilization. More on this in Part 2.

Another very peculiar (for Collins) feature is push-pull audio from two 6AQ5 tubes with a large ultra-linear audio output transformer. High fidelity audio from this receiver is a distinct possibility. IF selectivity is provided by 0.3 kHz CW, 3 kHz SSB, and 6 kHz AM mechanical filters (no 6 kHz filter was provided in this prototype, although there is a position for it). The desire for Hi-Fi audio may be the reason a mechanical filter was not installed.

There is no serial number data plate present on this radio, nor is there a Collins winged emblem present. The St. James grey panel is engraved, rather than silk-screened, and most of the metal work looks to be hand made (presence of tooling marks, and random penciled assembly instructions abound). There is no silk screening on any part of the chassis. Generationally, there are older RF connectors as used in the R-390 series, rather than the profusion of D-sub connectors used in the later URG-0 equipment. The radio uses point-to-point wiring, no PCBs, and only five solid state devices, a Zener diode and four selenium rectifiers are present. The radio has a total of 35 tubes, many of them dual triodes.

Examining the receiver further, it is clear the KWT-6 design architecture was beginning to take shape, albeit with older generation components and assembly techniques. For example, the under-chassis view (Figure 3) show the two PTOs for coarse and fine tuning to be generationally similar to R-390 PTOs, all tubes are miniature types, and a unitized construction technique, similar to the 75A-4, is used with minimal use of inter-unit connectors. It is also clear that this was intended to be an amateur product, as there are simply too many "knobs to fiddle with" for a commercial/military product.

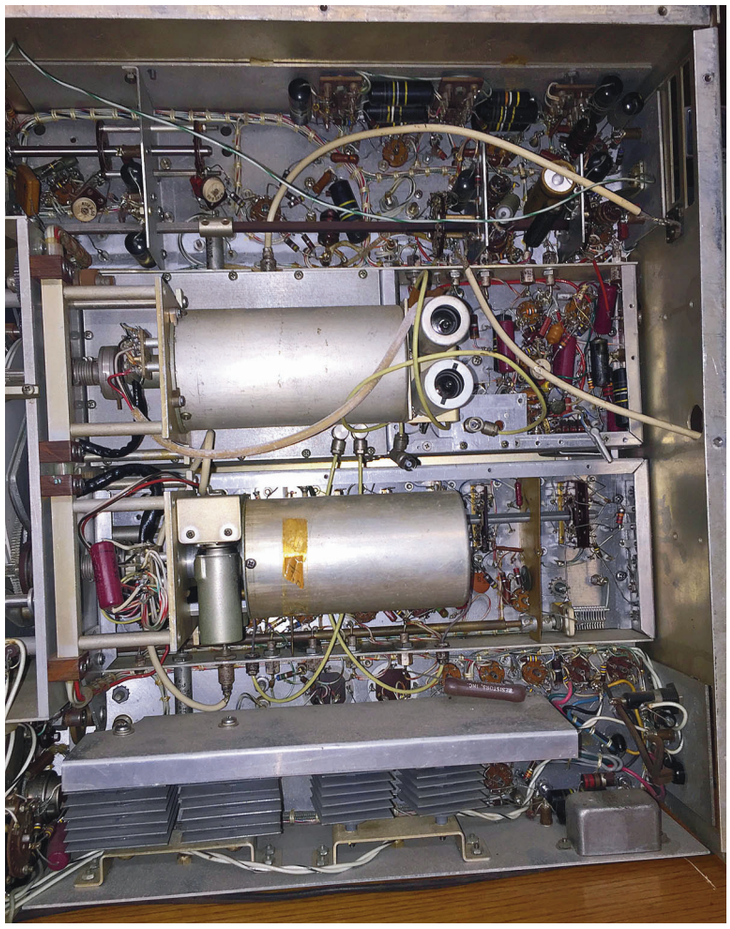


Figure 3, Receiver Under-Chassis View

I have to wonder what an entire system might have looked like. Perhaps several power amplifiers were planned -- maybe 100, 500, and 1000-watt PEP designs, with drivers to accommodate the 100mW drive level from the exciter and broad-band tuning to match the four bands. Perhaps a 50E receiver, 310F-1 exciter, and a 500W power amplifier/power supply in a cabinet similar to the KWS-1 power supply? Having the exciter present for examination would have been nice, but it is fairly easy to fill in the pieces. The exciter (with its 40 tubes) most likely contained the time base and dividers to feed the injection signals to the receiver. The system I envision would have looked much like an updated KWS-1/75A-4 station.

