SSB and the Phasing Exciter

Hints and Kinks for Best Performance and Being Nice to One’s Neighbor’s

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How is SSB Generated?

Brute Force v. Elegance

One way is to design a steep-sided bandpass filter that passes one sideband and hugely attenuates the other.

Or

We can use a mathematical analog of phase relationships to cancel the unwanted sideband and reinforce the desired sideband.

A Tug or War in the 1950s

Steep-sided filters was expensive in the 1940-early 50s. Required carefully selected and ground individual crystals or expert machining of temperature-stable materials for a *mechanical* filter.

Or

Audio filters having linear phase shift made with inexpensive Rs and Cs.

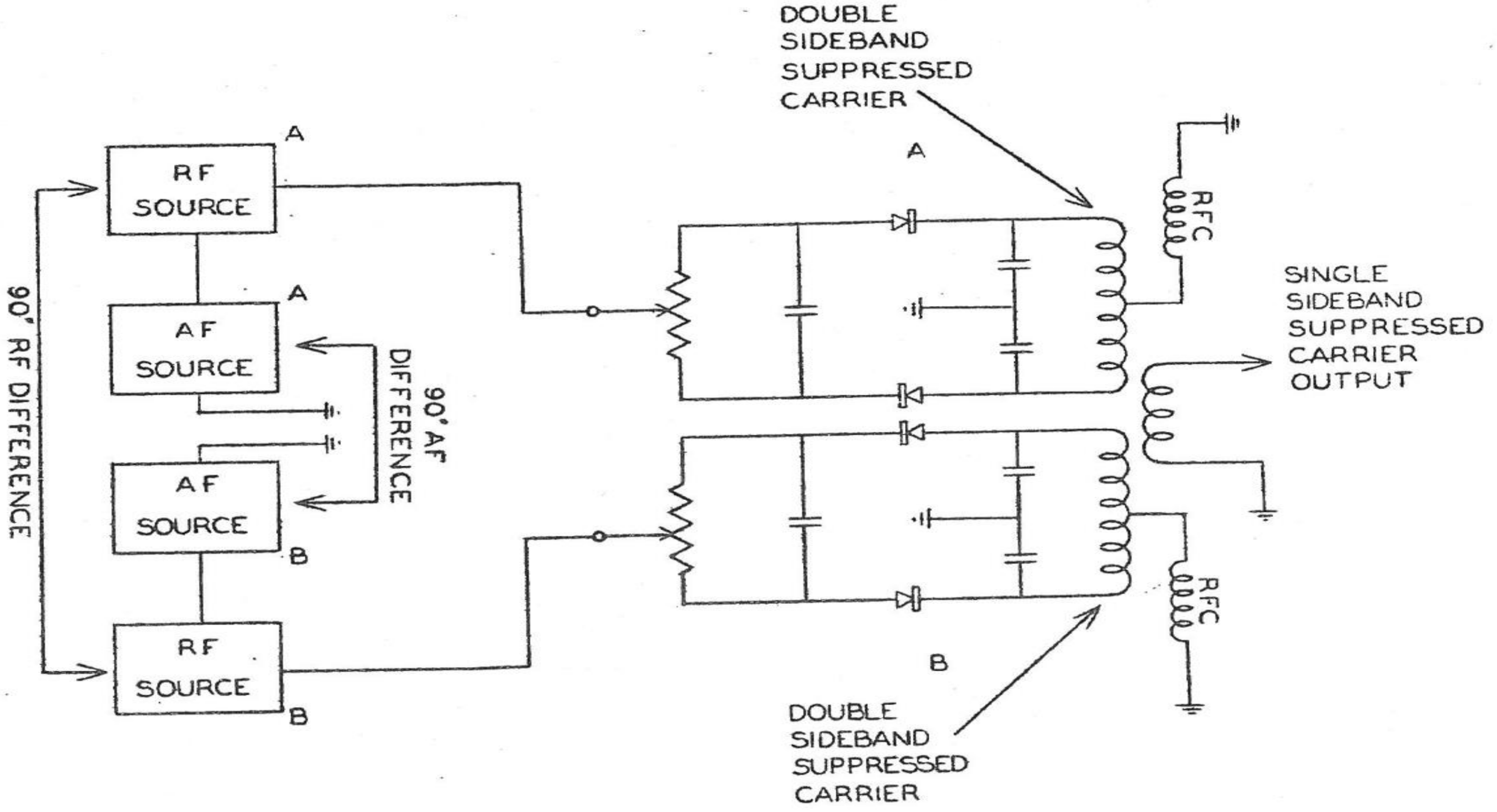
In Amateur Circles, Phasing Led the Way

Don Norgaard really got the Amateur Ball rolling with his SSB, Jr. published in GE HAM News. *(Refer to George W1LSB's SSB discussion at last year's W9DYV Event and CE website).*

