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Receiver R1155

Philip Moss M0PBM describes this classic wartime receiver.

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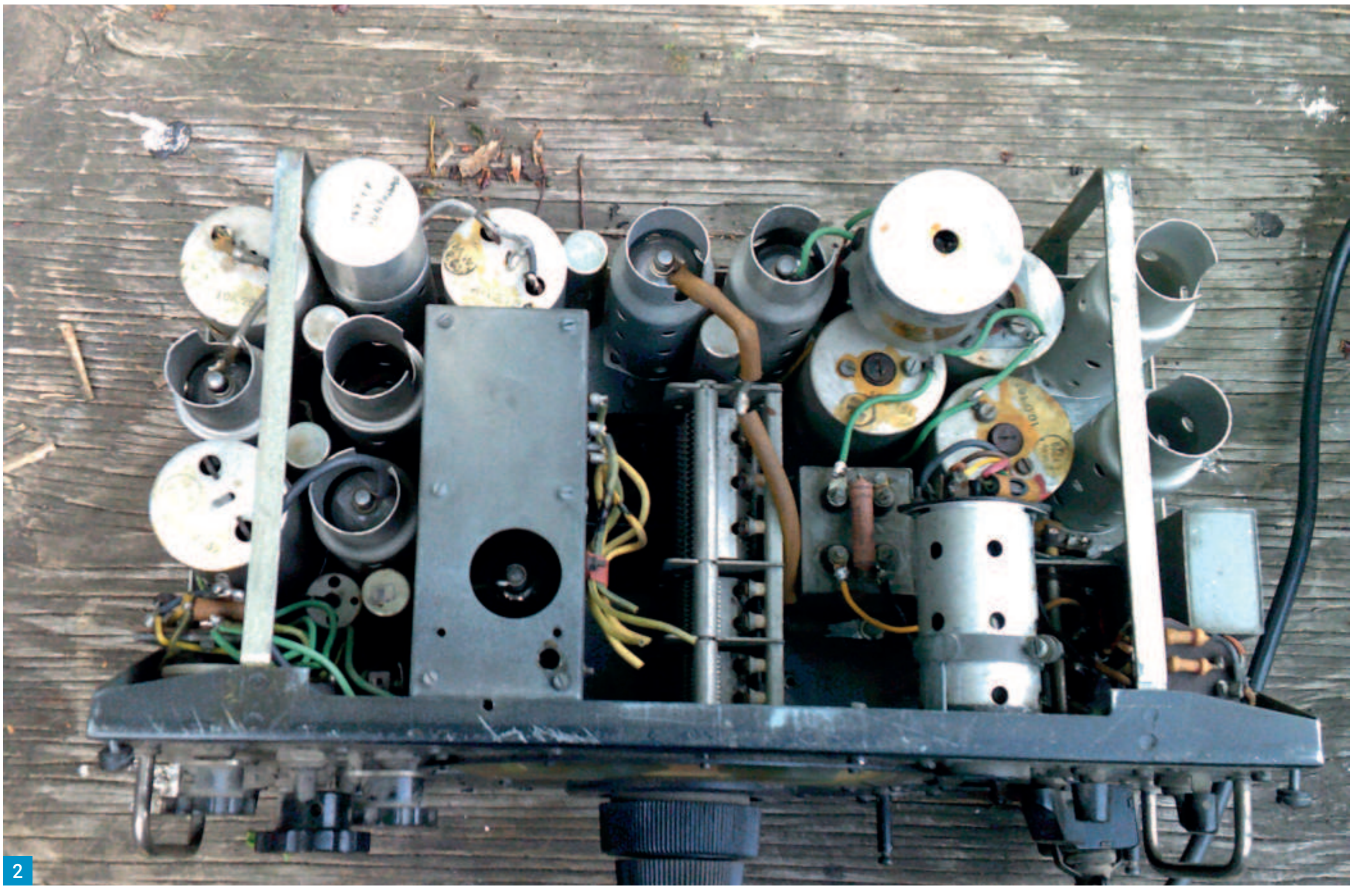
This receiver is one that was donated to the British Vintage Wireless and Television Museum, Dulwich. Unlike most, it was unmodified, and little touched, and that not irretrievably so. A piece of red plastic wire to the lamps was the only immediately visible change, and later it was noted some of the coils in the RF/oscillator pack had been adjusted. As so many of these sets are butchered, it was a great relief when I found it in this condition.

