# Chapter 9 – Supplemental Repair Information Section 1

Edited 8/09: Major Technical Additions

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## *Introduction*

It has been snidely remarked that a zebra was a "horse designed by a committee". Had the military let Collins radio handle all the manual editions, revisions, and Tech Bulletin updates for the R-390A much of what is here would not have to have been added. As all the services went about it in that "our way is: "THE right way", many variations of manuals were issued and sometimes information was dropped in the next issue. What we have attempted to provide here is the distillation of practical experience of people who have specialized working on these radios for long periods of time.

What is here is the result of feedback from the reflector list subscribers. This is a collection of information mostly from the R-390A reflector list. One superb exception is the gear train re-build article from Scott Seickel. This was never taught in tech school. Without the pictures Scott provided, a gear train re-build just using the tech manual would be an almost insurmountable effort for most of us.

Since this information was not of a originally intended to write a manual, the editors have attempted to roughly categorize the material. It is not all inclusive and there is overlap. Many complete "basket cases" have been restored to "factory new" condition. This information will aid you in reaching the goals you have for your radios. ( [After your first there will always be another - trust us.])

This can be summed up no better than by this quote from Roger L Ruszkowski who has graciously donated much material to this chapter:

**"You have a working receiver. It works on some bands. What it needs now is within your ability to provide. The US Military taught thousands of guys and some gals to convert that receiver into an up - to - spec receiver with under 4 hours of hard work using only a screwdriver, spline wrench, volt meter, 600 ohm resistor, signal generator and one hand behind their back for safety. It took the instructors 50 weeks to teach the required theory and mechanical skills to each student. It took 40 hours to teach someone every thing the military mind knew about an R-390A and what was needed to service any problem that receiver may ever have. Two Instructors taught me what I needed to know as part of a class of 10 guys. I used what I learned to fix receivers for 8 years back in 68 to 75. I have still not found a R-390A problem I could not isolate and fix. The credit goes to the receivers. The engineers at Collins did an awesome job. For as many parts as these receivers have they are still flat reliable and simple. There is not any problem in that receiver you cannot fix. Ask here on the R-390 reflector and you will more help and humor than you will need to get er done."** ***Roger KC6TRU***

Today we all can afford quality used test equipment to assist us that we could only dreamed about just a few years ago. We all can do it! Good Luck!

This chapter because of its nature will never truly be done. Additions, corrections and new material keeps adding to the chapter. It will be edited and revised as time is available then posted on the usual sites. Its size will probably have more pages than chapters 1 thru 8.

Editor's Note: The information here is not posted in its original chronological posting but rather some attempt has been made to put it in a bit of order.

## *Judging a R-390A for potential purchase*

Short of a real chopped up wire harness, almost any R-390 or newer R-390A can be repaired. If it has not actually undergone a fire, it is likely repairable.

Over the net, ask for lots of pictures. Its worth driving over to see it and bring it home yourself. Nothing like seeing one, first hand at a swap meet. Fair Radio delivers as advertised.

If it has just been setting around, these are easiest to fix. Painted front panels are about $150.00. Do not fret over bent metal, that is all fixable.

Consider your own skills. There is no reason to buy something you cannot fix up your self. Do not worry if you don't know what needs fixing in an R-390A. The folks here on the list will happily walk you through any problem. We've been there and we have done it. But you're stuck doing the work your self. You are going to have to do your own washing and soldering.

Pick a problem - any problem - jump in anywhere with it on the reflector list. We will slow you down, back you up and feed it to you step by step with the test equipment you have on hand. We will help you get to the problem's cause. Then you have to fix it yourself. If you think you would like to take a ""project" on, R-390A 's are great "projects"". You can buy almost anything and get it operational. Over the long haul, the cost of tubes will be your biggest expense. You may do a one time tear - down with cleaning, new caps and some rework. The missing knob or meter can be costly. Mostly, the issue is finding time to make the repairs.

Back in the old days, ('68-'75), I never saw a problem that was not located with more than a signal generator and a volt meter. Neither needed to be calibrated or very accurate. Obviously, more is good, but not required. Older receivers are now presenting problems that take more thinking to solve their problems, or more careful inspection and test. But you do not need a laboratory of test equipment to support the receivers.

Over $650.00 you better be getting a fine receiver from someone on the list or past list member who put more hours than you want to know about and love into the receiver. If you can afford it you're still stealing the beast. Pay your dollars and run home with it.

$650.00: - Really good looking paint job, smoked inside. (you're buying a paint job)
$500.00: - Original paint and meters good, working receiver.
$450.00: - Original paint lost meters good, working receiver.
$400.00: - Original paint meters, ""It was working the last time it was powered on before the kids were born.""
$300.00: - It is at least all there. No real obvious missing broken parts.

For things missing subtract the cost of item from Fair radio and $100.00 for repair time, even if you are doing it your self.

Would I spend more than $650.00 on a receiver? From the right guys on the R-390 reflector, in a New York minute! Would I walk past one in a swap meet? Only when I have spent all my money.

***Editors note:*** **Prices have risen dramatically since this was written.**

### *Where to Start with a New Radio?*

Where do I begin?

Ah yes, the old "yesterday it worked today it does not problem".

Number zero if you have an R-390/A/A check C553 in the IF deck. If this is a brown or black plastic cap that looks original, replace it NOW. If this cap shorts or leaks it kill the mechanical filters. Use a .01μF 600 volt Sprague "orange drop" or other high quality cap.

Number one due to the hours of tube time used, all the tubes need to get checked. Likely you do not own a tube checker. So task one is to locate a shop that still has a tester you can use. Just finding a shop or parts house with a tester can be a job. Sooner or later, you are going to need to check the tubes and start weeding out the weak, noisy and bad ones. Getting a set of tubes that are good will likely get you some signals back. Then you will need to get into an alignment.

Number two is to find your self one of those silly spline keys to fit all the RF slug rack, cam clamps, and knobs. A good tool store. You can grind an L wrench off, solder a length of spline into a tube to make a long screwdriver tool. A once in a life time task.

Number three is to find your self a long #1 Phillips screwdriver. Get a #1 as a #2 is to fat for some spaces. Long. as in to reach into all the recesses to the green screws.

See the info below on noisy pots and getting them cleaned. Also see the section on cleaning up your gear train.

Back in 1999 the fellows did an awesome job of producing a great manual for the R-390/A on line and available also on CD. The work got titled *The Y2K Manual.*

You can fix your R-390/A yourself, no problem, if you have a voltmeter you can do a reasonable job of getting it aligned from just the Calibration tones.

If you have a voltmeter, an RF signal generator and the Y2K manual, you can read and adjust your receiver back up to a great receiver.

After old tube problems, the R-390/A has some sorry caps. Old age is getting the electrolytic filter caps. There are a bunch of brown or black plastic caps that fail. These just get replaced. Filter caps plug in. New ones are hard to find. You can put new caps in the old can. Put new caps in 8 pin octal tube sockets and plug those in. You can put caps in relay cases and plug those in. The brown or black caps just get replaced in circuit. New caps are smaller than the original. You will be amazed at how much space is under the deck after you get those caps all replaced.

Go read the R-390 archives. Lots of good detail. Lots of dead horses to read around. After reading for a day you get some topics to read on and then sort and read by thread.

You will want to deal with the 26Z5s being replaced with diodes. The ballast tube being replaced.

## *RF Signal to Noise Testing*

A short dissertation of what happens when a sig-gen, such as an URM-25() is used without consideration of impedance matching, RF leakage, etc.

Now this is a very dead horse in the archives. Mostly no one has an isolated shielded environment where impedance matching makes a "measurable difference". From a practical point of view in any ham shack you just ignore it, because the leakage exceeds any gain from cable matching and/- or impedance matching.

At the real levels in use, the open bench work area, and the leakage, the effort to shield things and do matching exceeds return on investment. Accept that thousands of technicians working on thousands of receivers for half a century did not even venture down this path and produced good results every day. There is an explanation for why this has worked. It is scientific. It stands up to good logical investigation. I do not have the exact data here to pass on in this mail. Hopefully someone will dig it out of the past mail and post it again. It's Christmas and we can put it on the wish list.

Addition three: Same thing in the above paragraph to the RF section all the while hoping for the 20dB difference between modulated signal to un-modulated signal. Of course ignoring impedance matching between the sig-gen/receiver, RF leakage, plus the antenna to be used with the receiver will vary your results in real life.

Exact calibration level and signal generator level is not required for this test. Exact output level is not required for this test. If you hang a 600 ohm 1/2 watt resistor (1 watt preferred, 560 ohm is OK) on the line output of the receiver you can use the line level meter for your output measuring device. The meter of military choice was exactly a TS585 test set. This is a milliwatt / dB meter with range switch and internal load resistors. One load resistor is 600 ohms and about 10-watt (de-rated because its in the case to 5 watts). Any AC voltmeter with a dB scale will work. Better meters and finer granularity of dB values just aid in getting the job done. Beyond the scope of this Christmas gift is the fact that with some math, just a plain AC voltmeter can be used to meter the local or line output of the receiver for this test.

So the signal generator does not matter, the output meter does not matter; the cabling does not matter. What counts is a relative difference in output meter reading when the signal generator modulation is switched on and off. All this gets you is a relative merit value of your receiver on any given day. It is not calibrated and it will not travel across the internet in mail as, "my receiver is better than your receiver," because we have no clue as to the wholesomeness of any of the receivers, equipment or people involved in the comparison of the two events reported to have been conducted on planet earth in one or more of its current dimensions or incarnations. This silly little test *does* work to determine if the last, tweak, tube swap, change, adjustment, fiddle, nudge or whatever was an improvement.

Why does this test need the un-modulated signal? Because with no input to the receiver, the front-end stages do not produce an output of the first stages noise into the next stage and thus yield a noise level at the output. So one test-state is with a continuous signal activating all the stages and providing an output that reflects all of the receiver noise.

Why does this test need the modulated signal? This provides the test with a second different state that can be compared to the first state. (Someone please jump in here with some good real explanation of the signal - to noise - test.) We were asked quite politely as a Christmas wish. I'm begging here not beginning here. (See past post).

Actually the modulated signal is richer in content and more of the receiver noise mixes with the modulated signal to produce a greater output level. Greater output level is not by its self, good. Observe that as we make changes to the receiver and inject the same modulated and un- modulated signal the difference between the two test states increases (good) or decreases (bad) and the relative output power may go up or down (indifferent). You may change one tube then measure; less noise less power (OK), less noise, more power (good), more noise less power (very bad) or more noise more power (bad).

More or less power is not the true grail. As long as there is the required ? watt (OK 0.4-watt). The exact input level is not critical the exact output level is not critical. Notice that the absolute noise of the signal generator is not an aspect of this test. As long as the modulated signal from the generator is not so microphonic that every thump on the bench pegs the output meter. Some is OK as long as you let the setup rest while you are trying to evaluate the output meter reading. Again moving targets should be avoided.

Accept that any change you make to the receiver that lets you reduce the signal generator output is good. Accept that any change you make to the receiver that produces a larger output meter reading between modulated and un- modulated signal is good. The method of coupling the signal generator into the antenna input is not critical because the leakage of the equipment on the bench often exceeds shielding provided by the test setup. Here impedance match can be ignored for much the same reason. On the output you do want to provide a 600-ohm load. 600 Is the "manufactures recommendation" 550 - 800 is likely OK. A wattage rating large enough to not smoke and change the resistance value during the conduct of the test is sort of nice. I hate working with moving targets. The output meter scale is not critical. It need not even be a dB scale. The right scales and easy to read numbers just makes the project more fun. More difference in range between the two test states is good. Having the value in dB across a 600-ohm load just takes the math out of the problem. Hang a 600-ohm resistor across the line output and use the line meter to find the dB ranges on your AC voltmeter. The better resolution of the AC meter will help you judge if small differences are better or not.

The military required 10:1 ratio in these two test states. The military required 0.4 watt output for 4 micro-volts of input. Collins engineers did a very good job on the design. We find that with good lab grade calibrated test equipment in very controlled test setups, the receivers will do 20:1 any day of the week even after half a century. Back when (68 -75) I saw receivers do 30:1.

Using just military calibrated test equipment, miss matched cabling, no extra shielding, just setting on the bench, one side of the balanced antenna input grounded, long ground straps from receiver to a bench ground that went forever to the station ground, and a TS585 for a load resistor and output meter.

That sorry test setup was used every day by every one in service. The test got good receivers up to the best we could get out of them. We'd shoot for a 20:1 ratio. If you were not getting it easy, you went looking for a few good tubes to install. Tweaking will bring the whole power level up and it will help the ratio. But you cannot tweak a receiver up to 20:1 if the tubes are not up to it. Tweak 20:1 on some poor tubes and you can have 25:1 just by swapping in some better tubes.

Exactly what were we getting? Who knows? But it was every thing those receivers were capable of. We could determine if every change we did was making the receiver better or worse. You just had to know your limitations.

How dead could you beat that receiver before the horse-meat began to smell so bad you got banded from the mess hall at mid-meal time. There is just no exact absolute benchmark in this test. But getting a 30:1 ratio was an all day job with a supply room that had all the tubes I wanted at no cost to me and no restocking charges.

At what RPM does your Mustang idle? Who knows. But you know when you get it down low and smooth enough so it fells right and does not stall at the stoplight. Where does your Mustang red line? Who knows. At what ever you need to dust that thing in the other lane.

So for the RF test, This is the full receiver from end to end. Specification is 10:1 signal to noise at 4 μ V in and a 0.4-watt out across a 600-ohm load.

Wonderful life is a 20:1 ratio and about 4 μ V in and 400-Milliwatt (0.4-watt) output. Never mind the impedance match or shielding. The exact audio modulation frequency is not critical. The URM-25 had 1000 and 400 Hz. We used 400 HZ just to save our ears.

Run the signal generator into one side of the balanced antenna input.

Ground the other side of the input IF bandwidth switch set to 2KC.

| | | |
|---|---|---|
| Antenna trim to max. | RF gain to Max Function to Manual | Limiter off. |
| KC and MC to peak the signal pass. | AGC not being used. | BFO off. |
| AF gain to Max. | | |

What did I miss? Like it says in the TM. Someone quote the Y2K paragraph just to drag this horse a few more yards.

Paragraph 93 Sensitive Test in the TM details this test. (Almost no one has a copy) The procedure calls for a ratio of 10:1 in milliwatt on the TS585. We would get a 20:1 ratio with this test set up. You can fudge a 30:1 dB ratio if you work at it.

**To do a by the book 10:1 we would set the AN/URM-25 for 4.0 micro-volts.**

1. Set AF and RF gain to max.
2. Adjust the IF gain for 0.4 watts with the 30 % 400 hertz signal. This is also 26dB on the TS585 meter (16+ 10).
3. Back the local gain off some. Switch the meter down one step.
4. Back the local gain off unit the TS585 reads 10 milliwatt (10dB).
5. Turn the modulation off and switch the meter range down until you get a meter reading.

To pass the test you needed to switch the meter down one step.

This was down 10 dB and from the 10-milliwatt range to the 1-milliwatt range. The meter had to read less than 1-milliwatt (1dB) to pass this test.

**For the 20:1 20 dB test we would set the AN/URM-25 for 4.0 micro-volts.**

1. Set AF and RF gain to max.
2. Adjust the IF gain for 0.4 watts with the 30 % 400 hertz signal. This is also 26dB on the TS585 meter (16+ 10).
3. Back the local gain off some unit the TS585 reads 100 milliwatt (20dB).
4. Turn the modulation off and switch the meter range down until you get a meter reading.

To pass the test you needed to switch the meter down two steps. This was down 10 dB and from the 100-milliwatt range to the 10-milliwatt range.

Plus down 10dB from the 10-milliwatt range to the 1-milliwatt range. The meter had to read less than 1-milliwatt 1(dB) to pass this test.

**For the 30 dB test we would set the AN/URM-25 for 4.0 micro-volts.**

1. Set AF and RF gain to max.
2. Adjust the IF gain for 0.5 watts with the 30 % 400 hertz signal.
3. This is also 27dB on the TS585 meter (17+ 10).

Turn the modulation off and switch the meter range down until you get a meter reading.

To pass the test you needed to switch the meter down two steps and watch the meter very close.

This was down 10 dB and from the 100-milliwatt range to the 10-milliwatt range. Plus down 10dB from the 10-milliwatt range to the 1-milliwatt range.

The meter had to read less than 1-milliwatt (1dB) to pass this test. If you had a good clean reading at 1-milliwatt 1 dB you were at a 27:1 ratio. If the meter would peak on noise at less than the number 9 mark on the meter you were down 30:1. This was of course a judgment call and you had to work at getting a receiver to do it.

I have read this a couple times and I think I have this all correct. Roger KC6TRU

## Achieving the 30dB Goal

A blow by blow account of what to connect, where to connect, the values are we looking for, and the correct order of tubes to swap while measuring for the 30dB goal. Is that clear??

Warning this diatribe will induce drowsiness. Warning most satire was left out and this is no fun to read. But it was asked for and I offer it in the spirit of the Season. May you all enjoy. If any one wants any thing more, just ask. I'll give it another shot. I can fix them myself faster than I can write about it. Roger KC6TRU

Ok so you have run all the subassemblies through the dishwasher. Pulled the RF deck, cleaned the gear train and lubed it with the magic synthetic Mobile oil. Everyone that went this far was sure to visually check the RF band switch alignment. Some have even taken the whole frame out in the summer sun light and given it a bath. A few more have removed the front panel, sanded it clean, scraped out the engravings an applied non military paint like things to the panel. Then all the parts were heaped back inside, the green screws (bolts) were snuggled up (yep snuggled), the connectors connected and the RF deck cover replaced, many more than the recommended tube shields inserted, all the knobs checked and twiddled, some (like me) mounted the micro dial on the BFO shaft, a few more installed the "@RARE@ dial bezel with @SPOOK@ cover to arrive at one specific incarnation of a good looking receiver. All this effort has been dully noted and good credit standing with Santa applied for.

Then the shocking receiver was placed on the "bench" and properly grounded so that it could be checked to be a working receiver. After much tube testing, tweaking and other maintenance procedures as described in the manuals were completed the receiver was found to have a calibration tone on every 100 kilohertz. The signal generator was attached to the antenna input, the voltmeter and load resistor attached to the output, the calculator dusted off and the End to End sensitive test was performed. After some button smashing on the calculator, review of math and magic thumping of test equipment, the receiver is found to clearly pass the military 10:1 signal to noise ratio any where on the dial. Some spots almost made 20:1 but the receiver clearly passes the 10:1 with less than 4 micro-volts in and .4 watts out. All this effort has provided a working R-390/A receiver in much better condition than some things we have seen sell on E-bay. At least you know what state your state is in and that's a step ahead of some things we have seen sold.

You have solid stated the rectifiers. Inspected the caps and replaced the brown and black critters. You have looked under all the subassembly decks and fixed any charred resistors, leaky caps and other real problems. You have the RF band switch properly adjusted by visual inspection.

You have the crystal oscillator switch adjusted by visual inspection. You have the dial over run set. You have the Zero adjust set. You have the detent load set. You have the mechanical alignment set. You checked the slug racks for nice operation. You have resolved your ballast tube problem to your satisfaction. You have the power supply caps on the Audio deck under control. You have the PTO end points set to your satisfaction. You have been through the RF alignment more than once. You have watched the receiver glow in the dark both the top side and the bottom side and none of the tubes have that that unhealthy blue glow in them. The 5654's tend to get it first. Then the 6C4's. Just using what you have you are doing the best you can. But maybe you can get a bit more with what you have if you just had some inspiration.

You have a good working R-390/A and you have done the real right stuff to get it up to snuff. You have done all the right stuff, But you've been watching Emeril Live and you want to kick it up a notch. Its Christmas and you deserve some additional sensitivity. Besides the sun-spots are not all that good this year and you need some additional sensitivity.

You have been reading the E-bay pages and other things where you have seen allusions to receivers that do better than just pass requirements and work. You have explored this subject and understand that if you just replaced every tube in the receiver it could be better. A quick look at some tube prices and your pocket book tells you that that approach is not practical. Asking for a tube tester is not a solution to the problem. A more selective scientific selection of tubes to place on the Christmas Wish List is in order. You could get every tube you ask for no matter what the cost if you approach the request with rational. That I want it may fly with the children but these kinds of glow tube procurements need a bit more presentation to get through the wifely procurement approval process.

So you put out an E-mail request for some help to the R-390/A reflector Fellows and start asking for the inside real spook tips on how to get this done. All right enough ducking and dodging. Enough introduction. Enough procrastination. Its time to fish as I am not cutting no stinking bait. I did the RF end to end sensitivity test in dB milliwatt and too much detail. So I will do this tube time in AC volts across a 600-ohm resistor. All in plain text as tables do not go through my mail tools. That's My choice and I'm sticking to it. Beat the 600-ohm problem with a pair of 1.2K ? watt resistors. A pair of 1.2K ? watt resistors will work. Pick you AC meter with the most readable scale. Go digital if you must. Warm up the signal generator.

OK so you have this receiver on the bench. Its semi time. You did a good face wash, mechanical check and electrical alignment. You do the RF end to end sensitivity test described in part 2 of Christmas wish list and the receiver fails to get the 20:1 you need to have the trick chief hack off on the paper work so you get down the hall and on to important things. Where and how do you start trouble shooting this receiver problem. The receiver is aligned. Its OK. It works (sort of). It has no specific problem. It just does not pass the shops 20:1 signal to noise test setup. I've seen this done twice a day, six days in a row, took a trick shift (2 days more or less) off and did it again for years. You need to know how to deal with this problem. It is not in the manuals. It was taught in school.

You need a minimum tube test set of each type tube in the receiver. (More is good but not required) For every tube type you need N-1 tubes. There is one 6DC6. N-1 is zero 6DC6 in the tube test set. There are 3 6C4's one is in the first mixer. Above 8 MHz the receiver uses only two of the 6C4's So N-1 is 1 6C4 in the test set. The 26Z5 are sand state and need zero. The 0A2 either lights or got replaced. N-1 is zero 0A2. The pair of 5654 AKA 6AK5 needs 1.

The three 6AK6's need 1 because the line and local are in parallel and you only meter one branch. You need 4 each 5749 AKA 6BA6. You can grab the 5814's out of the calibration area and V509 for the theses test, but 3 each 5814's help.

**So you need:**

| | | |
|---|---|---|
| 1 signal generator (and wire to antenna input) | 1 6AK5 | 2 6AK6 |
| 1 AC volt meter (and test leads) | 1 6C4 | 2 6BA6 /5749 |
| 1 600 ohm resistor | | |

That's the ingredients

**For the 60's Vets EXACT**

On the back of the receiver is J116. On the outside this is a BNC connector. On the inside this is a mini BNC connector. If your receiver is missing this item ask Santa for one this Christmas.

On the inside of your receiver is a coax with two mini BNC numbered P116 and P114. The P114 connector should be attached to J514 on the IF subassembly. The R-390/A did this sanely in BNC cable and all this mini stuff is avoided. If your receiver is missing this small assembly or it does not have continuity ask Santa for one this Christmas.

Set the signal generator up for 455 kHz, 150 micro-volts un-modulated. For those with a copy of the TM. this is paragraph 73 Adjustment of GAIN ADJ Potentiometer. Right out of the TM and to follow here in detail. But for reference and history just so every one knows where this stuff is being drug in from. Some people with keyboards say I miss the truth some days. Its close to Christmas, My wish list is in and I'm not about to jinx my chances with any fibs here. Understand?

If you were doing the electrical alignment of the receiver and got to paragraph 73 to set the IF gain R519, and knowing that proper prior planning prevents poor performance, you would make a could switch flips while in the conduct of this test and ensure the IF and audio deck was going to make the grade when you get to the end to end sensitivity test. Paragraph 73 has no clues on how to do a signal to noise test on the IF and Audio decks. This is where the inside information comes from. Believe you need a 30:1 ratio here. Exact reference to a voltage or power level is not needed. Exact calibration is not needed. The signal generator should be in the 2KC-band pass as best you can rock the generator into the band pass. The mechanical filter is not tunable, so you have to rock the generator into the filter. The 150 micro-volts is not exact. The 150 number is what got published in the book. Crank your generators output to 150-micro-volts and accept it.

If I have no frequency counter how do you get my signal generator set to exactly 455? And the follow on question is how do I get the BFO set to exactly 455 and the knob pointing at zero? Glad you asked and it offers a nice transition into the next paragraph.

1. Un-hook P218 from J518. Tube pullers worked good for this.
2. Un-hook P213 from J513. Tube pullers worked good for this.
3. Un-hook P114 from J514.
4. Hang a 600-ohm resistor across terminals 6 and 7 of TB 102.
5. Hang the AC voltmeter across this load resistor.
6. Set the local gain to max
7. Set the RF gain to max
8. Set the BFO off
9. Set the limiter OFF
10. Set the function switch to MGC

**To set the signal generator on frequency do the following :**

1. Back the signal generator output down very low.
2. Turn the BFO off.
3. Set the band width switch to 1KC.
4. Hook P114 to J513.
5. Turn the signal generator modulation on.
6. Set modulation to 30% and 400 Hertz as published in TM paragraph cited above.
7. Hook the signal generator to J116 using a suitable length of coax and connectors as required to make the setup.
8. Rock the signal generator into the 1KC band pass while watching for a AC volt meter peak.
9. Set the band width switch to .1KC.
10. Rock the signal generator into the .1KC band pass while watching for a AC volt meter peak.

This gets the signal generator peaked into the 455 crystal filter of the .1KC band pass.

**To set the BFO to zero do the following;**

1. Turn the modulation off on the generator.
2. Turn the BFO on.
3. Tweak the BFO Pitch knob to zero beat with the signal generator, while watching for an AC voltmeter null.

If null is not with the knob pointed to zero, perform a shaft clamp adjustment as required to correct problem.

**Do not** adjust knob to shaft. Shaft at knob is burred and will not adjust easily. Spline bolt in knob is inaccessible at BFO zero.

Set clamp inside front panel so Spline bolt is easily accessible while making this adjustment. (Just some inside info not in the TM.)

1. Turn the BFO off.
2. Set the generator output to 150 micro-volts turn the modulation back on and peak it into the 455 crystal as best you can.
3. Un-hook P114 from J513
4. Hook P114 to J518
5. Set the band switch to 2KC

You will likely pop the top off the mechanical filters here and trim each cap up to the best you can. This is a subject for another mail. You may neutralize the BFO at this point. This is a subject for another mail.

**Set the IF gain adjust as follows**. (I can name five ways to do this "properly" For this test do the following and readjust later if necessary.)

1. Hang a DC voltmeter on the diode load to ground.
2. Set the signal generator modulation off.
3. Set the signal generator output to 150 micro-volts.
4. Set the BFO off
5. Set the bandwidth to 2KC
6. Set the function switch to MGC
7. Adjust the IF gin R519 for -7 volts on the DC load.
8. Remove the DC meter.

As long as you are here, you may as well check to see if this receiver IF and Audio are going to make the signal to noise test. You can do it now as part of the alignment of come back as part of your trouble shooting. As long as you are here. 400-milliwatts across a 600-ohm load is Volts = square root ( P * R) = 15.4919 Volts = square root (0.4 * 600 )

**Verify the local gain as follows**

1.) Set the signal generator modulation on.
2.) Set the signal generator output to 150 micro-volts.
3.) Set the RF gain to max
4.) Set the local gain to max
5.) Set the BFO off
6.) The AC volt meter on the local gain must exceed 15.50 volts. (It could even be twice this voltage)

**Verify the line gain as follows**

1. Set the signal generator modulation on.
2. Set the signal generator output to 150 micro-volts.
3. Set the RF gain to max
4. Set the line gain to max
5. Set the BFO off
6. Move the AC volt meter on the line gain with the load resistor
7. Output must exceed 15.50 volts. (It could even be twice this voltage)

**Note**: The line level meter will flat peg out on the +10 meter setting. 100-milliwatts across a 600-ohm load is Volts = square root ( P * R) = 7.745 Volts = square root (0.1 * 600 )

8. Reduce the line gain from max until the AC voltmeter reads 7.745 volts.

The line meter should read 20 dB +10 on the switch and 10 on the meter scale.

I know this is tricky math but follow along.

Ok a 150 micro-volts modulated 30 % with 400-hertz tone should produce .4-watts of output into a 600-ohm load on both the local and line outputs. The power gain is there. Both channels work. The line meter works. The BFO is set. Run through all the 2, 4, 8, and 16 bandwidth switch settings and check that the power is up. All the mechanical filters are at least passing signal. You checked the .1 and 1 when you rocked the generator to 455. Depending on what modifications you have made to the caps in the audio section, the power output may be over 1 watt. At least a ? watt in a stock deck.

If you have -7 volts on the diode load and less than ? watt out of either audio channel you know you are looking for poor tubes between the diode load and the output. Grab your schematic and see which tubes are in the line.

If you have trouble getting -7 volts on the diode load, look at the 5749's and 6AK6 in the IF deck. The diode load should crank to -10 or -15 on the end of the resistor range.

Ok a 150 micro-volts modulated 30 % with 400-hertz tone should produce .4-watts of output into a 600-ohm load on both the local and line outputs. You can do the signal to noise test on either the line or local. You can do them both at the same time. If they are not equal you now the 5814 and 6AK6 in the audio deck is the difference between the two outputs.

Ok a 150 micro-volts modulated 30 % with 400-hertz tone should produce .4-watts of output into a 600-ohm load on both the local and line outputs.

To get the receiver to pass a 20:1 one signal to noise test this much of the receiver must be able to demonstrate a noise level that is 30 dB down from this output. 30 dB in AC volts across a 600 ohm resistor is 16.67 volts.

**Verify the IF and audio noise range as follows.**

1. Set the signal generator modulation on.
2. Set the signal generator output to 150 micro-volts.
3. Set the RF gain to max
4. Set the local gain to max
5. Set the BFO off
6. Set the band width to 2KC
7. Set the limiter off
8. Set the function switch to MGC.
9. Set the audio gain for the channel under test so the AC voltmeter reads 17.32 volts. This is .5 watts into a 600 ohm load and equivalent to27 dB.

10. Set the signal generator modulation off.

The AC voltmeter must read less than 0.65 volts.

**This test is not exact. Set the Audio as high as it will go.**

1. Turn the modulation on.
2. Read the AC volts.
3. Turn the modulation off
4. Read the AC volts
5. Is the difference more than 16.5 volts? Yes, you are OK. No, you have work to do.

Seeing all these silly AC voltages you understand why a nice Analog AC voltmeter with a dB scale and range switch you understand how to use is nice here. With a dB scale on the meter you just read the max dB level with the modulation on. Switch the modulation off and read the meter in dB again if the difference is greater than 30 you pass go and collect $200.00: if not you have work to do.

What do you do when you do not have the 16-volt or 30dB difference?

Round up those tubes. We know from life that front to back makes the most difference. In this test setup V501 is first and that 6AK6 in the audio channel is last. Some AGC tubes are out of the circuit. The exact order is as follows V501, V502, V503, V504, V506, V801, V602 and V603 or V604. That all there is in the test string, eight tubes.

Pull the BFO and PTO 5749s for test critters. Pull V508 for a test critter. V502 and V503 are under control for this test. V501 is the test socket. 5749 / 6BA6 is the test subject.

If you have two extra 5759's install them into V502 and V503. If you have been here and done this before you have the two poorest 5749 you own marked and ready for this test.

Run the test.

**Verify the IF and audio noise range as follows:**

1. Set the signal generator modulation on.
2. Set the signal generator output to 150 micro-volts.
3. Set the RF gain to max
4. Set the local gain to max
5. Set the BFO off
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This is .5 watts into a 600 ohm load and equivalent to 27 dB.

10. Set the signal generator modulation off.

The AC voltmeter must read less than **0.65 volts**.

**Swap the 5749 out of V501 and repeat the test.**

1. Did this tube provide a higher maximum voltage?
2. Did this tube provide a wider range between modulation on and modulation off than the first tube?
3. Check all the 5749's you can round up and rank them. More range is best.
4. If you do not have spares, swap the poor ones into V502 and V503 and run them all again.
5. If you do not have spares put the poor one in the BFO
6. Put the second poorest one in V508 AGC IF AMP.
7. Run the receiver in MGC do not listen to SSB or CW and wish for (a) 5749 for Christmas.

First put the very best 5749 into the PTO.

Second put the next best one into V501.

If this set up will not pass the 30:1 ratio test here, then put the best one in V501 and wish.

Third put the next best into V502,

Fourth is V503.

Fifth is V505 (BFO)

Sixth is V508 AGC.

Save at least two of the 5749's for test.

Any tube that will not get you the 30 after 2 spares is a discard.

Save the rest if you have them.

The next time you run this test put your two weakest but (hopefully) passing 5749's into V502 and V503 and grade all the other 5749's you can round up. Install the best of the 5749's and re-grade all the spares so you know which will at least pass and which bottom end ones to save to start the test with the next time.

**You next test the 6AK6's in V504.**

You need to leave one in the audio channel you have the meter on. You can swap the other audio channel with V504 and pick the best one to go into the audio channel under test. Then check that one against the third one again for comparison. Put the best one in V504 and the second best in the local channel V603. If you have one spare 6AK6 to start with you can rank all three and place them in V504, V603 and V604.

**You next test the 5814's in V602**
This socket tests both side of the tube at once in series. You can pull almost all the 5814's in the receiver and rank them.

You need to have a tube in V506 the detector and V602.

[NOTE: When you do this in the R-390/A you have to watch the series filaments to keep the tubes you need lit up.]

**Rank them all and put the best as follows.**

First one in V506 the detector
Second one in V601 audio.
Third one in V602 audio
Fourth one in V507 limiter
Fifth one in V509 AGC
Sixth one in V205 Calibration
Seventh one in V206 Cal buffer

Save at least two for the next test event.

Once you do this one time you start to see how tubes are making a difference. You swap the order of V501 and V502 a couple of your best 5749's and see a 6 or more dB change in the span of the modulated to un modulated signals and you become a believer. Once you get enough good tubes in the receiver to get the range in the IF and audio sections you can hear the difference in the receiver when you put it back on the antenna.

V501, V502, V504 are the first three to receive new tubes if you can not get the 30:1 range. This is 2 5749's and a 6AK6.

Three 5749's and two 6AK6 will get you there as V501, V502, V503, V504 and V603 or V604. You almost can always find a few good 5814's to fill the string. Trade a 6AK6 or 5759 for the 6DC6 on your Christmas list and have a 5 pack shipped in time for the Holidays.

Once you get the IF and Audio deck aligned and tested you put the receiver back together and start on the end to end sensitive test as detailed in part 2. You go into the RF deck alignment knowing the IF and Audio are good those tubes are good and the signal to noise ratio is good. What ever you need to do to the receiver now is in the RF deck.

If you went through this mess of testing for the um-tenth time it takes about a ? hour to just do it. First time can take a week of you hobby time. If you go through all of this and you have a meter needle that just wants to bounce big time, and none of the tube juggle seams to help, you may need to be rethinking caps. But you should still be able to rank your tubes and know the better from the poor. You can look into the IF deck and judge the cap problem. An assembly full of brown or black things is a cause to heat a solder iron. Been there done that is cause to consider some new tubes.

Once upon a time I brought 5 new Raytheon 6BA6's. They were the hottest tubes I have ever had. Power out over 1 watt. I can not get any of them to pass the noise test. I'm burning them in the BFO and AGC rectifier. I know its BFO noise but I can live with it. Moral: new tubes may be worse than what you have. There are lots of good brands. So all this work may not cure all ills.

In service we just knew if you did not get past this test you were not going to make end to end test. It was a place we learned to divide and conquer. We had to set this test up and did the BFO and IF gain here anyway. It was just a few switch steps to do the test. If you had to go for tube jockey status, this test at the half way point sorted the tube types. Only the 6C4, 6AK5 and 6DC6 were left for the RF section.

These tubes were done the same way with the receiver set up for the end to end sensitivity test. You set up the RF alignment and could get the 20:1 ratio when you did an adjustment or you swapped some tubes. If the receiver was looking poor after getting the IF to pass, you just started with a new 6DC6. If it did not make a lot of difference you put the old one back in and went through the adjustments. You swap the 6AK5 into the crystal deck above 8 meg and rank the 6AK5's. You swap all the 6C4's you have into V603 and rank them. Put the best one forward. Do you put the best 6C4 into V202 or V203? Depends on what you are going to do under 8 meg.

