

Restoring a 'Breting 12' Communications Receiver – Gerry O'Hara

My first encounter with a Breting receiver was a 'Breting 14AX' (see article [here](#) and photo, below left). Three years later, the owner of that set, a serious collector of vintage communications receivers, provided me with a 'Breting 12' to restore. This set had been procured by its current owner at a local ham radio flea market from a fellow radio ham, but beyond that its provenance is unknown. When



it arrived it appeared to be in reasonably good

physical shape (photo, below), however, a number of other projects had to be completed prior to checking it out and it remained in the 'waiting room' (garage) before finally arriving on the workbench several months later. However, I was in for a bit of a disappointment...



The 'Breting 12'

The Western Historic Radio Museum's website, [Radio Boulevard](#), on their page "Pre-WWII Ham Gear Part 1" includes the following introduction to its write-up of the Breting 12 receiver:

"Paul J. Breting started selling communications receivers in 1935. Breting Radio Manufacturing didn't have the necessary

RCA Superheterodyne license so their receivers were assembled at the exclusive "RCA licensed" Gilfillan plant in Los Angeles, California with Breting operating as a "sub-contractor" protected by Gilfillan's license. Breting was able to take advantage of Gilfillan's production processes, stock inventory and tooling while building his receivers. Ray Gudie, who was famous for the Patterson PR-10 [receiver] design, was Breting's chief engineer. Gudie came over to Breting after a wage dispute with Emmitt Patterson. Gudie felt the success of the Patterson PR-10 should have warranted him a salary increase. The PR-10 was quite a popular communications receiver that sold very well but Patterson disagreed that it warranted a pay raise for Gudie. Patterson's disagreeable manner in the matter caused Gudie to resign and go to work for Paul Breting (both Patterson and Breting were located at the Gilfillan plant, so Gudie didn't have to go very far to be hired by Breting,.. probably just across the hall). The Breting 12 was Gudie's first major



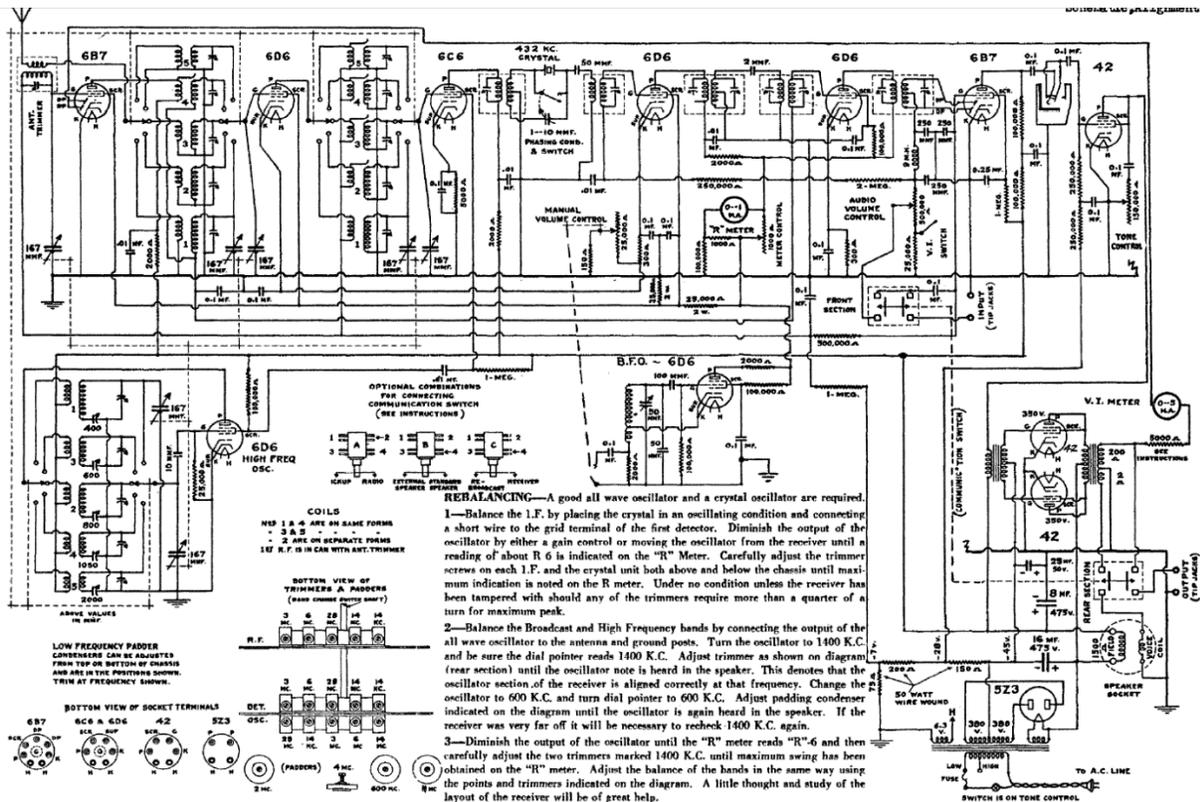
design for Breting and it was introduced in 1935. The advertising hype for the Breting 12 used the impressive description "Scientifically Correct D-X Radio" but exactly what that meant is vague. The list pricing for the Breting 12 shows several options. The receiver chassis without cabinet, meters or crystal (this meant the entire crystal filter unit, not just the crystal for it) was \$135. The crystal (filter) could be added but not the meters for just the chassis with no cabinet for \$145. The cabinet version could be purchased without the crystal (filter) for \$145. The complete receiver listed for \$155 but if the purchaser was a ham or experimenter a 40% discount was offered that reduced the cash sale price for the complete receiver to only \$93. Most dealers seemed to offer the complete Breting 12 for about the same discounted price with perhaps a slight markup but still less than \$100. All options included a 12" speaker and all of the vacuum tubes. Prices are from the Breting 12 sales brochure and old QST magazines."

"Breting offered five communications receivers during their manufacturing history, the Breting 6 (really a SWL receiver,) the Breting 9, the 12, the 14 [and 14AX], and the 40. Breting may have offered some entertainment-type radios but the documentation of this is non-existent and the authenticity of the scant number of examples is questionable. Breting went out of business in 1940."

Circuit and Construction

Circuit

At first glance the Breting 12 follows a typical communications receiver topology for the mid-1930's – see schematic below (also see the full-size schematics, one with several errors corrected, in the Appendix), with two stages of RF amplification (6B7, 6D6), mixer (6C6), local oscillator (6D6), a crystal



filter followed by two stages of IF amplification (2 x 6D6), BFO (6D6), detector/1st AF amplifier (6B7), AF driver (#42), push-pull output (2 x #42) and rectifier (5Z3). However, closer examination identifies several more unusual features:

- The 1st RF amplifier stage (pentode section of a 6B7) is switched into circuit only on Band 4 (7.0MHz to 15MHz), allowing the pre-amp to function on the 40M and 20M ham bands - the designer, Gudie, believed these two ham bands would benefit most from the pre-amp. This arrangement greatly simplified the band switching arrangement;
- The Antenna Trimmer is a pre-set trimmer, and is only connected into the circuit when Band 4 was selected and was a 'set and forget' adjustment that assumed that the ham operator would be using either the 40M or 20M band, but not both;
- A 'Volume Indicator' (V.I.) meter option was available for use with a switchable pre-set level of audio gain. This provided a meter indication of relative signal strength for CW signals since the 'R-Meter'¹ indication was inactive in the Breting 12 circuit when using Manual Gain (RF/IF gain). In addition, if the receiver is operated with AGC and with the AF Gain control somewhat advanced, and a strong AM signal tuned in, then the R-meter will indicate relative signal strength and the V.I. meter will move with the audio signal from the AF output stage. Also, if the audio amplifier section was being used as a speech amplifier, eg. to modulate an AM transmitter, then the AF Gain control position would determine the transmitter modulation level, and the V.I. meter readings would show relative speech levels. The diodes in the 1st RF amplifier stage tube (6B7 dual-diode pentode) acted as rectifiers for the V.I. meter (when fitted²);
- The audio section, using a #42 tube driver tube and push-pull #42 tubes in the output stage (all triode-connected) was really unnecessary in a communications receiver that would most likely be used with headphones output by 'serious' hams. The intention was that this amplifier could also be used to voice or tone modulate an (AM) transmitter;
- Audio input and output connections ('pin jacks') were provided on the rear apron of the chassis that linked to a 'Communications Switch'³ on the front panel. This allowed the audio output to be routed to the speaker or to the rear apron AF output connections, eg. to modulate a transmitter, and/or the audio input to the audio stages of the receiver to be from the receiver detector stage or from the rear apron AF input connections, eg. for microphone or phono input;
- Very loose coupling between back to back 2nd and 3rd IF transformers to enhance selectivity (at the expense of some gain);
- The AGC cannot be switched 'off' - instead, rotating the Manual Gain control (RF/IF gain) from fully clockwise will actuate a switch that only activates the BFO and further rotation counter-clockwise reduces the overall sensitivity of the receiver by lowering the RF/IF gain. By reducing



¹ Breting and some other communications receiver manufacturers of the era used the term 'R-Meter' ('R' = Reception strength) in place of the more usual 'S-Meter' ('S'=Signal strength)

² The Breting 12 was available with several options: the receiver chassis without cabinet, meters or crystal (this meant the entire crystal filter unit, not just the crystal for it). The crystal (filter) could be added later, but not the meters, for just the chassis option with no cabinet. The cabinet version could be purchased without the crystal (filter). All options included a 12" speaker and all of the vacuum tubes

³ The 'Communications Switch' concept was incorporated into several other receiver designs made in the Gilfillan factory for receivers designed for the ham radio market – a convenient 'send/receive' switch that could be adapted by the ham to suit the needs of the station

the RF/IF gain, the ratio of received signal versus the BFO injection level allows for optimal CW reception since the AGC action is reduced to the point where it doesn't control the receiver's sensitivity; and

- The nominal IF was 432KHz, rather than the more standard 455KHz, apparently as this was a 'favourite' of the designer, Gudie.

The set covers 550KHz to 32MHz in five bands, and has the following front panel controls (annotated image, right): Tuning, Band Change, AF Gain/switchable fixed AF Gain, RF/IF Gain BFO in/out, crystal in/out-phasing, tone/AC on-off, and the 'Communications Switch'.

Construction

The receiver, including its steel cabinet, weighs

around 60lbs, and the louvered cabinet, front panel and base attach to the chassis separately, these all being in a fine-grained black wrinkle finish. The cabinet and base are attached to the chassis using self-

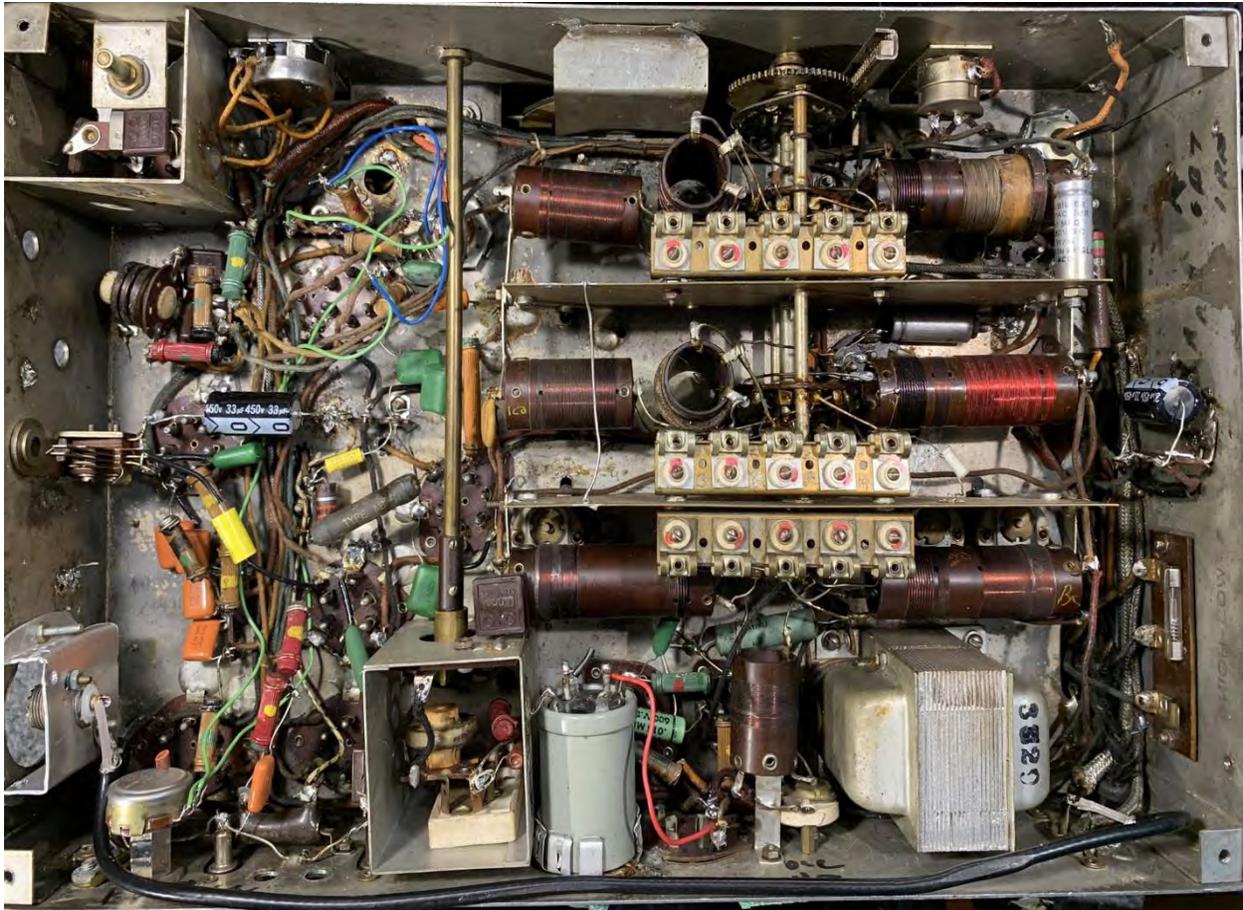


tap screws, and the front panel is held in place by nuts on some of the control shafts. The chassis is chrome-plated steel, and is a little lightweight given that it is not braced internally, allowing a degree of 'flex' when not supported by the base plate and cabinet. The dial, dial escutcheon and meter faces are the real distinguishing features of the receiver, all having a distinct 'art deco' silver-coloured metal styling and lettering. Early models had an 'oak leaves and acorns' pattern in a gold tone on the dial mask, whereas later models, as the one featured in this article, had a vertical 'ray' pattern either side of the '12' in the centre of the dial mask (photo, left).