I would welcome correspondence from anyone with knowledge of this program and the equipment that was under development. As to why it didn't see the light of day as a product line, I believe it would have been considerably more expensive than the Gold Dust Twins and didn't really give the amateur more of what was needed. The frequency stability would have been the biggest plus, but I believe the cost would have been prohibitive for all but the most well-heeled amateurs.

I have to think that much was learned that would later be put to very good use in the URG-0 program, though. In a few short years after this equipment was (almost) debuted, the USAF had their ARC-58 and KWT-6, and the Amateurs were wowed with the debut of the S-Line. The 50E/310F-1 is a faint footnote, but perhaps much more important than was realized.

In Part 2, I will continue the story of the 50E, after it is resurrected, aligned, and tested. Perhaps there will also be more to report about this history of this interesting artifact.

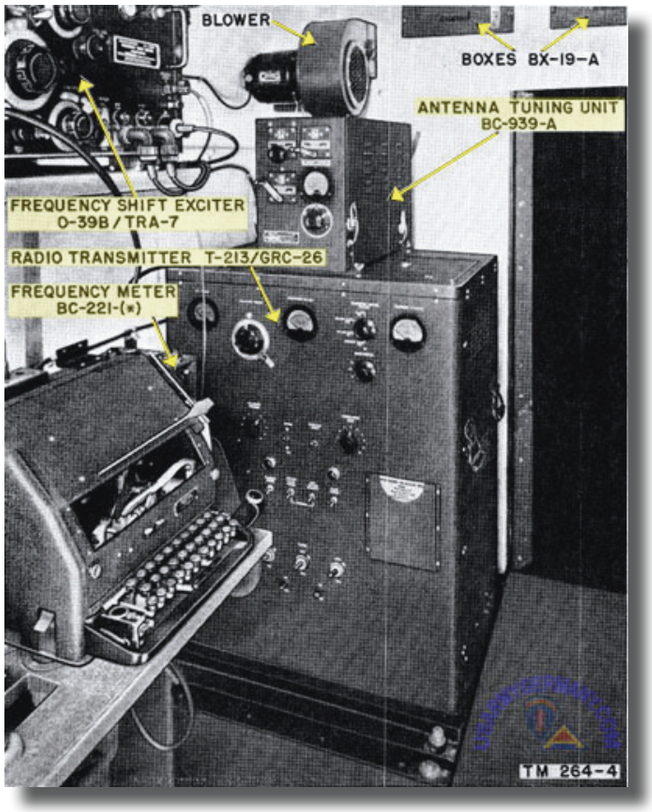
- Scott Johnson, W7SVJ/AFA6SJ

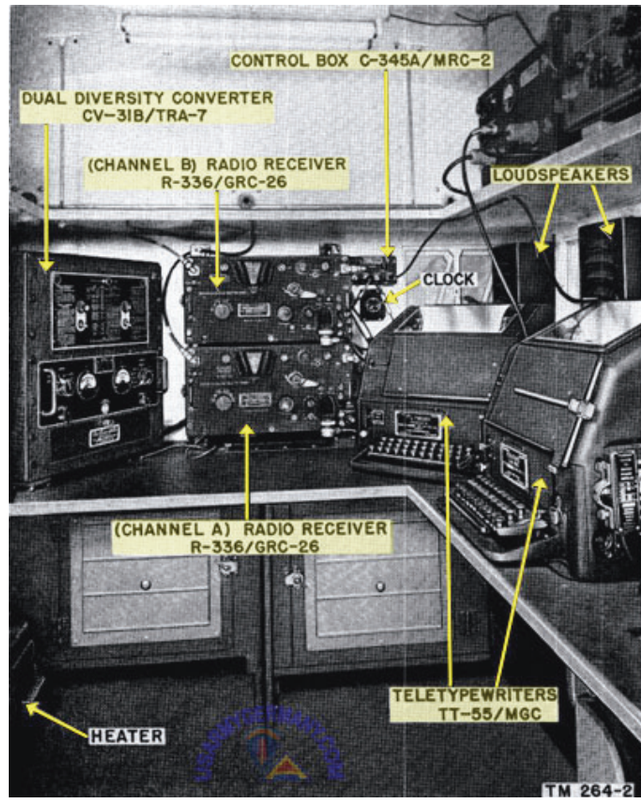
Editor's note: If you can help Scott learn more about these units, please email him at: scottjohnson1@cox.net

In The Shack with Peter Wittenberg Sr., K2LRC

My interest in radio started as a 10 year old kid in Queens NY, fooling with AC/DC 5 tube radios and adding a microphone to make a small PA system. I certainly did not know anything about the AC/DC non transformer power line dangers then. Just found where the audio stage was and connected a cheap kids mike. Worked fine till the unit failed due to a burned out tube filament. Well my novice ham license was issued in March of 1955 thanks to a school buddy, Ralph Morgenstern. Lots of fun with military radios, all ARC- 5's and SCR-522's (I still own the ARC-5 rigs). 6 meters was hot in those days and I added a home brew 6M converter to the BC-457.