You keep at this long enough, buying tubes and grading them you get over 20 end to end and have a wonderful receiver. You stay at it and you find you have 25 or more end to end. Then you find the meter is just not laying real still. So now you can go at it back to front one stage at a time with signal injection and see where that meter bounce is coming from. Then you can consider nosey caps. But until you get a real good set of tubes in the less noisy caps are not your major problem. I have found just getting good low noise tubes to be a problem or buy and try. This cap subject has driven most of us to just acquire a complement of good quality caps and re work the whole subassembly one-week end. Again the IF deck gets it first and then the Audio deck gets it and last we do the RF deck.

So I hope this covers the subject clearly and allows everyone to test their R-390/A so as to generate a concise wish list of parts that will make a difference in what they hear with out exceeding the allowance. Merry Christmas to All From Roger

## 455 KHz Crystal Filter Alignment

From Bill Hawkins:

The thing that determines the value of the IF frequency is the crystal filter at the narrowest bandwidth. You should center the IF in the crystal passband. In some cases that might be 455.00, but not always. Crystals move a bit with frequency, as well.

You really don't need a counter to align the set. Certainly the military didn't have many of them in the 50s. The HP 522B would work all the way up to 100 KC.

If the IF is peaked near 455, set the bandwidth to 100 Hz and tune the generator for maximum output from the IF. Do this after the set and the generator have warmed up. You would need a counter if the generator drifts, but just to keep the frequency at the crystal filter center.

Once the IF is aligned, go back and realign the RF and variable IF sections - unless you didn't move the IF more than a few hundred cycles. The bandwidth of the RF deck is about 16 KHz, right? At least, that's what I'd do ... Bill

From: Roger Fellows, Bill Hawkins, is right on this stuff.

1. If you do not have a counter on the signal generator. First run the 455 into the test point on the last stage of the RF deck. point E211.

2. Use what ever signal level you need to get a good meter reading on the diode load with the BFO off and signal generator modulation off.

3. Trim up the z501 cap C510 and coil L503 using the manual for setup of the band switch and when to adjust each item.

4. Also trim up T208 and leave it alone after this. Unless you change the 6C4 in the mixer stage. Then retune T208

5. You have pushed this coupling stage to best pass through your receivers 455 crystal and that's the best you can do.

6. It may not be exact 455 but it sure is the peak band pass of your receiver.

7. Work the signal gen frequency into the 455 crystal and peak every thing for maximum output on the diode load.

8. This gets the "IF" aligned into the center of that crystal and does it with the balanced input from the RF deck to the IF deck in place.

Some times you can get a little more out of the receiver this way.

If you are doing CW and narrow band stuff RTTY and computer stuff the following is worth the effort.

1. Once you find the peak 455 for your receiver and signal generator then go to the single end input to J518 and adjust the rest of the IF deck.

2. Leave Z501 alone.

3. The mechanical filters will lay over the crystal center. We have seen from testing earlier this year that peaking the mechanical filters does not change their center frequency but will change the signal level.

4. The mechanical filter trim caps act more like gain adjust than frequency shift adjust.

5. Trim up the IF slugs.

6. To stager or not to stager.

7. If you are a wide band AM listener try the stager tune in 16KC band width. If you have a sweep generator adjust for nice band pass in 16KC band width

8. Otherwise: center adjust for 455 and 2KC band width. Roger AI4NI

## More Tube Info

**Subject: [R-390] 26Z5W replacement**

Fellows,
Any time we can solid state some rectifiers and get some filament supply relief is likely a good idea. Some glow in the dark things must be left glowing. But when exact authenticity is not at issue, a good rectifier may be in order. Roger

Subject: [R-390] Tube microphonics & performance

George,

On a bad day you run what you got. You can use them, HOWEVER. Noise is noise. Try them, they may be better than what you have running right now. Then again they may not be better. Never turn down a tube. You can always use them as part of your test set. If you are not using your line output, you could drop one in that side of the audio deck. The microphonic per say will not hurt the radio. It may add noise to the signal. If its the difference between radio and no radio, run them. Always run the best tubes you have.

You can compare tubes by hanging a dB meter on the audio output with a 600 ohm 1 watt resistor and comparing tubes with each other when plugged into the same socket. A signal generator is easier to work with than the cal tone and bfo. Most AC meters have a dB scale on them. Hit a few web pages and see how to use your meters AC scale or dB scale. Exact numbers are not required for tube comparison. You are just grading what you have from good to poor. Put the best ones forward in the receiver and use the best of what you have.

Hang an AC volt meter across your audio output. The line level meter works but a volt meter will help you with tubes that are real close together. Set the receiver to cal and BFO off. observe the meter reading. Turn the BFO on. Observe the meter reading. How many dB difference did you get between BFO on and BFO off.

Now change a tube into one socket.

Repeat the test for that tube.

Did the second tube give you more or less dB difference?

Plug all your spare like tubes in the same socket and compare them.

After test put the worst of the bunch into the receiver.

Now retest all of the type you have that is not needed to populate the receiver. Grade all of these from most dB difference to least dB difference.

Now put the best of these into the receiver.

Save the old poor ones for future testing.

Do this for each tube type.

Do the dual triode 5814's twice. Pick a socket where you know which side of the triode is being tested. Use the detector socket for one side.

**Subject: [R-390] Tube longevity (summary)**

asked, To prolong tube longevity is it better to keep the set on with the volume and RF gain turned down or use the standby position on the function switch?

replied that, Military BAs generally don't beat their tubes (unlike a lot of home hi-fi equipment), so leaving them on is generally OK.

replied further, Some oxide-cathode tubes don't like having no B+ for long periods.

replied, With mil-spec tubes, heater failure from startup current is rare, though the old manuals said it better to keep the set on with the volume and RF gain turned down.

further replied, If you have done a solid-state mod to the Power supply rectifiers do not use the Standby position. If you do not have the 26Z5 tubes in the power supply, turning off the plate voltage by switching to standby will cause the plate voltage to raise excessively, and can cause some caps to blow. Never use standby.

recommends, Probably the best thing to do is to add a CL-80 surge suppressor in series with the 2 Amp fuse in back.

point to the counter issue: The exception is the Ballast Tube. That is rated in cycles (about 2000-5000). On-Off cycles will definitely affect the life of that tube.

adds, However if the ballast tube has been sand stated or replaced with a tube filament this limitation becomes a non-issue.

offers, Personally, I don't think tube life is reduced significantly by turning the receiver on and off. I suppose you will get a few hundred hours more from a tube that is about to loose it's heater if you leave it on continuously.

offers, In some industries part of regular maintenance is to "margin" the power supplies up and down just to find (and in some cases blow up) the weak parts. Thus, turning off the plate voltage by switching to standby will cause the plate voltage to raise excessively, and can cause some caps to blow. Blowing the weak parts up is an added bonus - it makes sure that nobody will try to reuse them! I'm thinking mainly of the original electrolytics and black beauties, although I'm sure some of the metal-can Westcaps/Vitamin Q's and yellow Aerovox-type caps will blow too. Some of us hate old crappy caps with a vengeance. (Or not-so-crappy-originally-but-now-50-years-later....) We're probably the same guys who stuck electrolytics across 120VAC to watch them blow and now hold titles like "Director of Destructive Testing"!

offers, It was published R-390/A standard practice in the ASA to never park an R-390/A (or its newer version for clarity R-390/A/A) in the standby mode.

So what's a body to do? How many hours are you going to listen to the receiver and how many hours is it going to just sit idle waiting for use? The military run them 24 x 7 for years. They got turned off twice a year for the semi annual maintenance. A technician would likely turn it on and off 4 or five times while doing the maintenance. Once the receiver went back in the rack, it was just left on until some maintenance guy come along again to do service.

If you only use your receiver once or twice a week, you may as well turn it off when not in use. If you are going to listen to it every day, even if only for an hour or so, you should leave it on. If you are going to do a week end event, turn the receiver on several hours early to let it warm up and stabilize. Then leave it on for the duration.

A tube has a working life. The military used them 24 x 7 until beyond acceptable noise performance. At six month intervals, the receiver was tested for signal to noise performance. Tubes were tested for shorts and put back into the receivers. The test set up was performed. Maintenance would try to get a 20:1 signal to noise performance out of the receiver. Noisy tubes would be replaced until the ratio was achieved. The receiver then went back into service for the next six months at 24 hours a day. 4380 hours. Unless the receiver died, it received no additional tube changes for about six months. Over this time the new and old tubes would "age" and get more noisy. Hopefully the signal to noise ratio would stay above the required 10:1 noise level. Most receivers did make the cut of 10:1 after six months use.

>From this we can conclude that tubes will make at least 4380 hours of good quiet life. Hours on a tube with no ears to listen is wasted tube life.

One trade is receiver stability and warm up time. Most R-390/A receivers will drift some as they warm up. But are you using the receiver in a mode that exact frequency is critical? Even if you have to ride the knob to keep a SSB signal in the band pass, the drift of the receiver is not that much.

Most of us have solid stated the rectifiers and the replaced the ballast tube, so the issue is cold filament surge failure against time on a tube until its emissions noise gets excessive. Life cycles on a ballast tube has a high end of 5000 cycles. A tube will likely do as many cycles.

So do not leave the receiver on more than twice as long as you are going to listen to it. Turn it on and off 5000 times and enjoy 5000 hours of low noise reception. If you use it for more than an hour at a time, you will then likely get more than 5000 hours of use with good noise performance, before you have a tube filament fail. If you leave the receiver on for 5000 hours the tubes will start to get noisy and performance will suffer. You age the tubes and get no return.

For the casual user, the analysis is to turn the receiver off if it will not be used in the next 6 hours. The exception would be, to leave the receiver on for the duration of an event to avoid a failure at power on and have a temperature stabilized receiver for use during the event.

## In Set Tube Selection

Always use a VTVM to measure voltage at high-impedance points, and read voltages with the tube in place. 73, Dave Wise

There is a list, about tube placement. It tells you where to put the best tube in the radio. Where you can put the weakest tube. Where to put the most stable tube. TKS Gary

Gary, What is the question here. After you have checked all you tubes in the R-390/A.

What did you check? How did you check it. All the tubes? All of the tubes?

This is a 3 stage process.

Stage 1 find all the tubes you can and check them on a tube tester. Throw the bad ones away. What is a bad tube? How will your tester know? How will you know?

Stage 2 sub the tubes into the receiver to find the best low noise tubes.

**Start with the 5749/ 6BA6 IF Deck tubes.**

Use the very first If amp.

1. Sub them all in to find some good ones.
2. Put the good ones into the deck.
3. Check all the tubes again to rank them.
4. Put the very best most quiet one in the first IF
5. put the second in the PTO
6. Put the 3rd in the BFO
7. Put the next best ones in to IF strip down the IF chain.

**Do the 6AK6's next.**

Put the best one in the IF deck
Put the 2nd best one in the audio chain you will listen to (may or may not be the phone output)
Put the 3rd best one over there on the other audio.

**Do all the 5814's into the audio link.**

Pick a socket where both sides of the of the tube is being used. Do not use the limiter. Do not use the diode detector.
Put the best ones in the audio chain.
fill the AGC and limiter last.
AGC is not listened to. Limiter is mostly off.

Do the 6C4’s
Do the 6AK5's
Do the 6DC6.

Turn the lights off and look for the pretty blue glow inside the bottle. These will first become test spares until you acquire enough tubes with out blue glow to test your tube set. If you are desperate (who is not) there is a zippo process to conduct on the pretty blue glow ones to get the glow out of the bottle. Then these tubes become trash.

**Stage 3 install the best of what you have.**

All ways put the best tube to the front end. Injecting a signal and metering signal plus noise to noise will provide a better test than the tube tester will.

Start with 150 μV (what ever [need not be calibrated]) into the IF deck and get a 30 dB difference in signal plus noise to noise in the If audio deck. You can hang an AC volt meter and 600 ohm resistor on the line out put. Do some math and determine what the voltage should be and difference is. signal plus noise is 455Khz with 30% mod at 400 - 1200 hertz. noise is 455 Khz is CW on the signal gen. 455 Khz is peaked into the 100 Hz .1 crystal filter of the IF deck.

You need .5 watt into a 600 ohm line load.

You need -7 volts on the diode load.

If you can not set these 3 things up, the If deck and audio deck are below space and nothing in the RF deck will over come the problem.

In the RF deck, just use the best tubes you can get. The first time you set the test up with 4 -5 μ V into the antenna and measure the line out with the signal generator on and off to see the ratio, and then swap a tube, any tube, and see what the difference is, you become a believer for swapping tubes in socket for performance.

You can use WWV and watch the meter bounce between carrier and tones if you do not have a signal generator. Roger KC6TRU San Diego.

Tom, You got it, this sand state stuff can never be trusted. You know you can not protect the sand state diode with a fuse. Murphy says the diode will always fail first to protect the fuse. We just have to live with some risk in our life. I am using 12BY7 myself for the 3TF7. I did have a jumper in the socket and used 2 12BA6's for the BFO and PTO. But a diode poked into that socket would much simpler to install. I do like the 6BA6 5749 tubes better than 2 12BA6's. When I when through my last noise reduction drill over Christmas, I found I had no way to judge the noise of the 12BA6's in the PTO and BFO circuits. By using the 6BA6's, I was able to select 2 very quiet 6BA6 tubes and use one in the PTO and one in the BFO. Selecting 6BA6's in the first IF tube socket for best noise is more sensitive than using the BFO or PTO socket. Roger.

## Home Brew Tube Tester

Leroy, If you have to part with a 100.00 or so AUS or US for a tube tester for your R-390/A why not hack an old 5 tube AM radio and a meter into a tube tester? If you can find a 12 volt filament transformer with a center tap (6.3) and a 100 - 300 volt B+ winding you can build a tester.

As you only need to test a select number of tubes, you can wire one socket for each type. A couple switches for the dual triodes can be keep it simple.

Testers are relative. You can look at the tube manual (on line some where) and find the expected current for a grid voltage.

Most testers tie the tube up as a triode (for short tests) and vary the grid voltage to get a mid scale meter reading.

The real test for R-390/A or A tubes come from use in circuit and judging the noise. These are all relative test. This one is better than that one. And you use the best of what you can get. The exact value is not known. Most tube testers just weed out the shorts and real dead emitters. Roger.

## Alignment

Jim, What are you doing to a R-390/A?

Since I was drafted and school trained as a repairman in 68 with 8 years in service doing it daily with a year as Instructor and now an owner, I have just never needed tube extenders to fix an R-390 or R-390/A /A.

The voltage gets measured with the tube out of the socket. If you need to do injection, pull the next tube up and with a cap to isolate B+ from your signal generator, inject into the plate pin of the tube socket.

You can stand the receiver up on either end and lay any deck out on the bench and get under it to work on it live. You can drop the front panel and work on it live. The PTO comes out and can be worked held in hand.

Pull the diode load jumper.

Inject some audio into (60 cycle hum) into the audio deck and get both audio paths sounding the same. (power will not be equal because of the attenuator in the line side)

**Put 455 into the IF deck and get it all working.**

1. Do the RF deck mechanical alignment.
2. Get the band switch sync correct.
3. Get the crystal deck switch sync right.
4. Find the bands that work,
5. Work the bands that do not.

If you do not have the parts to adapt the mini BNC to the signal Gen, put a cap on the wire lead and inject the signal Gen into the last test point of the RF deck. (use a whole lot less than 150 μ V because it will get amplified in the last mixer) The last test point is a grid of the last mixer (6C4).

You will make more progress measuring resistors gone high in value. doing visual inspection for bad solder, and replacing suspect caps by the number.

Once you get to a tube stage, It works, It does not work. If your trying to decide if one tube stage is OK not OK by measuring signal level in and out. you are really going at it will out regard to what Elmer's have learned about these receiver working on them several a day years at a time for now nearly 50 years.

In the mid 70's after 20 years of prime time big time use, I have still found that, there is no good table that says what the stage gain of any stage should be. It has big gain. If big gain is not found; fix it.

You can read all about calibrated AN/URM - 25 signal generators all week. That is no where near a standard. It just says a tube device is adjusted close. You can read all about calibrated volt meters. That is no where near a standard. It just says a tube device is adjusted close.

We will talk about signal to noise like it was dead on, it's just what ever we got on the bench that day.

Once you get to a bad stage. Working from the head phones to the antenna, you go in and do some voltage checks, this will find the smoked resistors. You then do a very good eyeball. You know where you are looking and why you are looking there. You have isolated the problem to a bad stage. It is bad because it does not have a big gain as expected.

Get the ohm meter out and point to point verify every thing in the circuit.
Crud in deck short.
Cold solder joint.
Broken wire.
Over value resistor

The caps are killing us after 50 years. You can not measure then, most have a lower resistor parallel path. So by the number you just swap them all out.

1. It is a 50 year old R-390/A
2. Experience has shown these items to be problems in these receivers
3. A practical affordable test is not available to most owners.
4. Testing exceeds return on investment.
5. It is just been shown time and time again to do the replacement.

I am not saying change every cap on the bench.

You front paneled your receiver down to one two or three tubes. (Yes Alice, you can do that to an R-390/A or R-390/A/A)

You jammed a signal generator into a plate pin or two.

You have decided a stage is suspect.

So now your under the deck and hunting in a circuit between two plate pin. This one is good. This one is bad. That is a fixed number of parts in a fixed space.

List your problems here and get some specific help. Quit trying to solve and re-invent it all by your self. It is more fun that way. I do agree.

What is your real objective? Do you want some tube extenders, or do you want to fix a receiver?
Roger KC6TRU San Diego.

## Alignment II

Barry, You are thinking too hard. I hope the following diatribe is helpful. If something just does not make sense, post some more questions. I retired because my senior moments were becoming problematic. Retirement did not cure the problem. I just am not making statements in retirement that impact peoples lives. I may be screwing your hobby up, but you will have time to recover.

---
Should the PTO be set to accommodate the off-frequency of the 17mc oscillator?

Answer NO.
---
PTO won't always track between 3.455 and 2.455 exactly, what do We do? Answer:

1. Set Zero adjust to center
2. Set dial to 500
3. Set PTO to 2,955,000.
4. Lock the clamps.

---
Is this a good method?

To do this, I can loosen the clamp from the Oldham coupler to the front-panel shaft, dial in a known frequency (say my 770 kc station), set the BFO to 455kc, and while holding the dial at 0.770kc, rotate the PTO shaft to zero-beat and retighten the clamp.

Answer NO.
---

Set the PTO for 3.455 or 2.455 Smack in the middle of the zero adjust. Use the frequency counter. Remember you want it to work with some 20 crystals and their harmonics. You may never get the PTO to exactly 1 Mhz in ten turns. Just do the best you can. Then have it spread both ways from center by setting it up at 500Khz rather than at either end point.

When using a broadcast signal (good idea because we know what the frequency is), during alignment process. Set the zero adjust to calibrate on the nearest 100 KC.

**This operation dials in the crystal offsets:**

1. Set the bandwidth to .1Khz (to get into the center of the filters)
2. Set the BFO to zero (in the center of the IF deck filters)
3. The 100Khz crystal has a 320 plus harmonic that is close at 31.000+
4. The PTO is then beat with all the mixers to get into the middle of the band pass.
5. The act of doing a cal zero at the closest Khz marker dials all these offsets in for you.

Roll the receiver counter to the same frequency as the signal is on. Now rock the Khz knob for the best peak output you can get.

This will get you around the offset of the fixed crystals on any Mhz. Believe this is close, remember it has worked for Army tech for the last 40 plus years. Now tweak the thing to be peaked at the frequency you are on.

Skip trying to inject frequencies any where except the antenna input. If you are aligning the first and second mixers second IF's. Use 10 uv or less of RF at the receiver dial reading into the antenna input. Use the frequency setting in the TM for the dial read outs. Adjust the item you need to adjust.

For the Second variable IF Para 75 page 116. it says:

1. Set the receiver to 1.900
2. set the signal gen to 2.1
3. Inject the signal at E210.
4. Adjust the 3 slugs in Z216 cans

**Really do the following:**

1. Set the receiver to 1.900
2. Do the receiver Cal at 1.900 (a calibration point)
3. Set the signal gen to 1.900
4. inject the signal into the antenna input.
5. Rock the receiver to max signal or rock the signal generator.
6. Adjust the 3 slugs in Z216 cans

Remember symmetry. If you are doing an alignment 250 off one end, then you want to be 250 off the other end for the matching alignment. (off the other end is likely 750, because its below the end)

The TM says find the nearest 100KHZ and zero adjust. Then it says rock the AN/URM25 to exact frequency. You are not going to rock the AM station, so you need to rock the receiver dial to peak.

Investigating this, I found the 17mc oscillator is 16.997mc.

Buy doing a calibration zero at 100Khz closest to the alignment frequency before injecting a signal and doing alignment, you factor this variation into the receivers alignment.

Trying to peak all the RF deck over a 3,000 cycle crystal shift is not going to make a performance difference in the receiver. We know these crystals are not super exact, which is why you want to inject everything at the antenna. Do the calibration zero beat against the BFO into the middle of the .1Khz 455 Khz IF before each tweak. Then set the dial where it belongs and then peak the innards to perform.

Then when a signal comes in the antenna and we peak it max, the dial should read the exact frequency we expect it to see.

I watched a lot of guys try a lot of thing over several years. Tried a bunch my self. The approach above works the best. You can get some frequency to Max out by playing around. But it will cost some where else.

We had 4 or 5 guys working 2 receivers per 8 hour shift. three shifts a day 365 days a year. We had time to try all kinds of stuff. Any and every variation was talked about. Some real tech wizards thought about this stuff. I had techs with math degrees drafted to be receiver repair guys. We had some other guys who were detailed to clean dust out of fans, some more that were just allowed to push a pencil. Every one was not equal in creativity. But over the years some real sharp guys with lot of time on their hands considered what was going on.

The TM procedure is pretty good.

The mid point alignment procedures are really needed if you have a dead receiver or a marginal problem and you are trying to decide if you need to re replacing, cans, slugs, caps, or other nasty subtle problem. So the TM is the over kill cover every thing approach.

For a good receiver just needing a good alignment, there are ways that get better results with less work. You try to do a real PM on your receiver in 4 hours. You are humping it. This is why we did them two at a time. Once you were dusting you dusted 4 or six, while your buddy shoved a bunch of tubes through the tester. You would be cleaning away and some guy would walk up and pop your 3 6C4's out and walk away. Soon he would bring you back 3 tubes plug them in and pop out some other tubes. If you were doing tubes you would grab all the 6C4 and test them all. The best would go back and you tried to put all the new tubes into one receiver. That receiver was noted on it PM record. In the next monthly you knew it would need alignment. The other 3 or 5 receivers would be OK in the monthly with well broke in tubes. Coming out of cleaning, someone would do the Calibration zero, BFO and PTO with the frequency counter. The rest of the alignment was done against the BFO, PTO and cal or the receiver. You could do 2 receivers by your self in 8 hours, go to lunch and do a couple trouble calls.

One more question: For aligning the second IF, the manual states to set the signal generator to 18.750mc and the R-390/AA to 7.250mc.

I think this should be 18.250 & 7.250.

Is this a known issue with the documentation? NO.

Remember you are doing a difference in this mixer. you are 250 off the ends. One way is 250 the other way is -250 = 750.

What you really want to do is:

1. Do the calibration zero adjust at 7.200 or 7.300
2. Then just insert 7.250 into the antenna input.
3. Let the mixers mix it with all the small offsets.
4. Tweak the proper item to get the best peak you can get.

Trying to re-zero, insert things in the middle, compensate for some item just drives you to distraction.

You want the receiver to perform the best it can on all frequencies. All frequencies may not perform equally well. But not because the receiver is not properly aligned.

Get each setting as good as you can.
Repeating the whole process 3 or more times will bring improvement on each pass.

Realignment after changing a tube, may or may not bring an improvement. The old and replacement tube may be very equal in distributed capacitance and gain. The first 100 tubes you try may all peak exactly the same. Then boom the next time you stuff a tube in, it will need a different alignment.

Let the receiver run 24 x 7 and do a realignment of the RF deck. You likely will not need to do the BFO and PTO settings. Things seem to change with a little burn in time. We use to re-align the receivers the first monthly TM after a semi annual PM and see some improvements. Enough to make it worth doing.

---
I used my frequency counter, tuned the PTO to the desired frequency (3.455 - 0.770) for a strong local station on 770kc and set the BFO to 455kc. At this point, the heterodyne theoretically should have been zero; however, I was hearing a very high-pitched heterodyne.

Investigating this, I found the 17mc oscillator is 16.997mc. This (along with any inaccuracy in the second crystal oscillator frequency) is the cause of the non-zero beat.

This is why you do a calibration at the nearest 100Khz and move the zero adjust where ever it is needed to get a zero beat in the middle of the IF band pass.

This is why you rock the AN/URM 25 to zero. The TM suggest the problem is the signal generator. You are not rocking an AM station to zero, so rock the receiver dial to zero.

The alignment points in the TM are not set in stone. They are some good point on the band width slug rack position to give good performance. Just get close to the frequency and peak every thing up. The TM says rock the generator. You can rock the receiver much easier and get just as good an alignment.

Good Luck with this Barry, Roger KC6TRU

From Flowertime01 at wmconnect.com Sat May 7 21:51:32 2005
Subject: [R-390] Alignment questions

writes:  The net result is that the PTO is running at who knows what frequency  most of the time. It will be within a few hundred cycles most of the  time.
---

Barry, Bob, nailed it pretty good. Roger KC6TRU

**Sensitivity Advice**

Jim, I put this mail up last week to a similar question. Do you have a copy of the Y2K manual? It is on line and a must have read.

Run the cal tones and tell us what bands have tones. You either have a tone some where in a 1MHz band or you do not. If tones are missing on one or more bands, then a band problem is to be resolved. If you are missing tones on whole octaves (.500 -.999 ) (1-1.999) (2-3.999)(4 - 7.999) (8 - 15.999) (16-31.999) Then you are looking at a set of octave transformers, slugs and caps. If you are missing two or more octaves, then you should look at the band switch.

Likely you have enough AM stations to get through some weak tubes. The rest of the receiver range just does not have enough antenna and signal to drive it to the output. From day one the most likely problem was just plain old tubes that have reached the end of their useful life.

You may need to check your RF band switch if the receiver only works on the .5 - 1 and 1-2 octaves. Pull the RF deck and do the band switch by eye ball. All the switch sections are not exact and you want to get the best possible adjustment on all the octaves. The switch contacts carry current. If you get one section just barely making contact, over time the contact will burn. You want a good alignment when the octaves are changed going both up and down in range.

Check your cam adjustments at 7 +000. The RF and IF slugs should all be about mid range. If any are at the upper or lower limits, some real good alignment is in order. You may need some tubes in the RF deck if the cam alignment is good and the slugs are at the ends or there range.

Now you get to checking tubes and RF alignment.

Once you get to the point where you have a calibration tone every 100 KC you have a working R-390/A/A. Between a working R-390/A/A and a wonderful receiving R-390/A/A is a range of work. A working R-390/A/A and a wonderful receiving R-390/A/A should not be confused with a good looking R-390/A/A. Each of these are different.

Good looking R-390/A/A are selling for over $1000.00 on Epay and may not work at all.

A good working tube and a real good tube is a range that a tube tester will not evaluate for you. Old used tubes can work better than some new tubes. I do not want to send you out shopping for bunches of new tubes, because what you buy may not in fact be any really better than what you have. All tubes are not equal. Swapping the 5749s around will change your signal to noise ratio.

Changing the 6C4s will also make a difference. Finding a good 6DC6 can be a treasure hunt. Swapping the 5814s around will make differences. The 6AK5s or 5654s also make differences. Start looking for tubes for your receiver. Accept what you can find when you find them. If you really need some tubes because some are just bad and you have nothing else to use, then buy some new ones. Hopefully not from Radio Shack. RCA and Sylvania are good. Other good brands are also around. Old JAN tubes are likely OK.

Then comes alignment. Do the mechanical alignment of the dial over run and set the zero adjust to center before doing the RF cams. Once through the mechanical alignment of the RF cams will get you OK.

Once the PTO is set you are OK. You can set the PTO against WWV and zero the cal osc to WWV. The mechanical coil alignment of the RF deck will improve with as many as 4 passes. If you change any RF tubes, 6C4, 6DC6, a realignment is in order. The Y2K manual will get you through that OK.

A signal generator and a volt meter will get you through any alignment you need.

Truth is that the cal tones and a volt meter will get you into good alignment. A good frequency counter that lets you set the PTO and BFO is a blessing. Not required, but use it if you have it.

Real good reception comes from just swapping tubes into the same socket and evaluating the results.

As my ear is not calibrated, I use a signal generator and a volt meter. I like my signal generator as I can turn the modulation on and off. This compares CW to Modulated, AM. Some (Military) like to call this signal to signal plus noise test.

I hang a 580 ohm (600 Ohm) 1 watt resistor across the local output on the terminal board with an AC volt meter. My AC voltmeter has a dB scale. A good receiver will put out 1/2 Watt so you need a 1 watt resistor or spares to burn.

Using any signal frequency you can and start swapping tubes for comparison. Run all the tubes through a tube tester some where just to get the shorted ones discarded. Watch them all to get out the ones that glow blue. In the receiver circuit thump them all a time or two to get out the microphonic ones.

Get all your 5749's or 6BA6's and sub them one at a time into the first IF socket. Using the same level of signal generator input. inset a tube and compare the audio output level with the signal generator modulation turned on and turned off.

A good (acceptable) receiver will have 10 dB difference. A nice (up to military spec) receiver will have 20 dB difference. 25 is very doable in today's R-390/A/A even with their age. 30 has been seen on many receivers and can still be achieved today. (You may spend more on tubes and caps than you paid for the receiver to get there.)

So sticking several tubes into a socket and comparing them to each other you can judge them for noise. Put the better performing ones into some of the other tube sockets. Set the test up again and compare the tubes you pulled. Find the best of what you have and use those tubes. Doing the 5814's needs two test to get each side of the dual triodes. Run the 6AK6's in the last IF not the audio deck. Swap the 6C4 into the second mixer above 8MHZ. If you are not blessed with tubes, Just buy your self a new 6DC6. Compare it to the one or ones you have and write that down some where (on the tube box side) so you can judge it again at some later date.

The Army ran these receiver 24 x 7 for six months or 4380 hours. Tubes would go for a year or 8760 hours. We would check all the tubes every six months and swap out the poor ones to get the receiver back up to minimum of 20 dB signal to noise at 1/2 watt output. Also need 4uv sensitive to get the 1/2 watt. If you do not have a calibrated signal generator this means nothing. It also has no impact on your ability to get your R-390/A/A working very good. You can compare tubes using the Cal tone and BFO on and off. It will let you compare the same tube type in same socket and judge them from best to not best. You can them insert the best to the front end and work down the line from there with what you have.

If you have a signal generator that puts out 150 uv at 455 you can get the IF deck into shape real fast. You need 150 uv in to the IF deck by moving the IF out jumper wire over to the IF input and feeding the BNC connector on the back panel. Set the RF gain adjust on the IF deck to -7 volts on the diode load. Set the RF gain to mid range and adjust the generator for -7 volts on the Diode load. Set the band switch to .1 setting and rock the signal generator frequency for maximum signal level through the 455Khz crystal. You can zero the BFO against the signal generator. This will get you amazingly close. If you think you generator is close, set it to 150 uv and then set the RF gain to -7 volts. Set your generator modulation to 30%.

Open the IF bandwidth back up to 2KC. Turn the BFO off. Start swapping between modulation on and modulation off, you need a 30 dB difference. If you do not have this 30 dB difference in the IF deck and Audio deck string, you will never get a 20 dB difference for the full receiver. You will get 30 dB in the IF deck and have the meter needle bumping around. This random noise will not get it. You may get 28 and have a rock solid flat meter needle. This may be OK and things are just not all that exactly calibrated. So accept this and get on with life. Better tubes will come in the future. A bouncing needle may be a leaky cap. More likely its a noisy tube. Over time and repeating these test, you will get a feel for what is passable. Just get your receiver as good as you can with what you have today. Enjoy it.

The IF front end 5749's will make the most difference. The 6AK6's are next in order. The 5814's will also make a difference. You can swap poor ones into the line audio path. Some 5814's are in the limiter, 455 cathode follower, and AGC circuit. You can get the better tubes into the critical path and put some of the others elsewhere until you can find some better tubes.

Once you are getting 30 dB in the IF deck and audio string, you know that end of the receiver is good. You can move over to the RF deck. In the RF deck you run 4 uv into the antenna input and look for a 20 dB difference between modulated signal generator to un-modulated signal generator.

You can set the IF band switch to the .1 position and rock the generator frequency into the band pass. Once you tweak over peak, you can roll the KC knob for maximum signal point. Doing the cap or core slug alignment in the RF deck within 50KC of the specified number in the procedure will not cause you any grief in the final alignment and signal to noise ratio. Get the generator close and use the KC knob to get max signal. Then do adjustments.

When you are done, go find the Chuck Riddle RF gain setting procedure and use that to get the best receiver sensitive setting.

Swapping tubes in the RF deck will make improvements. When comparing tubes, do not try to align the RF deck for each tube. Just plug what you have of each tube type into the same socket for comparison.

You will get real hot great gain tubes. Some will have lots of noise. Some lower gain tubes will give better noise ratios. Its just a plug and try process.

Once you get the best of what you have sorted and the best moved to the front of the line the receiver will improve in sensitive. Do the RF deck alignment more than once over with a set of tubes. It will make a difference.

If the R-390/A/URR receiver TM there is a procedure to feed both sides of the balanced antenna input from one signal generator wire through 2 each 68 ohm resistors, one to each side of the balanced antenna input. This set up lets you adjust the first antenna cap in the octaves of the RF deck. Any resistor pair between 50 and 120 ohms has been shown to work for this test setup. Grab a pair of resistors and do this alignment on your receiver at least once. While any single ended input setup will show no difference in output or signal to noise having these caps balanced will improve the minimum signal you can hear. If you ever get to feed the receiver from a balanced antenna, you will want these caps adjusted. The R-390/A/A URR manual has never covered this alignment procedure.

I do use an antenna match box and band pass filter with my R-390/A. It has a balanced output into the receiver. So I do this alignment.

You have a working receiver. It works on some bands. What it needs now is within your ability to provide. The US Military taught thousands of guys and some gals to convert that receiver into an up to spec receiver with under 4 hours of hard work using only a screwdriver, spline wrench, volt meter, 600 ohm resistor, signal generator and one hand behind their back for safety. It took the instructors 50 weeks to teach the required theory and mechanical skills to each student. It took 40 hours to teach someone every thing the military mind knew about an R-390/A/A and what was needed to service any problem that Receiver may ever have. Two Instructors taught me what I needed to know as part of a class of 10 guys. I used what I learned to fix receivers for 8 years back in 68 to 75. I have still not found a R-390/A problem I could not isolate and fix. The credit goes to the receivers. The engineers at Collins did an awesome job. For as many parts as these receivers have they are still flat reliable and simple. There is not any problem in that receiver you cannot fix. Ask hear on the R-390/A reflector and you will more help and humor than you will need to get er done. Roger KC6TRU

**Dead R-390/AA**

Thomas, Sorry to come in late on this one. I was up at Fair Radio in Lima getting myself another R-390/AA. Spent $900.00 on travel to avoid $50.00 shipping charges. Its a Polish thing, don't ask. OK so I was going to visit Mom in Michigan and just stopped on the way up as on the way back was scheduled for a Saturday and Sunday.

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Thomas, there is not any problem in that receiver you cannot fix. Ask hear on the R-390/A reflector and you will more help and humor than you will need to get er done. Roger KC6TRU

**AGC Troubleshooting**

Dennis, If switching over to AGC is not just plain killing the signals or you cannot tell the difference between AGC and MGC modes, you are likely OK.

You only have one receiver (yours) to listen to. If you were an O5H, 33B, 31E, or any other MOS that used the receivers and had a chance to listen to several hundred receivers, you would know when you were listening to a bad one. So your AGC questions are a wise pondering.

