

Bring That ARC-5/BC-45X Receiver Back To Life

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Introduction

The old military ARC-5/BC-45X series of receivers were used with a matching transmitter in B-17 and B-24 bombers (typically 2-3 pairs) and P-38 fighters (one pair), and probably other aircraft during WWII (Figure 1).



Figure 1: ARC-5 Equipment in a B-17 Bomber

The BC-453 (190-550KHz, the old Q5er), the BC-454 (3-6 MHz), and the BC-455 (6-9.1 MHz) receivers were very popular with hams in the 1950's and 1960's, as they were readily available and inexpensive. In the mid-60's I paid \$5 for a brand new BC-455 receiver. It was surprisingly sensitive and stable, and I used it as my primary 40 meter receiver for a year or so. Unfortunately, I don't know what ever happened to that receiver. But I recently picked up both a BC-454 and a BC-455. After studying the on-line conversions and schematics, I decided to try to document the conversion so as to make it easier for the average ham.

Receiver Modifications

These receivers use 6-tubes with 12-volt filaments. The tubes are paired-up and each pair's filaments wired in series so as to operate from 26VDC. The receivers need a 125-250VDC high voltage source for the tube plates. The plate current requirement is less

than 100ma, and the filament requirement is 1.5-amps. Other than a suitable power supply, these receivers are pretty much self-contained, so getting them up and running requires minimal effort. Basically, you need to figure out how to power it, replace the old paper and electrolytic capacitors, and add a headphone jack, a BFO ON/OFF switch and a volume control.

First replace the three 0.22uf, the twelve 0.05uf, and the three electrolytic (5uf, 8uf and 15uf) capacitors with modern capacitors. After 60+ years, these capacitors are almost certainly leaky, shorted or open. And these capacitors are large and take up a lot of room. It is much easier to continue the wiring modifications when you free-up more internal room. I used 10uf electrolytics for both the 5- and 8uf capacitors, and a 22uf electrolytic for the 15uf capacitor. Except for the 22uf capacitor, all capacitors should be rated at 250VDC or higher. The 22uf capacitor can be rated at 100VDC. Also, C24 (200pf) in my unit was a paper capacitor, so I replaced this as well. Remove the existing capacitors one at a time starting at C16 and moving counterclockwise. Snip the wires right at the capacitors, then mount the replacement capacitors on terminal strips using the original capacitor mounting locations. Solder the snipped-off existing wires to the new capacitors on the terminal strips. The terminal strips have 5-positions, including ground. I snipped off unused terminals just to make things a little neater.

Next remove L14. One wire on L14 connects to Pin 6 on the rear connector. Completely remove this wire as well. The other wire on L14 goes to Pin 7 on the front panel. Move the L14 end of this wire to the secondary of T1, the audio output transformer. We will use this wire to bring audio to the front panel. The secondary is connected to Pin 2 of the rear connector, but this rear connector will no longer be used. L15 is left in place, and provides some plate voltage filtering.

The next task is to rewire the filaments in parallel so the tubes will run on +13.8VDC. First remove the following wires:

- 1) Remove the wire from 12A6 Pin 7 to 12SR7 Pin 7
- 2) Remove the wire from the left 12K8 Pin 2 to the bottom-left 12SK7 Pin 7.

Figure 2 shows the bottom view/tube socket locations of the receiver and the re-wired filaments. The black wires are existing, and the red wires are new. Double-check that the filament wiring is as shown, and no other wires are attached to the tube filament pins. It is important to verify the orientation of the tube sockets, as some receivers may have one of the sockets rotated differently. Also, some receivers have a 12FS7 for the bottom-right/middle tube instead of the 12SK7. The filament pins are different on the 12SF7 (pins 7 & 8).

