Jim Toon, G0FNH

10GHz ATV The Easy Way
Part-1

At last year's British Amateur Television Club's convention, along with Dave G8NND, Steve G8JMJ and Bob G8OZP, I put on a display of my simple 10GHz ATV station. A great many people showed a lot of interest in the 10GHz set up because of the quality of the pictures and the simplicity of construction. Basically, all that I have done is to put together a lot of ideas from various publications, including the RSGB VHF/UHF Manual 4th Edition, The Microwave Newsletter and CQ-TV. My thanks to all.

1. THE TRANSMITTER

1.1. The Circuit Diagram and Construction

I use a separate transmitter and receiver utilising Solfan heads without the in-line mixer diodes for both. It is quite permissible to use Solfan heads with in-line mixers, but the results obtained are not as good.

The circuit diagram of the transmit modulator and Gunn diode power supply is shown in Fig.1, the PCB layout in Fig.2 and component overlay in Fig.3.

Once the board has been assembled and checked for short circuits and mis-placed components, **WITHOUT** the Gunn diode connected, apply the 12V supply. Confirm that by adjusting the 10-turn preset potentiometer that the output voltage to the Gunn diode can be varied between 6 and 10 volts.

Re-set the Gunn supply to 7 volts. Turn off the supply and connect the head unit, not forgetting to fit the 470-ohm resistor and the 0.01uF capacitor across the Gunn diode (see Fig.4).

WARNING: Gunn diodes are negative resistance devices, the lower the bias voltage, the lower the resistance and hence the higher the current. If bias below +5.5 volts is applied to the Gunn diode it may be damaged.

Also, NEVER look into a head unit with the power switched on. Similarly, it is inadvisable to look into, or stand in front of, an

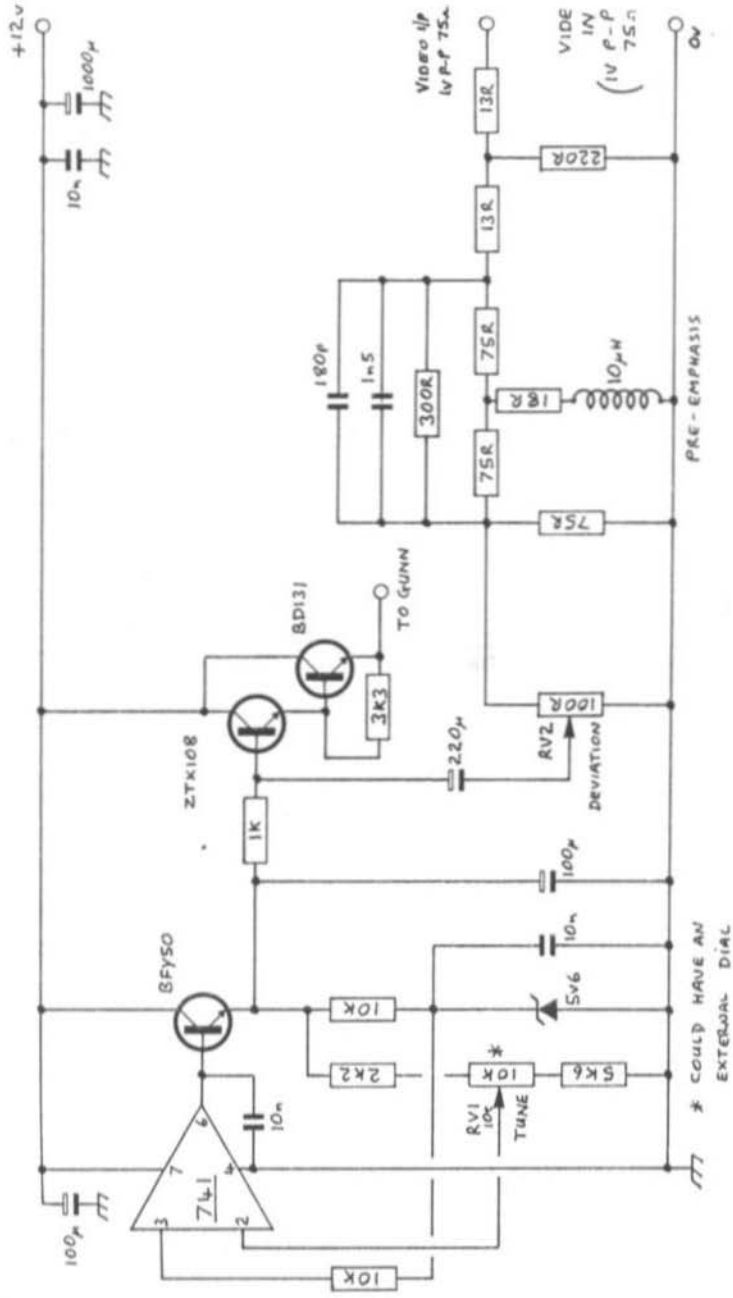


Fig.1 Transmitter Modulator and Gunn Diode supply.

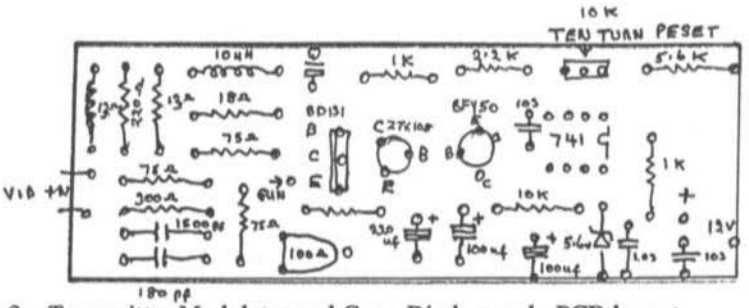


Fig.2 Transmitter Modulator and Gunn Diode supply PCB layout

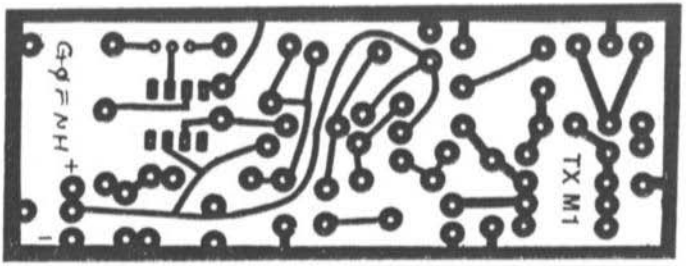


Fig.3 Transmitter Modulator and Gunn Diode supply PCB component overlay

illuminated dish or launching unit. **MICROWAVE RADIATION CAN BE DANGEROUS.**

1.2. Setting up a Gunn Diode Head

The transmit frequency should be set to 10.250GHz, and if an SHF frequency counter is not available this alternative method can be used: Remove any components at the Gunn diode. (Whilst microwave devices of this type are not particularly sensitive to handling, it is advisable to keep any contact with unconnected Gunn diodes to a minimum. Also, the use of isolated soldering equipment is recommended).

