Getting Your "ARC-5" Transmitter Running Without Hacking It Up.

The Command Sets have been the most popular of WWII equipment among milradio enthusiasts.

They were once common and cheap and were "converted" for many ham-radio uses.

Now that unmolested examples have become more difficult to find, attitudes have changed so that most of us now view these combat veterans as historic artifacts. Our community now looks with disfavor on drilling and hacking military radios, or doing anything that is not "100% restorable to original."

It's asking a lot for a milradio person to set his unit on the shelf as a static display; we want to see it on the air. The challenge now is to do that without making irreversible changes, and milradio people have met this challenge well with the several "flavors" of equipment we commonly call: "ARC-5." These units can be powered and used with minimal changes that are 100% reversible. This article will address only the transmitters and assumes that the reader does not have the mounting rack or other accessories, that the transmitter is in original" condition and undamaged.

We will get your transmitter running cleanly, with good power out and with no irreversible damage.

Before we get started, we need to put some old myths and misunderstandings to rest.

"ARC-5" and other WWII radios are not "TVI machines;" the engineers who designed these equipments knew what they were doing. The radios are clean when operated as designed.

In the 1950s and '60s, many units were "converted" and used by hams who did not have a good understanding of the output circuit designs of these radios. Radios designed to feed a 5-ohm aircraft antenna were willy-nilly connected to 50-ohm ham antennas. The output coupling links were "maxed-out" with no other tuning components used, defeating their harmonic filtering.

They used weak power supplies, resulting in excess chirp and harsh notes. This lead to "pink tickets" that were not the fault of the equipment, but of bad "conversions." Talk about these problems was simply repeated and milradios got an undeserved bad reputation.

With better understanding and more of these fine radios on the air, these old myths are slowly dying out and the "conversion" articles that spread them are being relegated to the archives.

There are actually three models of what we call "ARC-5" HF transmitters, with several "sub-sets." They are the Navy ATA, which was the first production of this style transmitter, the Army Signal Corps SCR-274N and the Joint Army Navy (JAN) model, AN/ARC-5 (which was, with a few exceptions, used only by the Navy).

The "sub-sets" of these three major categories are an interesting study in themselves, but we will not be addressing that in this article.

The Navy ATA and Army SCR-274N rigs are nearly identical electrically - the only real difference being paint jobs, nomenclature tags and a few more turns on the output links in later models. The AN/ARC-5 is an "upgraded" (though not necessarily "better") model. It has some wiring differences and a completely different power connector. The procedures for getting the radios on the air without damage are the same in either case.

Besides normal hand tools, we'll need some other things to get started:

1.) A screwdriver of the correct size for those little screws.
Don't "skimp" on this one; those screws are hard to find and the wrong screwdriver will "booger'em up." They are 3 X 48 binder-head screws of two or more lengths.

2.) A tray or holder for the screws and other small parts. Make it deep and stable: a misplaced coffee cup will send them flying (voice of experience).

3.) "3-in-1" Light Electric Motor oil. You can find this at most WallyWorlds.

4.) Light-duty gear grease, for the worm gears.

5.) Cream-type, non-abrasive silver polish. Yep. Don't waste your time with "dipping" solutions. They won't work. You can also get it at WallyWorld. Comes in a blue tub; "Wilson," I think.

6.) Lint-free polishing rags and "Q-Tips."

7.) Cramolyn, Caig's DeOxit-5, or other good contact cleaner.

8.) A large, old towel to cover your work area. This will catch dropped parts, saving aggravation and prevent finish dings.

9.) A clean toothbrush.

10.) Red or Orange fingernail polish.

11.) Small bottle of black paint, preferably "flat", or fingernail polish.

12.) Distilled water- lots of it.

Disassembly, Clean-up and Contact Maintenance

Begin by removing both covers and all the tubes. Test the tubes carefully, allowing them to warm-up well. Grid emission in the 1625s is a source of chirp, as is low emission in the 1626. Inspect the tube contacts for corrosion and/or bad solder joints.

Examine the three variable capacitors, looking for any damage/rubbing plates etc. The stators are fixed in place by adjusting screws and little clear plastic or glass beads.