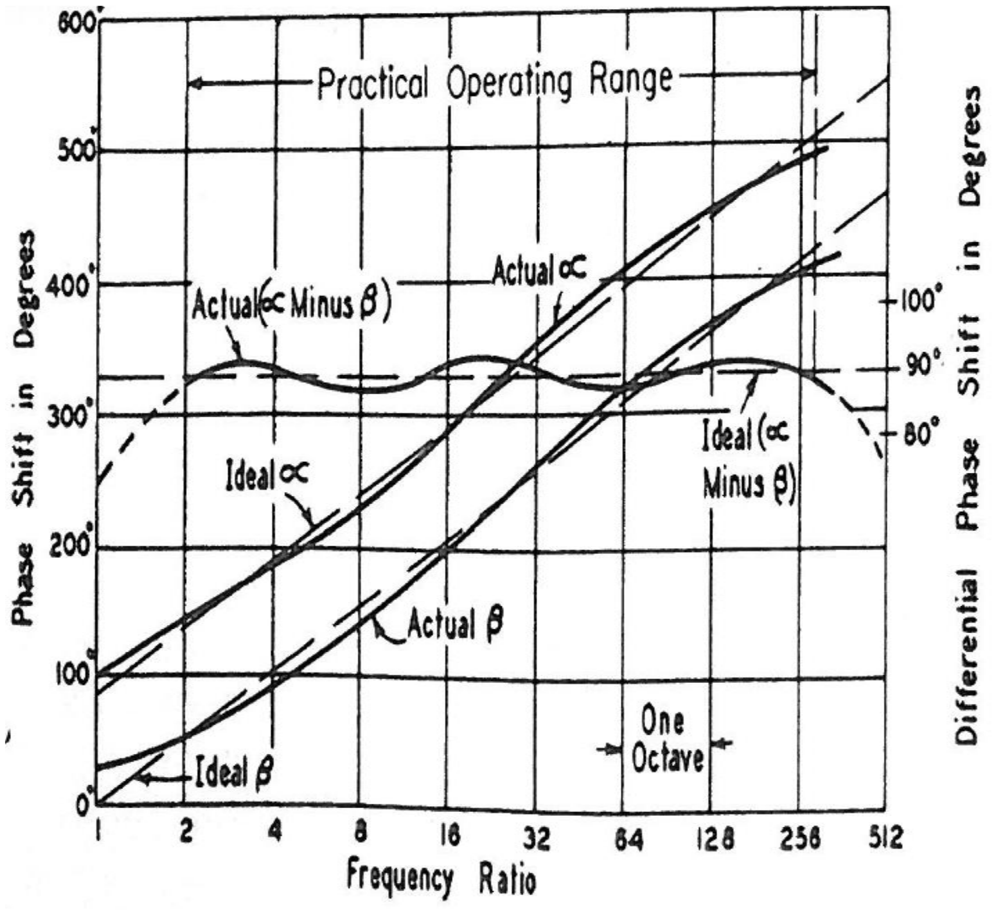
Companies such as CE, Lakeshore Industries, Eldico, Johnson, Hallicrafters, Heathkit, B&W and others produced exciters using the Phasing Principal.

By the late 1950s, filter technology improved and costs dropped, pushing Phasing aside…at least until the Software Defined Radio came along…

Basic Phasing SSB Exciter



Audio Phase Shift Linearity is Key to SB Suppression

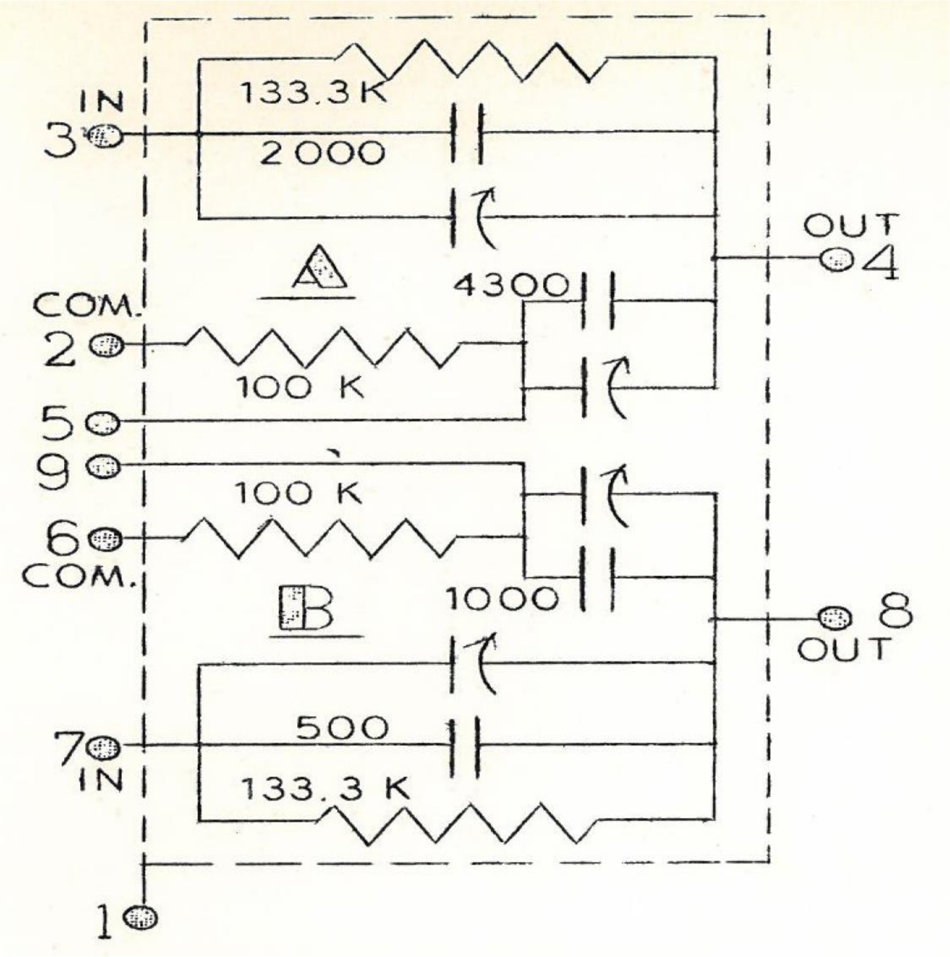


The AF Phase Shifter must maintain 90° differential across 300-3500Hz audio band.

Small deviations result in degraded SB suppression i.e., a 2° difference = 35db suppression.