If a Solfan head is being used then it is likely that the oscillator will be set to around 11Ghz. Initially undo the brass locknut and screw in the brass screw by 1-turn. DO NOT move the steel screws yet. Fix the head unit firmly to a flat surface and apply about +7.5 volts to the Gunn diode. Connect a multimeter between the mixer diode and ground with the Gunn supply on a current of between 1 and 3mA should be shown on the meter.

Take a flat piece of metal and, keeping it parallel to the mouth of the horn, move it slowly away and watch for a minimum reading on the meter. When this condition occurs mark the position of the plate. Continue moving the plate outwards until another position of minimum current is found and again mark the position of the plate. The distance between the two marks is half the wavelength of the oscillator and from this can be determined the frequency.

The accuracy of this method can be improved by finding several minimum positions and averaging the result. If the frequency is not correct make small adjustments to the BRASS screw until the correct frequency is obtained, turning the screw in reduces the frequency and screwing it out raises it.

The following equation is used to determine

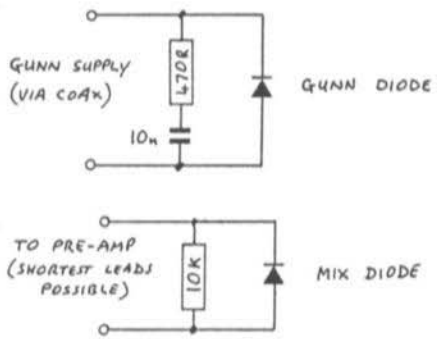


Fig.4 Connections to the Gunn Diodes

the actual frequency from the wavelength measurements:

Frequency = 150/distance mm

If a transmit head unit other than the Solfan type is used, the same method as above can be employed to calculate and thus set the oscillator frequency, but some experimentation with the tuning screws will be required to ascertain the correct procedure.

Finally, fine-tuning of the transmit frequency is obtained by adjusting the 10-turn preset on the modulator PCB.

1.3. Setting up the Modulator

Apply a 1 volt peak-to-peak video signal to the input and, with the aid of an oscilloscope, confirm that approximately 50mV of video is superimposed onto the Gunn diode supply voltage whilst varying the deviation potentiometer. If an oscilloscope is not available, set the potentiometer towards its low end and then adjust as necessary for best pictures on a receive system.

If required an external tuning potentiometer can be used so as to vary the transmit frequency whilst in use. However, I have found, as have most other operators, that it is better to have the transmit frequency fixed and to tune the receiver, as is done on the other bands.

The modulator PCB should be fitted into a small die-cast box, with the Solfan head mounted onto it and a small dish or horn aerial mounted onto the head. Sockets for the video input and DC power supply can then be fitted to the box as required.

2. REFERENCES

1) The British Amateur Television Clu journal CQ-TV, various issues.

2) The Radio Society of Great Britain VHF/UHF Manual 4th Edition.

Bring your index up-to-date !

The index of the preceeding year is always inserted in the middle of the Spring (this) edition of the magazine. It can be easily removed to update a comprehensive index. You will find the index for Volume 22 1990 on pages 31 to 34 of this issue.

Jim Toon, G0FNH

10GHz ATV The Easy Way
Part-2

Continuing along from part-1 in the last issue of VHF Communications I will now describe the receive section of the system.

2.
THE RECEIVER

The circuit diagram of the receiver is shown in Fig.4, with the PCB layout in Fig.5 and the component overlay in Fig.6. Once the PCB has been loaded, checked for short circuits and mis-placed components, the Gunn diode bias supply is checked as explained earlier for the transmit modulator PCB. After confirming that the voltage swing available is correct reset the 10-turn potentiometer to give a bias of approximately 7 volts. The Solfan head should be course adjusted to 10.250GHz as explained earlier for the transmit head unit.

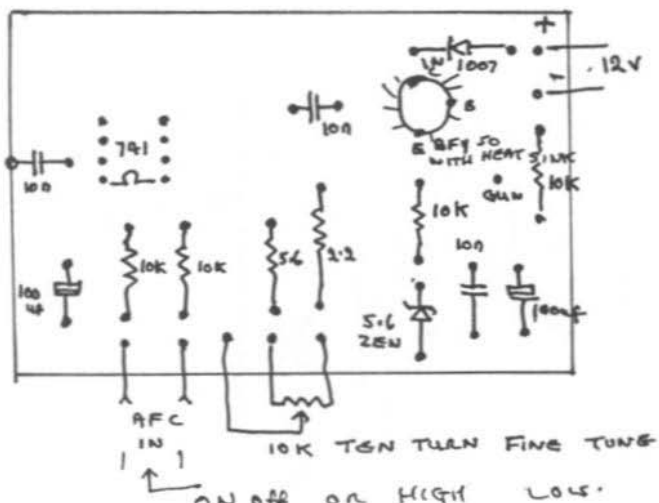
The PCB should again be mounted inside a small die-cast box mounted directly onto the Gunn diode head

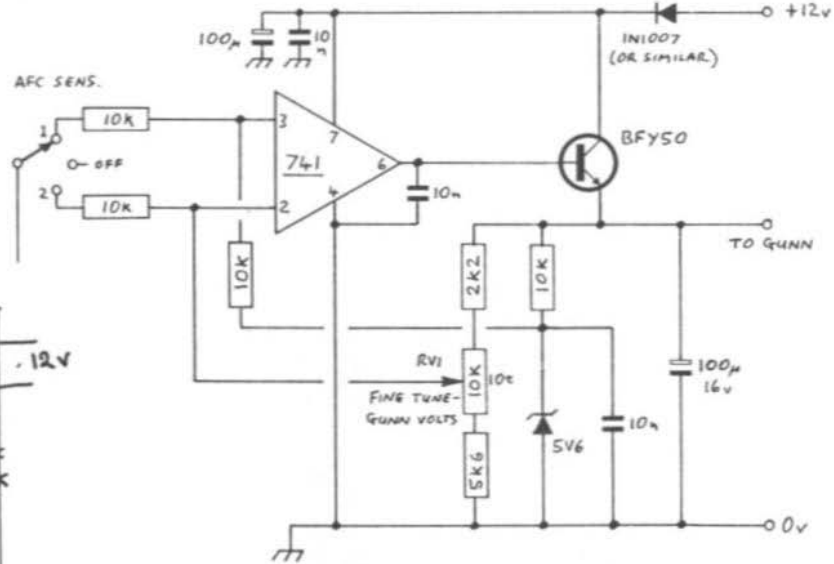
As stated earlier I prefer to use a head unit without an in-line mixer diode. The Gunn diode head (the local oscillator) is mounted onto one port of a cross-coupler, with the opposite port terminated with a small waveguide load. The dish or horn aerial is fitted to one of the ports of the cross-coupled arm and a diode detector fitted to the opposite port.