There are certain sets that get the title 'iconic' and this is one of them. This set is almost always described as being the radio on the Lancaster bomber, the most well-known and successful of our four-engined bombers. While this statement is true, it is truer to say it was the radio on all our four-engined bombers. It was not restricted to that service for although that was what it was mainly used for and designed for, it was used elsewhere. Indeed, there were two essentially different types. The air-borne was in aluminium, but there was a ground-use version with cheaper but heavier steel construction.

This set was not by any means the best GB radio of the Second World War in terms of specification. However, it has a most important distinguishing feature. It was not simply a normal set, but specifically designed for direction-finding, hence the very unusual circuit. Until I had the circuit, and indeed the manual, I could not understand it nor indeed how to initially power it up, beyond getting the heaters on, which does not attract many marks! I initially connected HT negative to chassis, logical but wrong. The chassis actually floats about 20V up when correctly connected. This difference forms the bias rail for many valves. It still didn't work until I found one of the frequency changers was a KTW61 – valves transposed. With them in the right place, it worked, after I noted an all-black resistor with one end cut, which I just soldered back. Note some sets will work with a pentode rather than a triode-hexode. If they have a separate oscillator, as in my CR100, a pentode works fine. Here the triode is used as intended, but this is not the best for good stability. A problem immediately encountered was the Jones plugs to connect it. As is usually the case, it did not come with them, and while a temporary solution was to solder wires to the back of the plugs, that was not going to do in terms of having the radio displayed. Also, how to power it? It would run off a dynamotor/rotary transformer in the aircraft, itself from the 28V DC supply. I built a mains PSU, from available parts from my collection, which also powered another of the Museum's sets, the HRO Senior/R106 (therein being another article). As a matter of interest, I decided to see how low an HT



it would work at – about 30V! At that point the local oscillator stopped. Not that I am suggesting you run it at this, but if you have a convenient supply well under the 250V intended, it will be fine.

Description

I am hampered in describing the circuit by the fact that as with my Murphy CR150/ Navy B40D receiver article, the circuit, even the simplified one, would take up far too many pages. As with that set, the manual is available online at the excellent VMARS website (below) for those with the interest in the detail, or who come by one of these and need service data. As is usual for military sets, there were several versions, and the frequency coverage I quote here is not the same for all. There are five bands: 75/200kc/s, 200/500kc/s, 600/1600kc/s, 3/7.5Mc/s and 7.5/18Mc/s. This is not ideal for shortwave listeners, nor does it cover the full LW and MW, and it misses out several amateur allocations, but then it wasn't designed for us. The set in use required three aerials: a rotatable loop, for the direction finding, a wire from the radio operator's position to the tail, and a longwire on a reel for the LF end of the spectrum, used for both normal and direction-finding. The loop was in a drum, had a number of turns on it, and went into the balanced input on the 4-pin Jones plug. The others went in on the multi-pin connector along with all the other connections.

www.vmars.org.uk

Valve Types

Before I go through the circuit, a note about valve types. They are all listed as Air Force types, therefore starting with V. I am not going to go over the strange world of military nomenclature. If this is new to you, you may wish to refer to my Murphy CR150/ B40D article of May 2021. I have, however, translated the valves used into their normal types, all Marconi/MOV. To do this I first had to translate them to CV types, then look up their equivalents. One, V10 the V.I.103, didn't have a VR number, but is a tuning indicator, or as more commonly known, Magic Eye, a Y63. V1 and 2 are VR99A, equals CV1581 or E1341, described as an unmetallised ECH35. Have you ever seen one of them (excluding ones where with time/damp it's fallen off)? No, neither have I. The valves fitted are very much the shape of ordinary X65s. V3, 5 and 6 are VR100 CV1100 or KTW61, much like 6K7G without the internal screening. V7 & 8 are VR101, CV1101 or MHLD6, or double-diode medium impedance triode, rather like 6Q7G. V9 is a rather fat double triode with one grid on the top cap, rather like 6C8G, but is CV1102 and a BL63. I will be referring to valves by their common nomenclature hereafter.

