## *RESURRECTING AN R109 RECEIVER*

The R109 is a general purpose, British Army 8-valve superhet communications receiver, of around WW2 vintage. There were four types made, each having slightly different circuitry and frequency coverage. The R109A covers from 2.0 to 4.9 Mc/s in one band and 4.9 to 12.0 Mc/s in another band, switched in the usual way. Some types tune down to 1.8 Mc/s. The receiver and the power supply are each on their own vertically mounted chassis, bolted to a frame and having a common front panel. The space between the power supply and the receiver provided storage for spare valves.

*The circuit*

The circuit is conventional with RF amp, mixer, oscillator, two IF amps, detector, two AF stages and BFO. All stages, except the RF, use directly heated filament valves type ARP 12 and AR8. The RF stage is an indirectly heated ARP36. Unusually though, the receiver has no AVC, or AF gain control, the volume being controlled by varying negative bias, and thus the gain, on the RF and IF stages. Power is derived from a 6-volt accumulator, via a non-synchronous vibrator supply providing HT and bias.

*A find...*

I found this R109A hidden behind other items on the floor in the garage, where it must have been "resting" unused and unloved for over 30 years. The front panel had been sprayed dark purple (not by me I hasten to add) and parts of the chassis and other metalwork was rusty. The set seemed complete except for the vibrator, case and front grill. Was it worth the effort making it operational? Certainly it seemed much labour of love would be needed and with no circuit diagram, things might be tricky. Mention of it on-air produced a circuit diagram for an R109C in the post, very kindly sent by Roger, G4BXM. Armed with this, it was clear to see the likely problem areas: in particular, a number of 0.01 uf paper capacitors, some of which were mounted inside the IF cans.....nasty.....being difficult to get at and requiring difficult removal of the cans and some dismantling of the innards.

*The restoration...*

The first job was to remove the purple paint from the front panel, and armed with paint stripper, rag, plastic and metal scrapers, this was laboriously attacked revealing the original paintwork and markings, but also the reason why it had originally been sprayed.....rust patches. Anyway, so far so good.

I had no 6 volt vibrator to hand, so set to work providing a mains to smoothed 6 volt DC supply for the valve filaments. No problem there and all the filaments seemed intact. I used a 16,000uf, 10 volt working, reservoir capacitor originating from a defunct switch-mode PSU, which subsequently proved sufficient to remove ripple when used in conjunction with the original L11A and a replaced C15B, though some juggling with the low voltage transformer taps and the load was needed to get near to 6 volts. I used a variac in

