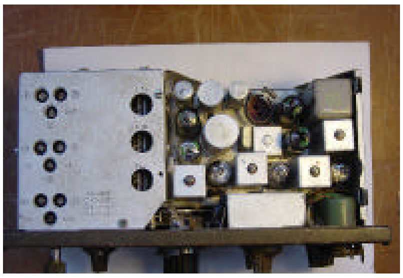
The Angrynine – a voyage of discovery – Part 1.

Mike Hoddy G0JXX

I acquired my GRC-9 about 9 months ago along with the Hallicrafters SX-16 mentioned in my article in Radio Bygones Issue 83 (June / July 03). I had heard about this radio from a number of sources but knew very little about it until now. As the details show this is a very versatile radio and has a good reputation in military radio circles especially in the US. It does appear to have had a long history from immediately post war replacing the BC1306 (3.8 to 6.6 Mc/s but uses exactly the same supplies), through to Korea, Vietnam, Congo (Belgian Army) and apparently the Contra rebels in Nicaragua! It is an excellent set as an entry - level introduction to our part of Amateur Radio and is very affordable, almost brand new ones are around £250 but good, tested used ones are in the region of £100 - £150 from a couple of good suppliers – see web addresses at the end). Mine is a little tatty but I don't mind that as it shows it has been used.

Technically the set is a traditional design using directly heated valves (1.4, 3, 6.3VDC). The PA valve is a 2E22 with approximately 500V on the anode and 6.3VDC @ 2.0A LT. Although it operates as a transceiver with full QSK it is in fact a receiver (RT-77) and transmitter and could be used / worked on separately. There is a variant that uses a transistor PSU / inverter for powering the receiver as a separate unit.



Receiver top view

Initially my set didn't work but was pretty much complete. Aided by some Jimi Hendrix playing in the background (well, it is a Vietnam era set!) I removed the units from their case and after a few false starts removed the connecting cable from the TX to the RX. This is quite simple if you know how. There are NO screws to remove and all it takes is a little gentle leverage with a screw driver and then pulling on the lugs. Do not yank (no pun intended) on the cable, as you WILL pull out one or more wires.

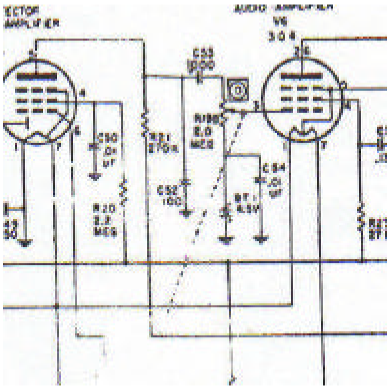
With the Receiver on the bench, the right way up, the valves can be accessed after removing the clipped in plate and valve shields - though a word of caution is needed. In the Spares Kit (Part number BX-53) there is a valve removing tool (type Metox no. 16183) and it, or something similar, is needed as the valves are very close to the screened cans and unless you have very thin fingers it is almost impossible to get them out. The valve tool is like a large spring or coil with a looped handle (see picture) and the theory is that you push this onto the valve and the action of pulling upwards forces the coil to tighten on the bulb. It sounds dangerous but it does work. Once the valve is out the fun starts as the coil is tight on the valve and the more you pull the tighter it gets. The technique seems to be to gently push the coil from underneath and ease it off that way but it takes practice. I had loads of practice as my example had been 'got at' by the 'Phantom Valve Swapper of Old London Town' and they were all in the wrong position or wrong type!! When replacing the valves I found it better to use my fingers rather than the tool as once the valve is in it is the devil's own job to pull the tool out without removing the valve again!! Also be very aware that the lettering on the valves comes off with the slightest touch so I would advise using a permanent marker pen with a fine point and write on what they are.

As you can see the boiler plate was missing, which is a shame (my thanks to Roy at MilRadio for supplying spares) but it clearly shows the date stamp of 7th September 1960 and is manufactured in France by TRT, Paris.

With my example, once I had put the valves in the right position, the set burst into life. The 3Q4 delivers quite a punch for a battery valve, certainly enough to drive a high impedance speaker to levels that allowed the set to be heard when used outside at Blandford!! Actually, the audio quality is quite good and listening to AM Broadcast stations was pleasant enough. BFO injection is at a high level and allows CW/ SSB to be resolved although there is no variable control and by backing off the RF gain control the quality improved dramatically. The tuning rate is too high for modern band conditions, especially on 40M, and it would be possible to fit an external slow motion drive but the risk would be that the set's appearance would be spoiled and that is something that should, in my opinion, be avoided. However, it may be possible to do a temporary modification without touching the case and I am working on that.

