

It's been 30 years since the Collins R-390 series of receivers first found a home at VK4QS. His current one has been in his shack for 15 years and was in need of refurbishing. Mike shares the story of his project, along with the fascinating history of this Cold War receiver.

Refurbishing a Collins R-390-A//URR Series Receiver

Plus, the Evolution of a Cold War Warrior 1950-1955

BY MIKE CHARTERIS,* VK4QS/VK4XQM

Prior to 1950, the U.S. military had been operating the Collins 51J series of receivers. The Army Signal Corps then approached Collins to develop a more advanced receiver to cover a frequency range of 500 kHz to 32 MHz. The Army also wanted improved selectivity, frequency accuracy, image rejection, dynamic range, stability, and good electro-mechanical design. Thus was born an engineering miracle, the Collins R-390//URR communications receiver.

The Contract and Security

The Collins R-390//URR was to be capable of receiving amplitude modulation (AM), frequency-shift keying (FSK), CW, and MCW (modulated CW). The details were covered under U.S. Signal Corps specifications SCL-1134-B, and contract No: W36-39-sc-44552. This order was placed by the U.S. Army Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey, and it was classified as SECRET, adding, "this document contains information affecting the national defence of the United States within the meaning of Espionage laws, Title 18, U.S.C., Sections 793 and 794. The transmission or revelation of its contents in any manner to an unauthorized person is prohibited by law."

Production and Costs

By mid-1950, the Collins engineering team had successfully completed the first units of R-390 & R-391, with both units exceeding expectations and spec-



Photo A. Front panel of the author's Collins R-390//URR. (Photos courtesy of the author, except as noted)

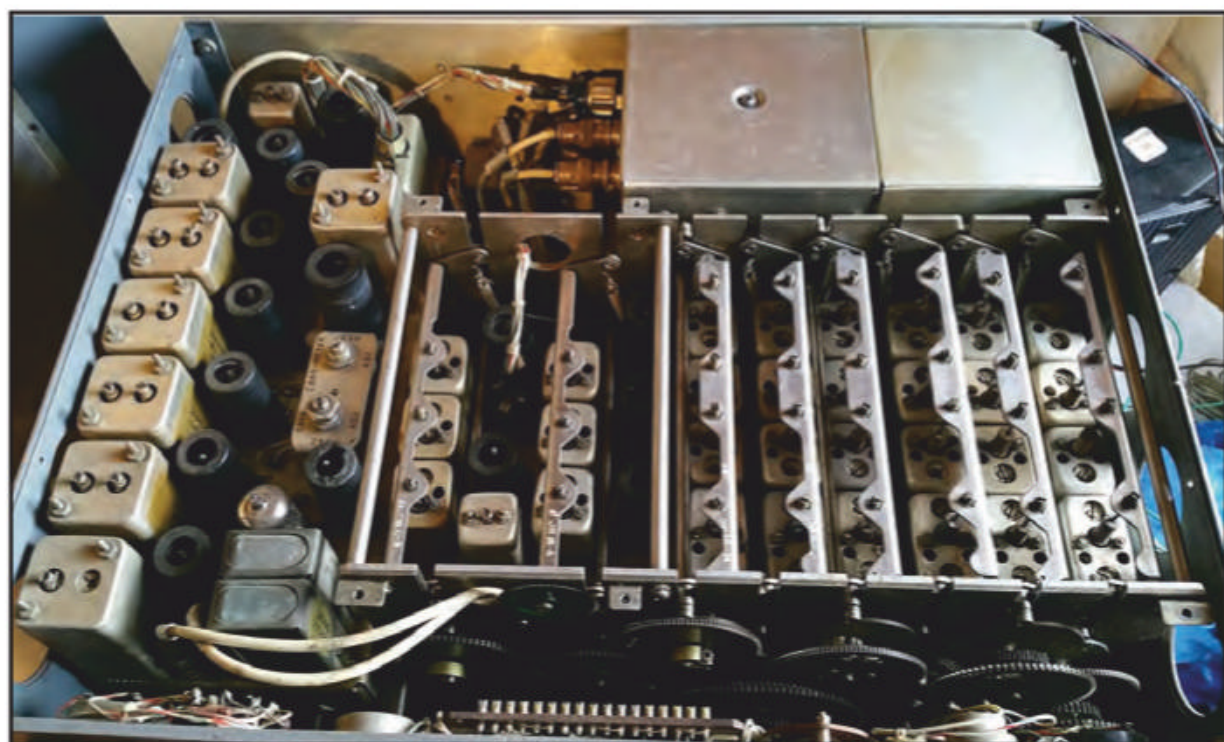


Photo B. The R-390//URR's complex interior.