A full review of the subject starting from some recent post follows.

Remember first that in the MGC position, the AGC line is simply shorted to ground in the function switch. The line at ground in MGC pulls the grids of the AGC controlled tubes toward zero volts. Cathode resistors in the tube stages provide some positive cathode voltage relative to the grid voltages. AGC voltage is negative. When the AGC voltage is applied to the grids of the tubes, it drives the tube stages toward cutoff. A couple volts on the grid of a tube that is working on micro volt signals go a long way in signal reduction.

If you have no signals in either the AGC or MGC mode, you expect you have a tube stage problem and have no reason to expect it to be related to the AGC line. You trouble shoot to find the stage that is not making the grade. The found problem may be in the AGC line, but it will not be the symptom that leads to a logical troubleshooting progression.

If you have an AGC voltage in the MGC mode, you should check the wire harness and function switch. In MGC mode the AGC line is not being held to ground by the function switch.

If you have strong signals in the MGC mode you may have just one more bad item pulling the AGC line to ground. No Problem.

When you switch on the AGC you expect the negative AGC voltage to reduce the receiver gain a little bit. If you get no AGC gain reduction then you have to wonder if the AGC line is shorted somewhere and the receiver acts as if it is still in the MGC mode.

The carrier level adjust has been a sorry circuit since the day it was implemented. Unless you have changed some of the parts, to improve the performance, what ever your carrier meter shows you when switching the AGC is not a real inspirational troubleshooting step.

You likely expect you have an AGC problem when you switch to AGC and you loose all your signals. Or a lot of the signals. How does opening a line from ground, and placing almost no negative voltage on it cause a loss of so much receiver gain?

You likely expect you have an AGC problem when the receiver starts acting intermittent with gain coming and going. The receiver appears OK in the MGC mode but looses signals in the AGC mode.

Now you are not looking for a shorted item. A shorted item in the AGC line looks like MGC.

You are not looking for an open resistor. The resistors work fine in the MGC mode.

Barry - N4BUQ wrote, "**When listening to a moderately strong station in the 15mc band, if I switch to AGC, the signal drops significantly from the MGC position, regardless of the AGC speed."**

This may not be bad. If the signal in the MGC position is strong, the receiver is being over driven and when the AGC is switched on, the strong signal produces an AGC voltage and a resulting signal level that is smaller than the MGC level but not over driven or distorted.

However, if the receiver seems to loose lots of signals in the AGC mode, there is a problem.

If the IF gain is not set to high (-7 volts) and the receiver looses it in AGC expect a problem.
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A most common AGC problem is with the mechanical filters. The AGC line crosses R507 (22K) and is filtered by C512 (5,000pf). From there the AGC voltage is applied through all four filters, all the time. If one filter is pulling the AGC voltage to ground this is a problem.

The filters may appear to have good band pass and performance so a simple check of bandwidth and sensitive with a signal generator and meter on the diode load may not find the filter problem. However this is a good first test if you have a signal generator. 200- 250 μ V at 455Khz into the IF deck and rock the generator both sides of center to find the bandwidth of each filter. Note the diode load voltage for each filter and see if one of them has more loss than the others or has a very wide response.

The next step is too place a tube extender under V502. You want to look at the control grid voltage. The AGC is applied to the control grid through the selected filter. As the AGC is applied to all filters, and if a filter is sucking AGC, the "bad" filter will pull the AGC all the time.

If you have a bad filter, you would expect zero volts on the grid, as opposed to several volts negative. The TM shows the grid to only be .4 volts negative. So this test is not a real sure bet either.

Ohmmeter checks may not get you anywhere either. On one side all four filters are tied to the AGC line. If the short were near that end of a filter coil winding in one filter, all four filters would read the same meter value. Thus you have no clue which filter is bad.

Good trouble shooting practice never supported unsoldering wires just to see what will happen. Heating mechanical filter terminals is not a high item on things I would do this week.

But, if we open **R507** and remove all AGC from the stage. Pull the AGC wire from the resistor and let that wire hang open. Short the end of R507 to ground, so the stage thinks it has zero volts AGC. Now review your AGC and MGC operation and retest the filter band pass with the signal generator and see how the receiver behaves. Missing AGC on one stage should give about normal performance. If all of this work has not isolated one of the filters as a candidate for concern, I would give them a passing grade and go on to the next likely items.

Second most likely AGC problem after the filters is the bypass caps on the AGC line. Locate the green screw extractor, Bristol wrench, schematic and meter. Go down the AGC line and just meter every cap and resistor.

wrote, **"With a signal generator as input and the RF gain all the way CW, I can adjust the signal generator to get -10V on the Diode Load in MGC. Switching to AGC, the Diode Load drops to about 3.4V to 4V (depending on the AGC speed position)."**

This is not a problem, -10 volts on the diode load is over driven by 3 volts. This should produce lots of AGC. The balance point is where going from AGC to MGC to AGC produces no change on the diode load. This may not be -7 volts. This may also not be the optimum operating point for the IF gain adjustment setting. So we never consider what this balance voltage point may be.

Roy Morgan offered the following to help deal with leaking caps on the AGC line:

Put an ohmmeter capable of reading high resistance on the AGC line to ground (notice if it reads the same with the negative polarity on the line as with the positive polarity on the line). Then unplug each module (RF, and IF) in turn to see where you might be getting leakage. Knowing how the AGC wires run from the source in the IF module to the rear panel terminal and the AGC switch and to the RF module will help figure out where any excess leakage is.

Pull the AGC jumper off the back panel and hang an amp meter across the terminals. Observe the correct negative voltage polarity. You'll be able to detect micro amperes of leakage and normal AGC line currents. Most DMM and analog meters have low amperage ranges that will handle the AGC current range.

We do not know the current of a good AGC line so until someone makes some test and offers some values the number your meter produces is not going to help.

Will someone please make a test of AGC current and offer up the values they get?

Inquiring minds want to know.

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Roy Morgan offered:

(One way to measure low levels of leakage is to hook up a 9 volt battery to simulate AGC voltage with a DMM on low voltage (or current) range in series plus side to ground, negative to the AGC line. You'll be able to detect microamperes of leakage and normal AGC line currents.

Start with a cold receiver.

Dennis,

I took out the IF deck and measured resistance from pin 6 to ground, and I see about 7 meg with no charging behavior. It says I should see infinite resistance.

If you were doing this in 1970 with a TS 505 or a TS 352 on the K ohm range, 7 meg would be infinite resistance. You are likely OK on this test.

TM 11-5820-358-35 8 Dec 1961 Para 72 b. Alignment of Z503 Page 113. says AGC should be in the range of -1 to -2 volts

Thanks for the reply Roger. Good point. 7 meg may not indeed be a problem. But why don't I see the 350K I saw from the AGC jumper? So let me review why think there is a problem: 1. With all modules connected, from the AGC jumper to ground is about 350K. When the RF deck is disconnected, it remains the same. When the IF module is disconnected, it goes to about 1.8M to ground.

Does this isolate it to the IF deck?

No not really. When you unplug the IF deck you open so many wire in the AGC line coming and going from the rear panel, front panel function switch, from the AGC diode, to AGC controlled stage, you just never know what you are checking. If you do not have a good schematic in front of you and consider what you have disconnected at any give instance of measurement, you can run your self ragged.

I don't see more than about -4.9 vdc at the AGC jumper on very strong, or the cal, signals.

OK.

No signal is +0.15

OK

There is distortion on strong signals.

OK. R-390/A/A are known for this aspect.

Two basic questions: Do I have an AGC problem given the measurements above? And, is it isolated to the IF deck? Dennis

So we come full circle to your original question.

The part not really dealt with here is, If the AGC is killing lots of signals and is related to one of the mechanical filters, how do we determine good and bad filters.

First I will go read the archives and see what I find. I'll kick out a new post when I get there.

Give me a few days to read up.

Dennis, I would say you are likely OK with your receiver. Go on with your other troubleshooting and cleaning. If you do have an AGC problem, operating the receiver will not cause more damage. You can always operate in MGC if you think you may have troubles with the AGC. You can always come back to the problem if it is still nagging at you. Having one receiver in isolation to care for by your self is a daunting task. The military trained us guys in groups to take care of bunches of receivers together with support, and this scared the hell out of most of us. Most of the tecks never got conformable about being repairmen. They did one four year enlistment and got out of the trade altogether. It was just not the military they did not like. They gave up electronics in general. Being a fellow willing to work on a glowing receiver puts you in a special class. Just being willing to give it a go earns you respect. Do not worry that you are working from a disadvantage. You have to start some where and you are down the road of glowing tubes. Just because some of us ran ahead and come back with tales does not make us any better. Do not let our tales worry you.

Roy Morgan added his best thoughts. Barry put in with his findings. No one has taken us to task for being way off base on this, so we are likely in the park. Roger L. Ruszkowski KC6TRU

Dennis, If you have a 16K filter bad, the side effect could be a bad AGC.

The output of all the filters is tied together on one side to the AGC line. The other side of the filter outputs are switched through the band switch. The unused filters are shorted when not in use.

A known side problem with bad filters is the AGC acts funny. This depends on exactly what goes wrong in a given filter. You can have a bad filter without having an AGC problem.

Ignore the bad filter and AGC problems for a while and work on the other items you have on the list of thing you want to do.

You could open the lines to the bad filter and just let it hang. See if this changes the AGC behavior. Then every thing but the that IF band width would work for you. And you can get to the filter replacement whenever you feel the need. Roger KC6TRU.

writes: **There is supposed to be a jumper on the rear panel terminal strip for a remote AGC line? What would happen if it was missing?**

In the R-390/A/A, V201 the RF amp has a R234 a 1.5 meg resistor on the AGC line to ground. So with no jumper this resistor completes the circuit path for the AGC line on the tubes that have AGC on the control grid.

In MGC where the AGC line is shorted, there are other resistors in the AGC line between the grids and the short point on the function switch. There will be a small loss of receiver gain in MGC with the jumper missing. You likely may not even be able to hear the difference between jumper and no jumper with the function switch set to MGC.

In AGC, no AGC voltage is feed back to any thing, The AGC and MGC positions on the function switch will act exactly alike to you. The carrier meter will peg over when switching AGC time constants because all that circuit is before the back panel jumper. The audio will not be lost like normal however when changing the AGC time constant, because the AGC charging time, when switched, is not being carried over the jumper and applied to the tubes.

If you did not know, you could run the receiver for years with the AGC jumper missing and never miss a thing. As much as the receivers AGC performance has been cried about, you may think your receiver is just normal. Roger KC6TRU

## Signal Generator Impedance Notes

Barry, As it was done way back when (68-75) and taught at the ASA school house at Ft Devens Mass. Skip all those adapters. None were actually used. We all read that same TM. Nice theory, good education, likely the real exact science way to do things. Just not what was practiced in the Field world wide for years.

The IF alignment procedures for the R-390/AA state to connect the URM-25* to the input connector using an impedance matching adapter (either Test MX-1487/URM-25D or CU-206/URM-25F depending on which generator you have). Assuming the URM-25* is 50-ohm output, what does this converter do?

>From Para 73 page 114. of the R-390/A/A TM 11-5820-358-35 Dec 8 1961 copy. Fellows, does someone have the AN/URM 25 TM and tell us exactly what is in these two Adapters? Thanks Roger KC6TRU

I find it odd that the adapter is mentioned for the IF GAIN ADJUSTMENT procedure, but not for the IF alignment procedures even though the generator is connected to the IF module the same way for both procedures.

Just one of those errors in the TM. Do you know what it cost to get an errata page distributed for a TM? This was our excuse for never using any adapter. Just look at the preferred paragraph and get it done.

I assume the input impedance of the IF module is something other than 50-ohms and the adapter is being used to match the two impedance, but I don't know what the input impedance of the IF module is.

No one at the school house or student of the school house knows either.

I have a GR1001A signal generator which, for most attenuation settings, has an output impedance of 10 ohms. The reason I'm asking about the above adapters is I'd like to construct a proper matching network for my 10-ohm generator to work the same way as the 50-ohm generators do for the IF alignment procedures.

Old 33's knew the input of the IF deck was not 50 Ohm's. Its likely not 10 Ohms either.

Field practice was to skip all the adapter stuff. Just cable it up. We did use 150uv into the IF deck. BNC to adapter on the back panel and mini BNC jumper cable moved from the 50 ohm output to The IF deck input.

Chuck Ripple had a good procedure to readjust the IF gain for over all receiver best signal to noise ratio. This procedure is not dependent on signal generator impedance matching and gives the real world best performance.

Just cable up your generator for alignment and tube noise testing. Every thing is relative. An adjustment either provides more output or less output.

A tube change either provides a better signal to noise or a poorer signal to noise when the generator is adjust for the same signal plus noise level. This checks the noise of a tube compared to another tube in the same socket. Changing tubes into the same socket with the signal generator held constant, checks tube gain. More tube gain may or may not be more tube noise. This is a definite place where YMMV.

Another question: **The instructions state to set the output at 150 μ V for the IF GAIN ADJUSTMENT procedure. If I'm using a different adapter for 10-ohms versus 50-ohms, will I need to change the output setting to something other than 150 μ V to account for the different adapter impedances?**

For alignment and test, just cable it up and use 150μ V. Run what you need to get a 1/2 watt of audio out.

You are running a 10 ohm source into a higher impedance. The higher impedance will not load the source. The receiver is essentially a voltage circuit as opposed to a current circuit.

You hang a 1 watt 600 ohm resistor on the local audio output and start measuring the output while reading the dB scale of the AC meter. You quickly find that when turning the audio modulation on and off, you either are getting a 30 dB change between modulated signal and un modulated signal.

As you play with the IF gain to change the diode load DC voltage (-7 volts) and the signal generator output level to get the 1/2 watt output. you are either getting the 30 dB change. Changing the exact gain and drive will not change the signal to noise ratio. Making adjustments will make changes. Changing tubes will make changes. Work on it until you get the 30 dB change.

Then just dial 150µ V and set the IF gain for -7 volts. Go on to the RF deck alignment. When you get that done then set the IF deck gain as Chuck Ripple details it.

Barry, If this is all not as clear as mud or darker, ask some more questions. Roger KC6TRU

**Below 8mhz problem**

Jim, More than one problem here. So what did you expect?

The receiver will not hear the signal generator at all, so I have not been able to align the variable IF's.

No signals but the Cal tones are killers. It sounds like an oxidized contact point in the antenna relay. As its from the massacre you will likely find some crud in the box.

Do some ohm meter checks on the antenna relay Pin inside on Mini BNC to pin in triax connector . Pin to pin should give continuity and pin to ground should be open.

Do you hear the antenna relay click as you go into cal mode and out of cal mode to mgc?

Strap the break-in pin on the back terminal board to ground. Operate the break-in switch off and on. Do you hear the relay in the audio deck click and kill the audio hiss? Do you hear the antenna relay click?

If a the relay is clicking and a couple operations do not clear it. It will open up and can be fixed. Some course paper ("newsprint") can be used to clean the contacts. Rain condensation has likely dirtied the contacts.

Get a very good small Philips screw driver and really lean into it as you take the very small screws out of the cover plate on the relay and look into the contact cavity. (dead spider or what ever in there).

Poor performance under 8. is .5 - 1, 2-3 and 4-7 all equally bad?

Look into the first mixer tube socket for crud. Look into the fist mixer Z cans for crud. Again likely just weather oxidation in a contact. Look at the RF band switch for crud. Likely you will pull a can off its contacts, open it up and put it back down and every thing will work no trouble found The normal experience.

Pull it all apart and clean the contacts (De Oxit preferred) Use what ever you have but:

1.) do not ever tell this mail reflector you did it.

2.) If what you use causes other problems always infer the trouble came with the receiver and was not self inflected.

Work over the antenna relay and get some signals coming through.

Read the manual. Read Chuck Ripples web pages. Down load and read the handbook.

As this was one of those receivers you will want to one day pull the every deck. pull all the tubes and all the RF deck cans and give every contact a cleaning.

**On the first IF .5 - 8 Mhz.**

Again, just because its been outside, you may find a cap in the RF cans to be shorted. These will come apart and can be cleaned up. The little rubber disk between the cap sections gets stiff. Read Chucks and Dave Medley's R-390/A/A and R-390/A web sight maintenance tips. The adjustment caps are in the RF and crystal decks and share a common problem. Do not take down any you do not have to. If and only if it is shown to be the problem. Aggravation exceeds return on investment.

Then go read the books again, Get all the stuff you need to treat the items correctly. Then go read the books again. Acquire a large rewarding stock of choice beverage. Do not start celebrating prior to completion of the task. Then just jump in and do it. Do not be intimidated. If it goes wrong stop and ask. It may take an hour or two to get mail back at 0 dark thirty But some one will gladly talk you through it. When its all done, just let your self go and revel in it.

While your at it you will want to give the gear train a good bath. a 32 to 40 hour ordeal is about typical.

Your only going to do it once and your only have to do it because some fool let those fine receivers set out over winter in the weather.

A good semi PM could get done on the depot bench in 4 hours. 8 hours was average for a tech his first year out of school. (to do it all and do it right). So 16 hours your first few times around is ok. Roger KC6TRU

## Audio Capacitance

Barry, Audio Capacitance,

Are you sure you have enough ear to discern the lower lows?
Did you get all the caps in the chain from the detector to the output?
If you missed one then that one is still limiting the lows.
**Get the cathode bypass caps also. These will keep you from hearing a difference.**
Does your speaker or headphones have enough low end to enable you to discern the difference?
Your R-390/A may have more bottom end than the speaker or headset or ears can reproduce.

Why do you believe the signal you were hearing has any more bottom end to hear?

Do not be deceived easily. Stay with it and review what going on in your receiving environment. There may be more low frequency than before, It just may not be as overwhelming as you expected. You are not going to get a boom box out of a 1/2 watt audio amp. Work with your BFO against a CW signal generator and listen for an improved lower audible frequency as you zero beat the BFO.

Big caps is better sound for sure. Many or have been there and done something. Those that have stay with it long enough to get all the items changed are happier with the sound.

Caps in parallel all add up to a simple sum. You are better off just doing a replacement. Things are not critical in the audio deck. Your not likely to send it into oscillation by doing cap replacement. The new caps are so much smaller you can do the whole deck with some 450 or 600 volt caps in some . 1 or . 3 values in place of the . 01 values. Find the 8uf and put a 20 or so in there. A low voltage elec will be OK. Roger KC6TRU

From Flowertime01 at wmconnect. com Tue Apr 19 18:28:58 2005
Subject: [R-390] Audio Capacitance

Fellows, Yes I did say go from . 01 to . 1 or . 3

A jump to . 03 from . 01 just will not give you enough to hear the difference. As some of the other post pointed out the transformers and other things are still effecting the changes Roger KC6TRU

**Audio Capacitance II**

Barry, Beefing up those caps is good practice. But, it is a little like standing on your sprinkler hose with both feet and taking one foot off.

Do the Rippell - C604 and C605 to 0. 033 uF and a 10 UF cap for C609. This should get you somewhere near 100 - 200 Hz for your -1dB point on the low end and your high end should be fine. Perhaps too fine. My top end was peaking above normal. Removing or reducing the value of C612 (68 pF) will flatten the high end. In any case you should be going out above 10KHz to the -1dB point. This should get you to 300mW at under 3% distortion. 1 Watt or so is about the maximum I could get out of the stock 600 Ohm iron for 11% distortion with this mod.

If you should try to bypass R614, the cathode resistor, with a 100 uF electrolytic in order to increase gain, the positive feedback at R615 will cause trouble, producing a novel circuit - more suited to a code practice oscillator. The positive feedback produced by R615, the 56 Ohm job, is yet another mystery circuit of the R-390/AA. I have elected to short this little bugger out.

If you are willing to do a simple rewire to replace the 6AK5 with a 6AQ5, lower R614 to 270 Ohms or so and install a small all-American 5 type output transformer, you can easily get to 1 watt at less than 1% distortion and obtain 30 Hz to 20 kHz bandwidth. With a better transformers and more fooling with the circuit, 2 - 3 Watts is possible. Warning - Playing with this circuit is addictive, buy another audio deck. Mike Murphy WB2UID

Subject: [R-390] Audio Capacitance

Hi Tom,

The "how" is positive feedback. This is a path which feeds some of the output signal from the output stage (developed on the cathode resistor), back, to the cathode of the audio driver stage. The "why" is less understood. This feedback method must have been added in the design to generate a deliberate effect that the designers wanted - like a peak in the response. The guys on line can help you more than I can. All I know is that positive feedback if taken too far can cause some nasty effects like oscillation! Adding a bypass or having the increased resistance is like turning up the regen control! Mike Murphy WB2UID

## Audio Problems

One of the audio problems with the R-390/A or R-390/AA is in the wire harness shape. On some receivers the loop in the audio harness to audio deck is a bit long. Setting the deck on a surface will scrunch the wires in the harness a bit. Some times it will cause the wire harness plug to pull off the deck connector. Over time things break.

As many things as you have had to try from the mail list here has not gotten the problem fixed. So its time to look into the audio deck wire harness back shell for a frayed wire.

I is right that the line audio and local audio should both die. There is only one detector, one limiter, and one audio amp V601 a 5814 in the audio deck. Then the audio comes through the deck plug J620 to P120 to the front panel. The audio is wired common going out on pin 2 of the plug to both the local and line gain pots.

Check your diode load jumper on the back panel. This is the 1/2 way point between the detector and the audio deck.

With an AM station and no BFO you should see -4 to -10 volts on the diode load. With the BFO on a cal tone you should have over -20 volts on the diode load.

If you have it travel to the audio deck.

If you do not have it travel to the IF deck.

Why do you think you have an Audio Problem?

Just because you were working on the Audio pots when the receiver died may have nothing to do with your problem. Hope this helps Roger KC6TRU

wrote, **I measured the diode load and have over -30 volts on both AM and with the calibrate/bfo, depending upon where I set the RF gain control. I pulled the hoods on both of the cables to the AF deck and could not find any broken /lose wires. Guess its time to start measuring things in the AF deck.**

>From the diode load the signal goes back into the IF deck and to the limiter V507. The tube is a 5814.

Turn the local gain all the way up. As you turn the limiter on and off you should hear a pop or click in the audio output as the limiter tubes goes into conduction when turned on.

>From V507 the signal goes to the audio deck and V601. The tube is again a 5814 and both sides of it are used as audio amps. The signal out of V601 goes to both the line gain and the local gain controls on the front panel. You should be able to hang an AC volt meter on the controls and measure a small AC signal when you have a good AM station or Cal tone and BFO on that pegs the carrier meter.

If you have AC signal on the local and line gain controls that you can very in voltage by changing the RF gain control, the you are good to that point.

If you do not have a measurable AC signal on both the line and local gain controls, you will have to explore V601 in the audio deck or V507 in the IF deck. You also need to keep the wire harness in mind as you are exploring. Do an eyeball on the 5814s to ensure you filaments on both side of each of the tubes.

The wide sharp audio response switch is associated with V601. You may need to explore this switch behind the front panel for a problem. When you dropped the front panel to clean the other controls, you may have the wide narrow switch and wiring giving you problems. It may have seen you working on the other controls and feels a need for a snit as it was being ignored. Roger

**Re-capping an IF Deck**

There are variations of four choices for the ACG cap.

1. Do nothing or similar more nothing.
2. The slow 2uf AGC cap can be replaced in the can like rebuilding power filter caps. Not more or less messy than power filter caps.
3. Add a new cap under the deck. Leave or remove the above deck can. C551
4. Install a socket in the deck hole and mount the cap in a crystal oven can and plug that into the new socket. An 8 pin octal socket will mount nicely and the other C548 cap will also fit in the oven can.

*Along with these rebuilds it is suggested that C548 be increased from .1 uf to 1. uf. Pushing C548 up into the new can fits nice. After recapping the IF deck, there is much more space under the deck. Those brown tubes were "big" in their own way.*

It is C553 that keeps the 1st IF B+ out of the crystal filters. Inspect this cap to see if it looks like a 600 volt rated cap. You may want to replace this cap if it even looks like less that a stellar quality item in your deck. Some time now for peace of mind over the next 50 years is a small price and some quality time with your receiver.

There are ranges of paranoid for your IF deck. Real severe leaves you unwilling to even apply power to your receiver. Not real common but known to occur. Less sever cases accept nothing less than a real full rebuild with nothing less than orange drops. Some will not even accept a self build and require the work be performed by a real "professional restorer."

Having a radio is supposed to bring you joy and not anxiety and misery. Lesser degrees of paranoid will let you install almost any current good brand of cap in the deck to get the brown tubes out and keep the receiver receiving.

Real caviler owners will run the receivers until the smoke escapees and then only replace the minimum carbon needed to return the receiver to operation.

As with all preventive maintenance the objective is to put in the minimum up front work to avoid even more work later. So changing caps is good.

Only the brown and black tube caps in the R-390/A/A are known to be more likely bad than good today given there age. Also for ever bad cap found some will post here that there old caps are still hanging in and working good.

As you do not have the brown tubes, your deck either never had them or has been rebuilt. A look at the solder will likely provide some clue as to originality. Some fried wire at the terminals is a clue someone got there with a solder iron after the wire had aged many years.

You will likely be OK with what is in the deck. Do inspect the cap to the filters, C553, you may want a good 600 volt cap in there. Something you have some confidence in. An orange drop is good. A Radio Shack part not so good.

Other than that you just need to reach a comfort level you can be happy with.

There are reasons to change lots of the caps. Some value changes have been offered over the years to improve the frequency response mostly in the audio deck.

Changing C553 to a break down voltage of 600VDC to protect the mechanical filters.

Changing C548 .1 AGC to 1. For less AGC pumping are a few.

Caps like resistors have their own popcorn noise. Parts have been hunted down and changed out just to get a better receiver noise floor.

As you have no brown tubes in your deck, you have no known issue driving you to make any changes. Now you get to make choices based on satisfaction and enjoyment. Enjoy Roger KC6TRU

**Stuck Slug Repair**

Jim, Wait for all the mail to come in on this topic.

Pull the can tops off the transformers. Dial the top slug all the way out of the transformer so you can work on the bottom one.

A hex key is an acceptable way to work a tight slug loose. Think about it and do not over force it.

The transformer slug can be adjusted from the bottom through the chassis deck.

Pull your deck up and look into the bottom to see if you get any clues.

Likely the wax has gotten hot in storage and bound the slugs. A bit more force than expected will pop them loose.

Pull the covers and the deck and look first. No reason to get surprised

The fellows will give you a list of solvents to try. My list or solvents from the 1970's is not OSHA or group approved. We don't do that any more. Roger KC6TRU.

## Stuck T501 Slug

Can't seem to get the top slug in T501 to move.

Sounds like a chance to stop and test.

Run the 455 into the IF deck and do a signal to noise test. If you can get a 28 to 1 signal to noise the coil is close enough and effort to adjust the stuck slug will exceed return on investment. If its close just leave it alone. If its not close then maybe you will be loosing some fidelity in the 16K band width.

Use the Adjustment of Gain Adj Potentiometer. Paragraph 73 in TM 11-5820-358-35. you want to run 150 uv of 455 into the IF deck. set the gain adjust for -7 volts on the diode load. With 30 percent modulation you should get about . 5 watt of audio across the 600 ohm output. We metered the headphone output with a test lead that ended in a phone plug. You can meter dB with most analog AC volt meters and the instruction book (page of paper) for the meter.

Turn the signal generator modulation off. Now you have just a 455 carrier signal. The audio output should have dropped 30 dB and there should still be -7 volts on the diode load.

If you cannot get 30 dB signal to noise here, start swapping tubes around and trying to do some alignment. Trouble is there is no easy way to determine if your IF deck was stager tuned or aligned at 455.

So try to perform the stager alignment procedure as detailed in the TM first. If you are loosing gain, go for the straight alignment.

Just leave the stuck slug for the very end. Get all the other bugs out of the way first. Get good tubes in and do the best alignment you can get other wise.

If you get up to about 28 to 1 just leave that stuck slug alone. Only after you get every thing else as best you can and you know by measurement that the IF deck is not up to minimum then get worried about that slug.

Get the cover off the can so you can see what's moving. The hot air hair dryer is the least offensive way in. Most of the time it will melt down some of the wax. Heat and soften the gunk.

You can get an IF deck from Fair Radio less crystal filters and tubes, and BFO and ballast tube. It will have a T501. The IF cans (T501, T502, T503) are all the same.

Push comes to shove and you conduct a destructive test, ask here on the reflector, someone likely has the part stuck on some of there collected spare parts and would make you an offer you’re not likely to refuse. Good luck and be gentle. Roger KC6TRU

Subject: [R-390] **Adjusting Z702 Tools**

writes: Is there a tool made to adjust the slug on Z702 (the can on the PTO)?

Barry, All the tools I have seen for Z702 were from the teletype side of the shop.

We had a round soft iron rod that had a slot sawed into the end of it. The slot was wide enough to fit the flats. Most guys had a wrap of tape (heat shrink sleeve) around the end of the rod over the slot to keep the tool from slipping off the nut. The best one I seen was an El Cheepo screwdriver shaft cut off and slotted. I had been slotted with a Dremel tool grinding wheel because even cheep screwdriver shafts are fairly hard to saw. Roger KC6TRU

## Antenna Information

John, You can hang any antenna on your R-390/A any way you want. Do not fool with Mother Nature, however. If the antenna is not in use, observe good operating practice, unhook the antenna from the receiver and ground in a way that will keep your home insurance agent happy. Lighting strikes are for real.

Hooking up two antennas at once is not a real problem. The type C connection by passes the first stage of tuning. You get a wider band of signal plus noise applied from the antenna into the first RF stage. While we would expect the next stages to filter that excess out of the mix before it gets to the ear, strange things can happen. This will not hurt the receiver. you may or may not get poorer desired signal and more noise. If its not there to cause interference, of course it will not cause interference. But it some strong signal is lurking around your megahertz of choice, you could get more noise than you have to listen to.

Even when you consider the antenna impedance mismatch going into the balanced input with one wire and the other side grounded, you often get a better signal.

Signal loss through a simple knife switch is not so much you can tell the difference in your ear. A relay or simple switch between receiving antenna's works well.

Loading the signal in from the balanced input antenna with the antenna from the C connector is not a real problem. Receivers were used with this type of antenna setup at times. There is a load from the second antenna presented. If you can tell the difference in your ear with your selected signal may or may not be a healable problem.

John, do you have the Y2K manual? Do you know how to run a single ended antenna into you balanced antenna input? Roger KC6TRU over 56 and understands your memory problem.

**RF Section**

From wd8kdg at worldnet.att.net Thu Dec 8 15:14:21 2005
Subject: [R-390] Christmas Wish List (part 2)

Rodger KC6TRU,

I see said the blind man! **Your following explanation is just for the RF section**. More in coming days, thanks.

Putting this into terms that us non-radio background old grayed hair farts can understand helps. Using equipment on hand, I will add these comments.

For lack of a TS585; the first time setting up this test, I'll use two meters to measure voltage and current across the 600 ohm load resistor. (P=IV) Write down those values somewhere not to be lost, for future reference, and should only have to dial in the voltage next time (oh my). In other words the first target is 0.4 watts across the 600 ohm load.

To make things just a little easier, more than one way to skin a R-390/A/A, I'll use a dB chart for power, voltage, and current ratios from an old ARRL handbook. This way, just have to measure voltage across the 600 ohm resistor and I trust the two meters owned.

After setting switches, dials, sig-gen, etc. and arriving at 0.4 watts; turn off modulation. Then back down the local gain to one volt AC across the 600 ohm load resistor. Next step turn on modulation and read voltage; a smidgen more than 3VAC is 10db, 10VAC is 20db, and 30VAC is close to 29.5db. Or where 20 x log(V2/V1)=dB

I had to do the math to understand the chart, suffering from CRS. If this is a valid method of squeezing the proverbial last bit from the RF section, I've got work to do, tubes to find, and so forth.

Going to guess the IF follows in similar fashion, it is fine in that event?? That part of the radio is near 28db. But will check everything again after all comments and votes are in. wd8kdg Craig

## PTO Adjustment

writes: **Anyone have a source for connectors to make some extension cables for the PTO? I want to do some linearity checks and would like to do it outside the frame on the bench.**

Barry Thousands of old ASA 33's worked on these R-390/A and R-390/A/A for years all over the world for years and never even seen an extender cable. Not one. Noda. Old school knowledge was the extender cables introduced more problems in feedback, loss of shielding, flaky connections than was gained by the extra working space.

Stand the receiver on it end. Use a 2x4 to level the back of the receiver with its front panel. Pull the PTO connector bracket loose from the chassis so you have some wire harness freedom. It is still a short leash. Set the PTO on a small cardboard box so it does not have to hang on its wire harness.

This setup was used to set the 10 turn end point adjustment.

If you just need to run the liner deviation, pull the Standard BNC to Mini BNC adapter off the 455 output on the rear panel and use it on the end of the R-390/A/A PTO. The R-390/A is a bit more creative as it has the B+ on the coax. You need to isolate the frequency counter from the B+ on the R-390/A. Leave the PTO in place and use the dial read out to count PTO shaft turns. Set one end at 455 and zero the dial. Start rolling off turns. At each 100 on the dial counter record the frequency counter reading.

Just hanging the PTO out the up ended receiver and using a pencil mark to index to, we would get the end points to within 10 cycles or so. Considering the counters and power company (Viet Nam, Korea, 69-75) we knew we were kidding out selves with those numbers. But you can do it.

If you were really going to go into a PTO and try to adjust the bank of little shins all stacked up along the PTO guide assembly, spring for the connectors from Fair for the PTO harness. You likely have the coax BNC adapter and can extend that cable to the counter with no problem.

I have seen PTO that would not make end point spread and needed work. I have not seen one that was considered so non linear as to warrant an adjustment of the shin stack.

However, these items are much older now and who knows what would do them some good. Good Luck with this Roger KC6TRU

## PTO Linearity

Just out of curiosity, Roger, what was considered acceptable linearity for working radios, considering that the factory spec was 300 cycles? Ed,

We would not even try to tweek the end points if it was off less than 3 Khz. As far as linearity went, if you could get a cal tone to zero on the 100 KC within reach of the zero adjust it was good enough. Hay we were fighting a war albeit a cold one.

We only checked the total spread end to end. If we could not get a fair end point adjustment, we sent the critter to depot exchange. We never tried to get inside one. You could still get brand new units from the depot, who would ever want to fix one?

Most of them were pretty good within the 300 Hertz factory spec. We just expected them to be linear and that was that nothing to inspect or test. The flip side was every shop did have a budget. We were putting hours on tubes 24 7 and needed lots of them. The teletype guys were also eating motor brushes, printer ribbons and paper. We would not go looking for items to change. We had a fairly loose 10 : 1 signal to noise ratio and did not work over time eking the extra out of receiver. We hated to give the operators real great receivers, they expected them to all work that well. We could spend time doing cleaning and alignment, theses were just time consuming and did not cost extra for parts. We were going to be on the bench for the hours so we did what we could with the time and tools to give the best we could for the operators. PTO were pretty linear and not worth the effort and cost over head to swap out.

You just were not going to tell the Warrant Officer you were dead lining a R-390/A/A and wanted a PTO because the operator would have to zero it every 200 kHz. Roger KC6TRU

**Subject: [R-390] PTO Tenny Bolts and war stories**

Seen a dozen examples of how to adjust the linearity ring, none tell the wrench size for that tiny screw that I've been able to find. Most likely I missed that part of the instructions.

Tom, this is another one of the do it your self tool making adventures. A small slot in the end of a shaft.

Personally, I think that inserting any metallic object into the innards of the PTO may possibly upset the reactance of the circuit. 73,Glen Galati, KA7BOJ

Glen, the PTO assembly has a transformer on it. The can has an adjustable slug like the one on the top of the Crystal Osc deck. Some of the models have a round "nut" on the shaft with two flats. You need a slotted tool to fit the flats, or you turn the shaft with a pair of pliers. A good home made slotted tool is better. So you are not really going into the PTO to do an adjustment.

Strange but some times running the PTO for maximum signal will not give the best signal to noise. Mostly some where in the alignment process, you peaked the PTO transformer for maximum signal through the receiver. Usually some where above 8 MHz so the first mixer was not in the signal path mix.