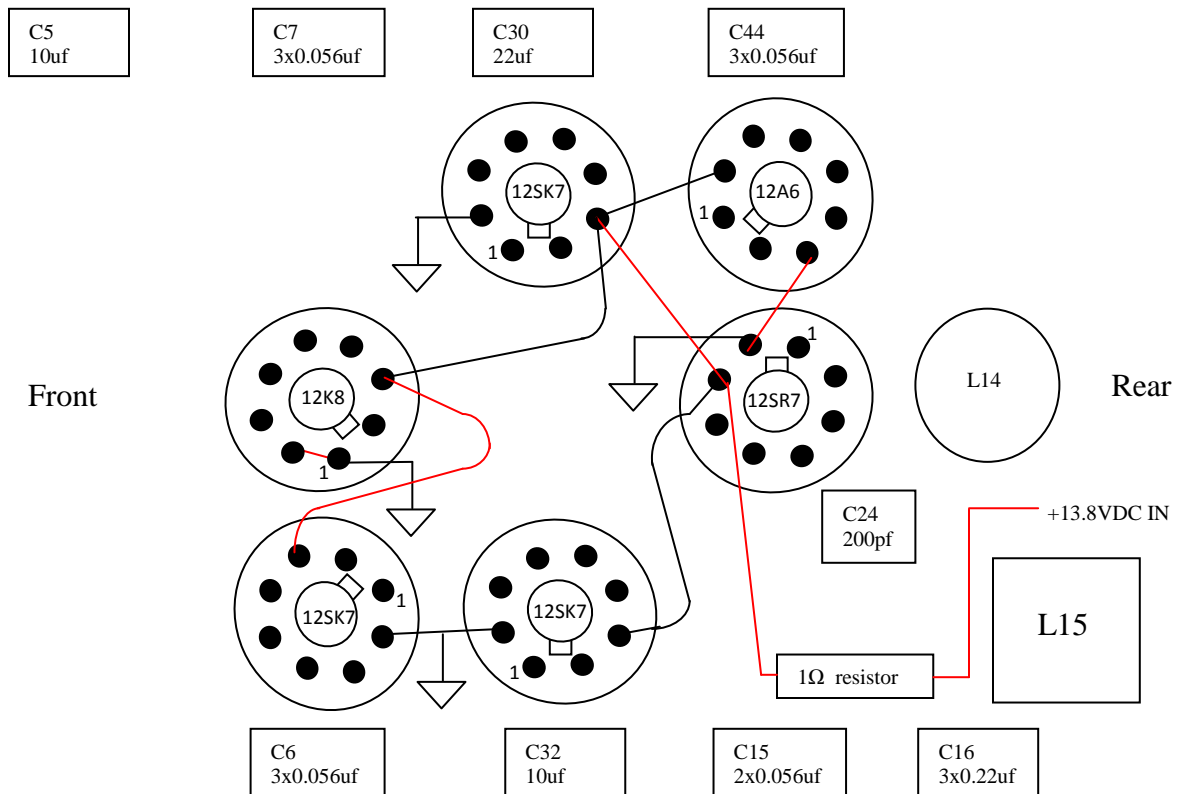


Figure 2: Component placements and filament wiring

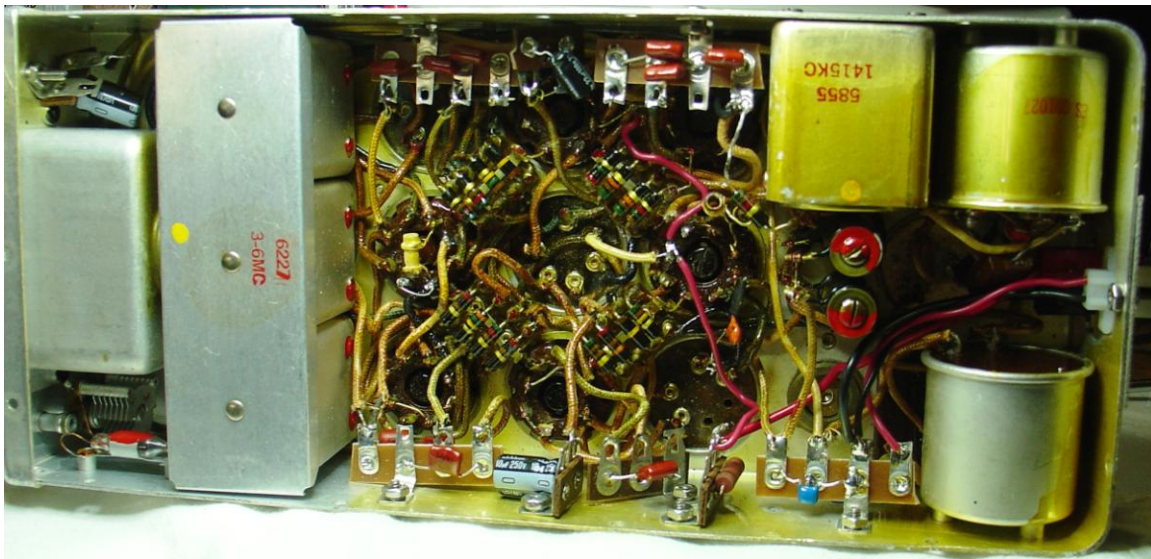


Figure 3: Bottom view of the re-wired and re-capped receiver

I used a Powerpole connector for the 13.8VDC filament input, and a 2-pin male Molex connector for the plate voltage input. I replaced the rear multi-pin connector with my own connector mounting bracket built from a 1.8" x 1.2" piece of pc board material and a nibbling tool, and half of a PowerPole mounting bracket (Figure 4).