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Photo C. Bert Pitt (L) and Mike Charteris, VK4QS, (R) working on the R-390-A/URR RF deck.



Photo D. R-390-A Front Panel Disconnected.

ifications of the U.S. Army. Consequently, Collins was awarded a contract to supply 3,000 receivers by the end of the year. Accordingly, a further contract dated in 1951 saw Collins manufacture another 10,000 units over the next two years. No cost was spared in the production of these receivers with the R-390 coming in at \$2,000 U.S. and the R-391 setting you back a whopping \$3,000. Based on 1950s prices, these figures equate to an increase of 978.5% for 2020 which comes to \$21,777.46 for the R-390, and a staggering \$32,666.19 for the R-391. By comparison, the average home in the U.S. in the 1950s cost on the order of US \$7,400.00, the equivalent of \$79,808.00 today.

Brilliant Engineering, 1950-53

The R-390//URR and R-391//URR were only manufactured by Collins and Motorola between 1950 and 1953

(Photos A and B). With 33 valves (tubes, for those of us in the U.S.) and no cost spared, they have been described as the ultimate valve communications receivers. They utilized a series of gears, cogs, and cams with inductive tuning and a very stable permeability-tuned oscillator, complemented by two R.F. stages, six I.F. stages, three audio filter settings, and six selectivity bandwidths.

The frequency conversion was as follows: It utilized triple conversion for frequencies between 500 kHz and 8 MHz and double conversion from 8 MHz to 32 MHz. Add to this the Veeder-Root mechanical digital readout for very accurate frequency readout down to 1 kHz or better (*actually kc and mc, since this was the 1950s – ed.*) and you have a tube communications receiver of the highest order. If this was not enough, the R-391//URR had the added feature and advantage of eight pre-settable fre-

quencies, locally or remotely, by way of a complex set of gears driven by a 28-volt DC motor. Even more amazing was the “repeatability” of this function to within 300 Hertz of the former frequency.

Complaints and Cost-Cutting

Despite the fact that the R-390//URR series had exceeded the expectations of the military across all services, there was still the nagging issue of the very high price of these units. The Signal Corps had also raised a few complaints regarding the heat generated by the unit’s 33 tubes and the side-effects it cause in the audio module. Another complaint centred on the complex serviceability in relation to the dreaded removable “green” locking gear that had to be installed before removing the RF module. In response to these concerns, a cost-cutting exercise was undertaken in late 1953 to see what could be done to modify the R-390//URR series to effect savings without compromising capability.

Transition to the Lower-Cost Collins R-390//URR

In late September 1953, the R-390 was put under the microscope, examined in detail and a list made of units and components that could either be removed for cost reduction or other improvements. These examinations were undertaken by both Collins engineers and the Signal Corps Electronic Laboratories. They were able to identify cost reductions of \$233 U.S. per radio. Now this may not seem like a lot of money, but the equivalent today is in the order of \$2,242 per unit. Now if you consider the fact that some 55,000 or so R-390-As were produced, then it runs into millions of dollars saved by the government.