Do it this way until you have a week or so and want to play with your receiver. You can then try varying the coil adjustments and checking the signal to noise. Tweak and measure and tweak and measure and find the real good settings.

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I don't have any B+ on the output cables of any of the 390's I currently have on the bench.

Once upon a time in Nam I had an R-390/A on the bench. I though I had an adapter cube from an AN/URM 25 that had a cap inside it. It in fact had been rewired straight through as a barrel connector. I did not know this and it was the only reason I was not shot. Plugged that critter in between the receiver and the only frequency counter in the whole shop. Smoked the front end resistors out of the frequency counter. It was dead lined for almost 60 days until the parts come in. That shop had no counter and there were 200 plus 33's that knew just who it was that killed the important item of test equipment. We ran the PTO cabled up in circuit with a Tee and cap. We had no idea how the load changed and just did it that way. It was so much nicer to use the frequency counter and not count cycles on the oscilloscope display. Sorry I do not have an R-390/A schematic to detail the exact reason the frequency counter will go up in smoke if not isolated. But I sure as hell barely lived through one experience with an R-390/A PTO that did smoke a frequency counter. Roger. KC6TRU

**Subject: [R-390] PTO Rebuild**

Does anyone have an idea of what an ideal stack should "look like", or is it too hard to predict?

The ones I looked at were fairly straight. Mostly even. The whole blog on setting the end spread, (Hi to low of Low to Hi depends on which way you want to spin the shaft first) and adjusting the caps to get the mid point correct is the way to go. Then you can try to adjust the stack to get closer at the other points. You would expect the stack to take on a sine shape. You are just looking to get every thing else as close to expectations and then get real close with the stack adjustment. The stack is the last thing to adjust not the first. Roger KC6TRU

Subject: [R-390**] 1. 0 and 0. 1 filter settings**

OOPS, Have you pulled the cover off Z501 and observed that there is a crystal in the location?

Just one step in the trouble shooting process. The crystal is 455Khz and they get grabbed for other projects. Roger KC6TRU

## PTO End Point Adjust

John, For luck the R-390/A/URR, R-390/AA/URR and your R392 all share the same PTO.

I think 7 KC is still well within adjustment range.

If you are 7 KC long you may be needing to open the can, undo the heater wires, open the inner can and change the winding on a very small coil. Or add / subtract some small (2PF) caps.

Watch the mail here, someone is already looking for the archive thread and will post that for you also.

On the front of the PTO there are two cover caps. You want the inner one on the right between Z702 and the shaft. Behind cover cap 1 is an end point adjustment.

Like Alice, one way will make you longer (taller) and the other way will make you shorter (smaller). Can you screw 7 KC out of that adjustment? Try it before you go opening cans of wires.

If you have a frequency counter you are better off. You can make adjustments with the PTO hanging out of the receiver. If not then you have to

1.) remember where you are.
2.) Pull the PTO
3.) make and adjustment.
4. Remember if you went left or right
5.) put in the PTO
6.) set the PTO on one end
7.) dial off to the other end
8.) determine if this is better or not
9.) consider if next adjustment will be left or right
10.) consider how much to adjust
11.) repeat until perfect.

If you have a counter it just goes faster.

1. Dial the PTO to X.455 and draw a mark across the coupler and the frame. Carefully rotate dial If you go the wrong way you will hit the stop before you get 10 turns. So having learned which way to go, start over and dial it off in the correct direction. We think clock wise is down in frequency and counter clock wise is up in frequency.

2. Think about the KC knob and the way the frequency conversion is done.

3. Rotate off 10 turns, line up your mark and see what the counter reads.

4. Every time you change the end span adjustment, the points will move.

5. So make an adjustment.
6. Line up for the counter at X.455
7. Mark the dial to frame
8. Roll off 10 turns
9. Line up the mark
10. Read the counter

You will either be getting closer or further off the exact 1Mhz

If you hit the end of the adjustment before you get exact there are two options

A.) accept what you get.

B.) Read some more help from the archives and prepare for some PTO surgery.

It is not hard to open the outer and inner can and do repairs. Good Luck with the fix. Roger KC6TRU

**Subject: [R-390] R-392 VFO End Point?**

John, R392's were considered tactical radios and got treated different from the R-390/A receivers.

If your R392 did not work, it was sent away from you for repair. Your repair guy was likely a module swapper. If your PTO was out of spec, it was just swapper. For a long time PTO's just piled up out back of the Depot. Then someone invented a "portable" frequency counter and it was discovered that the PTO could be easily "refurbished". It is not amazing there is nothing in the TM about making what is a simple adjustment. We know there are several good things missing from the R-390/A TMs.

Back when there items were new, you could get 10 plus years on a PTO and never need to adjust it. Once you get yours set, it may never need adjustment again. It likely has never been adjusted in its life or maybe once or twice. Roger KC6TRU

**Tube Shield Needs**

Scott, You may not need that many shields. Recommendations were to shield the RF, 1st, 2nd, 3rd mixers, VFO, BFO. Just the RF mixers and Osc need shields. Recommendations were to uncover every thing else.

We know the good shields will run cooler than the plain cans. I do not know if the good shields will actually get you a cooler glass bulb temperature than no shield with ventilation being the same. So it still may be best to run most of the tubes naked.

Just because we used those crummy old shields is not a reason to continue. We put in better caps today, so why not better shields? Round up as many as you can. One never has enough spare parts. Roger KC6TRU

**Subject: [R-390] Wanted to Trade**

ERC and similar shields will take the bulb temperature well below naked. FWIW, Dave Wise
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That being the case, Lets get all these fire bottles dressed properly. Cool is good. Roger KC6TRU

**Subject: [R-390] Re: R-390/A cooling fan**

Fellows,

No we did not run the receivers for years with those silly silver tube shields.

We had standing paper orders to take most of those silly hot silver tube shields off.

On top of that those hot shields were a full employment opportunity for a lot of maintenance men. We spent about an hour a month just looking around in rooms to find the receivers by serial number. Then we spent some time looking into the receiver for blue glows.

Once ever six months the receiver come out of the rack and had all the tubes pushed through a tube tester.

Those radios did not just run all those years with silver tube shields. That is some new urban myth. Roger KC6TRU

## Gears, Switches, and Frequency Relationship Table

| Band (mc) | Position of switch S201 and range of antenna and RF coils (mc) | Position of switch S401 | 1st variable IF range (mc) | 2d xlal osc crystal freq (mc) | 2d xtal osc output freq (mc) |
|---|---|---|---|---|---|
| .5-1 | .5-1 | .5 | 17.5-18 | 10.0 | 20.0 |
| 1-2 | 1-2 | 1 | 18-19 | 10.5 | 21.0 |
| 2-3 | 2-4 | 2 | 19-20 | 11.0 | 22.0 |
| 3-4 | 2-4 | 3 | 20-21 | 11.5 | 23.0 |
| 4-5 | 4-8 | 4 | 21-22 | 12.0 | 24.0 |
| 5-6 | 4-8 | 5 | 22-23 | 12.5 | 25.0 |
| 6-7 | 4-8 | 6 | 23-24 | 13.0 | 26.0 |
| 7-8 | 4-8 | 7 | 24-25 | 9.0 | 27.0 |
| 8-9 | 8-16 | 8 | | 11.0 | 11.0 |
| 9-10 | 8-16 | 9 | | 12.0 | 12.0 |
| 10-11 | 8-16 | 10 | | 13.0 | 13.0 |
| 11-12 | 8-16 | 11 | | 14.0 | 14.0 |
| 12-13 | 8-16 | 12 | | 15.0 | 15.0 |
| 13-14 | 8-16 | 13 | | 16.0 | 16.0 |
| 14--15 | 8-16 | 14 | | 17.0 | 17.0 |
| 15-16 | 8-16 | 15 | | 9.0 | 18.0 |
| 16-17 | 16-32 | 16 | | 9.5 | 19.0 |
| 17-18 | 16-32 | 17 | | 10.0 | 20.0 |
| 18-19 | 16-32 | 18 | | 10.5 | 21.0 |
| 19-20 | 16-32 | 19 | | 11.0 | 22.0 |
| 20-21 | 16-32 | 20 | | 11.5 | 23.0 |
| 21-22 | 16-32 | 21 | | 12.0 | 24.0 |
| 22-23 | 16-32 | 22 | | 12.5 | 25.0 |
| 23-24 | 16-32 | 23 | | 13.0 | 26.0 |
| 24-25 | 16-32 | 24 | | 9.0 | 27.0 |
| 25-26 | 16-32 | 25 | | 14.0 | 28.0 |
| 26-27 | 16-32 | 26 | | 14.5 | 29.0 |
| 27-28 | 16-32 | 27 | | 15.0 | 30.0 |
| 28-29 | 16-32 | 28 | | 15.5 | 31.0 |
| 29-30 | 16-32 | 29 | | 16.0 | 32.0 |
| 30-31 | 16-32 | 30 | | 11.0 | 33.0 |
| 31-32 | 10-32 | 31 | | 17.0 | 34.0 |

## Gear Train Alignment At +7.000

Barry, I think the item we are missing here is some black lines scribed on the cams and RF subassembly. Hopefully your receiver still has them. These lines were just inked on during manufacturing. Aggressive cleaning of the chassis is known to remove the lines.

At +7.000 a line on each cam will line up with a line on the RF deck face. At +7.000 all the cams are mostly pointed up, and it makes it easy to check the alignment.

Two ways into the alignment after replacing the clamp (Quick, Full Process). Depending on the clamp that is being replaced the outcome is more or less precise. If its the 16-32 band, the outcome of a quickie is more positive than if you are doing the 5.-1 band. Always more precision in adjustment is better receiving.

1. Check the zero adjust. This is an eyeball to center it in the midpoint of the adjustment range. Do set it to center.

2. Check the dial counter over run on each end. It should be at least 25 or more on both ends. A. change the zero adjust a little to get both over run counts equal. B. drop the dial cover and reset the over run (this should be followed by a full RF deck alignment). If your receiver has had a full up good alignment, the dial over run should be good.

3. Roll the count up to 7.000+ and look at the cam alignment marks. All 6 RF band cams should have their marks aligned (except the one with the broken clamp).

4. If the-5-1 bank mark is off just a little, you can do a zero adjust of 2 or 3 maybe 5. If its off more than that, then a mechanical cam adjustment and signal alignment are in order. (The receiver will work as is, some of us are just fanatics)

5. If some of the other band cams are off, consider a full mechanical alignment and full RF alignment. Mechanical being an eye ball thing. RF being the signal generator and slug alignment.

6. When installing the new clamp consider where the clamp bolt goes and where the spline wrench is going to be placed to adjust the bolt. Once you get the new clamp on the shaft, rotate the clamp so you can get the wrench on it. Rotate the cam to the alignment lines. And tighten the clamp.

7. If you had a full up running receiver, you can just put the new clamp in on the visual alignment and be done with it. If the receiver is carefully aligned, then loose and broken clamps can just be reset, replaced and your good to go. The mechanical setting of the clamp should be within the zero adjust range. You are trading VFO frequency against the band pass skirt of the RF band section in use (the one with the to be replaced clamp). The old prior proper planning prevents poor performance applies here. Roger L. Ruszkowski KC6TRU

## Band Switch Alignment

I care not what the manuals say about you can do a band switch alignment with a meter probing into the pins of tube sockets. Sure you can do a lot of things. The question is should you do it?

Drop the front panel, pull the RF deck, turn the deck upside down on the bench and put the MC knob back on the shaft.

Roll the MC through the ranges both up the bands and down the bands. Look at the switch and the amount of contact mesh at each wafer section and at each change point going both up and down. As you move the MC change knob through the receiver range you will see the band switch change as you roll up or down across (.5-1 , 2-3 , 4-7 , 8-15, 16-31 ). At each change point, the switch should move over one contact and seat as the MC change knob sets into its detent position.

Now this is a judgment call. Depending on the free lash slop, mechanical exact construction of any given wafer and straightness of the switch assembly, how much contact mesh you will get varies. Resist thoughts of touching or adjusting wafer switch contacts of section. Just do not go there.

Now looking at the switch contacts do the adjustment of the band switch. Your goal is to get the maximum contact overlap at all switch sections on each band.

You will find that one end the wafer is just making to the left of a contact, and when you dial to the other end of the receiver, the same wafer will just be making to right of a contact. One switch wafer will be lining up real good and another wafer will just barely be making contact. Remember, that receiver has worked for over 40 years, what ever adjustment is needed is very small.

The idea of doing this adjustment visually is to get maximum switch contact area. When you are doing the meter check, the meter current is very low and contact will "test" OK. You can get close with a meter and start burning the switch contact in actual use. Also the meter test is only one switch section. One section may be making contact while another switch section is not quite making it.

The first indication you may need a band switch adjustment is when you change bands and have to roll over (up or down past) the switch change point to get switch contact.

As long as you have the RF deck and crystal OSC deck there on the bench, check the crystal oscillator switch also. It changes every MC. Again contact area will drift from end to end. Also some contacts in the mid range may not be exactly spaced so some judgment must be applied to where best to set the switch. Check the contacts tuning both up and down as the gear lash will be different each way.

Roger KC6TRU P.S. Am I using the correct detent spelling here?

## BFO Shaft Alignment

Fellows, Two of you were working on your BFO problems.

It was suggested that you loosen the shaft coupler between the deck and the front panel to back the knob off the stop washer so the BFO could be adjusted from full end to end. The Idea being your BFO was running fine and just way off 455.

One of you ask if the BFO had some kind of mechanical center. Sorry not so. The coil will run from end to end and there is no "center" you just cranked the shaft to move the coil from end to end. Once you found the 455 point, you set the front panel knob and extension shaft up on zero. You adjust the knob, shaft, and clamp to not cause undue friction and stop against the stop washer. The bushing in the front panel has some play and can be adjusted to give a better center. Loosening the green screws on the IF deck and moving the deck a bit may improve the mechanical alignment of the BFO and band switch shafts.

If these simple checks did not get you in line, there are more things to do. Pull the tube and run around the socket for voltage checks. Check that the BFO on/off switch is turning the B+ on and off at the tube socket. Check your screen and grid voltages. The filaments are good as they are in series with the PTO and the receiver does play.

Before you go for a coil can replacement, heat all the solder joints. Cold solder joints are known to happen. The likely one are on the pins of the coil can.

If this has not got you going the BFO coil can is known to fail. Back when you just replaced them. Nothing actually went bad in the coil can that could not be fixed. You can get the cans open and do an inspection and repair. Most problems were in the form of cold solder joints or little broken wires.

The coils have a good range so fixes will not push them beyond the range where they will not tune 455 plus and minus 3 as expected.

The coil can is work to get it out and back in. It can be done. I have done it a few times. Let us know what you found your problems to be. Or if you got this far and still need some more help. Roger KC6TRU

**Subject: [R-390] 1st addendum topic bushing inspection / repair**

There are two bushing in the front panel around the Megacycle and Kilocycle shafts. These need alignment. There are also two bushing around the BFO and bandwidth shafts for the IF. These need adjusting. There is a bushing around the Antenna trim in the R-390/AA. Were you thinking of other bushings?

Fellows, does the R-390/A have a bushing around the antenna trim? Any other questions on bushings that need consideration? Roger

The MC, KC, BFO, Bandwidth, and ANT TRIM are exactly the ones that I believe are the most important and in the case of the radio I'm restoring, the KC shaft/bushing seems (naturally) to need attention the most. Didn't think these could be aligned, so look forward to The Instruction on this topic! /m

**Subject: Re: [R-390] Mechanical Alignment Part 01 Front Panel Bushings (start)**

Fellows, For reading and editing. Thanks Roger.

Mark Richards asked; is there any tolerance for the front panel control bushings?

Once upon a time and some where in all the military specifications you know in your heart that some one specified exactly how much clearance every one of the bushing must have. Enough to allow the shaft to turn freely and not so much as to be excessive. As a shaft is hand rotated, it is unlikely you have a bushing with a hole worn too large.

Mark Richards asked; how do you replace front panel control bushings?

The bushing come in two sizes. There is a small bushing for the Bandwidth, BFO pitch and Antenna Trim shafts. There are larger bushings for the KC and MC change shafts. The small bushing are standard ¼ inch shaft extension bushings.

A suitable replacement is available for small parts houses. A potentiometer can be scraped to salvage the mounting bushing from it as a replacement part. The larger bushings for the KC and MC change shafts are somewhat rare. If you are short a large bushing, place the one you have on the KC change shaft. Several members on the R-390/A mail reflector know of limited parts. The inventory is always changing so ask the current members in a mail posting if you need a bushing. The larger bushings are not exotic and a reasonable bushing can be machined to fit. The bushing need not be stainless steal. A plastic bushing would give years of service.

The bushings have two problems. The shafts get burs on them that prevent the front panel from being removed and bushing bind after the front panel is replaced.

To disassemble the large KC and MC change shafts bushing in order to removes the front panel remove the knobs and then remove the retaining nut from the front of the bushings. Let the large bushing remain on the change shaft. If your receiver bushings are assembled with the retaining nut inside the front panel, reverse the bushing assembly the next time you have the front panel off your receiver. The KC and MC knobs have a clamp and sleeve design so as not to score the shafts and prevent the bushings from sliding off the shafts when the front panel is removed. Burs happen. Use a small file to remove any burs that prevent the bushings from sliding off the shafts. Burs are a repeat offence and you may encounter one any time you need to disassemble the front panel.

The antenna trim bushing should also be assembled with the retaining nut on the outside of the panel. The knob and bushing retaining nut can be removed to disassemble the front panel. The shaft has a flat milled on the shaft. The antenna trim knob should always placed on the shaft so the knob set screw rest on the shaft flat. This practice helps reduce bus on the shaft that hampers the front panel disassembly process.

The Bandwidth Select and BFO Pitch knobs and extension shafts are almost never disassembled. The standard practice is to loosen the clamp on the extension shaft and pull the shaft forward to release it from the IF deck shafts before the front panel is removed. The shafts float in the front panel bushings while the front panel is removed. The knob pointers are set by positioning the knobs

and then tightening the extension shaft clamps onto the IF deck shafts. The knobs set screws on the extension shafts generate burs on the shafts. These burs make setting the knobs on the shaft for exact alignment a problem. These burs also make getting the shafts out of the bushings a problem. The shafts can be filed to remove the high burs and allow disassemble.

Once you have these five major bushings, shafts, knobs disassembled the front panel bolts can be removed and the front panel dropped. Remember to also disassemble the dial lock before pulling on the front panel. The front panel is almost never "removed" as the wire harness to the front panel is still attached to many switched mounted on the front panel. However the front panel can be dropped. There are several maintenance actions that require the front panel to be dropped.

Once the front panel is dropped and alignment is not an issue of the moment the bushings likely run free on the shafts. If a bushing is binding some small amount of filing or use of emery stone will return the bushing and shaft to a free moving condition. You likely find you do not need to replace the bushings. The bushing only needs to be replaced if the threads on the bushing have become so fouled that the retaining nut can not be easily seated.

Bushing can be drilled or reamed out. Likely a bur on the shaft has been forced into the bushing and "turned" some metal thus causing the bushing to bind on the shaft. Cleaning the grim and bits out of the bushings will also helps. Some bushing have been squeezed out of round. If one of these bushings can not be reamed to run free, then by all means replace it.

All bushing should be assembled with the nut outside the front panel. Thus if a shaft binds in the bushing, the nut can be removed and the front panel dropped with the barrel of the bushing left on the shaft. With the front panel dropped the shaft and bushing can receive whatever maintenance is required to remedy the assembly problem. When reassembling the dropped front panel, leave the bushing nuts loose on the bushing barrels.

Mark Richards asked; what do we do for the worn bushings between the front panel controls (particularly the tuning knob) and the proper operation of the gearing?

With the following ideas YMMV and FWIW here are some thoughts.

Joe contributes: There are THREE bushings on the KC CHANGE shaft the one on the front panel should be left "snuggish" so the other two won't be bound by it. Also, that shaft is the one most likely to be bent, being that it is so far from the protective handles. On a total rebuild of the radio it should be removed and centered on a lathe to be checked for run-out, then straightened. This will make it run true, not be apt to bind and will help to keep the DIAL LOCK from binding and making that awful scraping noise so common on these radios.

Tom Norris contributes:

Partially loosen all the front panel bushings before replacing the front panel to the shafts a bit of "play" so they'll be less likely to bind.

The sequence in which the front panel bolts are tightened will make a difference in the bushing alignment. Set the receiver frame on blocks so the front panel hangs free when reassembling the front panel. Leave the bushing nuts loose on the bushing barrels when first mounting the front panel. The IF deck green bolts can be loosened to shift the IF deck and improve the alignment of the extension shafts. The same can be done to the RF deck. RF deck alignment does not offer as much shift as the IF decks appear to have. But it has been found to work. A little here and a little there and soon you have a smooth running assembly.

The bushing are "standard interchangeable parts" that are not perfectly centric. Thus the bushings are eccentric by definition. That hole is not exactly in the center of the mass. So some time rotating the bushing to one position will allow some more freedom than other positions. Almost always some combination of deck shift, front panel bolt insertion sequence and bushing rotation will allow all the shafts to operate very smoothly with bushing nuts tightened.

If you have a bent KC change shaft, you can operate the receiver with the front panel bushing nut loose on the barrel until you have time to get into a shaft bending maintenance period. The shaft may be straightened with out removing it from the RF deck. Do not strike shafts. A proper diameter tube of good length should be placed over the shaft and gentle (this is steel to be bent gentle) pressure applied to remove the bend as best as can be judged with available resources. Feel free to use all the resources available to you when ever necessary.

The most common problem is the MC shaft binds. There are two sources to this problem. The detent spring is often seated with two much force against the detent stop ring or the MC shaft bushing needs service. Service may be cleaning or adjustment. Often removing all the front panel bolts and reinstalling them will shift the front panel and provide less binding of the bushings.

These receivers are getting over a half-century old. If the bushing holes in the front panel needed filing, it likely has been done. Mostly getting every thing aligned to operate smoothly is just a mater of persistence. Knowing that the front panel and decks can be shifted gives the maintainer insight into the problem. Also knowing the bushing may be eccentric and rotating the bushing may provide a better fit can help the maintainer achieve a smoother operating receiver from a mechanical point of view.

Miles Anderson: Although it may have been said before, I always retighten the bushings as the last step in front panel reassembly. I tighten all the panel to chassis screws hard to establish the orientation of the front panel. Then I slide the bushings forward on the shafts through the panel and attach the nuts from the outside. After making each nut finger tight I verify that the shaft turns freely and then dog down the nut, starting with the kilocycle shaft. I check the free movement of each shaft before going on to the next.

Thank you for the additional paragraph. Watch for it the next time I post the full text. Joe says I need to do these post in parts because the full post is two large for Yahoo mail to receive. I can do that for every one so watch these post to come in parts. Roger L. Ruszkowski

Although it may have been said before, I always retighten the bushings as the last step in front panel reassembly. I tighten all the panel to chassis screws hard to establish the orientation of the front panel. Then I slide the bushings forward on the shafts through the panel and attach the nuts from the outside. After making each nut finger tight I verify that the shaft turns freely and then dog down the nut, starting with the kilocycle shaft. I check the free movement of each shaft before going on to the next.

**Intermittent gear alignment**

The intermittent gear had been removed from the band switch.

Wally, Take the time to pull the FR deck to complete this alignment problem. Remember to remove the spring from the Odham coupler on the PTO. Once you have the deck out, you see the band switch is just a wafer switch.

Before you drop the front panel. set the dial zero in the center of its range. Forget the numbers on the counter the dial has a range. Set it as close the center as you can. Remember to loosen the dial lock before taking the front panel down.

Remember it switches as follows:
.5 - 1
2 - 3
4 - 7
8 - 15
16 - 32

You want to watch it as you run the MC both up and down. Watch that the switch wiper centers in the switch contact. watch that each switch section is making contact. Watch that as you roll up 1-2, 3-4, 7-8, 15-16 each movement point sets the switch into good contact on each wafer segment. Watch that as you roll back down 1-2, 3-4, 7-8, 15-16 each movement point sets the switch into good contact on each wafer segment.

Remember, this switch not only use to work, it use to work for years. There is some adjustment point where it will work again.

If you remove the deck and do the adjustment by eyeball. It takes less time. Plus the end results are much more positive.

You may also want to inspect the 6C4 2.2K resistors for value You may want to look at replacing brown and black caps. Look into the CAL 5814 tubes for burnt resistors.

You know as long as you have that deck out, there is no reason to put it back in with problems that will need fixing later.

Panic Not. Prop the front edge up on some 2x4 blocks so you can drop the front panel flat on the bench. Remember the there is a couple of green screws in the sides (outside right MC end) (inside under the deck from the left (IF) end. then there are two in the front. You need to stick the screw driver through a hole in the KC dial lock disk to get one of them. there are two (three) green screws across the back. you need a long skinny #1 to reach down to get those green screws. Remember to un couple all the cable (1 power) most are the mini RF. Watch the PTO coax as it is strung around and needs watching as the RF deck is lifted free.

In the wafer sections you can see which section is wired to which RF transformers. This helps you determine if the switch is set to the correct contact as the switch changes sections. The switch change is all magic in the gear train. A special gear there decides when to move the band switch shaft to change the wafer section contact.

You get that gear to move the change on the MC detente to detente stop. and the switch to center in the wafer by adjusting the switch shaft in the switch gear clamp. These changes should not change the KC setting. Run the KC to both ends (with the zero center) and set your counter. remember to set the KC back to where it was so you do not rip up the PTO. Reset your cams and PTO after you get every thing back together.

This should leave you with a good mechanical alignment on the RF deck. Except for PTO alignment you should never need to do this again in. Until some clamp comes loose or breaks.

Roger KC6TRU

P.S. You do have the Y2K Manual don't you? It really helps to have a book in one hand.

**Clutch Information**

Fellows, The zero adjust clutch has no "adjustment" they either work or do not work. The different production runs had different "feels" to the adjustment.

The critters did and do get dirty, mostly they were "washed" and "run dry" with a minimum of oil.

The disk on the zero adjust shaft does not have such a good shaft bearing. This has always been a point of friction in the design.

You can read the TM and take the clutch apart if you need to really get one clean (you may have to). Otherwise you hung the RF deck off the edge of the bench and sprayed liberal amounts of your favorite solvent through the gear train and followed with compressed air to blow dry. Mobil synthetic oil is now the relube of choice.

The clutches all sort of had a different feel. Some would open up and roll nice, others just felt like they dragged. We never did any thing about them in the service. The zero adjust was a go-no-go item. It did or did not function. when the receivers were much younger a good wash and lube got them back into a passing condition. No disassembly was required. Considering the age and where some of these receivers have been, a one time disassembly and cleaning could very well be in order.

I see some on the market trying to tell me I need to go an extra C on a receiver that has a smooth zero adjust and knobs that do not induce tunnel carpo and I may need a few minutes to pick my butt back up off the floor and stop snickering.

Real R-390/A's needed work to operate and were part of every operators personal physical fitness program. A day cranking a R-390/A and you bend an elbow to get a few beers disposed of.

Roger KC6TRU

### Meter glass stuck to meter face

Fellows. Its the old meter glass is stuck to the meter face trick. Sorry you both have old rubbers. This is quite common and not just R-390/A related.

Its skill and craft time. Get out the exacto knifes and do some surgery. I would recommend some solvents, however you have exposed meters and solvent in the jewels could be worse than the cure.

Start with two knifes or a couple razor blades. Do not respond if blood becomes involved. (be careful) No one on the R-390/A net will want to hear about it.

In easy with a blade between the glass and the rubber gasket. Do not pry at large angles. Try not to mark up the meter face with a blade point. You will likely need to work around the whole meter face.

What do you fellows plan to do to create new meter face art?

There are some real nice new art coming off the printers. However the problem is getting that ink onto a surface with stick stuff that will really stay on a meter for the next unpteen years. Roger KC6TRU

### How to Open the Meters

Scott, Yes, there are spanner tools to do it. A 1 x 2 pin stake.

Drill two holes in the stake with 4 penny nails at the correct span to fit the ring. Grind end of 4 penny nails to fit the slots in the ring.

OR

You can put a pin punch against one of the slots and tap the ring loose. You will want to grip the meter in a big bench vise if you can. Just a challenge in tools. Tim Allen never addresses these real life problems. Roger KC6TRU.

Subject: [R-390] Re: R-390/AA meter movement current.

I think the FS current on the Carrier Level meter is 1ma. Yes, the rub is the internal resistance. Barry - N4BUQ

## Receiver Rack Mounting on Rails

I have both a R-390A and SP-600 receivers which I would like to mount into a 6 ft tall x 19" wide standard rack cabinet. I have ball-bearing slide rails, however the rail mounting holes (standard 19" rack item) do not match up to the screws/holes on either side of the radios. Matter of fact, the R-390A doesn't even look like there are any threaded holes at all for mounting rack rails.

How were these receives mounted into racks when used in the military? I don't believe all the weight of these very heavy receivers was all place entirely on just the front panel. Was it????

Tom, The R-390/A's had angle brackets under then. about 2 1/2 x 2 1/2. These fit the RETMA rail pattern. When bolted to the sides, the rails held a receiver just right so the front panel bolt holes all lined up just right.

3/4 pine 22" long and 1 1/2 wide with two holes through the 1 1/2 dimension will let you bolt the wood slat to the side rail with a 2 inch 10 - 32 bolt. Use washers and do install several front panel bolts once you get the receiver into the rack.

Angle iron from the salvage yard can be drilled and works well. Larger wood slats (2 x 2 ) and 1U (1 3/4) blank panels work well. There is room for the slides between the rail and the radio. You can bolt an angle to the slide rail and set the radio on the angles this will make slide out drawers.

You can install U pans between the rails or slides. This causes a ventilation problem. So a hole saw to open up some air flow in the pans is in order.

An angle rail that is wide enough so that when the receiver is moved all the way over to one side, the other side will not drop off the rail is normal. You can mark and drill the angle to fit the rack pattern. Blots and washers will hold the rail in place with oversize (slotted) adjustment holes. Roger KC6TRU.

**Stuff not in the Manual**

HI Bill, Good job on the pot clean up and recovery.

Knobs set screws put burs on shafts. That why they did the big knobs with the split and clamp. So as not to burr the shaft. The idea on the IF deck extensions is to let the burred extension shafts stay in the front panel. Some receivers have the micro dial on the BFO for RTTY work. It was easier to do the clamps on the extension shafts.

If you do not have a long spline wrench that will reach in to the deck and your RF gears, you need to make one. Grind (sawing a spline wrench is a forever job) chunk of spline off an wrench so you have a straight piece. get out the acid core solder and solder the spline into a length of small brass tubing. Arrange a good handle.

> Oiled and re-set the bushings for KC and MC shafts,

Amazing what resetting the bushing can do for tunnel carpo relief

How about stuff in the manual that is wrong? Not all that much is wrong. But there was enough to motivate the Fellows to produce the Y2K manual.

I like that manual a lot. Roger KC6TRU

As a radio repairman from 68-75 I did some things to R-390/A/URRs R-390/AA/URRs that I will not even repeat. From these "experiments" I can assure you there is no paraffin compound that will soften or dissolve in a petroleum base solvent, in the R-390/A slugs.

## Problem Parts

This is a collection of parts problems reported by different list numbers. As our radios are 50+ years old many advocate complete or almost complete replacements of the resistors and capacitors. One reason given is that if you are going to all the effort or replacing the problem parts it takes little additional labor or expense to replace all the other parts, Warning: lead dressing in some of the RF sections if part of the total capacitance. Check previous R-390/A list posts for information. Previous treatment or repair quality may indicate that it is prudent to replace all parts in a sub-section or the whole receiver.

The one imperative part to replace is **C-553**. The capacitor which blocks B+ from the mechanical filters. Failure of this part will destroy all your mechanical filters. The original capacitor was .01ufd at only 300VDC. It should be replaced with one having a 600VDC rating

**C-531, C-547** and **C-549**. These have all been the cause of audio and Limiter function problems.

The 2 multi-section, electrolytic capacitors mounted on the AF deck.

**C-609** is an 8 ufd electrolytic and serves as the cathode bypass capacitor for V-601A. A **8 ufd 35V tantalum**

**C286** and **C327** should be replaced right out in each RF deck overhaul.

**C-327**, a 100pf mica capacitor failing. It is across the primary of T-207 and is accessed from the underside of the RF deck. It should be replaced by a **100pf, 1KV** ceramic disk capacitor and the circuit re-aligned.

I also replaced all **.1** and the **.033** caps.

**2.2K** resistors had drifted higher by as much as 3.15K. I replaced them all.

The **56K** resistor in **V207** circuit had also drifted to 61K and an **82K** resistor in **V202** circuit was 96K.

6025-B 1 Tall 9 Pin, used for the ballast tube
6020-B 9 Medium 9 pin, used on 5814A's and 26Z5W's
5015-B 2 Short 7 pin, used on the 5654's
5020-B 13 Medium 7 pin, used on 6BA6's, 6C4, 6AK5, etc.
5025-B 1 Tall 7 pin, used on the OA2

## Mechanical Filter Rebuilding- Ruszkowski

The Fellows here on the R-390/A reflector did a whole series on rebuilding the filters here last year. You will need to look through the archives. There were even web pictures and everything when we got done.

You can fix the filters if you can solder, We can help.

Inside the filters was some sponge packing that held things in place. Over time the sponge packing has turned to sticky stuff. This has left the filter part hanging on the very small wire leads. Over time the bumps and gravity will cause one of the wires to break. Thus the filter goes from band pass to full stop.

The procedure is to remove filter from the IF deck. Using a larger solder iron the ends are heated and the whole inside will slide out of the round sleeve body of the filter.

Use care the wires are short.
There are three parts inside the sleeve.
The two end caps and the filter part.
The three items are coupled with fine wire.

Heat one end and pull it free.
Turn the assembly over and do the other end.

With both end free, undo the wires.

You can then get every thing apart and clean up the solder joints.

Then you can put it all back together.

Some packing foam can be cut for new spacers.

Hang the sleeve with wire through the mounting flange holes.
Tie a second wire from the end terminals.
Hang the sleeve from over head.
Pull down on the second wire.
Take care not to catch hot solder on the human body.
Apply heat to the joint.

You can clean up the sticky stuff and do a wire repair.

The guys at Fair Radio have gone so far as to do a complete rewind on the input and output coils. Install new packing and do a re solder.

Others have just done wire fix and re solder.

I am still rebuilding my retirement home and have no bench unpacked and set up yet. So I am not doing repairs my self.

I hope you receive some mail from other Fellows. One was trying to develop a small market to do repairs and exchanges.

Here is an URL to a website that will at least help disassemble the filter. So far, I've had zero luck getting the coil winding apart. Can't dissolve the stuff used as a potting material. The last thing I tried was MEK. Soaked the coil for several hours; nada, zip, didn't faze it one bit.

http://collinsfilter.tripod.com

Here's the url of my web page on Collins My page is at:
http://webs.lanset.com/buzz/misc/filter/390Afilter.html

I posted it here on the list a few times because I figured anyone with a R-390 would be here.
Buzz

**Subject: RE: [R-390] Mechanical filter Repair**

wrote: >using a current filter available from one of the various electronic suppliers. As I recall, it wasn't perfect but was relatively inexpensive. <snip> we need to explore a reasonable cost substitution for a component that cannot directly be substituted. $600 of filters in a $600--$800 radio seems a bit questionable.

Unfortunately, 455 kc (455 kHz for the younger crowd) IF's are rapidly becoming a thing of the past. Murata makes several series of 455 kc ceramic resonator filters, some of which perform extremely well, but I have not found any of them available in the US except direct from the manufacturer in 100s. Even these would likely require some impedance-matching to retrofit into a boatanchor, so the chances are slim that someone could make a ready-to-use replacement available for less than $100-200 each. However, if the filters were available in small quantities, DIY might be a viable option.