Then things got serious when I signed up as a field radio repair technician in the Army. I went to repair school in Ft. Gordon GA for 6 months, and due to my ham ticket and having a background in radio, I ended up as an assistant to the teacher. Great times and learned much about the military systems and the related ground radio systems. I spent many hours repairing R-388, R-390 and R-390A's, BC-610's and all sorts of RTTY gear including Model 28's and the related shelters the gear was mounted in 2 ½ Ton AN/GRC-26 and 3/4 ton trucks. As well as AN/GRC-19 Jeep-mounted stations and a bunch of radio relay VHF gear. This all took place in the later years in the NY National Guard, while living in Huntington NY. Things changed when I found an estate sale and got my first S-Line. Here I had a tower and a TH7DXX beam.

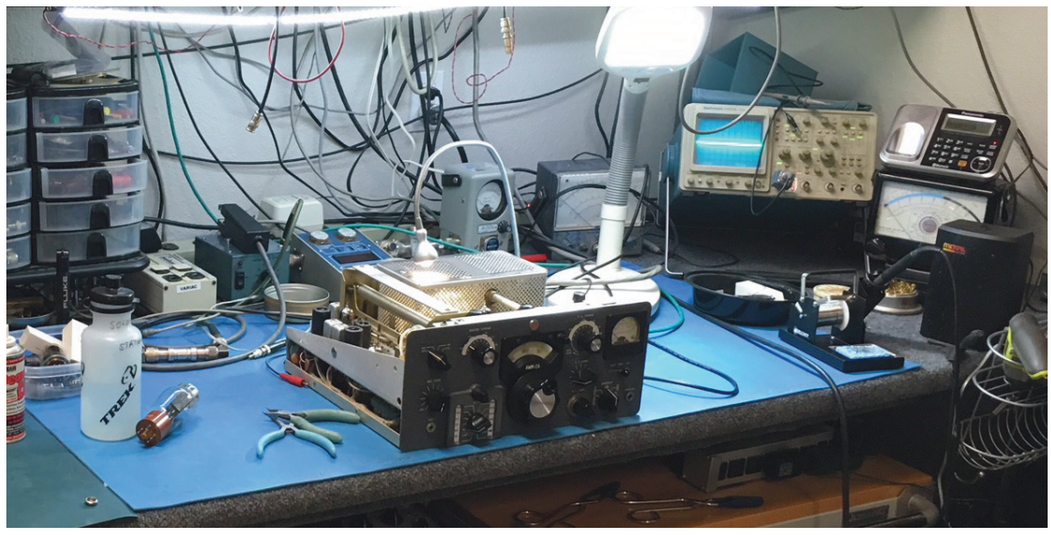




AN/GRC-26 Early Version

Here are a few shots of the inside of the new shop in Penryn California.

Final Checkout of a KWM-2



KWM-2 on the bench

In 1976 we moved to Seattle to work for Fluke Electronics and then in 1978 to Europe for 4.5 years. My job in the Netherlands was the European Marketing Manager in Euro HQ's and then in Germany I took over the presidency of the Fluke German Sales/Service Company.

Both sites had hams in the group. Lots of new antennas and at home I set up my favorite vertical antenna in both locations with my newly US acquired S-Line. Remember, most of us old guys when younger wanted Collins gear but could not afford it. It was interesting to work from another country and the sensitivity to time zones. I had a Kenwood HF rig in the company car and worked most of Europe and Russia and the US every day (those were the days the bands were still open). I returned stateside in 1982 and moved back to Seattle.