The Birth of the R-390-A//URR

The next challenge was to actually build this new cost-effective R-390-A and test it for performance before contracting it out for manufacture. What came out of this research was a receiver that now consisted of 26 valves, reduced from 33, the same frequency coverage, with just one RF stage, and the I.F. stages were reduced from six to four. Once again, the frequencies between 500 kHz and 8 MHz were triple-conversion while those from 8 MHz to 32 MHz were double-conversion. The I.F. system now used “LC” type filtering to obtain essentially the same bandwidths, but retained the crystal filter for the two narrowest bandwidths as before on the R-390. A good few mechanical changes

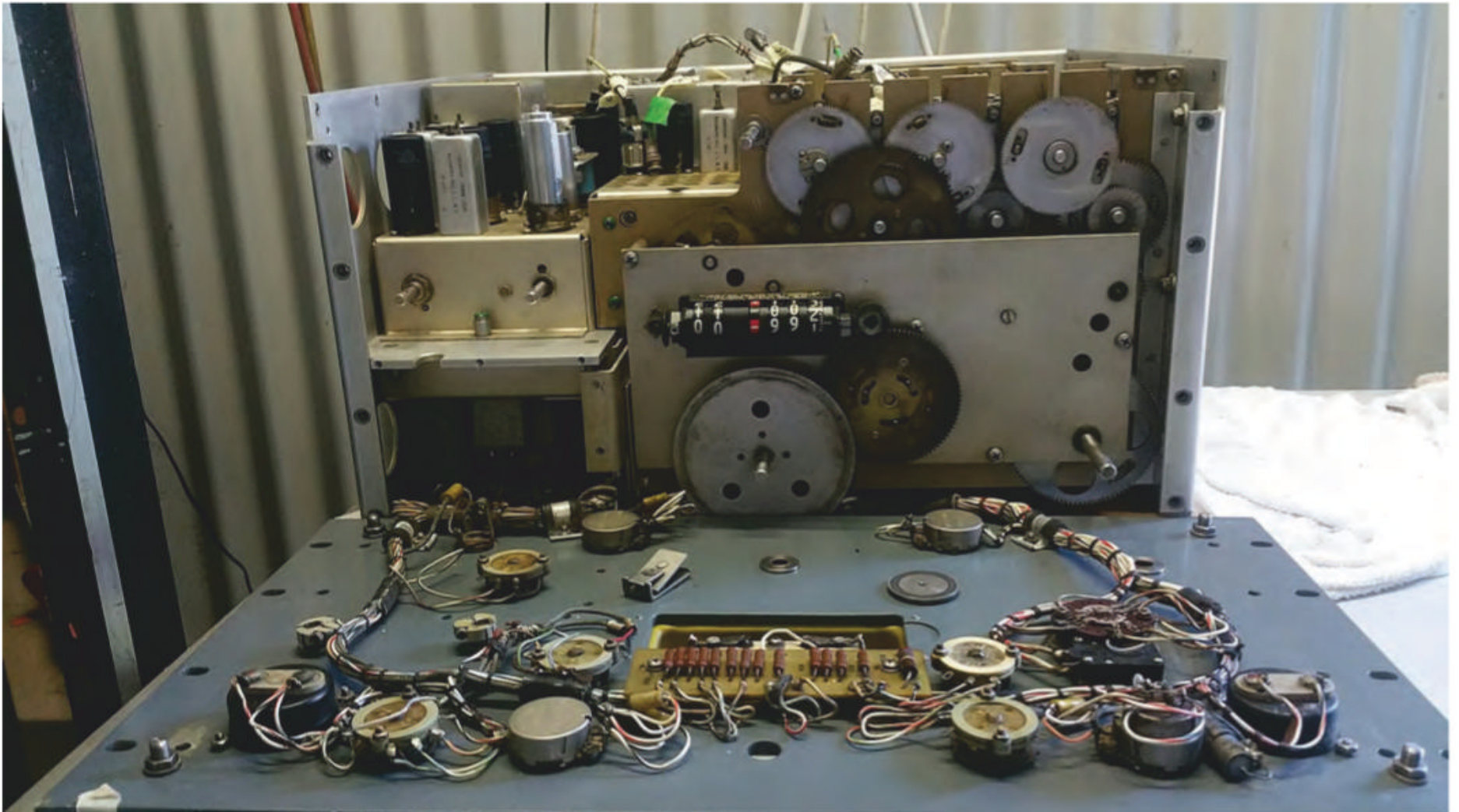


Photo E. Once unscrewed from the case, the front panel folds down for access.

were also introduced in the R-390-A to incorporate simplicity for serviceability. The full list of modifications, by way of parts and components for this new cost-reduced receiver, is extensive. Thus was born the R-390-A//URR, which saw Collins and Motorola contracted to produce 10,000 in 1954, with Collins further awarded a contract to produce another 10,000 of them in 1955. Additional contracts followed which saw the R-390A produced by many other companies apart from Collins.