If these beads have been knocked out - a common problem - you're going to have to remove the caps to fix them. That's more involved than we'll get to in this article. I'd suggest setting the rig aside until we can discuss that point later. If the caps are in good shape, we can proceed.

You'll need to completely disassemble the roller coil subassembly and, if needed for cleaning a dirty chassis, remove the tank coil. I recommend also removing the MO cover, because we're going to check for bad connections later. Be sure to separate those screws from the cover screws. Make notes or photos of how things come apart, especially the roller coil assembly. If you lose one of those small screws or washers, it's going to be a pain to find replacements.

While you have these coils out, locate the "antenna" relay on the front of the set. Carefully remove one wire and tuck it out of the way.

If your chassis is dirty, you'll want to take this opportunity to clean it up.

Do not use chemicals like "409" or other harsh cleaners. If you do, four or five years from now you'll see bright green corrosion peek out from every hidden corner. Use only distilled water and mild detergent. Scrub with a soft-bristle toothbrush and rinse clean with distilled water, using as much as you think needed to get the detergent off, plus a lot more.

Washing your radio with water and mild detergent will not harm it. Leaving detergent residue (or powering it wet, for that matter), will. If you rinse it well with distilled water and let it dry completely, it will be fine.

Once the unit is thoroughly dry, you can do any paint "touch-ups" you feel are needed.

The roller coil, roller bar, contact leaf spring on the ceramic end of the roller mounts, the contact end of the roller coil axle, the big leaf springs that mount the coil and the rolling contact are all plated in silver. If these are left dirty and discolored, they will make tuning difficult and add to chirp.

Use the cloths and the silver polish in the blue tub to polish these parts until they shine. Use the "Q-Tips" to polish the inside of the roller contact. Be sure to clean the part of the roller bar that accepts the mounting screws. Polish the big leaf springs that mount the roller coil.

Rinse everything thoroughly with distilled water and let dry.

If your roller coil is badly pitted or has been ruined with abrasive cleaning, you can find a replacement from other "ARC-5" fans who usually have a couple in their junk boxes.

When reassembling the now-dry roller coil unit, lubricate the thumbwheel gear mounts and the thumbwheel end of the coil axle. Do not use any lubricant between the axle and the ceramic mount, but do put a drop of contact lube, like Cramolyn or DeOxit-5, at the point where the coil axle contacts the leaf spring. When assembling the ceramic mount end, do not over tighten the screws in the ceramic. Just "finger-tighten" them and lock them into place with daubs of the black paint. Do not lubricate the roller contact on the roller bar.

Put drops of contact cleaner on the two contacts from the link coil in the tank coil assembly. Give it a few rotations, then leave it in the "least coupled" position.

Oil the shaft of the "coupling" control where it comes through the brake clamp and where it goes through the "L-" bracket that mounts it to the chassis.

Once it rotates correctly, set it for "0." Reinstall the roller coil assembly and the tank coil. Check to make sure the "coupling" control is properly aligned.

There are two relays in the set - one "selector" relay, which we will use for keying, and one "antenna" relay, which we will not use. The antenna posts and spiral relay contact are also plated in silver and should be polished. If you don't want to disassemble these, use nothing stronger than brown paper soaked in contact cleaner to clean the contact and posts.

Once cleaned, roll the contact around the post so that it makes permanent contact with the antenna post. This and the removed relay wire is all the "modification" this radio needs.

The "selector" relay is mounted on the side of the under chassis. Put a small drop of light oil on the hinges of the relay moving contacts. Clean these contacts with some contact-cleaner soaked brown paper. Carefully bend the shorter pair of contacts so they make contact before the longer pair. This starts the oscillator stage running before grounding the cathodes of the PA stage, helping to minimize chirp.

Use the light oil and gear grease to lubricate the VFO/PA tuning chain and dial mechanism.

Lubricate the ball bearings in one end of the variable caps. Put a drop of contact cleaner on the other end. Rotate the assembly through the entire range and back again to spread the lubricants.

Use the "Q-Tips" dipped in contact cleaner to clean the tube socket contacts of the 1625s.