Metox tube puller

GRC-9 mounted in a jeep (French Army?)



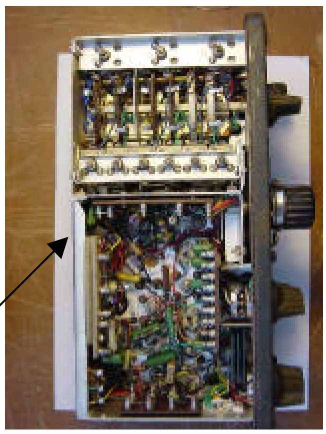
As you can see from the circuit there is a GB battery providing –4.5V to the grid of the Audio Amplifier and the one in the set was manufactured in Crawley, Surrey in 1964. It goes without saying that it was dead but in practice it didn't prevent the set from working. I would be interested to know what function this provides. In the end I removed the case to reveal a number of 'hearing aid' sized cells and these were discarded. I then left the battery open circuit and short circuit as an experiment but there seemed to be no detectable impact? The battery pushes into a socket and is held in place by a screw clip. The battery will come apart quite easily by cutting the case around the bottom join and gently pulling apart. Once apart you can then either insert enough 'hearing aid' batteries to make up the 4.5V or AAA cells (though they are difficult to fit) or something similar but as I said earlier it doesn't seem to make any difference. The case can be reassembled and sealed using plastic model glue.

[*Without the bias battery, the valve would draw an increased amount of anode current, both to its detriment and that of the HT battery, if running on batteries. I'd also expect some audio distortion to be evident – Ed.]*

Power Supplies

The set is designed for battery use on receive and as a consequence it is looking for a well smoothed LT and HT (though arguably the LT is more important as the valves are directly heated) and if using a mains unit it is worth spending time on getting the ripple down to miniscule levels. I found that using a variable circuit with a LM317T (1A) was quite acceptable either at the 1.2V reference level (i.e. Vadj. tied to ground) or adjusting up to 1.4V as per the specification worked well care should be taken to make sure that the output voltage is clamped to avoid more than 2V being presented as this could blow the valves. There is a VR105 voltage stabiliser in the transmitter section so if testing the receiver as a stand-alone unit you will need to provide additional stabilisation. It is possible to use the DY-88 dynamotor unit of course but this is bulky. If you want to test just the receiver the following socket information should be useful. Note that the pins are numbered on the inside of the receiver so to make sure you will have to take the base plate off. Remember the set will not work without a speaker or phones inserted in to the socket – you could just put a plug in if you didn't want audio.

Receiver pin connections	
1	Sidetone from Tx
2	Net +105V
3	Receiver +105V
4	+105V
5	Ground
6	Receiver 1.4 V
7	Mod Tube control
8	Receiver aerial
9	Receiver aerial



Receiver Socket. (*note, the pins are numbered inside the receiver*)

AN/GRC-9 HF AM/CW/MCW Transmitter-Receiver Specification

Source: TM 11-263/TO 31R2-2GRC9-1/June 1956 (thanks to WB6FZH web page)

Transmitter

Frequency Range:

- Band 1 --- 6.6 to 12.0 Mc/s
- Band 2 --- 3.6 to 6.6 Mc/s
- Band 3 --- 2.0 to 3.6 Mc/s

Transmitter Type: Crystal or Master-Oscillator power amplifier.
Crystal Channels: Two per band
Types of Signals Transmitted

- CW, MCW, and Phone (AM)

Distance range

- CW (Continuous Wave- Keying carrier)
  - Ground Operation: 30 miles
  - Vehicular Operation: 20 miles
- MCW (AM modulated CW- Keying tone)
  - Ground Operation: 20 miles
  - Vehicular Operation: 10 miles
- Voice (AM modulated- Microphone)
  - Ground Operation: 10 miles
  - Vehicular Operation: 10 miles
- Antennas
  - Ground Operation: Whip or Long-Wire
  - Vehicular Operation: Whip
- Type of Modulation: Amplitude
- Number of Valves: 5
- Weight: 29 lbs
- Power Output- PE-237/DY-88/DY-105/PP-327 power supplies {GN-58 PS}
  - In "HI" position
    - Phone/MCW: 7 Watts {3.6 Watts}
    - CW: 15 Watts {10 Watts}
  - In "LO" position
    - Phone/MCW: 1 Watt {1.2 Watts}
    - CW: 5 Watts {5 Watts}
  - Power Requirements: Early/Late Model
    - Transmitter Plate Voltage- 475 @ 90 mA/580 @ 100 mA
    - Transmitter Filaments- 6.5 @ 2 amperes
    - Keying Relay- 6.o @ .5/6.9 @ .575 ampere