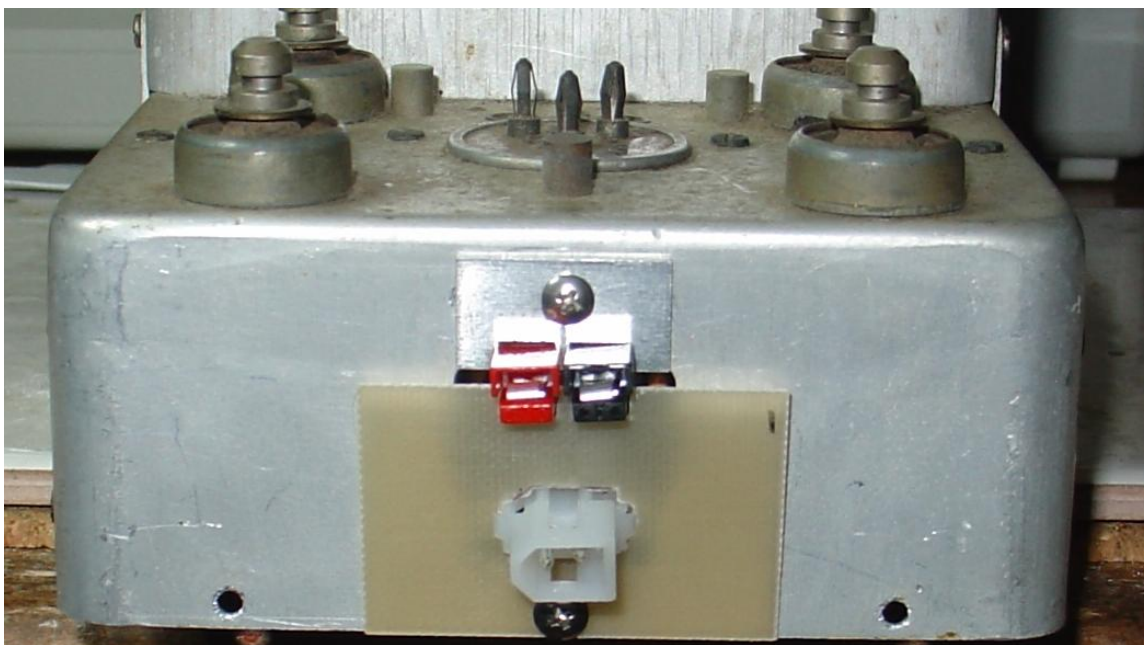


Figure 4: Rear panel filament and HV connector assembly

After adding the DC connector assembly, wire the 1-ohm 3-watt resistor in series with the 13.8VDC input to drop the filament voltage to 12VDC. You can see the resistor in a 2-terminal strip near the bottom middle of Figure 3.

Figures 5 and 6 show the front panel connector and component wiring diagrams. A 50K linear-taper (NOT audio-taper) potentiometer is used for the audio gain. A 1000:8 ohm audio transformer more closely matches the ARC-5 audio output to modern headphones. Figure 7 shows the internal wiring. The transformer is hot-glued to the panel, and also held in place by some of the wiring. I tinned the ARC-5 connector pins and then just lap-soldered the wires from the front panel controls to the connector pins. Figure 8 shows the headphone jack, potentiometer and BFO switch mounted on the front panel.

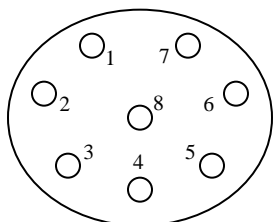


Figure 5: Front Panel Connector
(Viewed from front)