My First Collins, the R-391//URR

My journey with the Collins R-390//URR series of communications receivers began in 1990 when I phoned a guy who was advertising an R-391//URR for sale. I bought the set and the seller even threw in his copy of "Ferrell's Confidential Frequency List." Upon arriving home, I set up the receiver and decided to try out one of the frequencies the previous owner had noted in Ferrell's frequency list, being 11.175 MHz. The frequency was silent apart from atmospheric band noise. I wondered what my chances were of receiving any transmissions. Just as the sun was setting, the R-391//URR burst into life with the following loud and strong transmission.

SKYKING-SKYKING DO NOT ANSWER, MESSAGE AS FOLLOWS: B3CF MT6W K4QS VQ4M ETC ... YOKOTA OUT.

I had just intercepted my first-ever Emergency Action Message (EAM), a coded military transmission from Yakota Air Force Base, located 45 kilometers (28 miles) northwest of Tokyo, at the foot of the Okutama Mountains. These messages are transmitted across the world on various frequencies simultaneously on the HF Global Communications System. From that moment forward, I was hooked on these incredible receivers and consequently, over the past 30

years, have owned many that have come and gone to the good homes of fellow Collins enthusiasts.

Refurbishing My Collins R-390-A//URR 2018 to 2020

I have owned my current Collins R-390-A//URR for about 15 years now and it has served me well despite the fact it is 65 years old and was manufactured in 1955. In the past few years, though, I had noticed that the sensitivity had dropped off considerably even though it had recently had a new set of tubes installed. So, in May 2018, I decided I would have to bite the bullet and dismantle it for refurbishment.

I thought this was going to be a very daunting task as I had never undertaken such work before, despite being a Systems Electrician working on electric passenger trains for 13 years. But I was lucky enough to have the assistance of my good mate Bert Pitt, a retired ex-Telstra Technician, who visited each Wednesday (*Photo C*). Bert's passion is the restoration of broadcast-band valve radios, to the point of building them from scratch with the precision and skill of an artisan. He had never seen a communications receiver before I gave him a Racal RA-17 to restore for his collection. Thus we both embarked on the study and refurbishment of my R-390-A//URR with a view to attaining original specifications, if possible.

Now if you've ever looked into the depths of a Collins R-390A//URR to consider dismantling it, you could be forgiven for wondering whether you could ever get it back together again. I was fortunate to have the "Y2K" Handbook for this behemoth and a lot of study was undertaken before the first screw was turned. The internet is also a fantastic resource with first-hand information articles on the restoration process from the likes of David Medley, an Australian, and Chuck Ripple, WA4HHG, who are renowned R-390 series men. I am indeed indebted to the written knowledge of these men