Receiver

Frequency Range

- Band 1 --- 6.6 to 12.0 Mc/s
- Band 2 --- 3.6 to 6.6 Mc/s
- Band 3 --- 2.0 to 3.6 Mc/s
  - Receiver Type: Superheterodyne
  - Types of Signals Received: CW, MCW, and AM Phone
  - Number of Valves: 7
  - Weight: 8 lbs
  - Intermediate Frequency: 456 Kc/s
  - Method of Calibration: Built-In crystal oscillator
  - Calibration points: 200 kc intervals
  - Power Required
    - A- Power 1.4 volts at 450mA (Heater Voltage)
    - B- Power 105 volts at 20mA (Stdby: 17mA) (Rx HT)

Antenna: Same as AN/GRC-9 Transmitter

To test the basic functions of the receiver you need to apply 105VDC to pins 3 + 4 and 1.4VDC to pin 6. The aerial goes to pins 8 and / or 9 and ground / 0V on pin 5. Note that Pin 5 is offset.

Although I had tested the unit on the bench into a dummy load and with 500V on the anode the set would give around 18 – 20W RF into a dummy load or on the main aerial I hadn't had any QSO's from my home QTH. The target was to get the set working in time for the Royal Signals Association event in Blandford. I had built a mains PSU as had Simon 'GFN but for whatever reason neither of these liked the Inverter unit that we needed to use as /P operation would be needed.

Accordingly I fired up the DY88 dynamotor unit and it all seemed to work but is noisy when the dynamotor kicks in – plus the initial drain on the 12V battery is enormous.

However, on receive it uses a couple of Vibrator packs so at least we would be able to demonstrate the set. Thank goodness I stopped using it on transmit just before the Land Rover battery completely died.

At Blandford we had rigged up a Doublet aerial (30' twin feeder down lead and 55' in each leg) to a mast on the Land Rover. As you can imagine the Royal Signals camp is awash with RF of varying types so operation on 80M was out of the question during the day. I tuned the set to 40M however and it was very lively. Using the original key (J37) I sent a couple of CQ's and the first station that came back was a DL4, he gave me 559 , along came a F6 and another DL in fairly rapid succession and that was with 15W. The receiver audio bandwidth is too wide for general use on a band like 40M and if serious operation was envisaged you would need a CW filter of some sort (external, unless you want to modify the set internally). The CW note is chirpy and that needs to be looked at and there may be modifications needed if it is to be used seriously.

There are far to many accessories and variants to mention here but I recommend that you look at Mark Roubos web site (see below) where a comprehensive catalogue of variants and special sets are located.

Since beginning to write this article I have acquired a second set and that had a nasty little fault in that the 500V HT line measured 120Ω to ground! The fault lay in a decoupling 0.01µF capacitor but more on that in Part 2…

Useful web sites / addresses

www.milradio.com - stocks of GRC-9 and spares

www.Armyradio.com - stocks of GRC-9 and spares

http://members.aol.com/tcsopr/index.htm - Pictures of GRC-9 and other good vintage stuff

www.angrynine.nl - Mark Roubos page with lots of special sets and information

www.fairradio.com - USA stock of parts and manuals

The GRC-9 Part 2,
the journey continues....

Mike Hoddy, G0JXX

The Transmitter, Power Supplies and problems.

In Part One I wanted to give a flavour of the GRC-9 as a good entry-level rig and focussed mainly on the receiver. In this part I want to look at the transmitter, a suggested power supply and problems that may arise when using the rig.

Incidentally the power supply described here is one I put together to carry out testing and the final version will be more robust but please do take care if copying any circuits as I can accept no responsibility for shocks/swearing or death, don't forget there is at least 500V floating around - take care and keep one hand in your pocket!! Even switched off the capacitors carry a bite. If you have better versions send them into the Editor as we are always looking for ideas to get round the perennial problem of powering up vintage rigs.