Typical CE 10A/20A based on the Norgaard design = 40db *if perfect!*

Central Electronics PS-1 Network

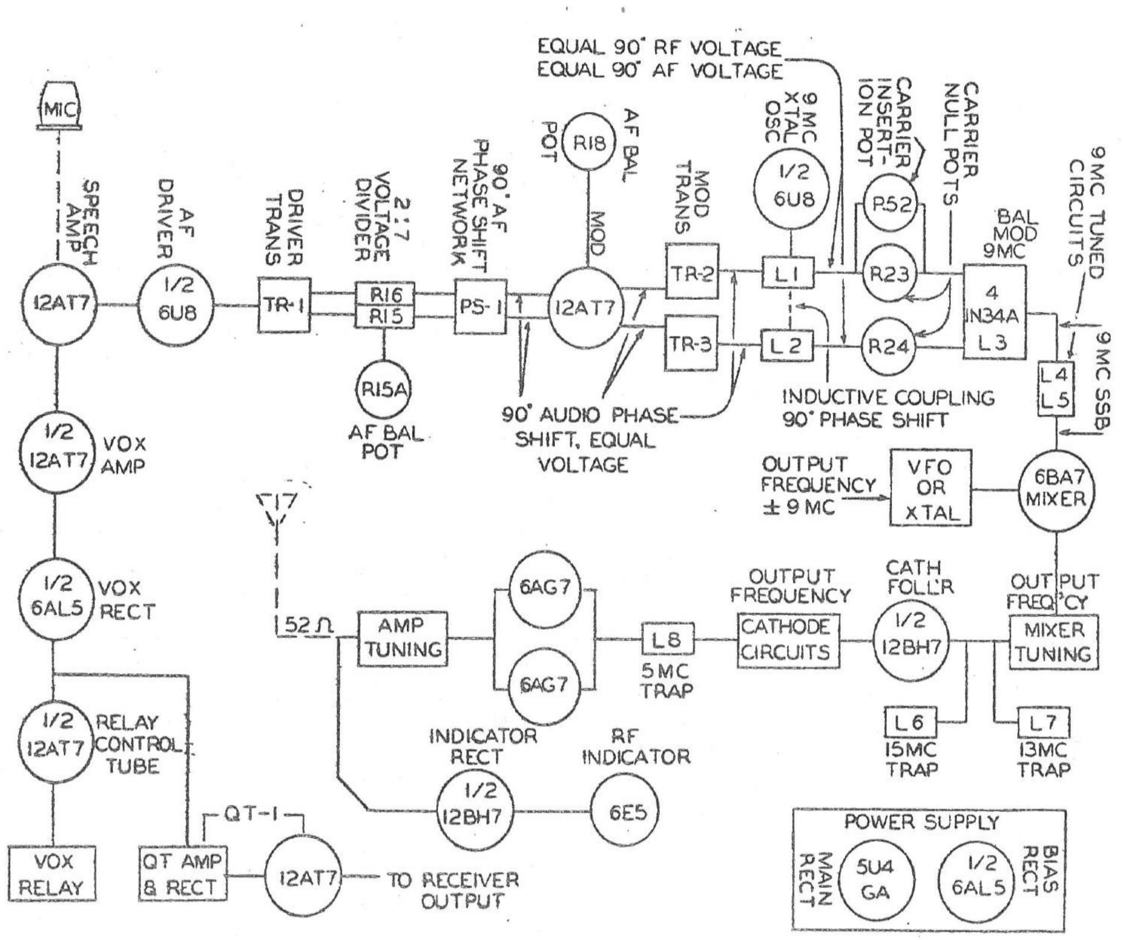


Based on Norgaard's SSB, Jr design. These are termed all-pass networks.

Phase differential is held within 1.3° over range of 225-2750Hz.

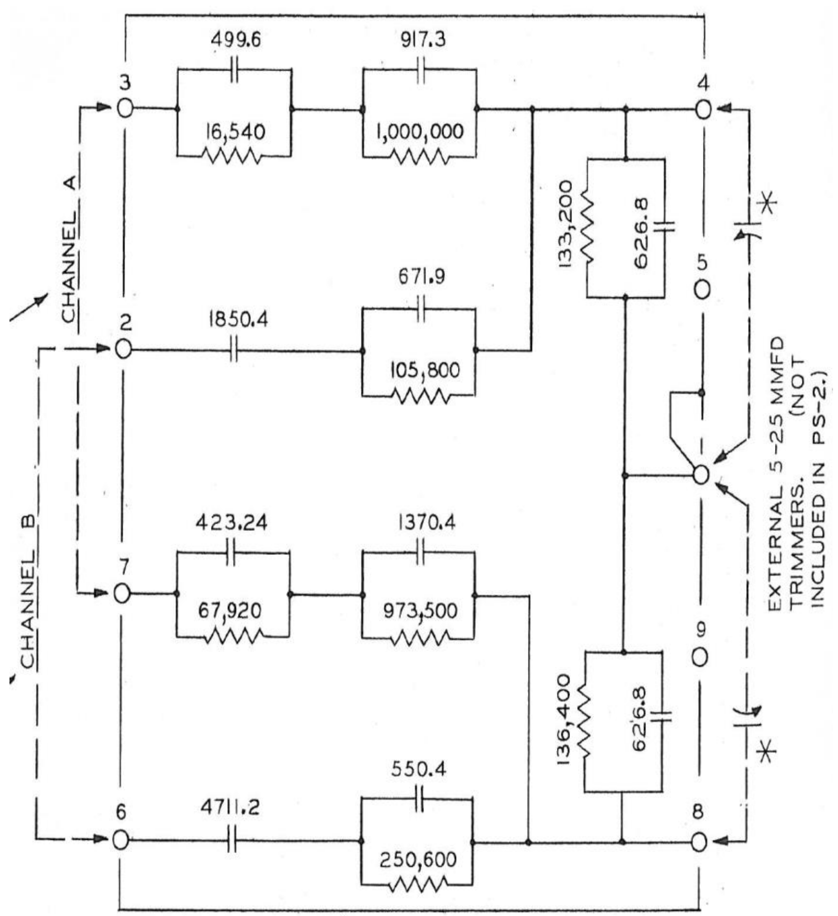
Outputs are equal in level, however the two channels have different insertion loss (2/7 ratio).