The band change switch operated a vertical 'guillotine'-style shutter mechanism via a rack and pinion arrangement (photo, left), with the band in use being displayed through a semi-circular slot in the dial mask. An articulated dial lamp that rotates with the tuning gang shaft projects a red translucent triangular dial pointer onto the scale, and the logging scale rotating at a higher speed, is illuminated by a fixed dial lamp.

Preliminary Inspection

I was quite disappointed when I removed the base plate and checked under the chassis – it was a real 'horror show' of someone's (actually, probably several folks') bodged workmanship, comprising many repairs and mods: rats nest wiring, hardly any original passive components – these mostly having been replaced with assorted junk box parts, some of the worst soldering I have ever seen, butchered metalwork, and general filth and mess (photo, below). Indeed, there was not much left of the original electronics save for the transformers, coils, silver mica capacitors, switches and some resistors.

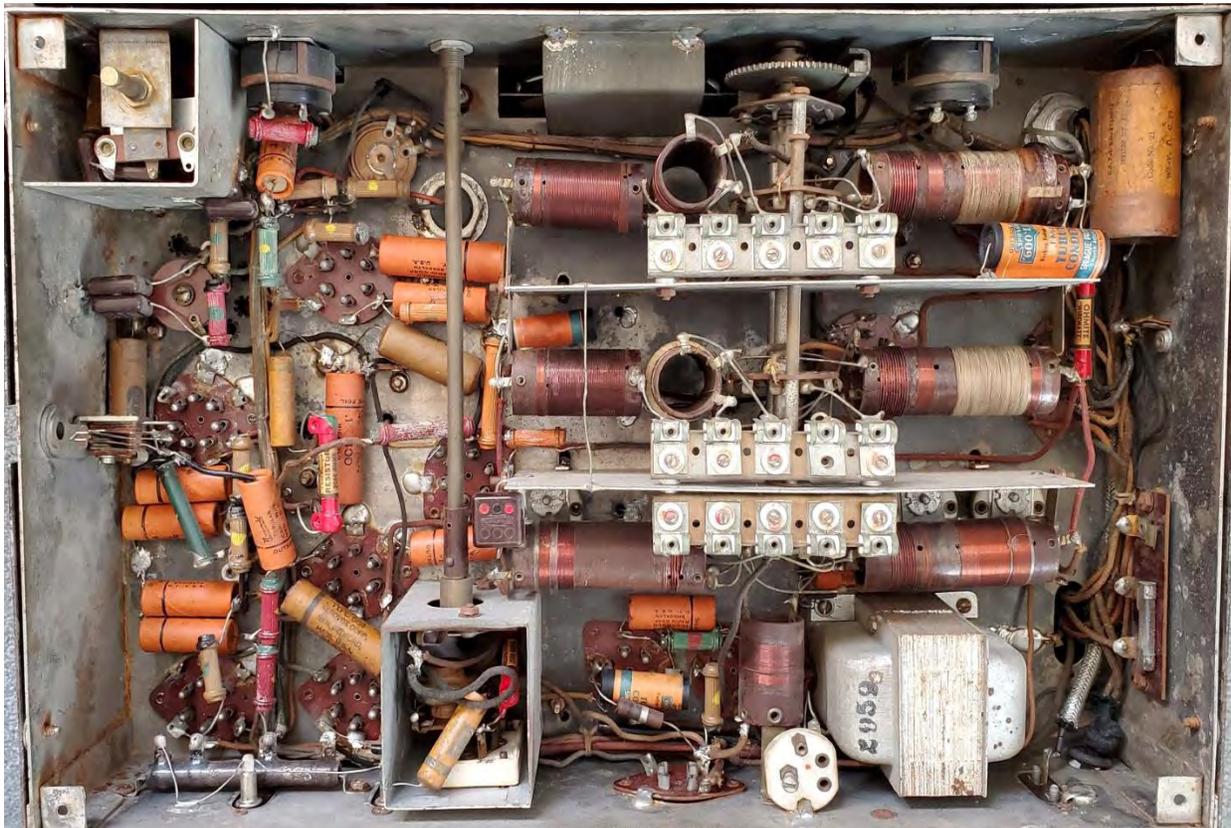


The owner's request was, given the collectability of this set (unusual and fairly scarce, plus its eye-candy art-deco dial), to 'give it the works' regarding refurbishment, ie. re-stuffing capacitors, reproducing resistors, etc. However, as can be seen, there were none of the original capacitors left to re-stuff, and I can only guess at what some of the original resistors looked like, though probably all 'dogbone' types.

Whether I could produce a reasonably faithful replica of the under-chassis or not depended on obtaining a good quality photo(s) of another Breting 12 chassis. So, I put out some 'feelers' for photos of the underside of a relatively 'unmolested' Breting 12 chassis. The next day, one of these paid off and,

courtesy of the [Western Historic Radio Museum](#), I soon had several excellent photos of two Breting 12 chassis in their possession⁴.

The under-chassis photo of the early version (photo, below) showed that it had almost all of its original 'Micamold' brand tubular paper capacitors still fitted, as well as most of the original resistors that were identified as 'Centralab' brand. Photos of the later model Breting 12 showed that it had a few ham-type mods done and several capacitors replaced (it appears that the original capacitors were mostly 'Solar' brand in that receiver).



Chassis Cleaning and Preparatory Work

First, I undertook a preliminary clean-up of the chassis and removal of some modification parts, eg. the SO-239 socket, its bracket and coax cable, and a large can capacitor fitted crudely onto the rear apron. This was followed by some wire tracing and resistor checking. In addition, resistance/continuity checks on the power, audio interstage and output transformers checked out ok - all good news for the set's owner.

I was pleased to see that under all the grime, the chrome finish on the chassis was not in too bad a shape and, with some effort, should look quite presentable. I also noted that many changes to the schematic had been made to this chassis. Next, I spent some time giving the under-chassis a preliminary clean using Q-Tips soaked with naphtha or IPA (photo, top of page 7).

⁴ One early model (mostly original) and one later model (more components replaced).

The band change switch wafers and some of the associated wiring were covered with a thick 'goo' – this could be '3-in-1' oil residue as the gears were also dripping with oil.

I also cleaned the chassis top, the tube shields and tube envelopes. I then tested the tubes on a STARK 9-66 mutual conductance tube tester: they all test good - no shorts and all within their spec. for Gm as follows:



- 6D6's: Gm's of 1750, 1850, 1650, 1550 and 1525 (ok range 1260-2000)
- 6C6: Gm of 1450 (ok range 695-1100)
- 6B7s: Gm's of 950 and 1000 (ok range 630-1100). Both diodes in both test weak. These are used as detector/AGC, in one of the 6B7's and to rectify the audio output for the 'VI Meter' in the other (in the 1st RF amplifier tube), so likely ok
- #42s: Gm's of 2050, 2150 and 2150 (ok range 1260-2000)
- 5Z3: both diodes ok

I then removed some PVC wiring from the chassis and removed the two meters from the front panel - one was almost falling out as its bracket was broken, and both need dismantling and cleaning. Before starting work on the electronics and replacing junk box parts with repro parts, I decided to do some further tidying-up of the chassis. First, I removed several large gobs of solder where components had previously been attached to the chassis using my mighty 'Wall' solder gun, and also removed two 'modern' 33uF 450vw electrolytic capacitors that would not be needed once the above-chassis can capacitors were re-stuffed.

Several surplus holes drilled by someone in the chassis were then plugged: I used JB-Weld to fill the smaller holes in one chassis side and the rear apron, and a plastic disk for the larger (2") diameter hole in the chassis side, held in place with JB-Weld (photo, right). I then gave the JB-Weld and the plastic disk a coat of metallic paint – the



result looks a bit like the areas of the chassis where I removed large gobs of solder – not 'pretty', but much better than gaping holes⁵.

Reproduction Capacitors

Given that none of the original tubular paper capacitors were visible⁶, I decided to make a set of 'Micamold' brand reproduction capacitor bodies, basing this on the photos from the Western Historic Radio Museum. I then mocked-up a few reproduction capacitors using the labels to check fit in the chassis.

According to the schematic (if it is to be believed, even when corrected!), a full set of tubular paper and electrolytics would comprise:

- 5⁷ x 0.01uF (4 x 400vw, 1 x 200vw)
- 16⁸ x 0.1uF (9 x 200vw, 7 x 400vw)
- 1 x 0.25uF (400vw)
- 1 x 16uF (475vw) - can
- 1 x 8uF (475vw) - can
- 1 x 25uF (50vw) - axial

I decided to print black and white labels and colour tint them prior to applying a thin coat of thinned-down amber shellac. A morning was spent 'mass producing' the set of reproduction capacitor bodies: it took just under four hours to reproduce the 21 tubular paper capacitor (all 'Micamold' brand tubular paper), and one axial electrolytic ('Sprague' brand) – photo, right - not too bad at around 10 minutes per capacitor, including painting and lacquering, and extending the leads of the electrolytic.

Next, I re-stuffed the two can electrolytics. At least one of these is a replacement (but likely both), and are of different manufacture (one 'Sangamo' brand and one 'Cornell Dubilier'). One of these, the Cornell Dubilier one, was still wired into the circuit, though the other had its leads cut off and had been replaced with a modern 33uF part. One of these can capacitors, a standard spigot type, has its can grounded, and the other does not, this therefore being a dual flying-lead type.



⁵ See 'Finishing-up' section on page 25 – use of ['Mirror' paint](#) on the filled areas on the chrome side of the chassis

⁶ I did find a couple of original tubular paper capacitors later in the restoration – one inside the crystal filter compartment (a 'Micamold' brand part), and one in the BFO compartment (a 'Solar' brand part)

⁷ A total of 6 x 0.01uF capacitors were eventually installed

⁸ A total of 19 x 0.1uF capacitors were eventually installed

I re-stuffed both can capacitors by hacksawing the can in two around a half-inch from the base (photo, right), removing the guts/cleaning out the can, installing the new capacitor(s)⁹, cutting an approx. 2" length of 'Schedule 40' PVC pipe and using this to joint the two halves together with some glue (but not too much as it may have to be split apart in the future to replace the capacitor - yes, I have had to do that a couple of times!). This sounds time-consuming, but it takes less than an hour per can from start to finish. Once the new capacitor is installed (photo, right, second from top), some aluminum tape is wrapped around the base of the can (across the join), and a label installed over the top as needed (bottom photo, right).



A good tip is not to seal the cans until they have been tried in circuit, or, mock up the circuit using jury-rigged ('bare') capacitors of the same value and voltage rating, or better, a higher voltage rating, to check that the surge voltage in the circuit is not above the working voltage of the parts installed in the cans.



The labels on the photos from the Western Historic Radio Museum were of 'Sprague' branded parts, however, these were both likely service replacements rather than original fitment. I found a scan of a similar type Sprague capacitor, though using a different colour combo, and used this as the basis for the can capacitor labels.