The GRC-9 transmitter is a fairly conventional master oscillator, buffer amplifier / doubler and power amplifier design with low - level modulation. It is based on the 3A4 valve (2.8V heater.) using three for the MO, BA and modulator with a

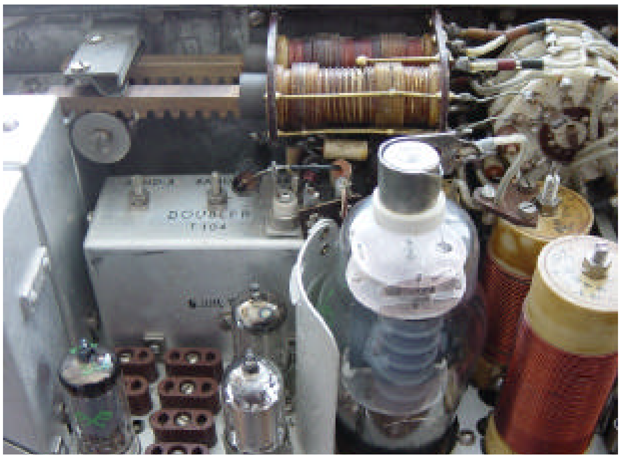
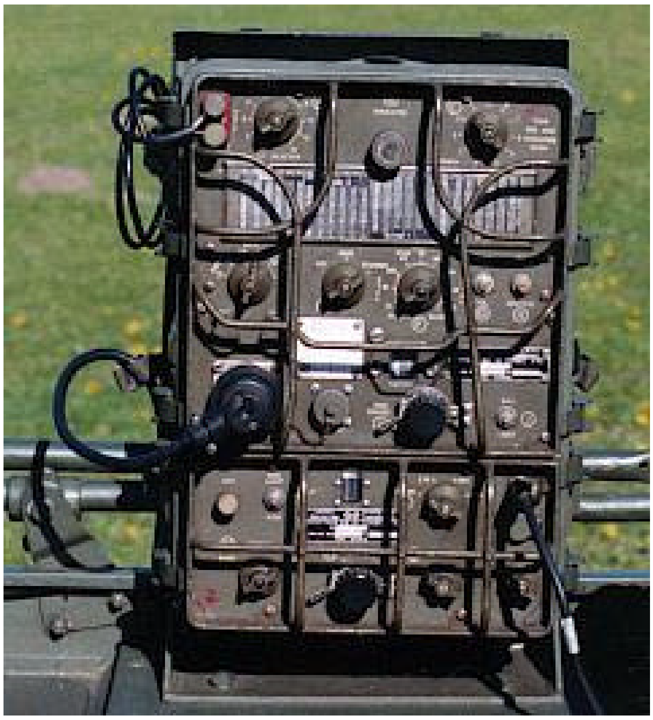


Fig. 1 The 2E22, doubler coils, Band-switch and variable permeability loading coils can be seen.

2E22 power pentode in the PA. Basic output is A.M., MCW and CW.

One word of warning is that the 2E22 is very expensive to replace (in the region of £40) as a single item so it makes sense to buy at least one Spares Kit type BX-53 from one of the suppliers mentioned in the last article as they are usually around £18 and contain spare valves including the 2E22 (check to make sure before you buy).

When the transmitter is removed from the case (remember to disconnect all power leads and the Tx to Rx lead) you can see the 2E22 quite clearly and the location of the three 3A4 valves and crystal sockets are visible once the retaining cover is removed.



The 2E22 is very hard to remove as it is gripped by screw clips and the pins are tight. Under no circumstances try to pull out the valve by the glass envelope, I did and it came away in my hand leaving me with the wires showing and the socket still in the holder!! A better technique is to loosen the screws and push the pins carefully, one at a time, from underneath.

There are 2 crystal positions per band (1A, 1B 2A, 2B, 3A, 3B) and the calculation is: - **2 x fundamental crystal frequency = Transmit frequency**, for example to transmit on 3.577 Mc/s you will need a crystal cut for 1.7885 Mc/s in band position 2A and if you wanted 3.615 Mc/s a crystal for 1.8075 Mc/s should be inserted in 2B. Using the chart on the front of the transmitter the Frequency Control is set to the desired frequency and the Antenna Tuning control adjusted to get maximum brightness from the indicator and a note made - in pencil! - on the crystal chart. This has to be done for each crystal for rapid changing. Crystals should be fitted that give a transmit frequency in the range indicated on the chart **(Band 1, 6.600 - 12.000 Mc/s Band 2, 3.600 - 6.600 Mc/s Band 3, 2.000 - 3.600 Mc/s)** as you can see there is some cross over, Band 2 does work on the 80M band!