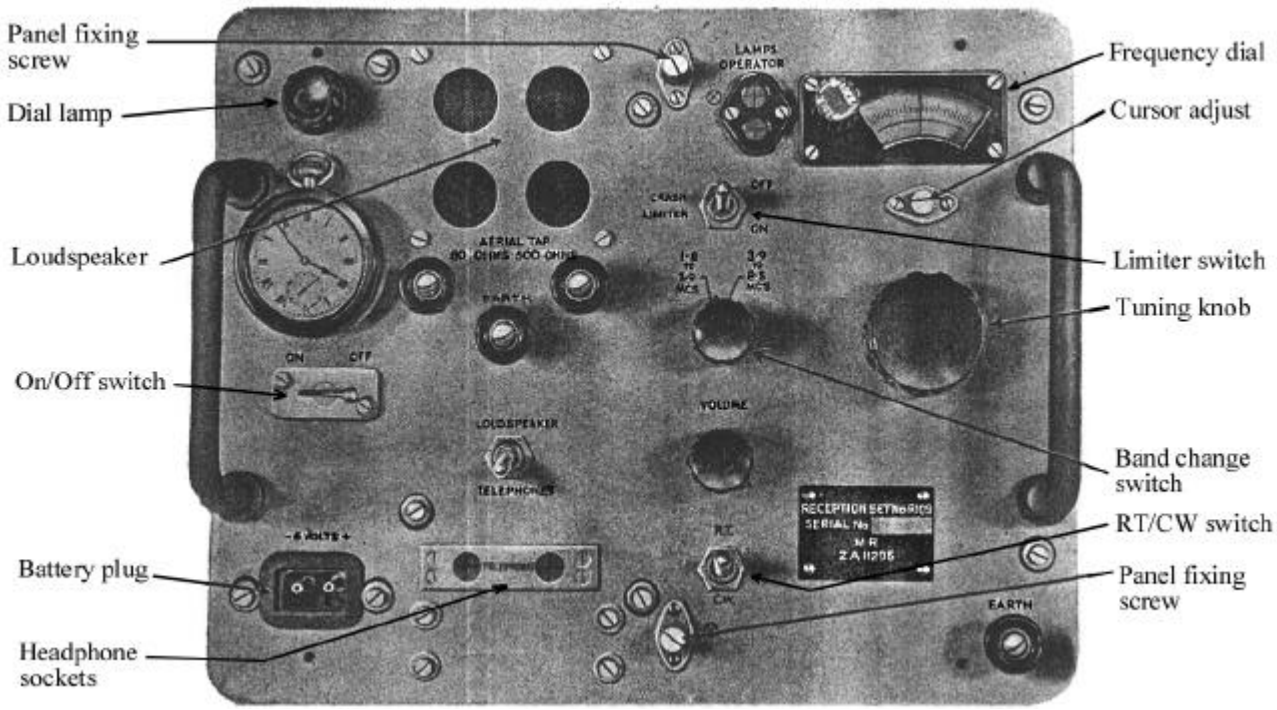



Fig.1 R109 Front Panel Layout

the primary circuit as an aid to ensuring excessive LT voltage wasn't applied during PSU set up, and ended up near enough to 6.3 volts, which seemed satisfactory.
Checking the HT rail with a high ohms range on an AVO 8 showed several thousand ohms resistance to chassis and to the HT minus rail, so that seemed promising too. The small mains transformer used for the LT supply also fortuitously had high voltage windings, and a simple diode bridge circuit and reservoir capacitor provided about 150 volts HT.....just about right to start with. Never mind the bias just yet. It seemed that without bias, the receiver should operate at full gain. The vibrator supply output was temporarily disconnected and HT applied to the receiver section whilst monitoring the current. Current limiting was provided in the event of a short. HT current was about 60mA, but not a sound came from the speaker.