Spray or dip contact cleaner on an octal tube with all its pins and "massage" the three octal socket contacts with the cleaner.

A bathtub capacitor, containing three .05 uFd @ 350 VDC capacitors, is mounted on the rear of the chassis. These caps are almost always leaky and cause several kinds of problems.

If you want to try to preserve this cap, be sure to remove and test it with a quality cap checker, allowing time under full voltage for any leakage to develop. These caps have been known to fail after testing "good." If you decide to replace it, I recommend either re-stuffing the cap or using small, new caps "tacked" into the circuit. Disconnect all the wires to the cap, taping them off. Do not remove the wires as their distributed capacitance is part of the design. Trace the wires to their connection points on the tube sockets and solder a .05 cap between them and the nearest ground. Caps about the size of a pencil eraser that will do the job are available.

Get your soldering iron hot. Recently we've begun to see problems with a lot of these 60-year-old solder joints. Even joints that look "good" turn out to be sources of intermittent problems.

I recommend you re-heat every joint you can reach, especially in the M.O. (which is why we pulled the MO cover) and the 1625 bases. Check for cracks in the resistors and other obvious problems.

Another problem beginning to surface is intermittent contact in the stators of the variable capacitors.

This trouble is appearing in the receivers as well. If you look at a Command Set variable, you will see a strip of metal that has been "press fit" to the end to provide a contact point. Contact between this metal strip and the stator metal is becoming intermittent due to long-term oxidation. Sudden, intermittent detuning and loss of power out is a symptom of this. It can also cause "jumpy" signals from the MO. I've repaired these by using a large soldering gun and some non-acid flux to solder the metal contact strip to one of the stator posts at the "press" point, where the wire is soldered to it. It's a tight fit for a soldering gun, but necessary if you find this problem. Don't forget the MO cap on top of the chassis, and to check the connections there.

Now we can reassemble the transmitter. Seal the screws to the MO compartment with the red or orange polish, depending on what was there before. If your green felt has deteriorated, you can buy self-adhesive replacement sheets at any craft store. Stick it down and "cut out" the holes with the tip of a hot soldering iron. It will burn away cleanly (at least mine does). Put a drop of oil on the hatch and door slider latches. Before putting the bottom cover on, loosen the screw that holds the center variable cap stator. This is the PA "fine tuning" and will be used to resonate the final tank during tuning.

Supplying Power.

The power connector for the ATA or SCR-274N transmitters is wired differently from that for an AN/ARC-5 transmitter. Be sure you have the correct diagram; many of the so-called "conversion manuals" show a 274N transmitter and call it an "ARC-5," which has caused many a radio to be trashed and ham to be frustrated.

You power supply needs to have "guts" enough to deliver 400 to 600 VDC at 200 mils and 24 VDC at about 2.5 amps. I very much recommend DC on the filaments and to properly operate the relay. Small 24 volt supplies are cheap and plentiful these days.

The original design used a resistor divider network to provide the various voltages from a single dynamotor 550 VDC source. I recommend its use.

You can draw a diagram of the power divider by getting a pencil and following along with this description:

Place a dot on your paper and call that point "A".
Draw a line right to point "B".
Draw a line down and to the right.
Connect a 20 K-ohm, 5 watt resistor here.
Call the other end of this resistor point "C".

Draw a line right from point "B" to point "D" (go farther than "C").

Draw a line down from "D" and connect a 15 K-ohm, 10 watt resistor.
Call the other end of this resistor point "E".
From point "E", connect a 100 K-ohm 1 watt resistor to ground.

Draw a line right from point "D" to point "F".
Draw a line right from point "E" to point "H".

+550 VDC in to point "A".
+270 VDC out to PA screens at point "C".
+200 VDC out to Oscillator at point "H".

If you wish to regulate the screens for AM, connect an 0D3 VR tube with a .5 ufd at 300VDC cap across it between point "C" and ground.

You can use lower B+ voltages and the divider will keep them in the proper proportion.

The rig is very forgiving and will put out usable power even at 200 volts on the plates.

I do not recommend exceeding 600 volts B+; the extra few watts are not worth the damage it will do in the long run.