It is possible to tune the higher portion of the 160m band, with my examples the limit seemed to be 1.983Mc/s but that is without any retuning or realignment. I suspect it will depend on your example and I know of models going lower.

To test out the frequency range I connected the radio set to HI CW to a dummy load, 50Ω, and Power Meter and set the antenna setting to DOUBLET and some variation of power output was noted –

Band	Doublet setting (A)	Dial (I)	Frequency	Power out
Band 3 HF	10	30 / 0	3.646	5W
Band 3 LF	9	00/0.69	1.983	15W
Band 2 HF	11	30/0	6.759	15W
Band 2 LF	11	00/00	3.546	18W
Band 1 HF	11	30/0	12.292	15W
Band 1 LF	10	00/00	7.000	5W

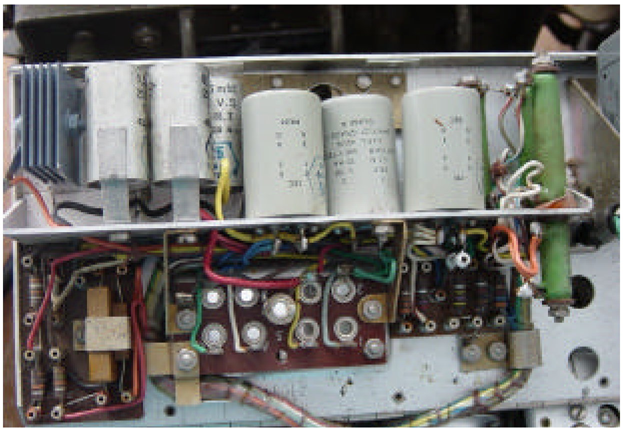


Fig. 2 Transmitter flap open, showing Rx socket

To gain access to the valve bases and components there is a hinged flap, which swings up to show the underside. I found that placing the Tx on it's front was the best way to get access after removing the screws marked "A, B, C, D" around the edge - this instruction is marked on the lid itself. If you decide to place the transmitter upside down (i.e. resting the top on the bench) just be aware that the anode of the 2E22 is very close to the bench and if there is any bits of solder, washers or other conductive material underneath you may get a nasty surprise if HT is present, also if you tilt the rig back in this position there is a high chance that you will break the cap off the valve or crack the glass - I recommend you don't do it!

In figure 3 you can see the cause of the 120Ω resistance to ground on the 500V line just below the 2E22 valve base. The left hand brown capacitor is a 0.01µF de-coupler from HT to ground and that had become low resistance; it produced a very lively bang and a lot of smoke. It is not easy to gain access to this capacitor without removing the tuning capacitor and a few other components. The manual gives clear instructions how to do this but, being lazy, I decided to leave the dead one in place, cut the leads and replace it on the upper side next to the 2E22, far easier if not so neat.

Very helpfully, there is a Meter Socket fitted that allows easy testing of the basic voltages and anode current which can speed up fault - finding. The expected voltages are marked in a table on the case and it is worth making a note separately as the anode of the 2E22 has 500V on it and moving the Tx around when live is extremely risky!

It is a safe bet that if you have bought a 'tested' rig you will need to check these voltages as I doubt it will have been run up on transmit even if it is working on receive. In most cases the voltages should be within a few percent (depending on what your supply voltages are) and if that is the case it's a reasonable assumption that there is nothing major wrong.

Measurement conditions in the manual are described as the transmitter is set for high power MO, CW operation with a 20Ω 20Watt resistor (non-inductive) and a 70pF capacitor dummy antenna connected - I suspect in the Reel or Whip positions and using a 20KΩ/volt meter. In the DOUBLET position into a 50Ω Dummy Load and careful loading the voltages read about the same using an AVO meter.