Electronic Refurbishment

Next, I started work on a relatively simple section of the electronics: the RF amplifiers, oscillator and mixer sections, plus part of the power supply. This involved removing a broken (non-original) tag strip that had been soldered to the chassis side, and installing a bolt-in replacement using the original hole in the chassis for this. I also installed a new chassis solder tag to wire-in the reproduction tubular (axial) 25uF electrolytic, again using the original hole in the chassis for the screw. I then replaced four capacitors in the RF amplifier sections and two in the local oscillator and mixer sections of the chassis. There was a 0.02uF capacitor (a replacement) that had been installed from the higher-impedance



⁹ The method of how this is done varies depending on the lead requirements of the part

secondary winding of the output transformer to ground. This capacitor is not marked on the schematic, but noticed that a capacitor was installed in a similar location in the photos from the Western Historic Radio Museum, who confirmed that it should be 0.01uF. This capacitor dampens the response of the V.I. meter

The resistors in these sections of the circuit tested just above the specified 20% tolerance and, the values being non-critical in the circuit, were left in place, except for one 100Kohm part which was open circuit. Rather than reproduce this part, I installed a new 1W 100Kohm resistor underneath the original part - the new part being invisible unless an inspection mirror is used.

Next, I started to work on the 'rats nest' IF/AF section of the chassis (photo, right). First, I spent an hour checking the wiring against the (corrected) schematic, noting several differences, wires that 'went nowhere', missing wires, and some wiring errors, as well as identifying which component in the chassis was which on the schematic - not always straightforward as, when comparing with the photos of the (mostly) original chassis at the Western Historic Radio Museum, they were sometimes located in a different position on each chassis.

I then spent some time checking more resistor values - most had drifted (always the higher-value ones), usually by <30%, but one or two by almost 50%. Again, none of these were critical values, so, for now at least, I decided to leave them in place. I later found another open circuit 100Kohm resistor, and used the same 'ploy' of hiding a new part under the old one.

I then started replacing the motley selection of junk box capacitors with the reproduction parts, checking and tidying the wiring as I progressed, noting several dry joints and a couple that had no solder on them at all - the joints simply pulled apart. There are a couple of capacitors that are hand-drawn onto the schematic, one of which is not present on the Western Historic Radio Museum photos. These were both bypass capacitors located at sensible places in the circuit, so I decided to fit them into this chassis.



While looking carefully, I found what was likely to be an original capacitor buried deep in the BFO compartment, access to which necessitated loosening and removal of the compartment screen, and removal of the front panel (photo, below of the chassis with front panel removed) to gain access to and allow the undoing of the securing bolts on the BFO pitch capacitor.



I had noted in my preliminary inspection that someone had removed the original 'R-Meter' adjustment pre-set (1Kohm) pot located on the underside of the chassis, and had installed a replacement on the rear apron. I had removed this pot as part of my tidying-up process, and

checked my junk box for a suitable replacement. I found an exact lookalike pre-set pot, but, unfortunately it was a 100ohm part, so I had to make do with an alternate style. Installing this pot in the correct location in the chassis allowed me to re-wire the 'R-Meter' circuit per the schematic, as this part of the circuit had been (seriously) mis-wired by whoever replaced the pre-set pot. I also jury-rigged in two new resistors in place of two of the previously replaced resistors which were of incorrect values, intending to replace these with reproduction resistors once the chassis was operational, along with some of the more out of tolerance original resistors with reproduction parts at that time also.

The screening can was removed from the third IF transformer (photo, right) to confirm the wiring to the plate of the second IF amplifier tube as this wire was missing under the chassis. I located the wire and brought it under the chassis through an eyelet. This was followed by a series of 'tidying-up' jobs around the chassis, including:



- Fitting a new power cord;

- Fitting two new dial bulbs: one is fixed, the other rotates with the tuning. The rotating one was easy to change, but the fixed one was really difficult to access - because of this I think it likely had the original

bulb still installed(!) - almost an hour to change one bulb, and that was with the case and the front panel removed, giving easier access;

- Tracing the last remaining loose wire - it ran into the antenna coil can, so I figured that it connected to the AGC line via a 500Kohm resistor located near the BFO compartment;

- Opening up the crystal filter screening can to change out the 0.01uF capacitor located in there: I found that it was an original 'Micamold' brand part (photo, right). I usually don't bother restuffing capacitors that are hidden inside IF cans and the like, but I re-stuffed this one (I simply slit the case, removed the guts, popped in the new capacitor with some packing material, and then put some brown hot-melt glue into the ends – takes about 5 minutes) – photo, below;



- Lifting the 2nd and 3rd IF transformer cans to check if there were any capacitors hidden inside (there were not);

- Replacing the capacitor (0.1uF) in the metal sleeve next to the 'Communications Switch'¹⁰ (that was a 'Solar' brand part), but also likely original;

- Removing a surplus 0.01uF 'Micamold' brand Bakelite lozenge (paper) capacitor someone had



added to the output 'tip jack' socket and checking operation of the 'Communications Switch';

- Cleaning the remaining heavy grease off the band change switch wafers and shaft, and cleaning the contacts with Deoxit D5 and Q-Tips;

- Cleaning and re-lubricating the tuning gang;

- Cleaning the 'Communications Switch' contacts with Deoxit D5 and Q-Tips; and

- Jury rigging the power supply filter capacitors into the chassis (cans not sealed) for initial power-up testing.

Following the above, I had some questions I hoped the Western Historic Radio Museum could shed some light on, including:

- The 0.1uF screen bypass capacitor for the BFO tube seemed to be missing: I replaced the 0.1uF capacitor in the BFO compartment, but that was one that is switched in the grid circuit (on/off

¹⁰ Interestingly, this capacitor is mounted under the chassis on both of the Breting 12 chassis at the Western Historic Radio Museum and is unscreened in both cases

switch for the BFO), not the bypass capacitor. So, my question was, where should this capacitor be located?;

- There was a red-bodied resistor (25Kohm?) behind the AF gain pot body on the Western Historic Radio Museum photos (both of their chassis) - this resistor was missing in this chassis – could they confirm value and purpose of this resistor?; and

- The second and third IF transformers are shown as loosely coupled on the schematic using a 2pF capacitor. This had been done above the chassis on this set using a small tubular ceramic part, though the arrangement did not look 'factory' – could they clarify what arrangement was used on their chassis?

These questions were answered very promptly as follows:

"- There are two paper capacitors inside the BFO compartment and both appear to be the same values, 0.1uF, although the values are turned down[wards] so you can't verify. But, they have to be the two caps shown on the schematic;

- The red resistor indicated is 25K[ohms];

- The 2pf coupling cap [between the 2nd and 3rd IF transformers] is a 'gimmick' that's above the chassis... ie. twisted wires with a black fabric sleeve."

Following receipt of these answers, I installed the additional 0.1uF capacitor in the BFO compartment (I could not see any evidence there was ever one installed in this chassis), and reverted the coupling capacitor between the 2nd and 3rd IF transformers to a 'gimmick' type as described above - this is much less conspicuous and can be adjusted if needed.

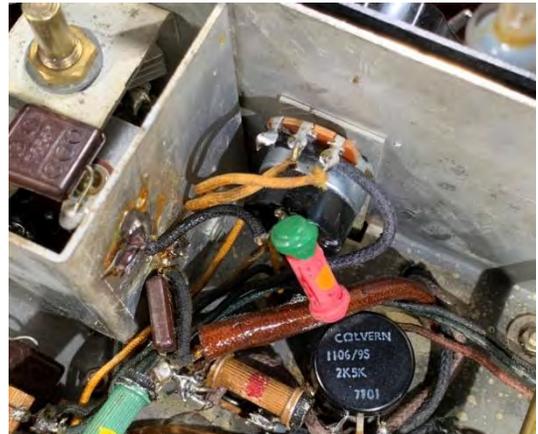
I deduced that the 25Kohm resistor was part of the AF Gain control, which should have had a switch fitted (this had been replaced in this chassis for a part without a switch). The photo, right, shows the arrangement in the early model chassis at the Western Historic Radio Museum. The resistor is connected between the 'cold' end of the pot and ground, and the switch shorts this out during normal operation of the set, and switches in when using the 'V.I.' meter to provide a fixed level of AF gain as described on and comments by the Western Historic Radio Museum website thus:



"The switch inserts a fixed 25K[ohm] resistance into the volume control circuit to allow the V.I. meter to have a 'calibrated' point of reference. It allowed the V.I. meter to indicate audio level if the receiver was in CW mode which disabled the R-meter. Also,[it] might have been useful if the audio section was used as a transmitter modulator speech amp. On my later version Breting 12, this switch and control work correctly, that is, with the switch 'ON' the volume level is fixed and sensitivity is controlled with the Manual [RF] Gain (switch on this pot turns on the BFO). If the switch on the Volume [AF Gain] control is opened, then the pot controls the audio gain level."

"On the Breting 12 you're working on, replacing the volume control pot sometime in the past, this particular function of a "fixed level" of audio gain probably wasn't important to whoever did the repair. Having the V.I. meter indicate something in CW mode probably wasn't all that useful anyway. Most receivers disabled the S-meter in the CW mode at the time and CW guys were used to just estimating the RST reports. And, I've never heard of anyone in the past using the Breting audio section as a modulator speech amp. Something that might have happened during the days of the Great Depression, I guess."

I found a new 500Kohm log-taper pot with switch and replaced the (previously replaced) AF gain control on the chassis with it. I wired the switch with a 25Kohm resistor as per the schematic to act as in the Western Historic Radio Museum's description. I used an old 250Kohm 'dogbone' style resistor that had drifted to over 330Kohm with a new 27Kohm resistor in parallel (and hidden). I changed the yellow dot on the resistor body to an orange one so it looks like an old 25Kohm part as it should (photo, right).



Cosmetics

That done, and while I had the front panel removed, I decided to dismantle and clean the dial and dial cover glass and front panel. I was very careful removing the dial glass as this is very thin convex glass, held in place by small metal tabs which have to be pried away to release it. The dial was cleaned



carefully with Q-Tips and a little IPA (photo, left). The dial glass was very grubby and greatly benefited from a clean on both sides. The dial itself was not very grimy - mainly surface dust, so it was only brushed gently with a soft brush - its all too easy to remove markings from radio dials if IPA (or even water) is used. On reassembly, I crimped the metal tabs just enough to retain the dial

glass and added a small dab of Duco cement to each tab to make sure the glass was held firmly – photo, right. I cleaned behind the front panel and reinstalled it, then paid some attention to the meters.



I had removed the meters before I took the front panel off the chassis, noting that one of the mounting clamps was broken (photo, top right on page 15). On closer inspection, I noticed that the

'good' clamp had suffered the same fate and had been repaired by someone previously - simply soldering the broken part back on. This seemed to have worked ok, so I duplicated the repair on the broken clamp (photo, below). That done, I re-fitted the meters to the front panel. I also re-made the wire connections to the meters using the correct type of 'hook' lugs,



to mitigate slight longitudinal movement caused by wear on the mechanism.

That done, I reinstalled the (tested) tube set and tube shields (photo, right), ready for an initial power-up once I had double-checked my wiring against the (corrected) schematic.

Circuit Checks and Power-up

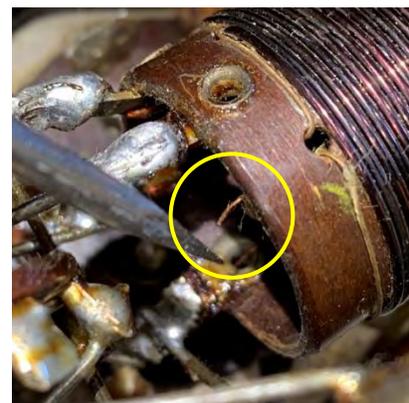
I then spent an hour or so checking over all my work on the chassis - I always find 'fresh eyes' after my breakfast coffee can spot issues that I could not the night before. I started by checking continuity between all the tube plate pins/screen pins (where appropriate) and the plate supply, allowing for the appropriate plate/screen resistor/transformer winding resistance values. These checks identified there was no continuity from the plate supply to the 2nd IF amplifier tube plate/screen pins. This was traced to (yet another) missing wire resulting from the modifications done to the 'R-Meter' circuit sometime in the past. I added the wire and the problem was solved.

During this inspection, I noted a disconnected piece of Litz wire on one of the mixer stage coils (circled in photo, right), however,



replacing the 500ohm resistor in the V.I. meter circuit with a 5000ohm part, sleeving it in heat-shrink.

Next, I washed the knobs in soapy water, polished them with Bakelite polish #5 and re-fitted them, except for the crystal phasing control and its shaft, the brass bushing of which needed to be re-soldered to the rear of the front apron before fitting the control shaft, coupling and knob. I also installed a felt pad and washer behind the tuning knob



continuity checks on all the coil windings indicated all was ok - I suspect the loose wire may be intentional as the schematic indicates four of the RF coils in the mixer stage include a stub winding from the primary to the secondary windings (though not connected to the latter). I therefore decided to leave it for the time being and investigate it further if there was a problem that this could be the cause of.