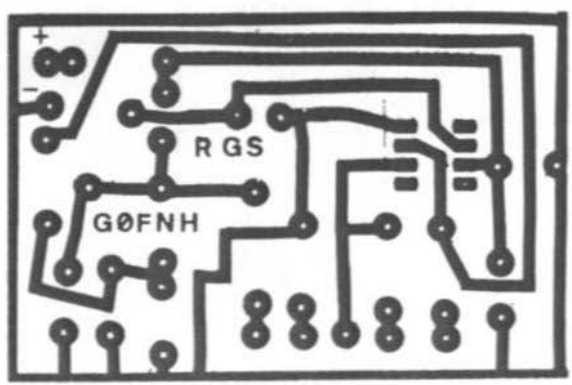
Cross-couplers are not difficult to manufacture and several designs are featured in the RSGB VHF/UHF Manual 4th edition. Alternatively they can often be obtained at rallies for around £2 to £4 each. Similarly, diode-detectors are easily obtained at rallies. Once again do not forget to add the 470-ohm resistor and the 0.01uF capacitor across the Gunn diode, and on the diode-detector add a 10K resistor across the diode (see Fig.11).

2.1 IF Preamplifier

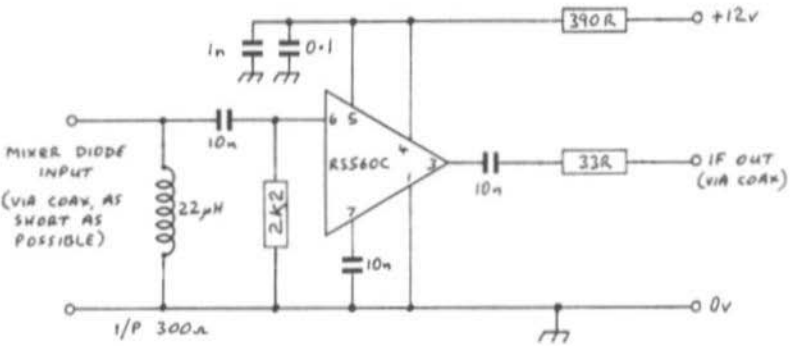
Now we come to the pre-amplifier, the circuit of which is shown in Fig.7, the PCB layout in Fig.8 and the component overlay in Fig.9. This unit must be constructed using double-

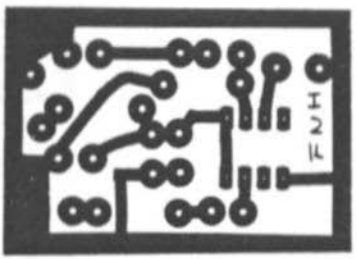


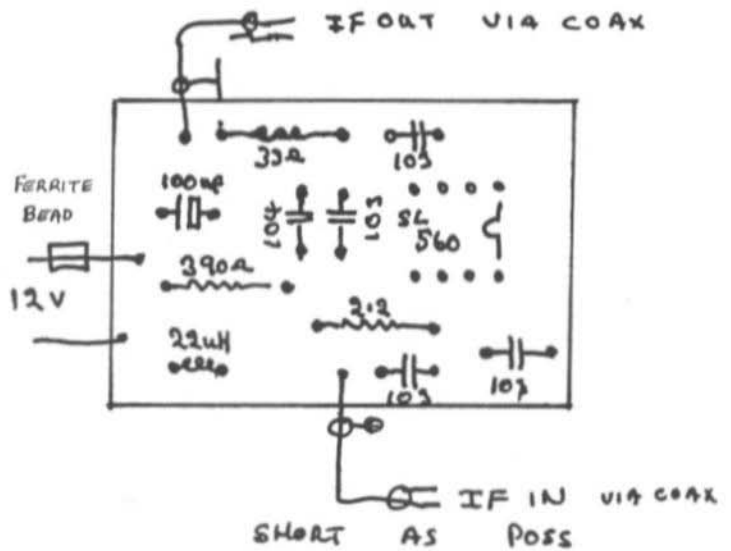




Fig's.4, 5 & 6 Receiver Gunn Diode supply, PCB layout and overlay.