Brief circuit description and design features

The basis of the circuit is a Master (or Crystal) Oscillator followed by a Buffer Amp / Doubler, modulator and PA. The circuit shows a fairly standard design with no real challenges except that the supply voltages go through a relay system (K101 and K102 on the circuit diagram) and this can make tracing through voltages and signals difficult. The manual (TM11-263) is a valuable asset and until very recently I was relying on some photocopied circuits and information but I would advise getting a full copy of the manual if you can - costs are around £25 for a new one but it is a good

Metering Socket pins NB (+ / - = polarity)		**Circuit**	**Volts**
1+	**7-**	PA Filament Voltage	**+6.3**
2+	**7-**	PA Plate Voltage	**+500**
2+	**8-**	PA Plate Current (loaded)	Bands 1,2 and 3 **110mA** maximum
		Plate Current (unloaded)	Less than **30mA** on all bands
3+	**7-**	PA Screen Grid Voltage	**+275 V** maximum on all bands
4+	**7-**	PA Suppressor Grid bias (CW)	**+6.3V**
4-	**7+**	PA Suppressor Grid bias (Phone)	**-40V**
5-	**7+**	PA signal Grid bias	**-46 to -70V**
6+	**7-**	Master Oscillator plate voltage, Modulator plate voltage	**+105V**
7+	**7+**	Terminal 7 is grounded to the transmitter chassis	**0V**

it is a good investment - and an interesting read if you are into this sort of stuff as it goes into very great detail.

The modulator 3A4 (V105) is used for NET and side-tone operation in Standby / CW mode in the receiver. (Note: that the manual suggests that this feature can be used to test any suspect 3A4 valves). In CW mode the doubler and PA valve both have their anode and heater voltages applied and the MO anode is keyed (see 'problems' later). In phone mode the doubler and PA only have their HT and heater volts applied once the PTT is pressed giving an approximate delay of 2 seconds before transmitting. The relay K102 utilises the presence of a small amount of grid current in the PA to energise and this is a point where problems may occur if there are alignment or loading faults as if the relay doesn't energise then no output will be generated. It is also worth noting that the NET facility is disabled in PHONE mode - but works well in MCW and CW positions.

In Use

In use I found the neon indicator a good way of seeing quickly whether I had a match or not (after all, that is what it was designed to do) and generally the brighter and more balanced the glow, the greater the RF power going into the aerial.

Which brings me onto one major drawback of the GRC-9. On one QSO I noticed that the other station was reporting chirp on the signal and some drift (albeit slight). On the monitor receiver the note sounded more like a Dwah-Dwit Dwah Dwit rather than a nice Dah Dit Dah Dit. My first thought was that the stabilising voltage (105V from a VR105) wasn't happy or possibly the heater voltage may be dropping on key down. After testing the PSU under load this wasn't the cause and I did find a design flaw. The anode of the 3A4 Master Oscillator is keyed via a relay contact (17 on K101), bad practice and I can't think what the designers were thinking when they did that. I know the rig was primarily intended as a phone transmitter but even as a back up CW facility it didn't make sense. That would also explain the slight drift on key down though the VFO is stable after the initial contact.The only options are to a) live with it, and run the risk of not using it as much on CW (though phone is fine) or b) make modifications to switch another part of the circuit. This is a technical and a moral question given our general view that original is best even if it wasn't very good! As I like using CW, I am looking at making removable modifications (without touching the appearance - that is beyond the pale) that will allow the MO to run continuously and perhaps key the PA but still working on that one. Having now seen the circuit explanation for this in the manual it may not be such a major task and it should be possible to 'improve' the CW performance by adding a few links, which can be removed to return it to the original state.

On Phone the heaters and HT are disconnected from the doubler and PA until the PTT is used. This means that there is a short, but annoying delay, of 2 seconds before RF appears. The draw back of that is that there is likely to be more stress on the 3A4 and 2E22 if you follow the theory that valve reliability is at its best when they are left on. Bearing in mind that these are directly heated valves I suspect that the theory is correct but is a drain on power supplies when used as a portable station and that is probably why it is designed that way. The main modification that could be carried out is to disable the heater switching side of the relay K101 (pin 15) and wire in a link. I am inclined to leave the HT side switched but will look at it again in more detail later - if anyone has carried out any modifications on the GRC-9 let us know as we are keen to share experiences.

A Simplified Power Supply

The circuit values are nominal and represent the state of my junk box at the time. T9 is a small 105-0-105 transformer capable of about 60mA and I would have preferred to fit a small choke but didn't have one at the time. This is intended as a guide but realise it's less than perfect - better ideas very welcome. For simplicity there are no fuses shown, but have been fitted since and the bleed resistors (Rb) added as a safety precaution. The strange thing is that there is no load resistor inside the GRC-9 for the VR105 regulator hence adding one in the PSU circuit.

The numbers after the voltage are the pins on the J102 socket on the transmitter itself and in the free plug.