The next check was a resistance reading between the plate supply and ground. This measured around 100Kohms, which I considered too high: there is a voltage divider comprising a 35Kohm and a 25Kohm resistor between the plate supply and ground, providing the screen supplies to the 1st IF and the two RF amplifier tubes, so the maximum resistance should have been around 60Kohms, but probably much less than this. Further checking identified that the 35Kohm resistor in this voltage divider had gone open circuit (tip of arrow in photo, right) - it had previously tested around 45Kohm - the fault likely happened due to collateral heating of this part while soldering in a new screen bypass capacitor. I removed the open circuit resistor and jury rigged in a 33Kohm resistor in its place. The plate supply resistance to ground was now around 30Kohms - much more reasonable.



I found an electrodynamic speaker with a 1690ohm field coil and a 3 ohm voice coil - near enough to that specified on the schematic (1500ohm field coil). I wired it up to a four pin plug (a tube base removed from a failed #80 tube), plugged it in to the speaker socket on the chassis (photo, left) and did a few further resistance checks. Satisfied with the results, I powered-up the chassis using a Variac, noting the wattage: at 110vAC, the chassis was drawing around 75W (about right for a 12 tube chassis). I could hear a slight 'hiss' from the speaker, but

no stations when tuning around the Broadcast band. I touched the grid of the 1st AF amplifier tube and was greeted with a loud buzz, confirming the audio stages were working well.

Troubleshooting

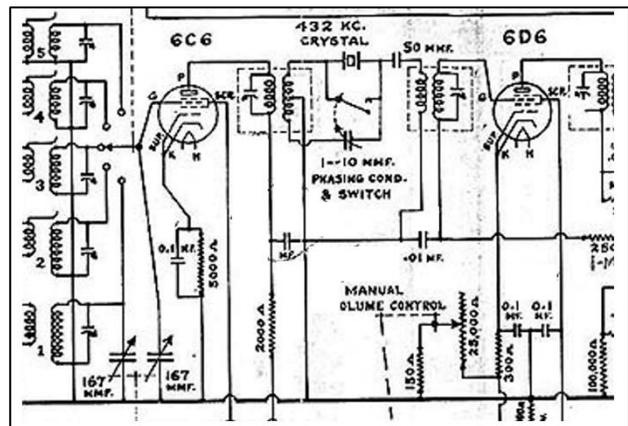
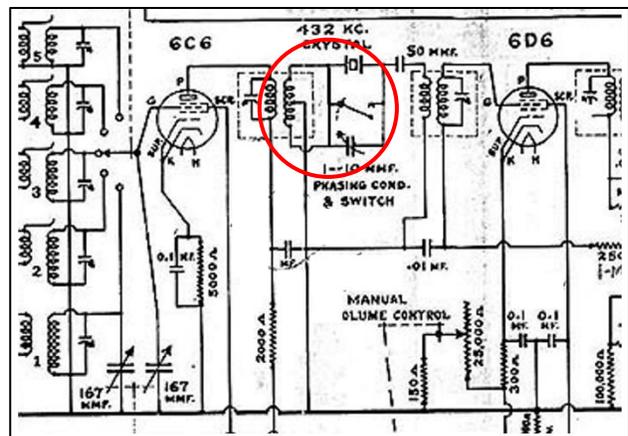
I then checked that the local oscillator was operating - I used a 'TinySA' spectrum analyser coupled to an E-Field probe placed near the local oscillator tube to sniff the local oscillator signal (photo, right), and confirmed that the oscillator was



working well on all bands. Next, a 432KHz AM modulated signal (that is the correct nominal IF for the Breting 12) was injected into the grid of the 2nd IF tube and a strong signal was heard from the speaker. I did the same for the 1st IF stage and a stronger signal was heard. I then tried injecting the IF signal into the grid of the mixer tube and and... nothing, unless I turned the signal generator up to around 0.3v(!). I then tried injecting the signal into one of the crystal socket pins and a loud signal was again heard, confirming all was ok 'downstream' of the crystal, though shorting the crystal made little difference.

I then tried injecting a strong (0.3v) 1.4MHz signal into the antenna input and tuned the set to the same frequency - a weak signal could be heard at the speaker. From this, I strongly suspected the problem to be in the mixer stage, more specifically the crystal filter immediately following the mixer. I tried changing out the 6C6 mixer tube for another known good one, but that made no difference. A short demo video of one of the initial power-up sessions can be viewed [here](#). This video demonstrates that the set was working but very 'deaf', as noted above.

Close inspection of the wiring and several continuity checks in the crystal phasing compartment under the chassis identified another (subtle) wiring error (circled in upper schematic, right), which effectively shorted out the crystal coupling transformer secondary winding(!). I corrected the wiring to what it should be per the schematic, below, right (bearing in mind the schematic is also riddled with errors!) – photo below. This fixed the problem and the receiver was now receiving signals on all bands. A short demo video of the set receiving on the Broadcast band at this stage of the work can be viewed



[here](#)¹¹.

I then spent a while cleaning and adjusting the friction drive in the tuning mechanism - I had noticed some slippage during my checks of the

¹¹ No additional alignment was undertaken prior to the set operating on the video other than a rough adjustment of the mixer plate tuned circuit transformer primary. Strong local signals received on a few feet of wire are displayed as around 'R9+' on the 'R-Meter'. I expected this could eventually be improved with careful realignment of the IF and RF stages.

local oscillator: the pinch wheel was splayed out and making intermittent contact with the edge of the phenolic logging scale dial, which itself was greasy. I gently nipped the pinch wheel halves together around their full circumference (photo, right), and also cleaned the greasy grime off it and also around the edge of the logging scale dial with naphtha and then IPA, applied with a Q-Tip, such that it made reliable contact. I also noticed that the stationary dial bulb (that illuminates the logging scale dial) was not working - I had replaced the bulb, but because it is hard to reach, I found that I could not snug it fully home in its socket (its a #40 screw thread type) such that the tip made connection with the contact at the base of its socket. I removed the bulb and built up the tip contact with solder such that the bulb did not need to be screwed in quite as far for it to make contact - this remedied the problem. However, with the bulb now illuminated, I noticed that the logging scale was



not displaying well through the aperture in the dial - either due to the bulb being incorrectly positioned and/or the phenolic becoming cloudy with age. I decided to investigate this further later.

During my junk box trawl for a speaker, I had found a more appropriate, metal-bodied pre-set pot (and correct value at 1Kohm) for the 'R-Meter' zero adjustment control rather than the plastic (2.5Kohm) part I had fitted earlier, so I fitted that (circled in photo, left), and then re-adjusted the 'R-Meter' zero setting.

Also, during the testing, I had noted that the V.I. (volume indicator) meter was not working at all. I checked that the meter movement was ok (it was), so I started to troubleshoot the V.I. metering circuit. This meter measures the audio output level with an audio signal derived from a higher impedance tap on the output transformer secondary, and the audio signal is rectified by the diodes in the 1st RF stage (6B7) tube - a bit of a convoluted arrangement. The schematic shows that the audio signal passes through the five-way 'Communications Switch', the wiring and operation of which is not clear on the schematic. I found that setting the switch between two of its detents resulted in the meter momentarily operating as it should, so I concluded there is an issue with the switch contacts or that someone had messed with the switch wiring.

Resistance checks identified that the higher impedance secondary winding on the output transformer that supplies the audio signal for this meter was shorted to ground. I had previously checked the (DC) resistance of this winding at 20ohms. Careful inspection of the 'Communications Switch' located the problem - a screening braid from the rear apron audio input 'pin jack' was rubbing against a switch contact solder lug underneath the switch (between the switch and the chassis - circled on photo, right) - impossible to see from above or from behind the switch, but visible when viewed from the side with the 1st RF amplifier tube



and screening can removed. Operating the switch occasionally moved the contact away from the braid and hence the intermittent operation I had noted earlier. I simply pushed the screened wire to one side, away from the switch contact and the problem was fixed.

Also, I noted that the series resistor to the 'V.I.' (Volume Indicator) Meter is shown on the schematic as 5000ohms, but the one in the chassis here, which looked original, measured 500ohms - this could have been an error on the schematic (there are plenty!), or someone had replaced the resistor in the past with the wrong value part, though it looked to be a 'factory' fitment. It was confirmed by the Western Historic Radio Museum that the value of this resistor on their chassis was 5000ohms. However, I found that the V.I. meter was not very responsive with a 5000ohm resistor installed, so I reverted back to the original 500ohm value, which worked well¹². I checked operation of the meter against the description on the Western Historic Radio Museum website and it performed exactly as it should: the set is switched to CW operation - the 'Manual Gain' (IF/RF gain) control is switched to manual gain (the switch is incorporated with the pot, but at the extreme clockwise end of its rotation), and left at maximum gain. This switch turns on the BFO. The 'AF Gain' control is then turned fully counter-clockwise until the switch on its shaft operates, which switches in a 25Kohm resistor between the 'cold' end of the AF Gain pot and ground, thereby providing a fixed level of AF gain. When a CW signal is then tuned in, the audio signal generated by the BFO beating with the receiver CW signal provides an indication on the V.I. meter that is a surrogate (relative) measurement of signal strength. The 'R-Meter' signal strength meter does not function correctly when under manual gain control, which is needed for optimal CW operation to adjust the balance between the signal and the BFO levels. A short video demonstrating how the V.I. meter works can be viewed [here](#).

Reproduction Resistors

Next, I fabricated some reproduction 'dogbone' style resistors to replace those that I removed from the chassis and had temporarily substituted (jury rigged) with modern parts for the initial power-on and troubleshooting. My method of fabrication of these is as follows¹³:

- Identify the resistance value and wattage of the original part (the original parts are often much larger for the same wattage rating than modern resistors);
- I then select one or a combination of several resistors (usually 1W rated flameproof parts) that approximate the specified nominal resistance value, ie. is within the tolerance rating of the part. For example, to make the 35Kohm 2W part, I used 2 x 10Kohm and 1 x 15Kohm 1W rated parts in series (selecting a combination of values to make sure that no individual resistor will be overloaded). As the resistors will be encapsulated, I de-rate the parts by using a combination that that will provide around 1.5x the specified wattage rating of each resistor;
- If several resistors are being used in series, I solder them together, leaving minimal space between the individual resistors (photo, right);



¹² The higher impedance secondary winding of the output transformer is specified as 200ohms on the schematic, however, it measures 20 ohms on this chassis. As such, the audio signal being fed to the V.I. meter would be around 10 times less in amplitude and hence the use of 500ohm resistor. This could be a later design modification

¹³ I use other methods too, eg. resistors having a hexagonal cross-section can be fabricated using a 'Bic' ballpoint pen body cut to the correct length

- I attach thicker lead wires to the end resistors to match the other resistors in the chassis (old resistors tended to have much thicker leads than modern parts);
- I then cut a piece of plastic or (or paper) drinking straw of similar internal diameter to the desired resistor diameter to the required length of the length of the resistor (photo, right) and slit it longitudinally;
- I mix sufficient two-part epoxy putty, eg. 'Milliput' brand, available in hobby shops, to make a batch of resistors (up to six, as otherwise the putty may harden



prior to fabricating all the parts) – photo, left;

- I then wrap a 'sausage' of the putty around the resistor assembly and place it in the straw, then work/roll the straw so it is back to its original round shape with the putty completely filling it, trimming off excess putty;

- The 'Milliput' putty takes around four hours to harden fully. Once hardened, I peel off the straw 'case' – photos, below and below left (plastic straw ones can be



retained and re-used, though paper ones tend to fall apart), and trim any stray pieces of putty off the



moulding;

- If desired, the surface of the

moulding can be striated or otherwise shaped/textured using a modelling knife (I did not

bother doing this here as the chassis contains a variety of resistor types anyway) ;

- Paint the resistor in the correct colour code (body-end-spot or whatever the original parts used);
- After the first coat of paint, I wrap the wire leads around the ends of the resistor bodies as per the original parts, and apply a second coat of paint - I use acrylic paints from a dollar store – photo, above;



- To 'age' the parts, I apply a coat of thinned amber shellac once the paint is fully dry (photo, right).

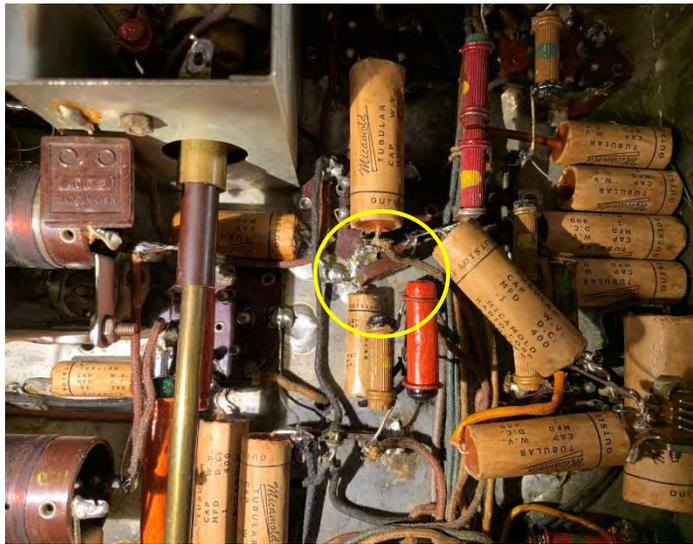
The above process is a little more time consuming and messy than the capacitor fabrication, but once a few have been made it becomes easier.