Fig's.7, 8 & 9 Receiver IF Preamplifier, PCB layout and component overlay

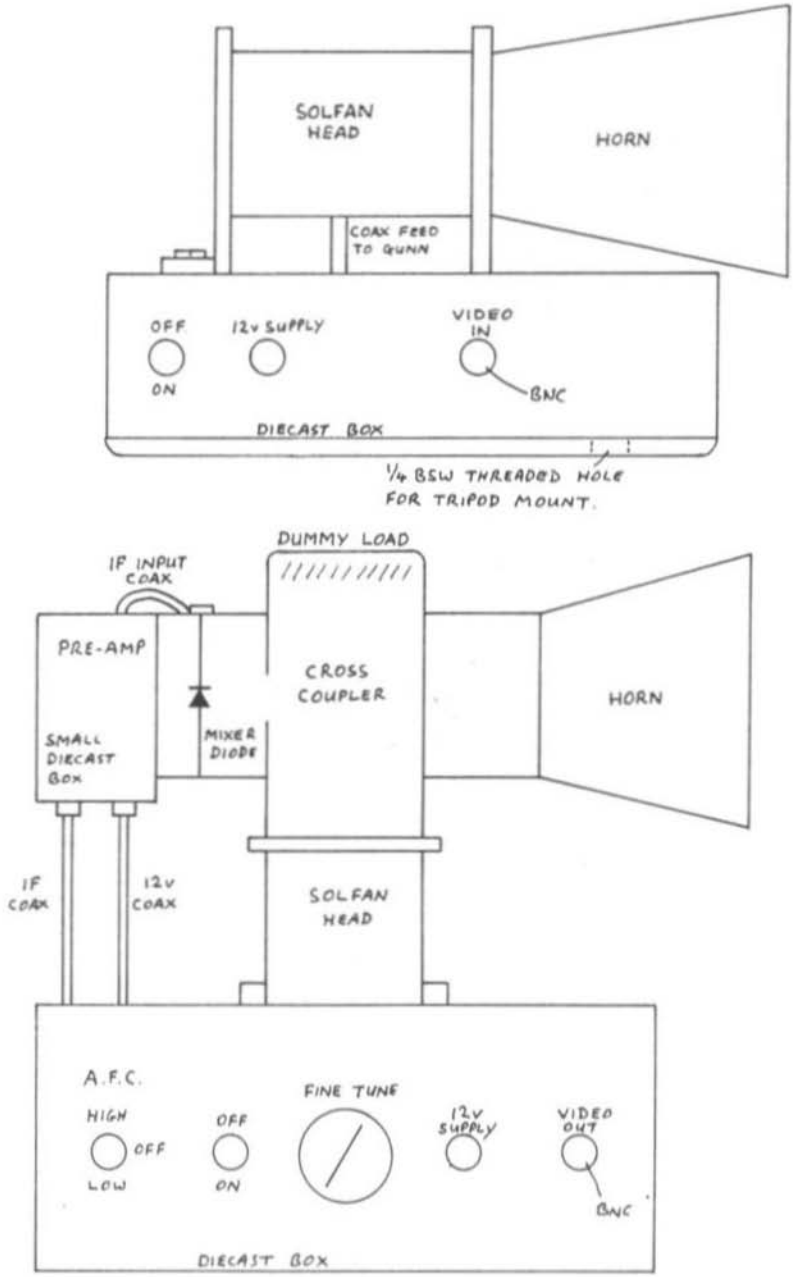


Fig.12 Mounting methods for the various assemblies

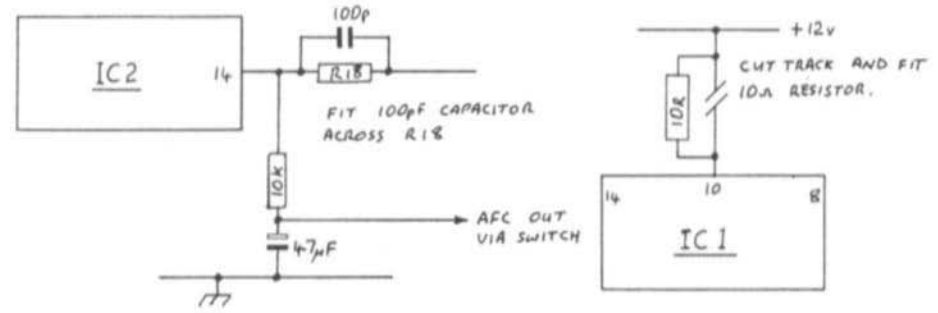


Fig.10 Modifications to the BATC FM-Demodulator

sided PCB material and fitted inside a small die-cast box. The unit should then be mounted as close as possible to the mixer diode in the diode-detector. The IF output from the pre-amp is taken via a coaxial lead to the BATC FM ATV demodulator PCB. The demodulator PCB is built according to the instructions supplied with if from BATC Member's Services, and then modified as shown in Fig.10.

Setting up the receiver is accomplished as follows: after ensuring that the local oscillator head is running at around 10.250GHz switch off the AFC and tune in the best possible picture from the transmitter by adjusting the brass tuning screw on top of the Solfan head.

NOTE: Ensure that the transmitter is some distance away from the receiver otherwise the receiver will be swamped and incorrect tuning may occur. Also, it may be necessary to readjust the video deviation on the transmitter to achieve good results. Once the best possible picture has been tuned in using the brass tuning screws fine tuning is achieved by adjusting the 10-turn potentiometer on the receiver Gunn diode bias supply. Now switch the AFC on and select High or Low as appropriate and that's it! With a little practice you soon get the hang of tuning signals in.

Audio can be added to the system, but this has been covered many times in other 3CM projects, and there are many ideas around showing how this can be accomplished (see CQ-TV 136/137/141 or the BATC ATV Compendium for further information). Fig.12 shows how I mounted the transmit and receive units into their respective die-cast boxes.

That completes this simple, but effective, 10GHz ATV station. Very soon Solfan Heads, cross-couplers, waveguide, plumbing etc will probably be old hat - but I enjoy it! See you on the band.

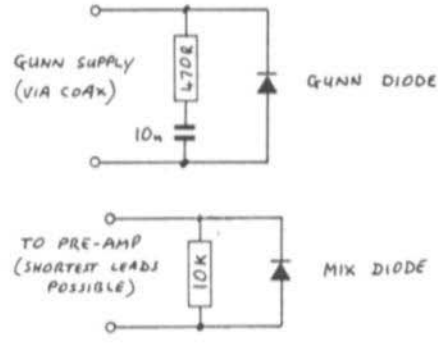


Fig.11 Connections to the Gunn diodes

3. REFERENCES

1) The British Amateur Television Club journal CQ-TV, various issues, the ATV Compendium.

2) The Radio Society of Great Britain VHF/UHF Manual 4th Edition.

Jim Toon, G0FNH

10GHz ATV The Easy Way
Part-3

Following on from my previous articles in VHF Communications 1 and 2/91, "10GHz The Easy Way", I am now going to describe in detail how to manufacture the following:

Waveguide Flanges

The Dummy Load

The Cross Coupler

The Diode Detector

all of which are used in the main unit. The only tools I was *ALLOWED* to use by Editor Mike, were a file, a hacksaw and a drill and bits.

All of the materials used, excepting the waveguide and the detector diode are obtainable from your local hobby shop and DIY store.