The three desirable Murata series, in order of preference, are CFK, CFS, and (distant third) CFZM. A specific filter is specified by the series designator, the center frequency in kc (455), and a letter indicating the bandwidth. The bandwidth codes are:

Code 6dB BW (kc) [calculated; Murata gives half-BW]

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 35 | C | 26 | E | 16 | F | 12 | H | 6 | J | 3 |
| B | 30 | D | 20 | E10 | 15 | G | 8 | I | 4 | | |

BWs A through D are generally too wide for a general-coverage receiver. The filters we can use, then, are:

CFK455E, CFK455E10, CFK455F, CFK455G, CFK455H, CFK455I, and CFK455J;

CFS455E, CFS455E10, CFS455F, CFS455G, CFS455H, CFS455I, and CFV455J; or

CFZM455E, CFZM455E10, CFZM455F, CFZM455G, and CFZM455H (there is no CFZM455I or J).

If anyone knows where any of these can be purchased in small quantities, please let us know! Some of the Japanese radio manufacturers (e.g., JRC) use(d) Murata filters (sometimes only as narrow-BW accessory filters), so some useful filters may be available from those manufacturers as spare parts. I do not know generally whether they use filters from the three series mentioned above (which have the best out-of-band performance).

MURATA CFW455F 455KHZ LADDER FILTER MULTI-ELEMENT 5-PIN ACTUAL 4 PIN ONE SIDE / ONE PIN OPPOSITE SITE $4.77

**455 KHz Ceramic IF Filter**

(FLX) LF-D6 455 KHz Ceramic IF Filter. -6dB pt = 6 KHz. 11 KHz @ -60dB. 2:1 shape factor. 1500 ohm in / out impedance. 1.9dB insertion loss. Dimensions: 2.5mm L x 7.5mm W x 10.5mm H. 4mm x 20mm pin spacing. Mfg: NTK. Same as Murata CFR455H. Fits many popular receivers and greatly improves slope. The LF-D6 is a direct replacement for Yaesu FRG7 700 & Panasonic RF4900. $16.90 SS of NB

Best regards, Don

From: ToddRoberts2001@aol.com Date: Sat, 2 Jun 2007 12:54:45 EDT
Subject: Re: [R-390] **Mech filter REPAIR Lankford Trial**?

writes: I was just re-reading Dr Lankford's suggestion yesterday. HSN #30, pages 2-8. He suggests the Collins "low-cost torsion filters", 6kc BW #526-8636-010, 2.5kc BW #526-8635-010, and 0.5kc BW #526-8634-10, along with some misc. chokes, impedance transformers from Mouser, resistors, etc. to match it all into the existing IF deck circuitry with some mods to the IF deck itself.

I can tell you the Collins low-cost Torsion mechanical filters are excellent. I have made up some replacement IF filters for the Racal 6790 and the Icom R75 using the 6Kc (really 5.5KHz) BW torsion filters and was delighted with the results.

If there is any interest out there I would consider making up a few drop-in replacement 5.5KHz BW mechanical filters for the R-390A. They would be mounted in brass tubing the same size and diameter as the originals with a mounting flange and feed-thru insulators on the ends.

Otherwise for the same bandwidths and specs it would be better to rebuild the original filters for the R-390A.

Once someone masters rebuilding the transducer coils the rest is relatively easy. For now the best thing the rest of us can do is hang onto any 'bad' filters you might have - save them for possible rebuild!

73 Todd WD4NGG

**Procedure for aligning T207 ( 17meg) or T401 (crystal osc)** Roger AI4NI

For T401 the procedure is to run the MC to 31 and peak T401 and the cap for maximum output.

In practice you find the MC band with the lowest output level and retune T401 to bring that band up enough to pass the 10:1 signal to noise ratio test on that weak megahertz band. There is no one best absolute setting for T401. You use it to get the best of all bands out of it.

T207 the output of the first crystal oscillator is the same approach. That transformer always passes 17Mhz. Pick any point under 8Mhz and adjust T207 for maximum output on the diode load for minimum RF input at the antenna input.

You get like one clause of a sentence in the original TM on these subjects.

**Procedure for aligning T207 ( 17meg) or T401 (crystal osc) Expanded** Roger AI4NI

Sorry to be off line and long in coming back to you. This is long but I hope it provides some insight. It is still not an exact step by step cook book.

The Second Osc alignment is about as clear as Mississippi River Water after a summer rain. After reading the TM a few times the subject clears up. It looks like the Beach Surf in Okinawa after a Typhoon just misses the Island. Once you the do the alignment a few times the subject looks like the crystal water and coral bottoms as viewed from the high beach cliffs of Okinawa and you wonder what the fuss was all about.

The TM says align the second crystal oscillator caps from the Cal tones and using the carrier meter as the output indicating level. That got some writer off the hook back in 52 for the R-390/A TM and was copied into the R-390/A/A TM. See TM 11-5820-358-35 Paragraph 74 (page 114 in the 8 Dec 1961 printing) The process works. And you can spread peanut butter on bread with a pop sickle stick.

But I digress and you asked me about T401 and the trimmer caps in the Second Oscillator in the R-390/A/A receiver.

The TM says there is no adjustment for 0 to 7. But we know 0 - 7 lays over 17- 24. The TM says start adjusting the caps for maximum carrier level output on each Mhz band from 8 to 31. Mud in your eye. Do this from 31 down to 8.

There is one obscure clause of a sentence in the R-390/A TM that suggest that T401 (numbered something else in the R-390/A) be adjusted for maximum output at 31Mhz.

These two items, set T401 to max at 31Mhz and set C31 to max at 31Mhz, imply these two adjustments will peak the output of the second crystal oscillator for maximum receiver performance across all frequencies in the range of the receiver. Another fantasy that passed muster with the TM editors. Hey it reads good in Jargon with no sarcasm showing.

In real life do the following:

Turn the BFO off because BFO on masks the real signal level.

Set the receiver to MGC to defeat the AGC which will cause output meter variations.

Hang a DC volt meter off the diode load as you choice of output indicator as this is the most sensitive easily accessible point to meter the receiver output.

Inject RF into the antenna input and use a level that gives a diode load reading in the range of -5 to -10 volts. The RF may or may not be modulated but un modulated RF is mostly preferred for adjusting and testing.

The Receiver has a range of 31,000+ - 500 = 31,500 hertz. There is one transformer (T401) and 24 caps that need to adjusted to optimize the second crystal oscillators output such that all frequencies at the receivers antenna input have optimum output at the headphone jack. Optimum output is left undefined as an exercise for the operator to complete.

The first crystal osc mixes RF input under 7,000+ Mhz with a frequency near 17Mhz and passes it on to the second mixer. Between 17 Mhz and 24 Mhz the second crystal osc uses a different crystal to mix that RF input under 7,000+ Mhz to a range of 3.455 to 2.455Mhz. The third mixer then mixes the VFO with this signal to produce a signal at 455Khz. On a good day this signal is centered into a crystal in the if deck with a band pass near 455Khz. Anywhere in the frequency range you can grab the zero adjust the and slide the VFO around a bit to peak the transfer.

The nonlinear VFO and its band spread will also impact the mixing frequency. One end of the VFO or the other may add or subtract from any given second mixer crystal error to increase the or decrease the receiver output.

So what good alignment? When do you quit?

Because the 17Mhz crystal is not exactly 17,000,000.000 you may find the optimum cap setting for 18Mhz is not the same set point as for maximum 1Mhz.

Like wise because some crystals at 17 -24 are not exact, the optimum setting for one of them may not be the same for the double conversion and the single conversion. If the 17Mhz crystal is off and the second mixer crystal is off the differences may add to make things poor, subtract to make things OK, cancel to make things good, do none of the above just to add reality.

Some of the second mixer crystals are used at more than one harmonic. You have a different cap to peak each of these harmonics. The output level at the harmonics may not be equal in amplitude or adjustable to equal amplitude while each frequency has a nice double peak on it's respective trimmer cap.

The thought is that crystal output is highest at low frequencies and drops off as frequency increases. If T401 is peaked at the highest frequency, it response will drop off as frequency decreases. The slope of T401's output plotted against the slope of crystal loss across frequency is considered to yield a near flat mixer output across the frequency span.

Thus the TM read to peak T401 at the highest frequency and adjust each cap in the second crystal osc deck from 8 to 31 Mhz. The procedure details using the Cal tone, BFO and carrier level meter. Me know this process is not the most sensitive.

We would like to think that peaking the trimmer caps only changes the impedance match to yield a better power transfer of the oscillator output and that the cap adjustment does not vary the frequency of the crystals. We would like to think every crystal is spot on exact to within under 100 hertz and stable as a rock.

What we find is one or more crystals have an output level below the curve. If it is off frequency, and in the range of the zero adjust, then zero adjust the VFO and peak the cap for the megahertz band and move on. This is just an off frequency crystal but still in specification. If the zero adjust it peaked and the output is low then the oscillator output is weak for that band. Try cleaning the crystal contacts, the tube contacts and the cap. But the first easy quick fix in a clean receiver where you know corrosion is not the problem (1968 - 1975 era) is to adjust T401.

You slide the low frequency slope of T401 down. This lets more of the crystal output from the weak crystal through the circuit to bring the weak band up to par. You hope the top frequencies do not go so far over the hump they fall under par.

You find the low spot (a dip / a weak output crystal) in what would be the curve of the crystal output levels. Then move the cutoff slope of T401 by adjustment so that when the two functions (crystal outputs / T401 cutoff slope) cross, the output performance level of the second osc is of acceptable performance.

Start at 31 Mhz and adjust T401 and cap 31 for maximum output. Use a RF signal generator and DC volt meter on the diode load for best indication of adjustments.

Continue down the bands in frequency to 8 Mhz. Adjust each cap but do not reset T401 while doing these adjustments.

Mark the 17 - 24 cap setting (pencil on the deck in line with the screw driver slot) and continue down in frequency.

Reset the caps for best output on the 7 - 0 bands.

Look at the cap settings when you complete this process. Are the caps still peaked at the same alignment point?

Are the 17 - 24 caps not all offset the same way (17Mhz crystal off frequency)?

Are the 17- 24 caps set above and below (the second crystals osc crystals off frequency)?

Now you have a choice.

Peak the caps for the low band (0-8) or the high band (17-24) or balance between the bands.

If in the process of aligning the whole receiver you find one or some of the 1Mhz bands to be low you can now think about readjusting T401 to bring the bands up to par.

First consider if you have done all the other adjustments on the receiver. Working over 17- 31 Z206 and T206 will yield more improvement than trying to optimize T401 and C20 to bring up a weak 20Mhz band.

Second consider if you have a clean machine.

Clean contacts under, caps, transformers, tubes, crystals and connectors go further than peaking adjustments.

After you adjust T401 to bring up some low band you should then go back and check all the other caps. What ever the last setting for T401, peak all the caps without ever touching T401 again.

The TM implies that setting T401 is not an exact most critical adjustment. The TM further implies that just close with a cal tone and carrier meter is good enough. But after 50 years, consideration and attention to detail can get more out of these adjustments than just a good receiver.

Put some time into your receiver working through these adjustments to come to an understanding of how your particular receiver balances out. In the end you will have a better receiver to listen too.

There are many other stages in the receiver that can compensate for the elected less than exact test book adjustment of the second crystal osc deck.

Once you understand what bands of the receiver you want to optimize for your use, how the many adjustments interact and the limits of the exact parts in your exact receiver, you find a pattern of adjustments that optimizes the receiver for your enjoyment.

**Subject: [R-390] Z503, AGC amplifier anode coil** Graham Baxter G8OAD

I just had to rewind Z503 on my current project, EAC S/N 162.

I was able to pick the coil and former out from above after desoldering the top paxolin plate. The glue used for assembly will soften and crumble with the heat from a soldering iron.

The ferrite cup was fixed to the coil using the same glue. By running the iron around the top edge and gradually pulling and rocking the former it all pulled out without breaking the ferrite. It got too hot to hold with the bare hand though. The cup needed some patient scraping to remove all the glue debris.

The middle pie of the three had rotted and turned green. This explained the 700 ohm resistance instead of 17.

In case anyone is interested I can confirm that Z503 has three identical pies, each wave wound with 120 turns of litz. The litz has 5 strands of 0.002" (0.05mm) enameled wire.

Since I was disinclined to use a wave winder ( I do have one in the loft, but I have never understood how to use it!), I random wound it using rubber washers as spacers. The washers were lightly oiled before winding. As each pie was completed I soaked it in superglue to make it self supporting. On completion I removed the washers by melting a small hole through the edge of each one and picking them out with tweezers.

I consider myself fortunate that my new coil will peak up with the original 82 pF capacitor; I was quite prepared to select a new value if necessary.

## Setting IF Gain for Optimum Performance

The most common single item responsible for holding an R390A back is not lack of sensitivity. Rather it is internally generated IF deck noise. In an otherwise properly operating R390A, the cause of this excessive noise is IF gain control being set to high. Even the mfg spec of setting the IF deck gain such that -7vdc at the diode load when fed by 150uv @455kc into J-513 is far too hot.

Here is a recently refined procedure to set the IF deck gain control. Anyone can perform the procedure whether they have access to a signal generator or not:

Procedure to set R390A IF Gain:

Once the receiver has been fully mechanically and electrically aligned, the final procedure to perform before "buttoning it up" is to set the IF gain control. Many otherwise very sensitive R390A's are thought not to be due to weak signals being covered by noise generated by excess IF deck gain.

Allow the receiver to warm up for at least 1 hour then:

1- Terminate the antenna input
2- Set receiver for 15.2 mHz
3- Set the "FUNCTION" control to MGC
4- Select the 4kc filter with the "BANDWIDTH"
5- Set "RF GAIN" control to 10 or maximum
6- Peak the "ANTENNA TRIM" for maximum noise as indicated on the "LINE LEVEL" meter
7- Set "Line Meter" switch to -10db scale
8- Set "Line Gain" control to full CW or "10."
9- Adjust IF gain control, R-519 to cause "Line Level" meter to indicate between -4 to -7 VU.
10- Re-zero the carrier meter control, R-523
11- Set controls above for normal operation and reconnect antenna

Discussion:

This will yield the best compromise on all bands. I usually "poll" those bands which I normally spec out. Then, using an HP signal generator set for internal modulation of 800 hz @ 30%, "massage" the gain setting and even specific signal path tube selections for the best overall performance.

Contribution by: Chuck Rippel, WA4HHG

## Variable IF Reference & Stage Gain

Part of the secret behind the R390A's incredible selectivity and its immunity to near RF fields is found in the two tracking IF sections. The First Variable IF operates while receiving frequencies below 8 Mhz and is tuned to pass IF signals from 17 to 25 mhz. This represents the sum of the actual received frequency that is amplified by V-201 and then applied to the grid of the First Mixer, V-202. The 17.0 Mhz output from the 1st Crystal Oscillator, V-207 is also applied to the cathode of the same tube. The signal represented by that sum is directed to the tracking coils Z-213-1, 213-2 and 213-3 which are kept tuned to the correct frequency within the 17 - 25 mhz IF frequency range by the cam system. This signal is then known as the First Variable IF Frequency.

During reception of frequencies 8 Mhz and below, the composite output of the First Variable IF is routed through S-208 (front), then C-286 and is applied to the grid of the 2nd Mixer, V-203. For reception of frequencies 8 Mhz and above, the amplified received signal from V-201 is routed around the First Mixer by S-206 and applied to the grid of the 2nd Mixer through S-208 and C-286. The output of the 2nd Crystal Oscillator, V-401 is also applied to the cathode of V-203. The resultant output is the 2nd Variable IF Frequency which is always between 2 and 3 Mhz. That difference is applied to the tracking coils Z-216-1, 216-2 and 216-3 which are also kept tuned to the correct frequency within the 2-3 Mhz IF frequency range by the cam system.

The 2nd Variable IF frequency is applied to the grid of the 3rd mixer, V-204 where it is mixed with the output of the PTO (V-701) applied to pin 7. The PTO tunes from 3.455 to 2.455 Mhz . The difference frequency between the 2nd Variable IF Frequency and the output of the PTO is always 455kc. This difference frequency is applied to T-208 which is tuned to 455kc. The result is the 3rd IF Frequency which is then routed from the RF deck to the IF sub-chassis through P-213 and P-218.

In analyzing a failure in the variable IF system, it can be seen that a signal related failure in the First Variable IF will result in low gain during reception of only the frequencies below 8 Mhz. A like failure in the 2nd Variable IF or 3rd IF would affect all frequencies.

Here is a quick test to see if the Variable IF stages are generally working.

**Initial checks:**

First Crystal Oscillator output as measured at pin 7 of V-202: Normal is approx 4V p-p
Second Crystal Oscillator output as measured at pin 7 of V-203: Normal is approx 3.2V p-p
PTO output measured at pin 7 of V-204: Normal is approx 6V p-p

**First Variable IF Gain Test:**

Tune the receiver to 00 500, AGC OFF, VTVM connected to read voltage at the rear Diode Load point.

Inject a 17.5 Mhz signal at approximately 15uv through an RF coupled probe to E-210. This should result in a reading of approximately -5V at measured at the diode load point. This bypasses the coils Z-216-1, 216-2 & 216-3 and can be used as a reference.

Inject a 17.5 Mhz signal at approximately 40uv through an RF coupled probe to pin 1 of V-202. This should yield approx -3.5V at the diode load point.

Discussion: An indication at the diode load point of approximately 1.5V of loss is nominal. If there is loss which cannot be corrected by proper alignment of coils Z-216-1, 216-2 and 216-3 or no signal at all, change the injection point coil to coil to moving "away" from the 2nd mixer to find the failure.

**Second Variable IF Gain Test**

Tune the receiver to 01 000+, AGC OFF, VTVM connected to read voltage at the rear Diode Load point.

Inject a 2.0 Mhz signal at approximately 15uv through an RF coupled probe to pin 1 of V203. This should result in a reading of approximately -2.2V at measured at the diode load point. Again, this bypasses the coils Z213-1, 213-2 & 213-3 and can be used as a reference.

Inject the 2.0 Mhz signal at approximately 15uv through an RF coupled probe to pin 6 of V-204. This should yield approx -4.2V at the diode load point.

Discussion: An indication at the diode load point of an increase of approximately 2V is nominal. Again, If there is loss which cannot be corrected by proper alignment of coils Z-213-1, 213-2 and 213-3 or no signal at all, change the injection point coil to coil to moving "away" from the 2nd mixer to find the failure.

To align the variable IF stages, I use a different method from that found in the various military manuals. My technique yields better results by taking a systems approach and also not loading down the stage to be aligned. Its a bit lengthy to explain here but that procedure, along with many other techniques are demonstrated in the 7 hour long, R390A video tape series available from Hi-Res Communications. Don't forget to ask about the new 4 hour addendum to the 7 hour series..

Page prepared by R. Charles Rippel Revision: 04 December 24, 2001

## IF Deck Tips

**R390A IF Deck Alignment** (Chuck Rippel)

R390's made after 1954 and those with mod 2 stamped on the IF chassis have a field change installed to the mechanical filters. Filter input and output trimmer capacitors have been added. The 4 input trimmer capacitors are found by removing the 2 square can on top of the IF chassis using the single nut in the top. The 4 output trimmer capacitors are located behind 4 holes in the left hand side of the IF deck. The IF chassis will need to be loose but still electrically connected to complete these procedures.

An accurate counter, analog VTVM and a signal generator capable of outputting 455.00 KC, is required for these alignments.

Connect the VTVM to the Diode Load bus on the rear and configure it to read a negative voltage of approximately -7vdc. Set the receiver FUNCTION control to MGC, BFO to OFF and the LOCAL GAIN control to a comfortable level. Lift and tilt the IF deck resting the front captive (green) screw over the front panel. You should be able to gain access to the mechanical filter trimmer capacitors through the large ventilation holes in the main chassis.

Locate the cable running from the rear of the IF deck to the *IF OUT* BNC connector in the rear panel, upper left side. Unplug the cable from the IF deck only. Also unplug J-513 and the one next to it. Plug the cable running from the rear IF Out jack into J-513 on the IF deck. Connect the output of your 455.000 kc generator.

**Mechanical Filter Alignment-**
• Set the 455kc generator output level to cause the VTVM to read about - 2.5V.

• With the IF deck oriented so that the bandwidth control is towards you, set the bandwidth to 2Kc and align 1 of the four the top trimmers.

• Adjust C-569 which is at 9 o'clock for a peak on the VTVM.

• Next, align the output trimmer in the left side of the IF deck, labeled C-567

• Set the BW to 4KC
• Align the top trimmer, C-568 located at 12 o'clock
• Align the side trimmer, C-566 located at rear, bottom.

• Set the BW to 8kc
• Align the top trimmer, C-570 located at 6 o'clock.
• Align the side trimmer, C-565 located at front, top.

• Set the BW to 16kc
• Align the top trimmer, C-571 located at 3 o'clock
Align the side trimmer, C-564 located at front, bottom.

**IF Transformer Alignment-**

• Select the 16KC filter
• Set the generator frequency to .467kc. Note: The generator output should be increased until the VTVM indicates approximately -2vdc. Do not be alarmed if that level is over .1 volts.

• Adjust the top slug (secondary) of T-501 for a peak reading on the VTVM

• Adjust the bottom slug (primary) of T-502 for a peak reading on the VTVM

• Set the generator frequency to .443kc. Note: The generator output should be increased until the VTVM indicates approximately -2vdc. Again, do not be surprised if that level is over .1 volts.

• Adjust the bottom slug (primary) of T-501 for a peak reading on the VTVM

• Adjust the top slug (secondary) of T-502 for a peak reading on the VTVM

• Decrease the generator output and adjust the frequency to . 455kc Note: The generator output should be decreased until the VTVM indicates approximately -3vdc.

• Select the 4kc filter then peak top and bottom of T-503 only

**AGC Alignment-**
• Verify the generator is still outputting 455.00kc. Set the FUNCTION switch to AGC and connect the VTVM between the AGC bus on TB-102 3 & 4 located on the rear panel & ground.
• Adjust the generator output for a reading of approximately -5vdc on the VTVM. Peak Z-503.

**BFO Alignment-**
• Verify that generator is still at 455.00kc

455.0 • Turn on the BFO and exactly zero beat it against the generator frequency.
455.1
• Loosen the bristol spline socket on the BFO shaft coupler,

• Verify that you still have exact zero beat.

• Set the BFO Pitch control to indicate exactly 0.

• Then, tighten the bristol socket on the non-mar clamp on the BFO shaft coupler

• The filters have been aligned to 455 kc. (When a station broadcasting in AM is zero beat, the carrier will be in the center of the filter selected).

• Re-install the IF chassis in the receiver.

**Setting the IF Gain Control for best performance**

The most common single item responsible for holding an R390A back is not lack of sensitivity. Rather it is internally generated IF deck noise. In an otherwise properly operating R390A, the cause of this excessive noise is IF gain control being set to high. Even the mfg spec of setting the IF deck gain such that -7vdc at the diode load when fed by 150uv @455kc into J-513 is far too hot.

Here is a recently refined procedure to set the IF deck gain control. Anyone can perform the procedure whether they have access to a signal generator or not.

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**Procedure to set R390A IF Gain-**
Once the receiver has been fully mechanically and electrically aligned, the final procedure to perform before buttoning it up is to set the IF gain control. Many otherwise very sensitive R390A's are thought not to be due to weak signals being covered by noise generated by excess IF deck gain.

Allow the receiver to warm up for at least 1 hour then:
• Disconnect the antenna
• Set receiver for 15.2 mHz
• Set the FUNCTION control to MGC
• Select the 4kc filter with the BANDWIDTH
• Set RF GAIN control to 10 or maximum
• Peak the ANTENNA TRIM for maximum noise as indicated on the LINE LEVEL meter
• Set Line Meter switch to -10db scale
• Set Line Gain control to full CW or 10.
• Adjust IF gain control, R-519 to cause Line Level meter to indicate between -4 to -7 db.
• Re-zero the carrier meter control, R-523
• Set controls above for normal operation and reconnect antenna

**Discussion:**
This will yield the best compromise on all bands. I usually poll those bands which I normally spec out. Then, using an HP signal generator set for internal modulation of 800 hz @ 30%, massage the gain setting and even specific signal path tube selections for the best overall performance.

Contribution by Chuck Rippel, WA4HHG

**RF Deck Test-**
I also encourage you to do a quick test that will verify the condition of your RF deck and state of alignment. The procedure is as follows:
1-Disconnect the antenna

2-Set the Line Gain and Line Meter controls for a relative -5 db indication on the Line Level meter.

3-Adjust the antenna trimmer for a relative peak on the Line Level meter and note the position of the control.

**Discussion:**
An R390A with a properly operating RF deck is capable of peaking on its own internal noise as indicated by the Line Level meter. Further, that peak with no antenna connected should be coincident with the Ant Trim control indicating 0.

Having the peak not occur at all indicates an RF deck failure or poor/improper alignment. Additionally, improper alignment can also be the case when the noise peak as indicated by the Line Level meter not coincident with the 0 (+- .5) position on the Antenna Trim control.
Chuck Rippel

**Testing the RF Deck Noise Power**

Here is an interesting test you can run to prove to yourself what the IF gain setting procedure is all about.

• Before running the above procedure, set the IF gain to maximum, ie. fully CCW looking from the top. Set up as above except:

• Set IF bandwidth to 8 kHz
• Set the Line Gain for 0VU on the Line Level meter.

Then, tune the antenna trimmer for a minimum reading

When I did this with my receiver the noise dropped by only 3 dB in IF Gain Setting Procedure, step 9. That means the noise from the receiver first RF amplifier, the place where the receiver noise floor should be established, is only 3 dB above the noise generated in the following stages. With the maximum IF gain setting, half of the noise power heard in the output is coming from stages later than the first RF amplifier.

Then I performed the adjustment as above and measured the difference between the antenna trimmer peak and minimum settings. When I did this, I found the difference to now be 5 dB. Now only about 1/3 of the noise power heard in the output comes from the later stages.

Your results may vary depending on how much gain your receiver has ahead of the stages controlled by the IF Gain pot. If you can't hear the noise peak as the trimmer is rotated through resonance, there is something wrong with your RF deck. I would be interested to hear your experiences running this procedure. Is my receiver typical, or do I need to give it a tune-up?

Contribution by Joe Buch, N2JB
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## R-390A 10 dB S+N/N AM Sensitivity - Dallas Lankford

There has been a lot of confusion about how to measure the AM sensitivity of an R-390A.

Unfortunately the manuals have contributed to this confusion. The 1970 Navships 0967-063-2010 manual has a sensitivity measuring procedure on pages 4-2 and 4-3 which involves setting the signal generator (URM-25D) to minimum output. This is equivalent to the method of turning the signal generator on and off which is used at several web sites to find the 10 dB S+N/N ratio.

However, the Navships manual does not mention a 10 dB S+N/N ratio, but rather a 10 dB rise, which it is. What the Navships and web sites measure is the 10 dB S+N1/N2 where N2 is the no signal receiver noise, and N1 is the noise due to the signal and receiver. Also, the 50 ohm impedance of the signal generator is not matched to the 125 ohm nominal (100 - 300 ohms) antenna input impedance (through a UG-636A/U and UG-971/U) of the R-390A. Consequently, the signal generator reading is not the number of microvolts that appears across the R-390A antenna input. The Army manual TM 11-5820-358-35 gives a Sensitivity Test, not a procedure for measuring the 10 dB S+N/N ratio. The earlier Army manual TM 11-856A in paragraph 166 has what it calls an AM Sensitivity measurement procedure. However, there are at least two things wrong with it: (1) a DA-121/U attenuator (8.9 dB) two way match (52.2 ohms to 128.8 ohms) is used between the URM-25D and R-390A, and (2) the 0.8 volt noise indication in step (f.) is not maximized with the antenna trimmer, nor is its value checked after the signal generator is adjusted for 2.5 volts, as it must be.

Here is a correct method for measuring the AM sensitivity of an R-390A.

I measured the real component of the R-390A antenna input impedance by connecting a 250 ohm 2 watt Clarostat composition pot in the signal path, and used a UG-971/U (twinax to C) and UG-636AU (C to BNC). The 10X scope probe was connected across the 636. The 25D was set to some convenient value that could bee seen on the scope. The signal was peaked (as seen on the scope) using the 390A antenna trimmer. The pot was adjusted so that the scope read half the open circuit voltage (the voltage from the antenna input side of the pot when disconnected from the antenna input). The value of the pot was read using an accurate voltmeter, call this value R1. The R-390A antenna input resistance is R = R1 + 50 at that frequency.

I may have gotten the high end numbers a little too high previously. My scope method is probably not all that accurate because there is quite a bit of uncertainty as to the half the open circuit voltage. A true RMS voltmeter might be better. Now I am getting 180 - 220 ohms for the high values. Previously I got up to 300 ohms. The low values still come in around 90 - 100 ohms. Low values were found at 1.001, 1.999, and 3.999 MHz. High values were found at 1.5, 4.5, and 5.5 MHz. I used a TEK 2465B (cal traceable to NIST), and a rebuilt (by me) URM-25D (cal by me using my 2465B and a precision 50 ohm terminator).

I used 2 feet of RG-58A/U to connect the 25D to the 390A, and a BNC T connector adapter with a short stub coming out of one of the females of the BNC T for clipping the 10X probe to. I measured the voltage across the 390A antenna input (UG-971/U and UG-636A/U) to get a correction factor to multiply the 25D reading by. Then I measured the S+N/N ratio as if the impedances were matched (which they weren't).

My method for measuring sensitivity for a 10 dB S+N/N ratio involves turning the modulation ON and OFF (NOT turning the signal generator ON and OFF or tuning the R-390A away from and back to the signal generator). I could use a volt meter on the diode load, but it is more convenient and about as accurate to use the LINE LEVEL meter. I adjust the meter and signal generator repeatedly if necessary, peaking the ANT TRIM at each resetting of the signal generator output level, until the meter reads 0 VU with modulation on, and the meter reads -10 with modulation off.

At 4.5 MHz, with the antenna input resistance measured as 187 ohms, using the 4 kHz BW, and a correction factor of cf = 1.57 (cf = 2R/(R + 50), where R is the measured antenna input resistance of the R-390A at the frequency where the measurement is being taken), with AGC off, and 30% modulation, I got a reading of 0.5 microvolts on the 25D for a 10 dB S+N/N ratio. Using the correction factor, the voltage across the UG-636A/U was deduced to be 0.785 microvolts. So the input power was P = (0.785)^2 x E-12/187 = 3.3 x E-15 watts, or -114.8 dBm. The sensitivity looks a lot better when you convert it to dBm. If you had a 50 ohm receiver with a -114.8 dBm sensitivity for a 10 dB S+N/N ratio, that would be 0.41 microvolts. Not shabby. Note that this is also quite close to the uncorrected 0.5 microvolt signal to noise measurement above.

I also used a broadband matching transformer and got a slightly better sensitivity, namely -115.2 dBm. This suggests that matching with a broadband transformer does not change the results very much.

My R-390A was a bit weak at the top end of the 4 MHz band, coming in at -109 dBm at 3.9 MHz. Maybe I need to go in there and up the 2 pF coupling capacitor in the double tuned circuit between the RF amp and MIXER? We'll see.

Revised 7/9/02, 7/13/02

**The Hollow State Newsletter Number 29**

By: Dallas Lankford

This issue is devoted to R-390A alignment. If you are already experienced with R-390A's, then these notes alone should suffice. If not, you should supplement these notes with one or more of the R-390A maintenance manuals TM 11-956A, TM 11-5820-358-35, and NAVSHIPS 0967-063-2010 (or NAVSHIPS 93053 Vols I, II, III).

Before aligning R-390A tuned circuits, alignment of the Veeder Root counter, cams, RF bandswitch gears, antenna trimmer, and PTO should be inspected, and, if necessary, realigned.

To determine if the Veeder Root counter (the MCS/KCS counter; see Fig. 1) is aligned, (1) turn the ZERO ADJ knob clockwise until the clutch is disengaged, i.e. until the digit wheel of the Veeder Root counter does not move when the KCS knob is turned through its zero adjustment range (about 14 kHz), (2) set the KCS knob at about the center of its adjust range, and (3) turn the ZERO ADJ knob fully counter clockwise to engage the clutch. The KCS knob should be left in the center of its zero adjust range for the remaining checks and alignments. Next, (4) turn the KCS knob throughout its entire range, from one limit of the 10 turn stop to the other. An aligned Veeder Root counter should read about xx-965 and xx+035 at the stop limits. In other words, the 1000 kHz tuning range of an R-390A has about 70 kHz of over range, and the over range should be divided equally between the two ends of the 1000 kHz tuning range.

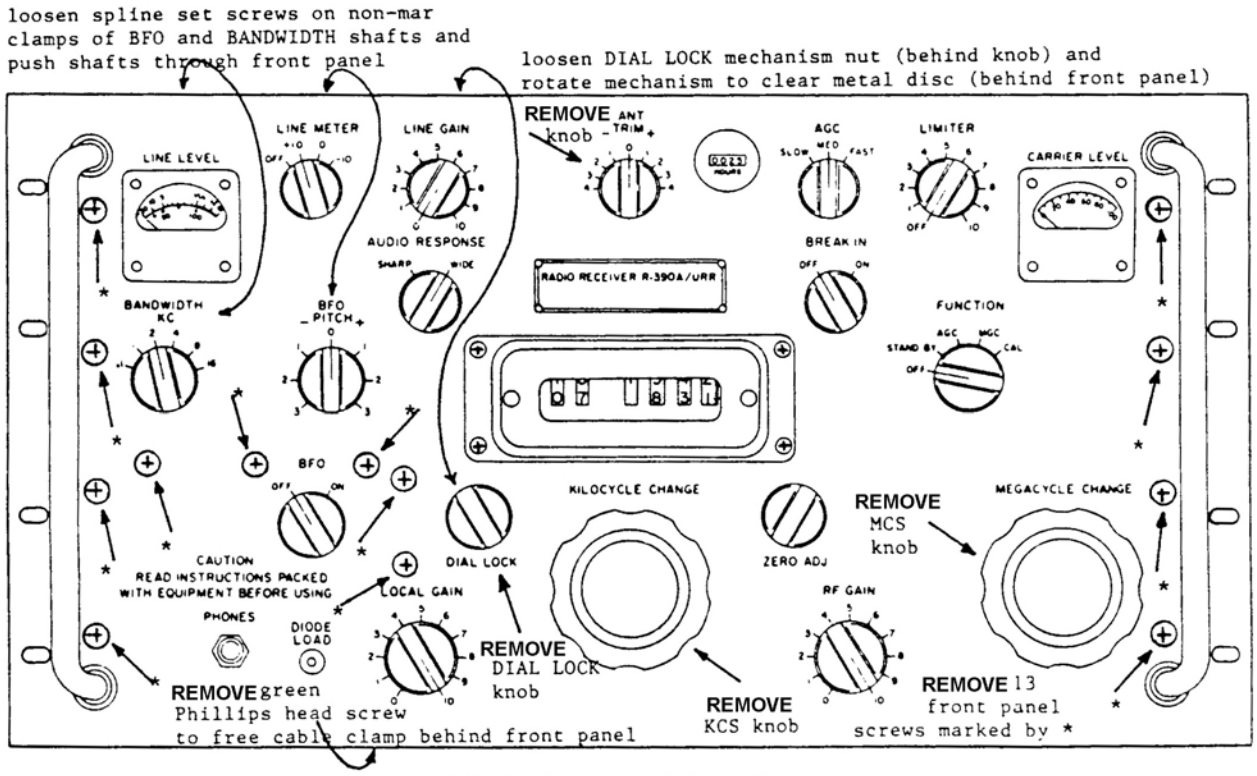



FIG. 1 Front Panel Removal

When an R-390A is tuned to 07+000 the cam tips should align with the lines on the front plate of the RF sub-chassis as shown in Fig. 2.

If the Veeder Root counter reads within 3 or 4 kHz of xx-965 and xx+035 at the stops, and the cams align within 3 or 4 kHz of 07+000, then they need not be realigned. But if they are off by more than 3 or 4 kHz, then you should consider realigning them.