Photo 1: The front panel.
Photo 2: Top view.
Photo 3: Bottom view.
Photo 4: The PSU.

The Signal Paths

The set has two different signal paths, the first being the straightforward radio receiver. As military sets go, it isn't the best by any means, with limited facilities, and without the switched bandwidth options. It's a lively enough set, and brings in many stations. It is for the reception of AM/RT voice, and CW, so it has a BFO, without the facility to choose your tone, but there is a pre-set accessible through the front panel.

On this path there is a tuned RF amplifier, V3, KTW61 followed by the frequency-changer V4, X66. This is run in 'normal' mode with the triode as the local oscillator, noting so many military sets where it is used but with an external oscillator. There are then two IF amplifiers, which are common to both functions of the set, V5 and 6. Note that their screen grids are fed from potential dividers, and that there are no cathode resistors –

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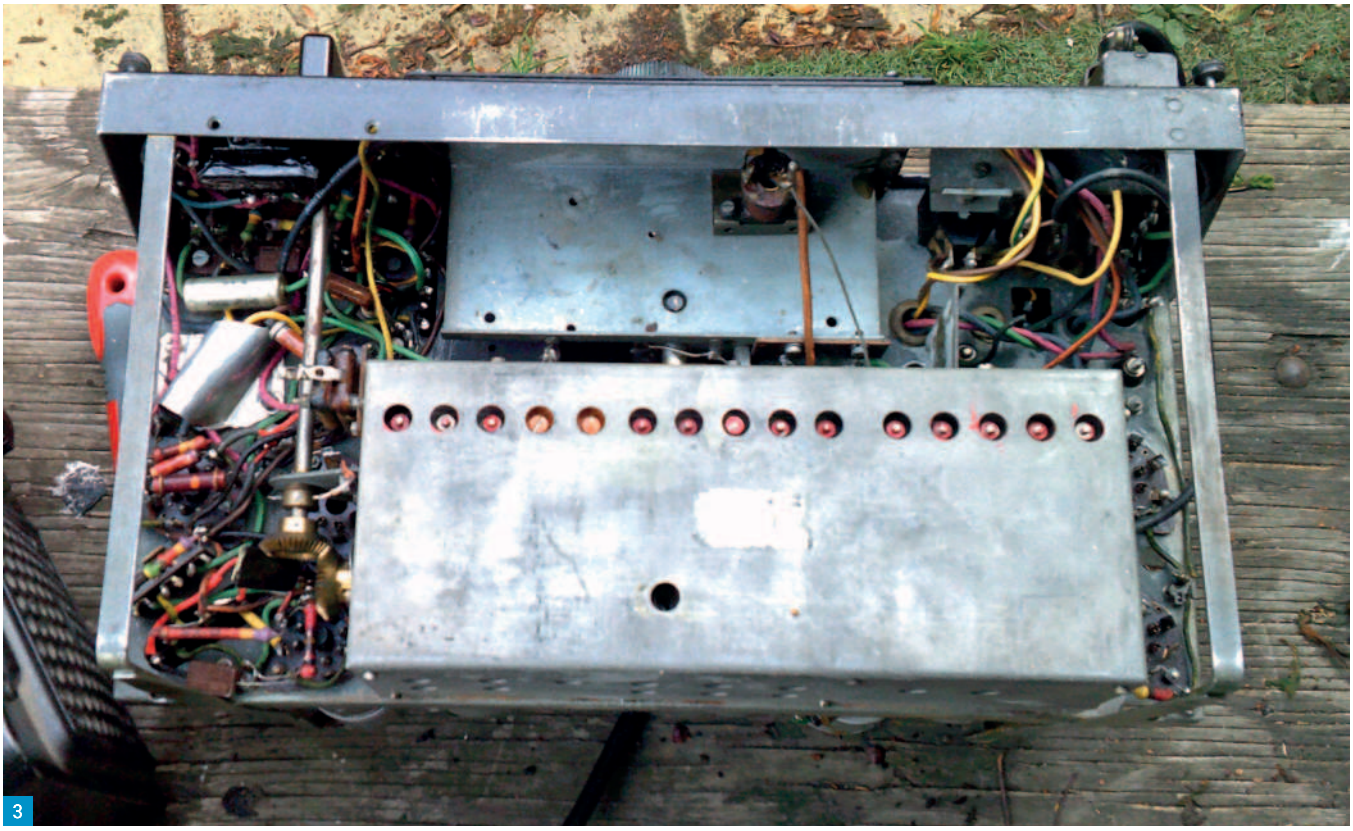