1. WAVEGUIDE FLANGES

Brass waveguide flanges are very easy to make, all that is required is some 1/8 to 3/16" brass plate. With reference to Fig.1, carefully mark out the plate with a scribe and square. Drill the bolt holes for 3BA size bolts and then drill a series of small holes on the inside of the lines marking out the middle hole. Place the brass plate on a very firm surface, an anvil or steel plate for example, and with a sharp chisel, carefully cut through the holes and punch out the middle rectangle of brass. File the hole until all the angles are square, and then continue filing until the flange is a tight fit over the end of the waveguide. When satisfied with the fit solder in place **ON THE OUTSIDE ONLY.**

NOTE: The type of solder I use and recommend is **LEAD-FREE,** which can be obtained from your local DIY store or from a

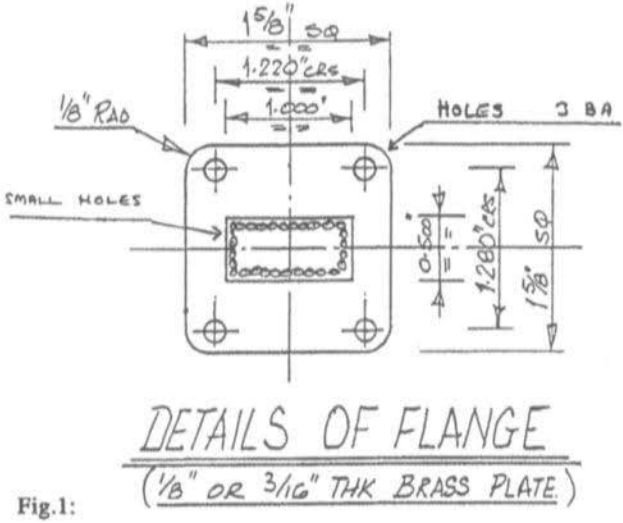


Fig.1:

friendly plumber. Remember, microwaves adore Lead, they will do anything to disappear into Lead and not come out again. Second only to open waveguide or LDM material (Lossy Dielectric Material - see next section), Lead is probably the most lossy substance you can use. Ensure that any solder containing lead is carefully scraped out from the inside surfaces of the waveguide.

2. DUMMY LOAD

Referring to Fig.2, you will require a 2'' section of waveguide with the ends nice and square, a flange and a small brass plate measuring 1'' x 1/2'' x 1/16''. Solder the flange on one end and seal the other end by soldering on the brass plate.

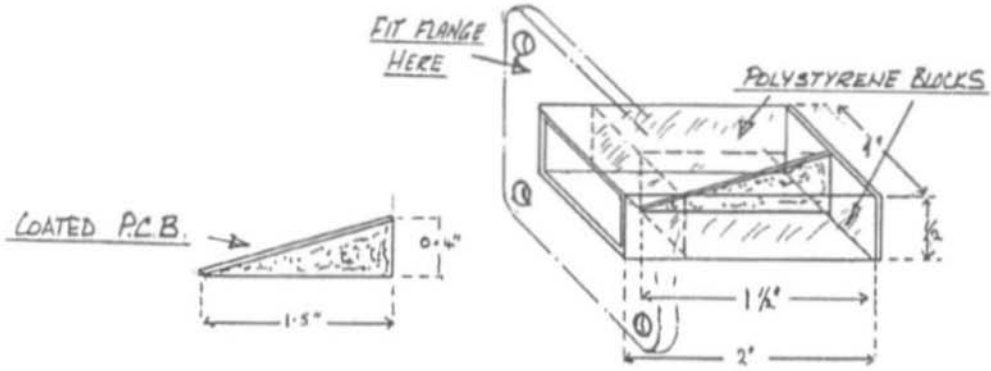
You will need to obtain some Graphite powder (approximately 70p per box) and ready-mixed wallpaper glue (**DO NOT** use the resin or solvent type, they will not work - only water-based paste) from your local DIY store. The wallpaper paste can be purchased in small handy-sized tubs.

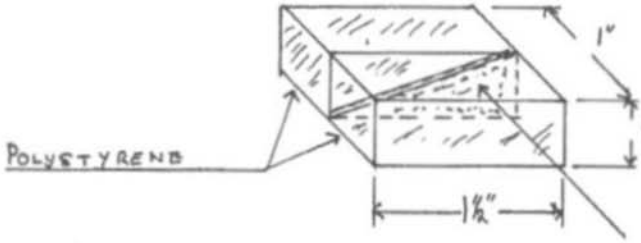
Now to make your own Lossy Dielectric Material. Prepare a small piece of PCB (at least 2'' x 1'') and remove the copper surface. Mix together a small amount of the wallpaper paste and graphite powder to form a thick paste.

Cut the PCB to the size shown in Fig.2 and then apply a thick coat (1/16'') to both sides and all edges of the piece of PCB and make it as smooth as possible. Put in a warm place (the airing cupboard above the home-brew will do, but keep it clear of the washing!) for 24 hours until dry, then smooth it up with sand-paper to remove any irregularities (what a big word!). Cut some expanded polystyrene to the sizes shown in Fig.2.

NOTE: Expanded polystyrene is transparent to microwaves. A useful tip is to fill the end of your Solfan (or whatever) heads with it - it will keep the warmth generated by the Gunn diode in and the cold, damp air out.

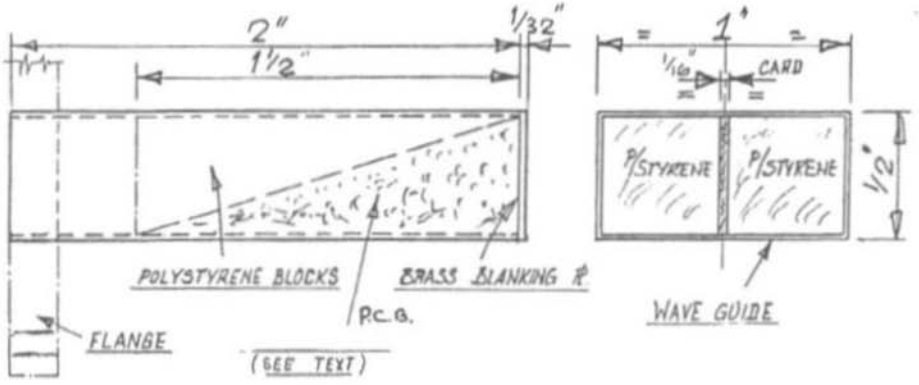
Sandwich the PCB coated PCB board between the two pieces of polystyrene and push the whole assembly into the piece of waveguide, making sure that it is a tight fit, and that it is the correct way round, as shown in Fig.2, and that's it.





POLYSTYRENE BIGGER SO AS TO SQUEEZE INTO THE WAVE GUIDE TIGHTLY.