The reproduction resistors were then installed in the chassis and the operation of the set tested.



More Little More Troubleshooting, Checks and Cosmetics

One thing I had noted once the V.I. meter was working, was that when the tone control was set for minimum treble cut, and the volume level was at around $\frac{1}{4}$ advanced (or higher), the audio stage went into supersonic oscillation, which 'pegged' the V.I. meter. I decided to investigate this and found that it was the #42 audio driver tube that was going into oscillation, producing a nice sine wave output just below 30KHz at a high level. Possible causes were a poor ground connection(s), dry joint, faulty tube, incorrect stage bias, or poor lead/component dressing.



I tried a different #42 tube and found this improved the situation such that the oscillation did not occur every time when the set was operating as noted, however, it would still occasionally break into oscillation, especially at high volume. I could not identify any dry joints or poor ground connections, and the lead dress and tube bias conditions were ok. However, I found that connecting a 1000pF capacitor from the #42 tube grid connection to ground completely cured the issue under all operating conditions, even with the original #42 tube installed. I therefore decided to make this slight (and easily reversible) mod to the circuit, using a 'period' silver mica capacitor so it was very inconspicuous (the capacitor is circled on the photo, above left).

I also investigated the visibility of the logging scale (I noted earlier that it was obscured when on Broadcast band). I found that this appeared to be by design: it is obscured only on the Broadcast band (Band 1), when the bottom of the translucent 'guillotine' scale drops in front of the logging scale, and is plainly visible on all the other bands when the scale is lifted up incrementally to expose Band 2 through Band 5 as the band change switch is operated. Why the logging scale should be obscured when the

Broadcast band is selected is puzzling. However, I checked with the Western Historic Radio Museum to see if their sets also have this feature, and yes, they both do¹⁴.

I also checked the peak voltages from a cold switch-on across both of the power supply filter capacitors: the reservoir capacitor, a 500vdc rated part, peaked at 464vdc (across the capacitor, not to chassis), settling to 330vdc once all the tubes were operating, and the voltage across the smoothing capacitor, a 450vdc rated part, downstream of the speaker field coil, peaked at 434vdc, settling to 240vdc when all the tubes were operating. I repeated this test several times, and satisfied that the voltages were satisfactory for the installed parts, glued the tops onto the two can capacitors. I also placed the 'temporary' labels over them until I could find the time to head to the printers.

Finally, I touched up some scratches on the black wrinkle finish paint on the front panel using a little 'Ebony Rub 'n Buff' applied with a toothpick (photo, below left), followed by a polish with Novus #1.

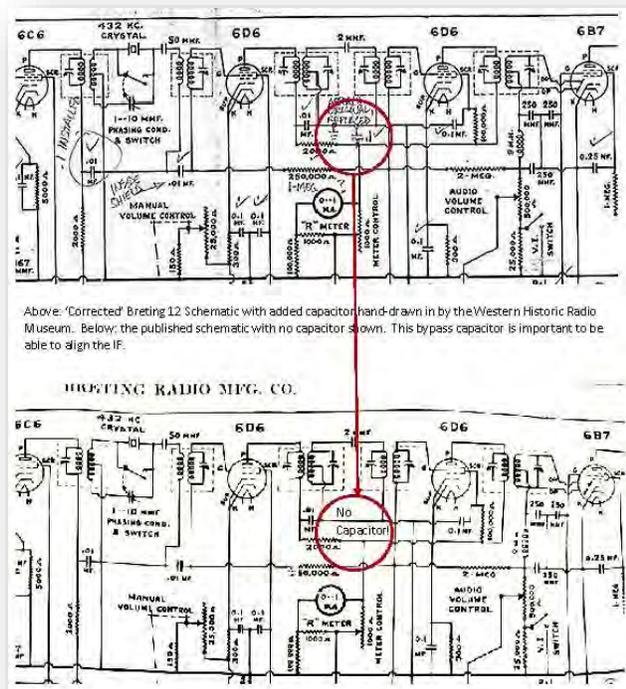


Alignment

IF Alignment

The IF alignment went fairly smoothly except one of the mica dielectric compression trimmers in the 4th IF transformer (primary winding) would not peak fully: instead, it started to 'click', indicating it had likely reached the end of its travel, ie. minimum capacitance. To confirm this and to check it looked ok physically, I removed the screening can and found that this was indeed the case - the trimmer was in good shape, but the adjustment screw was at the end of its travel. But why? I suspected a poor (signal) ground at the 'cold' end of the transformer secondary.

Careful examination of the schematic and the photos from the Western Historic Radio Museum revealed yet another error - the signal bypass capacitor at this node of the circuit was missing from the original schematic and was not fitted to this chassis when I received it (figure, above). However, the photos of



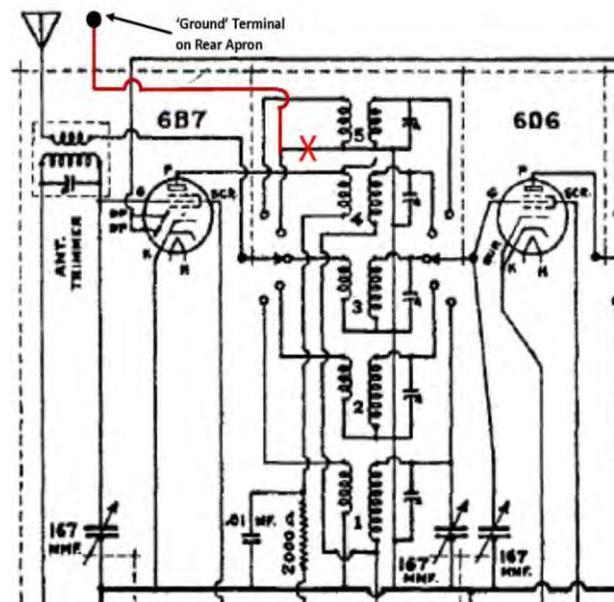
¹⁴ The Western Historic Radio Museum noted: "...I remember that the "Ray Gudie designed" Patterson PR-10 tracked perfectly on the AM-BC band. The were the regular trimmers and then the aluminum plates of the tuning condenser were really soft and easy to bend where needed. I got my PR-10 to track perfect from 550kc up to 1500kc. Maybe Gudie believed that the AM-BC dial on the Breting 12 could be aligned for the same accuracy...". The Breting 12 does actually track well on the Broadcast band (and quite well on the shortwave bands), so maybe this is the reason.

both chassis from the Museum and the 'corrected' schematic I downloaded from their website had the capacitor, a 0.1uF part, in place (it had been hand-drawn onto the 'corrected' schematic). Installing this capacitor cured the trimmer problem and allowed the transformer to be tuned correctly - I had a spare reproduction 0.1uF capacitor that I used.

I swept the IF (nominally 432KHz) with the crystal filter in circuit and the phasing control mid-travel, and found the crystal's resonant frequency to be 433.98KHz, so I used that frequency to align the IF transformers. The crystal filter works well, though the phasing control gives only minimal control of the crystal phasing (peak/null), but is adequate for decent CW reception.

RF Alignment

I had noticed some intermittent crackling noises during the soak testing sessions of the chassis that I had concluded was originating in the RF section of the chassis. I decided to locate the cause before I started the RF alignment process. I soon found the problem: the ground connection on the rear of the receiver is not wired directly to ground, rather, a screened wire runs from this terminal to the antenna wafer of the band change switch. This is a modification to the original circuit as shown in red



on the diagram, above, ie. it allows for a balanced antenna (dipole/doublet, etc) on Band 4 only¹⁵. The reason for the crackling noise was that the internal (rubber) insulation in this screened wire was completely perished and the internal wire was making intermittent contact with the outer braid (circled in the photo, left).

I tried removing some of the braid to see if I could reach some non-perished insulation, but it was in bad shape throughout. I ended up removing the

¹⁵ This unusual switching arrangement is not shown on the schematic - it was a mod implemented by a former owner. I asked the Western Historical Radio Museum to check their sets, with them commenting thus: *"Both of the "12" chassis here have the ground terminal soldered directly to chassis... I looked at your under-chassis photo and can see the difference in how your chassis is wired. I do know that Ray Gudie [the set's designer] felt that only the band that covered both 40M and 20M needed the RF pre-amp and the antenna trimmer. I wonder if there was some sort of update that was published for Breting 12 owners that communicated to them about this type of mod. It seems a little too sophisticated for a ham mod. In Ray Gudie's earlier creation, the Patterson PR-10, he wrote in a magazine article about the PR-10 and using a balanced antenna and how he thought that an end-fed wire was better. I don't remember his arguments - probably ease of installation and compatibility...."*



original wire and fabricating a new piece of braided-covered wire (photo, left). With this installed, the cracking noises were gone.

The RF alignment was straightforward. When completed, AM signals of around $<10\mu\text{V}$ can be discerned, and CW signals down to $5\mu\text{V}$ over most of the bands - not the greatest performing receiver from a sensitivity/signal to noise ratio perspective for the mid-1930's, though it should be born in mind that only one RF amplifier is in place except on Band 4, however, this is adequate when used with a decent antenna. The sensitivity on the part of Band 4 that the antenna trimmer is set for is

slightly better, eg. when tuned to 14MHz (20M ham band), a CW signal of $<3\mu\text{V}$ can be detected with the crystal filter in circuit. A brief demo video of the crystal filter operation can be viewed [here](#).

While I was undertaking the RF alignment, I found one more fault in the circuit while checking to see if I could squeeze any more performance out of the set – the suppressor grid of the 2nd RF tube, a 6D6, was not connected (circled in photo, right) - it had been at some point in the past, but someone had removed the connection (it should connect to the cathode). Why would anyone do that? Fixing this improved things, giving significantly more gain, however, I was surprised that the stage remained stable with the suppressor grid disconnected – I would have expected a tendency to oscillate, however it did not do so.



A Little More TLC...

While running the tuning back and forward during the alignment process, I noticed that there was still some occasional slippage in the friction drive. I spent some time cleaning and adjusting this again, this time removing the front panel to provide better access to the pinch wheel and the phenolic logging scale that it engages with. I also installed a rubber washer onto the inside of the tuning shaft between two thin metal washers such that the pinch wheel is pushed slightly harder against the side of the phenolic logging scale (tip of arrow in photo, below right). The 'give' in the rubber washer allows the tension to be set optimally to compensate for



decades of wear on the mechanism by tightening/loosening the shaft bushing retaining nut. This has made the tuning mechanism much more reliable and the feel is now 'right'. I also installed a couple of rubber spacers between the front panel and the front apron of the chassis such that it was better supported and not rubbing on the tuning knob shaft.

The cabinet was in reasonable shape save for some patches of missing paint, scuffs and stains, mainly on the top (top photo, right). The bottom plate, however, had been drilled by someone to allow access to the RF trimmers when it is in place, complete with some ugly-looking masking tape labels.

The set's owner confirmed that the labels were to be removed, but to leave the trimmer access holes in place, and that rather than consider a re-spray, to clean the original black wrinkle finish using IPA, and then to touch-up the original finish using ebony 'Rub n' Buff' applied with a Q-Tip and a black marker pen. The results were acceptable, retaining just a little patina as testament to its age... The bottom plate cleaned up well – bottom photo, right. Also, there were several 'butcher' holes in one side of the cabinet that corresponded to the ones on the side of the chassis. The smaller holes were filled with JB-Weld, and the large one with a plastic disc and JB-Weld. Once set, these were coloured black to blend in with the cabinet.

Finishing-up



I printed the electrolytic capacitor labels on a colour laser printer and replaced the temporary monochrome-printed ones with these (photo, left) – a definite improvement!

Next, the base plate was fitted to the chassis and, following a day of 'soak testing', I checked the alignment again as the presence of the base plate could affect the alignment, especially on the higher shortwave bands – only slight tweaks were needed.

During this project, I found a 'Mirror' paint being reviewed on YouTube [here](#) (photo, right), which claimed to be truly reflective compared with standard metallic finish paints. I brought this to the



attention of the set's owner, who thought it was worth giving it a try on the filled areas of the chrome side of the chassis. When this paint arrived, I prepared the filled areas of the chassis using 'Glazing and Spot Putty', carefully scraping off the excess when dry using a plastic card (photo, right), so as not to scratch the nearby chrome finish (though it was already scratched and marked by whoever drilled and cut the holes), and then very carefully lightly sanded the filled areas with a small piece of 1200 grit paper.