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they run fixed bias plus AGC. The third IFT (intermediate frequency transformer) is not conventional. The anode winding has two taps on it. One drives the AGC via C19, using both diodes in V7, MHLD6. The second tap goes to one diode on V8, and to one grid on V9, BL63, which is in the direction-finding circuit. The 'normal' detection is taken off the IFT's secondary, and uses V8's other diode, and then is amplified for headphone level by V8's triode, with transformer coupling to the output.

Direction-Finding

OK, you have had the easy bit. The direction-finding requires the user first to find the null direction on the loop aerial, as the null is deeper than the peak is sharp, then add in the signal from the sense aerial, which with the directional aerial set for null just gives an 'ordinary' not very directional signal. The use of the loop alone enables you to find a path where the transmitter is, but like a radio with a ferrite aerial, it does not tell you which end of it is aimed at the transmitter.

The sense antenna input is alternately added in-phase and out-of-phase to the loop signal. This is done by switching the two triode-hexodes alternatively on and off and adding their signals in the balanced transformer in their anodes. The two triodes that would normally be used as local oscillators are here used to produce the switching signal, at either slow, 30c/s or fast at 80c/s. This is achieved by switching in extra capacitors for the LF signal. The reason for the two rates is that for W/T the faster rate is needed, presumably so that a character cannot be missed between cycles, but for R/T the slower rate does not interfere with intelligibility of speech. The sense aerial input is applied equally to the first grid in each of V1 and 2, the oscillator is on the third grid. The resultant signal is then fed to the RF amplifier, and then to the normal mixer for the conventional receiver.

A small aside: note that many of this type of valve used the third grid as the signal grid, and indeed the X66 used in the straightforward receiver does. I have always thought that using the first grid as signal input would give better results and reference to the famous *Radio Designer's Handbook* by **F Langford-Smith** seems to confirm that after a long discussion of different designs of mixer valves.

Simultaneously with the switching of the mixers, the switching signal is fed forward to the double-triode V9, BL63. This drives the coils in the special meter, called the Visual Indicator. This is a twin movement meter, with the halves either side of the centre where there is a vertical white line. The signal moves the needles up as would be expected dependant on the signal strength. When the system is balanced and the plane is flying directly along the path of the radio beam, the needles cross over the white line. If they cross either side, then the plane is off course. The pilot then swings (their word, not mine) the plane till they are on the centre line. The signal drive to the BL63 is the rectified output from the detector diode. The switching process gives a result of the fixed aerial signal plus the loop output, the other fixed minus loop. When the loop signal is nulled, there is just the fixed aerial signal so both meters read the same. Not surprisingly, for this to work the set itself needs to be very accurately balanced, and that can be relied upon to drift with time and also, I would assume, with temperature, which presumably swung violently between ground and flying-height. To allow for this there was a balance control. Direction finding was available on several wavebands. This meant that for a particular operation, different transmitters could be used, such that the enemy wouldn't know which to jam.

By adding and subtracting the loop signal, the difference in meter reading was doubled for the same amplitude of remaining loop signal, thus doubling the offset from the centre line where the needles crossed. Considering how precise the system needed to be, it was surprising there were few close-tolerance resistors in it.

A full explanation of the technique is to be found in publication *AP1093*, Chapter XVI.

This as with the circuit is to be found on the VMARS website.

Work

The first job after getting it to do something, was to find the Jones plugs. The Museum has some odd plugs, and I did succeed in putting a suitable plug together with a shell, so it could be wired properly. As the direction-finding wouldn't be in operation, I didn't need the 4-pin plug. Initially, I used my Solartron variable HT power supply to run it, which also has a heater supply.