Central Electronics 20A Block Diagram



- Note 2:7 voltage ratio to PS-2, reason for AF Ratio Pot R15A.
- And AF Balance Pot R18, needed to insure levels to Bal Mod are exactly equal.
- The setting and physical location of L1/L2 determine the 90° RF phase shift.
- Spurious improvement added with 12BH7 cathode follower and on-freq tuned circuits.

Improved Central Electronics PS-2 Network



Designed in mid-1955 by two research students at Stanford University. Refined by RCA's Stu Seeley (Foster-Seeley Discriminator fame!)

Frequency range of 240-3460Hz.

Phase differential is within 0.15° which yields better than 60db of suppression.

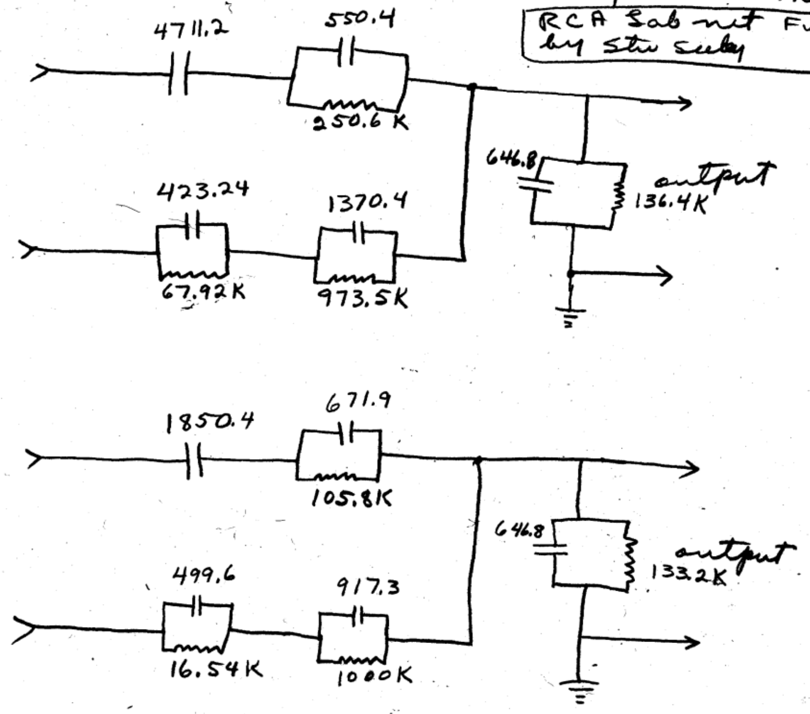
Parts were netted within +0/-0.2% tolerance.

Insertion loss = 18db per channel, but in/out levels are equal.

A Note From Joe Batchelor on the PS-2

Freq range 241~ to 3460~ (approx 60DB suppression)
network loss 18.85DB max Dev. from 90° — 0.153°

RCA Sab net Furnished by Stu Seeley



Components ±.1%
output capacities must be corrected for ckt + tube effects
capacitors also corrected for shunt cap. of Resistors

Stu says a big disadvantage is the large loss. The other net (weaver, Villard - Stanford) has much less loss (abt 10DB).
This may increase of course when corrected in such a manner that it works —

Joe Batchelor (CE)

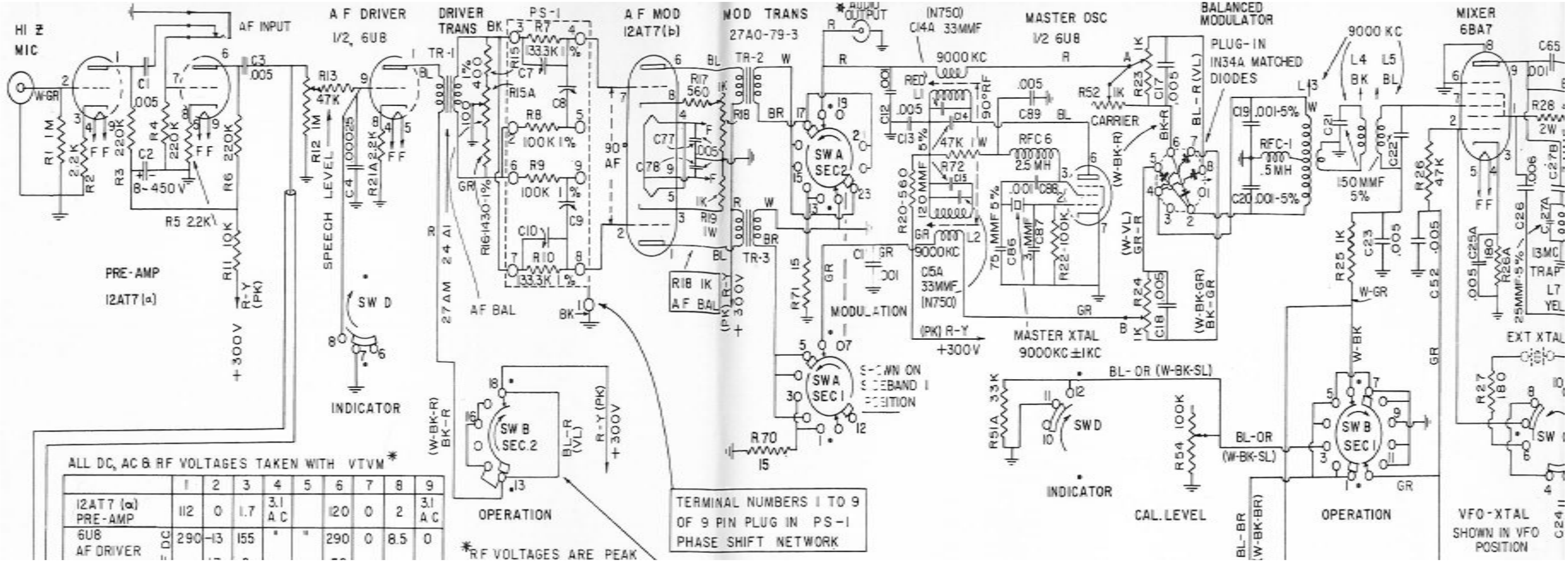
How Were These Networks Tuned??