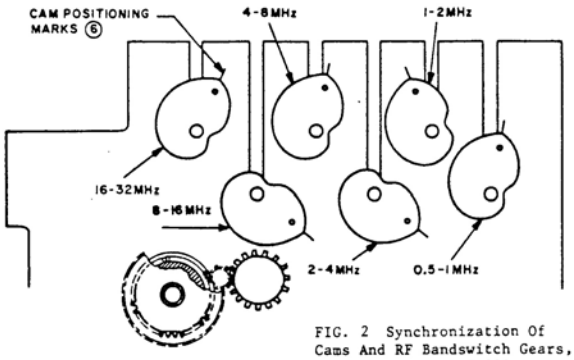


FIG. 2 Synchronization Of Cams And RF Bandswitch Gears, Frequency Set At 7+000

The Veeder Root counter and cams alignment are interrelated. Changing the alignment of the Veeder Root counter changes the alignment of the cams, and vice versa. Also, each cam can be aligned independently of the other cams by loosening the non-mar clamp on the gear in front of the cam.

Because the Veeder Root counter and the cams alignment are both dependent and independent, there are many ways they could have gotten out of alignment, and thus it is difficult to specify all ways to realign them. Nevertheless, here is a generic realignment of the counter and cams which should work in most cases.

If all of the cam tips align at the same frequency, and the difference between the cam tips alignment and 07+ stop is about 35 kHz (example: cam tips align at 07+015 and 07+ stop is at 07+050), then loosen the non-mar clamp on the right side bevel gear of the Veeder Root counter, and reset the digit drum of the counter to read 07+035 with the KCS knob at 07+ stop. The bevel gear can be accessed by removing the counter cover plate which is attached to the front panel by four Phillips head screws, see Fig. 1. After tightening the non-mar clamp on the bevel gear, turn the KCS knob through its range to make sure that the bevel gear is not binding and that there is no backlash in the digit drum. If there is binding or backlash, loosen the non-mar clamp, reposition the bevel gear, tighten the clamp, and check for binding or backlash again. Repeat until binding and backlash are eliminated or minimized.

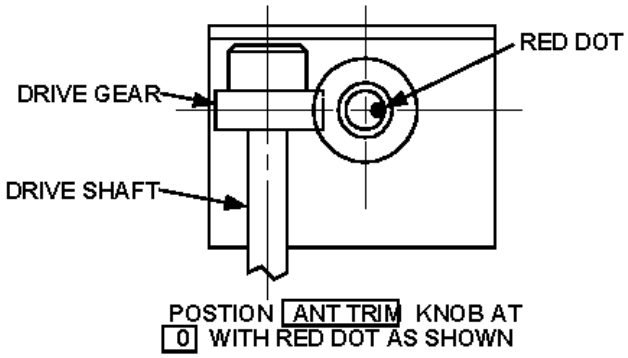
If all of the cam tips do not align on the same frequency, remove the front panel (see Fig. 1), set the KCS knob to the 07+ stop, align the Veeder root counter to 07+035, set the KCS knob to 07+000, and for each cam loosen the non-mar clamp in front of the cam, set the cam tip to its alignment line, and tighten the non-mar clamp. It may be necessary to remove the associated rack tension springs when aligning a cam tip.

If all of the cam tips align on the same frequency, but the frequency difference between cam tip alignment and 07+ stop is not 35 kHz, then you can either realign the counter and cams as described above, or pull the gear on the KCS shaft and reposition it so that the frequency difference is 35 kHz (be sure to observe the amount of tension on the split gear before removing it, and reinstall it with the same amount of tension).

The RF bandswitch alignment is also shown in Fig. 2. The 4 teeth on the large gear should point straight down (they can be seen from underneath). The only sure way to determine if an RF bandswitch is out of synchronization and to realign an unsynchronized RF bandswitch is to use a known good RF sub-chassis for comparison. Both RF sub-chassis should be removed from their respective R-390A's so that the positions of the bandswitch wafers can be compared as the MCS shaft is turned through its entire range.

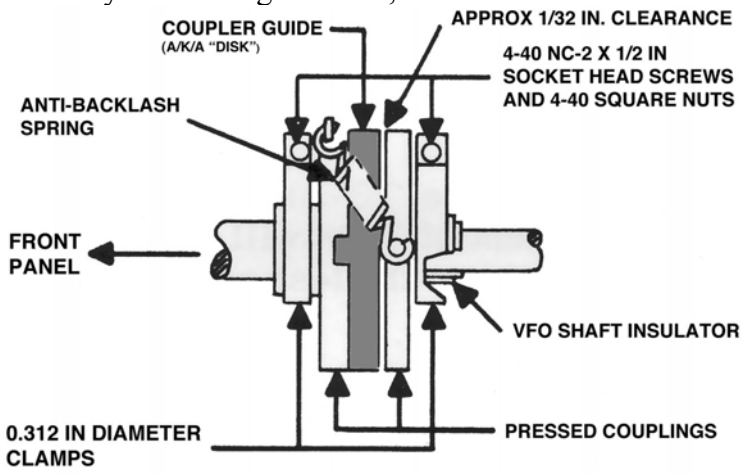
Synchronization of the xtal oscillator (attached to the RF sub-chassis) also requires a known good RF sub-chassis for comparison. It is unlikely that either the RF bandswitch or xtal osc. will be unsynchronized, and so I have not given many details about how to realign them. In both cases an obvious clamp is loosened, the shaft repositioned, and the clamp tightened. And in both cases several attempts may be needed to get it right.

Alignment of the ANT TRM is shown in Fig. 3. Two set screws behind the gear drive are loosened to realign the antenna trimmer. Often the red paint of the "red dot" has flaked off, and there is only a small dimple (like a center punch mark) where it was.




Do not tighten the set screws too tight, otherwise the bakelite insulation between the gear drive and antenna trimmer shaft may be crushed, which may cause the AGC line to be shorted to ground through R201.

If the PTO end points are aligned (tuning from xx-000 to xx+000 changes the received frequency by exactly 1000 kHz), then the PTO can be synchronized by adjusting the Oldham coupler; see Fig. 4. Before synchronizing the PTO, check the BFO and CAL alignments as follows.,

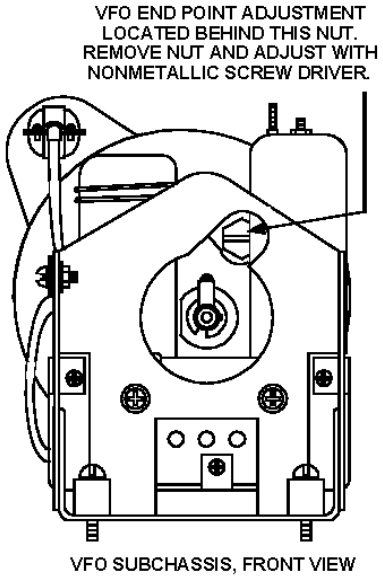



Set the BANDWIDTH to 2, FUNCTION to CAL, and tune any calibrator signal so that it is in the center of the filter passband. (For example, suppose that as you tune below the calibrator signal near xx 500, the carrier level falls by 10dB at xx 498.6, and as you tune above it falls by 10dB at xx 501.2, then the filter center is about (498.6 + 501.2)/2 = 499.4).

Turn the BFO on, loosen the BFO tuning shaft clamp, and rotate the BFO PTO shaft for zero beat while holding the BFO knob at 0 (12 o'clock). Tighten the BFO shaft clamp. Next, set BANDWIDTH to 16, change the FUNCTION switch to AGC, and zero beat to WWV (5, 10 or 15 Mhz, whichever is stronger). Change the FUNCTION switch back to CAL and zero beat by turning the CAL ADJ slut adjustment on the rear panel. If the calibrator will not zero beat, you probably have a defective 200 kHz calibrator xtal (which should be replaced). Set the Veeder Root counter to xx 000. (For example, let's say you were tuned to WWV 15, and the counter read 15 003.8. Then you would set the counter to 15 000 and hear a 3.8 kHz het with the BFO). Loosen the clamp on the front panel side of the Oldham coupler, and turn the Oldham coupler for zero beat while holding the KCS knob to keep the frequency indication at xx 000. Tighten the clamp.

PTO end point alignment for non-Cosmos PTO's has been described in detail in HSN # 6. For Cosmos PTO's, end point alignment is the same, except that the end point access hole is covered by a screw instead of a slotted hex nut, and the screw is hidden completely behind the inductor shield; see Fig. 5. If the end point alignment of a Cosmos PTO is done with the PTO in place, care should be taken not to make contact with inductor support wires because some of them carry +250VDC or higher, which can kill you.

Usually the end points of a PTO have spread (expanded) so that turning the KCS knob through1000 kHz changes the received frequency by less than 1000 kHz. In that case, you turn the end point adjustment slug clockwise to bring the range back to 1000 kHz.
The exact amount you will need to turn the slotted shaft of the slug depends on the amount of adjustment remaining (i.e., on the position of the slug inside the coil, which you can't see).



VFO SUBCHASSIS, FRONT VIEW

Try one turn and observe how much the spread is reduced. If the range is reduced by less than 1000 kHz, turn the slug counter-clockwise on the next try. After several tries, you have the range back to 1000 kHz, unless the end point adjustment range has been mostly used up before you started. In that case, if you are adventurous, you can take the PTO apart and remove one turn from the end point adjustment coil. But don't move any wires around inside the inner "can", don't take a turn off the big coil (the main tuning coil), and don't take a turn off the Cosmos "correct" coil. After the end point are aligned, you will need to resynchronize the PTO as described in the previous paragraph above because end point alignment moves both end points.

After having checked the alignment of the Veeder Root counter, cams, RF bandswitch gears, antenna trimmer, and BFO, the R-390A RF tuned circuits can be aligned as follows.

Basically, the idea is to use the R-390A xtal calibrator and carrier meter instead of a signal generator and volt meter. Fig. 6 is a line drawing of the RF chassis Utah-shaped cover plate which already contains most of the information you need.

In addition, I have sketched the locations of T207 and T208. Remove the Utah-shaped cover plate, and peak the inductors and trimmers at the frequencies indicated with the FUNCTION switch set in the CAL position. In use the 4 kHz or 8 kHz bandwidth; it doesn't matter which. The order in which you align the coils does not matter. It is good practice to align the inductor first, and then the trimmer. Adjust each inductor and trimmer at least twice. If there is any significant improvement on the second pass, adjust them a third time (or more if necessary).

The inductors should be adjusted with a # 8 Bristol multiple spline screwdriver. Xcelite makes a nice set, 99-PS-60, which includes the 99-X5 extension. The ceramic trimmer capacitors may be adjusted with a small screwdriver or alignment tool, but any metal shaft should be insulated (say, with insulating tape) so that you don't ground the high voltage B+ which is present on the metal slot of some of the trimmers. T207 and T208 may be adjusted with a small screwdriver. For best results, the antenna coils T201-T206 should be aligned with a 50 ohm source signal generator connected to the balanced antenna input through a UG-971/U twinax to C connector adapter and a UG-636A/U C to BNC connector adapter. But if you don't have a signal generator, or you are in a rush, you can use the CAL approach for them too.

If you align an R-390A which has not been aligned in many years, some of the ceramic trimmers may be nearly "frozen". Firm screwdriver torque will usually break them free with an audible "snap". However, if loss of signal level is observed after breaking the trimmer free, you should remove the coil (remove the rack and slugs for that coil set to access the # 4 Phillips head screw at the bottom of the bakelite coil form, and unplug the coil assembly), remove the coil assembly shield, and inspect the underside of the ceramic trimmer assembly to see if the metal base has rotated during "unfreezing" and shorted to one of the metal coil supports.

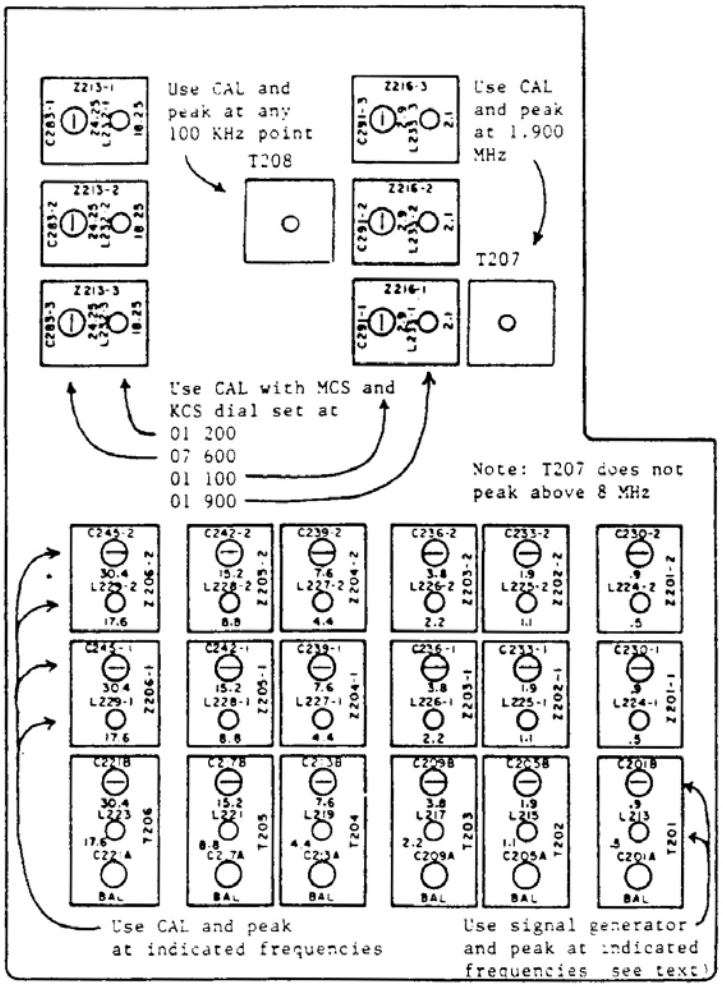



FIG. 6 RF and Variable IF Alignment

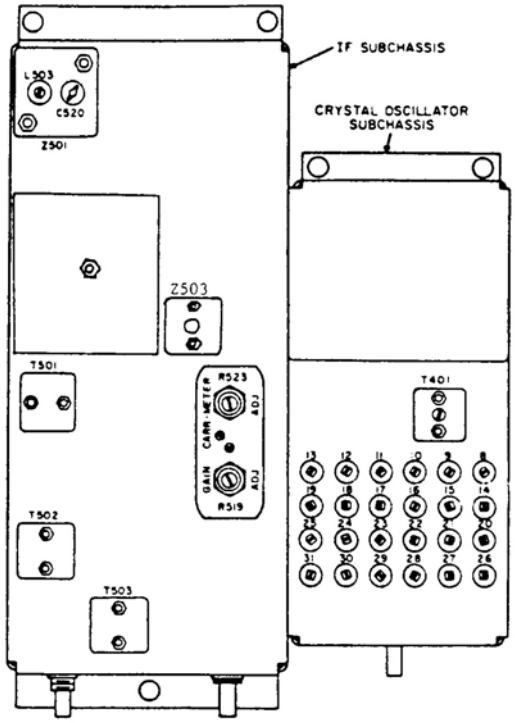



FIG. 7 Xtal-Osc. and IF Alignment

After the RF sub-chassis has been aligned, each of the ceramic crystal oscillator trimmers should be peaked. Tune to any CAL signal in the band indicated above the trimmer (see Fig. 7) and peak the signal. Not shown in Fig 7, eight of the trimmers can be peaked in either of two bands: 0-17, 1-18, 2-19, 3-20, 4-21, 5-22, 6-23, 7-24. After peaking such a trimmer in one band, you do not need to peak it again in the other band. Peak T401 (also marked T207).

Alignment of the IF sub-chassis is usually unnecessary. But if you insist on aligning it, get yourself a set of TV Alignment Tools from Radio Shack, catalog no. 64-2223. The white hex alignment tool may be used to peak the AGC IF transformer Z503. Do not meddle with the IF transformers T501-T503. They are stagger tuned, and their peaks are very broad. Even if they are somewhat out of alignment, it will not matter. The red alignment tool with metal rip is suitable for aligning trimmers (provided the metal shaft is insulated to avoid shorting RF trimmers; see above). The mechanical filter trimmers may be accessed by removing the shield on top of the chassis, and disconnecting the shafts to the front panel knobs, releasing the green quick release screws, and tilting the IF sub-chassis up far enough to access the trimmer holes in the side of the chassis. I'll let you discover for yourself which trimmer peaks which filter. Don't mess with the crystal filter inductor L503 or trimmer C520 unless you have to replace the 455 kHz xtal, and then consult the manual for alignment. The IF gain may be adjusted by R519, a slot adjust pot with lock nut. The manual provides detailed instructions for setting the pot. My approach is to set the IF gain for minimum, i.e., the slot adjust is rotated fully clockwise. However, in one R-390A the IF gain adjust pot was marked 10K (correct), but measured 20K (incorrect) at minimum gain (maximum resistance).

So I always measure the resistance of the IF gain adjust pot to be sure it is about 10K when the slot adjust is fully clockwise. Some of these 10K pots measure a bit less, say 8.5K, which is OK. Just don't go over 10K. The carrier meter zero adjust R523 is the only flaky feature on the R-390A. It is virtually impossible to zero a carrier meter with R523, and even if you do succeed in zeroing a meter (with no signal), the meter will not hold zero (because the pot wiper setting is so critical). There is only one solution to this problem. Replace R523 with a 10 turn pot, Clarostat 73JA 100 ohm 2 watt wire wound.

Instead of reusing the original 22 ohm 1 watt R537 which shunts the original R523, or trying to locate another 22 ohm 1 watt resistor (with leads which are too large to use effectively with a 73JA), get a 10 ohm 1 watt resistor at Radio Shack, catalog # 272-151 (it has smaller leads), and use it. After doing this mod, before turning on you R-390A and pinning the carrier meter while you are setting the meter zero, adjust the shunted pot to about 5 ohms (the nominal value for meter zero). The 73JA usually does not insert easily unless you use a circular file to remove a small amount of metal from the rim of the pot mounting hole. And the 73JA usually does not mount well unless you grind a nut thinner and run the thin nut all the way down on the pot threads (the diameter of the pot mounting base is too small). A nice finishing touch is to use a lock nut assembly, Miller 10061. The finished mod is professional both in performance and appearance. It is one of the few mods worth doing to an R-390A.

The 1956 R-390A manual TM 11-856A has a stage gain chart for signal inputs at the balanced antenna input and test points E208-E211 which is useful for trouble shooting a defective RF sub - chassis. The stage gain test for signal input at the balanced antenna input is also useful for identifying a defective RF sub-chassis, and sometimes for other problems. The test involves injecting a signal at the balanced antenna input and for each band determining the signal generator output required to produce -7 VDC at the DIODE LOAD terminal (terminal 14) on the rear panel with R-390A FUNCTION switch set to MGC, BANDWIDTH set to 8, RF gain control fully clockwise, BFO switch OFF, and all other controls in normal operating position.

Peak ANT TRM for each measurement, and tune the signal for maximum voltmeter reading. TM-856A states that with this test setup the signal generator output required to produce -7 VDC at the diode load terminal should be less than 4 microvolts. You should use a precision 50 ohm source signal generator, and the calibration should be checked before doing this test. I use a rebuilt URM-25D which I check with a Tek 453 mod H scope. To check the calibration of a 50 ohm source signal generator, connect the output of the signal generator to a 50 ohm non-inductive resistor, set the output of the signal generator to 100,000 microvolts, and measure the voltage across the resistor. The voltage should be 280 milli-volts peak-to-peak. I use a UG-971/U connector (twinax to C) and UG-636A/U (C to BNC) to connect the URM-25D to an R-390A balanced antenna input (through a short length of coax with BNC connectors). The signal generator output required to produce -7 VDC at the DIODE LOAD varies from one R-390A to another. For example, a 1956 Motorola (14- PH-56) required 3.0, 3.5, 2.0, 3.5, 1.0, and 2.0 microvolts at 0.5, 1.5, 7.5, 8.5, 16.5, and 26.5 MHz respectively, while a 1967 EAC (FR-36 etc) required 2.0, 3.5, 3.5, 2.5, 2.0 and 2.0 microvolts respectively. Another 1967 EAC required 1.0 microvolts at most frequencies, with a few as high as 1.5 microvolts, and a few as low as 0.5 microvolts. There are sometimes variations within a band. For example, one EAC in the 7 MHz band required 7.0, 3.5 and 6.5 microvolts for -7 VDC at DIODE LOAD at 7.000, 7.500, and 7.999 MHz respectively. On the other hand, the 1956 Motorola required 3.0, 2.0 and 2.0 respectively. I don't know whether this indicates a problem with the EAC in the 7 MHz band, but I am inclined to think not because the EAC 7 MHz band sensitivity was a uniform 0.45 microvolts for a 10 dB S+N/N (AM mode, 4 kHz BW), while the Motorola 7 MHz band sensitivity was a uniform 0.55 microvolts for a 10 dB S+N/N.

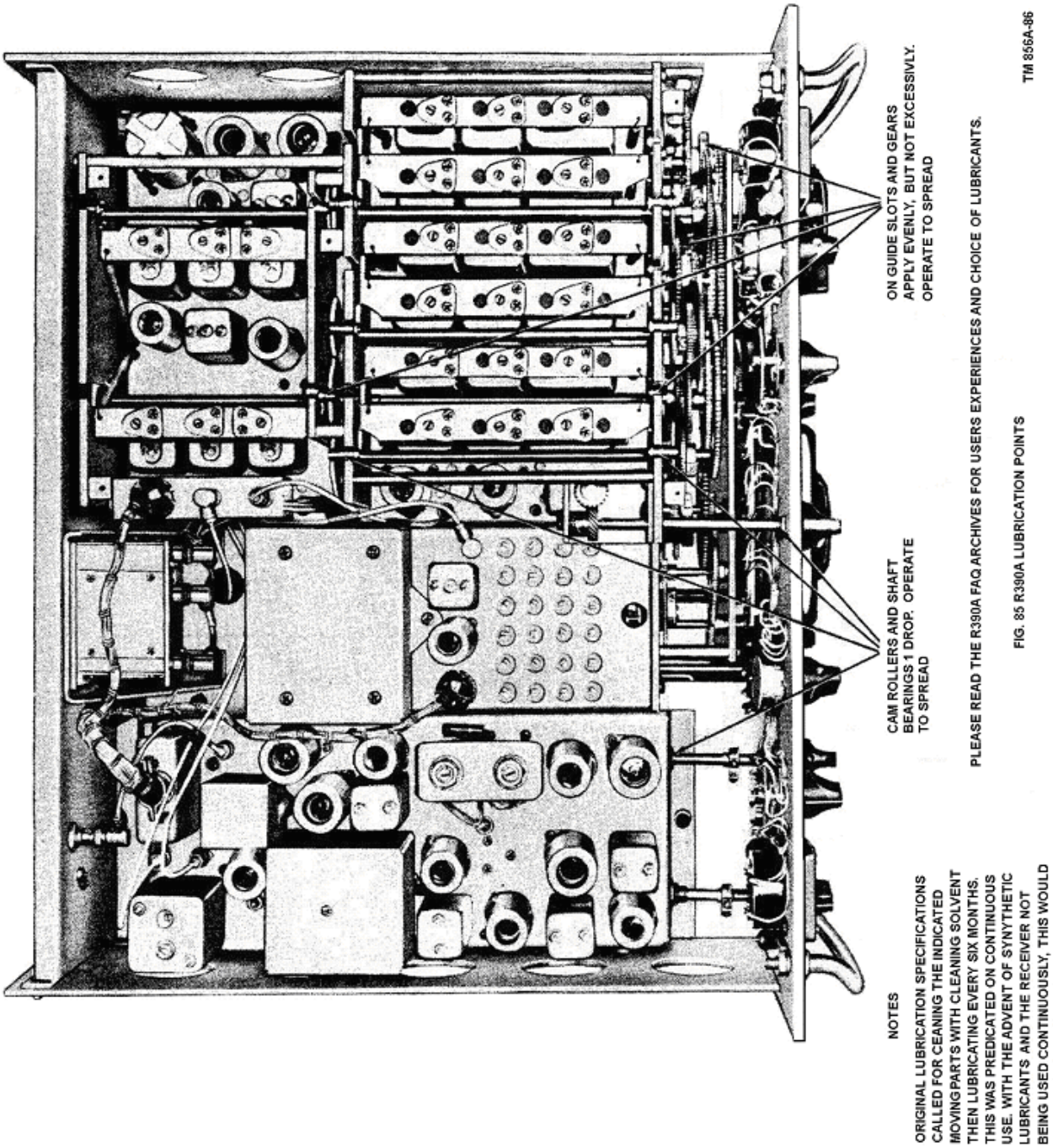
However, another EAC which required about 4.0 microvolts for -7 VDC at DIODE LOAD at 0.5, 1.5, 7.5, 8.5, 16.5 and 26.5 was defective (a defective LIMITER control which I found by turning the limiter control on and off while doing the DIODE LOAD test). So it is not always trivial to identify a defective R-390A with this test. As a general guideline, if 2.0 microvolts or less is required at several widely spaced frequencies to produce -7 VDC at DIODE LOAD, the R-390A under test is probably OK, while if 3.0 microvolts or more is required at most frequencies, then there may be a problem.

Another useful performance check is to measure the sensitivity for a 10 dB S+N/N ratio. The only equipment you need is a precision signal generator, such as a URM-25D. The R-390A LINE LEVEL meter, LINE LEVEL switch, and LINE GAIN control are used to measure the noise and signal power. Connect the signal generator to the balanced input through a UG-971/U and UG- 636A/U as described above, set the BANDWIDTH to 4, BFO to OFF, RF gain control fully clockwise, and all other controls in normal operating position. Set the signal generator to any frequency in the R-390A tuning range, tune the signal generator signal for maximum carrier meter indication (peak ANT TRM), and reduce the signal generator output to about 0.4 microvolts unmodulated. Set the LINE METER switch to 0 and adjust the LINE GAIN control for a reading of -10 on the LINE LEVEL meter. Change the signal generator to 400 Hz modulation at 50% modulation, and adjust the signal generator output for a reducing of VU on the LINE LEVEL meter. The signal generator output is now the 10 dB S+N/N sensitivity (for a URM-25D you will have to switch back to un-modulated CW to read the microvolts output from the 25D meter). An R-390A typically has between 0.4 and 0.5 microvolt sensitivity for a 10 dB S+N/N in AM mode for a 4 kHz BW using this method of measurement. When the sensitivity is measured using an external speaker and voltmeter connected across the speaker, the sensitivity tends to be somewhat better, about 0.3 microvolts. I don't know why. Perhaps the R-390A LINE METER is not as accurate as a precision voltmeter. Or perhaps the voltmeter I have been using to measure the R-390A sensitivity is not as accurate as the R-390A LINE METER. In any case, this provides a quick and easy check of R- 390A performance, provided the LINE METER circuits are not defective.

As a final performance check, disconnect all antennas, set the FUNCTION switch to AGC, set BANDWIDTH to 8, BFO to OFF, LIMITER to OFF, RF gain fully clockwise, frequency to 5.500 MHz, and all other controls in normal operating position (AUDIO RESPONSE set to WIDE). Adjust ANT TRM for maximum noise. You should hear a definite increase in noise as you rotate the ANT TRM. What you are doing is peaking the R-390A front end noise. Set the LINE METER switch to -10 and LINE GAIN control fully clockwise. The LINE LEVEL meter should read no less than UV.

Set the LINE METER switch to 0 and LINE GAIN control fully clockwise. The LINE LEVEL meter should read no more than UV. Similar RF alignment and noise performance checks were published by Charles A. Taylor in his article "R-390A Alignment Chart" in DX News 48, 25 (May 11, 1981), pages 25-28. The other alignment procedures discussed in this article were developed by me and other HSN subscribers.

**Receiver Lubrication Points Illustrated**




This illustration was take fro the Army technical manual. Please note the annotation on the illustration as there are now far superior lubricants available. See Chapter 10 for an excellent illustrated guide to rebuilding the mechanical gear train.

## Cleaning & Lubrication Materials and Helpful Hints

**Walter Wilson et all**

| | | |
|---|---|---|
| G5S-6 ProGold G5 Spray | (200mL) | $ 13.29 |
| Simple Green | | |
| Mobil 1 10W30or 30W Mix 50/50 W/MMO | | |
| Mobil 1 synthetic gear oil 90 weight | | |
| WD 40 Spray & liquid | | |
| Caig Laboratories, DeOxit® | | |
| Nevr-Dull | 5 oz can | $ 3.67 |
| Marvel Mystery Oil (Use 50/50 with Mobile 1.) | 16 oz | $ 2.04 |
| Phil Wood Waterproof Grease | 3 oz. | $ 2.99 |
| TRI-FLOW DRIP BOTTLE - | 2 oz. | $ 2.69 |
| TRI-FLOW AEROSOL CAN - | 12 ounce | $ 8.29 |
| Mineral oil | | |
| GoJo hand cleaner (the kind without pumice) | | |
| GoJo hand cleaner ( with pumice) for corroded aluminum IF cans | | |
| Naphtha | | |
| Something a little stronger - Goof Off | | |
| I will pass along a mix that was passed on to me. 409 - 50% and Ammonia - 50% | | |
| Redline Synthetic hi-pressure bearing grease | | |
| Windex-on the chassis | | |
| Sewing Machine Oil | | |

### General Tips

In most cases I replace the chassis hardware (screws) with new stainless ones. I buy these by the box full!

All the metal pieces that have been removed are cleaned with GoJo hand cleaner (the kind without pumice)

At this point I will mention that on some very old pieces (75A1, SX28), the IF cans often dull and develop a rough oxidized finish. These can be restored by rubbing with hand cleaner again, but the kind with pumice. Wash them down with soap and water when your done and they will be smooth again and look like new! I don't use the pumice cleaner on anything else except my hands!

I usually use only Windex on the chassis. I work it into the crooks and crannies with Q-tips and an old toothbrush. I cut up old T-shirts into little squares and use them as swabs. Slowly but surely I wipe away all the dirt.

Something a little stronger - Goof Off did the trick. It will eat at the silk screen on the chassis if you rub it very hard so try to avoid the silkscreen.

I have never installed an overlay on a dial drum. I just wipe these down with Windex also. I do this many times and gradually the old oxidized surface comes off. You have to know when to stop! It will not look as nice as an overlay, but it is original! Obviously if you go too far, you will need to install an overlay

On the subject of what to lubricate the contact surfaces with, I concluded that silver conductive grease is the thing to use. I found some at a local hardware store, ~ $15 for a tiny syringe full! Its a bit pricey but seems to work quite well.

Aluminum RF cans sometimes become ingrained with dirt, which can be difficult to shift. Solvo Autosol Paste (available from car accessory shops) is good for cleaning these. Take great care not to let it get inside the cans or under the chassis.

I will pass along a mix that was passed on to me. 409 - 50% and Ammonia - 50%.

For the tiny little bearings in the rotary switches, I use teflon lube in a hypodermic type applicator (Do not get teflon on the switch contacts!).

**When do I use DeoxIT (R5 Power Booster) vs ProGold vs PreservIT.**

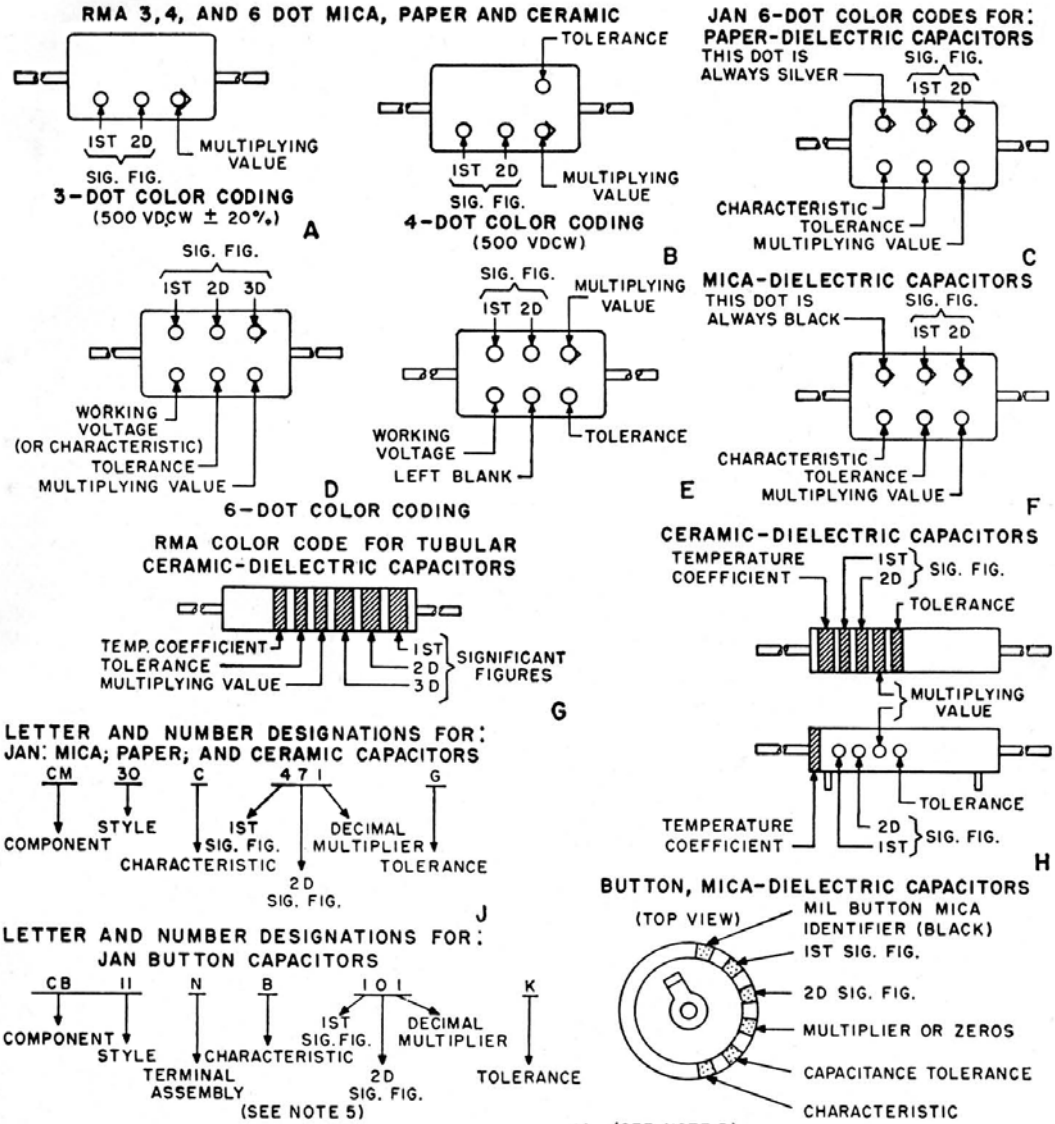
DeoxIT (R5 Power Booster). General purpose, for all metal surfaces. Use on non-critical metal surfaces with severe oxidation and corrosion on the metal surface. If there is a discoloration of the metal - it is severe. Use DeoxIT to dissolve the contamination. DeoxIT will also lubricate and protect the surface. For reference, DeoxIT has approximately 20% cleaning action.

NOTE:
The R5 Power Booster concentrate (100% solution) is identical to the DeoxIT concentrate (100%). So all references to R5 Power Booster and DeoxIT concentrates will be the same. In 5% solutions, R5 Power Booster utilizes Dupont Vertrel solvents which are nonflammable and fast evaporating. DeoxIT 5% solutions use OMS (odorless mineral spirits which flammable, slower to evaporate and more cost effective.

ProGold. Plated surfaces (gold and other precious metals). Recommended for critical applications were only slight cleaning action is necessary. For reference, ProGold has approximately 0.5% cleaning action. If the surface looks clean, then applying DeoxIT first is usually not necessary. If there are small amounts of oxidation on the surface, ProGold will be able to dissolve this. ProGold should be applied after DeoxIT when it is a plated metal surface except where noted with PreservIT below. The more critical the connection/part, especially low current applications, ProGold should be the final step.

PreservIT. All metal surfaces. Seals and protects. Recommended after DeoxIT for best protection and NEW metal surfaces, usually in the manufacturing process. It is also ideal where high degrees of pollution (sulfur, salts, acids, etc.) are present. PreservIT should be applied to a clean surface - after using DeoxIT or other cleaning method. For reference, PreservIT has 0% cleaning action.