P.C.B SANDWICHED BETWEEN POLYSTYRENE BLOCKS



2:1

DETAIL OF DUMMY LOAD

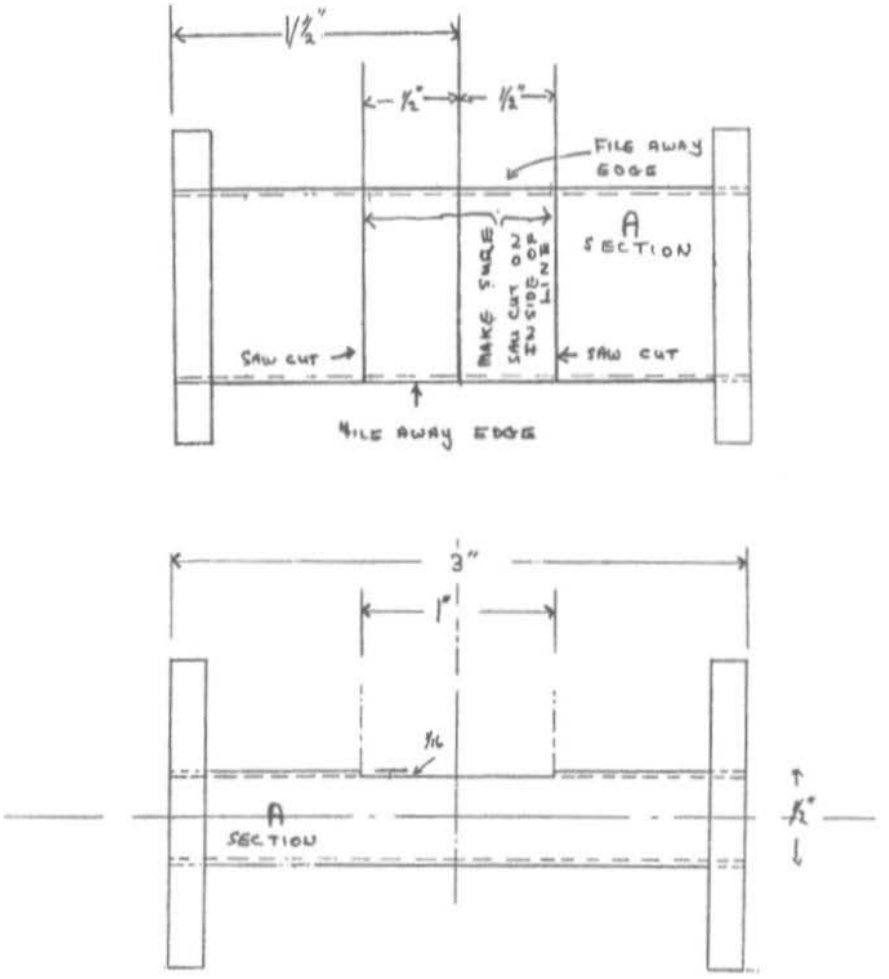

1 1/2"
1/2"
1/2"
FILE AWAY EDGE
A
SECTION
MAKE SURE SAW CUT ON INSIDE OF LINE
SAW CUT
SAW CUT
FILE AWAY EDGE
3"
1"
1/16
A
SECTION
1/2"

Fig.3a

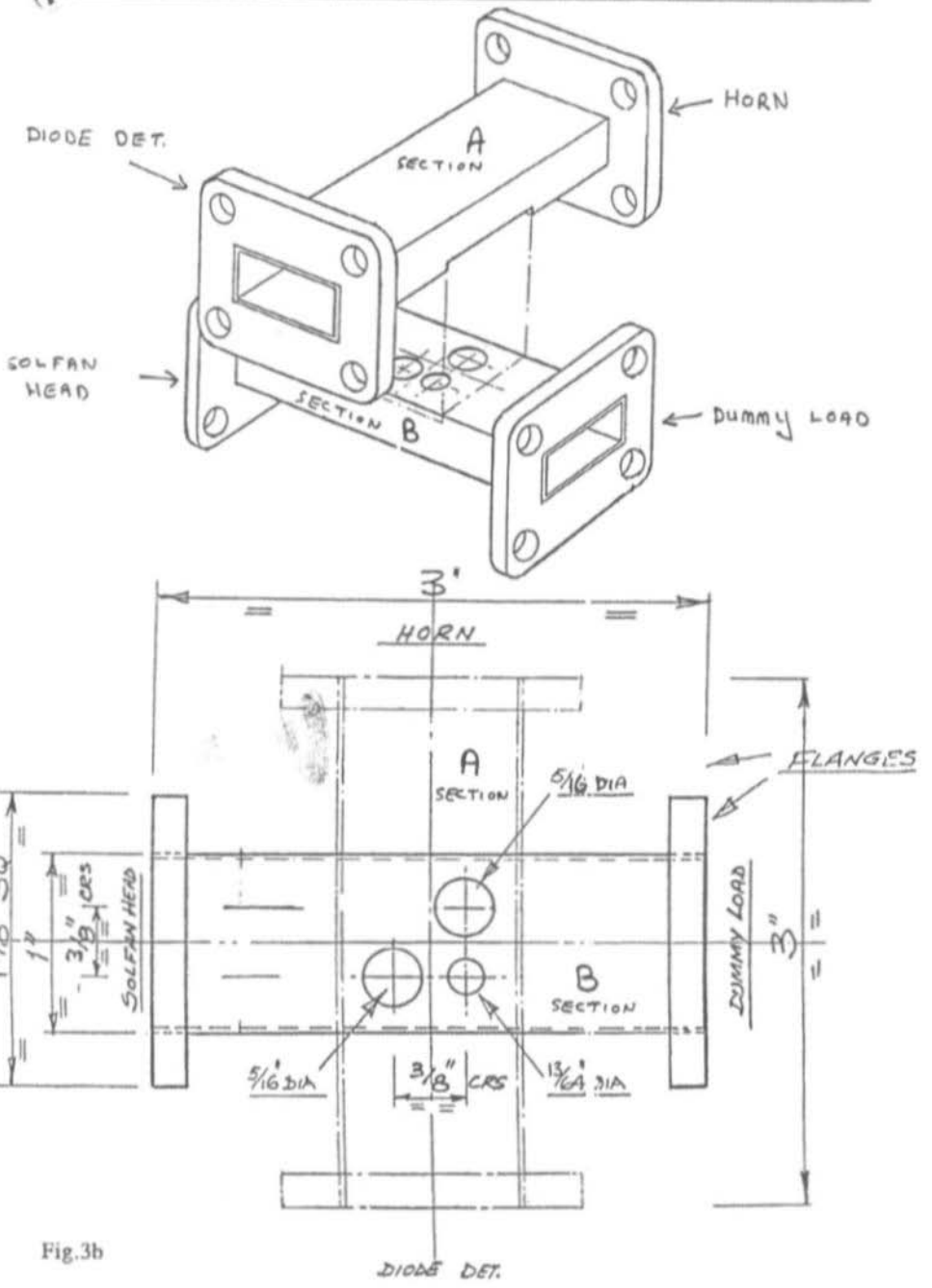

DIODE DET.
HORN
A
SECTION
SOLFAN
HEAD
SECTION B
DUMMY LOAD
3"
HORN
A
SECTION
5/16 DIA
FLANGES
1 7/8" SQ
1"
3/8" CRS
SOLFAN HEAD
B
SECTION
DUMMY LOAD
3"
5/16 DIA
3/8" CRS
13/64" DIA
DIODE DET.