The PS-1 networks had fix capacitors bridged with small ceramic trimmers. The networks were individually tuned with 2/7 ratio audio levels applied. Channel A was connected to the vertical amplifier channel of an oscilloscope. Channel B was connected to the horizontal channel.

Since the two output signals are of equal level, the resultant image on the CRT is a circle.

Techs would tune these using a specialized test set/scope and dab the tuned trimmers with paint. The alignment has held all these years!

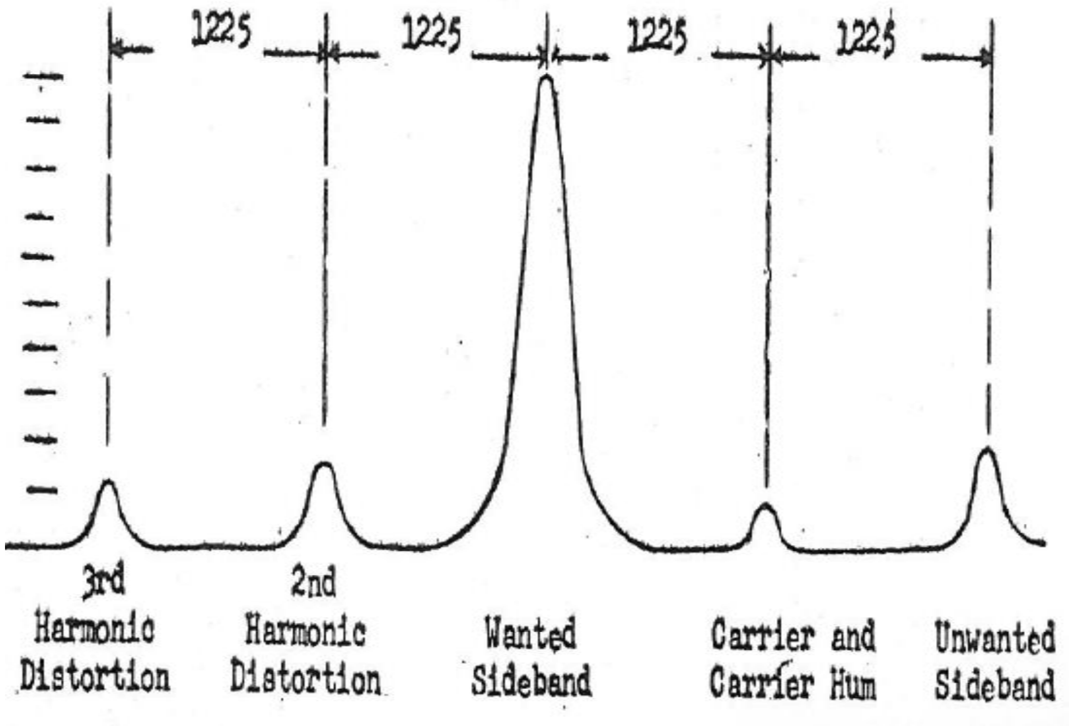
Central Electronics Sideband Generator Stages



One Design Problem: Lack of LP Filter in Speech Preamp. Needed to prevent splatter beyond the PS-1's functional bandpass. Add series RC shunts or passive/active filter if a linear amp is used.

CE 10/20A Phasing Rig Suppression Goals

Goal: Get Unwanted SB to -40db



What to Look Out For

- Use a low-distortion audio generator – less than 0.5%
- **Do not** overdrive the 6AG7 PA. Output level must be below PEP rating of exciter.
- Adjust AF pots first for best suppression and then RF 90° Phase Shifter, L1/L2, a bit at a time.
- Make sure to touch up Carrier Balance.
- All of these adjustments interact, so proceed slowly.