## CAPACITOR COLOR AND LETTER CODES



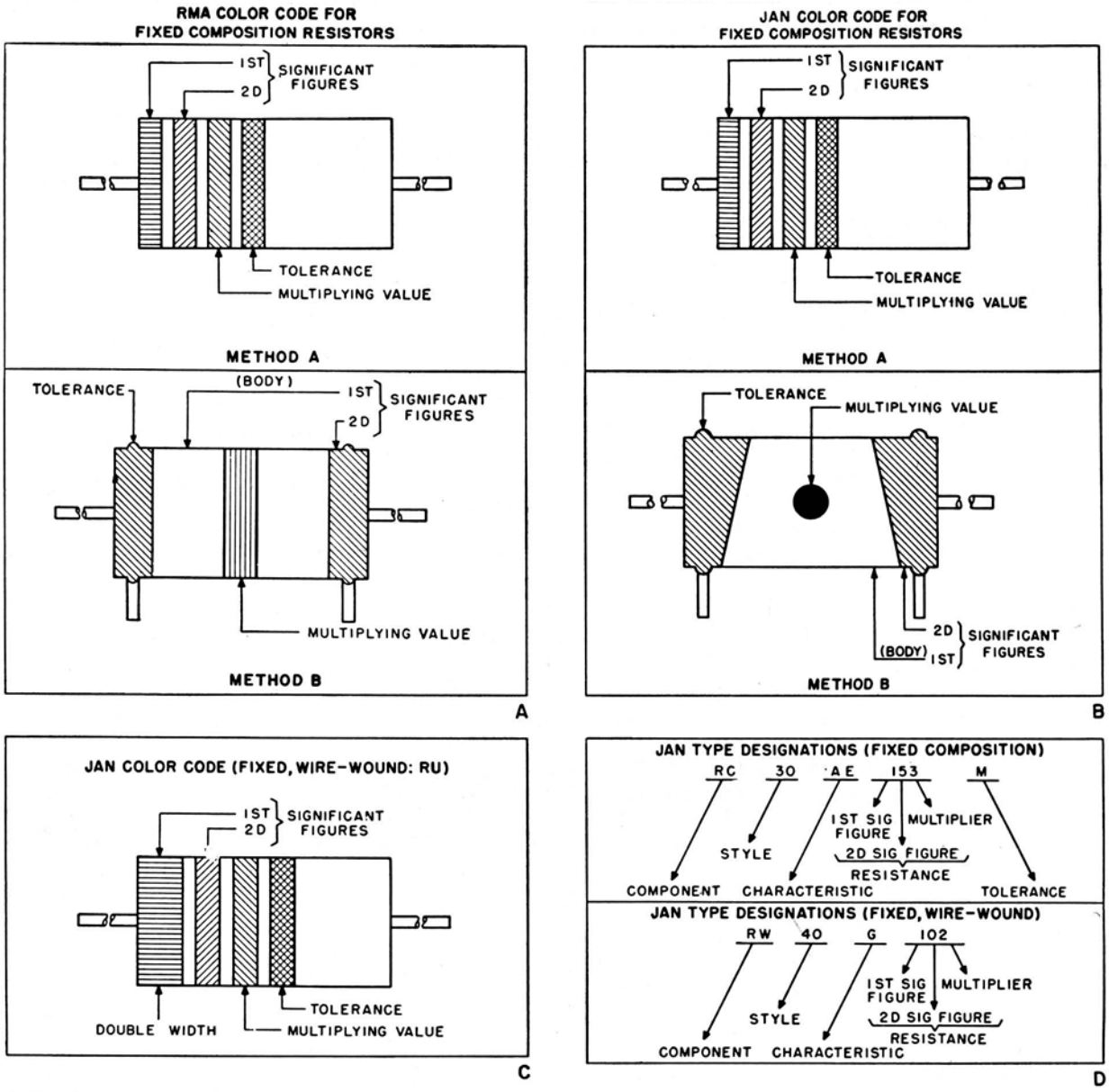

| - STANDARDS - | | | | | JAN MICA-CM | | JAN PAPER-CM | | JAN CERAMIC-CC | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | CAP. TOL. FOR MORE THAN 10 UUF | | CAP. TOL. FOR 10 UUF OR LESS | | |
| COLOR | SIG. FIG. | DECIMAL MULTIPLIER | % TOL. | VDCW | LETTER TOL. | CHARAC-TERISTIC | LETTER TOL. | CHARAC-TERISTIC | DEC. MULT. | % | LETTER DESIG-NATION | UUF | LETTER DESIG-NATION | CHARAC-TERISTIC |
| BLACK | 0 | 1 | ±20 | 500 | M | A | M | A | 1 | ±20 | M | ±2.0 | G | C |
| BROWN | 1 | 10 | ± 1 | 100 | - | B | - | E | 10 | ± 1 | F | - | - | H |
| RED | 2 | 100 | ± 2 | 200 | G | C | - | H | 100 | ± 2 | G | - | - | L |
| ORANGE | 3 | 1,000 | ± 3 | 300 | - | D | N* | J | 1,000 | - | - | - | - | P |
| YELLOW | 4 | 10,000 | ± 4 | 400 | - | E | - | P | - | - | - | - | - | R |
| GREEN | 5 | 100,000 | ± 5 | 500 | - | F | - | R | - | ± 5 | J | ±0.5 | D | S |
| BLUE | 6 | 1,000,000 | ± 6 | 600 | - | G | - | S | - | - | - | - | - | T |
| VIOLET | 7 | 10,000,000 | ± 7 | 700 | - | - | - | T | - | - | - | - | - | U |
| GRAY | 8 | 100,000,000 | ± 8 | 800 | - | - | - | - | 0.01 | - | - | ±0.25 | C | B |
| WHITE | 9 | 1,000,000,000 | ± 9 | 900 | - | - | - | - | 0.1 | ± 10 | K | ±1.0 | F | SL |
| GOLD | - | 0.1 | ± 5 | 1,000 | J | - | - | - | - | - | - | - | - | A |
| SILVER | - | 0.01 | ±10 | 2,000 | K | - | K | - | - | - | - | - | - | - |
| NO COLOR | - | - | ±20 | 500 | - | - | - | - | - | - | - | - | - | - |
| * THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3% | | | | | | | | | | | | | | |

NOTES

JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION

1. THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
2. THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
3. CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
4. BUTTON CAPACITORS ARE GENERALLY 300 VDCW
5. READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
6. CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
7. THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
   *CB* MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

**Resistor Color and Letter Code**




| STANDARDS | | | | |
|---|---|---|---|---|
| COLOR | SIGNIFICANT FIGURE | MULTIPLYING VALUE | TOLERANCE (%) | JAN LETTER TOLERANCE |
| BLACK | 0 | 1 | – | – |
| BROWN | 1 | 10 | ± 1 | F |
| RED | 2 | 100 | ± 2 | G |
| ORANGE | 3 | 1,000 | ± 3 | – |
| YELLOW | 4 | 10,000 | ± 4 | – |
| GREEN | 5 | 100,000 | ± 5 | – |
| BLUE | 6 | 1,000,000 | ± 6 | – |
| VIOLET | 7 | 10,000,000 | ± 7 | – |
| GRAY | 8 | 100,000,000 | ± 8 | – |
| WHITE | 9 | 1,000,000,000 | ± 9 | – |
| GOLD | – | 0.1 | ± 5 | J |
| SILVER | – | 0.01 | ±10 | K |
| NO COLOR | – | – | ±20 | M |

**NOTES:**

1. RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON – INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY – NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

## Capacitor Value Translation Table

Older and European schematics often use a different conventions for specifying capacitor valises. This table provides an easy method to compare conventions. This table was adapted from one posted by **Just Radios of Canada**. A good source for inexpensive tube (valve) equipment parts.

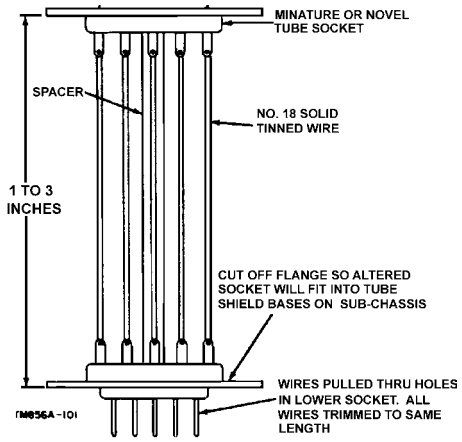
To use this table, just read across. For example, 1uF is same 1,000nF or 1,000,000pF.

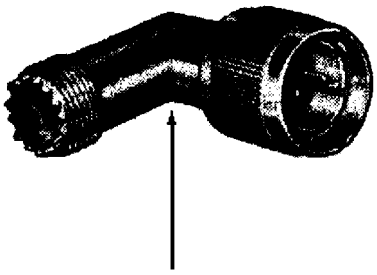
| uF/ MFD | nF | pF/ MMFD | uF/ MFD | nF | pF/ MMFD |
|---|---|---|---|---|---|
| | | | 0.0082uF / MFD | 8.2nF | 8200pF (MMFD) |
| 1uF / MFD | 1000nF | 1000000pF(MMFD) | 0.008uF / MFD | 8nF | 8000pF (MMFD) |
| 0.82uF / MFD | 820nF | 820000pF (MMFD) | 0.007uF / MFD | 7nF | 7000pF (MMFD) |
| 0.8uF / MFD | 800nF | 800000pF (MMFD) | 0.0068uF / MFD | 6.8nF | 6800pF (MMFD) |
| 0.7uF / MFD | 700nF | 700000pF (MMFD) | 0.006uF / MFD | 6nF | 6000pF (MMFD) |
| 0.68uF / MFD | 680nF | 680000pF (MMFD) | 0.0056uF / MFD | 5.6nF | 5600pF (MMFD) |
| 0.6uF / MFD | 600nF | 600000pF (MMFD) | 0.005uF / MFD | 5nF | 5000pF (MMFD) |
| 0.56uF / MFD | 560nF | 560000pF (MMFD) | 0.0047uF / MFD | 4.7nF | 4700pF (MMFD) |
| 0.5uF / MFD | 500nF | 500000pF (MMFD) | 0.004uF / MFD | 4nF | 4000pF (MMFD) |
| 0.47uF / MFD | 470nF | 470000pF (MMFD) | 0.0039uF / MFD | 3.9nF | 3900pF (MMFD) |
| 0.4uF / MFD | 400nF | 400000pF (MMFD) | 0.0033uF / MFD | 3.3nF | 3300pF (MMFD) |
| 0.39uF / MFD | 390nF | 390000pF (MMFD) | 0.003uF / MFD | 3nF | 3000pF (MMFD) |
| 0.33uF / MFD | 330nF | 330000pF (MMFD) | 0.0027uF / MFD | 2.7nF | 2700pF (MMFD) |
| 0.3uF / MFD | 300nF | 300000pF (MMFD) | 0.0025uF / MFD | 2.5nF | 2500pF (MMFD) |
| 0.27uF / MFD | 270nF | 270000pF (MMFD) | 0.0022uF / MFD | 2.2nF | 2200pF (MMFD) |
| 0.25uF / MFD | 250nF | 250000pF (MMFD) | 0.002uF / MFD | 2nF | 2000pF (MMFD) |
| 0.22uF / MFD | 220nF | 220000pF (MMFD) | 0.0018uF / MFD | 1.8nF | 1800pF (MMFD) |
| 0.2uF / MFD | 200nF | 200000pF (MMFD) | 0.0015uF / MFD | 1.5nF | 1500pF (MMFD) |
| 0.18uF / MFD | 180nF | 180000pF (MMFD) | 0.0012uF / MFD | 1.2nF | 1200pF (MMFD) |
| 0.15uF / MFD | 150nF | 150000pF (MMFD) | 0.001uF / MFD | 1nF | 1000pF (MMFD) |
| 0.12uF / MFD | 120nF | 120000pF (MMFD) | 0.00082uF / MFD | 0.82nF | 820pF (MMFD) |
| 0.1uF / MFD | 100nF | 100000pF (MMFD) | 0.0008uF / MFD | 0.8nF | 800pF (MMFD) |
| 0.082uF / MFD | 82nF | 82000pF (MMFD) | 0.0007uF / MFD | 0.7nF | 700pF (MMFD) |
| 0.08uF / MFD | 80nF | 80000pF (MMFD) | 0.00068uF / MFD | 0.68nF | 680pF (MMFD) |
| 0.07uF / MFD | 70nF | 70000pF (MMFD) | 0.0006uF / MFD | 0.6nF | 600pF (MMFD) |
| 0.068uF / MFD | 68nF | 68000pF (MMFD) | 0.00056uF / MFD | 0.56nF | 560pF (MMFD) |
| 0.06uF / MFD | 60nF | 60000pF (MMFD) | 0.0005uF / MFD | 0.5nF | 500pF (MMFD) |
| 0.056uF / MFD | 56nF | 56000pF (MMFD) | 0.00047uF / MFD | 0.47nF | 470pF (MMFD) |
| 0.05uF / MFD | 50nF | 50000pF (MMFD) | 0.0004uF / MFD | 0.4nF | 400pF (MMFD) |
| 0.047uF / MFD | 47nF | 47000pF (MMFD) | 0.00039uF / MFD | 0.39nF | 390pF (MMFD) |
| 0.04uF / MFD | 40nF | 40000pF (MMFD) | 0.00033uF / MFD | 0.33nF | 330pF (MMFD) |
| 0.039uF / MFD | 39nF | 39000pF (MMFD) | 0.0003uF / MFD | 0.3nF | 300pF (MMFD) |
| 0.033uF / MFD | 33nF | 33000pF (MMFD) | 0.00027uF / MFD | 0.27nF | 270pF (MMFD) |
| 0.03uF / MFD | 30nF | 30000pF (MMFD) | 0.00025uF / MFD | 0.25nF | 250pF (MMFD) |
| 0.027uF / MFD | 27nF | 27000pF (MMFD) | 0.00022uF / MFD | 0.22nF | 220pF (MMFD) |
| 0.025uF / MFD | 25nF | 25000pF (MMFD) | 0.0002uF / MFD | 0.2nF | 200pF (MMFD) |
| 0.022uF / MFD | 22nF | 22000pF (MMFD) | 0.00018uF / MFD | 0.18nF | 180pF (MMFD) |
| 0.02uF / MFD | 20nF | 20000pF (MMFD) | 0.00015uF / MFD | 0.15nF | 150pF (MMFD) |
| 0.018uF / MFD | 18nF | 18000pF (MMFD) | 0.00012uF / MFD | 0.12nF | 120pF (MMFD) |
| 0.015uF / MFD | 15nF | 15000pF (MMFD) | 0.0001uF / MFD | 0.1nF | 100pF (MMFD) |
| 0.012uF / MFD | 12nF | 12000pF (MMFD) | 0.000082uF / MFD | 0.082nF | 82pF (MMFD) |
| 0.01uF / MFD | 10nF | 10000pF (MMFD) | 0.00008uF / MFD | 0.08nF | 80pF (MMFD) |

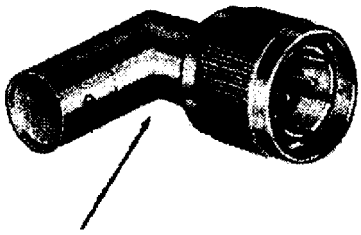
| | | |
|---|---|---|
| 0.00007uF / MFD | 0.07nF | 70pF (MMFD) |
| 0.000068uF / MFD | 0.068nF | 68pF (MMFD) |
| 0.00006uF / MFD | 0.06nF | 60pF (MMFD) |
| 0.000056uF / MFD | 0.056nF | 56pF (MMFD) |
| 0.00005uF / MFD | 0.05nF | 50pF (MMFD) |
| 0.000047uF / MFD | 0.047nF | 47pF (MMFD) |
| 0.00004uF / MFD | 0.04nF | 40pF (MMFD) |
| 0.000039uF / MFD | 0.039nF | 39pF (MMFD) |
| 0.000033uF / MFD | 0.033nF | 33pF (MMFD) |
| 0.00003uF / MFD | 0.03nF | 30pF (MMFD) |
| 0.000027uF / MFD | 0.027nF | 27pF (MMFD) |
| 0.000025uF / MFD | 0.025nF | 25pF (MMFD) |
| 0.000022uF / MFD | 0.022nF | 22pF (MMFD) |
| 0.00002uF / MFD | 0.02nF | 20pF (MMFD) |
| 0.000018uF / MFD | 0.018nF | 18pF (MMFD) |
| 0.000015uF / MFD | 0.015nF | 15pF (MMFD) |
| 0.000012uF / MFD | 0.012nF | 12pF (MMFD) |
| 0.00001uF / MFD | 0.01nF | 10pF (MMFD) |

| | | |
|---|---|---|
| 0.0000082uF / MFD | 0.0082nF | 8.2pF (MMFD) |
| 0.000008uF / MFD | 0.008nF | 8pF (MMFD) |
| 0.000007uF / MFD | 0.007nF | 7pF (MMFD) |
| 0.0000068uF / MFD | 0.0068nF | 6.8pF (MMFD) |
| 0.000006uF / MFD | 0.006nF | 6pF (MMFD) |
| 0.0000056uF / MFD | 0.0056nF | 5.6pF (MMFD) |
| 0.000005uF / MFD | 0.005nF | 5pF (MMFD) |
| 0.0000047uF / MFD | 0.0047nF | 4.7pF (MMFD) |
| 0.000004uF / MFD | 0.004nF | 4pF (MMFD) |
| 0.0000039uF / MFD | 0.0039nF | 3.9pF (MMFD) |
| 0.0000033uF / MFD | 0.0033nF | 3.3pF (MMFD) |
| 0.000003uF / MFD | 0.003nF | 3pF (MMFD) |
| 0.0000027uF / MFD | 0.0027nF | 2.7pF (MMFD) |
| 0.0000025uF / MFD | 0.0025nF | 2.5pF (MMFD) |
| 0.0000022uF / MFD | 0.0022nF | 2.2pF (MMFD) |
| 0.000002uF / MFD | 0.002nF | 2pF (MMFD) |
| 0.0000018uF / MFD | 0.0018nF | 1.8pF (MMFD) |
| 0.0000015uF / MFD | 0.0015nF | 1.5pF (MMFD) |
| 0.0000012uF / MFD | 0.0012nF | 1.2pF (MMFD) |
| 0.000001uF / MFD | 0.001nF | 1pF (MMFD) |

# Test Jigs and Adapters



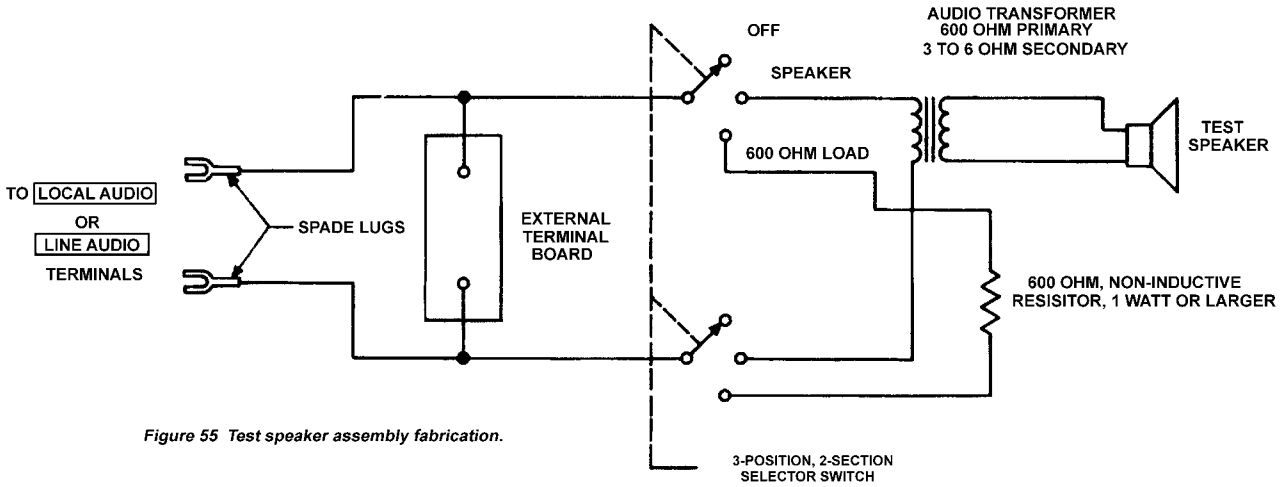




*Figure 55 Test speaker assembly fabrication.*

| | |
|---|---|
| Al Parker | Filter Caps C603 & C606 "restuff" the filter caps, for R-390A's. Present pricing as of 7/-7 is $50 for the pair (exchange), plus $2.50 return shipping in the USA. The cans are knurled shut, not epoxy or glue sealed. I'll update my webpage on the process soon (when I get a round tuit) it's at: boatanchors.org/filtercap.htm |
| Howard Mills | Front Panels. Usually booked up for months if not years. |
| Hank Arny | Mostly metal parts. Front panels, Knobs, Partial Chassis |
| boltdepot.com | /machine-screws.aspx |
| jamminpower.com | R-390 maintenance manuals for free, if you are willing to wait for them - they are large. |
| jamminpower.com | R 390A modules, junker modules, SP 600 parts. Andy is not in the parts business per se. He sells parts to help people out. Also has new SS replacement screws. |
| Fair Radio | R-390A Wide assortment of parts. Stock varies. |
| Mc Master-Carr | Tools and every conceivable screw one could ever use-even in stainless steel. |
| Mouser | Electronic parts. Takes small orders. Great selection |
| Dan's Small Parts | Internet only. Vast assortment of small electronic parts. Frequent sales. A+++ site. |
| Antique Radio Supply | They usually have a choice from the Chinese copies up to NOS JAN tubes-- |
| Krize Electronics | Tubes Frank Krize. 1373 Chapel Hill Rd. Natchez MS 39120 Telephone: 601-442-0973 Email: k5svc@NATCHEZ.net |
| http://www.r-390a.net/ R390 | web page by Al Tirevold |
| http://www.r390a.com/ | web page by master R-390A Rebuilder Chuck Ripple. Has 7 hour series of highly Recommended video tapes teaching all he knows. Has some parts. |
| Miltronix.com | Rick Mash re-builds R-390A'a as a full time living as well as doing repairs. Considered the premier re-builder by many. Sometimes has radios for sale. |
| Triode electronics | Tubes |
| HSN Newsletter | THE granddaddy pioneer predecessor to the R-390 list. Pure gold for R-390/A, SP-600's & R-388's radios plus lots of useful hints and procedures.. |
| Kongsford.com | Want the maximum stable performance from your R-390A? Dallas Langford's site will provide you with about all the proven improvements possible. A++++++ |
| Antique Electric Radio | NOS, Chinese, east European tubes plus BA related parts. |
| Just Radios | Canadian source for economical capacitors and resistors. Well recommended by users. |
| Surplus Sales of Nebraska | Expensive source for very hard to find R 390A and other parts. Stock will vary. |
| Jan Skirrow | |
| Leed's Electronics | Carrier level meter substitute from in New York |
| Rich Baldwin KD6VK | NOS silver mica caps in every shape and size Can ship small quantities 8105 Crichton Lane Durham, NC 27713 |

## Cosmos PTO Output Setting

From: SHELLY199@aol.com Date: Fri, 5 May 2006 11:54:45 EDT
Subject: [R-390] Re: R-390 Digest, Vol 25, Issue 6

Hi Barry,

Plse note this is my first post although I've been reading the mail for 5 yrs.

The typical output voltage from a Cosmos PTO fed into the rcvr thru normal connections and taken at the jack on the RF deck thru a X10 (10 meg impedance) is about 2.6 Vac.

I have taken the following readings on 4 ea. Cosmos PTO's as follows:

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| 2455 2.49 Vac | 2455 2.78 Vac | 2455 2.72 Vac | 2455 2.56 Vac |
| 3455 2.59 Vac | 3455 2.76 Vac | 3455 2.75 Vac | 3455 2.48 vac |

I adjust the output cap C706 for max output at 3455. This gives the flattest response.

The most significant item regarding output volts is the tube. I have used only tubes which have tested good with highest emission out of a bunch. I then put the best ones one at a time in the PTO and select the one which delivers the highest output. This can be a ratio of 2:1 for output voltage. It's surprising that it changes so drastically from tube to tube.

I've been rebuilding these things for 5 years and have test cables, ovens, cal dial setups, and you name it. I've never seen a defective part in any PTO except R702 which is typically high and once in a while R702. Although I've changed many in a shotgun attempt to achieve super stability which you can expect if everything is just right. I've rebuilt the 5ea. .005 bypass cap and found zero difference. I've almost given up on super stability on one and decided to clean up the tube socket a second time and that was the problem. The 10 pf caps in the osc tank circuit often need changed because they've changed value and the endpoint won't adjust without adjusting the turns on L701 or changing the caps. I prefer changing the caps. Also the 10 pf caps usually don't have the original temp compensation so we change them on that basis. The 370 pf caps seem pretty good and I've never found one of spec from a capacitance standpoint.

Hope this helped. Rich WD2Q

**Revised Version** I changed Vac to Vrms.

The voltage readings are RMS from a Fluke 192 scope thru a X10 probe at J217. The P-P equivalent for the readings I gave you is approx .76 Vp-p. Another interesting point is that there is some flatopping at the 2455 end of the PTO range. This is a characteristic of all the Cosmos PTO's. I haven't taken a harmonic reading mainly because it's on all of them so it ain't broke.

The typical output voltage from a Cosmos PTO fed into the rcvr thru normal connections and taken at the jack on the RF deck thru a X10 (10 meg impedance) is about 2.6 Vac.

I have taken the following readings on 4 ea. Cosmos PTO's as follows:

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2455 | 2.49 Vrms | 2. | 2455 | 2.78 Vrms | 3. | 2455 | 2.72 Vrms | 4. | 2455 | 2.56 Vrms |
| | 3455 | 2.59 Vrms | | 3455 | 2.76 Vrms | | 3455 | 2.75 Vrms | | 3455 | 2.48 Vrms |

I adjust the output cap C706 for max output at 3455. This gives the flattest response.

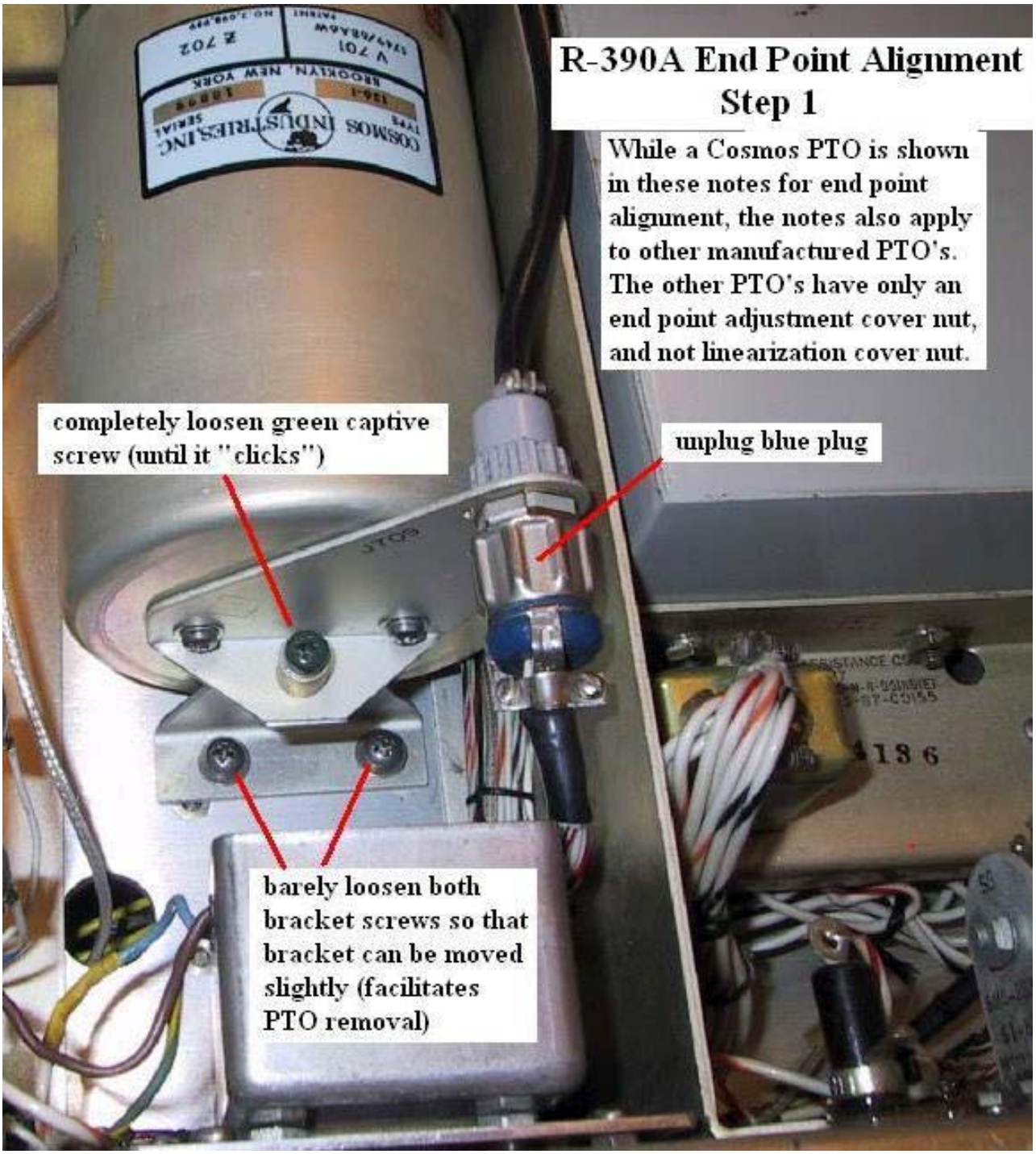
The most significant item regarding output volts is the tube. I have used only tubes which have tested good with highest emission out of a bunch. I then put the best ones one at a time in the PTO and select the one which delivers the highest output. This can be a ratio of 2:1 for output voltage. It's surprising that it changes so drastically from tube to tube.

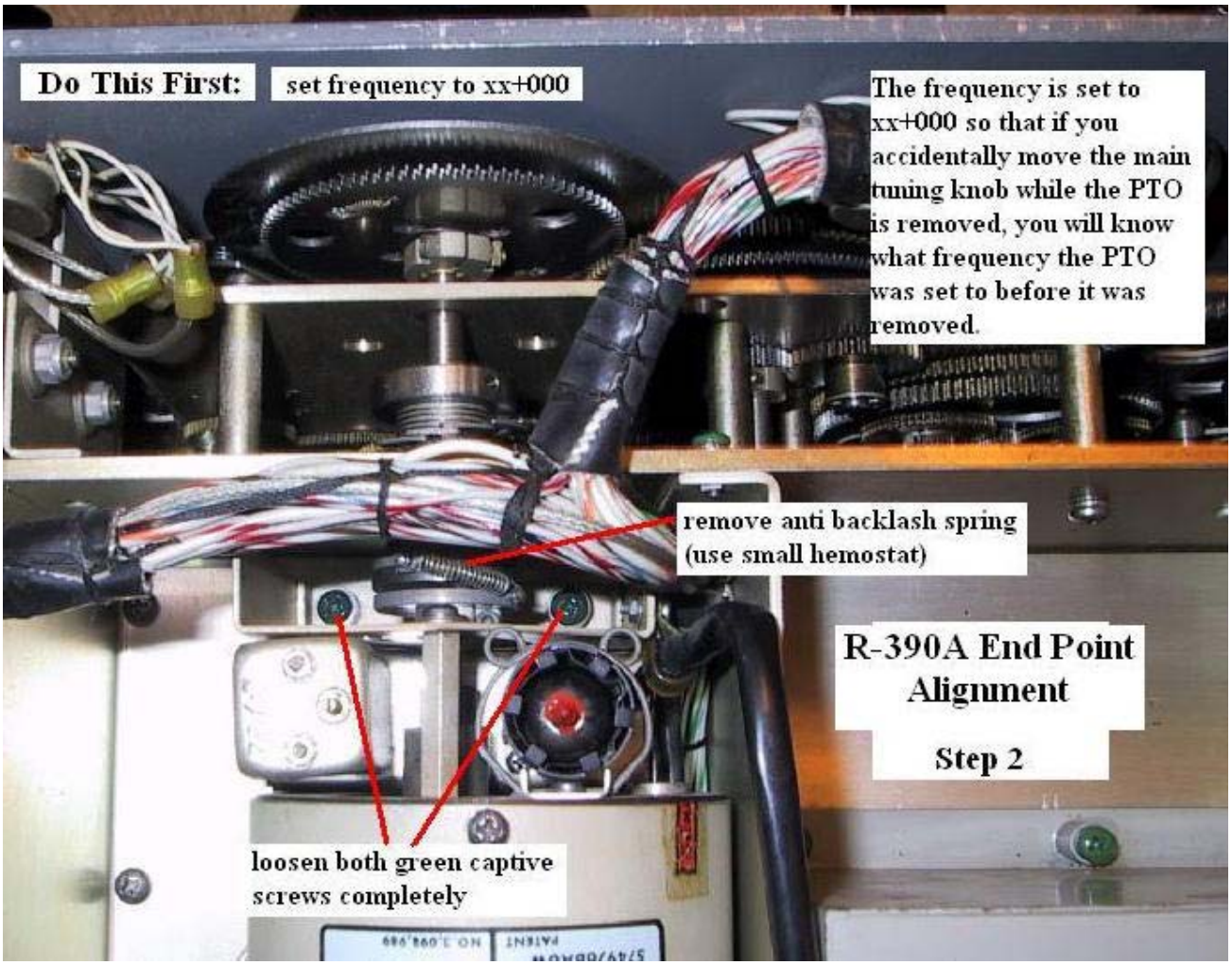
I've been rebuilding these things for 5 years and have test cables, ovens, cal dial setups, and you name it. I've never seen a defective part in any PTO except **R702** which is typically high and once in a while **R703**. Although I've changed many in a shotgun attempt to achieve super stability which you can expect if everything is just right. I've rebuilt the 5ea. .005 bypass cap and found zero difference. I've almost given up on super stability on one and decided to clean up the tube socket a second time and that was the problem. The 10 pf caps in the osc tank circuit often need changed because they've changed value and the endpoint won't adjust without adjusting the turns on L701 or changing the caps. I prefer changing the caps. Also the 10 pf caps usually don't have the original temp compensation so we change them on that basis. The 370 pf caps seem pretty good and I've never found one of spec from a capacitance standpoint.