Fig.3b

3.
THE CROSS COUPLER

The details of this unit are shown in Fig's.3a and b. For this unit you will need two pieces of waveguide, each 3'' long, and four flanges. Make sure that the end faces of the waveguide are nice and square. Study the drawings in Fig.3a and b carefully, do not be put off by the apparent complexity, you will find that it is really very simple. Take your time and mark out everything carefully, take care with the construction and the results will be excellent.

We will start with section-A. Mark off the middle point of the piece of waveguide (across the broad side) and then mark off 1/2'' on either side of the centre line. Mark down the sides of the waveguide 1/16'' and then scribe along. With a fine hacksaw carefully and slowly cut across the waveguide on the centre line side of the scribed lines until you just break through the waveguide.

Then, with a small fine file, file along the edge of of the waveguide (but not below the 1/16'' line) until a fine crack appears. Do this on both sides. With a small screwdriver at the corner, lift up the middle section, remove and discard. File the slot section carefully until the other piece of waveguide will fit across the slot with a nice tight fit and **FLUSH** on the inside.

Now to section-B. As with section-A, mark off the centre line on the broad side of the waveguide and then **VERY** carefully mark of the centres of the three holes at the positions shown in Fig.3b. Centre-punch the holes carefully and gently (we don't want to tune the waveguide!). Drill the holes with a 1/8'' pilot hole first and then the 13/64'' hole, and finally the two 5/16'' holes. Clean out any burrs inside and out.

Fit the two sections of waveguide together, again ensuring that the inside surfaces are flush. When satisfied solder the two pieces together on the outside. Solder on the four flanges and clean out all solder from the inside surfaces, and that's it.

4.
DIODE DETECTOR

The details of this, the most complicated unit, are shown in Fig's.4a and b. To fabricate it you will need a type CV2154 coaxial diode, these are available at most rallies or from J.Birkett, Lincoln (0522 520767).

Also required are: 1 flange, a piece of waveguide 1.5'' long, a brass plate 1'' x 1/2'', a short length of 3/8'' outside diameter brass tube and a short length of 13/32'' outside diameter brass tube (the brass tube is readily available from model/hobby shops, as is the brass plate). The larger size of tube will just slide over the smaller size, and also the coaxial diode will just fit into the smaller tube.

A small length of 3/32'' brass rod (non-fluxed brazing rod is just right) and a 75 ohm BNC socket (MUST be 75 ohm) will also be required.

Starting with the BNC socket, cut around the small burr at the end as shown in Fig.4a with a small hacksaw, not too deep as the PTFE bush inside will be required later. Carefully push out the centre pin and the two PTFE spacers. Discard the case.

Take the piece of waveguide and square up the end faces. Scribe a line 3/8'' from one end across the broad side and also down the two narrow sides. Mark off the centres of the faces on the lines just scribed (i.e. 1/2'' for the

broad side and 1/4'' for the narrow side). Carefully and gently centre punch the centre points and drill a 1/8'' pilot hole in each. Drill the holes in the narrow sides out to 3/16'' and the single hole on the broad face out to 3/8''.

Clean out any burrs and then solder the flange on the **OPPOSITE** end to the end with the holes. Clean out any solder from the inside of the waveguide.

Prepare a 5/8'' long piece of the 3/8'' OD brass tube and solder it into the 3/8'' hole in the broad side of the waveguide, ensuring that it is flush on the inside face. Prepare a 3/8'' long piece of 3/8'' OD brass tube and solder it centrally over one of the 3/16'' holes in one of the narrow sides.

Prepare the two **PTFE** bushes as shown in Fig.4b and fit one into both of the 3/16'' holes in the narrow sides of the waveguide (one of the bushes from the BNC socket should fit as is - if you have another spare BNC socket you will not need to manufacture the second bush from the spare block of **PTFE**, but just use the one that already fits from the second socket).

Cut a small round disc from a piece of singled-sided copper-clad board, and solder it into the piece of 3/8'' tube soldered to the **NARROW** side of the waveguide. Solder it flush with the top of the brass tube.

Now cut the 3/32'' brass rod to length (one inch and three eighths). Mark off 5/8'' from one end and centre punch. Drill a hole through the brass rod to the size of the centre pin from