That's it as a brief run through of the GRC-9 and I hope you have found it interesting, especially if you are a newcomer (or an old hand but have never come across one of these before) and wondering where to start. If you do decide to get one of these radios and would like to swap information then do get in contact. One word of caution is that these are very popular with Jeep owners / Military re-enactors and that can over-inflate the price for cosmetically good ones that may be duff electrically - caveat emptor and use reliable sources, the web pages given in Part One may help and there are other sources. Certainly some suppliers have brand new ones with German or Eastern European markings and these are just as good even if you can't read the text!

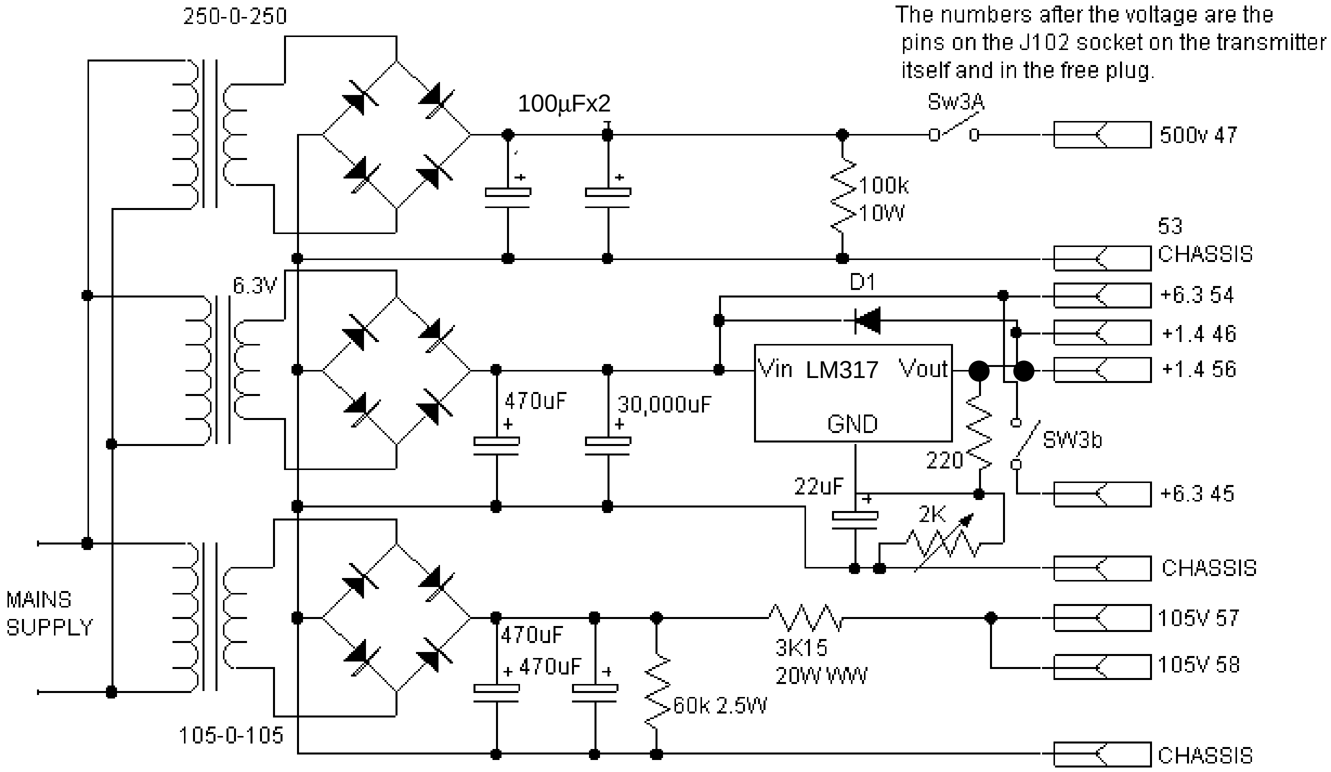


Fig. 3. The circuit of the simplified power supply as built by the author to test the transmitter and receiver.

Again we must reiterate that the voltages used in this unit can be lethal – if you have no experience of working with high voltage we strongly recommend that you obtain advice from someone more experienced!

Also we would advise putting three hefty diodes (e.g. 1N5401) in series across the 1.4V supply, negative of the diode to positive supply, to prevent a very expensive catastrophe in terms of destroyed valves, should the LM317 regulator fail – Ed.