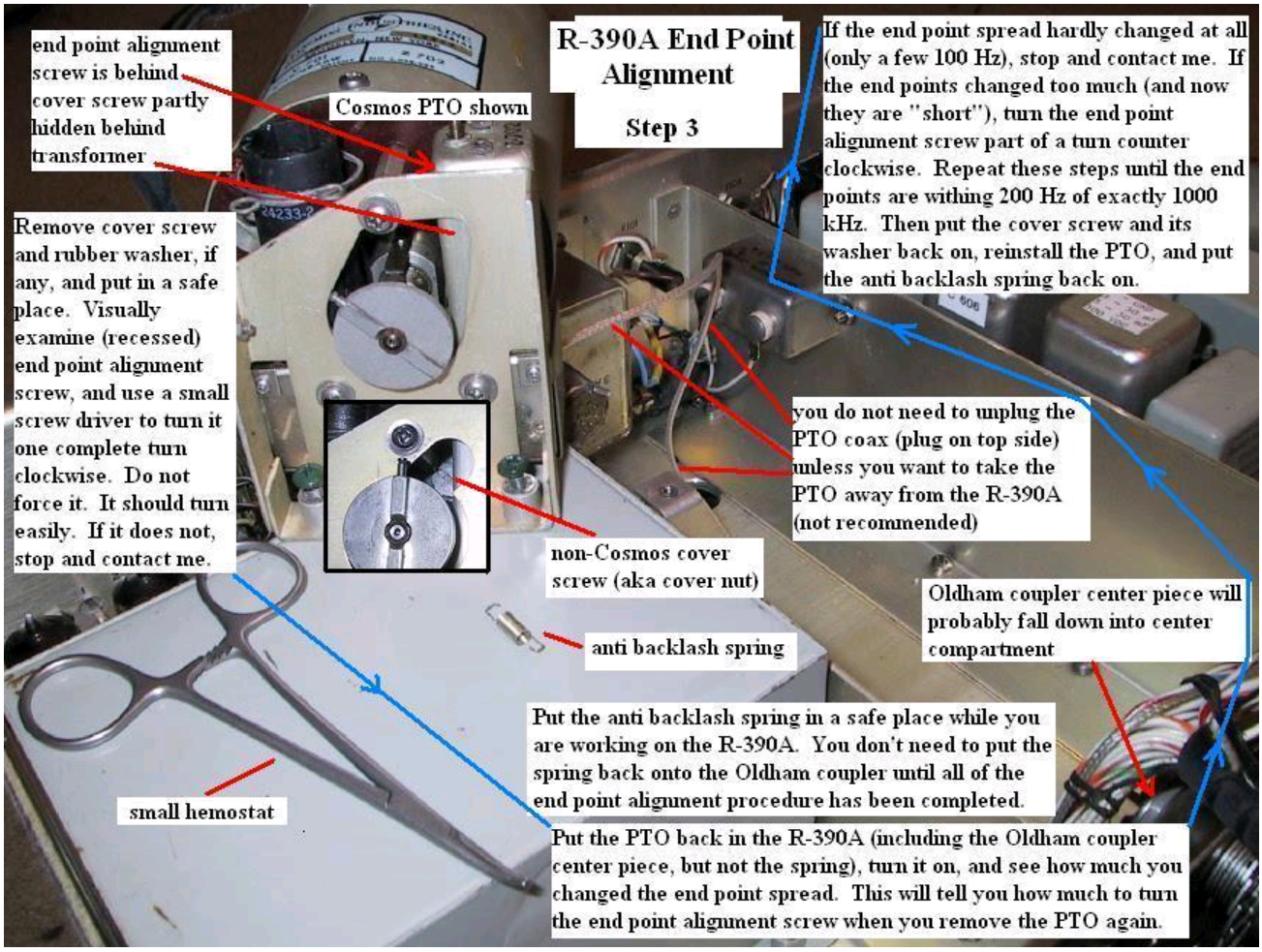
Hope this helped. Rich WD2Q

## PTO End Point Alignment and Linearization #1

by Dallas Lankford (c) Kongsfjord - 70°43'N 29°21'E




Do This First:
set frequency to xx+000
The frequency is set to xx+000 so that if you accidentally move the main tuning knob while the PTO is removed, you will know what frequency the PTO was set to before it was removed.
remove anti backlash spring (use small hemostat)
R-390A End Point Alignment
Step 2
loosen both green captive screws completely

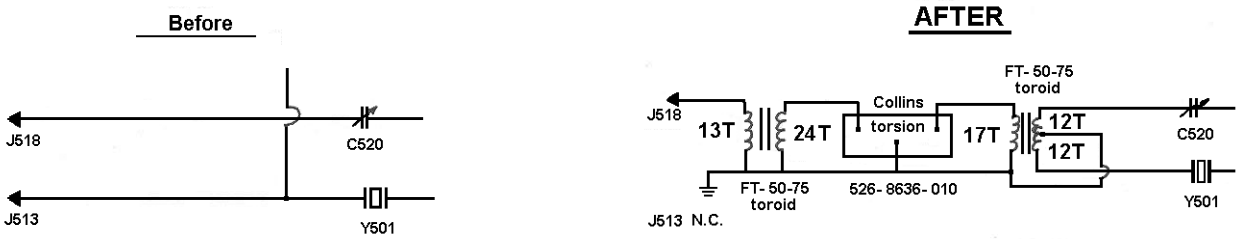

R-390A End Point Alignment
Step 3
end point alignment screw is behind cover screw partly hidden behind transformer
Cosmos PTO shown
Remove cover screw and rubber washer, if any, and put in a safe place. Visually examine (recessed) end point alignment screw, and use a small screw driver to turn it one complete turn clockwise. Do not force it. It should turn easily. If it does not, stop and contact me.
If the end point spread hardly changed at all (only a few 100 Hz), stop and contact me. If the end points changed too much (and now they are "short"), turn the end point alignment screw part of a turn counter clockwise. Repeat these steps until the end points are withing 200 Hz of exactly 1000 kHz. Then put the cover screw and its washer back on, reinstall the PTO, and put the anti backlash spring back on.
you do not need to unplug the PTO coax (plug on top side) unless you want to take the PTO away from the R-390A (not recommended)
non-Cosmos cover screw (aka cover nut)
anti backlash spring
Oldham coupler center piece will probably fall down into center compartment
Put the anti backlash spring in a safe place while you are working on the R-390A. You don't need to put the spring back onto the Oldham coupler until all of the end point alignment procedure has been completed.
small hemostat
Put the PTO back in the R-390A (including the Oldham coupler center piece, but not the spring), turn it on, and see how much you changed the end point spread. This will tell you how much to turn the end point alignment screw when you remove the PTO again.

## R-390A Roofing Filters

**Dallas Lankford 9/1/2004**

There are two reasons to put a roofing filter in an R-390A: (1) to improve the close spaced 3rd order intercepts, and (2) to provide a more appropriate wide AM bandwidth. The close spaced 3rd order intercepts for 2, 4, 8, and 16 kHz BW's without a roofing filter is about -20 dBm, which can definitely cause 3rd order intermod in high RF environments. With a 6 kHz BW roofing filter placed at the input of the IF deck, the close spaced 3rd order intercepts are improved to better than 0 dBm. The 8 and 16 kHz BW's are too wide for general AM listening in most cases, so a 6 kHz roofing filter kills two birds with one stone.

You could put a roofing filter in the RF deck, immediately after the 3rd mixer, and the performance would be the same. But removing and reinstalling an RF deck is an order of magnitude more difficult than removing and reinstalling an IF deck. Since the signal path from the RF deck to the IF deck is via two minicoax cables and two quick release miniBNC connectors, you could implement the roofing filter external to the IF deck, provided you had appropriate connectors. But it seems simpler to put it in the IF deck. The general idea behind the mod is quite simple. Below are "Before" and "After" schematics for the mod that I did.



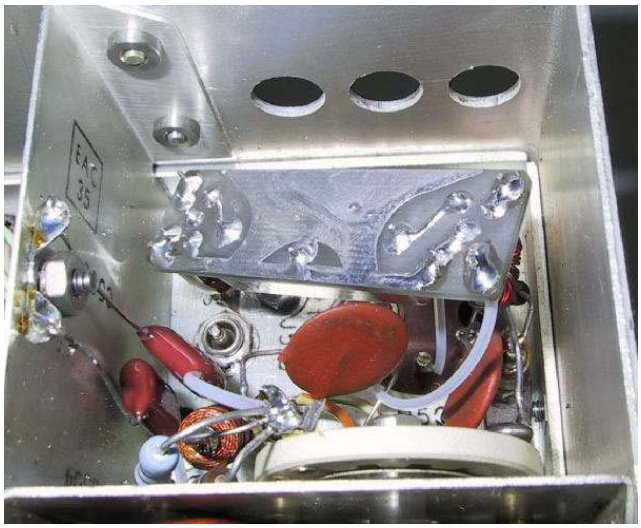

This mod is designed for 2000 ohm source and load filters, so you could also use a 6 Khz ceramic filter, like the LF-H4S which typically has a 6.5 kHz BW. But I would recommend a so-called low cost Collins torsion filter (they are definitely not low performance). The part number above is for the old style low cost torsion filter (with a metal case). Contact Collins filter division for current prices and availability of low cost torsion filters. The last time I checked prices, they were about $100 each.

If you look at an R-390A schematic, you will see that the 1st 455 kHz IF transformer (immediately after the 3rd mixer) has a high impedance LC tuned primary, and untuned push-pull outputs which are connected to the IF deck through minicoax using miniBNC connectors. I measured the output impedance of each output as about 600 ohms. To match 600 ohms to 2000 ohms requires a turns ration of about 1.826 (the square root of 2000/600), which is closely approximately by 13 to 24 turns (24/13 = 1.846). In the original R-390A circuit, the push-pull output of the 1st 455 kHz IF transformer worked into a high impedance load. Presumably the number of turns in the output windings of the 1st 455 kHz IF transformer were not chosen to match impedances (since the impedances were not matched), but to establish the desired signal level at the input to the IF deck. The 17 to 12 + 12 turn center tapped output transformer is an artifact from a previous roofing filter design and perhaps could be improved upon (a few more turns on the output? ... a few less?), but it seems satisfactory, so we have left well enough alone. Trying to use high a impedance standard size Collins mechanical filter is probably not a good idea because it would require more complicated impedance matching and it would be difficult to fit everything in the available space. The photos below illustrate the space constraints.

The PC Board Length Is About 2" Or 5.5 CM

In the photo below the two wires from J513 to Y501 and from J518 to C520 have been removed, two long #22 solid tinned copper wires added to the Y501 and C520 lugs, and a ground lug added between J513 and J518. Two shorter wires with Teflon insulation will be added to J518 and to the ground lug; these two wires will be soldered to one end of the PC board. Teflon insulation of an appropriate length will be added to the two longer wires which will be soldered to the other end of the PC board. A 100 ohm half watt resistor has been added in parallel with R504 560 ohms to recover the filter mod insertion loss.

IF Deck Rear Compartment Prepared For Filter Board



Completed Roofing Filter Mod

Observe that the PC board is slanted from front to back and from top to bottom. It is probably not feasible to use a larger filter for this mod.

## R-390A ILO AM Synchronous Detector Mod

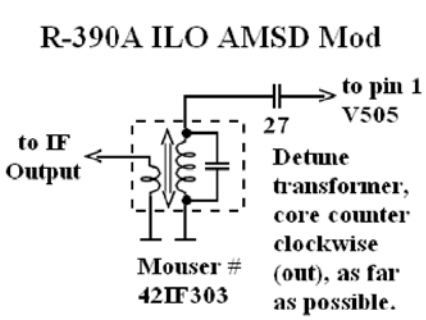
**Dallas Lankford, 6/1/06**

Here is a simple but effective AM synchronous detector for the R-390A which reduces fading and flutter distortion about as good as the best of them. It converts the R-390A BFO to an injection locked oscillator (ILO).

The injection source is the R-390A IF output. The injection source is stepped up to a higher voltage with a sub miniature IF transformer, 5K to 20K, black core, 3rd IF type, unloaded Q of 70, loaded Q of 35, fixed tuning capacitor of 180 pF, slot adjust core, Mouser catalog no. 42IF303. The stepped up source is injected via a 27 pF capacitor into pin 1 of V505, the 5749 BFO tube. For widest lock range the IF transformer should be adjusted by detuning the core counter clockwise (out) as far as possible. This ILO also works equally well with my product detector mod which uses a 5750 tube. A 500 volt silver mica is suggested for the 27 pF capacitor. My ILO AMSD was motivated by Graham Maynard's ILO AMSD which was published in Issue # 17 of The Hollow State Newsletter, Fall 1987 (more information may be found in subsequent issues). Back issues can be downloaded at http://www.hollowstatenews.com/ . My ILO has a wider lock range than Graham's ILO, about 200 Hz vs. 75 Hz. The R-390A ILO BFO can be offset to either side of 455 kHz to provide single sideband synchronous AM detection if desired. This, of course, requires that the R-390A be off tuned so that one or the other sideband falls within the IF filter in use. When the signal is off tuned as far as possible consistent with good lock and good audio, you will observe that by turning the BFO off and on (and hence the ILO AMSD off and on) that there is little or no fading distortion in either case. This is because maximum off tuning with an ordinary AM detector gives about the same amount of fading distortion reduction as center tuning with an AMSD. In other words, you can hear for yourself that selectable sideband AMSD is of little or no value. Nevertheless, some may wish to use selectable sideband AMSD anyway just in case it helps a little. With strongly fading SW signals these ILO type AM synchronous detectors ***will*** occasionally lose lock briefly during deep fades, manifested by a brief growl, ***if*** the AM carrier is not tuned precisely so that it is very close to the BFO frequency in the IF passband. Neither the main nor the BFO R-390A tuning has enough resolution to do such precise tuning reliably. My BFO vernier fine tuning mod with about 200 Hz per turn resolution is recommended to provide the fine tuning necessary to adjust the main tuning and BFO so that the ILO does not lose lock. With the BFO vernier fine tuning mod installed in your R-390A, adjust the BFO tuning, or the main tuning, or both so that lock is maintained throughout the BFO fine tuning range, and then set the BFO fine tuning pot to mid range. The R-390A BFO vernier fine tuning mod can be downloaded from The Dallas Files at http://www.kongsfjord.no/ .

One way to implement this R-390A ILO is shown here. The braid of miniature Teflon coax was soldered directly to the IF transformer shield, and the center conductor was soldered to the appropriate link coupling input.

Do not use excessive heat; it can melt internal parts of the IF transformer.

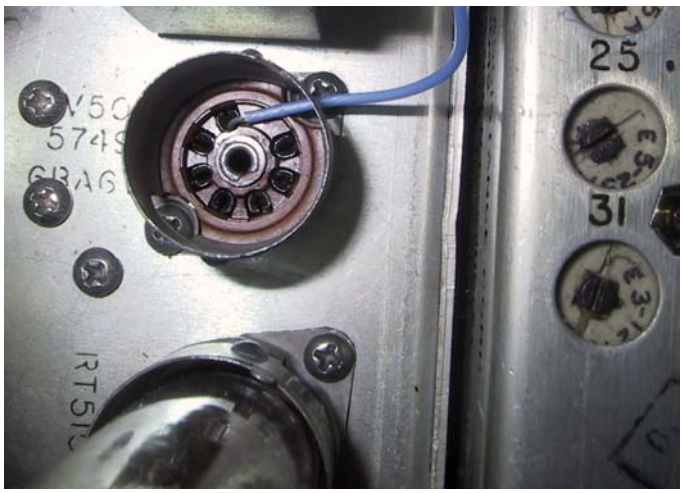



The two appropriate grounded pins of the IF transformer were connected to one of the IF transformer shield lugs with #24 solid tinned copper wire and soldered. A 4.7 Meg ohm resistor was attached to the IF transformer shield as shown. One lead was soldered to the IF transformer shield.

Three (3) turns of #24 solid tinned copper wire were wrapped around the resistor and one lug of the IF transformer shield and soldered. This provided an insulated standoff for attaching one lead of the 27 pF capacitor and a short length of #22 stranded insulated (blue color here) silver plated Teflon wire which was connected to pin 1 of the V505 tube socket as will be shown below. The other lead of the 27 pF capacitor was soldered to the appropriate IF transformer pin. The finished IF transformer assembly should be insulated with heat shrink tubing or some other good quality insulating material.

The assembly should be tested before insulation is applied. If heat shrink tubing is used, be careful not to apply too much heat. There are several options for connecting the miniature coax to the IF output. If you have a (used) miniature BNC connector like those used to connect to the IF output connector on the R-390A IF module, then you can attach it to the end of the miniature coax and connect to the IF output connector on the R-390A IF module (after detaching the miniature BNC connector with the miniature coax which goes to the IF output connector on the inside of the rear panel). If not, then you may use a regular size BNC connector and connect the end of the miniature coax to the BNC IF output connector on the outside of the rear panel. The BNC connector is small enough to pass through the hole in the rear panel for aligning the oscillator shaft.

Below is a photo of the connection of the insulated stranded wire from the 4.7 meg ohm insulated standoff to pin 1 of the V505 tube socket. First, the V505 tube was removed. Next, about 5/16 inch (8 mm) of insulation was removed, a right angle in the strands was formed, the end of the wire with the right angle strands was inserted through a small hole in the base of the tube shield support, and the end of the strands inserted into the 1 position of the tube socket. Finally, if the strands are not twisted too tightly, the V505 tube can be re-inserted. The ILO can also be installed underneath the chassis of the IF module because the only alignment required is the BFO frequency. After the R-390A has warmed up for an hour, select the 2 kHz BW and tune a steady AM signal so that it is in the center of the passband. Turn on the BFO and adjust the BFO tuning shaft so that zero beat occurs when the tuning knob is at 12 o'clock (0). The BFO is now re-aligned and you are ready to play with your ILO. When tuning selectable sideband AMSD you should set the BFO frequency (+ or -) to a little less than half the filter bandwidth. For example, when using the 4 kHz BW filter, single AMSD sideband is gotten by setting the BFO frequency to about + or – 1.75 as shown on the front panel, and then tuning AM signals without changing the BFO frequency, except slightly as necessary to adjust the ILO lock range. Of course, as I said above, with offset tuning like this, you will not hear much fading distortion, if any, in either case, with the BFO on (AMSD) and the BFO off (ordinary AM diode detection). The case where AMSD will give substantial reduction in fading distortion is when the signal is tuned near the center of the passband and the BFO is set near 0.

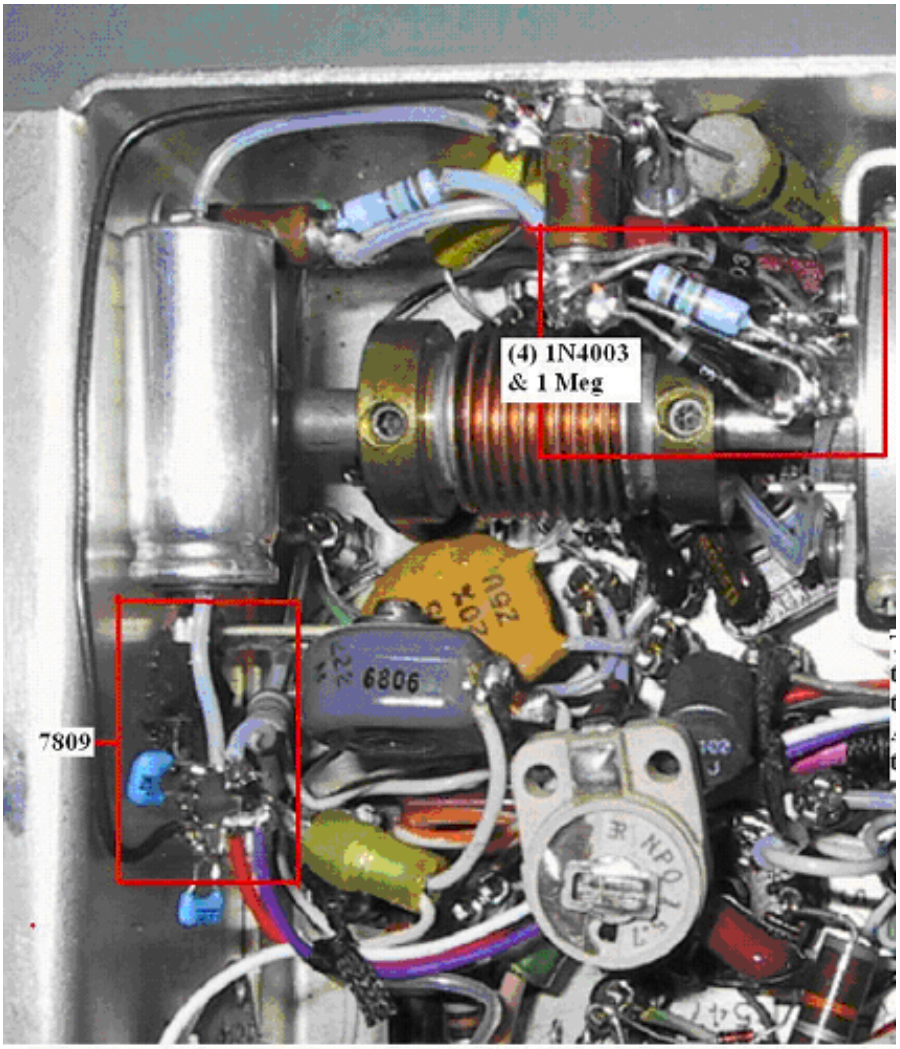


## R-390A BFO Fine Tuning  Dallas Lankford 12/24/03

It is very difficult to tune SSB well with an unmodified R-390A.  The same can be said for tuning AM via ECSS.  Neither the main tuning KCS not the BFO tuning (BFO PITCH) are slow enough.

Here is a BFO fine tuning mod which uses voltage tuned diodes.  It works very well.  Be sure to get a Clarostat type J 50K ohm pot from Newark.  Or a NOS AB pot would be equally good.  I mounted the pot in place of the dial lock mechanism.

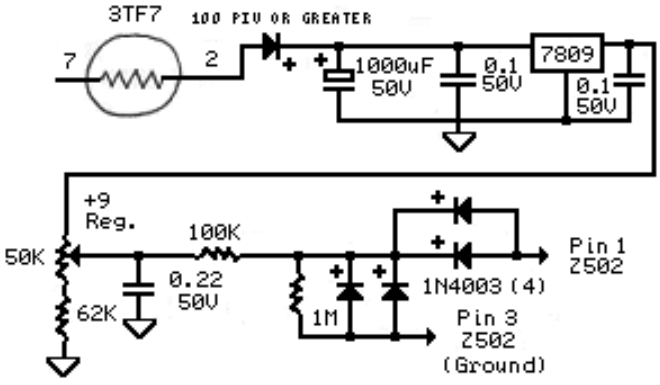
The pot tab hole on the back side of the front panel.  The pot tab did not mate with the dial lock tab hole on the back side of the front panel, but the pot tab can be bent appropriately.




The picture and schematic show most of the details. The 7809 is heat sinked by mounting it against the of the IF deck using the mounting bracket for L502. When mounting the 50K pot make sure the wiring does not contact nearby moving parts.  All grounds should be solder joints and should be returned to pin 3 of the BFO PTO for best frequency stability.

The BFO fine tuning frequency range is about 200 Hz.

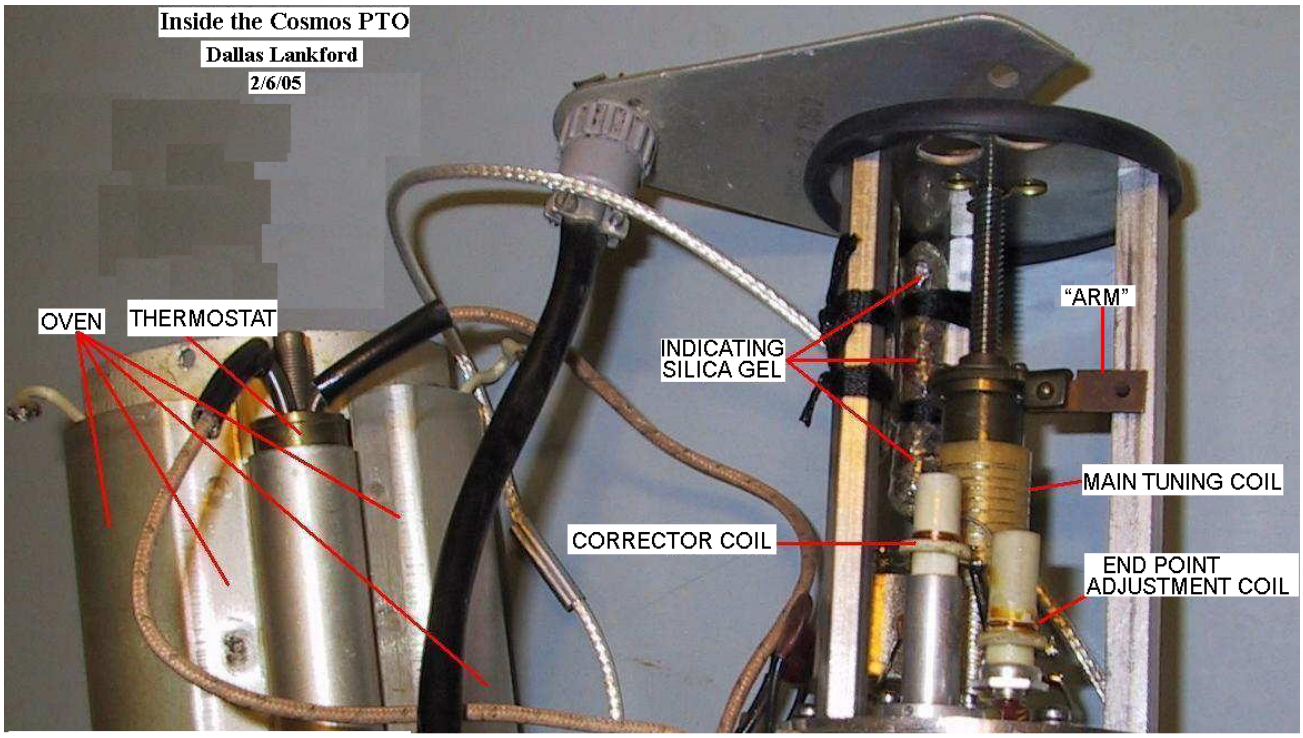
The there wires to the 50K ohm pot go through the holes in the IF chassis which pass the wires to the GAIN ADJ and the CARRIER METER ADJ.  Some recycled blue plugs were used so that these three wires could be quickly disconnected.




Note: In one IF deck mod, BFO frequency instability was observed.  The problem was traced to one or more (the exact number is uncertain) capacitors in the 5749 tube circuit which was modified to a 5750 tube product detector.  For this reason, all capacitors in the BFO circuit should be replaced with new high quality capacitors.

**Inside the Cosmos PTO I**

**Dallas Lankford 2/5/05**



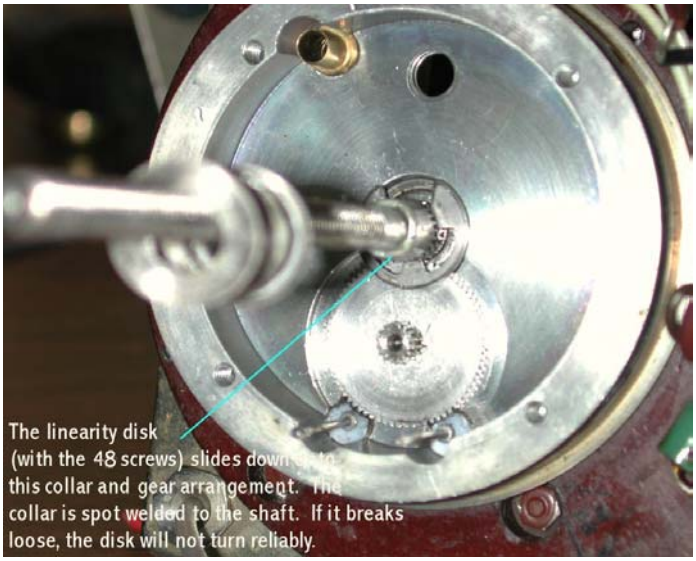

**SOONER OR LATER THE ENDPOINT SLOT ADJUST MAY NO LONGER ALIGN THE END POINTS. WHEN THAT HAPPENS YOU WILL HAVE TO OPEN YOUR PTO AND REMOVE ONE TURN FROM THE ENDPOINT ADJUSTMENT COIL. THE PTO ENTERIER SHOWN HERE IS A COSMOS. OTHER PTO INTERIERS ARE SIMILAR, EXCEPT THEY HAVE NO COORECTO COIL BUT A CORRETOR STACK OF THIN METAL PLATES WHICH THE "ARM" RIDES OVER WHICH ADVANCES OR RETARDS THE POSITION OF THE POWDERED IRON CORE OF THE MAIN TUNING COIL ON ITS THREADED SHAFT. WHEN THE SLOT ADJUSTMENT IS FULLY CCW TO THE "NEW" POSITION,REMOVING A FULL TURN CAN MAKE THE ENDPOINTS SHORTER THAN 1.00O MHZ SO IT MAY BE NECESSARY TO REMOVE ONLY A PART OF A TURN. THIS OCCURED TO ME WHEN I REBUILT A COSMOS PTO THAT WAS 10KHZ LONG, AMONG OTHER THINGS. THE COIL LUGS ARE OFFSET SO I REBUILT IT AGAIN, BUT THE SECOND TIME WITH 2 1/4 TURNS INSTEAD OF 2 TURNS. UNFORTUNAT-ELY, IT WAS NOW NON-LINEAR ABOUT + OR - 500 HZ BUT CAN BE LINEARIZED.**

**Other PTO's can also he linearized by re-aligning the corrector stack, but that is much more difficult than linearizing a Cosmos. After removing one turn, or rewinding an end point adjustment coil, I use Poly Q Dope to fix the ends. A good quality varnish can also he used, (I have used spar vanish, hut it takes several days to dry). Attached to one or two of the interior posts should he two bags of indicating silica gel. When activated (when all the moisture is driven out), it will turn dark blue in color; otherwise it will be pink or white.**

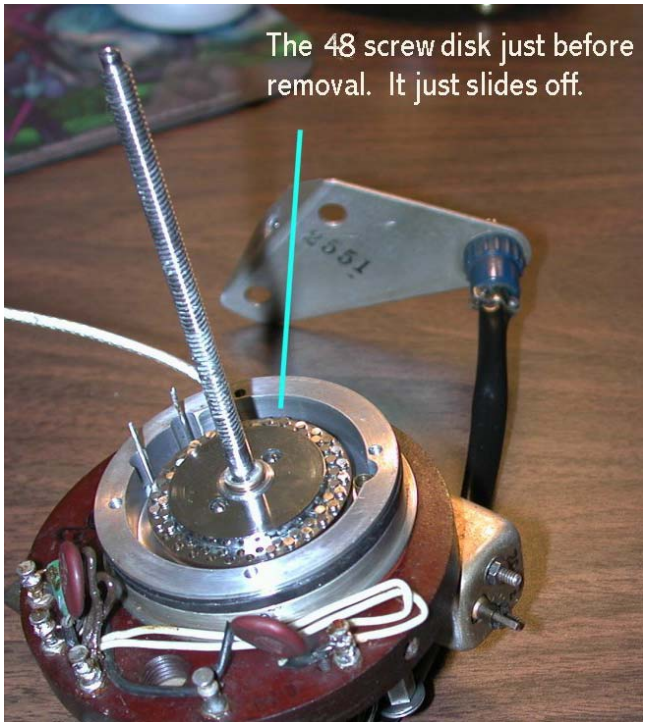
**To activate it, place it in an oven at about175 degrees F (80 C). It should turn dark blue in 30 minutes to an hour or so. The entire PTO assembly can he put in the oven. DO NOT TOUCH any of the wires near the main tuning coil or you will un-linearize your PTO so badly that it may be un-fixable.**

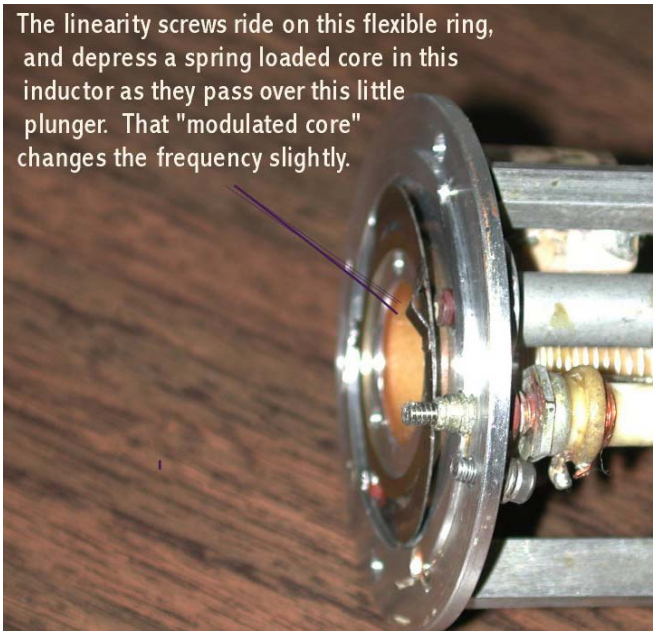
## Cosmos PTO Repair II

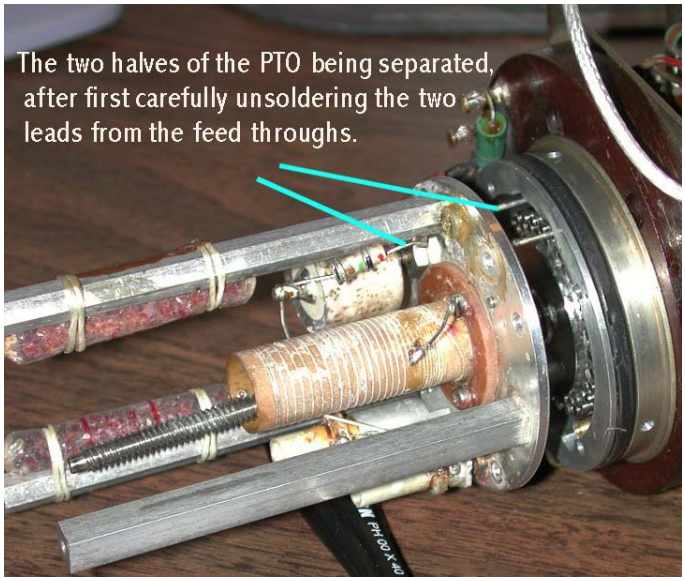
**Dallas Lankford**

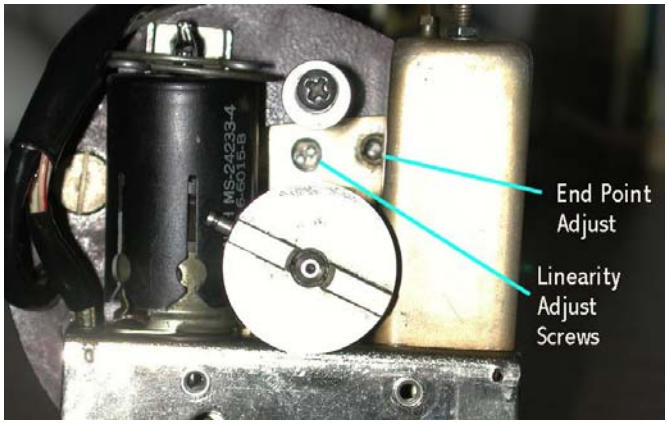


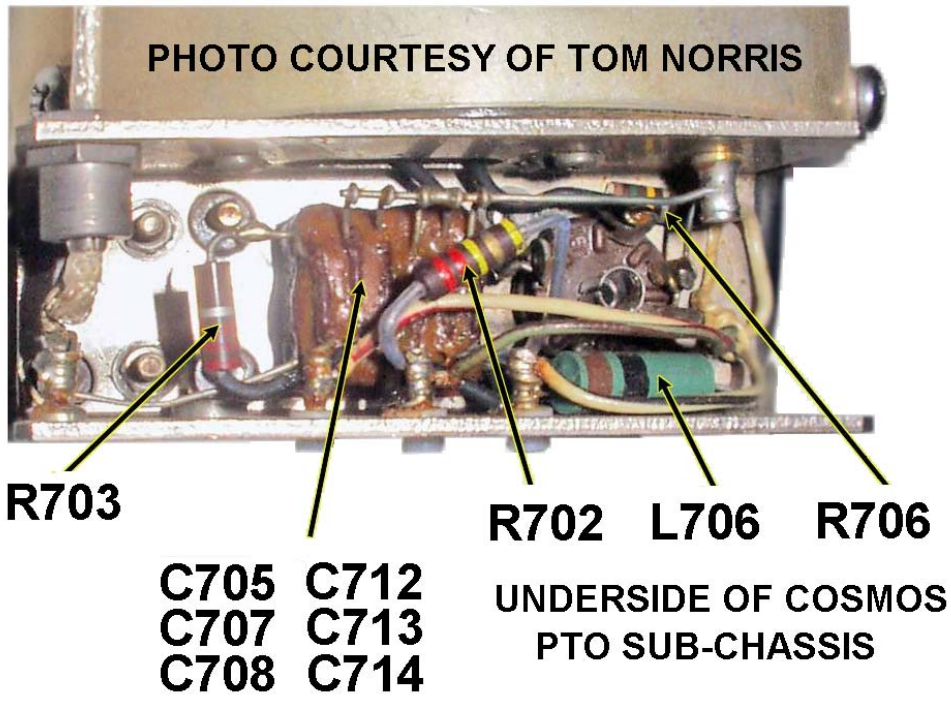

The linearity disk (with the 48 screws) slides down this collar and gear arraignment. This collar is spot welded to the shaft. If it breaks loose, the disk will not turn reliably.




End Point
Adjust
Linearity
Adjust
Screws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R703
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