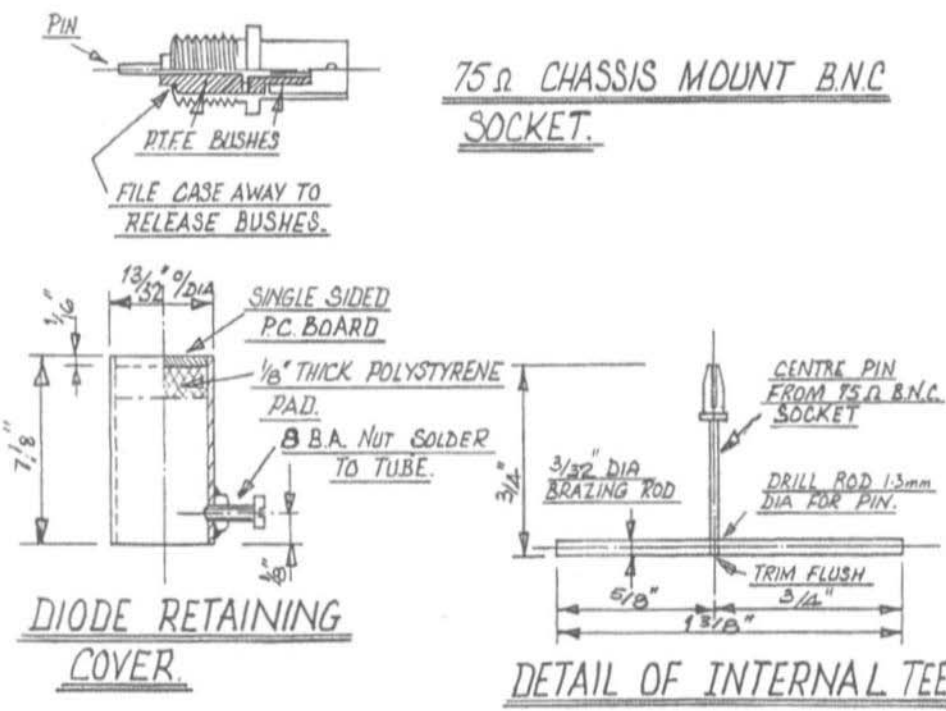
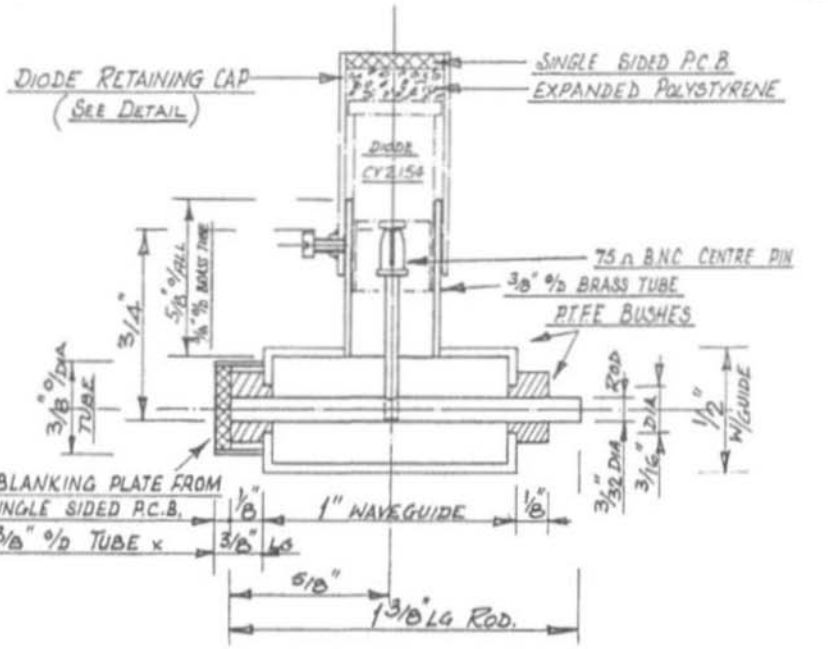
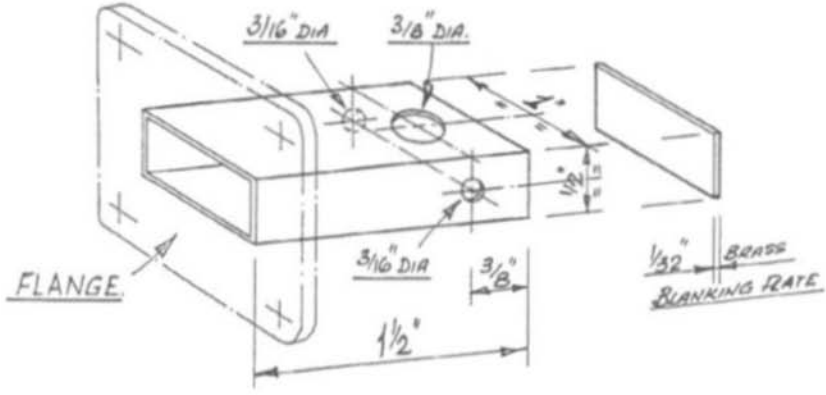


Fig.4a: The Diode Detector



SECTION THROUGH SHOWING ASSEMBLY.



DETAIL OF DIODE DETECTOR BODY.

Fig.4b The Diode Detector

the BNC socket (a PCB size drill is the correct size). Fit the brass rod into the waveguide as shown in Fig.4b, pushing the rod through the holes in both PTFE blocks so that it is firmly in place.

Temporarily assemble the pin and the diode into the brass tube allowing the pin to pass through the hole in the brass rod (handle the diode with care -static charges may have a harmful effect - use a dud one if available). When the diode is fully home in the brass tube cut off the excess pin projecting through the brass rod.

Remove the diode and the pin, ensure that the hole in the brass rod is central with the brass tube, re-insert the pin and solder in place. Clean away as much solder from around the pin as possible. Now solder the end plate onto the waveguide being careful not to get any solder on the inside, as it will now be extremely difficult to remove - this is really a must for using lead-free solder as it will not matter.

All that is left to do now is is to make the top cover for the diode holder as per Fig.4a. Fabricate the cover from a 7/8'' long piece of the 13/32'' OD brass tube and solder an end cap on one end using a piece of copper-clad PCB or brass plate. Drill an 8BA clearance hole 1/8'' from the other end of the piece of tube. Solder an 8BA nut to the outside of the tube over the hole and fit an 8BA screw into the nut.

Fit the diode into the holder ensuring that it ''clicks'' into place on the pin. Place the retaining cover over the diode and tighten in place.

I suggest that you make a small box from brass plate to house the preamp (page-62 CQ-TV 152). Drill a hole through the bottom plate of the box to enable it to fit over the PTFE bush and the brass rod extending from the side of the detector unit. Solder or glue the box in position and connect the preamplifier input to the end of the brass rod. The IF output and DC power connections to the preamplifier should be made using coaxial cable.

NOTE: Don't forget the 10k resistor to be soldered from the diode connection at the input of the preamp to earth - strange video effects may occur otherwise!

I spray my units with matt black paint after first covering the flanges with tape to protect the inside surfaces. If you take care in building these units the end results will be very good.

I would like to thank Ted G4GLY for his help in the preparation of the drawings and the RSGB for the information gleaned from the VHF/UHF Manual. I hope that you have as much fun playing with microwaves as I do.

In the next instalment I shall describe how to manufacture a large horn antenna and a 10GHz Dipole antenna.

5. REFERENCES

1) The British Amateur Television Club journal CQ-TV, various issues.

2) Mike Wooding G6IQM, the British Amateur Television Club, The ATV Compendium.

2) The Radio Society of Great Britain VHF/UHF Manual 4th Edition.