Proper voltages and currents for an AN/ARC-5 or SCR-274N transmitter operating at design-spec, CW mode, 3.5 MC, key-down under full load:

PA Plates: 530 VDC at 150 ma.
PA Screens: 260 VDC at 15 ma.
PA Grids: -50 VDC at 3.5 ma.
Osc. Plate: 200 VDC at 20 ma.
Filament: 26 VDC at 2 amps.
Design-rated output power for CW: 35-40 watts.

Tube Pin Voltage Chart

Pin	1626 Osc	1629 Eye	Cal. Crystal	1625 PA #1	1625 PA #2
1	--	0	0	12	24
2	12	24	--	530	--
3	200	50	0	260	270
4	200	130	--	-50	-50
5	**	0	-50	260	530
6	--	200	--	0	0
7	0	12	0	0	14
8	0	6.5	0	--	--
Plt Cap	--	--	--	530*	530*

* measure only at the DC feed point, not at the plate cap itself.
** don't measure- kills oscillation.

Tuning and Feeding an Antenna.

Be sure you have the bottom plate on before tuning up.

The Command Set transmitters are designed to feed an electrically short, capacitively reactive antenna of 5 to 12 ohms impedance. This works fine for a WWII fighter wanting to talk a few miles, but not so well for us. They will not properly load into a 50-ohm load without an external capacitor. Several schemes have been presented by users. A "quick and dirty" method is to do what the designers did: insert a high-quality, high voltage capacitor of 50-100 pFd in series with the antenna lead. This will not provide a perfect match, but will allow the transmitter to be tuned to a reasonable power out while providing good harmonic suppression.

If you use a fixed cap, make sure it's rated at least 1000 VDC and is a temperature-neutral "NP0" cap, which will not drift in value with RF heating. This solution will, in most cases, still require the "coupling" control to be at maximum, but the combination of the roller coil and external cap tune-out reactance and supply harmonic filtering. Some have used a variable cap in series, some in parallel to ground. A good solution is to wind an "UNUN;" an unbalanced to unbalanced toroidal transformer to transform the impedance upwards and then feed the signal through a transmatch. Your experimentation in this area will be important to others, so be sure to share what you discover as the "best solution for you."

When tuning up, simply adjust the "coupling" control and roller coil for maximum power out.

Then, through the holes in the side of the chassis provided for it, "tweak" the PA padder capacitor for minimum plate current. Adjust your tuning and PA padder until you have maximum power out and end with "dipping" the PA plate current.

Your output power will depend on how well you matched your antenna, but should be respectable even if you go the "quick and dirty" method.

If You Have Excess "Chirp:"

This is a classic MOPA rig. Anything that changes the loading while transmitting - such as a B+ voltage drop or even the antenna swinging in the wind - will cause a frequency change. While you can expect some small amount of chirp, I've got many transmitters in which it is difficult to hear any at all. It's usually a matter of how thorough one has been in restoration. I've never had one that, after I finished restoring it, had what I call "bad" chirp. Noticeable chirp in an "ARC-5" transmitter can usually be traced to these sources, in order of their usual appearance:

1. Poor power supply regulation.
   Your supply needs guts enough to maintain 400-600 VDC at 180 mils and 24 VDC at about 2.5 amps.

2. Leaky bathtub caps. Reduces osc. drive, messes with B+, reduces grid bias to the 1625s. See above.

3. Cruddy output tuning network or antenna connections. Anything that changes the loading- like heating the crud between the roller and coil- is going to pull an MOPA rig.

3. Low under-load emission in the 1626 Osc.
   Swap it out with a known-good one.

4. Grid emission in one or both 1625s. Especially
   noticeable in one that's been run at 800+ volts.
   Swap with known good ones.

I've seen changed resistor values in the osc. stage and misc. other stuff, but these four are the usual bandits. While I've heard of the other mica caps going bad, I've worked on many dozens and never seen it happen. I've also never seen that custom "button" cap go bad, though I've heard of that, too.

I hope this has been of help to you and look forward to hearing your Command Set on the air.

73 DE Dave Stinson AB5S
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