At this stage I had four of five bands going, with lots of signals. Band five though was dead, that being 7.5 to 18Mc/s. Suspecting oxidation of the switch contacts, I tried turning it back and forth but that didn't work. New repair method – leave it on that band. When next tried, it worked.

Modification

As this is a Museum set, and also as few remain unmodified, I did as little as possible. However, there was a need to drive a speaker, and although the output stage was intended for headphones only, I was aware that a signal triode is quite capable of giving adequate level. The existing output transformer was the wrong ratio and had a very high resistance primary, which wasn't going to do. What I did was the minimum. Using a small output transformer of the type we had a lot of, used in many AC/DC mains sets, including the much-sought-after Bush DAC 90 (though not by me), I drilled two 6BA holes in the runner under the chassis on one side, and connected the output triode to this, leaving the original in place, but with the primary disconnected one end, and the wire instead connected to the new transformer. The output was taken via the large Jones plug to a jack socket. This modification is reversible, except for the two holes.

Under the chassis I found a new capacitor hanging, and a cut wire to a slim can housing three capacitors. These are threaded and mounted through the chassis. Another was missing, and capacitors added under the chassis. These were all 'Liquorice Allsorts' type Mullard C280, the colour-coded ones. They were not well installed with their leads not cut as short as possible so I rewired them. Another tube got hot so obviously another leaky capacitor. Cut lead and add another more appropriate axial-leaded type in its place. I had been getting multiple whistles, so clearly instability, but this went when the new capacitors were connected. I then ran the set with 300V HT and no heaters to see what if anything got hot. Nothing did. The set drew 25mA, a substantial portion of the running total, but that was fine because the set has several divider chains across the HT. I noted missing caps to the screening cans on the valves, though they are adequately screened not to go unstable. The top-cap connections to the two X66s in the direction-finding circuit were missing (cut off). Replaced wires and top cap connectors, not that this part of the circuit is ever likely to be used. Found those valves were missing HT in most of the master switch positions, as a wire had been cut at switch (restored).

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Something that went badly was trying to get the tuning to feel smooth. I relubricated it and it was no better. There didn't seem to be much to go wrong, so I have left it in a frankly unsatisfactory state. I consulted two people at the Museum who have had these sets, but neither could remember what they felt like. As it happens, we have since received another donated set and its tuning does not feel much better. Absolutely lamentably this set demonstrates the butchery I have referred to, with the DF circuits unwired from valve sockets. Quite stupid.

The BFO didn't seem to work well. I measured its frequency as 271kc/s. It should be close to the IF of 560kc/s. The coil had been got at. I knew this as the slug had one side broken. The slug was jammed, so carefully heated with soldering iron, which melted the wax, and allowed me to adjust it. As I did a whistle was heard, so it had been ludicrously mis-adjusted. Took slug out, cleaned, and put in upside down, so able to use undamaged slot. Strangely, when correctly set for zero-beat, the frequency was only 282kc/s so it looks as though they used the second harmonic. Strange.

I realigned the front-end. I had great difficulty with the 3/7.5Mc/s range. Again, a damaged slug, which I replaced. I needed to add 20pF across the trimmer before it would align. I had to use the soldering iron trick again to free the cores. I did the alignment with the cover off to allow access so when it was put on it pulled the tuning a bit but it was good enough. The reason I couldn't align with the cover on was because a special very slim 4BA tube spanner was needed. Unusually, I didn't do SNR (signal-to-noise) measurements. The front-end tuned circuits are all in the box that can be seen under the chassis.

Conclusions

An unusual set and therefore more interesting than a standard receiver even though it won't give the same facilities as one. For general listening it is fine, and with a little ingenuity a slim output valve could be fitted without removing any of the original components. I did contemplate doing that. That would allow full speaker volume. Alternatively, a power stage could be added in the external PSU. Not a large set, and most of us have too little space for all the sets we would like to acquire, and not needing much in the way of a PSU. It is also said to have the most attractive tuning scale of any British set of the Second World War.