***Looking for faults***

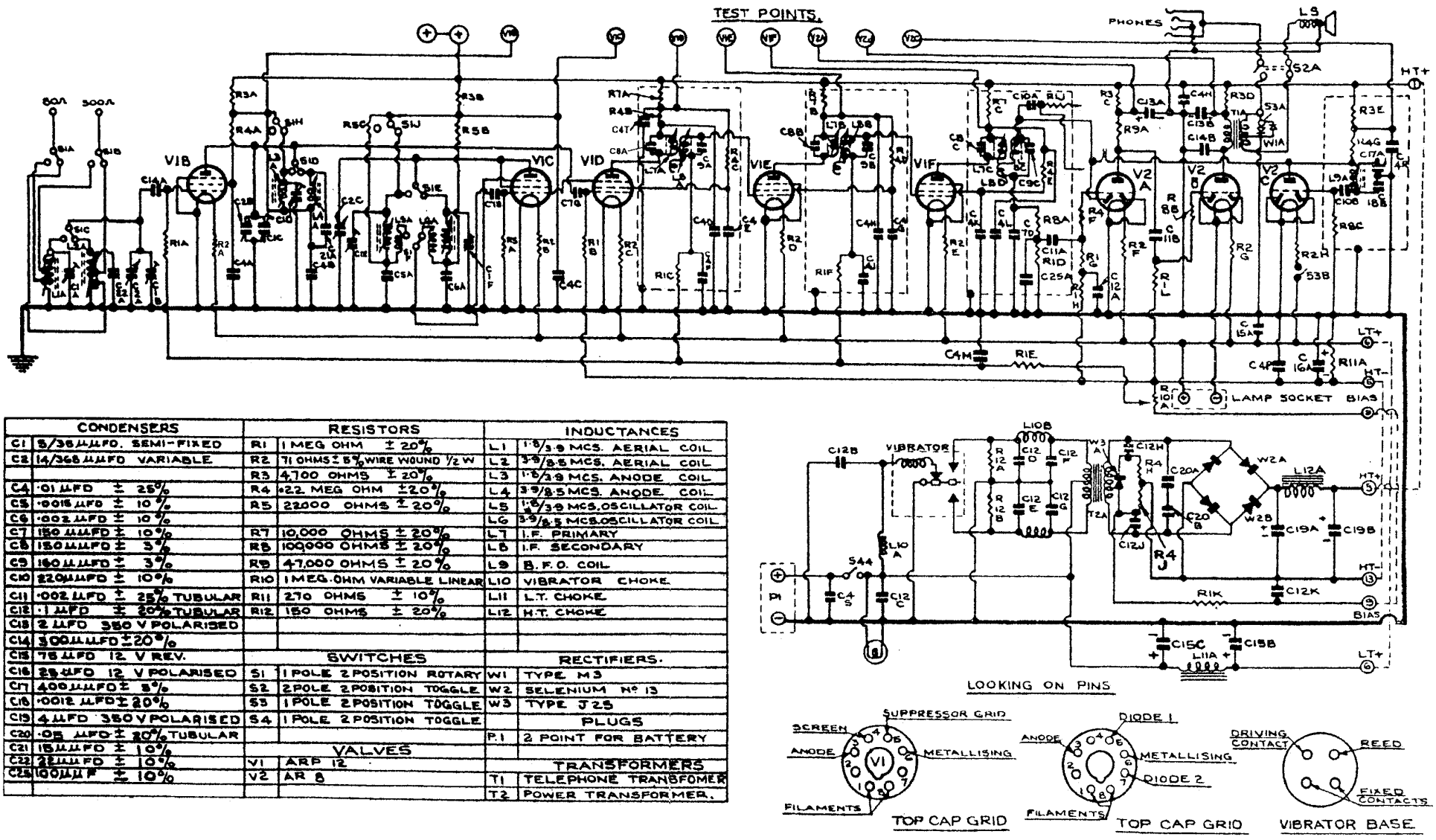
So elementary diagnostics were needed. First the speaker....oh dear, after disconnecting it from the o/p transformer its coil showed 5k ohm resistance on the AVO.....effectively open circuit. A small Japanese speaker was connected on flying leads.....yes, a buzz with finger on the grid caps of V2A and V2B. But in the meantime, the HT current was rising and rising and rising, until the pointer on the AVO 8 hit the end stop on the 100mA range. HT off. A check of resistance of the output transformer primary to chassis showed an unacceptably low reading, so it was disconnected and a small mains transformer wired in - 240 volt primary to V2B anode and HT, and the 6.3 volt secondary to the speaker. HT applied again....that was better, only 50mA HT current and it seemed steady, and finger applied to the AF stage grids produced the anticipated buzz. Scratching the grid connections of the IF amps V1E and V1F with a length of wire produced a crackling from the speaker, so there was some amplification, but a check on the anode and G2 of the mixer V1D, showed only about 10 volts HT on each. Of course, no signals were being received! Volts on the oscillator V1C and the RF amp V1B (or V3A in the R109A) seemed OK.

***Trouble with caps***

Time for something radical, so all the accessible 0.01uf paper caps, plus the two electrolytics C13A and C13B were replaced, bringing HT current down to about 40 mA, but what about the inaccessible caps? Knowing that electrolytic capacitors can often be re-formed, it seemed worth some time to try similar principles with the paper caps. They were rated at 350 volts and the anticipated HT would never exceed 200. So over a period of about 5 days they were cycled with full HT, current limited HT (lower volts) and HT removed, several hours for each, all with no volts on the filaments. Interestingly, after each off-cycle, with full volts applied at the start of the next cycle, the voltage on the anode and G2 of V1D increased until 90 or more volts was showing on each with the AVO, and the total HT current for the set was decreasing until it dropped to about 10 mA.
Time to apply LT. The HT current was now steady at about 30mA. Aerial applied, and yes...sounds from the speaker, but oh! - so very distorted. Sensitivity seemed adequate especially on the lower frequency range, but of course the set was stuck on full gain, and application of minus 25 volts bias on R10A had no effect, but what bias voltage was needed?
The original bias supply is somewhat peculiar being derived from a "pencil" type rectifier W3A capacitively coupled from T2A. The HT rectifier W2A is a bridge selenium type. After replacing C19A and C19B and disconnecting the secondary of T2A, about 150 volts AC was applied to the relevant connectors on W2A. HT dropped to about 140V and bias across C12K was about 30 however adjusting volume control R10A slider to full "volume" showed the bias reaching up to 70...clearly the bias line was being too heavily loaded. More paper 0.01 uf caps to change? This improved the situation though again some caps were hidden inside the IF cans, and it would have been a very time consuming job to undertake changing them, however after a similar cyclic procedure as used with the other inaccessible caps, plus replacement of R1E, minus 70 volts was showing with the volume control at zero, and yes, the "volume" control did have the desired effect.