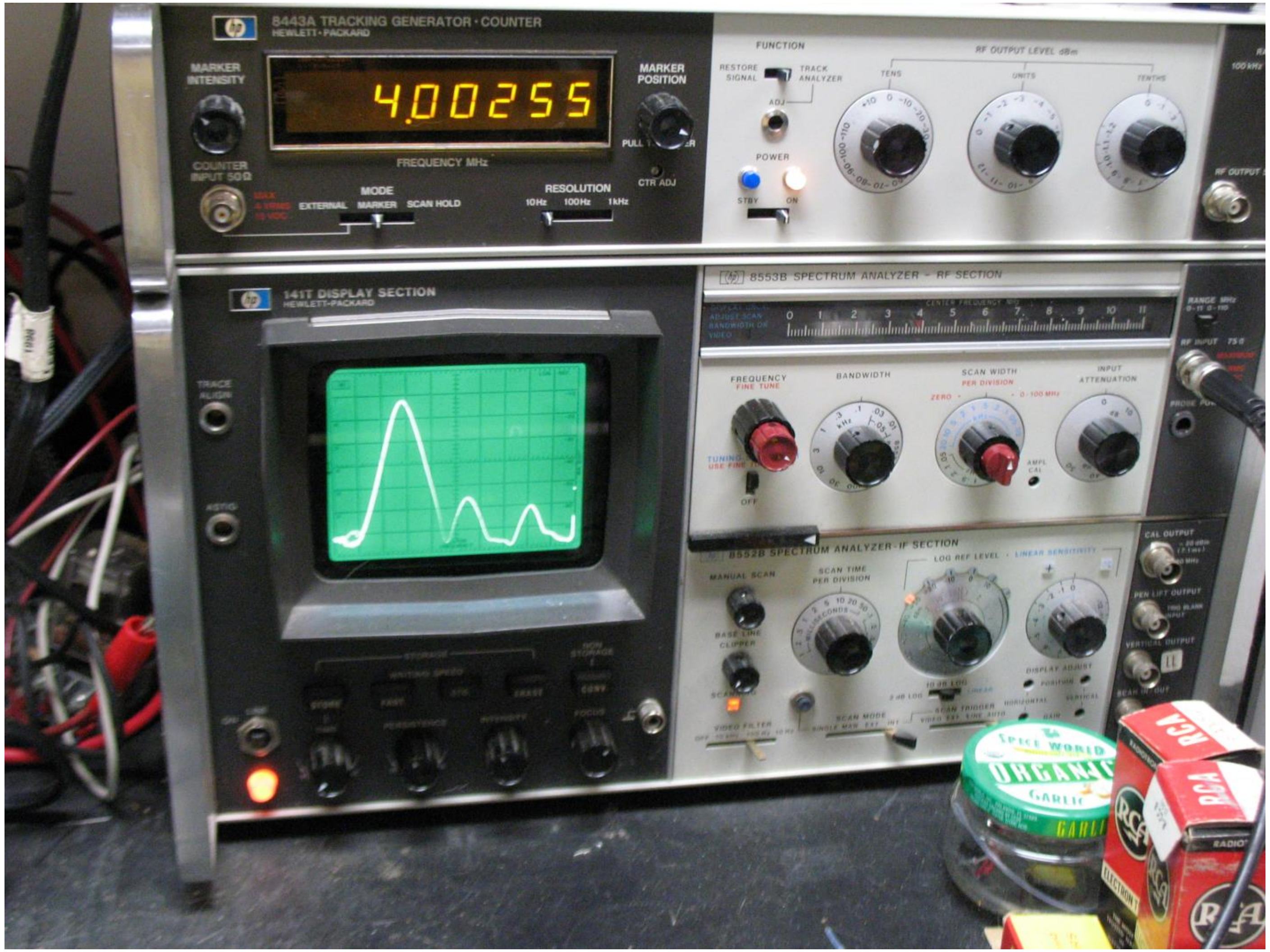
How to Observe Suppression While Aligning

Best way Today is with a spectrum analyzer. Set the selectivity to observe each component, with the display centered on the carrier. This way, as adjustments are made you can immediately see the result on the undesired sideband.

Make sure to switch between SB1 and SB2 frequently … otherwise you may find great suppression on one setting and poor suppression on the other. Remember: these amplitude and phase settings interact.

Or, you can use a good communications receiver as a selective voltmeter, however, this requires constant switching between SB1/SB2 and a vigilant eye on the S-meter!

Typical SSB Alignment Using Spectrum Analyzer



The Old Way of Adjusting a Phasing Rig

In the early 1950's spectrum analyzers were out of the range of Hams and the receivers of the Day often lacked the selectivity needed to adjust for proper sideband suppression...to full effect of the system.

But, if one views the exciter output on a monitor oscilloscope (such as a CE MM-1 or MM-2) and if a single audio tone is presented to the AF input, then when properly adjusted the 'scope should display a solid, steady stripe…a "carrier".

When the SB suppression is poor, there will be noticeable ripple on the stripe. The object then is to twist all four adjustments until the stripe is steady and clean (smallest ripple content).

Good Luck!!

Good Practices to Adhere to First!

Basic Exciter Integrity Tests

- If your set has its original electrolytic capacitors, change them NOW!
- Test all tubes and replace as needed.
- Do Not replace the RCA 6AG7 with GE tubes…unless you like smoke.