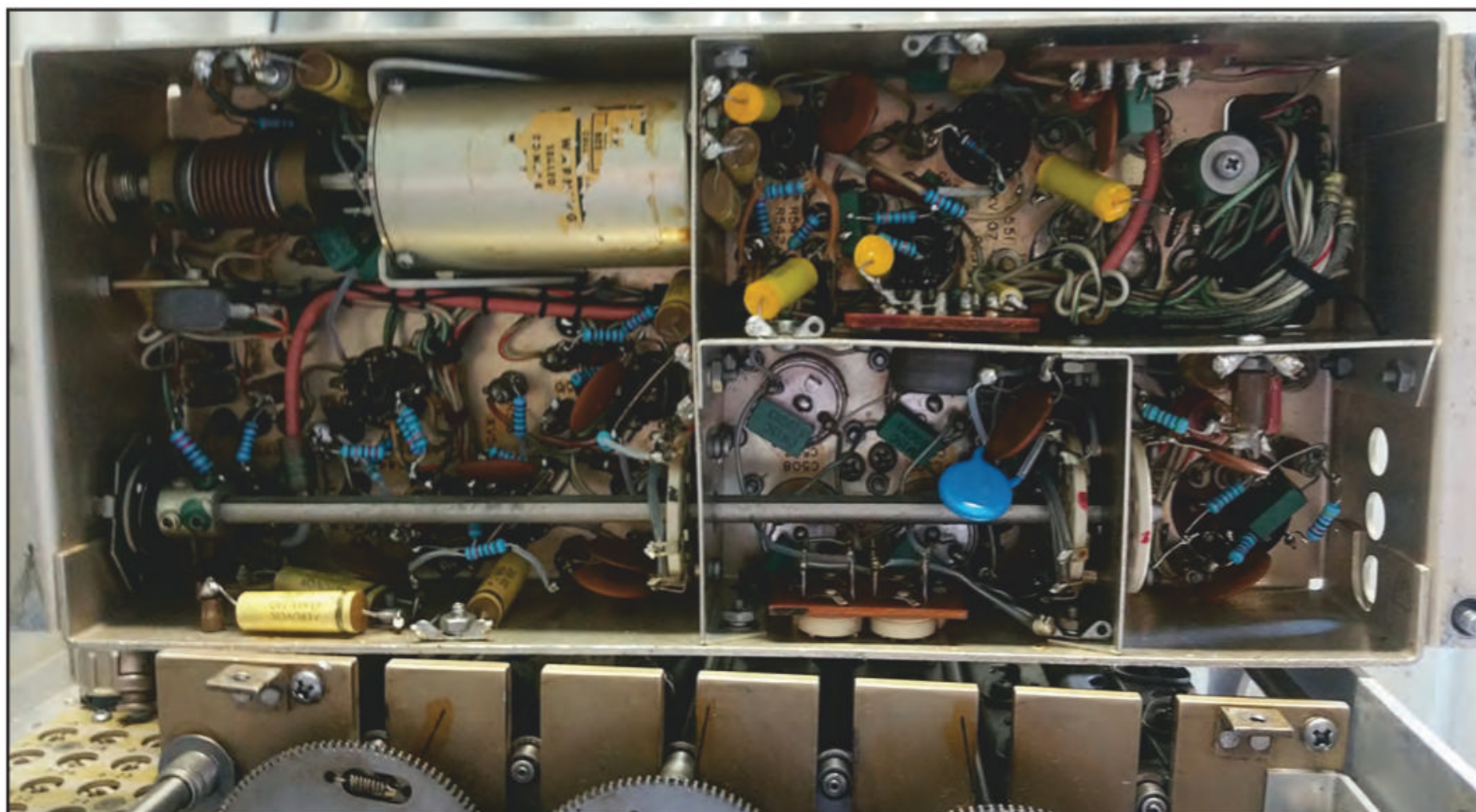


Photo F. Underside of the R-390-A IF unit.

and the contributors to the Y2K Manual for the vast amount of information covering these engineering miracles in order to refurbish one with confidence.

Removal and Refurbishment of the I.F. Module

Thus, the Phillips-head screwdriver was engaged into the first face panel screw as I embarked on what became a one-day-a-week, two-year journey. As it happens once the face panel screws are removed, all of the pots and switches of the R-390-A stay attached to the front panel to be lowered down in front of you (*Photos D and E*).

There are two coupling connectors on the inside of the panel for the BFO and the IF Unit that must be undone as well. When you get to this stage, the brilliance of this amazing receiver's construction emerges before your eyes. Once the front panel is laid forward, the GREEN cheese head captured screws holding the IF unit can be unscrewed. Next is the main multi-pin connector at the back of the IF unit that can be unplugged. This leaves a couple of small plugs that look like mini BNCs, that need to be dealt with very carefully. Now the IF unit can be removed and rolled over to reveal (*Photo F*) all the old 10% resistors and paper capacitors that have served so well over the past 65 years.