After dusting and wiping the areas clean with an IPA-soaked cloth, I applied a coat of the 'Mirror' paint with a soft (sable) brush. I was disappointed with the result - it was not much better than the regular 'silver' paint I had used previously. So, I lightly sanded and wiped the areas with IPA again, and this time applied two, thicker, coats of the paint, allowing the first coat to dry first before applying the second coat. The result was much better, with a glimmer of a reflection appearing, though hardly a true 'mirror' finish. So, I tried a third coat and finally a definite, though somewhat 'murky', reflection could be seen in the paint finish on the larger filled area (tip of red arrow in photo, left).



I concluded that if this paint was applied to a perfectly smooth surface, then it may be possible to have an (almost) mirror finish - but likely not if applied with a brush. I categorize this painting exercise to be in the experimental class - my conclusion being that although it does effect a definite improvement over the use of regular silver paint, unless expert car body repair techniques are used to fill and prepare holes in a chassis, 'perfect' results will not be obtained. Even then, highly reflective surfaces such as chrome and the 'Mirror' paint tend to show every miniscule blemish. Anyway, the result here was definitely better than the regular 'silver' paint - much more 'chrome looking'.

Finally, the chassis was installed in the cabinet and the receiver placed on soak test for another couple of days before loading into the car to take it to its owner.

Closure

In conclusion, the Breting 12 is a reasonable performing receiver for the technology of the period (mid-1930's). It's a compact design for a twelve tube receiver with internal power supply for its era, and the circuit incorporates a couple of innovative features, ie. the V.I. meter method of measuring relative signal strength for CW signals, and the additional RF amplifier only active on Band 4, hallmarking the

receiver as one designed primarily for radio hams, with performance focussed on the popular 20M and 40M ham bands.

However, it also has a number of design 'quirks', eg.

- there is a frequency coverage gap in the calibrated sections of the scales between 1.4MHz (upper end of Band 1) and 1.8MHz (lower end of Band 2);
- the masking of the logging scale on Band 1 (Broadcast band);
- the AGC cannot be switched off;
- the BFO cannot be switched off when the manual RF/IF gain control is in operation;
- the BFO pitch control is inconveniently located under the receiver;
- the Band 4 antenna trimmer for Band 4 is a pre-set, which needs (internal) adjustment when switching from 40M to 20M operation on that band; and
- the tuning rate is much slower than it should be for a single-speed drive without a flywheel, requiring 42 turns of the tuning knob to cover one band.

The internal noise level is one of the receiver's primary performance limiting factors - it would likely have benefitted from the 'next generation' of tubes of the mid-late 1930's, and the noticeable long-term drift at higher frequencies would be annoying for CW reception on the 20M - 10M ham bands, especially when using the crystal filter (no temperature compensation is provided in the local oscillator circuit). The choice of a 6B7¹⁶ dual diode pentode tube for the 1st RF amplifier is odd – this tube being designed primarily for combined detector/AGC/IF or AF amplifier duty (as is the second 6B7 used in this receiver), so the transconductance and noise figure for use of the pentode section at higher shortwave frequencies is questionable. Also, the lack of adjustable IF bandwidth, save for switching the crystal filter in/out of circuit, hampers AM performance under crowded band conditions, and a noise limiter would have been a useful feature, though perhaps these would not have been such an issue during operation in the era when the receiver was designed. Lastly, the front panel ergonomics leave a little to be desired for a right-handed operator (see annotated image, right) – I would have preferred the tone and AF gain controls to be juxtaposed, and likewise



¹⁶ The only reason for this choice that I can see is that it includes two diodes that were needed to rectify the audio output for the V.I. meter. However, a slight redesign of the detector circuit could have used one diode for signal detection/AGC and the other for the V.I. meter rectification, thus allowing a 6D6 tube to be used for the 1st RF amplifier

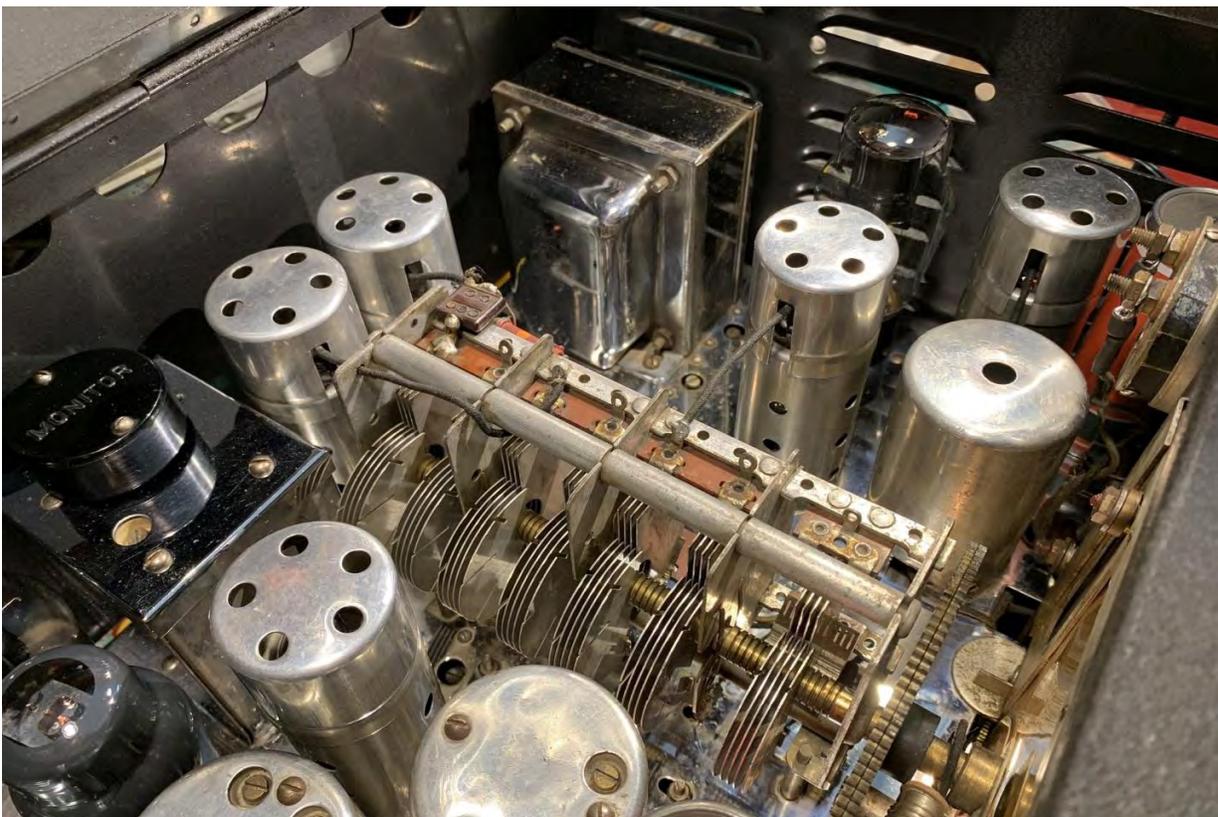
the band change switch and crystal phasing control, as well as the 'R-Meter' and 'V.I.' meter – but maybe I am 'nit-picking'...

That said, the receiver would likely have performed reasonably well on the ham bands in the 1930's and with the discount offered to hams bringing the 'fully-loaded' price to US\$93, would have represented good value. Also, there is no denying the eye-catching good looks of the dial, and the above-chassis aesthetics provided by the chrome-plated chassis top and 'INCA' brand transformer shrouds - still very attractive, even after over eight decades of wear and tear, and likely brought a gasp of awe (or jealousy) from visitors to the owner's ham shack when they lifted the lid 'back in the day'... WOW!





'Peek-a-Boo' views of the restored chassis through the opened cabinet lid. Above: IF/AF section of the chassis. Below: Power supply and RF section of the chassis





Above: One of the repro 'Sprague' brand (re-stuffed) can capacitors installed on the chassis. Below: the chrome-plated 'INCA' brand transformer shrouds are a work of art



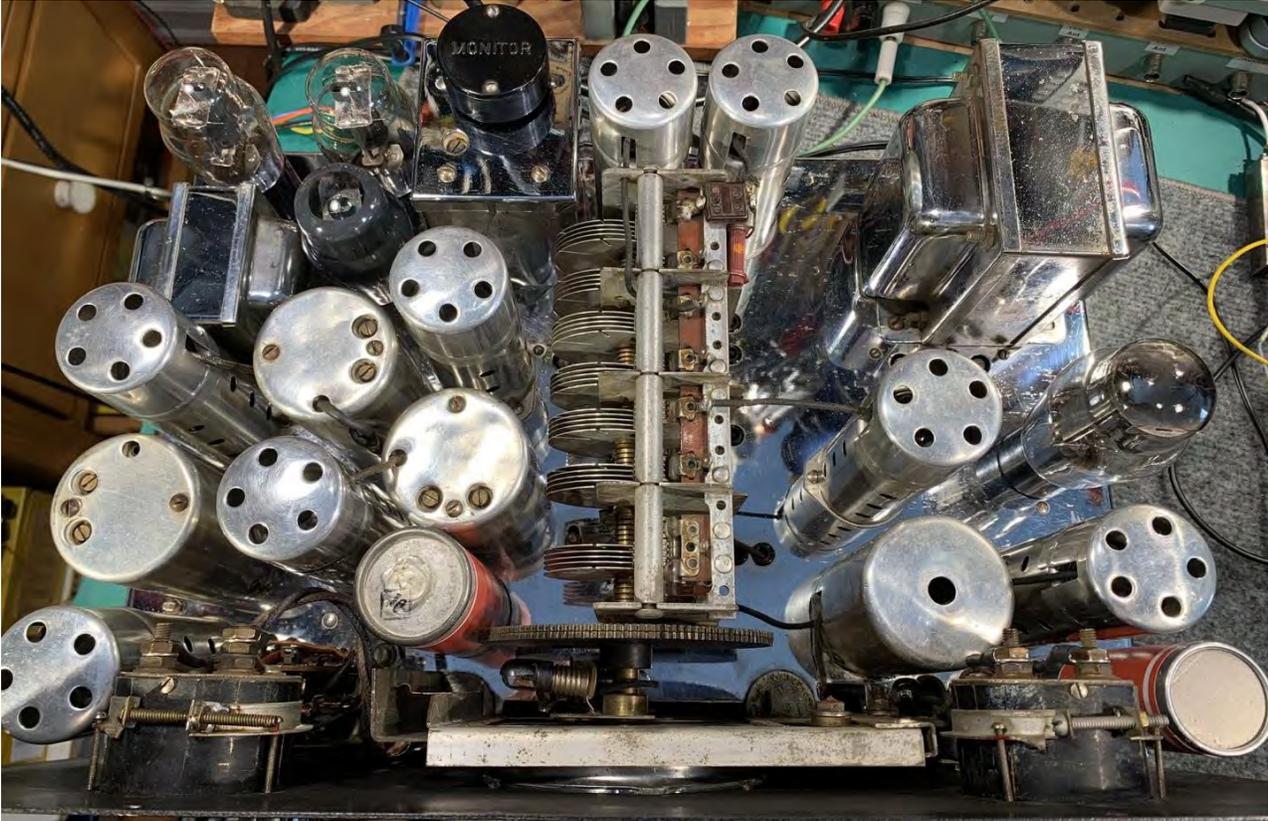


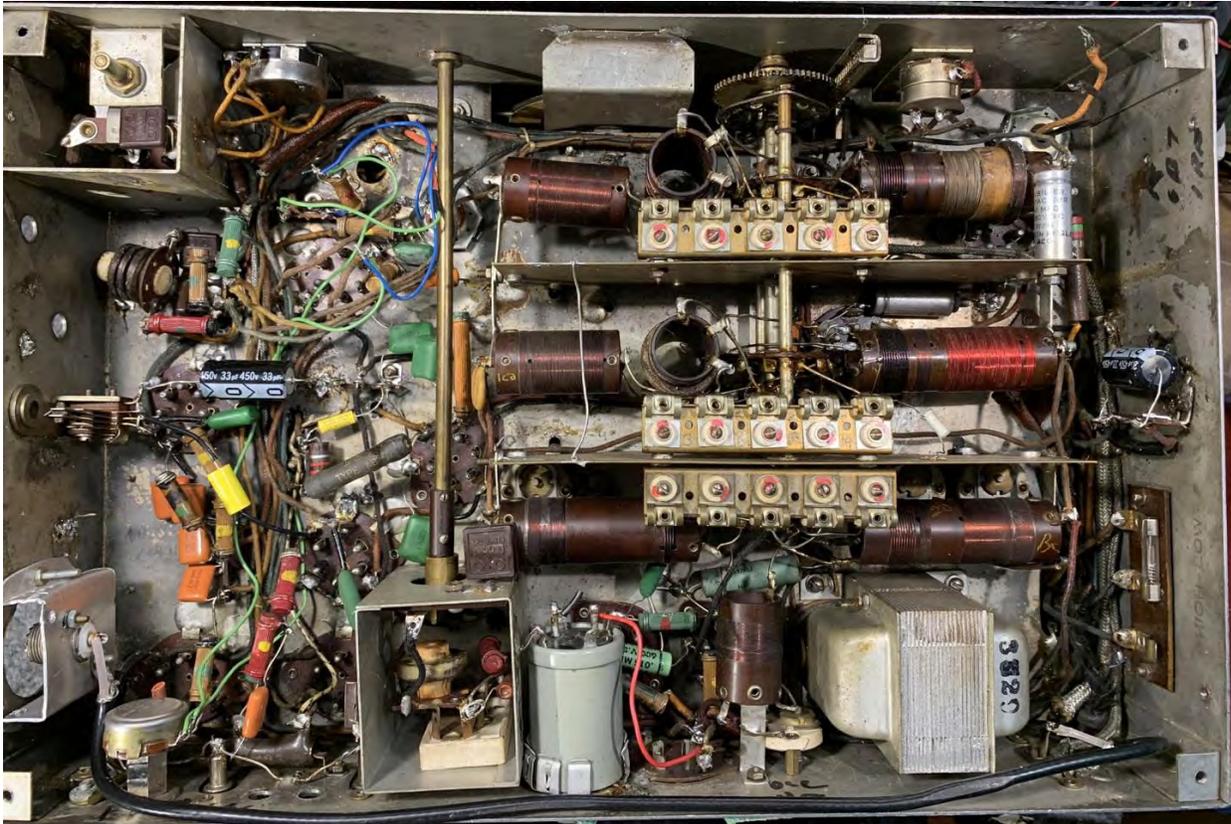
Above: patching the 'butchered' cabinet side. Below: patched areas after touch-up painting