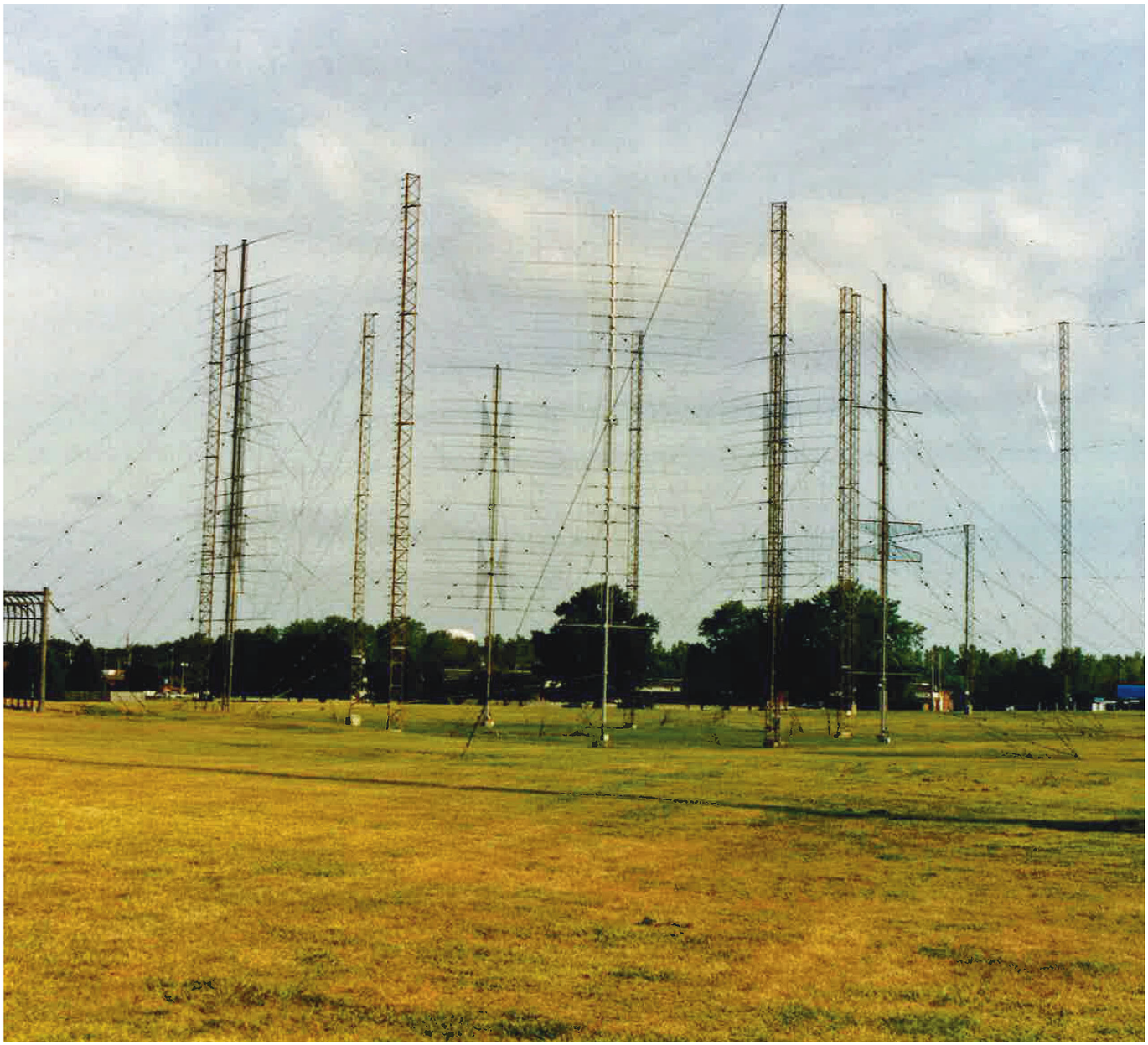
We then moved to San Diego were I started repairing Collins S-Lines for local hams -- mostly providing parts and favors. Then we moved to Maryland and the favors of repairing had turned into charging for the parts and a bit of labor. A number of local expert Collins guys became my friends, Bob Sullivan, WØYVA and Charlie Talbot K3ICH.

After I retired from Fluke in 2009 I established my Collins Rebuilders LLC company. The cost of tubes and parts got a bit too costly to give away.

Then I purchased and rebuilt a set of Gold Dust Twins and a 75A1/32V-3. Most of this gear came to me needing fixes. No fun there but it all works well today.

The Washington DC area has a large number of boat anchor repair Hams. A favorite of mine was Dee Almquest W4PNT who rebuilt Johnson gear in really neat condition. Also Howard Mills, W3HM, and I worked on many KWS-1's, KW-1's & 75A4's at his neat lab in West Virginia for over 20 years. My interest in Collins grew in San Diego. I joined the CCA in 1994 when the group was still a very small organization. Then I got a few more S-Line items, like a KWM-2A/312B-5/516F-2/DL-1.

After Maryland and the wonderful town of Annapolis we moved to join our kids and their families in the Sacramento California area. We are very fortunate that both sons have large properties and I have a chance to put up a tower and a neat beam. My present antenna is a lonely end fed wire. We live in the Sierra foothills and have my business humming along. We get lots of West Coast hams to visit my lab with Collins gear that needs work.
-73, Peter



Original Collins Antenna Farm
with both Low and High Frequency
Billboard Antennas, ca. 1950