***Success***

Now, CW was receivable, but SSB was tricky. The BFO output goes to the detector diode in V2A, the coupling cap being two twisted short bits of wire.....rubber covered and perished. There clearly wasn't enough BFO injection, and the BFO seemed unstable, or more accurately its frequency "juddered". This wire was replaced with a similar arrangement except the two new bits of wire used were about double the original lengths giving more coupling. This time when volts were applied and the BFO coil slug tuned properly, SSB was quite resolvable. The receiver including the BFO seems adequately stable and a tweek on the IF and RF cores improved sensitivity.




| CONDENSERS | | RESISTORS | | INDUCTANCES | |
|---|---|---|---|---|---|
| C1 | 5/36 μμFD. SEMI-FIXED | R1 | 1 MEG OHM ± 20% | L1 | 1·8/3·9 MCS. AERIAL COIL |
| C2 | 14/368 μμFD VARIABLE | R2 | 71 OHMS ± 5% WIRE WOUND ½ W | L2 | 3·9/8·5 MCS. AERIAL COIL |
| | | R3 | 4,700 OHMS ± 20% | L3 | 1·8/3·9 MCS. ANODE COIL |
| C4 | ·01 μFD ± 25% | R4 | ·22 MEG OHM ± 20% | L4 | 3·9/8·5 MCS. ANODE COIL |
| C5 | ·0015 μFD ± 10% | R5 | 22000 OHMS ± 20% | L5 | 1·8/3·9 MCS. OSCILLATOR COIL |
| C6 | ·002 μFD ± 10% | | | L6 | 3·9/8·5 MCS. OSCILLATOR COIL |
| C7 | 150 μμFD ± 10% | R7 | 10,000 OHMS ± 20% | L7 | I.F. PRIMARY |
| C8 | 150 μμFD ± 5% | R8 | 100,000 OHMS ± 20% | L8 | I.F. SECONDARY |
| C9 | 150 μμFD ± 5% | R9 | 47,000 OHMS ± 20% | L9 | B.F.O. COIL |
| C10 | 220 μμFD ± 10% | R10 | 1 MEG. OHM VARIABLE LINEAR | L10 | VIBRATOR CHOKE |
| C11 | ·002 μFD ± 25% TUBULAR | R11 | 270 OHMS ± 10% | L11 | L.T. CHOKE |
| C12 | ·1 μFD ± 20% TUBULAR | R12 | 150 OHMS ± 20% | L12 | H.T. CHOKE |
| C13 | 2 μFD 350 V POLARISED | | | | |
| C14 | 500 μμFD ± 20% | | | | |
| C15 | 75 μFD 12 V REV. | | SWITCHES | | RECTIFIERS. |
| C16 | 25 μFD 12 V POLARISED | S1 | 1 POLE 2 POSITION ROTARY | W1 | TYPE M3 |
| C17 | 400 μμFD ± 5% | S2 | 2 POLE 2 POSITION TOGGLE | W2 | SELENIUM No 13 |
| C18 | ·0012 μFD ± 20% | S3 | 1 POLE 2 POSITION TOGGLE | W3 | TYPE J25 |
| C19 | 4 μFD 350 V POLARISED | S4 | 1 POLE 2 POSITION TOGGLE | | PLUGS |
| C20 | ·05 μFD ± 20% TUBULAR | | | P1 | 2 POINT FOR BATTERY |
| C21 | 15 μμFD ± 10% | | VALVES | | |
| C22 | 25 μμFD ± 10% | V1 | ARP 12 | | TRANSFORMERS |
| C23 | 100 μμF ± 10% | V2 | AR 8 | T1 | TELEPHONE TRANSFOMER |
| | | | | T2 | POWER TRANSFORMER. |