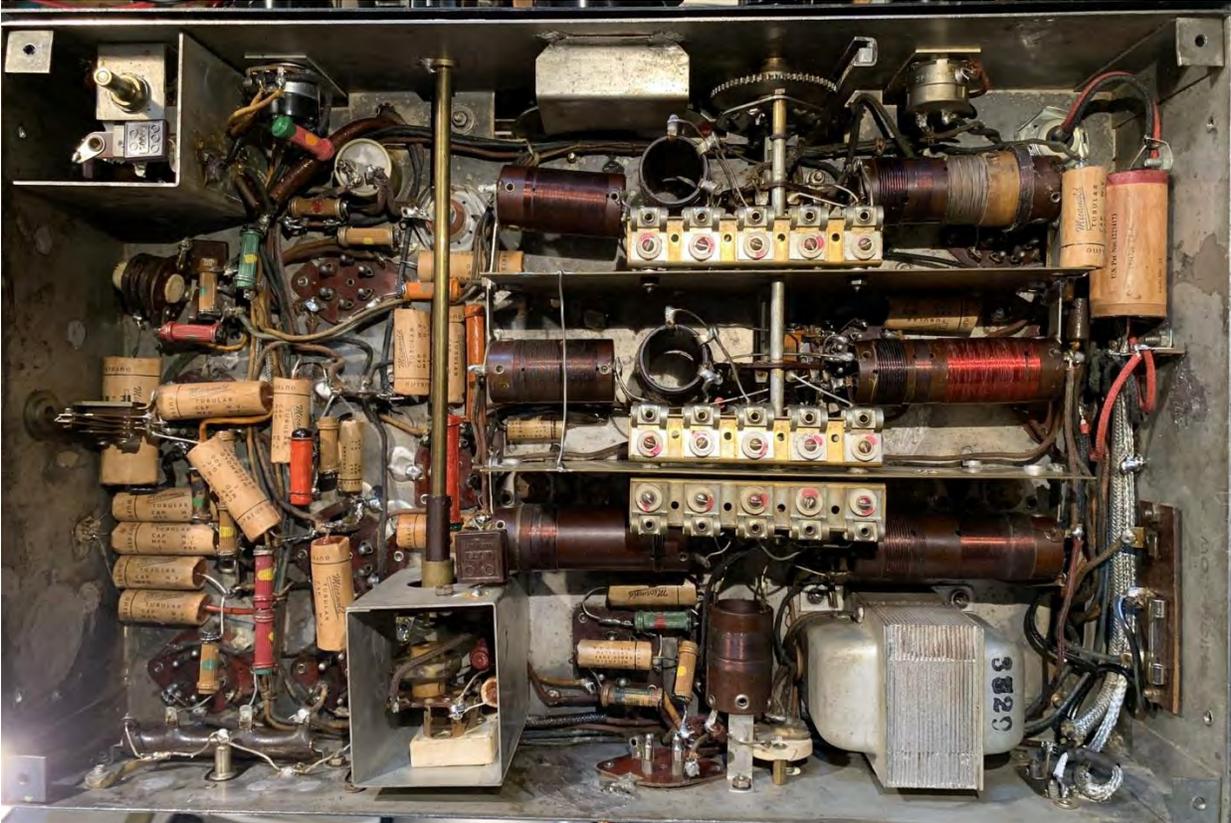


Above: top of chassis before restoration. Below: top of chassis after restoration





Above: below-chassis before restoration. Below: below-chassis after restoration





Above: receiver before restoration. Below: receiver after restoration



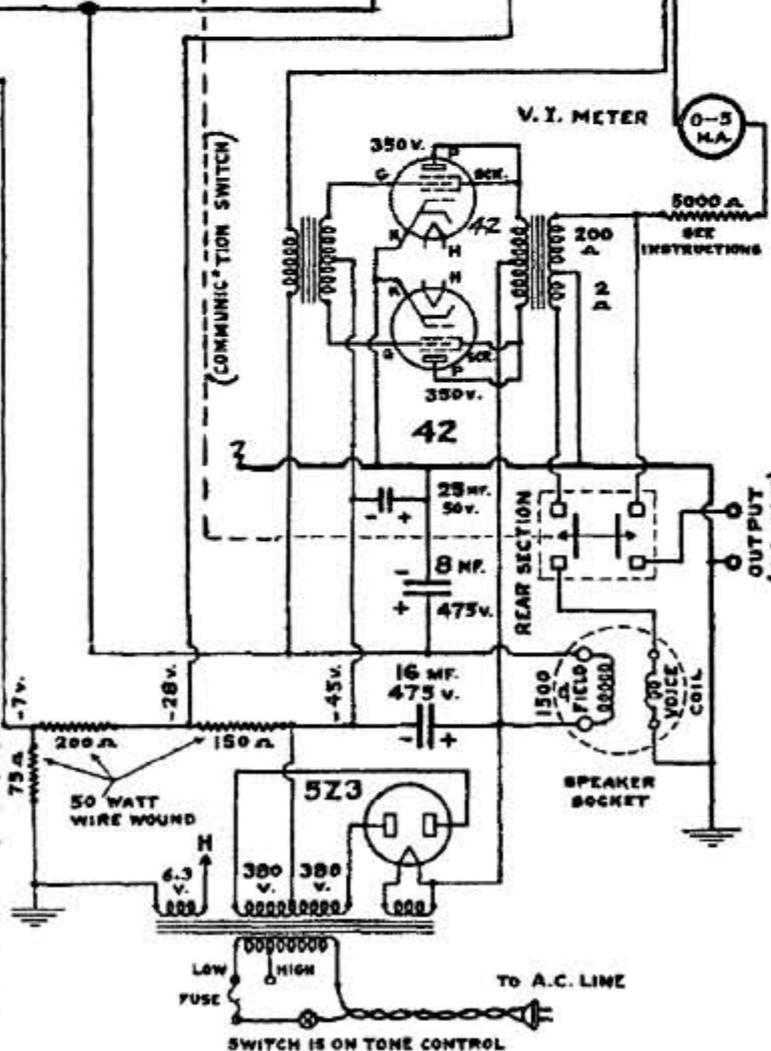
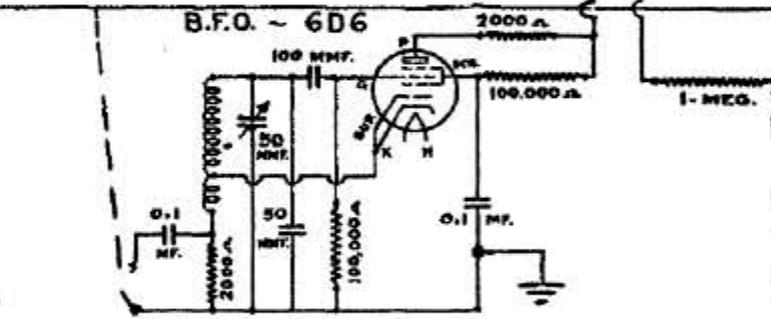
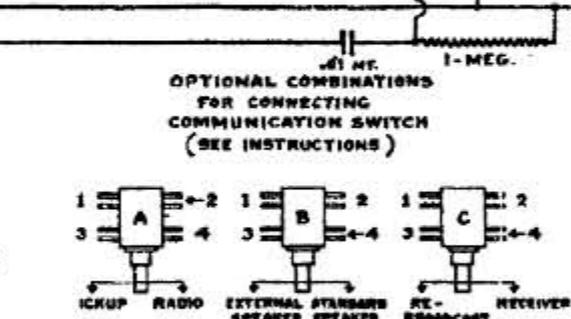
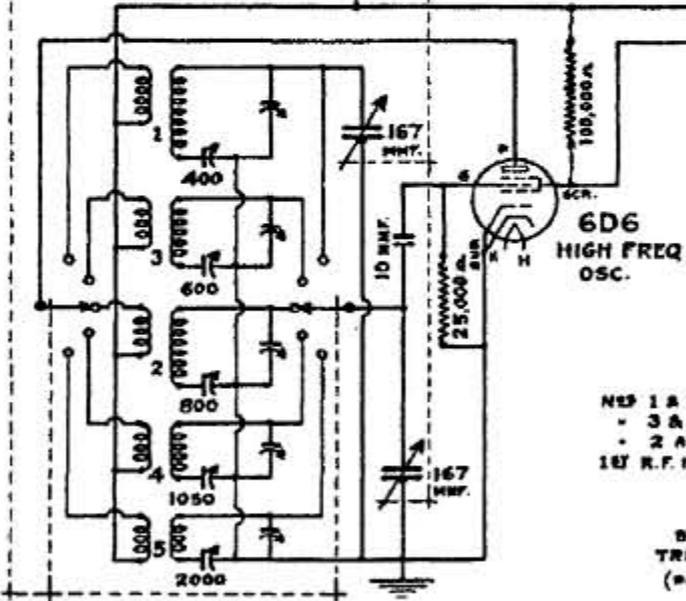
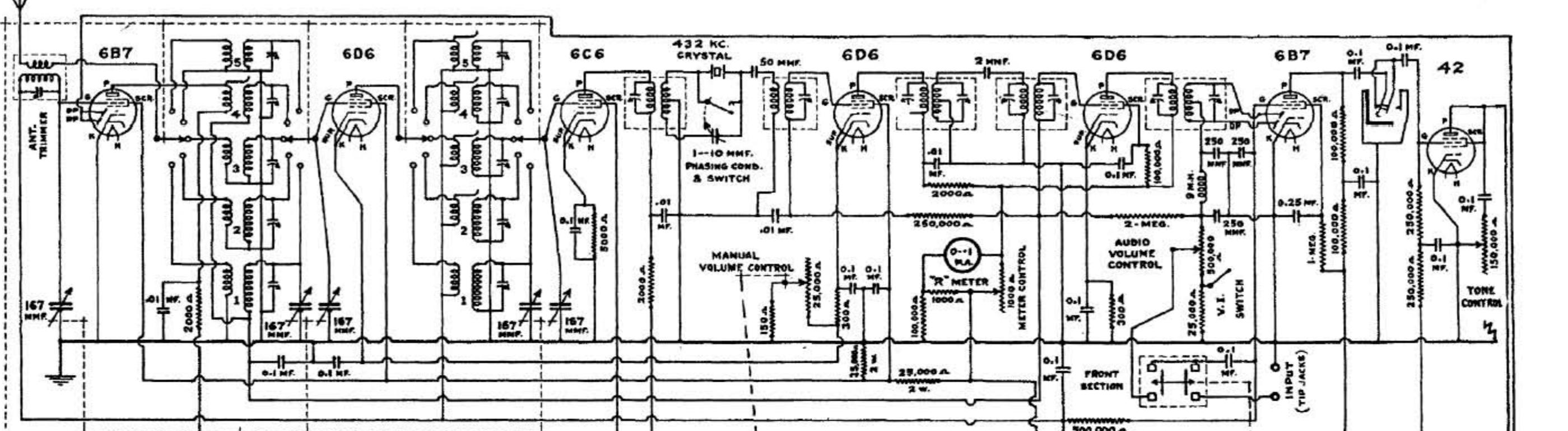


Perhaps diminutive and understated, but nevertheless, a very impressive receiver

Appendix

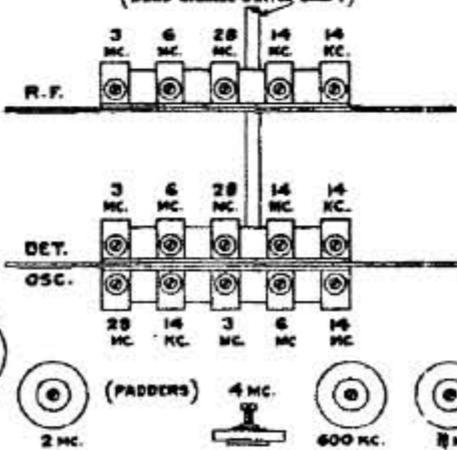
- Uncorrected Schematic
- 'Corrected' Schematic (Western Historic Radio Museum)
- Above Chassis Layout/Below Chassis Layout
- Reproduction Capacitor Labels:
 - 'Micamold' Tubular Paper
 - 'Sprague' Tubular Electrolytic
 - 'Sprague' Can Electrolytics





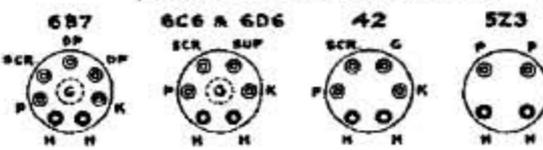
COILS
 NOS 1 & 4 ARE ON SAME FORMS
 3 & 5
 2 ARE ON SEPARATE FORMS
 1E7 R.F. IS IN CAN WITH ANT. TRIMMER

BOTTOM VIEW OF TRIMMERS & PADDERS (BAND CHANGE SWITCH SHOWN)



LOW FREQUENCY PADDERS
 CONDENSERS CAN BE ADJUSTED FROM TOP OR BOTTOM OF CHASSIS AND ARE IN THE POSITIONS SHOWN. TRIM AT FREQUENCY SHOWN.