Basic Test Equipment Considerations

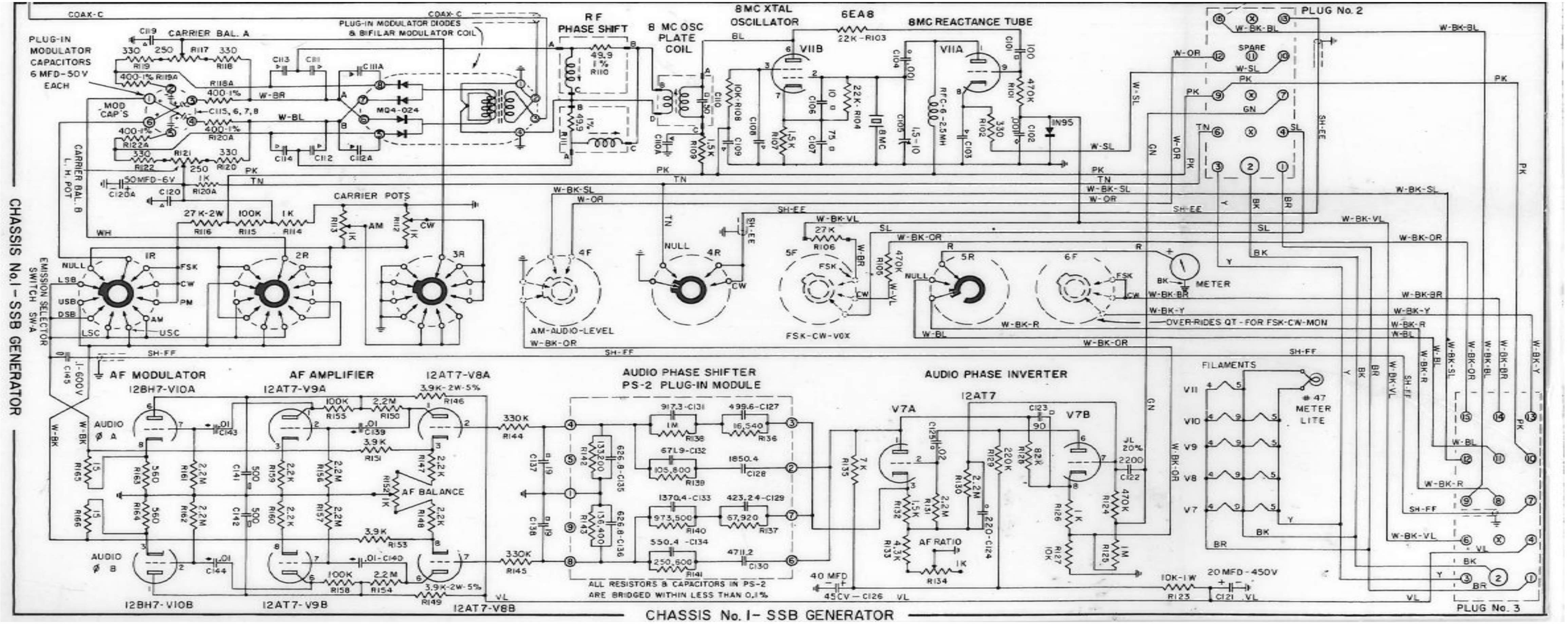
- Set the audio generator to the PS1 (PS2) center frequency and do not change.
- Use good test leads…much time is lost chasing “ghost” problems otherwise.
- Consider high-quality *older* gear. Its quality is excellent and the cost can’t be beat. H-P, Gen-Radio or Tektronix is what you want.

What About the CE-100/200V?

- The Carrier Phase Shifter is superior and its adjustment is smoother than in the CE10/20A, which were early-generation rigs.
- The PS2 network can degrade due to silver migration in the mica capacitors. Fortunately this involves just two capacitors C-128 & 130.
- The AF system incorporates 40db of inverse feedback to minimize post-phasing distortion. Left unchecked, the apparent SB suppression could degrade over time as preceding AF stage tubes aged.

Prior to the availability of true software-defined radios, the CE 100/200V was the best phasing exciter available in the amateur market and has the audio characteristics of Today's modern rigs.

Central Electronics 100V SSB Generator



While more sophisticated, the 100V likewise has AF Ratio, AF Balance and two RF Phase Shift Adjustments

What About Audio Filtering in the CE-100/200V?

Remember the problem with early phasing rigs and their lack of a good low-pass filter to prevent far-adjacent channel splatter?? Wes and Joe Batchelor solved that with the addition of an *active* bandpass filter- a first within an amateur radio transmitter!

This filter used a single 6U8 triode/pentode and multiple Bridged-T RC peaking and notching sections. The result was a 300-3500Hz bandpass filter that is flat in its passband and nearly -50db down at 5KHz.

Not bad stuff for a 1956 design!

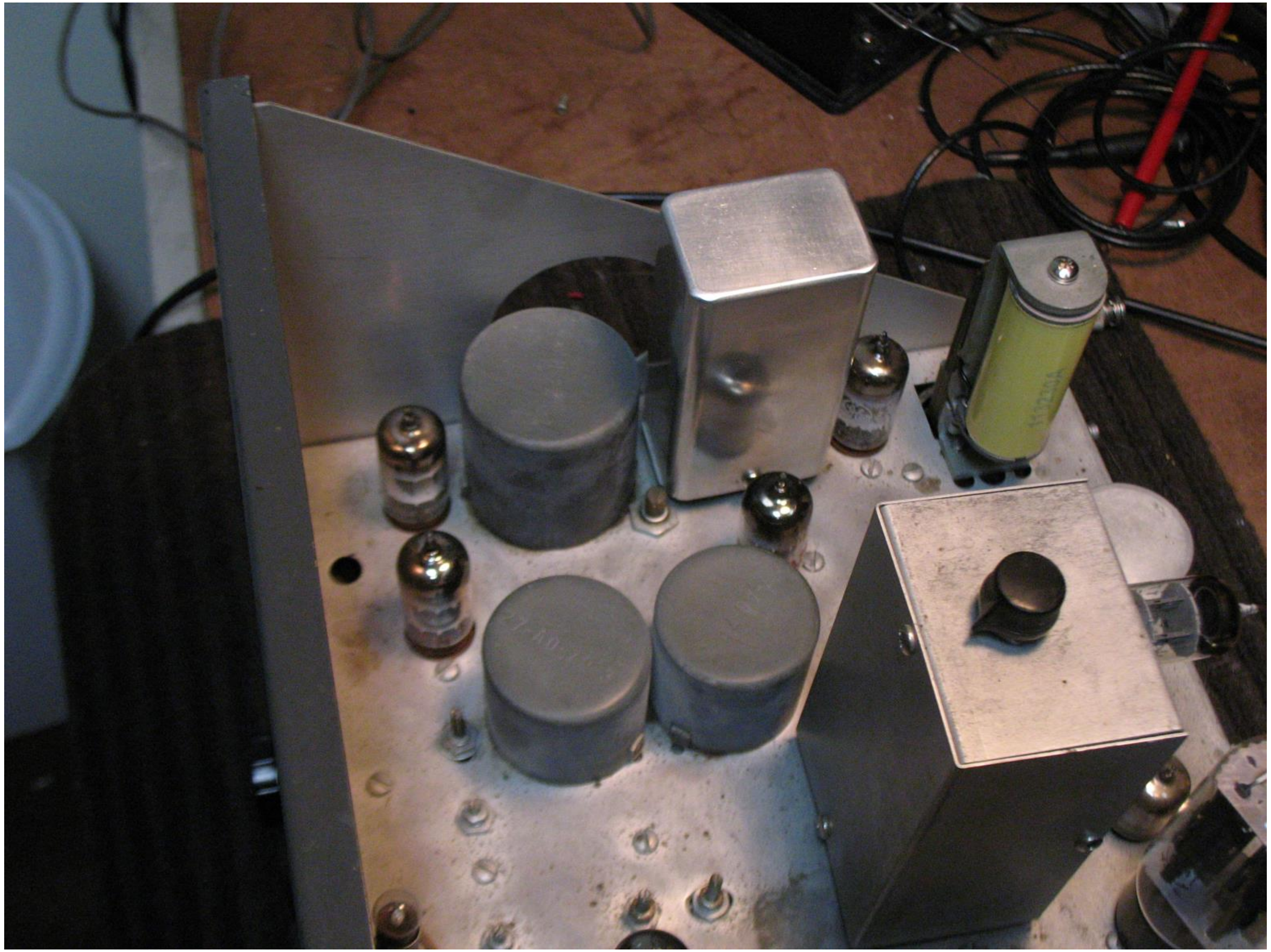
Want to "Soup Up" a 20A??