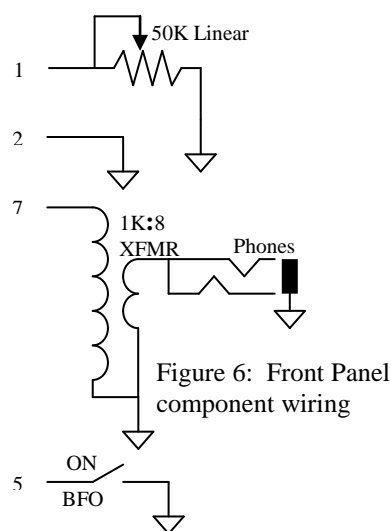


Figure 6: Front Panel
component wiring

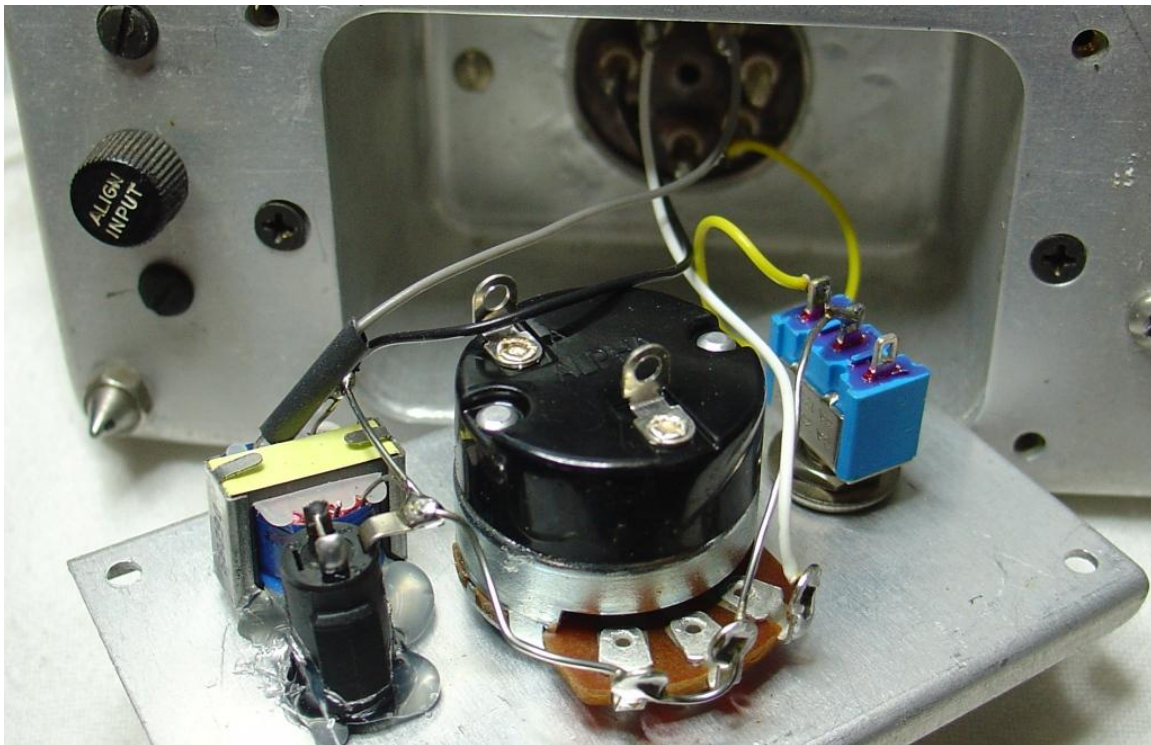


Figure 7: Internal front-panel wiring



Figure 8: Front Panel Controls

For the plate supply I used the full-wave rectified output of a 13.8VDC/120VAC inverter (Figure 9). Any inexpensive inverter can be used do to the low plate current requirement (check 120VAC inverters on eBay). You can either build the rectifier circuitry directly

into the inverter, or use an external rectifier assembly. Besides being easy to build, this inverter also provides isolation from the AC line!