Fig.2 R109A Circuit Diagram and Parts List

A replacement British made speaker of suitable size was found and bolted to the front panel. The transformer taps were adjusted, providing HT at about 180 volts and giving a worthwhile gain increase. The new PSU bits were secured

in the space originally intended for the spare valves...most convenient. The new "output" transformer was secured and testing commenced. Listening to some of the members who come on AM on 3.625 Mc/s weekday lunchtimes was a delight, indeed having to reduce the volume, and so reducing RF and IF gain undoubtedly improves readability, rather than operating at full RF/IF gain and relying on AVC as we often do. Selectivity seems better than a 19 set, though not as good as an R107, both of similar vintage. GKY1 didn't provide any problems. Listening to 80m SSB nets shows the set performance quite acceptable, bearing in mind its age and design simplicity.

***Conclusions***

Was it worth it? Well it certainly was a labour of love - as originally anticipated. The hours put in over a four week period were rewarded with an adequate performing though somewhat rusty old receiver, but something quite suitable for the outdoor shack/workshop where environmental conditions are not conducive to reliability of electronic equipment. The job had cost nothing except time with all "new" parts coming from the "spares box". Retaining authenticity was not the prime objective, the writer is not a fan of vibrator power supplies anyway, and a mains supply requirement is often more convenient for home use than finding 6 volts dc at an amp or two. Overall, if there had been more interesting things to do at the time, I imagine the R109 would still be rusting away in the garage, but as it is, the result is satisfying and was worth the effort. Some new paint, near original colour, for the front panel plus a wooden box for the set are thoughts for the future, unless replacements can be found.

***Howard Aspinall, G3RXH***

| *Item* | *Description* |
|---|---|
| 1 | Watches, G.S. Mk.II |
| 2 | Bulbs,6-volt J. |
| 3 | Straps carrying H |
| 4 | Aerial base No.10 |
| 5 | Aerial base No.8, Mounting No.3 |
| 6 | Aerial base plates, Connector No.2 |
| 7 | Antennae Rod F.16ft, No.1, comprising:- |
| (a) | Hammers, engineers, ball-pein, 8oz. |
| (b) | Straps carrying H |
| (c) | Aerial bases No.11 |
| (d) | Aerial bases No.11, Spikes |
| (e) | Antennae Rods F, Cases carrying No.1 |
| (f) | Antennae Rods F, Straps retaining No.1 |
| (g) | Antennae Rods F, Straps retaining No.2 |
| (h) | Antennae Rods, Sections No.1 |
| (i) | Antennae Rods, Sections No.2 |
| (j) | Antennae Rods, Sections No.3 |
| 8 | Condenser X.5, 5KV, Mk.II |
| 9 | Connectors, Single No.10C |
| 10 | Connectors, Single No.10D |
| 11 | Connectors, Twin No.78 |
| 12 | Lamps Operator No.6A |
| 13 | Leads Counterpoise No.2, Mk.II |
| 14 | Receiver Headgear D.L.R. Double No.1 OR |
| 15 | Receiver Headgear D.L.R. Double No.2 |
| 16 | Reception Sets R109A |
| 17 | Reception Carrier No.1 |
| 18 | Working Instructions Pt.1 |
| 19 | Satchels, Signal |
| 20 | Valves, W.T. type AR8 |
| 21 | Valves, W.T. type ARP12 and ARP36 |
| 22 | Vibrator No.2 |
| 23 | Voltmeters, pocket, 250-volt No.2 |
| 24 | Voltmeters, pocket, Cases |
| 25 | Batteries, sec, port. 6V, 40AH Mk.I |