All the new blue resistors you can see are high quality 5% values that I used to replace the old ones. The first step in the refurbishment was to check the value of each of the existing resistors. Most, if not all, started out life as 10%ers in 1955. But upon being checked, most if not all were found to have significantly increased in value. This, of course, leads to the deterioration of the signal stream which sees the sensitivity of the receiver nosedive. I purchased on eBay a bulk pack of resistors covering the range of values commonly used. These were sorted and mini-bagged in group values for easy access. Once the values of the resistors had been checked, they were systematically replaced, one-by-one, in all modules. The method used was a case of necessity where-

by the old resistors were cut with as much lead as possible. Next the new replacement resistor was cut for length and then had its lead spiraled around a thin piece of wire to coil loop the ends. These were now fed over the existing lead of the old resistor and neatly soldered in place. Some did require some plastic tube insulation due to their proximity to other wires. The same time-consuming technique was applied for the replacement capacitors as can be seen in yellow in the IF unit for neatness of task.

Removing the R-390-A//URR RF Deck

Once again, when it came to removing the RF Deck, it was really straightforward with the unscrewing of a few green cheese head captured screws, undoing a couple of MBC connectors and a little bit of jiggling, and out it came. This had been fundamental in the design to enable field repairs, if necessary, to return the unit to service. As I said before, you can't help but be amazed at the engineering simplicity by which this very complicated receiver can be dismantled in virtually no time at all. To my surprise, there was plenty of room in which to work and lots of fresh air space to keep everything relatively cool. The same procedure was carried out as when all the resistors were checked for their values. True to age and form, most (if not all) were way out of their 10% value ranges and were replaced with 5%ers.

We moved onto replacing as many capacitors as possible with the same procedure of cutting to the lead, looping on the new lead and soldering. All of the disc ceramics proved ok and were left alone. Some rather tight spots were encountered (*Photo G*) but eventually were overcome with persistence.

Problematic MBC Leads

After completing the refurbishment of the R-390-A//URR, I reassembled it and switched it on. All my fears were realized when, upon being connected to the antenna, the unit was flat out receiving AM broadcast stations. We carried out further

tests with the signal generator but, alas, this unit seemed to have a giant fault that prevented it from coming to life. The main suspects were the MBC (mini-BNC) leads that after 65 years were somewhat cracked. Eventually upon examining and wiggling the MBC leads tagged in *Photo G*, it was found that one needed to be re-terminated. If you have ever made

up BNC leads, then you can appreciate how tedious these leads were at half the physical size with wires as fine as your hair and tiny bead insulators. With this now completed, we again re-assembled the receiver and applied power to it. Well, the difference could not have been more remarkable as it just about jumped off the bench as the stations came in loud and