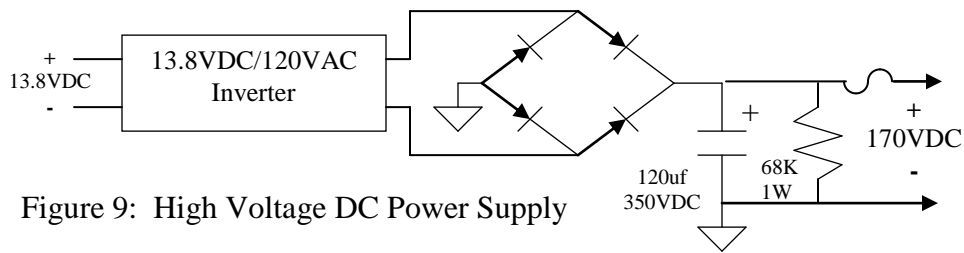


Figure 9: High Voltage DC Power Supply

Tuning Shaft

A final problem with these receivers is the recessed 1/4"-splined tuning shaft which requires a special knob. These knobs are hard to find, and are expensive if you do find one. My BC-454 receiver had the special tuning knob but the BC-455 didn't. So I built a very effective shaft adapter/extension that is easy to reproduce. All you need is a short piece of 3/16" ID plastic tubing, a 1/4" OD aluminum rod, and a 3/8NPT brass cap from your local hardware store. Figure 10 shows the individual shaft parts before assembly (top), the final shaft adapter (bottom left), the drilled 3/8NPT cap (bottom right), and the hard-to-find ARC-5 tuning knob (left).



Figure 10: Shaft Adapter (bottom left)

To make the shaft adapter, mix up a small dab of 2-part epoxy and lightly coat the first 0.2" of one end of the 1/4" rod. Force the 3/16" ID plastic tubing over this end of the 1/4"

rod so it overlaps 0.2" of the aluminum rod. When the epoxy has cured, cut the tubing and aluminum rod as shown in Figure 11.

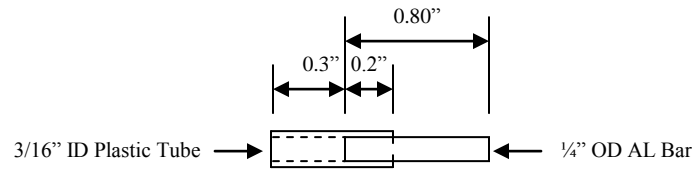


Figure 11: Shaft Adapter/Extension

Now align the open end of the plastic tube with the splined shaft and push the new shaft adapter into place. This takes a little effort at first, and then it almost snaps in place. Put a knob on the shaft and verify that tuning works well. Next, pull the shaft adapter/extension off the radio and put just a *small* amount of epoxy into the open end of the plastic tubing with a toothpick. Then push the shaft adapter/extension back over the splined tuning shaft. To help support the shaft, I used a 3/8NPT brass plumbing cap with a 1/4" shaft clearance hole drilled in the center. As the 3/8NPT brass cap is slightly larger than the ARC-5 shaft collar, wrap a few turns of black electrical tape over the shaft collar. Now you can screw the brass cap over the shaft adapter and the radio shaft collar. Figure 12 shows the new shaft adapter in place.



Figure 12: Shaft Adapter in place

The knob I used is an Eagle 1.75" diameter "spinner" tuning knob available from Mouser Electronics (part number 450-1755). Figure 13 shows the front of my BC-455 receiver with the new knob on the shaft adapter.



Figure 13: New tuning knob in place on author's BC-455

Conclusion

Re-building an ARC-5 receiver is one of the easier boat anchor restorations you can take on. Because so many of these receivers were built during WWII, they are still available on on-line auction sites at reasonable prices. When finished, you will wind up with a sensitive receiver that is both an interesting topic of discussion, as well as a nostalgic trip back to our youth (for some of us).

Table 1 – Components needed for ARC-5 conversion and powering

<u>QTY</u>	<u>Description</u>	<u>Mouser Part Number</u>
1	Molex 2-pin recept.	538-03-06-1022
2	Molex 0.062 sockets	538-02-06-1103
1	Molex 2-pin plug	538-03-06-2024
2	Molex 0.062 pins	538-02-06-2103
1	68K 1-watt resistor	594-5073NW-68K00J\$0.16
1	0.375A in-line fuse	576-0251.375MXL
12	0.056uf 250V caps	5989-250V.056-F
1	22uf 100V cap.	647-UVR2A220MED\$0.30
2	10uf 250V caps.	647-UVR2E100MPD \$0.39
1	200pf 1KV capacitor	75-562R10TST20
1	50K linear pot	313-2000F-50K
1	1 ohm 3-watt resistor	594-5093NW-1R000J
1	8/1000 ohm xfmr	42TL013-RC

10	Terminal Strip	158-1005
1	120uf/350V cap.	661-EKXJ351ELL121MLP
1	Bridge rectifier	625-W04G-E4
3	0.22uf 250	810-FK20X7R2E224K
1	1/8" stereo jack	161-3402-E
1	SPDT switch	108-1MS1T2B3M1QE-EVX
1 set	PowerPole™ mounting bracket	879-1462G1
2	Black PowerPole™ connector & contact	879-1330G4
2	Red PowerPole™ connector & contact	879-1330
1	13.8V/120V inverter	eBay