BOTTOM VIEW OF SOCKET TERMINALS



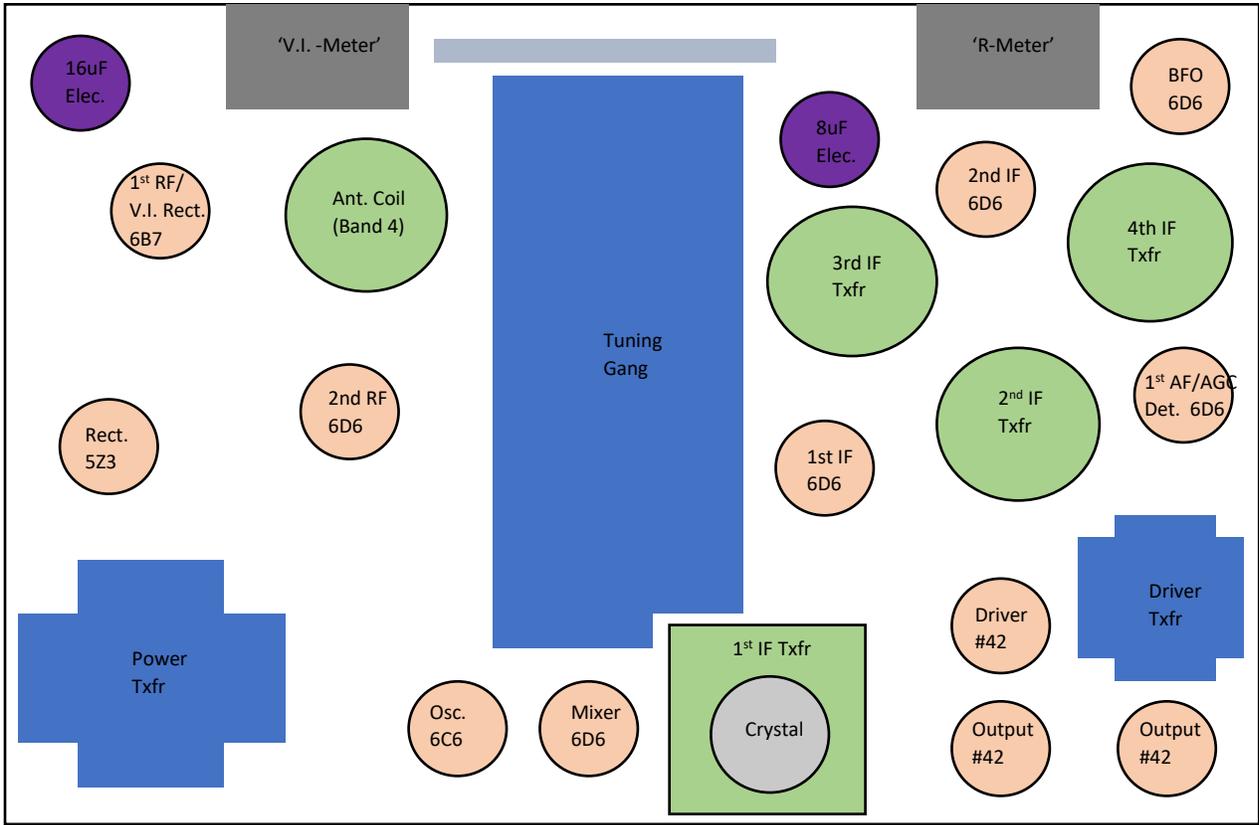
REBALANCING—A good all wave oscillator and a crystal oscillator are required.

1—Balance the I.F. by placing the crystal in an oscillating condition and connecting a short wire to the grid terminal of the first detector. Diminish the output of the oscillator by either a gain control or moving the oscillator from the receiver until a reading of about R 6 is indicated on the "R" Meter. Carefully adjust the trimmer screws on each I.F. and the crystal unit both above and below the chassis until maximum indication is noted on the R meter. Under no condition unless the receiver has been tampered with should any of the trimmers require more than a quarter of a turn for maximum peak.

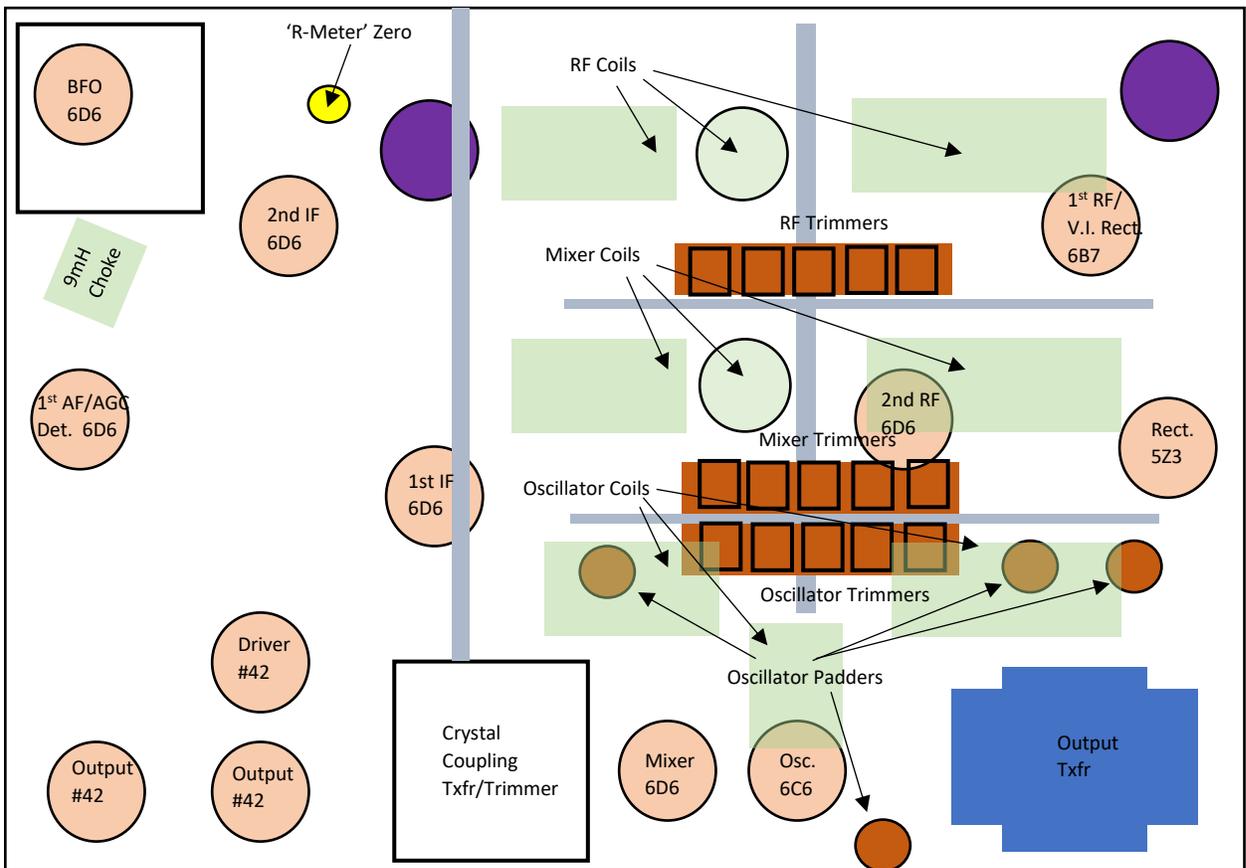
2—Balance the Broadcast and High Frequency bands by connecting the output of the all wave oscillator to the antenna and ground posts. Turn the oscillator to 1400 K.C. and be sure the dial pointer reads 1400 K.C. Adjust trimmer as shown on diagram (rear section) until the oscillator note is heard in the speaker. This denotes that the oscillator section of the receiver is aligned correctly at that frequency. Change the oscillator to 600 K.C. and turn dial pointer to 600 K.C. Adjust padding condenser indicated on the diagram until the oscillator is again heard in the speaker. If the receiver was very far off it will be necessary to recheck 1400 K.C. again.

3—Diminish the output of the oscillator until the "R" meter reads "R"-6 and then carefully adjust the two trimmers marked 1400 K.C. until maximum swing has been obtained on the "R" meter. Adjust the balance of the bands in the same way using the points and trimmers indicated on the diagram. A little thought and study of the layout of the receiver will be of great help.

SWITCH IS ON TONE CONTROL



Above: Breting 12 chassis layout (above chassis). Below: Breting 12 chassis layout (below chassis)



Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	200

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	200

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.01	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

OUTSIDE FOIL

Micamold
 TUBULAR
 CAP W.V.
 MFD D.C.
 .1 200
 MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold
 TUBULAR
 CAP W.V.
 MFD D.C.
 .1 200
 MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold
 TUBULAR
 CAP W.V.
 MFD D.C.
 .1 200
 MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold
 TUBULAR
 CAP W.V.
 MFD D.C.
 .1 200
 MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold
 TUBULAR
 CAP W.V.
 MFD D.C.
 .1 200
 MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR
 CAP W.V.
 MFD D.C.
 .1 400

MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR
 CAP W.V.
 MFD D.C.
 .1 400

MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR
 CAP W.V.
 MFD D.C.
 .1 400

MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR
 CAP W.V.
 MFD D.C.
 .1 400

MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR
 CAP W.V.
 MFD D.C.
 .1 400

MICAMOLD
 RADIO CORP.
 BROOKLYN
 N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.25	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.25	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

OUTSIDE FOIL

Micamold

TUBULAR

CAP	W.V.
MFD	D.C.
.25	400

MICAMOLD
RADIO CORP.
BROOKLYN
N.Y. U.S.A.

U.S. Pat. Nos.12294173

1951720 ET. AL.

Code No. 21

W.V. D.C. 50

MFD. 25

SPRAGUE

MADE IN U.S.A
ELECTROLYTIC

U.S. Pat. Nos.12294173

1951720 ET. AL.

Code No. 21

W.V. D.C. 50

MFD. 25

SPRAGUE

MADE IN U.S.A
ELECTROLYTIC

U.S. Pat. Nos.12294173

1951720 ET. AL.

Code No. 21

W.V. D.C. 50

MFD. 25

SPRAGUE

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ELECTROLYTIC

U.S. Pat. Nos.12294173

1951720 ET. AL.

Code No. 21

W.V. D.C. 50

MFD. 25

SPRAGUE

MADE IN U.S.A
ELECTROLYTIC

sprague
"600" LINE

DRY
ELECTROLYTIC
CAPACITOR

MFD. W.V.
8 475
(SURGE 500V.)

SPRAGUE PRODUCTS CO.
North Adams Mass. U.S.A.

U.S. Pat. Nos. 1,900,001

sprague
"600" LINE

DRY
ELECTROLYTIC
CAPACITOR

MFD. W.V.
8 475
(SURGE 500V.)

SPRAGUE PRODUCTS CO.
North Adams Mass. U.S.A.

U.S. Pat. Nos. 1,900,001

sprague
"600" LINE

DRY
ELECTROLYTIC
CAPACITOR

MFD. W.V.
16 475
(SURGE 500V.)

SPRAGUE PRODUCTS CO.
North Adams Mass. U.S.A.

U.S. Pat. Nos. 1,900,001

sprague
"600" LINE

DRY
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CAPACITOR

MFD. W.V.
16 475
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