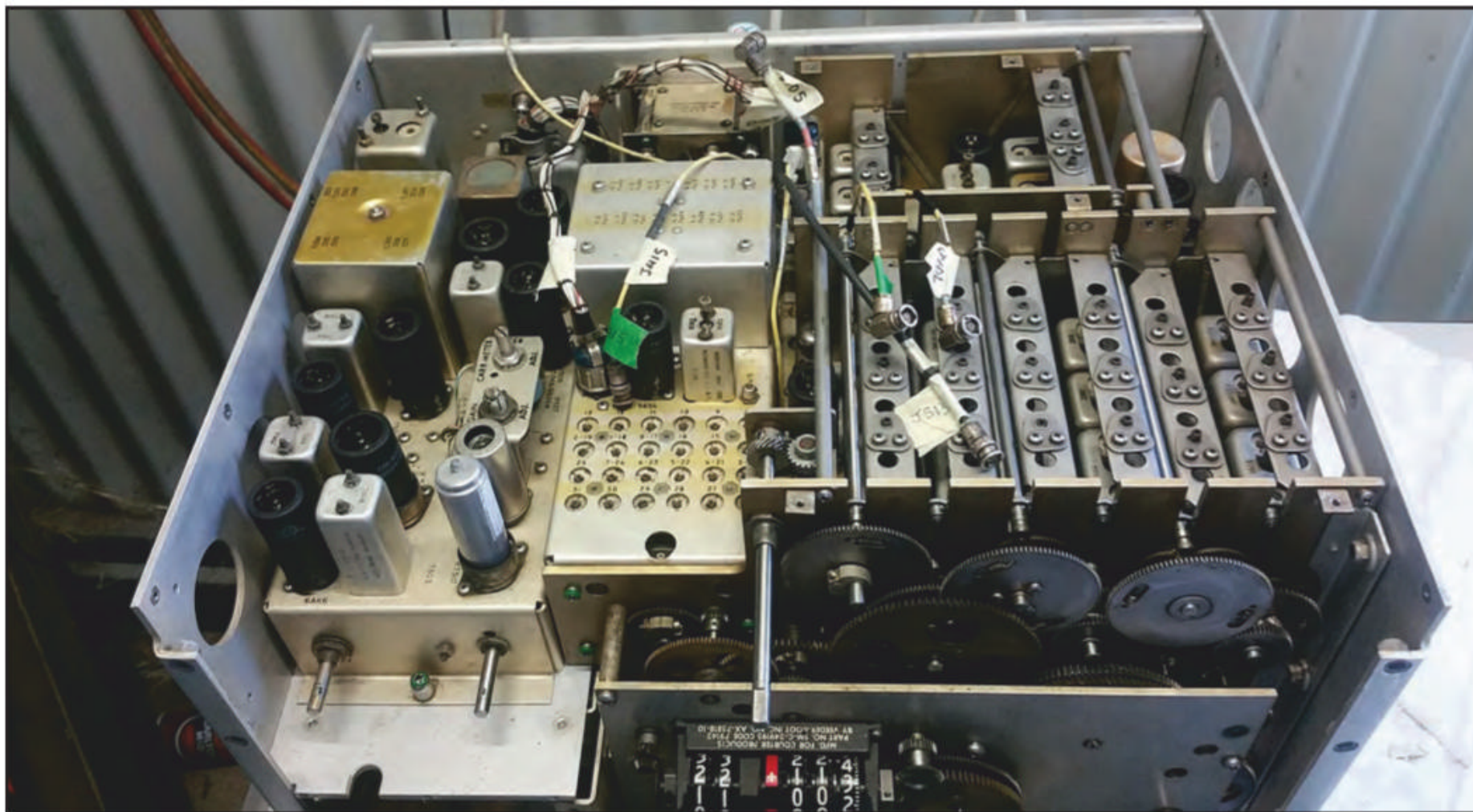


Photo G. Interior view of the receiver's top side.



Photo H. The refurbished R-390-A is now back home in the author's vintage Collins station.

clear from all over Queensland and New South Wales to Maryborough. Later that afternoon, I tuned into 40 meters for some CW and SSB with great results as strong signals raised the carrier level meter to 30 dB. Though not designed for the reception of SSB, the unit does remarkably well with a little riding of the RF gain control. Prior to this, an alignment procedure was considered, then dismissed because of the good results.

All Expectations Exceeded

A new set of valves and all these new resistors and capacitors actually saw my Collins R-390-A/URR reborn. I hooked it up to my URM-25 signal generator and injected 3 μV into the antenna socket. The response was loud and clear, so the level was lowered further to just 1 μV and, again, the signal came through pretty audibly. So, just to show off, I dropped it to a 1/3rd of a μV and blow me down if this receiver did not pick it up and show it as an audio signal. I was amazed and gratified that all my work had been rewarded with such amazing results.

What I took away from this refurbishment adventure across the course of two years was that these receivers were indeed the miracle of their day. Over the past few weeks, I have compared it to the weakest HF voice and CW signals I could find on my FTDX-9000, and my Collins is there side-by-side with bells on. Not bad for a Cold War warrior receiver that just turned 65 years of age (*Photo H*). I am looking to marry it up with my Johnson Viking Valiant in the near future to create a very nice 1960s CW station.

One thing we often fail to appreciate when sitting in front of such ex-military receivers is to imagine the places they were operated in service. Be it a ship, a submarine, a signals intelligence station in Asia or just out of the front line during a conflict. If only they could talk of the places they have been, we would indeed be privy to their secret world.

I do hope this article inspires others to refurbish one of their vintage communications receivers and to write about it for *CQ* magazine.

– Cheers and 73

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- 1) Final Engineering Report on the Collins R-390/URR, by L.W. Couillard, Project Engineer, September 15th 1953 by Des Ball & Richard Tanter
- 2) The Collins R-390-A/URR Y2K Manual
- 3) Various Websites on Collins R-390 Series, David Medley, & Chuck Ripple
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