First, install the PS-2 phase shift network. Just requires changing R15 and R16 to 1,400-ohms 1% tolerance and re-alignment.

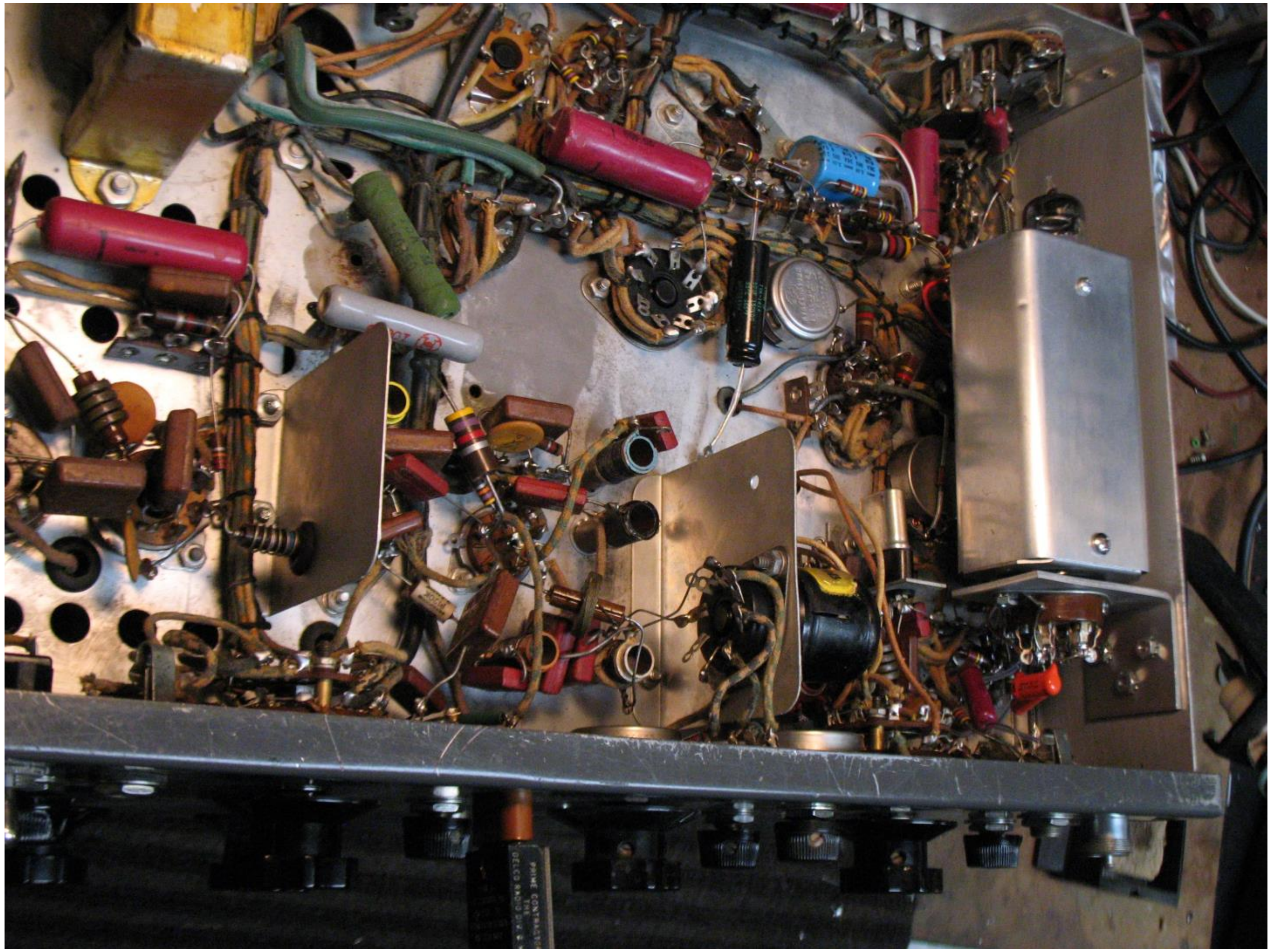
To add a final "Cherry to the Sundae", also install the CE-100V active audio bandpass filter or a design of your own.

My test 20A with both installed exhibits a consistent 50db of sideband suppression. Pretty respectable…

CE-20A with PS-2 Installed



20A with 100V Active Audio Filter Installed



Questions Anyone??